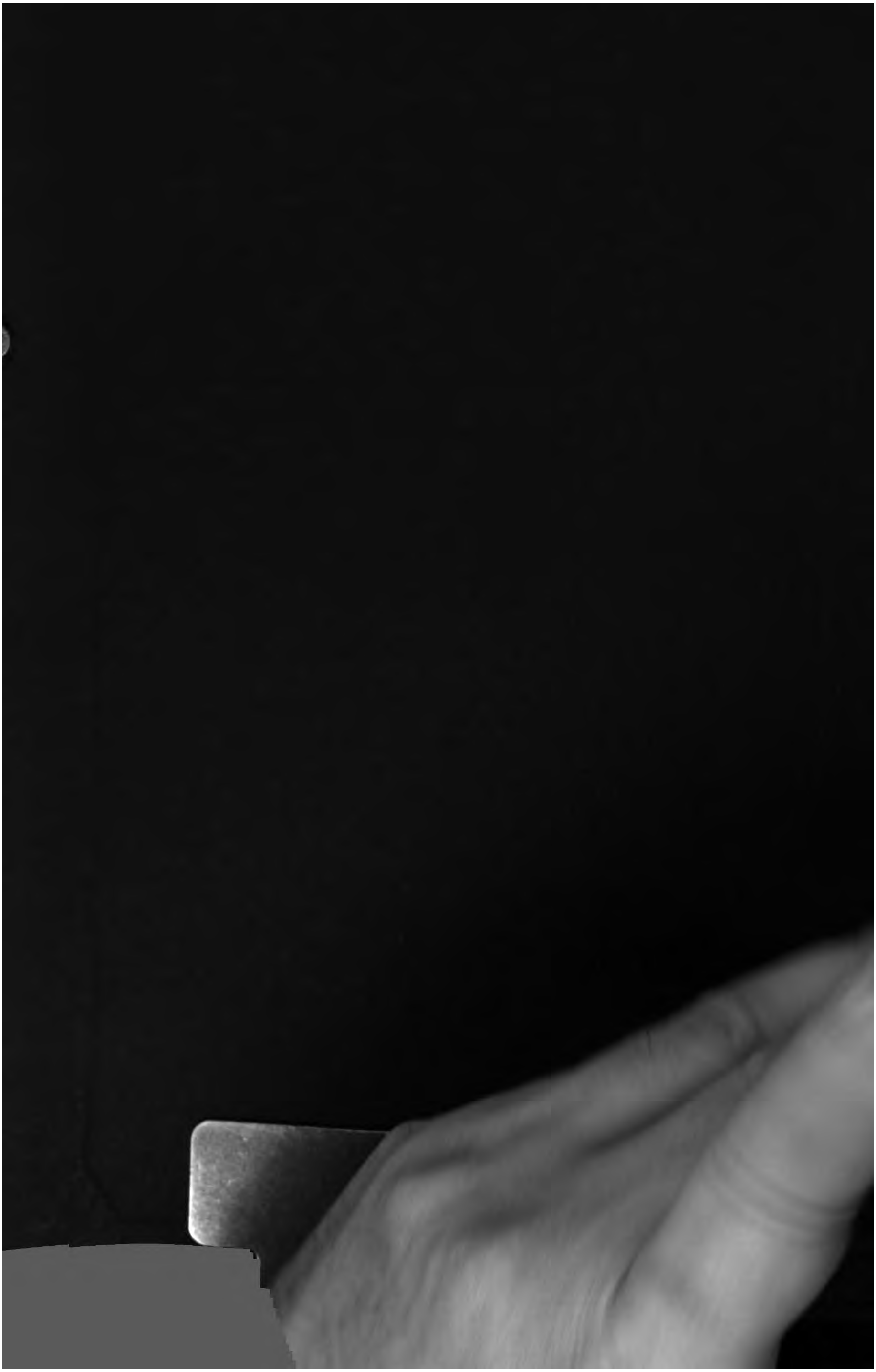

OBSTETRIC MEDICINE AND SURGERY

VOL. I.

OBSTETRIC MEDICINE AND SURGERY

VOL. I.

A SYSTEM

OF

OBSTETRIC MEDICINE AND SURGERY

THEORETICAL AND CLINICAL

FOR THE STUDENT AND PRACTITIONER

BY

ROBERT BARNES, M.D.

OBSTETRIC PHYSICIAN TO ST. GEORGE'S HOSPITAL : CONSULTING PHYSICIAN
TO THE CHELSEA HOSPITAL FOR WOMEN : ETC.

AND

FANCOURT BARNES, M.D.

PHYSICIAN TO THE ROYAL MATERNITY CHARITY AND TO THE BRITISH LYING-IN HOSPITAL
ASSISTANT OBSTETRIC PHYSICIAN TO THE GREAT NORTHERN HOSPITAL
PHYSICIAN TO THE CHELSEA HOSPITAL FOR WOMEN

VOL. I.

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PREFACE.

To write a fairly complete systematic treatise on any branch of medicine demands from the writer a very wide experience of his own, a large acquaintance with the work of others, considerable industry, and a critical faculty that will enable him to draw sound conclusions and precepts from his survey of the subject.

A sense of the difficulty of the task demanding such qualifications has long deterred the senior author of this book from publishing a treatise on Obstetrics. He has, indeed, travelled, in practice, teaching, discussion, and writing, over almost every step of the ground. A very considerable part of the field is covered in the 'Obstetric Operations,' a work which has probably exercised a greater influence than any other over practice in difficult midwifery. And this work—so rapid are the advances in the art—now requires revision. Moreover, when any one part of obstetrics is detached from the rest, it is necessarily maimed. To rightly comprehend the science, and to fully grasp the principles of its practice, all the several parts must be studied in their correlation and solidarity.

Another reason has had weight in stimulating the production of this work. It is a matter of observation that original work scattered in monographs often brings less credit to the authors than it does to those who possess the gift of assimilating it, and of reproducing it in the more attractive and convenient form of a 'system.' In these days, the student and practitioner are often too busy, if not too indolent, to indulge in research. This book, then, affords us opportunity of revindicating not a few claims to priority which have been attributed to more or less unconscious borrowers.

Still, impelled as we were by the conviction that the time had come when we ought to give effect to a long-cherished design to write a systematic treatise on Obstetrics, that design would in all probability never have been carried into execution but for the fortunate association of father and son, of teacher and pupil, in the task.

The share which each of the fellow-workmen has had in the structure will be in many cases indicated by individual references. It may be stated generally that the history of gestation, of puerpery, of the mechanism of labour and of hæmorrhage, is chiefly contributed by Robert Barnes, whilst much of that which relates to the prophylaxis of puerperal diseases, and the description of the operations, is contributed by Fancourt Barnes. Still, the work is essentially a joint production; neither could have done it alone; and still we have found it necessary to call in further assistance.

The systematic writer on Obstetrics naturally begins *ab ovo*, and thus we were met by a difficulty at the very threshold. No man can hope to master the facts and science of Embryology unless he spend several hours a day in the physiological laboratory. Such steady devotion of time and thought cannot be spared by those who are involved in the toils of obstetric practice. We, therefore, at once confess our inability to treat this subject in such a way as to give an adequate picture of it, capable of throwing full light upon the outflowing physiological and pathological problems. Not to waste precious time wanted to do justice to those topics which lay within our capacity, and not willing to descend to the drudgery of compilation, we sought the assistance of a master of the subject. Future authors will certainly follow our example. Our readers will thank us for having enlisted the services of Professor Milnes Marshall for this department.

We may here appropriately introduce some general remarks from him bearing directly upon our text:—

'It is usual,' he says, 'in works on Obstetrics to omit all reference to the earliest known stages of embryology, but we preferred a different course. No one will dispute that a proper knowledge of the early phases of human development is very important, yet if this study continue to be systematically ignored by those who alone have opportunities of extending our knowledge in this direction, what hope can there be of our completing it? The requisite specimens are difficult to obtain; they only turn up on rare occasions. This difficulty renders it more incumbent upon every one to whom the opportunities are likely to fall to be fully alive to the importance of making the most of them. The actual number of specimens less than a fortnight old that have been described with any degree of accuracy is surprisingly small. There can be little doubt that opportunities are frequently missed, and valuable specimens lost, simply through failure to appreciate their true value, and insufficient care in examining and preserving objects of great delicacy.'

To this argument, in itself unanswerable, we may add that in this elemental study we may now and then catch a luminous glimpse, if not a full explanation, of many things that come before us in clinical practice, which will not only throw around our work the enchantment of scientific research, but which may one day develop into the fulness of knowledge.

The study of the so-called malformations and diseases of the embryo is one of the most obvious illustrations of this argument. The only hope of understanding these and the cognate deviations from the standard structural development of father and mother, and other racial problems, must rest on the profound study of embryology. Again, with this view of placing the leading points of what we know in teratology, with especial reference to classification and clinical practice, we have sought the aid of Mr. Noble Smith, who has done so much to place Orthopædic Surgery on a sound and scientific basis.

The immediate purpose of the work is, in the words of the title-page, to serve as a handbook of Obstetric Medicine and Surgery for the use of the student and practitioner. We trust that the work will at least justify its title. But we indulge a hope beyond this. Just as it is impossible to attain to the right appreciation of any particular department of obstetrics if taken up by itself, neglecting the study of its mutual relations to the science as a whole, so it must be impossible to attain to the right appreciation of many of the great problems in general medicine and surgery if the increasing and reverberating light which the careful study of obstetrics can throw upon them be shut out. Obviously the converse is equally true. This means that obstetrics is not a specialty. It is an integral constituent of the great art of healing. He only deserves to be set down as a specialist who narrows his field of vision by the limits within which the prejudices transmitted by ignorance and arbitrary custom would bind him. The real specialist, in short, is he who, specially directing his attention to one factor of a medical problem, specially neglects to take note of the correlated factors. Tried by this test, the physician or surgeon who undertakes to treat a case of apparent nervous disease in a woman, neglecting all the while to ascertain the condition of the dominating organs in the pelvis, is a specialist. So, on the other hand, that gynæcologist is a specialist who, dealing with a real or apparent disease in the pelvis, neglects the aid which an enlarged study of general pathology might reflect upon the immediate problem before him. And since diagnostic and therapeutical skill are inseparable, so is he a hopeless specialist who consents to conduct a case a part of the way only, calling in a special surgeon to complete the treatment. To make a particular application of the old maxim, 'Curatio ostendit morbum,' it may be said that the surgical operation which crowns the treatment is often the most instructive element in the case. To abandon this source of knowledge is to contract at once the means of cultivating pathological knowledge, diagnostic power, and therapeutical skill. The obstetrist is, of necessity, a surgeon as well as a physician.

The scheme of the work is fairly set out for the first volume in the analytical index attached to it; and the whole scheme is sketched in the 'Synoptical Guide to the Study of Obstetrics,' by Robert Barnes. The leading idea has been to pursue a natural order, based on the sequence or evolution of the processes of gestation, parturition, and puerpery. To fully realise this idea is a difficulty which everyone who has tried to write a systematic work on any subject will readily acknowledge. It is impossible to adhere rigidly to any plan without repetition and overlapping, or without in some instances breaking up a subject which would be better understood if studied in its entirety. And, again, it is often impossible to fairly present the special topic under discussion without introducing episodical illustrations drawn from topics not strictly connected. For example, hæmorrhage occurs during gestation, labour, and childbed. Although certain characteristic differences mark the hæmorrhages in each of these periods, these differences are better seized when described in direct contrast. The fundamental laws which govern all hæmorrhages will thus stand out in more instructive prominence. Yet obedience to this order imposes this dilemma: either to omit from the history of gestation more than a provisional indication of the hæmorrhages which occur during that period, or to introduce in its seemingly natural place a full account of these hæmorrhages, and then to repeat that account when tracing the connected history of hæmorrhage.

Many new illustrations will be found. We have been careful to give the source whence the borrowed ones are taken, and have appended our names to those drawn by ourselves.

The first volume brings the subject-matter down to the end of gestation. The second volume will contain the history of labour; the mechanism of labour; the accidents of labour, including ruptures and hæmorrhage; the physiology of the new-born infant and its management; puerpery; the accidents of puerpery; the description of the diseases to which the puerpera is liable; lactation; and the description of the operations.

As to the manner in which we have acquitted ourselves of an arduous task it is not for us to say more than that we have striven to do conscientiously what we have undertaken. The reader in search of instruction, and the critic in search of matter for praise or censure, will determine for themselves what measure of success has been achieved.

ROBERT BARNES.
15 *Harley Street, W.*

FANCOURT BARNES.
7 *Queen Anne Street, W.*

January, 1884.

CONTENTS

OF

THE FIRST VOLUME.

CHAPTER I.

THE OVUM.

CHAPTER II.

THE FEMALE GENERATIVE ORGANS.

CHAPTER III.

IMPREGNATION AND CONCEPTION.

CHAPTER IV.

DEVELOPMENT OF THE HUMAN EMBRYO AND FŒTUS.

CHAPTER V.

THE PLACENTA. PHYSIOLOGY OF THE FŒTUS.

CHAPTER VI.

ANATOMY OF THE GENERATIVE ORGANS.

CHAPTER VII.

THE PROCESSES OF GESTATION, CHILDBED, AND LACTATION.

CHAPTER VIII.

THE SIGNS AND DIAGNOSIS OF GESTATION—PATHOLOGICAL STATES WHICH SIMULATE GESTATION—THE DURATION OF GESTATION—CARE OF GRAVIDA.

CHAPTER IX.

ABNORMAL GESTATION.

CHAPTER X.

DISPLACEMENTS OF THE GRAVID UTERUS.

CHAPTER XI.

THE DISEASES OF GESTATION.

CHAPTER XII.

ABORTION.

CHAPTER XIII.

DISEASES OF THE EMBRYO.

CHAPTER XIV.

DISEASES OF THE PLACENTA.

LIST OF ILLUSTRATIONS.

CHAPTER I.

THE OVUM.

THE PRÆGRAVID STATE.—PRIMITIVE OVA.—THE PERMANENT OVA.—THE GRAAFIAN FOLLICLE.—THE RIPE OVARIAN OVUM.—CORPUS LUTEUM.—DEVELOPMENT OF THE OVUM.—OVULATION.

MAN, like the vast majority of animals, is developed from an egg or *ovum*. This ovum, formed within the ovary of the female parent, is at a very early period set free from the ovary, and passing along the oviduct reaches and becomes lodged in the uterus; within which it remains for a period of about nine months, undergoing the complicated series of changes by which the ovum is converted into the embryo, and the embryo gradually built up and fashioned into the human form.

The present chapter is concerned with the earliest of this important series of events—the mode of formation of the ovum and the changes which it undergoes up to the time of leaving the ovary; together with which it will be convenient to consider certain other processes which accompany or are closely connected with the maturation of the ova.

In order to gain a satisfactory knowledge of the development of the human ovum it is by no means sufficient to examine the ovary of an adult woman or even of a child, for almost all the earlier stages of this development are already accomplished long before birth, and although in a female child the formation of ova does go on after birth, yet it only does so for a very short time and to a very limited extent. Indeed, it would appear from the researches of Bischoff, Waldeyer, Foulis, and others, that the formation of new ova ceases about the age of two years; in other words, that the ovaries of a female child already contain, at the end of the second year, all the ova that will ever be developed in them.

For this reason it is necessary to commence, not with the ovary of a woman or child, but with that of the embryo at a very early period of its existence.

The ovaries appear in the human embryo at about the fifth week as a pair of longitudinal ridges lying one on either side of the mid-dorsal line of the abdominal wall, and close to the inner sides of the Wolffian bodies or primitive kidneys. Each

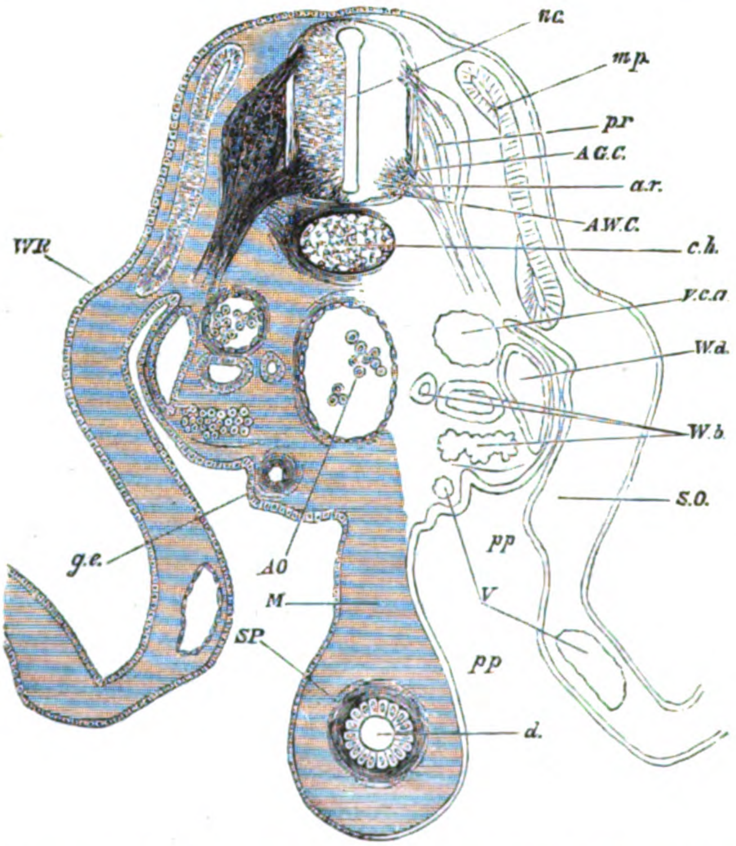


Fig. 1.—Transverse section through the lumbar region of an Embryo Chick at the end of the fourth day. (From Balfour.)

A.G.C. Anterior grey column of spinal cord. *AO.* Dorsal aorta. *a.r.* Anterior root of spinal nerve. *A.W.C.* Anterior white column of spinal cord. *c.h.* Notochord. *d.* Alimentary canal. *g.e.* Germinal epithelium covering genital ridge. *M.* Commencing mesentery. *m.p.* Muscle plate. *n.c.* Neural canal. *pp.* Pleuroperitoneal cavity. *p.r.* Posterior root of spinal nerve with ganglion. *S.O.* Somatopleure. *SP.* Splanchnopleure. *V.* Blood-vessels. *V.c.a.* Posterior cardinal vein. *W.b.* Wolffian body. *W.d.* Wolffian duct. *W.R.* Wolffian ridge.

ridge is formed by a slight local thickening of the epithelial layer which lines the peritoneal or body cavity, supported by a low ridge of connective tissue. The relations of these primitive ovaries or genital ridges, as they may be called, are shown in fig. 1, which represents the corresponding stage in the development of the chick.

The epithelium covering the ridge, which we shall henceforth speak of as the *germinal epithelium*, fig. 1, *g e*, is directly continuous with the peritoneal epithelium lining the body-cavity, of which it is indeed a part. It is at first perfectly similar to the rest, but at an early age becomes distinguished from it by its component cells acquiring a columnar shape, and so creating the prominence we have called the genital ridge. This primitive continuity between the germinal epithelium, which we shall find gives rise directly to the ova, and the peritoneal epithelium lining the body-cavity, is well shown in fig. 1.

As the embryo grows older the genital ridges gradually become pinched off from the abdominal wall, and acquire the definite shape and character of ovaries; the *hilum*, or groove by which the vessels and nerves enter, marking in each the part where the attachment persists longest. Each ovary consists of an external investment of epithelium—the *germinal epithelium*—and a central core of connective tissue, containing numerous blood-vessels derived from the dorsal wall of the abdomen and entering at the *hilum*. As we have already stated, and as is shown in fig. 1, the genital ridges are at first situated very close indeed to the primitive kidneys or Wolffian bodies, and during the early stages of development the connection between the two structures is made still closer by means of a number of rod-like outgrowths from the Malpighian bodies of the kidneys which later on become hollow, and form the so-called 'tubuliferous tissue' of the ovary. This tubuliferous tissue lies at first immediately beneath the germinal epithelium, but soon becomes separated from it by a layer of connective tissue, and so becomes confined to the central portion of the ovary: it has nothing whatever to do with the ova, and merely requires mention here on account of its great prominence, especially during the earliest stages of development.

Of the two other elements composing the ovary—viz. the germinal epithelium and the connective tissue core or stroma—the former is the more important, as from it the ova are directly developed, the connective tissue serving mainly to divide the several groups of ova from one another, and to support the blood-vessels which carry nutrient matter to the different parts of the ovary, and remove from them the effete products resulting from their growth and activity. It is therefore with the germinal epithelium that we have mainly to deal.

In its earliest stages this germinal epithelium consists of a single layer of columnar epithelial cells with large nuclei, the cells measuring on an average about 0·014 mm. in length by 0·007 mm. wide. By repeated division of its component cells the epithelium increases rapidly in thickness, and soon forms a layer several cells thick, whereof the most superficial ones still preserve their columnar form, while the deeper ones are mostly of an oval shape.

Whilst the epithelial cells are thus rapidly multiplying, the connective tissue stroma is also undergoing active changes: it gives off processes which grow in between the cells of the deeper layers of the epithelium, and so break this up into a series of irregularly branching rods—the so-called 'egg columns.' By a continuation of this process the epithelium becomes completely honeycombed by the stroma, which is accompanied by blood-vessels wherever it penetrates; so that, in place of the original arrangement of a layer of epithelium clothing a central connective tissue core, we now have a superficial layer of columnar epithelium, beneath which is a framework of vascular connective tissue, the meshes of which freely communicate together, and are filled with columns or 'nests' of epithelial cells.

Primitive ova.—The epithelial cells, at first all pretty nearly the same size, do not long remain so: at a very early period certain of them become conspicuous by their larger size and more spherical shape, and these large round epithelial cells with big nuclei are very important things: they are the *primitive ova*, each one of which is capable of developing into a definitive or *permanent ovum*, and so of giving rise to an embryo. Each one of these epithelial cells is, in fact, a potential human being.

These primitive ova occur both in the superficial layer of columnar epithelium and in the more deeply situated nests of epithelial cells that are cut off and invested by the trabeculæ of the vascular stroma. In these nests a tendency soon manifests itself for the smaller epithelial cells to arrange themselves around the primitive ova, and so enclose them in follicles.

At first there may be in a single nest several of these follicles, each containing an ovum, but the continued growth of the connective tissue stroma gradually breaks up the nests, and tends to isolate the several follicles from one another, forming round each one a separate connective tissue investment.

We are now in a position to understand the structure of the ovary at the time of birth. Fig. 2 represents a vertical section through the superficial portion of the ovary of a newly-born child. It shows the surface layer of columnar epithelium

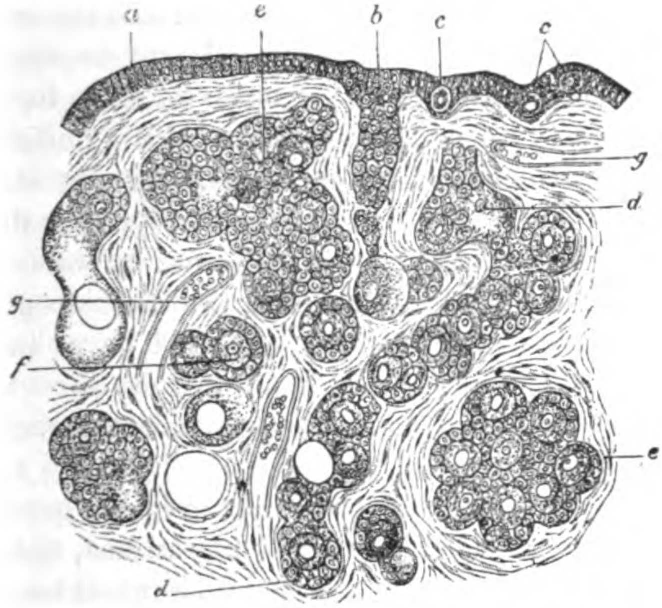


FIG. 2.—Part of a vertical section of the Ovary of a new-born Infant. (From *Stricker's Histology.*) × 150.

a. Superficial layer of columnar epithelium. *b.* Plate of epithelial cells formed by irregular growth of ovary. *c, c.* Primitive ova. *d, e.* Nests of various shapes, containing many ova and commencing follicles. *f.* Isolated follicle. *g.* Blood-vessel.

—the germinal epithelium—which is now separated from the deeper portions by a thin layer of connective tissue, the *tunica albuginea.* A little deeper we see large nests of epithelial cells, which are really the deeper portions of the germinal epithelium cut off and isolated from one another by the growth of the connective tissue stroma: in these nests certain of the cells—the ova—are distinguished by their larger size, and around these the smaller cells tend to arrange themselves so as to form capsules or follicles. In the deeper parts of the ovary the continued growth of the stroma, which is abundantly supplied with blood-vessels, has divided up the nests and more or less completely isolated the follicles from one another.

It will be noticed that in passing from the exterior towards the deeper parts of the ovary we meet with successive stages in the development of the ova. In the superficial layer of columnar epithelial cells we find the earliest stages; certain of these cells, the primitive ova, being of rather larger size than their neighbours. Beneath this surface layer we find large nests composed of epithelial cells which, except in the larger size of the primitive ova, differ but little from one another and present no regularity of arrangement. In the more deeply placed nests the cells immediately adjacent to the ova have arranged themselves round these latter so as to form follicles, but there are still in such nests many cells of indifferent character, whose ultimate fate is uncertain. Deeper still we find the number of these indifferent cells very greatly diminished, and the follicles separated from one another by trabeculæ of the stroma. In such a section, therefore, the most deeply situated ova are the oldest and most mature, and have, in attaining their present position, passed through in succession the several stages which we encounter in passing from the surface to the deeper parts of the ovary.

Owing to the rapid and somewhat irregular growth of the germinal epithelium and the underlying stroma, the surface of the ovary, which at first is smooth, becomes raised into a number of irregular projections, separated from one another by deep grooves or wrinkles. These grooves in vertical sections of the ovary have the appearance of tubular pittings-in of the surface epithelium, and have been by some writers erroneously described as tubular glands. By further growth of the ovary the two sides of such a groove may come in contact and fuse with one another, and the solid plate of epithelial cells so formed may, like other parts of the germinal epithelium, give rise to ova. An example of this is shown in fig. 2, *b*.

The permanent ova.—About the time that the egg follicles or capsules commence to be formed around the primitive ova, these latter undergo certain changes by which they become converted into the *permanent ova*; and this transformation is one of no little importance, for primitive ova occur not only in female embryos, but in male as well, and in both give rise, though by a very different series of modifications, to the special generative products. The conversion of primitive into permanent ova marks therefore the establishment of the sexuality of the embryo.

The changes in question chiefly concern the nucleus. This, which in the primitive ovum is uniformly granular, and has a rather ill-defined outline, becomes converted into a spherical vesicular body, with a sharply defined double-contoured wall. Within this wall the granules, instead of being uniformly diffused, become collected into a small darkly staining knob attached to the wall at one spot, the rest of the vesicle being filled with a transparent colourless fluid. The granular knob soon gives out processes, and so becomes stellate; and, by the processes branching and anastomosing, becomes converted into a delicate reticulum or network stretching all through the nucleus. The crossing points or nodes of the network are somewhat enlarged, and at one or sometimes two or more places become specially prominent, forming highly refracting bodies—the *nucleoli*. In this way from the nucleus of the primitive ovum are derived the nucleus, or, as it is more commonly called, the *germinal vesicle*, and the nucleolus or *germinal spot* of the permanent ovum.

Certain other changes which occur about the same time are probably less intimately concerned with the formation of the permanent ovum. The whole egg increases in size; its protoplasm, which was previously clear, becomes granular; and round the outside of the ovum a thin investing membrane, the vitelline membrane or *zona pellucida*, is formed.

Certain exceptions to the normal course of events as described above may occur in the development of the ova. Thus in many animals, as the rabbit and very probably in the human ovary as well, some of the primitive ova, instead of becoming directly converted into permanent ova, may fuse up together so as to form multinuclear masses of protoplasm. Of the nuclei, which at first increase in number, some ultimately disappear, while others become converted into the nuclei of permanent ova, into which the whole mass becomes finally divided.

The Graafian follicle.—Each ovum, as we have seen, becomes closely surrounded by a follicle or capsule formed of a single layer of cells; these follicular epithelial cells being, like the ovum itself, derived from the original germinal epithelium.[1] It may happen that two or even more ova may be enclosed in a single follicle, but this is exceptional, and when it does occur is usually only temporary; the connective tissue stroma, later on, growing in between the ova and so separating them from one another. As a rule each ovum has its own investment of epithelial cells, forming the commencement of what is known as the Graafian follicle.

The follicular epithelium forms at first a single layer of short columnar cells, with an average length of 0·008 mm., and of very granular appearance, applied very closely to the ovum which they surround. As the ovum begins to grow rapidly directly after the follicle is established, and as any nutrient matter reaching the ovum can only do so by first passing through the follicular epithelial cells, it is clear that these cells must play a very important part in the nutrition of the ovum; and their main function is probably that of transmitting food from the blood-vessels of the stroma to the ovum, and very possibly elaborating that food to a certain extent as they pass it on. The granular appearance acquired by the protoplasm of the ovum after establishment of the follicle is due to the accumulation of food matter passed into it from these investing epithelial cells.

The follicular epithelium does not long remain a single layer; it rapidly increases in thickness, the cells multiplying by division and so forming a layer several cells thick, the so-called *membrana granulosa*; at the same time the connective tissue immediately outside the follicle becomes modified so as to form a special outer investment, the *tunica propria* of the Graafian follicle, in which the blood-vessels are very strongly developed.

In the *membrana granulosa* the layer of cells immediately surrounding the ovum preserves its columnar character; while the remaining cells, which are usually smaller, are spherical or oval in shape.

Both the follicle and the ovum continue to increase in size, but the follicle grows far more rapidly than the ovum; in con-

[1] Foulis maintains that the follicular cells are derived from the connective tissue stroma. Balfour's observations on the rabbit's ovary appear, however, to be conclusive against this view.

sequence of this a cavity, somewhat crescentic in shape, appears in the midst of the *membrana granulosa*; this follicular cavity, which is filled by a transparent fluid, the *liquor folliculi*, grows

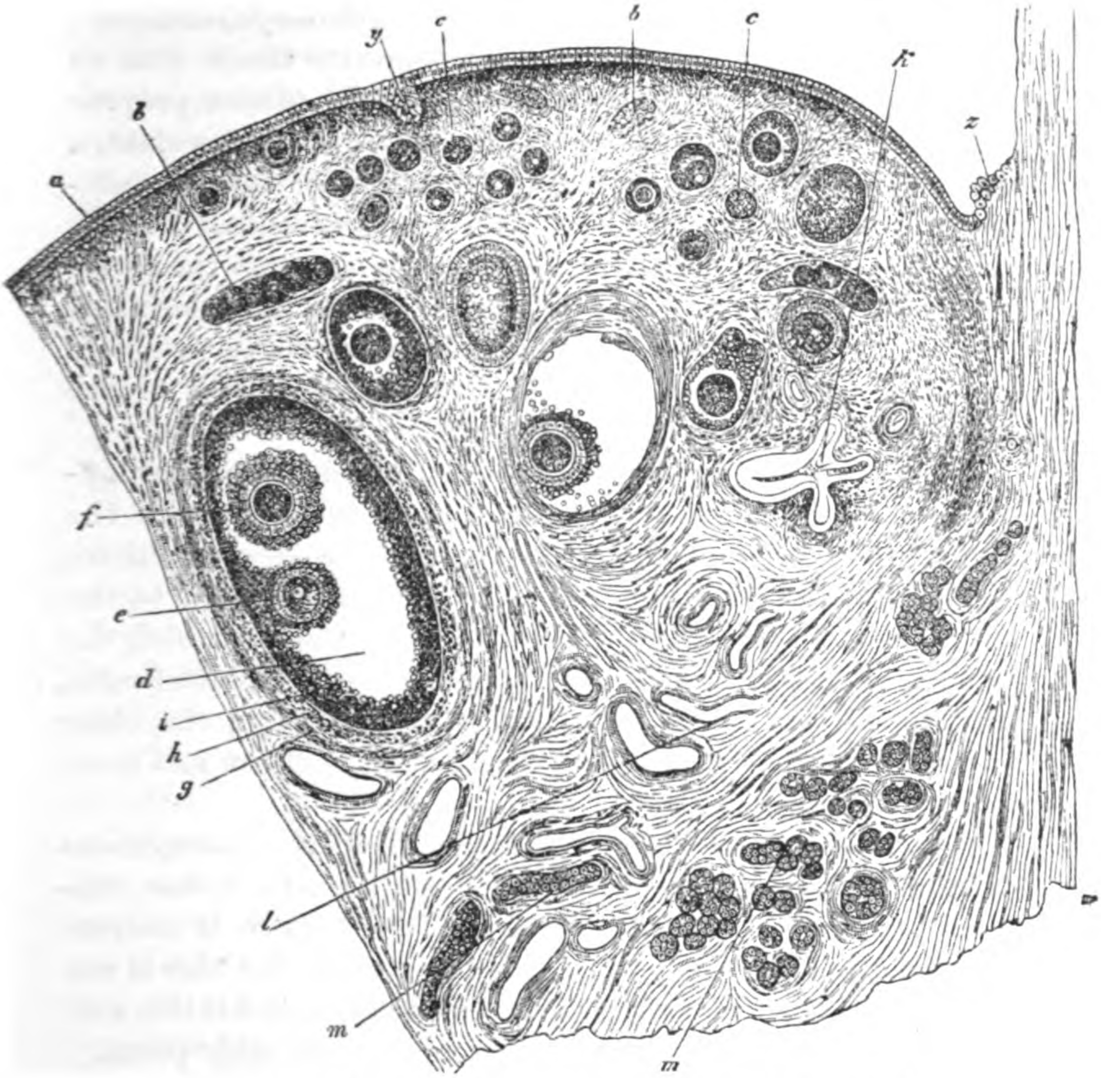


FIG. 3.—Part of a longitudinal section of the Ovary of an old Bitch. (From *Stricker's Histology*.)

a. Superficial layer of columnar epithelium. *b*, *b*. Nests. *c*, *c*. Young follicles. *d*. Older follicle. *e*. Discus proligerus, with imbedded ovum. *f*. Second ovum in the same follicle. *g*. Tunica fibrosa folliculi. *h*. Tunica propria folliculi. *i*. Membrana granulosa. *k*. Collapsed, atrophied follicle. *l*. Blood-vessel. *m*. Part of parovarium. *y*. Plate of germinal epithelium formed by irregular growth of ovary. *z*. Passage of germinal epithelium into ordinary peritoneal epithelium.

very rapidly, and the whole follicle soon acquires the shape and structure shown in fig. 3.

In this figure, which represents a section through the ovary of a bitch, various stages in the development of the Graafian follicle are shown. The fully-formed follicle, *d*, on the left side of the figure, is oval in shape; its walls consist of an outer vascular investment of connective tissue derived from the stroma of the ovary, and divisible, according to some authorities, into a rather ill-defined outer layer, the *tunica fibrosa folliculi*, and an inner well-marked layer of fine connective tissue with an abundant plexus of capillary blood-vessels, the *tunica propria folliculi*. Within this latter is the *membrana granulosa*, a thick layer of granular spherical (or, from mutual pressure, polygonal) cells. At one part the *membrana granulosa* is much thickened, forming a roundish mass projecting into the cavity of the follicle; imbedded in the middle of this roundish mass, or *discus proligerus*, is the ovum, the layer of cells immediately surrounding it being distinctly columnar. The cavity of the follicle is filled by the watery *liquor folliculi*.

We have already seen that in the earlier phases of development of the ova the younger stages are found nearest to the surface of the ovary, and the older ones in the deeper portions, and fig. 3 shows that the same holds good with regard to the later phases. The younger Graafian follicles, those in which the ovum is merely surrounded by a single layer of epithelial cells, are situated not far from the surface of the ovary; the older follicles are rather more deeply placed, and the oldest and most mature ones are the deepest of all.

The *discus proligerus*, with its contained ovum, occupies no definite position in the Graafian follicle: formerly it was supposed to always lie on that side of the follicle which is nearest the surface of the ovary; but it is now known that this is not the case, and that the ovum is quite as often attached to the wall of the follicle furthest from the surface as to any other point.

The Graafian follicles do not stop at the stage figured and described above; they go on increasing in size, and as their growth is now mainly towards the surface of the ovary, their outer walls ultimately become situated close beneath this surface, or may even push the superficial layer of epithelium and connective tissue of the ovary before them, and so form slight external projections.

At the most prominent part of the ripe follicle is a small spot, the *hilum folliculi*, distinguished from the rest of the follicle by being devoid of blood-vessels. At this place, shortly after the follicle has attained its full dimensions—*i.e.* a diameter of 1·25 to 4 mm. in the human ovary—rupture of the follicular wall occurs, and the ovum, together with the liquor folliculi, is discharged on the surface of the ovary. This rupture is due apparently to two causes; firstly, to extensive fatty degeneration of the cells composing the wall of the follicle; and secondly, to the growth of folds of the *membrana granulosa* and *tunica propria* into the cavity of the follicle; thereby, owing to the liquid filling that cavity, causing increased pressure from within. The growth of these folds we shall refer to again immediately.

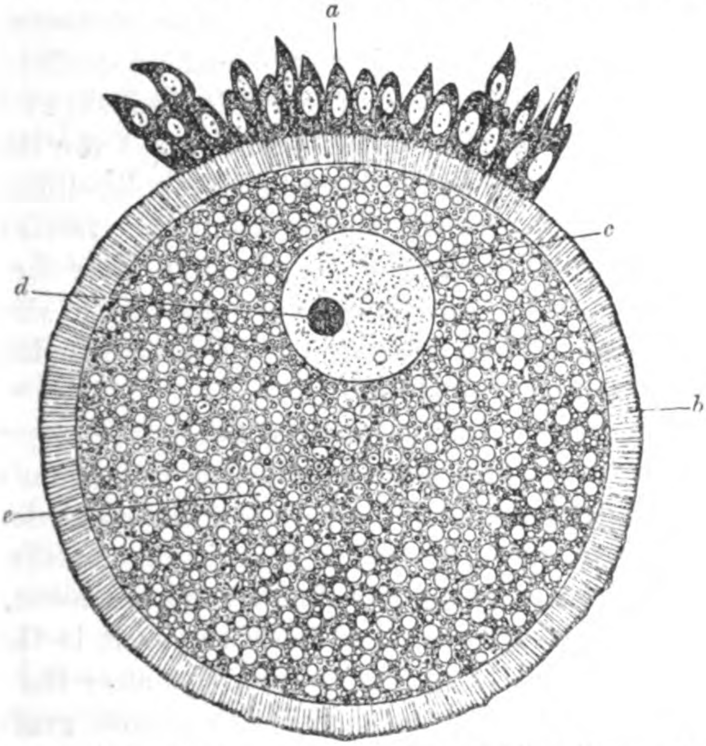


FIG. 4.—Mature Ovum of Rabbit. (From *Stricker's Histology.*)
a. Part of columnar epithelium of Graafian follicle still adhering to ovum.
b. Zona radiata, invested externally by the thin vitelline membrane.
c. Germinal vesicle or nucleus. *d.* Germinal spot or nucleolus. *e.* Yolk.

The ripe ovarian egg.—The ripe human ovum is a spherical body 0·2 mm. in diameter, consisting of a granular mass of protoplasm, within which is the nucleus or germinal vesicle, which has a diameter of ·045 mm. and contains, besides the reticulum already noticed, a nucleolus or germinal spot ·007 mm. in diameter. The ovum is invested by an elastic transparent membrane, the zona pellucida, about ·01 mm. thick.

The structure of the ripe mammalian ovum is well shown in fig. 4, representing an ovum of a rabbit.

At the upper part of the figure some of the columnar cells of the *membrana granulosa* are still adhering to the ovum. The investing membrane, or zona pellucida, is seen to consist of two layers—a very thin outer layer, the vitelline membrane; and a much thicker inner layer perforated by an immense number of very fine radial pores, and hence called *zona radiata*.

Corpus luteum.—After the escape of the ovum important changes occur in the Graafian follicle, leading to the formation of the body known as the *corpus luteum*, which occupies and fills up the cavity of the follicle. Before the discharge of the ovum the wall of the follicle was mentioned above as being thrown into folds, which project into and so diminish the size of the cavity of the follicle. These folds, which, by increasing the pressure within the follicle, probably aid the discharge of the ovum, consist of both the follicular epithelium or *membrana granulosa*, and the connective tissue *tunica propria* of the follicle; they are very vascular, and after the discharge of the ovum increase rapidly both in number and size, forming ultimately a number of converging processes completely filling up the cavity of the follicle.

The subsequent changes undergone by the *corpus luteum* differ considerably, according to whether the ovum which has been discharged from the follicle is fertilised, and develops up into an embryo, or on the other hand is not fertilised, and so dies without undergoing any further development. In the latter case the *corpus luteum spurium*, as it is then called, attains its full size in ten or twelve days after the discharge of the ovum, and then commences to shrink gradually, disappearing completely in a few weeks.

If, however, the ovum that has escaped from the follicle becomes fertilised, and gives rise to an embryo, the *corpus luteum*, which is then spoken of as *corpus luteum verum*, does not reach its full development until two or three months after rupture of the follicle; it persists throughout the greater part, or even the whole, of the period of gestation, towards the close of which it contracts to a small white stellate cicatrix —the *corpus albicans*,—which may persist for four or five months after delivery. We have seen a distinct cavity persisting after labour at term. The fully-developed *corpus luteum verum*, or *corpus luteum* of pregnancy, is a firm body, larger in size than the original follicle, and attaining one-fourth or even one-third of the size of the entire ovary. It consists of a central red (in later stages grey) mass of vascular connective tissue, like mucous tissue, in which are large cells containing hæmatoidin crystals, and a peripheral intensely yellow zone, derived from the converging folds of the wall of the capsule described at an earlier stage (*vide* fig. 46, p. 116).

The presence of a *corpus luteum verum* in one of the ovaries is a matter of some considerable medico-legal importance, inasmuch as it has been appealed to as positive evidence of pregnancy having occurred; but the best authorities now agree that there is no infallible sign or character by which the *corpus luteum* of pregnancy can be distinguished from that of the non-fertilised ovum. The differences are chiefly those of size and length of duration, and cannot be relied on in determining disputed cases. The terms *true* and *false*, as applied to the two kinds of *corpora lutea*, appear, indeed, to be altogether erroneous, as the two structures are essentially similar, and in many cases indistinguishable from one another.

Ovulation.— From about the time of puberty, and throughout the whole of the child-bearing period of life, the gradual maturation of the Graafian follicles, ending in rupture of the follicles and discharge of the ova, is continually going on; and in the healthy woman this discharge of ova occurs, not in an indefinite manner, but at regular intervals corresponding to the menstrual periods, one or more ova being set free about the time of each period.

This periodical maturation and discharge of ova is commonly spoken of as ovulation. It goes on perfectly independently of sexual intercourse, or of any kind of influence from the male; but it is very possible that, as held by many writers, the discharge of the ova, though in no way dependent on the act of copulation, may yet be hastened by it.

SUMMARY.

It will be convenient here to briefly recapitulate the leading features in the development of the human ovum.

The ovaries appear, in embryos of about the fifth week, as two ridge-like thickenings of the epithelium lining the body-cavity, situated close to the inner sides of the Wolffian bodies. The epithelium rapidly thickens; its deeper parts become divided into nests by outgrowths of the underlying connective tissue. Some of the epithelial cells very early become distinguished by their greater size from their fellows: these are the primitive ova. Later on, at a time not determined with certainty, but probably towards the end of the second month, these primitive ova begin to be converted into permanent ova, the change consisting in an increase in size, and in certain important modifications in the structure of the nucleus. The permanent ova become enclosed in follicles formed by those epithelial cells which have not themselves become ova. The follicular epithelium serves to feed the enclosed ova, which grow rapidly; the permanent ovum when first formed having a diameter of about 0·012 mm., while the ripe ovum measures ·2 mm.

Throughout the whole of fœtal life there is a rapid development of ova going on. At the time of birth each ovary of a female child has been estimated to contain at least 35,000 permanent ova. The formation of new ova continues for a short time after birth, but apparently ceases about the end of the second year, owing to the formation of the tunica albuginea, which cuts off the germinal epithelium from the deeper parts of the ovary.

Throughout the whole of the child-bearing period of life there is a periodical ripening of the Graafian follicles and discharge of their contained ova by rupture, the times of discharge of ova corresponding to the menstrual periods. The ruptured follicles become filled by the structures known as *corpora lutea*, which disappear early if the escaped ovum be not fertilised, but undergo further development and persist throughout the whole period of pregnancy if the ovum be fertilised and develop into an embryo.

CHAPTER II.

THE FEMALE GENERATIVE ORGANS.—THE EXTERNAL ORGANS OF GENERATION.—THE INTERNAL ORGANS OF GENERATION.—THE MENSTRUAL PROCESS, AND ITS ATTENDANT PHENOMENA.

It is usual to divide the female generative organs for descriptive purposes into two groups:—(1) The external organs of generation, *i.e.* the labia, nymphæ, clitoris, and other parts included in the vulva, together with the mons Veneris; and (2) the internal organs—the ovaries, Fallopian tubes, uterus and vagina.

I. The external organs of generation.

The vulva.—The term *vulva* or *pudendum* is applied to the whole of the parts that are visible externally: these are the mons Veneris, the labia, the nymphæ, the clitoris, and the hymen. These parts are chiefly concerned in copulation. With the perinæum they perform a subordinate function in parturition.

The mons Veneris (fig. 5) is a slightly rounded eminence in front of the pubic symphysis, caused by an accumulation of very dense connective tissue and fat beneath the skin. From the time of puberty it is covered with hair.

Labia pudendi.—The labia (fig. 5), called also labia majora or labia externa, to distinguish them from the nymphæ, are two rounded folds of integument, forming the lateral boundaries of the vulva, and extending from the mons Veneris in front to the perinæum behind. Between them is an elliptical space, the *rima*, within which is the entrance to the vagina. The anterior ends of the two labia unite together behind the mons Veneris to form the anterior commissure; and the hinder ends are sometimes described as uniting in a similar manner to form a posterior commissure; this latter, however, is indistinguishable from the perinæum. The hinder ends of the two labia are also connected together by a thin transverse fold—the *fourchette*, or *frænulum pudendi*—situated, in the ordinary erect posture, just above the 'posterior commissure,' and separated from it by a transverse groove—the *fossa navicularis*. The fourchette, which is very thin,

Fig. 5.—The external Organs of Generation. (From *Gray's Anatomy*.)

is commonly torn during parturition in primiparæ, if it has escaped obliteration in sexual intercourse.

The labia are covered on their outer surfaces with skin which bears hair, and on their inner surfaces with mucous membrane. At their bases are the *constrictores vaginæ* muscles. The two labia are normally in contact with one another, but shrink somewhat with age and so expose the other parts of the vulva.

The perinæum extends from the anus to the posterior commissure, which latter is merely its anterior border: it is usually about an inch and a half in length, but undergoes considerable distension during labour.

The nymphæ (fig. 5), called also *labia minora* and *labia interna*, are a pair of narrow folds of mucous membrane lying along the inner sides of the labia majora. In front the two nymphæ are linked together across the middle line, both above and below the clitoris; forming the *præputium clitoridis* and *frænum clitoridis* respectively. Posteriorly they gradually diminish in width, and end opposite the middle of the vaginal orifice. Beneath the prepuce and along the outer surfaces of the nymphæ are sebaceous glands secreting an unctuous and odorous substance.

The clitoris (fig. 5) is a small elongated body corresponding to the penis of the male, and about an inch and a half in length, situated immediately behind the anterior commissure. The greater part of its length is hidden by the folds of mucous membrane just described, but the slightly dilated extremity, the *glans clitoridis*, projects freely from between the prepuce and the frænum clitoridis. The clitoris consists of two *corpora cavernosa* united together along the median line; these diverge at the base to form the two *crura*, which are attached to the rami of the pubes and ischia.

The bulb of the male urethra is represented by the *bulbi vestibuli* (fig. 6), a pair of oval masses placed at the sides of the vagina, and consisting of dense networks of veins: from the anterior end of each of these masses a small plexus of blood-vessels is continued forward to the glans clitoridis; and this plexus, the *pars intermedia* of Kobelt, is regarded by him as equivalent on each side to one half of the *corpus spongiosum* of the male. It is erectile.

Vestibule.—The term vestibule (figs. 5 and 6) is usually applied to the triangular patch of mucous membrane situated in front of the vagina and between the two nymphæ. Its apex is formed by the clitoris, its sides by the inner edges of the nymphæ, and its base by a horizontal line drawn across the anterior edge of the vagina: the most important structure in it is the *meatus urinarius*, or orifice of the urethra (fig. 5), situated at the base of the vestibule in the median line, less than an inch behind the clitoris. Two guides lead to it—(1) from behind, by tracing the anterior wall of the vagina forwards until the finger reaches its termination in a small tubercle—in this tubercle is the meatus; (2) tracing backwards from the clitoris between the nymphæ, the finger equally reaches the tubercle. In the mucous membrane of the vestibule, as well as along the inner surfaces of the nymphæ, are numerous mucous follicles.

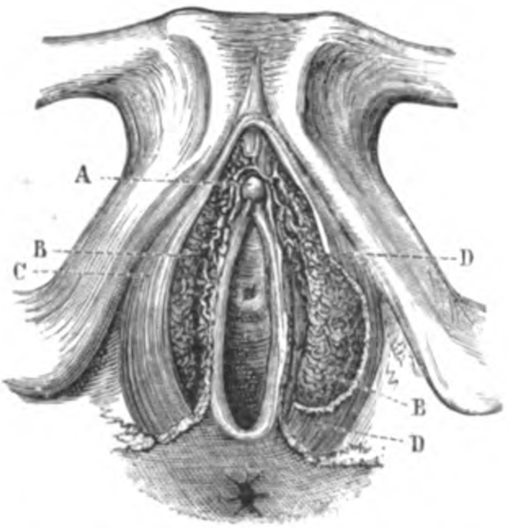


FIG. 6.—The Erectile Tissues of the external Generative Organs. (From Tarnier.)

A. Clitoris. B, B. Bulbi vestibuli. C, D. Right and left halves of the constrictor vaginæ muscle.

The hymen.—The orifice of the vagina is in the virgin partially closed by a thin membranous duplication of the mucous membrane, which forms a kind of diaphragm—the *hymen*—pierced by an oval aperture, which is usually nearer to the anterior than to the posterior end. [Budin (1879) disputes the correctness of this, the common description of the hymen. He contends that dissection shows that the walls of the vagina are quite isolable and terminate in front by a perforated hemispherical part which is the prolongation of the columnæ of the vaginal mucous membrane which clothes the internal surface and which reaches to the orifice of the hymen. Histological examination aids in proving that the hymen is nothing more than the anterior extremity of the vagina covered outside by the mucous membrane of the vulva.—R. B.] The hymen is subject to considerable individual variations: it is not unfrequently absent in front, in which case it takes the form of a semilunar fold, with the concavity directed forwards; it may be perforated by more than one aperture, and may also be reduced to a mere fringe. In rare cases it is stronger than usual, and completely closes the vagina, giving rise to the condition known as imperforate hymen.

The hymen is nearly always lacerated, either radially or concentrically, by sexual connection, and at the birth of the first child becomes obliterated, or else reduced to a series of small fleshy projections—the *carunculæ myrtiformes*—usually more abundant round the posterior margin of the vaginal aperture.

The *glands of Bartholin*, or *of Duverney*, which correspond to Cowper's glands in the male, are two small bodies about the size of peas placed at the sides of the vagina. Each gland has a duct of some length, which opens on the inner surface of the nympha outside the hymen, and about opposite the middle of the vaginal orifice. They freely secrete a viscid mucus under excitement and in labour.

All the parts of the vulva are abundantly supplied with *blood-vessels*. The superficial pudendal arteries supply the outermost parts, while the deeper parts receive their blood from the internal pudic arteries. The venous plexuses of the bulbi vestibuli, partes intermediæ, corpora cavernosa, and glans clitoridis, give these parts the character of erectile tissue.

The *vulvar orifice*, through which the child emerges into the outer world, is bounded at the sides by the labia majora, behind by the fourchette, and in front by the vestibule, which becomes folded on itself at the time. Laceration of any one of these parts may occur in the act of parturition. Laceration of the vestibule is chiefly dangerous from the close proximity of the very vascular structures just noticed, and the consequent liability to profuse hæmorrhage.

The female urethra.—Though not forming, strictly speaking, part of the female generative organs, it is convenient to insert here a short account of the female urethra, on account of its intimate connection with these organs.

From the *meatus urinarius*, whose position has been

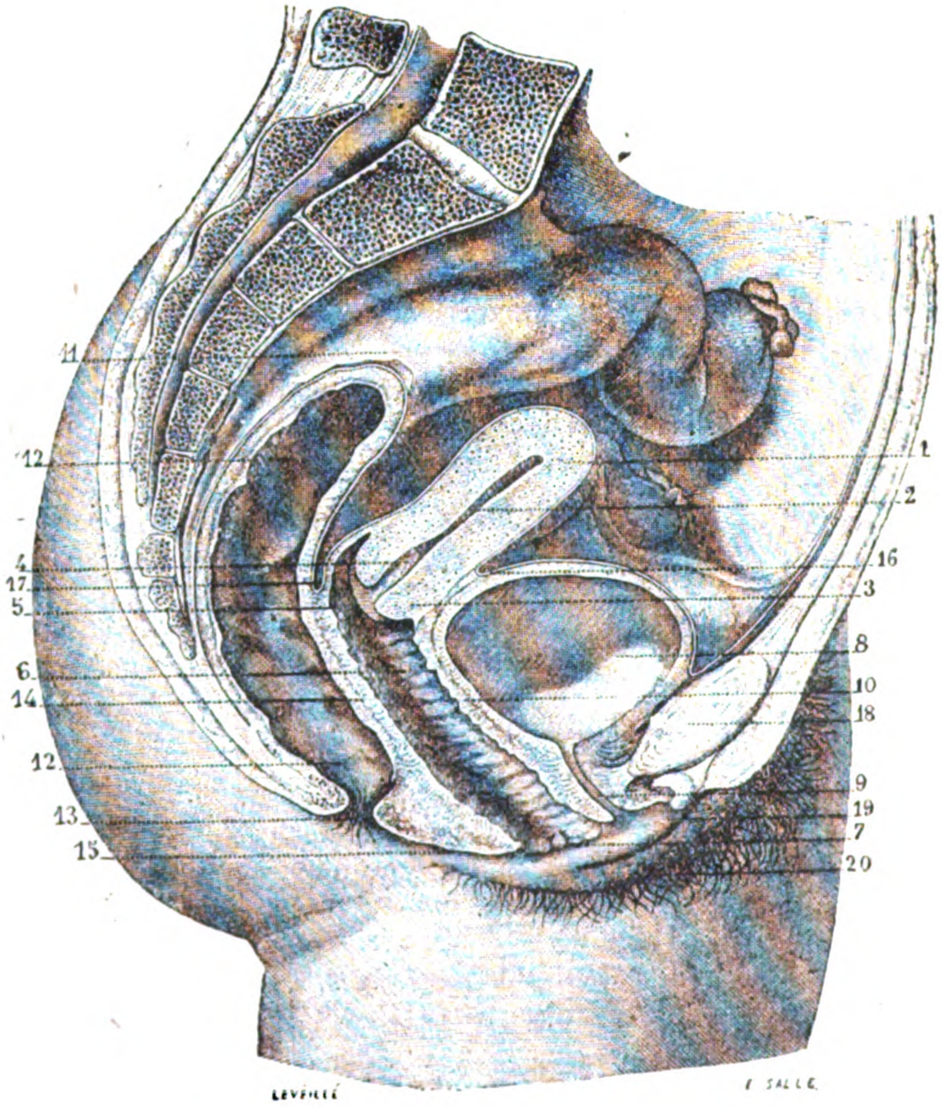


FIG. 7.—The Female Generative Organs, as seen in longitudinal vertical section. (From Tarnier, after Sappey.)

1. Body of uterus. 2. Cavity of body. 3. Cervix uteri. 4. Cavity of cervix. 5. Os uteri. 6. Cavity of vagina. 7. Vaginal orifice. 8. Bladder. 9. Urethra. 10. Vesico-vaginal wall. 11. Rectum. 12. Cavity of rectum. 13. Anus. 14. Recto-vaginal wall. 15. Perinæum. 16. Vesico-uterine cul-de-sac. 17. Recto-vaginal cul-de-sac. 18. Symphysis pubis. 19. Nymphæ. 20. Labium majus.

described above, the urethra passes upwards behind the symphysis pubis as a short tube about 3 cm. in length, and 7 mm. in diameter, but capable of considerable distension. The urethra, as shown in fig. 7, is slightly curved, the concavity of the curve being directed forwards.

II. The internal organs of generation.

The vagina is the tubular passage leading from the uterus to the vulva. It is situated, as shown in fig. 7, between the bladder and urethra in front and the rectum behind, being firmly connected with the former, but only loosely with the latter, and is enclosed laterally by the *levatores ani* muscles.

It is curved as shown in the figure, the concavity being directed forwards, and the anterior wall, which is about 10 cm. long, being 2 cm. or more shorter than the posterior wall. The upper part of the posterior wall, as shown in fig. 7, is covered directly by the peritoneum, which descends between the vagina and rectum to form a cul-de-sac, usually spoken of as the *pouch of Douglas.* The widest part of the vagina is at the fundus; behind the insertion of the uterus is a more expanded part called the *upper* or *posterior pouch* or *cul-de-sac* of the vagina. In normal conditions the pouch is small, and its walls are in contact; but in women who have borne children, or who have been the subjects of sexual intercourse, or of retroversion or retroflexion of the uterus, this pouch becomes greatly enlarged. The vagina narrows towards the vulva, where it is constricted by the vulvar sphincter; in the normal state its anterior and posterior walls are in contact with one another so as to obliterate the cavity. On the inner surface of the vagina, both on the anterior and posterior walls, slightly elevated ridges, the *columnæ rugarum,* run upwards in the middle line, and from these lateral ridges or *rugæ* run off at right angles: both columns and rugæ are more distinct at the lower end of the vagina, and in those who have not borne children.

The walls of the vagina consist of three coats: (1) an inner mucous coat; (2) a middle muscular; (3) an outer fibrous.

1. The *mucous coat* is covered by an epithelial layer, which is squamous. It was long thought that the vaginal mucous membrane was rich in mucous follicles, but anatomists now agree that it is destitute of glands. This mucous membrane, if exposed to the external air, very quickly takes on the characters and appearance of the external skin, becoming dry,

and in black women pigmented, like the external genitals. At the upper end of the vagina the mucous membrane is reflected round the neck of the uterus, which (fig. 7) projects some distance into the vagina. The part of the uterine neck thus projecting is distinguished as the *vaginal portion.*

2. The middle coat consists mainly of non-striated muscle, arranged, though not very distinctly, in internal circular and external longitudinal layers. These fibres are inserted in front into the ischio-pubic rami, and are continuous above with the fibres of the middle layer of the uterus.

3. Outside the muscles is a layer of loose erectile tissue, into which elastic fibres enter largely. This structure accounts for the great distensibility of the vagina, and the readiness with which it recovers its contracted state.

The vulval orifice of the vagina is surrounded by striated muscular fibres, forming the *sphincter vaginæ* muscle.

The vagina is very vascular, its blood being derived from the vaginal, internal pudic, vesical, and uterine branches of the internal iliac artery. The veins are numerous and large; they form several plexuses, taking their points of departure from the bulb and continuous with the veins of the uterus. They empty themselves into the venous plexuses at the sides of the vagina and terminate in the hypogastric veins. The lymphatic vessels run to the lateral glands of the pelvic cavity. Those of the inferior fourth of the vagina, however, unite with those of the vulva, and run with them to the inguinal glands. The nerves come from the hypogastric plexuses.

The uterus is a hollow muscular organ lying (fig. 7) between the bladder and the rectum, and inserted somewhat obliquely into the top of the vagina, with which its cavity communicates.

The uterus is of the shape of a somewhat flattened pear, measuring about 7 cm. in length, 5 cm. in width from side to side, and 2·5 cm. in thickness from before backwards. It is divided into an upper part or body, the rounded extremity of which is termed the *fundus*, and a lower part, or *cervix*; the boundary between the two being indicated by a slight external constriction, but being far more strongly marked internally both by an internal constriction—the *os uteri internum*—and by a very sudden alteration in the character of the lining membrane. These two parts may conveniently be dealt with separately.

The cervix is about 2·5 cm. in length: its walls (fig. 8) are thick, and its cavity somewhat fusiform in shape, being wider in the middle and narrowed towards both ends. The cavity opens below by the *os uteri externum* or *os tincæ* into the vagina, and above by the *os uteri internum*, which is smaller than the *os externum*, into the upper portion or body of the uterus.

The lower or *vaginal portion* of the cervix projects, as shown in fig. 7, into the vagina: owing to the oblique character

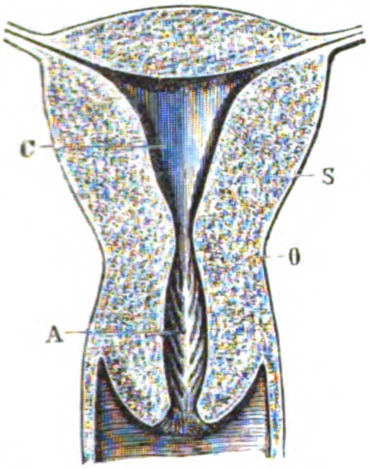


FIG. 8.—Longitudinal section of a nulliparous uterus. (After Tarnier.)

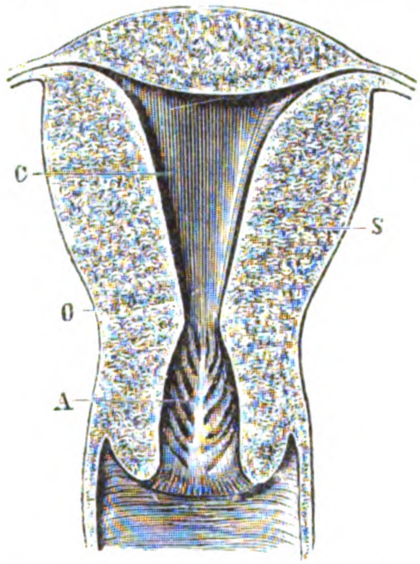


FIG. 9.—Longitudinal section of a multiparous uterus. (After Tarnier.)

A. Cavity of the cervix and arbor vitæ. C. Cavity of the body. O. Constriction between body and cervix, the *os uteri internum*. S. Wall of fundus.

of its insertion, the anterior lip of the os externum, though the shorter one, reaches lower down the vagina than the longer posterior lip. It is of great practical importance to thoroughly realise this oblique insertion of the *cervix uteri* into the vagina, because owing to it the os uteri appears, on digital examination, to be in the anterior wall of the vagina, and not at its summit. The os uteri itself is a small transverse slit, whose margins are in the healthy state perfectly smooth.

The mucous membrane lining the cervix, which is continuous at the os externum with that of the vagina, is very firm, and is marked on its anterior and posterior surfaces by median longitudinal ridges, from which lateral ridges, or *rugæ*, run obliquely upwards on each side; the median ridge, with its diverging rugæ, receiving the name *arbor vitæ uterinus* (figs. 8 and 9). The anterior arbor vitæ is usually more strongly marked than that of the posterior wall.

The epithelium of the cervical mucous membrane is columnar and ciliated, the cells becoming flattened and losing their cilia towards the *os externum*. Between the rugæ of the arbor vitæ are numerous simple follicular glands which secrete a viscid, transparent, alkaline mucus, which becomes increased in quantity during pregnancy, forming a plug completely blocking up the cavity of the cervix. Besides these glands there are, in the lower part of the cervix, numerous vascular papillæ.

The substance of the wall of the cervix consists chiefly of non-striated muscle, divisible into an internal layer, in which the muscle-fibres are arranged transversely or slightly obliquely, and which is thickened at both the os externum and os internum to form the so-called sphincters of these orifices; and an external layer, which is thinner, and in which the fibres run longitudinally.

The peritoneum (fig. 7) covers the whole of the posterior surface of the cervix, excepting, of course, the part that projects into the vagina, but on the anterior surface it covers merely the uppermost part, being reflected off about the level of the os internum, below which point the proper tissue of the vagina is directly continuous with the wall of the bladder. The anterior surface of the uterus is flat; the posterior wall is convex, in harmony with the concavity of the sacrum.

The body of the uterus is shown in sagittal section in fig. 7; *i.e.* the plane of section is the median vertical plane of the whole body, while in fig. 8 it is shown bisected longitudinally, so as to show the internal cavity. This cavity is seen to be triangular from side to side, and flattened from before backwards; its anterior and posterior walls being in the unimpregnated condition in contact, or almost so, with one another. It communicates below by the os internum with the cavity of the cervix, and above on either side with the cavities of the Fallopian tubes or oviducts.

The mucous membrane lining the body of the uterus is, when the uterus is at rest, smooth and of a soft spongy consistence and pale red colour; it is separated at the os internum by a very sharp line of demarcation from the mucous membrane of the cervix.

The structure of the mucous membrane of the uterus has been the subject of much dispute.

According to Ercolani, the lining membrane of the body of the uterus consists of a single layer of ciliated epithelial cells resting on an extremely delicate basement membrane. In this epithelium are a number of small holes, the orifices of the utricular glands, which are simple tubular glands lined by a ciliated epithelium, continuous with that of the uterine cavity, and having an average length of about 1 mm. These glands may branch at their outer cæcal ends, but as a rule do not do so while the uterus is in a quiescent state. Between the glands are irregularly arranged muscular fibres with connective tissue cells of various forms and sizes. The whole stratum, made up of the glands and the intervening connective and muscular elements, is spoken of by Ercolani as the musculo-glandular layer of the wall of the uterus; it has a total thickness of from 1 mm. to 1·8 mm., thinning as it approaches the os internum and the apertures of the Fallopian tubes.

By most writers the epithelium and basement membrane on which it rests, together with the musculo-glandular layer, are together spoken of as forming the mucous membrane of the uterus. Ercolani, however, objects to the use of the term mucous membrane at all as applied to this lining membrane of the uterus, since there is no proper connective tissue layer, and consequently no sharp boundary between the lining membrane and the deeper muscular layers.

The utricular glands are very numerous: they are placed vertically to the inner surface of the uterus, and are either straight or more or less convoluted; their blind ends are usually slightly dilated; they secrete a transparent, glutinous, alkaline fluid.

During both menstruation and pregnancy the lining epithelium and the musculo-glandular layer undergo very rapid and very extensive changes, which will be more fully described further on. These consist chiefly in a very great increase in thickness of the whole layer, and in a great increase in complexity of the glands, together with hyperplasia and hypertrophy of the cellular elements, and the formation of a thick layer of rounded cells on the inner surface of the epithelium.

The greater part of the thickness of the wall of the body of the uterus consists of non-striated muscular fibres. In the unimpregnated uterus it is very difficult, or even impossible,

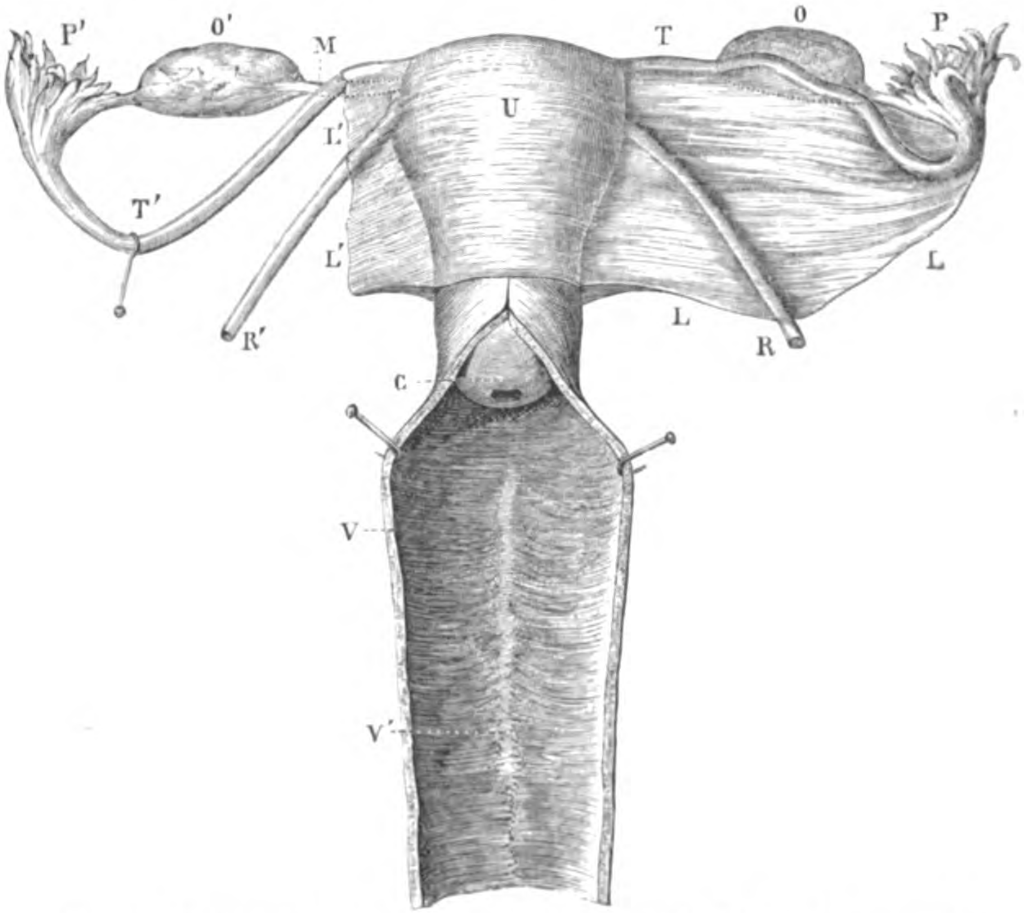


FIG. 10.—Internal Generative Organs. (After Tarnier.) The broad ligament of the right side has been partially removed, and the vagina laid open by a median longitudinal incision along its anterior wall.

C. Cervix uteri. L. Broad ligament of left side. L'. Broad ligament of right side. M. Right ovarian ligament. O. Left ovary. O'. Right ovary. P. Fimbriated aperture of left oviduct. P'. Aperture of right oviduct. R. Round ligament of left side. R'. Round ligament of right side. T. Left oviduct. T'. Right oviduct, pulled down to show ovary. U. Anterior face of body of uterus. V. Vagina. V'. Posterior column of vagina.

to make out any definite arrangement of these fibres in layers; but in the pregnant uterus the muscle fibres not only undergo great increase in number and in the size of the individual fibre cells, but also exhibit a more or less definite arrangement. The uterus as modified by gestation will be described further on.

Ligaments of the uterus.—The peritoneum (fig. 7) covers and is closely connected with the anterior and posterior surfaces of the uterus, but at each side is produced laterally as a double fold—*the broad ligament* (fig. 10), which is connected with the side of the pelvic cavity. The peritoneum forms, in fact, a double fold, stretching across the pelvic cavity between the bladder and rectum, and having between its two layers the uterus in the median line, and on either side (fig. 10) the Fallopian tube, the ovary, and, besides blood-vessels and nerves, muscular fibres and certain other structures which have now to be noticed.

The most important of these are the *round ligaments* (fig. 10, R), a pair of flattened cords, corresponding to the spermatic cords in the male, which arise from the upper angles of the uterus just in front of the openings of the Fallopian tubes, and run downwards and forwards at the sides of the bladder to the internal inguinal rings, which they enter. Passing down the inguinal canals they reach the fore part of the pubic symphysis, where they end by becoming united with the tough connective tissue of the mons veneris. The tubular investment of peritoneum ensheathing each round ligament in the inguinal canal is called the *canal of Nuck*, and usually becomes obliterated in the adult, though it may persist and give rise to hernia of the ovary. The round ligament consists of connective tissue and blood-vessels, and also contains muscular fibres prolonged from the outer muscular layer of the uterus.

Other structures lying between the two layers of the broad ligament are the *ligaments of the ovaries*, a pair of dense fibrous cords (fig. 10, M) connecting the ovaries with the upper angles of the uterus, which they join just behind and below the Fallopian tubes. There is also a sheet-like expansion of muscular fibres spread out in the broad ligament, continuous with the external muscular investment of the uterus.

A pair of small folds of peritoneum, the *vesico-uterine ligaments*, run from the side of the uterus to the bladder, and bound laterally the pouch between bladder and uterus (fig. 7); and a similar pair of folds, though somewhat more conspicuous, the *recto-uterine ligaments*, running from the back of the uterus to the rectum, form the lateral boundaries of the space of Douglas.

These so-called ligaments of the uterus hardly deserve their name, for they have very little influence in keeping the uterus in its place, and allow it to move freely to a considerable extent and in any direction.

Blood-vessels of the uterus.—The arteries supplying the uterus are four in number—viz. the two uterine and the two ovarian. The uterine arteries are branches of the internal iliacs, which, after passing down the neck of the uterus, ascend between the layers of the broad ligament along the sides of the uterus, supplying it with branches, and anastomosing near their terminations with branches from the ovarian arteries. These latter, corresponding to the spermatic arteries of the male, arise from the aorta a little way below the renal arteries, and on reaching the margin of the pelvis turn inwards between the layers of the broad ligament and, after sending branches to the ovaries and Fallopian tubes, join as stated above the uterine arteries near their termination.

The arteries are remarkable for their extremely tortuous course and their frequent anastomoses. The former feature has been supposed to be a provision to prevent stretching of the arteries during the great distension of the uterus in pregnancy; but inasmuch as the arteries become *more* tortuous during pregnancy, this can hardly be the true cause. The arteries of the two sides anastomose freely, and the smaller branches form a fine network surrounding the utricular glands.

The veins correspond to the arteries; they are chiefly characterised by having no valves and by their large size, forming irregular venous plexuses. In the gravid uterus, and especially in the placenta, the veins undergo very marked and special dilatations, as will be noticed more fully later on. Owing to their large size they are peculiarly liable to stagnation of the circulation, and hence to the formation of phleboliths. The veins are most abundant in the middle or intermediate muscular layer.

The nerves of the uterus are derived from the hypogastric and spermatic plexuses, and, according to some writers, from the third and fourth sacral nerves, though this is denied by Dr. Snow Beck and others. They reach the uterus by the broad ligament, and are said to be more abundant in the cervix than in the body of the uterus. During pregnancy the individual nerve-fibres, like the muscle fibres, increase greatly in size.

The lymphatics, like all the other tissues of the uterus, undergo great increase in size during pregnancy, when they form large plexuses immediately beneath the peritoneum. Their distribution in the deeper parts of the uterus is only very imperfectly known.

Besides the changes in size and structure that occur during menstruation and pregnancy, the uterus also varies at different periods of life. In the infant the cervix is larger than the body, and the cavity is very narrow. At the time of puberty the uterus has acquired its definite pyriform shape, but the cavity has undergone but little alteration in shape: the arbor vitæ is very distinct. In women who have not borne children the shape of the cavity undergoes but little change, but after pregnancy it acquires and retains the triangular shape shown in fig. 9. The os externum also, after pregnancy, remains wider than before, and its margins are often puckered.

After the close of the child-bearing period of life the uterus gradually shrinks; its coats become firmer and less vascular; and the cervix and body become less sharply marked off from one another.

The principal *congenital malformations* to which the uterus is liable consist in a more or less complete division of its cavity into two halves by a median septum, which may even extend the whole length of the vagina. These conditions find their explanation in the fact that the vagina and uterus are formed by the fusion of two originally distinct and independent tubes, the upper parts of which remain separate from one another throughout life as the Fallopian tubes; and the various abnormalities that occur are chiefly due to the fusion being, in exceptional cases, only incompletely effected, the two tubes remaining distinct from one another in places where they normally fuse together to form one. According to the varying extent to which the two tubes remain distinct, we may have a single uterus divided internally by a median septum; or else two uteri with a single vagina; or finally, in extreme cases, two uteri and two vaginæ.

The Fallopian tubes or oviducts.—These, as we have just seen, are the upper and persistently separate parts of the two tubes by the fusion of whose lower ends the uterus and vagina are formed. Each Fallopian tube forms a thickened cord about 8 to 10 cm. in length, running along the upper or free border of the broad ligament, and lying between the two layers of peritoneum forming that ligament (fig. 11). These cords are narrow at their inner ends, where they are attached to the upper angles of the uterus; but as they pass outwards increase in size, and, pursuing a somewhat undulating course, bend backwards and outwards, and end in expanded trumpet-shaped mouths, which are turned downwards towards the ovaries, and whose margins are produced into a number of fimbriated processes, in connection with which hydatid dilatations frequently occur.

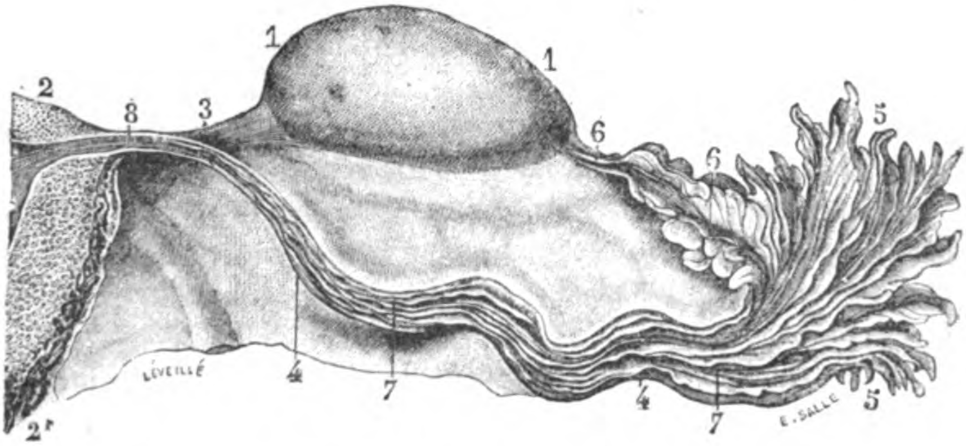


FIG. 11.—The Ovary and Fallopian Tube; the latter being opened longitudinally along its whole length. (From Tarnier, after Sappey.)

1. Ovary. 2. Part of uterus. 3. Ovarian ligament. 4. Fallopian tube. 5. Fimbriated aperture of Fallopian tube. 6. Grooved fimbria attached to ovary. 7. Longitudinal folds of lining membrane of Fallopian tube. 8. Opening of Fallopian tube into uterus.

One of the fimbriæ, rather larger than the rest, is attached to the outer end of the corresponding ovary. A slight groove running along this process leads to the *ostium abdominale*, or abdominal opening of the Fallopian tube, through which the ova, after their discharge from the surface of the ovary, enter the tube.

The cavity of the Fallopian tube beyond the external opening at first dilates somewhat, but towards the uterus contracts very considerably, its opening into the uterus—the *ostium uterinum*—being so small as only to admit the passage of a small bristle.

The Fallopian tube is lined throughout its whole length by a columnar ciliated epithelium, the cilia working towards the uterus, and probably being the principal means by which the ova are caused to pass along the tube to the uterine cavity. The lining membrane, which at the external opening of the tube is continuous with the peritoneum of the body-cavity and at the internal opening with the uterine mucous membrane, is raised into a number of longitudinal ridges (fig. 11, 7), which are best developed in the wider outer half of the tube, and which give this portion a stellate appearance in transverse section. Contrary to what was formerly asserted, there appear to be no glands in the Fallopian tubes.

Outside the mucous membrane is the muscular tissue, arranged as an inner circular and an outer weaker longitudinal layer, continuous respectively with the internal and external muscular layers of the uterus. Outside the muscular layer is a very vascular connective tissue layer; and outside this, the peritoneum of the broad ligament.

The ovaries.—The ovaries (fig. 10) are a couple of flattened oval bodies about 4 cm. in length, 2 cm. wide, and 1·25 cm. thick. They are attached along their anterior borders to the back of the broad ligament, which forms a special peritoneal investment round them. Along the line of attachment or hilum blood-vessels and nerves enter from the broad ligament. The inner end of each ovary is connected with the upper angle of the uterus by the ovarian ligament; the outer end with the mouth of the Fallopian tube by the elongated and grooved fimbria referred to above.

Each ovum consists of a connective tissue stroma containing blood-vessels, nerves, and a few muscular fibres, and invested by an epithelial layer formed by the peritoneum. In the epithelial layer and in the stroma are ova in various stages of development, the structure and mode of formation of which has been already described in the previous chapter.

Parovarium, or organ of Rosenmüller.—Attached to the upper and outer corner of each ovary, and lying between the layers of the broad ligament, is the *parovarium* (fig. 12), a group of convoluted tubules, converging below, and connected together above by a longitudinal duct, which ends on the outer side of the parovarium as a slightly dilated bulb, and which on the inner side, *e*, can be traced for a short distance towards the uterus. These structures will be referred to again when dealing with the development of the reproductive organs: here it will suffice to say that they have no functional relation to the female generative organs, and that the parovarium corresponds to the epididymis in the male, and its duct to the vas deferens.

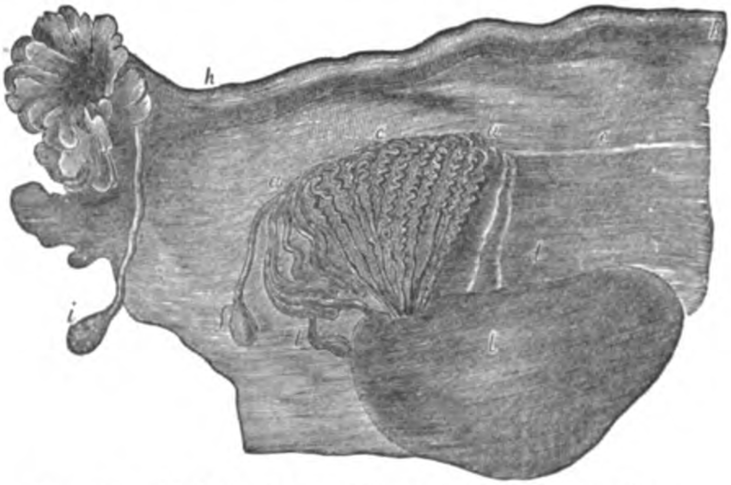


FIG. 12.—Adult Ovary, Parovarium and Fallopian Tube. (From *Quain's Anatomy*.)

a, *a*. Parovarium, formed from upper part of Wolffian body. *b*. Remains of uppermost tubes, sometimes forming hydatids. *c*. Middle set of tubes. *d*. Some lower atrophied tubes. *e*. Atrophied remains of Wolffian duct. *f*. The terminal bulb or hydatid. *h*. Fallopian tube. *i*. Hydatid attached to end of Fallopian tube. *l*. Ovary.

The ovaries and Fallopian tubes are supplied by the ovarian arteries, and also indirectly by the uterine arteries, through their anastomoses with the ovarian arteries already described. In exceptional cases these anastomotic branches may be so large that the main supply of the ovaries is through the uterine arteries.

The veins correspond to the arteries, and form in the broad ligament near to the ovary a plexus—the pampiniform or ovarian plexus—which communicates with the uterine venous plexus.

THE MENSTRUAL PROCESS.

Definition.—Menstruation is commonly taken to consist in the periodical discharge of blood from the uterus. This, the most conspicuous objective phenomenon is, however, only one act in a complicated process, of which the genital system is the focus, but upon which the entire organism is at work.

The menstrual flux is also known by the appellation *catamenia* (κατά, at the time, μήν, month) expressive of the periodicity of the flow. Women have various popular names for it, mostly metaphorical and conventional.

The phenomena constituting and attending menstruation are *local*—that is, especially affecting the ovario-uterine system; —and *constitutional or remote.*

The first in order are those observed in the ovary. In this organ resides the *primum mobile* of the process.

The changes in the ovary consist in the maturation of an ovum, the bursting of the Graafian follicle and its subsequent retrogression. This involves active hyperæmia of the organ and of the entire vascular system of the pelvis. Richet has shown that the venous system in the broad ligaments is enormously distended, so as to form bumps or swellings appreciable on vaginal touch. These may form a soft and fluctuating tumour, which disappears in a few days after the menstrual flux. We have known this venous swelling mistaken for enlarged ovary. The ovary itself is greatly enlarged; and the *Fallopian tubes*, especially their fimbriæ, become intensely gorged and swollen.

Cases in which a periodical flux not distinguishable from menstruation has been observed after removal of both ovaries are indeed not wanting. They may be explained to some extent as follows:—1. In some cases a remnant of ovarian structure has escaped amputation (Waldeyer; Spencer Wells). 2. The habit of menstrual flux, once acquired under the dominion of the ovaries, may be kept up after the removal of the organs. The system, accustomed to periodical accumulations of blood and its evacuation, readily pursues the old practice. The vascular tension so induced must be relieved, and the normal point of discharge is the uterine mucous membrane. Often, however, especially at and after the climacteric, it is some other portion of the mucous tract; and it is certain that beyond the ovaries there is a law of periodicity universal in its operation.

Before the first menstrual flow it is exceptional to find cicatrices on the surface of the ovary. These cicatrices are the marks of the escape of ova. A smooth ovary implies that menstruation and pregnancy have not taken place.

Changes in the uterine mucous membrane accompanying menstruation.—These changes consist in congestion and tumefaction of the inner wall of the uterus, affecting both the musculo-glandular layer and the lining epithelial membrane The musculo-glandular layer swells up considerably, becoming softer and more vascular than before while the utricular glands increase greatly in length and become convoluted. The whole layer increases from about 1·5 mm to 3 mm. in thickness, while the glands increase in diameter from ·08 to ·12 mm.

The epithelium lining the uterus, which we have seen is continuous with that lining the utricular glands, undergoes still greater changes; becoming converted into what is known as the catamenial or menstrual decidua, a thick cellular layer traversed by irregular channels leading from the utricular glands to the cavity of the uterus, and also containing an abundant capillary network.

It was formerly considered that the catamenial decidua was due to swelling of the musculo-glandular layer as well as the uterine epithelium, and that the channels traversing it were the modified utricular glands. Ercolani, however, who has recently devoted much attention to the study of the decidua both of menstruation and of pregnancy, has shown that the decidua is due almost entirely to the rapid proliferation of a layer of cells derived from and replacing the uterine epithelium. He has further shown that the channels are due in the first instance to the fact that as there is no epithelium over the mouths of the glands, this new formation cannot occur at these places, and that they are afterwards kept open by the continual passage of the secreted fluid into the uterus. The development of the decidua is so great and rapid that it sur-passes the ordinary capacity of the cavity of the uterus. It is therefore thrown into lobes or folds, somewhat resembling the cerebral convolutions. (See fig. 13.)

Having attained a certain development, the menstrual decidua stops, and then begins to retrograde, its cells undergoing fatty degeneration. It is at this period that the menstrual hæmorrhage occurs, and it is very probable that the hæmorrhage is directly connected with the process of fatty

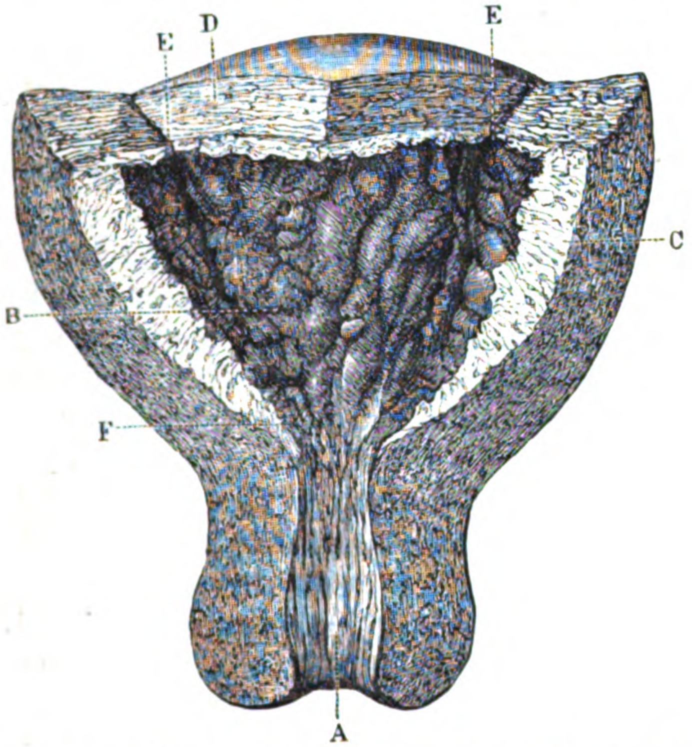


Fig. 13.—Uterus laid open to show the hypertrophy of the mucosa in menstruation. (After Tarnier.)

A. Mucosa of the cervix. B. Mucosa of the body, very turgid. C. Thickness of the section of the mucosa. D. Uterine tissue proper. E, F. Mucosa diminishing in thickness at os internum and openings of Fallopian tubes.

degeneration, although the exact nature of the connection has not yet been ascertained.

After the hæmorrhage the disintegration of the decidua continues, and finally the whole decidua is cast out in fragments, or more rarely as one single piece. In the latter case, observed in dysmenorrhœa membranacea, the decidua will be a cast of the inner surface of the uterus. The uterine epithelium is quickly replaced, apparently growing over the surface from the necks of the utricular glands, and is usually completely reformed by the ninth or tenth day after menstruation. By the eighteenth day a new decidua has commenced to form, and the whole process is then repeated over again.

Connection between Menstruation and Ovulation. — That there is some connection between these two processes is obvious from what has been said above. They are both periodically recurring processes, and the periods of the two correspond closely; they both commence about the time of puberty, and last throughout the whole child-bearing period of life. When, however, we try to investigate more closely the nature of this connection, we meet with difficulties which have not yet been satisfactorily surmounted.

The principal facts we have to guide us are the following:—

It has been ascertained by direct observation that one or both ovaries swell and become tender every three or four weeks. According to Oldham they enlarge for about four days, remain stationary for about three days, and then gradually subside. It has also been ascertained that the enlargement commences as a rule shortly before the menstrual period, that it attains its maximum about the time of this period, and subsides after the menstrual hæmorrhage (Robert Barnes and Fancourt Barnes).[1]

As the ovary is known to become congested just before the rupture of a Graafian follicle and the discharge of an ovum, it would appear a fair inference that this discharge occurs about the same time as, or shortly before, the menstrual flux; *i.e.* that ovulation and menstruation occur simultaneously. However, although this may be, and probably is, the rule, yet it is far from being an invariable one. Thus Kölliker, on examining the ovaries of seven women who had died directly after menstruating, found that in two of the cases there was no fresh corpus luteum in either ovary—*i.e.* that no ovum had been discharged at the time of menstruation; and Coste has cited similar cases.

If, on the other hand, we consider the process of menstruation more carefully, we are at once struck with the fact that the menstrual flux is not the perfecting of a process already com-

[1] See Robert Barnes's memoir on Hernia of the Ovary, *Amer. Journ. of Obstetrics*, Jan. 1882.

menced, but marks the commencement of retrograde development, the undoing of a process which has already reached and passed its full completion. The formative or constructive process, so far as the uterus is concerned, consists in the gradual building up of the decidua; and the menstrual flow marks the commencement of the destructive process by which that decidua is broken up and discharged.

Hence if we wish to determine the nature of the bond between the periodical discharge of the ova and the periodical changes occurring in the lining membrane of the uterus, it is clear that we must consider, not so much the menstrual flux, the destructive process, as the constructive processes involved in the formation of the decidua.

There is now hardly any doubt that the formation of the decidua is to be regarded as a preparation of the uterus for the reception of an ovum; and since menstruation usually ceases as soon as a developing ovum reaches the uterus, it is highly probable that the menstrual flow—*i.e.* the breaking up of the decidua—is simply due to the failure of an ovum to arrive.

We may therefore view the uterus as continually getting itself ready, by the development of a decidua, for the reception of an ovum; if no ovum arrives the decidua after a time breaks up and is discharged, accompanied by a certain amount of blood, as the menstrual flux; if, however, a developing ovum enters the uterus, the decidua is not broken up, but persists, and menstruation does not occur again until after the birth of the child to which that ovum gives rise.

We have seen above that the discharge of the ovum from the ovary probably occurs as a rule at or about the same time as the menstrual flow. Now, in order to reach the uterus the ovum has still to pass along the whole length of the Fallopian tube, and we shall see in a future chapter that this passage probably takes at least eight days to be completed. From this it follows that the decidua with which the ovum will ultimately come into relation is not that which is broken up and discharged at the time the ovum was set free from its Graafian follicle, but the next succeeding one; or, in other words, that the decidua which is discharged, as the menstrual flow, simultaneously with the setting free of an ovum by rupture of a

Graafian follicle, is not the decidua belonging, as it were, to that ovum, but the decidua belonging to the previously discharged ovum, which decidua, after waiting in vain for the arrival of the ovum, has undergone disintegration, and is being got rid of, to allow the formation of a new one.

If this view is correct, it follows that there is no necessary connection between ovulation and the occurrence of the menstrual flow, a point which explains the cases quoted by Kölliker, Coste, and others, in which there was no discharge of ova at the time of menstruation. If, on the other hand, we seek to determine why the two processes usually occur at or about the same time, the answer may perhaps be found in the consideration that there is at the time of ovulation very considerable congestion of the ovaries and Fallopian tubes; and this, owing to the close connection of the ovarian and uterine arteries, must almost necessarily cause congestion of the uterus; and this sudden determination of blood to the very thin-walled vessels of the decidua is not improbably the primary cause of the menstrual hæmorrhage.

Periodicity of Menstruation and Ovulation.—Why the ova should come to maturity and be discharged at tolerably uniform intervals is by no means clear. Among many animals a condition of sexual excitability with congestion of the external genitalia, known as the *rut*, occurs at a certain definite time of the year for each species, the time being such that if copulation occur during the rutting season, parturition (*i.e.* the birth of the young) will occur at a season when food is abundant. Hensen has shown that if copulation be hindered during the rutting season the excitability subsides in a few days, but is repeated at intervals of fourteen days in the case of the sheep, fifteen to eighteen in the sow, and four weeks in cows and mares; and this artificially induced condition, though it does not throw much light on the origin of the processes as seen in women, yet bears a singularly close resemblance to these latter.

Source of the menstrual blood.—In the living and dead it has been seen oozing from the inner surface of the body of the uterus; in the dead from the inner surface of the Fallopian tube (Letheby; Robert Barnes). In normal conditions no blood escapes on the surface of the canal of the cervix or from the vaginal portion. But in cases of morbid congestion, more especially if the epithelial layer is defective, blood may escape from this surface.

An excellent observation made by George Harley[1] is so precise as illustrating this and other points that it is transcribed in detail:—'A married woman, æt. 23, drowned herself when menstruation was impending. The uterus was congested and enlarged to about one-half more than its usual size. On section the uterine tissue was rosy, and the open mouths of its blood-vessels were distinctly visible. The vagina was somewhat congested externally, but of the normal colour internally. The mouth of the womb was filled with a white tenaceous mucus, while the mucous membrane of the interior was hypertrophied throughout its whole extent, of a pink colour, which gradually increased in depth towards the fundus, at which it attained a dark livid colour, and was covered with a quantity of blood. The blood was in greatest quantity at the mouths of the Fallopian tubes, but neither the congested nor hæmorrhagic state of the mucous membrane extended beyond the openings of the tubes. Their interior was quite white and clean at the uterine extremity, but highly congested and filled with a milky fluid towards the fimbriated end. This mucous secretion was loaded with ciliated and other epithelium. The ovaries were enlarged, especially the left one, which contained a Graafian vesicle ·75 mm. in diameter, ready to burst, and which actually burst whilst being handled. The vesicle contained a clear straw-coloured serum, with a few flakes of the membrana granulosa floating in it. On the interior of the vesicle were numerous vessels, which gave to it a highly-congested appearance.'

Characters of the menstrual fluid.—It is essentially an eruption of blood. It is usually of viscous consistence, especially at the outset and decline. Mucus is mingled in various proportions. Indeed the uterine glands frequently pour out a quantity of mucus before the blood-element appears, and mucous discharge is often continued for some days after the blood has disappeared. This mucus is alleged to have at times irritating properties, enough to distress the subject, and to cause blenor-

[1] *Pathological Trans.*, vol. xii.

rhœa in the man. At the beginning the fluid is lightly tinged; at the middle it is deep red, almost pure blood; at the end it becomes paler. In chlorotic women the fluid is pale or greenish, owing to the scarcity of blood-globules: the "menstruatio alba" of old authors. The fluid has a *peculiar odour*, varying in different subjects. It is attributed by Virchow to fatty acids. To this odour various evil properties are vulgarly ascribed—not, perhaps, absolutely without reason. Certain it is that in some cases of dysmenorrhœa from obstruction there is absorption from the uterus; the breath and skin, serving as emunctories, reveal the presence of the offensive material in the blood.

Microscopical and chemical characters of menstrual fluid. Blood-globules, white globules, and pavement epithelial cells, more or less granular, float in a serous fluid mixed with the secretions of the uterus and vagina.

Under ordinary circumstances menstrual blood does not coagulate. Whitehead explained this by showing that the vaginal mucus has an acid reaction, and that contact of the blood with this acid prevented its coagulation. Donné says that menstrual blood is acid, containing phosphoric and lactic acids. Mandl, however, showed that the smallest quantity of mucus or pus stopped blood from coagulating. Now the menstrual fluid is blood mixed with mucus. This accounts for the fluidity. The flux is seen to be fluid as it emerges from the os externum uteri, that is, before it encounters the vaginal mucus; and in cases of retention of menstrual fluid the treacly consistence is well known. If the quantity of blood be in excess of the mucus, coagula may form *in utero*. This is observed in menorrhagia.

The quantity lost varies much. In health it may be estimated at 4 to 6 ounces; but this may be greatly exceeded under all the conditions of health. But it may be taken as a general fact that, if the quantity is not only excessive in amount but discharged rapidly, presenting clots, and depressing the vital powers, there is disease, local or general, or some other disturbing force.

The duration of the flow has some relation to the quantity. A typical menstruation lasts three, four, or five days. In some women it lasts a week. If protracted beyond this, a morbid factor must be sought. The passing away should be gradual. If suddenly stopped, some accident, as cold, emotion, or disease, may be suspected.

The age at which menstruation first appears is usually that at which *puberty* is attained. This epoch is marked by the entrance of the ovary into active function. The universal law of periodicity now acts upon conditions prepared to respond. The determining conditions are—1. The energy of the sexual sense; 2. Latitude and mean temperature of the habitation; 3. Education, occupation, and diet; 4. Race.

1. *Influence of sexual energy.*—In some individuals the tendency to early sexual development is strongly marked. The ovaries mature and discharge ova very early; the ovaries are large; the system generally exhibits evidence of precocity: hair grows early; sexual proclivities are manifested. Susewind saw a child, 27 months old, who had menstruated from the age of 12 months; she exhibited the molimen hæmorrhagicum; her breasts and mons veneris were developed as in girls of 14 or 15. D'Outrepont and Carus relate analogous cases. Le Beau and Comarmond relate others. The subsequent history of these children has not been told. The following, related by Mr. Dodd ('Lancet,' 1881), is therefore of special interest. Its authenticity is placed beyond dispute. On August 8, 1871, Mr. Dodd delivered F. M. of a female child. This child began to menstruate at 12 months, not very regularly at first, but varying from four to six weeks' intervals. The last two years (1878–9, 1880) the menstruation was every three weeks. The last appearance was on June 22, 1880, when she became pregnant. Mr. Dodd attended her in labour on March 17, 1881. The child weighed 7 lbs. It died some time after in convulsions. The labour was not difficult. The hirsute growth on pubes and in axillæ is profuse; the breasts a week after labour were large and gorged with milk. This child was thus pregnant before she was 9 years old. The duration of her gestation may be estimated at 269 days.

Other illustrative cases are related (see 'The Clinical History of the Diseases of Women,' by Robert Barnes, 2nd ed. 1878). In several cases of premature menstruation exhaustion and death occurred (Clifford Allbutt, 'Med.-Chir. Trans.' 1866). But this is not the rule. Kussmaul says precocious menstruation is sometimes the result of disease, especially of new growths in the ovary.

2. *Influence of latitude and longitude.*—Joulin divides the peoples subjected to his statistical analysis into three zones. The temperate zone, situated between lat. 33° and 54° north; the second, belonging to hot climates, between 33° and the equator; the third corresponds to the cold regions, and extends from lat. 54° to the pole. Menstruation sets in in the temperate latitudes towards the 15th year; in the hot regions about the 12th year; and in the cold about the 15th or 16th; but great variations occur in each region, some of which are explained by the other influences specified.

Influence of temperature.—Generally speaking, heat promotes menstruation, cold checks it. Thus we know women who menstruate regularly, perhaps profusely, in India, and scarcely see anything in England. Others we know who in England menstruate only in the summer.

3. *Influence of education, occupation, and diet.*—The easier classes, who live luxuriously, generally menstruate early and freely, whilst those who live hard laborious lives menstruate later. Girls coming from the country to the great cities to work in sedentary occupations, hot rooms, and under new excitements, often menstruate sooner. (Stoltz, Brierre de Boismont, Leudet, Bernard, Faye, Mayer.)

4. *The influence of race.*—Certain races preserve the menstrual type proper to them in the country of their origin, even when transplanted. Jewesses, whatever their habitat, menstruate generally somewhat earlier than girls of Saxon origin.

Periodicity.—The typical periodicity is every twenty-eight days. In many women the return is exact. In some, however, the interval from the commencement of one menstruation to the return of the next is less; but it rarely exceeds thirty days in health. The relation of menstrual periodicity to gestation and labour will be discussed hereafter. (See 'Gestation.') The periodicity observed in menstruation and gestation is only one instance of the great general law of periodicity which governs the tides, animal and vegetable life. (Darwin, Wiltshire.)

The cessation of the catamenia.—The cessation of the function marks the *climacteric epoch.* This is also called the *menopause* (μήν, month; παῦσις, arrest). The age at which this occurs is even more difficult to fix than is that of the beginning. It rarely occurs before the age of 45. But many women present a periodical flow, which they persistently designate as menstruation, until the age of 50 or even more. In some of these it cannot be doubted that the menstruation is real and normal. In others, mixed up with the habitual flow, there is as certainly a morbid factor at work. In some, again, menstruation is arrested at from 35 to 40. J. Y. Simpson explained these by the theory of hyper-involution. Intercurrent conditions of the ovaries and uterus may arrest ovulation. The ordinary involution after labour seems to pass the physiological bounds, and to proceed to positive atrophy, ushering in a premature senility. We can attest the fact that women who have borne a child at 36 or 37 have never menstruated or conceived again.

Négrier explains premature climacteric by original feeble ovarian development. Languid genital capacity is exhausted long before the normal period. In other cases disease involving disintegration of the ovaries, or disease of distant organs, may be the cause.

The argument drawn in favour of protracted menstruation from cases of pregnancy at advanced ages will be discussed under 'Gestation.'

It is a popular belief that women who begin to menstruate early will cease early, and *vice versâ.* This is not always true. It would even appear that in some cases menstruation begins early and is continued late under the influence of unusual ovarian energy.

The history of *the disorders of menstruation* properly belongs to gynæcology. It is fairly discussed in Robert Barnes's 'Clinical History of the Diseases of Women.'

An important point may be considered here: *What is the significance of the arrest of menstruation in women during the period of reproductive capacity?* Is it due to disease? This we cannot here discuss, but the question should always be present to the clinician. Is it due to gestation? This will be discussed under 'The Signs of Gestation.' Menstruation is also arrested, commonly, during lactation.

Constitutional Phenomena attending Menstruation.

Menstruation is immediately preceded by *increased nervous tension and mobility*, manifested in exalted psychical, emotional, and reflex action.

Closely following upon the increase of nervous tension is *increased vascular tension*, manifested by turgescence of the capillary and venous system. The vascular tension falls quickly when the menstrual blood-flow sets in.

Increase of nervous and vascular tension, implying a more active process of nutrition, entails a rise of temperature. This rise, observed to the extent of ·5° F., under strictly physiological conditions, may rise to 1·0° F., or more, if any perimetric inflammatory action is present.

Increased nutrition-process entails increased excretion of urea.

The nervous phenomena.—The process of menstruation, like all exudations of the genital system, *increases reflex sensibility*. Thus are explained certain nervous phenomena, as shivering followed by sense of heat, yawning, heaviness of sleep, stiffness in the neck, loss of appetite, or boulimia, enteralgia, intestinal meteorism, palpitation, hoarseness, hiccup, vomiting, cramp, frequent desire to micturate, diarrhœa. These symptoms, however, more commonly in our experience are the consequences of difficult or impeded menstruation.

The vascular system undergoes exalted tension. — The quantity of blood is increased; the heart is stimulated to increased activity: this is proved by sphygmographic observations (Marey, Fancourt Barnes, Macdonald, Stephenson); the pulse is more frequent; the capillary or peripheral vessels are congested; the skin is more vascular; nævi are deeper-coloured; hæmorrhoids swell, perhaps bleed; sometimes eruptions of blood escape on the surface, but more frequently from a mucous membrane, as the conjunctiva, the nose, the lungs, the stomach or other part of the alimentary canal; or from the kidneys or bladder. These blood-effusions may attend the menstrual discharge, and are then called *supplementary menstruation*; or they may occur instead of the menstrual discharge, when they are called *vicarious* or *ectopic* menstruation

(Robert Barnes). There cannot be a doubt that these ectopic bleedings are sometimes conservative in their operation, saving the subject from internal effusions in the head, lungs, or peritoneum.

The entire glandular system of the body undergoes stimulation.—The pulmonary mucous membrane, the glands of the alimentary canal, of the skin, all exhale or secrete more actively. But the breasts exhibit the clearest phenomena. They swell, become tender to touch, even painful, and, rarely, a little serous oozing may flow from the nipples.

Pigmentation is also excited. This is mostly seen under the eyes, on the nipples, and on the genitals.

The relation of temperature, heart-beat, and urea to menstruation is thus expressed by Professor Stephenson, of Aberdeen[1]:—'Menstrual life is associated with a well-marked trace of vital energy, which manifests itself in the temperature of the body, in the daily amount of excretion of urea, and, to a slighter extent, in the pulse rate. The temperature is the most uniform and gradual in its rise and fall. In the urea-curve the transition to elevation takes place more quickly, even suddenly.'

What is the physiological purpose of menstruation?—The ultimate purpose is the preparation for conception and gestation. A comprehensive review of the phenomena of ovulation and menstruation in their sequence and correlation reveals the most striking points of similitude with gestation. We see in the formation of the decidua the preparation of a nidus in the uterus; in the reception of the extruded ovum in the Fallopian tube and uterus, the progress to meet fertilisation by contact with the male element. Up to this point menstruation is the simulacrum of gestation—a mimic pregnancy. We see again in the breaking-up of the ovum, the casting-off of the decidua; the hæmorrhagic discharge and the subsidence of nervous and vascular tension, a repetition of the most striking phenomena of labour. There is a missed pregnancy, a simulated labour (Robert Barnes).

If it be objected that it seems a contravention of the universal law, 'Nil natura frustra facit,' that a woman should go on spending thirty years of her life in monthly preparations for

[1] *On the Menstrual Wave*, Amer. Jour. of Obstet. 1882.

pregnancy when she can rarely bring forth more than twelve children, it will be enough to point out that a similar and infinitely greater waste of reproductive energy prevails throughout the entire animal and vegetable kingdoms. But is this expenditure really a waste? Future inquiry will almost certainly prove that this expenditure of excess of reproductive energy is a factor in maintaining the balance of vegetable and animal life.

The immediate purpose of menstruation is to discharge the superfluous material and energy prepared for the missed pregnancy. In the later stage we may have a similarity in the puerpery. The superfluous blood is thrown off, absorption is more active. Andral and Gavarret showed that the quantity of carbonic acid exhaled by the lungs rises until the age of 30 in men, but only until puberty in women; moreover, that in women it falls off as soon as menstruation is established, to increase again after the menopause. If for any cause the menstrual flow is arrested for several months, as by pregnancy or lactation, the quantity of carbonic acid is increased, as after the menopause. Lastly, old age, as in men, entails the diminution of the phenomena of combustion.

CHAPTER III.

IMPREGNATION AND CONCEPTION.—GENERAL ACCOUNT OF MAMMALIAN DEVELOPMENT.

In the ovum itself, about the time of attaining maturity, certain changes of great importance occur. Owing to the extreme difficulty of obtaining material at the proper time and in suitable condition for microscopic investigation, these changes have not yet been seen to occur in the human ovum; but inasmuch as they are now known to take place in nearly all the groups of invertebrate animals, and have also been described, though less completely, in fish, amphibians, and mammals, there is hardly any room for doubting that they occur in man also.

These changes, which appear to take place in mammals about the time of rupture of the Graafian follicle and escape of the ovum, are best known to us through the researches of Ed. van Beneden on the rabbit's ovum. The ovum first contracts slightly, so that it no longer completely fills the *zona pellucida* (*vide* fig. 14). The germinal vesicle, which had previously occupied a central or only slightly eccentric position, now travels to the surface of the ovum: the delicate membrane enclosing the germinal vesicle disappears, and the contents of the membrane, *i.e.* the nuclear reticulum and the germinal spot, become modified so as to form what is called the nuclear body, which is situated within the ovum, but close to its surface. A little later, part of this nuclear body is ejected from the egg, and forms two small 'polar bodies' (fig. 14) lying in the space between the *zona pellucida* and the ovum, formed by the shrinking of the latter, as already noticed.

Van Beneden held that the whole of the nuclear body was bodily extruded from the egg; but from the analogy of other animals it is in the highest degree probable that only a portion is extruded, and that the remainder stays within the egg, and, travelling towards its centre, forms what is called the *female pronucleus.*

The upshot of this process is, practically, that the germinal vesicle moves from the centre to the surface of the egg, and that, after undergoing certain changes, part of it is bodily extruded from the egg while the remainder stays within it. The change is an exceedingly important one, because it appears that after the polar bodies are extruded the ovum loses all power of further development. We have seen above that the ovum is a single cell, which originally formed part of the germinal epithelium, and that the germinal vesicle and germinal spot bear the

FIG. 14.—Rabbit's Ovum, taken from the Fallopian tube twelve hours after impregnation. (From *Quain's Anatomy*, after Bischoff.)

Numerous spermatozoa are seen embedded in the zona. In the space between the zona and the yolk, caused by the shrinking of the latter consequent on impregnation, are seen two polar bodies.

same relation to the whole ovum that the nucleus and nucleolus do to an ordinary epithelial cell. Now, in the ordinary process of multiplication of cells by division, the nuclei are known to play a very important part: when a cell is about to divide into two the nucleus divides first, so that we have a stage in which there is a single cell with two nuclei, and then, later on, the whole cell divides into two halves, each containing half of the original nucleus. From this it appears that the nucleus is the part of the cell specially concerned with the process of reproduction or multiplication, and the part in which that process is initiated.

The formation of the embryo from the ovum is, as we shall see immediately, essentially a process of cell multiplication by division, in which the nucleus of the ovum plays exactly the same part as the nucleus of an ordinary epithelial cell. An ovum with an entire germinal vesicle or nucleus must be supposed to have in itself the power of multiplication by fission, and so of producing an embryo, and, as we see in the case of many insects, such an ovum has actually this power; but after the extrusion of the polar bodies the ovum is left with an imperfect, an incomplete nucleus, and is *no longer capable of multiplication, unless the portion of the nucleus that has been extruded is replaced.*

The above considerations will enable us to obtain a clearer idea than would otherwise be possible of the nature and importance of the act of impregnation.

Impregnation and conception.—By impregnation, fertilisation, or conception, is meant the act by which it is determined that the ovum having reached the stage just described does not stop at it, but develops into an embryo; the two former words being generally applied to the process as it affects the ovum itself directly, while conception is employed in a more general sense to include the changes that occur in the maternal organs in consequence of the act of fertilisation, as well as this act itself.

Fertilisation is effected by contact of the male reproductive elements or *spermatozoa* with the female element—the ovum. The human spermatozoa are filamentous bodies about ·06 mm. long; each consists of a flattened oval head, and a long slender tail tapering gradually towards its free end; during life they possess the power of moving rapidly by vibrating or lashing movements of the tail. During the act of copulation large numbers of spermatozoa floating in the viscid transparent seminal fluid are injected into the vagina; these pass into the uterus and along the Fallopian tubes until they encounter the ovum, their transportation being probably effected mainly, if not entirely, by their own inherent power of locomotion. Why the spermatozoa should thus work their way upwards has been much debated; but when we consider the enormous number of spermatozoa discharged into the vagina, and their active power of movement, it is almost inevitable that some of them should find their way up the uterus and into the Fallopian tubes. Ciliary action, to which the movement is sometimes ascribed, can hardly have anything to do with it, for the mucous membrane of the uterus is subject to such constantly recurring changes owing to menstruation, and in the Fallopian tubes themselves the cilia work the wrong way to be of any use.

Fertilisation of ovum.—On arriving at the ovum the spermatozoa bury themselves in the *zona pellucida*, and in fig. 14 a number of them are shown in this position. One of them goes further; its head penetrates into the ovum itself, and separates from the tail, which remains outside and ultimately disappears. The head, once inside the ovum, increases in size, assumes a radiate appearance, and is known as the *male pronucleus*. The male and female pronuclei, the latter it will be remembered being the portion of the original germinal vesicle which has remained in the ovum, now gradually approach one another, and ultimately fuse to form the definite nucleus of the fertilised egg.[1]

After the formation of this definite nucleus the ovum regains the power of multiplication by fission which it had previously lost by the formation of the polar bodies; in other words, the act of impregnation consists in the replacement by the head of the spermatozoon of that portion of the original germinal vesicle, or nucleus of the ovum, which had at an earlier stage been extruded bodily from the ovum in the form of the polar bodies.

It has been stated that primitive ova occur in the male as well as the female embryo. In the female they become converted, as already explained, into the permanent ova; and in the male they give rise by a series of changes to the spermatozoa; so that from these primitive ova the essential reproductive elements of both sexes are derived; the main difference between them being, that while in the female each primitive ovum becomes a single permanent ovum, in the male each primitive ovum gives rise to a considerable number of spermatozoa.

We thus see that the male and female elements, the spermatozoa and ova, are fundamentally very similar to one another; and if we reflect further that the head of the spermatozoon is almost entirely made up of its nucleus, derived by repeated division from the nucleus of the primitive ovum, we shall see that in the fusion of female and male pronuclei we

[1] All the details of this process have not yet been seen in the mammalian ovum, but the analogy of lower animals leaves little room for doubt that the above description is correct in all essential points.

have really the fusion of a portion of the nucleus of a permanent ovum, which is itself derived from the nucleus of a primitive ovum, with the nucleus of a spermatozoon which is also derived by fission from and is therefore a part of a nucleus of a primitive ovum; *i.e.* that the fusion is between two parts of very similar morphological value.

If we inquire further as to the cause of this process of impregnation, the answer is probably to be found in the great advantage as to vigour of the progeny which is known to accrue to both animals and plants from cross-fertilisation as contrasted with self-fertilisation; it may even be, as suggested by Balfour, that the habit of forming polar bodies, *i.e.* of providing that development cannot possibly occur without impregnation, has been acquired and perpetuated for the express purpose of ensuring that cross-fertilisation should be the invariable rule.

As to the number of spermatozoa necessary to ensure fertilisation, or normally taking part in it, our knowledge is very imperfect. From observations on the lower animals it would appear that a single spermatozoon is sufficient, but that more than one may be concerned in the act.

Another much-disputed point is as to the locality at which impregnation is effected. It is naturally very difficult, from lack of evidence, to arrive at a definite conclusion, but from the analogy of other animals, and from such observations as we possess on the human species, it appears probable that the spermatozoa encounter the ovum and impregnate it as a rule in the upper third of the Fallopian tube.

Some writers have supposed that the ovum may be impregnated while still in the ovary, before rupture of the Graafian follicle has occurred, and this is possible, although the greater depth that the spermatozoa would have to penetrate in order to reach the ovum, and the great uncertainty of their coming in contact with the ovum at all, must render impregnation in this situation, if it occurs at all, very exceptional. The cases of supposed ovarian pregnancy which have been cited in support of this view are, as will be noticed in a future chapter, by no means satisfactorily made out.

Vitality of spermatozoa.—It is clear that if impregnation occurs in the upper third of the Fallopian tube, a certain interval must elapse between copulation and fertilisation, during which the spermatozoa have to work their way from the vagina into the uterus, and then along the Fallopian tube until they encounter the ova. Concerning the length of this interval we have no certain information; it is probably subject to considerable variation in different cases, for the varying condition of the lining membrane of the uterus cannot but influence materially the passage upwards of the spermatozoa. The superior limit of this interval is probably determined by the length of time during which the spermatozoa retain their vitality and fertilising power, but here again we are dealing with points on which our knowledge is very imperfect.

The spermatozoa of many animals are known to retain their fertilising power for very considerable periods. Thus in the case of domestic fowls the spermatozoa introduced into the oviduct of the hen retain their impregnating power for about eighteen days; in the bat the spermatozoa remain in the uterus and retain their power during the whole of the winter; and in the case of the queen bee the spermatozoa received from the drone, and stored up in the receptaculum seminis of the queen bee, have been known to retain their fertilising power for as long as three years.

Concerning the human spermatozoa we know that, after reaching their full development, they may remain for months in the testes before being discharged without losing their fertilising power; and when we remember for how long a time spermatozoa in animals are known to retain their power after introduction into the female organs, it is, at any rate, probable that the human spermatozoa remain alive and functionally active for some time after passing into the uterus and oviducts.

Exact observations and determinations are not yet forthcoming; indeed we have no observations whatever on the spermatozoa in the human oviduct. Spermatozoa have often been collected from the vagina, or even from the cervix uteri, and have been known to preserve their mobility, and therefore presumably their fertilising power as well, for five days, and in one case for seven and a half days after their introduction into the vagina.

We may therefore conclude that in all probability the human spermatozoa retain their vitality and functional power for at least a week after introduction into the uterus, while the analogy of lower animals renders it very possible that they may do so for a considerably longer period.

Vitality of ovum.—Returning now to the ovum: if this be not impregnated it soon dies. The length of time during which the ovum retains its vitality and capability of impregnation is not known to us with any degree of certainty; indeed no unfertilised human ovum has yet been seen outside the ovary. Some experiments of Bischoff on lower animals point to the conclusion that in them death of the unfertilised ovum occurs in the lower part of the Fallopian tube before reaching the uterus; and if we assume the same to occur in woman, and also, as is done by the best authorities, that the human ovum takes at least eight days to travel down the Fallopian tube, we arrive at the conclusion that the human ovum probably retains its power of fertilisation for about a week after its discharge from the ovary.

Concerning both ova and spermatozoa these determinations are, however, matters of mere speculation. All that we are justified in asserting with any certainty is that (1) the human spermatozoa undoubtedly may retain their vitality after entering the cervix uteri for at least a week, while the analogy of other animals renders it probable that this is by no means the superior limit; (2) that the human ova probably retain their vitality and power of being impregnated for some time after discharge from the ovary, but ultimately lose it, probably before reaching the uterus.

Intimately connected with these questions are certain other points of much interest and practical importance. Thus, inasmuch as impregnation consists merely in contact of the spermatozoa with the ova, it is clearly, so far as the woman is concerned, a perfectly involuntary act; and hence it becomes intelligible how impregnation, as is known to be the case, may be effected during a state of unconsciousness—either from deep sleep or from narcotic poisoning—*i.e.* how a woman may become pregnant without having the slightest knowledge or suspicion of how or when she was rendered so.

A further point in dispute concerns the relation between the processes of impregnation on the one hand, and, on the other, ovulation and menstruation.

The discharge of ova from the ovary is a process which recurs periodically at intervals of about a month; these ova only retain their power of being impregnated for a certain time, which is probably less than the interval between the successive discharge of ova. Hence there must be certain periods during which there are ova ready to be fertilised, and certain times during which there are none—*i.e.* impregnation can only be effected at certain recurring periods, and cannot occur in the intervals between these periods. Concerning the respective lengths of these periods we have no certain knowledge, but it is probable that the intervals when there are no ova capable of being fertilised are at least as long, if not longer than those in which there are such ova.

In other words, assuming, as we may do, that the discharge of ova from the ovary occurs at the time of the menstrual period, and that these ova retain their vitality for from ten to fourteen days (a pure assumption), there would be an interval of two and a half to two weeks before the next menstrual period, *i.e.* the next discharge of ova, during which interval there would be no fertilisable ova in the oviduct and consequently during which impregnation could not occur.

However, if we consider the problem from the other side, the combined testimony of almost all authors who have of late years dealt with the subject shows conclusively that pregnancy *may* result from copulation effected at any time as regards the menstrual periods, but that the probability of its occurring varies much according to the period as regards menstruation at which copulation is allowed.

Concerning the most favourable period for impregnation to be effected Dr. Montgomery says: 'My own observations lead me to the conclusion that conception occurs, in the great majority of instances, within the first week after the menstrual discharge,' a statement which is abundantly confirmed by other writers. The experience of the Jewish nation is about the best evidence available. It is very strong. The women keep aloof from marital intercourse until they have 'taken the bath'—*i.e.* just after menstruation. Their calculations, based upon the first intercourse being fruitful, are generally correct. In this case there can be little doubt that the ovum which is fertilised is the one discharged at the time of the immediately preceding menstrual period, as such an ovum would probably reach the uterus just as the new decidua was commencing to be formed within it, which would clearly be a favourable condition for its future development.

Conception following copulation effected a short time—a week or ten days—before the menstrual period, is probably to be explained as due to the spermatozoa retaining their vitality until the occurrence of the period of discharge of the ovum, which they then fertilise.

The above account is avowedly imperfect, and any description of these processes must remain so until we obtain more satisfactory knowledge than we possess at present on the following points:—(1) The time normally taken by the spermatozoa to work their way up the uterus and Fallopian tube; (2) the duration of vitality of the ovum; (3) the duration of vitality of the spermatozoa.

The one inference of importance which we may safely draw from the fact that conception may follow copulation effected at any time is, that no one of the varying conditions of the uterus during the different phases of menstruation offers any insuperable obstacle to the passage of the spermatozoa into the Fallopian tube.

General account of mammalian development.—The earliest stages in the development of the fertilised human ovum have not yet been seen at all, and several of the later stages are only very imperfectly known. Inasmuch as a general knowledge of these early and intermediate stages is absolutely essential to the proper understanding of the structure of such early human embryos as have been described, a short general account of the leading features in the development of mammalian animals will be useful here, while the development of the human embryo itself will be dealt with in the next chapter.

Segmentation of ovum.—The changes that immediately follow impregnation are best known to us, through the researches of Bischoff and Van Beneden, as they occur in the rabbit. The ovum is fertilised in the upper part of the Fallopian tube, down which it travels slowly to the uterus, which it reaches in three days. During its passage it is still invested by the *zona radiata*, and receives, in addition, from the walls of the tube an outer albuminous envelope. The changes that are undergone by the ovum during its passage down the Fallopian tube are commonly spoken of as the segmentation of the ovum, and are of the following nature.

A few hours after fertilisation is effected the whole ovum divides into two very nearly equal portions (fig. 15 A); a little later each of the two divides again, and then each of the four; so that we get, in place of the original single sphere (fig. 14), eight spherical bodies, of which four are slightly larger than

A

B

A

FIG. 15.—Three stages in the segmentation of the Rabbit's Ovum. (From *Quain's Anatomy*, after Bischoff.)

A. Shows the division of the ovum into two nearly equal masses.
B. The formation of four spheres by division of the two of the preceding stage.
C. The stage with eight segmentation spheres.

the other four (fig. 15 C). Each of the eight again dividing, we get sixteen, of which the eight larger ones—which we shall speak of as epiblast cells—become arranged round and partially enclose the eight smaller or hypoblast cells. Both sets of cells go on multiplying, and at about the end of the third day after impregnation, when the ovum passes from the Fallopian tube into the uterus, it has the structure shown in fig. 16 A. It is still spherical, ·09 mm. in diameter, and very little, if at all, larger than at the time of escape from the Graafian follicle; but instead of being one single cell, it consists of an outer layer of epiblast cells, almost completely surrounding a central mass of hypoblast cells.

This phenomenon of segmentation, always the first process in the development of an egg, is clearly a process of cell multiplication by fission; and it is almost certain that the nucleus plays the same part here that it does in ordinary cell division, *i.e.* that before the whole ovum divides into two the nucleus divides first, and that at every subsequent division the nucleus divides before the cell itself, so that the nuclei of the cells

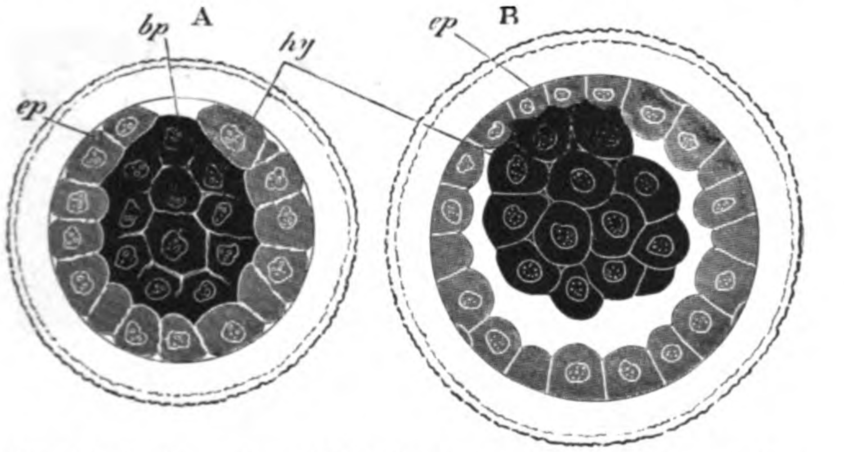


FIG. 16.—Optical section of Rabbit's Ovum at the close of segmentation. (From Balfour, after Ed. van Beneden.)

ep. Epiblast. *hy.* Primitive hypoblast. *bp.* Spot where the epiblast has not yet grown over the hypoblast.

shown in fig. 16 are derived by fission from that of the fertilised ovum.

If we consider that the ovum is a single cell, and that from that single cell the embryo, with its various tissues, epidermis, muscle, nerves, &c., themselves all composed of cells, has to be derived, we shall not be surprised to find that the very first thing the ovum does in developing is to give rise by fission to a heap of cells—to convert itself from a unicellular to a multicellular condition.

The blastodermic vesicle.—Having reached the uterus, the epiblast cells first grow over the hypoblast cells so as to completely enclose them, and then a narrow cavity, crescentic in section, appears between the epiblast and hypoblast (fig. 16 B), extending nearly, but not quite, all round. The epiblast, and consequently the whole ovum, now grows very rapidly, and during the fourth day acquires the appearance shown in fig. 17. It is now a thin-walled spherical sac, about ·28 mm. in diameter—the so-called *blastodermic vesicle*. Its wall consists of a thin layer of flattened epiblast cells, and attached to its inner surface at one part is a lenticular mass formed by the hypoblast cells. If the ovum be looked on from above, this patch of hypoblast will give rise to an opaque circular spot—the *embryonic area*.

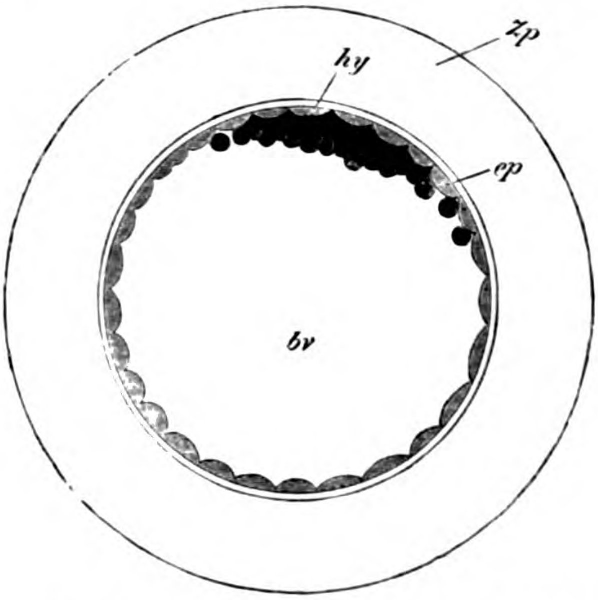


FIG. 17.—Rabbit's Ovum between seventy and ninety hours after impregnation. (From Balfour, after Ed. v. Beneden.)

bv. Cavity of blastodermic vesicle. *ep*. Epiblast. *hy*. Primitive hypoblast. *zp*. Zona pellucida.

The blastodermic vesicle still continues to grow rapidly; the circular patch of hypoblast also grows all round its edge, and so extends further and further round the inside of the vesicle; and in the embryonic area a third layer of cells—the mesoblast—appears between the epiblast and hypoblast. The appearance of the blastodermic vesicle on the seventh day is shown in fig. 18. The central white spot is the embryonic area; this is now somewhat pear-shaped, and consists of all three layers of cells—epiblast, mesoblast, and hypoblast. The rest of the upper half of the vesicle consists of two layers, epiblast and hypoblast, the slight constriction round the middle of the vesicle, seen in the right-hand figure, marking the limit to which the hypoblast has extended; and finally, the lower half of the vesicle, below the constriction, consists of epiblast alone. The whole vesicle is still invested by the *zona pellucida*, which is not shown in the figure.[1]

Formation of the embryo.—During the seventh day a narrow opaque patch—the *primitive streak*—appears in the posterior half of the embryonic area; and in front of this

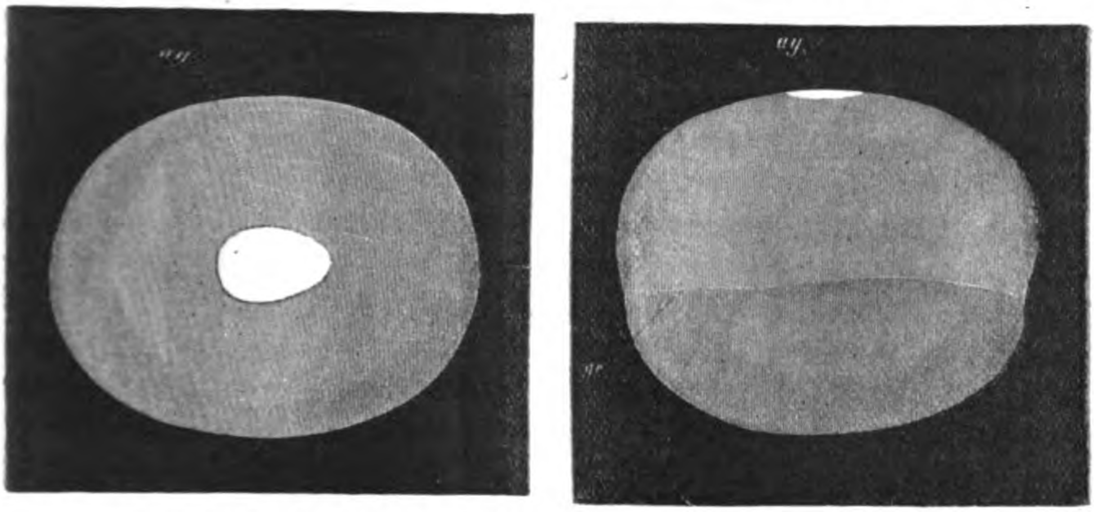


FIG. 18.—Diagrammatic views of the Blastodermic Vesicle of a Rabbit on the seventh day. (From Balfour, after Ed. v. Beneden.)

In the left-hand figure, the vesicle is seen from above; in the right-hand figure, from the side. The white patch (*ag*) is the germinal area; and the slight constriction (*ge*) marks the limit to which the hypoblast has extended.

streak there is formed, on the eighth day, a shallow median groove — the *medullary groove* (fig. 19), bounded by two folds—the *medullary folds*. This groove rapidly deepens; the two folds bounding it bend over towards one another, meet and fuse, thereby converting the groove into a closed tubular canal —the *neural canal*—which is the rudiment of the central nervous system, one of the very earliest systems to appear in the embryo, and which becomes differentiated into the brain in front

[1] The actual formation of the three germinal layers of the rabbit is probably not so simple as is described above, and is not yet thoroughly understood. According to Balfour and Keepe, the 'hypoblast' cells of figs. 16 and 17 divide into two layers, whereof the upper fuses with the epiblast, of which it becomes part, while the lower layer remains as the definite hypoblast of the embryo. The mesoblast, which appears later than the other two layers, is formed partly from epiblast and partly from hypoblast.

and spinal cord behind. From the mode of its formation—at first an open groove—it is clearly lined by, and indeed formed from the epiblast, the most superficial of the three layers of the embryonic area.

At the sides of this medullary or neural canal, about the ninth day, the mesoblast becomes divided into a number of somewhat cubical masses arranged in a linear series on either

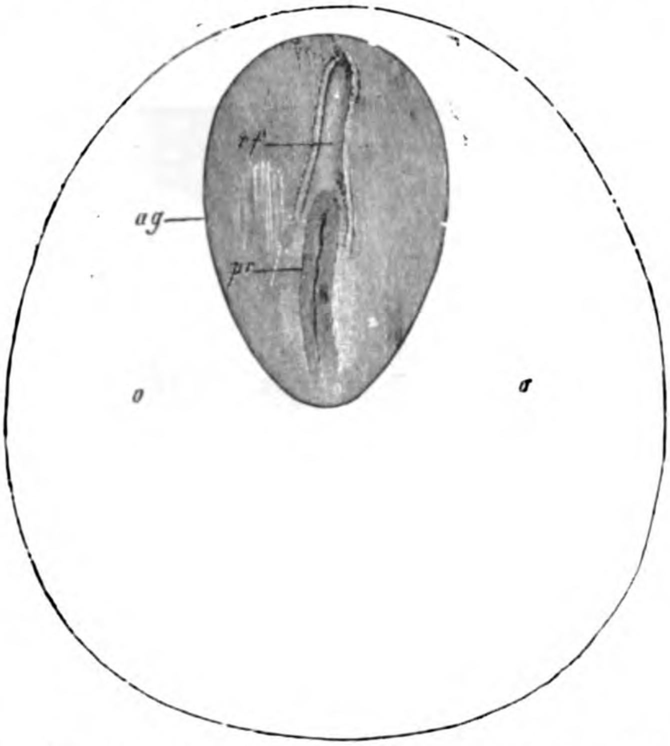


FIG. 19.—Embryonic area of a Rabbit's Ovum of the seventh day. (From Kölliker).

The shaded part (*ag*) is the embryonic area. *OO* is the region of the blastodermic vesicle immediately surrounding the embryonic area, into which the mesoblast has already spread, and in which blood-vessels will shortly appear. *pr.* Primitive streak. *rf.* Medullary groove.

side of the middle line; these masses (fig. 20) are the proto-vertebræ, and the transverse lines between them mark the division of the body into segments or somites.

We thus see that the formation of the embryo commences in the embryonic area of the blastodermic vesicle; and, further, that if the vesicle be placed with the embryonic area upwards, as in the right-hand figure of fig. 18, then the dorsal surface of the embryo, indicated by the central nervous system, will be directed upwards; and the ventral surface downwards, *i.e.* towards the cavity of the blastodermic vesicle. The head end is indicated in fig. 20, by the dilatations of the neural canal forming the lobes of the brain, and notably by the two large lateral outgrowths from its front end which forms the optic vesicles.

Yolk-sac, or umbilical vesicle.—Not only does the development of the embryo commence in the embryonic area, it is

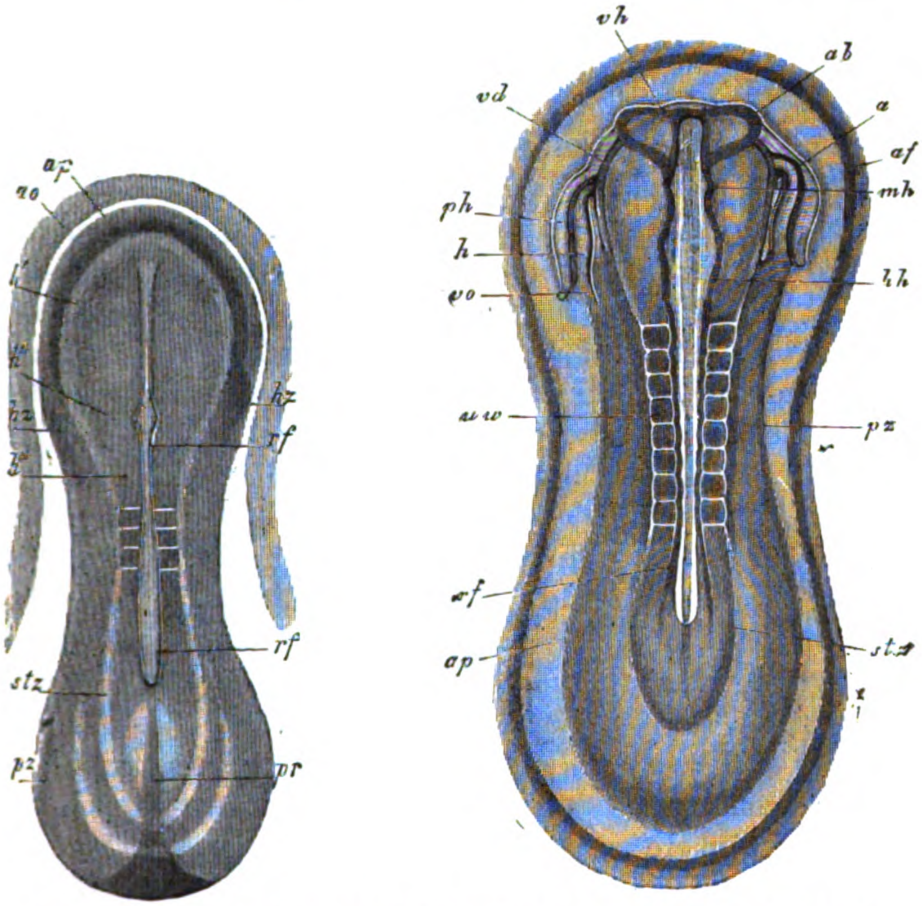


Fig. 20.—Rabbit Embryos of about the ninth day, seen from the dorsal side. (From Kölliker).

ab. Optic vesicle. *af.* Amnion. *ap.* Area pellucida. *h* and *hz.* Heart. *h'.* Medullary plate in region of future fore-brain. *h''.* Medullary plate in region of future mid-brain. *hh* and *h'''.* Hind brain. *mh.* Mid-brain. *ph.* Pericardial section of body cavity. *pz.* Lateral zone. *pr.* Primitive streak. *rf.* Medullary groove. *str.* vertebral zone. *uw.* Protovertebræ. *vh.* Fore-brain. *vo.* Vitelline vein.

also confined to it. About the ninth day the embryo begins to be marked off by a slight constriction from the rest of the blastodermic vesicle. This constriction commences first and is most marked at the anterior end of the embryo, where it receives the name of the head-fold; it is more prominent at the posterior end or tail-fold than at the sides. Its effect, well shown in fig. 22, 2, is to gradually pinch off the embryonic portion from the rest of the blastodermic vesicle, which forms then a thin-walled sac filled with fluid, and connected with the embryo by a stalk, which, at first short and wide (fig. 22, 2), becomes, as the constriction deepens (fig. 22, 4, 5), longer and narrower.

The portion of the blastodermic vesicle which is separated in this way from the embryonic portion, and takes no direct part in the formation of the embryo, is spoken of as the *yolk-sac* or *umbilical vesicle*, and the stalk connecting it with the embryo may be called the *yolk-stalk*.

Alimentary canal.—From the mode of formation of this umbilical vesicle, and from an examination of fig. 22, it is clear that there will be formed underneath the embryo a cavity closed in front and behind by the head and tail folds, but opening freely in the middle portion of its length through the yolk-stalk into the cavity of the umbilical vesicle—*i.e.* into the cavity of the original blastodermic vesicle, of which it is really a portion. This cavity, which it is also clear from the figures is lined by the hypoblast, or lowermost of the three layers of the embryonic area, is the rudiment of the alimentary canal of the embryo. From the mode of its development it is clear that there is at first neither mouth nor anus, that the alimentary canal, indeed, has at this stage no communication whatever with the exterior. Its communication through the yolk-stalk with the cavity of the yolk-sac is at first (fig. 22, 2) a very wide one, but as the constriction separating the embryo from the yolk-sac gets more and more marked, the yolk-stalk necessarily becomes narrower and narrower (cf. figs. 22, 3, 4, 5), until ultimately its cavity becomes obliterated, and the alimentary canal becomes a completely closed tube.

The mouth and anus develope at a comparatively late period as pittings-in of the surface of the body, which gradually deepen until they meet with and open into the alimentary canal, which then first acquires its definite communications with the exterior. The mouth opening is formed before the anal one, which is usually not completed until very late in development. In exceptional cases it may not be formed at the time of birth, thus giving rise to congenital occlusion of the rectum.

The whole embryo now grows rapidly, and about the twelfth day acquires the shape and appearance shown in fig. 21, the rudiments of all the important organs being by this time established. The embryo is no longer straight, but is very strongly bent on itself, the dorsal surface being convex and the ventral concave; the head end is disproportionately large, as indeed it is throughout the whole of development; in the neck a series of transverse ridges, the *visceral arches*, have appeared, and between these are slits, the *visceral clefts*, which lead into the alimentary canal, and so place it in communication with the exterior. Of the visceral arches the most anterior pair

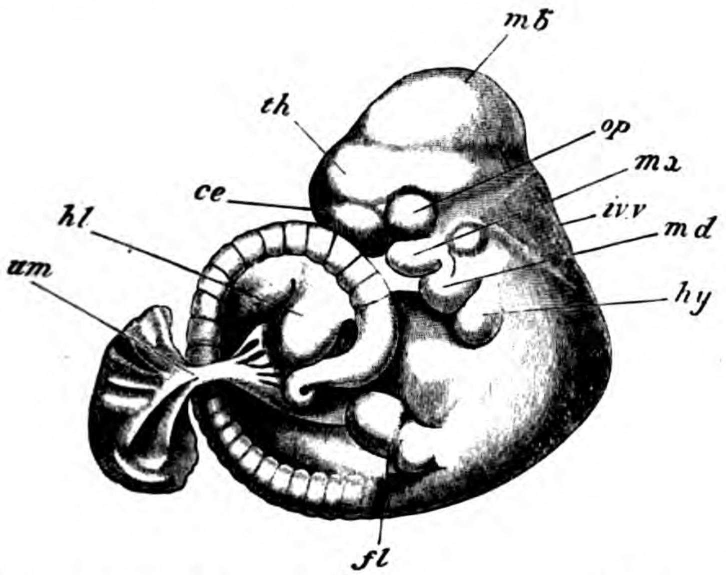


Fig. 21.—Rabbit Embryo of about the twelfth day. (From Balfour, after Weldon.)

ce. Cerebral hemisphere. *fl.* Fore-limb. *hl.* Hind-limb. *hy.* Hyoid arch. *iv.v.* Fourth ventricle. *mb.* mid-brain. *mx.* Maxillary arch. *md.* Mandibular arch. *op.* Eye. *th.* Thalamencephalon. *um.* Umbilical stalk.

(fig. 21, *m x*) lie at the sides of the mouth and form the basis of the upper jaw; the second pair (fig. 21, *m d*) bound the mouth behind and give rise to the lower jaw; while the third pair (fig. 21, *h y*) form ultimately part of the hyoidean apparatus.

Rudiments of eyes (fig. 21, *o p*) and ears are present, as are also both pairs of limbs (fig. 21, *f l*, *b l*) in the form of simple buds, presenting as yet little or no trace of subdivision into segments.

The embryonic membranes.—We have now to consider certain structures which, though not forming any actual part of the embryo itself, or only doing so to a very limited extent, yet play an exceedingly important part in its development. Together with the formation of these embryonic membranes on the side of the ovum, it will be convenient to consider certain changes which occur in the uterus itself, and which are closely connected with the former.

The decidua.—Previous to the arrival of the ovum the lining membrane of the whole of the uterus has become much swollen and very vascular, and has undergone other changes, which will be more fully described hereafter, leading to the formation of what is called the *decidua*, a membrane specially developed to receive the ovum. The ovum on entering the uterus comes in contact with the *decidua* at some spot, and adheres to it; the *decidua* soon grows up around the ovum, forming at first a low wall round it, and ultimately completely enveloping it. The portion of the *decidua* which grows over the ovum in this way receives the name *decidua reflexa*; the part with which the ovum first came in contact is the *decidua serotina*; and the part lining the rest of the uterus, the *decidua vera*; this latter is of no further use, and soon disappears; it is apparently only developed because it is uncertain with what portion of the uterus the ovum will first come in contact, and consequently all parts must be ready to receive it.

The ovum imbedded in the *decidua reflexa* at first occupies but a small portion of the cavity of the uterus, but owing to its rapid growth it soon fills the greater part, and ultimately, in woman, the whole of the uterus, the *decidua reflexa* coming in contact with the *decidua vera*. A stage shortly before the occurrence of this event is shown for the human embryo in fig. 37, p. 94.

We now return to the ovum itself. At the stage represented in fig. 22, I, which is slightly older than that in fig. 18, the ovum or blastodermic vesicle is completely surrounded by the *decidua reflexa*, and has the following structure. The whole vesicle is invested in the *zona pellucida*, which gives off from its outer surface a number of little processes or villi (fig. 22), which fit into little depressions in the *decidua reflexa*. The blastodermic vesicle itself presents in the embryonic area all three layers, epiblast, mesoblast, and hypoblast,

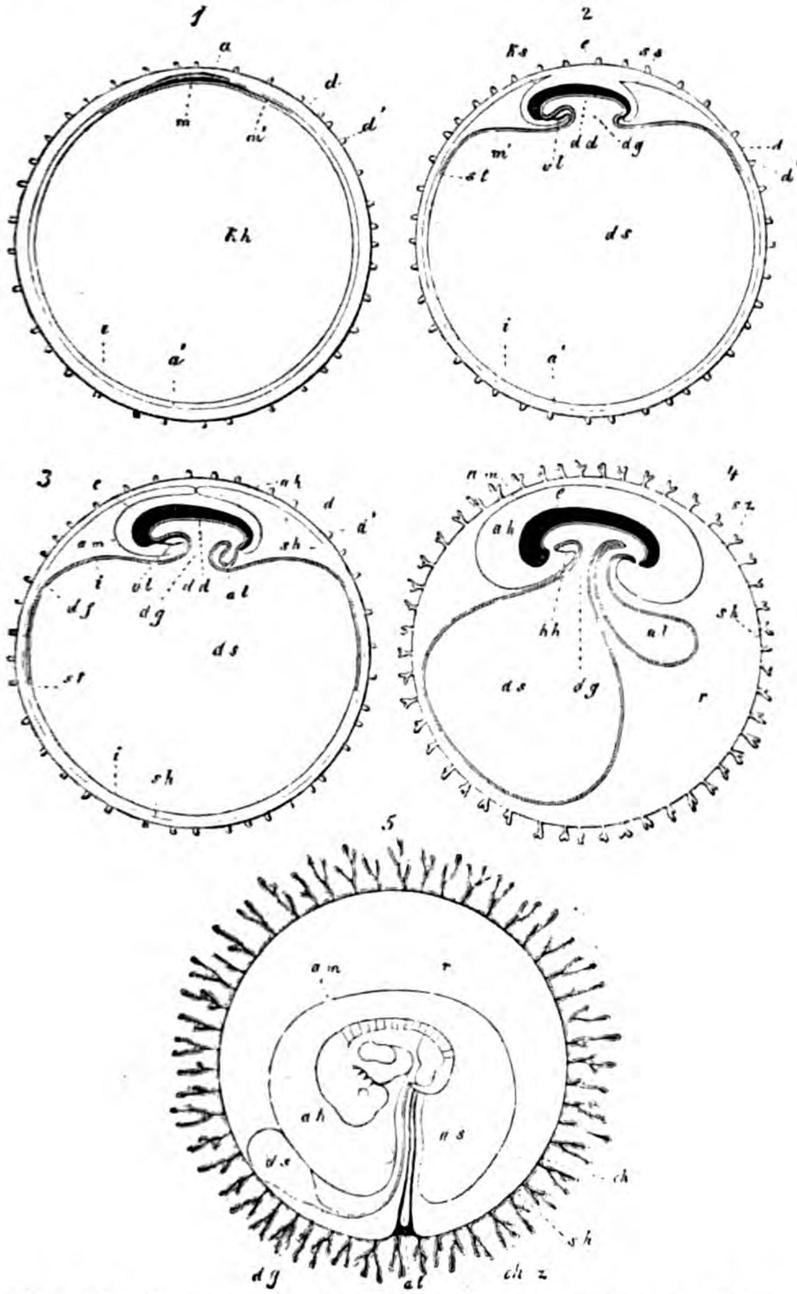


FIG. 22.—Diagrammatic figures, illustrating the Development of the Mammalian Embryo and the Fœtal Membrane. (From Kölliker.)

1. The blastodermic vesicle invested in the zona pellucida, and showing at its upper pole the embryonic area.
2. Shows the pinching off the embryo from the yolk-sac, and the formation of the amnion.
3. Further development of amnion, and commencement of allantois.
4. Completion of amnion, and growth of allantois. The false amnion, or subgonal membrane, gives off villous processes.
5. The allantois has grown all round the vesicle, and gives off processes into the villi which are much larger than before. The yolk-sac is greatly reduced in size.

a. Epiblast of embryo. *a'*. Epiblast of non-embryonic part of blastodermic vesicle. *al*. Allantois. *am*. Amnion. *ch*. Chorion. *ch*. *z*. Chorionic villi. *d*. Zona pellucida. *d'*. Processes of zona. *dd*. Embryonic hypoblast. *df*. Area vasculosa. *dg*. Yolk-stalk. *ds*. Yolk-sac. *e*. Embryo. *hh*. Pericardial cavity. *i*. Non-embryonic hypoblast. *kh*. Cavity of blastodermic vesicle. *ks*. Head-fold of amnion. *m*. Embryonic mesoblast. *n*. Non-embryonic mesoblast. *r*. Space between true and false amnion. *sh*. False amnion, or subgonal membrane. *ss*. Vail-fold of amnion. *st*. Sinus terminalis. *si*. Processes of zona pellucida. *vl*. Ventral body-wall of embryo.

and as shown in the figure the mesoblast has extended a little way beyond the embryonic area, so that surrounding this area is a ring in which, as in the area itself, all three layers are present. The rest of the vesicle consists of two layers, epiblast (or ectoderm of Kölliker) and hypoblast (entoderm, Kölliker), the latter having now grown so as to line the whole of the vesicle (cf. the earlier stage represented in fig. 18, in which it has only extended about half-way round).

Splitting of mesoblast.—The mesoblast (mesoderm, Kölliker) continues to spread by growth at its margin, and ultimately, like the hypoblast, extends completely round the vesicle. About the time of the first appearance of the constriction separating the embryo from the yolk-sac, the mesoblast splits into two layers. Owing to this splitting, which takes place in the marginal though not in the axial part of the embryonic area, as well as in the part of the mesoblast outside the embryo, the portion of the blastodermic vesicle in which it occurs consists now of four instead of three layers—*i.e.* firstly, the epiblast; secondly, the upper or *somatic* layer of the mesoblast; thirdly, the lower or *splanchnic* layer of the mesoblast; and fourthly, the hypoblast.

The upper or somatic layer of the mesoblast becomes very closely connected with the epiblast, the two together practically forming a single layer, which is spoken of as the *somatopleure*. Similarly, the lower or splanchnic layer of the mesoblast becomes intimately connected with the hypoblast, with which it forms what is practically a single layer—the *splanchnopleure.*

The body cavity.—In the embryo itself the somatopleure forms the lateral and ventral portions of the body wall, while the splanchnopleure forms the similar portions of the wall of the alimentary canal. The space between somatopleure and splanchnopleure, *i.e.* the actual split between the two layers of the mesoblast, becomes the pleuroperitoneal or body cavity of the embryo. These relations will become more evident from an inspection of fig. 23.

The amnion.—Outside the embryo the somatopleure rises up so as to form a low wall surrounding the embryonic area. This wall, which receives the name of amnion, rapidly increases in height (fig. 22, 2), and the folds forming it arch over the back of the embryo so as partially to cover it. A little later the folds meet one another along the middle line of the back, and so completely cover the embryo (fig. 22, 3). At this period we have an inner layer of the amnion (fig. 22, 3 *a m*) closely investing the embryo, and an outer layer (fig. 22, 3 *s h*) lying immediately beneath the *zona pellucida*, and continuous below with the outer wall of the yolk-sac, *ds*.

A little later still the two layers of the amnion coalesce along their line of meeting above the back of the embryo, and the inner

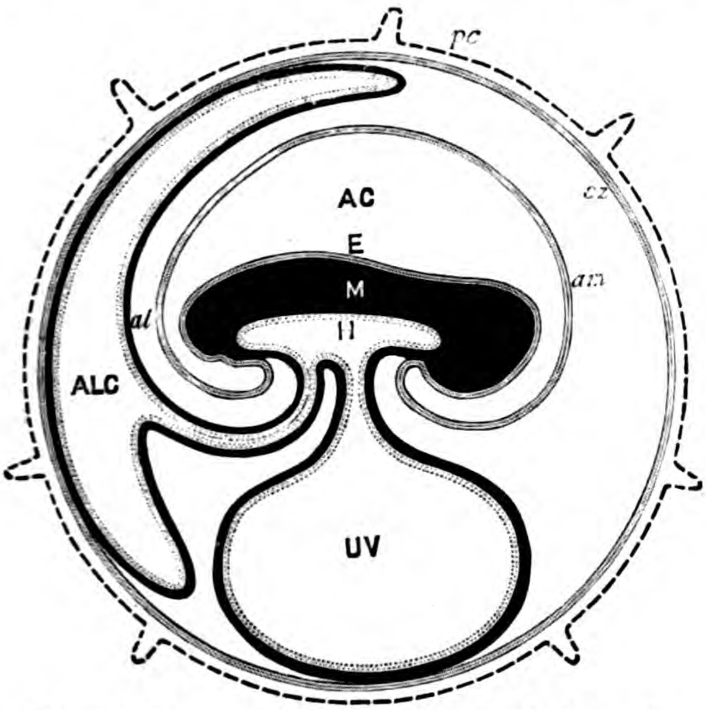


FIG. 23.—Diagram of the Fœtal Membrane of a Mammal. (From Balfour, after Turner).

Structures which either are or have been, at an earlier period of development, continuous with one another, are represented by the same character of shading.
AC. Amnionic cavity. ALC. Allantoic cavity. *al.* Allantois. *am.* Amnion. E. Epiblast of embryo. H. Hypoblast of embryo. M. Mesoblast of embryo. *pc.* Zona, with villi. *sz.* False amnion or subgonal membrane. UV. Yolk-sac or umbilical vesicle.

layer becomes completely separated from the outer layer (fig. 23). At the same time, owing to the splitting of the mesoblast extending all round the yolk-sac, the outer layer of the amnion becomes completely separated from the yolk-sac, and now forms a thin lining membrane closely applied to the inner surface of the *zona pellucida*.

The condition of things at this stage is shown in figs. 22, 4, and 23. The outer layer of the amnion, *sh* in fig. 22, 4, and *sz* in fig. 23, lining the *zona pellucida*, sometimes receives the name *false amnion*, but is better called the *subzonal membrane*; the inner layer *am*, which forms an investment over the back of the embryo, but at some little distance from it, and which is clearly, from its mode of formation as a fold of somatopleura, continuous with the body wall of the embryo, is spoken of as the *true amnion*, or simply as *the amnion*.

It will further be evident from the figures that the space between the two layers of the amnion *r* in fig. 22, 4, being part of the space formed by the splitting of the mesoblast, is continuous with the body cavity of the embryo.

It is customary to speak of the space between the inner layer of the amnion and the embryo, AC in fig. 23 , which is really not between the layers of the amnion at all, as the *amnionic cavity*.

The allantois.—During the growth of the amnion a small hollow bud grows out from the ventral surface of the alimentary canal close to its posterior extremity. This is known as the *allantois* (fig. 22, 3). As it is an outgrowth of the alimentary canal, its walls must consist, like those of the alimentary canal itself, of splanchnopleure, *i.e.* of an outer layer formed by the splanchnic layer of the mesoblast, and an inner lining of hypoblast.

The allantois hangs down at first into the body cavity; it grows rapidly, and soon passes out beyond the embryo into the space between the two layers of the amnion, which space we have already seen to be directly continuous with the body cavity of the embryo (cf. figs. 22, 4, and 23). Continuing its growth, it comes in contact with the subzonal membrane, and then spreads out so as to form an inner lining to this membrane, which, growing at its edge, ultimately extends round the whole or greater part of the ovum (cf. figs. 22, 5, and 23).

The chorion.—The outer wall of the ovum now consists of three layers—viz. the *zona pellucida* on the outside; inside that, the subzonal membrane or false amnion; and inside that again, the allantois. These three layers, originally distinct, soon become fused completely with one another, and are spoken of collectively as the *chorion*.

The vascular system of the embryo.—Blood-vessels are developed in the embryo at a very early period. The heart appears in an embryo of about the age represented in fig 22, 2, *i.e.* shortly after the commencement of the constriction separating the embryo from the yolk-sac, as a pair of tubes one on either side of the body; these soon meet one another and fuse underneath the throat to form a single tubular heart, in connection with which are vessels developed in the mesoblast both of the embryo and of the yolk-sac.

Circulation of yolk-sac.—The heart very soon commences beating: it drives the blood forwards through a series of aortic arches on either side, whereof one is situated in each of the visceral arches already described; from these some of the blood goes forwards to the head, but the greater part is sent back to the hinder part of the body along a couple of arteries, the dorsal aortæ, which subsequently unite together to form the single dorsal aorta of the adult. From the dorsal aortæ vitelline arteries take the blood to a network of vessels developed in the mesoblast of the yolk-sac, and from these it is returned to the posterior end of the heart by vitelline veins.

Circulation in allantois.—The allantois is from its earliest appearance very vascular, and its blood-vessels increase very rapidly in size as it develops. Two very large branches from the posterior end of the dorsal aorta, the allantoic or umbilical arteries, carry blood to it from the embryo, and a couple of umbilical veins return it back again to the heart of the embryo.

The placenta.—At the stage represented in fig. 22, 4, it will be remembered that the whole ovum is embedded in the *decidua reflexa* formed by the mucous membrane of the uterus of the mother. The outer wall of the ovum or blastodermic vesicle is formed by the *zona pellucida* and the subzonal membrane, and its outer surface is studded with small processes or villi (fig. 22, 4 *sz*) which fit into corresponding depressions or pits in the *decidua reflexa*, and so serve to connect the two structures moderately firmly together.

As the allantois develops these villi become larger and often branch, and when the chorion is established by the allantois reaching the subzonal membrane and spreading out so as to form an inner lining to it, vascular processes from the allantois penetrate into the villi (fig. 22, 5). At the same time the maternal vessels in the *decidua reflexa* surrounding the ovum become very greatly developed. In this way it comes to pass that the prolongations of the blood-vessels of the embryo contained in the villi of the chorion come into very close proximity with the blood-vessels of the mother contained in the *decidua reflexa*, *i.e.* the mucous membrane of the uterus; and the two sets of structures, fœtal and maternal, that are thus brought into close relation with one another, together make up what is called the *placenta*.

There is never direct continuity between the fœtal and maternal vessels, yet the two lie so close together side by side that an exchange of contents can take place through the walls of the blood-vessels; and in this way the fœtal blood receives nutrient matter from the blood of the mother, and sends it by the umbilical veins to the embryo to serve for its nutrition and growth; while, on the other hand, the excess of effete matter in the blood of the fœtus passes into that of the mother and is so got rid of.

The fœtal villi are at first (fig. 22, 5) uniformly distributed all over the chorion; but, after a time (fig. 45) they become in the human species much smaller in the region of the *decidua reflexa* and ultimately disappear from this part. To compensate for this loss they attain a very much higher development in the part where they remain, that part which we have called *decidua serotina*. Here both the fœtal and maternal structures exhibit very great complexity; the maternal vessels dilate enormously so as to form large sinuses, while the fœtal villi branch and subdivide so as to form extremely complex tufts, which push the walls of the maternal sinuses before them, and so hang down into these sinuses bathed on all sides by the maternal blood.

The relations between the fœtal villi and the maternal portion of the placenta are now so intricate that the former cannot be simply pulled away from the latter at birth, as occurs in many of the lower mammals, but the fœtal portion drags away with it considerable portions of the maternal part; this necessarily causes rupture of the large sinuses containing the maternal blood, and so leads to the hæmorrhage that invariably accompanies parturition in woman.

Umbilical stalk.—The amnion, which at first invests the embryo tolerably closely, later on grows rapidly so as to leave a considerable space—the amnionic cavity—between the embryo and itself. As shown in fig. 22, 5, the amnion as it recedes from the embryo forms an investment to the stalk of the allantois; and it is further evident from the figure that, in addition to the allantoic stalk, the yolk-stalk will also be included in this investment. The compound stalk formed in this way, which includes both the allantoic stalk with the placental vessels and the yolk-stalk with its vessels, and is ensheathed, as stated above, by the amnion, receives the name of *umbilical stalk*. It serves, as shown in figs. 22, 5 and 45, to attach the embryo to the placenta.

Bladder and urachus.—It will be remembered that the allantois was at first a *hollow* bud, its cavity communicating with the alimentary canal, of which it was indeed a diverticulum (fig. 22); the cavity soon becomes lost in the placenta itself, if, indeed, it is ever present there; it may persist in the umbilical stalk, more or less completely, throughout development; within the body of the embryo the portion of the cavity next to the alimentary canal becomes ultimately the urinary bladder, while the portion of the stalk extending from this part to the body wall of the embryo becomes the urachus.

Fate of the germinal layers.—It will be convenient to conclude this chapter with a very brief account of the ultimate fate of each of the three germinal layers of which the embryonic area consisted at a very early stage, viz. epiblast, mesoblast, and hypoblast.

In the first place, it will be noticed that out of one or other of these three layers every portion of the body of the embryo or fœtus is derived, directly or indirectly.

The epiblast, which is clearly the most superficial layer of the three, gives rise to the epidermis covering the whole of the body, and also, as we have seen, to the whole of the central nervous system, both brain and spinal cord, and indeed to the nerves themselves inasmuch as these arise as outgrowths from the central nervous system. It also forms the lining of the mouth and anus, which as already noticed are pittings-in from the exterior; and it takes a very important share in the formation of the organs of special sense.

The hypoblast, or lowermost of the three layers, forms the epithelium lining the alimentary canal and its glands, and also that lining the bronchi and lungs, which arise as diverticula of the alimentary canal. It also forms a longitudinal solid rod—the notochord—which runs the whole length of the body underneath the central nervous system in the position afterwards held by the vertebral centre and the base of the skull.

The mesoblast forms all the rest of the body: muscles, bones, connective tissue, and blood-vessels, wherever they occur, are mesoblastic; also the peritoneal epithelium and the urinary and reproductive organs.

CHAPTER IV.

DEVELOPMENT OF THE HUMAN EMBRYO AND FŒTUS.

CONCERNING the early development of the human embryo, our knowledge is still in a very unsatisfactory condition. Of the stages passed through during the first fortnight after impregnation we know exceedingly little, and those occupying the third week are only very imperfectly known to us; but from the end of the third week onwards the various stages of development have been tolerably fully and satisfactorily described.

For reasons stated in the preface, we shall here give a brief account of such early stages as have been described, and endeavour, by the aid of the facts set forth in the preceding chapter, to frame something approaching to a consistent account of the development of the human embryo from the ovum.

Estimation of age of embryos.—A preliminary difficulty, and one that cannot be satisfactorily disposed of at present, lies in the fact that, after we have obtained an embryo, we have no really trustworthy means of determining its exact age. One of the most constant accompaniments of pregnancy is cessation of menstruation; and His, one of the greatest authorities on the subject, considers that this fact affords the most trustworthy basis for estimating the age of embryos. He lays down the following rule [1]:—The age of an embryo is the time that has elapsed since the first day of the first omitted period. Thus, supposing the commencement of a period to be due on January 5, and that when this time comes the period is omitted, but some time subsequently, say February 9, an embryo is

[1] His, *Anatomie Menschlicher Embryonen.* To this very important and beautifully illustrated work, which has been freely used in compiling the present chapter, the reader is referred for more detailed descriptions of the development of the human embryo than can be given here.

aborted; then the age of that embryo would be, according to His, the interval between January 5 and February 9—*i.e.* five weeks.

In arriving at this result His argues in the following manner:—The ovum leaves the ovary either at or shortly before the menstrual period: if fertilised, presumably by spermatozoa previously introduced, menstruation does not occur; but the changes in the uterine mucous membrane, instead of, as usual, becoming retrogressive, continue to be progressive, and so prepare the uterus for the reception of the ovum. Hence the first omitted menstrual period corresponds in point of time with the fertilisation of the ovum; and hence the age of the embryo may be taken as the time that has elapsed since the first omitted period.

This method of calculation is, however, open to very grave objections. We have seen in the preceding chapter that there is much reason for thinking that the decidual membrane, which is broken up and discharged at the menstrual period, is prepared for the reception, not of the ovum which is liberated from the ovary at the time of the period, but of the ovum set free at the last preceding period. The process of fatty degeneration associated with the break-up and discharge of the decidua has almost certainly commenced before the occurrence of the period; and it is almost inconceivable that the mere act of fertilisation at the commencement of the Fallopian tube of an ovum which, in all probability, will not reach the uterus for at least a week, should be able to arrest the degenerative changes already commenced in the decidua, stop suddenly the menstrual discharge that is on the verge of taking place, and convert the retrogressive changes of the decidua into progressive ones. His' theory also does not accord with the well-established fact that, in order to ensure pregnancy, the most favourable time for copulation is shortly after the period, in which case fertilisation and the commencement of development of the ovum could hardly be coincident with the first omitted period.

For these reasons the theory advocated by Pflüger and others appears preferable, according to which the decidua discharged at any period is not related to the ovum set free at that period, but to the ovum liberated at the immediately preceding period. On this view, however, we are left absolutely without means of determining the age of embryos; and although an exact determination is immaterial in the case of later embryos, yet when we are dealing with early ones it is a point of great importance.

Partly for this reason, and partly because it has hitherto been customary to calculate the age according to the system of which His is the most recent advocate, we shall in this chapter give the ages estimated in this manner—*i.e.* by the age of an embryo will be meant the interval between the first day of the first omitted period and the time at which the embryo is discharged from the uterus. It must be repeated, however, that this method of calculation can only be justified by its general adoption, its readiness of application, and most of all by the fact that no other precise system has yet been proposed. Viewed on its own merits the method is not only imperfect, but is even opposed to many well-established facts.

The first week.—The process of segmentation in the human ovum has not yet been seen. It is, however, in the highest degree probable that segmentation takes place during the passage of the ovum along the Fallopian tube, and that it is effected in a manner practically identical with that described in the preceding chapter in the case of the rabbit.

Neither do we know the length of time taken by the human ovum to travel down the Fallopian tube to the uterus. According to the best authorities this passage 'probably occupies not less than eight days in the human subject.' In the rabbit we have seen that the uterus is reached on the third day, so that either the process of development must from the first be much slower in the human embryo than in the rabbit, or else the human ovum must enter the uterus in a far more advanced condition than happens in the case of the rabbit. Such evidence as we have points rather in favour of the former alternative.

Second week.—Of embryos towards the close of the second week of development, a few examples have been described; but there is some doubt whether any of these few can be regarded as perfectly normal.

Reichert's embryo.—The best known instance is an ovum described by Reichert, and estimated to be of about the thirteenth day.

This ovum, which is represented four times the natural size in figs. 24 and 25, was found *in situ* in the uterus of a woman who had committed suicide. There was a fully formed *decidua reflexa*, within which was the ovum itself (figs. 24 and 25), a vesicular body of the shape shown in the figure, measuring 5·5 mm. along its greater diameter, and 3·3 mm. from side to side. Of the two sides the one turned towards the uterus (the upper surface in fig. 25), was more convex than the opposite side, facing the *decidua reflexa*. The margin of the vesicle, as shown in the figure, was thickly fringed with villi, the largest of which were 0·2 mm. long, and slightly branched. The villi were absent both from the uterine surface and from the opposite

FIGS. 24 and 25.—Front and side views of Reichert's Ovum. (From *Kölliker.*) × 4.

one, leaving two bare circular patches. In the middle of the uterine patch was a smaller circular spot of a darker colour, 1·6 mm. in diameter, and indicated in the figure.

Not the slightest trace of any embryonic structure was discovered; there was no indication of either primitive or medullary grooves. The wall of the vesicle is described as consisting of a single layer of epithelial cells prolonged outwards to form the villi. In the circular patch on the uterine surface, which is spoken of as the germinal area, a second inner layer of finely granular cells was present. The cavity of the vesicle was occupied by a gelatinous fluid, traversed by a network of fine fibres, and containing within it a spherical body.

Ova of somewhat similar appearance, and of apparently about the same age, have been described by Wharton Jones, Breuss, Kollmann, and others; but in none of these cases was any trace of an embryo discovered. The chief points that we learn from these other specimens are, first, that the spherical body described by Reichert is made up of nucleated cells, and is apparently solid and in connection with the germinal area; and, secondly, that it is highly probable that the wall of the vesicle really consists, not of a single layer, but of two layers, of which the inner one is of the nature of connective tissue, and *therefore of mesoblastic origin.*

It is not easy to make any satisfactory comparison between these ova and the stages already described as occurring in the rabbit, and the difficulty is much increased by the doubt we must feel as to whether the ova in question are perfectly normal, or are not to a greater or less extent pathological. As the different ova described appear, however, to agree in the most important points, it is advisable to make such comparison as is possible between them and the more usual processes of mammalian development.

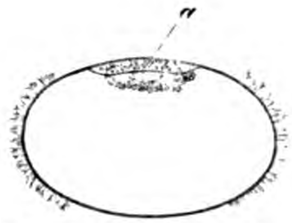


FIG. 26.—Diagrammatic section of Reichert's Ovum. (From *His.*) × 5.
a. The germinal area.

His considers that the stage reached by these ova is a very early one—but very little older indeed than that represented for the rabbit in fig. 17; and he illustrates his views by the diagrammatic section of Reichert's ovum given above (fig. 26).

He considers that the outer wall of the vesicle consists of epiblast alone; that hypoblast is present only in the germinal area, where it forms the inner layer described by Reichert; and that the spherical mass of cells is also hypoblast, and will afterwards become hollowed out and expanded to form the yolk-sac.

Against this interpretation it must be pointed out (1) that the stage in question is in the rabbit a very early one, and it would follow that, except in its much greater size, the human ovum on the thirteenth day has advanced no further than the rabbit's of the third day, which, considering the usual rapidity of the early embryonic processes, would be at least very extraordinary; (2) that the evidence is very strong indeed—practically conclusive—for thinking that the wall of the vesicle has in addition to the epiblast layer an inner connective tissue lining, which is even described by some observers as vascular and which must be of mesoblastic origin. It appears, therefore, certain that the stage reached is a considerably later one than supposed by His; and it is also clear that, if normal, it does not exactly correspond to any definite stage in the development of the rabbit.

The human ovum, indeed, would appear to be peculiar (1) in the unusually early[1] or 'precocious' development of a layer

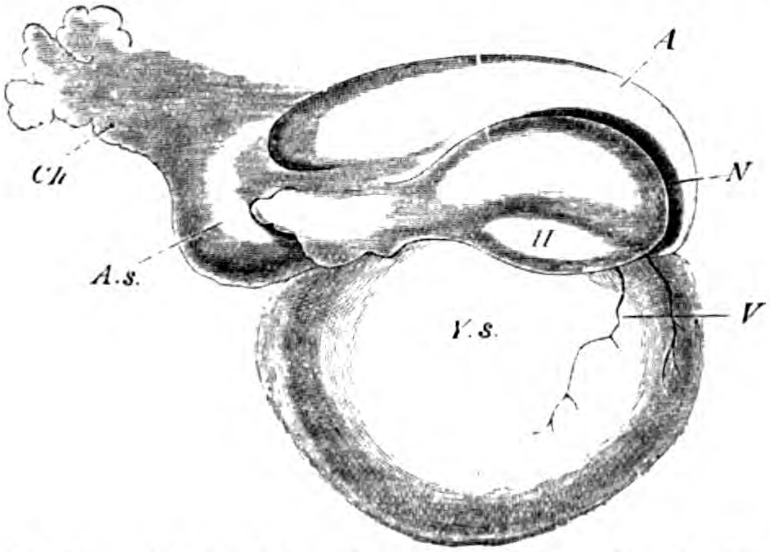


FIG. 27.—Human Embryo of about the fourteenth day, seen from the right side. (From *His.*) × 20.

A. Amnion. *A.s.* Allantoic stalk, connecting the hinder end of the embryo with *Ch.* The Chorion. *H.* Heart. *N.* Medullary or neural groove. *V.* Blood-vessel of yolk-sac. *Y.s.* Yolk-sac.

of vascular mesoblast lining the blastodermic vesicle; and (2) in the very exceptionally late appearance of definite rudiments of the embryo itself. It is extremely important that no opportunities of determining whether the latter feature is normal or pathological should be lost in future.

His' embryo E.—The youngest human ovum containing a distinct embryo is one obtained by His in 1869, and carefully described by him, and is at present deposited in the Anatomical Museum at Basle. This embryo, which is considered by His to be of about the fourteenth day, is represented magni-

[1] Unusually early, not in point of absolute time, but relatively to the other processes of development. Cf. Balfour, *Comparative Embryology*, vol. ii. p. 225.

fied twenty diameters, in fig. 27. The whole ovum is an oval vesicle, measuring along its greater diameter 8·5 mm., and along its lesser 5·5 mm., and covered all over with branched villi. The contained embryo is 2·1 mm. in length, and attached at its hinder end by a short thick stalk ·5 mm. long to the inner surface of the vesicle. The embryo is separated by a very slight constriction—most marked at its anterior end—from the yolk-sac (fig. 27, *Y.S.*), which measures 2·3 by 1·6 mm. Covering over the embryo, but at a short distance from it, is a membranous fold A, which is clearly the true amnion. The embryo itself presents on its dorsal surface a medullary groove, bounded by two prominent medullary folds; the only other organ visible is a slightly prominent fold between the embryo and yolk-sac (fig. 27, *H*), probably the rudiment of the heart; two vessels arising close to this were traced over the yolk-sac.

Other embryos of apparently about the same age have been described by His, Allen Thomson, and others, which agree in their main features with that just noticed, and differ principally in being rather further advanced—the constriction between embryo and yolk-sac being more marked, the embryo itself being rather larger, and the medullary groove both deeper and longer.

On comparing these embryos with the corresponding stages in the rabbit, the most marked difference is seen to lie in the fact that the human embryo is already at this very early period connected with the chorion by a stalk, while in the rabbit this connection is not acquired till considerably later. This stalk is clearly the allantois, so that the difference might be expressed by saying that the allantois develop earlier in the human embryo than in the ordinary mammal. But this is not all. Not only does the allantois develope earlier; it also develops in a totally different manner. Usually among mammals the allantois arises, as we have seen above (*cf.* fig. 22), as a hollow saccular outgrowth from the alimentary canal, which grows to and becomes connected with the chorion. In the human embryo, however, the allantois appears, from the researches of His, not to arise as an outgrowth from the alimentary canal at all, and, indeed, never to pass through the saccular stage shown in figs. 22 and 23, but to be present from the very earliest period as a stalk connecting the hinder end of the embryo with the chorion.

The following series of diagrams, copied from His, will make this clear, and will show how the stage now being considered may be derived, and probably is actually arrived at, from the stage represented by Reichert's ovum. The figures represent a series of diagrammatic longitudinal sections through ova at successive stages of development. Fig. 26, as we have seen, represents Reichert's ovum, with the exception that the layer of mesoblast, which is undoubtedly present as an inner lining to

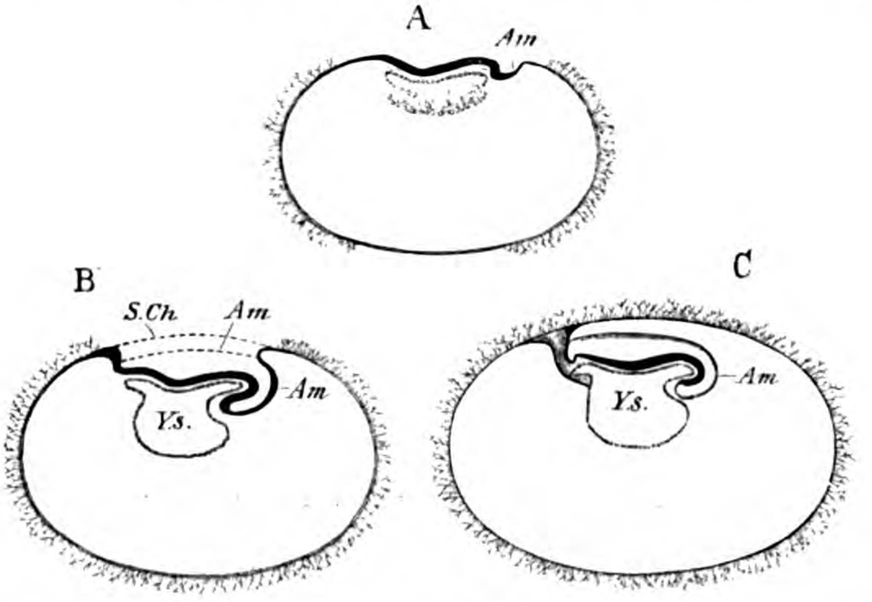


FIG. 28.—Diagrammatic longitudinal sections through Human Ova, representing stages (hypothetical) intermediate between Reichert's ovum and His' embryo E. (From *His.*) × 5.

A. Shows commencement of head-fold, and of amnion (*Am*). B. Rather later stage: the head-fold and amnion are more marked, as also is the yolk-sac (*Y.s.*). The hinder end of the embryo is continuous with the chorion through the allantoic stalk The dotted lines indicate, hypothetically, the subsequent growth of the amnion. C. A still later stage: equivalent to that of His' embryo E (*vide* fig. 27). The amnion is completed, and the villi extend completely round the ovum.

the wall of the vesicle, is omitted. In fig. 28 A the commencement of the formation of the embryo is indicated; the germinal area has become somewhat depressed, but at its anterior end (to the right in the figure) is lifted up slightly by a constriction—the head-fold. In fig. 28 B this head-fold has deepened, and the head-end of the embryo is now distinctly raised above the yolk-sac Y.S.; at the *hinder end of the embryo the germinal area, however, still preserves*, as in the former figure, *its primitive connection with the chorion.* In fig. 28 C the embryo has reached the stage shown in fig. 27; indeed, fig. 28 C is a diagrammatic longitudinal section through this very embryo. At the hinder end of the embryo the tail-fold has now just commenced; but this does not interfere with the stalk—the allantoic stalk—which still connects directly together the embryo and the chorion.

If this view is correct, it is clear that in the human embryo the allantois is formed unusually early, and in an altogether exceptional manner. We may clearly connect this 'precocious' development of the allantois with the 'precocious' appearance of the vascular layer of mesoblast lining the blastodermic vesicle in the stage represented by Reichert's ovum; and we may perhaps regard both features, in so far as they are exceptional, as examples of the tendency to abbreviation or shortening of the processes of development, which is a feature so constantly encountered by the student of embryology. The establishment of a vascular connection between the embryo and the chorion, and so indirectly with the mother, is as we have seen *the* characteristic feature of mammalian development, and therefore we need not wonder at finding in the most highly developed of all mammals this feature thrown back to an earlier stage than that at which it originally appeared, and hurried on prematurely, even at the expense (as it would seem) of the embryo itself, whose development is unusually retarded.

The series of figures given above indicate also the supposed stages in the development of the amnion, the sole peculiarity in which is that the head-fold—always the most prominent portion —here forms, with the side folds, the whole amnion, there being no tail-fold developed at all. After completion of the amnion, the villi, previously absent over the germinal area, extend all over the ovum, *cf.* fig. 28, C.

Summarising what we know about the processes of development in the first fortnight, it would appear probable that the ovum—fertilised in the upper part of the Fallopian tube—travels slowly down towards the uterus, which it reaches about the eighth day. While in the tube it almost certainly undergoes segmentation in the usual mammalian manner, but does not increase greatly in size; according to Allen Thomson 'its diameter on arriving in the cavity of the uterus does not probably surpass one-hundredth (·25 mm.), or at most one-eightieth, of an inch.' After entering the uterus it probably increases rapidly in size. It very early develops villi on its surface, and is completely enclosed in the *decidua reflexa* at any rate by the thirteenth day. In the development of the ovum the most noteworthy features appear to be the very early establishment of a lining of vascular mesoblast to the blastodermic vesicle, the very early appearance and peculiar mode of formation of the allantois, and the curiously late appearance of the embryo itself.

Krause's embryo.—Concerning the allantois it ought to be mentioned here that a human embryo of a very much later stage than those we have just considered—*i.e.* about the fourth week—has been described by Krause, in which there was no allantoic stalk connecting the embryo and chorion together, but the allantois hung down as a bag from the hinder end of the embryo, very much as shown in fig. 22, 4. As this is at present an isolated exception to the general rule concerning the allantoic stalk in human embryos, it is perhaps permissible to regard it merely as an abnormality, in which case it may be viewed in the light of a reversion to the primitive mode of development of the allantois.

Third week.—Of embryos belonging to the first half of the third week, only a very limited number have been accurately described and figured; but towards the close of the week specimens become far more abundant, and from this point onwards our knowledge of the development of the human embryo is in a tolerably satisfactory condition.

Fig. 29 shows the condition of the embryo at an age between the fifteenth and eighteenth days, as described and figured by Coste. The whole ovum measures 16·2 mm. along its greater diameter, and is covered exteriorly with short, slightly branched villi. The embryo is attached to the inner side of the chorion by the short allantoic stalk seen at the left-hand end of the figure A.S. The embryo itself is 4·4 mm. in length; and is invested—not closely, but at some little distance—by the amnion. The head end of the embryo is completely raised above the yolk-sac, but the body is still so widely connected with the yolk-sac that one can hardly speak of a distinct yolk-stalk. The hinder end of the embryo is bent upwards rather strongly—a very characteristic feature of the early human embryo, and one which is very probably to be ascribed, at any rate in great part, to the peculiarity already noticed concerning the allantois.

In the neck three thickenings—the visceral arches—are visible on each side, but the clefts between them have not yet been completed; below the neck, in the angle between the embryo and the yolk-sac, is the heart, a large tube twisted into an **S** shape. Blood-vessels are visible on the yolk-sac—which has a diameter of 2·75 mm.—and also in the allantoic stalk, whence they pass into the chorion, the inner layer of which is vascular all round the ovum, though the blood-vessels do not as yet pass into the villi.

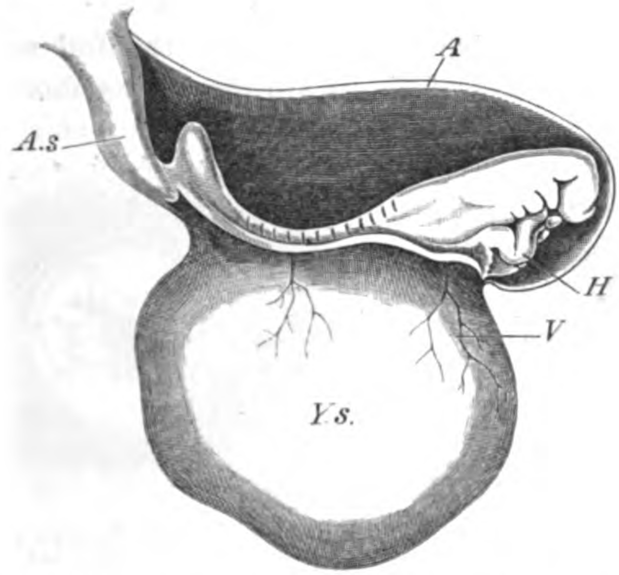


Fig. 29.—Human Embryo of about the middle of the third week. (From His, after Coste.)

A. Amnion. *A.s.* Allantoic stalk. *H.* Heart. *V.* Blood-vessel of yolk-sac. *Y.s.* Yolk-sac.

The middle portion of the embryo is clearly divided into proto-vertebræ; but there are no traces whatever of limbs, or of either eyes or ears.

End of third week.—By the end of the third week or commencement of the fourth the embryo has undergone important changes. Figs. 30 and 31 show the whole ovum and the embryo at this age.

The whole ovum, which is shown of the natural size in fig. 30, is somewhat pyriform, and measures 27 mm. along its greater diameter; it is covered all over with long branched villi. The embryo, which is represented on a larger scale in fig. 31, has increased very considerably in size. It is no longer straight, but is bent very strongly on itself—so much so, indeed, that it forms more than a complete circle, the flexure of the whole embryo being quite as strongly marked as in a rabbit embryo of the twelfth day (fig. 21).

The yolk-sac is about the same size as before, having a diameter of 3 mm., but its surface is wrinkled, and it is now connected with the embryo by a very distinct stalk. The amnion is very closely applied to the embryo, and the allantoic stalk as before connects the embryo with the chorion.

In the embryo itself the most noteworthy features besides the strongly-marked flexure are the following:—There are indications of thirty-five proto-vertebræ, the full number ever present. Both pairs of limbs are present as short buds with

FIG. 30.—Human Ovum at about the commencement of the fourth week. Part of the wall of the ovum has been removed to expose the embryo. (From Kölliker, after Allen Thomson.) × 1.

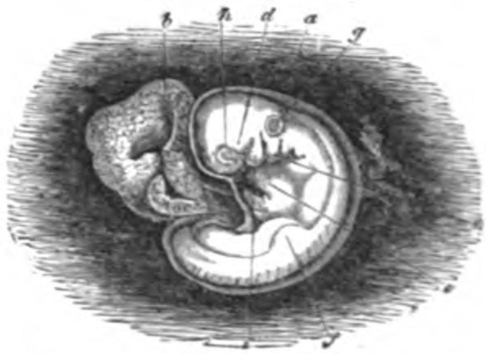


FIG. 31.—The same Embryo as in fig. 30, removed from the ovum, and magnified.

a. Amnion. *b.* Yolk-sac. *c.* Mandibular arch. *d.* Maxillary arch. *e.* Hyoidean arch; behind this are the first and second branchial arches. *f.* Rudiment of fore-limb. *g.* Auditory vesicle. *h.* Eye. *i.* Heart. × 5.

very wide bases of origin, the arm and leg of either side being connected together by a low ridge, the Wolffian ridge, of which the limbs are merely special local developments. All the main divisions of the brain are present, and can be easily recognised, as can also the ganglia of several of the nerves. Five visceral arches are visible on each side—viz. the maxillary (forming the upper jaw), mandibular (forming the lower jaw), hyoidean, and first and second branchial arches. The optic vesicles are present as outgrowths of the brain, but there is as yet no trace of the lens. The alimentary canal is a nearly straight tube, which communicates with the yolk-sac by only a very narrow channel.

The whole embryo measures about 4 mm. along its longest diameter, but, owing to the flexure of the body, its real length must be at least double this.

Fourth week.—By the end of the fourth week the rudiments of all the more important organs have become definitely established, and the embryo has arrived at a very well-marked period of development. It has now reached a stage corresponding closely with that attained by the rabbit embryo about the twelfth day, and by a chick embryo towards the end of the fourth day of incubation.

We have already had occasion when considering the earliest stages of development to notice the extreme slowness with which the human embryo develops. This is very strikingly exemplified by the facts just stated—viz., that the human embryo takes four weeks to reach the same stage of development and complexity of organisation, and what is more, the same actual size, that a chick embryo accomplishes in exactly one-seventh of the time.

This is doubtless in part due to the fact that the chick embryo is exceptionally well off in having an enormous supply of food ready to hand in the shape of the yolk of the egg; while, on the other hand, the mammalian embryo has to devote part of its energies to the establishment, at as early a period as possible, of the placenta for the sake of obtaining nutriment from the mother. But although this may explain why the mammal develops more slowly than the chick, it does not in any way help us to understand why the human embryo develops during its early stages at less than half the rate of the rabbit, and we must be content for the present to accept as an unexplained fact that the human embryo does dawdle over its development in a manner as yet completely inexplicable.

As the stage we are now dealing with, the end of the fourth week, is an important one in many ways, and as our knowledge of it, owing to His' admirable investigations, is in a very satisfactory and fairly complete state, it will be well to describe it in some detail.

Figs. 32, 33, and 34 are different views of an embryo of this age. Fig. 32 shows the external appearance as seen from the right side; fig. 33 is a longitudinal section to show the alimentary canal and parts in connection with it; while fig. 34 is a diagrammatic representation of the principal blood-vessels *in situ*.

The embryo is bent on itself as shown in the figures, and is closely invested by the amnion; it is connected with the yolk-sac by a short but narrow stalk, and with the chorion by the wide allantoic stalk, now somewhat longer than it was before.

The body measures along its greatest diameter 7 mm., but if straightened out would be about 14 mm. in length. In the

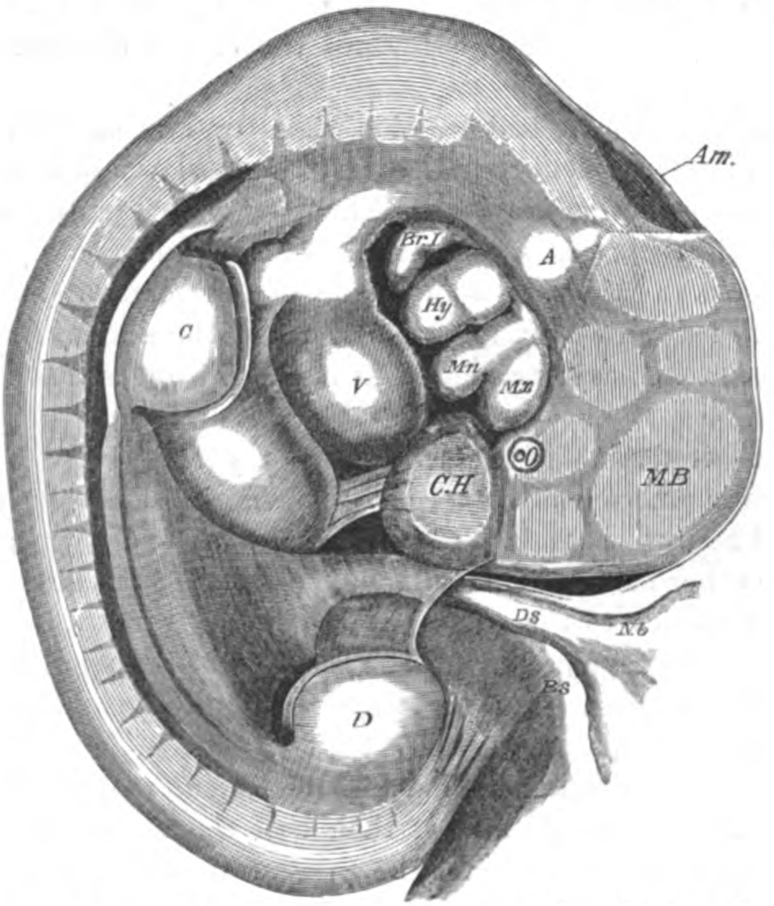


FIG. 32.—Human Embryo of the fourth week, seen from the right side. (From His.) × 13.

A. Auditory vesicle. *Am.* Amnion. *Br.I.* First branchial arch. *Bs.* Allantoic stalk. *C.* Rudiment of arm. *C.H.* Cerebral hemisphere. *D.* Rudiment of leg. *Ds.* Yolk-stalk. *Hy.* Hyoidean arch. *MB.* Mid-brain. *Mn.* Mandibular arch. *Mx.* Maxillary arch. *N.b* Yolk-sac. *O.* Eye. *V.* Ventricular portion of heart.

head the several divisions of the brain are clearly visible, as are also the visceral arches and clefts, and the eye and ear. In the body the full number of proto-vertebræ, thirty-five, is present; and the limbs are still short and very broad buds, whose bases extend over several segments. Immediately underneath the neck is seen the large prominence formed by the heart, and below this again a lesser one due to the liver.

The alimentary canal forms a continuous and but slightly twisted tube. The mouth, on the under surface of the head, opens into the buccal cavity, from which the pituitary diverticulum is given off towards the base of the mid-brain, while in the floor of the hinder part is the rudimentary tongue. Behind this the buccal cavity passes into the pharynx, which opens to

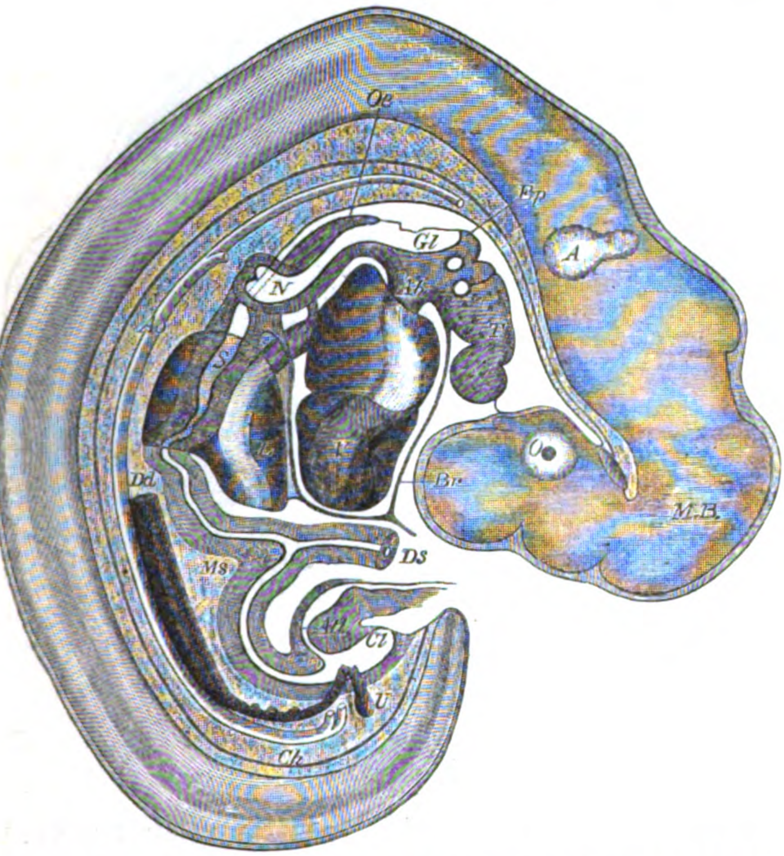


FIG. 33.—Diagrammatic Section of Human Embryo at the end of the fourth week, showing the alimentary canal and parts in relation with it. (From His.) × 13.

A. Auditory vesicle. *Ab.* Truncus arteriosus. *All.* Allantoic stalk. *Ao.* Aorta. *Br.* Ventral wall of thorax. *Ch.* Notochord. *Cl.* Cloaca. *Dd.* First part of small intestine, the future duodenum. *Ds.* Yolk-stalk, connecting intestine with yolk-sac. *Ep.* Epiglottis. *Gl.* Glottis. *L.* Liver. *M.B.* Mid-brain. *Ms.* Mesentery. *N.* Right lung. *O.* Eye. *Oe.* Œsophagus. *S.* Stomach. *T.* Tongue. *U.* Ureter. *V.* Ventricle.

the exterior by two visceral clefts on each side. In the floor of the pharynx is a slit-like opening, the glottis, leading into a short canal, the trachea, which bifurcates into two blind sacs, the rudiments of the lungs.

Behind the pharynx the alimentary canal is continued as a narrow tube, the œsophagus, with the lungs on either side of it. The œsophagus opens into a stomach which is but very slightly dilated, and is continued into the small intestine. This runs forward and (fig. 33) joins the large intestine at a rather sharp angle. From this angle the cavity of the yolk-stalk, leading to the yolk-sac, arises. The large intestine is at first tubular, but after giving off the cavity of the allantois it ex-

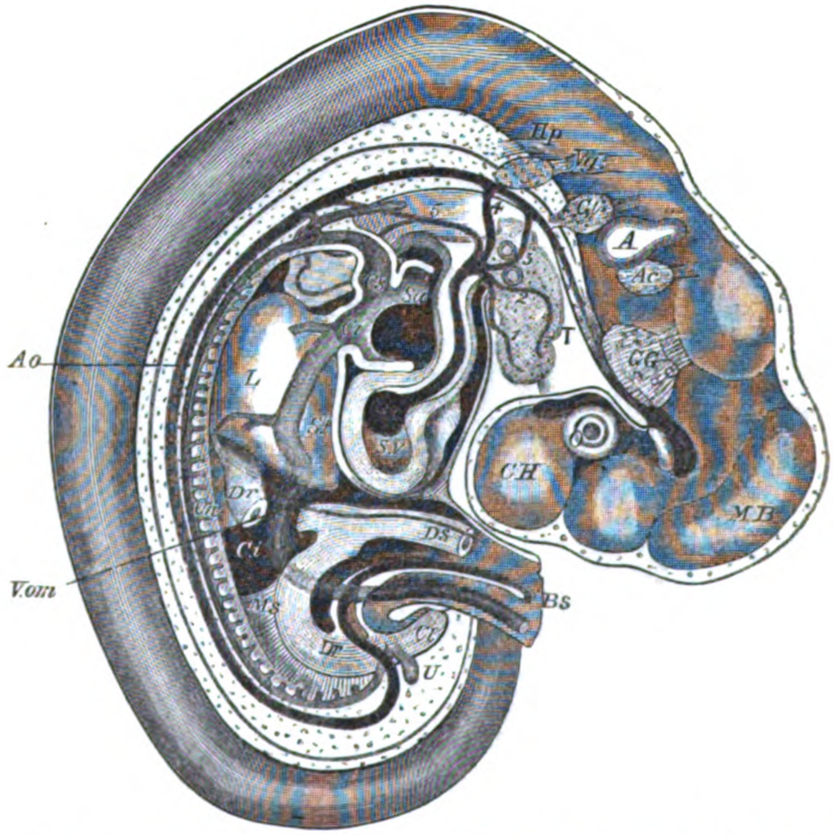


FIG. 34.—Diagrammatic Section of Human Embryo at the end of the fourth week, showing the heart and blood-vessels. (From His.) × 13.

A. Auditory vesicle. *Ac*. Auditory nerve. *Ao*. Dorsal aorta. *Bs*. Allantoic stalk. *CH*. Cerebral hemisphere. *Ci*. Vena cava inferior. *Cl*. Cloaca. *Cs*. Vena cava superior. *Dr*. Small intestine. *Ds*. Yolk-stalk. *GG*. Gasserian ganglion. *Gl*. Ganglion of glossopharyngeal nerve. *Hp*. Hypoglossal nerve. *L*. Liver. *MB*. Mid-brain. *Ms*. Mesentery. *O*. Eye. *Sa*. Auricular septum. *Sv*. Ventricular septum. *T*. Tongue. *U*. Ureter. *Un*. Wolffian body, or primitive kidney. *Vg*. Vagus, or pneumogastric nerve. *V.om*. Vitelline or omphalomesenteric vein. 1. First aortic arch, forming lingual branch of external carotid artery. 2. Second aortic arch, forming external carotid artery. 3. Third aortic arch, forming internal carotid artery. 4. Fourth aortic arch, forming on left side the dorsal aorta. 5. Fifth aortic arch, forming the pulmonary artery.

pands to form a cloacal sac, which opens to the exterior at the anus: just before doing so it receives on its dorsal surface the openings of the Wolffian ducts, the ducts of the primitive kidneys. A slight dilatation near the commencement of the allantoic stalk is the rudiment of the future urinary bladder.

The liver is a large organ whose position has been already noticed; it opens by a short bile-duct into the intestine just below the stomach.

The vascular system, which is shown in fig. 34, has attained very considerable complexity. The heart, which is of great size, lies between the head and the liver, and already exhibits all the principal divisions of the adult. It is bent on itself like a letter ∩∪, whereof the first or upper loop is the auricular portion of the heart; the second or lower loop, which is in very close proximity to the cerebral hemispheres, is the ventricular part; and the terminal limb of the ∩∪ is the aortic bulb which runs backwards (upwards in the figure) beneath the lower wall of the head. The auricular portion of the heart is very wide transversely; it is partially divided by a semilunar fold into right and left auricles, whereof the right auricle receives (1) venous blood brought from the body of the embryo by two large veins, the right and left *Ductus Cuvieri*, each of which is formed by the union of an anterior cardinal or jugular vein returning blood from the head, and a posterior cardinal vein coming from the hinder part of the body and chiefly from the Wolffian bodies or primitive kidneys; and (2) blood which is more arterial in character, brought back from the chorion by the umbilical or allantoic veins, and discharged into the right auricle by the *vena cava inferior*. The opening of the vena cava inferior into the right auricle is guarded by two prominent lips, the outer one of which is the Eustachian valve, which direct the blood from the inferior cava into the left auricle, which also receives the exceedingly small pulmonary veins.

The ventricular portion is partially divided into right and left ventricles by a septum incomplete above. The aortic bulb contains at present only a single tube, the cardiac aorta, into which both ventricles discharge; this runs back (up in the figure) to the hinder part of the floor of the buccal cavity, and then gives off on each side a series of aortic arches which run up in the visceral arches, forming the side walls of the pharynx, and unite together above the pharynx to form the dorsal aorta, which runs back to the hinder end of the body. Of these aortic arches there are at first five on each side. The first and second aortic arches, lying in the mandibular and hyoidean arches respectively (figs. 32 and 34) have already lost their primitive consuffice to state the leading features of each of the well-marked periods of development, and to give brief accounts of the formation of some of the more important organs up to the time of birth.

At the end of the fifth week the embryo measures about 10 mm. in length, and weighs about 1 grm. Its external ap-

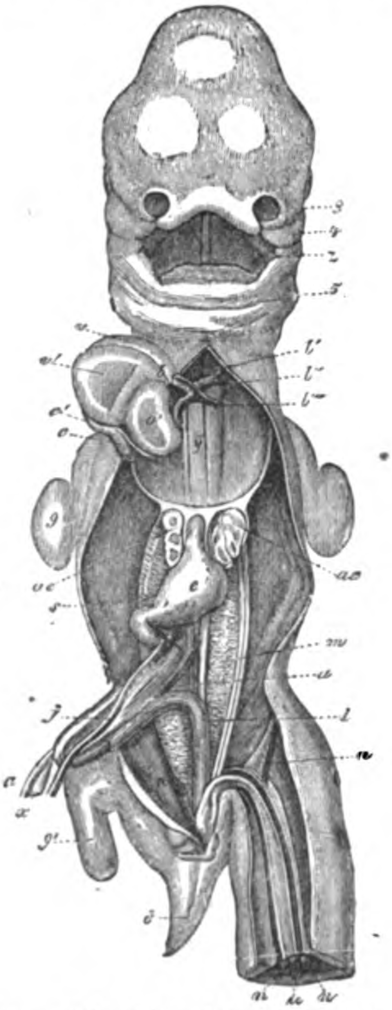


FIG. 36.—Human Embryo of the thirty-fifth day, seen from the ventral surface, and partially dissected. (From Kölliker, after Coste.) × 5.

3. Left external nasal process. 4. Maxillary arch. 5. Mandibular arch. 8. Tail. 9. Arm. 9′. Leg. *a*. Right vitelline artery. *ae*. Lungs. *b*. Aortic bulb. *b*′. First persistent aortic arch, the carotid arch. *b*″. Second persistent aortic arch, the systemic arch. *b*‴. Third, or pulmonary arch. *c*. Right vena cava superior. *c*′. Venous sinus of heart. *e*. Stomach. *i*. Rectum. *j*. Left vitelline vein. *m*. Wolffian body. *n*. Umbilical or allantoic artery. *o*′. Left auricle. *s*. Portal vein. *u*. Umbilical vein. *v*. Right ventricle. *v*′. Left ventricle. *x*. Yolk-stalk. *z*. Tongue.

pearance is shown in fig. 35, and the leading features of its anatomy in fig. 36.

In this latter figure the embryo is represented from the ventral side, and is partially dissected, the liver being completely removed. The chief features in which it differs from the embryo of the fourth week are the following:—The whole body is not nearly so strongly flexed, but has begun to straighten out. The limbs are considerably larger, and already show signs of division into their several segments. The gill clefts, with the exception of the hyomandibular cleft, have completely closed up, and the face is more fully formed than before. The yolk-sac is small, and is connected with the embryo by a long slender stalk. The allantoic stalk is still short and thick. The amnion, instead of closely investing the embryo, is now at some distance from it, and is very nearly in contact with the chorion. The villi of the chorion are very large and branched, and still extend over the whole surface of the ovum, though they are rather larger opposite the spot where the ovum is directly attached to the uterus—i.e. the *decidua serotina*, the site of the future placenta—than they are elsewhere.

Of the internal organs of the embryo, the stomach is now a more conspicuous dilatation than before; while the small intestine has elongated so as to form a loop, from the apex of which the slender yolk-stalk still arises; lower down, at the junction of small and large intestines, a rudiment of the cæcum has appeared. The lungs, liver, and heart have all increased in size, while the right umbilical vein, which has been all along the smaller of the two veins returning blood from the allantois to the embryo, has disappeared. The Wolffian bodies are rather shorter than before, and along their inner borders two slight thickenings of the peritoneal epithelium—the genital ridges—have appeared. There are also present two new ducts, the Müllerian ducts, which will become in the female child the oviducts or Fallopian tubes, and the uterus and vagina.

Sixth week.—The embryo has grown considerably, and is now from 15 to 20 mm. in length. It is shown *in situ* in fig. 37; while fig. 38 is a profile view on a larger scale.

Fig. 37 shows us that the amnion is now a considerable distance from the embryo, and has indeed nearly reached the chorion; that the allantoic stalk is still short and thick; that the yolk-stalk is long and slender, its proximal portion being bound up with the allantoic stalk in the sheath formed round both by the amnion (*cf* fig. 22, 5), while its distal portion, ending in the small yolk-sac, lies between the amnion and chorion (*cf.* figs. 22 and 45). The limbs are larger, and show at their extremities rudiments of the fingers and toes. The mouth is still very wide; a slight prominence above it marks the commencement of the nose, and the margin of the hyomandibular cleft forms a slightly projecting ring, the external ear.

FIG. 37.—Pregnant Uterus of about the fortieth day. The uterus has been opened from in front, and the *decidua reflexa* has also been cut through and the flaps turned aside to expose the ovum. The chorion has been laid open by a crucial incision, and the flaps turned aside to show the embryo invested by the amnion, and with the small yolk-sac lying between the amnion and chorion. At the upper part of the figure the apertures of the Fallopian tubes are seen. (From Kölliker, after Coste.) × ½.

Of the internal organs the alimentary canal has increased in length, and the cæcum is now very evident; the Wolffian bodies are somewhat smaller than before, while the genital organs have increased in size, and the permanent kidneys and ureters have become definitely established. Finally, by the end of the sixth or commencement of the seventh week, ossification commences in the clavicle, and very shortly afterwards in the lower jaw.

Second month.—At the end of the second month the embryo measures from 30 to 40 mm. in length, and weighs 12 to 20 grms. The head is very large, and forms at least a third of the whole embryo. The nose is rather more prominent, but is still very small; slight folds of skin round the mouth and eyes mark the commencements of the lips and eyelids. The external ear is definitely established, and in it helix and

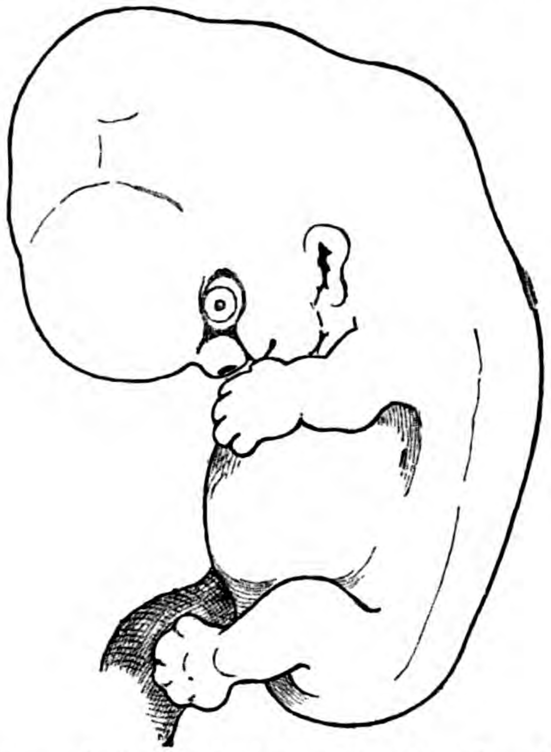


FIG. 38.—Human Embryo of about the sixth week. (From His.) × 5.

anti-helix, tragus and anti-tragus, can already be recognised. The limbs project some little distance from the trunk; the bend of the elbow being directed backwards, and that of the knee forwards. The ventral wall of the abdomen is completely formed; and the umbilical cord, which usually measures about 8 or 10 mm. in length, is as a rule straight, but may be slightly twisted on itself. The anus is marked by a dark point, and the rudiments of the external organs of generation are visible; ossification has commenced in the frontal bones and in the ribs and in many of the bones of the limbs. The epidermis can now be distinguished from the dermis.

Tenth week.—The embryo has now a length of 4 to 6 cm., and weighs 45 to 48 grms. The limbs are still short, but their

FIG. 39.—Human Embryo at the end of the second month. (From His.) × 5.

several divisions are far more evident than before, and rudiments of the nails have commenced to appear as small tubercles.

The ventral wall of the body is far more completely formed than heretofore. The umbilical stalk, formed, it will be remembered, of allantoic stalk and yolk stalk bound together and ensheathed by the amnion, has grown considerably; it is now longer than the embryo, and is twisted on itself in a spiral manner; it still contains at its base a loop of intestine.

The face has developed considerably, and all the features are now definitely established; eyelids are present; there is a distinct though very flat nose, definite lips, and well-developed external ears. In fig. 40 the leading stages in the development of the face are shown. At the sixth week, B, the mouth opening is still very wide; it is bounded in front by the median fronto-nasal process, at the sides by the maxillary arches, and

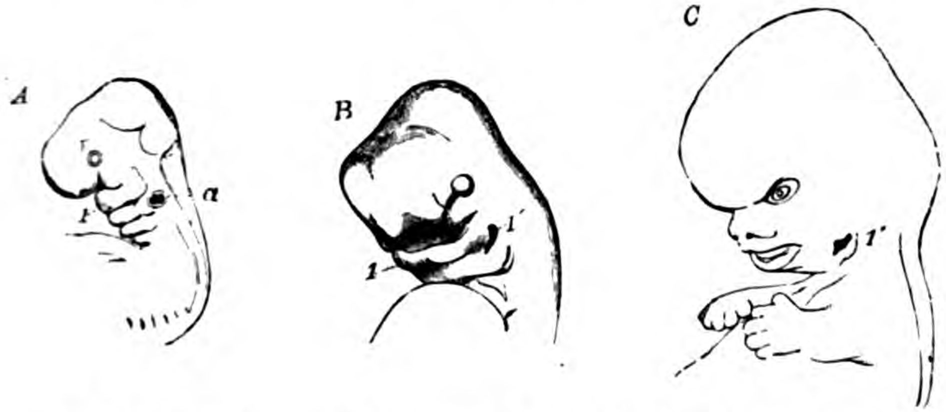


FIG. 40.—Figures illustrating the formation of the Face in the Human Embryo. (From *Quain's Anatomy.*)

A – Head of an embryo of about four weeks. (After Allen Thomson.) 1. Mandibular arch. *a.* Ear.
B.– Head of an embryo of about six weeks. (After Ecker.) 1. Mandibular arch. 1'. Hyomandibular cleft.
C.– Head of an embryo of about nine weeks. (After Ecker.)

behind by the mandibular arches, which meet one another in the middle line at the site of the future chin. By the eighth or ninth week, C, the maxillary processes have grown in towards one another so as to reduce the width of the mouth, and have fused with the fronto-nasal process to complete the upper jaw. The nose is an outgrowth from the fronto-nasal process; folds of integument give rise to the eyelids and lips, while another fold arising behind the hyomandibular cleft forms the external ear.

Third month.—At the end of the third month the embryo, which from this time is commonly spoken of as the fœtus, is from 13 to 15 cm. in length, and weighs 100 to 125 grms.

The head is still very large relatively to the rest of the body, but not nearly so much so as in the earlier stages. Both mouth and eyes are closed. The neck, already present at the eighth or ninth week, is now far more evident, and the limbs, though still small, have acquired their definite shapes and proportions; the nails are present as very thin plates. The integument is slightly firmer than before, but is still very thin, transparent, and rose-coloured. Hitherto part of the alimentary canal has been situated in the allantoic stalk, and therefore outside the embryo (fig. 33), but by the end of the third month this is withdrawn, and the whole alimentary canal, which has increased greatly in length, is thenceforward situated entirely within the abdominal cavity.

Nervous system.—The cerebral hemispheres are large, but do not yet cover the mid-brain, which latter is smooth and presents no trace of its subsequently acquired division into the *corpora quadrigemina.* The cerebellum is a broad transverse band; the fourth ventricle is a large cavity with a very thin roof; and the spinal cord presents well-marked brachial and lumbar enlargements.

Urino-genital organs.—By the end of the third month very important changes have been effected in the mutual relations of the rectum, bladder, and urinary and genital ducts—changes which result in the establishment of the external generative organs and in the external differentiation of the sexes. Though these changes commenced at an earlier period than that with which we are now dealing, it has been convenient to postpone their description until we were in a position to deal with them in their entirety.

The condition of the parts with which we are concerned about the end of the fourth week is shown in figs. 33 and 34. The terminal portion of the intestine is dilated to form the cloaca, *Cl.* Into the cloaca open—(1) on the ventral surface, the cavity of the allantois, *All,* which later on becomes the bladder; (2) on the dorsal surface, nearly opposite the aperture of the bladder, the two Wolffian ducts, coming from the the Wolffian bodies or primitive kidneys.

By the end of the fifth week the following changes have occurred: (1) the essential organs of reproduction have appeared as a pair of longitudinal ridges lying along the inner sides of the Wolffian bodies (fig. 36); (2) a pair of new ducts, the Müllerian ducts, have appeared, which open in front into the body cavity, and unite together posteriorly to open into the neck of the bladder just before it opens into the cloaca; and (3) the Wolffian ducts have shifted so as to open into the neck of the bladder with the Müllerian ducts, and so only indirectly into the cloaca.

During the sixth week the permanent kidneys and ureters appear. The exact mode of their development in man is not known, but it is probable from analogy that the ureters are formed as outgrowths from the dorsal surface of the Wolffian ducts, in which case it is very possible that the saccular outgrowths seen in this position at the end of the fourth week (*vide* fig. 34, *U*) are their first rudiments. The kidneys are probably formed from two masses of tissue immediately behind the Wolffian bodies and directly continuous with them. The ureters very early acquire independent openings into the bladder, rather higher up than the openings of the Wolffian and Müllerian ducts. From this period up to the ninth week the changes are comparatively unimportant.

By the ninth week the essential reproductive organs have increased greatly in size; while the neck of the bladder has elongated considerably to form a *sinus urinogenitalis*. The two ureters open directly into the bladder, and the Wolffian and Müllerian ducts into the *sinus urinogenitalis* some distance below the ureters. Owing to the development of a median septum the *sinus urinogenitalis* and the rectum are almost completely separated from one another; they still, however, open to the exterior by a common cloacal orifice, though the cloaca itself is now a very shallow chamber.

Immediately in front of the cloacal aperture is a small conical prominence, which, inasmuch as it becomes in the female the clitoris and in the male the penis, we may speak of as *clitoro-penis* (fig. 41); on its posterior surface is a groove continued into the urino-genital sinus; and on either side of it are prominent folds of skin, *h l*, which we may call *labio-scrotal* folds.

A very little later, in the course of the tenth week, the septum between the urino-genital sinus and the rectum grows downwards so as to reach the surface. We now have no longer a cloaca, but two perfectly distinct apertures (fig. 42, *a* and *e*), whereof the anterior is the urino-genital and the posterior the anus.

Up to this time the changes are the same in all embryos, but about the end of the tenth week external sexual differences

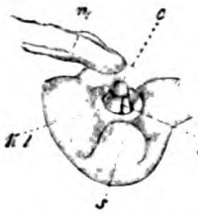


FIG. 41.—External Genitalia of a Human Embryo of about the ninth week. (From Kölliker, after Ecker.) × 2.

e. Clitoro-penis. *f*. Groove continuous with urino-genital sinus. *hl*. Labio-scrotal folds. *n*. Umbilical cord. *s*. Coccygeal region.

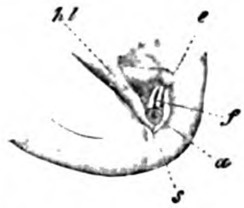


FIG. 42.—External Genitalia of a Human Embryo of about the tenth week. (From Kölliker, after Ecker.) × 2.

a. Anus. *e* Clitoro-penis. *f*. Urino-genital aperture. *hl*. Labio-scrotal folds. *s*. Coccygeal region.

become apparent. In female embryos (fig. 43) the conical eminence remains small, and becomes the clitoris; the folds of skin surrounding it become the *mons veneris* in front and the *labia majora* at the sides, while the smaller folds bounding the urino-genital orifice become the *labia minora* or *nymphæ*;

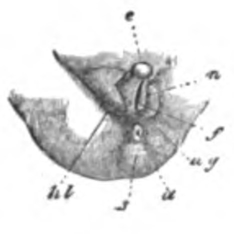


FIG. 43.

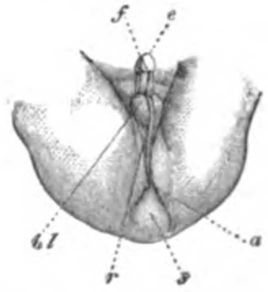


FIG. 44.

External Genitalia of Human Embryos towards the end of the third month. (From Kölliker, after Ecker.)

Fig. 43.—(*Female*.) *a*. Anus. *e*. Clitoris. *f*. Urino-genital aperture. *hl*. Labia majora. *n*. Labia minora, or lips of urino-genital aperture. *s*. Coccygeal region.

Fig. 44.—(*Male*.) *a*. Anus. *e*. Penis. *f*, *r*. Lips of genital cleft fused together. *hl*. Scrotum. *s*. Coccyx.

the urino-genital canal shortens considerably, so as to bring the aperture of the urethra very close to the surface.

In male embryos (fig. 44) the conical eminence elongates and becomes the *penis*, the groove on its posterior surface closing to form the canal of the penis or penial urethra; the folds of skin similarly unite together in the middle line behind the penis and so form the *scrotum*.

The above changes are usually effected, and the organs mentioned definitely established by the end of the third month, but the processes may be delayed till later.

Concerning the essential organs of reproduction and their ducts there is yet something to be said. The ovary and testis are at first absolutely indistinguishable from one another, and it is not until about the eighth week that characteristic differences appear between them. In both sexes there is a very close relation between the essential reproductive organs and the Wolffian bodies, which latter, as was noticed in the chapter on the ovary, send off outgrowths from their Malpighian bodies, forming the so-called 'tubuliferous tissue,' which lies very close beneath the germinal epithelium.

In the female the 'tubuliferous tissue' gradually gets separated by connective tissue from the germinal epithelium; the Wolffian body shrinks considerably, and becomes converted into the *parovarium* or *epoophoron*, called also the organ of Rosenmüller (*vide* fig. 12). The Wolffian duct is usually only recognisable in its upper portion, where it forms part of the parovarium; in ruminants, and sometimes in woman, its middle and lower portions persist as the *duct of Gaertner*, running in the broad ligament to the uterus. The Müllerian ducts become in their upper portions the Fallopian tubes, and in their lower portions unite to form the uterus and vagina. The fusion of the two ducts proceeds from below upwards, and, if it fail to extend as high as usual, may give rise to a double uterus, or even double vagina as well.

In the male the 'tubuliferous tissue' becomes directly continuous with the seminal canals of the testis, forming by so doing the efferent canals for the passage of the spermatozoa to the exterior, the Wolffian body and duct becoming converted into the *epididymis* and *vas deferens* respectively.

The Müllerian ducts in the male are of no physiological importance; their lower united portions form the *vesicula prostatica* or *uterus masculinus*; the middle portions usually disappear, and the upper parts may either disappear or else persist in the neighbourhood of the epididymis, and give rise to the 'hydatids of Morgagni.'

The lungs.—The lungs make their first appearance as a hollow median diverticulum of the ventral wall of the œsophagus, just behind the gill clefts; the diverticulum consisting of an outer thicker wall of mesoblast, and an inner thinner lining of hypoblast, continuous with that of the alimentary canal.

The diverticulum very soon gives off two lateral outgrowths from its blind end, and so becomes bifid. Its condition at the end of the fourth week is well shown in fig. 33. Later on, the mesoblast thickens considerably, and becomes riddled by a number of tubular outgrowths of the hypoblastic lining. These outgrowths become ultimately the bronchi, while their blind ends dilate to form the air-cells, which lie at first close to the surface, and so give it a granular or tubercular appearance.

The original opening of the diverticulum into the œsophagus becomes modified to form the glottis, while the median portion of the diverticulum lengthens and becomes the trachea.

Fourth month.—At the end of the fourth month the fœtus measures from 16 to 20 cm. in length, and weighs from 230 to 260 grms. The skin is of a rosy colour, and is much firmer than before. Short whitish hairs appear on the head, and a slight down on other parts of the body. The eyes, nostrils, and mouth are all closed. The chin, which has hitherto been very inconspicuous, begins to become prominent. The legs and arms are of about equal length. The external sexual characters are usually well marked. The anus is open, and the duodenum contains meconium of a light greyish-white colour. The umbilicus, or point of origin of the umbilical cord, is low down, close to the pubes. In the skull the bones are still far from meeting one another, so that the sutures and fontanelles are very wide. The muscles are more fully developed, and may give rise to distinct movements of the fœtus. In abortions at this period the fœtus may live for some hours.

Fifth month.—Length of body, 20 to 27 cm.; weight, 250 to 350 grm. From this time onwards, according to Casper, the length of the fœtus affords a ready and easily remembered means of determining roughly its age; for from the fifth month to the end of pregnancy the length of the body in inches is approximately double the number of lunar months the fœtus has lived. Thus at the fifth month the length is 10 inches, at the sixth month 12 inches, and so on. The weight is subject to far greater variations than the length, and consequently affords a far less trustworthy criterion of age.

The skin is more consistent than before, and presents on its surface at certain places small patches of sebaceous matter. Hairs are more extensively developed, but are still devoid of any distinct colour. The legs are now longer than the arms, and the nails are well-formed. The umbilicus is further forward than at the preceding month, and is now some distance above the pubes.

The head is still very large in proportion to the other parts. The heart, liver, and kidneys are also disproportionately large. The small intestine contains meconium, which is now, owing to the secretion of bile, of a pale greenish-yellow colour. The gall-bladder is distinct.

Ossification has commenced in the pubes and in the os calcis.

Sixth month.—The length, according to Cazeaux, varies from 28 to 32 cm.; the average length, according to Casper's calculation, is 12 inches, or 30 cm. The weight is much more variable; its average amount is stated by Cazeaux to be half a kilogramme.

The skin is of a dirty reddish colour and much wrinkled. It is covered, at any rate in the axillæ and groins, with a sebaceous deposit. The hairs are more strongly developed and of a darker colour than before. Both eyelashes and eyebrows have commenced to appear.

A complete pupillary membrane is commonly said to be present; but there seems to be some doubt on this point, and according to Velpeau and Cazeaux a large pupillary aperture is already present in the iris. Indeed Velpeau contends that no pupillary membrane is ever present in the human embryo.

The umbilicus is still further forward than before. The meconium is much darker and more viscous than before. The testes of the male have not yet descended into the scrotum, but are found within the abdominal cavity, lying on the psoas muscles and immediately below the kidneys.

The sternum is well-developed and has commenced to ossify. The nails reach to the ends of the fingers, and extend about a quarter of the way round them.

Seventh month.—At the end of the seventh month the fœtus has a length of from 32 to 36 cm., and weighs on an average about 1 kilo.

The skin is still of a dirty reddish colour, but is not so dark as it has hitherto been. There is an increased deposit of fat in the cellular tissue, causing the body to appear more plump and round. The hairs are plentiful and about a quarter of an inch (6 mm.) in length.

The several bones forming the roof of the skull become strongly convex, the central portion of each, whence ossification starts, forming a very evident prominence. The eyelids, which have been closed since reaching their full size in the fourth month, now open.

The whole of the large intestine is filled with a dark olive-green viscous meconium. The liver is still very large relatively to the whole body, and is of a deep brownish-red colour.

The testes have, as a rule, descended as far as the inguinal ring, and may even have entered the inguinal canal.

The end of the seventh month is of interest as being perhaps the earliest period at which the fœtus can be born with any reasonable chance of surviving.

Eighth month.—During the eighth month the increase in bulk is far more marked than that in length. At the end of the month the fœtus measures from 40 to 45 cm. in length, and weighs as much as 2 to $2\frac{1}{2}$ kilos.

The skin is of a brighter flesh colour than before, and is covered all over with the sebaceous deposit known as 'vernix caseosa.' This substance, which usually makes its first appearance about the middle of gestation, was formerly considered to be a deposit formed from the liquor amnii, but appears rather to consist of matter formed by the cutaneous glands of the fœtus, mixed with dead epithelium cells. It varies much in quantity in different cases, and is always more abundant in certain situations, notably the head, axillæ, and groins.

The chin is now far more prominent than before, the lower jaw equalling the upper in length. The pupillary membranes, if ever present, are at any rate absent now. One of the testes, usually the left one, has passed through the inguinal canal into the scrotum, while the other one is still in the canal as a rule. There is no ossification in the lower epiphysis of the femur.

Ninth month.—At the full time the fœtus is 50 to 60 cm. long, and weighs on an average 3 to $3\frac{1}{2}$ kilos.

The skin is paler than before. The cellular tissue is filled with fat, giving roundness and firmness to the body and limbs. The hair is thick, long, fairly abundant as a rule on the head, while the down has begun to disappear from the body.

The umbilicus, formerly supposed to mark the exact middle of the body at full time, is stated by Cazeaux, on the authority of Moreau and Ollivier, to be on the average as much as 23 mm. below the middle point.

Both testes are as a rule in the scrotum, which has now a corrugated surface.

Ossification has commenced in the centre of the cartilage at the lower end of the femur. This is the first epiphysial ossification to appear in the body, and is the only one present at the end of the ninth month. Its presence appears to be very constant at this period, and it has therefore received much attention as a ready and apparently reliable test of a fœtus having reached its full time.

CHAPTER V.

THE PLACENTA. PHYSIOLOGY OF THE FŒTUS.

The Fœtal Membranes.—The youngest stage in the development of the human ovum that has yet been found in the uterus is, as we have seen, that described by Reichert, and figured on page 76. This ovum, estimated to be thirteen days old, was already completely invested in a *decidua reflexa.* Its outer wall was described by Reichert as consisting of a single layer of epithelial cells, a description accepted also by His; but we have seen above that there is hardly any doubt that the wall is not of so simple a structure, but that immediately under the epithelial layer there is an inner vascular layer. As the vessels in this layer can be traced at a rather later stage into continuity with the umbilical vessels of the fœtus, there is little room for doubt that this inner vascular layer is really the allantois, developed very early relatively to the other organs, and in a very unusual manner.

The chorion.—Such being the case, we may speak of the outer wall of Reichert's ovum as a *chorion.* A typical chorion, as we have seen in Chapter III., consists of three originally separate and distinct membranes fused together to form a single one—(1) on the outside the vitelline membrane, or zona pellucida; (2) within this the subzonal membrane, or false amnion; (3) within this again, the allantois. In the chorion of the early human ovum the zona pellucida does not appear to be recognisable; the epithelial layer may possibly be in part the equivalent of the subzonal membrane; while the inner vascular layer is almost certainly the allantois.

Reichert's ovum is surrounded by a broad marginal zone of villi, the centres of the two flattened surfaces forming bare patches. A short time later, towards the end of the third week, the villi extend so as to completely surround the ovum; they consist at first merely of epithelial cells derived from the outer layer of the chorion; but in the course of the fourth week, according to Coste, outgrowths from the vascular layer of the chorion enter the villi, each of which now consists of an external epithelial covering and a central connective tissue vascular core, the vessels of which are continuous with the umbilical vessels of the embryo.

From the fourth week up to the end of the second month the chorion grows rapidly; the villi also increase very greatly, both in number and in size; they give off numerous branches which imbed themselves in the decidua and end in free thread-like or frequently clavate processes, the so-called 'roots.' As in their first appearance, so also during the later stages of their growth, the epithelial layer is always in advance of the connective tissue core, the villi presenting lateral processes or knobs caused by local thickenings of the epithelium, into which, later on, the vascular tissue penetrates.

In the course of the third month, those villi which are in connection with the *decidua reflexa* begin to shrink, the blood-vessels of the part of the chorion from which they spring undergoing at the same time a gradual diminution in size. The villi that are imbedded in the *decidua serotina*, on the other hand, increase greatly in size and complexity, and ultimately form, as we shall see, the fœtal part of the placenta (*cf.* the diagrammatic figure 45).

In this way we get a distinction established between the *chorion frondosum*, opposite the *decidua serotina*, which is very vascular, and beset with closely placed and richly branched villi; and the *chorion læve*, opposite the *decidua reflexa*, which is a thin transparent membrane with no blood-vessels, and connected with the *reflexa* by scattered, slightly branched, inconspicuous villi.

Up to the end of the third month the villi can be readily withdrawn from the crypts of the *decidua* in which they are lodged, and the fœtal and maternal structures separated from one another; but after the placenta is once established, the connection between fœtal and maternal elements becomes so intimate that complete separation is no longer practicable.

The amnion.—The amnion, like the allantois, appears to develope in the human species in a somewhat aberrant manner, though it is very possible that further investigations will remove

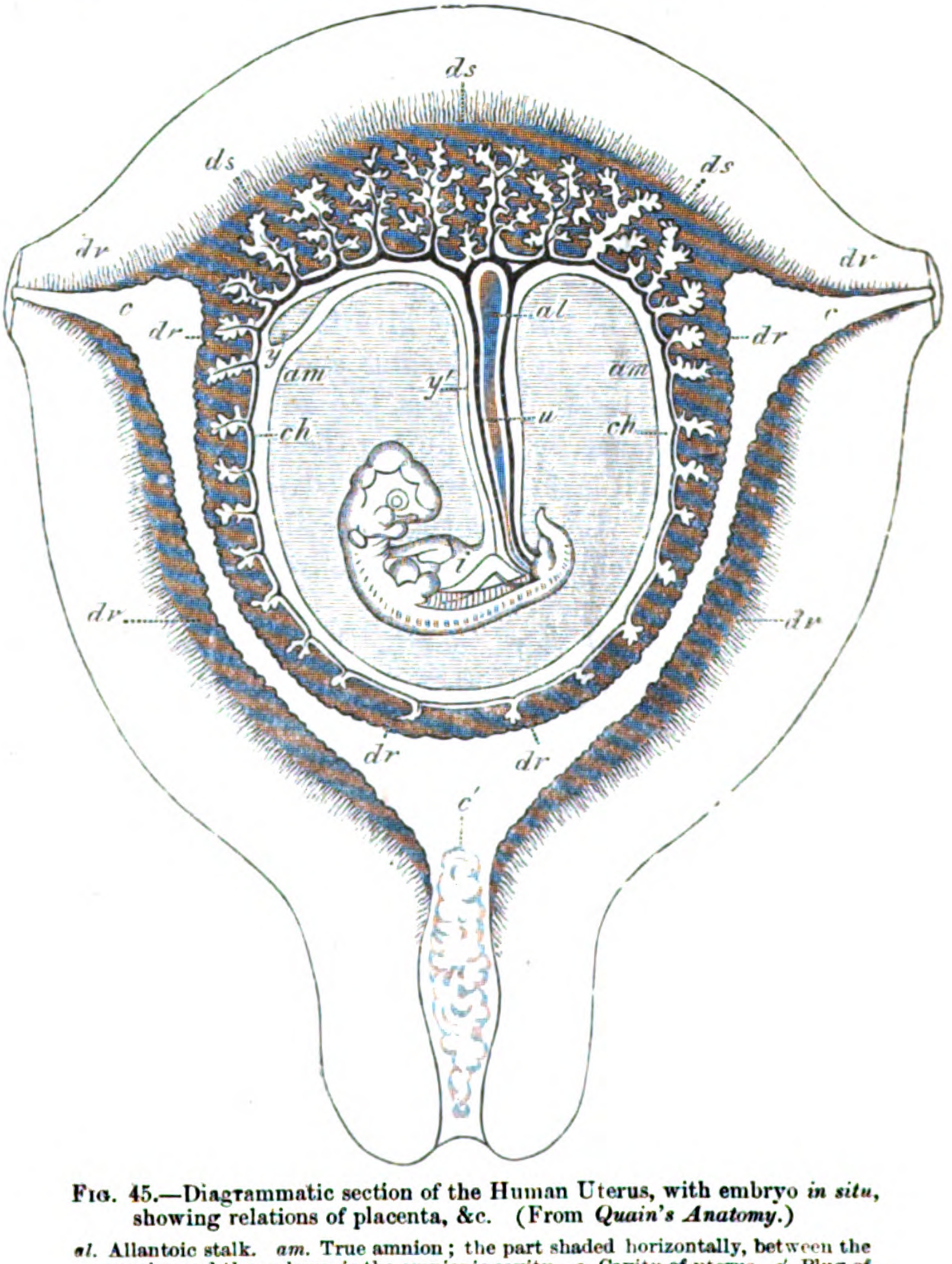


FIG. 45.—Diagrammatic section of the Human Uterus, with embryo *in situ*, showing relations of placenta, &c. (From *Quain's Anatomy*.)

al. Allantoic stalk. *am.* True amnion; the part shaded horizontally, between the amnion and the embryo, is the amnionic cavity. *c.* Cavity of uterus. *c'.* Plug of mucus in cervix uteri. *ch.* Chorion. *dr.* Decidua reflexa. *ds.* Decidua serotina. *dv.* Decidua vera. *i.* Intestine of embryo. *u.* Umbilical or allantoic arteries. *y.* Yolk-sac. *y'.* Yolk-stalk.

many of the apparent anomalies in its mode of origin. What is known of its early stages has already been explained in the preceding chapter.

The true amnion, with which alone we are now concerned, completely covers the dorsal surface of the embryo as early as the fourteenth day (*cf.* fig. 27, p. 78). Its condition at the middle of the third week is shown in fig. 29, where it is seen to be some distance away from the embryo. At the end of the fourth week, as at the corresponding stage of the rabbit or chick, the amnion (figs. 31 and 32) invests the embryo very closely indeed. During the second month the amnion grows rapidly, so as to leave a large space (the amnionic cavity) between itself and the embryo, a space occupied by the *liquor amnii*. The amnion, by its further growth, forms a sheath to the umbilical cord, and comes in very close contact with the chorion, from which it is usually separated by a small quantity of fluid, or else by a gelatinous *membrana intermedia*.

Liquor amnii.—The *liquor amnii*, which occupies the space between the amnion and the embryo, varies much in quantity at different periods of gestation. It is apparently most abundant about the fifth or six month. Its actual quantity varies also so much in different cases that it is difficult to fix its normal amount. When in excess—*i.e.* more than about $1\frac{1}{2}$ litres—it constitutes the affection known as *hydrops amnii*.

The *liquor amnii* contains urea, especially during the later months of gestation. It was formerly regarded as a nutritive fluid, but the researches of Gusserow point strongly in favour of its being really excretory. Gusserow considers that in the early stages of development it is simply a transudation from the fœtal vessels, but that later on it receives directly the urine discharged by the fœtus.

The yolk-sac persists throughout the whole period of gestation; in the fourth and fifth months it is a roundish white body from 7 to 11 mm. in diameter, lying between the amnion and the chorion, and usually close to the edge of the placenta (*cf.* fig. 45). It is connected by a long slender stalk with the umbilicus of the fœtus, the stalk being—together with the allantoic stalk—invested by the sheath formed by the amnion.

At the end of gestation the yolk-sac is still present in the same situation close to the edge of the placenta; it is rather smaller than before, measuring from 4 to 7 mm., and very commonly adheres closely to the amnion.

The umbilical cord.—The umbilical cord is composed of the following parts (fig. 45):—(1) The allantoic stalk with its vessels, the umbilical arteries and veins; (2) the yolk-stalk, and (3) the common investment formed round these two by the amnion. Its main if not indeed its sole function is to convey the umbilical vessels to the placenta, and so maintain the vascular connection between fœtus and placenta.

About the middle of gestation it is usually from 13 to 21 cm. long, and from 9 to 11 mm. thick. At the time of birth its average length is from 48 to 60 cm., and its thickness 11 to 13 mm.; but it is liable to very great individual variations. It may be as short as 12 cm., or, on the other hand, may attain a length of 167 cm.

The cord is almost invariably twisted spirally on itself, and the cause of this twisting, which commences about the middle of the second month, has been the subject of much discussion. If examined more closely, it is found that all the constituents of the cord are not twisted to the same extent; the spirals described by the umbilical arteries are always far more numerous and closer together than those of the whole cord, or of the veins round which they appear to twist. From this it would appear that the twisting is due to a peculiar spiral growth of the umbilical arteries, which involves, though to a less extent, the other constituents of the cord, and which may be compared to the spiral growth of the tendrils of plants. The umbilical arteries may describe as many as thirty or forty complete turns in passing from the fœtus to the placenta.

As the spiral growth does involve the whole ccrd, and this cord is fixed at the placental end, it is clear that, as the cord twists, the embryo at its free end must rotate in the *liquor amnii.*

The cord may become twisted round the neck of the fœtus, and may even be tied into knots; these knots must be produced by the cord, at an early stage of development, becoming thrown into a loop, and the embryo then floating through the loop.

Structure of the umbilical cord.—If the cord be examined moıe closely it will be found to consist of the following structures (*cf.* fig. 45):—

1. The sheath formed round it by the amnion. This invests it very closely, except at its insertion into the placenta.

2. The two umbilical arteries; these are quite distinct from one another along the greater part of the length of the cord, but just before reaching the placenta are almost invariably connected together by an anastomotic branch.

3. The umbilical vein; this has thinner walls than the arteries, and has also, according to Kölliker, rudimentary valves. There are at first two umbilical veins, but the right one is from the first smaller than the left, and usually disappears completely during development.

4. The epithelial lining of the allantoic cavity. During the first and second months the allantoic stalk is hollow, its cavity extending from the cloaca of the fœtus along the whole length of the cord as far as the wall of the uterus. Later on, the cavity in the cord itself becomes constricted or altogether obliterated; traces of it are, however, frequently found at birth in the form of an axial cellular rod, of greater or less extent.

5. The yolk-stalk and its vessels, the vitelline arteries and veins. These usually disappear during development, and are very seldom to be distinguished in the cord at full time. The yolk-stalk at first lies in a groove in the allantoic stalk, but soon becomes completely surrounded by this latter, and then ceases to be distinguishable.

6. The Whartonian jelly; this forms the matrix of the cord in which are imbedded the various structures named above; it consists of connective tissue of two kinds:—(*a*) a firmer portion forming a thin superficial layer, a sheath round the vessels, and a central rod (or investment of the allantoic cavity, if this be persistent); and (*b*) a network of fine fibres, the meshes of which are occupied by a gelatinous substance which makes up the rest of the cord, and is traversed according to some authorities by a system of canals.

7. Up till the end of the third month the end of the cord next the embryo contains, as already noticed, a loop of the intestine, but after this date the alimentary canal lies as a rule entirely within the body of the fœtus. (Occasionally at birth this persists, forming a hernia the size of an egg.—R. B.)

Strength of the umbilical cord.—Experiments to determine the resisting power of the cord by attaching weights to one end, show that it will bear a weight of from five to ten kilos. or more before breaking. Clinical observations show that in precipitate births in the upright or sitting posture the cord sometimes breaks under the weight of the child, which ranges from three to five and a half kilos. or more. The weakest point seems to be at the root near the placental insertion. It commonly gives way at this point, when the cord is pulled upon to remove the placenta.

The maternal membranes.—The earliest stages in the formation of the uterine decidua appear to be, so far as they are known to us, identical with those by which the catamenial decidua is formed. They consist in both cases of increased vascularity of the uterus, accompanied by structural changes in its lining membrane, changes consisting essentially in the formation of a new vascular membrane—the decidua—either by hypertrophy of the previously existing mucous membrane or by a process of new formation, accompanied by enlargement and modification of the uterine glands. Up to a certain point the formation of the catamenial decidua and of the decidua of pregnancy appears thus to be identical, and the sole difference between the two is that in the former the processes having reached a certain point stop, and then become retrogressive, the decidua being broken up and discharged together with a certain amount of blood as the menstrual fluid; while, on the other hand, in the case of the decidua of pregnancy, development after reaching the point mentioned does not stop but continues to be progressive.

The difference between the two courses appears to depend solely on impregnation having occurred in the latter, but not in the former case, so that the catamenial decidua may be viewed as a preparation on the part of the uterus for an ovum which never reaches it, the decidua after waiting a certain time becoming broken up and discharged. If, however, impregnation is effected and a fertilized ovum reaches the uterus, a new stimulus is set up and the developmental processes instead of stopping go on to further stages, and so give rise to the decidua of pregnancy.

Decidua vera.—The changes in the mucous membrane of the uterus during pregnancy are of great extent and importance. Before the fertilized ovum reaches the uterus a special vascular membrane has been formed, lining the whole of its cavity. This membrane after reaching a certain stage of development stops, and if no fertilized ovum enters the uterus, after a time breaks up and is discharged with the menstrual flow, and possibly is partly absorbed by the uterine vessels. If, however, a fertilized ovum enters the uterus the membrane continues to undergo progressive development and becomes the *decidua vera* of pregnancy.

The *decidua vera* forms a complete, and at first uniform lining to the uterus; it does not cover the orifices of the Fallopian tubes, which remain open throughout the greater part or whole of pregnancy; neither does it extend into the *cervix uteri*, but stops abruptly at the *os internum*. It attains its greatest development in the early part of the third month, at which time it has a total thickness of from 4 to 7 mm. It consists, according to Kölliker, of an amorphous ground substance in which are imbedded round and fusiform cells in great numbers. Certain large spherical cells, ·03 to ·04 mm. in diameter with sharply defined outlines and conspicuous nuclei and nucleoli, have been named *decidual cells* by Hassall, R. Barnes, and Kölliker, and appear to be very constant and characteristic elements, though their exact nature is not known. At the free surface of the decidua there is no longer a ciliated epithelium present, and it is indeed very doubtful whether any distinct epithelial layer can be described. The whole thickness of the decidua is traversed by very numerous blood-vessels with distinct walls; and is also perforated through and through by a large number of irregularly twisted tubular channels. These channels, which are so numerous as to give the whole decidua a sieve-like appearance, have no distinct walls of their own, and in the great majority of cases not even an epithelial lining, but appear to be merely channels hollowed out in the decidua. They open as a rule on the free surface of the decidua into the uterus, while their deeper ends are continuous with the mouths of the utricular glands. The musculo-glandular layer of the uterus in which these glands are imbedded, and which lies immediately beneath and supports the decidua, is very much swollen; the blood-vessels are greatly increased in number, and the glands themselves have undergone very great enlargement, both in length and in width, and are now twisted and contorted in a very irregular manner; they still retain their lining epithelium, at any rate at and near their blind ends.

The mode of formation of the *decidua vera* has been the subject of much discussion and is not yet satisfactorily known. It was formerly considered to be a coagulated exudation from the uterine mucous membrane, but histological examination has long since refuted this view. It is now commonly regarded as the modified and hypertrophied mucous membrane, and the irregular tubular channels are considered to be the peripheral portions of the utricular glands which have lost their epithelial lining, and become irregularly dilated by pressure of their fluid contents after their mouths have become plugged up.

Ercolani, who has recently investigated the question with great care, has been led to a somewhat different view. He points out that the uterus cannot, strictly speaking, be said to have a mucous membrane at all, as this only consists of an epithelial layer resting on an exceedingly thin basement membrane inseparably connected with the underlying musculo-glandular stratum. He holds that the decidua is an entirely new formation, which replaces the uterine epithelium, and which consists at first of a mass of spherical cells, probably of epithelial origin, into which blood-vessels penetrate from a very early period, and which subsequently undergoes further histological differentiation. The tubular channels which give the characteristic cribriform structure to the decidua, he regards as being formed over the mouths of the utricular glands, and kept open by the continual discharge of the secretion from the glands into the uterus. He therefore explains the absence of an epithelial lining to these channels as due, not to the disappearance from pressure or otherwise of the epithelium that once was here, but to the simple fact that such an epithelial lining is never formed in the channels at any time.

Ercolani's views appear to be more satisfactory than the older ones, though further investigation is necessary before they can be regarded as established.

The *decidua*, as we have said, lines the whole of the uterus, and is at first of uniform structure all the way round, so that any part of it with which the fertilised ovum happens to come in contact on entering the uterus is capable of giving rise to a placenta. After the ovum has once attached itself, the part to which it adheres is called *decidua serotina*, and the name *decidua vera* is retained for the remainder of the decidual membrane. This latter, which has apparently no further function to fulfil, continues growing up to about the middle of the third month, at which time it is from 4 to 7 mm. thick. Its vessels then begin gradually to shrink, and the whole layer to undergo retrogressive changes. By the end of the fourth month it is only 1 to 3 mm. thick, and according to Ercolani has already become separated over the greater part of its extent from the wall of the uterus, which has again acquired, in great part, its normal epithelial lining, which probably grows over it beneath the decidua from the epithelial lining of the mouths of the glands. According to other writers, who however do not appear to have investigated the question with so much care as Ercolani, the separation of the *decidua vera* from the wall of the uterus does not occur until very nearly the close of pregnancy.

The fact that the *decidua vera* lining the greater part of the uterus takes no direct share in the nutrition of the embryo, and after attaining a certain development first stops and then retrogrades, helps to render intelligible, especially when taken in conjunction with the further fact of the intimate relation between the decidua of pregnancy and the catamenial decidua, those not very uncommon cases in which menstruation occurs at least once after conception has occurred; and also those much rarer cases in which it has been stated to recur regularly throughout the greater part or even the whole of pregnancy.

Decidua reflexa.—The youngest ovum yet found within the human uterus, that described by Reichert, was already invested by a fully-formed *decidua reflexa*; so that concerning the formation of this membrane in the human species we know nothing from direct observation. It was formerly supposed the *reflexa* was formed by the ovum on entering the uterus, pushing before it, and so becoming covered by, an 'exudation-membrane'—the *decidua vera*—that was already present lining the uterus. We have, however, already seen that this view cannot be correct; for the *decidua* is not an exudation-membrane, neither does it cover the orifices of the Fallopian tubes.

Though the actual formation of the *decidua reflexa* has not been seen, yet it is almost certain that the view advanced by Sharpey is correct—*i.e.* that after the ovum has attached itself to the *decidua* lining the uterus, the *reflexa* is formed by active growth of the decidua round the ovum so as to en-capsule it; the object of its formation being partly to maintain the ovum in contact with the surface of the uterus, and partly,

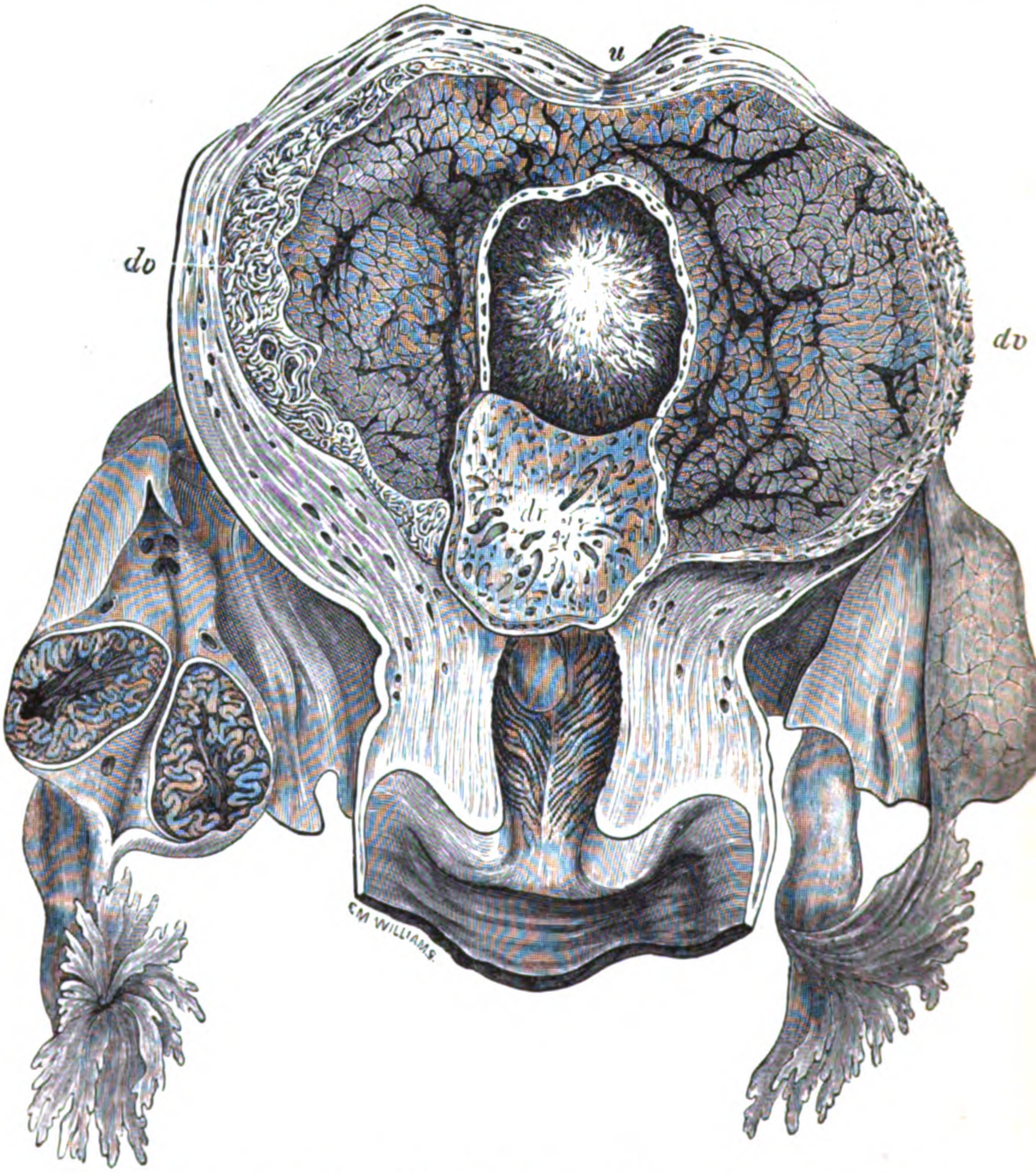


FIG. 46.—Pregnant Uterus of about the twenty-fifth day, cut open longitudinally. (From *Quain's Anatomy*, after Coste.)

Shows the *decidua vera* (*dv*) lining the uterus, and the *decidua reflexa* (*dr*) forming a capsule round the ovum (*o*); the *decidua reflexa* has been cut open and the flap turned down so as to show the crypt-like depressions of its inner surface, into which the villi of the ovum are received. The figure also shows the ovaries and Fallopian tubes. The right ovary has been cut open to display the *corpus luteum*.

perhaps mainly, to provide an increased extent of vascular surface from which the embryonic villi can draw nutriment.

The structure of the *decidua reflexa* is the same as that of the *decidua vera*. It has the same cribriform character, and is in its early stages exceedingly vascular, the vessels converging from its margin to a small patch of a somewhat cicatricial appearance on its most prominent part, which probably indicates the point of meeting and fusion of the folds by which the *reflexa* is formed.

The *reflexa* at first plays a very important part in the nutrition of the embryo, as the villi of the chorion are inserted into crypt-like depressions in its inner surface, and so obtain nutriment from its vessels (fig. 46).

After the second month, however, when the placenta is gradually increasing in importance, the villi implanted in the *reflexa* begin to shrink. The vessels of the *reflexa* at the same time diminish in size, and by the fifth or sixth month have completely disappeared.

As the ovum increases in size the *reflexa* necessarily grows with it; and since this growth is at first more rapid than that of the uterus itself, the *decidua reflexa* will ultimately come in contact with the *decidua vera*, and so completely obliterate the cavity of the uterus (*cf.* fig. 45). This usually occurs about the sixth month, and the two layers, *vera* and *reflexa*, as a rule not only come in contact but fuse more or less completely together, forming a single membrane of a yellowish-white colour, from ½ to 1 mm. in thickness, and usually spongy on its outer side corresponding to the *decidua vera*, and fibrillar on the inner or *reflexa* surface.

Before the *decidua reflexa* meets and coalesces with the *decidua vera*, there is a space between them—the *decidual cavity*. Up to the second, and possibly in some cases the third month, this cavity opens below into the cavity of the cervix, and above into one or both of the Fallopian tubes. This condition is the basis of a theory of superfœtation, since there is thus preserved a free communication between the ovary and the vagina for the concourse of ova and spermatozoa.

Decidua serotina.—The *decidua serotina* is simply that part of the *decidua* with which the impregnated ovum comes in contact on entering the uterus, and to which it adheres. It is at first, therefore, identical in structure with the *decidua vera*, of which it is indeed part. After the ovum has entered the uterus and fixed itself, thus marking out the site of the future placenta, a distinction is soon established between the *decidua serotina* and the *decidua vera*, owing to the chorionic villi of the ovum being received into depressions in the former; but it is not until near the end of the second month that any marked difference is established between the *decidua serotina* and the *decidua reflexa*. About this time (*cf.* fig. 45) the villi opposite the *serotina* become larger and more complicated, and therefore the relations between the fœtal villi and the maternal tissues more intricate, and in this way the placenta is formed; the *reflexa*, on the other hand, as we have just seen begins to retrograde, and rapidly becomes of less and less importance.

It appears to be to a great extent a matter of chance with what part of the uterus the ovum will come in contact on entering it, and therefore at what part of the uterus the placenta will be formed.[1] In the great majority of cases it is in the neighbourhood of the fundus, usually rather to one side of the median line, so as very often to close up the opening of one Fallopian tube, and more frequently on the posterior than the anterior surface. It may, however, be situated in almost any part of the uterus; and its position, as we shall see hereafter, may be a point of much practical importance.

The placenta.—From what has been said above it is clear that the placenta consists of two fundamentally distinct elements—*i.e.* (1) the fœtal portion, formed by the chorionic villi with their contained blood-vessels; and (2) the maternal portion, consisting of the vascular *decidua serotina*. It is of extreme importance to fully realise this double nature of the placenta, and further to remember that each portion, fœtal and maternal, has its own system of blood-vessels; the vessels of the fœtal villi being continuous through the vessels of the umbilical cord with those of the fœtus, and the vessels of the *decidua serotina* being continuous with the general vascular system of the mother. Further, that however intricately and inseparably connected together the two portions of the placenta may be, yet that the two systems of blood-vessels, fœtal and

[1] Ercolani suggests that the ovum on entering the uterus is prevented from at once sinking to the cervix by the fluid secreted by the utricular glands of the uterus, on the surface of which it floats until it comes in contact with and adheres to the wall of the uterus.

maternal, always remain perfectly distinct from one another. At no part of the placenta do the fœtal and maternal bloods directly mix.

Up till the middle of the second month the connection between the fœtal and maternal structures is a very loose one indeed, the fœtal villi being merely implanted in crypts in the maternal *decidua*, from which they can without any difficulty be withdrawn. About the end of the second month the fœtal villi begin to enlarge; they give off lateral branches, which again subdivide and so form arborescent tufts, which owing to their complicated ramifications can now no longer be pulled away without rupture from the maternal tissue into which they are inserted. At the same time the capillaries of the maternal tissues—the *decidua serotina*—begin to dilate so as to form large thin-walled loops. The utricular glands persist in a greatly modified form in the deeper musculo-glandular layer of the *serotina*; but the irregular channels by which they discharge on to the surface, and to which the cribriform character of the *vera* and *reflexa* are due, though present in the early stages of the *serotina* soon become inconspicuous.

The above changes go further and further: the fœtal villi with their contained capillary vessels form tufts of increasing complexity; and the maternal capillaries, which have already undergone considerable expansion, now dilate enormously, so as to become converted into large irregular lacunæ or sinuses (the cavernous ektasis of Virchow), the walls of which consist of a single layer of epithelial cells, outside which are the 'decidual cells' of the *serotina*.

The villi and lacunæ soon come in contact with one another, and by their further growth the lacunæ completely surround the villi, while the latter, pushing the walls of the lacunæ before them, project into their cavities and so become bathed on all sides by the maternal blood.

The vessels in the fœtal villi, which retain their capillary size, are at first separated from the blood in the maternal lacunæ into which they project by (1) the epithelial investment of the villi themselves, which, it will be remembered, is derived from the epiblast of the blastodermic vesicle, and (2) the wall of the lacunæ, which consists of a very thin outer stratum of decidual cells, and an inner layer of epithelium—the original lining of the capillaries from which the lacunæ have been formed by expansion. The epithelial investment of the villi soon atrophies and disappears, so that the fœtal capillaries are separated from the maternal blood merely by the very thin wall of the lacunæ, through which an exchange of gases and nutrient matter can readily be effected.

We shall now be able to understand the structure of the fully-formed placenta. The placenta at full time is a discoidal or cake-shaped body[1] of spongy consistency, measuring from 16 to 21 cm. in diameter and 3 to 4 cm. in thickness. The

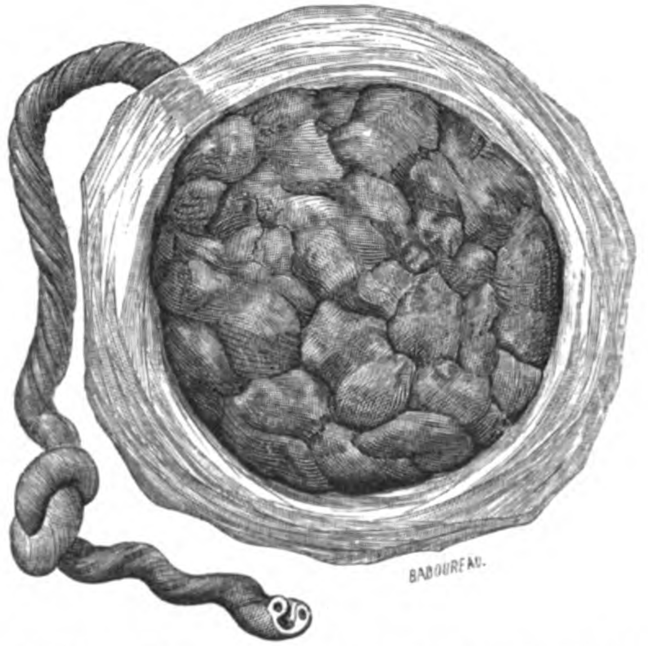


FIG. 47.—Human Placenta; uterine surface. (From Tarnier.) × ¼.

maternal or attached surface is convex, and the free or fœtal surface slightly concave. The blood is brought to the outer or maternal surface by a number of arteries which, from their very tortuous course, receive the name of curling arteries: these subdivide and soon lose all their coats except the endothelial lining and an ill-defined outer wall of connective tissue. After a few branchings the arteries open, without forming capillaries, into the enormous sinuses or lacunæ described above. When two of these lacunæ lie close together side by side their walls usually fuse to form a membranous septum, and

[1] Whence its name πλακοῦς, πλακοῦντος.

the strongest of these septa form a system of partitions arranged for the most part vertically to the surface of the placenta, and dividing it up into a number of very irregular and unequal cells, which have been compared by Kölliker to a honeycomb. The lacunæ open ultimately into veins which are chiefly placed, like the arteries, on the outer or maternal surface of the placenta; the largest veins run outwards to the edge of the placenta, where they unite to form a marginal anastomotic ring.

Concerning the fœtal portion of the placenta the villi are found as *cotyledons*, or tufts of branched finger-like processes,

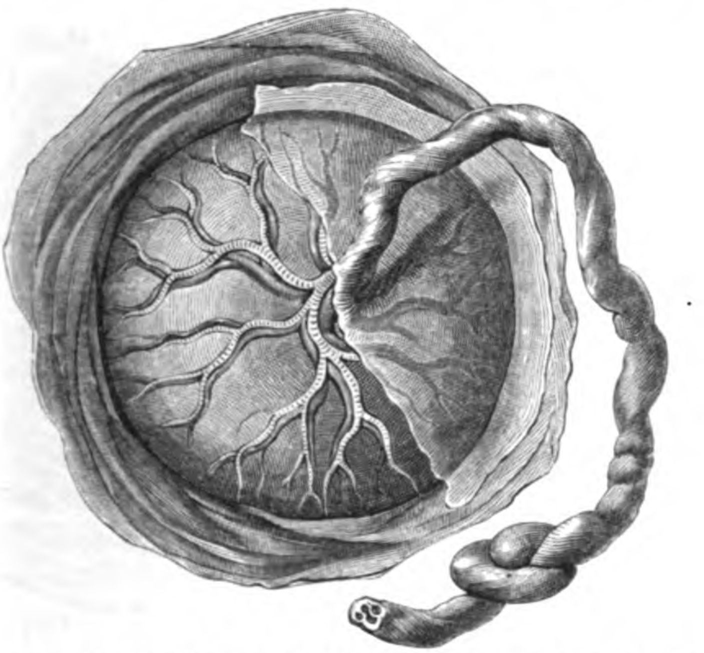


FIG. 48.—Human Placenta; fœtal surface. (From Tarnier.) × ¼.
Amnion dissected off one side to show vessels.

hanging down into the cells of the 'honeycomb,' and so bathed by the maternal blood: the ends may either hang down freely or else be attached, as the so-called 'roots,' to the sides or bottoms of the lacunæ. In all cases the villi are not really inside the lacunæ, but simply project into them from the exterior, driving before them the walls of the lacunæ which form a closely-fitting investment to each. Each villus contains a capillary loop in connection, through the vessels of the umbilical cord, with the vascular system of the fœtus.

This account is based mainly on the researches of Ercolani and Turner. The description given by Kölliker differs in some important points, which concern, however, not so much the actual anatomical disposition of the parts, as the interpretation to be placed on them. Kölliker regards the epithelial investment of the villi as belonging really to them and not to the lacunæ.[1] He also considers that the lacunæ are not dilated capillaries, but spaces that have primitively no connection with blood-vessels, so that the blood in them must be viewed as extra-vascular. The difficulties in the way of accepting this view are very great, while the theory supported by Ercolani and

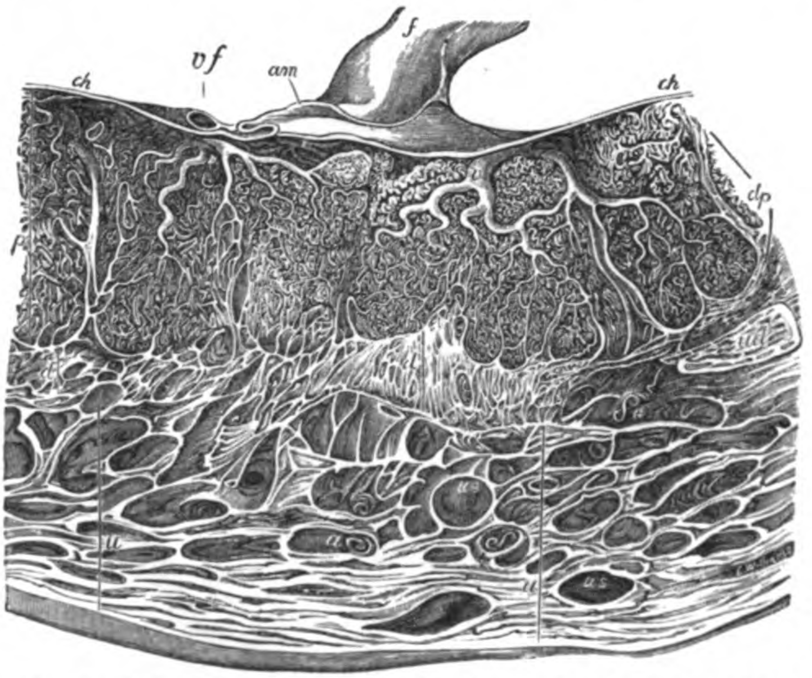


FIG. 49.—Vertical section of middle portion of Placenta; the fœtal surface being directed upwards, and the uterine or maternal surface downwards.

am. Amnion. *ch.* Chorion. *f.* Umbilical cord. *us.* Uterine sinuses or lacunæ. *v.* Branches of umbilical artery supplying the fœtal villi.

Turner has the merit not only of greater simplicity, but also of being far more in accordance with what is known to occur in other mammalia.

In parturition the placenta separates, as a rule, almost immediately after the birth of the child, and is discharged together with the *deciduæ vera* and *reflexa* (usually inseparably fused together) and the amnion. The line of separation

[1] Robert Barnes and Hassall have described and illustrated this view: Barnes' 'Memoir on Fatty Degeneration of the Placenta,' *Med.-Chir. Trans.*

of the placenta seems to be the same as that already described in the case of the *decidua vera*, *i.e.* the line marking the boundary between the original wall of the uterus and the newly-formed decidual tissue. As this line will cut across the outer parts of the lacunæ there will necessarily be considerable hæmorrhage accompanying the separation.

Separation of the placenta is effected, as a rule, by the great and rapid contraction of the uterus which follows the birth of the child, and the continuation of this contraction after the placenta is removed is the main agent in checking and restraining the hæmorrhage consequent on the removal.

Robert Barnes, after many measurements of placentas, estimates that the average area of the placenta, and consequently of the uterine surface to which it is attached, is from 70 to 80 square inches, whilst the uterine area after the placenta is cast is reduced to 8 or 9 square inches. This enormous contraction explains not only the detachment, but the rupture of the utero-placental vessels and the closure of their mouths.

The umbilical cord is usually inserted near the middle of the placenta; it may, however, be *excentric*, *i.e.* some distance from the middle; *marginal*, the 'battledore-placenta;' or even beyond the margin of the placenta, into a part of the chorion free from villi. The cord may divide into two parts, inserted separately into the placenta.[1]

The placenta is also liable to modifications other than those of simple position in the uterus. The chief of these, none of which are at all common, are:—*Placenta marginata*, in which the *chorion frondosum* only occupies the middle of the placenta and leaves the marginal part bare: *placenta succenturiata*, in which there is a subsidiary placenta more or less completely separated from the main one: *placenta duplex*, in which the placenta is in two completely separated halves, and the um-

[1] The insertion of the cord is probably governed by some conditions depending upon the seat of attachment of the placenta to the uterus. Thus it has been observed that when the placenta is seated centrally in the fundus, the cord is central; and that in cases of placenta prævia, when the attachment of the placenta spreads into the lower region of the uterus, the cord springs from the margin nearest the os uteri. Hence the liability to prolapsus of the cord in these and analogous cases of low placental implantation.—Levret, Robert Barnes.

bilical cord splits into two parts, one going to each half; this form of placenta is normal among the majority of old-world apes: *placenta tripartita*, a very rare condition, in which the placenta consists of three parts; and *placenta multiloba*, in which it is divided into a great number of completely separate parts, in extreme cases as many as twenty to forty.

(In some rare cases R. Barnes has seen the placenta diffused over the whole area of the uterus, except for a space of four or five square inches.)

The Fœtal Circulation.—The condition of the circulatory organs of the embryo at the end of the fourth week has already been described and figured (*cf.* p. 88, fig. 34). At this time the two auricles are only partially separated from one another, and the same is the case with the ventricles. From the ventricular cavity arises the *bulbus arteriosus*, from which are given off the five aortic arches on each side; of these the first and second arches have already in great part disappeared, their persistent portions forming the lingual and external carotid arteries. The third, fourth, and fifth arches of each side are connected together above the pharynx into one trunk, and the trunks of the two sides uniting together form the dorsal aorta. Each third arch also gives off an anterior branch—the internal carotid; from between the fourth and fifth arches arise the subclavian arteries; and from the left fifth arch the pulmonary arteries.

In the course of development the interventricular septum, which appeared first at the lowermost part of the ventricular cavity, the future apex of the heart, gradually extends upwards so as to separate the ventricles more and more completely from one another. At the same time a longitudinal septum appears in the *bulbus arteriosus*, commencing between the fourth and fifth arches and gradually growing downwards in a somewhat spiral manner so as to divide the *bulbus* into two tubes placed side by side, whereof one communicates with the fifth pair of aortic arches alone, while the other is in connection with the first four pairs. This septum continues its downward growth until it meets with the upwardly growing inter-ventricular septum, with which it fuses.

In this way it comes to pass that the two ventricles are completely separated from one another, and that while the left ventricle communicates with the first four arches, the right ventricle can only send its blood into the fifth pair of arches.

At the same time certain changes are being effected in the aortic arches themselves. These consist chiefly in the obliteration of certain portions of the primitive arches, and will be evident from an inspection of fig. 50. By comparing these figures with one another and with fig. 34 it will be seen that the chief changes which have occurred are the following:—(1) the third arch has, on both sides, lost its connection with the aorta, and now merely forms the internal carotid artery; (2) the fourth right arch has also lost its connection with the dorsal aorta, and now merely forms the right subclavian artery, from which the

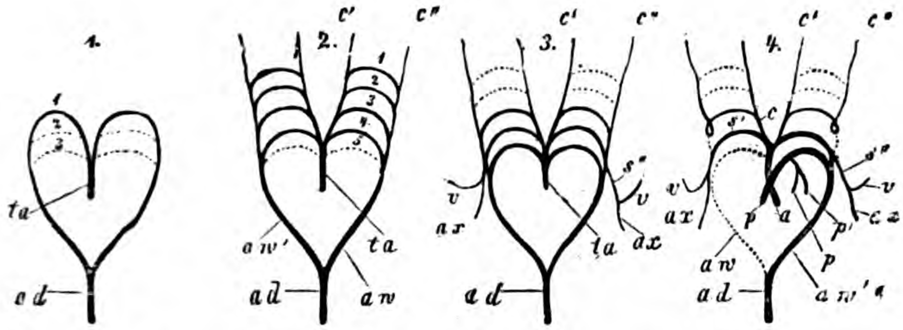


FIG. 50.—Diagrammatic figures showing the development of the large Arteries from the aortic arches of the embryo. (From Kölliker, after Rathke.)

1. Truncus arteriosus, with one pair of aortic arches, and indications of second and third pairs.
2. Truncus arteriosus, with four developed and one rudimentary pairs of arches.
3. First and second arches aborted; third, fourth, and fifth pairs present.
4. Arteries of adult, showing their relations to the aortic arches of the embryo; the dotted lines indicate vessels that have become obliterated.

1-5. First to fifth aortic arches. *a.* Aorta. *ad.* Dorsal aorta. *aw'.* Left or persistent root of dorsal aorta. *aw.* Right or obliterated root. *ax.* Axillary artery. *c.* Common carotid artery. *c'.* External carotid. *c''.* Internal carotid. *p, p'.* Pulmonary arteries. *s', s''.* Subclavian arteries. *ta.* Truncus arteriosus. *v.* Vertebral artery.

vertebral artery arises as a branch; (3) the fourth left arch has greatly increased in size and is directly continuous with the dorsal aorta; (4) the fifth right arch has disappeared completely; (5) the fifth left arch gives off both right and left pulmonary arteries, and is still connected by a wide vessel—the *ductus arteriosus* or *ductus Botalli*—with the dorsal aorta.

Concerning the venous system, we have already seen that at the fourth week there are three large veins opening into the right auricle, viz. (1 and 2) the right and left superior *venæ cavæ* or *ductus Cuvieri*, each of which is formed by the junction of a jugular vein from the head with a posterior cardinal vein from the Wolffian bodies and adjacent parts; and (3) the inferior *vena cava*, which is formed in this way (*cf.* fig. 34): the umbilical vein, bringing back blood from the chorion, enters the liver of the embryo; as it does so it is joined by the portal vein, formed by the union of the mesenteric veins from the intestines with the vitelline vein from the yolk-sac. Part of the blood thus brought to the liver passes straight through it by the *ductus venosus*, while part is first taken through the capillaries of the liver and then falls again into the *ductus venosus* close to its exit from the liver; this emerges from the liver as the hepatic vein, which joins a small vein from the posterior extremities to form the inferior *vena cava*.

By the time the placenta is fairly established, the veins have undergone some further modification. A communicating branch becomes established between the left and right superior *cavæ*, and by means of this branch, which becomes the left innominate vein, the blood of the left superior *cava* is taken to the right auricle through the right *vena cava*; the remaining portion of the left superior *cava* becomes in great part obliterated, a portion of it persisting as the coronary sinus. The cardinal veins have disappeared; while the median vein, formed by the union of the two veins from the legs, which were at first very small, rapidly increases in size and forms the lower part of the *vena cava inferior* of the adult.

The course of the circulation in the fœtus during the later months of pregnancy is shown in the following figure (51). Blood is brought to the right auricle A by two vessels—(*a*) the right superior *vena cava*, fig. 51, 3 (the left having disappeared), which brings back venous blood from both sides of the head and neck and from the upper extremities by the jugular and subclavian veins of the right and left sides: (*b*) the inferior *vena cava*, 4; this contains venous blood brought from the hinder part of the body, chiefly the posterior extremities and the kidneys, mixed with arterial blood brought back from the placenta by the umbilical vein, 5. A great part of the blood in the umbilical vein passes through the *ductus venosus* and so through the hepatic vein into the *vena cava inferior*, without passing through the liver; while the rest, together with the blood brought from the intestines by the portal vein, 6, only reaches the inferior *cava* after passing through the capillaries of the liver.

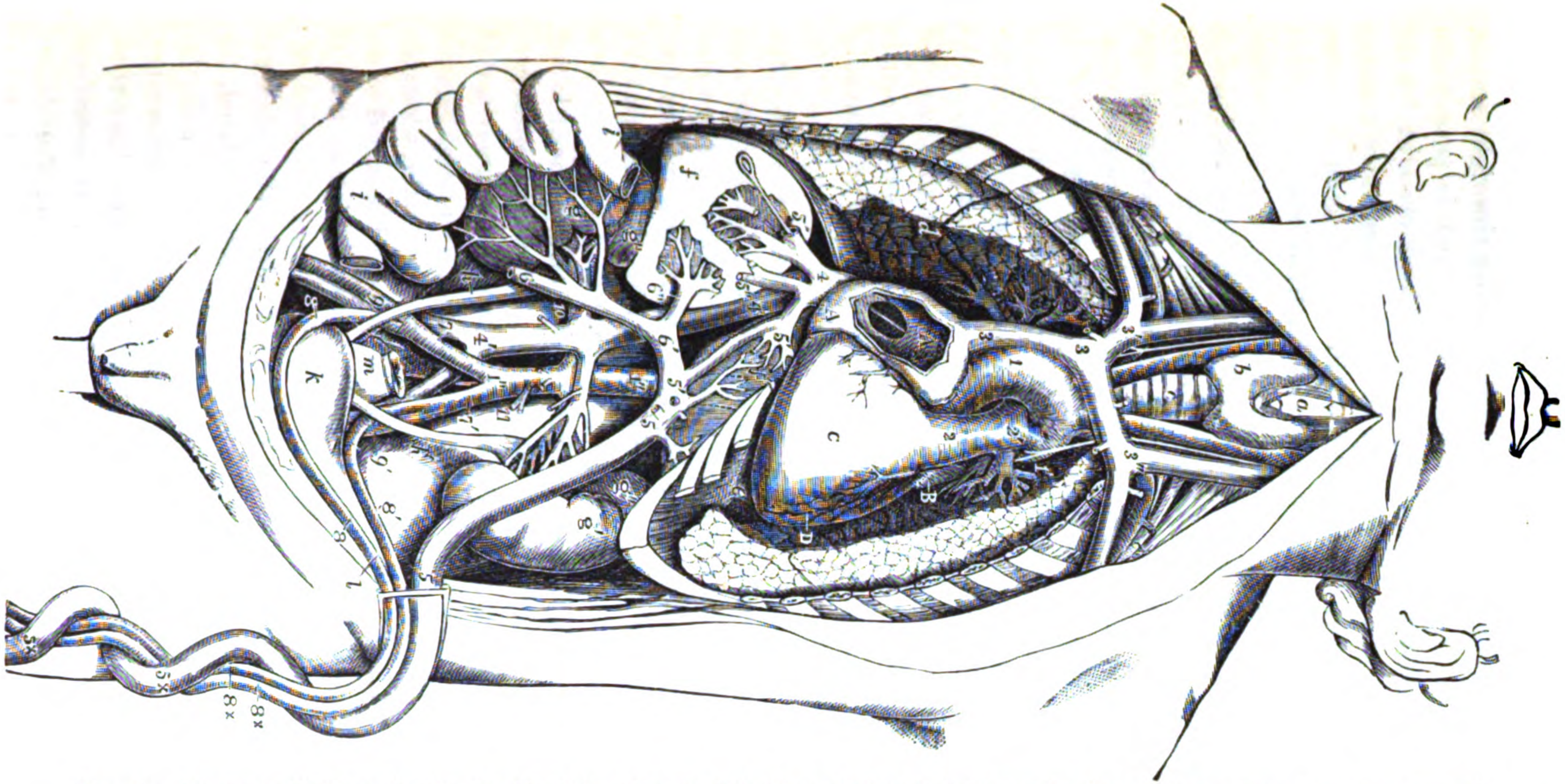


FIG. 51.—Diagrammatic figure showing the Circulatory Organs of the Fœtus during the later months of pregnancy. (From *Quain's Anatomy*.)

A. Right auricle. B. Left auricle. C. Right ventricle. D. Left ventricle. *a*. Larynx. *b*. Thymus gland. *c*. Trachea. *d*. Right lung. *e*. Diaphragm. *f*. Liver. *g*, *g'*, *g''*. Intestine. *h*, *h'*. Ureters. *i*. Small intestine. *k*. Bladder. *l*. Urachus. *m*. Rectum. 1, 1', 1''. Arch of aorta and dorsal aorta. 2. Pulmonary artery. 2'. Ductus arteriosus. 3. Superior vena cava. 3', 3''. Junctions of jugular and subclavian veins of right and left sides. 4, 4'. Inferior vena cava. 5, 5x. Umbilical vein. 5'–5'. Ductus venosus. 5''. Hepatic vein. 6, 6', 6''. Portal vein. 7, 7'. Right and left common iliac arteries. 8, 8', 8x. Umbilical or allantoic arteries. 9, 9'. Internal iliac arteries.

Of the two streams of blood thus entering the right auricle, the venous blood from the superior *vena cava* is passed into the right ventricle; while the mixed blood brought by the inferior *vena cava* is directed by the Eustachian valve through the *foramen ovale* (the aperture still persisting in the inter-auricular septum) into the left auricle, from which it passes into the left ventricle.

From the right ventricle (fig. 51 C) the venous blood is forced by the ventricular systole into the fifth left arch (figs. 50 and 51) or pulmonary artery; very little of it enters the lungs, which are in an unexpanded condition and therefore offer great resistance to the entrance of blood, so that nearly the whole of it passes through the *ductus arteriosus* into the dorsal aorta (*cf.* fig. 50), down which it courses to the bifurcation into the two common iliacs, then down these latter, and partly to the lower extremities, but principally along the umbilical arteries, fig. 51, 8 and 8′, to the placenta, where it gives up certain effete matters and receives nutriment, and whence it returns by the umbilical vein, fig. 51, *s*.

The blood in the left ventricle, which we have seen is of a mixed character, passes along the fourth left or main aortic arch, fig. 50, and then by the carotid and subclavian arteries to the head and upper extremities; very little, if any of it, passes down the dorsal aorta, which is already filled with the venous blood discharged into it by the right ventricle.

It will be seen that the effect of this arrangement is that the blood returned from the placenta is sent almost entirely to the head and upper limbs of the fœtus, while the lower part of the body only receives blood that has already circulated through the head and upper extremities. The right ventricle, which has to do the greater part of the work of driving the blood to the placenta, has during fœtal life walls quite as thick as those of the left.

Changes in circulation at birth.—At birth the placental circulation is arrested, and, the lungs becoming inflated, the pulmonary circulation is established. In connection with this shifting of the seat of respiration from the placenta to the lungs, certain important changes are effected in the circulation; these are (1), shrinking and obliteration of the *ductus arteriosus* and of the umbilical arteries; (2) obliteration of the *ductus* *venosus* and of the umbilical vein; (3) closure of the *foramen ovale*.

By these changes it is brought about that the blood in the inferior *vena cava*, as well as that in the superior *vena cava*, passes from the right auricle into the right ventricle. From the right ventricle it is no longer able to pass through the *ductus arteriosus* to the aorta, but can now only pass by the pulmonary arteries to the lungs. From the lungs it is returned by the previously insignificant pulmonary veins to the left auricle, and so to the left ventricle, which drives it not only to the head and upper limbs, but also down the dorsal aorta to the lower part of the body. By the obliteration of the *ductus venosus* all the blood in the portal vein is compelled to pass through the capillaries of the liver in order to reach the inferior *vena cava*. In other words, by these changes—the obliteration of the *ductus arteriosus* and *ductus venosus*, and the closure of the *foramen ovale*—the fœtal circulation has been converted into that of the adult.

The several changes noticed above do not occur immediately on birth, neither are they effected all at the same time. Obliteration of the umbilical arteries occurs first, and is usually complete by the third or fourth day. The umbilical veins and *ductus venosus* remain open rather longer, but are generally obliterated by the sixth or seventh day. The *ductus arteriosus*, according to Allen Thomson, 'is rarely found open after the eighth or tenth day, and by three weeks it has, in almost all instances, become completely impervious.' Finally, complete closure of the *foramen ovale* is the last of all the changes to be effected, and in many cases an oblique valvular aperture, large enough to pass a probe through, persists for the first year of infancy, or may even be permanent throughout life, in which case it is the cause of cyanosis or *Morbus cœruleus*, in which the two bloods, arterial and venous, are mixed.

Physiology of the Fœtus.

Respiration.—The respiration of the fœtus during intra-uterine life is effected by means of the placenta, the blood returning from the placenta by the umbilical vein being richer in oxygen, as well as in nutritive matters, and poorer in carbonic acid and excretory products, than that conveyed to the placenta from the fœtus by the umbilical arteries.

The respiratory changes in the fœtus are, however, so slight that there is but very little difference in colour between the blood of the umbilical artery and vein. Still, they are by no means unimportant, for it has been shown by Zuntz that if the mother be choked, so that the maternal blood becomes very poor in oxygen, the fœtus is very speedily asphyxiated; and in such a case it appears further that the small amount of oxygen contained in the fœtal blood passes back again through the placenta into the maternal blood, so that death of the fœtus occurs more rapidly than if asphyxia were produced by simple compression of the umbilical cord; for not only is there no further supply of oxygen brought to the fœtus, but what is already present in its blood passes back to the mother.

From this last observation it is almost certain that the process of respiration as effected in the placenta is one simply of diffusion, the blood of the fœtus containing less oxygen than that in the placental sinuses, but having a higher carbonic acid tension, and therefore, in its passage through the capillaries of the fœtal villi, gaining oxygen and losing carbonic acid.

Up to the time of birth the pulmonary respiratory processes are in complete abeyance; and this has been explained by supposing that the respiratory centre in the medulla receives throughout the whole of intra-uterine life blood that is too highly oxygenated to call it into activity; or, to use Dr. Foster's words, 'the oxygen-supply to the protoplasm of its nerve-cells is never brought so low as to set going the respiratory molecular explosions. As soon, however, as the intercourse between the maternal and umbilical blood is interrupted by separation of the placenta or by ligature of the umbilical cord, or when in any other way blood of sufficiently arterial quality ceases to find its way by the left ventricle to the medulla oblongata, the supply of oxygen in the respiratory centre sinks, and when the fall has reached a certain point an impulse of inspiration is generated, and the fœtus for the first time breathes.'[1] The expansion of the thorax thus effected is to a certain extent permanent, and the diminution of the pressure in the pulmonary circulation which it occasions is the main cause determining an increased

[1] Foster, *Text-book of Physiology*, 3rd edition, p. 626.

flow of blood through the pulmonary vessels, and so a decreased flow through the *ductus arteriosus*, which, as we have just seen, rapidly shrinks and becomes obliterated.

Temperature.—In the adult the muscles and the glandular organs are supposed to be the main sources of the heat of the body; in the fœtus, however, these two systems are almost entirely quiescent, and at any rate contribute very little towards maintaining the temperature of the body. It must, however, be borne in mind that, owing to the conditions in which the fœtus is placed, the cooling by radiation or evaporation must be extremely small, so that comparatively very slight metabolic changes suffice to keep the heat of the body at the normal temperature. That an actual production of heat on the part of the fœtus does occur, is evident from the observations of Gusserow, which show that the temperature of the fœtus immediately after birth is constantly from 0·1° to 0·3° C. above that of the uterus and vagina.

Nutrition.—Concerning the nutrition of the fœtus, Dr. Foster remarks: 'If oxygen and carbonic acid thus pass by diffusion to and from the mother and the fœtus, one might fairly expect that diffusible salts, proteids, and carbohydrates would be conveyed to the latter, and diffusible excretions carried away to the former, in the same way; and if fats can pass directly into the portal blood during ordinary digestion, there can be no reason for doubting that this class of food-stuffs also would find its way to the fœtus through the placental structures.'[1]

There is indeed no doubt whatever that the materials at the expense of which the fœtus is enabled to increase in size and complexity are derived from the maternal blood in the placenta, although as to the exact form and manner in which this conveyance is effected we have no definite knowledge.

That the character of the maternal blood has a very marked and direct influence on the fœtus, is evident from the occurrence of cases of congenital syphilis transmitted from the mother to her yet unborn offspring; but it would also appear that the nutrition of the fœtus is to a certain extent, and in a peculiar manner, independent of the mother. In evidence of this, Gusserow cites from Fumée[2] the case of a woman who, while

[1] Foster, *Text-book of Physiology*, 3rd edition, p. 622.

[2] Fumée, *Journal de Médecine* (1759).

suffering from small-pox, bore twins, one of which was born dead with small-pox pustules on the body, while the other was born living and healthy.

Diffusible substances taken by the mother as medicine have been found in the fœtus, proving that such substances can pass directly by the placenta—the only possible route—from mother to fœtus. The best known examples of this are cases of syphilitic women who have taken iodide of potassium during the period of pregnancy, which iodide has afterwards been found in the fœtus. Gusserow,[1] who has investigated a number of these cases very carefully, finds that although iodide of potassium does really pass from mother to fœtus, yet that its passage is exceedingly slow, and that unless administered to the mother for more than fourteen days no traces of it are found in the fœtal urine.

Concerning the nature of the processes by which in the placenta nutrient matter is transferred from the maternal to the fœtal blood-vessels, we know nothing definitely; but it would appear probable that the process is really, at any rate in chief part, simply one of diffusion. Ercolani, relying mainly on the structure of the placenta in lower mammals, maintains that the layer of cells between the maternal and fœtal vessels takes an active share in elaborating the nutrient matter for the fœtus, and speaks of the whole placenta as a 'glandular organ' whose main function is this elaboration of food. On the other hand, Dr. Gamgee points out that in cases of extra-uterine fœtation development of the fœtus and placenta proceeds in a normal manner; and yet this layer of special secreting cells (Ercolani) is in these cases represented solely by the ordinary peritoneal epithelium. He also urges that we have in the blood of the mother a supply of diffusible food already elaborated, so that there would appear to be no need or purpose for any special secreting organ.

At a very early period the tissues of the fœtus, especially the muscles, are very richly loaded with glycogen, which may be regarded as a store of partially elaborated material ready for immediate use whenever a demand arises for it.[2] Later on,

[1] Gusserow. 'Zur Lehre vom Stoffwechsel des Fœtus.' *Archiv f. Gynäkologie*. Bd III. Heft 2.

[2] Foster, *op. cit.* p. 623.

about the fifth week, the muscles have acquired their definite histological structure, and glycogen is found in them in much smaller quantities but now begins to be deposited in the liver.

Secretion.—In the fœtus 'the digestive functions are naturally, in the absence of all food from the alimentary canal, in abeyance. Though pepsin may be found in the gastric membrane at about the fourth month, it is doubtful whether a truly peptic gastric juice is secreted during intra-uterine life; trypsin appears in the pancreas somewhat later, but an amylolytic ferment cannot be obtained from that organ until after birth.'[1]

Excretion.—Excretion is doubtless in part effected by the placenta; but in addition to this, special excretory organs—the liver and kidneys—come into functional activity at an early period.

Bile is formed by the liver as early as the third month, and discharged into the intestine, where it accumulates especially in the rectum, forming with desquamated epithelium and possibly secretions from other parts of the intestinal tract the substance known as *meconium*, in which bile salts, bile pigment, and also cholesterin have been recognised.

Urine is also formed by the kidneys at an early period, according to Gusserow even during the second month. Its quantity is usually very small, but is subject to much individual variability. It appears, as a rule, to be passed through the cloacal aperture into the cavity of the amnion—*i.e.* the space between the true amnion and the body of the fœtus. If from any reason it is unable to escape it accumulates in the bladder, at the base of the allantoic stalk, which may become greatly distended.

In the liquor amnii both urea and uric acid have been recognised; and, says Gusserow, the urea is formed by the fœtus. This must be so in oviparous vertebrates, as birds, in which there is no other source for the urea but the secreting activity of the kidneys. That the kidney of the human fœtus is capable of acting in a normal manner is proved by the cases in which iodide of potassium administered to the mother was found in the urine of the fœtus.

[1] Foster, *op. cit.* p. 624, quoted from Langendorff.

CHAPTER VI.

THE PELVIS.

THE main interest which the pelvis presents from the obstetric point of view rests in this structure regarded as a whole. It is when bound together as one compact body that the several component parts acquire obstetric value.

The minute study of the several bones throughout the successive stages of development has, indeed, a high scientific and even applied interest as throwing light upon the origin of the malformations, diseases, and distortions of the pelvis. But this study would exceed the limits necessarily imposed upon this work. We shall, therefore, give but a brief sketch of the component elements of the pelvis, and shall describe more fully the great obstetric structure built up by the consolidation of these elements.

1. **The pelvis** is composed of bones and ligaments.

There are four bones: the sacrum, the coccyx, and the two coxal, innominate, or iliac bones.

1. The *sacrum* is a single, symmetrical bone of a quadrangular pyramidal form, wide above, tapering below. It rests between the two ossa innominata, wedged between them. On its posterior surface it presents the crested ridge of the sacral vertebral elements, strongly marked above, less marked below. On either side of this ridge are the posterior sacral foramina. It is convex. The anterior or inner surface is the more important in its obstetric bearings. It is strongly concave, forming the hollow of the sacrum. This is bounded above by the projecting *promontory*, formed partly by the first sacral vertebra, but completed by the last lumbar vertebra, which rests upon the sacrum. The inner surface is smooth, presenting on either side of the median line the openings which give exit to the sacral nerves. At the lower end is the articular surface by which it is united to the coccyx. The sacrum in its origin

consists of five vertebræ. These become fused together at the age of eight or ten. It becomes one solid bone at puberty or a little later.

2. The *coccyx* consists of four or five small rudimentary vertebræ. It may be regarded as an appendix to the sacrum. It forms a triangle, the base of which is articulated with the apex of the sacrum. Its anterior surface, concave in continuity with the concavity of the sacrum, is in near relation with the rectum. The posterior surface is rough, convex, and lies almost subjacent to the skin. It can always be felt behind the anus, and thus forms a landmark in examinations. In man the coccyx is rudimentary; in many animals it is developed into the tail.

3. The *os innominatum* or *ilium* or *coxal bone* is one of a pair, articulated behind with the sacrum, and joining its fellow in the median line at the symphysis pubis. It consists of two parts distinct in character: one inferior, flattened from before backwards, nearly vertical; the other, upper, larger, flattened, and projecting from within outwards. These parts uniting form an obtuse angle projecting inwards. The *external* or *femoral aspect* presents about its middle the *cotyloid cavity*. This is hemispherical, smooth, and cartilaginous; it holds the head of the femur; it looks downwards, outwards, and a little forward. A small cavity at its bottom gives attachment to the round ligament which ties the head of the femur to the cavity. The upper part of the external surface is expanded, convex in front, concave behind. It is traversed by two slightly elevated ridges, the *semi-circular lines*, one above, one below. Between the two lines is a broad space, to which is attached the gluteus medius. In front of the inferior line is a still broader space, which receives the insertion of the gluteus minimus. A small space above, marked out by the superior line or curve descending from the edge of the bone a little in front of the posterior superior spine to the greater sciatic notch, at the posterior border of the bone, gives attachment to the gluteus maximus.

The *inferior part of the external surface*—that is, the lower and vertical half of the os coxæ—presents the *obturator foramen*. This hole is bounded above by the *body of the pubes*, directly above it by the *horizontal ramus of the pubes*, outwardly by the *ischium*, a stout column slightly concave in front serving to support the cotyloid cavity, and terminated below by a rounded body, the *sciatic tuberosity*, and inwardly and below by the *ischio-pubic ramus.*

The internal or pelvic aspect.—A projecting line, the *linea innominata* or *ilio-pectinea*, separates this aspect into two parts. This line has a blunt edge, convex from above downwards, concave from before backwards; it is limited in front by the ilio-pectineal eminence, behind by the sacro-iliac symphysis. This line constitutes a part of the upper strait of the pelvis. The *upper half of the internal surface* looks upwards and inwards; it presents behind a strong tuberosity, the *iliac tuberosity*, convex, very unequal, giving attachment to the ligaments which bind the os innominatum behind to the sacrum; an *articular surface*, called auricular from its shape, corresponding to the sacrum; and more forward is a broad smooth excavation filled by the iliacus muscle: this is the *internal iliac fossa.*

The *lower half of the internal aspect*, that part below the linea ilio-pectinea, presents behind a quadrilateral bony surface, smooth, slightly concave, directed obliquely from above downwards, from behind forwards, and from without inwards. This surface constitutes, above, the *floor of the cotyloid cavity.* More in front is the inner surface of the obturator foramen. Above this foramen is the posterior surface of the horizontal branch of the pubes; within and above is the posterior surface of the body of the pubes; within and below is the posterior surface of the ischio-pubic branch; below and behind is the posterior surface of the ischium.

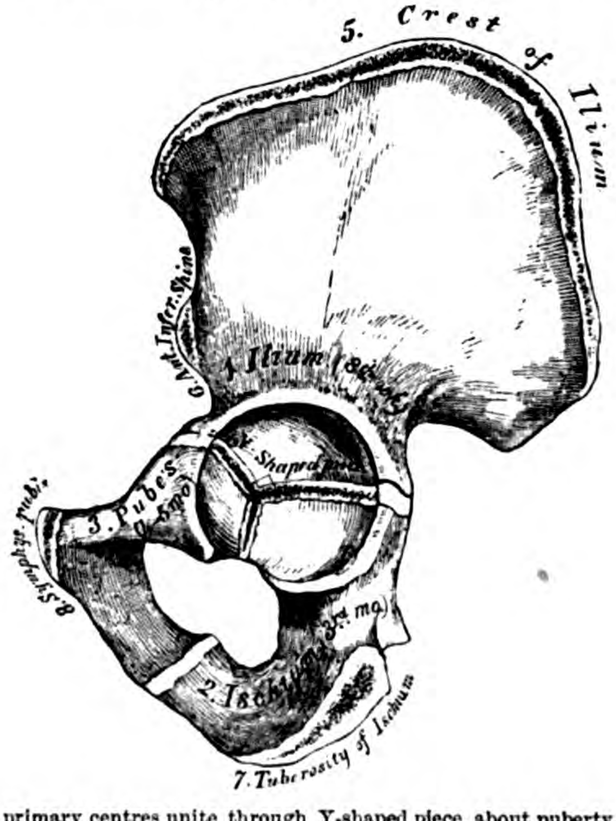
The *circumference* is divided arbitrarily into four borders: 1. *The upper border* or *iliac crest* is marked in front by the *antero-superior iliac spine*, behind by the *postero-superior iliac spine.* It has nearly the form of the letter S. It presents two lips; the external gives attachment to the greater obliquus abdominis muscle, the internal to the transversus muscle, and the line between the lips to the lesser oblique muscle. 2. *The lower border*, the *pubic*, is the shortest. The upper part presents the articular surface which corresponds with its fellow from the opposite side. This surface is an oval facet. The lower part, diverging from its fellow backwards and downwards, is the ischio-pubic branch. 3. The *anterior border*, the *inguinal*, is concave and limited outwardly by the antero-superior iliac spine, inwardly by the angle of the pubes. The posterior part is sinuous; it shows the *antero-superior iliac spine*, which gives insertion to muscles and to the external extremity of the round ligament; below there is a notch; then the *antero-inferior iliac spine*; and lastly, a groove, in which play the united tendons of the psoas and iliac muscles. The anterior portion, horizontal, regular, has a triangular surface, presenting a base, apex, and two sides. The *base* is marked by a rounded eminence, the *ileo-pectineal eminence;* the *apex* by a sharp prominence, the *spine of the pubes.* This is called the *pectineal ridge* or *crista pubis.* 4. The *lower border* is comprised between the postero-superior iliac spine and the tuber ischii. It is very irregular and presents—*a*, the *posterior and superior iliac spine;* *b*, a small notch; *c*, the posterior and inferior iliac spine; *d*, a large notch, the *sciatic notch*, destined to form, with the help of the great and small sacro-sciatic ligament, the *greater sciatic foramen;* *e*, a pointed triangular eminence, the *ischiatic spine;* *f*, a groove serving as a pulley of reflexion to the tendon of the obdurator internus muscle; *g*, the sciatic tuberosity.

The os innominatum is developed from three primitive points of ossification and eight supplementary points. Of the three primitive points, the first appears in the ilium, from the fiftieth to the sixtieth day of intra-uterine life; the second appears in the ischium at the beginning of the fourth month of gestation: the third in the pubic portion at four months and a half. The fusion of the ischio-pubic branch is effected at twelve or fourteen years of age; that of the three primitive points, ilium, ischium, and pubes, meeting in the cotyloid cavity, at fifteen or sixteen.

Of the eight supplementary points, there are three for the cotyloid cavity, one for the anterior and inferior iliac spine, one for the crista ilii and its antero-superior spine, one for the sciatic tuberosity and the ischio-pubic branch, two for the spine and angle of the pubes. This survey of the development of the bone is important as throwing light upon the genesis of deformities of the pelvis during childhood. Superincumbent pressure through the sacrum falling upon the cotyloid cavities which hold the heads of the femora tends to concentric collapse if the bones are not well set. Thus the points of chief indentation are those where the several primitive bones, ilium, ischium, and pubes meet. (See fig. 52.)

These bones may be studied by following the above description, or the more detailed descriptions of systematic works on anatomy, on the dried separate bones. But the main points

By 8 Centres. { 3 Primary (Ilium, Ischium, and Pubes). 5. Secondary.



The three primary centres unite through Y-shaped piece, about puberty, Epiphyses appear about puberty, and unite about 25th year.

FIG. 52.—(After Gray.)

may be satisfactorily traced on the consolidated pelvis, which further enables the student to follow the description of the ligaments and other features of the pelvis in its obstetric bearings.

The Pelvis as a Whole.

The component bones are united by joints. 1. The lumbo-pelvic joint, which unites the spinal column to the sacrum.

2. The sacro-coccygeal joint. 3, 4. The sacro-iliac joints uniting each ilium to the sacrum. 5. The symphysis pubis.

The modes of articulation have interesting obstetric bearings.

I. The *lumbo-pelvic or sacro-vertebral joints.* The sacrum is joined to the fifth lumbar vertebra by three articulations; the middle one is a *symphysis*; the two others, lateral, are *arthroses.*

a. The *sacro-vertebral symphysis* presents two large oval articular surfaces—one on the base of the sacrum, the other on the lower surface of the fifth vertebra. It resembles all the intervertebral discs in having a soft central part and a peripheral fibro-cartilaginous part. It is very obliquely cut, the front part being twice as high as the hinder part. The peripheral ligaments are simply prolongations of the vertebral ligaments.

b. The *sacro-vertebral arthroses*: one on either side. Each presents two articular surfaces, one being on the articular apophysis of the sacrum, the other on the articular apophysis of the fifth lumbar vertebra. They are united by ligaments, one of which is capsular. There is a yellow ligament resembling the yellow ligaments of the vertebral column. The other ligaments bind the sacrum to the bodies and spinous processes of the vertebræ.

II. The *sacro-coccygeal joint* and *intercoccygeal joints.* The sacro-coccygeal joint is an amphiarthrosis; it is composed of two articular surfaces, an interosseous fibro-cartilage and four peripheral ligaments. The sacral articular surface is oval, slightly convex; the coccygeal surface is concave to correspond. Cruveilhier says it sometimes possesses a synovial membrane. The interosseous fibro-cartilage is thick, and presents many varieties in the extent of the soft or central portion. Great differences result in the mobility of the articulation. After the age of thirty-five, the fibro-cartilage may undergo ossification, and the mobility is lost. Verneau says it is not rare to find in subjects still young the first piece of the coccyx consolidated with the last sacral vertebra.

III., IV. *The sacro-iliac joints* or *synchondroses.*—The bones are held together by powerful interosseous ligaments, the opposing bones being covered by cartilage.

There is also a small synovial membrane. The *ligaments* are of two kinds: four sacro-iliac ligaments and two sacro-sciatic.

1. The *anterior sacro-iliac ligament* is formed by periosteum which passes over the anterior surface of the opposing bones. 2. The *superior sacro-iliac ligament*, analogous to the anterior, but thicker, is formed from the periosteum stretching from the wing of the sacrum to the internal iliac fossa, and passing over the articulation. 3. The *inferior sacro-iliac ligament* rises above from the posterior and upper iliac spine, and is directed downwards to attach itself to the tubercle situated outside the third posterior sacral foramen. Its deepest fibres spring above, from the two posterior iliac spines as well as from the middle notch, and are inserted below over the entire space comprised between the tubercles situated outside of the second and third posterior sacral foramina. 4. The *posterior sacro-sciatic ligament* is the strongest and most important of all; its deepest fibres are the shortest; it presents two layers: the more superficial, composed of interlacing fasciculi, extends from the posterior part of the iliac crest and the rough surface below it to the tubercles situated outside the first posterior sacral foramina. The deeper layer occupies the large excavation situated directly behind the two articular surfaces, and is attached to the opposing aspect of the bones.

5. The *great sacro-sciatic ligament* is situated on the lateral and posterior part of the pelvis. Its shape is triangular; the base (very wide) is chiefly inserted into the lower portion of the lateral edge of the sacrum and coccyx, and accessorily to the tubercles of the sacrum outside the three last posterior sacral foramina, to the posterior surface of the inferior sacro-iliac ligament and to the postero-inferior iliac spine. The apex is inserted on the external aspect of the sciatic tuberosity. The anterior aspect of the ligament is in relation above with the lesser sacro-sciatic ligament; the posterior surface is covered by the gluteus maximus; the upper border helps in closing the greater sciatic notch, and limits, above, the posterior part of the great sciatic foramen, and, below, the lower part of the small sciatic foramen. The lower edge circumscribes the inferior strait at its lateral and posterior parts.

6. The *lesser sacro-sciatic ligament*, exactly triangular, is situated in front of the greater sacro-sciatic ligament, and is joined with it at its upper part, being separated below by the lesser sciatic foramen. It is attached by its base to the lower

part of the border of the sacrum and coccyx, and by its apex to the sciatic spine. The great notch is thus divided into two portions: the first, large and oval, the *great sciatic foramen*, through which pass the pyramidal muscle, the great and small sciatic nerves, gluteal arteries and veins, the sciatic and pudic vessels; the second, triangular, is the *lesser sciatic foramen*; through it pass the tendon of the obturator internus and the internal pudic vessels. These leave the pelvis by the great foramen, turn round the posterior aspect of the lesser ligament, and re-enter the pelvic cavity by the lesser foramen.

The two sacro-sciatic ligaments help to consolidate the sacro-iliac articulation. The fœtal head descending into the pelvic cavity pushes back the lower end of the sacrum, transforming this bone into a lever, the action of which tends to dislocate the sacro-iliac joint; but the two sacro-sciatic ligaments oppose this displacement by holding in the lower end of the sacrum, for the more forcible the pressure of the fœtal head, the more strained are the ligaments, and the sacrum, thus pulled in two opposite directions by two equal forces, remains immovable. The sacro-sciatic ligaments moreover serve to complete the walls of the pelvis. Their structure admits of a certain degree of elasticity, and thus diminishes the shock and compression of labour.

V. *The symphysis pubis*, formed by the meeting of the pubic portion of the innominate bones, plays a most important part as a landmark and guide in the mechanism of labour. The opposing bones present a small oval surface covered by a fibro-cartilaginous disc. In females there is a distinct articular surface. Sappey describes it as an amphiarthrosis or symphysis, resembling the articulation of the sacrum with the fifth lumbar vertebra. The interpubic fibro-cartilage is analogous to the intervertebral discs. Behind, this fibro-cartilage is thicker than in front, and projects beyond the bones, forming a ridge or knob, felt on making a digital examination. The centre of this fibro-cartilage is softer, simulating a synovial surface. In pregnancy, this soft portion is enlarged, and gives a slight degree of mobility to the symphysis.

The joint is further secured by *ligaments*. *Peripheral ligaments*. 1. The *anterior* is composed of periosteum; it is strengthened by tendinous fibres of the muscles inserted upon the body of the pubes. This ligament is thick and strong. 2. The *posterior* is thicker still, and resembles it in origin and disposition. 3. The *inferior sub-pubic* or *triangular ligament* is much thicker. Its upper border adheres in the centre to the interosseous fibro-cartilage; its ends are attached to the descending rami of the pubes; its concavity forms the roof of an arch, the *pubic arch*, under which the child's head revolves as it passes the vulva.[1]

The mobility of the pelvic joints is a question of great practical interest. As a general fact, it may be stated that the degree of mobility is commonly very slight; nor can it be said that the pelvis forms a rigid case. The several joints strengthen each other. It must be clear that no one joint, excepting the sacro-coccygeal, moves much if the rest are fixed. Thus, under ordinary circumstances, *the movement of the pubic symphysis* is very slight; but if the pubic symphysis be separated from the iliac bones by sawing through the pubic rami, it will be found that the two portions remaining can be moved freely. Hence, in discussing the operation of *symphysiotomy*, or division of the symphysis pubis, in order to enlarge the circumference of the pelvic brim, we have to postulate a yielding of the sacro-iliac joints.

What, then, are the movements of the sacro-iliac joints? These joints are hardly susceptible of movement if the pelvis is intact; but if the pubic symphysis be sawn away and the sacrum be held fixed, the os innominatum may be made to execute a movement of opening and shutting upon the sacrum.

The *sacro-coccygeal movements* are extensive and important. Under labour, the fœtal head at the outlet forces the coccyx back to the extent of an inch, expanding the outlet of the pelvis to that extent in the conjugate diameter—*retropulsion*. Lenoir (1865) maintains that part of this retropulsive movement is due to the yielding of the two first coccygeal joints, so that the coccygeal curve is straightened. This intercoccygeal movement is sometimes preserved even when the sacro-coccygeal joint is anchylosed and fixed. The *sacrovertebral joints* permit of slight movements. They share in the general movements of the pelvis on the vertebral column.

[1] Those who would pursue the study of the pelvis minutely should refer to Wood's article, 'Pelvis,' in *Todd's Cyclopædia*.

These are movements of flexion and extension, of lateral inclination and even of circumduction. The movements of flexion and extension alone have an obstetric interest. The vertebral column can bend itself upon the pelvis, and the pelvis may bend itself upon the vertebral column. By these movements the relation of the planes and axes of the pelvis to the horizon or to the vertebral column are considerably modified. Thus, when the woman lies with her knees drawn up and the body curved forward, the axis of the pelvic inlet is made to approach parallelism with the spinal column. This attitude is instinctively taken by women when labour-pains come on. In the upright attitude, the convexity of the lumbo-dorsal spine is increased, the sacro-vertebral prominence especially is increased, the lower part of the sacrum is tilted up, the pubic symphysis is lowered; the axis of the brim approaches more to the horizon. Zaglas and Duncan contend that the sacrum may execute a movement of oscillation under the vertebral column—that is, that the base of the sacrum may move backwards and forwards, the promontory advancing and retreating so as to lessen or increase the conjugate diameter of the pelvis; and Duncan explains very plausibly the different positions taken by women in labour according to the stage of advance of the head. Tarnier and other authorities do not accept this view; and it appears to us, as the result of some study, that the assumed advance and retreat of the promontory is more apparent than real. The amount of movement permitted between the fifth lumbar vertebra and the base of the sacrum must be extremely limited. A careful observation of the form of the joints, the relations of the bones, and the strength and bearings of the ligaments, is sufficient to prove this. The degree of backward and forward movement between any two of the lumbar vertebræ themselves is very small. The aggregate arching and straightening movements of the lumbar vertebræ combined with that of the sacrum are very appreciable. In this way the forward arching of the lower lumbar vertebra and sacrum together constitutes a virtual promontory. But the *true sacral promontory* is nearly fixed. The degree to which a *false promontory* may attain is well illustrated in cases of scoliosis.

A closely correlated point is the question, *What increase of space is to be obtained from the yielding of the ligaments* *which contribute to make up the framework of the pelvis?* There can be little doubt that the sacro-sciatic ligaments retreat to a small extent before the pressure of the child's head. As these ligaments are elastic they quickly recover their former state, so that it is difficult to estimate the extent of their yielding capacity. In the dried pelvis all is rigid, and experiments to illustrate the mechanism of labour made with a dead child on such a pelvis are not altogether trustworthy exponents of what takes place in the living subject.

The softening of the pelvic joints in pregnancy and labour. The question must be examined from two points of view: first, during gestation; secondly, during labour and puerpery.

1. *Softening of the pelvic joints during gestation.*—Softening has been observed in pregnant women and in subjects dying after abortion, so that the process cannot be due to the pressure encountered in labour. Hodge saw a marked case at the fifth month. Blundell relates four cases. Other cases have been observed. The analogical argument from animals is strong. In some mammalia the bones become so loose during gestation that they are almost lost in the midst of the soft parts. Roberton says: 'In certain animals the cartilaginous union of the ossa innominata at the pubes becomes ossified. This is hardly ever the case in woman. In her, the pubic and sacro-iliac symphyses admit of slight relaxation and motion. By far the most remarkable example of it is the guinea-pig. A pregnant one, expected to farrow the following night, was laid on her back; the *hinder extremities fell apart* and lay flat on the table, indicating that there was no firm union at the pubes. Applying the finger externally showed there was an open space of at least an inch. It was then killed. In the uterus were three apparently full-grown fœtuses, so disproportionably large in reference to the size of the mother, that they could not escape through the pelvis of so small an animal unless this were facilitated by some special provision.' The skull was insusceptible of moulding. Chailly asserted that softening of the ligaments was a constant phenomenon in gestation. Jacquemin thinks the ligamentous union of the pelvic bones is always swollen to a third or even greater volume. Velpeau endorses the views of Chailly. Lenoir affirms that there is a decided widening of the pelvic diameters during pregnancy. Dubois

recognised the mobility. Fordyce Barker relates some striking instances.

2. *Softening of the pelvic joints during labour and puerpery.*—Observations showing relaxation of the joints after labour are numerous and conclusive. Bertin and Bouvard in a celebrated thesis demonstrated the relaxation of the joints on a specimen. Dusch, van Swieten, Smellie, Levret, Desault, Boyer, and others relate cases actually observed. Laborie, in an instructive memoir,[1] contends for the affirmative. D'Outrepont says that in all dissections of puerperal women he recognised a considerable widening of the three pelvic symphyses. This he never failed to find in all the bodies of women dying during pregnancy or labour. He refers to Meckel as confirming this fact. Denman recognised the mobility and gives a good description of the affection. Knox and Rokitansky confirm these observations. We ourselves have seen instances which leave no doubt in our minds. Dr. Snelling[2] collects many of the recorded facts.

3. A third question arises: *Is the softening constant in gestation and in labour?* or, in other words, *is it of pathological import?*

The evidence is sufficient to prove that in gestation the interosseous tissues and the ligaments swell in common with all the pelvic structures; and the frequency with which mobility has been observed, without being followed by any disease or impairment of the joints, is sufficient to prove that the phenomenon is physiological. The relaxation is not produced during labour; it is consecutive upon the relaxation of gestation.

In labour many women complain of a feeling of strain upon the pelvis, as if they were splitting open at the joints. Much reliance cannot be placed upon this subjective sensation. But in a certain proportion of cases a real looseness of the joints after labour is not only obvious to the subject but also to the physician. Most get well without exhibiting any sign of arthritis or other mischief. Such cases, then, may be regarded as slight excesses of the physiological process. In some cases evidences of arthritis have appeared. But these probably began

[1] *Gazette de Paris*, 1862.

[2] *American Journ. of Obstetrics*, 1870.

physiologically, the morbid process being the product of some local or constitutional accident. Stoltz, however, insisted that the relaxation is almost always of a pathological origin. But it is certain that in a large proportion of cases the subjects were healthy. In cases related by Trousseau, Hayn, and others, the subjects being tuberculous, inflammation and suppuration was found in the joints. We must not forget that distant joints—the knee, elbow, shoulder, hip—are subject to suppurative inflammation ander certain puerperal complications.

Diagnosis.—The chief point to which attention is drawn is impairment of the power of standing or walking. In one case observed after labour, Fordyce Barker was struck with the circumstance that the patient could stand with comparative ease resting upon either leg, but that she could not balance herself upon both legs at once.

Duration and treatment of the severe cases.—The patients get relief by adapting a firm girdle round the pelvis, so as to compress the joints. Under the use of this contrivance and rest some cases recover in a few months, but some remain crippled for years. It does not appear possible to restore to joints which have been widely separated, and whose ligaments have been overstretched, their normal compactness.

These propositions may be stated :

1. There is mutual adaptation in labour between the child's head and the canal through which it has to pass.

2. The head yields most in this adaptation.

3. The bony pelvis is not absolutely rigid ; it yields a little at the joints, and the complementary ligaments also yield a little.

4. Under this combined yielding of all the factors much violence is avoided to mother and child. Probably the intra-pelvic muscles and fasciæ would be more frequently torn if the bones and ligaments were absolutely fixed.

The Soft Parts of the Pelvis.

We have now to consider the pelvic skeleton with its ligaments as it is when clothed with muscles and other soft structures. These soft parts, especially the muscles—leaving aside for the present the uterus and vagina—are material factors in the mechanical problem of labour. Other soft parts, as the vessels and nerves, are concerned in various phenomena arising in connection with labour.

The *external surface* may be very briefly described. The sacro-coccygeal region is covered by skin and the insertions of the sacro-lumbar muscles, which fill the channels on either side of the spinous processes; a strong aponeurosis covers them in. The coccyx is covered by them and a little connective tissue. The spines of the sacrum can be traced along by the finger continuously with the spines of the lumbar and dorsal vertebræ. These spines serve as landmarks in exploration. The depression between the base of the sacrum and the fifth and fourth lumbar vertebræ is especially important as indicating the position of the sacral promontory internally. It is one point used in measuring the outside antero-posterior or conjugate diameter of the pelvis; the other point being the outer surface of the symphysis pubis, also easily felt.

Between the vulvar and sacro-coccygeal regions very thick fleshy parts are found which make up the root of the thigh and the gluteal region. The rectus internus, the adductors, the external obturator and gluteus maximus muscles present the chief interest. The adductors, very powerful muscles attached to the outer surface of the pelvis and to the femur, bring the thighs together, opposing sexual intercourse (hence styled *custodes virginitatis*), and opposing the passage of the head in labour and obstetric operations.

The soft parts which line the interior of the greater pelvis.— The internal iliac fossa is covered by the iliac muscle, a broad, radiated, triangular, fleshy mass. Its fibres spring from the entire surface of the fossa, and, gathering together, pass under Poupart's ligament, uniting with the tendon of the psoas, to be inserted on the lesser trochanter. It serves as a cushion to the gravid uterus. When it contracts it flexes and abducts the thigh. The channels on either side of the sacral promontory are partly filled by the *psoas magnus*. This muscle is fusiform. Springing from the sides of the lumbar vertebræ, it traverses the pelvis along the border of the brim, overlapping it a little. It passes under the femoral arch; its tendon, to which the iliacus becomes attached, is inserted in the lesser trochanter. It flexes the thigh and pelvis upon the vertebral column. The muscles are covered in by an aponeurosis—the *fascia iliaca.* This fascia supplies a sheath for the external iliac vessels.

The *aorta* divides at the level of the lower part of the fourth lumbar vertebra, forming the *two common iliacs.* These run downwards and outwards, crossing obliquely the side of the body of the fifth lumbar vertebra, thence along the inner edge of the psoas muscle, and reaching the level of the sacro-iliac articulation, bifurcate to form the external and internal iliac arteries. The ureters and ovarian vessels pass in front of them.

The *internal iliac artery* plunges into the true pelvis, whilst the *external iliac artery* keeps the course of the common iliac, adhering to the inner border of the psoas, thus reaching the crural arch, under which it runs and becomes the *femoral artery.* It throws off the *epigastric* and *iliac circumflex arteries.*

The *veins.*—The *external iliac vein* is the continuation of the femoral. It runs from the crural arch to the sacro-iliac symphysis, where it joins the hypogastric vein, to form the common iliac vein. In the greater part of its course the external iliac vein is placed inside the artery and attached to it ; near the sacro-iliac joint it gets behind the artery. The compression of this vein by the gravid uterus is said (Tarnier) to explain the frequency of varices in the legs. But this factor, not to be disregarded, is, we believe, less operative than is the general vascular tension and turgescence of gestation.

The *common iliac vein* springs from the union of the external and internal iliac veins. Running upwards and inwards to the level of the joint of the fourth and fifth lumbar vertebræ, it joins the vein from the opposite side to form the *vena cava inferior.* This trunk is situated to the right of the aorta.

The *nerves* which traverse this region are *two* : the crural nerve and the genito-crural. The *crural nerve* rises from the lumbar plexus, is directed downwards, and traverses the iliac fossa, where it is placed between the iliac fascia and the psoas-iliacus, to which it furnishes twigs. Lower down, it gets under the crural arch, and gives branches to the muscles of the thigh ; other branches supply the skin. The genito-crural nerve also rises from the lumbar plexus, runs downwards, and gets behind the iliac fascia, descending to the femoral arch. There it bifurcates; the internal branch runs through the inguinal canal and distributes itself in the labium majus. The external branch continues its course to the skin of the thigh.

Modifications of the upper pelvis by the soft parts.—The iliac muscle lessens the depth of the iliac fossa. The psoas muscles and the vessels attached to their inner border cover at the side the entrance of the pelvic brim from the sacro-iliac symphysis to the ilio-pectineal eminences, so that this strait is transformed into a curvilinear triangle. These muscles and vessels therefore conceal a part of the upper strait, and considerably alter its width. The transverse diameter is thus shortened more than half an inch, or 1·50 centim. The oblique diameters are scarcely affected. Thus the transverse and oblique diameters are nearly equalised. How, then, do we explain the fact that the fœtal head almost always enters in the oblique diameter? Tarnier suggests as the most plausible theory that the transverse diameter is too near the sacro-vertebral angle, and that the bi-parietal diameter of the fœtal head is too long to permit it to engage in the brim at this level and in this direction, for one of the parietal protuberances would be arrested by the promontory. We have been accustomed to explain the oblique presentations in the following manner:—In the first place, a certain proportion of entrances at the brim are really transverse; secondly, the lower segment of the uterus containing the fœtal head is seized between the bellies of the opposing psoas muscles. If the slightest obliquity of the head exist, or if, as almost always is the case, one end of the lever formed by the fœtal head offer more surface for the psoas to act upon than the other end, it is necessarily driven forwards in advance of the transverse diameter of the brim—that is, the head assumes the oblique position. The occipital dip also disposes to screw-rotation.

The psoas-iliacal muscles, by their thickness, increase the depth of the pelvic cavity at the posterior part. The psoas muscles, when in tension, impede the entrance of the fœtal part. It thus becomes useful to relax them by flexing the limbs. The part of the upper strait comprised between the middle of the promontory and the sacro-iliac symphysis is covered by the fifth branch of the lumbar nerves, by the common iliac artery and vein, by the origin of the internal iliac artery and vein. At the left also we find the commencement of the rectum.

The soft parts which line the cavity of the true pelvis.—To the right and left are the pyramidal muscle and the internal obturator muscle. In front are the bladder and urethra; behind, the rectum. Vessels and nerves also are found.

1. The *pyramidal muscle* is inserted by several digitations to the anterior face of the side of the sacrum, outside the four last sacral foramina, and to the highest part of the great sacro-sciatic ligament. The muscle then passes across the great sciatic notch, which it partly fills, accompanied by the sacral plexus and the sciatic and gluteal vessels. Thence the fleshy fibres run to a tendon, which is inserted in the great trochanter. At the level of the great sciatic notch the muscle is covered by the gluteus maximus. An *investing aponeurosis* covers the pyramidal muscle throughout its whole intra-pelvic course. It closes the great sciatic foramen, and is inserted into the border of the sciatic notch to the sciatic spine at the side of the sacrum. In front it is continuous with the *pelvic aponeurosis.*

2. The *obturator internus muscle* is inserted over the surface which corresponds to the cotyloid cavity, over the circuit of the obturator foramen, on the obturator membrane; its fibres unite to a tendon which passes through the small sciatic foramen, and is inserted into the great trochanter. It is covered by an aponeurosis, which is divided into two layers by a fibrous arch—the pubio-sciatic—which, adhering to the aponeurosis of the muscle, runs as a cord from the pubes to the ischiatic spine, and gives attachment to the levator ani. The part of the aponeurosis above the pubio-sciatic arch is continuous with the pelvic fascia; the part below this arch forms by its posterior surface the external ischio-rectal hollow.

The *bladder* is situated behind the pubes. It varies greatly in size according to its contents. The relations of the bladder and other pelvic organs will be described when tracing the peritoneum.

The *rectum* begins at the level of the left sacro-iliac symphysis, reaches the median line near the third sacral vertebra, then follows the anterior surface of the sacrum and coccyx, and terminates a little in front of the coccyx by traversing the perinæal floor. From an obstetrical point of view the rectum may be divided into two parts: the upper, applied to the sacral hollow, may be compressed by the fœtal head in its descent; the lower part enters into the perinæal floor, and may participate in its distension. This is so marked that in some cases the lower inch or more of the rectum may be everted, and fissured. The *arteries* of the rectum are the *superior hæmorhoidal*, which come from the inferior mesenteric; the *middle hæmorrhoidal*, which come direct from the hypogastric; and the *inferior hæmorrhoidal*, coming from the internal pudic. The *veins of the rectum* all empty themselves into the inferior mesenteric. Those which come from the mucous membrane form *a remarkable network* in the sub-mucous connective tissue, greatly developed at the level of the semilunar folds. This dilatation, especially marked during gestation and labour, gives rise to *hæmorrhoids*, or *piles*. The *lymphatic* vessels of the rectum are numerous. They come from the mucous membrane, and run into a series of ganglia situated along the posterior aspect of the rectum. This abundance of lymphatics accounts for the faculty of absorbing nutritious and medicinal agents which is sometimes so usefully appealed to.

The *nerves* come mostly from the great sympathetic, some from the cerebro-spinal system.

Vessels and nerves of the walls of the pelvis.—We have seen that the internal iliac or hypogastric artery branches off from the common iliac; it descends in front of the sacro-iliac synchondrosis, the pyramidal muscle, and the sacral plexus. It divides into a number of branches—umbilical, vesical, middle hæmorrhoidal, uterine, vaginal, gluteal, obturator, ilio-lumbar, lateral sacral, ischiatic, and internal pudic. The *middle sacral artery* springs direct from the aorta. It descends vertically, and is very small. *Veins* corresponding in name with the arteries accompany them.

The *nerves* mostly come from the sacral plexus. This plexus is formed by the union of the anterior sacral nerves and the lumbo-sacral branch. It has the form of a triangle, whose basis occupies the entire length of the sacrum, and whose apex, directed outwards, answers to the great sciatic notch above the spine of this name. There the branches of the sacral plexus unite to form a large trunk—the *sciatic nerve*—which supplies the lower extremity. The cramps so often complained of during labour are partly due to the pressure of the fœtal head upon the sacral plexus. The *internal pudic nerve* detaches itself from the plexus, accompanies the pudic artery, and is distributed to the muscles of the vagina and perinæum, to the vulvar region. The *obturator nerve* comes from the lumbar plexus, traverses the psoas, passes the angle of bifurcation of the common iliac vessels, and, leaving the pelvis by the obturator foramen, gives branches to the adductor muscles. This nerve is liable to pressure from the fœtal occiput in occipito-anterior positions; and R. Barnes has frequently diagnosed the

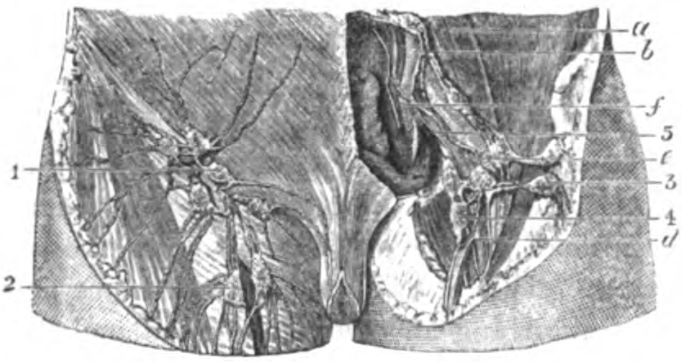


FIG. 53.—(After Savage.)

a. Psoas muscle. *b.* Common iliac artery and vein. *c.* Internal iliac artery and vein. *d.* Saphena vein and rectum. 1. Superficial lymphatics of the groin. 2. Saphena lymphatic glands. 3. Superficial inguinal glands. 4. Deep inguinal glands. 5. External iliac lymphatics.

position of the head at the end of gestation and in labour by the pain referred to the distribution of this nerve.

Modifications of the pelvic cavity by the soft parts.—The obturator and pyramidal muscles are thin, and cannot much alter the dimensions of the pelvic diameters.

The *lymphatics* play such an important part in the physiology and pathology of gestation and puerpery that they call for particular attention. These eminently absorbing vessels begin at the periphery.

First, we notice the *superficial or sub-cutaneous lymphatics*, which come from the thigh, and unite with superficial vessels and glands; secondly, deep lymphatic glands, which receive the deep lymphatic vessels which accompany the femoral artery and vein. The superficial and deep glands communicate. Thirdly, we may trace in fig. 54 (1, 2), superior lumbar glands, receiving the upper or spermatic set of lymphatics from the uterus and appendages, some of the renal lymphatics, some of the lacteals, and the efferent communicants from the (3) inferior lumbar glands, which receive the efferent lymphatics from the sacral and iliac glands; (4) the sacral lymphatic glands, receiving lymphatics from the iliac glands and the lymphatic communicants from the very abundant lymphatics of the rectum; (5) external and internal iliac glands; (6) common iliac glands,

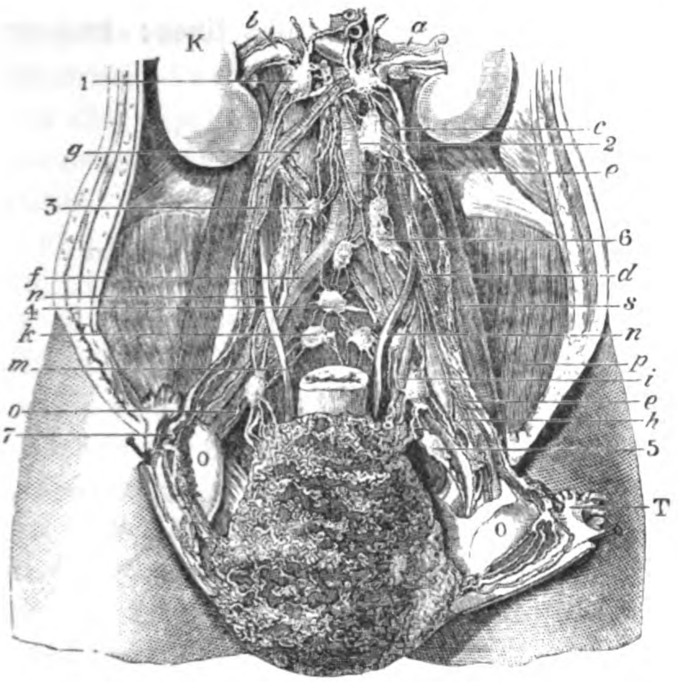


FIG. 54.—(After Savage.)

1, 2. Superior lumbar glands. 3. Inferior lumbar glands. 4. Sacral lymphatic glands. 5. External and internal iliac glands. 6. Common iliac glands. *a*. Left renal vessels. *b*. Left renal vein. *c*. Left spermatic vein. *d*. Left spermatic vessels covered by their lymphatic plexus. *e*. Aorta. *f*. Common iliac trunks. *g*. Ascending cava. *h*. External iliac artery and vein. *m*, *n*. Ureters. *o*. Right common iliac vein. *p*. Iliacus muscle. *s*. Psoas muscle. O. Ovary reversed to show lymphatics between it and its bulb. K. Kidney. T. Fallopian tube.

receiving inferior uterine lymphatics from (5, 7) spermatic lymphatic plexus, the uterine portion of which generally appears as a large separate lymphatic trunk.

In the same figure may be traced—*a*, left renal vessels covered by some ascending lymphatic efferents, which join the common duct higher up; *b*, the left renal vein, resting on the termination of the lumbar efferents with the *receptaculum Chyli*; *c*, left spermatic vein; *d*, left spermatic vessels covered by their lymphatic plexus; *e*, aorta, having the roots of the receptaculum on the right (generally on the left) and beneath the aorta; *f*, common iliac trunks; *g*, ascending cava; *h*, external iliac artery and vein; *m*, *n*, ureters; *o*, right common iliac vein; *p*, iliacus muscle; *s*, psoas muscle; O, ovary turned down in order to show lymphatics between it and its bulb.

The abdominal walls.—The upper border of the pelvis gives attachment to the flattened out soft structures which make the abdominal cavity. The abdomen is divided into nine secondary regions by four fictitious lines: two vertical,

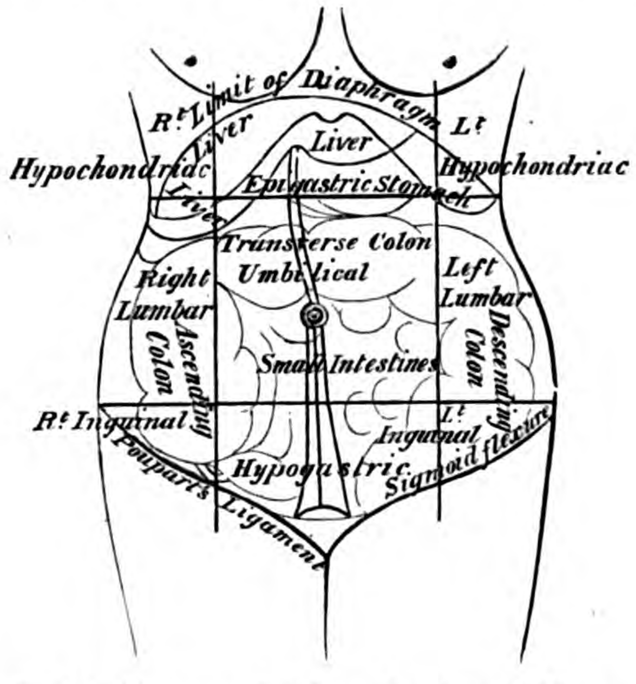


FIG. 55.—Diagrammatic Scheme of regions of Abdomen.

rising from the middle of the horizontal branches of the pubes to the lower border of the ribs; the others horizontal, cutting the verticals at right angles, the upper one below the false ribs, the lower one at the level of the two antero-superior iliac spines. Thus are obtained the nine regions: in the upper zone are, in the middle, the *epigastrium*, on either side, the *hypochondria*; in the middle zone are the *umbilical region* and *the flanks*; in the lower zone are the *hypogastrium and the iliac fossæ*.

The *posterior wall of the abdomen* is narrow and forms the skeleton of the abdomen. It is formed by the lumbar vertebræ. Behind the bodies of the vertebræ are found on either side, the sacro-lumbar, the dorsal, and the transversalis muscles, and their investing aponeurosis; more superficially are the subcutaneous cellular tissue and the skin. In front of the bodies of the lumbar vertebræ are the insertions of the diaphragm, the two psoas muscles, the abdominal aorta, accompanied on its right side by the ascending vena cava, the thoracic duct, and a series of lymphatic glands. The relations of the aorta to the vertebral column explain how it is that this vessel can be compressed after labour.

The *antero-lateral walls* stretch from the lower part of the chest to the upper border of the pelvis. They consist of six layers—namely, skin, subcutaneous cellular tissue, the investing aponeurosis (Richet), the muscular coat, the sub-peritoneal fascia, and the peritoneum.

The recti muscles, broad and flat, run from the superior border of the pubes to the cartilages of the fifth, sixth, and seventh ribs. They touch each other at their internal edge, near their inferior attachment, and separate a little as they approach their upper attachments.

The strength of the abdominal walls is greatly due to the muscles and aponeuroses. These two elements are intimately united. The weakest part, or at least that which most frequently gives way, is the median line where the recti meet. This not infrequently opens out under the violence of labour so as to leave little more than peritoneum, cellulo-adipose tissue, some aponeurotic fibre and skin to form the wall. Intestines may then push out this imperfect wall and form a *ventral or umbilical hernia.* The practical lesson from this is to support the abdominal wall during labour, and to keep the parts well supported afterwards with a binder, so as to help them to recover their normal condition.

Quite below, inside the spine of the pubes, between this spine and the symphysis, the aponeurosis of the internal oblique divides into two divergent bands, leaving an oval opening just admitting the tip of the finger. This is the *inguinal ring*, the external end of the *inguinal canal*, obliquely running in the thickness of the musculo-aponeurotic layer of the abdomen. Through this ring passes the round ligament. In the fœtus this round ligament is accompanied in part of its course by the peritoneum, forming a cul-de-sac, the *canal of Nuck*. It is along this canal that the small intestine or the ovary pass in inguinal hernia.

The muscles and aponeuroses of the abdomen form an elastic belt surrounding this cavity. They are inserted behind on the vertebral column, above to the base of the thorax, below to the upper border of the pelvis. Usually this belt supports the viscera; it may yield by its elasticity under pressure from within, or contracting promptly it compresses the viscera, and may cause those which communicate with the external surface to void their contents. If the pelvis is first fixed, the abdominal muscles contracting pull down the thorax and flex the spinal column. If the chest be fixed, the muscles contracting may pull up the anterior wall of the pelvis, and also flex the vertebral column.

The abdominal walls are liable to great distension. They enjoy a certain degree of resiliency; but the recovery of their ordinary degree of flatness is mainly due to the active and tonic contraction of the muscles. The skin stretches to almost any extent. But part of the enlargement of the superficies of the skin is probably due to *growth*, keeping pace with the growth of the gravid uterus; part, however, is well known to be due to stretching, a process which, exceeding the rate of growth, involves cracking of the dermis. Hence the *lineæ albicantes* seen on the abdomen of women who have borne children. The peritoneum, to keep pace with the distension of the abdominal wall, also grows. It has not, we think, been observed that this membrane cracks like the skin at this part. But on the surface of the uterus, under conditions that will be described under '*Rupture*,' cracks may be produced.

The pelvic floor.—The outlet of the bony pelvis is completed and guarded by a combination of tissues—peritoneum, mucous membrane, connective tissue, muscles, vessels, glands, and skin, which constitute the pelvic floor. This compound structure, viewed as a whole, plays a very important part in the physiology and pathology of generation. The pelvic floor forms a thick fleshy elastic layer, dovetailed in all round to the bony pelvic outlet. It may be considered as an irregularly-edged segment of a hollow sphere, with an outer *skin* aspect, and an inner *peritoneal* one. The external genitals have been described. On the inner peritoneal surface lie the uterus, tubes, and ovaries. The vagina runs at an angle of 60° to the horizon from the vaginal orifice upwards to the mouth of the womb as a transverse slit in the pelvic diaphragm. In front of the vagina lies the bladder, behind it the rectum.[1]

The pelvic floor is made up of two segments, the *pubic* and the *sacral*.

1. The *pubic segment* is made up of loose tissue, bladder, urethra, anterior vaginal wall, and bladder-peritoneum. It is loosely attached in front to the symphysis pubis. The bladder and urethra, meeting at right angles, are separated from the pubes by the pyramidal deposit of loose fat.

2. The *sacral segment* is attached to the coccyx and sacrum; it consists of strong tendinous and muscular tissue. The inferior portion of this segment, the perinæum, lies about one and a-half inches from the symphysis.

The pubic segment is also attached on each side to the anterior bony pelvic wall, while the sacral segment is attached in a like manner to the posterior bony pelvic wall. Finally, the two segments blend with one another on the right and left sides of the vagina.

The two segments are thus *anatomically* contrasted:—

The pubic segment is made up of loose tissue, and is loosely attached to the symphysis pubis; the sacral segment is made up of strong tissue, and is firmly dovetailed into the sacrum and coccyx.

They are further contrasted *functionally*. In labour the pubic segment, at first driven down, is then drawn up, forming, with the anterior lip of the cervix uteri, R. Barnes' *first valve* (see 'Mechanism of Labour'); the sacral segment, R. Barnes' *second or perinæal valve*, is driven down. Hart likens this, not inaptly, to the action of two folding doors. Uterine action pulls up the pubic segment, and drives the child down against the sacral segment. This is analogous to the way one passes out through two folding doors, where one pulls one door towards him and pushes the other from him. A more exact comparison would be with two doors close together, one in front of the other, hinged one to the right the other to the left, so that to

[1] Our description is chiefly borrowed from Hart and Barbour's *Manual of Gynæcology*, 1882.

pass one must pull the first open to the left, and then push the second open to the right. The two segments or doors overlap or cover each other, and are passed successively.

As the result of this elevation of the pubic segment, the bladder is drawn up above the pubes, and its peritoneum is stripped off.

The connections between bladder, urethra, uterus, and rectum.—*a.* The posterior wall of the bladder is *loosely* attached to the anterior vaginal wall.

b. The urethra and anterior vaginal wall are closely blended.

c. The posterior vaginal wall and anterior rectal wall are *loosely* connected as far down as the apex of the perinæal body.

Mutual actions of the pubic and sacral segments.—The sacral segment, strengthened at its tip by the perinæum, is the supporting one; it holds the pubic segment. The anterior margin of the sacral segment stops short of the pubes by about one and a half inches, and this interspace is filled up by the pubic segment. Intra-abdominal pressure presses the pubic segment against the oblique sacral one, which closes the pelvic outlet, therefore, like a valve. Excessive intra-abdominal pressure displaces, in prolapsus uteri, a definite part of the pelvic floor in front of the anterior rectal wall.

The pelvic floor projection is a term used to express the bulging of the floor in mesial line beyond the straight line joining the tip of the sacrum and the sub-pubic ligament. This is increased in pregnancy, and of course greatly in labour as the head advances. It is characteristically increased in retroversion of the gravid uterus.

The peritoneum.—The relations of the peritoneum are of great importance in obstetrics. Starting from the anterior abdominal wall, the peritoneum is reflected a little above the symphysis pubis on to the fundus of the empty bladder; passes downwards over the posterior surface of the bladder, thence crosses on to the anterior surface of the uterus at a point about level with the os internum uteri. From this it passes over the anterior surface of the uterus, thus covering the body of this organ; it passes over the fundus, down the posterior surface, and, still descending, covers the upper posterior vaginal wall for about an inch in the mesial line. It then rises to cover the anterior wall of the rectum.

The peritoneum at the sides of the uterus: the broad ligaments.—The peritoneum, which has enclosed the uterus back and front, passes off at each side, the anterior and posterior laminæ approaching to constitute a sheet-like membrane—the broad ligament. It presents three winglets on either side: the middle and upper one embraces the Fallopian tube, the posterior one covers the ovary; the anterior one covers the round ligament. Between the layers of the broad ligament lie connective tissue, unstriped muscle, blood-vessels, lymphatics, and nerves. The broad ligaments are continued to the sides of the pelvis, to which they are attached. The peritoneum thence lines the side-walls of the pelvis.

The broad ligaments, with the uterus in the middle, divide the pelvic brim and excavation into two parts, anterior and posterior. In the anterior is—

The utero-vesical pouch, formed by the reflection of peritoneum from the bladder to the uterus. It is shallow, it holds no intestine, and fluids can hardly lodge in it, owing to the movements of uterus and bladder.

The utero-sacral, or Douglas' pouch, is of far more importance. Its boundaries may be thus defined: First, the utero-sacral ligaments are the upper and lateral boundaries; its posterior boundary is the rectum and sacrum; the anterior boundary is the upper fourth of the vagina and the posterior wall of the uterus. But R. Barnes has shown [1] that the disposition of the pouch is not, as had hitherto been assumed, symmetrical or median. The dip is, in women who have not borne children, distinctly deeper on the left side. On the right side —that is, behind the right ovary and right broad ligament— the pouch is very shallow, sometimes scarcely an inch deep; it dips obliquely towards the left, descending behind the uterus and upper part of the vagina, and, still dipping, it attains its greatest depth quite on the left of the uterine neck and vagina. Thus the sac is mainly situated behind the left broad ligament, being here often three inches or more deep. Douglas' pouch is the most dependent part of the great peritoneal cavity; and fluids and free solids gravitate into it, separating the walls which are naturally in contact.

When the uterus is lowered, attended by a corresponding

[1] *Diseases of Women*, 1878.

degree of vaginal inversion, this pouch always goes along with it, so that in complete procidentia and inversion of the vagina the pouch will be external to the vulva behind.

Luschka described muscular fibres in the sub-peritoneal tissue of Douglas' folds, and styled them 'musculi retractores uteri.' They probably strengthen the peritoneum.

At the lower part of the pouch, which dips behind the vagina, the tissues between the fornix of the vagina and the peritoneum are scarcely one-third of an inch thick. This septum might be easily torn through by the finger, or forceps. It is sometimes chosen as the seat of incision for removal of the ovaries through the vagina. Solids or fluids getting into this pouch push the uterus forwards and downwards, compressing the bladder and urethra against the pubes. The retroflected uterus also lodges here.

Hart directs attention to the following facts about the peritoneum. When the bladder is distended the peritoneum is stripped off the lower part of the anterior abdominal wall to an extent varying with the distension. During parturition, also, the peritoneum is drawn off the bladder. Posteriorly, above the os internum uteri the peritoneum is closely blended with the uterus, and below this quite loosely.

Connective tissue of the pelvis.—This consists of the pelvic fascia and the loose connective tissue padding the interstices of the muscles, lying round the cervix uteri, and spreading out beneath the peritoneum. It has important bearings in child-birth and puerpery. In certain places, connective tissue is gathered into masses or pads; in others it is distributed in laminæ or sheets. *One* such pad is found between the posterior aspect of the symphysis pubis and the angle formed by the urethra and anterior wall of the bladder—the retro-pubic fat-deposit of Hart. A *second* mass is found between the base of the bladder and the anterior wall of the cervix uteri, but this is more dense. This mass, bounded by the peritoneal reflexion above and vaginal wall below, forms a firm bond between bladder and uterus, so that the uterus can hardly move without drawing the bladder with it. A *third* mass is found between the lower posterior wall of Douglas' pouch and the related part of the rectum. A *fourth* mass is found in each ischio-rectal cavity. Uniting these masses, connective tissue runs along between the muscles and organs in layers of varying thickness. One portion, specially distinguished by Virchow as the parametric tissue, is a loose tissue 2 cm. thick, with abundant blood-vessels and lymphatics surrounding the lower portion of the uterus and the upper portion of the vagina. By others the term is intended to embrace all the connective tissue in the pelvis. R. Barnes describes this part of the connective tissue as of especial interest in labour. It is invariably stretched as the head advances, and hence is the seat of blood and serous effusions, commonly rapidly absorbed, but which may easily be the starting point of pathological processes.

The continuity of the pelvic connective tissue.—This character, of immense importance in the pathology of pelvic inflammation, is illustrated by dissection and by injections of air, water, and plaster of Paris. König and others have made experiments in this way. Bandl has summarised them thus: (1) Water injected between the layers of the broad ligament high up in front of the ovary passed first into the tissue lying at the highest part of the side wall of the true pelvis. It then passed into the tissue of the iliac fossa, and, lifting up the peritoneum, followed the course of the psoas, passing only slightly into the hollow of the iliac bone. Lastly, it separated the peritoneum from the anterior abdominal wall for some little distance above Poupart's ligament, and from the true pelvis below it. (2) On injection beneath the base of the broad ligament to the side and in front of the isthmus, the deep lateral tissue became filled first; then the peritoneum became lifted up from the anterior part of the cervix uteri. The separation passed thence first to the tissue near the bladder, and ultimately the fluid passed along the round ligament to the inguinal ring. There it separated the peritoneum along the line of Poupart's ligament, and passed into the iliac fossa. (3) An injection at the posterior part of the base of the broad ligament filled the corresponding tissue round Douglas' pouch, and then passed on as described at (1).

These experiments, it will be seen, run parallel in a great measure with the pathological observations on pelvic cellulitis and abscess, lending most valuable aid to the clinical appreciation of pelvic inflammations.

The statics of the uterus. *What is the normal position of the uterus?*—This is difficult to define. It varies much in different individuals, even apart from pathological influences. It is very mobile, slung as it were in the embrace of the broad ligaments, and very lightly tethered by the round and utero-sacral ligaments. It rests upon the bladder in front, and its union to this organ is its most fixed point; through it the cervical portion of the uterus is impeded somewhat from retreating backwards. When the uterine neck retreats, the base of the bladder must follow; so also in its ascent and descent. The movement of the body of the uterus is hardly at all impeded by this connection with the bladder. Thus Aran describes the utero-vesical bond as the axis of movement of the uterus. R. Barnes gives a diagram ('Diseases of Women') to show that as the uterus descends in prolapsus, the cervical portion is held as if it were moored to the symphysis, whilst the body rolls back. Prolapsus, therefore, is almost necessarily attended by retroversion. Sections taken on frozen cadavers are not trustworthy evidence of the position of the pelvic organs. In life, the turgescence of the blood-vessels, the play of the muscles, and other vital conditions are all important factors. Clinical explorations, although seemingly less precise, give really better information. Generally, it may be said that the body of the uterus slightly curved forwards presents its fundus pointing in the axis of the brim, or rather anteverted (see fig. 56). A line (*a*, *a*,) drawn from the lower edge of the pubes to the sacral promontory will touch the summit of the fundus, so that the whole organ lies within the pelvic cavity. The os uteri externum will touch a line (*b*, *b*,) drawn from the lower edge of the pubes to the body of the fourth sacral vertebra. Frequently, however, the os will be found higher than this.

Inserted obliquely into the vagina, the uterus partakes of whatever support the vagina enjoys. The objections urged by some recent authors against the proposition that the uterus is supported by the vagina must not be accepted too readily. Hart, representing this view, contends that the uterus rests upon the posterior or sacral segment of the pelvic floor, and owes nothing to the vagina. But the uterus often maintains its normal level when this sacral segment is virtually destroyed, as in complete laceration through the sphincter.

The vagina, in effect, is a musculo-elastic column which, when in moderate vigour, will easily support the uterus. The vaginal column, moreover, is supported by its attachments through connective tissue and fasciæ to the sides of the pelvis. The uterus may owe little to its ligaments; but still they contribute something. If, as one party contends, the ligaments are useless for this purpose, and if, as another party contends, the vagina is also useless, how is it that the uterus keeps its place against gravity and abdominal pressure when the perinæum is destroyed? The uterus and anterior section of the floor of the pelvis move downwards on inspiration and forced

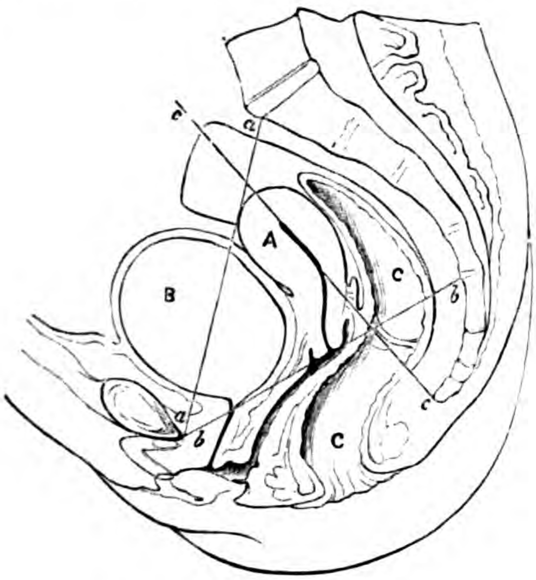


FIG. 56.
A. Uterus. B. Bladder. C. Rectum.

expiratory effort, the chest being fixed, the glottis closed. On ordinary expiration the floor of the pelvis rises again towards the abdomen.

Physics of the Abdomen and Pelvis.

Certain points in the structure, contents, and properties of the abdomen call for notice.

Dimensions of the stomach.—Bounded by the concave diaphragm above and the concave pelvis below, the average height is from 16 to 18 inches, or 40 cm. to 50 cm., or about one-quarter the body-length. The capacity may be estimated from the weight of its contents. These weigh together

12 to 15 lbs. = 6 to 7 kilos.; their specific gravity is between 1·02 and 1·07. Making allowance for the hollow intestines, the capacity then is about 6 to 7 litres, or 12 to 15 pints (Spiegelberg). In gestation all the usual contents of the abdomen find room in it. In order to make space for the gravid uterus, the organs are packed away upwards and backwards; and still more room being wanted, the abdominal wall undergoes distension. In this way the capacity of the abdomen is increased. J. Y. Simpson estimated the capacity of the gravid uterus at 6 to 8 litres; but Tarnier says this is exaggerated, and places it at 4 to 5 litres—that is, at about 8 to 10 pints. We do not think Simpson's estimate much too high. Certainly in some cases it is exceeded. Whatever the quantity, it is nearly all in excess of the usual capacity. This must give an impressive idea of the changes wrought in gestation.

The effect of intra-abdominal pressure on the female pelvic floor has been studied by Hart. In the upright posture, assuming that the floor is under fluid pressure, the effect of ordinary intra-abdominal pressure is to press the pubic against the sacral segment. In ordinary conditions atmospheric pressure is acting equally all over the abdominal and pelvic surfaces; but the pelvic floor, bearing the weight of the viscera, bulges more than the other boundaries of the abdomen. If the woman be made to assume the genu-pectoral posture, the bulge of the viscera will be at the sternum, and the pelvic floor projection is diminished. So long as the vulva remains closed the two pelvic floor segments remain in contact. But if in the genu-pectoral posture or the semi-prone posture the labia be held apart and the perinæum retracted, air rushes into the vagina, and the uterus, with the rest of the pubic segment, sinks towards the abdomen. This point was first explained, we believe, by Oldham, who submitted that by thus bringing the atmospheric pressure to bear, the retroverted uterus might be reduced.

Russell Simpson and Hart state the case in this way:—'The segments of the pelvic floor separate from each other when a woman assumes the knee-elbow posture, and the hymeneal orifice is opened. The pubic segment passes down with the viscera; the sacral segment remains behind, recoiling slightly upwards. Thus, they say, *functionally the pubic segment is visceral, and the sacral segment is vertebral.*'

The effect of respiration upon the abdominal and pelvic contents.—During inspiration the thoracic, abdominal, and pelvic cavities, *quoàd* pressure, become one cavity. The vacuum created in the chest forces down the lungs and diaphragm; these in turn drive down the contents of the abdomen and pelvis, causing projection of the pelvic floor. During expiration the reverse movement takes place. There is a general collapse of the chest and abdominal walls towards the centre; the pelvic floor ascends. This is clearly tested when the bladder is being emptied by catheter. During inspiration the stream of urine is stronger; during expiration it slackens. The ebb and flow of the urine is an exact gauge of the ebb and flow of the abdominal organs. Under this expiratory movement air may be drawn into the uterus, as in a case related by George Harley.[1] Under similar conditions, especially if seconded by the semi-prone posture, the heavy uterus, after labour, not supported by binder or abdominal muscles, bagging down creates a vacuum, and air is drawn into the uterus. Adolph Rasch[2] brought forward several illustrations of this law.

'There are interesting applications of this knowledge. It teaches that after labour, if not during labour also, and, in fact, in every case in which pelvic drainage is desirable, the best posture is the dorsal. It is by the semi-prone posture that we derive the greatest advantage from Sims' speculum. It greatly aids our efforts at reducing inversion of the uterus, and in replacing a prolapsed cord. On the other hand, in most operations upon the uterus and vagina, where it is of importance to bring the uterus as low down near the vulva as possible, the dorsal posture, by bringing the force of gravity to counteract the respiratory rise of the uterus, and which can be further greatly aided by direct pressure by the hand on the abdomen, is the best.'[3]

The pelvis as a base of support of the trunk.—The pelvis may be looked upon as a bony belt composed of two vaults: the one upper and posterior, supporting the weight of the

[1] *Obstetrical Transactions*, 1863. [2] *Ibid.*
[3] Barnes' *Diseases of Women*, 1878

trunk at its median level; the other inferior and anterior, serving as counter-arch to the first. These two vaults meet at their extremities, and at their point of junction are supported by the lower limbs. A transverse line passing through the centre of the heads of the femora represents the basis of support of the trunk and the axis of rotation of the pelvis. The weight of the trunk above bears first upon the sacrum and the sacro-iliac ligaments, tending to drive the sacrum inwards and downwards; secondly, is transmitted to the iliac bones, tending to compress them inwards towards the centre and downwards; thirdly, upon the cotyloid cavities and lower arch of the pelvis, where the down-pressure, being met by the resistance of the femora, tends to force the lower arch inwards and upwards towards the centre. All these tendencies are brought into clinical evidence in cases of osteomalacia, in which the softened bones yield to the lines of pressure.

Sometimes, as in some forms of scoliosis, the lumbar vertebræ yield under the superincumbent weight and sink forwards so as to overhang the pelvic cavity; or, as in disease of the sacro-lumbar joint, the last lumbar vertebra slips down dislocated from the sacrum into the pelvic cavity, a condition known as *spondylolisthesis*.

The *pelvis further acts as an organ of protection* to the structures contained within it.

The Measurements of the Pelvis.

Definition.—It is necessary to define precisely the points between which the measurements are taken. We adopt the rules laid down by Garson.[1]

The following are the dimensions of most practical use in obstetrics:—

S. L.	Length of the sacrum.
S. B.	Breadth of the sacrum.
A. S. S. W.	Width between anterior-superior spines of ilia.
C. W.	Crest-width.
P. H.	Pelvic height.
P. I. D.	Pubo-ischiatic depth.
A. P. D. B.	Antero-posterior diameter of brim.
T. D. B.	Transverse diameter of brim.

[1] *Transactions of International Medical Congress*, 1881.

A. P. D. O.	.	Antero-posterior diameter of outlet.
T. D. O.	.	Transverse diameter of outlet.
S. P. A.	.	Sub-pubic angle.

The capitals give the initial letters of the dimensions. They are useful to save space.

The sacral length, S. L., measured from centre of upper margin of promontory on body of first sacral vertebra to middle of inferior border of fifth sacral vertebra.

The *sacral breadth*, S. B., the maximum breadth of first sacral vertebra—*i. e.* about the middle of its upper surface.

The width, A. S. S. W. (see above) from centre of the most prominent part of the posterior-superior spine of one ilium to corresponding point on the other.

P. I. D., the distance between the upper border of the pubes, measured from the smooth level surface on the pubic side of the ilio-pectineal suture and the lowest part of the tuber ischii.

Measurements of the brim.—The conjugate, A. P. D. B., and transverse, T. D. B., are measured at right angles to one another; A. P. D. B. between the centre of the anterior-superior margin of the body of the first sacral vertebra and the most adjacent point of the linea symphysis pubis; T. D. B. across the widest part of the brim, which is usually a little above and anterior to the top of the great sacro-sciatic notch. Upon these two diameters, says Garson, the whole pelvis seems to be constructed.

Outlet.—A. P. D. O., the distance between the centre of the anterior-inferior margin of the fifth sacral vertebra and the nearest point on the linea symphysis pubis.

T. D. O., width between the most widely separated points on lines passing parallel to the brim-line from the lower ends of the obturator foramina to the spines of the ischia.

The sub-pubic angle.—Formed by the meeting of the ischio-pubic rami of each side at the lower end of the symphysis pubis.

The relations of the measurements of the ilia and pelvic brim, according to Garson, allow of their being mathematically determined, and it is thus possible to construct a diagram from the measurements of an individual pelvis, or from the average measurements of any number of pelves. The European and

Andamanese pelves (figs. 57, 58), are drawn from the averages taken by him, and may be considered as typical forms. These are constructed upon the A. P. D. B.

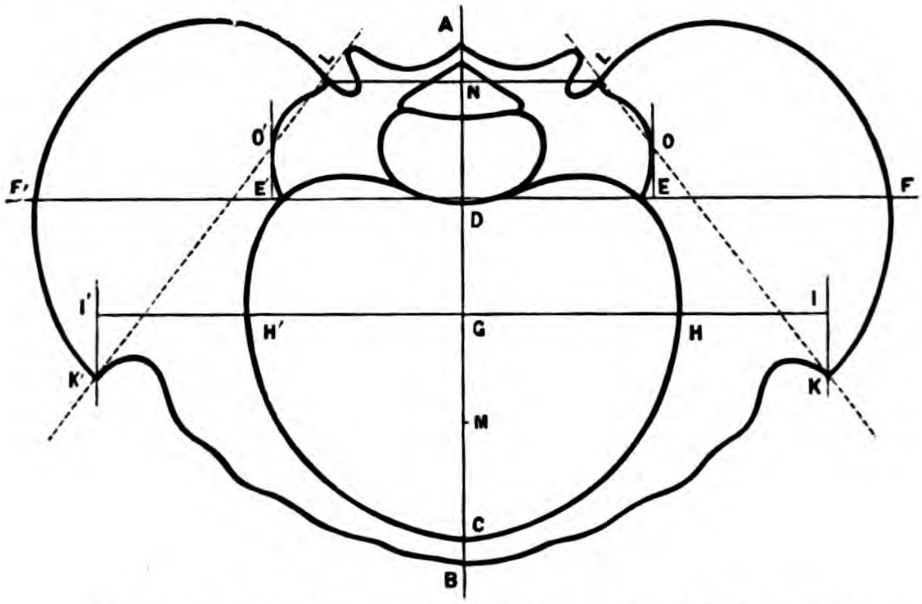


Fig. 57.—European Female, one-third natural size. (After Garson.)

The mean variations of the A. P. D. B. and T. D. B. vary but slightly, the T. D. B. less than the other. Garson, therefore,

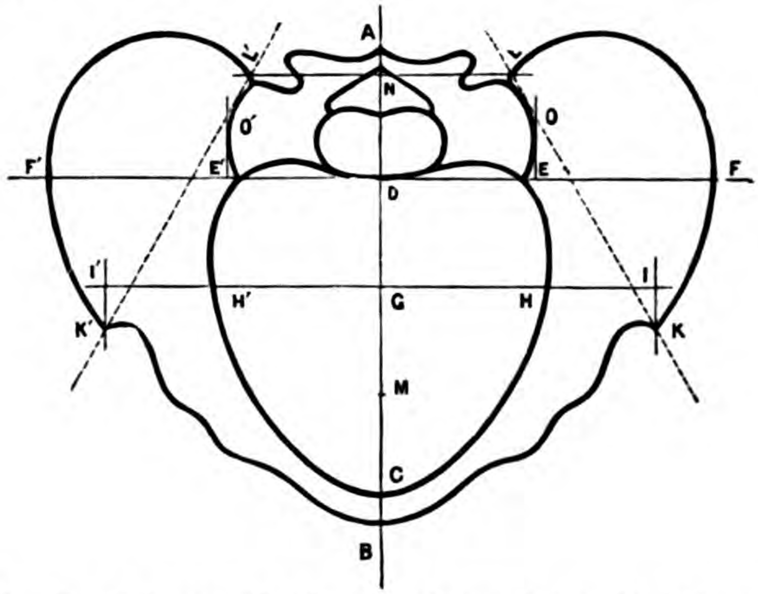


Fig. 58.—Andamanese Female, one-third natural size. (After Garson.)

selects the T. D. B. as the index or standard measurement. T. D. B. is then 100.

Fig. 57, from Dr. Garson's memoir, is a diagram of a normal European female, constructed from typical index of transverse diameter.

Fig. 58 is a diagram constructed on the same plan of the Andamanese female pelvis.

AVERAGE MEASUREMENTS OF THE PELVIS, in millimetres (Garson).

	S. L.	S. B.	A. S. S. W.	C. W.	P. H.	P. I. D.	A. P. D. B.	T. D. B.	A. P. D. O.	T. D. O.	S. P. A.
14. European .	101	118·3	231·5	271	201·7	91·4	106·6	133	116	115·9	76
5. Australian .	91·4	104·6	198·4	240·6	184·4	82·2	108·2	118·2	107·6	104·8	78
13. Andamanese	91·4	97	172·1	207·7	167	76·4	99·1	102·8	100·6	93·1	85
Indices of the above measurements.											
14. European .	75·3	88·7	173 8	205·8	151·8	68·4	80	100	87·2	87·2	—
5. Australian .	77·1	89	167·8	204·1	158·9	69 5	92·4	100	91·5	98	—
13. Andamanese	88·5	94·2	167	201·9	162·1	73·8	96·2	100	98	90·2	—

The pelvis in man in all the races is distinguished from that of woman by several features. The differences between the different races are not less important. Anthropologists now seek in the comparison of the pelvis, as well as of the cranium, data for establishing a classification of the human races. One day we may arrive at a scientific knowledge of the relations of the fœtal skull to the pelvis.

The most important researches in this direction are those of Vrolik (1826), Weber (1838), Barnard Davis, Karl Martin (1866), G. Fritsch, Flower, Verneau[1] (1879), Garson (1881).

Flower says that, 'next to the skull, the pelvis appears to be the osseous framework most likely to afford distinctive race characters.' Weber (1823) seeks to demonstrate that the head and the pelvis are subjected to the same laws of evolution; that the good or bad conformation of the one coincides with the similar state of the other. Hence, Weber says the inspection of the head indicates the state of the pelvis. His method is very simple—the occipito-frontal, bi-parietal, and fronto-mastoidian represent the sacro-pubic, bis-iliac, and oblique diameters. The brim is in relation with the cranium, the face with the outlet.

It is worthy of notice that the A. P. D. O. is greater than

[1] *Le Bassin dans les Sexes et dans les Races*, 1875.

the corresponding measurement of the inlet or brim in the Europeans, but smaller in the Andamanese; whilst in the Australians the two measurements are practically equal. The transverse diameter of the outlet is always smaller than that of the brim.

Comparative Anatomy of the Pelvis.

The distinctive characters of the woman's pelvis receive further illustration from the study of *the comparative anatomy of the pelvis*, including in this survey not alone the lower animals, but also the different races and the sexual differences. Since the differences in pelves are chiefly defined by measurements, it is convenient in this place to describe briefly the objects and methods of *Pelvimetry*. This practice is applied to two principal purposes—first, to the study of wet and dried specimens with a view to obtaining scientific data for anthropological investigations; secondly, for clinical purposes, to determine the dimensions of the true pelvis in woman, so that, possessing these data, we may educe an ideal standard pelvis as a basis for scientific obstetric argument. It is also applied to the living subject with a view to immediate and prospective clinical indications.

We will first apply Pelvimetry to the description of the pelvis in different races and sexes. We shall afterwards be better able to appreciate its application to the problem of labour.

Velpeau reminds us that Deventer and De la Motte even make no mention of geometrical measurements to determine the form or dimensions of the pelvis. It is dating from Ould and Levret that the expression of *diameter* found place in the domain of science. It was at first thought with Smellie that it was enough to indicate the sacro-pubic and bis-iliac diameters, but it was soon seen that the third or oblique was not less important; and Levret admitted it into the following editions of his work.

Pelvimeters for use on dried pelves admit of accurate construction and give precise results. For example, to measure the dimensions of the brim, cavity, and outlet, an instrument constructed on the plan of that used by hatters for measuring the inner dimensions of hats is perfectly applicable. But we cannot use such an instrument on the living subject. We must be content with approximate results, drawn partly from measurements, partly from calculation.

The pelvis in different ages.—*The fœtal pelvis* resembles in general characters that of the brute. It is small in its transverse diameter compared with the antero-posterior. The parallelism of the lateral as well as of the anterior and posterior pelvic walls is, says Wood, sufficiently marked and general to be considered as a characteristic of the infant pelvis, as it is of most of the lower animals, giving to it a square-sidedness.

As childhood advances the sacrum becomes more curved, and the transverse diameter widens. The sides of the pelvis grow until 19 or 20, so that, rightly, nubility is not reached until that age; but some subjects are developed much earlier.

The differences between the male and female pelves.—It is not unimportant to take note of the points in which the female pelvis differs from the male. The general character of each is impressed by the functions for which it is framed. The male pelvis is built for strength, to support the trunk and lower limbs, to give hold and leverage to the muscles and joints in the manner most favourable for powerful exertion. It is therefore compact and well ossified. The female pelvis is built with a view to the function of parturition. It is therefore capacious, and the bones are light in proportion.

The following are Verneau's principal conclusions:—

1. The form of the superior circumference is the same in both sexes; the relation of the antero-posterior maximum diameter to the transverse maximum is in both sexes 0·62.

2. All the dimensions of the internal iliac fossa are less in the female, except the distance from the anterior-superior spine to the sacro-iliac joint.

3. The internal iliac fossa is more hollow in the male.

4. The iliac tuberosity is more developed in man.

5. The pubic spines are wider apart in woman.

6. All the diameters of the superior strait are wider in woman, especially the transverse.

7. The superior strait is rounder in woman, partly from its wider transverse diameter, partly from its transverse diameter being situated more anteriorly than in man.

8. In man the distance between the ischiatic spines is seldom

more than 107 mm., and *often less* than 90 mm.; in woman it is often more than 107 mm., and *never less* than 90 mm.

9. The maximum transverse diameter of the inferior strait is nearly 15 mm. more in woman than in man.

10. The antero-posterior diameters of the inferior strait in woman are only a few mm. more than in man.

11. The pubic arch is wider in woman. (75° in woman, 58° in man).

12. The summit of the pubic angle is always round in woman. The ischio-pubic tubercle is more turned outwards, and the ischio-pubic ramus is concave towards its middle part.

13. The cotyloid depression is smaller, and looks more inwards and backwards in woman.

14. The obturator foramen is relatively larger in woman, and more oblique outwards and downwards.

15. The distance between the ischia is greater in woman.

16. All the vertical diameters are greater in man.

17. The total height of the male pelvis is usually 220 mm.; the total height of the female pelvis is usually 197 mm.

18. The distance from the ischiatic spine to the anterior superior iliac spine is usually in woman 137 mm.; in man 150 mm., which is never reached in the female.

19. The interval between the anterior-superior iliac spine and the lower part of the ischium is 165 mm. in woman; in man 182 mm., which is never reached in the female.

20. The relation between the maximum vertical and the maximum transverse diameters is only 0·74 in woman; in man it exceeds 0·79.

A characteristic feature is the eversion of the edges of the sub-pubic arch in woman. This facilitates the egress of the child's head. It adds to the capacity of the arch. The eversion is much less marked in the male pelvis.

The pelvis in the lower animals.— The chief points of comparison are the following: Davis pointed out that *the oblique direction of the symphysis pubis*—it forms an angle of 35° to 40° with the horizon in the erect posture—is peculiar to the human species. In animals the symphysis is parallel with the axis of the body. In all the lower animals except the tortoise, the inlet and outlet of the pelvis are in a straight line. In woman, the pelvis forms *a curved canal.* Both the *forward* *direction of the coccyx* and the *width of the pubic arch* are peculiar to the human species, and have reference to the erect posture. In all the lower animals the transverse diameter of the pelvis is considerably less than the conjugate. Even the pelvis of the gorilla is striking by its elongated oval form.

The pelvis is not essentially a part of the parturient canal. No animal, Roberton observes, is endowed with a pelvis unless it moves upon two or four limbs. The cetacea have no pelvis. Several species of quadruped mammalia either have an imperfect pelvis open in front, as the ant-eater, or so small that the vagina passes in front of it, as the mole, shrew, seal.

The man's pelvis approaches the type of the lower animals in this: the excess of the transverse diameter is more marked in the female: the increasing proportion of the transverse to the antero-posterior diameter may be accepted as the character which most constantly marks the rise in the scale of mammalia. In this respect man, the noblest ape, shows an advance upon the gorilla. Taking this as an index of progressive development, then we find the highest pelvic type in the European woman. Does this prove that man is the inferior animal? Man, perhaps, would appeal to another index—the cranium. If woman excels by the pelvis, man excels by the head. Do not the male and female features of excellence point alike to the influence which the reproductive organs exercise upon the development not alone of parts of the skeleton, but of the whole organisation of man and woman? If we commence from the earliest epoch in embryonic growth we cannot help seeing abundant evidence of the dependence of structural development upon sexual determination.

Variations in the pelvis in individuals.—If variations in the form and size of the pelvis are less frequently observed than are variations in stature and other characters, this may be partly because the pelvis does not so readily lend itself to observation. It is, however, certain that there is a considerable range of variations consistent with normal gestation and parturition. It is not easy to determine the relations which exist between the size of the pelvis and that of the whole body. We do not know that any precise observations upon this subject have been made. We may state from our experience that a large pelvis is not necessarily the appanage of a tall woman, nor that a short woman necessarily has a small pelvis. Small women not seldom have capacious pelves, and bring forth easily.

Hence the difficulty in determining a standard pelvis. This is no more easy than it is to determine the standard man. The standard of normal construction cannot be defined by a fixed number of inches. Elasticity within a certain range must be admitted. In some women the bones are thick, solid; the lines of muscular attachment are strongly marked. In others the bones are remarkable for lightness. The iliac fossa, the inclination of which forms, with the plane of the upper strait, an angle of 40° nearly, may be considerably more hollow or flatter, or more inclined to the horizon. The antero-superior iliac spines, generally directed towards each other by a scarcely perceptible curve, sometimes approach each other by an abrupt and decided curve, or diverge by turning outwards. The sacrum and pubic arch vary considerably.

Pelves may be distinguished as *large*, *medium*, and *small*. Text-books invariably describe a pelvis *æquabiliter justo major* and a pelvis *æquabiliter justo minor*, meaning that in these cases respectively, without deformity, the pelvis is sensibly larger or sensibly smaller than the assumed standard.

The *pelvis is rarely quite symmetrical*. The right side is generally a little larger than the left. This is probably the result of the greater muscular development of the right side of the body. If from any cause one leg be shorter or less used than the other, the corresponding pelvic half will be smaller (Paul Broca,[1] R. Barnes).[2] It is probable that this greater development of the right pelvis may influence the frequency of right oblique positions of the head in labour.

The pelvis presents *planes*, *axes*, *curves*, *inclinations*, *diameters*, *angles*, *inclines*, and *circumferences*.

Planes of the pelvis.—A plane is an imaginary level passing through the antero-posterior diameters and touching the sides of the true pelvis. For example, the plane of the upper strait or brim may be exactly represented by placing a sheet of paper cut to the shape of the brim upon the brim. *There are three principal planes*—(1) that of the *brim*, just described; (2) that of the *cavity*, taken in the centre of the pelvis, the front placed behind the middle of the symphysis pubis, the

[1] *Brown-Séquard's Journal.* [2] *Obstetrical Transactions.*

back in the centre of the sacral hollow; (3) that of the *outlet*, drawn from the tip of the coccyx to the edge of the pubic arch. Between these three cardinal planes any number of intermediate planes may be imagined.

A line falling perpendicularly upon each of these planes in succession would represent the curve of the pelvic canal, or its curvilinear axis.

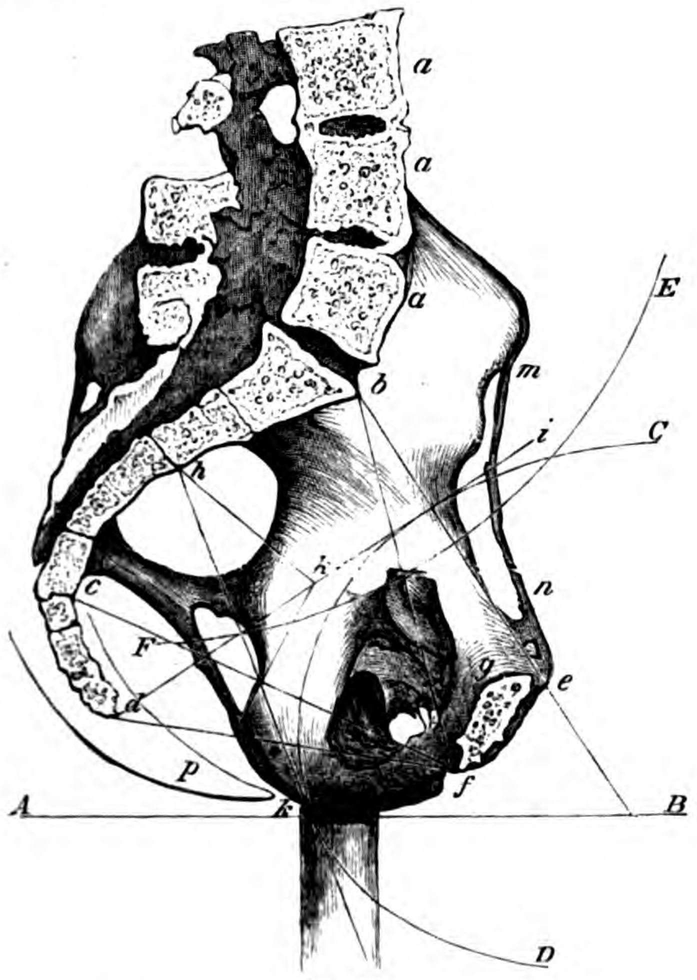


FIG. 59.

A, B. Horizontal, or datum-line. C, D. Curve of Carus. E, F. Barnes' curve. *a, a, a.* Bodies of lumbar vertebræ. *b.* Sacro-lumbar joint or promontory. *b, e.* Conjugate diameter of brim, and plane of brim. *d, f.* Conjugate diameter of outlet, and plane of outlet. *g.* Symphysis pubis. *d, i.* Axis of brim. *h, k.* Axis of outlet. *m, n.* Poupart's ligament. *p.* Perinæum.

The axes of the pelvis.—An axis of the pelvis is the perpendicular drawn upon a plane. Three axes may be adopted: that of the brim, of the outlet, and the curvilinear axis of the pelvic canal.

1. Thus, *the axis of the brim* is represented by a line per-

pendicular to the plane of the brim (d, i). Such a line produced to the umbilicus above, and continued below, would strike about the middle of the coccyx, the subject being erect. It coincides nearly with the axis of the uterus. This is the line the fœtus *nearly* follows to enter the pelvic cavity. It is usual to say *exactly* follows; but this R. Barnes has shown to be inaccurate, since the fœtal presenting part must roll round the promontory to get into the cavity, describing a curve backwards, sharp in proportion to the projection of the promontory. The axis of the brim is parallel with the inner face of the symphysis pubis.

2. *The axis of the outlet* is represented by a line perpendicularly falling upon the centre of the plane of the outlet (h, k). A perpendicular so drawn would—the coccyx being in its ordinary position—strike the sacro-vertebral angle. If the coccyx is extended as in retropulsion, the plane and axis of the outlet would both change with the retreat of the coccyx. This axis represents nearly the line taken by the fœtus in its exit.

3. *The axis of the pelvic canal.*—This is the curved line resulting from the conversion of the axis of the brim into the axis of the outlet. If we look at the axes of the brim and outlet we see (fig. 59) that they cross at an angle, obtuse pubeswards, about the middle of the pelvic cavity. If we continue the axis of the brim, keeping nearly in parallelism with the curve of the sacrum, this axis will strike successively all the planes of the cavity and emerge in coincidence with the axis of the outlet. This curved axis continued outside the pelvis round the symphysis as a centre will represent Carus' curve, the course taken by the head at birth.

The planes and axes in different attitudes.—These depend upon the *inclination* of the pelvis—that is, the angle formed by the plane of the brim with the horizon. In the erect posture, the plane of the brim forms an angle of 60° with the horizon. If the woman double herself up, crouching with the knees on the abdomen, the promontory will be lowered, and the anterior wall of the pelvis will be drawn up, the plane of the brim will become nearly horizontal, and the axis of the outlet will be inclined from behind forwards about 60°. The same thing occurs when the woman is lying in a posture between dorsal decubitus and sitting.

Two curves may be traced. They stand (1) in relation to the axis of the inlet; (2) in relation to the axis of the outlet.

No. 1 we venture to call *Barnes' curve.* This is the segment of a circle having for its centre the sacral promontory. (See fig. 59, E, F.) Under ordinary conditions—that is, with a well-formed pelvis, the promontory only slightly projecting—this curve has no great clinical importance. But in a large proportion of cases, in which the promontory projects ever so little beyond the standard, and more and more as the pelvis assumes more decided contraction, as in most cases of rickets, and in the scoliotic pelvis this curve cannot be disregarded. The head, which under the most favourable conditions descends nearly straight in the axis of the brim, until the vertex touches the floor of the pelvis, must describe a curve—the curve in question—round the promontory in order to get into the hollow of the sacrum—that is, into the pelvic cavity. Arrived here, to get out of the pelvis the head must describe a new circle, (2) *Carus' curve*, which has for its centre the symphysis pubis. This is the curvilinear axis already described. (See fig. 59, C, D.)

The **inclinations** vary between the two extremes of the upright posture and of the doubled-up posture, knees upon the abdomen. (1) The *inclination* of the pelvis in *the upright posture* places the plane of the brim at an angle of 60° with the horizon. (2) The *inclination* in *the doubled-up posture* brings the plane of the brim nearly horizontal—that is, the axis of the brim is made to approach parallelism with the vertebral column. This inclination obviously facilitates the entry of the fœtus into the pelvis. Between the upright inclination of 60° and the horizontal of the doubled-up posture there are corresponding inclinations.

The change of inclination depends mainly upon the flexion or extension of the dorsal and lumbar vertebræ, and very slightly indeed upon flexion or extension of the sacrum upon the last lumbar vertebra.

In proportion to the degree of inclination, and the attendant prominence of the sacro-vertebral angle, will Barnes' curve be more or less pronounced.

The diameters of the pelvis.—The diameters have reference to the circles or circumferences of the pelvis taken at certain stated points of the pelvic canal. Thus there are diameters of the brim, of the cavity, and of the outlet. (1) The *diameters of the brim* are of first importance. In the majority of cases even of difficult labour, the relations of the dimensions and shape of the brim to the child's head determine the course of the labour. The proportions of the lower parts of the pelvic canal, although in many cases important, are in most cases of secondary importance to those of the brim. *Three principal diameters* must be studied. Fig. 60, *a*, *b*, the antero-posterior

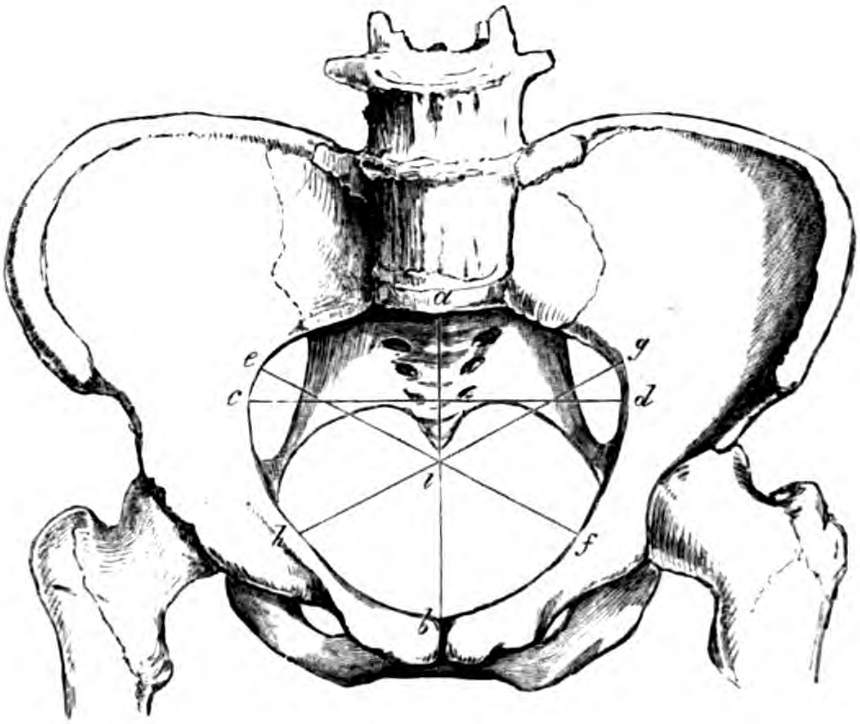


Fig. 60.—Female Pelvis, one-third natural size, showing form and diameters of brim or inlet.

a, *b*. Antero-posterior or conjugate diameter. *c*, *d*. Transverse diameter. *e*, *f*. Right oblique diameter. *g*, *h*. Left oblique diameter.

or conjugate ; *c*, *d*, the transverse ; *e*, *f*, *g*, *h*, the oblique. (See Garson's definitions of the diameters, p. 166) for indications of the points between which the diameters are taken. The oblique, also called diagonal, diameter is double ; the one measured from the right sacro-iliac joint, *e*, to the opposite ileo-pectineal eminence is called the right oblique ; and that drawn from the left sacro-iliac joint, *g*, is called the left oblique diameter.

It is convenient to set out the diameters of the three principal planes in a tabular form:—

Diameters	Brim	Cavity	Outlet
	Inches Centim.	Inches Centim.	Inches Centim.
Conjugate . . .	4·30 = 10·70	5·25 = 13·20	4·25 = 10·70 or 5·25 = 13·20
Transverse . . .	5·30 = 13·00	5·00 = 12·70	4·75 = 12·00
Oblique or diagonal .	5·00 = 12·70	5·25 = 13·20	4·75 = 12·00

Tracing the phases of the conjugate diameter through the pelvis, we see that at the brim it is the shortest diameter, and that it attains its maximum in the cavity and at the outlet.

The transverse is the longest diameter of the brim, medium in the cavity, and shortest at the outlet.

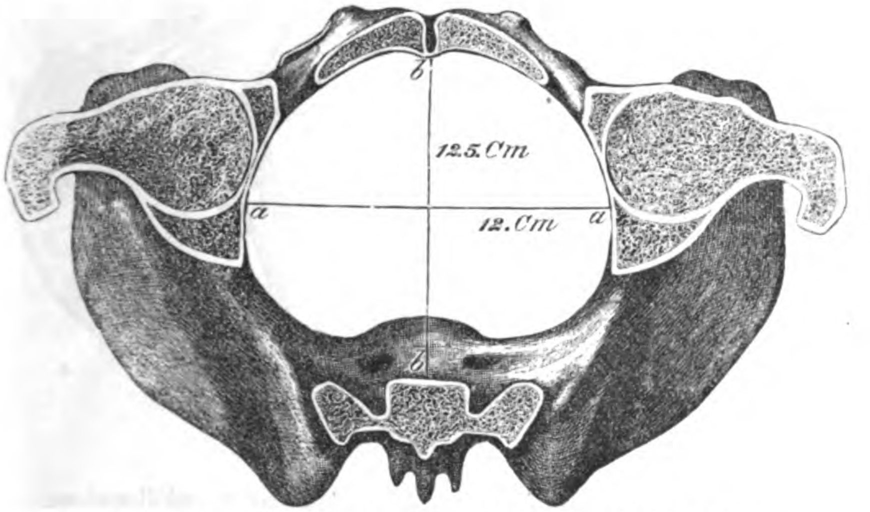


FIG. 61.—Transverse section of Pelvis, showing shape and diameters of the cavity.

a, a. Conjugate diameter. *b, b.* Transverse diameter. The two are nearly equal.

The oblique is capacious at the brim, long in the cavity, and comparatively short at the outlet.

Supposing, then, an ovoid body, the circumference of which is about equal to the circumference of the pelvis, and that this body is moderately plastic, it follows that, driven on, this body will adapt itself in position and shape to the form presented by the unyielding canal at the planes successively reached. Such a body is the child's head. The head will,

NOTE.—The dimensions given in the figures are not exactly those given in the table. They vary within normal limits.

therefore, enter the brim in a transverse, or oblique, diameter; having passed this strait, it will be compelled to turn its greatest length to the oblique and conjugate of the cavity; and, still progressing, it will continue its rotation on its own axis, and turn its long diameter nearly to the conjugate or longest diameter of the outlet. We shall see hereafter the part that plasticity of the head plays in this problem.

If we trace the transverse diameters through the pelvis, we see that they diminish sensibly from above downwards; the transverse diameter at the brim being 5·30 inches, falling to 5·00 inches or less in the middle of the cavity, and to 4·75

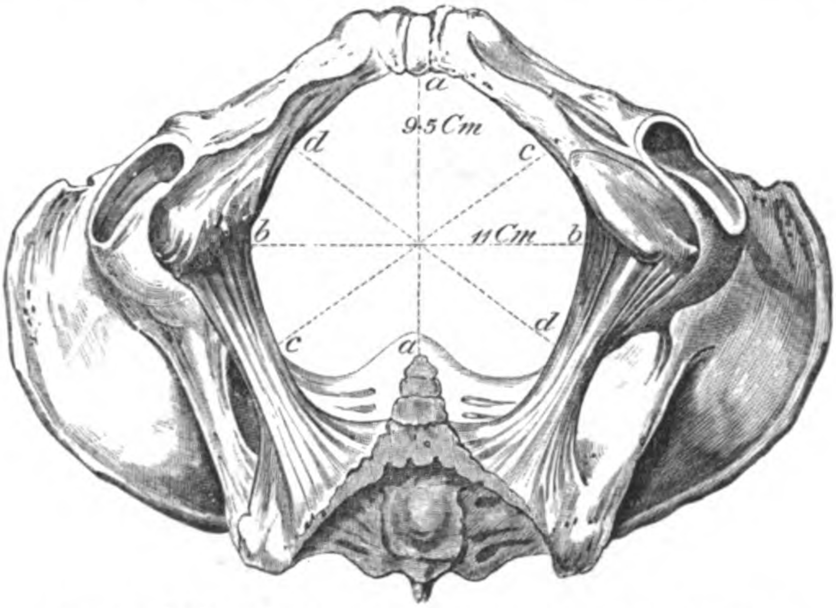


Fig. 62.—Outlet of Pelvis, showing form, boundaries, and diameters.

a, a. Antero-posterior diameter. *b, b.* Transverse. *c, c,* and *d, d.* The oblique diameters.

inches or less at the outlet. The true pelvis, therefore, narrows as we approach the outlet, by the convergence of its sides. We have to note besides a small transverse diameter about the middle of the cavity passing from one sciatic spine to the other. It is a fixed diameter and is smallest of all, measuring barely four inches. At this level, therefore, there is a kind of *middle strait.*

A *sacro-cotyloid diameter* is described. This is measured from the mid-point of the sacral promontory to the point behind the centre of the cotyloid cavity (*a, i, a, k,* fig. 64). This, in well-formed pelves, gives from 3·50 to 4·00 inches.

The most useful application of this diameter is to determine the characters of obliquely ovate pelves by comparing the two sacro-cotyloid diameters. Those who will take the trouble to measure pelves apparently normal in this way will discover how frequently one side of the pelvis—usually the right—is larger than the other. A perfectly symmetrical pelvis is very rare.

The *standard pelvis* is of course *an ideal pelvis*. This ideal is not obtained by striking the average of a large number

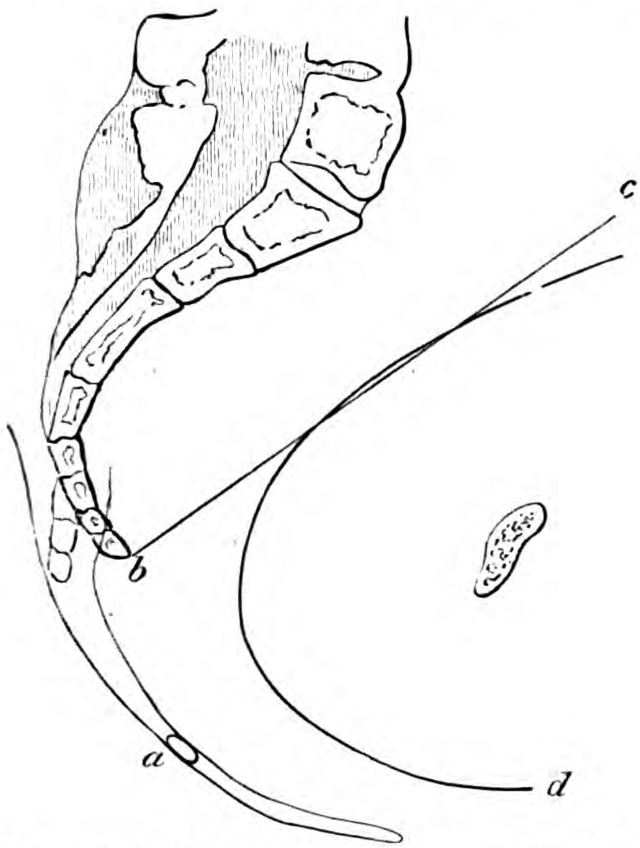


FIG. 63.—Showing axis of Pelvis and curve of Parturient Canal as it changes under retropulsion of coccyx and bulging of pelvic floor, or Barnes' perineal valve, in last stage of labour.

of indiscriminate pelves, but of selected pelves. The best selection would be from pelves of women whose parturient capacity had been proved by their having gone through normal labours. In practice there is found a considerable range of pelvic proportions; and at least equally considerable is the range of size of the child's head. It is not uncommon to find pelves larger than the assumed standard.

The **sacro-vertebral angle** is of the greatest obstetric interest. It is the cardinal point in labour. It is usually said to form an angle of 130° in woman. But many variations occur. We are familiar with pelves dry and in living subjects in which the angle is much more open, the promontory presenting a very moderate projection. The effacement of

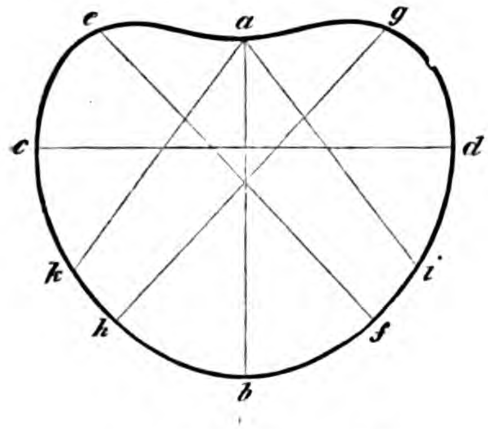


FIG. 64. Outline of Brim.

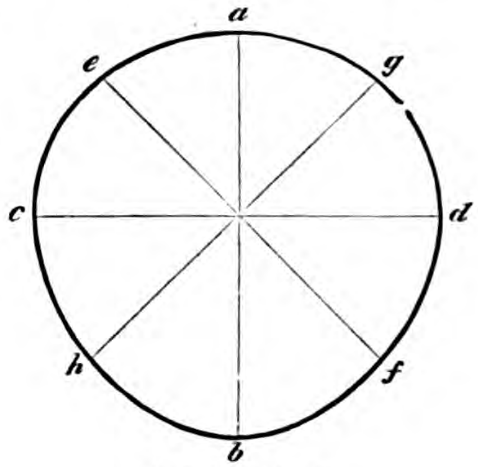


FIG. 65. Cavity.

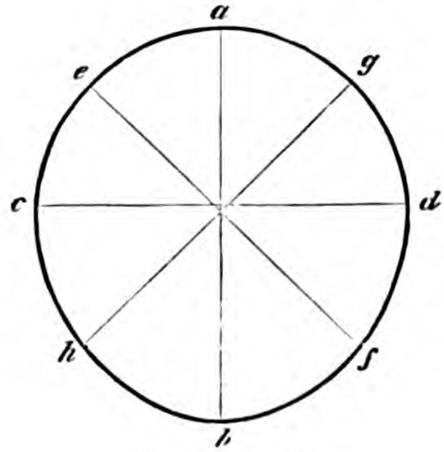


FIG. 66. Outlet.

this angle is most marked in the kyphotic pelvis, in which the conjugate diameter is thus inordinately lengthened. But considerable flattening of the promontory sometimes occurs in pelves fairly proportioned. It is this angle which rules the radius of Barnes' curve. Whenever the angle is less than 130° there is almost necessarily a proportionate increase in the depth of the sacral hollow.

The *sacral hollow* must be studied in relation to the sacro-vertebral angle. This hollow may be estimated by drawing a line from the most projecting point of the promontory to the tip of the coccyx. The length of this line is one factor in the problem. A perpendicular drawn from the deepest part of the hollow to the line which subtends the arc will give the measure of the depth. The subtending line may be stated at 5 in.; the perpendicular at greatest depth at 1·25 in. Observations of these data might furnish an index of the capacity of the sacral hollow.

If we suppose the sacrum to be flattened out, the length from promontory to tip of coccyx will be increased, and the perpendicular of greatest depth will be shorter. If, on the other hand, the sacrum be more curved, the promontory and tip of coccyx will be brought nearer together, and the perpendicular of depth will be increased. These relations have been too little studied; but clinical observation proves that the characters of the sacral hollow are of great practical importance. For example, an exaggerated hollow favours the production of occipito-posterior positions, and has a bearing upon the use of the forceps.

The *length of the anterior wall of the pelvis* is measured from the summit of the symphysis to the edge of the sub-pubic arch. This gives from 1·75 in. to 2 in. We have known instances where this was much exceeded, giving rise to dyspareunia.

The length of the sides of the pelvis increases from the pubic symphysis as we proceed backwards.

Inclines.—The measurements from above downwards of the sacrum, sides, and symphysis represent so many *inclines*. The inclines of the sacrum have been sufficiently described. The *lateral inclines* require a little more attention.

We have seen that the transverse diameters converge from brim to outlet. The result of lateral convergence is to form inclines at the sides of the pelvic canal. There are two inclines on each side, separated by an oblique ridge running from the brim of the pelvis just behind the upper angle of the obturator foramen down to the sciatic spine.

The anterior incline.—This incline is bony, resisting, and looks backwards, inwards, and upwards. The *posterior* *incline* looks forwards, inwards, and upwards. With the exception of the sciatic spine, this incline is entirely composed of soft parts. It is made up of the anterior aspect of the great and lesser sacro-sciatic ligaments, the two sciatic foramina, and the muscles, vessels, and nerves which traverse them. Tyler Smith assigned to these inclines an important part in directing the rotation of the head. The views of this sagacious observer upon this point have not been generally accepted; but we are disposed to think them well-grounded. If the head descend into the cavity with the occiput directed to either foramen ovale, it must be obvious that, coming from the anterior incline, the ridge running along the posterior margin of the foramen to the sciatic spine will guide the occiput forwards towards the symphysis pubis. The transverse diameter of the cavity narrowing downwards, the long diameter of the head must find accommodation by fitting itself to the space of least resistance; and this ridge will naturally guide the occiput forwards to the shallow part of the pelvis under the pubic arch.

The circumferences of the pelvis.—We are for the present concerned with the true pelvis. Starting from the geometrical axiom that the circle is nearly three times the length of its diameter, we may approximately arrive at the circumference, say, of the brim by adding up its three diameters. Thus: $4{\cdot}30 + 5{\cdot}30 + 5{\cdot}00$ inches $= 14{\cdot}60$ inches, or the circumference; for the cavity, $5{\cdot}25 + 5{\cdot}00 + 5{\cdot}25 = 15{\cdot}50$; for the outlet, $5{\cdot}25$ (with coccygeal retropulsion) $+ 4{\cdot}75 + 4{\cdot}75 = 14{\cdot}75$ inches. These calculations very nearly correspond with actual circumferential measurements. (See figs. 64, 65, and 66.) They show clearly that the brim and outlet are really straits, and that the cavity expands between the upper and inferior straits. Practically we know that the passage of the head encounters most difficulty at these straits. These pelvic circumferences have to be contrasted with the circumferences of the fœtal head.

The external measurements of the pelvis.—We may limit our attention to those measurements which can be taken from fixed points in the living subject. The circumferences may be disregarded. They are liable to such variations from fat and muscular development as to be useless for obstetric purposes.

The following measurements, all capable of being taken between fixed points easily felt in most women, are of chief importance. They are best taken by means of the curved calliper compasses of Baudelocque:—

	Inches
1. External antero-posterior or conjugate diameter . .	7 to 8
2. „ transverse between iliac crests . . .	14 „ 16
3. From great trochanter to opposite sacro-iliac joint. .	10 „ 12
4. Depth of pelvis from top of sacrum to coccyx . .	4·5 „ 6

The relation between the external and internal dimensions of the pelvis.—The chief value of the external measurements depends upon their service as indications of the dimensions of the internal true pelvis. To what extent can they be trusted? If there were a definite and constant relation between the external and internal dimensions, it would be only necessary to determine this relation in order to possess an easy and certain clue to the great clinical problem, the dimensions of the true pelvis. Baudelocque and Velpeau deduct from No. 1, the external conjugate, 3 inches.

The case would stand thus: External conjugate $= 7 - 3 = 4$, the true conjugate. Unfortunately this calculation is utterly falsified in practice, more especially in cases of pelvic deformity —that is, in the very cases where information is most desired. Hohl says, from measurements made upon dry faulty pelves, the relation has often been quite normal; and that in most cases the true conjugate was from 1 to 3 inches less than was indicated by the external conjugate. Measurements made by ourselves on dry pelves and in living subjects are quite in accordance with Hohl's statements.

Still, any marked diminution of the external standards may be trusted as giving an approximate idea of the state of the true pelvis. An unusually deep depression in the lumbo-sacral region, with straightening and jutting back of the body of the sacrum, is an almost sure sign of internal pelvic deformity; and unusual narrowness across the hips suggests a difficult labour.

The *bony pelvis may be explored at the following points of its external surface*—namely, along the *crests of the ilia*, and especially at the *anterior superior spinous processes*; sometimes along the *linea ilio-pectinea*; at the *symphysis pubis* from its upper border to the *sub-pubic arch*; the whole *spinous aspect of the sacrum and coccyx*; generally the posterior border of the ossa innominata; and below, the *tip of the coccyx* by the rectum, the *tuberosities of the ischia*, and the *ascending rami* of the ischia. In thin subjects all these points can be traced; in fat subjects all are more or less covered; but the symphysis pubis and the sacro-lumbar recess, the anterior superior spinous processes, rarely escape careful examination under firm pressure.

These points serve as important landmarks to determine the relations of parts, and as points whence to measure the dimensions of the external pelvis.

Pelvimetry applied to obstetric practice.— If we could obtain approximately exact measurements of the dimensions of the pelvis in a gravid, especially a parturient woman, we should have solved one part of the great problem of obstetrics. If we could also take accurate measure of the dimensions of the fœtal head still in utero, and be at the same time able to estimate the degree of its plasticity, we should be in possession of the two primary factors absolutely and in their relations to each other. If, thirdly, we could accurately gauge the driving force brought to bear upon the two first factors, allowing for the resistance of the soft parts, we should almost realise the proposition of Levret, that 'labour is a natural operation, truly mechanical, susceptible of geometrical demonstration.' Unfortunately we have not arrived at this point. We have not yet mastered any of the component problems. How far, then, are we from the grasp of these component factors in their solidarity and their mutual relations!

Still, we must endeavour to solve each elementary problem as nearly as possible. If we could but overcome the first difficulty, that of obtaining precise knowledge of the pelvic dimensions, we might, assuming that the head was of standard proportions, be in most instances masters of the position; since it is in our power to lessen the resistance of the soft parts, to increase, to supplement, or to lessen the *driving force*, and to aid the moulding of the head.

1. *How to determine the length of the conjugate diameter of the brim.*—The best pelvimeter for clinical use is the index finger. Before the head has engaged in the brim, it is always possible to reach the promontory with the finger by passing the hand into the vagina. The tip applied to the promontory,

the side or back of the finger will rest against the pubic arch. This point of contact with the pubic arch may be marked off by the finger of the other hand. We thus have the length of the sub-pubic conjugate, or *lower or inclined conjugate.* (See fig. 59, *b, f.*) This is estimated by Wood as about 0·50 in. less than the true conjugate. Thus, measured by the index, the inclined conjugate gives 4·50 in.; deduct 0·50 in., we obtain 4·00 in. for the true conjugate, the object sought. Pelvimeters have been constructed on the principle of the shoemaker's sliding-scale. One end of the rule is pushed up to rest on the promontory, whilst the sliding-rod is carried forward so as to rest against the inner surface of the pubic symphysis. This is the principle of Coutouly's pelvimeter. This would give the true conjugate. Various other contrivances have been adopted. We do not describe them because of the difficulty in using them and the imperfect results yielded by them. The skilful obstetrist always falls back at last upon his hand. It is not enough to know the length of the conjugate, and this is the only dimension within the purview of mechanical pelvimeters. The hand explores the whole region. Under anæsthesia it is not difficult to pass the hand into the vagina. The tip of the index thus is applied to the promontory; the thumb rests upon the inner surface of the pubes, and takes an estimate of the conjugate; the finger then sweeps round the pelvic brim, noting the depth of the recess on either side of the sacrum, the width of the pelvis; and if the child's head is presenting, he takes note of the relation of the head-globe to the circumference of the brim as well as to the promontory. He traces the circumference of a ring—the brim—and weighs in his mind the probability of a plastic ball—the child's head—resting upon the ring, passing through it, allowing for moulding, spontaneous or by aid of forceps. This knowledge, approximate though it be, and only to be acquired by considerable experience, is what no instrument can give.

It may be stated as a general rule, as a rough but valuable indication, that if the promontory be easily felt by the index passed into the vagina, the presumption that the conjugate is contracted is strong. This is confirmed if we find the sacrum externally very flat, or excessively curved, the coccyx pointing unduly forwards.

We have already discussed the relations between the external and the internal dimensions as indicating the length of the internal dimensions. Alone, they cannot be trusted. Taken together with internal examination, they may yield useful controlling or corroborative data.

For the purposes of scientific study, and with a view to the treatment in future pregnancies of the woman under observation, pelvimetry may be usefully supplemented by careful measurements of the child's head after birth, noting at the same time the degree and kind of plastic deformation undergone.

The Breasts.

The breasts (*μαστός*, from *μαστεύω*, to seek, because the infant seeks in them the milk) are glandular organs associated with the organs of generation, designed to support the child during the first months after birth. The breasts belong to the skin, of which they may be considered to be dependencies. They pour out their secretion directly on the external surface of the skin. The important function fulfilled by the breasts has led zoologists to class all animals possessing these organs in the same class under the name of mammifera. One character proper to this class is that all are viviparous—that is, all give birth to young which are born free from their fœtal envelopes.

The breasts exist in both sexes; but are rudimentary or atrophied in the male. They belong essentially to the female, and are not completely developed until the epoch of puberty. They are two in number in the human species, which is uniparous; generally amongst animals they are double the number of the young brought forth. Examples of triple or quadruple breasts in women are very rare; and sometimes the supernumerary breasts are more apparent than real, consisting of simple nipples or of masses of adipose tissue.

The breasts occupy the anterior and superior part of the chest, which, spreading transversely, affords a favourable condition for the development of the organs, and, says Plutarch, in order that the mother may embrace and hold up her infant whilst giving it suck. In animals whose young suck standing or squatting on the ground, the breasts are situated on the abdominal region.

The breasts are developed in proportion to the growth of the genital organs; they increase in volume during pregnancy and especially after delivery, and become atrophied in old age. Their size does not always correspond with the stature, strength, or constitution, and it is not uncommon to find delicate, phthisical women with very large breasts. But certain families and especially races present remarkable varieties. In certain African races—partly, perhaps, as the result of particular manipulations—the breasts are so long as to hang down as far as the groins, or, hanging over the shoulders, even permit the infants to suckle whilst being carried on their mothers' backs.

In judging of the size of the breast, care must be taken not to confound what properly belongs to the gland with that which depends upon fat. The largest apparent breasts are not always those which supply the most milk; in such the true glandular structure may be inconsiderable.

The free or cutaneous surface of the breast is convex, of a dull white, smooth, soft to the touch, and often covered with very fine hairs. Around the nipple is a well-defined circle called the *areola*. The tint depends upon the complexion —thus it is pale-rose in the fair, and dark in brunettes. In both the tint deepens in gestation. The areola presents a rough aspect, which is especially manifest during gestation. This appearance is due to a multitude of sebaceous glands, and principally to special glands, from five to fifteen in number, arranged in a circular manner around the base of the nipple, or dispersed irregularly over the space of the areola, and projecting a little on the surface. These are the *tubercles of Morgagni*. In some women, in addition to the sebaceous glands, there are found some hair-follicles in the areola. The diameter of the areola is from 3 to 5 centimetres (1·25–2 in.).

The *nipple*, slightly directed outwards and downwards, commonly answers to the fourth intercostal space. It is coloured rosy or brown, excepting at the summit, which remains pale; it is rough, as if fissured on its summit, and susceptible of a kind of erection. Sometimes it is cylindrical, sometimes conoid, and sometimes it is so short, flattened, or even buried in the substance of the breast that it is impossible for the infant to seize it. The surface of the nipple is uneven and covered with large closely-set papillæ, conical or nipple-like ; many of these papillæ present secondary papillæ, which however form no relief on the surface of the epidermis, but each contains a vascular loop. Between the large papillæ the small sebaceous glands open by microscopical orifices. At the summit of the nipple are seen depressions in which the galactophorous ducts open by a variable number of orifices.

Structure of the breast.—The breast is composed of an envelope of skin, of a layer of adipose tissue, and of the mammary gland. All these parts are united together by a very resisting connective tissue.

The skin covering the peripheral portion of the breast presents nothing remarkable. But at the level of the areola it shows peculiar characters : in addition to the extreme thinness of its epidermis, it is remarkable for a great accumulation of pigment in the deep strata of its mucous element, for the great number of sebaceous and sudoriparous glands, for the hair-follicles, rudimentary in woman, often much developed in man, and lastly for the glands which, projecting on the surface, constitute the tubercles of Morgagni. These glands, which are rarely absent, are developed during gestation in the same proportion as the mammary gland. They are small clustered glands composed of several irregular lobules, which themselves are formed of glandular vesicles. They give rise to a small excretory canal which opens at the summit of the tubercles of the areola, and supply a liquid possessing all the characters of milk. Beneath the skin of the areola there is a layer of smooth muscular fibres ; these are arranged in concentric circles around the nipple, which become more numerous and more thickly disposed as they approach the nipple. Besides these annular fibres there exist, according to Meyerholtz, radiated fibres, which arise from the skin of the areola, in the neighbourhood of the nipple, converge towards this organ, and meet in the cellular tissue underneath it, forming species of arcs with the concavity turned towards the skin. These fibres contracting increase the projection of the nipple.

The skin of the nipple is fine and pigmented, except at the summit, and is intimately adherent by its deep surface to the subjacent parts. Very numerous sebaceous glands are attached to this tegument and open directly on its surface, which is deprived of hairs. Beneath the skin are found the galactophorous canals, fifteen to twenty in number, united into a bundle, and occupying the axis of the nipple. In the child and adult man they are very small; in woman they measure from 0·4 mm. to 1 mm. in diameter, and two layers can be distinguished in their walls: the one, external, is formed of connective tissue; the other, internal, is folded longitudinally and composed of an amorphous membrane enclosing elastic network, and of a pavement epithelium, stratified near the orifices of the nipple, cylindrical further in.

Just beneath the nipple the milk-ducts expand and form ampullæ or reservoirs—the *sinus ductuum lactiferorum.* They may attain a diameter of 5 to 8 mm. when filled with milk; they then take a winding course and have an irregular bulging appearance (see fig. 67, 7). The walls of these larger ducts consist of connective tisue in which is enclosed a dense layer of ring-shaped elastic fibres.

1. The *muscular fibres* of the nipple surround the galactophorus canals, crossing each other in all directions. Some are parallel to the surface of the gland; they form a kind of trellis-work, through which pass the canals; some fibres are parallel to the axis of the nipple.

2. The *adipose tissue.*—The breast is, in fact, a dependency of the skin, for it is lodged in the subcutaneous adipose tissue; and more than this, the adipose tissue penetrates into the substance of the mammary gland, dividing it into small masses, and in very stout persons it appears even to insinuate itself between the glandular grains.

The depressions or cups presented on the outer surface of the breast are filled with masses of adipose tissue, separated by fibrous lamellæ stretching from the mammary gland to the skin (fig. 67, 5, 5). The fibrous spaces which contain these adipose masses do not communicate with each other, a circumstance which explains the frequency of circumscribed inflammations and abscesses of the breast. The development of the adipose tissue and of the mammary gland stand in inverse ratio to each other.

3. *The mammary gland.*—Freed from the fat in the midst

of which it is buried, the mammary gland is seen as a mass flattened from before backwards, thicker in the centre than at

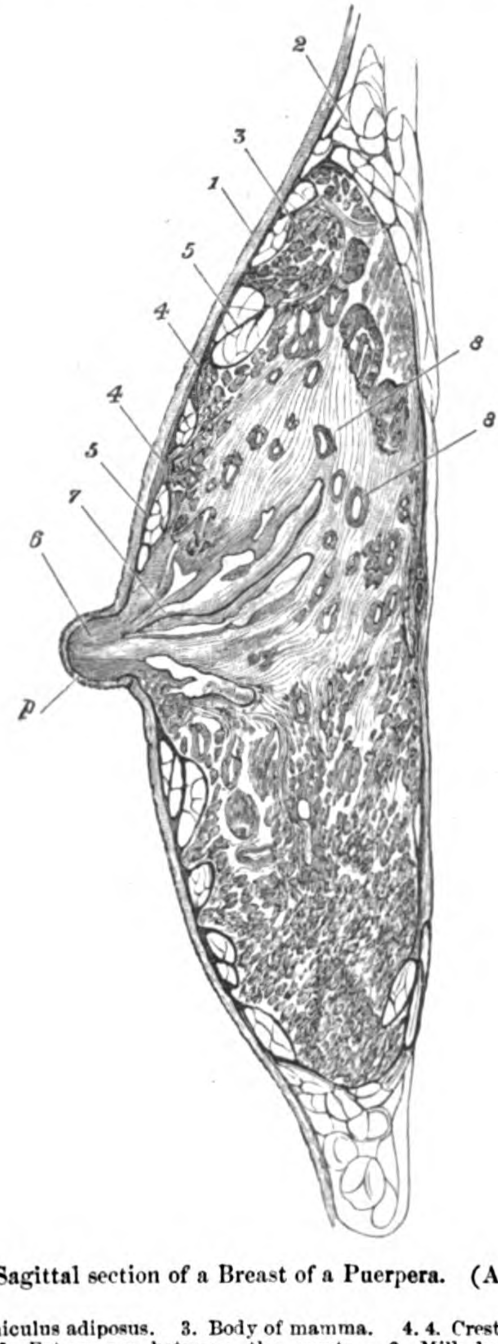


Fig. 67.—Sagittal section of a Breast of a Puerpera. (After Henle.)

1. Skin. 2. Panniculus adiposus. 3. Body of mamma. 4. 4. Crest-like projections of mamma. 5, 5. Fat-masses between the crests. 6. Milk-ducts of the nipple. 7. Sinus of milk-ducts filled with milk. 8, 8. Section of milk-ducts in centre of mamma, surrounded by glandular tissue.

the circumference, which is unequally notched. Its base, which is plane and even slightly concave, rests upon the great pectoral, and sometimes externally upon the serratus magnus muscles. A fibrous layer continuous with the superficial fascia and enclosing large bundles of elastic fibres separates it from these muscles, to which it only adheres by a very lax serous cellular tissue, imparting to the organ a great freedom of motion.

The cutaneous aspect of the mammary gland is very unequal, hollowed into pits separated by crested prolongations. (See fig. 67, 4, 4.) These pits are filled up with adipose tissue which conceal the irregularities of the surface. The proper tissue of the gland is denser than the greater number of glandular organs. It should be studied apart from and during lactation. In the first condition it presents the appearance of a very compact fibrous tissue, of a whitish colour, divided into unequal lobules, very much resembling certain tumours of the uterus. The granular disposition proper to the tissue of glands does not exist in an obvious manner. In fact, when the finer ramifications of the galactophorous canals are traced in children of both sexes, it is found that they terminate in swollen *culs-de-sac*. At puberty, small vesicles are grouped around these *culs-de-sac*; these vesicles are enveloped in a layer of cellular tissue, enclosing a multitude of elongated nuclei, whose great axis is parallel with the canaliculi. It is at this point that the development of the breast in the male sex is usually arrested, and becomes atrophied. In woman the development proceeds, the ramifications become more numerous and finer, stretch to the periphery of the gland, and are furnished with a multitude of vesicles.

During lactation the granular disposition becomes especially evident. The glandular grains, which measure from 1 to 2 mm. in diameter, are united into small groups or flattened lobules superposed on each other. From each little group proceeds an excretory duct, recognisable by its white colour; it is easy to inject, and results from the reunion of a number of radicles proportional to the number of glandular grains. Cruveilhier says that, having had the opportunity of dissecting the breast of a woman recently delivered, in which the cellular tissue uniting the glandular grains was infiltrated with serosity, he found the grains dissected as it were by this infiltration; the galactophorous ducts were injected with a yellow coagulated milk. He thus saw that some of the glandular grains were isolated and as if pedunculated, whilst others were agglomerated into regular or irregular groups; one of these groups was disposed in a circle, and from all the grains of this circle issued small excretory ducts, directed from the circumference to the centre like radii, and terminated in a common excretory duct, which went from the central point. Other groups were elongated. At the centre was a galactophorous duct receiving the small excretory radicles proceeding from each granulation. Each grain had a central cavity, from which a worm-like substance formed of coagulated caseous matter could be squeezed.

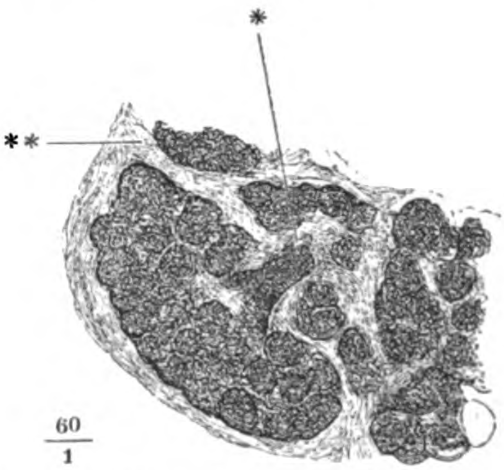


FIG. 68.—Section of the glandular substance of the mamma. (After Henle.)
* Terminal branch of a milk-duct. ** Connective tissue stroma.

These grains were composed of vesicles analogous to the salivary glands.

This transformation of the glandular tissue begins at the periphery of the organ, and in the kind of crests which rise on the surface. These crests become broader, flatter; the deep aspect of the breast assumes a granular appearance. At the same time the gland loses consistency and assumes a yellow colour. The glandular vesicles are composed of an investing membrane extremely thin, and contain globules of fat resembling those of the milk. (See fig. 69, *a*.) This fatty matter is dissolved by the aid of soda; the wall of the vesicle is seen covered with a layer of epithelial cells. Independently of the granulations there enters into the tissue of the gland a large quantity of fibrous tissue, which, after having formed a complete investment, sends into its substance processes more or less lax which hold together the lobules. It is to this large proportion of fibrous tissue that the gland owes its hardness. Sometimes the development experienced by the breast bears exclusively upon the fibrous element, and then it may acquire an enormous size; sometimes the glandular structure disappears, and the breast is transformed into a multilobular fibrous mass which has been sometimes taken for a degenerate lipoma.

The galactophorous ducts.—If the breast of a woman who has died during lactation be divided, milk oozes up from a multitude of small points, as if from the pores of a sponge.

FIG. 69.—(After Cloquet.)

a, a. Lobules of acini or glandules. *b, b.* Canals. *c.* Sinus of milk-ducts. *d.* Nipple in which milk-ducts terminate.

These are sections of the lacteal or galactophorous ducts. These arise from the granulations as already described, and are gathered into an indefinite number of principal ducts terminating at the centre of the mammary gland at the level of the areola. Here they attain their greatest size, and form dilatations leaving no interspaces. The number of these dilatations (*reservoirs* or *sinuses* of the galactophorous canals) varies from ten to twenty. They are of unequal size; at the base of the nipple the canals narrow, become straight and proceed parallel to each other, to open at the summit of the nipple by orifices much smaller than the canals themselves. (See figs. 67, 69.)

Thus, although there exists no distinct reservoir for the mammary gland, it may be considered that these dilatations fulfil the function of reservoirs. There is this difference, that instead of the single reservoir of other glands, there exist in the mammary gland multiple reservoirs.

The galactophorous ducts nowhere communicate with each other. The mammary gland, like most other glands, is divided into a certain number of distinct departments which may execute their functions independently of each other. Hence it is that diseased breasts may supply milk possessing all the normal characters. Injections show that the ducts have no valves. Fig. 69 gives a general idea of the arrangement of glands, canaliculi, ducts, sinuses, and their terminations in the nipple.

Vessels.—The *arteries* come from the thoracic, especially from the external mammary; from the intercostals, and from the internal mammary. The branches supplied by the internal mammary and the intercostals attain a considerable size during lactation. When thus hypertrophied they become flexuous.

The *veins* are very largely developed, and are divided into two orders: subcutaneous and deep. The latter accompany the arteries. The former are seen through the skin and form under the areola a circle, often incomplete, called the *venous circle of Haller.*

The *lymphatics* are very numerous; some are superficial, some deep. The first arise from the cutaneous networks, exceedingly delicate and very abundant, which cover the nipple, the areola, and its neighbourhood; they proceed to the axillary ganglia. The deep lymphatics proceed from the glandular lobules, and all run towards the axilla; there they form a plexus, composed of large vessels, whence run several trunks which also terminate in the ganglions of the axilla.

The *nerves* come from the intercostals and the thoracic branches of the brachial plexus.

Development.—The mammæ become apparent from the third month. Langer and Kölliker show that they are represented at their origin by a warty excrescence of the mucous body of the epidermis. From the sixth to the seventh month a number of pyriform buds, the rudiments of the lobes of the glands, appear on the surface of this excrescence; but it is only towards the end of fœtal life that these buds become isolated from each other, and open outwards. At *birth* the mamma is already composed of distinct lobes, each having an excretory duct. But before puberty no true glandular vesicles are found; until this epoch the mamma differs in the two sexes only in the greater size of the nipple, and a somewhat greater size of the gland in the female child.

At *puberty* the mamma acquires gradually its destined size. Its development coincides with that of the genital organs. The glandular vesicles show themselves at this time, but do not assume their full development before the first pregnancy. At

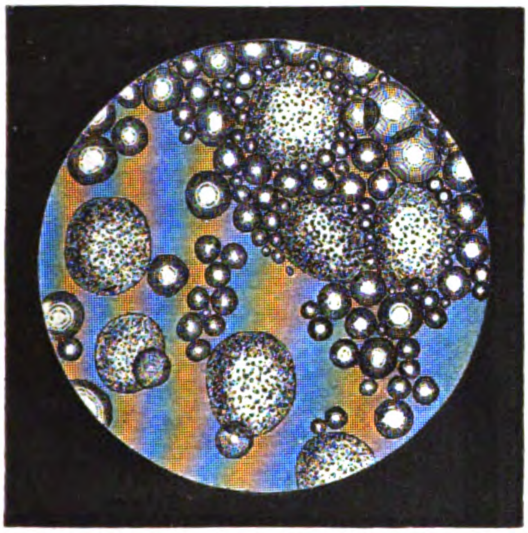


FIG. 70.—Showing colostrum and ordinary milk-globules, first day after labour, primipara aged 19. (After Hassall.)

the same time remarkable modifications take place in the epithelial cells which line these vesicles, whence result the secretion of milk. Globules of fat, the quantity of which increases more and more, accumulate in the epithelial cells, which, having grown bigger, end by completely filling the cavity of the glandular vesicles. At the same time, new vesicles are formed near the walls of these last, which by their development push the old ones into the excretory canal. There they accumulate and partly destroy each other, in order to be expelled externally during the first days after parturition with the yellowish liquid which bears the name of *colostrum* (see fig. 70). After labour, the production of cells in the glandular vesicles assumes an extraordinary activity; these cells, filled with fat-globules, disappear altogether in the galactophorous ducts, since no trace of their investing membrane is seen in the milk. There is found nothing but a multitude of rounded corpuscles, shining, of fatty nature, held in suspension in a plasma which contains in solution casein, sugar of milk, and a variable quantity of inorganic salts. Thus constituted, the *milk* forms a liquid of an opaline white, of a sweet and sugary taste, and combining all the essentials of a perfect nutriment.

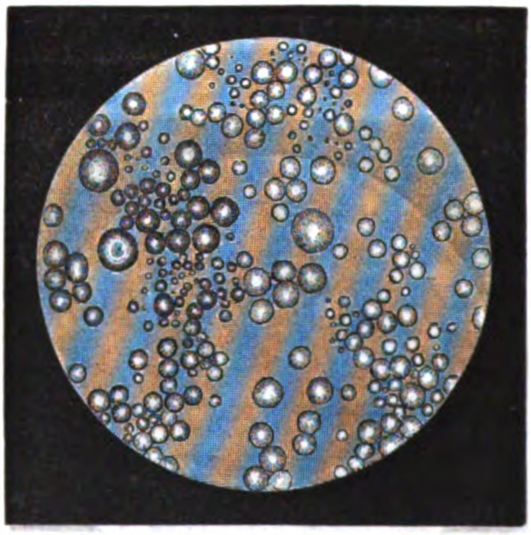


FIG. 71.—Globules of healthy milk; fourteen months' lactation.

The breasts become atrophied in old age; the vesicles disappear, and sometimes nothing but a little fibrous tissue is found in their place.

During the period of secretion the breasts receive a much larger supply of blood than at other times. Pregnancy favours the development of the secreting portions of the glands, but does not induce secretion. On the other hand, when pregnancy occurs during lactation, it diminishes, modifies, and may arrest the secretion of milk.

The secretion of milk is nearly continuous. When fully established, whilst there may be certain periods when it is formed in greater quantity, there is no absolute intermittency.

When the milk-ducts are filled to the utmost, before the overflow begins, there must exist an apparatus to keep the mouths of the ducts closed, and which will only give way under greater pressure. Such an apparatus is provided in the musculature of the papillæ. The ducts, whose calibre within the nipple is already smaller than before entering the nipple, look narrower still when compressed by the muscles between which they run.

The secretion of milk is undoubtedly stimulated by emotional excitement, and by reflex irritation. Thus, the mother thinking of her child feels 'the rush of milk' to the breasts; they quickly enlarge and milk flows; and the touch of the child sucking the nipple by mouth or hand acts partly by emotional influence and partly by reflex influence. We may see this in lower animals. The calf seeking milk tosses its mouth against

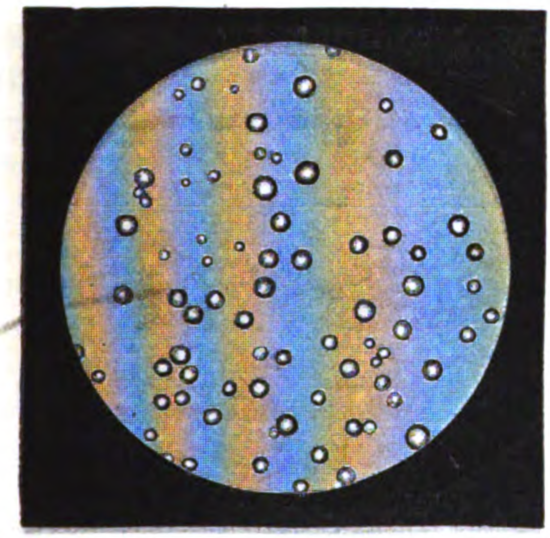


FIG. 72.—Impoverished milk; scanty globules. (After Hassall.)

the mother's breast, and thus increases the flow by gentle succussions. Under this excitement the sphincteric muscles relax, and the milk escapes.

The milk accumulates to the point of compelling relief at intervals varying according to the health of the individual and her habit. Generally the mother feels this want about every four to six hours.

Terror, grief, shock, any violent emotion may suddenly suppress the secretion. Astley Cooper relates two cases.

After eight or nine months' lactation the milk frequently becomes 'poor.' This condition admits of close appreciation by the microscope; the globules are small and scattered. (See fig. 72.)

When there is engorgement or inflammation of the breasts, healthy milk may still be secreted for a time, the chief seat of inflammation being the connective tissue. But often the globules become agglomerated. (See fig. 73.)

In cases where menstruation returns, the secretion of milk is commonly checked. In some cases (Robert Barnes) there is a monthly reappearance of colostrum-globules coincident with menstruation.

The breasts maintain intimate functional relations with the uterus and ovaries. During menstruation and gestation they feel the impulse and become turgid and tender. Sexual excitement sometimes starts from sensations in the breasts arising

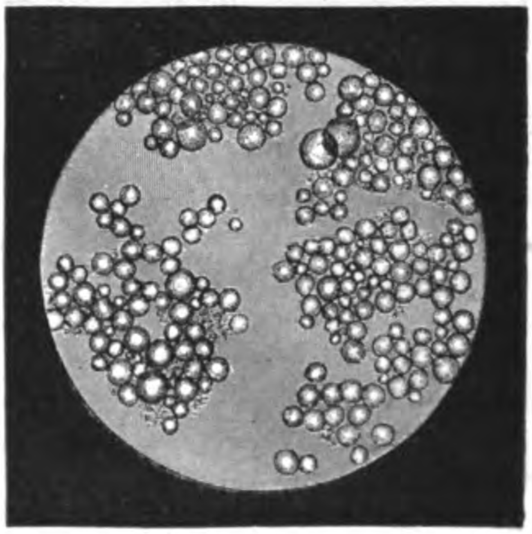


FIG. 73.—Milk-globules aggregated, as in engorgement of the breasts. (After Hassall.)

spontaneously or provoked by touch. At these times, the breasts become turgid, firmer, and the nipples stiff and erect. After labour, irritation of the nipples, as by the child sucking or other modes of milk-aspiration, will cause the uterus to contract. This is turned to account to control post-partum hæmorrhage. One of the great uses of lactation is to promote contraction and involution of the uterus. Women who do not suckle are especially liable to sub-involution. On the other hand, we have known slight hæmorrhage occur whenever the child was put to the breast. It is a common event for women to feel uterine spasm or colic when the child seizes the nipple.

There is a struggle between the ovary and the breast for supremacy. In the end the ovary is pretty sure to win and to put an end to lactation. On the other hand, persistent lactation will occasionally suppress menstruation and postpone conception for several years. We have notes of cases in which menstruation was thus kept in abeyance for five years. One woman had become a widow, so that all her feelings and functional work were concentrated upon her child. But in other cases the woman continued to live with her husband, and had no child to suckle.

Abnormalities.—These consist chiefly in multiplicity and unusual situations.

Robert of Marseilles reports in Magendie's 'Journal of Physiology' the case of a woman who had a well-formed mammary gland on the outside of the left thigh. The mammary glands upon the chest performed their function with regularity, and were normal in all respects; but the gland upon the thigh secreted during lactation such a quantity of milk, that the woman had nourished all her children, seven in number, indifferently from the three glands. The mother of this woman had three mammary glands, one on the left side of the chest and two on the right. This case is perfectly authentic, and was reported on by Chaussier and Magendie.

In Dunglison's 'Human Physiology' (1856) numerous very curious instances of unusual lactation are recorded.

Fancourt Barnes saw a woman in St. Thomas' Hospital who had four breasts. There were two in the usual places on her chest, and two additional ones on her abdomen, one on either side of the navel.

CHAPTER VII.

THE PROCESSES OF GESTATION, CHILDBED, AND LACTATION.

CONSTITUTING parts of one great function, Reproduction, the processes of gestation, childbed, and lactation must be studied in continuity, in their togetherhood, and in their relation to each other. It is true that this great function may not be completed—that is, the stage of lactation may not be reached; childbed, strictly speaking, may not be reached; and the right period of gestation may not be fulfilled. Still, the function of reproduction is in its essence one, and the conditions for its complete performance always exist, at least potentially or in design. Childbed is the necessary supplement to gestation, and forms the transition stage between gestation and lactation—the complement or culmination of the function. A special organ holds predominance at each stage of the function. During gestation the uterus, obeying the developmental impulse of the embryo, is the ruling centre of nutrition and of influence upon the nervous system. In a typical case the transition stage of childbed merges quickly and easily into that of lactation. The breasts, prepared beforehand for the work, enter upon duty almost at once. The new-born infant has not long quitted its nidus in the uterus before it seeks a new source of supply. It seizes the breast, and, its developmental force now acting upon this organ, makes it the dominating centre.

Looking beyond, that is, before and after the processes of gestation and lactation, Tyler Smith set forth the history of reproduction in the happiest manner. He summed it up in the description of the Genesial Cycle. In the ordinary state the active or dominating organ of the sexual system is the ovary. The reign of this organ is expressed by menstruation, the part taken by the uterus in this process being secondary, or in obedience to the impulse of the ovary. The ovary reigns supreme until conception takes place; then the uterus succeeds, and rules until the child leaves it. Then it is deposed, and yields its place to the breast. The breast rules with more or less authority until it is supplanted by the ovary, which is ever struggling for supremacy, and cannot long be kept in subjection.

These organs, the ovary, uterus, and breast, are the agents in carrying out the imperious law of reproduction. To this law they are alike subservient. Throughout the genesial life of woman there is a continual series of efforts to accomplish this purpose. Every menstrual act represents the ripening of an ovum, and its reception into the Fallopian tube and uterus ready for impregnation. It is an attempted pregnancy. The ovum is there, the nest is prepared, the breasts feel the nisus; but for want of the fertilising element the process is abortive.

The analogy between menstruation and pregnancy and labour is traceable in detail. A sketch of the menstrual process is a necessary introduction to the history of gestation. The *primum mobile* in either case resides in the ovary. The first step is ovulation, or the ripening of an ovum, and the depositing it in the uterus. But the work of preparation begins in the uterus long before the extrusion of the ovum from the ovary. In response to the development of the ovum nerve-force and blood are attracted to the uterus, the whole organ swells, becomes heavier and more sensitive, softer from the permeation of its walls by fluid; the utricular glands of its cavity enlarge, secrete more freely; the mucous membrane swells, grows, is developed into a thick, soft, pulpy membrane, the decidua. This process is the representative of pregnancy. It is marked by certain signs, more or less distinct in different cases. But in all there may be observed exalted nerve-tension, expressed by greater emotional and reflex mobility, sometimes revealed in neuralgia, in vomiting, and even in convulsion. There is increased central nervous irritability, and there is the eccentric source of irritation in the uterus. Concurrently with this increased nervous energy there is observed a marked increase of vascular tension. The pelvic vascular region especially feels the attractive force of the uterus, and the kidneys work more freely.

Then there comes the casting-off and casting-out of the useless decidua: the process is traumatic. This is the analogue of labour. The developed muscular fibre contracts under the influence of the intensified diastaltic function. Hæmorrhage attends. The mimic labour over, the blood-current and nervous energy are diverted from the pelvis, and for a time the ordinary equilibrium of the economy is restored. The uterus returns to its wonted state, and the breasts become quiescent. Compare this sketch with the succeeding history of pregnancy, and points of similitude will be discovered at every stage.

The Natural History of the Process of Gestation.

We may now pursue the history of gestation. This may be said to begin after a menstruation or missed pregnancy. The phenomena of insemination, fertilisation, and the consequent changes wrought in the ovaries and uterus have been described. We have now to trace the correlated changes wrought in distant organs and in the constitution at large.

Impregnation, that is, fertilisation, of the ovum is no sooner effected than the new impulse dominates the entire system. The embryo grafted on the mucous membrane of the uterus sits like a despot on his throne. The uterus and placenta are built up for its accommodation and growth. Its imperious demands tax every tissue and every organ in the body. Generally, it is true, a fair equilibrium between the wants of the parent and those of the embryo is maintained. The embryo is supplied without injury to the parent. But sometimes the demands of the embryo are so exacting that the parent cannot keep pace with them. She may perish from exhaustion, the embryo perishing with her, but not seldom surviving her destruction.

The physiological phenomena evoked by pregnancy must be studied and grasped as a whole, that is, as forces called into combined action to accomplish a definite object. We cannot arrive at a just idea of the state of any one organ or system of organs without taking into consideration the state of all the rest in their absolute and relative conditions.

A general law has been formulated by Robert Barnes—viz., *since, in pregnancy, every organ and the whole organism are* *specially weighted, undergoing extraordinary developmental and functional activity, so any defect or fault inherited or acquired, howsoever latent, will be liable to be evolved or intensified under the trial. Hence pregnancy is the great test of bodily soundness.*

When in a sound body, the just balance is kept between the several functions, and in the relations of parent and embryo we may expect the course of pregnancy to run smoothly. When, on the other hand, one organ or system of organs is damaged or overtaxed the balance is disturbed, and we may expect various morbid manifestations. The so-called diseases of pregnancy spring directly out of exaggerations or defects of the normal processes. They bear the seal of the gestation-process. They form a group governed by one common law.

The pathology of gestation then is simply a chapter in extension of the physiology of that process. It is especially in the study of normal and disordered gestation that we see demonstrations of the universal law, which may be formulated as follows:—*Pathology is physiology working under difficulties.*

In describing a complex condition some system must be followed. We may begin with *the nervous system, which probably first feels the influence of pregnancy.* The alterations observed are—1, increased psychical mobility; 2, increased emotional mobility; 3, increased diastaltic or reflex mobility; 4, increased ganglionic activity. These are manifested in various ways, partly subjective, partly objective.

The psychical and emotional alterations we cannot now dwell upon at length. Throughout the animal world the influence of gestation upon the female organism may be traced. And so striking is the influence of this process in many plants that we are almost tempted to deduce from it an argument for the existence in them of a nervous system. We cannot deny them the possession of a force of equivalent value. The wonderful changes undergone by the plant during inflorescence, fertilisation, and fructification present many points of analogy with the corresponding processes in animals. Who can see without wonder the upspringing of the stamens to join the pistil in the berbery at the slightest touch? It is strangely suggestive of the reflex function in animals.

In all ages, poets, by the divine afflatus gifted beyond other men with true insight into the energies of the animated world, have been struck with the transforming force of gestation. Thus Browning, greatest of all poets in mental analysis, describes

> The strange and passionate precipitance
> Of maiden into motherhood,
> Which changes body and soul by Nature's law;
> So when the she-dove breeds, strange yearnings come
> For the unknown shelter by undreamed-of shores;
> And there is born a blood-pulse in her heart
> To fight if needs be, though with flap of wing,
> For the wool-flock or the fur-tuft, though a hawk
> Contest the prize.

Here the physician, the poet, the historian, the moralist, the jurist meet upon common ground.

The general character of the alterations in the nervous centres may be summed up as exalted tension. Like a highly charged battery, they respond more energetically to slighter provocation. We may pass by the manifestations of exalted psychical and emotional tension. The most striking and perhaps the most pertinent to our theme are the evidences of exalted diastaltic tension. This tension increases with the advance of pregnancy, reaching its climax when labour is due.

One of the earliest manifestations is seen in *the morning sickness*. This does the duty of a regulator or governor of nervous energy, not only letting off excess of energy that may have accumulated in its diastaltic centres, but reducing the tension of all the nervous centres. The woman is sensible of quick relief. Many women suffer from spasmodic twitches of the legs quite uncontrollable. In all women, the increased development of structure and activity of function taking place in the glandular system especially, and in the enormous work of nutrition going on in the uterus, consume a vast amount of nerve-energy. To keep up the supply, a little excess, a reserve is necessary. Under certain conditions this excess may not be readily controlled or used up in a healthy manner. Then it is apt to run in abnormal courses to waste, or to work mischief. The morning vomiting, and other apparent nervous aberrations, are conservative in their action, preventing serious disorders, taking off intolerable strain, perhaps averting convulsion, frequently averting abortion by diverting nervous energy from the uterus.

How is this great amount of nervous energy produced? Does it not imply a corresponding increase of nerve-tissue, greater development of the substance of the nervous centres? This hypothesis is supported by many facts. If a leg is amputated, the part of the spinal cord which supplied it with nervous energy shrinks. Every structure called into unwonted functional activity undergoes a physiological hypertrophy. The heart does this in pregnancy. It is therefore reasonable to suppose that the spinal cord does so too. That there is a remarkable development of new nerve-tissue in and about the uterus is now recognised as an anatomical fact. Physiologically this increase is an *à priori* necessity. The scales and the microscope will one day put this hypothesis to the test.

Changes in the blood necessarily attend the increased demands of nutrition to maintain and develop the organism *The blood-mass is notably increased.* This is especially observed in the second half of pregnancy. The newly-developed uterine sinuses contain a large quantity; and the arteries, veins, and capillaries generally are more distended, and there is in addition a development of new vessels or enlargement of old vessels in immediate relation with the pelvic viscera especially, but real also in relation with the abdominal viscera and glandular system.

The constitution of the blood is altered.—The original observations of Andral and Gavarret have been confirmed by Becquerel and Rodier, Regnault, and more lately by Nasse.[1]

These modifications consist in *increase of water.* In the non-gravida the proportion is 791 in 1,000, and in the gravid, according to Regnault, 817 in 1,000 in the two latter months; but it is marked much earlier.

The *red globules diminish* from the onset of gestation. The diminution is slight in the first five or six months, sometimes considerable towards the end of gestation. According to Andral and Gavarret, the proportion of globules in the non-gravida is 127 in 1,000; at the end of gestation it is only 104·9 in 1,000.

In some cases there is *increase of white globules*, a kind

[1] *Archiv für Gynäkologie*, 1876.

of normal leucocythemia. Becquerel and Rodier found the proportion of *albumen* in non-gravidæ 70·5 in 1,000; in the gravidæ, 66·1 in 1,000. Regnault gives similar results. Virchow describes this as a *physiological leucocytosis*.

Fibrin diminishes until about the sixth month. From that time *it rises*. Andral and Gavarret give the mean in non-gravidæ as 3 in 1,000, during the first six months of pregnancy as 2·5 in 1,000; and in the last three months as 4 or more—that is, above the physiological standard. It resembles the blood in inflammation. It 'cups' when drawn into a basin. Jacquemier affirmed that when the blood cupped there was fever. Robert Barnes is able to state that the blood of gravid women may 'cup' when there is no fever. Increase of fibrin remains some time after delivery. It is important to remember this in studying puerperal diseases, lest we take excess of fibrin as evidence of fever or inflammation.

Becquerel and Rodier say the *iron diminishes*.

The ordinary proportion is 0·541 in 1,000.
In pregnancy „ 0·449 in 1,000.

The general result is that we have in gravid women blood in greater volume, more watery, diluted, deficient in the more vital qualities, overcharged with excrementitious matters. Beau describes the condition as hydræmia, Andral attributes more importance to the diminution of globules. Caseaux likens it to chlorosis. It is a relative anæmia. Andral and Gavarret found the globules return after gestation.

Changes in the circulating organs.—Increased nervous energy, increased volume of blood, increased work of nutrition throw increased work upon the heart and vascular system generally. The fulness of the vessels taxes the heart to greater exertion. The momentum is increased, the heart beats more frequently. Larcher in 1857 made known from researches carried out in the Paris Maternity in 1826, 1827, on 130 women dying in pregnancy or shortly after labour, that the left ventricle of the heart became hypertrophied; its walls thickened by at least a fourth. The right ventricle and auricles were not affected. Ducrest, applying the test of measurement to 100 women, confirmed Larcher. Blot, applying the test of weight, found this increased by one-fifth, and that this increase is limited to the left venticle. He further established that this hypertrophy of the heart being normal, called into existence for a special and temporary duty, is resolved after labour like the hypertrophy of the uterus.

Joulin (1866) concluded that the hypertrophy of the heart coincides with increase of volume of the uterus, and that the return of the two organs to the ordinary physiological dimensions takes place simultaneously.

It is necessary to state that Löhlein, citing Friedreich, Virchow, Dusch, disputes the conclusion of the French authors. Robert Barnes having had opportunity of witnessing some of the observations made in Paris, and of making others in England, not without diffidence, when names so eminent stand in conflict, feels justified in affirming that he has almost invariably found the weight of the heart of women dying soon after labour to be an ounce or more in excess of the standard of eight or nine ounces.

De Cristoforis of Milan has made instructive observations on the effect of pressure in the gravida.[1]

The mechanical action of pregnancy causes hydraulic derangements in the circulation. He describes a *mechanical inferior venous hyperœmia*, the result of the pressure of the gravid uterus on the iliac veins; and a *superior arterial hyperœmia*, the result of the pressure upon the abdominal aorta at the bifurcation of the iliac arteries. This gives rise to an imperfect distribution of blood, in *minus* to the lower extremities, in *plus* to the upper parts. The passage of the blood downwards is impeded. A primary effect of this is hypertrophy of the heart, stimulated to stronger efforts to overcome the mechanical obstacle. He thinks this has more influence than the simple physiological nisus, which Larcher thought was the main cause. Other applications of this theory will be discussed under the description of the Diseases of Gestation.

The pressure-theory has been overstrained by others as well as by De Cristoforis; but it is certain that it exerts some influence upon the circulation. The sphygmograph, however, has given greater precision to our knowledge of this subject. It proves that high tension begins early in pregnancy, long

[1] *Annali Universali di Medicina*, 1867.

before the uterus is large enough to cause any appreciable pressure upon the aorta or iliac arteries.

The observations of Marey, Mahomed, Macdonald, Fancourt Barnes, and others, illustrate the history of high tension with sufficient completeness to prove that the hypertrophy of the heart and other conditions long attributed to pressure upon the vessels are accounted for in a different way.

In many women the normal sounds of the heart are changed Jacquemier found a *bruit-de-souffle in the last three months* feeble and variable, and disappearing after labour.

The *heart beats more quickly in the gravida as well as more forcibly.* The pulse is harder. That is, the arterial tension is greater. Hémey[1] takes 75 as the average pulse of a healthy woman. Before labour it is from 75 to 84. Blot and others have verified the fall of the pulse after labour.

The peripheral capillary vessels in every part of the body are fuller and more developed. The veins, deep and superficial, are more developed, especially in the great centres of developmental nisus, the pelvis and breasts. Veins scarcely visible before become prominent, on the legs sometimes forming varices, at the anus forming hæmorrhoids; in the vagina bulging, turgid, forming sometimes prominent masses, and giving the deep purple colour to the mucous membrane characteristic of gestation. Nævi materni become more vascular.

The lymphatic vessels and glands undergo enormous development. The important part taken by the lymphatics in nutrition is an indication of their importance in puerpery and in their relation to septicæmia.

The respiratory apparatus undergoes changes mainly through *mechanical pressure.* The growing uterus alters the form and capacity of the chest. Küchenmeister (1849), and Fabius afterwards, by spirometric observations found that the base of the thorax increases in width during the latter months. Their results are confirmed by Wintrich and Dohrn.[2] Dohrn found in most cases that the base of the thorax during gestation presents greater width, but a diminished antero-posterior diameter. After evacuation of the uterus this relation is reversed; the transverse diameter lessens, the antero-

[1] *Archives générales de Médecine.*

[2] *Monatsschr. f. Geburtskunde*, Bd. xxiv.

posterior increases. The circumference remains the same. The diaphragm is pushed up, so that the vertical diameter of the thorax, and therefore its total capacity, are lessened. Hence in the latter months of gestation, the respiratory movements become more frequent, less full. Dyspnœa is easily excited by exertion. This dyspnœa is exaggerated in cases of rickets, osteomalacia, or deviations of the spinal column, and in some cases of extreme enlargement of the uterus, as from twins or excess of liquor amnii; conditions which compel the uterus to encroach further on the thoracic cavity.

Respiration is relieved during a few days preceding labour, when the head descends into the pelvis.

Certain *chemical changes* are produced in the process of respiration. Andral and Gavarret proved that the exhalation of carbonic acid by the lungs was increased during gestation as it is at the menopause.

The liver presents important alterations. Tarnier, in 1857, thus sums up his observations:—The liver is increased in volume; the liver-tissue does not present a uniform colour; its substance is interspersed with small yellow spots, very numerous, which give it a granitic aspect. These spots seem to form so many jutting points, in size varying from that of a pin's head to that of a millet-seed. These spots are sometimes scattered; at other times gathered together, forming islets; lastly, in some points the agglomeration is such that there results a large 'plaque' or patch several centimetres in diameter. This aspect is not confined to the surface; it is also seen in sections in the thickness of the organ. There are found in this tissue hepatic cells well preserved, in the midst of which are very numerous droplets of fat.

Tarnier associates this condition with the glycosuria of pregnant women. De Sinéty thinks it is only developed with lactation, that it progresses with lactation and finishes with it. Certainly lactation and glycosuria are intimately related.

De Sinéty always found the fat abundant in the centre of the lobule of the liver, whilst it was absent or very rare in the periphery. This disposition is the reverse of what is observed in the fatty degenerations or infiltrations due to a pathological cause or to artificial fattening.

Robert Barnes' observations agree with Tarnier's, that this fatty change takes place in pregnancy. Dr. Ewart, at St. George's Hospital, has verified this change in several instances. Further observations to illustrate the condition of the liver in women who do not suckle would be interesting.

Glycose.—In 1856 Blot announced *physiological glycosuria.* He found it in nearly half the pregnant women examined. He said it continued during lactation. Kirsten[1] calls this frequency in doubt. Robert Barnes has observed it in a very marked degree in women when pregnant who showed no sign of illness, and who lost it after delivery and lactation. Dickinson has seen many cases of diabetes insipidus in gestation.

The urinary apparatus and its functions are always to some extent, often to a serious extent, affected. It is convenient to begin with the bladder, urethra, and meatus urinarius. From the fourth month the bladder is drawn up nearly above the brim of the pelvis, pushed forwards by the uterus. In this action the peritoneum is partly dragged off the bladder. During labour the stripping is still more marked. Thus there is often accumulation of urine in the hypogastric region. The urethra is dragged up, and the meatus is often hidden behind the pubes. These conditions are especially marked in the case of retroversion of the gravid womb. The surrounding tissues are often œdematous. In the early stages of gestation frequent micturition is observed in many cases, due to the pressure of the enlarging fundus uteri upon the bladder. This trouble is often felt towards the end of gestation. Rarely, retention of urine occurs from dragging of the urethra.

The kidney.—The close relations in function between the liver and kidney imply that the kidney will present changes not less important than its associated organ. Hyperæmia, even congestion, are frequent; increased epithelium formation, a minor degree of fatty change, are not uncommon. This is often attributed to pressure upon the renal vessels by the gravid uterus. The influence of this cause appears to us to be much exaggerated. The kidneys are so placed in the groove on either side of the lumbar vertebræ, that direct pressure upon them can hardly take place; they and their vessels are further protected by lying above the angle of divergence of the growing uterus

[1] *Monatsschr. für Geburtsk.* 1857.

from the spinal column; and pressure is further lessened by the intervening intestinal canal, whose convolutions, filled with air, act as a buffer or pad between the firm gravid uterus and the spinal column. The backward pressure of the uterus is never constant; it is always mitigated by its own elasticity, plasticity and by the yielding of the abdominal walls.

The urine is altered.—Chalvet and Barlemont (1870) studied this subject. The urine is mostly acid, sometimes neuter, rarely alkaline. The water is increased in proportion. At the commencement the solids are rather less. Chlorides, however, increase. Phosphates, sulphates, urea, uric acid, creatine and creatinine diminish. The diminution of phosphates, sulphates, and urea is especially remarkable; it had been noticed by Lehmann and Donné. These observers suggest that the elements in defect in the urine are used in constructing the child. Chalvet and Barlemont attribute increase of chlorides to disassimilation of the mother's tissues.

Kyestein.—Nauche (1831) first described this as peculiar to pregnancy. If freshly collected urine is put into a glass in a well-lighted and aired spot, the following things are observed: After three hours there appears on the surface an iridescent pellicle (the kyestein), at first thin but gradually thickening. Towards the fifth day this pellicle breaks up, from centre to circumference, into pieces which sink to the bottom, where they form a deposit. Other pellicles may succeed the kyestein. The pellicle is not formed by a special organic substance peculiar to pregnancy. It has been observed under many other circumstances. It consists of crystals of ammoniaco-magnesian phosphates, vibriones, and monads.

Lehmann says the urine of women contains more water, less salts, and less urea than that of men. These differences are especially marked in pregnancy. As watery urine becomes more easily alkaline than concentrated urine, the urine of women more easily undergoes this reaction. It owes to the mucus which it contains the property of effervescing at times and of being covered with a pellicle (of *kyestein*), consisting of ammoniaco-magnesian phosphate and cryptogamia, and which was formerly regarded as exclusively belonging to the urine of pregnant women. These results are confirmed by Parkes, who reminds us that kyestein was at one time supposed to be composed of casein, derived from the mammary gland. He adds, very similar appearances are found less frequently in the anæmic urine of non-gravid women, and sometimes in the urine of men.

Elisha K. Kane describes the characters of kyestein in like manner. The cheesy odour he found in only a small proportion of cases. He does not regard it as an unerring sign of gestation.

Braxton Hicks ('Guy's Reports') has investigated the subject with great care. His conclusions agree with those above cited. He has found kyestein in virgins.

We may in conclusion state that, assenting to the propositions of these authorities, we have seen several instances in which a confident diagnosis of pregnancy expressed on the evidence of this appearance proved to be correct. Whilst, therefore, it is unsafe to affirm gestation on this ground alone, it may be enough to direct the physician to search for further evidence in affirmation or negation.

Physiological albuminuria.—Lever (1843) and Sir James Simpson, a little later, signalised the association of convulsion in pregnant women with the presence of albumen in the urine. The occurrence of albumen in the urine seems to mark the borderland between physiology and pathology. When things go smoothly, the urine is not tested, and the possible presence of abnormal ingredients escapes recognition. When convulsions set in during gestation, the urine is straightway examined; and albumen in considerable quantity is almost constantly found. This almost constant association is so deeply impressed upon the medical mind that we are apt to stretch it to the absolute conclusion that as convulsion implies albuminuria, so albuminuria implies convulsion. Logically this does not follow; and clinically it is not true. The systematic examination of the urine of a number of cases has revealed the fact that in a certain proportion of women albumen was found in more or less notable quantity, who notwithstanding went through gestation and labour without accident. We must then admit that the presence of albumen in the urine may be simply the indication of a physiological difficulty; and that the escape of albumen by the kidney may be a natural means of relieving vascular tension. The important researches of Dr. Mahomed point to the conclusion that the appearance of albumen in the urine is the direct consequence of high arterial tension. He demonstrates a 'præ-albuminuric stage,' the premonitory indication of undue tension, which if continued or exalted is followed by albuminuria. Albuminuria is frequently due to blood-exudation from the bladder. This is here distinctly proved.

The great lesson to be borne in mind is that the appearance of unusual ingredients in the urine—as glucose or sugar, albumen or leucine—is the signal of transition from physiological to pathological processes, and should warn us to institute a thorough examination of all the organs and functions with a view to clinical action.

The glandular system undergoes remarkable development. The changes in the liver, kidney, and cutaneous glands have been noticed. The glands of the alimentary canal will be referred to in another part when treating of salivation and vomiting. We may here specially mention the thyroid. This is generally larger in females than in males. J. F. Meekel by a figure of speech regards the thyroid as the repetition of the uterus in the neck, referring to the swelling which the thyroid presents during menstruation and pregnancy. It is a familiar classical story that the effect of pregnancy, or in some cases of marriage, was noticed by the ancients. Thus Catullus in the 'Epithalamium':—

Non illam nutrix oriente revisens
Hesterno poterit collum circumdare filo.

The enlargement of the thyroid is now known to be dependent upon increased action of the heart.

The breasts anatomically belong to the system of skin-glands. But their more immediate relation to the work of reproduction makes them a special focus of activity. The changes wrought in them are specially described under the Signs and Diagnosis of Gestation.

The spleen exhibits similar conditions to those observed in the liver and kidney. It enlarges notably; sometimes remains permanently hypertrophied.

The digestive apparatus is affected mechanically and functionally. The rectum is compressed. Constipation is promoted; and this is not explained simply by pressure. The peristaltic action of the bowels is interfered with.

The small intestines are pushed backwards and upwards by the growing uterus, which keeps in front close to the abdominal wall. They undergo considerable compression, and in their turn press upon the stomach.

The mucous membranes and the intestinal glands become more vascular. The glands of the stomach especially are more developed, and are thus enabled to throw off large quantities of water, of which the vomiting of early pregnancy largely consists. This is a physiological act, one of the provisions for relieving high vascular and nervous tension.

A very common thing in pregnancy is increase of appetite. Absolute hunger, a sensation perhaps rare when not pregnant, is felt by some women even though they do not suffer from vomiting. They have to eat for two.

The appetite is often capricious. Things previously relished become distasteful. The 'longings' of pregnant women are notorious. There is no doubt an instinctive craving for certain things for which a physiological call might be found. Sometimes the 'longings' are of an insane character, as in the case of the woman who, craving her husband's flesh, killed him, and to prolong her enjoyment salted him down.

The **skin**, a tissue lying conspicuously open to objective study, presents several important changes. Under the distension of the abdomen the skin, overstretched, cracks and presents the appearance of scars. Often the abdominal skin not yielding fast enough, call is made upon the skin of the upper and outer part of the thighs, where similar cracks also occur. The significance of this change will be more particularly discussed under the 'Diagnosis of Past Pregnancy.'

A remarkable phenomenon is *pigmentation*. In this singular process the peculiar state and action of the nervous and circulating systems and the blood are most remarkably manifested. Concerning this little precise knowledge has been gained. It lies open as a fertile field of study. A thorough investigation of the conditions under which pigmentation is produced in pregnancy could not fail to repay the trouble, and would probably lead to the solution of other physiological and pathological problems. Some illustrations are collected in Robert Barnes's memoir.[1] The *melasma* of the face, abdomen, and

[1] *On Pregnancy and General Pathology*, *Amer. Gynec. Trans.* vol. i.

breasts during pregnancy is the most familiar. It occurs also in some cases of ovarian disease. Sometimes in cases of functional disorder of the reproductive organs. Under normal and difficult menstruation it is observed. Le Cat refers to a case in which the left leg became black during each pregnancy. The mammæ of the Samoyed women are black. Dr. Latham, who notices this, thinks it may be due to a peculiar mode of sexual excitation. Amongst the several forms the most common is discoloration of the eyelids. There are two varieties: one in which there is simply a pigmentary deposit in the epidermic scales, like the ordinary swarthiness; and another, in which there is a deposit of free pigment on the skin, so that it can be wiped off. This latter is the true *Stearrhœa nigricans*.

Discoloration of the eyelids during menstruation is not necessarily due to pigment. In some cases it is due to a sort of venous lividity. This lividity differs, however, so much that there is probably pigment in the blood, but not deposited in the epidermic cells. Permanent or chronic blepharal melasma is seen in women with chlorosis or melancholia. In some cases, brown specks on the forehead, eyebrows, nose, and upper lip, produce a characteristic effect described as the 'Mask of Gestation.' An example of blue discoloration, *Stearrhœa cerulea*, is recorded in a pregnant woman by Büchner.

Laycock says this production of pigments may be looked upon from three points of view—(1) as the result of imperfect oxidation of carbon, so that it is not eliminated as carbonic acid, lactic acid, hæmaphein, &c.; (2) as the result of imperfect elimination of carbon proper, where that is the normal excretion, as in the hair and epidermic scales; (3) as the result of excess in the production of carbon from highly carbonaceous foods. In all there is a close analogy between the carbonaceous excreta as morbid pigments and the nitrogenous excreta as morbid pigments, and the nitrogenous excreta as morbid deposits of urates, &c. As to the first, it is obvious that all modifications in the blood-corpuscles which impair their functions as oxygen-carriers will favour imperfect oxidation of the carbon waste. Thus we can understand how carbon may be substituted for carbonic acid and lactic acid in leukæmia, leucocytosis, the anæmia of chlorosis, Bright's disease, and all cachectic states in which the blood-corpuscles are defective in oxygenating power. These are conditions closely represented in pregnancy.

In many cases, if not in all, the nervous system is closely concerned. Lister says, 'the cerebro-spinal axis is chiefly concerned in regulating the function of the pigment-cells.' It is extremely interesting to note that the pigmentation is often limited to areas more or less sharply defined. A singular example is figured in the 'Obstetrical Transactions, 1875,' by Dr. Godson. A girl, seven months pregnant, had chorea. She exhibited a characteristic dark pigmentation of the areolæ of both breasts, leaving an area of about one-third perfectly clear. This free area was almost exactly symmetrical, and sharply limited. It is inconceivable that any difference in the quality of the blood going to the part could exist. We can but conclude that this partial pigmentation was determined by nerve-distribution.

The discovery of Addison and the experiments of Brown-Séquard go to show that the supra-renal capsules play an important part in pigmentation.

Wilks observed[1] that in Addison's disease the pigmentation was more marked at the nipples, the navel, and the scrotum. These and other cognate facts lead us to conjecture that in pregnancy the supra-renal capsules, like other organs and tissues, undergo a special modification; that this modification also is transitory, and in harmony with the changes observed in other organs. It is curious to remark how rapidly and completely sometimes the dark pigmentation arising during pregnancy disappears after delivery.

It is certainly desirable that the supra-renal capsules should be examined in women dying during gestation and childbed.

Nævi become more vascular, turgid, and deeper coloured. This is due to the general increase of development of the capillaries. It is closely associated with the process of pigmentation. The *sebaceous, sudoriparous glands, and hair-follicles* often exhibit increased activity. The fuller peripheral circulation and greater vascular tension may account for this. We have observed that some women who had been losing

[1] *Guy's Hospital Reports*, 1859.

hair when not pregnant found its growth restored during gestation, and fall off again after labour.

The **osseous system** undergoes changes which, if not always evident, are rarely absent altogether. Under the combined influences of changes in the constitution of the blood, in the dynamics of the circulation, and in nutrition, softening of the pelvic joints takes place.

This subject is more fully discussed in the description of the Structure and Behaviour of the Pelvis.

The incurvation of the spine is increased. To maintain the equilibrium in the erect posture the woman throws the shoulders back, and so the anterior curve is increased.

Osteophytes.—Rokitansky in 1838, Ducrest in 1844, at the Paris Maternité, observed *osseous neoplasms or osteophytes*, or a tissue resembling bone outside the dura mater, between it and the inner table of the cranium. They both believe these formations to be independent of pathological causes. They found them in more than one-third of the cases. Alexis Moreau, in 1844, examined ninety-eight women dying in childbed at the Maternité; forty-two presented osseous concretions. He did not find them elsewhere than in the cranium. On the other hand, Virchow found similar concretions in phthisical subjects. Kühn analysed them and found them richer in lime and carbonic acid, poorer in phosphates and animal matter than the cranial bones. These concretions suggest the hypothesis that they are a part of the excess of ossific material prepared for the building up of the fœtal skeleton. Robert Barnes called attention to their relation to the calcareous degeneration of the placenta. They have also probably some relation to the preparation of milk, in which fluid a considerable proportion of calcareous elements exists.

Wallmann ('Virchow's Arch.' 1858) has frequently observed osteophytes on the inner surface of the cranium in subjects from ten to seventy-five years of age in different forms of disease. He confirms Virchow's statement that they are not less common after other disaases than in gestation. He says, nevertheless, that he almost invariably found them in puerperæ. The next most frequent relations are tuberculosis, chronic hydrocephalus, secondary syphilis.

The **body-weight** undergoes remarkable changes. These have been studied by Gassner.[1]

The results are so interesting that they deserve full analysis; and although many of the applications will more properly be discussed in the history of the diseases of pregnancy and childbed, it will be useful to give here a connected summary of them.

1. The pregnant woman gained in weight during the last two months, 1·5 to 2 kilogrammes.

2. She lost weight 2 to 3 kilogrammes within eight to fourteen days after the death of the embryo. In one instance, death of the fœtus was diagnosed through the loss of weight. Whence this increase? What are the factors of the increase?

	Kilog.	Of liq. amnii
We estimate the increase of child in 8th month	0·50	0·375
" " " 9th "	0·75	0·25
" " " 10th "	0·75	0·25

The placenta gains in the three latter months about 0·084 kilogramme. Thus the ovum gains about 1 kilogramme in each of these three months.

THE MEAN WEIGHT OF THE PREGNANT WOMAN.

At the end of tenth month.		At end of normal labour.		Of puerpera of seven or eight days.	
Cases	Kilog.	Cases	Kilog.	Cases	Kilog.
242	62·8	190	56·25	269	51·45

The loss of weight from normal labour is 10·45 per cent. The ovum is the chief factor in this loss. Its average weight is 5·76 kilogrammes, consisting of

Child	3·283 kilog.
Liquor amnii	1·877 "
Placenta	0·600 "

There is a further loss of blood, 0·250 kilogramme; of excrement, 0·404 kilogramme; of transpiration by lungs and skin, 0·150 kilogramme.

He further arrived at the following general facts: the larger the child, the larger the placenta and the more the liquor amnii.

The child of a primipara weighs on an average 0·104 kilogramme less than the child of a pluripara, and in accordance the

[1] 'Ueber die Veränderungen des Körpergewichtes bei Schwangeren, Gebärenden und Wöchnerinnen.'—*Monatsschr. f. Geburtskunde*, 1862.

liquor amnii and the placenta of a primipara weigh less than in the pluripara.

The uterus of a primipara is poorer in muscle. He connects this relative poverty of muscle with the duration of labour. The mean duration of labour in 110 pluriparæ was 10·40 hours; in 110 primiparæ, 15·52 hours.

He found a constant increase of liquor amnii with cross-births.

Loss of weight after normal labour.

From secretions and excretions and diminished diet a woman of average weight of 56·25 kilos. loses in 172·43 hours (238 cases) 4·575 kilos.; so that the loss is as 1 : 12·305, or about 8 per cent. The factors are—Lochia and milk, increased urine from resorption of œdema of legs, lung and skin exhalations, fæces, involution of outer and inner genitals.

In connection with body-weight we may study that phase of nutrition which relates to *fat*. It is a general rule that pregnant women lose fat. Waste of this element is more especially seen in the face: the features grow thinner and sharper. This is more marked in women who suffer much from vomiting. The deficiency of ordinary food is to some extent compensated by the absorption of fat. If a healthy woman, in whom menstruation is suspended, is seen to grow thin, it may be presumed that she is pregnant. On the other hand, many fat women show but little difference in adiposity during pregnancy. When married women quickly grow fat the probability is that they will remain sterile. Kiwisch[1] has never observed a general increase of fat in pregnancy. He says the waste of fat is observed in the floor of the perinæum, the abdominal walls, and thighs. We, however, know some women who improve generally in nutrition and fat when pregnant.

The changes wrought in the body generally and the non-sexual organs having been described, those which affect the genital apparatus have now to be traced.

Modifications of the uterus.—The uterus undergoes changes of volume, capacity, weight, form, situation, direction, relations.

Increase of volume.—The neck of the uterus is not remarkably changed until the latter months of gestation. This change will be described hereafter. The mucous membrane

[1] *Beiträge*, 1848.

and the cervical glands partake of the general increase of vascularity. Lott says it undergoes true hypertrophy. The glands are enlarged and secrete more actively. They throw out the viscid albumen-looking mucus which fills the cervix, known as the mucous plug. The bulk of the cervix is somewhat increased—it becomes thicker. It may be here noted that the mucous membrane of the neck, unlike that of the body, does not fall at the time of labour. It is not deciduous. After the expulsion of the mucous membrane of the body of the uterus there remains at the point of separation a more or less prominent ring.

The body of the uterus undergoes the most marvellous transformation. Levret measured the virgin uterus and found its surface presented 16 square inches, whilst the uterus at term gives 339 square inches, that is, it is multiplied twenty-one times. This increase of volume depends upon two causes acting together—passive distension and hypertrophy of its walls. The distension is in proportion to the development of the ovum, and takes the chief part in the increase of volume. Thus, as soon as the ovum is expelled the uterus retracts, and loses the greater part of the increase of volume acquired during gestation.

True hypertrophy also takes place, since the uterus, retracted as described, weighs considerably more than in the non-gravid state. In order to regain the condition of the non-gravid state a further process of absorption of the excess of tissue, known as *involution*, must be carried out. Hypertrophy takes place under the influence of gestation alone, as when the gestation has its seat outside the uterus, or in one horn of a two-horned uterus. The empty uterus also grows.

The uterus grows with the advance of gestation. Arthur Farre gives the following table:—

TABLE SHOWING RATE OF INCREASE IN SIZE OF UTERUS ACCORDING TO MONTHS OF GRAVIDITY.

	Length		Breadth	
	Inches	Millim.	Inches	Millim.
End of 3 months . . .	4½–5	113–126	4	101
" 4 " . . .	5½–6	138–151	5	126
" 5 " . . .	6–7	151–176	5½	139
" 6 " . . .	8–9	201–226	6½	164
" 7 " . . .	10	252	7½	189
" 8 " . . .	11	277	8	202
" 9 " . . .	12	302	9	227

Capacity.—Simpson estimated the capacity of the uterus of the multipara before impregnation at 2 to 3 cubic cm., and at 6 to 8 cubic litres at term; but Tarnier says this is exaggerated, the mean being 4 or 5 litres. The dilatation varies with the size of the child, and in the case of twins, and excess of liquor amnii.

Weight.—At term the uterus and ovum weigh from 6 to 7 kilos.; before impregnation the weight in nulliparæ is 42 grammes, and 55 in multiparæ. After labour and expulsion of the placenta, the weight of the uterus with its appendages is, according to Naegelé, from 750 to 1,000 grammes. Tarnier places it higher, that is, at from 900 to 1,200 or 1,500. It thus becomes twenty times heavier under gestation. Thus the increase of weight is in direct ratio with the increase in volume.

Form.—Different parts of the uterus are developed successively. At first, the anterior and posterior surfaces lying in contact before conception, part. The cavity, at first potential rather than actual, is triangular. The uterus then becomes pyriform, but always remains somewhat flattened antero-posteriorly. At the third month it is spheroidal.[1] Then the fundus becomes more arched, and is the principal seat of development, the lower third or segment remaining but little changed.

In the latter three months the lower segment is developed. Sometimes one side of the fundus is more developed than the other, presenting a perceptible out-bulging to palpation. This may be due to the more prominent side lodging the larger part of the fœtus, so that there may be felt a depression or groove between the two angles of the uterus. When twins exist a groove may also be observed at the fundus.

At the end of gestation the inferior segment plunges into the pelvic cavity, whilst the upper two-thirds or three-fourths rises into the abdomen. At this time the uterine walls are plastic enough to mould themselves on the sacrum and vertebral column, thus forming at the level of the promontory a marked retreating angle. Sometimes, as in pluriparæ whose abdominal walls offer little resistance, the fundus falls forwards

[1] See Bandl's fig. further on.

over the symphysis, and then the uterus forms a retreating angle or curve on the anterior surface.

Depaul further draws attention to the irregular development of the two sides of the uterus. It is rare to find the two tubes at the same level.

Usually the posterior wall grows in its upper two-thirds more than the anterior wall. Thus it will be seen that the insertion of the tubes is no longer situated at the union of the anterior and posterior halves of the uterus, but much more forward—that is, two-thirds of the uterus will be behind the seat of insertion. The contrary takes place in the inferior segment, which is more developed before than behind. This circumstance explains why the neck appears so strongly deviated backwards, making it difficult to reach at the end of gestation, and why the head engaging in the cavity is usually capped by the anterior wall of the lower segment (the anterior uterine valve of Robert Barnes).

Situation.—The changes of situation are worthy of note. They will be traced in the description of the diagnosis of gestation. We may here observe that in the latter months the uterus, especially in pluriparæ with lax abdominal walls, is different in the dorsal decubitus and in the upright posture. In the first posture the fundus falls back nearer to the spinal column, so that the whole organ forms a curve around the sacral promontory; whereas, in the upright posture, the fundus, falling forwards, quits the spine, bulges out the belly, and its axis straightens.

The projecting spinal column naturally throws the body of the uterus to one or other side, so that there is lateral obliquity. Dubois found that of 100 women the uterus was in the median line in 20, and inclining to the left in 4, to the right in 66. Many explanations of the more frequent right obliquity have been given. None appear to be conclusive.

Rotation.—The uterus commonly is turned a little on its axis, so that the anterior face looks to the right and the posterior face looks to the left and backwards. Tarnier points out that it is due to the left lateral border being thus brought more forward that the uterine souffle is more frequently heard on the left side. In opening the abdomen in Cæsarian section this rotation has to be corrected in order to bring the median line of the uterus into relation with the abdominal incision.

Relations.—At term the anterior surface of the uterus rests by its upper three-fourths against the abdominal wall: sometimes a bit of omentum or intestine slips down between. This must be guarded against when practising Cæsarian section. In its lower fourth the anterior surface of the uterus is applied to the posterior surface of the bladder to an extent varying with the size of the bladder. When empty the bladder falls behind the symphysis; when full it rises in front of the uterus, forming a large fluctuating tumour. Quite below, the anterior aspect of the uterus is in relation with the vagina.

The posterior aspect is in relation below with the rectum, sacrum, sacro-vertebral angle, and less closely with the common iliac vessels and the first branches of the sacral nerves; above, with the vertebral column, aorta, vena cava inferior, the pillars of the diaphragm, the mesentery, and the lower part of the ilium. Often some intestinal folds get between the vertebral column and the upper half of the uterus.

The upper border or fundus answers to the transverse colon, the greater curve of the stomach, the anterior edge of the liver, and it even lifts up the xiphoid cartilage and the lower false ribs, pushing them outwards.

The lateral borders are in relation, below, with the internal and external iliac vessels, the obturator nerves, and the psoas-iliacal muscles. Above, the right lateral border is in relation with the cæcum and ascending colon; the left lateral border with the sigmoid flexure, the descending colon, and a great part of the small intestine, which runs to the upper left side of the abdomen in consequence of the usual inclination of the uterus to the right. The lower extremity of the uterus projects into the vagina, and is applied in front to the bladder, behind to the rectum.

Thickness of the uterine walls.—The uterus enlarging partly by distension, yielding to the growth of the fœtus, is *thinned*—that is, the thickness of the wall of the uterus at term is generally somewhat less than that of the non-gravid uterus. Hence the parts of the fœtus are often felt with great distinctness on palpation. Sometimes it is barely 9 mm. thick at the part to which the placenta adheres, and only 2 mm. in other parts. The thinning is not uniform; thus, at the fundus and posterior wall, Smellie and Hunter noted special thinning. The thinning, however, varies in individuals: we believe it is less marked in multiparæ.

Consistency.—When empty, the uterine walls are firm, resisting like fibrous tissue. During gestation this firmness diminishes; the walls become soft and elastic, giving to the fingers a sensation resembling that felt on pressing upon a band of india-rubber. This suppleness explains how it is that the walls can mould themselves upon the fœtal parts, the spontaneous movements of which produce bumps, which sink again before the eye.

The *changes undergone by the mucous membrane of the uterus* have been described in the chapters on Embryology.

The musculature of the gravid uterus.—The muscular coat is formed of organic muscular fibres. Scarcely traceable during the non-gravid state, they become evident, 'colossal,' during gestation. Fig. 74 shows the nucleated fibres of the non-gravid uterus and the granular matrix in which they are imbedded. During gestation these fibres grow in all their dimensions, and new fibres are formed, especially in the innermost layers of the middle coat. The production of new muscular fibres, says Kölliker, is chiefly seen during the first half of gestation. The extraordinary increase of size of the uterus under gravidity is chiefly due to the development of its muscular element. Kölliker has not observed the generation of muscular fibres after the sixth month. Corresponding with the growth of the muscular fibres, there is growth of the connective tissue which binds them together.

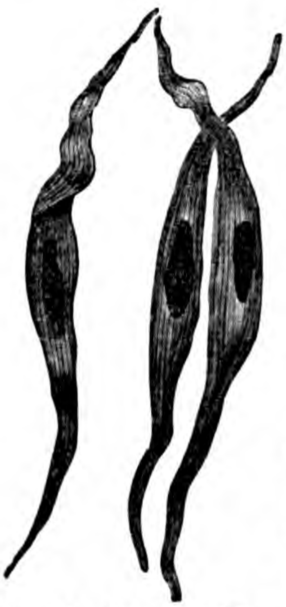


FIG. 74.—Muscular Fibres of Uterus during gestation. (After Wagner.)

Ranvier says the muscular fibres not only grow, but they become towards the end of gestation striated, in a less marked degree, however, than in the proper striated muscles.

The hypertrophy of the muscular coat is very marked in the body of the uterus; less marked in the lower third, and scarcely appreciable on the neck, the fibres of which, although redder, scarcely increase in size. After labour these giant muscular fibres have to be disposed of. The uterus contracting permanently, the blood-supply attracted by the gestation-process is turned off, and the muscular fibres having accomplished their function pass into fatty degeneration. This process is the preparation for dissolution and absorption. Fig. 75 represents this granular conversion. The exact time required for the completion of involution is not certain. But

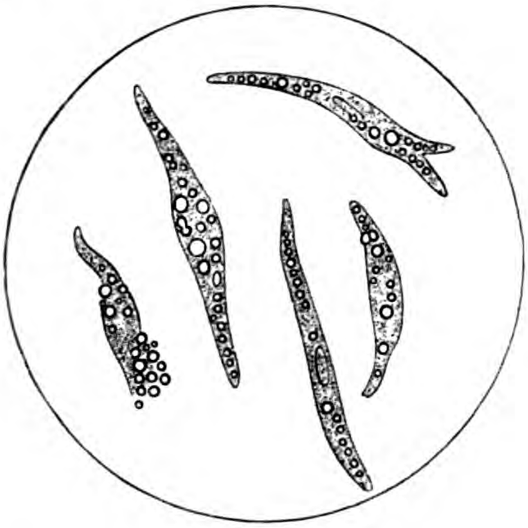


FIG. 75.—Showing fatty degeneration of muscular fibres during involution after labour.

since a new pregnancy may begin within two months, the uterus is probably reconstituted in less than that time.

The *disposition of the muscular fasciculi* is so intricate as to have led to much diversity of description. The admirable researches of Hélie seem to have unravelled this complex piece of anatomy, and to have corrected and harmonised the descriptions of his predecessors.

Three layers constitute the muscular tissue. But fibres of one layer pass into the other coats, forming a network binding all the layers together.

1. *The external layer of the body of the uterus* is composed of several planes of longitudinal and transverse fibres alternating with each other. The most superficial plane is longitudinal; it is formed of a median band (Sue, 1753); the

middle part of this is curved loop-like over the fundus of the uterus, whilst its two ends descend, one over the anterior surface, the other over the posterior surface. It descends lower in front than behind. Behind it begins at the junction of the body and neck; it is formed below of transverse fibres, which, uniting, ascend vertically. As it ascends fresh fibres run into it from the sides. When it approaches the fundus, its lateral fibres curve outwards, and are directed over the Fallopian tubes and broad ligaments, in which they are lost.

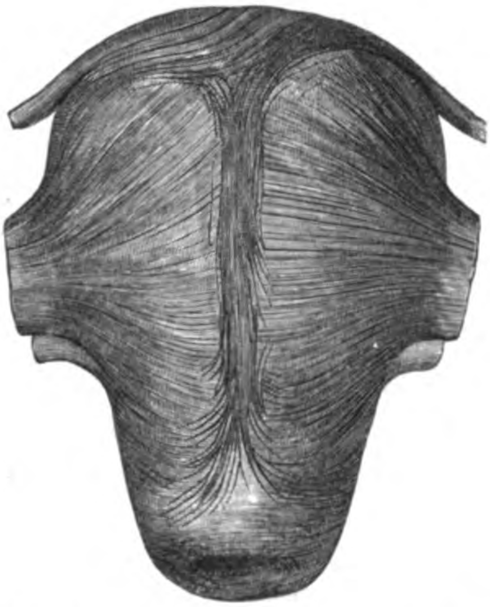


FIG. 76.—External muscular coat, anterior aspect. (After Hélie.)

This arrangement is seen in fig. 76, which shows the anterior surface. The posterior surface is similar, but the central band does not descend so low (fig. 77).

The middle fibres of the loop-like band alone turn over the fundus of the uterus. Some of the fibres from each side cross to the opposite side; but this is only partial, and is not constant.

This loop-like bundle is composed of two planes, separated by a layer of transverse fibres.

Next we have to study the transverse fibres, which, with the bundle just described, form the surface of the body of the uterus. These fibres (Sue, 1768) constitute the greater part of the external layer. Some help to form the loop-bundle;

but most of them run transversely across the median line beneath the loop and between its planes; they are prolonged outwardly into the broad ligaments, and especially into the ligaments of the ovary, the round ligament, and the Fallopian tube.

If we trace the fibres in the opposite direction, they may be said to arise from all the above points, and leaving the side of the uterus, they part into two laminæ, one of which passes over the posterior aspect, the other over the anterior aspect. Thus

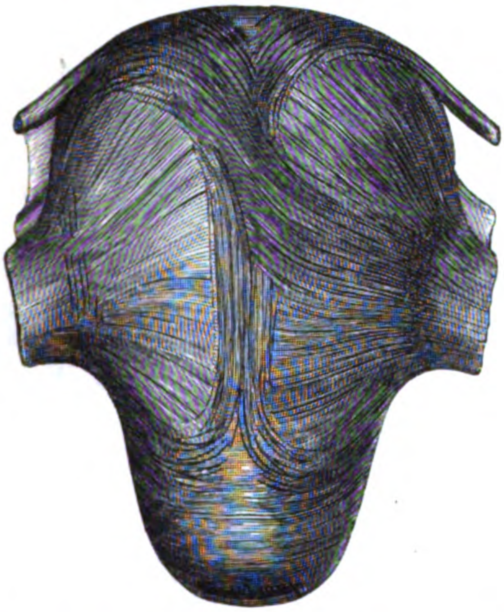


FIG. 77.—External layer, posterior surface. (After Hélie.)

the uterus is embraced between two sheets of muscular tissue, running from the broad and other ligaments.

Fig. 78 shows the second or deeper plane. At the side of the uterus the transverse fibres are seen to pass on forming horizontal *circular* muscles. The course of these fibres is, however, very complicated. They diverge to let vessels pass; fibres, at first superficial, plunge deep.

Above the tubes and at their level, the disposition of the fibres is different. The transverse fibres describe large arches over the fundus. Some go to the tubes, round and broad ligaments, but the greater part descend along the side of the uterus. In their course they meet vessels which interfere with their regularity; then they plunge deeply, curving forwards or backwards to become transverse on one or other aspect of the uterus.

2. *External layer of the cervix.*—The hypertrophy is much less marked, the course is more simple. The fibres nearly all run a little obliquely downwards from the sides of the uterus towards the median line, where they cross the fibres from the opposite side. On the sides of the neck they turn round and pass from one aspect to the other. The most superficial are continued in front, with the vesico-uterine folds; behind,

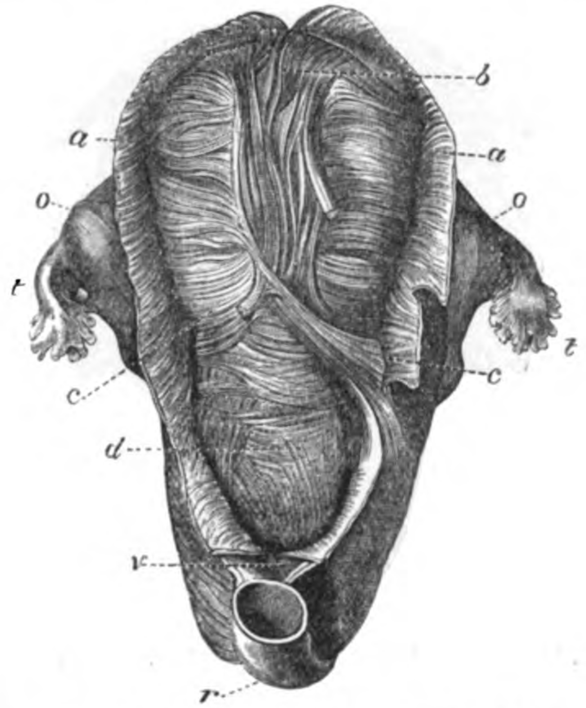


FIG. 78.—Posterior surface, middle layer. (Hélie.)

a, a. Superficial transverse fibres thrown back. *b.* Loop-like fibres, continuous with *c,* the transverse. *d.* Fibres of neck. *o, o.* Ovaries. *r.* Rectum. *v.* Bladder. *t, t.* Tubes.

with the recto-uterine ligaments; below, with the fibres of the vagina.

3. *The middle muscular layer* is the thickest of all; but it only exists at the level of the body. There is no trace of it in the neck. It is distinguished by the great number of vessels it contains; and it is especially thick in the region which corresponds to the placenta. When the outer layers are dissected off it is seen that many of the fibres of these layers merge into the middle layer, there being no distinct demarcation

between external and middle. It is composed of bands of variable size, which cross in all directions. Some are transverse, some oblique, some longitudinal; large apertures divide these bands from each other or the fibres of the same band. The muscular fibres coil round the uterine veins—the arciform fibres of W. Hunter (1772), and each loop crossed by another forms a complete ring surrounding the vein. A series of these rings forms a canal for the vein. Large rings like these surround several veins at once. Thus every vein is surrounded

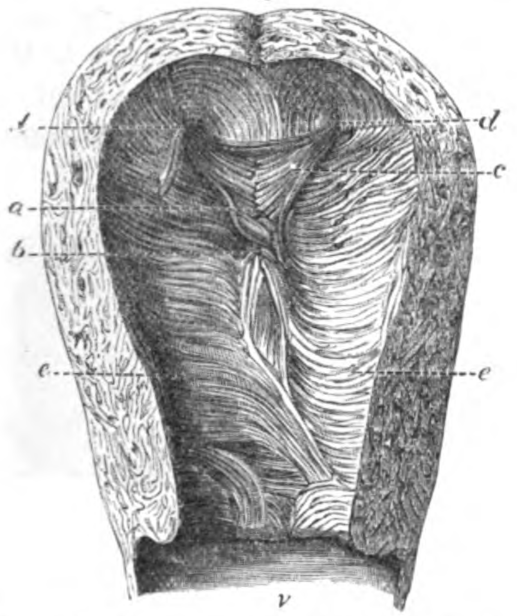


FIG. 79.—Internal muscular layer. (Hélie.)

a. Section of uterine wall. b. Triangular bundle. c. Fibres running to the tubes. d, d. Orifices of tubes. e, e. Transverse fibres. v. Vagina.

by annular contractile rings, and runs its course in a true contractile channel in the middle layer. This disposition is seen in fig. 80.

The arteries, like the veins, are surrounded by muscular rings; but the arteries are provided with a cellular sheath, which allows them to glide in the rings, whilst the veins reduced to their inner coat adhere to the muscular fibres. The contractile rings not only close the vessels, preventing hæmorrhage, but serve to some extent the office of valves.

4. *The internal muscular layer in the body of the uterus.*—When the uterus is opened there is always seen in the middle

of the posterior wall a slightly raised triangular bundle, whose base extends from one tube to the other, and whose apex descends to the os internum of the neck. This is seen in fig. 79. This was described by Charles Bell. Near the tubal openings this triangular bundle divides into two thin fasciculi, which plunge on either side into the tube (fig. 79 *c*, *d*). Transverse fibres, stretching directly across from one tubal orifice to the other, complete the triangle and form its base. A precisely similar triangle is found upon the anterior wall.

On the sides of these triangles, along the entire length of the body of the uterus, the muscular fibres of the inner layer run transversely, passing from one aspect to the other; they are therefore annular. At the os internum the transverse fibres form a ring-like bundle, which distinctly defines the

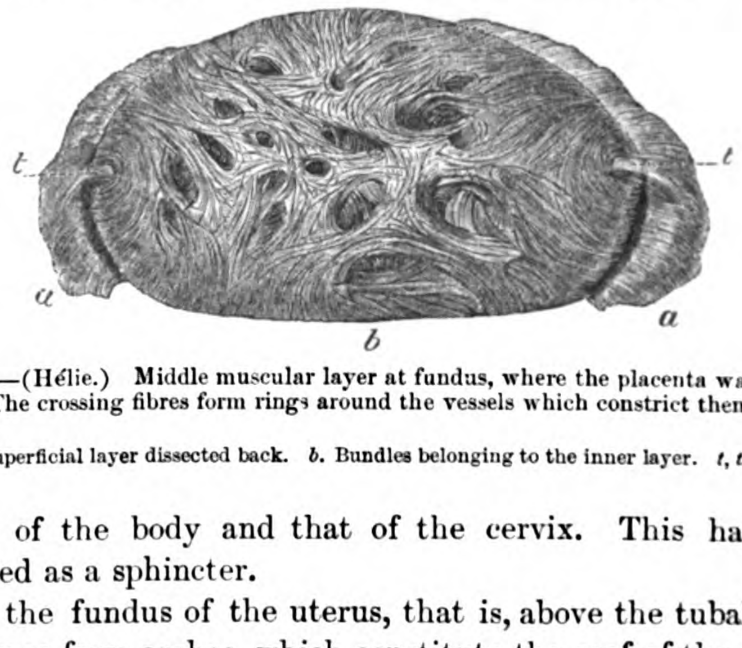


FIG. 80.—(Hélie.) Middle muscular layer at fundus, where the placenta was seated. The crossing fibres form rings around the vessels which constrict them.

a, *a*. Superficial layer dissected back. *b*. Bundles belonging to the inner layer. *t*, *t*. Tubes.

cavity of the body and that of the cervix. This has been regarded as a sphincter.

At the fundus of the uterus, that is, above the tubal opening, fibres form arches, which constitute the roof of the uterus. Descending in front and behind, these fibres pass under the transverse band of the triangular bundle; there they bend to be lost in the horizontal fibres.

At the orifice of the tubes the fibres are arranged in concentric circles. One was described by Ruysch. Charles Bell recognised the two. Calza (1807) called them the *orbicular muscles of the tubes*. (See fig. 79.) The mode in which the vessels are encircled by muscular fibres is well demonstrated in fig. 80.

Briefly the musculature of the uterus may be stated thus: 1. The texture is different in the body and in the neck. 2. In the body are found three layers: the *external*, with its loop-like bundle, its transverse fibres, whose ends are prolonged over the adnexa of the uterus, and its circular fibres; the *middle layer*, with its muscular bands, which describe loops and imperfect rings around the uterine vessels; the *inner layer*, with its two triangular bundles, its annular fibres around the tubal mouth. 3. At the *neck* there is the comparatively simple

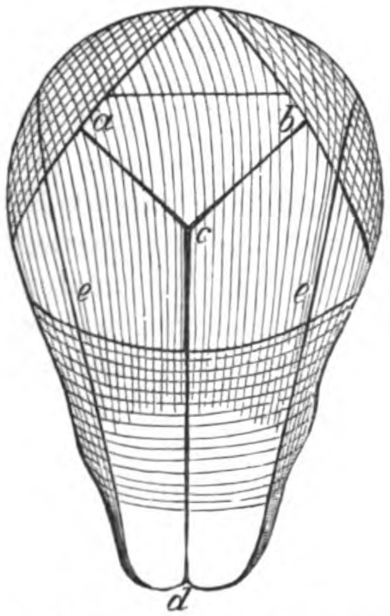


FIG. 81.—(Modified from Murphy), to represent actions of uterine musculature.

The muscles of the fundus at *a* and *b*, shortening concentrically, diminish the cavity towards *c*, and the resultant force aided by the longitudinal fibres, thus tend to drive the fœtus downwards; the longitudinal fibres at the same time pull the cervix upwards upon the presenting part. The circular muscles open like a sphincter before the down-driven head; they contract as a sphincter when the cavity is emptied.

arrangement, two layers only being seen, which are continuous above with the external and internal layers of the body of the uterus. The fibres of the neck are mostly annular. The vaginal-portion is almost entirely formed of the internal layer.

Action of the muscular wall.—Charles Bell says—(1) there is a general prevalence of longitudinal fibres, the action of which would be to shorten the uterus, pull up the lower segment, and thus to expel the fœtus; (2) whilst the orbicular muscles of Ruysch, contracting concentrically, would lessen the area of the uterus, and thus cast off the placenta. (3) The ring-like arrangement of fibres around the vessels would act as ligatures and stop bleeding.

Dubois and Jacquemier insist that the muscular tissues of the uterus being divided into three layers, it is between the middle and external layers, or at most in the middle layer, that the sinuses are found. Deprived of valves, these sinuses communicate so freely that they form a sort of cavernous organ in the uterus. In the neighbourhood of the placenta many of these canals approach the internal layer; some even are separated from the mucous membrane only by a very thin stratum of muscular tissue.

Cruveilhier, by throwing injections into the vena portæ or the pelvic veins, proved that the pelvic, hæmorrhoidal, internal pudic, and gluteal veins anastomose freely.

Chowne, also injecting the vena portæ, found the injection escape into the uterine cavity. This anatomical disposition and Chowne's experiments explain the occurrence of venous or retrograde hæmorrhage from the uterus when its muscular coat is in a state of inertia.

The *peritoneal coat* of the uterus, and its *mucous membrane* have been already described.

The Behaviour of the Lower Segment of the Uterus and the Cervix during Gestation and Labour.

Levret and Baudelocque supposed that during the first four or five months of gestation the uterus was developed at the expense of its fundus and body; and that thenceforward the neck opening out from above downwards contributed to the enlargement of the uterine cavity. It was supposed that the fibres of the body contracting dragged upon the fibres of the neck, the rings of which opened successively from above downwards until nothing remained but the lower orifice; then labour would begin.

Roederer (1753) set forth the same doctrine as Levret. The elder Stein, Roederer's pupil, admitted simply a shortening of the cervix, not its opening.

Kilian (1839) contested this doctrine, and thought that the shortening was produced by swelling and thickening of the vaginal-portion. He allowed that the cervix remained unaltered until the last four to five weeks of gestation, but that from that time it shortened from above. F. H. G. Birnbaum (1841) supported the views of his teacher (Kilian).

Stoltz (1826) went further still, and taught that the neck did not change in length throughout the course of gestation, unless during the last fourteen days. Caseaux, Scanzoni, Duncan, J. E. Taylor, Holst, Spiegelberg, P. Müller, Lott, and others adopted Stoltz's doctrine. Latterly Bandl,[1] A. Martin (1877), and W. Braune,[2] have shown grounds for rehabilitating in a modified form the old doctrine.

FIG. 82.—The cervix uteri of a primigravida at four months. ½ size *ad nat.* (Robert Barnes.) The constriction at the anterior lip of the os externum is due to a ligature placed to practise injection. This was done by Samuel Lane.

To explain the familiar fact of the lessening projection or flattening down of the vaginal-portion towards the end of pregnancy, the advocates of the doctrine that the cervix remains unchanged have put forth many inconsistent theories. As Bandl says, these many explanations are sufficient to prove that the natural process of the opening of the uterus was but little known to them.

During the first four months of gestation the cervix undergoes little change. This is demonstrated in fig. 84, drawn from the uterus of a woman who died in the fourth month of her second gestation, and still more clearly in fig. 82, drawn from nature by Robert Barnes. This exhibits the lower segment and cervix uteri of a young woman who died by poison when about four months advanced in her first pregnancy. In this specimen the cervix is perfect; the os internum forms a sharp boundary between the body of the uterus and the cervical canal. The decidua is seen dissected up down to the edge of

[1] *Ueber das Verhalten des Uterus und Cervix in der Schwangerschaft und während der Geburt*, 1876.

[2] *Die Lage des Uterus und Fœtus am Ende der Schwangerschaft*, 1872.

the os internum. Bandl, however, says that even at this epoch the lower segment of the uterus (Barnes's cervical zone) begins to be marked out from the body. In fig. 84 the part between *a b* and *b′ a′* is distinctly thinner and different in structure from the body of the uterus above. This will later become developed into a well-defined lower segment, as seen in the section (fig. 83) of a uterus from a subject dying in the eighth month upon whom Cæsarian section was performed *post mortem*. Comparing this specimen with fig. 84, the part *b a* is clearly distinguished from the body above *a*, by three features: (1) it is thinner; (2) the muscular structure is less marked; (3) it is less rich in vessels. The external layer of muscular fibres of the uterus is hardly traced below the level of the insertion of the vagina; the vaginal-portion shows only the inner muscular layer. This lower segment is divided from the body by a more or less well-marked ridge which goes all round the uterus. This is '*Bandl's ring*.' From this ring upwards the wall of the organ begins to be richer in vessels, the wide lacunæ of the middle layer begin, and corresponding to this line on the outer wall larger vascular trunks run in and out of the uterus. At this spot also one sees, when the uterus is *in situ*, the peritoneum investing the bladder, and Kohlrausch used this to fix the boundary between the body of the uterus and its cervix.

FIG. 83.—Section of Uterus and Cervix in eighth month of gestation. (After Bandl.) Cæsarian section after death.

UC. Body of uterus. *a*. Bandl's ring. *b*. Os internum. *oe*. Os externum. *Vg*. Vagina. *UI*. Lower uterine segment. *C*. Cervical mucous membrane. *d*. Connective tissue. *c*. Muscular layer. *b*. Seat of Müller's os internum. *a*. Seat of Braune's os internum.

This boundary between the body of the uterus and its lower segment is easily felt in the living organ at the level of the pelvic brim. It may be always felt on introducing the hand to practise version, and often when the hand is introduced to remove the placenta. The contraction of the body of the uterus at this part gives the sensation of 'hour-glass contraction.'

A further distinction is seen in the different structure of the uterine wall in the two parts. In well-developed uteri one sees in section of preparations which have been some time steeped in alcohol, the middle layer of the body of the uterus ending in a point downwards between the outer and inner layer of the lower segment. (See fig. 86.)

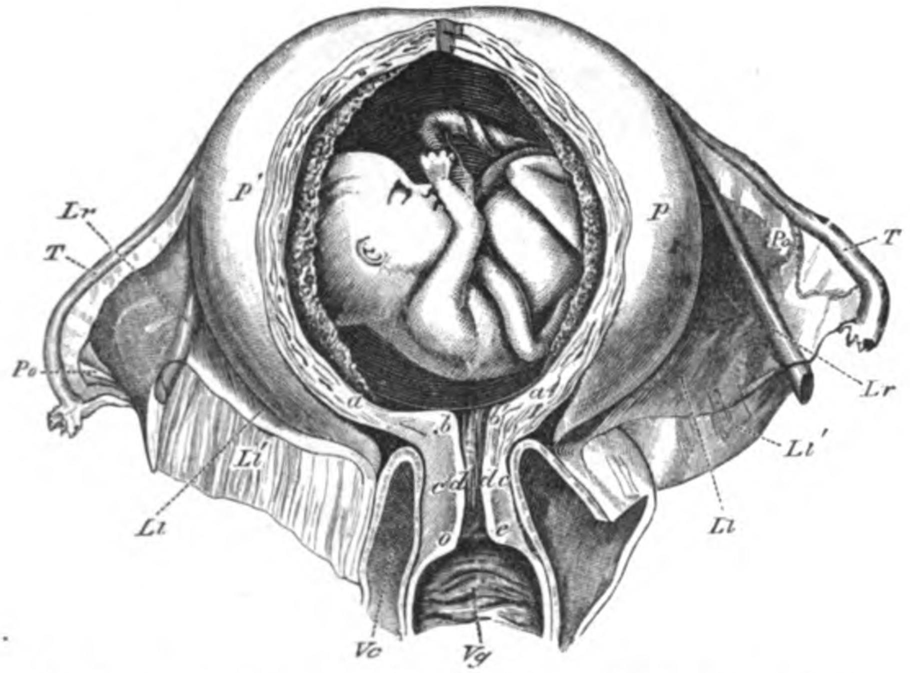


Fig. 84.—Uterus of woman who died in fourth month of second pregnancy. Cervix as yet quite unchanged. 4·5 cm. long; 1·5 cm. thick. Two layers distinctly seen; one tougher, of connective tissue, near the mucous membrane (*d*), and one softer, muscular (*c*), connected with the uterus above with the vagina below. (After Bandl.)

a b, *b′ a′*. Seat of formation of the lower uterine segment.

The formation of the lower segment begins at a date not exactly determined; but the walls are observed to become softer towards the seventh month. The very softened floor of the uterus, *a b*, *b′ a′* (fig. 85), together with the outer softened muscular layer of the cervix and vagina begins to yield, and the head or the ovum sinks in most cases with the softened floor more or less into the pelvis. The muscular tissues within the spaces *a b*, *b′ a′* (fig. 85), much softened, become elongated by the mechanical stretching of the on-pressing ovum or fœtal part. The uterus in fig. 85 shows at the boundaries *a b*, *b′ a′* the enlargement of this surface and the absorption of the outer layer of the cervix in the lower uterine segment. The section (fig. 83) shows plainly how with the ever-increasing development of the lower uterine segment this process is gradually achieved. During this process, the ovum not keeping pace with the expansion of the surface of the lower segment, the decidua is partly broken up; it is left in patches or sheds. Proceeding still farther, the

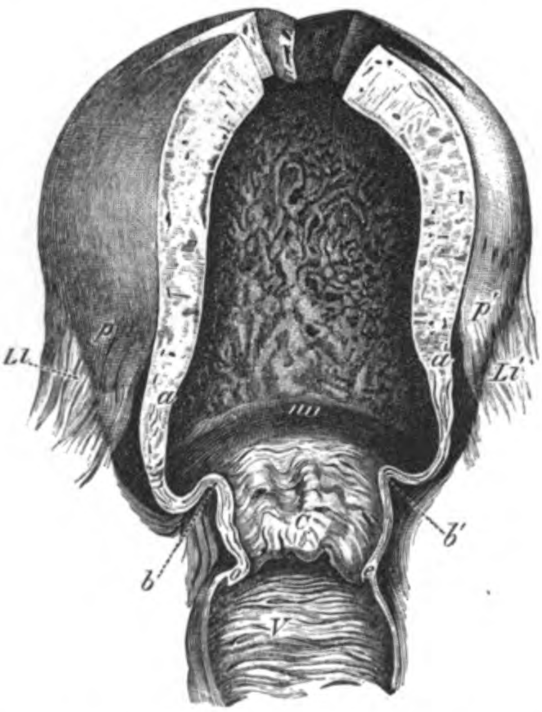


Fig. 85.—Uterus of a 2 para, who died in eighth month. Cæsarian section *post mortem*. (After Bandl.)

a. Body of uterus, distinguished from lower part by its thicker wall. *b.* Lower segment of uterus, distinguished by thinner wall, softer consistence. *C.* Mucous membrane of cervix with well-defined limit above and below. *oe.* Os externum. *V.* Vagina. *Ll.* Broad ligament. *p, p.* Peritoneum. *uu.* Lower uterine segment. *a, a′.* Seat of Braune's os internum. *b, b′.* Seat of Müller's os internum.

cervix yields more, and the cervical mucous membrane is found in parts on the lower segment. (See figs. 83, *b*, 84, *b*.)

If we look at the figures we distinguish two rings: 1, the os internum of Müller, *b*; this is expanding to enlarge the cavity of the lower uterine segment; 2, the boundary between the body and lower segment of the uterus, *a*; this is the *second os internum* of Scanzoni, or Bandl's ring. The space between these two rings is the canal of Braune. This canal is later lengthened by the taking in of a portion of the cervix.

Fig. 86 shows the condition of the uterus at term after labour. The cervix has greatly merged into the lower segment, and a rent is seen through its mucous membrane from the os externum to the os internum.

As to the neck itself diminishing in length as the cervico-uterine canal is formed, its muscular coat participates, to the

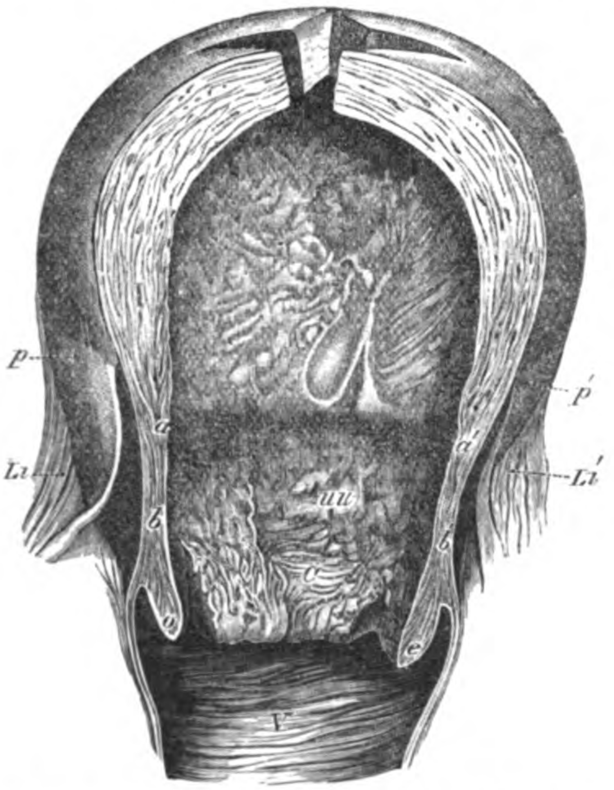


Fig. 86.—Uterus of a 1 para, who died twelve hours after labour at term. (After Bandl.)

uu. Lower uterine segment. *a, a'.* Seat of os internum in Braune's drawing. *b, b'.* Seat of Müller's os internum. *a b, b' a.* Lower uterine segment. *o e.* Os externum. *C.* Cervical mucous membrane. *Ll.* Ligaments. *p, p'.* Peritoneum, borders of. The cervix from *o* to *b* is seen cleft.

exclusion of the mucous coat, in the formation of this canal. The cervical mucous membrance, lined by the connective tissue which sustains it, yields and slides on the muscular layer. It thus forms imbricated folds, and the os internum formed by this mucous membrane comes near to the os externum. This explains how the neck seems to be at the end of gestation only 1 or 2 centimetres long. Tarnier points out that this doctrine of Bandl is analogous to that of Jacquemier, and still more to that of the older authors Levret and Petit, who admitted that the neck was gradually absorbed by the body during the latter months of gestation.

When we come to describe the physiology of placenta prævia we shall see how strikingly these researches of Braune, Müller, and Bandl illustrate and confirm Robert Barnes's theory of that event. It will then be seen that he had anticipated by clinical observation and physiological reasoning the discovery of the distinction between the lower segment of the uterus and its body, and that he had closely mapped out its extent and boundary.

The cervical canal in gestation and labour.—The cervix, as already noted, scarcely grows during gestation. It does, however, increase a little. The *shape* must be observed in the different epochs of gestation and contrasted in primigravidæ and plurigravidæ. Until the middle of the ninth month the changes of shape are slight. During the last fortnight of gestation the change is very important.

In primigravidæ, until the last month, the neck becomes more conical, the apex being represented by the os externum. Soon the middle part of the cervical cone expands a little, so as to represent an elongated spindle. (See fig. 82.) This depends upon the accumulation of viscid mucus. In multiparæ the canal also contains thick mucus, but the neck, instead of being spindle-shaped, remains cylindrical; and often the *os tincæ* softening assumes the shape of a club, hollowed at the level of the os externum.

In the primigravida the os externum commonly remains smooth, more or less rounded; in the pluripara, it is commonly lobed, jagged, divided more on one side, commonly the left, than the other, and more open. The cervix rises nearer to the sacral promontory during the first months of gestation. (See 'Diagnosis of Gestation.') The body of the uterus being deviated to the right, the neck necessarily in rising turns to the left.

Softening begins early. It is first observed at the tip of the vaginal-portion, affecting only the superficial layer. As gestation advances the softening invades in successive layers the whole length of the neck up to the os internum. That is, *the softening proceeds from below upwards*—from the os externum to the os internum. In the primigravida the supra-vaginal portion softens in the ninth month. In the multipara, the softening proceeds more rapidly, previous gestations having prepared the way.

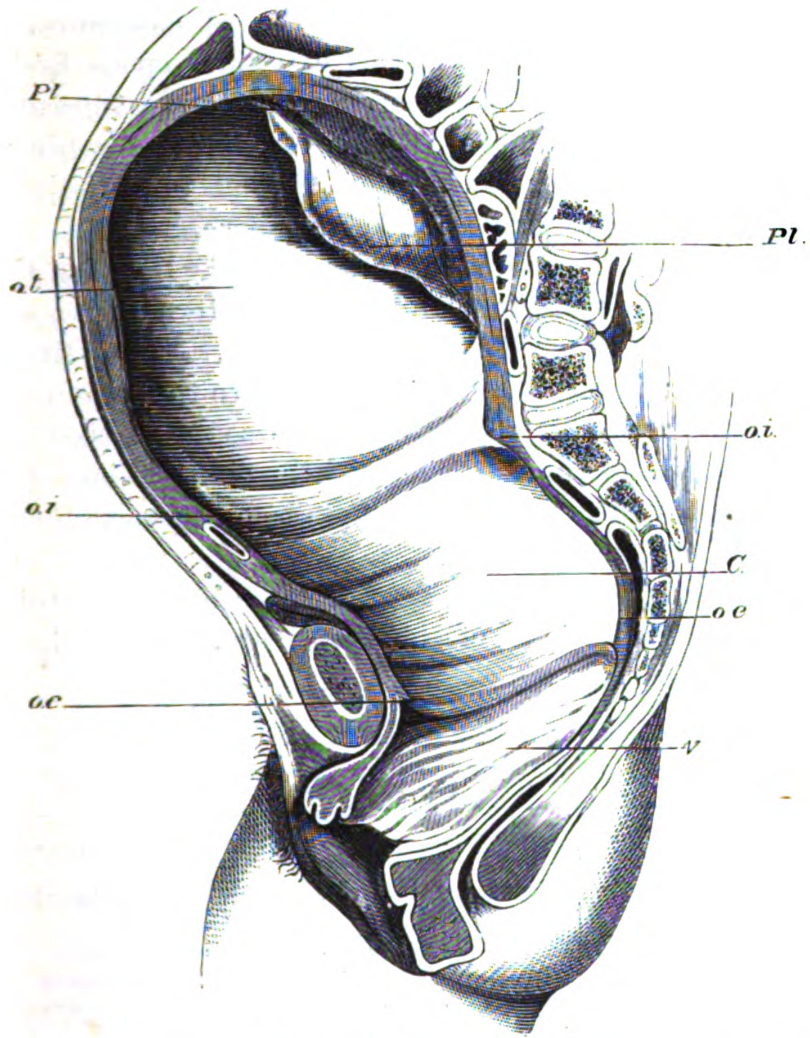


FIG. 87.—Section of genital canal after removal of child, showing the canalisation of the cervix and the canal of Braune.

Pl. Placenta. *o.t.* Tubal orifice. *o.i.* Os internum. *C.* Cervix. *o.e.* Os externum. *v.* Vagina.

Obliteration.—Since Stoltz's researches it is recognised that the neck does not change in length before the last fifteen days of gestation. But in the last fifteen days there is a real obliteration; the neck shortens by opening up *from above* *downwards*, so that at last it is reduced to its os externum. The process is as follows: first, the os internum, then the parts of the canal below successively open out, becoming lost in the cavity of the body of the uterus. When the obliteration is complete the uterus and cervix form but one cavity, of ovoid shape, pierced below by the os externum. It will be seen that the os internum does not approach the os externum. The opinion held by some that the os externum opens first, and that the finger passing this is arrested by the os internum, is illusory. In multiparæ the os externum is more gaping and soft, so that the finger easily passes it, but nevertheless the natural process is that expansion begins above.

After labour the neck is reconstituted, that is, the os internum is plainly marked, whilst the os externum remains so largely expanded as hardly to be recognised. The obliteration of the latter half of the last month is due to the painless contractions of the uterus acting upon the softened tissues. It must be noted that the softening and the obliteration follow an inverse order. Softening proceeds from below upwards, obliteration from above downwards.

The following table, from Tarnier, gives approximately the differential modifications of the cervix uteri in primigravidæ and plurigravidæ :—

State of the Neck	Primigravidæ	Plurigravidæ
Form of neck down to 8½ months.	Fusiform . . .	Cylindrical or club-shaped.
Os externum down to 8½ months.	Closed, regular, oval, or rounded.	Gaping, irregular, jagged, and everted.
Canal down to 8½ months.	Elongated spindle .	Thimble-, funnel-, or extinguisher-shaped.
Os internum down to 8½ months.	Closed . . .	Usually closed; sometimes open, especially in women who have had many children
External orifice at term	Closed and defined by thin lips, tight and regular.	Open and defined by thick lips, soft and irregular.

Modifications of the serous coat.—At term the serous coat of the uterus has the same aspect and thickness as before impregnation, although the superficies of the uterus has increased twenty-fold. How is this explained? It has been supposed that the folds of the broad ligaments and the looser peritoneum around the lower segment of the uterus, unfolded and carried upwards, formed a covering for the growing uterus. But the fact is that the broad ligaments are not equal to this task. The sliding of the peritoneum is in reality not great, and it must be limited to the lower segment. The body and fundus, therefore, depend for a peritoneal investment upon the continuous growth of this membrane.

Sometimes, however, the peritoneum failing to keep pace with the development of the uterus splits, and cracks are seen after labour.

The vagina in gestation.—The vagina becomes more lax, distensible, and freely lubricated with mucus and serous fluid. It undergoes changes of form and relation during the progress of gestation. The principal of these will be appreciated on studying the figures representing the positions of the uterus at the several stages. At first the vagina is lengthened and directed somewhat more backwards by the anteversion of the uterus, by which the cervix is carried upwards and backwards. Towards the end of gestation the vagina is shortened, squatting, by the descent of the uterus into the pelvis. The vagina, like the uterus, undergoes physiological hypertrophy of all its tissues. That it gains in muscular tissue seems proved by the marked contractile power sometimes manifested during the expulsion of the placenta and afterwards. It undergoes a process of involution after labour. The rugæ are less marked after labour than in the virgin and nulliparous woman.

The vessels and nerves of the gravid uterus.—The vessels grow under the developmental stimulus in a remarkable manner; vessels not before to be seen come into prominence, and assume quite new characters.

The *arteries* increase greatly in volume, the branches even more than the trunks. The uterine arteries on arriving at the borders of the uterus, instead of becoming smaller, are notably enlarged. The branches springing in turn from these exceed in size the arteries which supplied them. Not only do they grow in volume, but they grow in length in order to keep pace with the development of the uterus. And what proves that the elongation is the result of hypertrophy is the fact that they are not less tortuous than in the non-gravid state. The numerous divisions which run to the uterus form in the superficial layer a vast plexus or network of their branches, which results not alone from the frequent anastomoses between the ovarian and uterine arteries of the same side, bnt also from anastomoses between the arteries of opposite sides. Amongst these anastomoses, there may be seen right and left a large branch running from the uterine artery of either side to the ovarian artery of the same side. This branch, bigger than the radial, runs nearly parallel with the epigastric artery. Glénard describes it as the *puerperal artery*, and regards it as the habitual seat of the uterine souffle.

From all these anastomoses branches part which penetrate the uterine tissue, coursing through it in every part. The divisions which correspond to the insertion of the placenta are, however, bigger than the rest. A number of ramuscules reach the inner surface of the uterus and subdivide in the mucous membrane where they terminate. Those which are distributed in the uterine decidua are extremely delicate and short, those which are distributed in the serotina are larger and longer. They are the *utero-placental arteries*. Bloxam ('Med-Chir. Trans.') showed that these arteries also are tortuous or helicine.

A very thin cellular sheath accompanies the uterine arteries, and their walls are not confounded intimately with the muscular tissue in which they run, as is the case with the veins.

The arterial ramifications are continuous with the *capillaries*, which in their turn give rise to the veins. The uterine capillaries, says Jacquemier, do not differ from those in other tissues, unless it be that they are more permeable to injections. They enlarge during gestation. This disposition explains the activity of the uterine circulation, and the rapidity with which the blood may pass from the arteries into the venous sinuses.

The veins increase enormously in size. The ovarian veins become nearly as large as the internal or external iliacs. In the walls of the uterus the venous system is constituted by large canals or sinuses communicating with each other; they are seated in the middle layer, about equidistant from the inner and the outer surface. The community of these anastomosed canals forms a plexus, several of the divisions of which are as big as the little finger.

These canals are much larger and more numerous in that part of the uterine wall which corresponds to the placenta. They diminish as they part from the circumference of this organ. At the circumference a large number of venous canals or sinuses approach the inner surface, most of them running obliquely; they course for a certain distance on the inner surface of the uterus, covered within by a very thin lamina of muscular tissue, or simply by the mucous membrane, then they penetrate the serotina, and between the lobes of placental cotyledons. These are the *utero-placental veins.*

The venous plexus situated in the middle muscular layer receives a large number of venous radicles proceeding from the external layer or from the internal layer, or from the decidua itself. This disposition is strikingly analogous to the manner in which the veins of the brain and its membranes are disposed in relation to the sinuses of the dura mater.

The uterine sinuses appear to be reduced to their serous tunic, which, by its outer surface, adheres intimately to the muscular tissue. They are, therefore, true contractile canals. The uterine veins are destitute of valves. Injections thrown into the trunks penetrate in all directions. The muscular fibres which surround the canals perform the function of valves.

Dr. Graves illustrated his hypothesis of the independent or innate character of the capillary circulation by reference to the gravid uterus. 'Here we see not only vessels innumerable, but nerves developed without any increased *vis à tergo*, and the nerves like the vessels formed from the circumference to the centre.' Although a *vis à tergo* certainly does work in the development of capillaries, there is as certainly a *vis à fronte*, or *in loco*, contributing to the increase of capillary growth. The history of early embryology supplies evidence in favour of this hypothesis.

Reimann ('Arch. f. Gynäkol. 1871') concluded that the uterus, like the heart, had nervous centres independent of the cerebro-spinal system. He removed the uterus of bitches and cats from the body, and found that he could excite rhythmical movements by electricity, as in the heart.

The *lymphatic vessels* increase greatly. Cruikshank pointed out that they are as large as goose-quills, and so numerous that when injected with mercury one might be tempted to believe that the uterus was a tissue of lymphatic vessels. These vessels often present bulgings described by Cruveilhier. Fig. 54, p. 153, represents the lymphatic system. The study of it is especially important in relation to the history of involution and septicæmia after parturition.

The *nerves* of the uterus, like all other tissues, undergo enlargement during gestation. Whether or not we admit the accuracy of the descriptions of Robert Lee, we are driven by physiological reasoning to conclude that the contractile property of the uterus depends upon nervous energy; and that nerve-force is generated in enormous quantity for the purpose. And nerve-force is the product of nerve-tissue.

The changes, structural and functional, arising in gestation considered in their togetherhood.—If we gather into one focus all the phenomena evoked by gestation, we cannot fail to be impressed by the marvellous transformation wrought in every part of the organism. Every drop of liquid, every cell, every fibre, every organ feels the new impulse. All are compelled to work together to carry out the work of reproduction. Every function is doubled in energy and sphere of action. The impregnated woman digests, assimilates, her heart beats, she breathes, excretes for two beings. Healthy gestation is marked by exact equilibrium between the wants of the two organisms. But in truth the imperious demands of the new being often predominate. The maternal organism in its struggle to keep pace with the absorbing exactions of the embryo is severely taxed. The two functions which most conspicuously answer to the call are those of the nervous and vascular systems. These in their actions and reactions respond to and conduct the developmental processes in the uterus and the correlated processes throughout the body. The exalted nerve and vascular tension induced underlie all the vital processes alike—those which keep within the due physiological equilibrium, and those which breaking bounds manifest themselves in pathological deviations. The organs, separately and conjointly, are working under high pressure. If all are sound, and if no extraordinary trial be imposed from external sources, they will work smoothly under the natural regulating forces to their end. Gestation may thus be said to be a great experiment instituted by Nature. In a memoir on 'The Relations of Pregnancy to General Pathology' in the American Gynæcological 'Transactions,' Robert Barnes insisted that the study of gestation could not fail to illustrate and to solve many problems in pathology. 'Diseases'—such as those which lead to albuminuria for example—'that are slowly, by imperceptible degrees produced in man, may be almost suddenly induced or initiated under the definite conditions that justify a precise conclusion when an experiment *ad hoc* is performed. For what can more nearly resemble a scientific experiment than to take a healthy woman, to induce pregnancy, and then to observe and to record the effects of this change upon the economy? In the whole range of medicine there is nothing to compare for breadth of information with the opportunities thus presented to us by this natural experiment.'

Gestation tests the integrity of every structure in the body. Under this test a weak organ or constitution hitherto working fairly and sufficiently reveals its defects, and by its work shows the development of processes which, under other circumstances, are regarded as pathological.

The phenomena of healthy gestation, lightly sketched in this chapter, will be further illustrated in the chapters on the 'Diagnosis of Gestation,' on the 'Diseases of Gestation,' and on 'Abortion.' We shall then see how intimately the two processes are connected. These chapters should be read consecutively. We shall then appreciate the cardinal truth that the so-called diseases of gestation are for the most part simple exaggerations of physiological conditions, that almost every disease has its foundation in an antecedent correlated process. We shall see that the transition from physiology to pathology and back again is wonderfully rapid; that often the boundary can hardly be defined; that although the mind revolts against the dictum of Mauriceau that gestation is a disease of nine months' duration, the dictum of Boerhaave, 'Femina plurimis afficitur malis ex solâ graviditate oriundis,' is true.

This proposition may fairly be hazarded: all the blood-changes, all the modifications of secretion and nutrition, all the nervous phenomena and structural changes to which reference has been made, are inseparably associated by one common bond. If this be granted, we may reasonably hope that if we can but get firm hold of one link of the chain, we shall have in hand the clue to the whole mystery; that the explanation of many physiological and pathological processes which are at present imperfectly understood may be discovered. So fixed is the law of unity and interdependence in Nature, that to seize one point well is to grasp the whole, just as in the famous reconstruction of the extinct animal from a single bone by the illustrious Cuvier.

The Relations of the Fœtus to the Uterus.

Under this head we have to study—

1. The attitude proper to the fœtus in the uterus.

2. The relations of the fœtus to the uterine cavity.

3. The relations of the gravid uterus to the abdominal and pelvic cavities.

4. The accommodation of the head of the fœtus in the excavation during gestation.

1. *Attitude of the fœtus.*—The fœtus is usually curved upon its anterior aspect, the head bent, the chin near the sternum. The upper limbs are placed along the thorax, the fore-arms crossing in front of the chest. The principal segments of the lower limbs are flexed: the feet on the legs, the legs on the thighs, the thighs on the abdomen; and often the legs are crossed in front of the thighs. Thus the fœtus, from its anatomical construction, is everywhere flexed, rolled up upon itself like a chicken at the point of hatching. The general form of the fœtus represents an ovoid, of which the big end is formed by the pelvic extremity accompanied by the legs, and the small end by the head.

The long diameter of this ovoid at term measures 28 centim. or 12 to 13 inches.

This rolled-up attitude is due partly to the necessity of accommodating itself to the limited containing space, partly to the prevailing tendency to flexion of the limbs under proper fœtal movements.

2. *The relations of the fœtus to the uterine cavity.*—At the end of gestation the head of the fœtus is generally lowest.

Veit found that in 1,231 labours taking place in the seventh, eighth, and ninth months 62·88 per cent. presented by the head, 16·32 per cent. by the breech, 3·5 per cent. by the shoulder; whilst Dubois found in 2,020 labours at term that 95 per cent. presented by the head. From these and many other observations it follows that head-presentations occur in greater proportion as we approach the natural term of gestation; and, as a corollary, breech- and shoulder-presentations are frequent in proportion to the earliness of the gestation. When the fœtus has died some time before expulsion, irregular presentations are still more frequent.

Hippocrates supposed that the fœtus during the first seven months sat upright in the uterus, that then liberated it threw a header, and the head kept down. This hypothesis long reigned. Even Harvey seems to have thought that the fœtus acted under its independent faculties. Ambroise Paré and Dubois contended that the fœtus takes the head-position by virtue of its *instinctive power*. J. Y. Simpson inferred that the fœtus adapted itself to the uterus by *reflex muscular movements* excited by impressions—as by contact with the uterus—upon its surface. Credé and Kristeller think that the painless contractions of the uterus exert the greatest influence in producing head-presentations. Veit, M. Duncan, and Schroeder sought to explain it by gravity. Scanzoni united several of the hypotheses affirming that head-presentation is the result of multiple causes—as gravity, the form of the uterine cavity, the form of the fœtus, the quantity of liquor amnii, the contractions of the uterus, and even active movements of the fœtus.

The gravitation theory has been disposed of. It is based upon the vertical attitude of the woman, which is not constant. It assumes that the fœtus is suspended by the umbilical cord and that the head-end being relatively heavier in the early months, it must fall towards the lower segment of the uterus. But the cord is really too long to serve for this suspension. Hydrocephalic fœtuses rarely present by the head; anencephalous fœtuses often do. Dead and premature children often present by the breech.

The relation of the fœtus to the uterine cavity is in reality the resultant of several factors of a law of accommodation. Pajot[1]

[1] Art. 'Accouchement,' *Diction. Encyclop. des Sc. Méd.*

thus formulates *the law of accommodation in labour:* '*When a solid body is contained in another, if the containing is the seat of alternations of movement and repose, if the surfaces are slippery and only slightly angular, the contained will constantly tend to accommodate its forms and dimensions to the forms and capacity of the containing. The presentations and positions of the fœtus in pelves normal or faulty are governed by this law.*'

A similar law of accommodation governs the positions and presentations of the fœtus *in utero* during pregnancy and labour. In the early stages of pregnancy the embryo is so small relatively to the uterine cavity that it floats suspended in the liquor amnii. But about the middle of pregnancy the fœtus grows rapidly, it acquires form, and at the same time the uterus grows more in its longitudinal than in its transverse diameter. As soon, therefore, as the fœtus—an ovoid body—attains a size which approaches that of the capacity of the uterus, the walls of the uterus—the containing body—will impose upon the fœtus a vertical position. Mutual adaptation requires that the long diameters of fœtus and uterus shall coincide. This is one factor in the accommodation.

Then, it is now admitted that during the first six months the upper segment or fundus of the uterus is more developed than the lower segment. Moreover, during this time the head is the biggest part of the fœtus. Throughout gestation painless contractions of the uterus take place, and when the uterus contracts the transverse diameters are shortened, whilst the long diameters increase. These are the alternations of movement and repose. During the two first trimestria the fœtus enjoys a certain freedom of movement, and it is easy to make it turn about; but after a while it recovers its situation. This is because the capacity of the uterus is much greater than the volume of the fœtus; and thus the necessity of accommodation is not so imperative as it becomes later on.

During the last trimestrium the lower segment of the uterus is more capacious than the upper, and hence the breech or bigger end of the fœtal ovoid is lodged there. This is a second factor in the accommodation. Robert Barnes pointed out another reason why the head should present. The fundus, or at least the upper segment, of the uterus is the part designed for the attachment of the placenta. There it can grow undisturbed and continue free from injurious pressure during the expulsion of the child. The bulk of the placenta then added to the breech requires the region of greatest space—the upper segment. This is another factor determining the downward position of the head.

There is a condition to which Robert Barnes [1] drew attention as directly influencing the position of the fœtus. The preceding factors account for the coincidence of the long diameters of fœtus and uterus, and for the position of the head downwards. Why is the transverse diameter of the fœtus usually coincident or nearly so with the transverse diameter of the uterus? Why is the back of the fœtus most commonly turned forwards? The law of mechanical accommodation gives the answer: 'The uterus is normally somewhat flattened in the antero-posterior diameter. In the non-pregnant uterus the cavity of the body —the true and only gestation-cavity—is a flat triangular space, the angles of which are the orifices of the Fallopian tubes and the os uteri internum. A similar triangular superficies is marked out on each half of the uterus, anterior and posterior. The anterior superficies lies flat against the posterior superficies. When pregnancy supervenes these surfaces are necessarily separated to form a cavity for the growth of the ovum. But the original form is never entirely lost. The cavity is always more contracted from before backwards than from side to side. The uterine cavity after labour is closed' [not only by shortening, but also] 'by the flattening of the anterior and posterior walls together. Now this flattened form of the uterus is the cause of the fœtus taking a position with either the belly or the back forwards. The fœtus is broader across the shoulders than from back to front, and therefore its transverse diameter is fitted to the transverse diameter of the uterus.'

Why is the back usually turned forwards?—The child's back is firm and convex, its head is also firm and convex behind. The anterior surface is plastic and concave, and therefore fits better to the firm convexity of the mother's spine. Under the movements of the uterus, the convex spine of the child being moveable will necessarily move away from the convexity of the mother's spine and adjust itself to the

[1] *Obstetric Operations.*

anterior wall of the uterus, which has ample facility for expansion by pushing out the yielding abdominal wall. This is another factor in the accommodation.

3. *The relations of the gravid uterus to the abdominal and pelvic cavities.*—These, again, are governed by the law of accommodation. Let us see first what takes place in primigravidæ. The uterine sac becomes extremely mobile as it rises into the large abdominal cavity; its attachments, which admit of considerable displacements in the pelvic cavity, lose almost all influence upon the uterus in the abdominal cavity, excepting perhaps the round ligaments, which exercise a little action. It floats in the abdominal cavity; its lower segment is found at the upper part of the excavation. In proportion as the uterus and its contents develop, the pressure which the abdominal walls sustain increases, so that at a given moment the indirect action of the diaphragm making itself felt, the abdominal cavity becoming too small, the uterus is forced to descend into the pelvic excavation, hitherto empty. But it descends with a fœtal part, the flexed cephalic extremity. For other parts to enter, energetic contractions are needed, such as occur only during labour.

In multiparæ things are different. The abdominal wall has been distended, its cavity is much larger. The uterus is no longer supported; its long axis becomes oblique, diagonally disposed, or the fundus falls forwards, the belly is pendulous, the uterus in anteflexion. The fœtal axis, although still corresponding with the uterine axis, is no longer coincident with the pelvic axis. The lower segment of the uterus remains at the level of the pelvic brim, the neck is less accessible, the fœtal part is not driven into the pelvis, and uterine contraction does not always suffice to restore the long axis to the median line.

In these conditions, displacement of the fœtus is easy. Hence abnormal presentations. These are much more frequent in multiparæ than in primiparæ.

Another factor has been already explained—namely, the adaptation of the posterior wall of the uterus and the abdominal aspect of the fœtus to the mother's spine.

4. *The accommodation of the fœtal head in the pelvic cavity during gestation.*—In penetrating the excavation during the last three months of gestation in primiparæ, and

during the last month or fortnight in multiparæ, the head undergoes a new accommodation according to a strictly mathematical formula. It obeys the influence of the abdominal and pelvic cavities which contain it. To enter the lesser pelvis it is forced to bend in order to adjust its smaller diameters to the pelvis. Dubois observed that of 1,913 vertex-presentations, 1,355 were left anterior occipito-iliac; 491 right posterior occipito-iliac; 55 right anterior occipito-iliac; and 12 left posterior occipito-iliac. That is, the long diameters of the head were always found in relation with the oblique diameter of the pelvis; and of these two, the left or larger was engaged 1,886 times to 77 times of the right oblique.

Hence, to resume. During the first six months the situation of the fœtus in the uterine cavity is not fixed, but most frequently the cephalic end occupies the fundus.

During the last three months the cephalic end most frequently gains the inferior segment of the uterus, remains there, and enters the pelvic excavation.

The changes of presentation and position depend upon the defect of one or more of the factors of accommodation.

Plural or Multiple Gestations.

Veit[1] has analysed a large collection of cases with a view to determine the relative frequency of multiple births. Of 13,360,575 labours, there were 149,964 twin-gestations; triplets occurred 1,649 times; quadruplets 36 times. The proportion of multiple births was 1 in 88; of twins, 1 in 89; of triplets, 1 in 7,910; of quadruplets, 1 in 371,126. Thus the rarity in the number of children born of one gestation increases at a very rapid ratio. Examples of quintuplets are amongst the curiosities of obstetrics. But well-authenticated cases are recorded. Thus Hull, Chambon, Ramsbotham, Puech, Volkmann, and McClintock each relate one.

The relative frequency of plural gestations appears to vary in *different countries* and *races*. In England, twin-gestation occurs about 1 in 80. It has been imagined that it may depend upon the *energy of the ovary* in the individual. Thus it has been more often observed in women who have had many

[1] *Monatschr. f. Geburtskunde*, 1856.

pregnancies. It is certain that there is an *individual proclivity* to multiple gestation. Many instances are known of women who have several times successively brought forth twins or triplets. A more doubtful point is *paternal influence.* Are certain men endowed with the faculty of procreating more than one child at a time? There is the instance cited by Velpeau of the Russian peasant Wasilew, whose first wife had quadruplets four times, triplets three times, and twins sixteen times! The second wife had triplets twice and twins six times, so that this patriarch had eighty-four living children out of eighty-seven which he had begotten! It requires a robust faith to accept this marvellous story. But Leroy cites the case of four brothers in whose family twin pregnancies had been observed in collateral relations. Three of these brothers had twins twice, and the fourth four times. It is far more probable that the fertilisation of more than one ovum at a time depends upon the ovary evolving two or more ova together. There is evidence to show that multiparity is to a certain extent *hereditary.* This unhappy addition to the burthen of maternity is known to reappear in successive generations. Has the *age* of the parents any influence? We have known several examples of twins in first gestations in young couples.

Theories of multiparity.—1. Two or more Graafian follicles may burst at the same time, each yielding an ovum to be fecundated. 2. Two ovules may exist in the same vesicle, and being extruded together both may be fecundated. 3. One ovule may contain two germs. This latter event would explain what is called *fœtal inclusion.* The *ovum in ovo* is not rare in birds. There are specimens in the Hunterian Museum, and Robert Barnes exhibited a remarkable specimen of a perfect ovum with its shell included within another shell which contained its own perfect ovum. It is figured in the 'Obstetrical Transactions' (1863). We have seen in the Munich Museum the chest of an officer containing a developed fœtus. This is a clear case of 'fœtal inclusion.'

Then there is (4) The theory of *superimpregnation.* This implies that the ovules may be fecundated by two separate acts of copulation at a greater or less interval of time; or else that ovules extruded at different times may be fecundated by the same coitus. This is divided into *superfecundation* and *superfœtation*.

(A) *Superfecundation.*—There are examples of negresses who, having had sexual relations with a black and a white man within the *same ovulation period*, have brought forth twins, black and mulatto; and converse examples are related of white women who under similar conditions have brought forth a white and a mulatto. Buffon, Dewees, Dunglison, Beck, testify to facts of children of different races being born. Dr. Henry, in his excellent essay on superfœtation, quotes a case which occurred in the Brazils, where the indigenous race is copper-coloured, but where there are whites and negroes. A creole woman had three children at a birth—white, brown, and black—with all the features of the respective races.

It is probable, says Tyler Smith,[1] that in many cases of twin pregnancy the second ovum has been fecundated by a coitus occurring subsequently to the first impregnation. In rare instances, in twins, the placenta is found to be single. It may be that these are cases in which one ovule has contained two yolks and two germinal vesicles, just as we sometimes see in birds, one egg with a double yolk, producing two individuals. In these cases the twin impregnation must occur at the same time. More frequently the placenta and membranes are double, but the placentæ are side by side, and in these cases two separate ovules have probably descended from the same ovary, and have been impregnated at the same or at different times. In some cases the placentæ are attached to opposite sides of the fundus uteri, the inference being that the ova have descended from the two ovaries, but they may have been impregnated by a single coitus or otherwise. In all these cases the fecundation occurs within a short space of time (within the same 'ovulation-period'), and the same preparation of the uterus serves for the twin fecundation.

Physiological experiments support these observations. A mare covered by two horses of different races has brought forth foals corresponding to the two races. Similar observations are related of dogs. A mare covered by a horse and by a donkey has produced a horse and a mule; and that when there

[1] *Manual of Obstetrics*, 1858.

had been an interval of from one to sixteen days between the two fecundations.

(B) *Superfœtation.*—For this to take place two conditions must concur. (1) The sperm must find its way between the decidua reflexa and the decidua uterina, thence into the tube. (2) During gestation an ovule must be detached from the ovary and be received into the tube. Theoretically, both these conditions are possible. For some weeks after gestation there remains a decidual cavity, with free access from the cervix uteri in at least one tube, and ovulation certainly in some cases goes on.

What is the evidence bearing upon this question?

(1) Cases—they are not rare—are observed of the *expulsion at the same time of two fœtuses of unequal development.* These cases must first of all be divided into two classes:—(*a*) those in which one fœtus is alive or only recently dead, the other having obviously perished long before labour; (*b*) those in which both children are born alive or after recent death of one or both.

(*a*) To this class belong the rather numerous cases of twins of which *one child is born well-developed* and vigorous, the *other small, dead, shrivelled up*, having obviously been retained a long time after its death. There is an excellent illustration of this event in Cruveilhier's 'Anatomie pathologique.' A seven months' child is connected with a fresh working placenta, a small mummified fœtus of about four months' development is attached to an atrophied placenta. The two placentas are united, therefore the result of one impregnation. We are compelled, however, to dissent from the interpretation of the great master. He attributes the death of the dried fœtus to atrophy of the placenta. Our own researches leave us in no doubt that the change in the placenta was consequent upon the death of the embryo. Several museums in the London hospitals present similar cases. From time to time cases of this kind are brought forward as proofs of superfœtation. The fallacy of this evidence is obvious. The true interpretation is as follows:—There is an original twin-fecundation; one embryo is developed faster than its fellow, or is more favourably accommodated in the uterus. Continuing to grow by virtue of the right of the stronger, or, as it may be expressed, by the 'selection of the fittest,' it gradually compresses its brother or sister with the placenta, killing it. Then the developmental stimulus, created by its own need continuing to act upon the uterus and organism, its development goes on, its fellow being locked up, preserved from putrefaction by a process of adipocerous conversion, waiting until its fratricidal brother is ripe for birth. Then both are expelled together. These cases then do not sustain the theory of superfœtation.

(*b*) Cases of twins both alive of different stages of development, or one only recently dead, born either at nearly the same time or within a considerable interval. Naegelé, of Düsseldorf, relates the following case: A woman was delivered on June 22, 1857, at 9 P.M., of a large and vigorous girl, and half-an-hour afterwards of a second girl, very small, which uttered a few feeble cries, could not take the breast, and died at the end of fifteen days. Its cranial bones were soft, the fontanelles large; the nails imperfectly developed. Dr. Klykpennink, of Aalten, Holland, relates this: On May 2, 1835, a woman was delivered of triplets: the first still gave signs of life when it was born; it was well formed, developed to $4\frac{1}{2}$ months; the second was expelled next day at 6 P.M.; it had ceased to live some days, and appeared of the same age as the first; the third was at term, living at its birth, but died in a few days. Some analogous cases are recorded, one by Dr. Boyson (*Western Lancet*, 1879). These cases are not convincing. It is in a high degree improbable that fecundation can take place through a uterus in the fourth month of gestation when the decidual cavity is usually closed, and access to the tubal orifices is blocked. We would rather believe that all the embryos were fecundated together, and that the development of one was retarded by the superior vitality of the other.

Then there are the cases *of two living and viable children born at distant epochs.* Passing by cases of ancient date which cannot now be subjected to criticism, we cite one by Fordyce Barker, who relates that a woman gave birth on July 10, 1855, to a boy well made and apparently at term; on September 22, that is, seventy-three days later, she gave birth to a girl, also alive, but smaller. In this case a bifid uterus existed. It may be contended that impregnation may take place at distant intervals through the two uteri. *The theory of double uterus* offers the explanation most consistent with well-attested facts and with precise physiological knowledge. Still cases are cited in which the uterus was alleged to be single.

Cases of superfœtation beyond all doubt are those in which *uterine gestation follows upon an extra-uterine gestation.* Such cases are not very rare. There are examples of women going through two or more uterine gestations, an extra-uterine gestation existing all through. But these cases do not touch the theories of twin intra-uterine gestation.

The ordinary *history of twin-gestation* is of great practical clinical interest. It is desirable to understand the varieties that occur. (1) Each fœtus may be contained in its own complete fruit-sac—that is, there are two amnions, two chorions, two placentas; each fœtus has its own distinct circulation. In some cases of this class, the placentas grow apart from each other, and are extracted each entire, one after the other. In these cases, there can be no doubt that two ova came down either from one ovary, or one from each ovary, and were fecundated, either at the same time or within the same ovulation-period. Two corpora lutea have been seen in some cases of this kind. The children, having a distinct origin, may be either of the same sex or of different sexes. As in single births, male children predominate. In these cases the two ova approaching each other, the intervening decidual coats may be absorbed. Then the fœtuses are only parted by four sheets, two amnions and two chorions. Thus distinct, one fœtus may be expelled some days after the other. Of this event, examples are not rare. To cite one or two:—

Dr. Baranski ('Centralbl. f. med. Wissensch.' 1881) relates that a woman was delivered of a boy a little before term; the placenta was extracted in the ordinary time. She went back to her work. Seventeen days afterwards, while working in the fields, a copious flow of liquor amnii set in, without pain. Dr. Baranski called in, found an arm prolapsed; he delivered her of a well-developed child showing no trace of maceration; the placenta followed in some minutes.

Steele, of Liverpool, found a second child presenting in unruptured membranes twenty-two hours after birth of first child.

He ruptured the membranes. The woman had been walking about without pain. The placentas were distinct.

(2) *The two fœtuses may be enclosed in the same chorion*; each, however, has its own amnion. The placentas are united, forming one mass, but the circulations are usually distinct—that is, there is no interplacental anastomosis; each fœtus has its own district in the placenta; there are two distinct umbilical cords. Each placental district may be injected separately.

It may be supposed that the two ova, originally distinct, came into contact, and that under mutual pressure the chorions at the seat of contact became absorbed.

In such a case, one fœtus may perish, and be retained until the other has arrived at term. But if one is expelled, the other must soon follow.

(3) *The two fœtuses may be contained in the same amnion.* There is one placenta; the circulations are often common; sometimes there are two distinct cords, sometimes one which divides. Each embryo has originally its own amnion, but these at the point of contact may be absorbed, and so fused into one sac.

When the two fœtuses are included in the same fruit-sac they generally, if not always, are of the same sex. In the cases of united twins, as the Siamese, they are without exception, we believe, of the same sex. When the fœtuses are enclosed in the same amniotic sac the cords are apt to get entangled. P. Müller[1] found four cases recorded of twistings of the cord, and two of knotting—namely, by Tiedemann, Stein, Osiander, Sammhammer, Soete, and Newman. The last case deserves to be cited. Dr. Newman relates[2] that two fœtuses were enclosed in the same sac. From the centre of the solitary placenta sprang two cords. The cord of the first child presented at its middle a knot; the cord of the second passed through this knot and was so compressed that the cord was strangled. The two children were at term; the one whose cord was knotted was alive, the other dead. A singular instance of fratricide *in utero*! In these cases it is probable that one ovum only was originally fertilised, and that it divided.

Spaeth, who made elaborate studies regarding twins, found

[1] Scanzoni's *Beiträge*, 1868. [2] *Edinburgh Med. Journal*, 1858.

in 185 cases the placentas separate with two chorions and two amnions, forty-nine times; placentas united, with two chorions and two amnions, forty-six times; placentas united, one chorion and two amnions, twenty-eight times; placentas united, one chorion and one amnion in two cases. When the chorion was double he never found in the united placentæ any anastomosis between the vascular districts of the two umbilical cords, even when no line of demarcation could be discovered between them. Anastomosis was found in both cases where with one chorion one amnion existed; and out of the twenty-eight cases of one chorion and two amnions, anastomosis was met with seventeen times. In every case the anastomosis took place by thick vascular branches (Naegelé); it lay quite superficially on the fœtal side of the placenta. Its existence was always ascertained by injections. The anastomosis exists sometimes between the veins, sometimes between both arteries and veins. Smellie and Levret had noticed this.

Hence the practical deduction to tie the cord of the first child on the maternal side where twins are suspected. The second twin before its expulsion may bleed through the umbilical cord of the first unless its placental end be tied. Spaeth gives a case where the second child was quite anæmic from this cause.

In general the *children were of unequal size.* Although twins are generally inferior in size to single children, both may attain the normal size of the latter; the larger of the two commonly does so.

Vital relations.—Of Spaeth's 185 cases, both children were alive at birth in 176; in eight cases one was alive; in one both had been dead some time. 'In four cases the dead child was much smaller and macerated. In three cases twisting of the cord was the cause of death. In one case fibrinous deposit in the placenta was the cause of death.' The cause of death in this case specified by Spaeth is doubtful.

A curious phenomenon is sometimes observed. The two ova of a twin-pregnancy, or the two halves of a twin-ovum, present a high degree of *independence in their development.* Cases of one ovum remaining sound, and of the other being converted into a vesicular mole, and of one embryo being normal, the other malformed, are noted. Spaeth noticed in a case of united placentæ with two chorions, one of them studded with calcareous concretions, the other not. In another case fibrinous deposits have been found in one placenta and not in the other; in this case both twins were living. But the most singular cases are those in which one fœtus has died whilst the development of the other has gone on, although both were enclosed in a common chorion, and well-marked vascular anastomosis has been visible on the fœtal surface of the united placentæ, and the vessels of the dead embryo have not become impervious by twisting of the cord.

Tarnier relates a case in which one fœtus was acephalous, the other well-formed and living. Claudius[1] has made some very interesting observations upon this subject. All the capillary system of the placenta, he says, belongs to the well-formed fœtus. The umbilical vessels of the monster are composed of a venous branch and an arterial branch, which run respectively into the umbilical vein and one of the umbilical arteries of the other twin. Förster, admitting this disposition, applies it to explain the mechanism of the circulation in acardiac monsters. 'Under the influences of the contractions of the heart of the twin, one part of the blood of the umbilical artery of the well-formed fœtus penetrates the body of the acephalous through its umbilical artery, and is distributed to the different parts of the body; it is then taken up by the capillary venous system, is collected in the veins, and by the intervention of the umbilical vein runs into that of the well-formed fœtus, to be distributed a second time in the body of this last. It results that the acephalous receives always a blood which has served for the nutrition of its twin, and which must have passed through the placenta for oxidation. This may explain the incomplete development of the body and the special preponderance of cellular tissue, as well as the œdema seen in many acephalous monsters.'

Guillemot thought that the atrophy of one fœtus in the presence of a fellow that preserved its vitality was due to compression. Cruveilhier, as we have seen, thought it due to disease or detachment of the placenta. Caseaux and Tarnier think it due in most cases to disease of the embryo, of its membranes or placenta. Our own opinion is strongly in favour

[1] *Die Entwickelung der herzlosen Missgeburten*, 1859.

of the theory of compression. The dead fœtus is found so squeezed that it is called 'foliaceous.' When describing the diseases of the placenta, it will be seen to follow from the researches of Robert Barnes on fatty degeneration of the placenta, that the particular condition of the placenta found in these cases is really a *post-mortem* adipocerous-like metamorphosis.

We have seen that of twins one may be normal, the other deformed. Both may concur to produce a double monster. They may be fused together by the head, *cephalopagi* ; by the trunk, *xiphalopagi* ; or by the pelvis, *ischiopagi* (G. St.-Hilaire). These are almost certainly examples of division of one ovum.

Signs and diagnosis of twin-gestation.—The *general signs*, due to compression of the abdominal vessels and encroachment upon the thorax, are too uncertain to warrant confidence.

We must appeal to the *local signs brought out by obstetrical exploration.* The woman lying on her back or standing, a front view reveals *greater prominence of the abdomen* ; the shape is less regular ; we sometimes recognise *two prominent points at the fundus with a depression more or less central between* ; generally also, especially if the two heads are seated in the fundus, the *uterus and abdomen are broader across.*

The touch or palpation offers the best evidence. Pinard describes a *permanent tension of the uterine wall*, comparable to the sensation imparted by a tightly-filled cyst. Then the heads may be made out ; they offer each a round, hard, mobile mass, giving cephalic ballottement. Pinard gives the following method : 'One fœtal pole, the lower, is found in the pelvis or at the level of one of the ilia. The continuous and resisting plane is sought for and found. So far the sensations are similar to those of single gestation ; but on depressing the abdominal wall on the side opposite to the resisting plane, instead of recognising the small parts we find another, large or else a resisting plane. Then we must carefully explore both iliac fossæ and the upper segment of the uterus. Most frequently two large extremities are found either below or above. But whilst in some cases we may quickly detect the existence of four fœtal poles, two above, two below, it is sometimes only possible to make out three; the fourth, deeply situated, is hidden behind one placed in front. It is generally easy to recognise two resisting planes and the presence of small parts in several regions of the uterus. Thus proceeding gently, so as not to displace the fœtus, the presence of two big extremities, corresponding to the upper or lower region of the abdomen, puts us directly on the road to a diagnosis.'

Vaginal touch will sometimes enable us to make out a head in the pelvis; whilst abdominal touch may have demonstrated the presence of another head at the fundus of the uterus, or in an iliac fossa. Ballottement is difficult in presence of twins, unless there be great excess of liquor amnii.

During labour touch may distinguish two successive bags of membranes.

Auscultation may render conclusive evidence. We seek for two *maxima* of intensity of fœtal sounds; and we may also distinguish *two rates of pulsations*.

Course and terminations.—Twin-gestations frequently end before term, both being alive. Since one fœtus may die prematurely, it may excite the uterus as a foreign body and provoke the uterus to empty itself; but not seldom the developmental stimulus kept up by the living fœtus may overcome the influence of the dead fœtus, and gestation may be prolonged to the normal date.

The disposition of the fœtuses in twin and other multiple gestations in the uterine cavity is so essentially a clinical question that the consideration of it will be more convenient under the head of Dystocia.

It is enough to note in this place that the disposition is governed by the law of accommodation. In the cases of twins the fœtuses may be placed—1. Side by side, the most frequent arrangement. 2. One above the other. 3. One in front of the other. In order to pack most compactly, it commonly happens that one fœtus will present with the head downwards, its fellow with the breech, so that the head of each is in relation with the other's breech. Sometimes, however, both present head lowermost; in this case the head of one is at a higher level than the head of its fellow.

Triple gestation.—Puech has made a careful analysis of cases. He calculated that the proportion was 1 in 4,054 for Russia; 1 in 4,995 for Ireland; 1 in 5,442 for Norway; 1 in 6,824 for a large part of Germany; and 1 in 8,256 for France.

Anatomical arrangement.—In 8 cases there were three placentas; in 15 cases, two placentas; in 27 cases, one placenta.

1. With three separate placentas, there are three distinct fruit-sacs, each having a chorion, an amnion, and each containing a fœtus. Sometimes, as in a case which came under Robert Barnes, the three placentas are quite separate, being cast one after the other. More often they cohere at their margins; but the circulations remain distinct. Specimens may be seen in most museums.

2. *With two placentas distinct.*—One sac is complete for one of the fœtuses, and this sac corresponds to the smaller placenta. To the other placenta, which is about twice as large, the corresponding membranes may present one sac for the two fœtuses, or there may be two sacs with chorion and amnion dividing them, each with its fœtus; or there may be two sacs with intervening amnion only.

3. *With a single placenta.*—(1) There may be no line of demarcation. In this case there is one sac enclosing the three fœtuses. Or (2) there may be one line of demarcation. In this case the arrangement is similar to that in which there are two separate placentas. Or (3) there may be two lines of demarcation, and three distinct placental districts; then each fœtus has its own sac.

The sexes.—Veit found the same sex 768 times, different sexes 921 times, thus distributed: 3 boys, 409 times; 3 girls, 359 times; 2 boys to 1 girl 501 times; and 2 girls to 1 boy, 420 times. So that the general law that more boys than girls are born holds good here.

The diagnosis.—One sign has been noted: the great size of the abdomen towards the fifth month. By palpation Pinard made out three fœtal heads. Auscultation may distinguish three hearts or points of maximum intensity. Dunal[1] thus made out a triple gestation. But most frequently no diagnosis has been made until after the birth of one or two of the fœtuses. The successive presentation of a new bag of membranes and ballottement then point to the state of things.

[1] *Considérations pratiques sur les grossesses triples*, 1860.

The course and terminations.—Triple gestations rarely reach maturity; most commonly labour sets in about or before the seventh or eighth month. Abortion is more common in primigravidæ. As in twins, one of the fœtuses may perish; then it may either be expelled in the course of the gestation, or it may be preserved *in utero* until the other living fœtuses are born. In Robert Barnes's case, referred to above, the uterus ruptured spontaneously.

It is not rare to observe all three children to be born alive viable, and reared.

Quadruple gestation.—The placentas may be distinct or united; there may be one, two, three, four fruit-sacs. As to the *sexes*, there were 4 boys, 7 times; 4 girls, 6 times; 2 girls and 2 boys, 9 times; 3 boys, 1 girl, 8 times; 3 girls, 1 boy, 6 times. The aggregates are the same for each sex.

Diagnosis.—One is hardly likely to be called upon to make one. The difficulty increases with the complexity.

The termination is usually premature. We do not know of survivals. But the elder Dr. Rigby's wife brought forth four children born alive, who were named Primus, Secundus, Tertius, et Quartus. The same lady brought forth, we believe, twins and triplets.

Quintuple gestation.—Galopin[1] relates the following case: A woman in her seventh pregnancy brought forth five children at five months and a half. All were living at birth, but died in a few minutes. All were boys. There were two placentas adherent by a small part of their circumference; three cords were inserted in one placenta, two in the other.

[1] *Journal de Bruxelles*, 1867.

CHAPTER VIII.

THE SIGNS AND DIAGNOSIS OF GESTATION—PATHOLOGICAL STATES WHICH SIMULATE GESTATION—THE DURATION OF GESTATION —CARE OF GRAVIDA.

The Clinical Discussion of the Signs and Diagnosis of Pregnancy.

THE preceding study of the process of gestation in its successive stages will supply the groundwork and many of the details out of which the diagnosis of pregnancy may be established. But for clinical purposes a special line of study *ad hoc* is necessary. This special line will also serve to fill in several points in the history of gestation hitherto passed over lightly in order to avoid repetition. We will therefore set out first the problems which have to be solved in practice; and then by analysis and synthesis examine the value of the several signs or phenomena of pregnancy individually and collectively.

The question: *Is a woman pregnant?* may present itself under various circumstances. And we may usefully dispose at the onset of certain moral, psychical, and emotional complications which force themselves into almost every case, often embarrassing our judgment.

We may divide the women who become the subjects of inquiry into three classes: 1. Those women, mostly married, who have no motive for misleading and no wish to mislead the physician, but in whom the existence of pregnancy is doubtful.

2. Women, mostly married, who wish to persuade themselves and to persuade the physician that they are pregnant. This class includes those cases of women, sometimes single, who seek to found a claim upon other persons. It includes the cases of women who at the climacteric misinterpret certain subjective phenomena, and believe themselves pregnant; and

other cases, climacteric or not, in which the subjects are under the influence of insane delusions.

3. Women, single or married, who fear they may be pregnant and who would persuade you they are not.

The question of pregnancy is sometimes complicated with other conditions. For example: not only may ovarian tumours, fibroids of the uterus, ascites, ectopic gestation, and other conditions simulate uterine gestation, but any one of them may coexist with uterine pregnancy. These complications present the greatest difficulty. One of the complicating conditions may be detected, the other overlooked.

The simple issue, pregnant or not pregnant, then, is surrounded and obscured by all the fallacies of history and of innocent or wilful deceit. To guard against being misled by these sources of error we must draw a rigid line between subjective and objective phenomena. Without altogether disregarding the purely subjective signs, it may be stated broadly that they should never be accepted as sufficient proof of pregnancy. The subjective signs rest almost absolutely within the consciousness of the woman. To accept them from her, or even to be influenced by them, is to surrender the function of the physician. The wise physician must suppress that kind of reflex or emotional reasoning which consists in hasty responses to the impressions conveyed by the mental or emotional expressions of the patient. His duty is to solve a medical problem by the strict processes of medical science. That is, he must rely mainly if not absolutely upon the objective signs.

Gooch expressed this idea grossly but tersely, saying, 'In these matters we must not believe a woman's words, but her belly.'

Basing upon this principle, we shall see that it is not less dangerous than ungenerous to seek to extort a confession of immorality or error from a woman suspected to be pregnant; and still less shall we be justified in taxing her with her misfortune in the presence of others.

We must not help out what should be a purely scientific objective diagnosis by applying the torture of moral inquisition. When we have come to a positive conclusion, the woman may be told gently but clearly that she is pregnant; we may advise her that she must take measures accordingly. She may deny the possibility of this condition. We may reflect that she is not bound to criminate herself; and we may be sure that, howsoever eagerly she may outwardly repel the unwelcome decision, she will inwardly accept it. Above all, we must never forget that we are physicians; and that we have no right to step outside our proper domain by assuming the functions of the law.

It is convenient to *divide gestation into three stages* for the purposes of diagnostic description. These may be defined as follows: *first stage, ending with the fourth month*; the *second, ending with the sixth or seventh month*; and *the third, ending with the full term.* The first stage presents the most difficulties. During the second and third stages, whilst the signs of the first persist and become even more accentuated, new signs, some of them of conclusive value, are developed. This division is made purely to facilitate description. The stages cannot be rigidly defined; they merge by imperceptible gradations.

A few lines, then, will suffice to enumerate the *subjective signs*:—1. Peculiar sensation at the time of coition interpreted as evidence of conception. 2. The arrest of the catamenia. 3. Certain sensations of pelvic distress, perhaps frequent micturition; 4. Disturbance of the digestive system, of which the prominent mark is *vomiting*, the 'morning sickness.' 5. Sensations of swelling, &c., and tension in the breasts. 6. In advanced gestation many women feel the movements of the child, or movements of the uterus.

Appreciation of the subjective signs.—These signs do not carry positive evidence either individually or in the aggregate. Each is open to fallacies. Each and all constantly deceive. The *first* is vitiated by two facts. In the first place, the peculiar sensation is not a necessary phenomenon. Many women conceive without noticing anything of the kind; they may be even altogether unconscious of impregnation having taken place. In the second place, many women—the wish or the dread being mother to the thought—have fancied or declared they had experienced the sensation who had not conceived at all. The *second sign* is notoriously untrustworthy. Menstruation, in the first place, may have been absent some months before conception. This happens not seldom to suckling women. Some have thus conceived, bringing forth and suckling several children in succession without menstruating. In the second place, the cases are not uncommon in which menstruation, or at least a simulating periodical discharge of blood, is observed during several months of gestation. The *third sign*, the pelvic distress, sense of weight, heat, frequent micturition, may be produced by enlargement of the uterus from other causes. The *fourth sign*, the morning sickness, is perhaps the most valuable; but it may be absent altogether; it may be due to other causes, amongst them to uterine distension from other causes than pregnancy; and it may be procured designedly or falsely affirmed to exist. The *fifth sign*, the sensations in the breast, have no absolute value, for reasons similar to those which vitiate the fourth sign. It only merits attention when it is confirmed by objective signs. The *sixth sign*, subjectively considered, is sometimes of value; but we cannot always place implicit confidence either in the correctness of the woman's interpretation of her sensations, or in the truthfulness of her statements. We have even known more than one instance of a pluriparous married woman, apparently free from all motive for dissimulation, declaring herself quite unconscious of being pregnant, until overtaken by labour at term. We conclude, then, that these subjective signs, separately analysed, justify no decision, positive or negative. Nor do they acquire value considered synthetically. In this respect they differ from certain objective signs which, taken together, almost compel an affirmative judgment, illustrating the old Roman law maxim: 'Multa collecta probant, quæ singulatim non probant.'

One remark it is important to make. Whatever the value of the subjective signs, it is chiefly limited to the first two or three months of pregnancy, when the more certain objective signs are not yet developed. For this evidence we should wait. Justice to the patient, prudent regard for his own reputation, will dictate to the physician reticence in the absence of conclusive evidence. Adjourn the case for a month, and so on from month to month, until Time, the great solver of mysteries, shall develope exact positive signs, or enable us to decide in the negative.

The Objective Signs of the First Stage, or Trimestrium, of Gestation.

Referring to our sketch of the natural history of gestation, we may distribute the objective signs of early gestation as follows:—(A.) Alterations in the play of the nervous system, including some subjective phenomena. (B.) Alterations in the vascular system. (C.) Alterations in the glandular system, including the breasts. (D.) Alterations in the skin and mucous membranes, including pigmentation. (E.) Alterations in the uterus and vagina.

(A.) *Alterations in the nervous system* may be passed by, referring back to the description under the Natural History of Gestation. It is enough to state here that, although some of the nervous phenomena have a distinct objective value when witnessed by the skilled observer, they only acquire real diagnostic value when studied in connection with the more absolute objective signs to be described in succeeding paragraphs.

(B.) *The alterations in the vascular system* possess great objective value. Referring back to the chapter on the Natural History of Gestation for the main facts ascertained as to the chemical and microscopic characters of the blood, we have here to consider more especially the changes in the dynamics of the circulation and in the structure of the heart and blood-vessels. The physiological hypertrophy of the heart can hardly be estimated for diagnostic purposes by percussion or other means; but its action upon the arteries and the attendant changes produced in the capillaries and veins are open to precise observation. There are three leading facts: first, the predominant vascular activity in the region of the pelvis, determined by the developmental nisus; secondly, the correlated increase of arterial tension; thirdly, the general fulness and distension of the capillaries and veins. We get distinct objective evidence of all these conditions. First, examining the vulva, vagina, and vaginal-portion by the eye, using the speculum, *the mucous membrane is seen tumid, deepened in colour, from dark to dusky-red, even of violet hue*, and in some cases almost black. Sometimes the smaller veins are so greatly enlarged that they form prominent tortuous elevations at the lower part of the vagina and on the labia vulvæ. So marked may this venectasis be that large masses are found, projecting like a tumour, outside the vulva. Thus we have known such a mass described by the patient as the presenting foot of the child. This is sometimes called *Kluge's test.* McClintock says—and we confirm his statement—that the colour fades if the embryo dies.

But the capillary and venous fulness is not limited to the genital organs. The anus and the rectum, as far as it can be seen, are intensely hyperæmic; piles may be produced, and, where already existing, are greatly enlarged and of darker colour. More than this: although the centre of greatest hyperæmia is in the pelvic vascular region, a similar condition is seen elsewhere. The *thighs and legs commonly show the superficial veins red and branching*, and *varicose knots* are often seen on the legs and at the crural arch. So significant are these superficial venous arborisations, that we are accustomed to regard them as the strongest presumptive evidence of pregnancy. Whenever we see them in a distinct form on the thighs of young women there is ground enough to make further inquiry, and it is very rare indeed not to find corroborative evidence in the state of the mucous membrane of the vagina already described. Singly, these signs are of great value; taken together, they challenge almost implicit confidence. The arborescent state of the superficial veins of the legs may, indeed, exist under other conditions than that of pregnancy, and the purple coloration of the vagina may be simulated by the hyperæmia dependent upon impediment to the portal veins, as in women at or approaching the climacteric. But the concurrence of the two conditions will almost invariably be found to be due to pregnancy. We are, however, seldom reduced to the position of having to decide upon these alone. The active hyperæmia of the vagina is attended by a *white cream-like secretion hanging about the vaginal-portion* and the fundus of the vagina, which is all but characteristic when seen upon the described purple mucous membrane. This secretion consists almost entirely of vaginal pavement-epithelium-scales in a state of granular degeneration, held together by a little plasm. This *epithelium-shedding* is the natural result of the intense vascularity of the mucous membrane. The addition of this sign, again, lends cumulative weight. If we discover, as we shall rarely fail to do where these are present, *increased weight and bulk of the uterus*, we then arrive at a compact and consistent body of evidence pointing almost irresistibly to pregnancy. The *veins of the breasts at the same time exhibit similar prominence* and development. But the value of the breast appearances and the conditions of the uterus will be discussed further on.

We may now consider the *correlated increase of tension of the arterial system.* The sphygmograph places this in the clearest light. Fancourt Barnes has studied this subject with care. In the diagnosis of early pregnancy the aid of the sphygmograph should be called in.

(C.) *Alterations in the glandular system, including the breasts.*—The changes produced by pregnancy in the breasts naturally attract more attention than those of other glands. They form a second centre of developmental activity. The changes in them proceed, *pari passu*, with those in the uterus.

In the appreciation of the worth of the signs given by the breasts we must bear in mind—first, that the appearances of fulness, distension, superficial venous development, prominence of the glandules of the areola, darkening of the areola, and secretion of milk, may all be due to the transient influences of a menstrual period; they, or one or more of them, may be associated with ovarian or uterine disease; in some cases of pregnancy these signs are so faint, even if recognised at all, that they carry no weight. Again, in some cases of women who have borne children, the breast-changes persist in so marked a manner that it is difficult to decide whether or not the changes observed are due to an antecedent gestation. Another caution is necessary: Whatever confidence skill in observation of the breasts may give, evidence offered by them should not be accepted as conclusive. If pregnancy exist we shall surely find other evidence of it to confirm a diagnosis which otherwise can only be presumptive. Some physicians who have devoted particular study to the subject have acquired great confidence in the signs the breasts present. An anecdote is reported of William Hunter, that on seeing the body of a young woman in the dissecting-room, on looking at the breasts, he pronounced her to be pregnant. She was found to have an intact hymen. Hunter persisted notwithstanding, and on opening the abdomen his diagnosis was verified.

Montgomery[1] says: 'When conception has taken place and the menses have been suppressed for one or two periods, the woman generally becomes sensible of an alteration in the state of the breasts, in which she feels an unceasing sensation of throbbing, or of stretching fulness, accompanied by soreness and tingling pains felt about the centre of them, and in the nipple. The breasts grow larger and firmer; a circle around the nipple becomes altered in colour and structure, constituting the areola; and as gestation advances milk is secreted. But there is considerable variety in the period of gestation at which these changes may occur.' In some they are developed early, in others the changes are hardly perceptible until gestation is far advanced; and in some they are so little developed as to present nothing characteristic.

It is difficult, if not impossible, therefore, to give a definite statement of the breast-changes to serve for diagnostic purposes according to the successive stages of pregnancy. Generally they are not very well marked during the first trimestrium they become more conspicuous during the second trimestrium, and increase in value towards the end of the last trimestrium. But at this time they are more or less superfluous, since absolute signs will have been developed in the uterus. Milk oozing from the breasts will stiffen the linen of the dress with which it comes in contact. In this way suspicion of gestation has often been aroused.

The mammary signs of pregnancy are thus admirably summed up by Rœderer: 'Menstruorum suppressionem mammarum tumor insequitur; quocirca, mammæ crescunt, replentur, dolent interdum, induresscunt; venæ earum cæruleo colore conspicuæ redduntur, crassescit papilla, inflata videtur, color ejusdem fit obscurior, simili colore distinguitur discus ambiens, qui in latitudinem majorem expanditur, parvisque eminentiis, quasi totidem papillulis, tegitur.'

To Rœderer's description the following conditions may be

[1] *Signs and Symptoms of Pregnancy*, 2nd ed. 1856.

added as deserving special notice: A soft and moist state of the skin of the areola, which appears a little raised above the surrounding skin, and in a state of turgescence, giving the idea that if touched by the point of the finger it would be found emphysematous; 2, the little glandular follicles or tubercles of Morgagni are bedewed with a secretion sufficient to damp and colour the woman's inner dress; 3, later on the dark pigmented areola presents round spots lighter than the prevailing tint, resembling what might be imagined to be the effect of letting drops of water fall upon a black pigment and partly washing it out; 4, blue veins, slightly prominent, are seen coursing over the breast and the areola.

These features do not all come into prominence at once or at an exactly defined time. They also vary in intensity in different individuals, being especially marked in brunettes. But the development of the superficial veins is often marked in blondes. The combination of these conditions affords very strong evidence of gestation. It is rare to find a case where a similar combination is produced under any other circumstances.

The breasts increase in volume. During the first pregnancy, says C. Langer,[1] new glandular vesicles are formed; thus in the breast, as in the uterus, new elements appear. In the succeeding pregnancy the breasts enlarge again, but there is no development of new vesicles.

Montgomery says the colour of the areola depends on the deposition of an actual pigment between the cuticle and subjacent skin. Dubois says he saw an instance in which the cuticle peeled off the disk of the areola, carrying with it the pigment in small scales.

(D.) **Alterations in the skin and mucous membranes.**—Some of these alterations dependent upon changes in the vascularisation and glandular action have been already described. A most remarkable change is that resulting from pigmentation. This has been described in the chapter on the Natural History of Gestation. It only remains in this clinical connection to refer to the fallacies which attend pigmentation when regarded as a test of pregnancy. It may be stated in the first place that the pigment-phenomena are chiefly of value in

[1] 'Ueber den Bau und die Entwickelung der Milchdrüsen.'—*Denkschriften der Wiener Akademie*, 1851.

first pregnancies. The pigment-deposits found in the first pregnancy are apt to persist more or less, to be intensified probably in subsequent pregnancies, but also to be seen in the non-pregnant intervals. Secondly, pigment-changes in the breasts, on the abdomen, and elsewhere, as produced in pregnancy are occasionally simulated under conditions distinct from pregnancy, and especially in connection with uterine and ovarian diseases which may be attended by abdominal enlargements, and therefore suggestive of pregnancy.

Still the significance of the characteristic pigment-changes should not be disregarded. Although never attaining *per se* to more than presumptive value, they do possess a certain weight as part of a body of cumulative evidence.

The skin-changes will be further described with the signs of the third trimestrium.

(F.) **Alterations in the uterus and vagina.**—The visible alterations in the vaginal-portion and vagina have been already described and estimated. The alterations in the uterus proper are of the highest importance. They consist in changes of (1) size and weight, (2) of form, (3) of position or relation to other organs. These are all made out by touch.

(1) Immediately after fertilisation the uterus swells, becoming turgid from the attraction of blood into its substance. The increase in size and weight soon becomes sensible to the touch. But before a month has elapsed the difference is hardly marked enough to justify more than conjecture. At the end of a month, however, the difference gives an objective sign of considerable value. In conducting the examination, the woman is placed first upon her back with the shoulders slightly raised, and the thighs a little flexed. The index finger is then passed into the vagina, and carried along the posterior wall until it strikes upon the vaginal portion of the uterus. We then determine several physical conditions. The *position* of the vaginal-portion: this is in the sacral hollow. If a line be drawn subtending the arc formed by the sacrum from the projection of the promontory to the top of the coccyx, the os externum uteri will at the end of the first month point a little above the middle of the line. The vaginal-portion gives a soft velvety sensation to the finger; the os itself may be more or less open: in primiparæ it may admit the tip of the finger, in

pluriparæ much more ; secondly, carrying the tip of the finger forwards along the anterior surface of the vaginal-portion, tracing it to the body of the uterus, we feel through the anterior upper wall of the vagina the smooth rounded form of the uterine body, depressing this part of the vaginal wall, smoothing out to some extent its rugæ. This is due to the nutation of the uterus under the increase of weight which

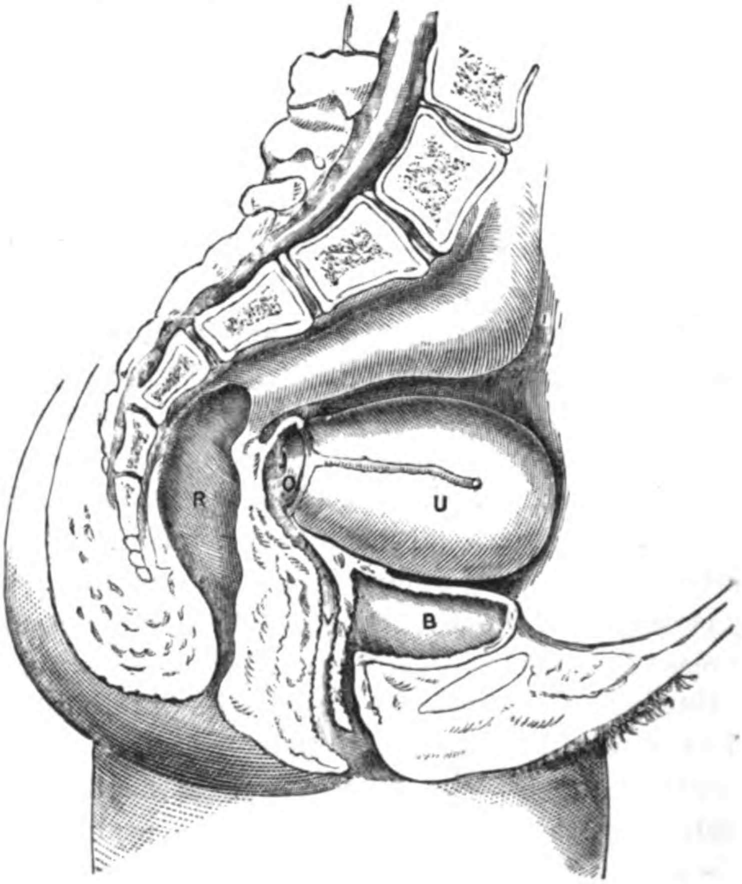


FIG. 88.

Diagram showing nutation of uterus at second month of gestation and 'anterior vaginal roof-stretching' (Robert Barnes).

U. Uterus. O. Os uteri. R. Rectum. V. Vagina. B. Bladder.

affects the body and fundus of the uterus. This nutation of the fundus tilts up the vaginal-portion, and explains why the os is felt so high up underneath the promontory, and also the smoothing of the anterior wall of the vagina. Thus is formed an inclined plane upon which the uterus rests. By the ascending retreat of the vaginal-portion the base of the bladder by its connection with the anterior wall of the cervix uteri is dragged up, and the urethra is sometimes drawn up a little behind the symphysis pubis. This condition and the pressure of the fundus uteri upon the bladder explain the frequent desire to micturate which harasses women in early pregnancy. In this up-tilting of the vaginal-portion, the vagina is really deviated from its ordinary track. Its upper half is carried backwards. This condition, very characteristic, Robert Barnes has called '*the anterior vaginal roof-stretching*.' The woman still in the dorsal position, the finger pressing upon the uterine body through the anterior vaginal wall finds that it is heavier and bigger than the healthy not-pregnant organ. This observation is repeated in another way: the finger is carried back to the os uteri; poising the uterus upon the finger-tip, the weight can be closely estimated; keeping the finger in the same position the finger-tips of the other hand are pressed upon the abdomen just above the symphysis pubis; thus the fundus of the uterus may be felt, and the combined or alternate pressure of the finger on the os uteri and of the fingers outside give very close estimate of the size and weight of the uterus.

The observation may now be extended and repeated by placing the woman on her left side with the knees drawn up. In this posture one can often get a better command of the uterus between the two hands. Should there be any difficulty in examining by the vagina, the finger may be passed up the rectum. The vaginal-portion is thus easily felt.

Appreciation of the signs described.—Increased weight and size telling most upon the fundus and causing similar irritation and vaginal stretching and deviation may be due to fibrosis, to general hyperplasia, to intra-uterine polypus, or other morbid conditions. But it will rarely happen that anything else than pregnancy will also produce the changes of colour in the mucous membrane and the other objective alterations described. We have known a case in which the heart was weak, often intermittent in action, the circulation slow, the hands often blue, in which the vagina presented a deep-blue injection hardly distinguishable from that of pregnancy. Obstruction of the portal circulation also may give rise to a similar appearance. Thus the evidence, howsoever strong, is not absolute; and it will not be wise to commit oneself to a positive opinion either in the negative or affirmative. Take note as accurately as possible of the conditions observed, and store them for future comparison.

At the end of the second month all the signs just described are more pronounced, and the comparison of the state of things at the two epochs gives evidence of increasing value. Proceeding by the same method of examination, we find the nutation of the body, the rising of the os uteri, which now will be found near the upper third of the line subtending the coccygo-promontorial arc, the vaginal roof-stretching, the volume and weight of the uterus increased; by the bimanual touch the fundus of the uterus is more distinctly felt a little above the level of the upper edge of the symphysis pubis. The dark colour and turgidity of the vagina are intensified. The evidence grows stronger every day.

At the end of the third month the signs have become even more distinct. The vaginal-portion is still prominent, it is closer under the promontory; the fundus is still in nutation, and it may be felt more clearly under the bimanual touch, coming more close to the abdominal wall.

The objective signs as now developed taken together form a very strong body of evidence; and if we have had the opportunity of making observations at the end of each of the two preceding months, and thus are in a position to trace the gradual and regular increase of the uterus in size and weight, we then possess evidence that rises to the highest degree of probability. Still we have not attained to certainty, at least not to that certainty which would warrant us in delivering an unqualified affirmative opinion in a court of law.

This is to say, that the diagnosis of pregnancy during the first stage is still not absolute, although it may be clear enough to guide the conduct of the physician in advising his patient.

New evidence of increasing intrinsic value is gathering, and adding strength to the evidence developed during the first trimestrium.

Objective Signs of the Second Stage or Trimestrium.

This new evidence is brought out—1, by auscultation ; 2, by abdominal palpation ; 3, by repercussion or ballottement.

At the end of the third month, sometimes auscultation lends its aid. Before setting forth the applications of Mayor's grand discovery, it will be convenient to state simply what signs are detected by auscultation, in the order of their relative importance, disregarding the chronological order of their evolution.

These *auscultation-signs* are—1, the sounds of the fœtal heart—Mayor's original discovery, 1818 ; 2, the uterine souffle—De Kergaradec's discovery, 1822 ; 3, feeling the movements of the fœtus by a metroscope applied by vagina—Nauche's discovery, 1829 ; 4, the pulsation of the umbilical cord, the funic souffle—Evory Kennedy's discovery, 1833.

If we take these phenomena in the order of clinical observation, the order most useful for our purpose, we first seek to detect the *uterine souffle*. This is rarely detected earlier than the thirteenth or fourteenth week. This sound has been variously interpreted. Some thought it simply due to anæmia, that it was in fact an anæmic souffle heard in the external iliac arteries. This theory has not been widely received.

The placental theory.—Hohl and others held it to be produced by the passage of blood from the uterine arteries into the placental sinuses: hence it has been called the placental souffle or bruit. That this theory cannot be absolutely true is proved—1, by the fact that the sound is often heard with equal distinctness in both inguinal regions in cases where observations during labour prove that the placenta was situated at the fundus uteri ; 2, that the seat of the sound is shifting, now heard in one place, now in another ; 3, that Bailly and Maggia show that the sound continues for several hours, even three days, after the expulsion of the placenta.

The *iliac theory* advocated by Bouillaud is that the sound is produced in the large arteries of the pelvis under compression from the gravid uterus. Whenever an arterial trunk is compressed, a *bruit de souffle* is produced ; and then there is the quasi-chlorotic blood of gravidity to favour the production of the sound. But the theory is untenable—1, because the sound has been heard in the second or third month, that is, before the uterus is big enough to compress the pelvic arteries; 2, because the sound should invariably be heard in the sides and lower part of the abdomen, which is not the case; 3, the sound is still heard when the subject is placed in the knee-elbow posture, so that the uterus falls away from the arterial trunks; 4, because the fact of persistent compression of the vessels even in advanced pregnancy is doubtful; 5, the *chlorotic* part of this *theory* is disproved by a clinical observation made by Robert Barnes. In a woman seen at St. Thomas's Hospital, the placental or uterine souffle was heard characteristic on one side, and the normal sound of the iliac artery was heard on the opposite side.

The uterine theory.—The theory that the sound is produced in the uterus was started by P. Dubois, and is adopted by Tarnier and Marey. The sound is sometimes quite superficial; even a thrill is sometimes perceived by the touch. This can only come from the uterine vessels. Dubois likened the sound to that which takes place when an arterial thrombus suddenly throws its blood into a vein. He held that the uterine walls were transformed during gestation into a kind of erectile tissue. But Jacquemier demonstrated that the large and free communications between arteries and veins admitted by Dubois do not exist. Corrigan and Depaul thought the *bruit de souffle* was due to a change in the calibre of the uterine arteries. At the point where the arteries penetrate the uterus they divide and expand, so that the divisions have a greater calibre than the trunk from which they rise. Now whenever fluids run under these circumstances a friction sound is produced.

This theory will explain the occasional occurrence of the sound in the front of the uterus. But it appears that it is quite consistent also with the placental theory. The uterine arteries emerging from the inner wall of the uterus suddenly open into the placental vascular system. This is exactly the condition postulated by the theory now discussed. The placenta may be likened to a vascular tumour.

The epigastric theory.—Kiwisch,[1] Glénard,[2] of Lyons, and Hecker showed that the sound may be in the epigastric

[1] *Klinische Vorträge*, 1849. [2] *Archives de Tocologie*, 1876.

artery. Glénard said that by compressing this artery the sound was stopped. To this Tarnier objected that the compression used to stop the epigastric might compress the trunk of the uterine arteries. Thus Glénard abandoned the epigastric theory, and after new observations submitted that the seat of the sound was in an artery situated on the antero-lateral wall of the uterus, which he called the *puerperal artery*. This is to fall back upon the uterine theory.

We are disposed to conclude that there are two scurces of the sound—1, in the vessels in the uterine walls; 2, in the utero-placental circulation. We do not think the placental theory can be absolutely rejected.

Its distinctive characters are:—1. A blowing, snoring, whistling, or rushing sound, resembling the sound heard in the neck of chlorotic girls; Depaul says it is very closely imitated when we pronounce the word '*vous*' softly. 2. Isochronism with the mother's pulse. It is a maternal sound. 3. It is inconstant in place, intensity, and other qualities. It may change seat; heard at one time in one spot, at another time it may be heard in a spot where it could not be heard before. Sometimes the sound is lost for a time, then reappears. Its *intensity* increases usually with the advance of gestation. It is modified, says Depaul, by all causes which diminish the calibre of the vessels of the uterus; by strong compression with the stethoscope, by certain active movements of the fœtus, and, above all, by uterine contractions.

How to observe the uterine or utero-placental sound.—Place the subject on her back, with the shoulders slightly raised; bare the abdomen from the pubes to the epigastrium, so as to command the entire area occupied by the uterus. Apply the stethoscope first immediately above the pubes in the median line; then on either side above Poupart's ligament; then carry it over the whole accessible surface of the uterus. To determine its isochronism with the maternal heart-beat, either, first count the souffle-sounds watch in hand, and then count the radial-pulsations and compare the number of beats obtained from each source; or compare the two simultaneously by concurrent observations of ear and finger.

The binaural stethoscope is especially useful in uterine auscultation, as its flexibility enables the observer to apply the cone to any part of the uterus without awkward stooping or changing his position.

Fallacies.—A sound, hardly if at all distinguishable from the uterine souffle of pregnancy, is heard, rarely indeed, in some cases of ovarian tumours and myomatous tumours of the uterus. In such cases other signs, negative or positive, will rarely be wanting to establish a diagnosis.

Sometimes where pregnancy is undoubtedly present the sound is not detected at all. It may be heard one day and not the next. If not heard, therefore, the observation must be repeated before pronouncing a decision against pregnancy or concluding that the child is dead.

Sounds produced by the active movements of the fœtus.—The fœtus executes certain movements. Listening, one hears the sound of shocks comparable to that produced when the finger-tip strikes a bit of cloth stretched out. These sounds, say Tarnier and Chantreuil, can be heard from the end of the third month. Then they are the effect of the displacement of the entire fœtus. At the end of gestation they are more localised towards the fundus of the uterus. Then they are produced by the movements of the limbs or of the head. The fœtus may even rotate on itself. Auscultation at this moment reveals a particular *rustling sound* ('*frôlement*'). In some rare cases there is heard a rhythmic sound, of slow cadence, apparently produced by the shock of a limb against the uterine wall. These shocks are equal in intensity and occur at regular intervals.

At the third month the sounds due to the *active movements* constitute an excellent symptom of pregnancy not to be neglected, since at this time the heart-beats are commonly inaudible.

The fœtal shock—the '*choc fœtal*' of Pajot is thus described. 'Under the pressure of the stethoscope one perceives, at the same time, at the moment when the movement is produced a double sensation of *shock* and of *quick sound*, but of *extreme delicacy*; the ear struck at the same time in its general and special sensibility receives at once a tactile and an auditory impression.' This sign may be noted at the fourth month. It has, however, but a limited value, since taken alone it is open to fallacies, and when more certain signs are developed it is superfluous.

The fœtal heart-sounds.—The next sounds observed in clinical order are those produced by the movements of the fœtal heart. They resemble those of the adult heart in the mechanism of their production.

The character of these sounds is that they are double. They have been aptly compared to the ticking of a watch heard through a pillow. A more exact idea may be acquired by listening to the heart of a newly-born child. There is a first sound, the stronger, then a brief silence, then a second sound, less intense, then a longer silence. The first sound is due to the ventricular systole.

When is the sound first heard?—Depaul and Tarnier say that in some instances by applying the stethoscope firmly on the fundus of the uterus above the pubes, and repeating the observations, it may be heard about the middle of the fourth month and even as early as the end of the third month. But most authors agree that it is rarely detected earlier than at four months and a half.

The *intensity* of the sounds varies according to the force of the organ giving them; this varies in individuals, and increases with the advance of gestation. It is affected by circumstances favourable or the reverse to its transmission. Thus the thickness of the abdominal walls and those of the uterus, the quantity of liquor amnii, and the position of the fœtus in the uterus, may modify the sounds. During labour, they become louder when the membranes are ruptured.

Generally the sounds are heard over an area four inches in diameter and sometimes over the whole anterior surface of the uterus. But there is one point—*the point of greatest intensity*—where the sounds are clearest. Its seat will vary with the position of the fœtus. Where two maximum-intensities are observed we have evidence of twins.

The *frequency* of the fœtal heart-beat is greater than that of the adult or of the mother. It is stated to range from 120 to 160. Robert Barnes has observed cases in which it did not exceed 100. But it can only be by the rarest coincidence that it will be isochronous with that of the mother. The frequency may vary under conditions arising in the fœtus, such as spontaneous movements or displacements caused by the observer. There is no relation between the rate of pulsation of the fœtal and maternal hearts. But Winckel[1] says, 'When the mother's temperature is raised the fœtal heart beats more quickly;' and that the child is endangered in proportion to the increase of its mother's temperature.

The *slowing* of the fœtal heart-beats is rarely observed during pregnancy except when the life of the fœtus is threatened. The slowing is, however, constant under the energetic uterine contractions of labour. This is observed: at the commencement of the contraction an acceleration of very brief duration occurs, then as the contraction goes on a variable slowing, but never in normal conditions falling below 100. As soon as the contraction yields the beats increase. When the slowing is permanent the fœtus is in danger. Hardy and McClintock found that under the administration of ergot the strength, number, and regularity of the pulsations diminished, and were even extinguished. Robert Barnes made[2] precise observations on the fœtal pulse as affected by uterine contractions and by aërial respiration in cases of children prematurely born before division of the cord. In cases where no respiration was made the heart slowed and was for the time stopped under the uterine contractions, recovering its former rate as the uterus relaxed. Exactly similar conditions were observed under the influence of respirations. These took place at long intervals, so that the observations were easy. When the child breathed the heart-beat rose; when the respiration ended the heart-beat fell, and revived again at the next respiration. This experiment is easily made by feeling the umbilical cord at the navel. It illustrates the analogy between placental and aërial respiration, showing that one is the equivalent of the other in influence upon the heart.

Is the rate of heart-beat different in the two sexes?—Frankenhaüser (1859) affirmed that the female heart beat more quickly than that of the male, and that a beat above 144 in the minute indicates a girl, and a beat below that rate a boy.

Others have tested these conclusions, some supporting, some contradicting. Our own experience agrees with Budin and Chaignot's observations. They declare that there is no constant relation whatever. Quick and slow rates are found in

[1] *Die Pathologie der Geburt.* [2] *London Hospital Reports.*

fœtuses of either sex; and one may in the same subject find the rate vary fifteen to twenty beats within a brief period.

What does the observation of the fœtal heart-beat teach?

1. When heard it teaches that there is a child; and that it is alive.

2. It gives information as to the vigour of the child.

3. It indicates the presentation and position of the child *in utero*.

To arrive at a diagnosis of the presentation we search for the spot of *maximum-intensity*, since the heart is situated at the level of this maximum. In presentations of the head, gestation advanced, this maximum is found below a line drawn horizontally across the umbilicus, or by the middle of the height of the uterus measured from the pubes to the fundus of the organ; whilst, in presentations of the breech, this maximum is heard at the level of, or above this line. Depaul thus explains these facts: The heart is nearer to the cephalic than to the pelvic extremity, so that of necessity its maximum-intensity is heard lower when the head presents than when the breech presents. But Ribemont-Dessaignes proves, by sections of the fœtus, that the heart is quite as near one extremity as the other. The true explanation is, that towards the end of gestation the head sinks a little into the pelvis, especially in primiparæ, and the heart thus following the descent is heard below the umbilical level. In breech-presentations the breech keeps above the brim, and thus the heart, kept at a higher level, is heard above the umbilicus.

But if from narrowing of the pelvic brim, placenta prævia, or excessive size of the head, the head cannot enter the pelvis, the maximum-intensity may be heard as high as in the case of a breech-presentation.

Transverse presentations cannot be with any certainty diagnosed by auscultation.

Can the positions of the fœtus be diagnosed by auscultation?— Tarnier, after analysing the views of Depaul and Ribemont-Dessaignes, concludes generally in favour of the latter observer. In the left anterior occipito-iliac (or first) position, the maximum is heard to the left of the median line; but it is on a line running from the navel to the left antero-superior iliac spine, and not to the left ileo-pectineal eminence. It is not the vertebral column of the fœtus, but the left side which corresponds to this ileo-umbilical line.

In the left posterior occipito-iliac (or fourth) position the maximum is heard a little to the left or behind the ileo-umbilical line ; sometimes it even reaches this line, for in this position it is the right side of the fœtus which is in relation with the antero-lateral wall of the uterus and abdomen, which best transmits the sounds of the heart. It is therefore difficult to distinguish the left anterior position from the left posterior by auscultation.

In the right anterior occipito-iliac (or second position) Ribemont-Dessaignes found the maximum on the median line. This line corresponds with the left side of the fœtus which directly transmits the heart-sounds to the uterine and abdominal walls. In the right posterior occipito-iliac (or third position) the maximum is heard on a line running from the navel, either to the right ileo-pectineal eminence, or to the right antero-superior iliac spine. The left side of the fœtus corresponds in this position to the antero-lateral wall of the uterus and of the abdomen.

But palpation gives more trustworthy indications of the positions.

The fœtal souffle.—This is a sound isochronous with the heart-beat. It is simple or double. At times it has its seat at the level of the heart. Then it is called *cardiac* or *intra-cardiac.* At times it is heard in the vessels of the cord. Then it is called the *umbilical* or *funicular souffle.* Cardiac souffle may be due to insufficiency of the tricuspid and mitral valves, and to vegetations on them (endocarditis).

The *umbilical souffle,* discovered by Kennedy, who, with Naegelé, Depaul, and others, thought the sound indicated that the cord was twisted round the child's neck. When heard it proves that the child is alive.

How to observe the fœtal heart-sounds.—Generally the plan laid down for observing the uterine souffle may be adopted. We should seek for the heart-sounds more especially in the region indicated in the preceding description—that is, nearer the umbilicus or near the centre of the uterine globe. Having detected the sound we then, by shifting the stethoscope and following the sound in all directions, track out the point of maximum-intensity. We then count the pulsations and compare them with those of the mother's radial. If the rates differ the diagnosis of a live child is absolute.

Fallacies.—These are really very few. When the maternal circulation is excited its frequency may simulate fœtal pulsations, if heard through the abdominal walls. Error is avoided by noting that these pulsations are isochronous with the radial beats. Where doubt remains we must invoke the light of other signs, as palpation.

Palpation.—In the second stage abdominal palpation acquires importance, increasing with the advance of the process. At the beginning of the fourth month palpation may detect the fundus of the enlarged uterus pointing above the pubes; and this is especially useful if combined with internal touch upon the vaginal-portion, as described for the first trimestrium.

But gradually, as the uterus rises higher and higher, it is more easily felt with increasing distinctness. Not only is the fundus felt, but a great part of the contour of the uterus may be traced between the two hands, applied above and on either side. And its position and size may be delineated also by percussion; one mode of exploration aiding and correcting the other.

Palpation and percussion will enable us to follow the uterus in its gradual development. Thus we may estimate the stage of pregnancy arrived at.

At the end of the	3rd	month	the fundus uteri	rises	just above the symphysis pubis.
,, ,,	4th	,,	,,	,,	half-way between pubes and navel.
,, ,,	5th	,,	,,	,,	within a finger's breadth of the navel.
,, ,,	6th	,,	,,	,,	a finger's breadth above the navel.
,, ,,	7th	,,	,,	,,	three or four fingers' breadth above the navel.
Between 7th and	8th	,,	,,	,,	the fundus inclines to the right.
In first half of	9th	,,	,,	,,	in the epigastric region and under the edge of the right false ribs.
In second half of	9th	,,	,,	,,	the fundus drops.

RATE OF INCREASE IN SIZE OF THE GRAVID UTERUS ACCORDING TO MONTHS. (After A. Farre.)

	Length	Breadth
End of 3 months . . .	10 to 12½ centimetres (4 to 5 inches).	10 centimetres (4 inches).
„ 4 „	13 to 15 centimetres (5 to 6 inches).	12½ centimetres (5 inches).
„ 5 „	15 to 17½ centimetres (6 to 7 inches).	13½ centimetres (6 inches).
„ 6 „	20 to 22½ centimetres (8 to 9 inches).	16 centimetres (6½ inches).
„ 7 „	25 centimetres (10 inches).	18 centimetres (7½ inches).
„ 8 „ . .	27½ centimetres (11 inches).	20 centimetres (8 inches).
„ 9 „	30 centimetres (12 inches).	22½ centimetres (9 inches).

The antero-posterior diameter has usually an average of 2½ centimetres less than the lateral diameter.

The above statement is more especially exact as regards primiparæ. In pluriparæ, whose abdominal walls are more relaxed, the uterus ill-supported may fall forwards, more or less overhanging the pubes; and the uterine fundus does not drop by its lower segment sinking into the pelvis.

Abdominal palpation applied to the diagnosis of pregnancy.—This has been gradually brought to perfection under the successive labours of Rœderer, Wigand, Joerg, Schmidt, Hohl, Velpeau, C. Devilliers and Chailly, Hubert, Jacquemier, Matteï, Esterlé, G. Murray, Scanzoni, Tarnier, Schröder, J. R. Chadwick, Spiegelberg. The history of the method, beginning almost with this century, is carefully drawn by Pinard.[1]

Information obtainable by abdominal palpation.—By this manœuvre we determine the existence or absence of a tumour in the abdomen or emerging from the pelvic cavity. If a tumour be felt we determine its nature. If determined or presumed to be the uterus, we determine its size, shape, direction, relations, and consistency. If the uterus be developed to four months' gestation or more, we may by palpation discover the attitude of the fœtus and thence its presentation and position; it is especially useful in making out

[1] *Traité du Palper Abdominal*, Paris, 1878.

twin-pregnancy ; it also enables us to estimate the proportion of liquor amnii.

How to practise abdominal palpation.—1. The disposition of the patient. She is so far undressed that the chest and abdomen are free; she is placed on her back, the head and shoulders resting upon a pillow, the arms falling on either side; the bladder and rectum must be emptied.

2. *The conduct of the examiner.*—He warms his hands to the temperature of the patient's body, lest by cold he cause the muscles of the abdomen to contract and harden. A hand is then applied, at first very gently, on either side of the abdomen; then pressure is gradually increased, so as not to awaken emotional, volitional, or reflex resistance. When the muscles resist, the hand is kept quite still, neither increasing nor lessening the pressure, and presently the muscles will relax. The pressures are repeated several times in succession, progressively increasing their intensity. This manœuvre is best done during expiration; and it is useful to get the patient to breathe in and breathe out deeply, keeping the mouth open as if she had just been running hard. In this way, the glottis being freely open, there is no fixed point for the abdominal muscles, and they offer no resistance to pressure by the hand.

The results of palpation are sometimes obscure when the abdominal walls are loaded with fat or infiltrated with serum; when the uterine wall, instead of being supple, is very firm and adapts itself to the ovum so closely that it is difficult to depress it; when the uterus contracts, for then it is impossible to feel or to distinguish the fœtal parts. In this latter case, we simply wait until the contraction ceases. The death of the fœtus may modify the resistance of the tissues. Ascites and dropsy of the amnion, complicating tumours of all kinds, may oppose difficulties. Hyperæsthesia of the abdominal walls, or even pain, may oppose. In such cases, anæsthesia may be invoked.

How to determine the size of the uterus.—The hand is applied flat transversely, its radial edge downward on the hypogastric region. We depress the abdominal wall by pressing especially with the little finger. We feel a certain resistance, due to the presence of the uterus. Then, the hand in the same position, it is applied from the pubes towards the sternum, using a gentle pressure; when its cubital edge reaches the fundus of the uterus, it sinks above this into the abdominal cavity, and the hand caps, as it were, the fundus uteri.

During the latter months of gestation the consistency of the uterus grows weaker. It gives the sensation of a soft, depressible tumour, whose shape is nearly regular, and whose elasticity is comparable to that of a cyst incompletely filled with fluid. Solid parts are felt inside it of various sizes, which are the different regions of the fœtus. Lastly, there is produced at this epoch a phenomenon which enables us easily to limit the womb and to trace its outlines; these are *the painless contractions* of the organ, recurring at more or less distant intervals, which reveal themselves by an intermittent hardening of the organ, appreciable to the touch and somewhat to the woman.

Important as palpation undoubtedly is as a means of simply diagnosing the pregnant uterus, its value is much greater in its clinical application to the detection of the presentation and position of the fœtus.

Braxton Hicks's test.—Delicate palpation reveals another sign. Tyler Smith insisted much that peristaltic and rhythmical movements of the uterus could be distinguished. At one time he even thought that mothers and physicians, deceived by these sensations, erroneously attributed them to movements of the child. Later, however, he recognised the double fact that there were both uterine and fœtal movements.

Braxton Hicks, in 1872,[1] elaborated this sign and raised it to the rank of an important, if not an absolute test. Pinard,[2] Tarnier, and others have verified the contractions of the uterus enlarged by fibroma, and further say that the bladder may contract in a manner to simulate the uterus. Hicks maintains that the movements felt in tumours were brought out by manipulation, and are not of the same constant and spontaneous character as those of pregnancy. He further points out the physiological uses of these movements.

By palpation and gentle taps imparted to the uterine globe we may excite movements, not easy without great

[1] *Obstetr. Trans.* [2] *Traité du Palper Abdominal*, Paris, 1878.

practice to assign to the fœtus or to the uterus. The uterine peristaltic wave sometimes rolls into lumps, which singularly resemble a projecting knee or elbow.

Still, in some cases where there is so much liquor amnii that the fœtus floats freely, we may by gentle succussions obtain distinctly the phenomenon called *ballottement*. The hands are placed one on either side of the uterus, by one hand you depress rather suddenly the uterine wall, the other hand keeping its place. The following sensations may be perceived:—Sometimes the fingers which depress feel the solid body retreat, and sometimes the body returns; the sensation, then, is double; again, the working hand feels nothing, but the opposing hand perceives a light shock produced by the displaced body, which passes over to strike the uterine wall. The conditions producing ballottement and the sensation it imparts may be very closely imitated by putting a hen's egg into a small bladder filled with water; holding the bladder up so that the egg sinks; then tapping the egg at the bottom, so as to displace it upwards. First we feel the egg recede, presently we feel it drop again, impinging on the finger.

How to practise ballottement.—The most effective way, however, of practising ballottement is by the finger applied to the anterior wall of the uterus by the vagina.

1*st Posture.*—Place the woman with the shoulders gently raised, on her back, the legs slightly flexed, and the knees turned outwards. Then pass the index up to the os uteri as a guide to the broad surface of the anterior wall of the uterus. A sense of elasticity, of tension is felt; then by a sudden tap of the finger-tip strike this part. If the pregnancy be sufficiently advanced; if the fœtus float in sufficient liquor amnii, its body will be felt to rise from the finger and presently to come back upon it, constituting repercussion.

2*nd Posture.*—Some authors recommend and figure the standing posture for ballottement, under the impression that thus gravitation acts more readily. This is really an error. In the upright posture the axis of the uterus approaches more nearly to the horizon than it does in the semi-recumbent posture. Little or nothing is gained in precision by adopting an attitude often distasteful to women; and something is lost in convenience and steadiness.

It will be observed that in ballottement there is a double phenomenon. It is compounded of fluctuation and the impact of a solid body floating in the liquid. Sometimes, when the liquor amnii is in excess and the fœtus small, nothing but the sense of fluctuation is perceived. At other times, when the fœtus is large, and the liquor amnii relatively scanty, it is not easy to get ballottement. But instead we have simply the firm rounded anterior wall of the uterus bulging before the pressure of the fœtal head.

The *fallacies* of the ballottement test are not serious. In a case of ascites, an ovarian tumour of moderate size attached by a free pedicle may give a sensation analogous to ballottement. Robert Barnes has also felt the gravid uterus itself move so freely in ascitic fluid under impulse given by the vagina as closely to simulate ballottement of the fœtus *in utero*.

The Objective Signs of the Third Trimestrium.

The signs of the first and second trimestria are further pronounced. The positive signs furnished by palpation, auscultation, and ballottement acquire greater distinctness and value.

Changes in the skin of the abdomen.—*The umbilicus* is said to sink during the first two months. This event, if real, is not of much significance. *The flattening out of the umbilicus* is, however, a sign of real importance. From the middle of gestation, the bottom of the umbilicus rises to approach the level of the abdominal arch. It attains this level at the seventh month. During the two final months, the skin of the umbilical cicatrix even protrudes above the surface of the rest of the abdomen. Sometimes the umbilical ring is dilated so as to admit the tip of the finger, and it may even let omentum or intestine protrude, constituting *umbilical hernia*.

Pigment.—In many women the median line of the abdomen presents a brown streak, from three to six lines wide, from the mons Veneris to the umbilicus, and sometimes extending above this point. It is most marked in dark women; in negresses it is black as ink. In fair women it may be scarcely perceptible. In dark women the pigmentation extends more or less over the whole abdomen and upper part of the thighs.

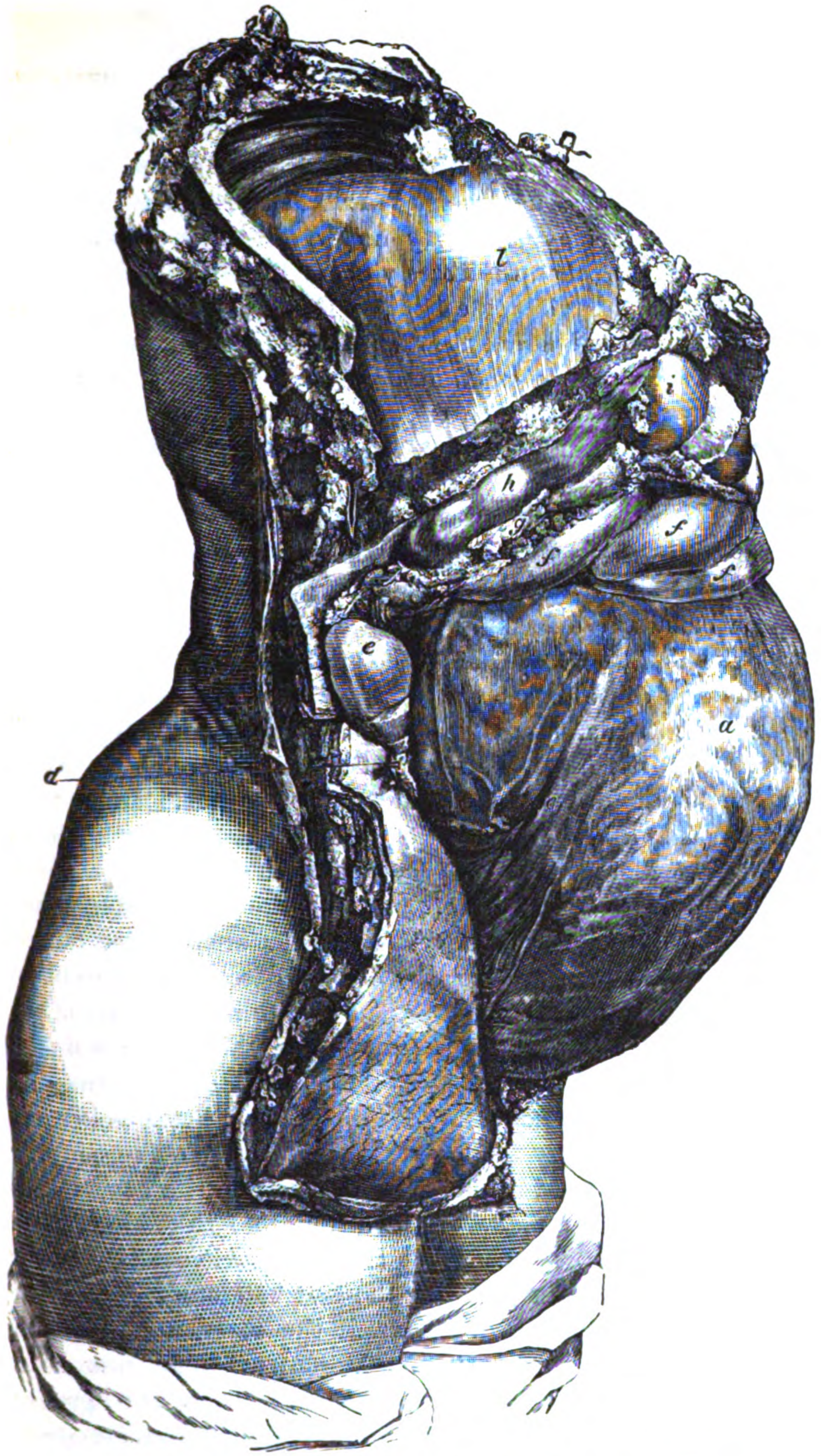


Fig. 89 (from W. Hunter) shows the position of the Gravid Uterus near term, and some of the relations of the Intestines.

a. Gravid uterus. d. Ascending colon. e Kidney. f, f. Small intestine. n. Transverse colon. i. Liver. l. Diaphragm.

Sometimes whitish spots are scattered over the dark surface, exactly resembling the spotted areola of the mammæ.

Change in the musculo-aponeurotic layer of the abdomen. The linea alba may give way under distension; and being separated or stretched the fibres yield and permit the intestines to bulge. Under violent efforts, as in bearing down, *eventration* or abdominal hernia takes place. This weakness is apt to increase at every gestation. It must be met by a well-adjusted belt. In extreme cases, the uterus itself may project through the opening, and fall over the pubes, forming hernia of the uterus.

The scars, striæ, or cracks on the skin. Striæ gravidarum (*Vergetures*, Fr.)—Commonly the skin of the abdomen of gravid women is observed to be furrowed with striæ, chiefly in the region below the umbilicus. They are superficial and slightly depressed. But sometimes they rise above the skin-level. This is said to be due to the infiltrations of the subcutaneous connective tissue, following on compression of the epigastric vein. The striæ are the result of the rapid stretching of the skin under the distension of the growing uterus. It is pretty certain that the *skin grows* to some extent to adapt itself to the new occasion. But the growth of the uterus commonly exceeds the accommodating growth of the skin. Hence the cracks. In a first pregnancy these cracks are rosy or bluish-red, and sometimes are the seat of smart itching. The intervening spaces in fair women are dull white like the rest of the skin; they are brown in dark women, and this colour is due to pigmentary deposit. The cracks are usually regularly disposed, forming concentric zones around a centre a little below the umbilicus. In many women they are found on the anterior surface of the thighs, on the buttocks, and on the back. This is evidence of the rapidity of the distension; the skin of these parts is called into requisition. In primigravidæ these cracks are rare and so scattered during the first half of gestation that they are easily overlooked. Towards the seventh and eighth month they become marked. Most frequently new striæ are produced at every new gestation. Thus the greater number of pregnant pluriparæ present recent and old striæ. The first are rosy, the second pale. This may be of some value in legal medicine. But the variations are infinite.

Some women never show them. Montgomery saw a woman, mother of five children, quite free from striæ. Credé found striæ wanting in 10 per cent.; Hecker, 6·6 per cent. We have failed after diligent search to find striæ in several cases. If a woman escape in her first pregnancy, she may have the striæ in subsequent labours, especially if she carry twins.

Under ascites, ovarian or other abdominal tumours, or general œdema, the skin may present similar appearances. The striæ then are more general over the abdomen. It might be possible to differentiate the origin of the striæ by noting their special characters.

Similar striæ are often noted on the breasts; these have a similar significance.

Küstner denies that the rete Malpighii is ruptured. By sections he claims to have demonstrated that the rete mucosum is undisturbed, but that the deeper layers of the cutis and the subcutaneous tissue are separated from each other. Langer[1] thus describes what occurs: 'The fibre-bundles of the connective tissue of the skin are arranged in such a manner that they cross one another, forming rhomboid meshes the longitudinal axis of which is placed upon the trunk, corresponding somewhat to the direction of the ribs, from the spinal column forwards and backwards. The cutis tissue, therefore, may be the more easily expanded in a direction perpendicular to the long axis of these rhombs than in the contrary direction. In a slight dilatation of the abdomen the distension will occur in this direction, but this is very soon obliterated; it is different, however, when the distension is great: the elasticity of the tissue is thereby destroyed. In the latter case the cutis tissue will obtain a permanently different arrangement.' Hence Langer contends that there is no solution of continuity, but only a permanent disarrangement of the tissue produced by stretching.

Dr. Busey[2] has studied the subject with great care. Admitting to a great extent the accuracy of Langer's description, he maintains that 'these striæ and white scar-like spots are not in the pathological acceptation of the word cicatrices.' He says: 'In view of the histological and pathological demon-

[1] *Medizinische Jahrbücher*, 1879.

[2] *American Gynæcological Transactions*, 1879.

strations of the lymph-channel system of the skin, and of the modes of formation of lymph-vesicles on the integumental surfaces (Thilesen, Hecker, Handfield Jones, Biesiadecki, Odenius), the presumption is strongly justified that the statement of Schultze, that striæ are occasionally developed into vesicles in œdematous conditions of the abdominal integument, the serous infiltration of striæ frequently observed, and the vesiculation which Küstner asserts is the ordinary condition of the striæ during the earlier days of puerperal convalescence, are

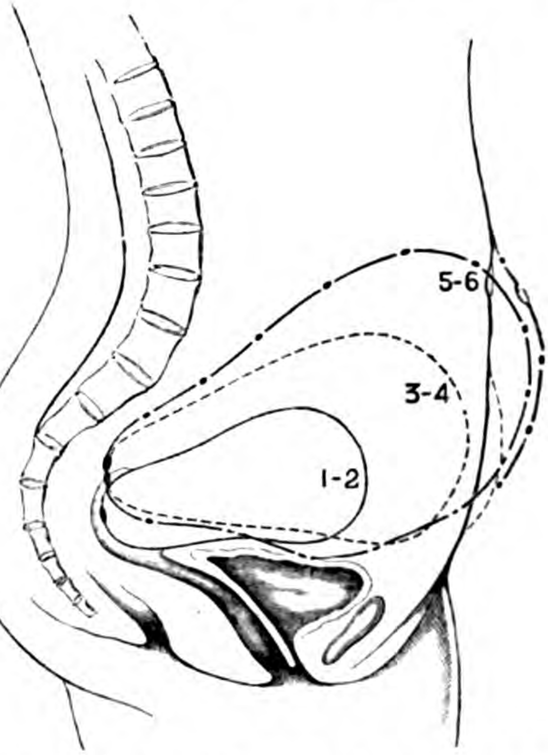


FIG. 90.—Represents the successive developments of the uterus: 1-2, first and second months; 3-4, third and fourth; 5-6, fifth and six months (Robert Barnes).

due to disturbances of the circulation in this system of vascular channels and tissue interstices.'

When the distending cause is removed, the skin falls into loose folds and furrows, often œdematous. The striæ become pale, shrink a little, but never quite disappear. Old striæ become white, and when again disturbed by a new gestation they present a glistening pearly appearance.

Appreciation of the value of these striæ for clinical and medico-legal purposes.—1. The presence of striæ gives no absolute proof of pregnancy past or present. 2. The absence of striæ is not trustworthy evidence that the subject is not, and has never been, pregnant. 3. The presence of striæ on the lower abdomen of the characters usually noted offers strong presumptive evidence of present or past pregnancy, and points to the expediency of seeking controlling testimony.

Diagnosis of the stage of gestation.—Having determined the existence of pregnancy, the next point, often of great practical

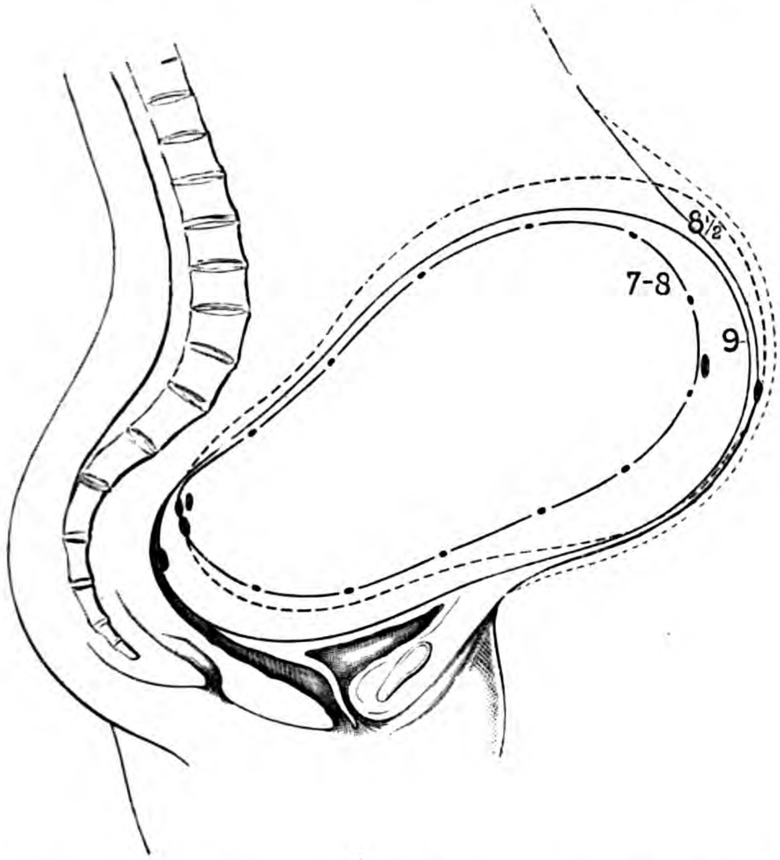


FIG. 91.—To represent development of the uterus in the 7th, 8th, 8½ and 9th months (Robert Barnes).

importance, is to determine how far the pregnancy is advanced. The investigation of this question is based upon the successive appearance of particular signs at or near particular dates; and mainly upon the degree of development of the uterus.

Setting aside the subjective signs, we may set forth the leading objective signs in tabular form.

Figs. 90, 91 will serve to realise some of the changes of sign and position set out in the table.

TABLE TO INDICATE THE PERIOD OF GESTATION ATTAINED.

Month	Body of uterus	Changes of uterine neck	Some functional changes	Particular characters
1st and 2nd	By double touch felt enlarged in anteversion, vaginal roof-stretching. Fundus felt on level of or above symphysis at end of 2nd month.	Softening of os tincæ; slightly open in pluriparæ. It is raised towards sacral hollow, or under promontory.	Breasts swelling; areola becoming darker.	Turgescence of vaginal-portion, of vagina and vulva (by speculum), and creamy secretion.
3rd and 4th	At end of 3rd month fundus is above level of symphysis; at end of 4th month it is half-way between pubes and umbilicus.	Softening of os more marked: more open in pluriparæ.	Swelling of breasts more marked; pigmentation more marked; erectility of the nipple.	Vascular turgescence more marked. Uterine souffle sometimes heard. Movements of uterus sometimes felt.
5th and 6th	Hypogastric prominence marked. Fundus at end of 5th month felt a finger's breadth below umbilicus; at end of 6th month a finger's breadth above, inclining to right.	At end of 6th month the lower part of vaginal-portion softened. Os in pluriparæ more open.	Œdema and varices sometimes appear. Breast-signs more marked; areola spotted; Montgomery's tubercles.	Palpation; movements of fœtus; ballottement. Uterine souffle, fœtal heart. Umbilicus nearly flat; brown line. In primiparæ head sometimes in pelvis.
9th month, 1st half	Fundus rises into epigastric region, and under edge of false ribs of right side.	The whole length of neck softened. In primiparæ os now slightly open.	Breast-signs still more marked.	Ballottement now rarely distinct, but head is *lifted up*.
2nd half	The fundus drops	Os internum softens and opens a little in multiparæ.	—	Head more or less engaged in pelvis.

The pathological states which simulate gestation.—The study of the objective signs of gestation we have made will almost always enable us to arrive at a definite conclusion, positive or negative, under simple conditions; that is, where gestation is simple, or where an abdominal tumour exists alone. The really difficult cases are those in which the gestation is abnormal, and those in which a uterine gestation is complicated with tumours or other forms of abdominal disease.

We may first of all dispose of those cases of *simply simulated gestation*. The most frequent of these is that condition called, since the time of Mason Good, *Pseudocyesis* (from ψεῦδος false, κύησις pregnancy).

(A.) The most familiar variety of this is the pseudocyesis of the menopause, or the *climacteric pseudocyesis*. Just when the reproductive faculty has disappeared, under the aberrant nervous freaks which mark the menopause, the woman, eager to retain the parting proof of motherhood, construes every sensation and every symptom as evidence of that state which she hopes or fears may exist. Nor are signs wanting to lend force to her conclusion. There are even objective signs which may impose upon others, as well as subjective signs, which to her are often absolute. Under ordinary conditions we place little reliance upon subjective signs. Under no conditions are they more illusory than here. We may, then, in the case of a woman of fifty or thereabouts disregard the irregularity or suspension of menstruation and her assertions that she feels swelling of the breasts and the movements of the child, although she may honestly believe in them. Seeking for objective evidence, we find two signs which deserve attention. These are:—1. The frequent enlargement of the abdomen. 2. The sensation on palpation of movements. The enlargement is commonly due to accumulation of fat in the omentum and abdominal walls, and to distension of the intestines by air. It is usually not difficult to judge the situation. The woman lying on her back, the abdominal walls relaxed by flexing the thighs, percussion elicits resonance, somewhat muffled it may be, where the gravid uterus would yield nothing but dulness. Inspection usually recognises a flatter and flabbier abdomen, and the umbilicus is rarely effaced as in pregnancy. Palpation gives the doughy sensation of fat; and the hand, grasping up a mass of abdominal wall, may commonly be pressed down so as to feel the spinal column and the pelvic brim, no uterus opposing. Should the abdominal muscles be rigid under reflex or voluntary action, Simpson's plan of giving a little chloroform removes all opposition, and enables one to make a perfect exploration. Then there is the vaginal touch. The senile uterus of the menopause is characteristic: it is small, the vaginal-portion is small and hard, less projecting in the vagina, and the os externum is becoming smaller and rounder. Such a uterus is unfit for gestation. Should conception occur, as it sometimes does, the end is abortion. The evidence here is all negative. The breast-signs are rarely so marked as to deceive. The woman is only big with fat and wind.

The physician may have convinced himself, but the woman may still cling to the fond delusion, even for much longer than nine months. The obstinacy of the delusion sometimes assumes the character of insanity. Dr. Crichton Browne relates a remarkable example of a woman who not only could not be shaken in her belief that she was pregnant, but who even went so far when her time was up as to fall into simulated labour, which evoked a sanguineous discharge—an example of the force of the imagination directed to a particular organ.

A variety of pseudocyesis of which we have seen some striking examples is that which sometimes occurs in young women who either fear or hope they may be pregnant. We have seen cases where, without any motive to deceive, recently married young women have been firmly convinced that they were pregnant. Menstruation not seldom is suspended under the emotions and other changes attending married life, although there be no conception. The wise rule in all cases of doubt is to suspend definitive judgment for a month, and to watch the development or subsidence of the symptoms suggestive of gestation. Appeal to Time, the great solver of mysteries.

(B.) *Fibroid or other morbid enlargement of the uterus.*—If the uterus be quite smooth, regular in shape, and rising above the symphysis, it may simulate the enlargement of gestation. But a fibroid is usually hard in texture; it does not, except in rare instances, give the sensation of peristaltic movement, it is not elastic like the gravid uterus. A sound synchronous with the mother's pulse is sometimes heard in one or the other groin, but not always, and the fœtal heart never. Then the vaginal touch and the speculum give only negative answers to the questions of softening of the vaginal-portion, the colour and creamy discharge of the vagina. And Time again will solve the doubt, by showing that the progress of the tumour differs from the steady evolution of the uterus under gravidity.

Remanent enlargement from sub-involution of past gestation.—This may or may not be attended by menstruation. The positive signs of gestation will be wanting.

Enlargement from *hæmatometra*, as from occlusion of the vagina. This condition may simulate gestation by the size of the uterus and its position. But other features differentiate the two states. In retention of the menses from occlusion of the cervix uteri or vagina, menstruation has never appeared by external flow; the obstruction will be recognised on examination; and there is commonly evidence in the dirty complexion, febrility and wasting, of absorption of altered blood-elements.

Functional modifications of the uterus, as amenorrhœa, often the first sign to suggest pregnancy. When not due to gestation, the small size of the uterus will declare the state of the case.

Menorrhagia may exist with gestation and cause embarrassment. In the intervals of the flow, examination will reveal the positive signs of gestation.

(C) *Extra-uterine tumours* give rise at times to doubt. Of these, *ovarian tumours* are the most frequent. They may have the following points in common with pregnancy—(1) size; (2) shape; (3) corresponding area of dulness; (4) a sound in one groin simulating the uterine souffle. They will differ in one or more of the following characters—(1) The size will be likely not to correspond in equable rate of development—that is, a size like that of eight months' pregnancy will have been reached by an ovarian tumour in a shorter or in a longer time; (2) the shape will rarely be so uniform, irregular lumps are commonly felt; (3) there is often fluctuation; (4) the souffle is not so likely to be heard; (5) the fœtal heart will not be heard, nor will the other positive signs of gestation be found; (6) the patient, instead of the 'mask of gestation,' will probably exhibit the '*facies ovariana*.'

(D.) *Small ovarian tumours* getting into the pelvis behind the uterus may cause difficulty. The feel of the vaginal-portion of the uterus, hard; its position, pushed forward by the tumour; the absence of the proper signs of gestation; the sensation of a tense bag—the ovarian sac—in Douglas's pouch; and, if the conditions warrant it, the use of the sound by which the size and relations of this organ may be accurately fixed, are points which will generally clear up the case.

The observations also apply to *small dermoid cysts*. Occasionally it is desirable to explore these retro-uterine cysts by the aspirator-trocar. In this case, the examination of the fluid drawn, the collapse of the cyst, and the retreat of the uterus to its normal position, establish the diagnosis.

(E.) *Hepatic cysts, abscess or hydatid*, or enlargement of liver from other causes, may be so large as to invade the entire abdominal region, and under certain concurrent conditions may suggest the idea of pregnancy. The hydatid cyst yields free fluctuation and the characteristic 'thrill.'

(F.) *Renal cysts* may give rise to the same doubt. Both may almost be excluded as against gestation and ovarian tumours by this simple physical test. Hepatic and renal cysts develop from above downwards, whilst gestation and ovarian tumours develope from below—*i.e.* from the pelvis upwards. Percussion and palpation, therefore, will rarely fail to show that in hepatic and renal cysts there is no line or area of resonance immediately below the ribs or in the epigastric region, except in renal cysts still so small as to give no resemblance to gestation; and, on the other hand, an area of resonance will commonly be made out below the cyst, between it and the pelvis. And pelvic exploration will complete the diagnosis by showing that the cyst is not of pelvic origin.

Ovarian tumours and gestation yield dulness from the pelvis upwards, and rarely fail to leave a resonant area between their upper margin and the epigastric region.

(G.) *Ascites* will sometimes have to be distinguished from gestation. To do this we may (1) examine heart, lungs, liver, and kidney to determine if there is any organic disease likely to cause ascites. This course is the more indicated because in any case of a gravida suffering, these organs should be carefully examined. (2) Inspection of the abdomen in dorsal decubitus will commonly show a flabbier, less prominent abdomen—it bulges at the flanks. (3) Palpation gives freer fluctuation than is found in gestation. (4) Percussion declares a resonant area at the highest point, and this area is either circular, or *its upper margin is concave*, the *concavity upwards*; the reverse being the case in gestation and ovarian tumours in which the *area of dulness is convex upwards.* (See figs. 92, 93, 94.) Again, there is dulness in the flanks, and the area of resonance changes with the posture of the subject. Tapping by an aspirator-needle may be practised in doubtful cases.

Enlargements of the spleen and omental tumours may at first be mistaken for gestation; but search for the characteristic signs of gestation ought to lead to a right conclusion.

By careful exploration, conducted on the lines above indicated, the skilled observer will rarely fail to arrive at a correct diagnosis when the question lies in its simple form as of gestation or not gestation.

But *when the question is complicated*, when the case comes before us of uterine gestation *plus* one of the conditions stated, the difficulty is often great. We shall seldom, perhaps, fail to make out *one* of two conditions present, say gestation and ascites, or gestation and ovarian tumour, but there will be the probability of our coming to the erroneous conclusion that the condition detected is all, the complicating condition being overlooked. The fact is, one condition will often assume predominance and mask the other condition. The concealed condition may nevertheless undergo dangerous development in itself, or act injuriously upon the other condition.

The complication of uterine gestation with uterine fibroids is one of intense clinical interest. Here also the fibroid may have been known before the gestation supervened. Then the developmental stimulus imparted to the uterus seizes upon the tumour as well. The enlargement is disproportionate to the date. The contour of the uterus will probably be irregular. The position in the abdomen will present a deviation from the normal.

Uterine gestation complicated with ovarian tumour.—The uterus and the tumour both grow. Thus the enlargement of the abdomen is more rapid than from simple gestation. Distress is greater, often becoming urgent from the crowding of the abdominal and thoracic viscera. The tension of the abdominal walls is greater. The shape of the abdomen is different ; it is wider across, and generally a deep fork or depression may be seen or felt at the upper part where the uterus and tumour diverge, and a sulcus or line of demarcation may sometimes be felt, extending downwards. By palpation and auscultation we may make out the outline or the head of the fœtus and hear its heart. The uterus will be pushed on one side by the tumour, so that the fœtal heart will be heard at a distance from the median line. The tumour on its side may yield characteristic fluctuation. By vagina it may not be possible to make out ballottement, from the uterus being pushed up out of the pelvis. But the speculum will, if the fœtus be alive, exhibit the colour and discharge characteristic of gestation.

Encysted peritoneal dropsy or abscess may present features similar to those of ovarian cysts. The diagnosis of extra-uterine gestation complicating uterine gestation may be extremely difficult. Perhaps the extra-uterine may have been known before the uterine gestation supervened. In such an event the problem is easy. But a woman may present herself for the first time the subject of the complication. The following rule applies usefully here and in many cognate cases. First, examine in the usual way to establish the existence or absence of gestation. If gestation exist, it ought to be made out by its positive signs. And we shall generally be able to estimate approximately the date of the gestation. This point established, we then consider how far the enlargement and other features observed are accounted for by the gestation. The excess of size and abnormal features must be assigned to another cause, and if by a process of elimination we can exclude ovarian, hepatic, renal, and uterine tumours, we approach a solution, which, if not absolute, will still be of clinical value. But it must be confessed that there are few things more difficult than to differentiate some cases of partly solid, partly fluid, ovarian tumours from abdominal gestations. Practically this indecision is the less important because our action would in either case probably be the same—namely, to operate upon the tumour.

Gestation is sometimes complicated with ascites.—This may happen either from pre-existing ascites, the result of Bright's disease, or in connection with albuminuria arising during the gestation. We have seen cases of ascites combined with fibroid enlargement of the uterus very hard to distinguish from the uterus enlarged by pregnancy. And we have seen the gravid uterus of four, five, and six months, so floating in ascitic fluid that the usual exploratory means of search for gestation were baffled. We could get a ballottement of the uterus itself in the fluid, like that which we sometimes get when an ovarian tumour is complicated with ascites. Here the

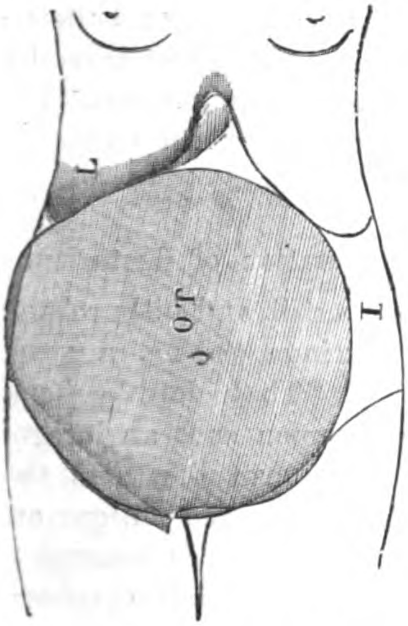


FIG. 92.—Represents the area of dulness and fluctuation in ovarian tumour (Robert Barnes).

O T. Tumour. L. Liver. I. Intestine.

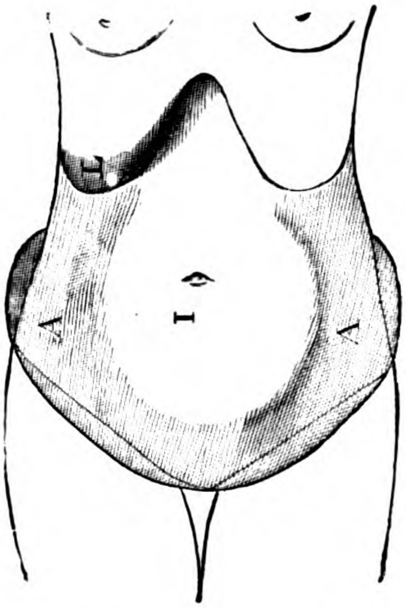


FIG. 93.—Represents area of dulness shaded, and of resonance in ascites (Robert Barnes).

A A. Ascites. L. Liver.

history may lend important help. The presence of albumen in the urine, together with a rational history of gestation supported by some of the usual signs, will justify a diagnosis.

In any of the foregoing questions, the history, if it come to us as the record of observations made by competent persons, may lend valuable, perhaps decisive aid. It will always give a clue to guide the line of inquiry; unfortunately sometimes a misleading clue. History, rightly called a lying jade, then must not be trusted alone. It must not be allowed to bias our interpretation of the objective evidence, which, after all, is the only solid foundation for a verdict.

Gestation may be attended by a distended bladder. This will be discussed in connection with retroversion of the gravid uterus.

The diagnosis of gestation continued after the death of the embryo or fœtus is often difficult. The active signs of gestation have subsided—that is, the deep colour due to vascular fulness, and the auscultation signs are lost, the breasts fall; the uterus ceases to grow; ballottement is frequently lost from disappearance of liquor amnii. This subject will be again treated of under 'Abortion.'

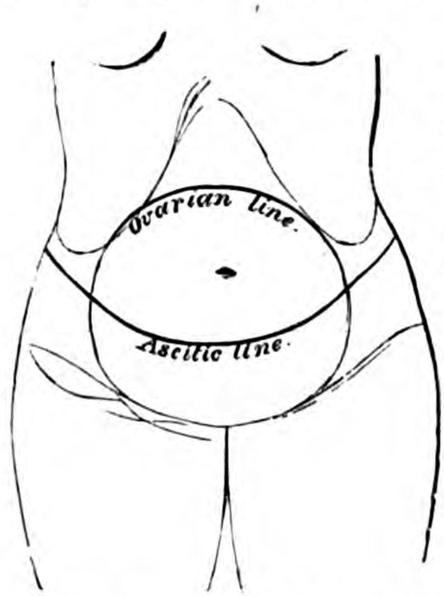


FIG. 94.—Represents the differentiation of ascites and ovarian tumour by the convex outline of ovarian tumour and the concave line of ascites (Robert Barnes).

The Duration of Gestation.

This is still, and will probably long continue to be, a vexed question. That doubt should still exist upon such an integral event in human life, one that has always arrested vulgar and scientific interest, is enough to show how difficult is the problem. And not only this: it raises the strongest presumption that the duration of gestation in woman is a variable period. Still there must be limits; and these we must endeavour to determine as nearly as possible.

Harvey the Immortal thus expresses his opinion: 'Unquestionably the ordinary term of utero-gestation is that which we believe was kept in the womb of his mother by our Saviour Christ, of men the most perfect; counting, namely, from the festival of the Annunciation, in the month of March, to the day of the blessed Nativity, which we celebrate in December.' This is a period of 275 days. 'Prudent matrons, calculating after this rule, as long as they note the day of the month in which the catamenia usually appear, are rarely out of their reckoning; but after ten lunar months have elapsed, fall into labour, and reap the fruit of their womb the very day on which the catamenia would have appeared had impregnation not taken place.'

The Jewish law and experience supply the most authentic general experience. The Rev. Isaac Samuel gave us in 1870 the following statement: 'The Talmud fixes the maximum period of pregnancy at 271 days, and as extending sometimes to 272 or 273 days.' Robert Barnes, after large experience, is able to say that Jewish women are more correct in their reckoning than those of other races, and that it corresponds closely with the period assigned by the Talmud.

In France 270 days is held to be the usual duration of gestation. The Napoleonic code admits legitimacy of a child born 300 days after cohabitation.

In Norway Faye and Vogt give 270 days as the mean, estimated from presumed fruitful intercourse in 63 cases.

Raciborski, in five cases of presumed single coitus, records labour as taking place in 268 and 275 days. Montgomery, in seven cases, cites longer periods, from 280 to 291. But these, Simpson says, were selected as proof of the prolongation of pregnancy. They are so much at variance with facts more rigidly controlled that they may safely be set aside. Reid (*Lancet*, 1850) studied this question with great care. He notices twenty-five cases; labour came on at from 265 to 280 days, with the exception of one at 287 and one at 293 days.

Veit[1] tabulated a mass of observations in regard to the interval between the end of menstruation and parturition. The average interval was 278·5 days.

Hohl[2] says that in young healthy women pregnant for the first time, labour sets in only a few days, two or three, before the 280th day, or exactly on that day, rarely earlier.

The solution has been sought in the history of *pregnancies ensuing upon a single coitus*. If a considerable number of well-authenticated cases of pregnancy so started and ending in the birth of a live mature child could be collected, we should approach nearer to a solution than by any other evidence. Easy as this is in cows and mares, difficulties innumerable surround the attempt to arrive at trustworthy facts in the case of women. The facts cited are few in number, and mostly

[1] *Brit. and For. Med.-Chir. Rev.* 1854. [2] *Geburtshülfe*, 1862.

open to question. Collections may be found in Montgomery, Ahlfeld, Faye, Clay. Some have been cited. But if all were summed up the total would still be too small to be of material value, on account of the many fallacies which beset them. They, however, support the evidence derived from other sources helping to fix the normal term of gestation at from 270 to 275 days.

The history of *pregnancies presumedly dating from the first coitus*, as after marriage, is freer from some of the fallacies which beset that from an assumed single coitus. The day of marriage, and hence of the first coitus, is commonly fixed during the first week after a menstrual epoch, and is undoubtedly in many cases a fruitful one. A careful collection of cases in which menstruation did not reappear after the period immediately preceding marriage would furnish valuable evidence. In the few cases observed by Robert Barnes the birth of a mature child followed at 270 to 275 days, again confirming the testimony from other sources.

In recording such cases especial care must be taken to note that the child is born mature, and that an ordinary menstrual epoch occurred immediately before the marriage. It sometimes happens that a mature child is born at seven or even six months after marriage. But subsequent children by the same parents take the usual time of nine months to attain maturity.

One case is worth relating from its probable precision. A lady who had been married several years without issue, the cause being a contracted os uteri externum, was operated upon by Robert Barnes on December 1. Marital intercourse for the first time after the operation took place soon after the succeeding menstruation—*i.e.* on December 15. The catamenia appeared very slightly on January 6. She was delivered of a healthy mature boy on October 3—that is, after 270 days' gestation.

It has been supposed that a new departure from which to calculate pregnancy may be found in the *sensation of the movements of the fœtus—quickening*—and that this event may serve to control the calculation based upon the last menstrual epoch. It is too fallacious to be trusted. 1. The sensations are illusory. Some women believe or declare they feel the child when there is no child. This subjective sign is the most fondly cherished by women who are past bearing. 2. Some pregnant women never experience it. 3. The date when the first sensation is perceived varies greatly. Ahlfeld found that in forty-three cases it ranged from 108 to 134 days, and in others to 159 days after the last menstruation. Veit gives one case at 79 days, and the average about 132 days.

Argument drawn from *unusual development of child* is of little value. Bigger children than any produced after alleged protracted gestation have been born within the ordinary limits. Robert Barnes has known one child born at ordinary term to weigh 18 lbs. And children supposed to be born after protracted gestation have been below the average weight.

Charles Clay contended that *the duration is regulated by the ages of the parents*, and deduces that the longer gestations are observed in the older women. This agrees with observations on cows.

The observations of Faye, Hecker, and Ahlfeld do not correspond as to *the relative duration of gestation in primiparæ and in pluriparæ*. Observations made in hospitals are open to fallacy. Where frequent examinations are made, and other hospital influences act, premature labours are easily provoked.

Is there a *special individual gestation-period?* This is not improbable. If there be a special menstrual-type there may also be a correlated gestation-type. A woman who menstruates every thirty days may be supposed to carry longer than one who menstruates every twenty-eight days. Thus we may have a gestation consistent with the most widely-received theory lasting 300 days. Is this in accordance with experience? It is certainly not universally true. Women, howsoever long the intervals of their menstruation, still calculate correctly the day of labour at 270–280 days from the last menstruation.

Dewees, Hamilton, and Retzius (see Simpson) record instances of apparent protraction recurring in the same woman, and as an hereditary peculiarity in a mother and two daughters.

The strongest case observed by Robert Barnes was that of the wife of a physician, who was confidently believed by her husband, who dated from a last menstruation and checked the calculation by the quickening, to have carried her child on two occasions a month beyond the ordinary time. The children, of excessive size, weighing 10 and 12 lbs., were lost in labour.

Robert Barnes was consulted when she was thought to have completed nine months in the second pregnancy, with a view to bringing on labour and getting a live child. He attended her in labour a month afterwards. The husband was of mature age, the wife approaching the climacteric.

The argument of analogy has been appealed to. What is the teaching derived from the *observation of other mammalia?* The mare and cow, domestic animals whose whole life is under observation and control, seem to offer especial facilities for giving precise dates. The experiments of Tessier, Lord Spencer, and Krahmer are constantly cited. They are full of interest.

The gestation-period of cows approaches most nearly to that of women. It averages 285 days from coitus. The instances in which 301 days were exceeded were extremely rare. It appeared that bull-calves were carried a little longer than heifers, and when an aged bull covered the period was longer. It was also found that the youngest cows went the shortest time. These observations are supported by records of 641 cows ('Buffalo Med. Journ.'). Of these, 50 calved between 260 and 270 days, and these were all heifers on their first calf.

Too much importance has been assigned to this argument. Granted that the duration of gestation in cows is variable, and even protracted in some cases, it would not settle the question as concerns woman.

Latitancy, or the lying in wait of the ovum and spermatozoa for each other, has an important bearing on the question. This hypothesis postulates that coitus or insemination may take place some days before the spermatozoa meet the ovum to fecundate it; or that the ovum may be kept in the tube some time waiting for the spermatozoa. That the spermatozoa can retain their vitality for some time out of the body is proved by the experiments of Spallanzani, who impregnated frogs, and John Hunter and others, who impregnated mammalia by artificial injection of sperm. Stored in the congenial soil of the female genital passages, it is established that the spermatozoa preserve their movements for several days; Valentin says for a week or more. Haighton's experiments on rabbits showed that the conjunction of the ova and semen did not take place under two days. De Graaf, Cruikshank, Saumarez, Bischoff, believed that vivification of the ovum does not take place immediately on coition, but after an uncertain interval. Bischoff says it can scarcely be doubted that the time occupied by the transit of the ovum and the preparatory changes in the mucous membrane differs greatly in individuals, and hence entail a longer or shorter duration of pregnancy. Bischoff, Prevost, and Dumas have seen the movements in the sperm in the Fallopian tubes of the bitch and rabbit seven or eight days after copulation. Percy, of New York, says he collected live spermatozoa from the neck of the uterus of a woman eight days after the last coitus.

The evidence of latitancy of the ovum is not so precise. The ovum probably soon perishes if not fecundated. Bischoff favours the idea that impregnation takes place *on* the ovary, and thinks that, unless it take place before the ovum has made much way in the tube, its capacity for impregnation is lost. Coste thought impregnation takes place *in* the ovary.

Allowing six or seven days for latitancy—and there is little or no evidence to show that a longer time may be granted—it will account for gestation being protracted to 285 or 287 days. This confirms the law as to the definiteness of the period of gestation.

Hohl[1] especially insists upon the non-coincidence of the time of coitus with that of fructification as a disturbing factor in the calculation of the gestation period.

Dr. Duncan,[2] pursuing this theme (1854), has much insisted upon the distinction between insemination and gestation, contending that gestation proper can only date from the moment of fertilisation of the ovum, and not from the coitus. Joulin[3] also insists upon this distinction.

This argument has been pursued in another form by Stadfeldt (1875), Kundrat and Engelmann, Williams, Schroeder.

Stadfeldt calculates—1. From the last menstrual period in twenty-six cases; this gave a mean of 280 days, the shortest being 244 days, the longest 304 days, and therefore a range of sixty days. 2. In twenty-four cases he tried to fix the epoch of the first suppression. The mean calculated from this day was 254 days; the shortest, 240 days; the longest, 273 days;

[1] *Geburtshülfe*, erste Ausgabe, 1855.
[2] *On Fecundity, Fertility, and Sterility*, 1871.
[3] *Traité d'Accouchement*, 1867.

range, 33 days. If one admits that fecundation took place eight or ten days before the first menstrual suppression, the mean duration of the gestation from the physiological point of view could, according to Stadfeldt, vary only from 260 to 264 days.

J. Williams,[1] from sixteen cases, concludes that the rupture of the follicle and escape of the ovule take place before the appearance of the corresponding menstrual flow. It is contended that the processes which might fix the ovule of this period in the uterus have passed, and that, therefore, the ovule which brings the gestation belongs to the next ovulation, which is not attended by hæmorrhage. Williams, then, not content with one week's latitancy of the sperm, postulates one to three weeks—that is, insemination takes place one to three weeks after a menstrual period; that the sperm is stored up in the infundibulum of the tube, waiting for the ovule, soon after its extrusion—that is, just before the next menstruation. This hypothesis, again, would reduce the term of gestation proper by from one to three weeks.

Against this there is the strongest presumptive evidence that conception may take place during menstruation; that the most commonly successful intercourse takes place within a week after the cessation of menstruation—that is, at the time sanctioned by Jewish custom, 'after the bath;' and that—and upon this point Robert Barnes speaks from frequent observation—when the next period is due, and when the time is only just past, all the objective signs of early pregnancy are characteristically developed, which means that conception took place two or three weeks before the suspended menstrual epoch. It is also highly probable that there is no strictly fixed time for the escape of a ripe ovum.

After all, it must be seen that howsoever just may be the distinction between insemination and conception from a purely physiological point of view, it gives little or no help in the solution of the social, medical, and legal problems connected with pregnancy. Of what avail, for example, is it to a husband, a physician, or a lawyer to be assured that a woman delivered of a mature living child had only been 250 days in true ges-

[1] *Philosophical Transactions*, 1875.

tation, when stubborn facts testify that she had cohabited a month earlier?

Again, is Science prepared to advise Law to accept as legitimate a child born, say 300 days after legitimate intercourse, on the ground that legitimate semen might have been sown 300 days or more before the birth? If such a doctrine be accepted, Science must resign her authority, and questions of chastity must be decided by detectives and ladies' maids.

Admitting that there may be a marked interval between insemination and conception, this interval is not known; it is probably variable. The rational way, then, is to merge this unknown quantity in the gestation-period, regarding it at most as a preliminary stage of the gestation.

Amongst those who admit protracted gestation are J. Y. Simpson, who relates four cases of apparent protraction to 336, 332, 319, and 324 days; Atlee, who gives two cases in which the subjects went through the entire calendar, or 365 days; and Merriman, whose longest case was 309 days.

Duncan concludes 'that while absolute proof of the prolongation of real pregnancy beyond its usual limits is still deficient, yet there is evidence to establish the probability that it may be protracted beyond such limits, to the extent of three or four weeks, or even longer.'

Moreau gives a case in which he believed a lady went 328 days. The observation was controlled by movements of the fœtus and attempt at labour a month before delivery.

On the other hand, Gooch, Ch. Clarke, and David Davis did not believe in protracted gestation. Stoltz says labour cannot be protracted beyond fifteen days, taking 270 or 280 days as the normal term. He says the French law, which allows 300 days, is extremely liberal. Depaul is of the like opinion.

Kleinwächter[1] says the duration of pregnancy is 280 days, and that there is no protracted gestation. In a trial before Cockburn, C.J., in which Tyler Smith and Robert Barnes gave evidence, Tyler Smith distinctly denied protracted gestation.

There are several sources of fallacy that may disturb calculation. (1) We can rarely fix the date of the fruitful coitus. (2) Sir James Simpson recalls the fact that the caduca is not at first a closed sac; the tubes open into it, as well as the os uteri

[1] *Grundriss der Geburtshülfe*, Wien, 1877.

internum. Hence it is not impossible that the ovule of a first conception may be disorganised without the caduca being broken up, whilst a second ovule may come into and be grafted upon the caduca already formed. Then a catamenial period might pass without flow, and an excess of three or four weeks in the calculation would be made. (3) Menstruation may be suspended from other causes a month or two before conception. Some women do not menstruate from one pregnancy to another. Women continuing to suckle may have one menstrual show, then suppression, and may wrongly assign this to pregnancy. (4) Stoltz contends that fecundation may take place a little before a menstruation is due, and suppress it. If, then, we count the gestation as beginning immediately after the last menstruation, we count fourteen to twenty-one days too many. Thus a gestation really of 273 days may appear to be of 293 days or more. Robert Barnes has reason to suspect that this often happens. Having diligently compared, when in charge of a lying-in hospital, dates of expected and of actual labour, he found that in a large proportion the women came in at periods ranging from a week to three weeks after expectation. (5) Labour may be protracted several days. Thus it may be fairly or apparently started a week before it is completed. And the gestation would be protracted by this week.

J. Y. Simpson suggests that the state of health and activity of the uterus may sometimes lead to the postponement of labour.

Hohl says that no fixed period of gestation can be determined, because (1) the ripening of the ovum in the ovary does not take an equal time in all women; (2) the ripe ovum does not always quit the ovary at a fixed time; (3) the coitus is not always effected at the time when the ovum lies ready for fertilisation, which may be shortly before or immediately after menstruation; (4) the spermatozoa may meet the ovum in the uterus, or tube, or upon the ovary, and this will make a difference in time; (5) all children do not mature in equal times.

We may safely conclude that Nature's law, which prevails in all other things, prevails here; that this law, which in all other things works with so great uniformity, works with uniformity here; that evidence drawn from every variety of source establishes as the law of gestation a duration of from 270 to 280 days; and therefore that any wide departure from this limit must be looked upon as at variance with Nature's law, and not be accepted without rigorous proof. In this question of the duration of pregnancy it is surely wiser to treat an alleged case of protracted gestation as deceptive than to believe that Nature's law has been suspended for the occasion. We shall do well to remember that in cases of alleged protracted gestation which are made the subjects of forensic discussion, strong motives exist for making out the particular case.

The contest lies between Science based upon the rigorous compulsion and comparison of innumerable facts, and Assumption resting upon a few facts, often tainted, the reality of which is rarely if ever clearly established. Science on the one hand represents general law, Assumption on the other hand rests upon doubtful exceptions.

We may state the following propositions as approximately true:—

1. A well-developed child will have been carried at least 260 days from the fruitful coitus. And the appearance of a well-developed child even at the 260th day is exceptional, and justifies doubt as to the accuracy of the date of coitus.

2. The most common time observed for the delivery of a well-developed child is from 270 to 275 days from the fruitful coitus.

3. A not uncommon time observed for the delivery of a well-developed child is from 275 to 280 days from the fruitful coitus.

4. Cases of children apparently carried more than 280 days are exceptional, and every day exceeding 285 renders the accuracy of the computation more and more doubtful.

5. Cases of children alleged to have been carried more than 290 days must be regarded as apocryphal until verified by absolutely unimpeachable evidence.

It is difficult to fix the *ultimum tempus pariendi*. It is more difficult still to fix the limit of audacity prompted by cupidity. The function of Science and of Law is to take care that the duration of pregnancy shall not be extended to suit the ends of interested audacity.

The prediction of the day of labour is a point of interest in every pregnancy. The physician is continually called upon to give a definite answer to it. The experience of mankind has led to fairly approximative calculations.

1. Where a single coitus is admitted, count 270 to 275 days. The latter date will rarely be exceeded.

2. In the ordinary social relations, reckoning is made from the beginning or the cessation of the last menstrual epoch. The most usual plan is to count from the last day of the period. Count 275 days on the calendar from this date, and labour may be expected within a range of a week earlier or later.

Tyler Smith contrived an ingenious dial, which he called a 'Periodoscope,' to assist in these calculations. It is based on the theory that 280 days is the normal duration of gestation, and that the menstrual or ovulation nisus determines the expulsive action of the uterus. His periodoscope thus indicates the most probable epochs for abortion and premature labour.

Schultze also constructed a dial for calculating the day of labour. It is copied in several recent text-books. It is not reproduced here, because the method of counting the days on the calendar is not less simple and accurate.

The Limits of the Capacity for Reproduction in Woman.

The earliest age is announced by the appearance of menstruation. It is not common for English girls to become mothers earlier than at sixteen or seventeen years. This does not exclude the possibility at an earlier epoch. Social laws to a great extent account for the rarity of very early maternity in England. Roberton recorded the case of a girl who became pregnant in her eleventh year. When in labour she had convulsions, but was delivered without difficulty of a full-grown still-born child. Smith, of Coventry, relates a case of delivery at term of a living child at twelve years seven months. Dr. Wilson, of Glasgow, records a case of delivery at thirteen years six months. Henry Dodd, of Billington, York, in *Lancet* 1881, records the following: On August 8, 1871, he attended a woman when she was delivered of a female child. This child menstruated more or less regularly from the age of twelve months until June 22, 1880, when, on her mother's statement, she became pregnant. She was delivered by Mr. Dodd, after an easy labour, of a live child weighing seven pounds on March 17, 1881, just 147 days before she had reached the age of ten years. The girl had free hirsute growth on the pubes and in the axillæ; the breasts became gorged with milk. Mr. Dodd has given us authentic proofs of the facts of this case.

Dr. Paris says, in his 'Medical Jurisprudence,' that in 1816 and during the French Revolution girls were admitted to the Maternité at thirteen, and some even at eleven years of age.

In Oriental races, maternity at twelve years of age is not at all uncommon. In Persia, for example, girls marry at eleven or twelve, and soon become mothers.

The latest age of gestation has been a subject of keen contention. We may adopt the statement of Fordyce Barker.[1] He met with the case of a lady born May 5, 1801, who was delivered May 6, 1852, and again in July, 1853. He cites two other instances of women over fifty having become mothers. He says: 'After the most careful and laborious research I can find but one authentic case, based on the evidence of a respectable medical man, who carefully investigated the documentary proof, where a woman who had reached the age of fifty-five years has given birth to a child. This case is recorded by Dr. Davies, of Hertford, England.[2] I feel warranted in stating the proposition that the laws of physiology, the experience of mankind, and the decisions of courts of law, justify a medical man in declaring that a woman over fifty-five years of age is past the period of child-bearing.'

A correlated question is: whether a woman may conceive some months after the cessation of the catamenia? If it can be established that a woman who had been regular throughout had ceased to menstruate at the usual climacteric age, say forty-eight, the presumption is very strong that she is no longer capable of conceiving.

The physician is occasionally consulted as to the probability of pregnancy in women of a certain age, marriage depending upon his opinion. There are signs which aid in arriving at a decision. Putting aside all subjective signs, he examines the sexual organs. If the breasts have become shrunken, if the vagina is getting tense and contracted, if the uterus is smaller,

[1] *Philadelphia Medical Times*, 1874.
[2] *London Medical Gazette*, vol. 39.

lighter than in the stage of active function, if the vaginal-portion is shortened, nearly flush with the vaginal roof, the os externum a small round hole, and the colour of the mucous membrane yellowish pale, we may conclude that the organs are in process of senile atrophy, and that pregnancy is, if not impossible, in the highest degree improbable.

The latest age is not to be decided by the subjective phenomenon of sexual passion. In many women this passion survives the capacity for conception. And many women who bear children never experience it.

The premature and protracted occurrence of menstruation have been respectively relied upon as evidence of capacity for reproduction. But it is necessary to avoid the error, now less frequent indeed than formerly, of confounding hæmorrhages more or less periodical with true menstruation. The older books on forensic medicine teem with cases of menstruation in children and old women. These are to be regarded as almost invariably cases of hæmorrhage from local or general disease. Hæmorrhagic discharge continuing or appearing after the age of fifty is an indication for local examination.

THE CARE OF THE GRAVIDA.

The Hygiene of the Pregnant Woman.

To keep the process of gestation in its due physiological course, is a duty of the highest importance. Upon the fulfilment of this object depends not alone the present well-being of the woman during her gestation, and the safety of the fœtus, but also her riding safe through the perils of puerpery.

A healthy woman when pregnant has but few rules to observe. They may be stated as follows: (1) To keep the secretions in order; (2) to take regular exercise, in the open air when possible; (3) to avoid late hours; (4) carefully to avoid heated and foul atmosphere, as in badly ventilated houses or public buildings; (5) to take care that her habitation be clean as regards drainage and sewerage; (6) to be careful in diet, avoiding indigestible food and excess in stimulants; (7) to dress warmly, avoiding all tight lacing, and other tricks for 'preserving the figure' at the cost of free play for the lungs, heart, and abdominal viscera. This condemnation extends to corsets which compress the breasts and nipples. Those women in whom the abdominal walls are lax may with advantage wear a well-devised belt so made as to support the abdomen and uterus from below.

This great principle should be borne steadily in mind, that, since the safe passage through the trials of puerpery depends mainly upon the effective working of the excretory system, all rational means, as exercise, baths, and other factors of health, for developing the functional capacity of the glandular system should be pursued.

During the first three months whilst the uterus is lodged in the pelvis, violent exertion should be avoided with special care. Retention of urine should be guarded against, and if frequent dribbling or dysuria occur, examination should be instituted.

It is desirable—although sometimes not within the power of the physician to carry out—(1) to examine the urine for albumen and sugar at frequent intervals, say once a week during the latter four months of gestation; (2) during the first three months to ascertain if the uterus is in due relation to the pelvic axis. This rule is imperative in the case of women known to have been subject to prolapsus and retroversion when not pregnant. (3) Opportunity should be taken to ascertain if the pelvis and soft parts be well formed and adapted for healthy labour. (4) In the last month it is especially desirable to ascertain if the position of the fœtus be normal, in order to rectify it before labour supervenes.

CHAPTER IX.

ABNORMAL GESTATIONS.

THE principal forms of abnormal gestation may be classified as follows:—

A. Ectopic or extra-uterine gestations.

B. Gestation in one horn of a two-horned uterus or other imperfectly developed uterus.

C. Uterine gestation complicated with tumours, uterine or extra-uterine or other abnormal conditions.

D. Superfœtation.

A. *Ectopic or extra-uterine gestations.* We first adopted [1] the term 'ectopic' as more accurate than the old term 'extra-uterine.' Some gestations, as those taking place in the lower segment and in the cervical canal of the uterus, and in the wall of the uterus, are abnormal and ectopic, but not strictly extra-uterine.

The ovum may be arrested and fecundated at any point along its transit to the uterus. Thus we may have (1) ovarian, tubal, tubo-ovarian, abdominal, mural or interstitial gestation; (2) it may reach its normal nidus, the body of the uterus, constituting normal gestation; or (3) it may pass through the body of the uterus proper and be grafted upon the lower segment of the uterine cavity, constituting sub-ectopic gestation—this is the condition that obtains in placenta prævia; or (4) it may even drop into the cervical canal and be developed there—this is strictly an ectopic gestation; and (5) a fifth variety consists in the development of the ovum in one horn of a two-horned uterus.

Extra-uterine gestation is seen in the lower animals. Specimens are preserved in University College and in other museums.

[1] *Diseases of Women.* 1878.

1. Beginning with the seat of genesis of the ovum, we first have to consider *ovarian gestation*. The ovum failing to escape from the ovary is fecundated *in loco*, and the postulate is that there it is developed. The possibility of fecundation in or on the ovary can hardly be disputed; but the development in the ovary has been formally contested by Velpeau, Arthur

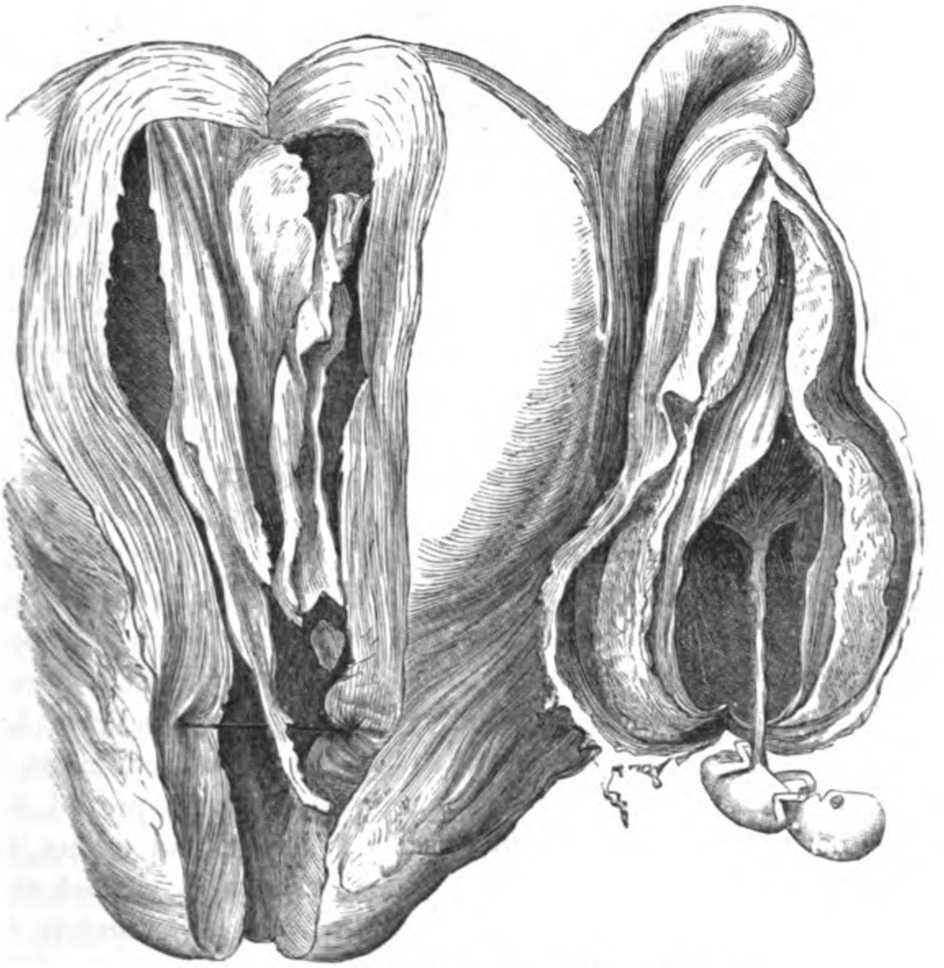


FIG. 95.—St. Thomas's Museum. (Natural size.)
Gestation in left Fallopian tube. The sac ruptured. Uterine mucous membrane developed to thick decidua.

Farre, and, more lately, by A. Willigk, who has minutely examined several alleged examples, and failed to find embryo or membranes in the ovary. On the other hand, Duverney, Goupil, P. U. Walter, Hecker, and Puech relate cases which it is difficult to reject. It is convenient to merge the history of ovarian gestation in that of the other forms.

2. *Tubal gestation.*—The ovum may be arrested in any part of the Fallopian tube. A common part is the outer third, which presents more dilatation; sometimes it is arrested in the grasp of the fimbriæ, and sometimes near or in the *ostium uterinum.* When the arrest is within the fimbriæ the case is nearly akin to or may merge into the tubo-ovarian variety; when the arrest is near to or in the ostium uterinum the case is akin to or may merge into the mural or interstitial variety. The simple tubal gestation is perhaps the most common; it presents the most typical history.

The *causes* of arrest of the ovum are — inflammatory adhesions of the tube (Hecker); obstruction of the ostium uterinum by polypi, or fibrous tumours in the uterus (specimen in University College Museum); hard work has been frequently observed in this connection (Robert Barnes); twins have been observed many times, the two ova may obstruct each other (Robert Barnes). A remarkable fact has been frequently observed—namely, that the gestation takes place in the tube opposite to the ovary in which the corpus luteum is found. How is the passage of the ovum, say from the right ovary to the left tube, to be explained? There are two theories: *a.* That insisted upon by Oldham, the *extra-uterine transmigration*, by which it is supposed that the ovum dropped from the right ovary, evading the grip of the right *morsus diaboli*, falls into the abdominal cavity, and is carried over by the movements of the intestines to the left tube, by which it is seized. The possibility of this migration seems proved by cases narrated by Rokitansky, Luschka, Schultz, and others, in which the tube, corresponding to the ovary which yielded the ovum, was impervious. But the ovum frequently wanders to the opposite tube where both tubes are quite normal. Mr. Stirling, of the Edinburgh University, informed Robert Barnes (1875) that in eight out of twenty sheep the ovum was found in the opposite horn of the corpus luteum.

b. There is the hypothesis of *intra-uterine transmigration.* Tyler Smith started the idea that the ovum received in its associated tube might travel along it, enter the uterus, cross over to the opposite ostium uterinum, and thus get into the opposite tube, and be developed there. That the ovum may wander in the uterine cavity is proved by cases of placenta prævia, and fluids may pass from the uterine cavity into the tubes. Klob, however, denies the possibility of intra-uterine transmigration.

The *influence of extra-uterine gestation upon the uterus* is remarkable. The uterine mucous membrane is developed into decidua. The nest is prepared, but the ovum does not come to occupy it. This decidual development is, as Velpeau pointed out, proportionate to the proximity of the gestation-sac. It is most marked in mural and tubal gestations; less so, or perhaps absent, in abdominal gestations. Most museums show examples. The figure (95), from a specimen in St. Thomas's Museum, illustrates this and other features.

The relations of the ovum to the mucous membrane of the tube differ in important points from those observed in uterine gestation. Oldham, Kiwisch, and Virchow showed that the tubal mucous membrane does not develop a true decidua. It is deficient in the utricular glands which the uterine membrane possesses. The chorion-villi are implanted directly upon the mucous membrane. Poppel says that even if a decidua vera be formed there is no serotina. Hennig says the placenta is developed on a different plan from that of the normal uterine placenta; it is developed according to the plan which governs the normal gestation in rabbits, cats, and dogs. This slender attachment may serve to explain the facility with which separation and hæmorrhage take place. In like manner, and *à fortiori*, in abdominal gestation there is no decidua or proper representation of the maternal element of the placenta. The placenta is attached directly to the outer surface of the uterus or of some abdominal organ.

The course of tubal gestation.—The ovum, arrested in the tube, develops its chorion into placenta, which adheres to rather than penetrates the tubal mucous membrane; growing, it distends the tubal wall, forming a gestation-sac; usually within three months—Hecker says in the great majority of cases within eight weeks—the stretching and growing capacity of the sac is exhausted, and the tube bursts. This bursting usually occurs at a menstrual epoch. There is, as Robert Barnes insisted, a close physiological analogy with placenta prævia and abortion. Hæmorrhage from the uterus commonly precedes bursting. This premonitory hæmorrhage, he explains, is due to the growth of the ovum exceeding the accommodating growth of the tubal sac; vessels get separated and yield blood. Some of the blood escapes by the uterus, some is retained in the tube, and, adding to the distension, leads to the rupture by producing spasmodic action of the muscular wall. The ovum itself does not always burst. The accumulated blood in the tube, together with fresh blood proceeding from the torn vessels, is now poured into the abdominal cavity, causing the shock and other phenomena which mark the climax.

The injury sustained is compound: there is the traumatic violence attending the rent, and the sudden impression upon the ganglionic centres producing shock and the hæmorrhage. The symptoms are twofold: shock induces collapse, marked by coldness, prostration, near extinction of the pulse, vomiting; deadly pallor supervenes, and in a short time—a few hours perhaps—the patient may die. To this assemblage of symptoms Robert Barnes gives the name 'abdominal collapse.' The suddenness and the character of these symptoms, quickly killing a woman who up to the catastrophe might have been in sound health, have often excited suspicion of foul play by poison or other violence. Hence the necessity for an autopsy. If the woman survives the shock the symptoms of hæmorrhage become manifest; the general signs are those of anæmia; the local signs may be the feeling of an accumulation of blood in Douglas's pouch, the 'cataclysmic' form of retro-uterine hæmatocele. At this stage, again, the patient may sink under the combined effect of continuous shock and hæmorrhage. If she survive this stage she has still to encounter the third danger—that of peritonitis. This may set in rapidly. Intense pain continues, the abdomen swells, becomes tense, the pulse rapid and small, the temperature rises two or three degrees, and the countenance puts on the anxious drawn expression characteristic of abdominal injury. Still the case may end in recovery. How can we help to this end?

Treatment. There are two distinct epochs in the history to be studied: (*a*) the stage of development of the gestation before rupture, with a view to the prevention of this catastrophe; (*b*) the state after rupture. The treatment during the first stage must depend upon the *diagnosis*. A tubal gestation may be predicated from the presence of the usual subjective signs of gestation, added to which is pain—this, says Goupil, is constant; and the local objective signs. There is a swelling commonly seated behind the uterus, usually more on the left side. This is fluctuating, tense, pear-shaped or sausage-shaped, possibly moveable; the uterus is always somewhat enlarged, and, as is the case whenever a tumour gets behind it from above, it is pushed downwards and forwards nearer to the symphysis pubis, often pressing on the bladder and causing retention of urine. This tumour has to be differentiated from small ovarian tumours, retroversion of the gravid womb, or retro-uterine hæmatocele. Retention of urine is far less frequent during the development of a gestation-cyst than in any of the three cases specified. Retroversions may be distinguished by tracing the firm rounded body of the uterus by vaginal and rectal touch, and by the mass behind the cervix being much lower, nearer to the pelvic floor, than is at all common with the gestation-sac.

The ovarian cyst has probably given rise to more protracted symptoms: it does not cause suspension of menstruation; the uterus is not enlarged; the characteristic coloration of the vagina and the other signs of pregnancy will be wanting. Partly by a process of exclusion, partly by positive signs, we arrive at the presumptive, if not the absolute conclusion that the case is one of tubal gestation. This settled, several methods of treatment offer themselves. The necessity for active treatment to arrest the growth of the embryo is emphatically stated by Lesouef, who affirms that every woman who has become the subject of an extra-uterine gestation is doomed to more or less speedy death. The qualification of this sentence is certainly limited. *a.* The cyst may be tapped by an aspirator needle or trocar. The liquor amnii drained off, the cyst collapses, and the embryo perishes; atrophy of the cyst ensues. This has been successfully practised by Greenhalgh and E. Martin. *β.* Injections into the sac. Friedreich injected a solution of morphia with complete success. *γ.* Bacchetti proposed to kill the embryo by passing an electric shock through the cyst. Duchenne suggested the shock of a Leyden jar. Of these methods the simplest is the tapping the cyst by the aspirator needle. Indeed, it is probable that the puncture of the cyst, which forms a part of the other methods of operating, is by itself adequate to account for the successful results. δ. It has been proposed to arrest embryonic growth by agents introduced into the mother's blood. Iodine and starvation have been discussed. We may succeed in iodising or starving the patient, but the desired effect upon the embryo cannot be counted upon. ε. The sac may be cut down upon, ligated, and removed.

b. Then comes the question what to do when rupture has taken place. There is a growing consensus of opinion in favour of performing *laparotomy*, seeking out the sac, tying the tube on the uterine side, and excising the sac. By this proceeding the risk of further hæmorrhage is avoided, and the abdominal cavity can be cleansed of effused blood and clots, thus lessening the risk of peritonitis. This operation does not materially add to the shock already dealt by the rupture, and it gives the best chance of recovery in severe cases. It must, however, be borne in mind that the first shock and hæmorrhage may be fatal. Our judgment is decidedly in favour of the operation. It should be done early.

c. There is still a third stage requiring treatment. It is that when the period of shock has passed, when the blood effused is segregated as hematocele by peritonitic effusion. This is often attended by irritative fever. The uterus is set fast, pressed downwards, and a mass is felt behind, sometimes more prominent in the seat of one broad ligament. Sometimes the retro-uterine mass is firm, nodular; sometimes soft, semi-fluctuating. In the latter case especially it may be useful to tap by the aspirator trocar, and to insert a drainage-tube to let the liquid blood or pus run off. For this purpose a special trocar and canula, longer than those usually supplied with Dieulafoy's apparatus, are required. Through this, on withdrawing the trocar, a wire drainage-tube is run into the sac before the tube is withdrawn. Even in this case it may still be the wiser course to open the abdomen, and remove the offending structures.

The general treatment is indicated by the constitutional reactions. Pain may be allayed by subcutaneous injections of morphia, by cataplasms, hot fomentations, and suppositories of opium. Collapse must be combated by stimulants, of which the most efficient is the subcutaneous injection of a drachm of pure ether. In the suppurative stage quinine is most useful.

3. *Tubo-ovarian gestation* occurs when the ovum is contained in a sac formed between the fimbriated end of the tube and the surface of the ovary. It is less likely to end in rupture than the tubal form. It is prone to go on to the full development of the fœtus. What then happens resembles the course of the next form.

4. *Abdominal gestation.*—It appears to us doubtful whether this form is ever primary; that is, whether the ovum attaches itself *ab initio* to some spot of the peritoneum. It is true that ova, impregnated or not, may escape the *morsus diaboli*, and fall into the abdominal cavity, there to perish; and Kiwisch insists that spermatozoa also stray into the peritoneum, there to meet the stray ovum. Such a fortuitous concourse of atoms rests upon conjecture. Probably abdominal gestation is always secondary upon tubal or ovarian gestation. Inflammatory adhesions form with the peritoneum, and the sac is enlarged. The course of an abdominal gestation is prolonged. Intercurrent attacks of pain, the expression probably of attacks of peritonitis, occur. The cyst may burst, but this is rare. The fœtus arrives at maturity and dies. An abortive labour occurs. Under the exhaustion of this effort the woman may sink. Peritonitis proceeding from rupture or perforation of the sac, preceding or following the death of the fœtus, may prove fatal. In one case of this kind narrated by Robert Barnes, a fluctuating swelling formed behind the uterus. Perforation may take place into intestine or bladder, into the vaginal roof or rectum, or even through the abdominal wall. In these cases the fœtus, decomposed, broken up, may be discharged piecemeal, partially or wholly through fistulous openings. This is a tedious process; hectic and emaciation may after weeks or months exhaust the patient. The diagnosis is often difficult. Almost all the cases in which this form of gestation was suspected which have come under our observation turned out to be ovarian cysts. The confusion does not entail injury to the patient, since the course to be adopted is the same in either case. The *treatment* is to open the abdomen for exploration where doubt exists. An ovarian tumour will of course be removed. If the case turn out to be a gestation-cyst the cyst is laid open, the fœtus

is extracted, and the placenta is left with the cord hanging out of the abdominal wound, which is then closed. After a time the placenta is detached, breaks up, and comes away whole or in *débris*. In cases where fistulous openings are formed into the rectum or through the abdominal walls, these should be enlarged, and fœtal *débris* extracted; discharges should be evacuated by drainage-tubes, and antiseptic irrigation should be practised.

There are three successive epochs at which laparotomy may be practised: (1) during the development of the embryo; (2) when the natural term of gestation is accomplished; and (3) after the death of the fœtus. During the first stage the embryo or fœtus may be killed by Duchenne's plan of shock by a Leyden jar. The sac may be punctured; but in a case where this was practised by Hicks the patient died of hæmorrhage. Upon the whole expectancy is perhaps the wisest course until the second stage is reached. Then new dangers arise, the cyst may burst, hæmorrhage and peritonitis may set in. Levret, Gardien, Velpeau, Kiwisch, Koeberlé, and most recent authorities advise laparotomy. It offers the best chance. Koeberlé cites nine cases, seven children and four mothers being saved. Meadows related a good case to the Obstetrical Society (Nov. 1883). In the third stage, when tolerance has been attained, the operation is still advisable. The process of calcification is hardly to be trusted; and when all vital action is at an end by the death of the fœtus, opening the sac is hardly more dangerous than opening an abscess. Hutchinson and others prefer this, the so-called secondary operation.

In some cases tolerance of the abdominal gestation-sac is established. The dead fœtus becomes compressed, the liquor amnii being absorbed. Then a process of calcification of the sac and membranes takes place, and the fœtus is shut up as it were in a calcareous shell as an inert mass. In this way women have lived many years, dying ultimately of old age. There is a remarkable specimen sent by R. W. Watkins to Robert Barnes, and by him described in the 'Obst. Trans.' vol. viii., and presented to St. Thomas's Museum. This fœtus had been retained forty-three years. Sappey recently communicated to the Academy of Sciences, Paris, a case in which a well-formed fœtus, enclosed in a calcareous case, was found *post mortem* in Douglas's pouch. It had been diagnosed fifty-six years previously. The fœtus in such a case is usually called a 'lithopædion,' it being supposed that it undergoes a calcareous transformation. But Robert Barnes, from a minute examination of Watkins' and other specimens (see memoir on 'Missed Labour,' 'Obst. Trans.' 1881), has shown that the calcification is limited to the membranes and sac, the shell thus formed preserving the fœtal structures but little changed.

5. *Parietal* (Ramsbotham), *mural*, *interstitial*, *or tubo-uterine gestation.*—In this form the fecundated ovum is de-

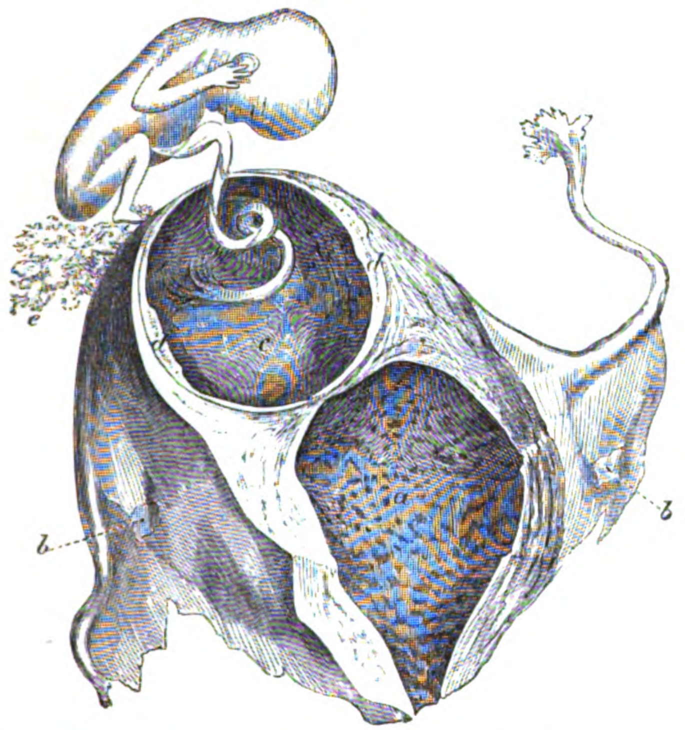


FIG. 96.—Tubo-uterine ; interstitial or mural gestation. (After Poppel.)

a. Cavity of uterus clothed with decidua. *b.* Broad ligament. *c.* Tubo-uterine sac which contained embryo. *d, d.* Thicker part of cyst-walls. *e.* Placenta.

veloped in the uterine portion of the tube. Such cases are relatively rare, and for the most part the gestation-sac encroaches upon the free part of the tube. Hence the term tubo-uterine. These gestation-sacs burst early. The diagnosis from tubal gestation is difficult. The uterus may be expected to be enlarged, as being more implicated. Several presumed cases of parietal gestation have been proved on minute examination to be really examples of gestation in a rudimentary uterine horn. The issue is commonly fatal. Some cases of supposed 'missed labour' were probably ectopic gestations of this variety. And some cases presumed to be mural more strictly belong to the next order.

6. *Gestation in one horn of a two-horned uterus, or in the horn of a single-horned uterus.*—Luschka, Kussmaul, and others have demonstrated the characters of these forms of gestation. In cases in which the horns of the uterus or one of them persist in a rudimentary form, not being completely fused into one uterine body, an ovum may be developed in a

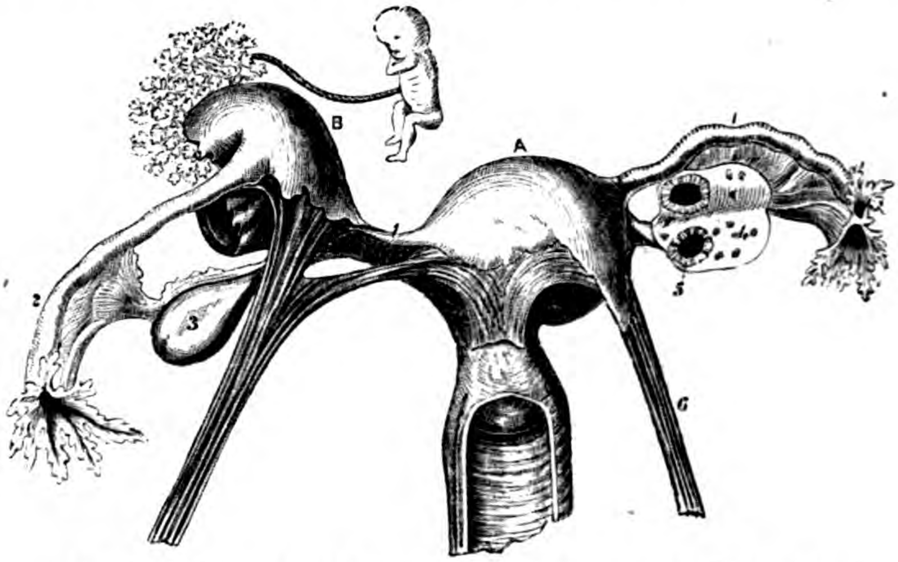


FIG. 97.—Gestation in a rudimentary horn of uterus. (After Luschka.)

A. Developed right horn. B. Rudimentary horn, with a rent through which the embryo had escaped. 1. Right Fallopian tube. 2. Left Fallopian tube. 3. Left ovary. 4, 5. Right ovary and corpus luteum. 6. Round ligament.

horn never reaching the imperfect uterine body. Thirteen cases collected by Kussmaul all terminated by rupture of the fruit-sac and death. Professor Turner has thrown additional light upon this variety.[1]

7. *Retro-uterine gestation.*—It deserves to be noted that extra-uterine gestation-sacs generally find accommodation at least in part in Douglas's pouch. Here they may often be felt and diagnosed, and offer facilities for treatment. They may be punctured through the vaginal roof, liquor amnii drawn off, and fœtal bones may be extracted by this route. Forming a tumour behind the uterus they may obstruct the entry of an

[1] *Malformations of the Organs of Generation*, Edinb. 1866.

intra-uterine fœtus into the pelvis. Fig. 98 (from a beautiful specimen in St. Thomas's Museum) shows well the fruit-sac between the uterus and rectum, and other relations.

8. *Hernial gestation.*—Still another variety of ectopic gestation remains to be noticed. *Hernia of the gravid uterus* cannot indeed strictly be classed under extra-uterine gestation. The gravid uterus has been found in a hernial inguinal sac.

FIG. 98.—Retro-uterine gestation.

B. Intestines. U. Uterus. V. Vagina. R. Rectum. The fruit-sac between uterus and rectum laid down, showing fœtus.

Here it is the uterus which is ectopic, not the gestation. The case will be found described along with the 'Displacements of the Gravid Womb.'

Sub-ectopic gestation may be said to occur (a) when the ovum is implanted upon, and grows in the lower zone of the uterine cavity, below Bandl's ring (Robert Barnes). This is the condition marked by 'placenta prævia.' It will be described under 'Hæmorrhage.'

(β). When the ovum is developed in the canal of the cervix uteri. Chavanne narrates a case. It is extremely rare. Below this point there seems no hold for the ovum. We are not acquainted with an instance of gestation in the vagina.

Apparent gestations.—Dermoid cysts in some respects simulate gestation.

The *fœtus in fœtu* presents a stronger resemblance to gestation. One embryo may be included in another. The *ovum in ovo*, described and figured by Robert Barnes ('Obs. Trans.' vol. iv.) is a typical example of this phenomenon in the fowl. A remarkable fact in this case is that the shells of the two eggs always differed in colour. The inner shell was reddish, like the Cochin fowl's and the partridge's, the outer shell dull chalky white. The hen was a half-breed between the Cochin and Dorking. There are specimens of one complete ovum and shell inside another in the College of Surgeons. Analogous examples are known in man. In the museum at Munich we saw a remarkable specimen, the skeleton of an adult man whose thorax includes a developed fœtus. The subject had served in the army. Other examples are figured in Förster and Ahlfeld.

C. Uterine Gestation may be complicated with—

1. An ectopic gestation, especially the abdominal variety.
2. Ovarian cystic tumour, or dermoid cyst.
3. Enlarged liver.
4. Cystic disease of the kidney.
5. Pelvic hæmatocele.
6. Ascites.
7. Uterine tumours.
8. Cancer of uterus.

1. *Complication of uterine with extra-uterine gestation is* rare; but several cases are recorded. The uterine gestation may go on to term, and the ectopic gestation may be undisturbed. Indeed, an ectopic gestation may persist through several recurrent uterine gestations. But the danger is serious —first, of premature expulsion of the uterine fœtus, from impediment to the due development of the uterus; second, of rupture of the uterus under labour at term from the ectopic gestation-sac blocking the entrance to the pelvis; third, from inflammation being set up in the sac or neighbouring structures under the pressure of the growing uterus or the violence during labour.

2. *Complication with ovarian tumour.*—The history offers points of great clinical importance: (α) the gestation may go on to term, and labour take place naturally; we have known cases of several successive gestations run their course; (β) the case may end in abortion or premature labour; (γ) the term of gestation attained, the uterus may rupture from obstruction to the labour, the tumour getting in the way; (δ) the ovarian cyst may burst under the rapid double growth of uterus and tumour, shock and peritonitis may ensue and prove fatal; (ε) the cyst lifted up by the growing uterus may be rotated on its axis, twisting its pedicle, strangulating its vessels, leading to necrosis, and death by exhaustion and peritonitis. Robert Barnes records two examples of this termination.

The dangers then are very great. In no given case can we feel secure that one of the catastrophes specified may not occur, and that at any moment without warning. This consideration compels us to adopt a decided measure to put an end to the complication.

The *diagnosis* is difficult. The first point is to verify the existence of uterine pregnancy. The positive objective signs will establish this element in the case. The next points to determine are, that there is a complicating tumour and the nature of it. Assuming the extreme difficulty of determining whether the complicating tumour be an ectopic gestation or an ovarian tumour, we must generally be content with the conclusion that it is one or the other. The common features are: (α) the abdominal enlargement is greater than the estimated stage of uterine pregnancy will account for; (β) the shape of the abdomen is different; it is stretched out on either side, the two swellings, more or less spherical, leave a sulcus between them at the point of divergence above. This obtains to some degree in the case of uterine twin-gestation, but in this case we ought to hear two fœtal hearts; and in the case of the complication under discussion, the uterus will be pushed to one side, so that the fœtal heart and the other proper uterine characters, as peristaltic movements, will be made out in an iliac region or a flank and generally nearer the pelvis than usual; (γ) the ectopic gestation-sac commonly projects more or less behind the uterus in Douglas's sac, where it may be felt.

The above rules apply merely to the ovarian cyst. In this latter case an area of fluctuation may be made out. But this is not constant.

Treatment.—The system will hardly tolerate the concurrent progress of two growing tumours, as of uterine gestation and ovarian cyst. The process of accommodation might keep pace with one; but it is unequal to the double strain, mechanical and constitutional. Something must give way. It is an urgent case for the intervention of art. Upon which factor shall we operate? The uterus or the tumour? The readiest course is to act upon the uterus by inducing abortion. The case is thus reduced to its simplest expression. But the measure is unsatisfactory. The ovarian tumour goes on unchecked; and we know that its natural tendency is to kill at no remote period. Very little then is gained. Nor is the proceeding free from immediate danger. The puerperal process may be disordered. And another consideration is important. If we induce abortion the offspring is necessarily sacrificed; and if we wait for the period of viability we are running all the risks attendant upon the complication. On the other hand, if we act upon the tumour by extirpating it, the morbid element of the complication is removed; the uterus is left free to its natural development, and the child may be born alive at term. It may be apprehended that ovariotomy during gestation would provoke abortion. Experience has solved this question. The operation has been successfully performed under these circumstances several times.

An alternative is tapping the tumour. Under exceptional circumstances forbidding ovariotomy this may be practised. But it can at best afford temporary relief. It cannot be regarded as a substitute for the complete operation.

The tumour then should, as a rule, be removed. There should be no hesitation or delay: (α) if the tumour is growing rapidly; (β) if there is increasing distress in the circulation and respiration; (γ) if the cyst is multilocular, colloid, or dermoid; (δ) if it become inflamed, suppurate, or twisted; (ϵ) if peritonitis or severe prostration suggesting rupture of the cyst occur. It is better to operate as early in the gestation as possible.

Like reasoning and practice will apply to the case of ectopic gestation.

We find twelve recorded cases in which the ovarian tumour has been removed during pregnancy. Nine of these are by Spencer Wells; five went on to term, mother and child surviving; in one case the fœtus was removed at the same time; in two abortion followed, one mother dying; in one case operated upon at seven months, the child was born alive twenty-five days after, the mother recovered. In Tait's case abortion and death followed. In Baum's case abortion followed; the mother recovered. In Galabin's case the woman went to term, a live child was born; the woman recovered after an attack of phlegmasia dolens.

3. *Gestation with enlarged liver.*—In this complication the growth of the gravid uterus is impeded. Abdominal distension leads to gastric disturbance and distress of the thoracic organs. The *diagnosis* is established by (α) previous knowledge of the liver disease; (β) dulness on percussion extending from the costal cartilages downwards; in the early stage of gestation an area of resonance will be left between the liver above and the uterus below; later on this resonant zone will disappear; (γ) the positive evidences of gestation. The enlargement of the liver may be solid or cystic from hydatids.

Abortion may occur spontaneously. If not, the question will arise as to the induction of labour, and the best time for taking this step. This must be determined by the urgency of the symptoms. But, as a general rule, bearing in mind the pernicious effect of gestation upon liver and kidney disease, the elimination of the pregnancy should not be delayed too long.

In the case of hydatid cyst, the aspirator-trocar should be used to tap the cyst, before acting upon the uterus.

4. *Gestation with cystic disease of the kidney.*—Similar distress from distension may arise. Here again an area of dulness will be traced from above downwards to meet the dulness of the ascending gravid uterus; an area of resonance is made out between the cyst and the uterus until they meet. Fluctuation in the cyst will probably be evident. The first course to discuss will be the expediency of tapping the cyst. The next will be the question of inducing abortion.

5. *Gestation with pelvic hœmatocele.*—This complication is rare, but we have met with it. Unless symptoms lead to

digital examination, the existence of the hæmatocele may not be suspected. If the tumour encroach much upon the pelvis, the question of inducing labour will arise. The diagnosis will clash with that of ectopic gestation.

Gestation may be complicated with other abdominal tumours, as hydatids of the intestines, malignant and other tumours of the omentum.

6. *Gestation with ascites.*—This complication is most likely to arise in association with albuminuria. It is rare. If the fluid in the peritoneum be in large quantity, and the gravid uterus small, the gestation may be masked, and we may have to depend for diagnosis partly upon the subjective history. If the dropsy depend upon heart disease or liver disease, it will probably have been of a duration antecedent to the computed pregnancy. The treatment will be governed—(1) by the urgency of the symptoms due to pressure; (2) by the disease to which the ascites is due. We may be called upon to act upon the uterus by inducing abortion, or to tap to relieve the ascites. The best plan of tapping is by help of Southey's drainage-needles. Special treatment will be directed to the causative disease.

7. *Gestation with uterine tumours.*—The relation of fibroids to the gravidity will vary according to the size, position, and other characters of the tumour. We have in this place to refer briefly to the bearing upon gestation. The greater clinical interest centres upon the relations to labour and puerpery. The characters of the tumours present great variety. It may be stated generally: (α) that tumours projecting from the external wall of the uterus are the most harmless; they may not disturb the gestation or the labour; (β) tumours growing in the wall of the uterus may interfere with the easy development of the uterus, and thus provoke uterine spasm, perhaps hæmorrhage and abortion; they may even lead to laceration of the uterine wall; they partake in the developmental growth of the uterus, and may thus take on rapid enlargement, causing severe pain; (γ) tumours projecting into the cavity of the uterus also grow under the stimulus of gestation, and are likely to lead to hæmorrhage, pain, and abortion; (δ) tumours growing at the fundus, or upper part of the uterus above the ovum, are least harmful, whilst those growing in the lower segment below

Bandl's ring are especially dangerous during gestation, and still more during labour.

In foresight of the great dangers that gather during labour at term and puerpery, it will generally be an anxious question whether abortion or premature labour should not be induced. It is difficult to lay down specific rules. Each case must be treated according to its peculiarities. But when the tumour occupies the lower segment of the uterus or the cervix, it will rarely be justifiable to let the gestation proceed. Sometimes a still more serious course must be adopted. Tumours enlarging under gestation may lead to impaction in the pelvis, and by eccentric pressure endanger life by pressure on the bladder and other pelvic structures, or by undergoing necrosis. In such a case ablation of the entire organ must be performed by laparatomy. Such a case is narrated by Robert Barnes.[1]

Fortunately, in a large proportion of cases of fibroid tumours, the uterus is so deformed and its functions so disturbed that impregnation is prevented, and in other cases, if conception takes place, it is cut short by early abortion. The question is often put to the physician, Should women bearing uterine tumours be forbidden to marry or to run the risk of pregnancy? The advice dictated by prudence and experience will almost invariably be: Accept celibacy and sterility. To graft a parasitic being, as an ovum may be regarded, upon a uterus unfitted to bear it, will too frequently be to court danger and death.

8. *Gestation with cancer of the uterus.* The dangers attending this complication grow with the advance of pregnancy. In one or two rare instances, the reality of which is open to dispute, pregnancy has seemed to cause the necrosis of the diseased mass, and thus to produce a cure.[2] The common seat of the disease is the cervix uteri, therefore exactly in the line of transit of the ovum in abortion and labour. At the same time the body of the uterus, the true nidus of the ovum, may be unaffected. It will keep pace with the development of the embryo, and the gestation is more likely to go on to term than in the case of fibroid tumours. Discharges, aqueous and hæmorrhagic, will occur, and sometimes septicæmia from absorption of the foul discharges; but this is not common

[1] *St. George's Hosp. Reports*, 1877, and *Diseases of Women*, 2nd ed.

[2] Newman's case, *Obstet. Trans.* 1867.

during gestation. It is doubtful how far the progress of the disease is affected by the gestation.

The diagnosis is generally, but not always, easy. An irregular lobed condition of the vaginal-portion with shot-like knobs from obstructed or inflamed glandules, combined with the great turgidity and occasional abrasion of the cervical epithelium proper to gestation, may simulate epithelioma.

The questions arising are complicated. The life of the mother, whether the gestation be allowed to go on or not, is almost equally compromised; so that the question of saving the child assumes greater relative importance.

The questions to be discussed are: *a.* The complication being recognised early, can anything be gained by inducing abortion? The answer will be in the negative. The embryo, of course, is sacrificed, and the mother's condition will not be improved. *β.* Can we treat the disease with any advantage, leaving the pregnancy to go on? Two plans are offered: (*a*) In some cases the greater part of the diseased structure may be removed by the wire-écraseur and cautery. In this way we have operated upon a woman in two successive pregnancies, securing her from hæmorrhage, and so improving the condition of the cervix that live children were delivered, the mother hardly suffering more than under ordinary circumstances. (*b*) Another course is to carry out Freund's operation of removing the entire uterus, and with it the disease. If the uterus is still free, so that the whole of the disease can be removed, this is the course to be preferred; and this, whatever be the stage of the gestation. The operation has been successfully performed by Spencer Wells.[1] If the disease has invaded the neighbouring structures fixing the uterus, the operation is not available, (*c*) and we have to weigh the questions of provoking labour, so as to lessen the injury to the diseased structures that must occur at the birth of a full-sized child, and, if that is not available, of performing Cæsarian section.

The presence of malignant disease is unfavourable to fecundation. In many cases probably the condition discourages sexual intercourse; where this is practised, the discharges will tend to prevent fecundation. Still, unhappily, the complication is not rare.

[1] *Médico-Chir. Transactions*, 1882.

CHAPTER X.

DISPLACEMENTS OF THE GRAVID UTERUS—RETROFLEXION—PROLAPSUS—PROCIDENTIA AND HYPERTROPHIC ELONGATION OF THE CERVIX—ANTEVERSION AND ANTEFLEXION.

The Displacements of the Gravid Uterus.

THE gravid womb may suffer all the dislocations and flexions to which the non-gravid womb is liable.

A dislocation of the uterus exists when it has shifted from its normal relations to the surrounding structures. Dislocation is another word for ectopy. A flexion of the uterus exists when its normal axis undergoes deviation.

There is a normal position of the uterus proper to each stage of gestation—that is, the position undergoes a progressive change as the uterus is developed (see Figs. 90 and 91).

These normal positions have been described under the head of 'Diagnosis of Gestation.' They must be carefully borne in mind when discussing the question of ectopy, especially during the first trimestrium.

In a less conspicuous degree the axis of the uterus also changes with its development. The general change is towards straightening. The axis of the body at first forms a curve with the axis of the cervix, concavity forwards; as gestation advances, the axis of the body and that of the cervix tend to merge into one straight line.

The dislocations of the gravid uterus are: retroversion and prolapsus, commonly co-existing—that is, either almost necessarily entails the other; anteversion, upward displacement, and displacement to one or other side.

The flexions are: anteflexion and retroflexion. Retroflexion often complicates retroversion and prolapsus. Retroflexion, pure and simple, of the gravid uterus can hardly exist. There may be complete procidentia. Retroversion and retroflexion are illustrated in Figs. 99, 100.

Retroversion of the Gravid Uterus.

The history of the subject is well given by Ramsbotham. Clinical observations of several older authors show that retroversion and its consequences had been recognised by them. But it appears that Grégoire was about the first to describe it definitely. William Hunter and Smellie, both pupils of Grégoire, made it known in England. Hunter figured it from an observed case.

1. *Retroversion* is the most serious form of ectopy. It is *complete* when the whole uterus is contained within the cavity of the pelvis; this may for clinical convenience be called 'pelvic gestation'; *incomplete* when part is contained in the pelvis and part rises into the abdominal cavity.

Hence complete retroversion is almost exclusively limited to the first three or four months of gestation.

Frequency. Retroversion of the gravid womb causing serious symptoms is comparatively rare. Dubois and Depaul hardly observed twenty cases between them. In our experience it is much more common. As many as twenty or more have been admitted into St. George's Hospital alone. And retroversions not leading to serious complication—that is, cases in which relief is brought either by spontaneous abortion or by the rise of the uterus out of the pelvis, are certainly common.

The clinical history and symptoms. The symptoms are *subjective* and *objective.* Subjective symptoms lead the patient to seek advice; then the objective symptoms come into evidence. During the first two months the patient may experience no serious distress, although the condition is gradually, *pari passu* with the development of the uterus, proceeding to a climax, which, by the end of the third month, or soon afterwards, declares itself quickly, in some cases almost suddenly, by intense suffering. But in most cases, women who are accustomed to take note of their feelings experience in an aggravated degree the symptoms that attend retroversion in the non-gravid state. The *pelvic signs* are: a sense of bearing down at stool, fatigue on walking, standing, or other exertion, with lumbo-sacral pain—'backache'; irritability of the bladder, frequent micturition, occasional difficulty in voiding the bladder, even passing attacks of retention. The *general signs* are: fatigue, malaise, disturbed digestion. At length, perhaps after some unusual exertion, as long walking, lifting weights, stooping and straining, the woman finds that she cannot pass the urine, and agonising hypogastric and pelvic pain sets in; not seldom vomiting ensues.

Later on, the stage of impaction, locking, or incarceration arrives; the *subjective symptoms* are still more urgent. They are—(1) those of pressure, with severe pelvic and abdominal pain; (2) shock, the result of pain, interruption of the bowel and bladder functions, and the local violence caused by the displaced uterus; (3) reflex phenomena, straining or bearing-down, from the distended bladder and pressure of the fundus uteri upon the rectum; (4) secondary or constitutional symptoms, as urinæmia and exhaustion, and sometimes albuminuria; (5) numbness of the legs, from pressure on the sacral nerves.

The sufferer is compelled to seek advice.

The *objective signs* discovered are: first, those made out by abdominal palpation and percussion. This brings out pain. The abdomen is found larger, more prominent than the stage of gestation will account for. The area of dulness mapped out extends from the pelvis below to either flank, and frequently higher than the umbilicus. The sensation is that of great renitent or elastic tension.

The shape of the projecting abdomen differs from that produced by the gravid uterus. It is more pointed. This is due to the distension of the bladder. Yet in answer to questions *ad hoc*, the patient and her attendants may declare that 'she is constantly passing water.' So far from leading the physician to accept this tale as evidence that the bladder is relieved, he ought to take it as strong presumptive proof that there is retention. There is no clinical aphorism truer than this: 'Dribbling of urine is proof of retention.' The bladder struggling spasmodically to overcome the obstruction at the urethra, and further compressed by the abdominal muscles thrown into spasmodic reflex contractions, gets partial relief by driving a little urine through the urethra. If this did not take place, liquid being incompressible, the bladder must quickly burst. Now this accident is very rare. In any case it is a wholesome rule to pass the catheter. This proceeding is at once diagnostic and remedial. If an unusual quantity of urine—say forty to sixty ounces—is drawn off, sensible relief is obtained; the abdominal distension and projection fall, the abdominal walls become comparatively flaccid, permit freer

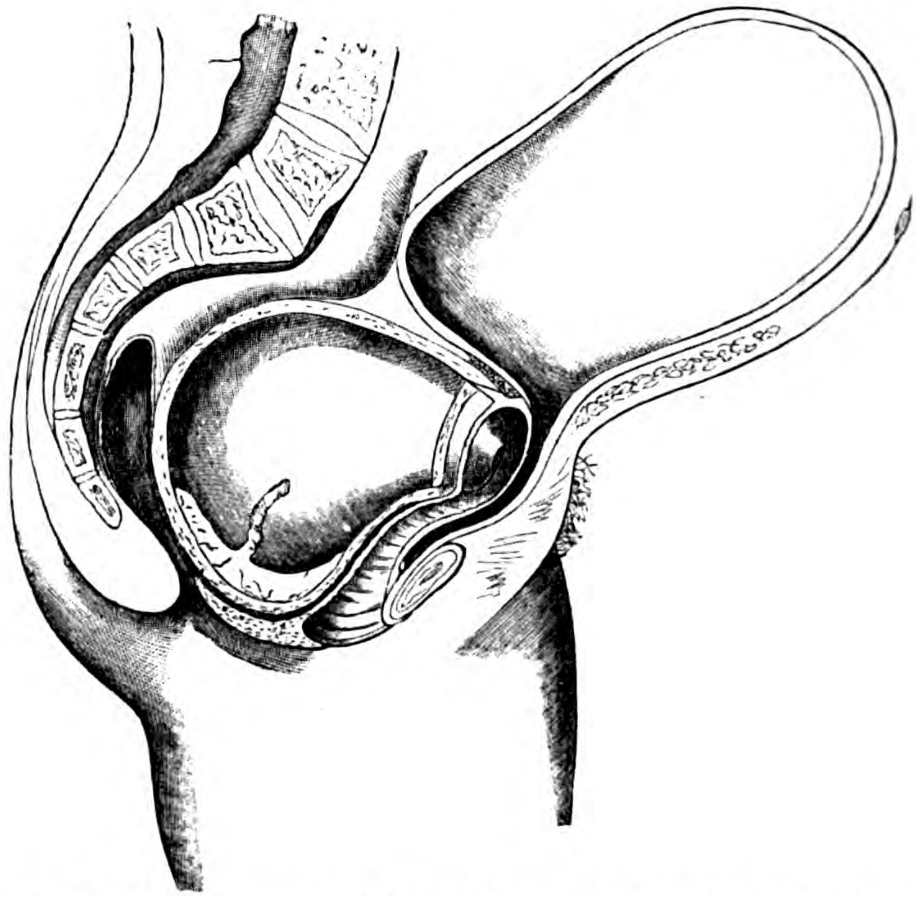


FIG. 99 shows retroversion of the gravid uterus at three months about. The cervix rises above symphysis, drags up and compresses urethra, causes retention and distension of bladder, and forward deviation of the vagina. (Robert Barnes.)

palpation. The hand may sink down and feel the spinal column, giving evidence that the tumour was not due to morbid growth or the gravid uterus. Search is then pursued by the vagina. The finger, instead of finding its way backward and upward as usual towards the sacral hollow and promontory to find the cervix uteri, is directed by the peculiar deviation of the course of the vagina upwards and forwards to the symphysis pubis, and the cervix and os uteri are found close against the symphysis, or even lifted up above it, so as to be difficult to reach (see Fig. 99). The sacral hollow, in fact, is blocked by a firm rounded mass which projects the posterior wall of the vagina forwards. This mass is the body of the uterus which, fallen back, rolled over on its transverse axis, has thrown the cervix up and forward. The relation of the uterine axis to the pelvic axis is reversed. In vulgar phrase the uterus is capsized. This is shown in Fig. 99.

The uterus rolls over on its transverse axis, the fundus descending, the cervix ascending. The ascending cervix uteri drags up the attached base of the bladder, and this in turn drags up the urethra, so that the meatus is commonly pulled up behind the symphysis, so as not always to be easily found. At the same time the base of the bladder and the urethra are compressed against the symphysis. Hence obstruction and retention of urine. Posteriorly other objective signs appear. The enlarged body of the uterus, driven down by the spasmodic reflex expulsive efforts, causes perinæal projection or bulging. Sometimes this sign is not conspicuous, but in others it is very prominent. Halbertsma relates a case in which the fundus uteri actually opened the anus and partly protruded through it.

Diagnosis.—Almost all the subjective and objective signs described as belonging to retroversion may be produced by other causes. Thus: a small ovarian tumour, an ectopic gestation cyst, a fibroid tumour of the posterior wall of the uterus, a retro-uterine hæmatocele or abscess; an accumulation of fæcal matter in the rectum; anything, in short, getting into Douglas's pouch may push the uterus bodily forward against the symphysis, and cause retention of urine. It must be borne in mind that up to this point we have been restricted to abdominal palpation and touch by vagina and rectum. We can at best take cognisance only of the physical condition of the parts as felt from below.

We now proceed in our exploration. The problem is to determine the nature of the rounded mass in the sacral hollow. There are differentiating signs that will rarely fail to lead to a safe clinical conclusion. First. As a general rule, *bodies getting into Douglas's pouch come from above the uterus, and so press the uterus downwards as well as forwards against the* *symphysis.* Thus the vaginal-portion and os uteri will, when the displacement is produced by bodies external to the uterus, be found low down near the vulva, and pointing downwards. The meatus urinarius is not drawn up, as is the case in retroversion. These conditions are enough to distinguish the case from retroversion of the gravid uterus. But commonly, by rectal examination, and combined vaginal and abdominal touch, the uterus may be ascertained to preserve its normal axis, the fundus pointing over the symphysis, in line with the vaginal-portion. Of course the sound passed into the uterus would make this relation quite clear, and the uterus thus defined, the mass felt behind the vaginal-portion is proved by the process of exclusion to be something else, that is, one of the retro-uterine bodies enumerated above. But the probability of gestation precludes the use of the sound at present.

But without recourse to the sound we may conclude that, when the os uteri points downwards, and is carried low down near the pubic arch, the case is not retroversion. It remains to differentiate *retroflexion* from the cases in which the uterus is driven bodily downwards and forwards by something behind it. There are two signs that help. First, retroflexion of the gravid uterus is almost invariably attended by retroversion; the rolling over and descent of the body of the uterus will carry the cervix and os upwards, dragging the urethra and meatus as well. Thus, although the os may point downwards, it will be high up, perhaps on a level with or above the upper border of the symphysis, and hard to reach. Secondly, palpation above the symphysis may trace the cervix back into continuity with the body of the uterus. And, if the sound be used, it will not pass more than an inch beyond the os. The condition we have known to be most frequently mistaken for retroversion is retro-uterine hæmatocele.

In both cases of retroversion and retroflexion the test of reposition or reduction comes into operation.

History, again—most treacherous of guides—may help. If there is clear evidence of regular menstruation, pregnancy may be excluded, and the sound may be used.

The *causes* of retroversion and retroflexion form an intimate part of the history. Denman, Dubois, Jacquemier, even Ramsbotham and later authorities, attributed the accident almost exclusively to distended bladder. The error of this doctrine was demonstrated by Tyler Smith,[1] who urged that retroversion of the gravid womb was simply a continuing condition from retroversion existing before gravidity. We think that, as a general rule, this is satisfactorily proved. We ourselves have traced the continuity in several cases. On the other hand, it is true that in some cases the dislocation may be produced suddenly under the pressure of the intestines upon the fundus uteri during severe effort in the stooping posture, as in lifting heavy weights, and a full bladder may under such effort contribute to the displacement. The cases resulting from prægravid retroversion may be distinguished as of *gradual development*. The growing uterus in its eccentric enlargement occupies more and more space, and at last compressing the surrounding soft parts against the unyielding walls of the pelvis in which it is locked, the pressure-symptoms arise. Behind, the rectum is compressed, leading to constipation, sometimes to tenesmus and dysenteric symptoms. When the fundus comes down near the anus reflex irritation ensues, straining efforts follow; the sacral plexus pressed upon, cramps and pains are felt down the thighs; the bladder drawn up, the urethra compressed, retention of urine and distension of the bladder quickly follow. This is another source of reflex irritation, and violent efforts to void the urine are added to the effort of defæcation. Thus we see that the retention of urine and distension of the bladder are consecutive upon, not causative of, the displacement of the uterus. It is the old story of τὸ ὕστερον πρότερον.

When dislocation is produced, *ab origine*, under the direct influence of straining or pressure, the case may be called *acute retroversion*. The large uterus filling the pelvis, locked in it, equally compresses the urethra and causes retention. So in this case, as in that of gradual rise, the retention of urine is the consequence, not the cause. It is doubtful whether distension of the bladder simply is ever an adequate cause of retroversion. When the uterus is pushed forward by a body from behind, the retention is clearly due to the external pressure. The presumption is strong that the retention found associated with retroversion is equally due to pressure.

[1] *Obstetrical Transactions*, vol. ii.

An analogous cause is vomiting. This may lead to acute retroversion.

A sudden fall upon the back may cause retroversion. This was the case in a woman brought to St. George's Hospital.

Retroversion may result from a fibroid outgrowth from the posterior wall of the uterus. The mass getting fixed under the promontory of the sacrum, the lower part of the uterus rises as gestation proceeds, until at length the eccentric pressure obstructs the bladder and the bowel. In one case of this kind we were compelled to remove the whole organ. The compression to which the uterus was subjected led to gangrene. The case is described in the 'Diseases of Women.' The preparation is in St. George's Museum.

An ovarian or fibroid tumour may prevent the uterus from rising out of the pelvis.

Another cause of retroversion is from the posterior wall of the uterus being bound down by adhesions. Most commonly, we believe, adhesions existing before gestation are in great measure atrophied or absorbed under the stretching produced by the growing organ. But sometimes adhesions may hold the fundus uteri back under the promontory; then, the lower segment of the uterus rising under the development of gestation, retroversion is produced. Blundell relates a remarkable case. A young lady ruptured an ovarian cyst when single, conceived when married, had retroversion of the gravid uterus irreducible from old adhesions, and died.

Narrowing of the pelvis, especially a too-jutting promontory, has been noted (Bailly, Callisen, Boivin) as a predisposing cause. It is obvious that in such a case the fundus in its rise, impinging under the over-arching promontory, may easily be directed backwards.

Incomplete Retroversion or Retroflexion. It often happens that retroversion of the gravid womb tends to spontaneous cure. It is usually imagined that this is effected by the uterus suddenly or gradually liberating itself, as it enlarges, from the pelvic cavity. It is true that in most cases this occurs. In some instances, however, the train of events is as follows:—Up to the end of the third or fourth month of pregnancy there is pelvic gestation, with retroversion or retroflexion. At this stage the effects of eccentric pressure upon the pelvic contents are often felt; they may, however, gradually subside, and yet, on examination by the vagina, a retroflexion or a retroversion is discovered. What is the explanation of the disappearance of the symptoms? The ovum has continued to grow, and a pouch-like diverticulum has formed from the upper surface of the uterine walls. This as it enlarges receives the greater bulk of the fœtus, and so at last only a lesser pouch containing a lesser portion of the fœtus remains as the retroflexion or retroversion in the pelvis.

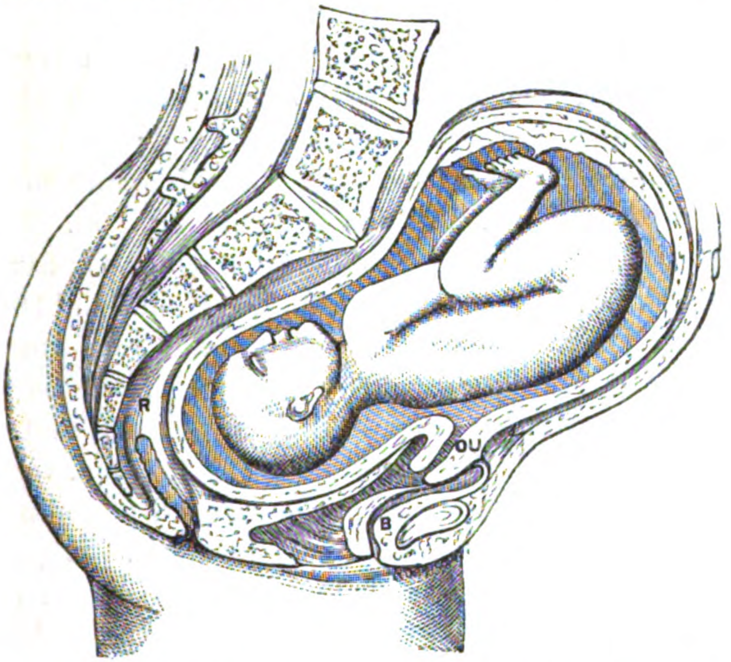


FIG. 100.—Showing incomplete retroflexion of gravid uterus. (Robert Barnes.) The bisacculated uterus.

R. Rectum. OU. Os uteri. B. Urethra and bladder.

In this way is produced the *incomplete retroversion or retroflexion* called by the French the '*sacciform dilatation of the uterus*.' Here we find an interesting application of Bandl's description of the peculiar formation of the lower segment of the uterus. The pelvic pouch which contains the head or breech is formed by the stretching of the lower segment below Bandl's ring. The abdominal pouch which holds the larger bulk of the fœtus is formed by the growth of the body of the uterus proper.

These two pouches thus formed may persist throughout the pregnancy, the larger one in the abdominal cavity, the lesser one in the pelvic cavity. These phenomena have been distinctly traced and observed from beginning to end by Robert Barnes. The above process may be regarded as the ordinary way in which Nature releases herself from the dangers of pelvis-locked uterus. In some cases the advancing enlargement of the abdominal pouch lifts out the pelvic pouch. Thus the gestation becomes wholly abdominal.

This favourable issue, however, does not always arise. The two pouches develope as described; the pelvic portion still remains so considerable that the os uteri is kept fixed above and behind the symphysis pubis; and so, when the patient falls into labour, the pelvic cavity is filled with the pelvic pouch containing, perhaps, the child's head; and it is thus impossible to lower the os uteri into the pelvis, and so to afford a passage for the fœtus. This is shown in fig. 100.

Merriman and Denman related cases which appear to have been of this kind. Scanzoni ('Lehrb. der Geburtsh.' 1867) says the 'partial' retroversion is rather a fault of form than of position. It is always caused by pressure of the part of the child upon the posterior lower wall of the uterus, and is especially observed when, with slight pelvic inclination, the fundus of the uterus falls down through the relaxed abdominal walls. The trunk of the child thus sinking forwards, the presenting head pushes the relaxed hinder wall into the sacral hollow in form of a sac. The vaginal-portion (cervix) is pushed forwards. This form, Scanzoni says, is only seen in the last two months. It causes no interruption to pregnancy. But Hecker observed a remarkable case in the sixth month. After repeated attacks of dysuria, active pains set in; the fundus was felt above the womb, the os uteri above the symphysis, the pelvis filled by a uterine pouch. This at length rose out of the pelvis, and the membranes came down. Oldham relates a still more striking case ('Obstetr. Trans.' 1860).

This case again illustrates Bandl's description of the behaviour of the lower segment of the uterus. The head, instead of lodging in and distending the yielding anterior wall of the lower segment, as is the rule, finds accommodation in a pouch formed in the posterior wall of the lower segment.

The following case was seen by Robert Barnes in conjunction with Drs. Hilliard and Brunton. A lady, a week before term of gestation, complained of headache and œdema of the face and legs. The urine contained albumen, blood discs, and casts. Taken in labour, no os uteri could be found until anæsthesia was produced. The posterior wall of the vagina was then felt closely compressed against the anterior wall by a rounded firm mass filling the cavity of the pelvis. Passing the finger up the vagina, the os uteri was found soft and patulous above the symphysis. Through the os could be felt a hard rounded mass, which was taken to be the fœtal head covered by the membranes. This head came close to the rounded mass in the pelvis, giving the idea of two heads interlocking. This intrapelvic mass presented a hard ridge unlike the head, and Dr. Brunton, on careful auscultation, could only hear one fœtal heart. The abdomen was irregular in shape; the enlargement was transverse and bilobed, suggesting twins. An endeavour was successfully made to push up into the abdomen the mass that occupied the pelvis, so as to enable the head which lay above the pelvis to be seized by the forceps. When the mass was lifted into the abdomen, the os uteri came down into the centre of the pelvis. The cervix was then dilated by Barnes' bags, and delivery effected by the application of the long forceps. The child, small but mature, was born alive. Next day mother and child were doing well. The case proved to be one of incomplete retroversion; a pelvic pouch contained the breech, an abdominal pouch contained the head. The pressure upon the pelvic and abdominal vessels and upon the bladder was probably the cause of the albuminuria.

Terminations.—1. *Recovery* may happen by *restoration* of the uterus *spontaneously*—perhaps the most frequent event—or by surgical manipulation.

2. *Recovery* is occasionally effected by the safety-valve process of *partial outgrowth* or sacculation of the uterus upwards into the abdominal cavity—that is, by the conversion of 'complete' into 'incomplete' retroversion.

3. *Recovery by abortion* is not uncommon. The immediate diminution in bulk of the uterus and the cessation of the attraction of blood to the pelvis bring quick relief. Arthur Farre says:[1]—'The sequelæ, when reposition cannot be effected, are usually premature expulsion of the ovum, or

[1] *Cyclopædia of Anatomy.*

sloughing of the uterine parietes, and slow discharge of the contents by fistulous openings into the vagina, rectum, or bladder.' Some of the cases thus described were most likely cases of ectopic gestation.

4. *Death* by blood-poisoning: the matters which should be excreted by the kidneys being retained in the system = *urinæmia.* This, Robert Barnes says, was the main cause of

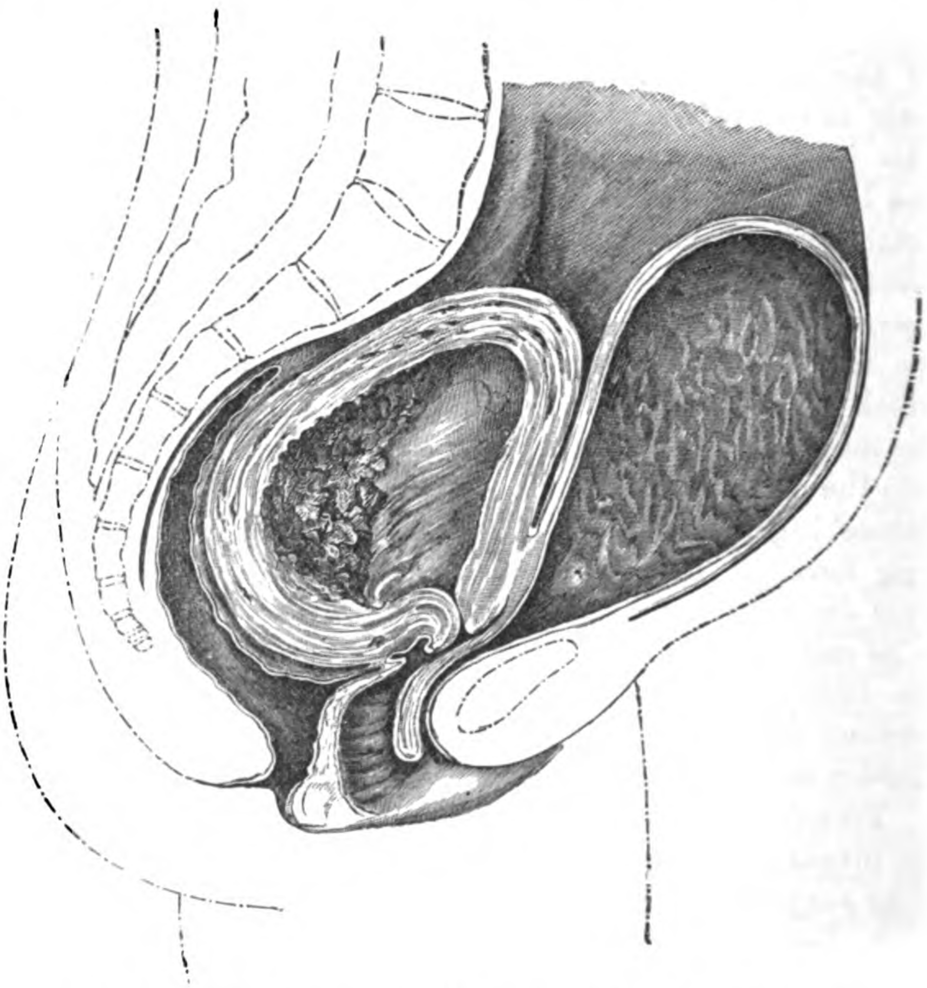


FIG. 101.—Showing uterus and bladder, from a fatal case (Dr. Chambers'). Specimen in St. Thomas'. (Robert Barnes.)

death in four cases observed by himself. Braun[1] relates a case in which death followed eclamptic attacks associated with *Bright's degeneration of the kidneys* and secondary uræmia.

5. In many cases conjoined with urinæmia there is *disease of the bladder*, as intense congestion, hæmorrhage from the

[1] *Klinik der Geburtsk.*

mucous membrane, excessive distension and paralysis, inflammation, even sloughing of the mucous coat. Schatz relates[1] a case in which not only the mucous coat but the muscular coat also became necrosed and entirely separated. Several cases are recorded of partial or complete exfoliation of the mucous coat. Robert Barnes has seen one. Wardell and de Havilland Hall describe one ('Brit. Med. Journ.' 1871). In this case Wardell regarded the membrane cast as a croupous plastic exudation. On its inner surface were gritty deposits consisting of oxalate of lime and uric acid. Moldenhauer relates ('Arch. f. Gynäkol.' 1874) a fatal case in which the whole mucous coat, with muscular fibres attached to it, was found detached, necrosed in the bladder. The pyramids of the kidneys were full of blood. Luschka ('Virchow's Archiv,' 1854) relates the case of a woman who died in the twentieth week of gestation after three weeks' retention; the catheter failing, the bladder was tapped above the pubes. She died twelve hours after the operation. Exfoliation of the mucous membrane of the bladder is not necessarily fatal.

6. *Death from rupture of the bladder.* The case narrated by Lynn (1771) is that referred to by William Hunter. Van Doeveren, of Groningen (1765), relates two similar cases. Schwarz relates a case ('Medical Record,' 1880). This issue would be more frequent but for four compensating factors: (a) dribbling or overflow; (β) stretching of the bladder; (γ) absorption or exosmosis from the bladder; (δ) diminished secretion of urine, the skin throwing off water, in all probability charged with urea. Thus death will occur from urinæmia, shock, and exhaustion long before the bladder will burst. Probably some sudden sprain or violence brought to bear upon the distended bladder is necessary to determine rupture. The quantity of urine that gathers varies from three to twelve pints. In Dr. Chambers's case the woman measured 39 inches round the abdomen. It was at first supposed to be an ovarian tumour. Twelve pints of fluid charged with blood, and having scarcely any urinous odour, were drawn off. A fœtus of four or five months' gestation was removed. The uterus was fixed in the pelvis. At the autopsy the bladder was found to contain two pounds by weight of black clot. There was no trace of

[1] *Arch. f. Gynäkologie*, 1870.

peritonitis. There is a grand specimen in St. George's Museum showing enormous dilatation of the bladder and ureters, with necrosis of the inner layers of the bladder and appearances of the bladder having given way. The history is wanting. The fœtus is of about four months.

7. *Peritonitis* has been described as a cause of death. We believe it to be rare. In five fatal cases seen by us there was no peritonitis. Misley, however, relates a case ('Med. Times and Gaz.' 1855) in which, after reposition, the patient died, twenty days later, of peritonitis. Adhesions of intestines were found, and the ureters were distended fourfold. This latter fact renders it highly probable that, like the great majority of cases, retrograde obstruction to the function of the kidney was an important factor in the fatal issue. In some cases where no autopsy was made, peritonitis has been inferred from the intense pain. But this sign is fallacious. In cases where pain had been so interpreted, autopsy revealed no trace of peritonitis.

8. Death may ensue from *gangrene of the uterus*, or other parts compressed. Burns says inflammation and gangrene of the vagina and external parts have been produced. We have already mentioned a case—the one in which the uterus was removed by gastrotomy, in which the uterus, enlarged by fibroids, fell into necrosis.

9. *Shock and exhaustion* enter into every case, but they may be the main fatal factors.

10. *Rupture of the posterior wall of the vagina*, caused by violence of the expulsive efforts, has been noted.

Treatment.—If the displacement is recognised in the early stage, before urgent symptoms have arisen, the simple and effective treatment is to keep the uterus *in situ* by a suitable Hodge-pessary. In this way not only may abortion be frequently averted, but the occurrence of incarceration and the attendant dangers will be obviated. If this opportunity be lost, and the case has developed into danger, successful treatment becomes more doubtful, but the course to be pursued is well-defined.

1. *Pass the catheter.* Use a flexible male instrument, and, in anticipation of difficulty, it will generally be wise to induce anæsthesia. The point of the catheter must be directed close up behind the symphysis. It is not always easy to empty the bladder, even when the catheter has entered it. It should at

first be passed in as far as it will go; then, as the urine ceases to flow, draw it gradually forward, and generally more urine will continue to flow; towards the end, gentle external pressure should be made. The bladder, it must be remembered, is paralysed. Sometimes the stream is obstructed by detached mucous membrane, by blood-clot, or mucus. Where this is suspected, a stream of tepid water may be injected through the catheter.

2. The bladder being emptied, the *reduction of the uterus* by taxis may be tried. Difficulty from two causes may oppose. Adhesions may bind the uterus down, as in Blundell's case. Moldenhauer's case is a similar example. We believe this complication is very rare.

The other difficulty is from the swelling of the parts contained in the pelvis. When the bladder is emptied, under rest this may to some extent subside, so that it is not desirable to push attempt at taxis too abruptly. If gentle efforts do not succeed, it is wiser to keep the woman on her left side in semi-prone posture, to give a subcutaneous injection of morphia, to empty the bowel by enema, then to introduce a Barnes' bag into the rectum. In this way Playfair reduced the uterus. In one case in Robert Barnes' hands, at the London Hospital, this plan failed; but in two others at St. George's it completely succeeded.

This failing after some hours, taxis may be again tried. The manœuvre is as follows:—The patient under anæsthesia, in semi-prone posture, one or two fingers are passed up the rectum so as to get a fair purchase on the right side of the fundus of the uterus. Steady pressure is then made, not directly upwards, but over towards the left ilium. The object is to release the uterus from the over-arching promontory. Thus pushed over to the side the fundus finds room in the retreating excavation at the side of the promontory. As soon as this is attained, the fundus will rise forward with little difficulty, sometimes even with a spring. We have succeeded in a difficult case by what may be called the bi-polar method—that is, by combining with pressure on the fundus, as described, traction of the cervix in the opposite direction. It may even be useful to pull upon the cervix by help of Barnes' axis-traction vulsellum forceps.

3. *Induction of abortion.* Taxis failing and urgent symptoms persisting, reduction must be facilitated by first lessening the bulk of the uterus. This can be done in one of two ways. If the os uteri is accessible, a sound or stilet may be passed into the uterus to puncture the amniotic sac, and even to break up the ovum. The immediate effect of this is to reduce the volume of the uterus. Then the tissues generally shrink a little, and the taxis, tried again at the end of a few hours, may be successful. At any rate the excessive pressure is lessened, and time is gained. The next effect is abortion. The ovum cast out or extracted, a further reduction of volume is gained, and, as far as pressure is concerned, the danger may be considered at an end. But it may be difficult to reach the os uteri; then we have a resource in tapping the uterus through its posterior wall. The best instrument is Dieulafoy's aspirator-trocar. The forefinger of the left hand applied inside the vagina or rectum discovers the most bulging part of the uterus, and the trocar, guided by it, is pushed into the uterus, taking care to enter perpendicularly. The rectum is to be preferred, as offering more certainty of penetrating into the body of the uterus. This has been successfully practised. Abortion follows.

Where it has been found impossible to pass a catheter, reduction of the uterus being also impossible, the expediency of puncturing the bladder above the pubes may be considered as well as puncturing the uterus. The aspirator-trocar may also serve to puncture the bladder. In the 'Obstetrical Operations,' three cases are recorded.

When the symptoms are not urgent, the bladder being kept empty, and there is no marked eccentric pressure, it is not wise to use any great effort to reduce at once. We may try the action of a Hodge-pessary. The gradual influence of this instrument may reduce the uterus within twenty-four hours, as we have seen in a case at St. George's Hospital. The pregnancy was not disturbed.

After-treatment. Absolute rest, care in emptying the bladder by catheter every six hours, sedatives, light diet, combine the principal indications. The bladder will demand special care, as cystitis is common. An important point after reduction is to prevent the uterus falling back again by adjusting a Hodge-pessary. Richter, Baudelocque, and Simpson advised this.

Looking to the history of retroversion, and regarding it as a condition existing before pregnancy, the *prophylactic treatment* should have prominent attention. We have on many occasions used a pessary to support the uterus when retroverted during the first three months of pregnancy, as a precaution against impaction, and to obviate and relieve retention of urine.

Retroversion, or rather retroflexion, may occasion difficulty even after delivery at term. The uterus remaining uncontracted, and therefore enlarged and flaccid, may bend back, and become locked in the pelvis. Retention of urine may result. This accident will be more fully described in the history of labour.

The general rules, then, may be thus summed up:—(1) Empty the bladder; (2) make a gentle attempt at reposition; (3) if this fail, be governed by the urgency of the case: if there be great distress, induce abortion or puncture the uterus by the aspirator-trocar, and wait; (4) when abortion has taken place, make further cautious attempts to reduce; (5) if there be still difficulty, wait again; (6) when the uterus is reduced, support it in position by a suitable Hodge-pessary.

The history of *partial or incomplete retroversion*, with sacculation in the abdomen, more properly belongs to 'dystocia,' under which head it will be described.

Prolapsus or procidentia of the gravid uterus.—This may be *real* or *apparent*. A minor degree of prolapsus is frequent in early gestation. We have seen that it exists in one form as a condition of retroversion. But it may exist without the retroversion to the extent previously described. The uterus rests upon the pelvic floor, the os pointing between the labia, and the fundus not seated below the promontory, but pointing to the brim. The axis of the uterus will pass in front of the promontory.

The effects of this descent are (1) to pull down the bladder and to cause irritability of the bladder; (2) to press upon the rectum and cause constipation. Locomotion is also somewhat impaired.

In such a case it is wise to raise and keep the uterus at its proper level. This is done by adjusting a suitable pessary. It should be worn until the uterus is large enough to rest upon the brim. This will commonly be about the fourth month.

In some cases, comparatively rare, the gravid uterus escapes almost entirely from the pelvis, the os uteri being found at the lowest extremity of a rounded fleshy mass. The vagina is completely everted, and forms a covering for the procident mass. As the uterus grows it is liable to become gripped by the vulva and strangled. Hence the obvious importance of early reduction. It has happened that procidentia persisted beyond the sixth month of gestation, when reposition can hardly be effected unless the uterus be first reduced in bulk by removing its contents.

The subject belongs more properly to dystocia. We may here state that conception may take place in a procident uterus, copulation being performed within the cervix uteri.

Procidence may occur suddenly under severe strain.

Apparent procidentia consists in hypertrophic elongation or outgrowth of the cervix uteri. This will be described under 'Dystocia.'

Anteflexion and Anteversion of the Gravid Uterus.

For the greater part of our precise knowledge of this subject we are indebted to Graily Hewitt.[1]

In early pregnancy there occurs, as we have seen when describing the Diagnosis of Gestation, fig. 96, a normal increase of nutation of the uterus. Hence in many cases a degree of irritability of the bladder. But in some cases this nutation is so extreme that the fundus gets locked behind the symphysis. Incarceration with anteversion is necessarily less frequent than with retroversion. The symphysis presents no over-arching like the promontory to prevent the rise of the fundus uteri. But it may occur. Hewitt cites cases from other authors, and describes cases that came under his own observation.

As in retroflexion, anteflexion may take place *after pregnancy* has begun, or it may have existed *before the pregnancy*. Hewitt thus sketches the history:—'In many cases the uterus is anteflexed in the first or second degree with first degree of anterior rotation. Pregnancy occurs. An unusual degree of sickness is observed from almost the moment that pregnancy

[1] *Diseases of Women*, 4th ed., 1882.

begins. There is great frequency of micturition. Walking and sitting aggravate both these symptoms. The patient is more or less uncomfortable in other respects. This condition persists up to the middle of the third month. Then the symptoms undergo a change—either improve or become very much worse. If they improve, that indicates that the bend in the uterus has given way, the organ is expanding more easily, and rising up out of the pelvis. If, on the contrary, there is intensification of the symptoms, this means that incarceration is present. The incarceration, perhaps, is only temporary; at the end of a few days the expansion does the work required, and the uterus rises.

'In another set of cases the history is as follows:—The uterus has been anteflexed for some time. It is hard, rigid, and firm in texture. Pregnancy occurs. Instantly great pain is felt; sickness is very troublesome, so also, great micturition. The patient continues to go about; the uterus is not kept at rest; at the end of about two months abortion occurs. In some cases the patient loses blood from time to time—the indication often of impending abortion, but not necessarily so.'

The *diagnosis* is not difficult. The os uteri is very far back, and the dense resisting tumour, the anteflexed uterus, is felt through the vaginal roof. As it increases in size it assumes an oblique position. This was so in Ulrich's fatal case, and Hewitt verified it in two cases. The *treatment* in the milder cases consists mainly in rest and expectancy, giving the uterus time to right itself under advancing development. The dorsal or reclining postures are to be observed. In more severe cases the patient must take to bed. An air-ball pessary, worn from time to time, may by elastic pressure lift up the uterus. Hewitt speaks well of his cradle-pessary in some cases, and, reasoning from our own analogous experience in retroversion, we cannot doubt the importance of this practice. The caution, however, is necessary, that the patient should be under observation, and not indulge in free exercise.

Anteflexion of the gravid uterus, with lax or pendulous belly. The '*utérus en bésace.*' This condition is observed in some women whose tissues are weakened and left stretched by previous gestations. The abdominal walls offer no support to the growing uterus, and the uterus itself, partaking of the general laxity of tissue, bends or bags forwards, riding over the symphysis like a pack-saddle. In some cases there is actual hernia of the body of the uterus, the recti muscles having been stretched asunder in labour, so that the fundus uteri is covered only by stretched aponeurotic membrane, connective tissue, and skin.

The uterus may develop to term under this condition, and give rise to dystocia, from lack of aid of abdominal muscles and loss of relation between its axis and the pelvic axis. How to deal with this case will be described under 'Dystocia.' During gestation, the case is best met by a well-adjusted belt, which grasps the uterus well from below, carrying it back and upwards, thus supplementing the lost power of the abdominal walls.

CHAPTER XI.

THE DISEASES OF GESTATION.

'Fœmina plurimis afficitur malis ex solâ graviditate oriundis.'—BOERHAAVE.

As a general proposition it may be stated that the diseases of the gravida may be divided into :—

A. Pathological exaggerations of the physiological conditions of gestation.

B. Pathological processes continued from the pre-gravid state, or grafted upon the gravid state. In either case the disease in its origin, independent of the existing gravidity, becomes modified by it.

The diseases which are the expression of physiological excesses are essentially, if not directly, diseases of high nervous and vascular tension; and the pathological processes originating independently of the gravid process equally fall under the influence of the high tension of gravidity.

The diseases of the gravida are thus stamped with an opposite character to those which affect the puerpera. The diseases of puerpery are essentially diseases of lowered nervous and vascular tension.

The characteristic diseases of gestation then are convulsions in various forms, hæmorrhages, effusions, albuminuria. The characteristic diseases of puerpery are septicæmia, thrombosis, mania. The first class have for their genetic feature centrifugal force, action from the centre to the periphery. The second class have for their genetic feature centripetal force, disintegration of tissue, absorption, excretion.

The study of the diseases of the gravida is rich in illustrations of the genesis of disease even beyond the domain of gestation. In this study we may acquire faith in the aphorism: *Pathology is simply physiology working under difficulties.*

There are few opportunities of observing the initiatory stages of morbid processes with so much precision, under conditions so simple and so complete, as those afforded by gestation. A woman who becomes pregnant may be regarded as the subject of a scientific experiment performed under more exact conditions than can often be commanded in the physiological laboratory. We begin with a healthy subject. She becomes pregnant. From that moment she is under the dominion of a new impulse which, acting upon every tissue and every organ, tests their structural soundness and working capacity. Hence the aphorism or law which we have already enunciated: *Pregnancy is the great test of bodily soundness.*

If the subject prove sound, and no serious disturbing cause from without intervene, the equilibrium between the new motive power, and the organs acting under this power, is preserved. But if from any cause the happy balance be disturbed, so that the physiological strain upon the organs be in excess of their capacity to respond, there will be danger of a break-down. In the gravid state the system strained to the utmost does not easily tolerate the concurrent course of physiological processes carried to excess, or of engrafted pathological processes. The consequence is, either that the pathological process will develop into more serious degrees, entailing perhaps organic changes, not ceasing with the gravidity; or that the system, rebelling under the pressure, refuses to carry on the gravid process; and so abortion solves the difficulty, thus not seldom averting a fatal issue.

Abortion, then, is an indication of a system or organ overtaxed, or of disease; and is a means adopted by nature for relief or cure. That is to say, abortion is often conservative as regards the gravida.

Under the testing power of gestation latent morbid conditions are evoked. Of this law many instances will appear in the sequel, illustrating the genesis and evolution of disease. To cite one here, ague may be mentioned. Years after having suffered from ague the subject considered cured will be seized with aguish fits on becoming pregnant. Paget has called attention to the like revival of ague under the trial of surgical operations.

Physiological processes strained to excess do not necessarily induce abortion. Mother and child may be imperilled or destroyed, or they may struggle on with more or less distress to the natural termination. Certain phenomena, sometimes regarded as diseases, really serve as regulators or moderators of the forces at work, tending to keep the equilibrium. Amongst these may be cited, salivation, pyrosis, vomiting, diarrhœa, hæmorrhage, as hæmoptysis apart from tuberculosis, hæmatemesis, melæna, hæmaturia, bursting of superficial veins, hæmorrhage from the cervix uteri and vagina and from the decidual cavity. Thus abortion and other evils are averted.

Nor do independent morbid processes necessarily lead to abortion. But when abortion does not ensue, the morbid processes already in action are likely to be intensified, and to persist after the gravidity is over. On the other hand, most of the diseases arising out of excess of physiological actions may, when the gravidity is at an end, disappear, leaving no trace of organic lesion.

These leading facts before us, we can with more intelligence follow the evolution of disorder and disease in the gravida, and grasp the relations of phenomena essentially linked together but which must be described in succession.

A. **Pathological exaggerations of physiological processes proper to gestation,** or pathological conditions arising in the previously healthy woman under the impulse of gestation.

The logical and clinical order of exposition of these conditions is the same as that pursued in the chapter describing the natural history of gestation. If we take the nervous system first, it is because there is reason to believe that this part of the organism is first affected; but it must be remembered that the vascular system and the other organs, and notably the blood, almost immediately feel the new impulse, and work for good or evil with the nervous system.

The neuroses of gestation. The increased psychical, emotional, and diastaltic mobility occasionally reveals itself in ultra-physiological excess.

A general proposition may be stated which applies more or less to all nervous aberrations of gestation. The nervous system is tripartite in analysis, but it is one in reality. The emotional function is rarely affected without involving the psychical and diastaltic functions, and so it is with each in turn.

We may, indeed, often discern which is the first to be disturbed; it is nevertheless abundantly proved by clinical observation that all three functions are quickly affected together; and that as the disturbing acts become more frequently repeated in one direction, the stronger, the prompter is the associated disorder of the other functions or nervous centres. We have not here dwelt distinctly upon the ganglionic centres and the functions of this system. But although not so open to direct observation, there can be no doubt that this part of the nervous system is in equal solidarity with the rest.

B. **A group of paralytic affections.** 1. Of the special senses, as amaurosis, deafness, loss of taste, loss of smell. Hemiplegia, paraplegia, depending or not upon lesion of the nervous centres.

The neuroses developed under excess of physiological action are:—

a. A group of convulsive affections—as vomiting, singultus, reflex convulsion simple (cramps, twitchings in the legs), epilepsy, tetanus, chorea, hysteria, puerperal eclampsia (including the history of albuminuria gravidarum).

b. Reflex paralyses, as paraplegia.

c. A group of mental disorders (including puerperal insanity).

The vomiting of gestation. Usually classed with the diseases of the stomach, we do not hesitate to place it first in the rank of convulsive disorders. This familiar symptom of physiological gestation is simply the expression of the concomitant high nervous tension. When a new motive force is created, there must be a provision for the maintaining the balance between the quantity generated and the quantity applied to its destined use. Any excess must be discharged. Vomiting helps to perform this regulating office.

It is even less rational to call vomiting a disease of the stomach than it would be to ascribe to disease of the stomach the vomiting which attends disease of the kidney or of the brain. The stomach may be perfectly healthy. It is simply the seat of election for the discharge of superfluous nervous energy.

Etiology of the vomiting of gestation. Given the centric irritability, what are the eccentric or peripheral irritants? The first class of causes must be sought in the womb itself. Bretonneau supposed that the sympathetic vomitings depended upon the difficulty the uterus experienced in distending, and upon the special irritation that might result from its rigidity. Translated into the language of modern science, 'sympathetic' is 'reflex.' Many facts lend support to Bretonneau's theory. Thus the vomiting is more severe in first pregnancies; it occurs early in pregnancy—that is, when the new growth is telling most upon the undeveloped uterine fibre; whenever the uterine fibre is suddenly or rapidly stretched, especially in pregnancy, vomiting readily occurs, as under the rapid formation of liquor amnii, the spontaneous or artificial dilatation of the cervix. The occurrence of vomiting in the morning on assuming the upright posture is also explicable on this hypothesis. This posture causes a sudden hydraulic pressure upon the uterine vessels, thus distending the uterine tissue.

In another class of cases the uterus, subject to external pressure, excites vomiting. Moreau relates a case of locking of the uterus under the promontory, in which severe vomiting set in, relieved on releasing the uterus. Mayer and Ulrich give cases of vomiting with anteflexion, relieved by supporting the uterus. Graily Hewitt[1] insists that the cause is anteflexion or retroflexion, and explains the morning attack by the sudden change to the upright posture, thus throwing the weight of the intestines upon the uterus. But it is a fact that vomiting often comes on before getting up. Accepting to a certain extent Hewitt's theory, we believe the morning sickness is more frequently due to hunger and weakness. And we have another theory to offer. Its constant occurrence in the morning seems to imply that at this time there is a maximum of central nervous irritability, so that comparatively slight peripheral causes will then act with more effect. The immediate irritating cause we believe to be the stretching of the uterine fibre under the eccentric pressure of the growing ovum and the turgescence of the uterine vessels. This turgescence receives a sudden increment under the hydraulic pressure which takes place on assuming the erect posture. In addition to this there is the proclivity arising from fasting.

An analogous condition is seen in some cases of *Dysmenor-*

[1] *Obst. Trans.* 1871.

rhœa, especially if depending upon narrowing of the os externum uteri or flexion—frequent causes. Here the analogy between menstruation and gestation is enforced. In both there is the predisposing exalted nervous tension and the uterus distended by developed decidua and blood.

Rapid artificial distension of the non-pregnant uterus will cause vomiting. This is seen in dilatation by laminaria-tents.

Certain morbid conditions of the uterus give rise to vomiting. Henry Bennet and Richelot recognised inflammatory conditions of the cervix as the cause.

Emotions, if intense and of oppressing kind, may start uncontrollable vomiting. Robert Barnes saw in consultation a lady who suffered severely in her first gestation, went lightly through the three succeeding pregnancies, and when one month pregnant for the fifth time, underwent severe family trials, came home exhausted, was attacked by unremitting vomiting, and died in a few days. We have seen other cases of vomiting induced by severe mental shock, also ending fatally notwithstanding the induction of abortion. Vomiting so induced under the exciting action of emotion is indeed the most dangerous form. In another case, that of a young lady of singular beauty, incoercible vomiting set in between two and three months after marriage. She had conceived probably immediately after marriage. Her husband committed murder and suicide. The wretched widow also found herself syphilised. Haunted by the dread of bringing forth a child foredoomed to insanity and syphilis, she implored that abortion might be induced. Her prayer was not assented to, and in a week she died exhausted.

An offending body in the uterus is a not infrequent cause. Thus we have known a dead fœtus retained cause severe vomiting until it was expelled. A diseased placenta or fœtus will act in like manner. Some of the most severe cases we have met with were cases of hydatidiform degeneration of the placenta. This probably acted partly at least by distending the uterine fibre. McClintock relates a case of severe vomiting due to an intra-uterine polypus. This is not uncommon. Pain and vomiting cease when the polypus is extracted from the uterine cavity. The retention of a detruncated head *in utero* may have the same effect. Perfect relates a case. Dance relates a fatal case at three and a half months in which he found inflammation of the decidua; another, also fatal,[1] from inflammation of the chorion and amnion at four months, and a third from softening and engorgement of the uterine walls.

Intercurrent disease. We have known *whooping-cough* attacking a pregnant woman determine severe vomiting. This is not surprising when we reflect that a convulsive affection is grafted upon a system strongly predisposed to convulsion.

Alcoholism has in our experience given rise to or kept up severe vomiting. This form is the more grave because alcohol is the popular remedy, and one most easily abused.

Albuminuria, as a cause, was pointed out by Sir J. Simpson. We have verified this on many occasions. Usually eclamptic convulsions attend albuminuria; and it is not surprising that convulsion in the form of vomiting should be evoked.

There has been noticed a deficiency of urea in the urine. Thus we may have a condition analogous to that described by Andrew Clark as 'renal inadequacy.' On the other hand, it is probable that as in some cases of incoercible hysterical vomiting, the formation of urea is scanty, and that some is thrown off by the vomit. The vomited matters should be examined for this and other conditions.

Course of the affection. Passing over the physiological vomiting, which is not injurious, and usually abates at the end of the third month when the uterus rises out of the pelvis, we may note that—1. There are cases of pathological import within the first trimestrium. The most serious of these are the cases in which severe mental shock is the starting point. In these the vomiting sets in perhaps suddenly, with unusual severity, is attended by gloomy depression passing into despondency. These cases may run rapidly to a fatal issue, resisting all treatment, even the induction of abortion. The pulse rises in frequency, sinks in power, the temperature rises, and yet the ovum retaining vitality, we can hardly admit septicæmia as a factor. But here, as in all aggravated cases, a form of blood-poisoning sooner or later complicates the condition. First there is *starvation*, giving strong impetus to the process of absorption; secondly, no adequate material for

[1] *Arch. Gén. de Méd.* 1829.

nutrition being supplied from without, *the system feeds upon itself*, that is, a rapid process of disintegration of all the tissues, most marked in the fat-tissue, is set up. The blood is degraded and empoisoned. This condition intensifies the vomiting, and renders treatment more difficult. If the patient survives long enough, she becomes emaciated to the last extreme. The secretions, the urine especially, are scanty. Some albumen commonly appears in the urine. These cases are not to be confounded with those in which albuminuria plays a primary part; but we believe that, as in these, uræmia enters as a factor. Delirium sets in towards the end.

All these events may occur within the first trimestrium; they are more frequent in the second trimestrium. That is, having begun during the first, they culminate in the second.

A point of great clinical interest is, that once started, the convulsive disorder acquires intensity by repetition of the attacks. Slighter exciting causes will provoke a fit. The nervous centres, weakened by the repeated shocks and by defective nutrition, become inordinately susceptible to centripetal or centric impressions. And we may witness in severe cases how the several nervous centres react upon each other. At first, the excitant of vomiting is simply diastaltic; presently, a thought, an emotion, and soon the slightest physical disturbance, the most ordinary impressions upon the senses, will provoke an attack. The smell of cooking becomes an intolerable offence; a bright light; a loud noise vibrates through the organism, and irrepressible vomiting or singultus breaks out.

At this stage, diarrhœa, the evidence of toxæmia, often sets in; marasmus soon succeeds, and the situation is rapidly becoming critical.

It appears to us as extremely probable that incoercible vomiting induces or aggravates organic change in the liver and kidneys. We have seen it as the first symptom of acute yellow atrophy of the liver.

When vomiting sets in after the fourth or fifth month, and *à fortiori* later still, the earlier stages having been passed without unusual distress, we may presume that the cause is a dead fœtus, albuminuria, septicæmia, alcoholism, or the rapid distension of the uterus by excessive secretion of liquor amnii.

In all of these cases the vomiting will probably persist so long as the uterus retains its burthen. In a certain proportion of instances Nature solves the difficulty by abortion. In some, tolerance is induced under treatment and time. Burns observed that vomiting ceased on the death of the fœtus; but this is not constant.

Prognosis. The majority of cases recover without the interruption of gestation. But in a far larger proportion than is commonly accepted, death is the termination unless averted by abortion. It is impossible to state the case numerically. But every author of experience gives examples of fatal cases. Severe vomiting should always be looked upon with anxiety, and a prognosis should not be hazarded until the symptoms exhibit decided progressive amendment.

The danger of the affection is sometimes doubted, and this doubt, founded on subjective ignorance, is urged as a plea against the induction of labour. McClintock[1] says, 'With a very moderate amount of research I have been able to collect close on fifty authentically recorded cases, and I know of others which have not been published.' We, ourselves, have seen nine fatal cases.

Vomiting is frequently attended by or alternates with *singultus*, another form of convulsion, depending upon disturbance of the ganglionic centre reacting upon the spinal system.

A frequent accompaniment is *pyrosis*; a watery glairy fluid sometimes streaked with blood is ejected.

In the Lumleian Lectures, 1873, Robert Barnes distributed the cases of severe vomiting into three groups. The *first group*, that comprising cases of severe vomiting within the first three months, includes primigravidæ as well as pluriparæ, although the primigravidæ are the most numerous. In these the preponderating condition is the extreme convulsive tension of the nervous centres. In some the subjects are constitutionally 'nervous,' susceptible to emotional and physical impressions. In some there is a morbid diathesis. In some, especially pluriparæ, there is probably blood-degradation. Sooner or later, blood-degradation surely supervenes; but this factor does not appear to be necessary to the production of vomiting in primigravidæ in the first month.

[1] *Dubl. Journ. of Med. Sc.* 1873.

In the *second group*, including cases of continuous vomiting increasing in severity, the initial conditions are those which mark the first group. But very soon another condition arises; continuous vomiting implies impaired or arrested nutrition. The influence of this seems to be to increase the irritability of the nervous centres. If the strength can be raised the susceptibility is diminished. But this is not all. If food be not supplied from without, the starved system feeds upon itself. Absorption goes on actively. The proceeds of tissue-change find their way into the blood and empoison it. At this point the danger is extreme. The blood-poison further increases the irritability of the nervous centres; it oppresses the brain; delirium supervenes; and utter prostration is at hand. Every fit of vomiting acts as a shock, and leaves the system more open to the next attack. At this point, the slightest peripheral or emotional disturbance will excite a fit. Diarrhœa is not uncommon at this stage. It bears further evidence of toxæmia. The indications of danger are: extreme emaciation; a pulse small, easily put out, exceeding 130; hollow, staring eyes; hippocratic aspect; delirium. We have not seen a patient recover in whom the last symptom had persisted for a few days, supervening on the rapid pulse. The vomiting may now subside; even premature labour may take place; but the patient will sink notwithstanding. In some cases the urine is albuminous. Where this complication exists, the cases are in close affinity to albuminuric eclampsia.

In the *third group*, that in which the vomiting becomes obstinate in the latter stages of gestation, the etiology is sometimes pretty clear. The uterus has rapidly, almost suddenly, undergone excessive distension from undue secretion of liquor amnii, or from twins, or a diseased ovum. At this time vomiting has set in. The explanation appears to be this: normally, the uterus grows *pari passû* with the embryo. The adaptation is so well-balanced that there is no strain. But if the contents of the uterus be suddenly augmented, the harmony of correlation is destroyed. The uterus cannot suddenly grow or yield to keep pace with the eccentric pressure within. Its fibres are stretched, perhaps torn, and vomiting results. In other cases there is unmistakable evidence of blood-poisoning. Jaundice attends, sometimes preceding, sometimes apparently induced by the vomiting. The most striking example of cholæmic vomiting is that connected with acute atrophy of the liver.

Treatment. A careful exploration, pelvic and systemic, to discover the causes in operation can alone furnish a rational therapeusis. If we find displacement or inflammation of the uterus, we must lose no time in eliminating these factors; if we find an offensive discharge or hæmorrhage from the uterus, we must discuss, with a view to prompt action, the emptying of the organ and disinfection; if we find the uterus distended beyond measure by plural gestation or liquor amnii, we must deliberate as to the probability of the patient tiding over the interval before the natural term of gestation, or the attainment of viability by the fœtus; and if we decide that procrastination is too hazardous for the mother, we must provoke labour without undue hesitation. We are sure that we have seen more reason to regret delay in resorting to this *ultima ratio* than from having had recourse to it too early. Several times have we witnessed a fatal issue because abortion was induced too late. At the same time it is proper to bear in mind that cases occur which seem doomed from the first, against which all means fail.

McClintock tabulates 36 cases in which the induction was resorted to; in 6 of these death ensued notwithstanding.

Copeman's Method.[1] Standing before the operations for arresting gestation comes Dr. Copeman's method of dilating the cervix uteri. This is done by the finger, or if the os is narrow and hard, by bougies. Cases have accumulated proving the most remarkable success. We ourselves bear testimony in its favour. Unless the indications for bringing the gestation to an end quickly be very urgent, this method should always be tried first. What is the explanation of its efficacy? Until this is established on clear grounds we may be satisfied with using it empirically. It is free from danger, and does not seriously imperil the gestation.

The treatment of the milder cases is generally expectant. Although the patient or her friends may declare that 'she vomits everything she takes,' the balance of nutrition is still supplied from without. She does not greatly emaciate; she preserves a fair aspect; intervals of cheerfulness follow the

[1] *Brit. Med. Jour.* 1875, 1879.

attacks of vomiting. Under these conditions we may try a variety of remedies more or less empirical. These may be classed as sedatives, alteratives, antacids and peptics. Amongst the sedatives, the bromides rank highly, then digitalis, which has the undoubted property of regulating nervous and vascular tension; five-minim doses of chloroform in emulsion; pyroxylic acid; Indian hemp. Simpson spoke well of a teaspoonful of naphtha in tincture of hops, calumba and soda; carbonic acid in effervescents, lime-water alone or with milk, bismuth, magnesia, nitrate and oxide of silver, chloride of calcium. Tyler Smith, Tessier and others speak highly of pepsin. Strychnia is sometimes of great service; Metcalfe Johnson (1871) found the hydrated phosphate of lime successful. Salicine, extract of walnut, the oxalate or nitrate of cerium, are recommended by Simpson; Bedford cured by $\frac{1}{4}$ or $\frac{1}{2}$ grain doses of ipecacuanha two or three times daily. A valuable remedy is caffeine, given in $\frac{1}{4}$ or $\frac{1}{2}$ grain doses every hour or two; guarana, maltine, koumiss, have their use. A drop of solution of nitro-glycerine (1 in 100) on a lump of sugar is sometimes very efficacious. Ingluvin has been extolled.

The vomiting distresses most when the patient is hungry. It frequently comes on *before getting up*. This is the time then to take some nourishment: hot tea or coffee and milk, lime-water and milk, soda and milk, iced coffee and milk give great relief. Roberts endorses Ringer's plan of giving single drop doses of ipecacuanha wine the first thing before lifting the head from the pillow. In the day-time iced champagne and milk often allays the irritability. The stomach wants the normal stimulus and work to divert it from abnormal courses.

The use of the remedies in the preceding list depends upon the tolerance of the stomach. They may, like food, simply provoke the stomach to rebel. Then we fall back upon the rectum, the skin and cellular tissue, and the lungs as the roads by which nourishment and medicines may be carried into the system. Sedatives can easily be applied in this way; chloroform or ether inhalations, nitrite of amyl the most effective of all, thus give invaluable service; chloral may be administered by enema in scruple doses. Extract of belladonna may be rubbed in over the epigastrium. Beef-tea or milk enemata may be made the vehicle of medicinal agents.

We have found great relief in vomiting and hiccup, from breathing over the mouth of a bottle containing a few drops of ether.

In severe cases of marasmus, the question of *intra-venous injection* of milk, of defibrinated blood, of saline solutions must be considered. The patient ought not to be allowed to sink without trying the effect of these measures, which sometimes give marvellous results. Flying blisters to the epigastrium, followed by morphia or belladonna dressings, have been useful; hot fomentations or water dressings may serve. S. Iffla[1] relates a very severe case promptly relieved by passing a steady current of electricity through the epigastric region.

Then we have the invaluable resource of *subcutaneous injection*; ten minims of solution of morphia is often of the greatest service; one drachm of ether introduced in the same way is especially useful in extreme prostration, lifting up the vital powers and giving the opportunity of supplying nourishment.

In the era of phlogistic medicine, venesection was a favourite resource. Thus Mauriceau relates successful cases, and Smellie relates a case of a woman whom he bled at every monthly period, the vomiting always ceasing, and who thus went on to term. Campbell says: 'The irritability manifested during the early months must be attributed to the suppression of an habitual hæmorrhage.' Hence the first mode of arresting it is to bleed. If venesection is contra-indicated, leech the epigastrium. Burns advocated bleeding. In Italy, even now, bleeding is a favourite remedy. We must not omit to watch the secretions. Although diarrhœa sometimes attends, there may be accumulation of noxious matter in the intestines. Enemata will be useful. Slight *ptyalism*, induced by small doses of grey powder, may be tried. Dr. Bagot[2] relates an interesting case of extreme exhaustion recurring in three successive pregnancies, each time effectually controlled by keeping up slight salivation. He says the symptoms were so urgent that life was despaired of. Frequently, no doubt, the function of the liver is impeded or perverted; and we think there is a rational indication to try Dr. Bagot's plan. If mercury cannot be tolerated by the mouth,

[1] *Austral. Med. Gaz.* 1871. [2] *Dubl. Med. Press*, 1859.

we might succeed by inunction, mixing belladonna with the mild mercurial ointment.

Then there is the great principle of *rest*. This term embraces rest from emotional influences; physical repose, general and local. In the milder cases, after the morning attack has subsided, exercise is beneficial, but in the severer cases absolute repose may be necessary. By local rest we mean rest for the uterus. It seems certain that, whether it be explained by Graily Hewitt's theory of exaggerated displacement of the uterus, or simply by the ordinary movements to which the uterus is subject, movements of the irritable organ do excite vomiting. What is the remedy for this? Dr. Aubert,[1] reasoning upon Hewitt's tenets and clinical observation, recommended in some cases the use of pessaries. We ourselves have derived signal service from a well-adjusted Hodge-pessary in the early months; and this when there was no perceptible prolapsus, version, or flexion. Where there is obvious abrasion of the cervix uteri, applications of nitrate of silver may be of great service.

As in other maladies for the relief of which a multiplicity of remedies are extolled, we may suspect either that the vomiting of pregnancy is easy of cure, or that the beneficial action of the remedies is more apparent than real, or that this malady, being intractable, baffles the search for the remedy. The truth seems to be that under almost any treatment the majority of cases will resist for a time, and then get well. All the remedies specified have been credited with success, the part played by Nature being overlooked. At the same time we should not ignore the fact that, by a judicious application of the means at our command, the severity of the disorder and the consequent shock to the system may be materially moderated, and the path towards natural subsidence be so smoothed that the goal will be more surely reached.

The disease may steal on insidiously but rapidly, so that the time for hopeful action may quickly pass away. If the pulse have risen to 120–130, if there be marked hippocratic countenance, considerable emaciation, continuous difficulty in keeping down food, sleeplessness, and especially any degree of delirium, it is highly probable that the induction of labour will

[1] *Lyon Médical.*

be too late. It may even provoke distress which will accelerate the fatal issue. But in several cases we have seen there was no albumen in the urine, so that whatever poison there was in the blood the condition was probably different from that which is called uræmia. Comparing these cases with the phenomena of acute atrophy of the liver, and with other cases of rapid sinking in pregnancy, we cannot help suspecting that there is developed some graver systemic or organic disorder than has yet been recognised. The irritative fever, the delirium witnessed towards the end, are the result mainly of starvation. There is first defect of nutrition, so that the sufferer sinks from inanition; but there is also a peculiar empoisonment of the blood, resulting from the absorption of waste material and probably of some peculiar poison developed during the process of starvation.

Of all the cases that come before us, those in which albuminuria is an efficient factor leave the least room for doubt as to the course to be adopted. Abortion or premature labour should be promptly induced. We must remember that eclampsia is probably close at hand, and if not exorcised quickly, will overtake and perhaps destroy the patient. We believe that the induction of labour is imperiously indicated when the pulse rises to 120, the temperature exceeding 100° F., emaciation becoming marked, the stomach intolerant of food, when the patient is harassed by want of sleep, and vomiting is provoked by slight causes and frequently renewed. When once the balance of nutrition is clearly turned against the patient, so that she is feeding upon the waste products of her own tissues, she is in imminent danger, and the time within which a successful therapeusis can be practised is quickly passing away.

On the other hand, we must not forget that in the majority of cases there is a natural tendency of the vomiting to subside after three or four months. We must, therefore, study patiently to meet the distress by palliation as long as we can, hoping for the time when Nature will assert her power and relieve the physician. Giving this principle emphatic approbation, we feel compelled to protest with equal emphasis against a plausible but dangerous aphorism not seldom urged by the disciples of a timid '*far niente*' school: 'Treat the disease and let the pregnancy take care of itself.' The reply to this, too often enforced by clinical experience, is: 'The disease depends upon the pregnancy, and cannot be treated apart from its cause. Whilst you are fighting the assumed disease on empirical principles, the woman is drifting to death.'

Reflex convulsions simple.—By this term we mean convulsions neither true epilepsy nor albuminuric. We have seen women attacked with violent shuddering, with or without vertigo, but not passing into coma. The fits are accompanied by distressing tremors, and sometimes by syncope. Palpitation precedes and follows. These attacks suggest the term epileptoid; and perhaps the condition is closely allied. But they occur sometimes in women who have exhibited no antecedent epileptic tendency; and epilepsy, according to our observation, is rarely generated by gestation, but is a revival of a latent diathesis.

Cramps, or spasms in the legs, in the abdomen and elsewhere. In minor degree spasms and pains in various muscles may be regarded as simple evidence of the ordinary exaltation of nerve-tension. When they become severe, as they sometimes do, causing loss of rest or sickness, sedative treatment by digitalis, bromides, even opium, may be indicated. They should always dictate a systematic interrogation of all the functions, especially of the alimentary and urinary organs. Removing the source of irritation from the stomach may allay the distress. Examination of the urine may reveal albuminuria; and in this case we must act upon the special indications in that affection.

We know women who are always troubled with a *cough* when pregnant. It is not attended with any bronchial secretion, it is purely nervous; it is of an explosive or convulsive character. And cough, especially whooping-cough, will, proclivity existing, sometimes set up true convulsion.

Epilepsy may for the first time break out under the trial of pregnancy, so that it now falls under consideration. But it is more frequently observed as a pathological process antecedent to and revived by the gestation. For the sake of continuity, and for the better appreciation of the inter-relations of the neuroses, it is better to comprise the description of the disease in this place.

A case is related in the Lumleian Lectures of a woman whose history revealed a strong hereditary disposition to nervous disorder. After a labour and several abortions, being much exhausted, epileptic fits declared themselves during her seventh pregnancy. A slight fit occurred at every menstrual epoch after this. At the next pregnancy she 'took fits' again, and had them frequently during the whole pregnancy of nine months. The fits ceased after labour; she nursed thirteen months without fits, but in succeeding pregnancies she had frequent fits, and also during lactation. In her twelfth pregnancy fits recurred; she went to term; severe and protracted fits followed labour, she being semi-comatose between. When pregnant for the thirteenth time, on quickening she had a very severe fit; a fortnight later the right leg was paralysed. At five and a half months severe fits set in, with prolonged coma, the paralysis of the leg continued. Labour was induced by rupturing the membranes; she had no fits during labour or puerpery. The paralysis remained. The urine, examined at four different times, showed no albumen. The abortions and the protracted lactations induced a gradual blood-deterioration, the effect of which culminated after six years of reproductive troubles in the first epileptic fit during the nervous tension of gestation.

Although, as in this case, epilepsy will frequently provoke abortion, it is not nearly so likely to do so as eclampsia, indicating that the blood-poison in eclampsia is more noxious and more acute in its formation, and therefore is a more potent irritant of the nervous centres.

The case sketched illustrates the main features of the relation of epilepsy to gestation, namely, the faculty of gestation to evoke a latent organic or functional disposition to epilepsy; the early appearance of epileptic fits on the commencement of gestation; the liability of the fits to be repeated with the advance of gestation; and the renewed proclivity to the disease during lactation. Throughout there is generally anæmia. This appears to be the most obvious blood condition. But, as we have explained, anæmia, especially in a pregnant woman, almost always entails some degree of toxæmia, the result of bad nutrition and weakened excreting power. It differs markedly from eclampsia in the absence of albumen from the urine, and therefore of the acute toxæmia which attends albuminuria. It is a chronic disorder called into activity by the degraded blood acting upon nervous centres in exalted tension under the influence of gestation, and affected by the organic changes proper to the epileptic diathesis.

The effect upon the child is not constant. If abortion occur, it is not necessarily through the death of the embryo. The child has on rare occasions exhibited convulsions at or soon after birth; and the *damnosa hæreditas* will in all probability, especially in the case of a girl, sooner or later assert itself.

Treatment. Is there any prophylaxis? Epileptics cannot be advised to marry. Marital intercourse will sometimes cause fits. Gestation is almost certain to exercise a baneful influence. The remedial treatment consists in moderating the fits, obviating the effects of the coma, and restoring general tone. Regulate the secretions; give iron, zinc, bromides, cod-liver oil; good diet; encourage exercise. If the brain show sign of debility, the induction of labour must be considered.

Tetanus, pre-eminently an affection of exalted centric nervous irritability, is an occasional complication of pregnancy. It is not uncommon in hot countries in connection with pregnancy and labour. Mr. Waring[1] recorded 232 cases observed in India. We have often seen in labour evidence of such extreme reflex and emotional irritability that we have expressed it to ourselves as tetanoid. But we have not seen true tetanus in a pregnant woman which we could identify with what we have seen of tetanus after surgical operations, or of so-called idiopathic tetanus. Sir James Simpson collected 28 cases connected with abortion and labour. In some of these there was no unusual lesion; in some there had been hæmorrhage; in some the vagina had been plugged to arrest hæmorrhage, and this has been observed to cause peculiar irritation. One observation made by Simpson is undoubtedly true—namely, that in this country tetanus is extremely rare in women independently of pregnancy. Dr. Wiltshire has related two cases, both in pregnant women; both died. Of Simpson's 28 cases only 6 recovered.

It has been generally thought that tetanus in pregnant women is sufficiently explained by comparing the condition of the uterus after labour to a surgical injury. But this is

[1] *Indian Annals*, 1855.

inadequate. It accounts for the source of the peripheral irritation only, not for the exalted responsive centric irritability. Is there a poison *sui generis* at work? The comparative frequency of tetanus in abortion deserves attention. We do not know if albuminuria has been observed in connection with this disease. The convulsion differs in some respects from that usually associated with albuminuria, one great characteristic being the absence of coma. A resemblance is seen in the readiness with which fits are excited. The *treatment* must be based on the same lines as those laid down for puerperal convulsions. Upon absolute rest, nitrite of amyl, or chloroform the hope of recovery must be fixed.

Robert Barnes saw a case in which whooping-cough induced tetanus in a boy aged nine months. He had first trismus, then emprosthotonos, the hands touching the feet, then the body arched back into opisthotonos. Such a case must be studied in connection with the 'trismus nascentium.'

Chorea.— The investigations of Robert Barnes on chorea render it[1] doubtful whether chorea ever arises in the course of gestation as a new disease. The mass of direct evidence shows that when chorea arises in gestation, there is either a clear history of the subject having suffered chorea as a child, of having acquired the predisposition before pregnancy, or of having inherited a nervous diathesis predisposing to chorea. Andral noticed this, and that recovery followed on abortion. A striking exception to this proposition is found in a case narrated further on, in which scarlatina, causing mitral disease and albuminuria, was followed by chorea at the eighth month of gestation. It is not therefore strictly logical to class chorea with the neuroses arising under excess of physiological action. But the affinity which all the convulsive diseases occurring during gestation exhibit, renders it more instructive to study them side by side in the same group.

In the memoir cited the author collected 39 cases of recovery from chorea during gestation, and 17 cases ending fatally. Of the first series, abortion or premature labour occurred spontaneously in 15, in 1 it was induced artificially, and in 23 gestation went on to term. Of the second series, of 17 fatal cases, 4 died undelivered, in 5 abortion or premature

[1] 'On Chorea in Pregnancy,' *Obstetr. Trans.*, 1869.

labour set in spontaneously, in 1 it was induced, 2 died undelivered, in 5 the matter is not specified.

It must not be assumed from these figures that the deaths under chorea in pregnancy are as 17 to 39. It is almost certain that a larger proportion of fatal cases are recorded. But the figures show, nevertheless, how disastrous the complication is. These facts exhibit the main features of interest as to the relation of chorea to gestation. The two conditions are distinctly antagonistic. Chorea tends to force the termination of pregnancy, or to kill the mother; and pregnancy will hardly suffer a latent proclivity to chorea to remain in abeyance.

In a large proportion of instances the chorea breaks out in the first pregnancy, whilst the subjects are still young—that is, not far remote in point of time from the antecedent attacks of the disease. When it has occurred in one pregnancy, the probability is great that it will recur in subsequent pregnancies, the patient remaining free, apparently cured, in the intervals.

Not only does gestation evoke latent disposition to chorea, but it greatly intensifies the disease. It may be said that the greater number of severe cases, of cases culminating in mania and in death, are cases of chorea complicating gestation. Marcé affirms that moral and intellectual disorders are very common, that two-thirds at least show obvious marks of these disorders. Loss of memory, hallucinations, mania occur. This estimate may be overstrained in the case of children, but it is assuredly under the mark in chorea with pregnancy.

In this liability to be evoked under gestation chorea resembles epilepsy and ague, and other convulsive disorders. Other conditions which impair the blood and disorder the nutrition of the nervous centres resemble gestation in disease-evoking power. Thus Blache notes[1] that exhausting discharges, protracted illness, as in a case of typhoid ending in anæmia, may excite chorea in a choreic diathesis.

The following propositions seem to be established :—

1. Chorea complicating pregnancy is attended with more danger both to reason and to life than under other circumstances.

2. In some cases under restorative treatment the chorea has subsided during pregnancy, and the patients have been delivered at term.

[1] *Dictionnaire de Méd.*, 1834.

3. In some cases premature labour has occurred spontaneously during the continuance of the chorea. This event has been quickly followed by the cure of the chorea; in some it seems to have rescued the patient from imminent death; but in some cases the abortion has been quickly followed by death.

4. Abortion is not due to the death of the fœtus, for this has been frequently born alive. In its tendency to provoke labour chorea resembles eclampsia. Both cause shock; both tend to accumulation of carbonic acid in the blood; both impair nutrition of the nerve-centres, and disturb the function of the great excreting organs—the liver and kidneys.

The pathology of chorea as illustrated by gestation. We cannot here dwell upon the light which pregnancy complicating chorea throws upon the pathology of this disease. This interesting question has been discussed in the 'Memoir' already cited. We can only here point out that the theory of 'embolism of the small branches of the middle cerebral artery supplying the structures near the corpus striatum,' so ably contended for by Hughlings Jackson, is difficult to reconcile with the clinical facts—(1) the frequent recovery of choreic patients; (2) the occasional immediate cessation of choreic fits upon delivery; (3) the *progressive character* of the disease during pregnancy, convulsions increasing in severity, and the gradual development of mania in some cases; (4) the fact that embolism is rare during pregnancy.

There is evidence of tissue-waste. The patients generally emaciate; they sleep badly, and during sleep the convulsions remit or cease. The appetite and digestion are impaired. The temper is irritable; the pulse is often accelerated. In a case witnessed by Robert Barnes in Chomel's wards the diaphragm, larynx, and heart were affected, as shown by hiccup, irregularity of heart's action, and hissing respiration coming on at intervals.

Walshe[1] observed four phases of the urine—(1) febrile, high specific gravity, deep colour, odour strong, lithates abundant; (2) great excess of urea, result of muscular waste from convulsive action; (3) oxalates; (4) abundance of phosphates, result of nerve waste. Todd and Bence-Jones confirmed these observations. Beale noticed a large amount of solid matter

[1] *Lancet*, 1849.

caused principally by the organic matters; also increase of sulphates; no sugar or albumen. Dr. Fleetwood Buckle gave us several analyses quite in accordance with the above. In one case in which we examined the urine we found no albumen or sugar; it contained 0·4 per cent. of urea, and crystals of urate of soda and uric acid. The case was very severe; it lapsed into mania.

We may now venture to state our provisional conclusions as to the primary genesis of chorea, and its secondary reproduction under the influence of gestation. 1. There is in many, if not all cases, an inherited nervous diathesis, or acquired under diseased processes that degrade the blood and tissues. 2. But at the starting of the disease the primary condition of the brain, apart from this assumed diathesis, is simply that of irritation. 3. That irritation is soon complicated with impaired nutrition. 4. That the source of the irritation is a compound of psychical or physical shock and degraded blood. 5. That the disease continuing aggravates itself and the mal-nutrition of the nervous tissue. 6. That by a vicious circle of action and reaction the choreic convulsions directly injure the nervous substance, and thus the gross or microscopical changes of structure become developed.

In childhood, under favourable medical and hygienic conditions, and the transforming influence of development into adolescence, the disease may be arrested, apparently cured, and is *de facto* cured as far as outward manifestations are concerned; but a certain change of structure persists in many cases at least, only waiting to be recalled into activity under the influence of pregnancy or other conditions which degrade the blood and excite the nervous centres. Of all known influences, pregnancy seems to be the most potent and the most disastrous.

The great sympathetic nerve, as Voisin says of epilepsy, probably plays an important part in chorea.

In connection with the widely-accepted theory of rheumatic affection of the heart as a cause of chorea, it is useful to bear in mind how commonly the heart is affected in pregnancy, hypertrophied, and its irritability greatly increased. At the same time, in considering the embolic theory, it should be borne in mind that thrombosis and embolism are rare in gestation. These events are characteristics of the puerperal state, of low nervous and vascular tension, of active degeneration of tissue and absorption.

Chorea causes mental disorders. This it does by the repeated shocks which at first stun the nervous centres. These shocks are equivalent to concussions; they exhaust and divert the nervous force from its proper uses, and after a time impair the nutrition of the nervous substances, either directly or indirectly, by inducing degradation of the blood. This hypothesis is consistent with the clinical facts that the cerebral disorders are progressive in proportion to the duration and severity of the chorea; and, if not too far advanced, undergo amelioration with the decline or cessation of the chorea.

The effect of chorea upon the child is not sufficiently known. It must be noted at three periods—(1) during intra-uterine life; (2) during and immediately after labour; (3) during early infancy.

During the first period it seems probable that the fœtus in which the germ of choreic diathesis exists may suffer convulsions *in utero* under the same influences which act upon the mother. Precise observations upon this point are defective. Where premature labour has occurred spontaneously or surgically, the embryo or fœtus has generally been alive up to the time, and viable fœtuses have been born alive. If the child survive, it is eminently desirable to put it to a wet nurse rather than to the mother.

Treatment. The great question here, as in other forms of convulsion, is: Can the gestation be allowed to proceed? In some cases Nature solves the question by spontaneous abortion. We must accept this as evidence of the rebellion of the system under the burthen. Again, death may ensue if the gestation continue. We must be governed by the severity and obstinacy of the disease, and the extent of the injury inflicted upon the system. We must anxiously watch the pulse, temperature, and general conditions, prepared to act in time. If nutrition be seriously impaired, the favourable opportunity may easily slip away. The general treatment is similar to that indicated for incoercible vomiting. Repose; removal of irritation, psychical and physical; morphia by subcutaneous injections, bromides, digitalis; mineral sedatives, as cerium, bismuth; tonics, as zinc, iron, arsenic. Sedatives are of great service. Succus conii has been extolled by Clifford Allbutt.

The diet should be nutritious; if food is rejected by the stomach then nutrient enemata are resorted to. In extreme cases subcutaneous injections of ether, and intravenous injections of saline solutions may turn the scale to recovery.

If mania break out, or threaten, premature labour should be induced. This step taken in time, may save the patient from protracted or permanent brain-disease.

Hysteria.—Pathologists not familiar with obstetrics and the sexual diseases of women are often disposed to call hysteria all anomalous nervous phenomena which they cannot trace to some cause within the range of their study, and to which they cannot give another name. Regarded in this way, many of the aberrant nervous phenomena would fall under the general and vague term of hysteria. But if the phenomena be carefully analysed by the light of the physiology of gestation, they may for the most part be assigned to one of the acknowledged definite neuroses. Adopting this view, the cases of hysteria will be rare, and will certainly become rarer as our knowledge increases. It is not too much to say that hysteria is an *asylum ignorantiæ*, which will one day be closed.

The phenomena which most commonly call up the idea of hysteria are the various mental aberrations from which few women are altogether free. Capricious appetite, wilfulness, restlessness, languor, idleness, subjective pains more or less defined; changes of character, the 'longings.'

Some of the subjective troubles which on-lookers find it hard to realise, are real enough to the sufferer. Some are reflex motory or reflex emotional, some, perhaps many, take their rise in the ganglionic system.

Burrows says: 'I have seen two cases where hysterical symptoms attended during pregnancy, and the patients almost immediately on delivery became insane.' And 'puerperal delirium consequent on labour is sometimes predicated, though not absolutely developed during gestation. If while pregnant there attend frequent hysteric affections, preternatural susceptibility, unaccountable depression or exuberance of spirits, morbid aptitude to exaggerate every trivial occurrence, suspicion, irritability or peevish excitation, or what is still worse, a soporous state, with a very quick pulse, then the supervention of delirium on labour may be dreaded.' The prognostic meaning of these signs is interpreted with characteristic clinical sagacity. But surely they are not hysteria, they are the premonitory symptoms of insanity, the 'sopor and the quick pulse' may indicate albuminuria.

We only mention here, for the sake of order, the *convulsions* that attend deliquium *from hæmorrhage*; the convulsions of the moribund from other causes, as acute yellow atrophy of the liver; and the *convulsions* due to accidental *poisoning*.

Albuminuria gravidarum. Eclampsia gravidarum or **puerperal convulsions**, or *puerperal eclampsia*. The adjective 'puerperal' is erroneously applied to describe this grave disorder. Convulsion is a characteristic affection of pregnancy. It is the immediate expression of high nervous and vascular tension. As a clinical fact, in many cases, the convulsions break out before labour sets in; indeed, long before labour is due; in other cases they may break out during labour when nervous tension is at the acme; and it is only in a comparatively small proportion that the convulsions declare themselves *for the first time* after labour. And in these latter cases, the train was laid during the gestation. On physiological and clinical grounds, therefore, we class this form of convulsion with the other convulsive disorders of gestation. This argument we have enforced and illustrated elsewhere.[1] We may here venture to state a general proposition. The chief acts of reproduction in woman are marked by nervous phenomena allied to convulsion. The orgasm of coitus, the vomiting, cramps, and other phenomena of gestation and labour itself are of this character.

One great essential character of the disorder we now treat of is the concurrent presence of albumen in the urine. This association stamps it with a special type. The complication with albuminuria, not unnaturally, was first observed in Guy's hospital, the field of the luciferous discovery of Richard Bright. Lever announced his discovery in 1842.[2] Sir J. Simpson confirmed it by independent observations in 1847. In 1840, Rayer[3] announced that he had repeatedly observed his '*néphrite albu-*

[1] Lumleian Lectures on the 'Convulsive Diseases of Women,' 1873.
[2] *Guy's Reports.* [3] *Traité des Maladies des Reins.*

mineuse' in pregnant women. We shall offer presently an opinion as to the probable nature of this '*néphrite*.' In 1846 Cohen and Delpech confirmed Rayer, showing that albuminuria was frequent in pregnant women. Since then the association is an undisputed acquisition to science. Different theories, nevertheless, still prevail as to the genesis of the albuminuria, as to other complicating conditions, and as to the immediate causes of the convulsions.

Two apparently conflicting clinical facts must be studied in relation to the foregoing propositions:—1. Cases, not rare, are seen in which convulsions break out in pregnancy which were not preceded by albuminuria. 2. Albuminuria, even with œdema, has been noted, and no convulsion has appeared. Litzmann found albuminuria in 37 out of 131 gravidæ; of the 37, 26 were primigravidæ. These facts, and the connected theories, will be discussed presently.

We will first endeavour to describe an attack. It may be analysed into three periods. 1. The convulsion. 2. The coma. 3. An interval of apparent recovery or of remission.

1. The *fit*. Frequently this occurs suddenly, premonitory symptoms, if any, escaping observation. The patient may have been engaged in her ordinary occupation, when she turns pale, the eyeballs roll in their sockets, the whites alone being seen; the corners of the mouth are drawn, producing a horrid grimace compared by Dubois to the countenance of the fabled satyrs. The face is drawn to one shoulder, the muscles of the face twitch and become contracted, and this contraction quickly extends to the muscles of the trunk and extremities; the fists are doubled, generally with the thumb compressed in the palm by the fingers; sometimes the trunk is bent to one side, more often the back is arched as in opisthotonos. The neck swells, the carotids beat violently, the jugular veins stand out, the face becomes bloated, cyanosed, the eyes even start. The aspect strangely suggests strangulation. There is, as Marshall Hall described it, trachelismus.

The contracting muscles of the neck obstruct the return of blood by the jugulars; the tongue is protruded, it is often bitten and bloody; froth oozes, or is expelled in jets from the mouth. The muscles of respiration, especially the diaphragm, appear as if 'set' in tonic contraction. Hence breathing may be suspended for several seconds. This condition of tonic convulsion does not last ordinarily more than twenty or thirty seconds, when it is followed by the clonic convulsive movements. Rapid jerking movements of the muscles of the face, body, and limbs now succeed the muscular rigidity. The glottis opens; a short noisy broken inspiration, with stertorous expiration, attends the escape of foam from the mouth. The patient can neither feel, see, nor hear. The pulse, at first hard and strong, now becomes rapid and feeble, capillary circulation is retarded; hence the purple hue especially noticed on the hands and face. Carbonic acid accumulates in the blood. Reflex action for the time is suspended as in other forms of deep narcosis, the sphincters relax, and the urine and fæces are discharged. Generally the eyelids refuse to contract on irritation; the pupils respond feebly, or not at all, to light. They are sometimes dilated, sometimes contracted. Towards the end of the paroxysm all these symptoms progressively disappear. The spasmodic movements become less frequent and less violent until they entirely cease. The circulation and respiration become regular, the superficial colorations disappear. Perspiration frequently breaks out. This period of clonic convulsions lasts from two or three to twenty minutes.

The tonic convulsions are really much more dangerous to life; death may occur from asphyxia or serous or sanguineous effusion in the brain. But, says Barker, the clonic convulsions are much more frightful to the uneducated bystanders.

2. The *coma*. Insensibility has set in during the convulsion period. It continues for a variable time after the paroxysm, according generally to the severity of the convulsion. Sometimes it takes the form of heavy sleep, from which the patient wakes up, opens her eyes, and returns to self-consciousness and perception. What she has gone through she knows nothing of, excepting a dull recollection of the headache and vertigo which ushered in the fit. In other cases the patient may lie motionless, the extremities stretched out and flaccid, the respiration frequent and laboured, at first stertorous, afterwards slower and snoring. Sometimes she is capable of being imperfectly aroused.

3. The *remission*. The respiration becomes more even and free, less rattling, and the pulse less frequent. After

awaking, the patient generally complains of a confused, dull headache, and great languor, which continue until a renewal of restlessness, stretching, slow tremulous bending of the arms, twitching of the facial muscles with reddening of the face announce a new paroxysm. Soon after the passing off of the coma, a remarkable condition of the nervous system may be observed. This consists in a renewal of nervous excitability, as when clouds are gathering for another storm. At this stage so intense is the diastaltic irritability that the slightest emotional, or peripheral irritation, whether arising from the uterus, as when a labour-pain begins, or from attempting to swallow, or from undue restraint applied to her limbs, or sometimes even a loud voice or other sounds, even the jar caused by walking across the room, a shake of the bed, may provoke a convulsion. Dr. Townsend relates[1] a case in which, when the hair was being cut, every stroke of the scissors caused twitching of the muscles. At this time also touching the vulva, vagina, or os uteri, for examination, or the passing the catheter may easily start a convulsion. Dashing cold water on the face, a blister to the nape or to the calves—popular remedies, sometimes even accepted by physicians—act in like manner. At this stage, the highest art is exerted by securing absolute repose. 'Masterly inaction' here finds its legitimate application. The one active thing to do, is to lessen the irritability by the inhalation of chloroform.

The condition described closely resembles the tetanoid state induced in the frog by strychnine. On seeing convulsion excited by some of the causes specified we have been forcibly reminded of experiments in which we assisted Dr. Marshall Hall. A strychnised frog lay motionless, and recovered if not disturbed. Strychnised again, there was no convulsion so long as perfect repose was secured; but a prick on the skin, a shake of the table, would instantly provoke a paroxysm; and if a succession of fits was induced, the frog would die of a dose which would be innocuous under repose. The application of this to practice is obvious. We shall recur to it when discussing the treatment.

The interval of calm before another storm is of variable duration. Its length depends a great deal upon the freedom

[1] *Dubl. Quart. Journ. of Med.* 1871.

from irritation. There can be no doubt that each recurring fit is a heavy blow and shock dealt to the nervous centres, depressing the heart, and threatening life with accumulating force. One fit, even several fits, may be followed by recovery. But certainly the danger to life increases in an accelerating ratio with every fit.

In the more severe cases the convulsions recur with shorter intermissions; the coma is more prolonged, or scarcely remits; the breathing becomes more stertorous; the interval of calm is lost; convulsion and coma run together; and this state but too frequently ends in death.

Are there any *forewarning symptoms* to tell the physician what is coming, and to furnish indications for averting the threatening danger?

1. In some cases the convulsion attacks suddenly; the patient and her friends have no suspicion of anything wrong; the physician has no opportunity of seeing her before the storm has burst. It is more than probable that, even in such cases, scientific observation instituted beforehand would detect signals of danger. Thus, to anticipate the discussion of the pathology of the affection, we may state that in one class of cases convulsions break out in women whose urine showed albumen beforehand, and that in another class there is no antecedent albuminuria. To take the first class, the albuminuric cases. In these the albuminuria is commonly attended by anasarca; the elective seats of the effusion are the face, especially under the eyes, giving a bloated aspect; the hands, so that rings become tight, and the feet swell so that boots are ill-borne. In some cases the dropsical effusion is all but universal. Ascites may be so extensive as to conceal the uterus from touch; the pericardium and pleuræ are also filled; the connective tissue of the lungs is invaded, and the brain does not escape. These cases are commonly fatal. No function can be efficiently carried on where the whole system is water-logged. These conditions are objective, and can hardly escape notice. Whenever they are seen, the urine should be immediately tested for albumen. If this is found—and its presence may be confidently predicated—further evidence is hardly necessary. But there will rarely be wanting certain subjective signs, by themselves too significant to be disregarded, and, when added to the objective signs,

forming a compact and irresistible body of evidence. These are: headache, sometimes dull and continuous, sometimes throbbing; vertigo, a feeling of syncope; impairment of sight, temporary perhaps at first, afterwards becoming permanent. This may be confirmed by objective examination. The ophthalmoscope may reveal haziness of the fundus of the eye, the papilla swollen, the retinal veins enlarged, and very probably some hæmorrhagic effusions in the retina.

Ringing or buzzing in the ears, difficulty of articulation, nervousness, a sense of terror, irritability of temper, difficulty in finding the proper words to express the thoughts, are further subjective signs, also more or less open to objective perception. Aphasia is a not uncommon forerunner of convulsion.

The cases in which albuminuria does not precede the convulsion are much more difficult, and generally baffle forejudgment. Nothing short of a systematic and frequently repeated examination of the patient throughout pregnancy can avail. Thus watching for the first steps of the deviation from the strictly physiological path, we may hope to have timely warning. In these cases the objective signs described may be wanting; the subjective signs, also, may fail to arrest the attention of the patient. The fact seems to be that, under the blood-and-nerve conditions present leading to the development of danger, the patient's self-perception is apt to be dulled. Dr. Mahomed has, in memoirs[1] of great scientific and clinical value, pointed out that there is a pre-albuminuric stage, in which clear evidence can be elicited of the advent of albumen in the urine. This state is proved to be a first or premonitory stage of the affection produced by the action of the same causes. The crystallisable principles of the blood transude into the uriniferous tubules before the albumen. This he proves by *Mahomed's test.* A small slip of white blotting-paper is dipped in the urine and dried over the flame of a spirit-lamp; by this means the dilute solution of the crystalloid is concentrated by evaporation; two drops of tincture of guaiacum are then dropped on the paper, and after a minute or so allowed to evaporate; a single drop of ozonic ether is let fall in the centre of the guaiacum stain. A quarter of an hour may elapse before the reaction becomes visible.

[1] *Medico-Chirurgical Trans.* vol. lvii. 1874; *Brit. Med. Journ.* 1877.

Sibson gives the following signs of high vascular tension:— 'Pulse hard, sustained; a forcible and sustained after-beat, prolongation of the first sound, a re-duplication of this sound near the apex over the septum, whilst at the base the first sound is dull and indistinct, the second loud and clacking.'

There are three signs of the high tension, with arterial pressure on the kidney, disposing to convulsion, with or without albuminuria:—(1) The high-tension wave indicated by the sphygmograph; (2) the pulse and heart-beat as observed by auscultation; (3) Mahomed's test.

Where these signs concur the danger of convulsion is serious. But these signs become manifest only on examination *ad hoc*.

The further or ulterior consequences of albuminuria or convulsions.—Where quick death or recovery does not take place, other phenomena appear. In the first place, *abortion or premature labour* is very likely to be provoked. The outbreak of convulsions, albuminuria being present, may be delayed until the natural advent of labour. But the irritation running from the uterus to the diastaltic centre, it is nevertheless true that, in the majority of instances, the convulsion sets in first. Then, the diastaltic function excited to an inordinate degree, the uterus—an organ physiologically predisposed to act—receives the impulse and enters into contraction, partly, probably, from the blood carried to it being highly charged with carbonic acid. The fact that convulsions frequently attack women at six, seven, or eight months of gestation is enough to show that labour is not the essential cause.

Where convulsions supervene upon albuminuria the gestation will rarely go on to term. If labour do not occur spontaneously, the physician would induce it as the best way of arresting the convulsions and the pathological process which produces them.

Puerperal phlegmasiæ of the cellular tissue and serous membranes are especially likely to occur. These will be described under the 'Diseases of Puerpery.' In this connection it may be stated as a general proposition that convulsions and albuminuria increase the disposition to, and the severity of, most of the diseases to which the puerpera is liable. Denman, Gooch, Collins, all refer to the frequency of abdominal inflammation.

Robert Lee [1] was one of the first to refer to *the state of the Eye* in albuminuria.

Grenser [2] relates a case of convulsion breaking out soon after delivery; albuminuria; total blindness observed on returning consciousness. This disappeared in a fortnight. By ophthalmoscope under atropin, the veins were seen fuller, arteries empty; papilla nervi optici green; around it on the retina were insular grey turbid spots. The flame of a lamp induced no sense of light.

Spengler relates [3] a case of hemeralopia in a pregnant woman.

The subject of amaurosis in connection with the albuminuria of gestation is well illustrated by Fordyce Barker.[4]

Feeling the deep importance of this subject in its immediate clinical relations, as well as in its elucidating power applied to many problems in the physiology and pathology of gestation, we sought the aid of Mr. Power, whom we knew to have devoted careful attention to it. The following account of the affections of the eye observed in pregnancy is a contribution from Mr. Power:—

He has seen a group of cases presenting characters in all respects identical with those that are characteristic of albuminuria. The optic disc was swollen and pinker than natural; its margins indistinct or altogether lost; the veins large and tortuous, sometimes varicose; the arteries less conspicuous; both sets of vessels covered with a thin veil of effusion as they traversed the region of the disc. The retina near the posterior pole of the eye presented hæmorrhages and white patches, which were much fewer and smaller near the equator. The hæmorrhages were generally irregular in form and dark, and the particular vessel from which the blood had escaped was sometimes recognised. In such cases the vessel sometimes terminated abruptly at the hæmorrhage, or was only with difficulty traced beyond it, whilst in other cases the course of the vessel could be distinctly followed beyond the hæmorrhage. In all the cases Power saw there were many hæmorrhages, and so the sight being seriously affected the subjects sought advice; perhaps in other cases the sight not being much

[1] *Med. Chir. Trans.* 1863.
[2] *Monatsschr. f. Geburtsk.* 1866.
[3] *Monatsschr. f. Geburtsk.* 1865.
[4] *The Puerperal Diseases*, 1876.

affected, and therefore advice not being sought, there might be fewer hæmorrhages.

The white spots were identical with those seen in albuminuria. Like the hæmorrhages, they were chiefly around the posterior pole, and were either in the form of irregular but rounded patches or of minute dots, and the fovea centralis was on several occasions surrounded by a corona of radiating dots and striæ. These, in fact, are the features seen in albuminuric retinitis. Power believes that in these cases albumen was either actually present in the urine, or had been so a very short time previously.

The hæmorrhages and white patches Power conceives might be accounted for in part on the theory of over-distension of the vessels, the white glistening patches being due to such a degree of distension as allowed of white corpuscles, of which such patches are chiefly composed, escaping through the dilated stomata of the vessels; whilst the hæmorrhages are the result of distensions pushed to actual rupture. This view is supported by the fact that most of these cases occur in the later months of pregnancy.

The affection is a serious one, for the rupture which takes place in the vessels of the eye might occur in those of the brain and spinal cord, which are under the same pressure. But Power, like ourselves and others, has seen recovery both of health and vision. We have, however, also known a fatal issue to follow on delivery.

Power describes another form of ophthalmic disease, the pathology of which is obscure, namely, *white atrophy of the optic disc.* This has arisen in cases where there had been great loss of blood; probably this had been preceded by optic neuritis. Possibly the arteries supplying the corpora quadrigemina and the corpora geniculata of the optic thalami, or those supplying the psychical centre of the brain, may spasmodically contract, or may be occluded by embola. He has seen a case in which vision almost lost in a first confinement was recovered to a great extent in a second.

One of the most frequent as well as most easily curable affections of the eye that occur in the later period of pregnancy and during lactation is impairment of the power of accommodation, which leads to minor disturbances of vision. The diminished power of accommodation is essentially due to exhaustion of the neuro-muscular apparatus of the eye. It is earliest seen and most strongly marked in those who are naturally hypermetropic. The symptoms complained of are: impossibility to read for more than a few minutes at a time, great fatigue in the eyes on attempt to sew or do fine work, the type or the threads running together; with a sense of dizziness and confusion in the head. If work or reading be discontinued, the eyes rubbed and the eyelids strongly closed, the feeling passes off, but the symptoms soon return on resuming work. Pain is experienced, black spots are seen floating before the eyes; these are not always subjective only but also objective, due to particles of pigment detached by strong pressure or friction from the ciliary region. The patient complains of redness and lacrymation, of the lids sticking together in the morning, and of inflammation along the margin of the lids. The whole chain of symptoms results from temporary failure in the power of accommodation. The patient makes violent efforts to bring the ciliary muscle into play, and both nerve and muscle soon become exhausted. The treatment is simple and effective. Convex glasses of low power, attention to the general health, steel and strychnia, are the main agents of cure.

Amaurosis may persist for weeks or months. This usually ends in recovery, provided, as we believe, there be no persisting albuminuria and degeneration of the kidney. We have witnessed complete recovery when there was not persistent albuminuria. Fordyce Barker relates several cases, and believes the prognosis is generally favourable.

The *Ear* lends itself less readily to observation than the eye. But it presents many points of great interest.

Sudden powerful emotions may cause deafness.

Mr. Dalby says that a young woman who, without any change in the middle or outer ear, becomes deaf during her first confinement, is pretty certain to be subject to an accession of deafness on every subsequent pregnancy, and will be in danger of increasing it infinitely if she nurse her children. This sums up very much of what we know concerning the ear in gestation. Deafness standing alone does not throw much light upon the gestation process.

The ear seems to be subject to the same laws as those which govern the eye in its relations to pregnancy. Deafness does not appear so frequently to be associated with albuminuria as is defect of vision.

Deafness has not been studied so carefully as amaurosis. The complication is not uncommon. Lever relates a case.[1] The deafness increased as pregnancy advanced. The hearing was better from day to day after delivery. She relapsed under suckling; and recovered under weaning and tonic treatment.

We know cases in which deafness recurs and becomes more marked in every succeeding gestation. In these the women have stated that the glands of the neck swelled simultaneously. We think this fact throws light upon the genesis of the affection. The tonsils swell with the other glands, and the mucous membrane of the Eustachian tubes thickening, it is easily understood that the hearing will be impaired, and how partial recovery takes place as the thickening subsides.

Cerebral apoplexy is an event to be dreaded. It is one of the most probable causes of death. This may take the form of serous or sanguineous effusion. If the patient survive she may be left a sufferer from paralysis.

Pulmonary apoplexy is another probable event. Complicating asphyxia or occurring without it, it is an event of the gravest import.

One source of danger following albuminuria with œdema which has not attracted attention, is the sudden inpouring of the effused serum into the blood after delivery, when the tide is turned from high pressure and extravasation to low pressure and absorption. This is one source of danger of phlegmasiæ.

Mania is a not uncommon sequela of convulsions. During the mania the patient is sometimes destroyed. But if she survives, the mania commonly subsides in a few weeks, or earlier. Barker, who has had an exceptionally large experience in this field, says that mania follows puerperal convulsions in quite as large a number of cases where albuminuria has not existed, as in those where it has been present.

Hallucinations of sight especially are not uncommon during the immediate premonitory stage.

[1] *Guy's Hosp. Reports*, 1847.

Paraplegia in gestation and puerpery is in many cases associated with albuminuria. Convulsions may or may not have occurred. Sometimes the only morbid condition that can be discovered is retroflexion of the sub-involved uterus.

Fordyce Barker cites a case reported by Dr. Fourgeaud of a lady who had several abortions and two children born prematurely. In the last pregnancy, seen a week before labour, the face was œdematous, she could scarcely see, she was delivered of a seven months' child, which had been dead apparently for three or four days. She had no convulsions, perhaps owing to the use of chloroform. Next morning she was found to be paraplegic; the motor power of both legs was entirely lost, sensibility partially impaired; there were paralysis of the rectum and sphincters, with involuntary discharge of fæces, paralysis of bladder with retention of urine; and amaurosis, the sight being almost entirely gone. At the end of a year she had recovered.

Aphasia is occasionally observed. Barker records a unique case of a lady who forty years before the report had in her only labour severe convulsions followed by long-continued coma. Since that time she could only utter the words 'Oh, yes,' through which, by various inflections of voice, she contrived to keep up intelligent intercourse with her intimates.

Aphonia we ourselves have observed.

Disease of the kidney is especially to be apprehended. It is certain that in many—perhaps the majority of cases—the kidney is left intact. This is one of the striking examples of the light thrown by the study of gestation upon general pathology and the genesis of disease. A healthy kidney is suddenly called upon by an overwhelming pressure to perform more than its ordinary duty; it is unequal to the task; albumen filters through its structures in enormous quantities; still it preserves its structural integrity, and comes out of the ordeal unscathed. Like other observers, we have seen many instances of healthy young women who suffered severely from albuminuria and convulsions in their first pregnancy, and who enjoyed perfect health afterwards, bearing several children without any untoward complication.

On the other hand, all are not so fortunate. The kidneys may be permanently affected; and although, the gestation at an end, and its concomitant high vascular tension subsided, the albuminuria may be much moderated and the kidney may remain apparently stationary, no sooner does a new pregnancy occur than the disease is exacerbated, there is an increase of albumen, and if the pregnancy go on, the condition becomes more and more confirmed.

Pathology of convulsions.—The most useful plan of studying the pathology of the disease, if not the most logical, will be next to trace the changes found in the body after death. Similar changes will not indeed necessarily arise in the early steps of the disease, nor in those patients who recover. Still we shall draw from this inquiry valuable facts to illustrate the phenomena observed in the living.

Braun describes the appearance with great exactness. The brain shows anæmia, œdema, diminished consistency. Hyperæmia of the membranes is rare. Inter-meningeal apoplexy is rare. When it occurs it may, according to Kiwisch, be regarded as secondary, produced by impeded circulation of blood. Macdonald, in one case, found minute apoplectic extravasations in the corpora striata, a condition which has struck us forcibly in the watery state of the brain. In the lungs œdema is constant. The heart is commonly empty and flaccid. The spleen is large, as generally in gestation and childbed. Braun distinguishes three degrees of disease of the kidney. *First stage*: hyperæmia, at the commencement the surface is smooth, the capsule easily removed, the plexus of veins on the surface is dilated, full of blood. The cortical substance is brownish-red; from the surface of the section there flows a sticky bloody fluid, with which the parenchyma is infiltrated. The pyramidal masses are also hyperæmic, injection-striped. The mucous membrane of the pelvis and infundibula is swollen, covered with vascular arborescence; hæmorrhagic effusion is frequently observed. The epithelium of the tubuli uriniferi is not essentially altered, but is easily separable. The tubuli, filled with coagulated or fluid exudation, sometimes contain blood-corpuscles.

In the *second stage*, that of exudation and of commencing fatty metamorphosis, the cortical substance is of a dull yellow, the striped vascular ramifications and red spots in it disappear. The organ is bulky, much exceeding the normal weight. It then gets softer, more friable, milky and dark. The surface is sometimes smooth, sometimes granulated, covered with elevations of the size of a poppy-seed. The capsule is easily separated; the pyramidal masses dark red. The infundibula show a dirty-red mucous surface. Between glomeruli and capsule lies a thick stratum of firm exudation of granular structure, showing fat-droplets. The interior of the epithelial cells of the tubuli is, in extreme cases, filled with fat-droplets, becomes turbid, and at last the cells themselves are decomposed into aggregations of granules.

The *third stage*, that of retrogression and dissolution of the glandular substance (atrophy). The kidney becomes smaller. The capsule is dirty white, thickened in parts, closely united to the cortical substance. The surface is uneven, tuberculated. Similar conditions are described in a series of cases by Krassing,[1] and they are confirmed by other observers.

Dickinson [2] says the morbid changes in the kidney are 'such as obstructive or venous congestion would be apt to produce. They are allied to those which occur as the result of heart disease with attendant venous repletion. They may be epitomised as congestion succeeded by excessive growth of epithelium, interstitial nucleation, fibrosis and granulation. But when of uterine origin it is to be observed that, partly perhaps by reason of the susceptibility of the subjects, it is more mischievous than when it is cardiac. Both undergo at first increase of epithelium and ultimately of fibrous tissue, both become at last granular. But the cardiac kidney is usually to the last red, hard, and free from oil, while that of uterine origin often becomes fawn-coloured and fatty.'

Depaul,[3] in a report on a memoir by Dr. Mascarel, stated that in the autopsies he had made, the kidneys were perfectly healthy, or simply congested.

We may now usefully discuss the various theories put forth as to the pathology and etiology. The first theory in order of time is the pressure-theory started by Lever. It was adopted by Rayer, Litzmann, Caseaux. It still finds many adherents. This theory rests mainly upon the assumed compression of the

[1] *Monatsschr. f. Geburtsk.* 1860.
[2] *Pathology and Treatment of Albuminuria*, 2nd ed.
[3] *L'Union Médicale*, 1854.

renal arteries and veins by the gravid uterus. The arguments urged in support are—(1) the comparative frequency in primigravidæ, in whom the abdominal walls being firmer, press the uterus backward against the spine more forcibly; (2) the occurrence of œdema and venectasis of the lower extremities, pointing to pressure upon the vena cava: the inferior mechanical venous hyperæmia of De Cristoforis; (3) the greater frequency when the uterus is of excessive size from twins or liquor amnii.

Professor Halbertsma[1] urges the pressure-theory in another form. He contends that the kidney suffers through *compression of the ureters* by the gravid uterus. Löhlein[2] adopts this view, saying that he found dilatation of one or both ureters in 25 per cent. of the deaths from puerperal eclampsia, and in 3 per cent. only of deaths from other causes.

Against the general theory strong facts are in evidence—(1) the pressure is not adequate. As the uterus rises from the pelvis, it diverges from the spinal column, leaving the kidneys and their vessels protected in the receding lumbo-dorsal region; at most there is pressure upon the common iliac veins and the lower part of the vena cava; (2) albumen sometimes makes its appearance at the third or fourth month, before the uterus can possibly press upon the kidney or its vessels; (3) the albumen may disappear under treatment by purging or bleeding, although the uterus continues to grow (Robert Barnes); (4) albuminuria and convulsions not seldom occur in pluriparæ, though escaped in the first pregnancy; (5) the greater frequency in cases of distension from twins may be more reasonably explained by the greater nervous and vascular tension induced by the double demand, and by the greater amount of excrementitious stuff thrown into the circulation.

These facts are not so conclusive against Halbertsma's theory of special pressure upon the ureters. Still, even here it may be objected that pressure upon the ureters will hardly account for eclampsia in the third and fourth months of gestation.

2. Another theory is that the convulsions are caused by *labour-pains*. Undoubtedly this is occasionally true as regards the convulsions. Indeed, labour itself may be regarded as a

[1] *Trans. Intern. Med. Congress*, 1881. [2] *Deutsche Med. Zeitung*, 1883.

physiological convulsion. It, however, fails to account for the albuminuria. When the albuminuria already exists, then, as we have seen, uterine action may be the immediate cause of convulsion. Often albuminuria and convulsions both occur without any sign of labour. Braun, however, says that of 44 cases of eclampsia seen by him, it broke out 24 times during labour and 8 times in puerpery. Wegscheider collected 435 cases; of these, 236 cases broke out during pains, 109 before and 110 after labour. Von Wieger has tabulated 455 cases; the convulsions preceded the commencement of labour in 109, attended labour in 236, and followed labour in 110. The tables of these authors probably contain many cases in common. Here, as so often occurs when statistics are invoked, the necessary analysis of the cases is baffled. It cannot be doubted that in many instances the labour was premature, probably provoked by the conditions leading to albuminuria and convulsion. It may be admitted that in many cases the outbreak was immediately excited by the uterine contractions or by some other irritation proceeding from the uterus. The nervous tension has attained its acme at the time for labour, and will naturally respond to slighter irritation. Braxton Hicks[1] brought forward a memoir 'On the Behaviour of the Uterus in Puerperal Eclampsia.' In two cases he noted that coincidently with a convulsion, a powerful and prolonged contraction of the uterus occurred.

Analysing the histories of 55 cases of puerperal eclampsia, of which Robert Barnes has preserved notes, we find that in 18 the convulsions broke out without any antecedent sign of labour; labour being either an epiphenomenon caused by the convulsion or induced by the physician. It is scarcely probable if eclampsia break out for the pregnancy to go on. One of two things will almost certainly happen—(1) if not delivered, the cause of the toxæmia persisting, the convulsions will be continued, and prove fatal by exhausting the sufferer by shock, or by direct lesion of the brain; or (2) labour will be induced by the circulation or stagnation in the nervous centres and uterus of blood charged with carbonic acid. Such blood acts, as Marshall Hall and Brown-Séquard have shown, as a direct stimulant to muscular contraction. When black blood is cir-

[1] *Obstetr. Soc.* 1883.

culating, uterine action begins. Once started, the nerve-storm seizes the uterus as well as the voluntary muscles; the sphincters then relax, the os uteri dilates, and the labour proceeds.

Gübler's *theory of super-albuminosis*.[1] This supposes that the disease depends upon the elimination of an excess of albumen which the pregnant woman's blood contains. If the proportion of albumen exceeds the normal wants of the mother and fœtus, the excess must accumulate in the blood and be eliminated by the kidneys, as is observed in animals fed exclusively on albumen, or in whose veins a solution of albumen is injected. The kidney, therefore, is not primarily diseased, but serves as a filter. This hypothesis contains a part of the truth. Allied to this theory is that of Peter,[2] who suggests that there is 'transudation of albumen,' and 'auto-typhlisation.'

Caseaux, dwelling upon the pressure-theory to account for the albuminuria, attributes the disease to a *serous plethora*, a condition observed in chlorosis and gestation, producing greater tension of the whole vascular system. This contains a part of the truth. The theory of anæmia is allied. But the convulsion of anæmia from hæmorrhage differs from that of albuminuric eclampsia. It precedes death; it is the sign of 'agony.' It is preceded by general tremor, a kind of universal shuddering; consciousness is not always abolished, and there is no trachelismus or congestion of the face. There is often vomiting, and the pulse is rapid or even imperceptible. These signs make up a picture quite distinct from convulsions.

Temporary or permanent disease of the kidney.—This theory received the sanction of Bach, Imbert, Goubeyre, Litzmann, Frerichs, and Braun. The conclusive objection is the complete recovery which in many cases follows.

We have already cited Braun's description of the lesions found in the kidney. These, it must be remembered, are conditions found in fatal cases. They are far from proving that like changes are necessary to the initiation of the albuminuria or of the convulsions. In his second and third degrees of Bright's disease, it is indeed highly probable that had the patients survived they would have suffered from more or less

[1] *Dict. Encyclopéd. des Sciences Méd.* [2] *Archives de Tocologie*, 1875.

prolonged albuminuria. Dr. Southey in an excellent clinical lecture[1] describes the condition under the name of 'pregnancy nephritis.' But we much doubt whether the first degree is really more than extreme hyperæmia. Here we venture to set forth an explanation of the *néphrite albumineuse* of Rayer and of the acute desquamative nephritis of recent English authors which we believe has not hitherto been suspected. If we examine the cervix uteri and vagina during pregnancy by the eye, we see intense hyperæmia and the surface covered with creamy discharge. This consists of epithelial scales shed under the intense physiological hyperæmia; these scales are in fatty degeneration; they are suspended in an albuminous plasma. A similar condition is often found in the other parts of the mucous tracts open to direct observation. It is in the highest degree probable that the mucous membrane of the glandular structure of the kidney, an organ specially within the range of the high vascular tension, and liable to constant irritation by waste-stuff brought to it for elimination, suffers in like manner. We infer from this that no structural lesion of the kidney is necessary. The kidney conditions attending the initiatory stages of albuminuria and convulsions are nothing more than the result of the high vascular tension which tells upon the whole mucous tract. This theory is in harmony with Mahomed's observations on the præ-albuminuric stage, and the clinical history of albuminuria in scarlatina, in which disease there is high tension, intense congestion of the mucous membrane, and an irritating poison in the blood. Depaul, we have seen, found the kidneys healthy.

The following passage from Warburton Begbie is in point. 'What is the cause of the albuminuria in simple scarlatina, and what is its pathological import? I conceive it to be as essential a symptom of the disease as is desquamation of the cuticle, to be, in fact, the result of a desquamative process, which the mucous membranes in this disease equally with the skin are subject to. Granted then that the desquamation occurs when such a change is taking place in the epithelial membrane lining the minute tubes of the kidney, the office of the cells composing which is to eliminate from the blood the matters solid or fluid which in the normal exercise of the renal function

[1] *Lancet*, 1883.

compose the urine, it surely is not surprising that the albumen from the former should to a slight amount enter into the latter. It indicates the separation of epithelial cells and their passage into the current of the blood.'

We have presupposed *toxæmia as a factor*. What is the poison? It is impossible to give a precise answer to this question. 1. There is the *theory of uræmia*.

That urea is found in excessive proportion in the blood in the albuminuria and eclampsia of gravidæ is well-attested. Gegenbauer and George Harley were amongst the first to attest it. Robert Barnes having bled a patient, had the blood analysed by Professor Bernays, who found urea and uric acid in it.

A correlated fact is that urea is found in diminished quantity in the urine. But do these facts prove that the urea is poisonous? Claude Bernard showed that injections of large doses into the veins caused no convulsion, and Chalvet and Gallois say that, far from being a poison, it is a valuable diuretic.

Lehmann found that chlorides almost disappear from the urine as in other diseases attended by abundant exudation.

2. The *ammonæmia theory of Frerichs* assumes that the urea is oxidised, forming carbonate of ammonia. But no analysis has shown this decomposition in the blood. Richardson, J. Dumas, and others have shown that ammonia is a normal constituent of the blood. Hammond rejects Frerichs' theory. Jaksch, in a valuable clinical analysis,[1] shows that in true ammonæmia, such as arises from decomposition of urine in the bladder and absorption, the symptoms are altogether different from those of puerperal eclampsia. Rosenstein also argues against both the uræmic and the ammonæmic theories.[2] Certainly these hypotheses are not necessary to explain the convulsion. Monck injected carbonate of ammonia into a dog, having first tied the ureters. The dog did not suffer.

3. Rosenstein dwells upon *anæmia and œdema* of the brain. Monck again tied the ureters in a dog, and injected water into the carotid. Convulsions and coma ensued. As in Bright's disease, anæmia and œdema of the brain were found on dissection.

[1] *Vierteljahrsschr. f. d. prakt. Heilkunde*, 1860.

[2] *Monatsschr. f. Geburtsk.* 1864.

4. Schottin surmised that *the extractive matters* of the urine formed the poisonous element.

5. In the absence of precise chemical evidence we prefer the general term of *urinæmia*. That the kidneys fail to eliminate the waste-stuff of nutrition is certain ; that this accumulates in the blood is a necessary consequence ; that absorption of urine and failure of the kidney to do its duty lead to empoisonment and convulsion is a familiar clinical fact illustrated not alone in obstetric practice, but in general surgery and medicine.

6. A *material alteration of the nervous centres or of their membranes.* The objections to this theory are: 1. That the lesions found after death, however they might have been the cause of death, were most probably the result of the conditions which caused the albuminuria and the convulsions. 2. The lesions found do not bear especially on those parts which physiologists show to be the only ones capable of determining convulsions, namely, the spinal cord, the medulla oblongata, the corpora quadrigemina. Congestion or anæmia of the brain and its membranes which attend the anasarca of some albuminuric women do not produce excess of activity or disorder of movement. 3. The lesions accused are not constantly found. 4. This theory fails to account for the cases that recover.

Frerichs and Blot observed that subjects much infiltrated appeared less disposed to convulsions than those in whom there was little or no œdema. It is true, at least, that there is no certain relation between the convulsions and the extent of anasarca.

We are driven to conclude that it is not with eclampsia, as Voisin and others hold to be the case with chorea and epilepsy; that is, the visible alterations found in the brain and cord in persons who have died of epilepsy and chorea, are consecutive upon, not antecedent to, the disease. These structural alterations are more strictly connected with the ulterior superadded symptoms of the disease than with the initiatory or proper symptoms. For example, when the disease has long endured, when the fits have become frequent and severe, the brain commonly shows signs of impairment, and exhaustion, paralysis, dementia or mania is the result. In his memoir on chorea,[1] Robert Barnes adduced reasons for concluding that the

[1] *Obst. Trans.* 1868.

graver symptoms—the paralysis, the mania, death—were produced by the repeated shocks of convulsion. In the cases of tetanus, perhaps also of strychnism, it can scarcely be doubted that the fatal prostration is almost purely the result of the repeated shocks.

We have seen almost sudden death in labour which could be ascribed to no other cause than the shock of pain and the convulsive action of the uterus. In some cases of paraplegia arising in labour it seems reasonable to attribute the paralysis to exhaustion or to shock upon the spinal cord.

It is greatly by the influence of shock that we must explain the cerebral disorder which so often attends the progress of puerperal convulsions, of epilepsy, and of chorea. The fits act as repeated shocks which stun the nervous centres. These shocks are equivalent to concussions. The *ictus epilepticus* is as real a blow as the apoplectic stroke. Both exhaust and divert the nervous force, and after a time impair the nutrition of the nervous substance.

In the case of chorea proceeding to mania we have to note that the cerebral disease is almost always *secondary and progressive.*

In cases of puerperal mania breaking out after labour, where there has been no convulsion, it may seem that some other factor than shock must be invoked. In some of these there is albuminuria; that is, blood-poisoning. But in other cases there is neither convulsion nor albuminuria. But in all there is the shock of labour, with its attendant exhaustion, its severe physical and psychical revolution, and the blood-degradation of puerpery, acting upon a nervous system wrought up to a climax of irritability. It would seem that convulsions, collapse, insanity are not indeed interchangeable, but that the issue in any one of these is determined by idiosyncrasy, by diathesis, or by some pre-existing peculiarity in the nervous centres.

Tyler Smith enunciated the theory that the albuminuria '*may depend upon sympathetic irritation of the kidneys* by the gravid uterus, similar with the irritation of the salivary glands, the mammæ, the thyroid, &c. and not upon mere pressure.' Frankenhaüser reasons against the pressure-theory, and applying his discovery of a direct connection between the nerves of the uterus and the renal ganglia, suggests that the nervous system and not the vascular system is the starting point of puerperal convulsions; he also bases his theory upon the occurrence of eclamptic fits where no albuminuria existed.

Rosenstein, extending the theory of Traube, submits that eclampsia, like the starting of nervous symptoms in ordinary uræmia, supervenes when, in a very hydræmic person, the pressure in the aortal system is suddenly raised; then there is formed in the brain an acute œdema, the effused serum compresses the cerebral vessels, and hence there arises acute anæmia of the brain. When this condition affects the cerebrum only, coma ensues; if it seizes the middle convolutions, convulsions break out. This theory seems plausible; but it is inadequate.

The observations of Bourneville throw useful light upon the pathology, prognosis, and treatment. He studied the changes of *temperature connected with eclampsia*. Nine observations [1] lead to the conclusions: 1. That during the eclamptic fit the temperature rises from the beginning to the end; 2, in the intervals, the temperature remains high, and, at the moment of convulsions, there is a slight rise; 3, if the fit is to end in death, the temperature continues to rise 41°–42°, and reaches a high figure; at the moment of death it may reach 43°. If, on the contrary, the fits subside, and coma diminishes or ceases distinctly, the temperature falls progressively and returns to the normal degree. In ordinary uræmia, on the other hand, the temperature falls.

We must now discuss a very important question. What is *the connection between albuminuria and eclampsia*? We have already stated the two facts that eclampsia sometimes breaks out without albuminuria, and that albuminuria may exist without eclampsia ensuing. There is a third fact well-established. The eclampsia is sometimes so quickly followed by albuminuria that the eclampsia seems to cause the albuminuria. We must commence by clearing away a possible source of fallacy. Litzmann showed that albumen is occasionally found in the urine of puerperæ as the result of catarrh of the bladder due to pus-globules.

Depaul, Legroux, Lévy, Braxton Hicks, Fordyce Barker,

[1] Bourneville, *Études cliniques et thermométriques* (*Urémie et Eclampsie puerpérale*), 1874.

and others attest the fact that albuminuria occasionally follows upon the eclampsia. Casati relates a clear case.[1] It is necessary to distinguish cases of simple epilepsy which are a revival of a latent epileptic diathesis, and which are not connected with albuminuria. The argument of the authorities cited does not rest upon cases of this kind, but upon cases of pure eclampsia; although Hicks affirms that albumen is observed in epileptics, the epileptic fit is far from being frequently the cause of albuminuria. Thus Dr. Gibson [2] repeatedly examined the urine of three epileptics during and in relation to the fits. He says sugar and albumen were always absent. Urea was somewhat above the average; chloride of sodium much below. Althaus examined the urine of epileptics after a long series of attacks and found no albumen. Hicks's account calls for quotation:—

'A woman approaching the full period of pregnancy, apparently in perfect health, without albumen in the urine, is suddenly seized with an epileptiform attack. After a certain time, albumen is noticed in the urine, at first in small quantities, shortly in profusion; then blood-globules, waxy and epithelelial casts, are found in it. The urine becomes scanty, of high specific gravity, with very high-coloured crystals of lithic acid in considerable quantity. The case, which is now one of acute desquamative nephritis, may terminate by gradual recovery, the albumen slowly disappearing; or death may ensue from the violent effects of the original attack, or from the retention of urea, &c. in the system in consequence of the acute mischief in the kidneys.' He thence argues that: '1, the convulsions themselves are the cause of the nephritis; 2, that the convulsions and the nephritis are produced by the same cause; e.g. some detrimental ingredient circulating in the blood, irritating both the cerebro-spinal system and other organs at the same time; 3, that the highly-congested state of the venous system which is produced by the spasm of the glottis in eclampsia is able to produce the kidney complication.'

Accepting the facts of Depaul, Hicks, and others cited, we submit that they have only a limited application to the solution of the problem. If some cases of eclampsia occur, not preceded by albuminuria, but followed by it, it is nevertheless true that

[1] *Annali Universali di Medicina*, 1868.
[2] *Med.-Chir. Trans.* 1867.

in a much larger proportion the albuminuria precedes, or at any rate is found abundantly, not after twenty-four hours, but at the time of the first fit. We must, then, seek further back than the fit for the cause of the albumen. The most philosophical explanation appears to be that the high vascular tension telling upon the kidneys impairs their working powers; and that from this cause, and from the accumulation of noxious stuff, the proceeds of the double nutrition of mother and fœtus, there ensue two things: irritation of the kidney and irritation of the cerebro-spinal centres. The researches of Mahomed go far to explain the occasional precedence of the fit over the albuminuria, by showing that the kidney is already labouring in the præ-albuminuric period. These researches and the facts observed are further in harmony with the views of Gull and Sutton, which imply that arterial fibrosis and hypertrophy of the heart re-act upon the kidney in causing Bright's disease. The hypertrophy of the heart is a constant condition in gestation associated with the high tension, and the consequent fulness and tension of the small arteries carries the analogy still closer.

One circumstance that lends weight to this view is the increased liability to convulsion at the menstrual epochs, when the nervous and vascular tension is increased.

The tension falls when the child dies in utero. Spiegelberg even relates a case in which the albuminuria and convulsions ceased on the death of an extra-uterine fœtus.

Analogy with Bright's disease, the acute dropsy from cold, from scarlatina and similar conditions, throws a strong light upon the acute albuminuria and convulsions of gestation. In all these cases we also find deteriorated blood, impeded excretion, and high vascular tension. Then there are the researches of Mahomed, which prove that under high vascular tension the kidney is struggling before albumen exudes. We may from these clinical facts construct a strong hypothesis. There is the strong predisposition to exaggerated diastaltic action, increased by the imperfect nutrition of the nerve-centres; all that is wanted to overthrow the balance is an exciting cause; this is found in the noxious stuff retained in the blood through imperfect excretion; this, irritating the diastaltic centre, provokes the convulsion.

Author's theory.—Several conditions concur to cause the associated disorders. These are—(1) The hydræmic state of gestation leading to imperfect nutrition of the nervous centres, increasing (2) the normal nervous tension and irritability, and (3) the normal vascular tension; with these comes (4) blood-poisoning from imperfect elimination of waste stuff by the kidneys and other emunctories.

This view, set forth in Robert Barnes's Lumleian Lectures, 1873, is advocated by Hypolite, 1879.[1]

The prognosis.—The account given of the symptoms and issues of the affection will supply the materials for a prognosis. The question is threefold:—1. Will the patient recover? 2. Will the gestation be brought on to an end? 3. Will she recover completely, or with damaged kidneys? Then there is a fourth question as to the fate of the child.

Hypolite says eclampsia breaking out during labour is much less severe than when it breaks out during gestation. It tends to disappear as soon as the gestation is ended. A rising temperature with frequent fits, prolonged coma, especially if continuing after delivery, dictate a grave prognosis; the opposite conditions, especially if attended by lessening quantity of albumen, justify a favourable prognosis.

He says, further, that eclampsia is attended by febrile reaction, and therefore by rise of temperature. This continues to rise or to fall progressively, according to the unfavourable or favourable issue, as Bourneville also showed.

The risk of convulsion is less when the albuminuria and attendant blood-poisoning assume the chronic character. In cases of albuminuria dependent upon chronic Bright's disease the pregnancy aggravates the affection. It has appeared to us that the convulsion is less likely to ensue than in the rapidly-produced acute albuminuria. In chronic Bright's disease a process of accommodation takes place, whilst in acute albuminuria the nervous centres, suddenly invaded by poisoned blood, are unprepared for resistance.

Barker puts and answers the question, *In which period is the occurrence of convulsion the most dangerous?* Eighteen years ago he published a table of cases collected from all sources, from which it appeared that 32 per cent. of all cases which occurred before and during labour, and 22 per cent. of

[1] *De l'Eclampsie puerpérale.* Paris, 1879.

those that occurred after delivery, ended fatally. Since then Barker observes that the disease is better known, and therapeusis improved, and we may expect more favourable results. He states elsewhere his conviction that the use of chloroform would diminish the mortality by at least 50 per cent. Dohrn analysed 747 cases: these gave a mortality of 29 per cent.

The effect upon the child.—In some instances the fœtus seems to be affected by the poison circulating in the maternal blood. Children are born dead in larger proportion than under ordinary circumstances. In the case of convulsions breaking out at term during labour, the prospect of the child is at the best. This consideration may weigh when discussing the question of inducing labour.

That the fœtus is frequently expelled dead by abortion is certain. It is highly probable that the death is due to the slow asphyxia by degradation of the maternal blood. But a large proportion of children are lost during the labour, especially if it be premature and artificially hurried.

Sometimes the child in utero seems to be convulsed. A deeply-interesting case is related by Dr. James Whitehead.[1] He felt the child convulsed at the same time as the mother.

A point to be noted is the not infrequent complication of albuminuria and convulsions with hydatidiform degeneration of the chorion. In such a case there should be no hesitation in emptying the uterus.

The treatment.—The principles of treatment flow logically from the views we have taken of the etiology and nature of the disease. Four cardinal principles stand out for our guidance:—

1. To moderate and control nervous irritability.
2. To moderate vascular tension.
3. To cut off emotional and peripheral irritants or excitants.
4. To eliminate all complicating morbid conditions.

The treatment is (1) prophylactic, (2) remedial, (3) restorative. 1. The *prophylactic treatment* applies to two states: first, to the preservation of the healthy condition of gestation, to the præ-albuminuric stage; and, secondly, to the albuminuric stage, with a view to avert eclampsia. 2. The *remedial* treatment applies to the moderation of the fits and its effects. 3. The *restorative* treatment applies to the restoration of the

[1] *Brit. Med. Journ.* 1867.

equilibrium of the system and of the kidneys and other organs to their normal state.

1. The *prophylaxis.*—The general principles laid down for the care of the gravida apply: exercise, moderate diet, sparing use of stimulants, great care in regulating the secretions, baths to keep the skin, the great alternative organ of the kidneys, in healthy action; testing the urine, watching the pulse by sphygmograph, and the state of the nervous system, to detect early notice of excess of tension, and, in this case, to give salines and digitalis. The hydræmic condition, also, is an indication for the administration of iron. Small doses of the sesquichloride or sesquinitrate we have found extremely useful.

Perhaps the greatest of all prophylactic remedies in the albuminuric stage—saving the induction of labour, to be presently discussed—is absolute rest, including under this term the removal of every source of mental, emotional, or physical disturbance. The attendants should avoid all force or loud speaking. The clothes should be so opened as to give free play to the lungs. A golden rule we insist upon as of the last importance is, *in any case where a fit is probable, to make no examination, not to pass the catheter, and to force no food or medicine, until the patient is under the influence of chloroform.* The slightest disturbance, especially touching the genitals, may provoke a fit, whereas all necessary manipulation can be readily carried out under anæsthesia. Under the same indication, avoid blisters, at one time a routine practice, and still, we fear, resorted to. We have seen the first effect to be the provocation of a fit. They cannot possibly do good. They are almost certain to do harm. The cantharidine, moreover, irritates the kidney.

In the præ-albuminuric stage, especially to give salines and digitalis, and saline purgatives, elaterium, calomel, or podophyllin or jalap. If vertigo, flushing, red face, disturbance of sight appear, bleeding to twelve ounces, twelve leeches to the temples, or cupping in the loins, may avert mischief to kidney and brain.

Before resorting to the induction of labour, it may be useful to try Copeman's method of dilating the cervix uteri, under chloroform, of course.

Prophylaxis in the *albuminuric or præ-eclamptic stage.*

The preceding rules apply. In addition, we have a resource in the milk diet advised by Tarnier.[1] This consists in putting the patient on an exclusive milk diet; of this she may take as much as she likes. Chantreuil relates a striking case in which there were extensive anasarca, œdema of the lungs causing suffocating attacks of dyspnœa, which in a fortnight were quite subdued by a bleeding and the absolute milk diet. She was delivered without having suffered from eclampsia.

2. *The remedial treatment.—How to treat the fits.*—The first question—one too much neglected of late years—is that of venesection. At one time it was in great vogue, and was, no doubt, abused. It is undoubtedly the most powerful and prompt resource at command for lowering the high vascular tension—a primary cause of the eclampsia. Hall Davis advocates it in sthenic cases. Richardson extols it in uræmia when the temperature is raised, and this, Hypolite says, it always is. Fordyce Barker and Scanzoni practise it. Chantreuil relates cases of successful application. We ourselves are clear as to the advantage derived from it. There are three ways of bleeding: venesection, leeches, cupping. Each, under certain conditions, may have its advantages. Against bleeding an apparently strong case has been made. Comparative statistics, showing more recoveries under chloroform than under bleeding, are adduced. Thus Charpentier,[2] analysing 133 cases observed under Depaul, found a mortality of 45 per cent.; under bleeding (single), 41 per cent.; under repeated bleedings the deaths were 54 per cent.; under anæsthetics, 84 cases gave a mortality of only 18 per cent. There may be a fallacy underlying these statistics. The cases may not have been of equal severity, and they may not have been comparable in other points. The Traube-Rosenstein theory seems to explain the deleterious action of bleeding. Schrœder puts it that the sudden depletion of the vascular system, by diminishing the arterial pressure, will stop the fits. But after bleeding the quantity of blood soon becomes as great as before from the absorption of effused serum. Now this involves deterioration in quality of the blood; it is made more defective in red globules. Abstraction of blood then would first do good; but soon the arterial tension will return, and the

[1] Tarnier, *Progrès Médical*, 1875; *Leçons cliniques*, du Dr. Chantreuil, 1881.
[2] *Thèse de Concours.* Paris, 1872.

state is worse than before. If the temperature is falling and the fits are becoming less severe, bleeding should not be resorted to. It is assumed by some that chloroform must displace bleeding. It is one of the great errors of modern medicine, in taking up a new remedy straightway to discard the old. Bleeding may be of occasional value ; but in the great majority of cases it must yield to chloroform.

The next class of remedies adapted to fulfil the indication of lowering vascular tension is purgation. Elaterium, calomel, croton-oil, salines, by producing watery evacuations, reduce the blood-mass and allay vascular tension. The croton-oil is especially valuable, because a drop or two can be put upon the tongue when the patient refuses to swallow.

Then there are certain sedatives which moderate nervous tension as well as vascular excitement. Amongst these are chloral, which may be administered by enema; but this should not be carried beyond one dose of twenty or thirty grains. It is dangerous to repeat it within a few hours. There is a general consensus now in favour of chloroform-inhalation. Nor is it possible to speak too highly of it. It is prophylactic and remedial. Used during the fit, it shortens the attack. Watching for the premonitory signs of a fit, as the facial twitchings and restlessness, and, then given, the fit may commonly be averted, certainly mitigated. Thus, if time is gained for labour to be completed, the patient is carried over the critical stage. In this way chloroform may be freely but discreetly given during many hours.

Chloroform blots out memory, one source of emotion; it shuts out perception, another source of emotion; it lessens reflex irritability. It further acts in averting or shortening a fit by inducing asphyxia in a modified form, in the same way as Achille Foville represents a fit of epilepsy as ceasing under the effect of the asphyxia which itself produced.

Closely allied to chloroform in its *modus operandi* is nitrite of amyl. Robert Barnes had the good fortune to cure a severe case of strychnism by the persevering use of this remedy, and advised it in all cases in which it is desirable to relax muscular spasm.

A successful case has been reported. Robert Barnes advised its use in his Lumleian Lectures in 1873.

The *nitro-glycerine* is extremely promising as a resource. Mr. Green reports a case.[1] The patient took 1 ♏ every hour. It was given after labour, and, therefore, when there was a natural tendency for the symptoms to subside. Lately Drs. Ringer and Murrell have shown that nitrite of sodium possesses similar properties. It may be given in three-grain doses.

During the fit *guard the tongue.* In the Paris Clinique d'Accouchements the tongue is put back, when protruded at the beginning of the fit, by pressing on its back with the edge of a folded napkin stretched between two hands and held between the jaws until the fit is over. A cork or a piece of indiarubber held between the jaws at the molars answers very well.

Cold to the head or elsewhere should be avoided. We have seen it provoke a fit.

Excellent results have followed the subcutaneous injection of *morphia.* Barker and Hecker give clinical evidence of its value. Dr. Bowstead[2] relates two cases in which injection of 2 ♏ of Fleming's tincture of aconite, and $\frac{1}{3}$ gr. of morphia acted most successfully. Scanzoni used it. Belladonna acts well. In the form of atropia-injection it is most convenient.

Pilocarpine has recently been tried on the initiation of Hyernaux.[3] In our opinion, the results of the experiments are not encouraging.

Postural treatment.—Graily Hewitt and Routh, believing that the disturbances of the abdominal and renal circulation, caused by pressure of the gravid uterus, exercised a powerful influence in provoking eclampsia, placed the patient in such a position as to diminish this pressure. Routh had seen marvellous benefit from the knee-elbow posture. It must often be difficult to adopt this posture; but the side or semi-prone posture may be tried.

A question of great moment, one that often calls for prompt solution is: *Shall the gestation be interrupted?* Can we venture to let the gestation go on? The disease depends upon gestation. Can the system bear the double strain of gestation and of the disease, working, as it must do, with organs which have proved unequal to the task? The question, as we have seen, is frequently solved by Nature. Labour comes on

[1] *Brit. Med. Journ.* 1882. [2] *Lancet*, 1869.
[3] *Du Chlorhydrate de Pilocarpine en obstétrique*, 1879.

spontaneously. The system over-taxed throws off the burthen. Another example of many illustrating the maxim that abortion is often a conservative process. But Nature, whilst showing us the way, sometimes procrastinates too long. Does she present us with any indications to guide us as to the when and how to help her? If we carry the feeble policy of temporising too far, the opportunity of rescuing the woman from imminent peril may slip away.

We would say (1) that in every case in which convulsions have set in, premature labour should be induced; (2) that where there is marked albuminuria with œdema, difficulty of breathing, a quickened pulse, with rising temperature; or amaurosis or other form of paralysis, and relief does not follow bleeding, purging, and sedatives, the operation should not be deferred (3) when the patient has had albuminuria in previous gestations, or is known to have had Bright's disease and hypertrophy of the heart, no time should be lost before labour is induced. We must not suffer the gestation to go on when it imperils life, or permanent damage to the kidney or the eye.

The good effect of labour.—The moment labour is started a call is made upon the nervous centres for nerve-force to be expended upon the uterus. This is its physiological destination; and if it can be kept steadily directed to this, its proper work, we may hope to obviate its diversion to convulsion or other morbid action. It is indeed a matter of observation that uterine action will often excite a convulsion. But upon the whole we believe it acts beneficially; and we shall be the less afraid of calling it into operation if we reflect, first, that labour must take place, and that it cannot be effected without uterine action; and secondly, that we can greatly control the irritability by chloroform. The induction of labour is the most natural means of discharging the excess of nervous tension.

We have known a cough excite labour; but under other conditions of special influence, as of blood-poisoning, or of proclivity from hereditary disposition, a cough might set up convulsion. We have seen an example of this in whooping-cough. This law of the propagation of excitation from one part of the spinal cord to another part in a state of peculiar susceptibility is admirably illustrated in a remarkable clinical experiment by Harvey. 'It seems to me,' says our Immortal

Physiologist, 'on deep investigation, that the throes of child-birth, just as sneezing, proceed from the motion and agitation of the whole body. I am acquainted with a young woman who during labour fell into so profound a state of coma that no remedies had power to rouse her, nor was she in fact able to swallow. Finding that injections and other remedies had been applied in vain, I dipped a feather in a powerful sternutatory, and passed it up the nostrils. Although the stupor was so profound that she could not sneeze, or be roused in any way, the effect was to excite convulsions throughout the body, beginning at the shoulders, and gradually descending to the lower extremities. As often as I employed the stimulus, the labour advanced, until at last a strong and healthy child was born without the consciousness of the mother.' It is in the highest degree probable that in this instance there was albuminuria and urinæmia. But how well must Harvey have been acquainted with the reflex function when we see him thus turning it to practical account to accelerate the course of labour!

The intimate relation between the cerebral and spinal axes is further illustrated in the vivid sympathy which springs up between pregnant women. Thus, if a woman far advanced in pregnancy assist at the labour of another, she seems herself to catch every pain that seizes upon her suffering sister; and cases are known—we have seen one—in which labour has in this way been actually induced. The same thing, it is said, is observed in pregnant mares and cows, so that those who have charge of pregnant animals take care to separate from the rest any one which may be taken in labour.

The mode of inducing labour.—In the first place observe the golden rule, '*festina lente*,' avoid precipitance, that is, the '*accouchement forcé*.' To deliver rapidly before the cervix is fairly dilated is to provoke violent convulsive reaction, to risk lacerating the uterus, and to reduce the child's chance to a minimum, thus sacrificing at one stroke the two objects of the operation. Proceed under anæsthesia; empty the bladder, puncture the membranes. This at once lessens uterine distension and irritation; then dilate the cervix gently by Barnes' bags; then proceed to accelerative measures as by forceps, turning, or craniotomy, according to the special indications.

Should there be œdema of the labia vulvæ, the preliminary precaution should be taken of draining the connective tissue either by a number of superficial digs with a lancet, or by Southey's drainage needles.

Conclusive arguments are based upon the following considerations, which apply to all the foregoing three conditions: (1) if the case be suffered to go on, even if the woman recover, every day adds to the strain upon the kidneys and the eye, and may lay the foundation of permanent disease; (2) it is not justifiable to let her run the risk of losing her life, or of drifting into grave disease, under the expectation of saving the child; (3) granted that the object of getting a live child should rule our judgment, the prospect is better of getting a live child in a future pregnancy than by trusting to the actual pregnancy already gravely threatened; (4) the fate of the child is linked with that of the mother; too commonly if the mother perishes the child perishes too; (5) we are doubly bound to seek our motive of action in the interest of the mother.

Admitting that some women have under our own observation and sanction gone the full period of gestation, and been delivered of living children apparently without damage, frankly speaking, we would not with enlarged experience again encounter a responsibility so great.

If these arguments are fairly presented to the husband and friends, they ought to prevail.

3. *The restorative treatment.*—When labour is over, the convulsions ceased, and the albumen disappearing, the proper treatment consists in rest, sedatives, light diet, of which milk should form a large element, avoiding stimulants. Iron is indicated, but its use should follow salines.

When able to endure it, warm baths should be used to promote the action of the skin.

Should the patient be much reduced by hæmorrhages or otherwise, transfusion of saline solutions or defibrinated blood may turn the scale in favour of life. Dr. Lange[1] relates a case of recovery after thirty-two fits and severe exhaustion, after transfusion of seven ounces of defibrinated blood.

The urine should be carefully examined from time to time for some weeks after labour.

[1] *Prager Vierteljahrsschr.* 1868.

B. **A group of paralytic affections.**

1. There may be paralysis of the special senses, as amaurosis, deafness, loss of taste, loss of smell, loss of touch. These have been described as sequelæ or attendants upon albuminuria and other forms of convulsion. Apart from this connection the paralyses are comparatively rare. We may call to mind aphasia and aphonia, also mentioned under 'Albuminuria.'

2. **Reflex paralysis as paraplegia.**—This, too, is sometimes associated with albuminuria. But it may have at least two other causes. The first is shock of labour, which seems to exhaust the spinal centre; the second is pressure of the uterus upon the sacral nerves. This may occur during pregnancy, but is more frequently caused during severe labour.

Lever had described two cases of paralysis of the limbs which ended in recovery after labour.

Paraplegia may be due to retroversion of the gravid uterus and pressure upon the sacral plexus. Retroversion may also cause reflex paraplegia (Brown-Séquard).

Apoplexy may occur at any period of gestation. Gestation testing the integrity of the organs, may find the cerebral blood-vessels unequal to the strain. We have seen it at the second, third, and subsequent months. It is perhaps most common at the time of labour. The complication is rare. In one case now under our observation, the subject æt. 28, a pluripara, was seen by Dr. Wilks, when seven or eight weeks pregnant; she had been seized suddenly with weakness of the right side, with some difficulty of speech; an hour later she became fainter, speechless, and paralysed on the right side. Complete right hemiplegia and aphasia set in. She had slowly recovered partially from the hemiplegia and more completely from the aphasia when six months gone. No albumen was detected until during convalescence, when a trace appeared. The hemiplegia persisted; but delivery took place naturally at term.

Dr. Wilks communicates a second case, that of a primigravida, æt. 22, who was struck when three months pregnant. The attack began with severe neuralgia of the head; drowsiness and lethargy followed; stertor, left hemiplegia, lateral divergence of head and eyes, slight convulsions preceded death. 'A clot of blood was found in the substance of the brain,' and an ante-mortem clot in the left lateral sinus. This suggested thrombosis of vessels as the cause of the hæmorrhage.

The paralysis, if unilateral, is likely to be the effect of cerebral apoplexy, associated or not with albuminuria. Apoplexy in gestation, independent of albuminuria and convulsions, we believe to be rare. In two cases seen by us the stroke occurred during the expulsive stage of labour, when the glottis was closed, and the tension upon the cerebral arteries was at its maximum. In one of these the woman was over forty, and it is not improbable that the cerebral arteries were in process of degeneration. Clotted blood was found. This sub-group is intimately linked with group A. Indeed, as is continually observed, the affections more prominently referred to one organ or fluid, overlap or dovetail with the primary or secondary affections of other organs.

Dr. Hughes Bennett in an instructive lecture[1] relates six cases of chronic hemiplegia. In two the disease began in pregnancy; in one, suddenly during labour; in two, soon after labour; in one, three weeks after an abortion. No albuminuria was noted when these cases came under Dr. Bennett a long time after the attack. He sums up as follows: These six cases of chronic hemiplegia are due to a destructive lesion in that portion of the brain supplied by the middle cerebral artery; (2) the disease began suddenly during the puerperal state, which was the predisposing cause of it; (3) the exciting cause was probably an embolus; (4) this embolus was the result of acute endocarditis, or due to the hyperinotic state of the blood, or possibly to both of these conditions combined. It will be noted that four of these cases occurred after labour, that is, at a time when the disposition to thrombosis is greatest, a proposition which will be set forth more fully when describing the diseases of puerpery.

Cerebral thrombosis is, we believe, a rare affection during gestation. Embolism is essentially an affection of puerpery, and it will be more profitably studied in connection with the proper puerperal pathology.

Thrombosis of the cerebral sinuses, Wilks says, occurs mostly in anæmic women.

[1] *Brit. Med. Journ.* 1881.

C. A group of mental disorders (including puerperal insanity).

Insanity in women, associated with child-bearing, is best studied in harmony with the scheme of this work under the four epochs of gestation, delivery, puerpery, and lactation. The conditions of the blood and circulating organs, of the nervous system, and of the body generally, present features which differentiate these epochs, although they are physiologically linked together. On this ground it will be more instructive to take the subject throughout the four epochs continuously.

Relative frequency of insanity in the different epochs.—Esquirol noted 54 cases arising in puerpery, and 38 during lactation, out of 92 patients.

Marcé found in 79 patients, that 18 fell ill during gestation, 41 in puerpery, and 20 during lactation.

All statistics concur in showing that insanity does not declare itself so frequently during gestation as after labour.

The causes of puerperal insanity are predisposing and exciting, in this respect, as in others, falling under the common laws under which insanity is developed in other subjects.

Of all the causes, *heredity* occupies the first place. Esquirol had traced hereditary influence in 1 out of 2·8 cases; Marcé traced this influence in 24 out of 56 patients; and there cannot be a doubt that more exact information than it is often possible to obtain as to the consanguineous history would reveal a much larger proportion. It is a factor in most cases, no matter at what epoch the outbreak may happen.

Anæmia, produced by gestation, increased by labour and puerpery, is an important element in etiology. It may be partly predisposing, partly exciting. Certainly in most of the cases of insanity breaking out after labour we have found this condition; in some the anæmic souffle was marked. The late Dr. F. W. Mackenzie, whose researches on phlegmasia dolens we shall have occasion to cite, insisted much upon this. The influence of this condition may account for the comparative frequency of insanity in multiparæ whose constitutions have been impaired by child-bearing and the development of debilitating diseases.

Linked with anæmia are certain states of *toxæmiæ*, more especially those depending upon *albuminuria* and *cholæmia.* The powerful influence of these states is exhibited in the fact that, arising, as they are especially liable to do, in primigravidæ, they are in a notable proportion of instances the precursors of insanity.

Lactation is a strong predisposing, if not also an exciting cause, and related to this condition is the fact supported by fair evidence, that suckling boys is more frequently followed by insanity than suckling girls. The first tax the mother's strength more severely.

Savage says:[1] 'We must be prepared to recognise in hysteria, epilepsy, chorea, and perhaps rheumatism, diseases that are related more or less closely to insanity. If one parent be insane and the other phthisical, the offspring run a greater danger than if only one parent were tainted. Several cases have come under my observation, in which all those of the family who have not died of phthisis have had mental troubles.'

The exciting causes are sometimes more apparent than real. There is no such frequent relation between *severe labour* and insanity as to suggest dystocia as a cause. *Hæmorrhage* certainly is an efficient factor.

The use of *chloroform* in labour has been accused as an active cause. In the early days of anæsthetic midwifery this reproach was hotly urged. It might, however, be supposed that the obliteration of pain and fear, two powerful agents in disturbing the equilibrium of the nervous system, would diminish the liability to insanity. Are the attendant evil influences of chloroform to weigh against immunity from pain and fear? Is it a fact that insanity in undue proportion follows the use of chloroform? To the first question it must be admitted that chloroform greatly disposes to hæmorrhage, a powerful factor in the development of insanity. The second question is not so easy to answer with precision. But it is certain that chloroform confers no immunity from insanity. Probably no obstetric practitioner of much experience has failed to see cases of insanity breaking out after the use of chloroform. With certain reservations it may be affirmed as a physiological fact, however harsh the opinion may appear to some, that the pain

[1] *Guy's Hosp. Reports*, 1875.

of labour fulfils a useful function in regulating the nervous energy, in directing it to its proper destination. One of the reservations is the extreme sensitiveness of many women lapped in luxury, upon whom pain has a crushing effect, outweighing its physiological uses. It is also to be remarked that chloroform is most frequently given to women in whom the nervous system is most highly developed, and who are the more prone to fail under the trial of gestation.

The influence of *moral emotion or shock* has been too often observed to be doubtful.

The appearance of the *first menstruation after labour* has often been the signal of an attack of insanity. Baillarger pointed this out to Robert Barnes when studying at the Salpêtrière. He has verified this in practice, and further, that succeeding menstruations have been attended by exacerbations of the malady.

In many cases more than one of the preceding causes are in action.

Marcé's idea was that there exists a sympathy between the uterus and the brain. This is the old idea. Certainly we have seen the clearest evidence of retroflexion, hyperplasia, and congestion of the uterus associated with insanity; and we have the conviction that by curing these complications we have cured the insanity. Graily Hewitt bears similar testimony.

Boyer relates a case of a lady who during her first pregnancy was attacked by insanity. Ten years later, the mental alienation having returned, it was concluded that she was pregnant. Boyer removed a polypus from the uterus, and she quickly recovered.

The insanity of gestation.—At the onset of gestation many women are overtaken by various nervous disturbances. The new situation brings a strange bodily and mental revolution. We have known women of the strongest character, not given to 'fancies,' not introspective, unwilling to yield to subjective impressions, or to excite sympathy, to be affected by hallucinations of sight and hearing, driving them to get out of bed, and flee from subjective perceptions, even to the point of running into danger.

The senses not only deceive them, but often fail them or become impaired. Thus the sight and hearing are at times enfeebled; temporary amaurosis occurs; the taste is often completely perverted, things heretofore eaten with relish are now objects of loathing, and things before disliked are now those which are sought. The 'longings' of pregnant women have in all ages been familiar to mankind. Women may, indeed, sometimes turn them to account in order to get what they want. But it is nevertheless true that in many instances these 'longings' are the expression of an irresistible bodily and mental disturbance.

Savage observes[1] that he has seen cases in which 'unnatural longings in the mother have reappeared as melancholia and mania in the children.' This affords strong presumption of the alliance of these longings, when passing ordinary bounds, with insanity.

Dipsomania and kleptomania are forms that occur.

One remarkable feature in the mental state of women during gestation is the pursuing dread that child-bearing will be fatal. This idea seizes upon most women, pregnant for the first time, with more or less force; in some it dominates and depresses, assumes the character of melancholy, and may culminate in insanity. Indeed, the most common form of mental aberration in pregnant women is the melancholic. Associated with the mental disorder are certain bodily disorders: the digestion is disturbed, the liver and kidneys act imperfectly. We have several times seen jaundice preceding or complicating insanity.

In many women these mental aberrations subside as the gestation advances.

In some melancholic cases, suicidal tendency is marked.

Savage remarked that the suspicion of poison in the food was common. Most of the cases were suicidal. Hallucinations are common. Mania is also a form observed in gestation.

Does gestation exert a favourable influence upon insanity? The affirmative has been contended for by some authorities. Esquirol said the instances of insanity being cured or modified favourably are rare. Dubois and Désormeaux[2] state the case in these terms: 'Mania, and especially dementia, often show a favourable experience from pregnancy; but we can hardly hope

[1] *Guy's Hosp. Reports*, 1875.

[2] *Dictionnaire de Médecine*, art. 'Grossesse.'

for a durable amelioration or a complete cure, in these cases and in other chronic diseases, except when they depend upon disordered menstruation or certain diseases of the uterus.' Outside these conditions they believe that pregnancy is hurtful rather than useful, not by itself, but by the debility which follows delivery.

In our own experience we have seen the truth of these opinions strikingly confirmed.

As to the *treatment*. Separation from friends is generally desirable. Remedies that reduce nervous and vascular tension are especially indicated. Savage speaks emphatically against the induction of labour. He says it will almost certainly only convert a case of insanity of pregnancy into a case of puerperal insanity.

Effect upon the child in utero.—Marcé, basing upon a small number of cases, shows that the children of insane gravidæ are more likely to be still-born when the insanity declared itself during the gestation, than when the women were insane at the time of conception. The explanation seems to be that acute disease attacking a gravid woman causes more disturbance; and it is also probable that in some cases albuminuria is associated with the insanity.

What is the influence of labour upon insanity? The process rarely suffers much disturbance. A point which has been often observed is the remarkable unconsciousness of pain; in some cases the woman has not been conscious of the delivery; and in not a few she has refused to believe that the child of which she had been delivered was hers. These facts point to the necessity of carefully watching an insane gravida, lest she fall into danger unperceived, and the child perish.

The temporary mental aberration during labour.—This form is generally recognised. It may occur in women who are not known to be the subjects of predisposition to insanity. It is a transient delirium. It is most commonly observed at that stage of labour when the head is stretching the cervix uteri or the vulva; that is, when the pain is most excruciating, and when the whole system is under the empire of the reflex nervous system. At this stage it is not surprising that a frenzied desire to be released at any cost from her agony should overpower all self-control. Hence a woman may attempt violence upon herself or upon her child at the moment the head is born, or soon after complete delivery. Such cases, it is true, are more frequent in single women, to whom childbirth brings not only acute physical suffering, but the most poignant mental distress, and the prospect of misery. Delivery under chloroform or ether will entirely obviate this form of transitory mania.

In the great majority of instances this form of aberration passes away in a few minutes or hours. But in women predisposed to insanity, this acute mania of labour may be the starting-point of persisting insanity. A similar argument applies when there is albuminuria.

Simpson, in his first enthusiasm for chloroform, claimed it as a prophylactic against puerperal insanity. This has been falsified by experience. We ourselves have known cases of mania break out after the use of chloroform in labour. It is doubtful whether it possesses any virtue in lessening the risk of insanity, unless it be, and this is important, in mitigating albuminuric eclampsia, a disorder which sometimes is the forerunner of insanity.

The insanity of the recently-delivered woman.—This is the most frequent of all the varieties of insanity connected with childbearing. The forms observed are mania, melancholy, hallucinations, monomania, and a particular form of mental debility observed after severe hæmorrhages, which is not difficult to cure by tonic treatment.

Mania is the most frequent form. This may or may not be ushered in with fever. We have found no elevation of temperature or pulse, but the skin is often dry. There is a dry tongue, thirst, insomnia, excitation, violence in action and in speech, sometimes erotic ideas, more often aversion from husband and child. Simpson made in one case the remarkable observation that albuminuria followed on three successive attacks, and disappeared on recovery. But the association is by no means constant.

The outburst of mania in a large proportion of cases occurs at two distinct epochs: in one class within the first eight days, in the other not before the fifth or sixth week. This may be explained by the action of the shock of labour and the establishment of milk secretion in the first class, and by the first menstruation in the second class. About two days after delivery some women become excited, sleepless, incoherent; the face is flushed, pulse rather full, and there is slight rise of temperature.

The prognosis and duration of the disease.—The prognosis bears upon two points: 1. The danger to life. 2. The prospect of cure of the disease. A certain proportion of cases terminate fatally within a few days or weeks. Of those that survive by far the greater number, probably three-fourths, recover their reason. Gooch used to say that the question was not 'Will they recover?' but 'When will they recover?' Subsequent observation, however, compels a modification of this assumption. The greater number recover within twelve months, many in a much shorter time. Of those in whom the disease lasts beyond a year, a considerable proportion are incurable. The cure is slower in melancholia than in mania. Savage says in most cases of mania the cure is made in three months, in melancholia it takes six months.

The immediate cause of death is usually acute delirium (Marcé). Other cases terminate by tubercle in the lung, pneumonia, pyæmia, or Bright's disease.

It may be said generally that puerperal mania threatens life, and melancholia threatens reason.

The insanity of puerpery proper.—The transition from the violent agitation of labour to puerpery is commonly marked by calm. But under the new condition, the disposition to mental aberration is revived. What are the causes that call this disposition into activity? The favourite doctrine of old—expression of the humoral theory—was that the insanity was caused by the suppression of the lochia and of the secretion of milk. This theory in one of its modifications rested upon the assumption that there was metastasis of these fluids. In popular belief these theories still hold a place. 'Those things,' or 'the milk flew to her head,' is an expression we sometimes hear. In its literal sense of course this theory has no place in science, but it contains an element of truth. Broussais[1] stated his opinion as follows: 'The insanity so common after labour does not arise under the influence of one organ alone; all are in a state of surexcitation; at this epoch so remarkable,

[1] *De l'irritation et de la folie*, 1839.

congestion is imminent for all the organs, and if the necessary evacuations are interrupted, a slight cause may fix itself upon the brain, as upon any other visceral apparatus, and this determining cause is often of a moral kind.' Thus this eminent author, accepting the prevalent humoral theory, sought in the complex conditions of gestation the solution of the problem, assigning, however, to congestion an active part.

As to the suspension of the lochia, it has been observed that sometimes the flow is prematurely suppressed, that sometimes it continues uninterrupted, and that not seldom the insanity breaks out after the flow has run its normal course. Much the same statement may be made as to the milk. But in the case of this secretion, there is greater difficulty in arriving at conclusions. When a woman becomes maniacal, she is rarely allowed to suckle, and so the milk dries up. Whether insanity dries up the milk or no, it is not easy to decide. We ourselves have seen a case in which insanity broke out a few days after labour whilst suckling; the child was taken from the mother, who was sent to an asylum. There she stayed two months, came out well, and resumed the care of her infant, when the milk came back abundantly.

Insanity in suckling women.—Insanity begun during gestation or puerpery may be continued into the period of lactation. But it may originate after puerpery. The proportion of cases commencing at this period are not nearly so frequent as those of puerperal origin. This may be partly explained by the consideration that women predisposed to insanity will succumb under the trial of gestation, labour, and puerpery, and that emerging safe from that ordeal, they will have proved at least comparative soundness.

Generally speaking the causes of insanity during lactation are the same as those which act during gestation and puerpery. But there are special conditions which it is of practical moment to note.

All the cases of insanity which break out in lactation may be arranged in two classes: 1. Those which appear during the first six or seven weeks after labour. These are intermediate between the proper puerperal and the lactation cases. 2. Those cases which occur much later, that is, after eight, ten, or even twenty months of nursing, or within a few days after weaning.

It is rare to observe insanity originating during the intermediate period.

The most obvious factor in the production of insanity during prolonged lactation is anæmia and debility. In some cases we have known a complication with a new pregnancy, and in some the re-establishment of menstruation. These conditions importing fresh elements of nervous and vascular disturbance, seem to determine the outbreak. In many poor women, the struggle to support the suckling is rendered harder by lack of food and bad hygienic surroundings. If, in spite of anæmia, women persist in nursing, and sleeplessness supervene, disturbances of innervation or of nutrition soon arise, and render the system susceptible to morbific influences. Emaciation, pallor of the mucous membranes, languor of all the functions, are noted; and a special risk arises, pointed out by Nasse, that is, of softening of the cornea, just as happened to the dogs subjected to long starvation by Magendie. This condition ceased on weaning, and returned on suckling. Mr. Power tells us of a similar process, but thinks the starting point is a scratch upon the cornea.

In other patients, nervous symptoms predominate. Neuralgia, partial paralyses, contractions of the muscles, are met with, sometimes of tetanoid character. Acute dementia sometimes sets in, and catalepsy is not infrequent.

The effect of weaning.—In some cases timely weaning may arrest the insanity, or apparently obviate its outbreak. But in some cases insanity breaks out on, or soon after, the weaning. This may be explained, first, by the fact that weaning was enforced because the nervous system was evidently giving way; in these cases clearly the weaning is not the cause. Secondly, the milk has dried up under a sudden physical or emotional shock; here the insanity is due to the shock, which at the same time arrested the secretion of milk. Thirdly, in some cases insanity may break out some days after weaning, under conditions distinct from the two first described. Is there a special danger from the revulsion attending the sudden arrest of the milk secretion? Does this secretion act as an emunctory, and being checked, some deleterious element is left to work as an irritant to the nervous system? These questions are not easy to answer.

In a large proportion of cases it has been observed that insanity breaking out during lactation has not arrested the milk secretion.

Mania and melancholy occur in about equal proportions during lactation.

The *prognosis* is generally favourable. The duration of the illness may extend to some months, but is not seldom cured in a few days or weeks.

The treatment.—The first indication is clearly to stop the cause of exhaustion, to wean, then to regulate the secretions, to feed well, and to place the patient in the best conditions for quiet and health. Opiates, bromides, quinine, iron, will render signal service. Shower-baths are often useful.

Shall a woman who has recovered from insanity return to her husband?

If the insanity has been associated with uterine disease which has been cured, our experience is favourable to the renewal of conjugal relations. We have known subsequent pregnancies proceed happily.

On the question of marriage of women who have been insane, our experience, which upon this point is not inconsiderable, agrees with that of Savage, who says: 'It is satisfactory to know that we do see patients who have recovered from insanity marry and bear children with impunity; and I am inclined to think that we shall some day be able to point out certain varieties of mental disease that are scarcely more liable to return than are broken bones.'[1]

The responsibility of pregnant women and of women in labour and puerpery.—This is a medico-legal question, the discussion of which would lead us beyond the proper limits of this work. We can only state the chief points.

1. In the case of women who have been undoubtedly insane before the actual pregnancy, the presumption, *primâ facie*, is that any extravagant or criminal act she may commit, especially if inconsistent with her natural character, is done under the influence of insanity.

2. Since in the early stage of pregnancy it is not uncommon for women to be subject to passing hallucinations which may

[1] Some interesting illustrations of puerperal insanity have been published by Dr. A. Campbell Clark. *Lancet*, 1883.

influence their actions, it is quite probable that in this state they may do things for which they ought not to be held responsible. The temporary hallucinations, or illusions, or delirium of epileptics present an analogous condition.

3. The temporary delirium or aberration at the moment of delivery, when a woman is 'beside herself' with pain and emotions—under the control, in short, of the reflex nervous system—has always been held to be a condition during which she may commit acts for which it is difficult to prove her responsibility.

The English courts but rarely find any girl guilty of murder for infanticide soon after labour. The madness may be at most a temporary furor, a madness that exhausts itself in the impulsive commission of the crime.

We may fitly conclude this section on convulsive diseases with a few general observations.

To show how nearly an expulsive labour pain is allied to convulsion, observe the course of a pain towards the end of labour. A premonitory shudder (the forerunner of the storm), often a rigor, often vomiting, usher in the pain, just as we frequently observe before the outbreak of a fit of epilepsy. Women have told us that at this moment they felt sure they were on the verge of convulsion.

We have known several instances of an epileptic fit being repeatedly induced by the sexual act. Tyler Smith told us of one. Voisin mentions one. La Motte knew a woman who, not pregnant, always vomited *solâ actione coitûs.*

General Considerations.

We cannot fail to be struck with the common features of resemblance or of relationship between the different forms of convulsive disease which occur in pregnancy. In this comparison we ought to include the relationship of syncope, vertigo, migraine, apoplexy, paralysis, delirium, insanity. They often form links of one chain. Syncope and vertigo should be studied in their relations to epilepsy; apoplexy in its occasional relations to uræmic eclampsia; paralysis in its relations to apoplexy and epilepsy; and insanity in its relations to epilepsy, eclampsia, and chorea. All the convulsive diseases may culminate in mania or dementia.

What is it, then, that determines epilepsy in one case, vomiting in a second, chorea in a third, tetanus in a fourth, eclampsia in a fifth? We must invoke a peculiar antecedent condition of the nervous centres, probably unknown or unsuspected until it declares itself under the magical ordeal of gestation. This is illustrated by the history of chorea, which, we have shown, rarely, if ever, occurs *ab initio* in gestation, the subjects having had it in childhood; in epilepsy, in the subjects of which there can generally be traced hereditary proclivity or previous attacks. But the postulate of an antecedent condition is indisputably settled by the case of ague. We cannot conceive the possibility of ague being evolved out of the proper conditions of pregnancy; and we know that other conditions will act in reproducing ague.

Pathological exaggerations of physiological affections of the heart and other organs of circulation.

In tracing the normal history of gestation we have sketched the features which gestation impresses upon the blood, heart, and other organs of circulation. To that sketch we refer back, as the basis of what remains to be said concerning the phenomena resulting from pathological excess.

The blood may present an unusual degree of anæmia. There may be exaggerated leucocytosis, and even the condition called acute idiopathic or pernicious anæmia.

These are conditions favourable to serous effusions and œdema, and even to hæmorrhage.

Virchow combats the general opinion that chlorosis is due simply to alteration in the blood, urging that structural changes in the vascular apparatus are concerned;[1] and defends the proposition that the origin of inflammatory affections of the heart is determined by mechanical causes. He agrees with Raciborski, that chlorosis almost always leaves traces for the rest of life.

He frequently recognises in autopsies *recent* and *recurrent* endocarditis. He says they are easily misinterpreted clinically and set down as ordinary puerperal fever. These are commonly

[1] Virchow: *On Chlorosis and the Related Anomalies of the Vascular Apparatus, especially with Endocarditis Puerperalis.* 1872.

complicated with obvious diseases of the uterus and adnexa. So endocarditis is only a complication of the puerperal state. He affirms that there is a special predisposition to puerperal endocarditis in a peculiar defective formation of the vascular system. This is brought into play by gestation and puerpery. The altered nutritive processes of gestation, and still more of puerpery, increase this predisposition, and lead to the greatest development in the defective organs.

Embolic processes affect chiefly three organs: kidneys, spleen, retina; and the choroid and the joints.

The heart affections.—Under the influence of undue anæmia, and probably other factors, the chief of which are nervous tension and irritability, the hypertrophy of the heart may exceed the usual limits. Ollivier says,[1] if the irritation be carried beyond a certain point, inflammation of the myocardium may ensue, leading to fatty degeneration. He, however, cites Spiegelberg's case of sudden death three days after labour from *rupture of the left ventricle*, in consequence of acute myocarditis; there was considerable fatty degeneration. The heart, generally, was flaccid and brittle; the valves were sound.[2]

Ollivier further cites Danyau and Mordret as giving cases of myocarditis.

Fatty degeneration of the muscular fibres of the heart must not be taken as absolute proof of antecedent inflammation. In several instances of women dying suddenly during and after labour, we have observed fatty degeneration. This has been in women worn down by repeated pregnancies, and ill-nourished. It must be remembered that the normal excess of muscular tissue developed during gestation has to be removed by a process similar to that by which the involution of the uterus is effected. At any rate, this fatty change observed in subjects dying several days after labour must be regarded in relation to this process.

Endocarditis is sufficiently attested. It may, says De Lotz,

[1] *Archives générales de Médecine*, 1873.

[2] Robert Barnes saw at the Hôpital des Cliniques at Paris, under Dubois, a singular case of sudden death during defæcation from the rupture of a hydatid cyst in the wall of the aorta. It burst into the pericardium. The subject was an otherwise healthy primigravida expecting her labour.

be primitively chronic, or consequent upon acute or sub-acute endocarditis. Dr. Millard, cited by Ollivier, describes a case of simple acute endocarditis coming on towards the end of gestation, characterised by a rough systolic sound at the level of the apex, frequent pulse, at times irregular, and some dyspnœa. The symptoms subsided gradually, and in ten weeks had nearly disappeared. The very acute form was described by Simpson.

It is highly probable that in some cases there was albuminuria. The reception of noxious matter into the blood may determine the disease.

One cause of endocarditis may be puerperal rheumatism.[1]

As we have had occasion to repeat, *thrombosis and embolism* are especially diseases of low vascular tension attending the involution-process of childbed. All the forms are rare during gestation. The train may indeed be laid during gestation, but the explosion is deferred until after labour, when the waste stuff of disintegration of tissues is thrown into the circulation. We have, however, seen a few examples of so-called phlegmasia dolens during gestation; one especially marked case in a lady in the sixth month of gestation presenting all the characters of 'phlegmasia dolens.'

Embolism, when it occurs, is more likely to be the result of endocarditis started before the pregnancy; fibrin deposited on valves already affected may break up, give rise to emboli, and these may be carried to the lungs or to the brain. The left heart is the more frequent seat of this disease in gestation, the right in childbed. The subject is simply recorded here for classification. It will be fully described under the 'Diseases of Childbed, or Puerpery.' As has been shown at p. 416, it may lead to apoplexy and paralysis.

Pericarditis.—Ollivier has not seen primitive pericarditis during pregnancy, but there seems to be no improbability of its occurring.

Dr. Macdonald says:[2] 'The evils likely to arise from pregnancy in connection with cardiac lesions seem to be referable to two classes:—

[1] *See* Simpson, 1856.

[2] *The Bearings of Chronic Diseases of the Heart, Pregnancy, Parturition, and Childbed*, 1878.

'1. Destruction of that equilibrium of the circulation in heart-diseases which has been established by compensatory arrangements. This result seems intimately associated with the high vascular tension and coincident hypertrophy of the left heart, present during the latter months of pregnancy.

'2. Introduction of fresh inflammatory lesions upon the valves and endocardium of a heart already weakened by disease. These changes may either assume the type of ordinary plastic endocarditis or of ulcerative endocarditis.'

Ollivier affirms that the discovery of the modifications which the endocardium may undergo in gestation furnishes in some cases an explanation of the so-called *puerperal hemiplegia*. As a consequence of the progressive course of the valvular lesion, and of the distress in the circulation caused by the gravid womb, fibrinous deposits, vegetations, may be detached, forming embola, carried to the arterioles at the base of the brain. He relates a case in which there was no rheumatism, chorea, fever, or syphilis.

Robert Barnes has seen several cases of hypertrophy of the heart, apparently starting from gestation, end fatally soon after labour. They occurred in women approaching forty. The morbid process may be stated thus: The greater development of the uterus, and the necessity of maintaining the fœtus, demand greater cardiac force; hence hypertrophy, which has to be reduced by involution. In an enfeebled system, involution is impeded; fatty degeneration remains, and the patient dies of heart-disease. This is more especially likely to happen if the first pregnancy occur at an advanced period of life, when the system is unequal to those sudden impulses of evolution and involution, those active processes of nutrition and atrophy, which are inseparable from gestation.

Simple goître.—One of the most interesting consequences of hypertrophy of the heart is the hypertrophy of the *thyroid gland*, or *goître*. This probably differs in kind, as it certainly does in origin, from the goître of mountainous districts. Laycock found goître much more common in women than in men —that is, there were but twenty-six men out of 551 cases.

J. L. Petit (1740) recognised the influences of menstruation, pregnancy and labour, and puerpery in causing goître. In the case of his wife, Petit observed that the affection may persist and increase in succeeding pregnancies, and that the gland may inflame and suppurate.

Dr. E. W. Jenks [1] has written an excellent history of this subject, to which we refer for fuller information than can be given here.

Of late years the relation between pregnancy and goître has been generally recognised. We ourselves have seen, and have under actual observation, several striking examples. Guillot (1850) wrote a valuable memoir, and Ollivier (1873) described it carefully. He says it usually appears about the third or fourth month of gestation. He describes one form as sub-acute and temporary; this never causes distress on breathing, is not subject to pulsation, and is therein distinguished from the vascular or exophthalmic goître. It disappears after labour. In a second form, the goître may develop rapidly, and cause serious distress. Tarnier relates a case in which symptoms so threatening came on that labour had to be induced. Tarnier admits that the enlargement diminishes somewhat after delivery, but that it rarely disappears entirely. This is completely verified by our own experience. The hypertrophy once started, the consequences are hardly ever completely obliterated.

Goître may develop *slowly during gestation*. In this case the hypertrophy is explained by the high vascular tension maintaining engorgement of the vessels of the gland. It may be developed *rapidly under the effort of labour*. Independently of gestation, violent muscular exertion has been known to cause goître. Dr. Luton [2] gives examples of this influence. Under the straining of labour, no doubt the pressure upon the thyroid vessels is greatly increased. May not this reception of a large volume of blood, serving as a diverticulum, exert a conservative influence by sparing the brain?

The swelling, tension, and distress of the enlarged thyroid undergo marked exacerbation at every menstruation. In one case, under our observation for many months, this periodical swelling was very marked. The tumour almost disappeared when dysmenorrhœa depending upon atresia of the os externum

[1] 'The Relations of Goitre to Pregnancy and Derangements of the Generative Organs of Women.' *Amer. Journ. of Obst.* 1881.

[2] *Nouveau Dictionnaire de Méd. et de Chir.*

uteri was cured by enlarging the os by incision, aided by appropriate general treatment.

In connection with this disease, Graves enunciates a theory of *globus hystericus* which deserves attention. He connects this sensation with a temporary enlargement of the thyroid attending palpitation. This sensation, he says, only continues whilst the paroxysm of palpitation lasts. The lump in the throat which the subjects complain of is often referred exactly to the seat of the thyroid.

Macdonald advises that *marriage* be forbidden to persons having chronic heart-disease, especially stenosis of the mitral valve, or serious aortic incompetency. Dyspnœa, hæmoptysis, palpitation on exertion, are contra-indications.

Lactation and over-exertion should be forbidden to subjects of such disease.

Exophthalmic goître.—Sometimes called Graves' disease, and Basedow's disease. The title of Basedow to give the disease a name falls before the antecedent claim of Graves. Parry before 1825 described the connection between enlargement of the heart and enlargement of the thyroid. Graves[1] stated the following conclusions:—That under certain circumstances the action of the heart may become permanently excited, as shown by its rapidity, irregularity of action, and increased force; and that this state is attended with three remarkable epiphenomena: first, turgescence of the thyroid gland; secondly, increased action of the arteries of the neck; and, thirdly, the enlargement of the eyeballs; and that it is most commonly observed in females, associated with hysteria, neuralgia, or uterine disturbance. The case could not be more truly or concisely stated. The increased action of the heart, postulated, obtains in a marked manner in gestation, under which state a large proportion of cases arise.

Attendant upon the hypertrophy of the thyroid gland, it is not uncommon to observe the development of exophthalmos. The two conditions undoubtedly own a common origin. Both start from the high vascular tension of gestation exaggerated by undue hypertrophy or irritability of the heart. The first symptoms are palpitation, a rapid pulse, often 140, then nervous debility. These are followed by enlargement and pulsation of

[1] *Diseases of the Heart*, 1854.

the thyroid gland, violent beating of the carotids, and, lastly, projection of the eyeballs. This last condition is sometimes painfully striking, suggesting a likeness to the pedunculated eyes of some crustacea.

The thyroid gives sometimes a vibratory thrill to the touch, and a musical sound may be heard by the stethoscope.

The theories of etiology may be classed as nervous and vascular. Both systems are undoubtedly concerned, and it is difficult to assign priority or predominance to one or the other. The immediate cause is assuredly in the vascular system which brings the blood, the *sine quâ non* of hypertrophy, to the gland. But there may be in most cases a precedent condition of the nervous system, which impels the heart to drive the blood with undue force. If the nervous system then acts first, it acts through the medium of the vascular system; thus the nerves may initiate and keep up a trophic action. The essential part played by the vascular system is demonstrated by the important observation of Warburton Begbie,[1] who says that albuminuria is almost always concomitant with exophthalmic goître, and that it is met with not only in the advanced period of the disease, when the heart is disturbed in its function, but almost at the very beginning of the attack. George Johnson has observed the same relation. Alexander Robertson, Morell Mackenzie, and Meynert have each related a case in which insanity ensued upon exophthalmic goître.

The structure of the goître is sometimes that of simple hypertrophy of the natural tissues; sometimes cysts are formed in the gland. These may be the result of absorption of apoplectic effusions. In another form, described as *vascular*, the arteries are greatly dilated and sinuous; the veins are swollen. Cornil says the vessels exhibit sac-like dilatations.

A swelling doubtfully classed here is the *emphysematous goître* of Larrey, the *air or pneumo-guttural goître*. This is formed at the front of the neck, especially at the sides of the larynx. It sometimes attains a considerable size. Heidenreich cites several cases. The swelling is not strictly in the thyroid. We have ourselves seen some remarkable examples. They occurred under the violent throes of the expulsive stage of labour, one in particular under the influence of ergot.

[1] *Edinb. Med. Journ.* 1870.

The treatment.—The disease once started is likely to go on if the causes persist. It must therefore be an anxious question whether a woman in whom the disease has made progress during gestation should be allowed to nurse her child. During the growth the most rational prospect of checking it is based upon moderating the action of the heart and improving the quality of the blood. To this end, digitalis, bromides, and iron are indicated. We can attest their value. In the chronic state, iodine and iron are useful. If the tumour is large and firm, injections of ergotine or iodine and galvanism have given good results. In the cystic form, aspiration or hair-setons to drain the cysts and excite adhesive inflammation may be tried. Morell Mackenzie has cured many cases by injecting ferric chloride. When dyspnœa is distressing, and especially if asphyxia threaten, Duncan Gibb proposed to liberate the pressure on the larynx by dividing the isthmus. Recently Mr. Sydney Jones[1] advocated excision of the isthmus, and described a successful case. The operation was followed by atrophy of the gland substances. This proceeding will certainly supersede the dangerous one of total extirpation of the gland.

Phlebectasis, varicose veins, hæmorrhoids.—This subject has been systematically described by Briquet[2] and by Budin.[3] Varices are noted in, 1, the lower extremities, 2, the external and internal genital organs, 3, the anus and rectum, 4, the urethra and bladder, 5, on the trunk.

1. Phlebectasis of the *lower limbs* may affect the *superficial veins* and the *deep veins*. The veins may be simply enlarged, or dilated with thickening, or dilated unequally; and there may be the changes in related veins called venosity. In the simple dilatation and the dilatation with thickening, the calibre is increased, but the form of the vein remains cylindrical. In the third form there is lengthening and flexuosity, the vein may acquire two or three times its natural length, and its coats alter; the middle membrane is thinned in parts, in others thickened. This produces projections into the cavity of the vein. Varicose bulgings are formed resembling

[1] *Trans. of Clinical Soc.* 1883.
[2] *Mémoire sur la phlébectasie*, *Arch. de Méd.* 1825.
[3] *Des varices chez la femme enceinte*, *Thèse de Concours*, 1880.

aneurismal sacs. These dilatations are formed above or below the valvules. Sometimes the valvules are folded back, even torn. It is obvious that the proper function of veins so affected is impaired. The circulation is impeded. Thrombosis is favoured. Cornil has shown that new connective tissue is found in the veins, and venous sinuses result.

In the case of large varices, the surrounding tissues are thickened, lardaceous, and in places the appearance is as if the thinned compressible walls are tunnelled out of the hardened tissues.

The chief seats of the superficial varices, are the level of the internal saphena; sometimes the course of the external saphena; the internal aspect of the thigh. Œdema is not a constant attendant.

Phlebectasis may affect the deep veins of the leg, the *venæ comites*. A symptom of this, says Verneuil, is severe pain in the sole of the foot. This sign should never be neglected. It comes on in the upright posture, and subsides on lying down. The pain may be explained by the pressure upon the nerves. Verneuil also calls attention to a sign common in varicose subjects. The varicose limbs are the seat of permanent moisture and free epidermic desquamation.

Causes.—Varices may develop during the first pregnancy, and even during the early months; but they are more frequent in pluriparæ, and often more developed in the later months. They have been attributed to pressure of the gravid uterus, a condition so often invoked to explain many diverse phenomena of gestation. Since varices may arise very early in gestation, and even under the influence of menstruation, pressure cannot be an essential cause. They, moreover, are rare in the case of even large ovarian cysts, as Kiwisch pointed out. At least three factors concur: 1, increased volume of circulating blood; 2, increased arterial tension; 3, increased nervous tension. Under the increased pressure the weaker vessels give way, especially those in which the centripetal current is liable to retardation, as is the case with the veins of the inferior extremity, under the influence of gravitation. Kiwisch attributes considerable influence to the 'serous blood-crasis' of gestation.

Ulcerations occur but rarely in pregnant women. Erysipelas occurs now and then. Ulceration may eat through the vein and *permit hæmorrhage* difficult to repress, and even fatal. Murat relates a case. Robert Barnes attests another. Bryant records a case in which a varix burst subcutaneously, forming a large swelling inside the thigh. It was absorbed.

Thrombosis and phlebitis do not frequently occur during gestation. But thromboses do sometimes form in the course of the varicose vein. Waldeyer, Cornil and Ranvier, against the statement of Virchow, contend that the clot does not become organised, but that the changes observed are the result of modifications in the wall of the vein. Sometimes inflammation and suppuration take place in the seat of the thrombosis. Blot has described a spontaneous radical cure as arising in two cases from this process.

Treatment. Women affected with large or tortuous varices cannot without risk undergo severe exertion. Equable compression by well-made and well-adjusted stockings or rollers is useful in supporting the yielding coats of the vessels; and from time to time relief must be sought in the horizontal posture. It is proper to note that some cases have been recorded in which compression of the veins seemed to provoke abortion and other troubles. Not ignoring these cases, we cannot think them so weighty as to call for the neglect of a treatment undoubtedly of great service in many cases.

Martin and Spiegelberg advised to attempt the radical cure by the subcutaneous injection of ergot near the varices. The method is painful, not without danger, and its efficacy is doubtful, since it is necessary to combine with it rest. In the event of varices assuming great size and threatening to burst, it may be wise to ligate them.

2. *Varices of the vulva and vagina.*—These form especially in the labia majora; sometimes forming large convoluted brain-like masses projecting visibly, sometimes on one side, sometimes on both. Varices not uncommonly form in the vagina as well, presenting deep violet convolutions. In one case reported by Robert Barnes a mass projected beyond the vulva, which the woman took to be the child's foot. She was delivered without accident. The veins subsided.

Then varices may burst and give rise to serious hæmorrhage. Simpson, (J. Y.) reports a fatal example. Tarnier relates one, the result of a blow on the vulva. Simpson relates a case which nearly proved fatal from coitus. Hæmorrhage from rupture of varices in the vagina has occurred during labour.

Hæmorrhage may also take place from the clitoris under injury. If the rupture take place beneath the mucous membrane, which itself is not wounded, blood collects in the connective tissues, forming a *thrombus*. This condition will be more particularly described in tracing the history of 'hæmorrhage.'

In the event of hæmorrhage from bursting of vaginal varices during pregnancy, plugging offers the best results.

Varices also form in the *cervix uteri*: these will be described under 'Hæmorrhage.'

Varices in the broad ligaments.—The utero-ovarian plexus sometimes undergoes great tortuosity under the influence of menstruation simply; and the over-distended vessels may even burst; constituting one form of retro-uterine hæmatocele. This varicosity is still more frequent and considerable under the influence of gestation; and may also be the source of retro-uterine hæmatocele during gestation. This was probably the case in the observation referred to in a subsequent page. In early pregnancy this varicose state of the utero-ovarian plexus can sometimes be made out by touch by the rectum.

Varices of the round ligaments were noticed by Haller. They occur at the root of the veins of this ligament. Sappey explains their origin as the result of the compression which the large veins experience in carrying the blood on to the heart.

3. *Varices of the anus and rectum. Hæmorrhoids*.—These come under observation during gestation and labour. When they occur during gestation, Budin affirms, from close inquiry, that it is in most cases after attacks of constipation. We are inclined to think that he underrates the influence of the high vascular tension and the general engorgement of the pelvic vessels so characteristic of gestation. One might *à priori* expect that the hæmorrhoidal veins, which are so apt to become varicose even in the non-pregnant, would become so under the great and rapid vascular turgescence of gestation. And this we believe is the case. Piles more or less distressing are very common even amongst primigravidæ. The influence

of constipation, however, is very great. Duret describes a system of *derivative veins* which carry off the excess of blood from the proper hæmorrhoidal veins when under pressure. Thus, he says, during normal defecation the blood is retained in the hæmorrhoidal vessels—these become turgescent; but at the moment when the sphincter relaxes to let the fæcal mass pass, the blood, submitted to high pressure, runs away quickly by the canals of derivation into the external hæmorrhoidal veins, and thence into the system of the vena cava inferior. On the other hand, when the subjects are constipated, it is not only because the fæcal matters compress the vessels of the rectum that hæmorrhoids are produced, but especially because the unhappy patients make violent efforts, and these efforts bring about in the vena cava, and especially in the internal hæmorrhoidal veins, a considerable distension of the venous walls. Moreover, since most frequently the straining efforts are abortive, the sphincter does not dilate, the canals of derivation are imperfectly opened, and thus the stagnation of the blood in the internal hæmorrhoidal veins is increased; and this particularly in their network and ampullæ. Fordyce Barker says diarrhœa has the like effect. Attacks of diarrhœa and tenesmus provoking frequent straining may bring the same mechanism into action.

Piles occasion serious distress during pregnancy. Sometimes they bleed to a serious extent. Fatal cases are reported.

It is convenient in this place to complete the history of hæmorrhoids by describing briefly the *influence of labour*. At the moment of labour, hæmorrhoids are frequently seen starting from the anal orifice. A series of conditions favourable to the production or aggravation of hæmorrhoids come into action. The head driven down presses upon the walls of the rectum and the walls of the pelvis so as to greatly retard the circulation and dilate the hæmorrhoidal vessels. This dilatation is increased under the expulsive efforts. When the fœtal head distends the perinæum there is direct pressure upon the hæmorrhoidal veins; there is even complete opening of the anus, so that the rectal mucous membrane is exposed, and the dilated veins are seen sometimes as true ampullæ gorged with blood as if ready to burst.

Treatment.—Immediately after labour the hæmorrhoids may return into the rectum; but in not a few cases it may be some days before the return is effected; and during their retention outside there is usually a degree of strangulation, with swelling and pain.

In the event of laceration of the perinæum during labour threatening to involve large hæmorrhoidal vessels, an incision of the perinæum on one side should be made.

The necessity of avoiding constipation is universally recognised. During gestation we have found nothing superior to the compound liquorice powder of the German Pharmacopœia. It should be taken regularly, so as to cultivate and keep up the habit of daily relief. Fordyce Barker earnestly cautions against the use of castor-oil, insisting that it promotes the formation of piles. Acting on his advice we have never given it of late years; but it is possible that the greater care lately brought to bear on the preparation of the oil may have deprived it of its irritating properties. The watery extract of aloes with belladonna is a most useful aperient. We cannot speak favourably of the mineral waters so much in fashion. But they are sometimes useful in accelerating the action of the other medicines specified.

In case of great turgescence, with strangulation of piles, leeches have been resorted to. We have arrived at the conclusion that leeches should be discarded. They are unintelligent animals, refusing sometimes to bite when desired; the quantity of blood drawn is uncertain; and they may be unclean animals, possibly sources of infection. Scarification with a clean lancet is in every way to be preferred. The lancet does exactly what is wanted, and in the best and safest way. Barker advises forcible stretching of the anus under anæsthesia after the expulsion of the child, to facilitate the reduction of protruding hæmorrhoids.

4. *Varices of the urethra and bladder* sometimes occur. They have been carefully described by Winckel and by Skene.

5. *Varices of the trunk.*— Occasionally varicosities are observed near the breasts, and on the abdominal walls and gluteal regions.

In conclusion, it is well to bear in mind the common conditions which reign over all the forms of phlebectasis: the increase of the blood-mass, the high nervous and vascular tension, the general tendency to venous and capillary turgescence. We must seek in this relation for the guide in treatment. Salines, sedatives, digitalis, bromides, and gentle aperients will almost always be useful; and in severe cases venesection should be resorted to. This remedy is of supreme efficacy in lowering vascular tension, and thus in taking off injurious or dangerous pressure.

Progressive pernicious anæmia.—A clear case of this dire disease has been related by J. J. Bischoff.[1] In a young woman, badly nourished, very soon after conception severe pains came on in the abdomen; she fell off in strength; some hæmorrhage occurred, excessively offensive. At the end of a month she presented the aspect of intense anæmia; there was œdema of the legs; pulse 96, temperature 38·2° C.; breath very offensive; sullen behaviour. Remains of ovum removed from fornix vaginæ. Then swelling, loosening, and infiltration of the gums followed, with some bleeding from the mouth. Vomiting, failure of digestion. There was no enlargement of spleen, no rigor, or such rise of temperature as would suggest septicæmia; and the loss of blood was too small to account for the anæmia. She sank about six weeks after the presumed date of impregnation. Autopsy showed œdema of lungs; numerous punctiform ecchymoses in both ventricles; the left heart contained a very little thin pale-red blood, with pale-red clots; same in right heart; the heart was enlarged; some fat-spots. Kidneys extremely anæmic; spleen not enlarged. All the appearances ended in those of extreme anæmia, justifying the conclusion that an antecedent oligocythæmia, which caused little distress in ordinary conditions, proved pernicious under the first trial which the organism had to endure.

Leucocythemia is an affection of the blood which is apt to arise under gestation. The principal features are fairly represented in the summary of three cases narrated by R. Paterson.[2] Two were primigravidæ; vomiting was excessive in the early months; towards term there was increasing sallowness or yellowness of the skin; no bile in the urine; then came enlargement of the liver and spleen, then swellings of the glands of the neck, rising pulse, hectic. The labours were

[1] *Correspondenz-Blatt für Schweiz. Aerzte,* 1879.
[2] *Edin. Med. Journ.* 1870.

natural, children alive, robust; great hæmorrhage followed A few days later rapid change for the worse set in; the skin was hot and tawny; the enlargement of the spleen, liver, and lymphatics greatly increased. Death occurred in the two primiparæ from asphyxia, due to swelling of the glands of the neck. Red globules were as one-fourth of leucocytes. Paterson cautions to look out during pregnancy for the sallow skin and enlargement of the spleen and liver, and to examine the blood by microscope.

The lungs.—Asthma is liable to great aggravation under the trial of gestation and labour.

Hæmorrhages.

From the alterations in the blood and in the circulating organs to hæmorrhage the transition is natural and easy. Under high arterial tension and capillary congestion the blood breaks bounds. The more commonly described hæmorrhages of gestation, those which are associated with the ovum and uterus especially, will be described in a distinct chapter. The hæmorrhages we now enumerate are those which break out in other parts of the body, remote from the seat of gestation. These may be classed as—(1) hæmorrhage from mucous membranes; (2) from the skin; (3) into serous cavities; (4) into the tissue or substance of organs, as the brain, eye, lungs, kidney, liver, spleen.

Hæmorrhages on the surface of mucous membranes are at once the most common and the least hurtful. As Trousseau remarked, all physiological hæmorrhages take place from mucous membranes. Extending this dictum, we may affirm that many of the hæmorrhages observed in the course of gestation have a direct physiological purpose; that if they break out on mucous surfaces, they are for the most part conservative in their tendency, reproaching the physician who has abjured the lancet; that if they break out in serous cavities, or in the structure of organs, the design is not the less conservative, but from *error loci* is too apt to be injurious, or even fatal.

We have seen many instances of hæmorrhage from the *alimentary canal* during gestation, either by vomiting, in the form of melæna, or of florid blood by the rectum. Hæmorrhoids not uncommonly bleed at this period. But we refer to cases in which the blood was traced to a higher part of the alimentary tract. Sometimes the loss has been considerable, producing deep anæmia. We have also seen cases of effusion into the *bladder*; and the liability to hæmorrhage from the kidney in the præalbuminuric and albuminuric conditions has been already pointed out.

Hæmorrhage into the bronchi and smaller bronchial tubes is not uncommon. Such cases naturally excite serious alarm. Hæmoptysis is almost another expression for phthisis. But we have notes of several cases in which very free hæmoptysis recurred in successive pregnancies, ceasing with the pregnancy. One case may be specially cited. We saw a young lady in May 1872, then six months pregnant for the first time. Hæmoptysis began at this time; she had blood in the mouth every morning; it was frothy and florid. There was some increase of intensity of the respiratory sounds in both lungs, no expiratory murmur; palpitation, slight anæmic souffle; the hands and feet swelled. Under digitalis this subsided a little, but not completely until delivery. She has had four children since, and the same symptoms recurred each time. During gestation the sphygmographic tracing showed unusually high tension. She is now, after ten years, quite strong, showing no indication of phthisis.

Bleeding from the nose is not very uncommon.

Subconjunctival hæmorrhages are not rare. We do not remember to have seen bleeding from the free surface of the conjunctiva; the seat is in the conjunctival layers or in the subjacent connective tissue.

To this order of hæmorrhages strictly belong effusions from the mucous membrane of the upper part of the vagina and the cervix uteri. This region is not only subject to the general vascular tension which prevails throughout the system, but is directly within the area of the special blood-attraction, of which the developmental focus is the uterus. But these hæmorrhages will be more particularly described in connection with abortion and the uterine hæmorrhages of gestation.

It is worthy of remark that similar hæmorrhages from mucous membranes are observed under the analogous condition of menstruation.

Thus Nature points the way by which undue vascular tension may be relieved. These hæmorrhages act for the most part as safe regulators of the dynamic machinery of the circulation. Failing this, or equivalent modes of regulation, there is imminent danger of internal hæmorrhages or of other catastrophes.

Hæmorrhage from the *skin* has been observed in the form of oozing; but more frequently from the bursting of varicose veins.

Hæmorrhage in the form of *purpura hæmorrhagica* occurs when small-pox complicates gestation.

Hæmorrhage into *serous cavities*. We do not call to mind examples of hæmorrhage into the pericardium or pleuræ, but we have known considerable effusions take place into the peritoneum. The source of the blood has been the utero-ovarian plexuses, which give way just as a varicose vein may under high tension suddenly exaggerated. In one case an effusion took place rapidly about the seventh month of gestation; it became encysted, and the gestation went on to term. When labour came on, a firm tumour behind the lower segment of the uterus obstructed the head; presently a large compressed clot was expelled through an opening in the roof of the vagina. This roof had yielded under the expulsive efforts of labour. The woman made a good recovery.

Bernutz relates a case of *hæmorrhage into the peritoneum* attending acute jaundice in a pregnant woman. The hæmorrhagic tendency of this dire disease will be dwelt upon further on.

Hæmorrhage from the bursting of a tubal or other ectopic gestation-sac hardly comes under consideration here.

Hæmorrhage into the *serous cavity of the brain*. Although this may occur independently of albuminuria, this connection is especially to be considered. We refer to the section on Albuminuria and Apoplexy.

Pulmonary apoplexy.—Under similar conditions, effusions of blood may take place into the substance of the lungs. Probably in some cases the first effusion is into the smaller bronchial tubes and air-cells; but these are broken down, and then the blood invades the parenchyma of the lungs. We have seen this in cases where there was no suspicion of tubercular mischief; but in other cases there was chronic lung-disease.

Placental apoplexy, which offers points of analogy with lung-apoplexy, will be noticed under Diseases of the Placenta.

Hæmorrhages into the parenchyma of organs.—The propositions just stated regarding blood-effusions into the serous cavity of the encephalon apply, perhaps, *à fortiori*, to hæmorrhage into the substance of the brain. Still, a certain proportion of cases are associated with embolism. It is true that thrombosis and embolism are especially *post-partum* affections. Simple hæmorrhages analogous to those which we have seen to occur from mucous and serous surfaces are more characteristic of the quality of the blood and of the dynamics of the circulation obtaining in pregnancy. This hæmorrhage into the brain-substance may occur :—

1. Under an excess of the ordinary high tension during gestation. We have seen fatal apoplexy thus caused at three months.

2. Under the temporary strain of the expulsive stage of labour.

3. Under a complication of hypertrophy of the heart, or of other affections modifying the quality of the blood or the dynamics of the circulation.

Serous or watery discharges.—During gestation it is not uncommon to observe watery discharges from the vagina. These mostly come from the cervix uteri, some from the decidual cavity probably; and in the advanced stages of gestation they may be the result of oozing through, or rupture of, the membranes of the ovum. These discharges are commonly spoken of under the name '*hydrorrhœa gravidarum.*' The hypertrophied glands of the cervix may throw off a considerable quantity of watery fluid in a short time. Without entering upon a critical discussion of the several theories offered in explanation, we will briefly state that the three sources named above seem to be well established :—

1. *The discharge from the cervical canal.*—In one case under our close observation, hydrorrhœa, to the extent of a pint or more daily, occurred during the three latter months of gestation. This certainly came from the cervix. Other cases in non-pregnant women afford proof that the cervical glands may secrete large quantities of watery fluid, and that there is generally no necessity to seek higher up for the source. This cervical secretion is analogous to the salivation and pyrosis of pregnancy. The entire glandular system is more active in

pregnancy, and the glands of the cervix uteri are especially developed, besides being within the range of high vascular activity.

2. *The decidual origin.*—Dubois says hydrorrhœa is the result of loosening of the membranes from the uterus, when the vessels pour out serum. This theory probably holds good in some cases of hydrorrhœa in the latter months. But in the earlier months we believe the view of Hegar[1] is truer. This observer describes the glands of the mucous membrane as being found in the decidua at the sixth month of gestation, and argues that their sudden disappearance in the subsequent months is improbable. In a case of hydrorrhœa he found in the decidua vera, at the beginning of the eighth month, an enormously developed glandular body. At the bottom of this morbid growth was a general hypertrophic condition of the decidua and its glands. These gave out the excessive secretions. In a case related by Graef,[2] the patient suffered during the last three months from repeated watery discharges, the uterus rising and falling with the gathering and escape of the fluid. The membranes were found without rent. He regarded it as a case of catarrhal hydrorrhœa.

In the above cases, 1 and 2, the fluid differs from liquor amnii.

3. Fluid escaping from *the amniotic sac.* We have stated that under pressure fluid may *transude* through the membranes. Certain it is that in many cases of free hydrorrhœa, which could not be referred to the cervical glands as the source, the membranes remained intact; and it is in strict accordance with hydrostatic laws that membranes permit of this rapid oozing. In some cases another explanation is at hand. The amnion may form under the chorion several layers, leaving spaces between filled with serous fluid. The outermost may burst, yielding their contents, the inner layer of the amnion remaining intact until labour. Preparations in most museums exhibit this laminated structure of the amnion. And again, in some cases the entire membranes may really burst prematurely, and yet labour may not ensue directly.

4. The fluid may come from *hydatidiform degeneration of the ovum.*

[1] *Monatsschr. f. Geburtskunde*, 1863. [2] *Jenaische Zeitschrift*, 1865.

5. From *cauliflower excrescence* of the vaginal-portion.

These discharges may be very puzzling. They raise suspicion of abortion or labour. The doctor is sent for, urged by the plea that 'the waters have broke.' If, on examination, he find the os uteri closed, or but little open, he may procrastinate; and still more so if by ballottement he find the child still floats in the uterus, and there be no active pains, he may usually go home and wait in peace for another summons. An examination should in all cases be made.

The '*hydrorrhœa puerperarum*' will be described in the proper place.

Serous metrorrhœa.—Chassinat[1] refers, under title, to a discharge of thin transparent yellow fluid at an earlier or advanced period of gestation. Ruysch, Röderer, and Dance thought it due to rupture of lymphatic vessels, or of hydatids of the uterine neck or fundus; Stuart, Böhmer, and Sigwart thought it escaped from a second abortive ovum; Delamotte and Cruveilhier from a cyst near the ovum; Caseaux from the space between amnion and chorion; Astruc, Deleurye, Puzos, Gregorini, P. Dubois, Devilliers *neveu*, and Nägelè from the inner surface of the uterus, that it is secreted externally to the ovum. Dubois says this hydrometra is the result of loosening of membranes from the uterus, when vessels pour out serum.

The quantity is usually greater than that of the liquor amnii; it is odourless, and like blood-serum, or like serous effusions in peritoneal sacs. The appearance is not adverse to continuance of pregnancy.

Disorders of the Alimentary Canal.

We may first complete the history of the 'watery discharges' by referring to the cognate discharges from the alimentary canal. To begin with *salivation*. The salivary glands are often conspicuous for their activity amongst the other glands which exhibit an excess of energy during gestation. Some increase of saliva is common. But occasionally these glands seem to be inordinately excited, becoming a focus of secreting energy. When once an action of this kind is set up in a particular part of the secreting apparatus, a concen-

[1] R. Chassinat, *Gaz. de Paris*, 1858; *M. f. G.* June 1860.

tration of energy seems to be determined to it, so that the process acquires force and permanency. The quantity of fluid thus discharged is at times very serious, enough to affect the system. In moderate amounts it may be regarded as a natural derivative and evacuant, regulating the blood-mass, and thus the nerve and vascular tension. But like so many other natural processes in pregnancy, the equilibrium is easily lost. A lady came to consult us, holding under her shawl a pint mug as well as a supply of handkerchiefs. These were in constant requisition. She assured us that she filled the pint mug several times a day. The parotid and submaxillary glands were swollen and tender. She was much emaciated and anæmic. She was about five months pregnant. She had been under steady treatment in Birmingham without effect, and we were hardly more successful. The remedies tried were opiates, bismuth, kino, and other astringents, borax, chlorate of potash, belladonna.

The fluid discharged as saliva may come partly from the pancreas and stomach.

The salivation of pregnancy differs from mercurial ptyalism by the absence of the fœtor. The buccal mucous membrane is sometimes tumid and congested. The gums are rarely sore, spongy, or ulcerated.

Dewees relieved a case by strictly animal diet.

One principle of action is to set up a derivative flux, as by hydragogue cathartics. Creasote lotion has been useful.

Pyrosis.—Sometimes the *secreting energy falls upon the glands of the stomach.* This seat is determined probably by the nervous action which sets up vomiting. More or less serous mucus is almost constant under the influence of vomiting. But sometimes the quantity thrown off is very great, amounting to two or three pints or more a day. The subject is discussed as an attendant upon vomiting, and need only be mentioned here for the sake of classification.

Diarrhœa.—Sometimes the current of nerve and vascular energy is directed to the intestinal canal; and we have watery diarrhœa. This may in some cases be caused by irritant matter, under epidemic influences, or as the result of cold. It may be due to septicæmia, as when it attends incoercible vomiting. But in a certain number of instances the flux is of a physiological character in its origin.

These watery discharges, whether from the uterus, stomach, or intestinal canal, occur in obedience to the same laws as those which in other cases determine hæmorrhages. In moderation they regulate nervous and vascular tension; in excess they assume the character and entail the danger of disease. They may so far exhaust the strength as to make it necessary to consider the question of inducing labour. In our experience they rarely provoke abortion. Remedies that lower nervous and vascular tension, as digitalis, belladonna, bromides, may be tried. Bismuth, lead, opium, ipecacuanha are occasionally serviceable, and we are often reduced to empirical treatment. Before resorting to the induction of labour, Copeman's method of dilating the cervix uteri should be tried; we have found it efficacious.

Constipation.—Apart from the disorders of the alimentary canal marked by discharges, we have to consider *constipation*, that troublesome attendant upon gestation. This is emphatically a disorder which should be counteracted by early care, if not anticipated. By exercise, diet, and mild aperients, enemata if necessary, the daily habit of relief may be secured, and much evil may thus be avoided.

Affections of the liver.

These affections, although imperfectly understood, occupy a prominent place in the pathology of gestation. We have seen that Tarnier describes a peculiar form of fatty change as a normal condition. This condition, which we ourselves have verified, differs so greatly from the ordinary condition of health, that, under any accidental increment of work, the boundary-line between physiology and pathology is easily passed. And the additional work thrown upon the liver is enormous. Excessive taxation of the functional capacity of the liver may result in disturbance of its great recognised duties. 1. The secretion of bile; 2, the glycogenic function; 3, the excretion of cholesterine.

Robin recognised two distinct parts in the liver, namely, a biliary organ and a glycogenic organ. Austin Flint[1] has proved experimentally the work of the liver in excreting cholesterine. It is probable that no one of these functions can be greatly disturbed without entailing disturbance in the rest. But it is necessary to study each separately.

1. The *biliary function.* This is the most frequently and the most easily noticed disturbance. We may note two principal forms: First, *simple jaundice*; second, *malignant jaundice*, so-called, that associated with acute yellow atrophy of the liver. The first is essentially functional; the second depends upon organic disease.

2. The *glycogenic function.* In like manner the glycogenic function presents two principal forms: first, *simple excessive formation of sugar or glucose*, showing itself in the urine second, a form in which the physiological balance is completely overthrown, and there is developed a condition analogous to severe *diabetes mellitus.*

3. The *cholesterine excretion* probably is liable to obstruction in various degrees. In the slighter, recovery takes place either by the liver pulling through its work, or by compensatory work by other organs. In the severer forms the system may break down under the variety of toxæmia which Flint calls cholesteræmia.

It is hardly possible to imagine the liver struggling alone. All the secreting and excreting organs act in solidarity. So when the liver is oppressed, the kidneys especially feel the blow and suffer. Thus the blood-changes wrought by the liver disorder are complicated with changes due to defective or faulty action of the kidneys.

Simple jaundice of pregnancy.—This can be best illustrated by a typical case. A young lady, L. H., became pregnant immediately after marriage, and soon suffered much from vomiting. She had occasional bilious attacks, attended by constipation, pain in the right side, and sudden icteric suffusion of the skin, languor, depression, headache; icteric urine, no albumen. These attacks were always relieved by more moderate diet and saline purgation. The icteric tinge always remained more or less marked from an early period of gestation. Labour was effected normally on the 273rd day after marriage. Child alive,

[1] *Physiology.*

healthy, showing no icteric symptoms. Lactation was also carried out healthily. On the tenth day after labour a free eruption of urticaria broke out, covering the trunk, arms, and legs. It disappeared in three days. This lady made a perfect recovery, and has had several children without complication. Here there was only functional disturbance of the liver. Ficinus[1] gives a case in which jaundice recurred in four successive pregnancies.

Another case exhibits the disorder in a different form. A young lady, A. C., had an abortion shortly after marriage. In her second pregnancy she suffered much from vomiting during the first five or six months. During the seventh month she was harassed by colicky pains and diarrhœa; crops of aphthous ulcers formed in the mouth; the mouth at times was so sore that eating was almost intolerable; she became emaciated and anæmic. The diarrhœa was greatly controlled by nitric acid, cusparia, and laudanum. She still further improved under the use of peracetate of iron. Nevertheless during the last month two or three fluid pale stools were passed daily, and the skin had a marked icteric tinge. She was delivered easily at term; child healthy. The very next day the stools, which had hitherto been white, consisted almost entirely of bile. She seemed relieved for a time, but soon febrile excitement set in, ending in violent mania. Under temporary seclusion she recovered perfectly, and has borne children since without trouble.

A distressing complication of jaundice is pruritus. The itching of the skin is sometimes intolerable.

The *treatment* of this form is simple. Alteratives, mercurial and saline are indicated. Unless urgent symptoms occur, the question of inducing labour does not arise.

The following is a characteristic case of the so-called *acute yellow atrophy of the liver* not hitherto published. Mrs. J., æt. 35, was seen in consultation with Dr. Asher in 1863. She has had several natural pregnancies. Did not suffer much from sickness until the fifth month of the present pregnancy, then vomiting became at times very distressing, and was followed by jaundice and great prostration. On September 15 the icteric tinge was very marked; pulse 80; it had been

[1] 'Zur Casuistik des Icterus gravidarum,' *Monatssch. f. Geburtsk.* 1863.

more, and had varied in character. She was languid, prostrate, but still intelligent, answering questions. The uterus reached half-way to the umbilicus, was freely moveable. The os was directed to the sacrum; position of uterus normal, not exercising any perceptible pressure anywhere. The stools had been scanty and clayey; the urine deeply tinged. The question of inducing labour was deferred. Next day there was considerable lethargy, but she put out her tongue slowly when told; she has not spoken; sits up in bed sometimes; pupils dilated, but contract on exposure to light. Some hours earlier Dr. A reported that the pupils had been 'remarkably irritable,' contracting quickly on exposure. The jaundice was now more intense on the face and neck; not very marked on the hands and legs. She has not vomited much since last night. We decided to induce labour. The membranes were punctured. The liquor amnii that drained away was stained deep yellow. At 10 P.M. the jaundice had become more intense, coma more marked; some convulsive twitchings of the arms. On vaginal examination she manifested restlessness, and complained of pain. The liquor amnii had all drained off. The uterus had contracted on the embryo, but the os was tight, barely admitting the tip of the finger. No tenderness in region of liver complained of, and no part of the organ could be felt on pressing the fingers up under the cartilages. Ten ounces of urine drawn for examination. On the 17th, at 8.30 A.M., she was sinking, pulse 120. Icteric tinge still deeper, and more marked in the extremities; pupils dilated, still responsive to light, but feebly; coma deeper, occasional stertor; no evidence of uterine action. She died soon after.

There had been no cause known for mental distress, but she had from the first an unalterable conviction that her illness would be fatal. During the illness no blood passed by stool, but a week previous to the attack there was a large flow of blood by rectum; she had suffered from hæmorrhoids. During the illness she repeatedly vomited bloody mucus in very large quantity. The onset of the disease was marked by languor and pain in the *left* hypochondrium, with itching over the skin. This was a month previous to the outbreak.

Dr. Letheby examined the urine, and reported: deep yellow green; turbid; deposited dirty yellow sediment; odour peculiar; very offensive; like a mixture of urine and putrid bile; sp. gr. 1018·2. It yielded 3·32 per cent. of solid matter; the residue had the character of a mixture of bile and urine extractive; it was very deliquescent; it furnished 0·78 of a white saline substance on perfect incineration. The ash was not alkaline, but consisted chiefly of chloride of sodium, with an alkaline sulphate and phosphate of lime. The urine itself was faintly acid; it gave characteristic reaction of bile with nitric acid; with strong hydrochloric acid it became rich green; with Pettenkofer's test it gave the rich red colour. Microscopic examination showed that the deposit consisted of numerous fat globules, and transparent colourless globules of leucine, as well as numerous yellow globules of the same substance aggregated together, and consisting of concentric laminæ like small prostatic calculi. There were also numerous yellow globules of tyrosine, some quite smooth on the surface, and others covered with minute crystals like spicula from the surface; a large quantity of granular matter of a pale yellow also appeared. Large tufts of crystals of urea, and the peculiar form of common salt and urea were observed. On addition of hydrochloric acid the urine furnished crystals of uric acid in about the same proportion as normal urine.

The complete analysis of the urine gives this case a peculiar interest. The history is full enough to present a fair picture of the course of this dire disease. There was no reason to suppose that any serious disease of the liver or kidneys existed before the attack came on. The onset was not preceded by any premonitory symptoms, unless, indeed, the hæmorrhagic vomiting and blood by stool shortly before be excepted. The gradually, but rapidly, deepening jaundice, the advancing coma, running rapidly and irresistibly to a fatal issue, are features that have been observed in other cases. The hæmorrhagic disposition is characteristic. In one case retro-uterine hæmatocele occurred. In two other cases seen by Robert Barnes, one in a young man, the other in a woman past the climacteric, which both ran a rapidly fatal course, the proximate cause was overwhelming mental distress.

Not to cite cases related in well-known works, we may refer to one reported in the 'Lancet,' 1874, which was observed carefully in the London Hospital, under Dr. Head. The general history is similar to the foregoing. The urine presented similar characters. A fœtus of eight months' development was born dead. It presented no appearance of jaundice. The labour was normal, no unusual hæmorrhage. The edge of the liver could not be felt even on deep inspiration. She died in coma. A peculiar value attaches to this case because the necropsy was performed by Dr. Sutton. There were numerous hæmorrhagic spots scattered through the skin. The scalp, skull, and dura-mater were bile-stained, but not deeply so. The pia-mater was healthy, not very noticeably bile-stained. The grey matter of the convolutions was paler than natural; in other respects healthy. The white substance looked normal. There was a small quantity of bile-coloured fluid in the lateral ventricles. The pleuræ were bile-stained only. The lungs were congested, otherwise normal. The bronchial tubes contained a quantity of blood-stained mucus, and their mucous membrane was stained with bile. There were some small hæmorrhagic extravasations on the pericardium, it was also bile-stained. The right ventricle contained some yellow bile-stained clots and fluid blood. The left ventricle was contracted; a little blood was extravasated into its endocardium, and its wall had a dirty reddish-yellow appearance. The muscle was very easily torn, evidently abnormally softened; and one aortic valve was somewhat thickened. The peritoneum was healthy, only slightly blood-stained. The liver was not seen on cutting through and folding back the abdominal walls; but on drawing down the coils of intestine, it was observed shrunken, and lying up under the ribs against the diaphragm. When removed it was seen much smaller than natural, and much thinner from above downwards; it was very flaccid, and folded by its own weight over the hand. It weighed 1 lb. 15 oz. There were many old adhesions uniting its peritoneal covering to the diaphragm and adjacent abdominal walls. Its surface was smooth, and of a pale reddish-yellow colour. On section its substance for the most part had a Turkey rhubarb-like yellow appearance; almost all signs of lobular structure were lost. Here and there, however, were portions that seemed more healthy; in some parts the intralobular veins were distinct; and here also were some minute blood extravasations. The liver substance was not softer than natural, nor indurated. The gall-bladder was almost empty; it contained one or two teaspoonfuls of greenish mucoid substance; examined by Pettenkofer's test and nitric acid, it gave no evidence of bile. The microscope showed recognisable lobular arrangement; and although the minute biliary ducts seemed smaller than natural, yet their outline was distinct; the liver-cells were greatly altered, broken down, almost completely disintegrated, and in their place was a larger quantity of granular *débris*. There were many granules, which permitted light to pass readily through their centre; so-called fat granules; also some yellow seemingly bile pigment. The fibrous matrix was very distinct. The capsule was for the most part normal; but from its under surface a number of corpuscles were seen extending into the liver substance, looking as if some new growth were going on at the time of death. The *spleen* was about the normal size, certainly not enlarged. Some old adhesions united it to the surrounding walls and tissues. When cut into, it was seen very pale, much softened. The *kidneys* were bile-stained, and about the normal size. A few blood extravasations were found in the mucous membrane of their pelves. In other respects these organs were healthy. The *stomach* contained a quantity of 'coffee-ground-looking' fluid, and this and the mucus were with difficulty washed off. Blood extravasations were seen in the mucous membrane. The *uterus* was large; its walls thick. It was not firmly contracted. Its lining membrane was pulpy, and coated with small blood-clots. The *fœtus* weighed 5 lb. 14 oz. Its skin was not yellow; the membrana pupillaris still existed. The body was well nourished. The liver occupied the usual space; it was purple, apparently healthy. All the other viscera were healthy. The fluid in the pleural sacs and peritoneum seemed to be blood-stained.

Dr. McDougall[1] relates a case of acute yellow atrophy, demonstrated by shrinking of the liver during life, and *post-mortem* observation, which presented some peculiar features. The subject was delivered of a healthy boy; the placenta was united to the uterus by firm adhesions, small abscesses being scattered over its surface. The patient had complained of languor and intermittent jaundice; occasional vomiting for two months before delivery; incipient phthisis revealed itself after

[1] *Edinb. Med. Journ.* 1872.

labour; she became comatose; petechiæ appeared on the skin; urine showed leucin and tyrosin. The long continuance of the disease or its slow development, and the appearance of leucin and tyrosin only after the stage of liver-atrophy had set in, are remarkable.

In twenty-one cases occurring during gestation collected from Oppolzer, Frerichs, Scanzoni, Spaeth, Kiwisch, Roper, Wilks, Mali, Hecker, Braun, V. Haselberg, Grainger-Stewart, Paul Davidson, Head, and myself, the age ranged from seventeen to forty-two, no age seeming to be specially prone or exempt. The majority of the patients were primigravidæ. The period of pregnancy when the jaundice appeared was, in one case, the third month; in three, the fifth; in five, the sixth; in six, the seventh; and in three cases, the ninth month. In the majority of cases there was a history of severe mental disturbance preceding the attack. In almost all the cases abortion set in. In almost all hæmorrhage from the uterus, as well as in other forms, occurred. All in which the history is complete were attended towards the close by coma, delirium, convulsions, or other symptoms of brain-disorder.

The pressure-theory so constantly invoked to explain the disorders of gestation has been called in here also. It is unequal to the occasion, and the occurrence of the disease in the third month is enough to exclude it. The disease, moreover, occurs in non-pregnant women and in men.

Virchow observed jaundice in one pregnant woman in whom a tight-lace lobe of the liver, together with the gall-bladder, was turned up in such a way that a stoppage of bile necessarily resulted from the tension of the bile-ducts. J. P. Frank met with a case in which a fatal rupture of the gall-bladder took place during labour.

The participation of the *kidneys* is noted by Spaeth, Hecker, Frerichs, Grainger-Stewart, and Paul Davidson, who found fatty degeneration of this organ. Sutton, however, found the kidneys essentially healthy. The peculiar changes in the urine, the disappearance of the urea, the temporary occurrence of albuminuria, point at any rate to trouble in the work of the kidney. The *spleen* is generally enlarged.

In connection with this history we must take note of the peculiar fatty change described by Tarnier as common in pregnancy, and of observations made by Hecker[1] under the title, 'Contributions to the Knowledge of Acute Fatty Degeneration in Puerperal Women and New-born Children.' He thought he was in a position to affirm that puerperal women are liable to a disease running rapidly, even suddenly, to death soon after labour, the symptoms being obscure without jaundice or intestinal hæmorrhages, and only recognised as acute fatty degeneration on dissection, the basis of which was laid in pregnancy. Dr. McDougall's case, cited above, appears to be an illustration of Hecker's views.

Trousseau observes that 'the diminution in volume of the liver is all the more remarkable, that a great many cases occurred in women pregnant seven, eight, or nine months—a stage of gestation at which we know that there is a notable augmentation in the size of the liver, irrespective altogether of any morbid condition.' He further says, 'The German school has erred in applying the term "*atrophy*" to this alteration of the cellules; and Charles Robin has done well to point out that there is *destruction*, and not atrophy, with or without change in the volume or consistence of the liver.' He agrees with Budd in the opinion that toxæmia is the starting-point. The poison may enter from without; it may be analogous to that which engenders typhoid, or its source may be in the individual.

Hecker insists upon the simultaneous affection of the heart, liver, and kidneys. He says the disease is acute parenchymatous inflammation of the liver. He contends that there is toxæmia, and that albuminuria is constant. There was no albumen in Robert Barnes's case.

It is of deep interest to make a comparative study of jaundice in the pregnant woman and in the new-born infant.

What is the cause of the coma and delirium which attend the latter stages of the disease? Is it the circulation of the bile-matters in the blood? Frerichs says he has convinced himself by a long series of injection-experiments that the presence of the constituents of bile in the blood is harmless. Leucine has been several times found in the blood. But Frerichs does not take into account cholesterine. We think it probable that the brain-symptoms are dependent upon the

[1] *Monatssch. f. Geburtsk.* 1867.

circulation of this substance and of urinary excretions in the blood.

The altered condition of the blood is shown by the almost universal occurrence of hæmorrhage in the form of epistaxis, by vomiting, by stool or from the uterus. The effusion of blood from the uterus is probably a main factor of the abortion which has been so constantly observed. Nor is the effusion of blood confined to the mucous membranes. It is sometimes seen under the skin. It is seen in the form of ecchymoses in the parenchyma of various organs—for example, in the kidney (V. Haselberg), in the liver (Mall), under the pericardium (Grainger-Stewart).

The *fœtus* is not necessarily affected. It has been born of natural appearance, and, in some cases, jaundiced. The liquor amnii has been observed deeply icteric. It was remarkably so in Robert Barnes's case. It stained the boards of the floor on which some fell.

We submit that the sequence of events most conformable to observation is as follows :—

1. The high vascular and nervous tension which underlies all the phenomena of gestation. 2. The accumulation of excrementitious stuff in the blood resulting from inability of the excreting organs to keep pace with the work thrown upon them. 3. Impaired nutrition of the tissues, especially of the excreting organs and of the nervous centres, increasing their incapacity for work. 4. Exudation of albuminous matter in the liver and kidneys, with tendency to fatty degeneration of the epithelium of the secreting surfaces. 5. Some sudden intervening commotion of the nervous and vascular system, physical or psychical, which, increasing the strain upon the damaged kidneys and liver, intensifies the toxæmia, so that all the consequences of suddenly-suppressed excretion break out.

The theory of inflammation of the parenchyma needs proof.

Treatment.—The question of highest interest is—Are there any antecedent morbid conditions necessary to the development of this disease, which can be recognised at a stage when their removal by treatment is possible? When the disease is once fairly started, so far as we can see at present, nothing avails to arrest its fatal course. One of the most striking and discouraging features of the disease is the suddenness, or at least the insidiousness, of its onset. It may be supposed that this suddenness of invasion, often apparently caused directly by some severe mental shock, is evidence that the disease arises suddenly without any particular predisposing conditions. But this reasoning should not be accepted too hastily. Nothing can exceed in apparent suddenness the outbreak of some cases of uræmic convulsions; yet it is almost certain that a particular condition of the blood and of the kidney already existed without which the sudden explosion would not have taken place. The discovery of the præ-albuminuric stage in the kidney-affection by Mahomed suggests the hope that an analogous præ-icteric or præ-cholesteræmic stage may be detected, and give warning for effective treatment. Research for this discovery must be directed to diligent analysis, chemical and microscopical, of the fæces and urine, and to close clinical observation of all the functions. We are much inclined to believe that the first factor is the altered constitution of the blood in the pregnant state; the second, the overpowering of the working capacity of the liver; the third, the circulation in the blood of the secretory and excretory products of the liver; and the fourth, the organic change in the structure of the liver. It will probably be found that the retention of cholesterine in the system plays an important part in the process.

If we could get a reasonable suspicion of what was coming before the stage of organic change, the induction of labour might avert the danger. When the disease is pronounced, it is too late to take this step.

The general history of the disease shows that a very large proportion of the total cases of acute yellow atrophy of the liver occur under the influence of gestation. Dr. Bardinet has even described an epidemic of this disease which occurred at Limoges, attacking thirteen pregnant women. Other similar epidemics have been described. This strongly indicates the expediency of cutting the gestation short, if the proceeding could be adopted in time.

In summary it may be stated that icterus in pregnant women is observed in two forms: (1) The simple, without fever or cerebral symptoms. This is sometimes described as *icterus catarrhalis*. This form does not generally lead to abortion.

If of long duration the child suffers. (2) The icterus with febrile and cerebral symptoms, that of acute yellow atrophy.

Glycosuria; mellituria; diabetes. The study of this affection, on account of its physiological relations, follows that of jaundice. We have already described the glycosuria which keeps within apparently physiological bounds; we have now to sketch the history of the affection when it has passed over into the domain of pathology. This proposition may fairly be laid down as the basis of the study. The train which leads up to the pathological development is laid in the normal conditions of gestation. The beginning may be traced in the association between the ordinary fatty change of the liver described by Tarnier, and in the development of the breasts and the preparation for the secretion of milk. The researches of de Sinéty, previously cited, establish a relation between the formation of milk and the appearance of glycosuria. This relation is sometimes alternative. We must also bear in mind the phenomenon of glycogenesis in the fœtus established by Bernard. This physiologist demonstrated that sugar appears in the placenta very early in fœtal life, and in the third or fourth month has attained its maximum. At about this time, when glycogenic matter begins to appear in the liver, the glycogenic organs of the placenta become atrophied, and are lost at some time before birth. His observations were made on fœtal calves. Epithelial cells filled with glycogenic matter are found in the placenta.

Apart from pregnancy, glycosuria is more rare in women than in men. We do not know of any trustworthy data from which it could be shown what is the numerical relation of diabetes in pregnant women to women not pregnant. In our experience diabetes out of pregnancy occurs most frequently at the climacteric; and in some of these instances the morbid process may be a remanet from pregnancy.

Dr. Matthews Duncan[1] has collected the published cases of diabetes complicating gestation, adding several others, the sources of some of which are not given. 'The histories comprise twenty-two pregnancies in fifteen women, varying in age from twenty-one to thirty-eight years. So far as is known all, with one exception, were multiparæ. In some, death occurred by

[1] *Obstetrical Transactions*, 1883.

collapse rather than by coma. Of the twenty-two pregnancies, including those going to term and those ending in miscarriages, in fifteen mothers, four ended fatally after delivery, premature labour having been induced in one of these to avert death before delivery. These four were puerperal deaths in point of time. Hydramnios was frequent, and in one case sugar was found in it; in another its observed stickiness made its saccharine character probable. In seven of nineteen pregnancies, in fourteen mothers, the child died during the pregnancy, having in all of these reached a viable age. In two more the child was feeble and died a few hours after birth, making an unsuccessful result in nine out of nineteen pregnancies. In one other case the child had diabetes. The dead fœtus is sometimes described as enormous, or its weight is extraordinary, and this probably arises from dropsical infiltration, as in one case recorded.'

A case related by Bennewitz[1] is especially instructive. Diabetes appeared during the fourth, fifth, and sixth pregnancies. It disappeared after each pregnancy. The fifth child was premature and born dead, weighing twelve pounds. On one occasion blood was drawn. It formed an abundant dark-red crassamentum without siziness, and a clear serum of a peculiar faintly-sweetish smell and taste. The urine about this time contained two ounces of saccharine matter per pound.

It is much to be regretted that we possess such scanty information as to the state of the blood in these cases. The influence of pregnancy in originating, or at least in evoking, diabetes is manifested in Bennewitz's case and in others. That the condition arises during pregnancy, and disappears after pregnancy, is conclusive evidence that it is started under physiological processes which, under abnormal strain, merge into pathological conditions. In the discussion on Dr. Duncan's memoirs, Dr. Robert Barnes drew a parallel between the histories of albuminuria and glycosuria in pregnancy, for the purpose of showing that just as albumen was frequently found in the urine of pregnant women without entailing any grave symptoms, and quite passed away with the pregnancy, so it was in the case of sugar or glucose; in both cases the physiological boundary might be passed, and then the gravest accidents might occur. It might be regarded as a question of individual

[1] Reported in *Edinb. Med. Journ.* 1828, and cited by Duncan.

tolerance or accommodation whether in any given instance pathological phenomena were developed or not.

To dissociate the pathological cases from the physiological cases is to disregard the clearest teachings of clinical observation, to close our senses against the most luciferous experiments instituted by Nature for the demonstration of this great problem.

Is there a pathology of diabetes? In other terms, is the rise of diabetes always a physiological error or cause, and not depending upon tissue-change? Dickinson affirms that diabetes is associated with, even depends upon, organic changes in the brain. Pavy contends that whatever the organic changes found after death, the primary condition is a chemical fault. We feel confident that a careful study of the physiological and pathological diabetes in the pregnant woman will confirm Pavy's proposition.

In the interesting discussion held at the Pathological Society in 1883, several pathologists brought forward specimens demonstrating lesions in several organs. Dickinson especially stated that to rough examination 'the brain passed as natural, although it was generally hard in texture, often injected, and more rarely marked with extravasated blood on the surface. On section, pores, in a cribriform arrangement, exaggerating the ordinary puncta vasculosa, were often conspicuous in the centrum ovale and the white matter underneath the lateral ventricles. In parts presenting such peculiarities to the naked eye, the microscope usually showed dilatation of the blood-vessels, extravasation of blood in a small amount, enlargement of the perivascular spaces, and alterations in the perivascular sheaths and nervous matter bounding the cavities. The walls of the cavities were often superabundantly sprinkled with grains of blood-pigment; and in many cases the nervous matter at their surface was rendered translucent and gelatinous by some degenerative change.'

Dickinson urges against the opinion that the changes in the brain seen in diabetes were the result of the circulation of morbid blood, the testimony of clinical experience, that the disease continually began as the consequence of a mental impression or cerebral state, than which there was no fact with regard to diabetes better declared. This argument is strengthened by the experiments of Claude Bernard, in which he produced glycosuria by irritating the floor of the fourth ventricle.

Dr. Pavy has conducted elaborate series of experiments supporting the proposition, that in the liver, by an action of the same nature as that which moves the carbo-hydrates from one to another in the carbo-hydrate group, they were, under certain circumstances, carried out of the group altogether, and converted into some body which was insusceptible of being converted into glucose by sulphuric acid. When carbo-hydrates were taken by a healthy person, they were converted, not into a glucose, but into a dextrine, or maltose, and subsequently carried out of the carbo-hydrate group altogether. This was the process of assimilation of the carbo-hydrates in a healthy person; but in diabetic persons this power was lost; starch and sugar in them were converted into glucose, and appeared in the blood, from which it was eliminated by the kidneys. For this to occur there must be a glucose-forming ferment. Such a ferment existed in the liver, but only under certain circumstances. When the blood was supplied with blood which was thoroughly venous, it converted carbo-hydrates into maltose; but if the blood was imperfectly venous, or partook of the nature of arterial blood, the resulting body was glucose. It could be shown by a number of different methods that an excess of oxygen in the portal blood led to glycosuria. He was convinced that this excess of oxygen was due to a dilatation of the arteries of the chylo-poietic viscera brought about by vaso-motor paralysis.

Does heredity or diathesis enter as a factor in the development of this disease? Several considerations point to the affirmative. Glycosuria in pregnancy bears idiosyncratic features. It may be that like chorea, ague, and other affections, a latent disposition is evoked under the peculiar conditions of gestation. This speculation would bring into mutually supporting contact the anatomical and the chemical theories of the genesis of the disease. It is reasonable to conjecture that, as in the case of chorea, a structural change in the nervous centres may be an essential factor, lying dormant and unsuspected until pregnancy puts the organism to the test by starting the high nervous and vascular tension and other characteristic changes. Under the gestation process the pre-existing latent alterations in the nervous centres no doubt become accentuated, and thus we get those marked changes which are manifested after death.

The *prognosis* of glycosuria which has passed the physiological boundary is grave both for the mother and child.

The *treatment* must be regarded as doubtful. We have little evidence upon which to base a rational therapeusis. The great question which arises in all the grave complications of pregnancy is as to the induction of labour. The answer, as in these other cases, is also doubtful. In Aubrey Husband's case, cited by Duncan, Robert Barnes was consulted as to the expediency of inducing labour. Could we get timely warning of the advance of the disease there might be an opportunity of arresting it by cutting short the pregnancy. But too commonly the disease will have drifted on to a perilous degree before the indication is seized. We must look to the development of chemical science for prophylactic or remedial resources. Such may be discovered by the assiduous pursuit of investigations based upon the plan of Dr. Pavy, aided by well-devised experiments upon pregnant animals. In the meantime the therapeusis must be based upon the principles recognised in the case of diabetes not complicated with pregnancy.

The spleen.—There is little to add to what has been said about the spleen in the chapter on the Process of Gestation, and incidentally in connection with albuminuria and disease of the liver. One condition, however, deserves note. It is the remanent enlargement after ague. This will be considered when the relations of ague and gestation are described.

The kidney.—The more common changes in this organ have been sufficiently described in connection with albuminuria. It remains to take note of the occasional occurrence of *pyelitis*, and of the structural changes in the organ acquired before a pregnancy begins. Whilst it is certain that a ‘ severe attack of albuminuria, with or without eclampsia, may leave the kidney perfectly sound, it is equally certain that the foundation of kidney disease is occasionally laid in this way. And granular disease may have been produced in other ways. In any case, when gestation is superadded, the kidney disease is liable to exacerbation. No complication can be more unfortunate than that of pregnancy and Bright's disease. Just as we should apprehend an untoward issue of the major operations of surgery in the subjects of this disease, so we may fear that the course of gestation will not run smoothly. In such a case, the risk run by mother and child is so serious that we can rarely hesitate as to the expediency of lessening the danger to the mother by bringing the gestation to an end. This done, the kidney is relieved *pro tanto*, and treatment directed to it will be pursued under more favourable conditions.

The bladder.—The most important affection of the bladder during gestation is its distension under retention of urine, due to retroversion of the uterus.

Retention if prolonged entails congestion, inflammation, sometimes even exfoliation of the vesical mucous membrane; then there is the liability to retrograde obstruction to the function of the kidneys leading to pyelitis and urinæmia.

A frequent affection is irritability of the bladder, amounting sometimes to incontinence. This is due to pressure of the enlarged uterus, and in some cases to alterations in the character of the urine, as lithiasis, uric acid, and glycosuria.

These affections will be more conveniently discussed in connection with the cause, that is, retroversion.

Simple cystitis in early gestation is rare, but Monod[1] has observed and collected cases. The disease is marked by great pain in micturition, especially in expelling the last drops, sometimes by blood appearing in the urine; viscid mucus is almost constant; hypogastric pain increased by pressure; and febrile movement. In some cases cold acting upon a mucous membrane in a state of intense physiological hyperæmia may have been the cause; in some it is not improbable that gonorrhœal infection has extended up the urethra to the bladder.

The serous membranes and connective tissue may be the seats of serous effusions. These arise mostly in connection with albuminuria, as already described. But not seldom œdema or anasarca occurs without albuminuria, under the influence of pressure retarding the return of blood by the veins, of heart-disease, or of hydræmia.

[1] *De la cystite chez la femme*, 1880.

The skin is often the seat of pathological conditions, either the immediate consequence of gestation, or revived or exacerbated by the gestation. The increased activity of the glandular system has been referred to as a physiological condition. Under this influence the growth of hair is generally stimulated; and sometimes to an inordinate extent, so as to give rise to the term '*hirsuties gestationis*.' Dr. Slocum relates an example:[1] a woman, in three successive pregnancies, grew a beard on the sides of the face and chin. It always began with the pregnancy, with itching.

Pruritus may be general, or chiefly localised in the pudenda. It is often intensely distressing, destroying rest, and compelling the sufferer to scratch the part. Under this treatment the epidermis is often torn, and bloody puncta are seen. Sometimes *eczema* seems to be the immediate cause of the pruritus; but in many instances no visible alteration exists. The distress is traceable to glycosuria, to jaundice, to irritating ingredients in the urine, and sometimes it can only be explained on the hypothesis of peculiar nervous irritability. A cure was effected in one case by smoking a cigarette daily.

Psoriasis is rarely generated by pregnancy, but where it already exists it is almost certainly aggravated.

Herpes gestationis is described by Dr. Liveing.[2] He says it is rare; that it is a disease of neurotic origin characterised by an eruption of small bullæ and excessive pruritus. Wilson has described cases under the name of herpes circinatus bullosus. D. Bulkley, of New York, described nine cases. The bullæ leave dark-purplish or brown-pigment spots on the skin; it does not usually disappear immediately after labour. In a case by Liveing, bullæ were interspersed with hard solid papules. It broke out after labour and during lactation.

Pemphigus.—Klein[3] relates an extreme case lasting three months. It ended in complete recovery after delivery. The husband was not syphilitic.

Pityriasis.—Startin had seen one form of pityriasis in pregnant women only. We have seen several cases.

Chloasma uterinum.—Hebra and Kaposi[4] describe, under the head *Chloasma symptomatica*, the pigmentary affection

[1] *New York Med. Record*, 1875. [2] *Lancet*, 1878.
[3] *Allgem. Wiener medic. Zeitung*, 1867. [4] *Diseases of the Skin.* N. Syd. Soc.

observed under the influence of menstruation and gestation. They state that the chloasma patches are sometimes confounded with pityriasis versicolor. We sometimes meet with a brownish pigmentation on the face, which extends over the whole forehead as high as the level of the hairy scalp, and is either of a uniformly yellow or dark-brown colour, or presents isolated paler spots here and there. The streaks do not always take a horizontal course, corresponding with the wrinkles on the forehead, but are not infrequently oblique, irregular, scattered, or run from one frontal eminence to the other. In other cases, the dark pigmentation is confined to two symmetrical patches, between which the skin remains of normal colour. They frequently arch over the eyebrows. Sometimes the skin of the upper or lower eyelid is tinted a peculiar brown, giving the expression of sickness or suffering. In many persons the whole of the skin of the face is covered with a dark chestnut-brown, which extends to near the angle of the lower jaw. The areola round the nipple and the linea alba are especially liable to pigment patches and streaks. That all these pigmentary changes are the result of physiological changes may be inferred from the facts that they never make their appearance before puberty; that in many they only appear during menstruation and pregnancy; and that with the cessation of these conditions the pigmentation fades or disappears.

Swayne describes (*Obst. Trans.* vol. iv.) a remarkable case of discolouration of the forearm during pregnancy.

The breasts.—The intense physiological hyperæmia and the acute development of the gland-structure may run into acute inflammation. Mastitis is much more frequently observed after labour, but we now and then see cases during gestation. In the early months some engorgement, induration, and tenderness are not uncommon in primigravidæ of delicate constitution and of imperfect skin and glandular development. Imperfection of the nipple may be a cause. Cold or injury is sometimes urged. But we believe that, in some cases observed by ourselves, lascivious manipulation was to be accused. We have seen inflammation go on to abscess. The treatment will be the same as in post-puerperal mastitis.

Diseases grafted upon the gravid state.

Amongst the most important of these are the class of zymotics: as typhoid, typhus, variola, relapsing or famine fever, scarlatina, rubeola, erysipelas, cholera, yellow fever, diphtheria, ague.

It may be stated as a general proposition that gestation confers no immunity against zymotic diseases. But we believe that gravid women are less susceptible to infection than the non-gravid. The case is entirely altered from the time of labour. In puerperæ the susceptibility to invasion by zymotics is greatly increased. And we have seen reason to suspect that in gravidæ exposed to infection, the zymosis will not always be developed as under ordinary conditions. It seems that under the energy of high vascular tension, which concentrates the forces upon the work of structural growth, fermentation or germ-development is checked. The zymotic germs are either destroyed or thrown out of the system, or lie dormant, in latitancy as it were, until labour takes place. Then centripetal absorptive action sets in and zymosis is favoured. Hence the frequent outbreak of fever often heterogenetic in puerpery. To take *typhoid* first. This complication is not very frequent. Considering the wide prevalence of typhoid at times, the comparative immunity of pregnant women is surprising. We are tempted to invoke a protective virtue in gestation. Baratte [1] collected 94 cases. He confirms others in the observation that it promotes a hæmorrhagic tendency. The proportion of abortions ensuing was 57 or 60 per cent. In 62 cases collected by Duguyot (1879) there were 40 abortions. Of 42 children whose fate was noted only 5 survived. The prognosis is much worse for the fœtus than for the mother.

Gusserow [2] collected valuable data. He says typhoid is rare in pregnant women. In an epidemic at Bâle 83 per cent. ended in abortion, and at Vienna 58 per cent. This difference was ascribed to difference in treatment. He never found evidence of fever in the fœtus. Most cases of fœtal death

[1] *Thèse de Paris*, 1882. *De la fièvre typhoïde dans la grossesse.*
[2] *Berlin. Med. Wochenschr.* 1880.

occur in the second or third week of the disease, when high temperature rules. Severe hæmorrhage is likely to attend abortion in the early months. He regards the induction of labour as a grievous error.

Variola.—The history of small-pox in its relations to pregnancy is full of interest. The disease presents two distinct varieties for study: 1. The confluent, or pure variola. 2. The discrete, or modified variola. Then we have—3. The influence of vaccination simple.

Dr. Gayton, superintendent of the Homerton Small-pox Hospital, has given us the statistics of this institution. He saw 9,671 cases. Of this number 95 were in pregnant women. Of 29 women gravid at different stages, from 3 to 8 months, taken with confluent, semi-confluent, or hæmorrhagic small-pox, 22 recovered, 7 died. Of 30 women taken with discrete small-pox, all recovered. Of 26 women with confluent, semi-confluent, or hæmorrhagic variola, abortion took place in every case, 21 of the women perished, 5 recovered. Of 10 cases of discrete small-pox all aborted, 1 only died.

As to the offspring: In one case, in which the mother died undelivered at 8 months, the fœtus on autopsy showed no mark of small-pox.

Twins at 8 months, born of a woman who died, were still-born, showing no mark of the disease; one child at 6 months was born alive, but quickly died, it bore doubtful marks; one child of 8½ months, born alive, quickly became cyanosed and died, it bore no evidence of small-pox; in one fœtus of 4 months, doubtful vesicles were seen on the chest; one child born at 8 months lived 5 hours, bore no marks. Of the children of the 10 women affected with the discrete form, one of 8 months lived 24 hours, no evidence of small-pox; one of 8½ months lived 4 days, died of convulsions, no marks; one at 8 months, whose mother died of metritis, lived 8 hours; one child of 9 months at term showed no evidence of small-pox; it was vaccinated the day after birth, and again on the fifth day, both attempts unsuccessful; it stayed in hospital a month exposed to risk, and left with its mother quite well.

Serres[1] observed 23 abortions in 27 cases of variola. Chambrelent noted 4 abortions in 5 cases.

[1] *Gazette Médicale*, 1832.

1. What is the effect of variola upon the gravida? *a.* The *confluent*, or hæmorrhagic form, is, Gayton says, likely to be fatal whether the subject be pregnant or not. But we think the mortality is almost certainly greater than it would be in non-pregnant women. *b.* The *discrete* form seems scarcely more dangerous in pregnant than in non-pregnant women. It seems that the period of greatest danger is that of puerpery. It is probable that pregnancy tends to impart the hæmorrhagic character to the disease.

2. What is the effect upon the pregnancy? Abortion is almost constant. Non-viable children aborted of course are lost, and so a large proportion of the total of embryonic lives perish. In others the child is still-born, dying under influences which will be discussed hereafter. Some few, born at a viable age, die soon after birth. The children that survive are rare exceptions.

3. Are the children affected by the disease *in utero*? In an unknown proportion of instances the child is certainly attacked. Some resist vaccination and exposure to small-pox; some are born bearing vesicles or scars, showing that they have gone through the disease *in utero*.

Desnos, cited by Chambrelent, relates that a pregnant woman took small-pox. The stage of desiccation reached, she brought forth a healthy child which showed no trace of eruption. It resisted vaccination with lymph that succeeded with other children. Chambrelent relates a similar instance from his own experience. But Fumée, of Montpellier, relates a more remarkable case. The woman bore twins; one child only showed variolous pustules.

It is desirable to record examples observed by classic authorities in the præ-vaccination era, since in the present era simple cases cannot be frequent. In John Hunter's works (vol. iv.) is a very full account of the subject down to his time. He relates the following:—'Mrs. Ford had been seized with shivering and the other common symptoms of fever, on December 5, 1776. She was considered to be in the sixth month of pregnancy. In the 8th small-pox appeared. She passed through the disease well, and was delivered on the 31st. An eruption was observed all over the body of the child, and several of the pustules were filled with matter. Dr. Leake had observed that it might be necessary to inquire whether those adults who are said totally to escape the small-pox have not been previously affected with it in the womb. The child was, therefore, seen by Dr. Leake, the two Hunters, Cruikshank, and Mr. Falconer, who all concurred that the eruption was the small-pox. Dr. Hunter said that in all the other cases of the same kind that he had met with the child *in utero* had escaped the contagion. Sir George Baker mentions[1] the case of two pregnant women who were inoculated at Hertford. They both had the small-pox favourably, and afterwards brought forth children perfectly healthy. Both children were inoculated at the age of three with effect. Dr. Watson relates[2] the following deeply interesting case:—'A woman big with child, having herself long ago had variola, assiduously nursed her servant during the whole process of this disease. At the proper time she brought forth a healthy female child, on whose body Dr. Watson discovered evident marks of variola, which she must have gone through in the womb; he pronounced that this child would be free from infection. After four years her brother was inoculated, and also this girl, at the same time with the same pus. The boy had the regular eruption, and got well; the girl's arm did not inflame; on the tenth day she turned suddenly pale, was languid for two days, and got well. This case shows that the mother may carry the variolous poison to her child, herself being unaffected by it. She may be a simple carrier.'

The late Mr. Streeter held that the fœtus, taking the disease from its mother, went through it at a distinct period—that is, the disease in the fœtus had its stages of incubation and eruption after the corresponding stages in the mother. He observed that the fœtus had only arrived at the incubative stage, whilst the mother was already maturating the vesicles.

Chambrelent's investigations[3] on the passage of figured elements through the placenta are of extreme physiological and pathological interest. He found that the microbe of the 'choléra des poules' inoculated in pregnant animals passed to the fœtus, and that the blood of the fœtus, cultivated in Pasteur's fluid, and then inoculated into other animals, produced the disease in a fatal form.

[1] *Med. Trans.* vol. ii. [2] *Phil. Trans.* vol. xlvi.
[3] *Recherches sur le passage des éléments figurés à travers le placenta.* 1882.

'How is it,' asks Chambrelent, 'that in some cases the variola affects the fœtus *in utero* and fails in others?' He contends that the variolous microbe passes through the placenta, but that in some cases it finds in the fœtal blood a congenial medium for culture, in which cases the disease is produced, whereas in other cases the microbe finds a soil not suitable for culture, and then the disease is not produced.

The effect of vaccination upon pregnant women and the fœtus.—Precise data are not so copious as might be expected. Behm reports[1] 33 vaccinations of women pregnant in the eighth, ninth, and tenth months. Humanised lymph, for the most part, was used. In 4 cases the operation failed in 22 it succeeded completely, in 7 partially. Of the 33 children 25 were vaccinated successfully, the rest without success, but in 6 of these the lymph was not good; one, on whom good lymph was used, failed. This is the only instance of presumed protection from intra-uterine action. New-born infants, he says, experience less constitutional disturbance from vaccination than at a later period.

In 1870 Thorburn vaccinated several pregnant women successfully, and found no insusceptibility in their infants.

It has been proved by fairly numerous experiments that many of the children born of women who went through small-pox when pregnant resist vaccination, although they show no mark of having gone through the disease *in utero*. Thus there may be acquired immunity without having had the disease in its ordinary form.

Again, vaccination practised upon pregnant women presents analogous phenomena. Burkhard, of Bâle, re-vaccinated 28 pregnant women. In 4 of 8 cases tested the infants resisted vaccination.

Rikett and Roloffs, operating on sheep, inoculated variola in 700 sheep in the latter weeks of gestation. Their young were inoculated four or five weeks after birth with the lymph of sheep-pox; the inoculation failed in every case, whilst it succeeded fully in thirty-six lambs whose mothers had not been inoculated.

M. Masse[2] states the following problem:—'The species

[1] *Centralbl. f. Gynäk.* 1882.

[2] *Des inoculations préventives dans les maladies virulentes.*

which now appear to enjoy a certain immunity may owe it to the fact that their ancestors have all been affected by the disease. Their actual immunity may be due to a vaccination which they enjoy by heredity.'

Thus it may well be that the almost universal practice of vaccination through successive generations has been and is telling in (1) lessening the susceptibility of our children, (2) in diminishing the virulence of the small-pox—that is, in substituting a modified disease for the virulent disease which afflicted our non-vaccinated ancestors.

It is very interesting to examine *by what process small-pox excites abortion and kills the fœtus.*

In some cases the abortion follows the death of the embryo, but in many cases the child is born alive. We shall examine presently the evidence proving that the embryo or fœtus almost necessarily perishes if the mother's temperature be long kept up to 41° C. or more. We will now discuss the causes of its premature expulsion alive. In this case the abortifacient influence must be mainly if not wholly exerted upon the mother. The following propositions were stated by Robert Barnes:[1]—

a. Nature hardly tolerates the concurrent progress of an active disease and pregnancy.

b. If the disease be of zymotic character, the morbid poison, aggravated by the further blood-poisoning resulting from arrested or disordered secretory function—so important in pregnancy—acts upon the whole system, producing fever, increasing the irritability of the nervous system, impeding the nutrition of the muscular system, including the most important muscle of all, the uterus, and directly irritating this muscle. The influence of blood poor in oxygen and loaded with carbonic acid, in causing contraction of the involuntary muscles, has been well established by Marshall Hall, Brown-Séquard, and others. It is a matter of experience that pregnant women suffering from asphyxia, chronic or acute, are extremely apt to abort. The blood in fever wants oxygenation. In this respect it resembles the blood in asphyxia. But superadded to this condition are the materies morbi, and other consequent blood impurities, which it is probable act in a similar manner upon

[1] *The History of Small-pox complicated with Pregnancy.—Obst. Trans.* 1868.

involuntary muscle. The result is that the uterus is directly stimulated to contract, and labour is induced.

c. There appears to be this difference between the action of acute and chronic blood-poisoning upon the embryo and pregnancy: in acute disease, where respiration is impeded and where the blood is rapidly poisoned, the first effect is upon the uterus. In chronic poisoning, as in the case of secondary syphilis, the embryo may be first attacked. Its nutrition is sapped, it perishes, and then, the uterine development being arrested, and involution taking its place, in the course of a period ranging from seven to twenty-one days contraction sets in, and the dead fœtus is expelled.

d. There is another way in which it is probable that abortion is produced in zymotic diseases. The blood is in a state favourable to extravasation. Apoplexy of the placenta or effusions between the placenta and the uterus take place, and thus uterine contraction is excited.

e. Abortion, or premature labour, may be excited in yet another way. The sudden impression upon the nervous system, or shock, may cause the uterus to expel its contents. We have seen this happen under the influence of an attack of apoplexy, and it is at least a principal factor in the causation of labour when uræmic convulsions break out during pregnancy.

The effect of vaccination upon puerperæ.—This is a practical question. A woman was vaccinated[1] the day after labour. The milk dried up. The infant died from defective nutrition. A coroner's jury, reasoning that the sequence of events proved that they flowed as the effect of the vaccination, censured the doctor for vaccinating. Is there any danger in vaccinating or revaccinating a recently-delivered woman? Without approving the censure of the jury, which was based upon entirely arbitrary assumptions, we believe there is. Any zymotic introduced into the working blood of the puerpera during the involution-process is likely to disturb the process and set up fever.

At the same time the question of vaccinating a puerpera must be governed by circumstances. If an epidemic of variola be raging, if the puerpera be living in a community

[1] See *Times*, May 28, 1883.

herself exposed to risk of contagion, and thus liable to pass it on to others, vaccination may be justified.

Two practical questions arise—(1) Is it useful to induce abortion or premature labour in a woman suffering from small-pox, in the mother's interest? We think this must be answered in the negative. It is in a high degree probable that she will abort spontaneously. The process is in operation early, and there is no evidence to show that by precipitating the impending event any advantage is gained. (2) Does induction of labour offer a better chance of saving a child arrived at a viable age? We think the evidence of children born spontaneously and living, and of others in which the child is born dying or dies very soon after birth, lends weight to the opinion that timely induction of labour, by subtracting the child from lethal influences, would give it a better chance, and that without materially adding to the danger of the mother. In the section on the influence of high temperature on the fœtus *in utero* which follows, we shall find reasons strengthening this conclusion.

Is it useful to vaccinate pregnant women whom there is reason to think inadequately protected? This invokes the question: What is the effect of vaccination upon pregnant women? Dr. Yarrow, who has used good opportunities for testing this point, tells me that he never hesitates to vaccinate pregnant women, and that they experience no bad results. We cannot discover evidence of the mother being more prone to abort. Then, are the children of mothers who were vaccinated when pregnant protected? The case is covered by that of small-pox. It has been found that some children thus born resisted vaccination; but, as might be inferred from the fact that some children whose mothers, when pregnant with them, were not thereby protected, so some children, probably most, of women vaccinated when pregnant will not be protected. The belief is, however, held by some physicians that the children born of mothers who were vaccinated whilst carrying them are protected. Still, vaccination may be properly applied as a test of protection; and for the public safety such children should not be exempted from the wholesome general law to vaccinate.

Relapsing or famine fever.—Murchison says that pregnant women invariably abort if attacked with relapsing-fever, sometimes in the first, but oftener in the second paroxysm. Abortion is sometimes, but not invariably, a cause of death. Delivery is sometimes followed by copious hæmorrhage, or by rapid sinking, and death; but, as a rule, the mother recovers. Even when pregnancy is advanced, the child is always still-born, or only survives a few hours. Murchison submits that on the supposition that relapsing fever is but a mild variety of typhus, it would be very remarkable that in the former abortion is almost invariable, and the fœtus dies; whereas in typhus, abortion is the exception, and when it occurs the child, if near the full time, usually lives. Wardell, in the Scotch epidemic of typhus 1843-4, saw several cases in pregnant women, and remembers no case of abortion occurring.

Accepting the statements of Murchison, and our own observations are in accord, we may see in the reaction of the pregnant woman under relapsing and typhus fevers a test by which these fevers may be differentiated.

Scarlatina.—Opportunities of observing the complication of gestation with scarlatina are not rare. The complication is grave, although we and others have seen many cases in which the gestation went on to term without obvious injury to mother or child. It certainly increases the liability to abortion. This it may do in two ways: 1, by killing the child; 2, by setting up uterine action.

The late Dr. Woodman reported to us a case of a primigravida, æt. 18, who took scarlatina when 3½ months gone. It left her with a systolic mitral murmur. About six weeks before delivery choreic movements, bilateral, very violent, set in. In the labour these became exchanged for eclampsia. She died after giving birth to a dead child. The urine was albuminous throughout. This case strongly suggests the conclusion that scarlatina, itself a disease that puts the kidney on severest trial, intensifies the risk of albuminuria. In this way the complication is especially to be dreaded. The danger is less in the case of women who have had a previous attack of scarlatina.

Do children born of women who had scarlatina during gestation acquire protection from the disease? Observations are wanting. The following case reported by Dr. M. Williams, of Liverpool,[1] proves that the disease may pass to the child *in utero*. A woman eight months pregnant took scarlatina from her children; she had had it before. It came on with vomiting. She desquamated and recovered. At term she was delivered of a fine girl, whose skin was desquamating. A week later the child had erysipelas, beginning at the navel; it subsided. An abscess formed on the left foot; it recovered.

Thorburn relates the following case: G. K., pregnant, was exposed to the influences of scarlatina. About a fortnight subsequently she was confined of a girl a little before the expected time. The child, when born, was covered with desquamative scales—no very rare occurrence—but in a day or two suppuration of the cervical glands set in, and the urine was for three or four days highly albuminous. A fortnight afterwards the mother was attacked by scarlatina, which ran a tolerably severe course. Both did well. Thorburn says: 'I can hardly resist the conclusion that the fœtus received the poison and suffered its primary effects whilst yet unborn, the mother being then insusceptible, and that she afterwards, probably owing to the puerperal weakness, became susceptible and was infected by her own offspring.'

If a woman take scarlatina near the advent of labour, then the outbreak of the disease appears to be suspended until after delivery. Then the blood-degradation of the involution process of puerpery assumes more dangerous characters. It becomes one of the worst forms of heterogenetic puerperal fever. This will be discussed under the 'Diseases of Puerpery.'

The treatment must be conducted on the same lines as those which rule in the scarlatina of the non-pregnant. The chief special question is as to the induction of labour. Our opinion is that under ordinary conditions the gestation should not be interrupted. But when the child being viable and living, the mother's life is in imminent danger, labour should be induced in the hope of saving the child. Again, if albuminuria be detected, labour should, as a rule, be brought on.

Cholera.—The terribly rapid course of this disease gives little time for the development or observation of the reciprocal action of it and pregnancy. We have seen two severe epidemics, but have no notes of cholera complicated with pregnancy.

[1] *Brit Med. Journ.*, 1875.

The intense carbonisation of the blood must dispose to abortion and to death of the child.

Four memoirs on the relations of cholera to gestation contain the greater part of the information we possess on the subject, namely, by Bouchut,[1] A. Drasche,[2] Baginsky,[3] and Hening.[4] Hening, from observations of an epidemic in Leipzig, concluded that the proclivity to cholera of pregnant women is not material, and that the mortality is less than that amongst the general population. Of 38 cases, 13 died. A larger proportion of women in the latter half of gestation were seized. The greater number of deaths occurred on the third day of the disease. In the cholera hospital at Berlin, Baginsky reports the mortality at 61 per cent. He observed 23 pregnant women in cholera; 10 aborted, and 7 died without aborting. It may be presumed that some of the latter would have aborted had they lived a little longer.

Abortion or premature labour occurred in a large proportion of cases.

There was no special tendency to hæmorrhage in the third stage.

The question of rapid delivery by the natural passages or by the Cæsarian section when the woman is moribund, or a few minutes after death, with the hope of saving the child, may have to be decided.

Diphtheria.—Of the influence of diphtheria upon pregnancy we possess no personal experience, nor are we aware of any very precise observations by others.

Rubeola.—Measles. This zymotic is very rare in pregnant women. Bourgeois in 15 cases noted 8 abortions. The disease did not appear to be aggravated. The child has been born bearing evidence of measles.

Influenza.—In 1837 an epidemic of influenza raged in Paris. Almost all the pregnant women in the Maternité were seized. Jacquemier thought that the course of gestation was not materially affected; but Cazeaux observed that abortion was more frequent.

Erysipelas.—The pregnant woman is not exempt from erysipelas; but there is little experience upon this subject.

[1] *Gaz. Méd. de Paris*, 1849.
[2] *Wien*, 1860.
[3] *Deutsche Klinik*, 1866.
[4] *Mon. f. Geburtsk.* 1868.

General considerations.—The apparent immunity of pregnant women from zymotic infection is partly explained by the fact that many have previously gone through these diseases. On the other hand, the comparative frequency with which puerperæ are affected indicates a renewal of proclivity to the development of the zymotics.

Montgomery and Ramsbotham insisted that pregnancy served to operate as a safeguard against infectious diseases; but, urges Ramsbotham, this immunity is more than counterbalanced by the unusual susceptibility evinced after delivery. He observed that during epidemics a zymosis ran through whole households, the mother, if pregnant, alone escaping; but that if she fell in labour before the infection had expended itself she would almost invariably become attacked, and suffer more severely than the rest. We ourselves, like many physicians, have witnessed several instances of gravid women nursing their children assiduously through scarlatina, themselves escaping.

Ague. Primary.—Ritter[1] concluded that in malarious regions pregnant women rarely took ague, whilst puerperæ frequently did so during the first three weeks. It is a popular belief that pregnancy is protective against ague. This agrees with the theory we have enunciated, that under the high vascular tension of gestation the system is not prone to absorb from without; but that this proclivity is especially favoured by the low tension and active absorptive power of puerpery.

The child *in utero* may take ague. The spleen of infants is found large in malarious districts.

It is found that the disease yields to quinine and arsenic, as in the non-pregnant subjects.

Ague disposes to abortion. Göth observed 46 women taken with ague; of these 19 aborted. The fits lost something of their ordinary rhythm. The uterine contractions of labour were irregular. The fits returned after labour. Several observers besides Göth and Ritter found that women who had escaped the fever whilst pregnant took it in childbed.

The influence of temperature of the mother on the fœtus.—High temperature attending acute fevers or disease in the pregnant woman induces increased rapidity of pulse in the fœtus,

[1] Virchow's *Archiv.* 1867.

and if prolonged may even kill it. The limit of temperature compatible with the survival of the child seems to lie between 40° and 41° C.

Complicating conditions, as noxious matter in the blood, must be considered. The temperature may be only an exponent of septicæmia.

When the temperature keeps up to 40°, and the child's heart-beat is maintained at a high rate, the propriety of inducing labour to save it is indicated.

The influence of simple high temperature has been investigated experimentally by Runge,[1] who subjected pregnant bitches and rabbits to heat in a stove. He found that in one series of experiments in which the temperature in the mother's vagina did not exceed 41°, all the fœtuses were born alive; in another series, in which the temperature exceeded 41·5°, the fœtuses died, especially if the temperature was kept up.

Kaminsky (1866)[2] having observed 87 women affected by typhus or relapsing fever, came to similar conclusions. He said the prejudicial effect of high temperature of the mother on the fœtus was not alone noted in zymotic disease, but in pneumonia and other acute diseases. The heart-beats become masked, tumultuous, without rhythm, then disappear; the movements of the fœtus at first more frequent, then degenerate into convulsive movements and cease. On autopsy the fœtus shows ecchymoses in various parts; the brain, liver, spleen are gorged with blood; and the same lesions are found in the placenta. As a general rule, the expulsion of the dead fœtus only takes place some time afterwards; in typhus and relapsing fever it frequently does not take place until convalescence.

Kaminsky contends that the one constant factor in the effect wrought upon the fœtus *in utero* is the high temperature. He attributes minor influence to the blood-poison, to the cause of the ferment producing the rise of temperature. In 43 cases of pneumonia collected by Ricau, abortion took place in one-half, whilst only 2 aborted out of 13 cases of pleurisy. The difference may be explained by the comparatively high temperature of pneumonia.

Hohl (1833) observed that a low temperature of a woman during gestation and labour lowered the pulse-rate of the

[1] *Archiv f. Gynäkologie*, 1880. [2] *Deutsche Klinik*, 1866.

fœtus, and that a high temperature raised it. Hüter (1861) observed that the fœtal pulse responded to the mother's suffering from fever. Fiedler, in five cases of typhoid, observed that the fœtal pulse presented, like that of the mother, evening exacerbations and morning remissions. Kaminsky, in 1869, and Winckel, made further researches, and stated generally that when the high temperature had lasted a certain time the heart-beats were perceptibly increased, and that the pulsations of the fœtus and the temperature of the mother went *pari passu*. When the high temperature lasted a certain time the child was born asphyxiated or dead.

There is some evidence, hardly extensive enough to attest the conclusion, that high temperature in eclampsia may kill the fœtus.

The Diatheses original and acquired.

First a few words may be said as to *struma* and *tuberculosis* (*phthisis*). When these exist the course of gestation may not be materially affected. Labour may take place at term and without special accident. But we have had many occasions to observe the proneness of strumous women to abscess of the breast and perimetric inflammation. Placentitis and calcareous change in the placenta are especially apt to occur.

Lungs; Asthma, &c. Tuberculosis.

Phthisis: *its Relations to Gestation.*

It was at one time thought that gestation gave immunity against phthisis. Scanzoni even favoured this opinion. He examined the bodies of several hundred women who had died of puerperal fever and never found lung-tuberculosis. This negative reasoning is not conclusive.

Dr. Warren, in an elaborate memoir,[1] argumentative, statistical, and somewhat vague, collects the opinions favourable to this view. Amongst the authorities cited are Andral, Eberlé, Heberden, Chailly, Montgomery, Burns, Denman, Jacquemier, and Churchill. He concludes that gestation retards phthisis by opposing sanguineous determination to the lungs on the

[1] *Amer. Journ. of Med. Sc.* 1857.

principle of derivation and revulsion. Larcher also says: 'The heart driving the blood towards the fœtus, this is diverted from the lungs.'

This theory of immunity is opposed by physiological history and by clinical facts. The negative evidence of Scanzoni falls before positive evidence. The theory of derivation from the lungs is fallacious; it is in direct contradiction to facts; the entire organism, including especially the mucous membrane of the lungs, feels the impulse of increased heart-pressure; it is more vascular. Rokitansky's argument that the lung is compressed is also fallacious. The fact of its compression is denied. Küchenmeister maintains that the lung capacity is increased. Certainly the lung has more work to do; respiration is increased in frequency. More excrementitious stuff is brought to it for elimination. Working under increased pressure, it may be expected, like other organs, to be more prone to disease. Thus Grisolle[1] gives the histories of 27 cases of phthisis occurring during gestation. In 24 of these it began during gestation. In none was the disease retarded; on the contrary, it made rapid progress. Dubreuihl also having examined the question clinically, rejects the theory of antagonism. Louis also rejects it.

We think precise recent experience will confirm this doctrine of Dubois (1860): that gestation may become the cause of numerous pathological conditions; that it aggravates most of those arising during its existence; and that it preserves from none. The whole history of the diseases attending gestation is illustrative of this text. De Cristoforis[2] says observation has shown the disastrous influence of gestation. He has seen many times women in the last trimestrium, with signs of advanced phthisis, become rapidly worse, fall precipitately into extensive pulmonary destruction, and hurried to death more rapidly than would otherwise be the case. The pulmonary congestion, one of the consequences of the superior mechanical arterial hyperæmia, explains this. The lungs become less pervious; serous infiltration ensues. These two conditions, added to that of the specific tubercular deposition, have for direct effect imperfect hæmatosis. Hence softening of tubercles

[1] *Arch. Gén. de Méd.* 1857.
[2] *Annali Univers.* 1863.

is greatly favoured. He says that autopsy showed œdema as well as tubercular deposition in the lung.

The relations of phthisis and surgical operations illustrate this text. Paget[1] says, 'In all cases of acute or progressive phthisis great risk is incurred by almost every operation. The risks of the excitement, of many days of feverish disturbance, and of loss of blood, and of pain, and all such consequences of operations, are much above the average; to say nothing of the special chances of exciting pneumonia. I cannot doubt that I have seen patients whose acute phthisis has become more acute, and others in whom the early stages of phthisis were accelerated by the consequences of operations. The case is very different with chronic or suspended phthisis. These benefit by removal of a source of irritation.

Another related question is as to *the acceleration of phthisis after labour.* The affirmative is the general belief. Our own experience, which has been extensive, compels us to affirm: 1. That pregnancy confers no immunity against the invasion of phthisis. 2. That it exerts no retarding influence upon its progress. 3. That there is a rapid aggravation of the disease under the trial of puerpery.

What, on the other hand, is *the effect of phthisis upon gestation?* We have no distinct evidence that it promotes abortion or premature labour, unless indeed the disease is hurrying on the patient to death; then in the agony, or a little earlier, when carbonic acid is accumulating in the blood, the uterus is sometimes stimulated to contract; and so labour precedes death.

The effect upon the child.—The child, a true parasite, drains the mother for its own support. It is generally born well-developed; and if, as Rokitansky says, it be true that it rarely shows tuberculosis, the disease is very apt to be developed later either as tuberculosis or as meningitis peritonitis, or some other cognate disease. With regard to the placenta, we have repeatedly made the observation that tuberculous women are more prone than others to calcareous deposits on the placenta.

Still another question: *Should phthisical women be advised to marry?* On medical grounds the question is

[1] *Clinical Lectures.*

answered by the preceding statement. The health prospect of the woman, and that of her probable offspring, say, No. It has been supposed that such subjects are not prone to conceive. But in this opinion we cannot concur. We are tempted, statistics failing, to believe the contrary.

Sometimes phthisis is disguised under a severe and rapidly fatal pneumonia.

The syphilitic diathesis exerts the most disastrous influence during gestation, involving mother and child. The general affection of the mucous membranes embraces the uterine mucous membrane and the outcoming decidua. It may originate in primary sore, or by propagation of secondary or tertiary taint through the fœtus. The subject will be further discussed under 'Abortion.' We may here state that syphilis contracted from the fœtus presents, according to Hutchinson, the following symptoms:—First, a peculiar cachexia marked by a pallid earthy complexion, loss of flesh, debility, great depression of spirits, and liability to aching pains in the bones on taking cold. This is often accompanied by some specific signs, as loss of hair, sores on the tongue, fissures at the angles of the mouth; eruptions of the tertiary form, as psoriasis, condylomata, nodes. It is remarkable that the cachexia sometimes occurs unaccompanied by any of the above specific marks; and this is especially the case in women who have conceived but once, or whose own powers are vigorous enough to enable them to resist to a great extent the influence of the poison. Such women date their illness from the pregnancy.

The rheumatic diathesis existing before gestation may also bear upon the placenta, disposing to fibrinous effusions in it. The chief effect, however, is pain. Naegelè and E. Rigby insisted much that the gravid uterus was liable to rheumatism. Kiwisch denied it. We are disposed to agree with Naegelè and Rigby. The affection is characterised by severe uterine pain during gestation.

Acute rheumatism during gestation is certainly rare, but unmistakeable cases have been observed. One case became the topic of national interest; it culminated in a stiff knee-joint. When we reflect upon the hyperinotic state of the blood and other characters in pregnancy resembling those of acute rheumatism, we might expect the disease to be more frequent.

When it occurs, the symptoms differ in no material respect from those observed in the uncomplicated disease. The danger of pericarditis is serious. If the fever is severe and the temperature very high, there should be no hesitation as to bleeding from the arm. The question of inducing labour will arise, but the propriety of its execution will be doubtful.

Bourgeois cites two cases of rheumatic arthritis in pregnant women; in one, in whom the rheumatism was acute and general, abortion took place. Grenser relates cases.[1] In one case the woman suckled, the rheumatism remitted for a few days, returned, and became chronic, lasting several months.

Under the **neurotic diatheses**, original or acquired, we rank insanity, chorea, epilepsy, and ague.

Insanity, chorea, and **epilepsy** have been already described.

Ague.—In strictness, the place here assigned may be disputed. But remembering that the symptoms evoked are mainly neurotic, allied to convulsion, it is convenient and instructive to consider chronic ague in this connection.

In Robert Barnes's Lumleian Lectures instances are adduced of the awakening influence of gestation upon latent malarial disorder. He infers that this action raises a strong presumption that ague exerts some persistent change of nutrition in the nervous centres; so that although a woman may for years have been considered cured, gestation, coming as a test, proves that the cure was only apparent, not absolute. A similar history is traced in the relations of traumatism. Thus Verneuil insisted that surgical operations resuscitated latent ague. Paget[2] says:—

'Patients with ague bear operations as well as others of the same class; but in the course of their recovery they may alarm you by having one or more ague fits, exactly resembling those that precede pyæmia. And more than this: if a patient has ever had ague, and, even many years afterwards, you perform an operation on him, ague may seem to be renewed in him at some short time after the shock or loss of blood, or whatever other damage he may have sustained. I have so often noticed this, that whenever I hear of severe rigors following any operation, I ask for a previous history of ague.'

[1] *Mon. f. Geburtsk.* 1865.

[2] *Clinical Lectures.*

This subject has been well studied by Dr. Billon.[1] Assimilating traumatism and labour he describes the ague diathesis or intoxication as *chronic impaludism*. In cases he cites, the ague fit was evoked in some during gestation, in some during labour, in others during puerpery. In some, again, the fits seemed suspended during gestation, in order to break out more violently after labour.

Involution of the uterus was not apparently retarded; the lochia persisted.

Désormeaux cites a case from Schweig: A woman pregnant six or seven months was seized with quartan; every time when on the point of a fit, the fœtus had tremulous movements, and after delivery the child had quartan ague.

Sir Thomas Watson relates a case of a woman who 'had tertian, which attacked her of course on alternate days; but every other day, when she was well and free, she felt the child shake, so that they both had tertian ague, only their paroxysms happened on alternate days.'

An important clinical point is not to confound the rigor, fever, and sweating of septicæmia, with the cold, hot, and sweating stages of ague. The main features of differentiation are the greater persistence of the symptoms in septicæmia, and the history of ague, and the periodicity of the attacks.

Quinine is, however, valuable in both cases. It may be useful to give it by subcutaneous injection.

[1] *Thèse de Paris*, 1882.

CHAPTER XII.

ABORTION.

Abortion may be regarded as an 'accident of gestation.' But the event has so many interesting physiological, pathological, and clinical relations that it demands special study. It is of the deepest importance to analyse carefully the causes remote and immediate which lead to the premature interruption of gestation. This study will throw a flood of light upon many problems that must otherwise remain unsolved, leaving the physician to grope blindly for true therapeutical indications.

Most of the conditions described in the previous chapters on the Diseases of Gestation, Complicated Gestations, and the Accidents of Gestation, may entail abortion. In these chapters, therefore, a great part of the history of abortion has been written. What now remains is to complete this history; to set the subject forth in systematic order, to describe the process, and the prophylactic and therapeutic treatment.

Close clinical study of cases of abortion will establish one point much overlooked—abortion is in many instances a practical protest of the system against gestation. Pregnancy being a physiological test of the soundness of the subject, and the subject proving unsound or unequal to the strain, abortion is nature's resource. Hence we may draw the physiological corollary, that *abortion may be regarded as a conservative process*; and to this we may add the therapeutical corollary: The indications for treatment must be sought in the constitutional as well as in the local conditions.

Three factors have to be considered in the study of abortion: 1. The father. 2. The embryo. 3. The mother. The mother's state is a complex state resuming all three, in those cases especially where the father is the subject of certain diatheses or diseases.

Abortion may or may not be preceded by the death of the embryo.

Death of the embryo necessarily curtails abortion.

Definitions.—Abortion means the arrest of gestation at a stage antecedent to the viability of the embryo.

Abortion is complete when embryo and membranes are expelled.

Abortion is incomplete when the embryo is expelled, the membranes being retained.

Abortion is 'concealed' (Stoltz) when the embryo has perished, and the whole ovum is retained. This has been absurdly styled 'missed abortion,' for, as McClintock put it, every woman who is delivered at term may be said to have missed aborting.

Abortion is the scientific equivalent of the vulgar *miscarriage.*

'*Criminal abortion*' is the legal construction put upon the act of attempting to procure abortion for other than strictly medical reasons, and this whether the attempt be successful or fail.

To the popular mind the word 'abortion' is likely to suggest the idea of wilful or criminal interruption of gestation. To avoid erroneous inferences by non-professional persons, it is therefore judicious to use the word 'miscarriage.' The unskilled also often speak of a 'slight miscarriage,' meaning a very early abortion. We shall use the term 'abortion' only, understanding that it includes all cases of untimely death of the embryo.

Premature labour is distinguished from abortion by occurring after the embryo has attained viability, but is still immature.

'*Missed labour*' means the hypothetical retention of a mature fœtus in the uterus beyond natural term of gestation, signs of labour at the proper time having been manifested. All the presumed cases are resolved into 'concealed abortions' or 'ectopic gestations.'

If we subject all cases of abortions to a broad theoretical analysis from an etiological point of view, we shall find that they may be distributed into two classes: 1. Cases in which the ruling cause lies in the mother. 2. Cases in which the ruling cause was derived from the father. In all cases it may in strictness be contended that, whatever the cause, it acts *through* the mother. But it is not the less true that in many cases the death-giving cause comes solely from the father. The ovum at the moment of fertilisation receives from the male parent the principles of life and death. The female parent may or not be affected morbidly through the embryo. Cases are not uncommon in which a woman has borne a series of aborted ova to one man, and living children to another.

For the purposes of description the analytical method is essential. We are compelled to take the causes of abortion separately in some kind of succession. But when we come to look at cases clinically, we shall often find it impossible to isolate the particular cause which brought about the abortion. In many cases the causes are complex; both paternal and maternal influences may be at work to produce the result. Nor shall we always be able to determine which influence was predominant. The causes specified in the following or in any classification will occasionally overlap.

Some theoretical light, which may be reflected upon the clinical features of the case, may be seen in the condition of the ovum and its involucra. It may be stated broadly, far from absolutely, however, that the impress of the father's fault will be more especially marked in abnormal states of the embryo itself and in its strictly fœtal envelopes, that is, in the amnion and chorion; whilst the impress of the mother's fault will be more especially marked in the maternal envelope, that is, in the decidua and maternal placenta. The diseases of the ovum, including the placenta, will be more conveniently described together under the 'fœtal causes of abortion,' since it is seldom possible to distinguish with precision the causes which begin respectively in the fœtal and maternal elements.

The reciprocal action between the pregnant woman and the embryo forms a subject of study necessary to the just appreciation of the causes of abortion.

Propositions: 1. The blood of the fœtus receives morbific materials from the blood of the mother. This would appear to be self-evident. The fœtus can only grow by what it receives from the mother, and must take what the mother's blood conveys. But this reasoning may be too absolute. It is certain that there exists at the point of contact of the maternal and fœtal bloods some discriminative property by which noxious materials may be arrested or converted. We cannot otherwise account for the fœtus resisting the variolous and other zymotic poisons, as undoubtedly happens. The placenta exercises a function analogous to that of the lymphatic glands, reducing or rejecting noxious stuff brought to it. This function is certainly limited, but it exists.

Experiments, however, prove that along with the healthy constituents, the maternal blood may carry other substances. Thus Flourens gave madder to pregnant animals; the bones of the embryos were coloured with the pigment.

Majendie injected camphor and oil into the vessels of pregnant animals. These foreign substances were quickly detected in the fœtus. David Williams, of Liverpool, performed similar experiments with like results.

Frerichs says that biliary matter in women suffering from jaundice is transmitted to the fœtus. Bonetus describes a fœtus born of a jaundiced woman, '*ita flavus ut e cerâ confectus puer, non partus humanus videretur.*' Similar observations were made by Wrisberg and Finke. But for this a long continuance of the jaundice is necessary. Frerichs says in jaundiced women who have aborted from five to fourteen days after the commencement of the jaundice, he has been unable to perceive any alteration in the colour of the fœtus. In one remarkable and protracted case of jaundice persisting until the moment of parturition, the child was not affected.

Conversely, the blood of the mother may receive noxious elements from the fœtus. This also may appear to be self-evident. The mother's blood is the natural channel by which the waste products of nutrition in the fœtus are carried off. Savory, however, proved this by direct experiment. Opening the uterus of a pregnant sheep, he injected a minute dose of strychnine under the skin of a fœtus; in a very short time the mother exhibited evidence of strychnism.

Again, Hutchinson adduces evidence which seems conclusive that constitutional syphilis may be communicated to mothers by the agency of the diseased ova. Abraham Colles, Baumés, Egan, and Diday affirm that, although abundant instances are known in which syphilitic infants having sore mouths have infected wet-nurses who have suckled them, yet not a single one is recorded in which the child's own mother has been so contaminated. Now as mothers suckle their own infants far oftener than they employ wet-nurses, they ought, were their liability equal, to furnish a larger number of instances of sores communicated from the mouth to the nipple. Whence their immunity? Unless we admit that they have already received from the infant prior to its birth such contamination as it is capable of conveying, the problem is not solved. Balfour, Harvey, Langston Parker, Montgomery, confirm this doctrine of contamination through the fœtus. Parker adds that 'when the father diseases the ovum alone, the mother in a great number of instances escapes.'

To this we may add the remarkable fact observed by ourselves that a woman has borne healthy children to a first husband and abortions to a second.

Analysis of causes of abortion.—Bearing in mind that the analysis sketched below is open to the objections which apply to most pathological analyses, we may accept it as furnishing a useful provisional scheme of classification and basis of description, and as offering a rational clue to clinical investigation. The following table will serve as a classified index of the causes of abortion. These may first be divided into

1. Cases in which the determining cause lies in the mother.
2. " " " father.
3. " " " embryo.

ABORTION.

MATERNAL CAUSES.

I. *Poisons in mother's blood.*
   1. Communicated = *Heterogenetic.* Fevers, malaria, syphilis.
      Gases as CO, CO_2.
      Mineral: lead, copper, mercury.
      Vegetable substances: ergot, savin.
   2. Products of morbid action = *Autogenetic*; as in jaundice, albuminuria.
      CO_2 from asphyxia, and in moribund.
   3. Anæmia, over-suckling, obstinate vomiting.
      Bright's disease, lithiasis, jaundice.

II. *Diseases disturbing the circulation dynamically.*
   Some liver diseases, obstructing portal system.
   Heart diseases, excess of vascular tension.
   Lung diseases, thoracic and abdominal tumours.

III. *Causes acting through the nervous system.*
Some nervous diseases.
Shock, physical and psychical.
Diversion or exhaustion of nerve-force, as from vomiting. Reflex action.
Convulsion. Apoplexy.
(These two last act partly through asphyxia, producing CO_2 in blood.)

IV. *Local or pelvic disease.*
Of uterus, as inflammation, hypertrophy, tumours, diseases of decidua.
Mechanical anomalies, as flexions or versions of uterus, fissures of the cervix uteri, pressure of tumours upon uterus, or adhesions of uterus preventing its growth.

V. *Adolescent and climacteric abortion.*
Uterus immature (infantile), or
Uterus in atrophic involution (senile).

VI. *Artificially caused by violence.*
Blows, squeezing, puncture of uterus, injury to ovum.

Epidemic abortion.

Sympathetic abortion.

FŒTAL CAUSES.

I. *Diseases of ovum.*
Primary or secondary upon diseases of maternal structures or blood.

II. *Diseases of embryo, generally causing its premature death.*
Faults of development.
Diseases of nervous system.
" of kidney.
" of liver.
" general, as syphilis.
Mechanical, as torsion of cord, or anything causing death of embryo.

Hæmorrhage.—Many of the causes, maternal and fœtal, entail *hæmorrhage.* This may be an *apparent* cause of abortion; it is the first objective note of what is going on. But we can hardly imagine a pure primary hæmorrhage. There is an antecedent cause for the hæmorrhage which is probably the real cause of abortion.

Maternal causes.—1. *Poisons in the mother's blood, communicated or heterogenetic.* Foremost in this group rank the zymotic fevers—variola, scarlatina, typhus, typhoid, rubeola, cholera, diphtheria, erysipelas, malaria. The abortifacient in fluence of these diseases has been described in the chapter on the Diseases of Gestation. To that chapter we must refer.

The immediate factors of abortion in fevers are chiefly the following: 1, irritation of the uterine fibre by the specific fever poison carried to it by the mother's blood, exciting the uterus to contract, proved by occasional expulsion of a living embryo or fœtus; 2, irritation of the uterine fibre by hyper-carbonised blood, the result of the zymosis and of imperfect respiration; this may also act primarily upon the uterus; 3, high temperature of the mother. We have seen (p. 481) that the embryo almost invariably perishes when the temperature rises above 105° F.; 4, the embryo may be poisoned by the fever poison. In the two latter cases, the embryo first dying, abortion necessarily follows.

2. *Diathetic disorders or poisons, as inherited or secondary syphilis, struma, tuberculosis.*

Primary syphilis may be classed with the *heterogenetic poisons.* A chancre acquired during gestation is far less likely to lead to abortion than is the secondary or chronic form of syphilis in the mother, or the secondary or tertiary form in the father. When the mother is suffering before impregnation from secondary or tertiary syphilis, the uterine mucous membrane, out of which the decidua and maternal element of the placenta are developed, is liable, like the mucous membrane of the throat and the skin, to be diseased. Hence the fœtal nidus being tainted, the ovum is badly nourished, the placenta is apt to degenerate, and abortion ensues. This will be more fully discussed under 'Diseases of the Placenta.'

The proneness to abort varies. In women who themselves have been the subject of primary syphilis, the proneness to abort is very great. Not so in the case of women infected through the embryo. In these, as Hutchinson notes, the fœtus derives its morbid constitution from but one parent, and in all probability from one who has himself nearly worn out the tendency. It is evident that a fœtus begotten by a father who suffers only from constitutional taint, and nourished in the womb of a healthy mother, excepting insomuch as she may have received contamination from itself, has a very fair chance of life. It is a fact that the vast majority of syphilitic infants are born healthy-looking, and show no sign of disease until from a week to a fortnight old. The most probable explanation of this is that in the vast majority of cases the mother is healthy and the father diseased. Receiving therefore while *in utero* an abundant supply of well-elaborated nutriment, the fœtus lives and thrives, there being no need for the exertion of its own organs of assimilation; but after birth it loses this advantage, and with a constitution enfeebled by its taint, is compelled to digest its food, and to aerate and elaborate its own blood. Hence the speedy manifestation of the hitherto latent disease. In those cases in which the fœtus is born dead, with the skin peeling or covered with eruption, it may be inferred that either the mother has herself had primary disease, or has by repeated pregnancies become saturated with the tertiary taint.

Struma and *tuberculosis* may also affect the uterine mucous membrane, preventing the construction of a healthy placenta, and so promote abortion. Apart from this mode of action, to which we think we have traced some cases of abortion, it does not appear that these diatheses or phthisis are frequent causes of abortion.

Noxious gases.—We know most of the abortifacient influence of *carbonic acid* and *carbonic oxide*. Breslau narrates [1] an instructive example. Two women slept in a room in a lying-in hospital into which gas was suffered to escape. Both were deeply poisoned, rendered insensible, and the fœtus of one was killed. It had been proved to be alive the day before. It was expelled dead next day. The gas was the product of the destructive distillation of wood; it contained a large proportion of carbonic oxide.

In one of the Algerian campaigns it is told that many hundreds of Arabs who had sought refuge in caves were suffocated by lighting fires at the mouths. Many of the women were found to have aborted.

We have also been able to trace abortion to the action of *sewer-gas*.

1. Metallic Impregnations.

Arsenic.—Dr. du Vivier [2] treated two pregnant women for psoriasis with arsenic. Both aborted at seven months of dead children. Dr. A. Guérin observed similar consequences from giving mercury. But under moderate doses not long continued we do not think abortion is very likely to be induced.

[1] *Monatsschr. f. Geburtsk.* 1859.
[2] *Annales de dermatologie,* 1869.

Lead.—M. Paul,[1] from inquiries in type foundries, found that 4 women had 15 pregnancies: of these 10 ended in abortion, 2 in premature labour, 1 in still-birth, and 1 child died in 24 hours. In a second series, 5 women had borne 9 children before working at lead, and had had no abortions. After exposure they had 36 pregnancies; of these 26 ended n abortion, 1 in premature labour, 2 in still-births, and 5 children died, 4 in the first year. A woman had 5 pregnancies all ending in abortion; she left the business and bore a child. A woman having left the business had 2 children, she returned to it, and had 2 abortions. In other observations M. Paul made out that like bad effects follow when only the father works in lead. These observations have all the force of crucial experiments.

In the case of *mercury* an interesting history is given by Ad. Lizé.[2] He observed the influence of this metal upon work-people engaged in the hat manufacture, in which mercury is used. He classified cases in three series: (1) in which men were exposed to exclusion of their wives. Of 10 pregnancies, 2 issued in stillborn children, 3 children died in early infancy, 5 survived in a sickly condition; one born before the father worked in mercury was healthy; (2) husbands and wives both exposed: 14 pregnancies issued in 5 births at term, 5 children stillborn; 2 died before third year, 4 before five years, remaining 3 in doubtful health; (3) women only exposed: of 7 pregnancies, 3 ended in abortion.

In many cases in which the child happens to be born alive, its constitution is deeply impaired, and it often dies young.

These observations on metallic poisoning suggest several inquiries of extreme interest. If we can accept the presumption that in those cases where only the husband was exposed the poison acted from him, the mother serving only as a vehicle, we have evidence of paternal transmission similar to that which we possess in the case of syphilis. This is a point rich in physiological and pathological applications. It must, however, be remembered that the woman, living in close contact with a mercurialised man, could hardly escape contamination by other processes. These cases give strong evidence in favour of the

[1] *Arch. gén. de Médecine*, 1860.
[2] *Union Médicale*, 1862.

præ-natal treatment of the fœtus where it is presumed to be diseased. Further observations are needed in this direction.

Iron has often been accused of causing abortion. The belief in its abortifacient properties lingers in the minds of some medical practitioners. Our observations, based upon long experience of the action of iron on pregnant women, is decidedly contradictory to this opinion. It may be true that a large dose of some forms of iron may excite such disturbance that abortion may follow, but, as a rule, its action is beneficial; it counteracts the anæmia so common in pregnancy; and thus conduces to prevent abortion and to lessen the risk of hæmorrhage in labour.

In connection with iron a few words may be usefully stated as to the presumed identity of ecbolics, emmenagogues, and abortifacients. It is a popular belief prevailing amongst lawyers, and to some extent countenanced by medical men, that agents reputed to have the virtue of provoking menstruation will also provoke abortion. Although there may be a substratum of truth underlying this assumption, nothing can be more unscientific. The causes of amenorrhœa and of abortion are manifold; they frequently differ in nature; and so the agents that may be effective in inducing the one may utterly fail in inducing the other. It is extremely important rightly to appreciate the distinction. Criminal charges have been based upon the administration of iron in medicinal doses, regardless of the fact that iron is strongly indicated in the anæmia of pregnancy to prevent abortion.

Vegetable substances.—Savin, ergot, quinia, pulegium.

Savin may provoke abortion if administered in very large doses. Letheby relates a case.

Ergot has undoubted power to provoke uterine contractions; but in the case of a healthy pregnancy the action of this drug is very uncertain. It frequently fails in the hands of the physician when there is a medical indication to anticipate the normal advent of labour. The subject will be referred to when describing the methods of inducing labour.

Pulegium, or pennyroyal water, has, we believe, no effect whatever.

Generally it may be stated that irritant medicines administered in decidedly irritant doses may produce abortion. In this way strong purgatives in drastic doses may act. But even in cases where abortion follows upon the administration of such doses, there is probably a pre-existing tendency to abort. It may be laid down as an axiom: That *the healthy ovum clings to the healthy uterus with wonderful tenacity.*

2. Products of morbid action; Autogenetic.

Next to poisons invading the body from without, we find a class of poisons generated in the mother's system. Such poisons arise in jaundice, albuminuria, in slow asphyxia from heart and lung disease, and in rapid asphyxia from brain diseases, as apoplexy, and generally in the moribund. In the ordinary forms of *jaundice* which occur in pregnancy, unless attended by severe vomiting, abortion, or premature labour, so far as I have observed, is not common. In malignant jaundice or the acute yellow atrophy of the liver, abortion is almost certain to occur. The entire organism is profoundly deranged. A hæmorrhagic tendency is engendered; effusions are seen in various parts of the body, and uterine hæmorrhage rarely fails. The effusion of blood into the membranes of the ovum is an efficient cause of abortion; but probably other factors concur.

Obstinate vomiting not seldom leads to abortion if much prolonged so as to entail serious blood-poisoning. This is induced by the denial of nutriment from without, so that not only is the ordinary refuse matter of nutrition retained, but the system, feeding upon itself, absorbs its own degraded tissues; the morbidly-exalted irritability of the nervous centres easily responds to eccentric irritation, and abortion results, generally, in our experience, too late to save the patient. When she aborts, she is moribund.

The association of abortion with *albuminuria* is well established. The history of albuminuria in pregnancy has been already traced. It is enough in this connection to observe that three factors concur in bringing about abortion. 1. The hæmorrhagic character of the blood is increased, favouring extravasation into the membranes of the ovum. 2. The retained and accumulating refuse of the processes of nutrition in the fœtal and maternal circulation may empoison and kill the embryo. 3. This refuse poison acting upon the exalted diastaltic centre and upon the uterine fibre provokes uterine contractions. Carbonic acid certainly accumulates in undue proportion during the comatose stage, and this is an efficient cause of abortion.

In the asphyxia, or cyanosis, at first slow and intermittent, then advancing rapidly and becoming intense, of some forms of heart and lung disease, the accumulating carbonic acid is probably the most active factor in causing the abortion so frequently observed. This result may be explained by the action of this poison upon the uterine fibre which Marshall Hall and Brown-Séquard insisted upon, or through the direct irritation of the diastaltic centre, and partly through the extravasating property acquired by the blood.

The efficiency of carbonic acid in the blood in provoking abortion is most clearly demonstrated in the asphyxia of the *moribund*. Thus in coma from cerebral apoplexy I have seen abortion take place with hæmorrhage in the agony of death, when the presumption was strong that no other cause was at work.

2*a*. Closely related to the foregoing examples of autogenetic poisoning are the blood conditions associated with *anæmia*, ordinary and pernicious; of *over-lactation* with *obstinate vomiting*, with *true Bright's disease* (as distinguished from the simple albuminuria of pregnancy), with *lithiasis* and *jaundice*. In anæmia there is infallibly defective elimination of refuse matter; the attachments of the ovum to the uterus are badly maintained, nutrition being imperfect; the blood-vessels easily permit of watery effusion, which still further impair the utero-ovular attachments, and the nervous irritability being exalted, abortion is easily provoked.

Over-suckling.—When a suckling woman conceives, the probability of abortion is great.

The factors are—(1) the blood degradation, or anæmia and its attendant empoisonment; (2) the mal-nutrition of the embryo and its uterine attachments; (3) the tendency to blood and serous exudations; (4) the double eccentric irritation of the diastaltic function proceeding from the uterus and the breast. To this last factor Tyler Smith attributed the main influence. We believe that the first three enter largely into the process. It may be stated broadly that few women can bear the task of supporting three organisms. One must be abandoned, and Nature mostly throws off the least important, the embryo. Often she is aided in this conservative work by the ovaries, which, resuming functional activity, determine blood to the uterus, leading to extravasation and increasing the activity of the diastaltic function.

Anæmia is a very wide term, and includes perhaps conditions of blood that essentially differ. It is often attended by abortion. It may be conjectured that the maternal blood, without carrying any positively poisonous ingredient to the child, may destroy by its negative qualities, by its lacking the proper nutritive and depurating capacity.

Lithiasis has in several cases been the only condition to which an abortion could be referred. It probably is an indication of defective action of the liver and kidneys, and of consequent retention in the blood of refuse matter.

II. Diseases disturbing the Circulation Dynamically.

Liver diseases, which impede the return of blood by the portal system ; heart diseases, especially regurgitant disease and hypertrophy ; and lung disease, with severe dyspnœa are apt to cause abortion. These conditions are rarely simple ; alterations in the blood soon become added to the mechanical difficulty in the circulation.

Excessive vascular tension is a form of dynamic disturbance which may lead to abortion. This, when not much exceeding the normal condition of pregnancy, is met by the accommodating capacity of the system ; but if it be much in excess, or be increased suddenly, abortion is very likely to ensue. Here we see an illustration of the conservative operation of abortion. The ovum thrown off, the dangerous excess of vascular tension is instantly reduced.

Thoracic and abdominal tumours may act by compressing the organs of circulation.

III. Causes acting through the Nervous System.

Strictly speaking all causes involve nervous action ; but here we mean those causes which act primarily or specially through nervous disturbance. We believe the influence commonly attributed to nervous impressions, as emotions, shock, and reflex or diastaltic excitation, is exaggerated. The healthy ovum clings to the healthy uterus with wonderful tenacity. Unless the utero-ovuline attachments be impaired, the strongest emotions may be undergone with impunity. Shock all but fatal, fatal even, has been sustained without provoking abortion. Limbs have been amputated, ovarian tumours have been removed, without disturbing gestation. The explanation seems to be that where nervous impressions act, there is something defective in the gestation. Under extreme anæmia, for example, the embryo may be badly nourished, the utero-placental attachments are tending to degeneration. In such a condition a strong nervous shock, especially if occurring at a menstrual epoch, may suddenly determine an unusual blood-flow to the uterus, and under the hydraulic strain blood is effused into the ovular membranes, and abortion ensues. The extravasation is mechanical. If by hypothesis we substitute the pumping force of the syringe for that of the heart, we might liken the extravasation that takes place under shock or emotion in the living to the extravasation produced by forcible injection of the uterine arteries after death.

That reflex excitation simply is not very efficient is proved by the frequent failure of irritation applied to the cervix uteri to produce abortion. Irritation applied higher up to the fundus uteri almost necessarily involves disruption of the attachments of the ovum as well.

Convulsion, as from vomiting, epilepsy, eclampsia, acts indirectly; partly by derivation of nerve-force from its proper destination, partly by associated blood disorder, partly in some cases by the consequent killing of the embryo, partly by the attendant asphyxia, and partly by concussion or strain telling mechanically upon the uterus. Apoplexy can hardly be said to produce abortion directly by the convulsion. It is, we believe, almost always through the induced asphyxia.

Severe and repeated coughing, especially whooping-cough, may produce abortion by succussion and disturbance of the ovum. This is more likely to tell near the end of gestation. We have several times known coughing to precipitate labour.

IV. Local or Pelvic Diseases.

Disease of the uterus is a frequent cause. Whitehead and Bennet insist much and rightly upon the influence of inflammation and congestion of the cervix in promoting abortion. Whitehead traced to disease of the lower part of the uterus 275 abortions out of 378. Although the cervix does not enter directly into relation with the ovum, it is so far in solidarity with the body of the uterus that excessive hyperæmia of the cervix, with the attendant morbid processes, can hardly fail to entail undue afflux of blood and nervous disturbance in the body of the uterus. Hence the risks of extravasation into the membranes, and abortion. Moreover, a long-standing endometritis will be likely to produce an unhealthy decidua, so that at an early stage of gestation it breaks down, and thus arises another cause of abortion. Frequently, indeed, gestation is prevented by endometritis; but if partially cured, gestation may take place, proceed a little way, and end in abortion.

Placenta prævia, a form of ectopic gestation, in which the ovum grows in the lower zone of the uterine cavity, a site not adapted for full development, often ends in abortion.

Mechanical anomalies of the uterus, as flexions and versions, are frequent causes of abortion. The history of these anomalies will be traced elsewhere.

Tumours in the walls of the uterus and extra-uterine tumours, especially the former, readily cause abortion. These complications have been described in the chapter on Diseases of Gestation.

Fissures of the cervix uteri, the result of injury sustained in labour, may, according to Whitehead and Emmet, lead to abortion.

Adhesions of the uterus, the result of peritonitis, may cause abortion by impeding the due growth and evolution of the uterus.

V. Adolescent and Climacteric Abortions.

The two extremes of the reproductive epoch are often signalised by abortion. Impregnation may take place before the uterus is developed enough to carry through the gestation. Its capacity for keeping pace with the rapidly-growing ovum being outrun, abortion ensues. Added to this incapacity of immaturity other conditions may concur. The fact is undoubted that very early pregnancies give a large proportion of abortions. Whitehead says that in Manchester marriage before pubescence is frequent, and abortions result. Probably sexual excesses enter as a factor. Serres found abortion at four or five weeks very frequent in young prostitutes.

During the period of sexual decline, abortion is very common. The last effort of the generative system seems to be to produce a child. Advancing atrophic involution cuts short the gestation. Ovulation or the maturation of ova begins before, and persists for a time beyond, the capacity of the uterus to adapt itself to the development of the embryo. Towards the climacteric the muscular structure of the uterus begins to degenerate. A process of atrophy sets in. The mucous membrane, too, undergoes a change which unfits it for development into decidua. This, added to a disposition to menorrhagia depending upon torpid hepatic circulation, determines abortion at about two or three months of gestation, or earlier. A frequent factor of abortion at each extreme of life, especially at the climacteric, is the marked disposition to hæmorrhage.

VI. Abortions artificially caused by Violence.

Blows, or severe pressure upon the abdomen, may cause disruption of the utero-placental attachments, and thus entail abortion. We have known several instances of women subjected to squeezing in crowds aborting. In such cases metritis and perimetritis are likely to follow; in some cases even rupture of the uterus has been thus produced.

Then there are *injuries inflicted directly upon the ovum*, mostly with the intent to procure abortion. These are generally in the form of punctures or tearings of the ovum by means of instruments passed into the uterus.

Tardieu[1] enumerates the following as amongst the means resorted to:—

[1] *Étude médico-légale sur l'avortement.*

1. *Indirect means.*—Bleeding: but this is generally of no effect; baths; forced exertions. Medicines: he denies the efficacy of squills, sarsaparilla, guaiacum, aloes, camomile, matricaria, saffron, borax, juniper, iodine, savin, rue, ergot, taxus baccata.

2. *Direct methods.*—The use of stilets, injections. Tardieu cites a large number of deaths following criminal abortion.

Surgical operations.—In this place it is convenient to give a summary view of the relation of surgical operations to gravidity. This subject has been discussed by Robert Barnes[1] and Cohnstein.[2]

Venesection and tooth-drawing do not entail serious risk of abortion or other evil. Cohnstein collects eleven cases of herniotomy, the patients being from three to six months pregnant. In 3 abortion followed soon after the operation; in 1 of these death ensued by peritonitis; in 7 the gravidity went on to term, living children being brought forth. Crural hernia was the most frequent form. Healing was quick. Considering that the operation was resorted to after procrastination and repeated taxis, it can hardly be said that the gravidity made much difference in the result.

Penetrating wounds of the abdomen, from falling on a pitchfork, from a scythe, or by goring by a bull's horn, have generally caused abortion, even when the uterus escaped injury. (In one classical case Cæsarian section was performed by a bull.) Healing of the wound has been quick.

Tracheotomy has been done in 6 cases. In 3 death ensued within forty-eight hours—that is, the operation failed to save. In 2 abortion quickly followed. It is probable that the defective oxygenation of the blood due to the disease which called for the operation was a material factor in causing the abortion.

It does not appear that the bones are more liable to fracture than in the non-gravid state; the healing is as good. Even complicated fractures have not induced abortion. There is a history of a woman falling from a great height to escape from a house on fire without aborting. Four cases of amputation of

[1] Lane's ed. of Cooper's *Surg. Dictionary*.
[2] *Volkmann's Klinisch. Vorträge*, 1870–75.

limbs[1] are recorded; in 2 abortion occurred; 1 woman died of septicæmia.

Operations, even upon the genital organs, may be performed with safety. Œdema of the vulva may be drained by Southey's tube. The labia, hypertrophied by cancer or condyloma, may be amputated. Robert Barnes has thus removed an enormous mass of condylomata, the patient doing well. Polypus uteri, if projecting into the vagina, may be removed. This is best done by the wire-écraseur.

Ulceration, so called, of the cervix uteri has been repeatedly treated by caustics without inducing abortion. We must, however, affirm that such treatment is very rarely called for. The intense hyperæmia and epithelium-shedding characteristic of gestation have been mistaken for inflammation and ulceration, and even for epithelioma.

Amputation of the cervix uteri, or at least of the vaginal portion, for epithelioma, has been practised several times, by ourselves amongst others, without entailing abortion or other mishap.

The breast has also been amputated for cancer successfully. Tapping for ascites may be done without special danger. The comparative safety of ovariotomy has been noted.

Griesinger says that operations on pregnant women suffering from diabetes may be fatal.

In discussing the question of operating we must be governed by the nature and urgency of the surgical indication. If this is clear, the complication of gestation may be practically disregarded. We cannot be justified in letting a woman drift into peril from advancing disease, refusing her the resources of surgery because she is pregnant. If at any time there might have been a dispute upon this point, the advances in surgery, aided by Listerism, are enough to solve all doubt.

Reparative processes seem even to be promoted by the conditions of pregnancy. The risk of septicæmia is even less. A cognate question is as to the action of chloroform. Does chloroform, or ether-narcosis, dispose to abortion? We are inclined to think it does. But even this consideration cannot outweigh that of the indication for surgical treatment.

Epidemic, or endemic abortion has been described. In

[1] See Napper, *Obst. Trans.* 1866, for one.

certain seasons and in certain districts it has been observed that abortion was so common as to suggest the presence of an epidemic influence. Are abortions more prevalent during epidemics of fever amongst women who do not manifest the usual characters of the disease? It is not improbable that the zymotic poison may be taken up by the pregnant woman, and provoke abortion either by first killing the embryo, or by exciting uterine action.

In times of great political agitation, terror may cause abortion in many women simultaneously; but there is reason to conjecture that physical meteorological agencies may have similar influences. Although the fœtus does not breathe directly, it breathes through its mother. It is, therefore, subject to the influence of the air which the mother breathes. If the south wind prevails in the winter, if the season is rainy and the spring cold, pregnant women are liable to abort; and if they go their time, the children are languid and weak.[1]

Sympathetic abortion has relations to the preceding conditions. Pregnant women, in proportion as they approach their time, at the sight of other women in labour often experience uterine contractions. A similar phenomenon is observed amongst cows. A doctor in the family way should not attend a woman in labour; awkward complications might arise.

The Process of Abortion.

In a large proportion of the cases of abortion occurring under the above influences, not only very marked congestion, but extravasations in various forms are found in the placenta and membranes. The abortion is brought about in one of two ways. The embryo may or may not be destroyed prior to the expulsion of the ovum. The process of extrusion may be slow and gradual or abrupt. But the chief distinction that pathological observation leads us to make, is that between abortions following upon simple congestion, and abortions from congestion complicated with extravasation. In the first class the process is as follows: in those conditions of the maternal system which bring about a gradual deterioration of the mother's blood, the

[1] *Clinique des hôpitaux des enfants*, 1842.

placental congestion is of a passive character; the nutritive and eliminative changes required by the fœtus are consequently imperfectly carried on; but it is only gradually that the embryo suffers, and its death may be long postponed. In abortions of this class the death of the fœtus is the *first* step. The *second* consists in the death of the placenta, which for the most part, but not always, soon follows upon the withdrawal of the attractive force which the life-processes of the embryo supply. The fœtal portion always dies, and quickly, as necessarily as does the lung of the air-breathing animal. It is the maternal portion that may, and sometimes does, live on for an indefinite period. But whether the whole placenta die immediately after the death of the embryo, or whether the maternal portion retain for a time its vascular connection with the uterus, the probability is great that the embryo will soon be expelled from the uterus. It often happens, especially in the case of abortion after the fourth month, that the embryo is expelled before the placenta and membranes, these last retaining a more or less intimate relation to the uterus for some time longer. But in abortions at an earlier period, and especially as we approach the third or second month of gestation, the ovum more usually comes away in a mass. But for this to happen, a *third* stage must be completed: the death of the fœtal and maternal placenta and envelopes taking place retrogressively, the vascular connections between the uterus and placenta are cut off; the uterus itself, no longer stimulated to active growth, falls back towards the unimpregnated condition—that is, it undergoes a process of involution, its blood supply diminishes, and its muscular structure, first feeling the want of nutritive elements, and then undergoing fatty metamorphosis, the uterus rapidly contracts in all its dimensions. But simultaneously with the involution of the muscular structure of the uterus, the decidua is undergoing a similar process. The end of the involution of the uterine mucous membrane is exfoliation or detachment. The minute observation of a considerable number of aborted ova, in cases where the abortion followed upon death of the embryo, has satisfied us that this gradual detachment of the mucous membrane is effected by a fatty metamorphosis of its elements. This detachment effected, the ovum lies loose in the cavity of the uterus, and is in all respects a foreign body. When the contraction of the uterus attending its advancing involution has attained a certain point, the dead ovum is pressed upon by the walls of the lessening cavity. The contraction, which up to this moment had been mainly atrophic and passive, is now replaced by active muscular contraction, the result of reflex or diastaltic excitation. Under this spasmodic action, the *fourth* stage of abortion, the expulsion of the ovum is effected. But sometimes the stimulus to expulsive uterine contraction is of a different kind; the diastaltic arc does not begin and end in the uterus itself. The ovaries resume their sway, and the next menstrual or ovulation nisus will stimulate the uterus to contract, the menstrual blood effusion precipitating the detachment.

The separation may thus be forcible. What violence sometimes attends this separation of the maternal element of the placenta may be judged of from a fact we have often observed: the uterus, contracting with spasmodic fury, not only casts off its mucous membrane, but numerous muscular fibres are torn off with it. These may be seen, by the microscope, attached to the decidua on the external surface of the expelled ovum.

Such is the course of the abortive process, as it usually takes place when the death of the fœtus, ensuing upon passive congestion or slow asphyxia, constitutes the first step. But abortion frequently happens much more suddenly. Under the influence of any of the causes producing congestion, it may be that, owing to a peculiar hæmorrhagic condition of the blood, the exaggerated force with which the congestion acts, or more frequently, to the intercurrence of some powerful exciting cause, active congestion of the uterus, of course extending to the decidua or maternal placenta, is induced. This is quickly followed by extravasation into the placental parenchyma. Should the extravasation be extensive, so as to disable *suddenly* a large portion of the placenta, the fœtus is destroyed immediately, and in all probability the commotion set up in the uterus goes on to excite active contraction, so that the forcible separation and extrusion of the ovum are effected. Sometimes, however, although the extravasation is extensive, the embryo is not so immediately killed but that the complete detachment and expulsion of the ovum precede, the embryo being born alive. In such cases it commonly happens that the ovum is burst by the violent compression of the uterus, and the embryo is expelled before the membranes.

Theoretically and actually the causes of abortion are *predisposing and exciting*. It is of clinical importance to recognise this. It is true that emotion, shock, coitus, ovarian, mammary, alimentary irritation may seem to be causes of abortion; but abortion induced purely in this manner is of very rare occurrence. The healthy uterus, containing a healthy ovum, is not at the mercy of every emotional or diastaltic accident. To admit the affirmative would be an impeachment against the conservative provisions of Nature. The action of these influences presupposes conditions favouring abortion. Diastaltic action, in fine, is the mechanical force which completes the abortion, not its primary cause.

The most common period of abortion.—The greater number of abortions probably take place at the second and third months of gestation—that is, before the fœtal and maternal elements of the placenta have fairly amalgamated. It is probable also that a number of ova perish at an early period from original defect of vitality.

The symptoms and diagnosis of abortion.—The two main symptoms are *hæmorrhage* and *pain*. In most cases hæmorrhage is preceded by thin mucous or watery discharges, pain at first not being felt. This may go on for two, three, or more days, when gradually or suddenly blood is observed. If the blood be copious, and especially if it come in clots, pain usually sets in. When these two signs concur, abortion is imminent. The pain is likened to colic at first in the hypogastrium; later it is likened to labour-pains. The colic indicates distension of the uterus by blood; the labour-pains the contraction of the uterus to expel its contents. But it must be remembered that neither pain nor hæmorrhage is necessary to abortion.

To *diagnose abortion in progress* we must first prove pregnancy. To distinguish abortion from dysmenorrhœa and menorrhagia we rely upon a history of—(1) one or more missed menstruations; (2) a uterus uniformly enlarged to correspond with the time elapsed since the last menstruation, and the other objective signs of early pregnancy; (3) we seek to exclude other conditions which may account for the suspension of menstruation and the uterine enlargement.

The conditions found on examination are significant: the *vagina is relaxed, lubricated with mucus; the uterus is lowered in the pelvic cavity*; and if contractions have set in, there is a characteristic *dilatation of the vaginal roof*, forming a true cavity, the walls being held apart. This is due to the contraction of the muscular fibres in the broad and round ligaments which pull the vaginal roof upwards and outwards, whilst the body of the uterus is driven down into it. This condition was described by E. Martin. In conjunction with copious hæmorrhage and pain it is almost pathognomonic of abortion. It may to some extent be simulated during the expulsion of a polypus; but mostly the presence of adjunctive symptoms will establish the diagnosis. Then there is observed *softening and dilatation of the os externum and cervix uteri.* And if abortion is advancing, we shall feel a soft quaggy substance presenting in the cervix, which may be clot or a portion of the ovum.

To *diagnose an accomplished abortion* we examine the substances expelled from the vagina. If we detect chorion-villi, the evidence is conclusive. Wanting this, a discreet reserve is the wisest policy. We may generally conclude that the abortion is not completed—that is, that something is still retained *in utero* if hæmorrhage and pain continue.

According to the age of the conception and other circumstances, the ovum comes away in different forms. In abortions, at from six to eight weeks, the embryo is often expelled enveloped in its amnion and chorion. The shaggy white villi are seen covering a small bladder which contains a clear fluid — the liquor amnii and the embryo. The decidua may remain attached for some time longer. In abortions at three or four months, the embryo is sometimes expelled first alone, the ovum having burst *in utero*. Then the amnion, chorion, decidua, and placenta are cast out together. But the whole ovum may come away *en masse*. This is more likely to happen when the embryo has perished some time before expulsion, and when the process of retrogression of the connecting media between uterus and placenta has made some progress. The diseased ova are the most likely to be thrown off in this entire form.

In every case it is important to examine what comes away, to judge whether any part yet remains unaccounted for.

Treatment.—Rest in bed must be enforced. The first point to consider is: Can the threatening abortion be averted? Can the gestation continue? All hope of this may be given up if we find any portion of the ovum in the discharges, or if hæmorrhage and pain continue, and the cervix be dilating. Under these conditions, the sooner the uterus is emptied the better. But this does not always imply that it is necessary or wise to empty the uterus precipitately. So long as the hæmorrhage is moderate in amount, it may be wise to temporise, giving time for the natural forces to loosen the attachments of the ovum to the uterus. The pain and hæmorrhage may be moderated by digitalis, hamamelis, and opium; and if it be considered desirable to promote active contraction of the uterus, ergot may be given. Watching the patient, we estimate the impression made upon her system by the losses. If we find hæmorrhage continue, the pulse rising in frequency, falling in strength, tendency to syncope, we may conclude that expectancy is no longer safe, and we proceed to empty the uterus.

How to empty the uterus?—If the cervix be well expanded so as to admit one or two fingers, the patient is rendered insensible by ether or chloroform. Lying on her left side in obstetric posture, one or two fingers of the left hand are passed into the uterus, whilst the fundus uteri is pressed firmly down upon the exploring fingers. In this way the cavity of the uterus is explored and the ovum is detached. Great care is necessary in this operation; it is often very difficult; and without anæsthesia most painful. Not seldom it is necessary to pass the entire hand into the vagina. It requires firmness, gentleness, and patience.

Levret and others used ovum-forceps and scoops to bring away the ovum; and from time to time instruments of this description are re-invented for this purpose. Without absolutely condemning them, we may say that experience has taught us to abandon them. No instrument can vie with the sentient finger, which, whilst carrying out the operation, gives information of its progress and tells us when it is completed.

Care should be taken to ensure relief of the bowels. A copious enema of soap and water with a table-spoonful of turpentine proves of great value.

Then there is another case. Hæmorrhage, and the general condition of the patient, indicate that it is expedient to deliver, and yet the undilated cervix will not permit the operation to be carried out. What is to be done? The vagina may be plugged with pledgets of lint or sponge, squeezed out of weak carbolic water, 1 in 50, a string being attached to each to facilitate removal. In this way a twofold object is accomplished. The hæmorrhage is retarded, if not stopped, and the dilatation of the cervix is promoted by diastaltic excitation. Commonly in a few hours the plugs get so compressed and hardened by infiltration of blood, that they cease to fill the vagina, and blood may flow past. But the plugs should rarely be left more than eight hours. Fresh ones may be introduced if required. Whilst in use, it is necessary to ascertain if the bladder is relieved. The catheter may be required.

Should plugging the vagina fail, or the urgency of the case indicate more certain proceedings, the cervix itself should be dilated. One or more laminaria or sponge-tents may be introduced into the cervix, and kept from slipping out by a vaginal plug. This will always command sufficient dilatation within six or eight hours, and in the meantime hæmorrhage is controlled.

Should hæmorrhage persist after the emptying of the uterus, and the subject be considered to be in danger, ergot, acids, opium, turpentine may be tried; but if obstinate, we have recourse to topical treatment. First, we may insert a piece of ice in the uterus; this failing, we may inject gently a stream of hot water (110° F.) into the uterus; then a stream of cold water; then a solution of tincture of iodine, 1 in 10, tepid; and if this fail, the case is one for stronger styptics, of which the most efficient is the ferric chloride. This should be applied by swabbing the interior of the uterus with a probang, armed with sponge soaked in the solution, 1 in 10.

It is very rare for fatal hæmorrhage to attend abortion, but drainage may be so severe as to expose the patient to other dangers.

The *after history of abortion* is similar to that of labour at term.

1. *The physiological phenomena.*—When completed, the hæmorrhagic discharge gradually lessens; it becomes more watery, then mucous; merging into leucorrhea. The uterus

contracts, undergoes involution, and the return to the ordinary state of non-pregnancy is completed within a month. Not seldom a menstrual flow will set in a month after the abortion, but sometimes a period may be missed.

2. *Pathological.*—The subject is liable to the diseases of low nervous and vascular tension.

After-treatment.—Even in so-called 'slight miscarriages' rest in bed for a week at least is wise. The patient is liable to all the ills that may attend labour at term. Locally, there is the risk of metritis, perimetritis, thrombosis, and retroversion of the uterus if the patient get up too soon. Constitutionally, septicæmia may arise.

To obviate these accidents, the diet should be moderate; generally stimulants should be avoided; ergot, quinine, digitalis, opium are useful for the first week. The vagina should be syringed out daily with carbolised water, 1 in 50. If the discharge is offensive, the physician himself should syringe out the uterus.

In the event of septicæmia, the uterus should be explored to make sure that there is no part of ovum, clot, or offensive matter there.

The restorative treatment is conducted on ordinary principles. The recovery from the abortion effected, *prophylactic treatment* comes into consideration. The causes which led to the abortion may persist or return. We must trace back, if possible, the history of the patient, and subject her to such treatment as may be indicated. One rule we hold to be of great practical importance: if the patient has been known to suffer from retroversion or prolapsus of the uterus, a suitable Hodge pessary should be adjusted on her resuming the upright posture, and worn for two or three months, or until the pelvic structures and the system at large have recovered due tone.

CHAPTER XIII.

DISEASES OF THE EMBRYO.[1]

EVIDENCE is not wanting to prove that the embryo may be diseased, deformed, and perish through inherent fault derived from the father, the mother remaining healthy. In this way the embryo itself must be regarded as the proximate cause of abortion. Heredity from the paternal side, then, accounts for some abortions. It has been stated in an earlier part of this work that we must regard the ovum from the moment of impregnation as a distinct animal, possessing an individuality of its own; that it finds in the uterus a nidus where it may go through the earlier or incubative stages of its growth; and that in this position, although dependent upon the mother for the materials of nutrition and for the means of excretion, it is not strictly a part of the mother, but a new organism grafted upon her. It is strictly a parasite.

In searching out the diseases of the embryo, we are necessarily led to examine the placenta. This organ, in fact, holds a part of the embryo. We shall, therefore, follow up the study of the conditions of the body of the embryo by tracing the abnormal conditions of the fœtal element of the placenta. On the other hand, we shall have to trace the morbid conditions of the mother, structural and humoral, into the maternal element of the placenta. Thus, taking up the diseases of the fœtal and maternal elements, first separately, we shall then endeavour to trace them to their point of junction, and to examine their mutual reactions. The study is beset with difficulties; we are compelled to have recourse to *à priori* reasoning, sometimes to conjecture, but it will amply repay

[1] The student is advised to turn back to the chapter on the Physiology of the Embryo. Thus prepared, he will enter upon the study of the diseases of the embryo with greater intelligence and profit.

investigation. In this study we may perhaps discover the germs of the pathology of the child and the adult; we ascend more nearly to the origin of diathesis, the great problem in pathology, the one most momentous in its influence upon the human race.

CLASSIFICATION OF THE FŒTAL CAUSES OF ABORTION.

A. *Diseases of embryo generally causing its premature death.*
- Faults of development; some monstrosities.
- Diseases of nervous system.
- Diseases of kidney, liver.
- Diseases, general, as syphilis.
- Mechanical, or anything causing death of embryo, as torsion of the cord, strangulation of the cord, pressure from a twin fœtus.
- Inflammation of serous membranes: peritonitis, pericarditis, pleuritis.
- Sclerema, ichthyosis, goître, or bronchocele.

B. *Diseases of the ovum, membranes, and placenta.*

The membranes of placenta are compounded of *fœtal elements* and *maternal elements.*

Hence there are *diseases of the fœtal element* mostly derived from the fœtus and the father, and *diseases of the maternal element* mostly derived from the mother.

1. Diseases of the *fœtal element, i.e.* of the amnion and chorion: congestion and inflammation.

   Dropsy, hypertrophy, atrophy cystic or hydatidiform degeneration, fatty degeneration, calcareous degeneration.

2. Diseases of *maternal element of placenta.*

   Disease of decidua, not yet formed into placenta, inflammatory, syphilitic, strumous.

   Disease of decidua when forming part of structure of placenta: congestion, inflammation, abscess, apoplexy or hæmatoma, 'fleshy mole,' fibrinous effusions, induration, hypertrophy, atrophy, fatty, calcareous, and fibrous degenerations.

   Distinction between fatty degeneration and fatty metamorphosis; fatty degeneration attacks living tissues, and is of pathological significance; fatty metamorphosis is a change in dead tissue.

   Fleshy, fibrinous, fibrous tissue moles, distinguished from placental or true ovular moles.

The following sketch of the pathology of the embryo is not limited to the description of those conditions or cases which lead to abortion. Such a limitation would present but a very partial view of the subject. It is therefore more convenient and instructive to sketch in one continuous history the malformations and diseases of the embryo and fœtus, whether resulting in abortion or not. In one sense, indeed, many even of the subjects of intra-uterine disease and malformation which survive birth may be said to be abortions. They are more or less unfitted for life, and are frequently foredoomed to early death.

Malformations.—In early times, even down to the eighteenth century, malformations gave unbounded scope to the fancy. Heads of dogs, cats, pigs have been depicted set upon human bodies; the '*mulier formosa superne quæ desinit in piscem*' has even been exhibited in our day. But these creations of the imagination have vanished from scientific discussion, and their place is taken by well-observed facts. The study of development now supplies the basis for a scientific understanding of the genesis of the various forms.

The scope of this work makes it impossible to give even a sketch of the infinite aberrations met with. We refer to the admirable works of Förster[1] and of Ahlfeld,[2] in which they are systematically described and figured. We must be content with describing the more common varieties which offer special clinical interest, either in their bearing upon labour or as regards the immediate treatment of the new-born subjects. Those aberrations of form which give rise to dystocia will be referred to in that connection.

Definition.—Comprehensively, malformations are defined as *vitia primæ conformationis*, including every aberration of form due to disturbance in the first stages of the evolution of the embryo. Usage has assigned various designations to the degrees of deformity. Thus: a malformation affecting a large part, and assuming an ugly or revolting appearance, is called a *monster*, or '*teras*' (from *τέρας*, a sign, portent, or huge unearthly monster); if the body generally is well-shaped, and only small parts are malformed, it is called a *lusus naturæ*, anomaly, or deformation, and slighter degrees are called *varieties*.

Many *classifications* have been propounded. Geoffrey St. Hilaire's is the basis of most.

We quote the following passage from Simpson:—'The happy idea that was first suggested by the master mind of Harvey, relative to certain malformations consisting, *not* in the

[1] *Missbildungen der Menschen*, 1861.

[2] *Die Missbildungen der Menschen, mit Atlas*, 1880–82.

substitution of an entirely new and anomalous type of structure in the malformed part, but only in the simple *permanence* of some of its transitory fœtal types, has been reduced within the last thirty years (before 1839) by the able investigations of Wolff, Autenrieth, Meckel, St. Hilaire, and others into one of the most certain and comprehensive, and at the same time one of the most beautiful, laws in teratological anatomy.'

Ahlfeld discusses the several theories of the genesis of malformations. In the first place, he ranks the cases of *splitting of the not-yet differentiated germ.* These are the *double formations.* First of these is *entire splitting of the germ.* These are:—1. Homologous twins; 2. Omphalopagus (union of twins at the umbilicus); 3. Thoracopagus (union at the chest); 4. *Craniopagus*, with its varieties; 5. *Sacralteratom*; 6. *Inclusions:* i. abdominalis (double inclusions), i. testiculi, i. ovarii, i. subcutanea, i. of the mediastinum, i. of the lungs, i. of the cranial cavity.

Fœtal transplantations.

Partial splitting of the germ.

Multiple splitting of the germ.

Homologous triplets.

Tricephalus.

Splitting of single organs, or duplication.—Doubling of the extremities, of the hands, feet, fingers, toes; splitting of the finger-nail, splitting of the mammary-gland, or polymastia; doubling of the nipple; multiplication of the vertebræ (formation of a tail, tail-like outgrowths); multiplication of the ribs, cervical.

Giant formations.

Gigantic growth.—Excessive development of one entire half of the body; excessive development of the whole heart; strong development of one-half of the head; one-sided enlargement of one limb; gigantic growth of hands and feet; trophy of the external ear, of the cheeks; macroglossia; gigantic growth of a tooth; struma congenita; hypertrophy of breast, heart, kidneys, bladder, uterus, clitoris, penis.

Splittings of the anterior union line.—These will be noticed hereafter.

Splittings of the posterior union line.—Watery collections in the course of the cerebro-spinal canal; hydrocephalus;

defective ossification of the cranial vault; intercalated bones; cerebral hernia; encephalocele and hydrencephalocele, occipital and frontal; cerebral hernia of the base; microcephalus; parencephalus; cyclopus; hemicephalus; hemicrania; cranioschisis; spina bifida; cysts of the sacrum.

We will now point out more especially the principal deformities which it is important to recognise clinically with a view to surgical treatment. For the following summary we are chiefly indebted to Mr. Noble Smith, whose studies and experience in this relation give him an authority to which we cannot pretend.

DEFORMITIES FROM ARREST OF DEVELOPMENT.

1. Non-closure of the anterior part of the body (the visceral arches), more or less extensive.

(*a.*) In which the whole anterior part of the body is fissured, leaving the thoracic and abdominal viscera exposed, and often, also, displaced.

(*b.*) Fissure of the thorax alone.

(*c.*) Fissure of the abdomen alone.

(*d.*) Fissure of the pubic and hypogastric region.

There may be only a fissured sternum, or deficiency of its lower end, or deficiency of muscular structure.

2. Fissure of the face, including cleft palate, hare-lip, &c.

3. Fissure of the skull (acrania). Various degrees of deficiencies of the cranium have been grouped with various types.

4. Fissure of the back part of the body from non-closure of dorsal laminæ, producing spina bifida.

5. Hydrocephalus.

6. Acephalus. Fœtus without a head.

7. Want and defective formation of the trunk.

8. Absence or defective formation of the extremities.

9. **Cyclopia.**

10. **Deficiency of lower jaw.**

DEFORMITIES FROM EXCESS OF DEVELOPMENT.

1. Fœtus in fœtu. Some remarkable examples are known. We have seen a specimen in the Munich Museum of the chest

of a man who had served as an officer in the army. Included in it is a nearly developed fœtus.

II. Parasitic monsters.

III. Double monsters.

IV. Additional parts, such as supernumerary arms, legs, fingers, toes, &c.

MONSTROSITIES.

Under this head we include those severe cases of malformation which cannot be benefited by surgical operation, and which are either born dead or die very soon after birth; and also cases of united fœtuses, regarding which the question of surgical interference may arise.

Twin children united together.—If the children are in juxtaposition, and the union extensive, a successful separation is impossible. If a band of union exists between them an operation may possibly be practicable. At the *post-mortem* examination of the Siamese twins, Dr. Pancost considered that the closeness of the two livers, and the free anastomoses of the two portal circulations, would have rendered an operation in adult life fatal; but that separation might have been, perhaps, safely effected at the time of birth.

Parasitic fœtus.—In this monstrosity an imperfectly-developed fœtus, or part of a fœtus, is attached more or less extensively to a living child who is otherwise healthy. If there is no insuperable barrier to operation, such as the implication of vital organs, the removal should be effected in early infancy, care being taken that the child is in good health at the time.

DEFORMITIES OF THE HEAD AND NECK.

Hernia of the contents of the skull may exist either as *meningocele*—the protrusion of a sac filled with fluid communicating with the ventricles of the brain—or as *encephalocele*, in which the brain protrudes covered by its membranes, or the sac may contain both brain and fluid.

The **cause** of these conditions is probably always hydrocephalus; their **situation** is generally in some part of the middle line of the skull, extending from the root of the nose to the base of the occipital bone; but the protrusion may take place at any part of the skull where the bones are united by membrane—at the inner side, or above the orbit, or at the side of the skull, or even at the base; the tumour from the latter situation has been known to protrude out of the mouth.

Diagnosis.—The fact of there being a congenital tumour in one of the possible situations of this deformity is strong presumptive evidence. Any one of the following symptoms is confirmatory:—

1. Transparency.
2. Brain symptoms produced by pressing the tumour.
3. Pulsation, unless due to pulsating cancer of the bone, which, however, has never been known to be congenital.
4. Irreducibility by pressure.

But the above symptoms may be absent, and the diagnosis very difficult. Great caution should be observed in forming an opinion.

A sebaceous or encysted tumour can be freely moved over the skull. Erectile tissue may exist over an encephalocele, and so disguise it.

Treatment.—The tumour should be supported by a gutta-percha shield. If it enlarges, pressure may be tried, and if the case be one of meningocele, and increasing so rapidly that it threatens a fatal result, the injection of Dr. Morton's iodo-glycerine may be worth trying. A few cases have been cured by injection of iodine, but of course any operation upon such a tumour is a most serious and desperate proceeding, and, even if successful at the time, the child is very likely to succumb, at a later period, to hydrocephalus.

Deficiencies in the bones of the skull.—In consequence of imperfect development of the bones of the skull, openings may be found in the cranium. These are quite distinct from

Unossified fontanelles.

Hydrocephalus.

Supernumerary cranial bones.

Thickening of sterno-mastoid muscle—probably a hypertrophy—can be cured by simple treatment: hot-water bathing and the application of iodide of potassium ointment.

Acephalous monsters.—One example is carefully described by Dr. Dickinson.[1] Like all others of the same character, it was a twin. It had no head, heart, lungs, or liver. Drs. Young, Brodie, and A. Cooper found, as is constant in these cases, both cords attached to the same placenta. The cords anastomosed. The maintenance of the monster is due to the heart-impulse of the well-developed twin.

Hare-lip may occur alone or in combination with fissure of the palate. The common form is that of a division of the upper lip upon one side, opposite and joining the centre of the nostril.

Varieties:—

(1.) Cleft in the muscular structure only, skin and mucous membrane being normal, but the covering stretches, and a gap gradually forms. The upper part of the cleft only may be covered in this manner.

(2.) Double hare-lip.

(3.) Double hare-lip, with loose and projecting intermaxillary bone. The number of teeth in the latter bone may vary.

(4.) Absence of inter-maxillary bone, the cleft being in the middle of the lip.

Operation.—Age at which it should be performed. If the child has no difficulty in sucking, Noble Smith is of opinion that surgical interference may be delayed until the child is about two months old, or until he is in good general health; but when bad health results from inability to suck perfectly, no time should be lost in performing an operation. Dubois was decidedly in favour of early operation. *Chloroform* should be given for the operation if we can manage to prevent the blood from running into the trachea; this has hitherto been found a great difficulty.

Fissure of the lower lip occurs very rarely.

Lateral fissure of the mouth.

Lateral fissure of the nose.

The treatment of these deformities presents no great difficulties.

Cleft palate.—The uvula alone may be cleft, or the fissure may involve more or less of the soft palate. The hard palate may also be un-united in the middle line as far forwards as the

[1] *Med.-Chir. Trans.* 1863.

alveolar ridge, from which point, if the fissure is continued, it proceeds upon one or other side of the intermaxillary portion of the bones of the upper jaw, or, in the most severe cases, proceeds at both sides of this piece of bone. The cleft is sometimes, though rarely, in the middle line of the palate only, union of the parts having taken place before and behind the deficiency. In the most severe cases the intermaxillary bone is separated from the superior maxilla and attached to the septum nasi. Varieties between these extremes exist.

Treatment.—There is often great danger to the child from inability to suck; so the child must be fed artificially. The bottle (containing its mother's milk) must be so arranged that its contents will flow easily into the throat.

Operation chiefly aims at allowing speech to be properly acquired, and should be deferred until the child is between two and three years of age.

Absence of one or other of the bones of the face.

Fissures from non-union of upper maxillary bones.

Supernumerary lower jaw.

Dislocation of jaw.

In these cases there is always some malformation of the bones.

Atresia oris.—Complete closure of the mouth is a rare deformity, and is sometimes the result of deficient development of the lower jaw.

Treatment.—Transverse incision and the use of a mechanical appliance to keep the parts asunder, or other means to prevent re-union.

Microstoma oris.—Extreme smallness of the mouth is also very rare, and is sometimes associated with deficiencies of neighbouring parts.

Treatment, if any is necessary, should be by gradual dilatation or operation.

Absence of the nose.

Absence of one or both eyes.

Absence of the eyelids.

Absence or deformed shape of the iris.

Cataract.—The late Mr. Critchett informed us that congenital cataract is not rare.

Absence, deficiency, or misplacement of the ears. Atresia

auris.—The auricles may be misshapen in various degrees, or may be rudimentary, or supernumerary auricles may exist in the neck.

Treatment. — Misshapen ears may often be improved by means of carefully arranged mechanical means.

In cases of closure of the meatus, if the organ of hearing is supposed to be perfect, an operation may be considered. Supernumerary auricles may be removed. In any of these cases treatment should be resorted to early.

Fissures and fistulæ from non-closure or imperfect closure of the branchial arches. The fistulæ may open into the trachea, pharynx, or other parts.

Treatment.—The injection of corrosive fluids has been practised with not very good and sometimes with dangerous results. The affection does not imperatively call for surgical interference, but if an operation is desired, a plastic operation would be the best.

(See also **Abnormal conditions which may affect any part of the body**).

DEFORMITIES OF THE BODY.

Closure of the œsophagus.—This tube may be found obliterated in a part of its length, and under such circumstances it frequently communicates with the trachea; food is either ejected or produces symptoms of choking. If unrelieved, the result is of course fatal, and the chances of doing any good by operations are very remote.

Stricture of the œsophagus and pouched œsophagus.—Congenital stricture, although very rare, has been found in the lower part of the tube, and part alone has been dilated, probably as a result of food being delayed in passing the stricture, but the pouching is also stated to be congenital.

Deformities of the vertebral column.—There may be supernumerary vertebræ or vertebræ may be deficient, or a portion of a vertebra may be absent, producing **congenital lateral curvature.** Two or more of the bones may be fused together.

Spina bifida (*Hydrorachis*).—This deformity may involve the whole length of the spine, or any one part of it. The arches of the vertebræ are un-united, and through the fissure the membranes of the spinal cord protrude. The sac thus formed is filled with fluid.

Coverings of the sac.—May consist of normal or corrugated skin, but more commonly the wall is very thin and translucent, or the skin may be absent.

Large nerves or the cord may or may not be involved in the tumour.

The presence or absence of portions of the cord or the cauda equina in the sac is a matter of importance, as it should influence our mode of dealing with the tumour.

Diagnosis.—The tumour is in the middle line and is attached to the bones. The aperture into the spinal canal can generally be felt. Pressure usually makes the fontanelles more tense. There may be paralysis or other symptoms of nerve implication, such as *club-foot.*

If the fluid is found to contain grape sugar we know that the subarachnoidean cavity has been opened, but the converse does not show that the tumour is not spina bifida. If nothing is done, the majority of cases die.

Treatment.—If the tumour is small, a hollow truss should be applied, and the effect of support and gentle pressure tried for a time. But if there are no indications of a natural cure, the question of operation presents itself. If symptoms of spinal or cerebral pressure occur, or if the tumour increases in size notwithstanding the truss, an operation should be advised. And there can be no doubt that the injection of the iodo-glycerine solution as used by Dr. Morton, of Glasgow, is the best and safest means of operation which can be performed. Mr. Noble Smith, who has had considerable experience in the treatment of these cases, had the opportunity of dissecting a case which he had operated upon successfully several years before, in a child who died from another affection, and he found the opening in the bones firmly closed by dense fibrous tissue.

In all cases there is great danger in the operation, and especially when large nerves are in the sac.

False spina bifida may consist of: 1. The sac of a true spina bifida, the neck having been obliterated.

2. A congenital tumour.

3. Included fœtal remains.

False spina bifida must be treated upon general principles.

These tumours may be connected with some of the pelvic viscera.

It is not uncommon for hydrocephalus and spina bifida to co-exist. They are related in mode of origin.

Sacro-coccygeal tumours have a clinical interest in obstetric practice. They may give rise to confusion in diagnosing the presentation, and may, if large, be the cause of dystocia. They have been described by Ammon,[1] and illustrated by Hutchinson.[2] There is a drawing of a remarkable specimen in St. Thomas's Museum, given in Barnes's 'Obstetric Operations,' 3rd ed.

J. Y. Simpson figured examples.[3] These tumours sometimes resemble tails. Some are varieties of spina bifida. Meckel believed some were examples of the *fœtus in fœtu*. They vary very much as regards structure. Sometimes they consist of masses of fatty substances alone; sometimes they contain bones, rudimentary, or more or less developed; or teeth, being, in fact, dermoid. Portions of intestines have been found protruding into them from the infant's abdomen.

In some cases the tumour has been successfully removed.

Mr. Noble Smith has called our attention to specimen No. 296 in the Museum of the Royal College of Surgeons, in which the child died from ulceration of the tumour. The section shows that the tumour could probably have been removed with success.

Thorax generally.—May be small from arrested development, lungs and heart being also small and ill-developed.

Hernial protrusions of heart and lungs from imperfect development of walls of thorax, such as the next deformity.

Complete or partial absence of the Sternum.

Fissure of the sternum.

Absence of one or more ribs, or incompletely developed ribs.

Forked ribs, fusion of ribs.

Pelvis generally.—May be misshapen, and sometimes from ankylosis of one sacro-iliac synchondrosis.

Cleft abdominal walls.—A similar arrest of development to that of cleft sternum may exist in the muscular structures of

[1] *Angeborene chirurgische Krankheiten.*
[2] *Illustration of Clinical Surgery.* [3] *Med. Times and Gaz.* 1859.

the front of the abdomen, which may expose the contents of the abdomen, or the central line of the abdomen may be weak from deficiency of muscular structure.

Hernia.—When hernia occurs as a congenital affection, there is always a tendency to natural cure if the bowel is supported within the cavity of the abdomen. A ring pad should be placed over the weak part of the wall, and the whole abdomen supported.

Fig. 102 shows an example of umbilical hernia, or exomphalos.

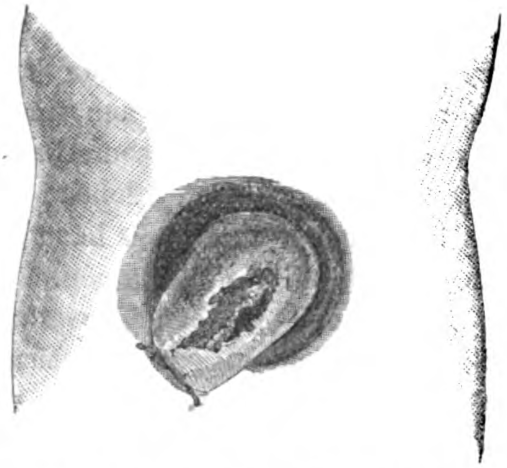


FIG. 102.—Exomphalos, or hernia at the umbilical ring. (Robert Barnes.)

Plastic operations have been successful in cases of this kind.

Simpson traces it to peritonitis. In some cases this is probably true. It is more commonly traceable to fault of development. In early embryonic life intestines project into the vitelline duct; and if the abdominal wall does not close in so as to secure the intestines behind it, hernia results. The appearance presented at birth is seen in fig. 102. In 'congenital hernia' (specially so-called) the bowel descends into the tunica vaginalis. It may descend into the scrotum, or may not leave the canal. It has no true peritoneal sac. Congenital inguinal hernia may be encysted, being separated from the testis by a septum of the tunica vaginalis. This is the so-called 'infantile hernia.'

Diaphragmatic hernia may also occur congenitally.

Hernia of the ovaries is sometimes congenital. They descend along the canal of Nuck and bulge in the groins. The bowel alone may occupy this position.

Various *malformations of the intestines* are found. Simpson said these are generally due to inflammation.

Extroversion of the bladder.—Deficiency of a part of the anterior abdominal wall and bladder, so that the interior of the bladder is exposed.

Although this condition is not necessarily dangerous to life, the inconvenience and suffering which it causes are very great. Mechanical guards may be fitted temporarily. Plastic operations have been partially successful. Attempts to turn the urine into the rectum have hitherto failed.

The best course in many cases is probably to transplant skin upon the mucous membrane of the bladder, so as to convert it into a non-irritable surface.

Epispadias consists in a deficiency, more or less extensive, of the upper part of the penis, leaving the urethra open in the form of a groove. It is often associated with extroversion of the bladder.

The pelvis may be un-united at the position of the symphysis.

Treatment.—By plastic operation an attempt may be made to cover the exposed urethra.

Hypospadias consists in a deficiency more or less extensive of the under part of the penis or of the scrotum. (See 'Hermaphroditism.')

In these cases there may be attachment of the penis to the scrotum, so that erection cannot take place naturally.

Operation is demanded when the orifice of the urethra is too small to allow free exit for the urine. When the orifice is so far back that procreation will probably be interfered with, it may be desirable to endeavour to construct a more natural passage.

Although the opening of the urethra may be in the situation of the scrotum, yet the urethra may be continued forwards to the glans, and there have a cœcal termination. In such a case perforation of the glans in the natural position of the meatus should be performed, and the posterior opening closed by a plastic operation.

There may be urinary perineal fistulæ.

Urethra.—1. May be absent, as in cases of extroversion.

2. Occluded, in which case the occlusion may exist in any part of the tube, and may be only membranous on several lines in length.

3. Stricture.

4. There may be more or less deficiency of the upper part (epispadias) or of the lower part (hypospadias).

Treatment.—If the tube is occluded an operation must be performed at once.

Imperforate anus and rectum.—The occlusion may be incomplete or complete; it may be situated at the anus or in any part of the rectum; it may be simply membranous or very extensive. There may be total deficiency of anus and rectum, or of either part alone.

With any of these conditions there may co-exist fœcal fistula between the gut and the bladder, or urethra, or vagina, or the surface of the body.

Treatment.—If there is no escape for the fæces, it is self-evident that an operation must be performed without much delay; but if there are no certain indications of the nearness of the gut, it is better to wait, so long as the symptoms are not urgent, with the hope of the accumulation of meconium producing a bulging which will indicate the position of the bowel. When the occlusion is too extensive to allow the gut to be reached from the natural direction, colotomy has to be performed.

In cases of fistulous opening from the gut to other parts, an endeavour must be made to form a natural passage.

It may be mentioned that the sigmoid flexure may curve to the right instead of to the left. There may be two congenital fistulæ.

If the genital organs are situated further back than natural, it is probable that no rectum exists.

Occlusion of the lower part of the small intestine has been known to exist.

Umbilical fistulæ.—The urachus may remain open, allowing the urine to pass through it, or there may be an opening into the bowel.

Treatment.—The application of the actual cautery, ligature, or a plastic operation may be tried, but these cases are very difficult to cure.

Herniæ.—From deficient structure of the abdominal walls various herniæ may occur.

This deformity may be:

umbilical, inguinal } the usual forms.

vaginal, through linea alba, above umbilicus } uncommon forms.

Treatment.—Reduction of the hernia and support by a pad and bandage, pressing upon the edges and not plugging up the opening. A natural cure usually takes place.

Inguinal hernia in conjunction with retained testis.—The hernia being caused by the testis remaining in the inguinal canal. The intestine is often attached to the testis.

Retained testicle.

Treatment.—No attempt should be made to alter the position of the gland unless a truss can be placed between it and the ring. If painful, it may be guarded by a hollow truss, or it may be pushed up the canal and a pad with a plug placed upon the opening. In some cases it is desirable to remove the gland.

Misplaced testicle.—The gland may be situated in other parts, such as in the perineum.

Treatment.—The gland may have to be guarded by a hollow truss or removed by operation.

Hydrocele.

Treatment should be commenced early. Evaporating and irritating lotions, such as spirit lotion or acetate of ammonia. The various forms of iodine (Mr. Noble Smith recommends the iodide of potassium ointment) should be tried first for a few weeks.

If such means fail the tumour should be punctured and the fluid withdrawn, and a truss applied to the inguinal canal.

Dermoid cysts of the testicle and included fœtal remains will be described later on.

These tumours should be removed early in life, as they are apt at any time to grow rapidly.

Phimosis.—The prepuce is more or less contracted and may be a natural length, or unnaturally long. In all cases an operation ought to be performed; but unless the interference with micturition is severe, operation may be deferred until the child is at least several months old and in good health.

Noble Smith recommends that the prepuce should be divided with a pair of spring scissors and the edges neatly stitched together, and that circumcision should only be performed when the prepuce is very long. He states that the deformity may be simulated by attachment of the prepuce to the glans.

Hermaphroditism.

The malformations of the sexual organs which constitute hermaphroditism vary very materially in degree. In the slighter

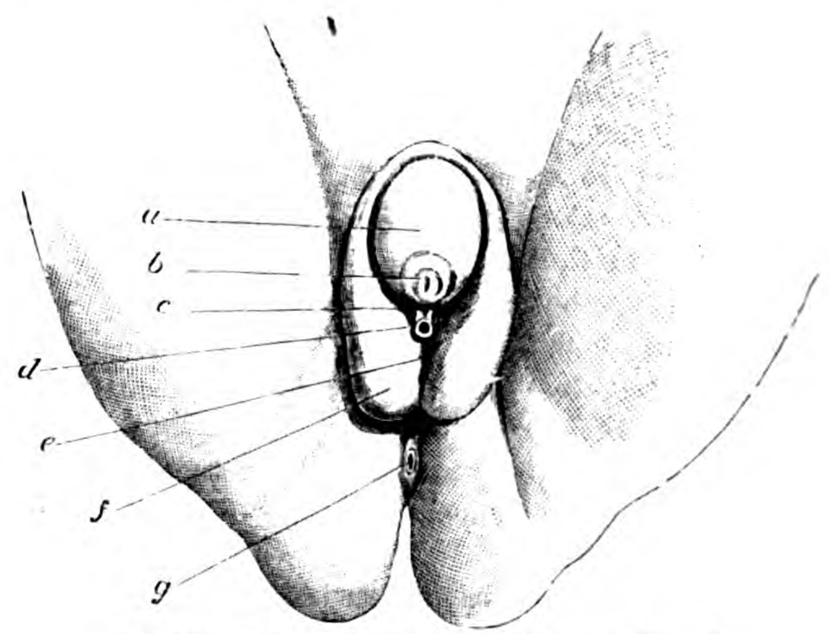


FIG. 103.—Female hermaphrodite. (Fancourt Barnes.)

a. Enlarged clitoris. *b.* Depression simulating orifice of urethra. *c.* Frænum. *d.* Canal through which urine was voided. *e.* Sulcus between labia majora. *f.* Labium majus. *g.* Anus.

cases no difficulty is experienced in determining the sex to which the child belongs, but in other cases the distinction is very difficult to draw; and as the determination of the sex is a matter of very great importance, we have thought it desirable to summarise the chief points which have to be considered.

1. The female may simulate the male in one or more of the following points.

(*a.*) The clitoris being large.

(*b.*) The glans being indented in the position of the male meatus urinarius, or the glans actually perforated more or less imperfectly by a canal.

(*c.*) The vulva nearly closed by a strong membrane or hymen, and the labia united and resembling the scrotum. This is well illustrated in fig. 103 from a child born in the British Lying-in Hospital, in the wards of Fancourt Barnes.[1]

(*d.*) The ovaries being situated in the labia simulating the testicles.

(*e.*) Rounded masses of fat in the labia simulating the testicles.

These cases may be complicated in after life by general masculine development of the rest of the body. Features may become masculine, hair grow upon the face and chest, mammæ remain rudimentary, voice become harsh and deep-toned.

The male may simulate the female in one or more of the following points:—

(*a.*) Extroversion of the urinary bladder mistaken for the vulva.

(*b.*) Rudimentary condition of the external genital organs.

(*c.*) The adhesion of the inferior surface of the penis to the scrotum by a band of integuments.

(*d.*) Hypospadias, or more extensive fissure of the parts beneath the penis, in which the scrotum is divided and a fissure of the perineum exists.

Cases are recorded of **true hermaphrodites** in which some of the sexual organs of both sexes existed in one individual.

Deformities of the vagina.—Adhesion of the anterior part of the walls. This not uncommon condition is sometimes mistaken for imperforate vagina.

Treatment.—The membranous union is to be broken down with the finger or with a blunt instrument, and the edges separated with oiled lint. This should be done as soon after birth as possible.

Imperforate vagina.—The degree of obliteration differs in different cases. The space between the bladder and rectum should be carefully ascertained before any operation is resorted to.

[1] *Obstet. Soc.* 1882.

Treatment by operation, as a rule, should be performed in early life.

Atresia vaginæ is fully treated of in Barnes's 'Diseases of Women.' There may be entire closure of the vagina, coexisting in some cases with absence or imperfect formation of the uterus. The defect is commonly overlooked until the age of nubility.

Hernia of the vagina already referred to.

Tumours.

Transpositions of, and abnormalities of formation, and deficiencies of the thoracic, abdominal, and pelvic viscera may exist.

DEFORMITIES OF THE EXTREMITIES.

Deficiencies.

(*a.*) *Absence of one or more of the extremities.*

(*b.*) *Absence of the intermediate parts*, the hand being attached to the shoulder or the foot to the hip.

(*c.*) *Limbs too short.*

(*d.*) *Deficiency of individual bones.*

(*e.*) *Fusion of bones to one another.*

(*f.*) *Limbs truncated.*

1. From arrest of development.
2. From amputation and constriction by the umbilical cord or a membranous band.

(*g.*) *Diminished number of fingers and toes.*

These cases are beyond remedy by means of treatment except in the instances of truncated limbs, when artificial hands or feet can be supplied at subsequent periods of life.

Limbs may be grooved, or indented, or otherwise injured by the pressure of the umbilical cord or bands of membrane, a partial result of the constriction which might, if continued, have produced the amputation referred to above.

Intra-uterine fractures have been observed. Dr. Richardson, in his Fothergillian prize essay on 'Diseases of the Fœtus,' collected most of the known cases, amongst others that of Chaussier. There were 112 fractures. The child lived twenty-four hours. The mother had borne four children. Baudelocque related a case which presented 43 fractures. The mother had had no accident during pregnancy. Delivery had been rapid and easy. Some of the fractures were consolidated, some were in process of re-union. Montgomery refers to several cases. One was that of a woman eight months pregnant who fell from a window twenty-five feet on her face. The hip-joint was dislocated; the uterus was not ruptured. She was delivered the same night of a dead child which had some of its bones broken. She recovered perfectly. The late Dr. Herbert Barker narrated [1] an interesting case: The subject was in her fourth labour. The three first children were sound. The mother showed no sign of cancerous, tubercular, or syphilitic taint. She had several times fallen on the stairs, once with her entire weight on the abdomen. The father was also healthy. During labour the child's limbs were felt to crepitate on the least movement. There was an entire absence of cranial bones. It cried, but died in ten minutes. The limbs were very deformed, preternaturally short. The long bones were all broken. All the bones forming the base of the skull were duly developed. The bones of the vault scarcely showed traces. The spinal column was well developed. The bones were extremely fragile. The organic matter of the bones amounted to 66·66, as against 33·34 per cent. of inorganic. This corresponds with the proportions observed in rickets.

With regard to the fractures of cranial bones, Montgomery observes: 'Instances of injury to the cranial bones before birth have been recorded by Osiander, W. J. Schmidt, Schnuhr, D'Outrepont, and Graetzer; and still more recently, three well-marked cases, in which several fractures were found under bloody tumours, were published by Flügel and Schelling. When these injuries were first observed, they were attributed to violence by Haller, Rosa, and others, the error of which opinion was first perceived by Rœderer and Baudelocque.'

These cases present points of great obstetric and medico-legal interest. They prove—1st, that numerous fractures of cranial and long bones may occur which cannot be accounted for by injury during or after labour; 2, that, although it is probable that fracture may be caused by injury sustained by the mother during gestation, yet they may occur without such injury; 3, that they may occur as solitary instances in a series

[1] *Brit. Med. Journ.* 1857.

of healthy children by the same parents, or at least by the same mother.

The dimpled or puckered appearance frequently found in the limbs of children has been attributed to fractures occurring in early fœtal life.

Amputation of the limbs in utero.—Montgomery, Sir J. Simpson, and others have illustrated this subject in a manner to leave little to desire. Children are born occasionally with one or more limbs defective. Cases of survival, all four limbs being truncated, are not very rare. In some of these cases there is the appearance of a clean cicatrised stump; in others, there is the appearance of small processes suggestive of fingers or of rudiments of the parts of limbs which are wanting. Two hypotheses may be discussed. Either, there was a defect of developmental force resulting in the non-formation or arrested development of the missing parts; or there has been a real amputation. In the latter case the budding processes are accounted for on the analogy of what happens in the crustacea, which possess the faculty of reproducing a lost limb. The human embryo at an early stage resembles in other characters the lower animals, and it presumably does so in this.

Amputation undoubtedly takes place. Thus Montgomery relates a case from Mr. Watkinson, who delivered a lady of a child which had the left foot amputated a little above the ankle; the stump was nearly healed, the child was alive. The amputated foot was found in the uterus nearly healed. This foot was much smaller than the one which grew to the other leg. In this and similar cases the amputation was due to gradual strangulation by amniotic bands, the result of inflammation of the amnion. The authors quoted figure amputations in process in this manner. Many of the more striking illustrations are reproduced in Martin's 'Atlas.'[1]

United or 'webbed' fingers and toes.—The operation for these deformities may be deferred until the child is six months or a year old.

Supernumerary limbs are considered under the heading of parasitic fœtus.

Supernumerary digits should be operated upon early if

[1] See Martin's *Atlas of Obstetrics and Gynæcology.* English edition by Fancourt Barnes. 1880.

there is no doubt regarding the necessity of operation. Care should be taken not to injure a joint when an additional digit has a joint common with a normal digit; a small piece of the former must be left. In a case of double terminal phalanx of the thumb, giving a cleft hoof-like appearance, Mr. Noble Smith united the two halves, producing a fairly good-looking thumb.

A supernumerary hand may exist, and may be a very useful member, or may require removal.

Hypertrophy of digits or limbs.—Treatment by pressure should be commenced early, and if that fails, the question of amputation has to be considered.

Dislocations.

Congenital dislocations have been found in the majority of the joints, and probably may occur in any of them. The hip and the shoulder are the joints chiefly affected. The deformities have been attributed to a variety of causes. There is very frequently some malformation of the ends of the bones forming the joint.

Treatment, if likely to be beneficial, should be commenced early.

Under this heading may be referred to those malformations of the joints in which the ordinary movements of the joint are perverted, the leg bending forward instead of backwards. In these cases the patella is generally imperfectly developed or may be absent.

Deformities from Abnormal Contraction of Muscles.

The most familiar examples of this class of congenital deformities are the various forms of *club-foot.*

We meet also with—

Club hand.

Wry neck.

Contractions of the muscles of the arms and forearms.

Contractions of the muscles of the thighs and legs.

Treatment.—Much good may be done by manipulations at the earliest period of life. Subsequently stretching by means of splints, plaster bandages, or instruments, alone or with the help of tenotomy, will complete the cure. For full directions regarding the treatment of these cases, see 'The Surgery of Deformities,' by Noble Smith.

Paralysis of muscles.—Various deformities, and especially of the limbs, may occur from this cause.

DEFORMITIES AFFECTING ANY PART OF THE BODY.

Congenital fibro-cystic tumours may occur in any part of the body, but the purely cystic have not been observed in the limbs. They are most frequent in the neck, and not uncommonly surround the carotid vessels, or the trachea, or œsophagus. They may occur in the mouth, and have been found beneath or involving the tongue.

Diagnosis.—In the head we must distinguish these tumours from meningocele, cancer, fatty tumours, nævus and sebaceous cysts.

Treatment.—These tumours, if not involving important structures, ought to be removed as soon as the child is strong enough to undergo the operation; for although they occasionally disappear spontaneously, they are yet very liable and at any time to grow rapidly and destroy life; and the older the child, the more dangerous the operation for their removal. If the tumour involves important structures, it may be left so long as it appears disinclined to increase, when an operation if practicable should be performed.

Fatty tumours occur congenitally, although rarely. Their removal is usually not difficult.

Dermoid cystic tumours, containing sebaceous matter or serous fluid, or both, and hairs usually grow from the lining membrane. These tumours are very commonly found in the region of the upper and outer border of the orbits. They are very movable beneath the skin, but although they may appear superficially situated they often extend deeply.

Treatment.—It is necessary to dissect the growth out carefully as soon as the child is strong enough to undergo the operation, otherwise they will increase in size both superficially and deeply, and their removal become much more difficult and dangerous.

Sebaceous tumours.—The common form of these tumours may occur congenitally, and as they are liable to penetrate through the tables of the skull, they should be carefully removed as early as practicable.

Nævus consists in an abnormal dilatation or ènlargement of capillary blood-vessels. They are found in the skin and mucous membrane, or in the subjacent cellular tissue in all parts of the body.

Diagnosis.— Those situated superficially are readily diagnosed ; those beneath the skin must be distinguished from fatty and other tumours. Nævi swell and assume a darker colour when the child makes any violent expiratory effort, as in crying, &c. If the nævus is too deep to be distinguished by this symptom, it may be punctured with a grooved needle. A meningocele has been mistaken for a nævus, and Mr. Holmes has known a cancer of the bones of the skull operated upon for a vascular tumour.

Treatment.—If situated over bone, pressure may be tried. Operation is desirable early, as the nævus may at any time increase rapidly. The following are the means one or other of which is usually adopted.

1. Excision by the knife. 2. Ligature. 3. Caustics. 4. Setons.

Excision may be employed when it is desirable to preserve the skin. There is some danger of secondary hæmorrhage. *Ligature* is most useful in the majority of cases. *Caustics* are useful for small nævi. *Setons* may be used in some cases when excision is contra-indicated.

We may add that the injection of strong solution of iron is very dangerous, especially in the case of nævi of the face and neck. The solution carried to the heart has caused thrombosis and quick death. Vaccination upon the nævus is an unsatisfactory plan of dealing with these cases.

Moles.

The influence of imagination on the embryo.—In all ages speculation, contention, and imagination have been exercised upon this problem. Credulity has been met by ridicule. Is there scope for a philosophical discussion and conclusions between these two extremes of unreason? We believe there is, but we cannot indulge in it here. We will simply try to state the case.

A woman brings forth a fœtus, single or double, presenting some deformity. She or her friends then recollect that at some time during gestation she had been impressed by some object more or less resembling the misshapen child. It has been objected—1, that the 'impression' was an after-thought hunted up in the memory, and greatly an image built up after the birth upon slender foundation; 2, that if there had been any 'impression,' it was so slight and transient that it could not be supposed to have had any influence; 3, that very marked 'impressions' are often experienced by women during gestation, exciting in them the dread that the child will be affected, and yet the child is born faultless; 4, that if occasionally a monstrosity is born to a woman who had made known an 'impression' at the time it was received, it must be regarded as a coincidence; 5, that deformities, similar to those which have been ascribed to mental impressions, are frequently observed where no such impressions have been noticed; 6, that the deformities can all be traced to faults of development which admit of interpretation according to the known laws of embryology; 7, that it is not possible to understand how an embryo which has followed the normal development down to the moment of the alleged impression can thence undergo changes of form—for example, an anencephalous fœtus is born: how can the sight of an anencephalous child destroy the brain of a fœtus developed to five months? 8, that monstrosities are frequent in the lower animals, and in birds, and in plants; 9, that many deformities and peculiarities may be traced to heredity, especially from the father. How do we account for women, married to mutilated men without legs or arms, bringing forth well-formed children?

The following facts deserve attention. Mares are known to bring forth foals bearing the characters of the sire, and this not once but several times, although the subsequent foals have been begotten by different horses from the first. Thus Rollins asserts that the common mule from the ass and horse is particularly apt to have bars on its legs. According to Mr. Gosse, in certain parts of the United States about nine mules out of ten have striped legs. This may be accounted for on the theory of heredity. But there is the famous case of Lord Morton's hybrid from a chestnut mare and a male quagga. Not only the hybrid, but even the pure offspring subsequently produced from the mare by a black Arabian sire were much more plainly barred across the legs than the pure quagga. Darwin, so rich in observation of natural experiments, records many facts and speculations illustrative of this problem. This history of the mare and quagga is in harmony with many facts known to breeders, which tend to show that the first sire stamps his mark upon all the subsequent offspring of a mare. Can heredity explain this? Does imagination or mental impression arising in the mare influence the result? Are we justified in concluding that the mare and other animals are not, like women, subject to 'impressions'?

It may be explained on the hypothesis of Dr. Harvey, of Aberdeen, whose researches on cognate subjects are so full of interest, namely: that the blood of the mother (we should rather say the intimate molecular tissue-structure) had been contaminated by her first pregnancy, and had acquired some of the peculiarities of the first fœtus which it had nourished. The deterioration in temper and spirit which is known to ensue to a mare in foal by a donkey is strong evidence in point.

The influence of imagination through the father.—Captain Speke relates the following story: 'Having shot a pregnant Kudu doe, I directed my native huntsman, a married man, to dissect her womb and expose the embryo; but he shrank with horror, fearing lest the kid striking his mind should have an influence on his wife's future bearing, by metamorphosing her pregnancy to the likeness of a fawn!'

Can a strong prepossession existing in the father's mind before and at the time of fruitful intercourse influence the form of the child?

The children of drunkards often exhibit in their physical as well as mental features traces of the paternal vice. 'Ebrii gignunt ebrios,' says Plutarch.

Diseases of the nervous system. Brain disease.—Jacobi, of New York, says a frequent cause of epilepsy is premature synostosis of the cranial bones. The brain diseases attributed to syphilis will be stated when giving the history of syphilis in the fœtus.

Encephalitis and myelitis.—Virchow says many new-born infants said to die of apoplexy have in reality died of encephalitis and myelitis. The alteration consists in fatty metamorphosis of the cells of the nerve-tissue. These elements increase in size, become filled with fat-globules, and for some time form large round granular bodies in which the nucleus soon disappears. These granular bodies and masses of fat-globules have their seat particularly in the white substance. Virchow thinks this change is the result of inflammation. He has observed it chiefly in cases of syphilis and of the acute exanthems in which the mother alone has been affected. He asks: May not this condition have an active influence upon the production of infantile paralysis and icterus?

Diseases of the eye.—The late Mr. Critchett informed us that he had repeatedly seen cataract fully formed and involving the entire lens during the first few weeks, in which the pupil was perfectly active, the conjunctiva and cornea healthy, and no trace of inflammation in any structure of the eye. Cases in which the opacity is limited to the nucleus of the lens are singularly illustrative of the intra-uterine character of congenital cataract.

Convulsions may take place *in utero*, and the fœtus may die in consequence. The mother is conscious of violent movements of the child, and the child has shortly afterwards been dead-born. The cause may be some blood-taint communicated from the mother, pathogenetic, or from extraneous poison, as strychnine; or the convulsions may be from ague.

More commonly, probably, convulsions are the result of tubercular meningitis, of inflammation or malformation of the nervous centres. Hydrocephalus is certainly an intra-uterine disease, and connected with tubercle.

Bronchocele, or goître.—Cases are collected by Simpson and F. Weber.

Sclerema, skin-bound, ichthyosis.—Specimens are found in various museums. There is one in Guy's.

Mechanical conditions causing the Death of the Fœtus.

Torsion, knotting, or strangulation of the cord.—Many instances are recorded in which death of the fœtus was apparently produced in this way. Of the sufficiency of this condition there cannot be a doubt. Tying the umbilical cord so as to render the vessels impermeable is equivalent to tying the pulmonary vessels or the trachea of the adult. Asphyxia results. Most museums exhibit specimens of twisted and knotted cords. The embryo and fœtus up to an advanced period of gestation preserve great mobility in the uterus, especially where the proportion of liquor amnii is large. Severe exertion, the action of the abdominal muscles, as in defecation, may change the position of the fœtus. External pressure, as in copulation, may cause the fœtus to rotate. But how do we explain knots? The embryo must pass through a loop of cord, and thus commit suicide. Sometimes it stops short of strangulation. Indeed, complicated knots have been found on the cord, the child being born alive.[1] It is a familiar fact that the neck of the child may at birth be encircled by one, two, or even three rings of umbilical cord. This may be regarded as the first stage of knotting. The fœtus does not pass through the loop, it is caught at the neck. In these cases the child does not often perish *in utero*. The danger comes at the time of labour, when, the head descending, the cord is tightened. If this be cut in time the child is saved. The most obvious cause is the undue length of the cord, so that it settles in loops at the lower part of the uterus. Dohrn [2] gives a good account of torsion and the ensuing stenoses of the cord. Ruysch and D'Outrepont described them. Meckel [3] affirmed that they are due to revolutions of the fœtus, and that they are more frequent in male children. About ·75 inches from the umbilicus is the *locus minoris resistentiæ*. Where twistings produce morbid results, Hohl thinks they take place when the head of the fœtus rests upon the floor of the ovum; and that strictures rarely occur in mature children. Dohrn narrates a case. A woman conceived in December; in

[1] R. U. West, *Brit. Med. Journ.* [2] *Monatsschr. f. Geburtsk.* 1861.
[3] *Müller's Archiv.*

June she lost sensation of the child, presumably from a fright; in the December following, labour set in; no hæmorrhage; a female fœtus of seven months was born by breech, macerated and shrivelled. The cord was twisted twenty-eight times from right to left, and at its fœtal end was a strong constriction three inches long. The navel was dragged out. The vessels were permeable, but much narrowed. There was no thickening and no Wharton's jelly at this part.

In far the greater number of cases in which local stenoses occurred, the cord was found in the rest of its length to have numerous windings. Meckel once found ninety-five turns on a cord 11 inches long. On the other hand, several instances are given in which partially stenosed cords were only slightly wound in the rest of their course. But even here axial turnings of the fœtus may be the cause. The accident appears in many cases to have followed violent shocks.

Dohrn found the cord twisted from right to left in 11 cases, from left to right in 9. In most instances the fœtus perished at seven months. Where the fœtus had been dead some time, the placenta was found atrophied, sometimes with numerous apoplexies. In some of the cases the fœtus was hemicephalic.

Chiari, Braun, and Spaeth[1] describe atresia of the cord resulting from the compression of amniotic bands.

Twins have destroyed each other by their cords getting entangled, or from one fœtus passing through a loop in the cord of its companion. Figures of the varieties of knots are given in Martin's 'Atlas.'

The serous membranes.

Peritonitis.—Simpson has collected and observed several cases. *Some are referable to the mother.* Thus in some cases the mother had been exposed to cold, fatigue, or injury, to general ill-health; in one case the mother herself had been twice attacked with peritonitis during gestation, suffering at the same time with syphilis. In other cases, also, the mother had venereal symptoms. Other cases are more especially attributed *to the fœtus.*

Strangulation of the intestine, closure of the urethra, and retention of urine have been noted. The peritonitis may prove fatal during gestation. The child is rarely born alive.

[1] *Klinik der Geburtsk.* 1855.

In most cases the disease is independent of syphilis. Simpson relates a history of twins, in which one fœtus had died of peritonitis, the other being born alive, healthy. Peritonitis is probably in all cases secondary upon other morbid conditions. The distension of the abdomen may be so great as to be the cause of dystocia.

Pleuritis has been very rarely observed.

Rickets not infrequently begins in uterine life. Winckler describes two forms—the *Rachitis micromelica* and *R. annulans.* The first is characterised by marked shortening of the extremities and thickened diaphyses; the annulans may pass into the micromelica, and has a doubtful practical value. The causes are obscure. It can hardly be assigned essentially to faulty nutrition, since, in the case of twins, one fœtus has been found rickety, the other healthy (Klein).

Struma has been observed.

Syphilis is one of the best recognised diseases of the fœtus. Its action is seen on the skin, in the thymus, lungs, liver, spleen, suprarenal capsules, pancreas, intestines, serous membranes, and bones; most frequently in the bones and spleen. As Spiegelberg remarks, the alterations are best marked in fœtuses which had approached term, less so in those which had perished early. In these last the diseases had not become developed, and maceration will have changed the appearances. The *skin* shows numerous ecchymoses and subcutaneous indurations. Vesicular formations, as pemphigus, varicella, syphilitica confluens. Sometimes the blebs contain pus, or blood-coloured fluid. They are most frequent on the volar aspect of the hands and feet, fingers and toes. When confluent, the corium lies bare in large areas, and sometimes the skin peels off the living child in large pieces from the hand and foot. This condition observed in the live child during labour may be taken for maceration. In some cases bleb-formations have been noticed as epidemic. On the *mucous membrane* of the mouth, nose, throat, air-passages, may be seen spots and cracks sometimes passing into suppuration, so that defects are caused in the palate, and the vocal cords may be partly destroyed.

The *serous membranes* may, like the skin, show numerous spots, and blood-tinged serum in the cavities. Martin described this as *hydrops sanguinolentus*, and as characteristic of syphilis. But Spiegelberg says a similar condition may be produced by maceration.

When the *thymus* is affected, it is enlarged, and contains small abscesses (Dubois).

In the *lungs* and large organs of the abdomen the changes are more frequent and important. They appear in the form of gummata, neoplasms of cells, which are doomed to degeneration, as in the visceral syphilis of adults; and it is these degenerations which, if they do not kill during intra-uterine life, do so after birth.

In the lungs one meets numerous knots, the size of a pea, separated from the surrounding parenchyma by a paler colour; at first greyish-red, then, in later stages, yellowish: they soften and contain cheesy pus. In more advanced cases one finds in their place brawny cicatrices. Conditions likened to white hepatisation or induration are also found.

Cory thus describes the liver in syphilitic new-born children. The liver was large, weighing 195 grammes, or at least three times the weight of a healthy fœtus. Cut into, the surface of the section was seen light yellow, mottled here and there with patches of normal colour. There seemed much increase of connective tissue surrounding the portal vessels, but the hepatic veins were normal. The whole of the gland was studded over with lightish grey spots. In two cases the coils of intestines were glued together by a thin layer of fibrine. The spots were very numerous they resembled little gummatous growths. Spiegelberg found that in some places the nodules had given place to scars.

The *pancreas* exhibits changes similar to those seen in the liver. There is interstitial hypertrophy and induration, so that the organ is enlarged and heavier.

The *spleen* enlargement is one of the most common conditions. It is even found in the macerated fœtus.

The *suprarenal capsules* are not often diseased.

In the *osseous system*, changes in the cranial bones are the least frequent, and even these are most rare in the inner plate. But, according to Wagner, changes in the long bones are almost constant. Disease never fails at the transition point of the bony diaphyses into the cartilages of the epiphyses. The lower end of the femur shows the greatest change. In addition to the osteochondritis, a change in the medulla, either diffuse or *in foci*, occurs.

Intra-uterine death of the fœtus offers many points of pathological and clinical interest. Whatever the cause, the issue is almost necessarily in abortion. The history given of the diseases of gestation, maternal and fœtal, comprises the etiology of this event. It is in this study that we must seek for the rational indications for prevention. It is a matter of clinical observation that some women habitually bring forth dead children. It is probable that in such cases the same conditions which led to the first death continued to operate. The hypothesis has been maintained that the *habit of aborting* may be acquired independently of disease. This is not quite without a physiological foundation. We have observed that in cases in which labour has been provoked artificially in successive gestations, the response to provocative measures is more and more easy in proportion to the number of times provocation is had recourse to, so that at last the labour seems to set in almost spontaneously at the wonted time. In these cases the child may be living. But this can hardly apply to the child's death. We can hardly imagine that the child dies in successive gestations through the influence of habit in the mother. We are compelled to postulate disease either in the mother or in the fœtus.

Whenever, then, a woman brings forth a dead child—that is, one which had died before labour, we must search by dissection of the body, by examination of the placenta, and of the mother and father, clinically and historically, for the probable cause, and direct our treatment accordingly. In cases where syphilitic taint is suspected, the treatment must be applied to the father as well as the mother, even before a new gestation is started. A thorough course at Aix-les-Bains is perhaps the most efficient. This not being available, the recognised treatment must be punctiliously pursued. When a gestation has begun, the mother should continue the treatment. Chlorate of potash, much extolled by Simpson, has given us happy results. In those cases in which two or more children have died before birth, it may be wise to bring on labour before the time at which death had been observed to take place in preceding gestations. In this way the child born alive may be subjected to direct and more effective treatment.

The signs of death of the child in utero.—These consist, in the first place, in the negation of the signs of life, as the failure to hear the heart, the failure of the movements; and, secondly, in certain signs which point to the arrest of the process of development. The mother may show signs of disorder of digestion, shivering, a dull, pallid aspect, fatigue, a sense of cold and weight in the hypogastrium and pelvis, as if she were carrying a foreign body; the cessation of the progressive development of the uterus and abdomen, the uterus becoming even smaller, its rhythmical movements perhaps no longer felt; its sinking lower down and getting softer; the appearance of reddish watery discharge; the breasts becoming flaccid and milk ceasing. The temperature of the uterus falls. The characteristic deep colour of the vagina fades when the child dies. Should the os uteri admit of examination by finger, it may be found that the fœtus no longer floats in liquor amnii; this may have been discharged; and sometimes the loose cranial bones may be felt wabbling under the flaccid scalp, and shreds of cuticle may come away. In this case the diagnosis is certain. The expediency of emptying the uterus now must be considered. The diagnosis between a dead fœtus *in utero* and other conditions is not seldom very difficult.

The changes which the dead fœtus undergoes in utero consist chiefly in maceration and mummification. In the case of very early embryos complete disappearance may take place through fatty liquefaction, and thus give rise to the hypothesis of absorption. But after the fourth month, at any rate, this process can hardly take place. The nature of the change will depend somewhat upon whether or no air be excluded from the uterus, and whether liquor amnii be discharged or present.

If the liquor amnii remain, the process of *maceration* takes place. The soft parts fall off in shreds. The cuticle gives way first; it rises in large blebs and is easily detached. The corium is swollen and reddish-brown from infiltration with blood serum. The inner tissue becomes flaccid, discoloured, infiltrated with hæmatin. Blood-stained fluid collects in the serous cavities; the abdomen is sometimes so distended in this way that it bursts. The brain is soon transformed into a greyish-red pulp. The liver undergoes the greatest changes. The joints soften and break down, so that the bones may fall apart. The placenta becomes soft, and its vessels bloodless; the cord becomes soft and discoloured; it becomes thick at the fœtal end, and easily torn. The membranes resist maceration for a longer time (see fig. 104).

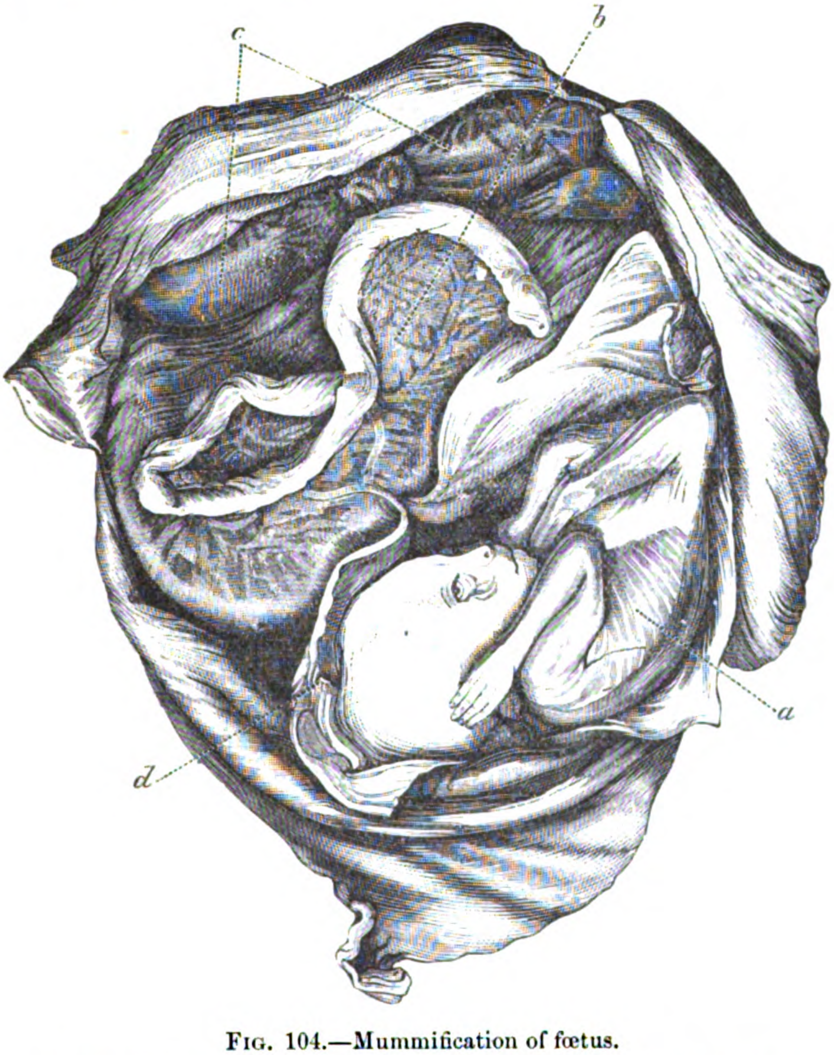


FIG. 104.—Mummification of fœtus.

a. The shrivelled fœtus. *b.* Placenta. *c.* Membranes. *d.* Membranes.

Mummification takes place, especially when the fœtus is dry. It resembles the condition seen in alcoholic preparations. The subcutaneous connective-tissue disappears; the skin lies immediately on the muscles; the colour of the muscles is uniformly dark-red. In the serous cavities only traces of dark fluid are found. The intestines are small and soft. The shape of the body may be preserved, but frequently it is flattened according to the pressure to which it has been subjected.

Mummification occurs especially in twin-gestation, affecting the fœtus, which dies, when the umbilical cord, twisting or knotting, causes death.

The dead ovum may be retained a long time *in utero*. Usually it will be expelled in about three weeks. Retention is not necessarily, perhaps rarely, the occasion of serious danger to the mother.

The intra-uterine, or præ-natal, treatment of the fœtus.—The initiative in the medical treatment of the unborn child was taken by Sir J. Y. Simpson. He sought to combat the syphilitic diathesis by giving the mother chlorate of potash. His hypothesis was that from the large amount of oxygen contained in this salt the mother's blood became more highly oxygenated, and morbid processes were thereby counteracted. The improved oxygenated blood of the mother imparted a similar condition to the blood and tissues of the fœtus. This hypothesis is difficult of rigorous proof; but it is full of interest, perhaps pregnant with important applications. Clinical observations afford at least presumptive evidence of its truth. For example, a woman brings forth a succession of syphilitic infants, born dead, or exhibiting the disease soon after birth. In succeeding gestations she is treated with mercury, iodine, chlorate of potash, and she brings forth healthy children. Thorburn, in a most suggestive memoir,[1] follows up this by interesting clinical observations. In syphilitic cases he has obtained good results from mercurial treatment. In the neurotic diseases he has seen good effects from bromide of potassium. We also, as well as others who have followed Simpson, have seen women who in successive pregnancies had brought forth dead or diseased children prematurely, carry on to term, and at last bear healthy children.

[1] *Liverpool and Manchester Med. and Surg. Reports*, 1875.

CHAPTER XIV.

DISEASES OF THE PLACENTA.

HAVING traced the diseases which, on the one hand, seem primarily to affect the mother, and on the other traced those which seem primarily to affect the embryo, we may on this physiological basis study the diseases which affect the placenta, the intermediate organ. In this structure the two organisms, maternal and fœtal, meet, and exert a reciprocal influence.

The full description of the placenta, and of the relations between mother and fœtus, given in the first chapters, renders it unnecessary to give more than such a brief recapitulation here as will enable us to trace the pathology of the placenta upon its proper anatomical and physiological foundations. We shall for this purpose state concisely the results obtained by the original investigations of Robert Barnes and Hassall, published in the 'Medico-Chirurgical Transactions,' 1851, and those of Robert Barnes in the 'British and Foreign Medico-Chirurgical Review,' 1854–5–6.

The generally received doctrine of the anatomy of the placenta may be thus briefly stated. The organ is made up of a maternal and a fœtal portion. The maternal portion consists of the utero-placental vessels, arteries and veins, preserving an unbroken continuity; these vessels on entering the placenta push before them a thin investment of decidua, a membrane derived from the inner wall of the uterus. On the other hand, the fœtal portion consists of the fœtal-placental or umbilical vessels, arteries and veins, also perfectly continuous; these, which branch out from the umbilical cord on entering the placenta, carry before them an investment of chorion, the external membrane of the ovum. In the substance of the placenta these two portions, maternal and fœtal, come into apposition. The changes effected between the blood circulating in the separate systems are wrought through the walls of the containing vessels and their decidual and chorionic investments.

Goodsir's description differs in one point from that of Barnes and Hassall. He maintains that the cells found investing the villi are continued from the decidua. 'I saw that the great system of cells was a portion of the decidua *all but cut off* from the principal mass by the enormous development of the decidual vascular network, but *still connected with it by minute files of cells which fill the cavities of the placental threads.*'

FIG. 105.—A chorion-villus containing blood-vessel filled with blood-globules, normal. (Robert Barnes.)

It appears to us that decisive facts disprove the correctness of this view. 1. The structure of the membrane investing the umbilical capillaries which he describes as decidua is essentially different from that of decidua observed elsewhere. 2. The continuity of this membrane with the decidua is not clearly demonstrated. 3. This membrane adheres in a very intimate manner to the underlying tissues of the vessels. 4. When it is stripped off, no intermediate membrane between it and the walls of the vessels is observed. 5. This membrane may be observed in very early ova to be *continuous with the outer layer of the chorion.* 6. Cells resembling those of the decidua are found external to this layer of cells, which, we contend, are chorionic.

We shall assume, then, that this layer is chorionic—that is, fœtal, and thence that its pathological changes are of primary or secondary fœtal origin.

The following classification of diseases of the placenta is adopted for convenience rather than as the expression of a strictly physiological method, or as one that will be rigorously adhered to in description.

1. Morbid conditions originating in the placental structure.
2. Morbid conditions resulting from the state of the mother's

blood brought into it, or from contact with diseased uterine structures.

3. Morbid conditions secondary to disease or defective developmental force in the embryo.

The lesions that may least doubtfully be ranged under this head are—mechanical injuries, as rupture of the tissues, congestion, extravasation of blood (by some authors called apoplexy or aneurysm), inflammation, hydatidiform degeneration of the chorion. Fatty degeneration is sometimes primary in the placenta, more frequently, probably, of secondary origin. To what extent hypertrophy or atrophy are primary is doubtful. Calcareous and osseiform deposits are most frequently connected with constitutional conditions of the mother, and their seat is commonly in the maternal tissues. We may put aside the mechanical lesions, such as laceration, as scarcely coming within the idea of disease. The first morbid condition, that which presents the least divergence from health, is *congestion*. As there are two distinct circulations in the placenta, so there are two distinct forms of congestion. The maternal placenta may be congested, the fœtal portion may be congested. Strictly speaking, in the great majority of instances, each of these forms is connected with some abnormal condition of the circulatory apparatus, or of the blood of the mother or of the fœtus. But either form, or a mixed form in which both the maternal and fœtal placentas are congested, may, under some circumstances, depend upon simply local causes. In the case of a placenta of an advanced period, it must often be difficult to determine whether the maternal or fœtal congestion predominate. In early ova, in which apposition of the two portions of the placenta is incomplete, the vascular condition of each admits of being more easily distinguished. We believe it may be stated generally that maternal congestion is more frequent in early ova, and that fœtal congestion, or the mixed form, is more frequent in older ova. Fœtal congestion in its simplest form may be observed in cases of delivery at the full term, in which the child is born alive, the cord having been tied on the placental side as well as on the fœtal side of the point of division by the scissors. In such a case the vessels of the cord are seen to be greatly distended, presenting the appearance of varicose enlargements. Tracing the vessels back, a similar appearance is seen on the fœtal surface of the placenta. The whole mass of the organ is firm, rounded, of a dark purple, and gorged with blood. The vessels of the villi, examined by the microscope, are seen crammed with blood-corpuscles, and enlarged from distension. This state might be called mechanical hyperæmia.

The illustration given by Simpson marks a second and more advanced degree of congestion. He refers to the condition of the placenta in cases in which the child's heart has been long impacted in the pelvis. The physical conditions resemble those just described. Rokitansky gives a precisely similar description. We witness the counterpart of congestion of the placenta in the intensely livid hue and swelling of the face of the child, arising from stagnation of the blood from long-continued pressure. These are examples of fœtal or chorionic congestion. If we bring to our aid the physiological homology of the placenta and the air-breathing lung, we shall have no difficulty in understanding how the placenta may be exposed to congestion, inflammation, and effusions from analogous causes to those which induce similar lesions in the lung. In the adult death by asphyxia is read in the lung; in the fœtus it is read in the placenta. The true fœtal trachea is constituted by the utero-placental arteries, which convey to the cavernous structure of the placenta the oxygenated blood of the mother. If this flow be intercepted, the fœtus dies of suffocation. If blood not duly oxygenated, or blood impregnated with some noxious ingredient, is supplied, again, the fœtus dies of asphyxia, or of poison, just as the adult would perish if made to inhale carbonic acid. This is illustrated by the following observations, which answer to all the requirements of experiments *ad hoc*. A case occurred in which we deemed it necessary to bring on labour at the seventh month. When the labour had made some progress the cord fell through into the vagina. Thus the pulse of the unborn child could be watched. When the uterus was quiescent, the pulsations of the cord were 80 in the minute and strong. The torpid uterus was roused to action by galvanism. During every contraction so induced, the pulsations became first intermitting, feeble, then stopped. Had not the galvanic stimulus been withdrawn the child must have died of asphyxia. Being withdrawn, blood flowed again into the placenta, the fœtal circulation was again set in motion, and the pulsations returned. Presently, uterine contractions came on spontaneously. The same phenomena were observed. In another case the child was born prematurely, scarcely viable; the uterus contracted strongly; the cord was not tied. The firm contraction arrested the placental circulation. The child's life depended upon breathing air. It gasped feebly; the heart beat 90 in the minute. The gasp at an end, the pulse fell to 60. Respiration excited artificially, the pulse rose at once to 90, and dropped again to 60 as respiration ceased. And so, for a considerable time, the pulse ebbed and rose as respiration ceased or returned, and this even after the cord was severed. Now, precisely the same effect upon the heart's beat had been watched by the stethoscope before birth, the pulse falling on uterine contraction, rising during its relaxation. We do not know of any other recorded observations which so conclusively prove the equivalence of aërial and placental respiration. It would be extremely interesting to institute observations upon the influence of asphyxia in the mother upon the placental circulation and thence upon the fœtus. They might be made upon the lower animals.

This form of congestion may be called fœtal. In placentas approaching maturity, fœtal congestion is probably in most cases accompanied by maternal congestion, constituting a mixed form, or general placental congestion. In the same manner as asphyxia in the air-breathing animal induces congestion of the lung, so does interruption to the flow of maternal blood through the placenta, that is, asphyxia in the blood-breathing embryo, induce congestion in the fœtal vessels of the placenta.

The causes of blood-extravasation in the placental tissue. —Certain tissue alterations of the placenta, as fatty degeneration, are the most constant factors. Other causes are the causes of congestion. Thus all conditions that lead to deterioration of the mother's blood—anæmia and hyperæmia, defective power of circulation, excessive vascular tension—may lead through congestion to extravasation. To enumerate these conditions would be to give a list of all those diseases which cause dyscrasia of the blood, or toxæmia. The zymotics—typhus, small-pox, measles, scarlatina, acute rheumatism, acute inflammation, especially pleuritis and pneumonia; many chronic diseases, as phthisis, scrofula, scurvy, obstructive heart-disease, cirrhosis of the liver, granular degeneration of the kidneys, some uterine or ovarian diseases; and diseases leading to exhaustion, as hæmorrhages or lactation.

The forms in which blood-extravasations are found in the placenta.—The maternal source and seat of hæmorrhage are most unequivocally manifested in early abortion. In young ova the entire decidua is often found thickened to an enormous extent by infiltration with blood, part of which is still fluid, part freshly-coagulated, part condensed into firm masses of fibrin. Most commonly the decidual cavity, the space between the decidua uterina and the decidua reflexa, is free from blood; but the quantity effused into the substance of the decidua compresses the uterine and reflected laminæ together, obliterating the cavity. Sometimes the effusion is entirely limited to the decidua; but occasionally some escapes beyond the limits of this membrane, and flows into the loose tissue formed by the villi of the chorion. Very rarely is the membrane of the chorion or the amnion ruptured so that blood is found in the cavity of the amnion. When this does happen, it is probably owing to the violent compression exercised by the contracting uterus during the act of expulsion. But although rarely rupturing the amniotic sac, the blood effused or forced into the yielding tissue of the chorion-villi or new-forming placenta forms rounded masses that push the membrane of the amnion into irregular knobbed elevations, which, looked at from within, have, in their bluish-black colour, irregular shape, some resemblance to varicose veins. This is the condition described by Baudelocque and Granville as 'tuberculated ovum,' an unfortunate name, as suggesting a false idea of the pathological nature of the affection. Specimens of ova affected in this manner are to be seen in most museums.

Hæmorrhage may also take place between the uterus and the decidua, or between the two layers of the decidua. Sometimes the effused blood forms a uniform layer of considerable thickness lying between the decidua and chorion, so as to completely invest the ovum.

In ova a little more advanced, that is, when the placenta is marked out, it is very rare to find extravasation of blood in the decidua without also finding blood in the substance of the placenta. In this structure the blood is commonly seen in more or less rounded masses, the villi and loose parenchymatous tissue being torn, and sometimes broken up, so that unless portions be submitted to microscopic examination the placental tissue might not be recognised.

In ova of a still more advanced period, when the placenta is fully formed, the appearances assumed by hæmorrhages are different. The decidua is no longer so thick or vascular as in the earlier period; the placenta itself has become the chief seat of vascular development. The almost exclusive seat of blood-extravasation is now the body of the placenta.

Blood-effusions into the placenta appear in three principal forms:—1. The extravasated blood forms for itself a wide irregular cavity in the centre of a cotyledon, often communicating with smaller cavities in the vicinity. That a cavity of this kind be formed, it is obvious that a considerable quantity of blood must be effused suddenly, and this cannot take place without tearing or breaking up the delicate tissues. The tissue surrounding the cavity is stained dark and brown-red by imbibition. Owing to the laceration of the placental tissue and the compression caused by the effused blood, it is seldom that we are able to find remains of villi in the extravasation; but in the periphery of the cavity, villi altered in various ways are detected. The condition of the blood will vary according to the length of time it has escaped. It may be fluid, semi-coagulated, or quite solid. 2. The extravasations may assume a lobular form, and be inclosed in sharply-defined cavities, varying in size from that of a bean to that of a walnut. The seat of these may be near the fœtal or the uterine surface, and may cause projections, seen and felt under the normal tissues. 3. Scanzoni describes another form, in which one or more cotyledons are found, dark-coloured, hard to the touch, the tissue more fragile, but no cavity containing blood. On section, however, there are seen several pear-shaped, dark-red foci, containing fluid blood, surrounded by hypertrophied tissue. Scanzoni has found this form exclusively in cases in which a long-continued pressure upon the cord, as in breech-births, prolapsus of the cord, &c., has arrested the circulation. He infers that these extravasations arise from rupture of the fœtal vessels.

The changes undergone by the effused blood.—If abortion and exclusion of the placenta do not follow immediately upon hæmorrhage into its parenchyma, the blood soon loses its fluidity and dark colour. The mass first undergoes a separation into its fibrinous and serous elements. The freed serum partly infiltrating the surrounding healthy tissue is gradually absorbed; part, surrounding for a time the contracting fibrin, serves for a macerating medium, and helps to extract the colouring matter; the fibrin goes on contracting, hardening and losing colour. It is now obvious that through the removal of the serum and the contraction of the fibrin, the fibrin, being all that remains, cannot occupy the same space as the mass originally effused; the placental tissue is not contractile; the surrounding structure does not, at least as the rule, collapse upon the diminished mass. There must, therefore, result a vacant space or cavity. Now *cysts*, or empty cavities of various sizes, sometimes as large as a walnut, are not very unfrequently seen in placentas, and we believe that their formation may be accounted for in the manner described. We have found the tissues immediately surrounding these cysts more hardened than normal, and the villi more or less atrophied, obliterated, or absent. These cysts may properly be called *apoplectic cysts*, and are strikingly analogous in origin to the apoplectic cysts of the brain. The process described, resulting in the formation of cysts, may be looked upon as one of the modes of cure of placental hæmorrhage. In one case in which we found five such cysts, accompanied by consolidation of other parts of the placenta, obviously from extravasated blood, gestation went on to the full term, and the child was born alive, although very small and feeble. These cysts, as Millet and Bustamente point out, are generally found on the fœtal surface.

In some cases the extravasation is neither so sudden and extensive as to cause immediate abortion, nor so dependent upon one accidental transient condition as to end in one simple attack, leaving a large portion of the placenta unaffected, and tending to a cure. The morbid conditions may be persistent, even progressive, and the hæmorrhage will be recurrent. Some cases of fatty degeneration are of this kind. In such cases we shall witness the appearances so faithfully depicted by Cruveilhier (see fig. 106). We shall be able to trace in the same placenta all, or the greater number of, the transformations that sanguineous effusions can undergo. Confined to one cotyledon, or extending into several, we shall see a *foyer*, composed of several defined strata concentrically disposed, resembling closely the successively deposited layers of an aneurysmal tumour. On making a section of a placenta so affected, the diseased mass

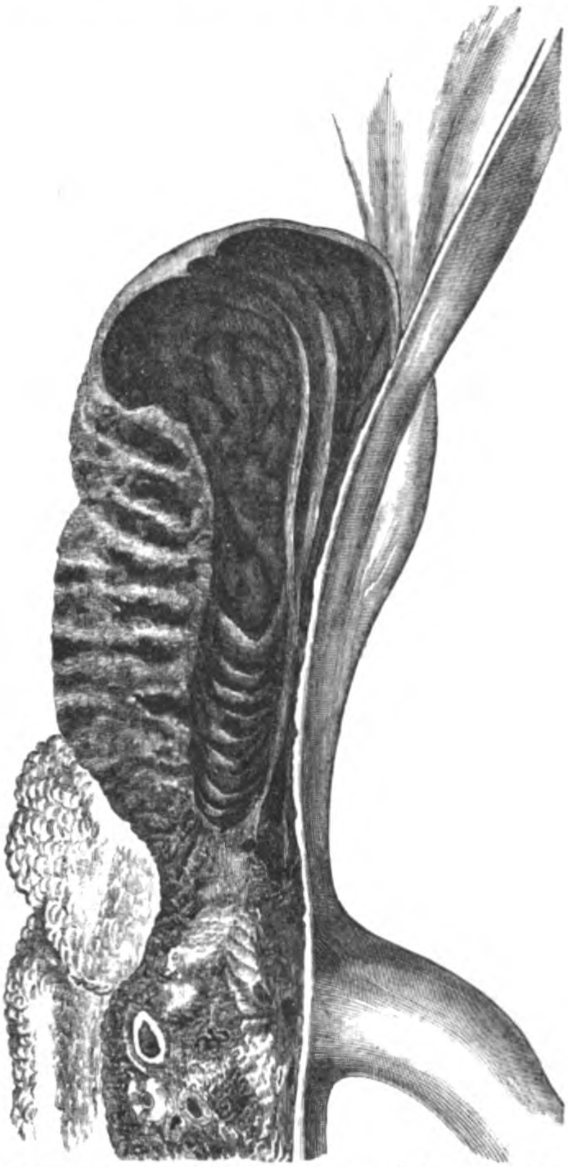


FIG. 106.—Apoplexy of placenta. (Cruveilhier.)

will be seen embedded in the tissue proper; the layers of the circumference are composed of fibrin condensed and freed from colouring matter. These are evidently the result of effusion of a date long anterior to the expulsion of the placenta. Internal to these are layers of fibrin less condensed, and deprived to a less extent of the colouring matter—the result of more recent effusions. The centre is occupied by blood partly coagulated, and still dark-red or black—the result of effusion immediately preceding the expulsion of the placenta. Accompanying this condition, it is usual to find the tissue surrounding the seat of effusion more or less infiltrated with blood, partly indurated from the consolidation of this blood.

In another form of recurrent placental hæmorrhage the blood is not extravasated in one or two large *foyers*, as in the preceding case, but in numerous small round masses, dispersed throughout every part of the organ, and having healthy tissue between them. In a placenta affected in this manner, we may sometimes see individual *foyers* exhibiting blood or fibrin in the different stages of metamorphosis that indicate distinct periods of extravasation; and also different *foyers*, some showing the hard, colourless fibrin of long standing, and others consisting entirely of freshly extravasated blood. In such cases there is commonly some disease of the placental tissues, as fatty degeneration, predisposing the vessels to yield under moderate tension.

Still another form of placental hæmorrhage especially deserving attention is that occasioned by partial detachment, as in *placenta prævia*. Here the phenomena presented by extravasation of blood into the placenta may be observed in all their simplicity. The hæmorrhage depends upon purely mechanical causes, and the elements of the placenta and the blood itself may be perfectly healthy. Here, also, we have frequently the opportunity of observing the different appearances assumed by different portions of blood poured out at different epochs. It is a familiar fact that when the placenta is implanted on the lower segment of the body of the uterus, the patient is liable to successive hæmorrhages occurring at intervals more or less distant. It was advanced by Gendrin, and maintained by J. Y. Simpson, that the occasional arrest of the hæmorrhage in these cases was owing to the coagulation of the blood poured into the separated portion of the placenta. This coagulation undoubtedly takes place, but it is not enough to explain the whole case. How the flooding is arrested will be shown when describing Placenta Prævia. In these cases the blood is certainly maternal. The mother shows unequivocal marks of the loss of blood, whilst the child exhibits no such loss, unless some of the larger umbilical vessels have been accidentally ruptured.

Masses of fibrin are not uncommon in the placenta. What is their *significance*? These facts must be noted. They are frequently found sharply-defined in the midst of healthy placental tissue; their most frequent seat is immediately under the fœtal surface. The child is born alive at term. The inference is that these masses have little pathological importance.

Another question is—What is their *origin*? They may be supposed to be the remains of blood-extravasations, or simple exudation of fibrin, or of inflammatory effusion. Against the hypothesis of blood-clots are the facts that they are perfectly homogeneous, and show no trace of blood-corpuscles or hæmatoidin, thus differing from the apoplectic extravasations last described. Against the inflammation-hypothesis are the facts of the sharp limitation of the masses by healthy tissue and the absence of any symptoms indicative of this process. We believe the most frequent source to be exudation, as fibrin, from the fœtal vessels. The blood of the fœtus is hyperinotic; the seat is almost invariably near the fœtal surface in the neighbourhood of the large vessels gathering to run into the cord. Qualifying this statement, however, we must note that a frequent seat of the deposit is round the margin of the placenta near the circular sinus. Of this we have seen remarkable examples, and we made a drawing of one case in which there was a thick layer of yellowish-white fibrin completely encircling the placenta, and which, contracting, had so raised the edge all round as to convert the fœtal surface into a cup. This is described by William Hunter, who calls it pleuritic blood. It is conceivable that this concentric marginal contraction might detach the placenta partially from the uterus, and so cause hæmorrhage. Or the contraction might interfere with the circulation in the large umbilical vessels by compressing them. But we have not seen proof of this. Sometimes the mass is distinctly laminated, as if deposited at distinct times.

In one case we thought the cause might be inflammation. The late Mr. Pretty brought a placenta with the following history. The patient had suffered intense pain in the hypogastrium during gestation, depriving her of sleep. She went the full time, and was delivered of a living child. She was a delicate, feeble woman. A considerable portion of the placenta retained the normal appearance externally, but, on cutting into it, numerous indurated portions were discovered, some having small cavities. One point, isolated, contained a recent coagulum surrounded by indurated tissue. The indurated part felt and cut like liver. The villi in the indurated parts were much smaller than normal, bloodless, some of their ends black and nodulated, their texture brittle. In this case there had probably been inflammatory action, leading to fibrinous effusion and hepatisation (?), and partial degeneration of the villi involved from pressure.

Changes undergone by the fibrinous masses.—As in the case of like deposits elsewhere, these masses are prone to fatty metamorphosis. Viewed in the mass, to the naked eye they look like lumps of fat, and for this they have been constantly mistaken. Under the microscope no placental tissue is seen; nothing but fibrillæ of condensed fibrin filled with oil-granules. The 'scirrhus,' 'tubercles,' 'steatomatous tumours' of older authors are nothing else but deposits of fibrin such as we are now describing. Denman mentions it as 'adipose substance,' Wilde as 'placenta obesa.' This condition has also been frequently spoken of as 'stearoid' or 'fatty degeneration' of the placenta, and on this ground it has been imagined that Robert Barnes's discovery of fatty degeneration of the placenta had been anticipated. The two things are totally distinct. During his researches on the subject, many placentas with these fibrinous deposits were brought to him as examples of fatty degeneration. True fatty degeneration, as will be seen presently, is the granular change of the proper structures of the placenta, not the molecular conversion of accidental masses of effused fibrin.

Inflammation.—Placentitis.—A priori, inflammation may be predicated as possible. Wherever blood and blood-vessels are found, there, it may be inferred, inflammation may arise; and the blood of both mother and fœtus is hyperinotic. But it is confessedly a difficult study. The most suggestive marks of inflammation are seen in the membranes. A case recorded by Dance as inflammation of the fœtal surface of the placenta is not, to our mind, free from doubt as to its nature. Ollivier's case is less equivocal. The membranes were thickened, whitish, opaque, and villous on their inner surface, and traversed by very fine vessels. The woman had suffered pain and slight fever when four months pregnant. She was delivered at term of a live child. Thickening and opacity of the membranes are not uncommon. We have met with cases in which the membranes were so thick and tough that labour was arrested from this cause. The liquor amnii could not be discharged until an opening was made by puncture in the presenting pouch. The bands and strings occasionally found in the amniotic sac, strangling the fœtal limbs, or making adhesions between the fœtus and membranes or placenta, strongly suggest inflammatory effusions. Dubois takes this view, and says adhesions cause monstrosities.

Inflammation was described by Brachet (1828). He compared placentitis with pneumonia. Hennig says the decidual cells swell, and split into a network of connective tissue. Thus yellow or white septa force themselves between the villous masses. The villi, at first swollen, become compressed and fatty, as well as a great part of the placenta. On the fœtal surface effusions of blood and cysts form, and on the uterine surface brown-red knobs, which, wedge-like, with the apex downwards, penetrate between the villi. Later it assumes the appearance of contracted granular liver (hepatisation), and thence leads to adhesions of the membranes or of the placenta to the uterus, and thus to disturbance of the placental stage of labour. The discoloured portions, seized by inflammation, shrink, harden to a red, then lemon-coloured, knob; the exudation, for the most part of strings of connective tissue, penetrates even into the substance of the uterus, so that it is difficult to detach the placenta. Or the exudation falls into pus; lobular abscesses form in the placenta (Chiari, Braun, and Spaeth), whence pyæmia of the gravid woman or of the fœtus may arise. The fatty and calcareous changes are of less importance.

The gravid woman feels sometimes at the seat of the internal inflammation, for several weeks, or even months, a dull pain or burning; if peritonitis uteri supervenes, a stabbing or tearing is felt on deep inspiration and in certain positions.

In the *villi* inflammation causes first a gelatinous exudation (molecular infiltration), then the villi atrophy. The fate of the fœtus depends upon the extent of this change.

There is observed a tendency to recurrence of the same placentitis and symptoms in successive gestations.

Chronic inflammation.—Hennig once saw on the membranes a croupous-like exudation; anastomosing pale threads penetrated to the fœtal surface. A layer was formed which bound amnion and chorion intimately; the membranes were thickened.

In the placenta chronic inflammation appears under the form of connective tissue and thickening of the arteries. This last condition leads to hyperplasia. The lumen of the vessels is narrowed or closed. The remaining villous tissue is compressed, atrophied, fatty. The consequences of this disease of the vessels is serious for the fœtus; enlargement of the heart, causing enduring communication of the cavities, greater filling of the lungs and cyanosis, may ensue.

It must, however, be noted that able observers deny the occurrence of inflammation. Not even the semblance of abscess can be accepted as proof. Robin says what has been taken for inflammation is nothing but a condition characterised by the transformations of blood-effusions in different degrees of progress. What has been regarded as pus consists of fine molecular granulations soluble in acetic acid, with white globules and sometimes red globules. If true pus is found it comes from the uterine tissues and vessels.

We see strong presumptive evidence that there may be decidual inflammation. Endometritis undoubtedly occurs in the non-pregnant. The condition known as dysmenorrhœa membranacea, depending as it does upon inflammation, does not absolutely exclude pregnancy. The result is commonly abortion. Possibly inflammation of the maternal element of the placenta may arise under the influence of small-pox or scarlatina, diseases which commonly attack all the mucous membranes.

Fibrinous deposits.—It is interesting to consider the analogy of the structure of the placenta with that of the liver. In both organs there is a large volume of blood slowly moving. It may be surmised that impurities derived from the fœtus coming in contact with the maternal blood may cause precipitation of fibro-albumen. The form and size of the deposits found on the fœtal surface render it probable that they are thrown into the maternal cavernous structure as injected size may be. Villi close around these deposits may be quite healthy, and sometimes atrophied villi are involved in the edges of the fibrinous masses.

Sclerosis.—Bustamente describes as sclerosis an alteration appearing under the form of a red fleshy lobulated smooth mass, homogeneous and dense, resembling the tissue of the thymus. The affected part adheres partly to the fœtal surface of the placenta; the healthy tissue is driven back and compressed. At the level of the mass thus affected the mucous layer covering the maternal surface of the placenta can be detached, which is impossible in the normal state.

Calcareous deposits.—Not unfrequently the maternal surface of the placenta exhibits a number of whitish opaque specks lying just beneath the decidual membrane. These specks have a gritty feel, and are, in fact, earthy deposit. It is usually amorphous, but sometimes it presents acicular crystals; it effervesces freely with hydrochloric acid, and turns yellow with nitrate of silver. The decidua covers the specks like a coat of transparent varnish, but in places the appearance is as if the decidual covering were rubbed off; the earthy specks are then naked. This is accounted for by the tearing away of the placenta from the uterus, some of the decidua remaining behind. Unusual adhesion of the placenta is one of the phenomena observed in this affection. That it is mainly a decidual affection is further seen by tracing the septa between the placental cotyledons; the same deposits are seen in these offshoots from the decidua. Again, the fœtal vessels and other structures show no trace of the affection; they may be quite healthy, full of blood, and the fœtus be born alive, and strong It is astonishing to observe in some cases how extensive the deposit may be without interfering perceptibly with the function of the placenta or the welfare of the child. In some cases the maternal surface is plated or cased with thick crusts of earthy or bony matter.

These deposits are, in our experience, frequently associated with scrofula, tuberculosis, and poor living. We do not know that this relation has attracted attention. The following case is an apt illustration:—Mrs. A., pregnant for the first time, applied to Robert Barnes, when four months gone, on account of retroversion of the womb. This was rectified. She was then apparently in good health. Two months later she came again, suffering from emaciation, night-sweats, diarrhœa, 'purulent expectoration streaked with blood, hoarseness,' and lately, expectoration of 'chalky matter, which she could crumble between her fingers'; vomiting was severe. When labour set in she was extremely reduced, but she was delivered without difficulty of a full-sized vigorous boy. The maternal surface of the placenta was everywhere studded with minute points of calcareous matter embedded in a soft cartilaginous-like substance. The placenta, in other respects, was normal. The patient sank, exhausted by phthisis, three weeks after labour. In another case the alteration was noted in three successive labours. The woman was of marked scrofulous diathesis, and at each labour had mammary abscess, also a frequent complication of the scrofulous diathesis. When these calcareous deposits are found in healthy subjects they may be regarded as simple deposits of excess of the calcareous matter called for by the fœtus.

The connection between calcareous deposit in the placenta and phthisis is very suggestive, and more so if we take into account the osteophytic deposits occasionally observed in the membranes of the brain. That it should occur in the lung of the mother, and in the fœtal homologue, the placenta, is very remarkable. It deserves to be noted that the deposit takes place in maternal structure--that is, in the decidua.

Another form of chalk-alteration is seen in the *fœtal vessels*. The significance of this is quite distinct from that of the decidual kind just described. Lobstein noticed this form. It has been taken to be atheroma of the placental vessels. In our experience it is more commonly found in association with fatty degeneration of the fœtal villi and vessels. The ends of the villi become opaque; the villi and their blood-vessels lose their functional capacity; blood ceases to circulate in them; and consequently, if the affection extends to a considerable portion of the placenta, the fœtus dies. In this respect, then, the calcareous affection of the fœtal structures differs from that which attacks the maternal structures. It is, however, possible that both forms may be found together.

Chalk concretions are also found in the *fibrinous masses* effused in the placenta.

It is interesting to note that there seems a special tendency to the chalky deposit or conversion in the uterus and adjacent structures. This is seen in phleboliths, in the calcareous investment of the fœtus in ectopic gestation, in the calcification of fibroid tumours. We must also bear in mind the special want of calcareous matter to build up the fœtal skeleton.

Œdema, or dropsy of the placenta, is not uncommon. Occasionally we see a placenta greatly exceeding the normal bulk, friable, paler than natural, and full of water. If suspended, a large quantity of thin serous fluid will ooze away, and the residual placental tissue may be found somewhat greater in bulk and weight than the normal placenta of corresponding age. The conditions which we have observed in connection with dropsy are—(1) dyscrasia, hydræmia of the mother; (2) sometimes the mother has anasarca or ascites; these two conditions may arise from heart, liver, or kidney disease in the mother; thus we have found albuminuria to co-exist; (3) dropsy and peritonitis of the fœtus.

Dropsy of the placenta almost necessarily entails hypertrophy of the placental villi. When watery blood, deficient in nutritive and oxygenating power, is brought to the placenta from the mother, an attempt is made to compensate for the loss in concentration of power by calling into requisition a larger quantity of the inferior or diluted blood. The fœtal villi and vessels grow—that is, undergo hypertrophy—in order to carry the increased volume. Some degree of fatty degeneration is commonly observed.

The issue is commonly death of the fœtus or premature labour. Abortion may be provoked in two ways—(1) the expansion of the placental tissue may not keep pace with the wants of the fœtus, so that it is killed at six, seven, or eight months, and so labour comes on prematurely; (2) the bulk of the placenta may become so great and increase so rapidly as to exceed the accommodating capacity of the uterus, and so labour is excited. In such case the fœtus may be born alive.

Hypertrophy and atrophy are more especially affections of the fœtal placenta. It is necessary to distinguish hypertrophy from hyperplasia. Hypertrophy strictly means increased expansion or growth of normal structures. Hyperplasia implies the addition of new matter outside or in the substance of the proper tissues. It may, however, be said that hyperplasia generally involves more or less hypertrophy. The placenta must keep pace in bulk and efficiency with the development of the fœtus. Generally speaking there is a relation in size between the fœtus and the placenta. Gassner demonstrated this by weighing. If the maternal blood is rich, a smaller placenta may suffice; if, on the other hand, the maternal blood be poor and watery, more placental tissue is required. In this condition we find one cause of hypertrophy.

The anatomical condition consists in an enormous multiplication of the capillary fœtal vessels. These vessels and the chorion may, to the microscope, reveal little alteration of structure.

It appears to us that Ercolani has confounded true hypertrophy with hyperplasia and fibrosis.

Atrophy, like hypertrophy, is generally a secondary disease. The example described and figured by Cruveilhier as atrophy of the placenta, we believe to be an example of fatty metamorphosis occurring after the death of the fœtus. Atrophy may be produced as the result of pressure upon the fœtal vessels by effusions into the substance of the placenta; or it may result from failing innate powers of the fœtus. An atrophied placenta is small, pale. Some villi may be found comparatively sound, and carrying red blood; but even in this case the villi will be paler than the healthy placenta. Points on the maternal surface, generally in the middle of the cotyledons, show recent vascular connection with the uterus—that is, the maternal element of the placenta retains some degree of vitality.

Pigmentation.—Ercolani figures a fine example of *melanosis* in the cells of the serotina. Hennig states that pigment is found in the villi and their stalks after chronic stases, as from heart-disease and blood-disease of the fœtus.

Tumours have been described by Danyau and others. He is probably right in regarding them as due to sanguineous effusions. A remarkable example in St. George's Museum (xviii–8*a*), which we have examined, is of this nature.

It may be stated provisionally as a general proposition, that most of the morbid alterations observed in the placenta have their origin in exudations or extravasations of blood or of the elements of blood.

Syphilitic placenta.—Virchow describes an aborted ovum of from two to three months, which had come from a woman who became affected with syphilis after marriage. The chief change was in the maternal part. The decidua was formed on an *endometritis papulosa et tuberosa.* He considers it probable that the tubercles were condylomata, having observed similar conditions of the mucous membrane of the uterus of syphilitic patients. Dohrn describes and figures [1] a case illustrating Virchow's views. Ercolani, however, says that researches on syphilitic lesions show that a form of disease regarded as analogous to the broad condylomata or the mucous papulæ of Virchow occurs also in placentas whence the venereal element is excluded, and is nothing more than an angioma. This view is adopted by Hennig. We think, however, the presumption in favour of a special decidual affection due to syphilis is very strong. The uterine mucous membrane can hardly escape the fate of mucous membranes elsewhere. Upon this point Lebert should be consulted.

Fatty degeneration of the placenta.—This affection and its importance as a cause of death of the embryo, hæmorrhage, and abortion was first described by Robert Barnes.[2] Under the title, 'A New Disease of the Placenta,' the publication of this discovery had been partially anticipated by Kilian.[3] Soon afterwards other observers, especially Robin, made further investigations. It is the same disease that attacks the heart, vessels of the brain, liver, kidney, and muscles of the adult. In proportion as it advances it unfits the structures attacked for the performance of their functions; and hence, in proportion to the importance of these functions, the life of the subject is imperilled. It attacks both the maternal and fœtal elements of the placenta; it cannot be always shown which was the first to suffer, but it is almost certain that the other will soon fall under the like degeneration.

It is desirable at the outset to distinguish between fatty

[1] *Mon. f. Geburtsk.* 1868.
[2] *Med.-Chir. Trans.* Feb. 1851.
[3] *Neue Zeitshr. f. Geburtsk.* 1850.

degeneration, an affection beginning in living tissues, and fatty metamorphosis, a change which takes place in dead tissues.

Fatty metamorphosis.—When a placenta is retained *in utero* after the death of the embryo, it is liable to undergo fatty conversion; a change analogous to the adipocerous. It is marked by the general or universal character of the change, every part of the decidual and chorionic structures being nearly equally affected. No blood is found in the chorionic vessels; the proper chorionic investment of the

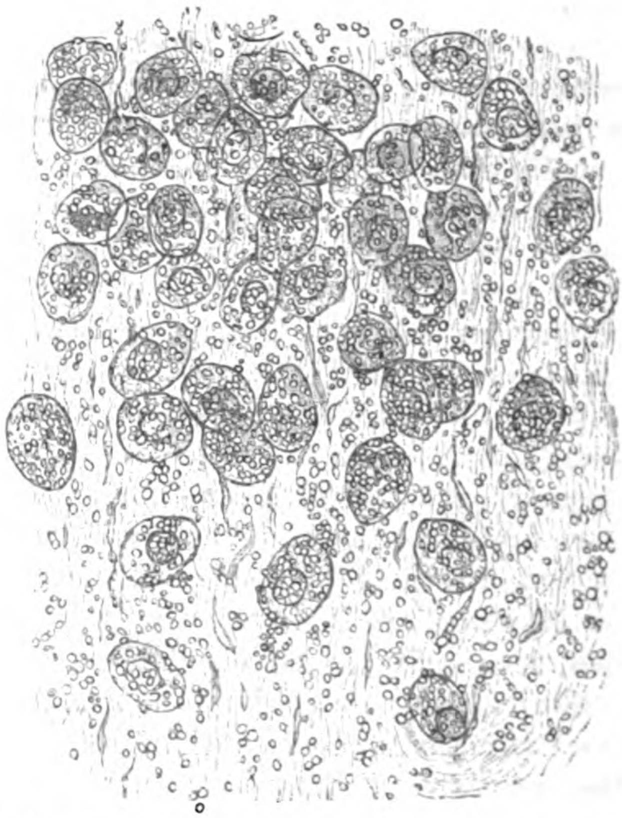


FIG. 107.—Showing decidual cells in fatty degeneration. (Robert Barnes.)

vessels is lost in granular fat; it easily separates from the vessels, and the vessels themselves hardly show traces of their proper structure. To the naked eye the placenta is smaller than normal; it is pale, of a more or less fatty appearance, very *friable* instead of lacerable, like the normal placenta. On the maternal surface it may still show remains of recent vascular connection with the uterus. Generally in the centre of the cotyledons will be seen a blood-point or clot, the mark of a vessel torn on separation from the uterus.

True fatty degeneration differs widely from the above description. In the first place it is generally partial, invading one or more cotyledons or part of them, forming in many cases diseased masses imbedded in comparatively healthy tissue, thus giving evidence that it originated during the life of the fœtus. In some cases we find, indeed, a living fœtus with a placenta in part affected; in others we find the disease more advanced and the fœtus, dead but with some healthy placenta, the vessels still containing blood. To the naked eye the fatty placenta may exhibit masses of yellowish pale colour, more solid than the spongy, healthy tissues surrounding them, and easily friable. Under the microscope we distinguish the precise tissues affected.

The maternal element or decidua presents the characters drawn in fig. 107, p. 568. The decidual cells are studded over with minute spherules of oil, some are also on the surface, some on the coats of the vessels and in the cavities of the cells. In some cases there is also evidence of fibrosis of this membrane.

The fœtal portion, consisting of subdivisions of the umbilical vessels, and their chorionic investment, presents the following features. On placing a small portion in water, the first thing that strikes the eye is that the tufts of villi do not expand or float out as does healthy placenta, and on teasing with needles the extreme brittleness of the structure is apparent. Viewed with a half-inch object-glass, the villi are seen much broken up, opaque, darker than usual, especially near their terminations, which reflect a yellowish colour. Magnified 420 diam., the villi are seen thickly studded with minute spherules of oil (see fig. 108, p. 570); the chorion is much altered, thickened, the nuclei are lost; the walls of the vessels have also lost their nuclei; spherules of oil are contained, some in the chorion, some in the walls of the blood-vessels, and many in the intervals or spaces between them; the cavities of the vessels are mostly free from fatty deposition; lastly, the vessels are destitute of blood. Some lobes which present to the naked eye a normal appearance, yet show clear evidence of the same destructive change in progress; considerable fatty change is visible, and the nuclear structure of the walls of the blood-vessels and of the chorion is to some extent invaded. In these portions the distribution of the oil-molecules coincides with the course of the blood in the vessels. This observation shows that the condition of the blood itself is intimately connected with the origin of the deposit.

What are the consequences of fatty degeneration of the placenta? 1. It leads to *abortion*. If the change begins in the chorion or fœtal vessels, these structures become unfitted for their functions; circulation of blood and osmosis cease. If only a small portion of the fœtal villi be affected, the remainder of

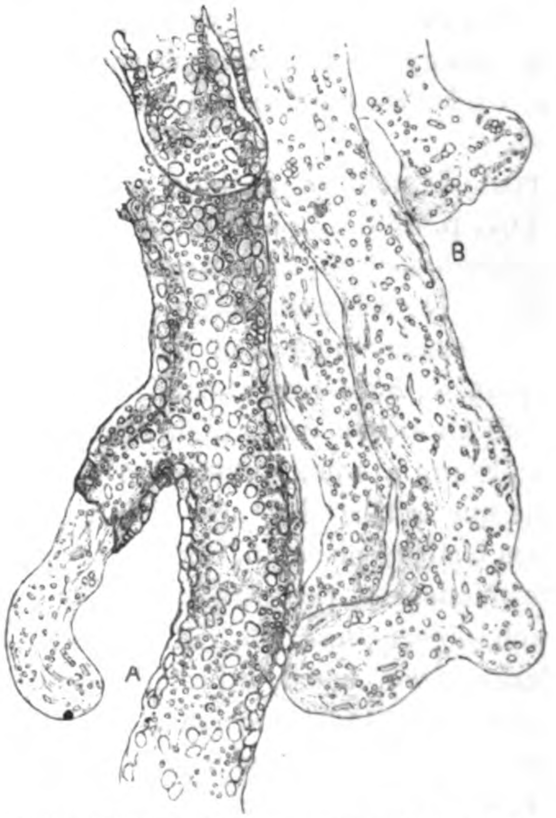


FIG. 108.—Villi in fatty degeneration. (Robert Barnes.)
A. Vessels invested with chorion. B. Vessels denuded of chorion, void of blood.

the placenta may suffice for the nutrition of the fœtus, which may be born alive. If the affection be at all extensive the fœtus will perish. When the fœtus perishes, the utero-placental circulation quickly flags and ceases. The next step is gradual atrophy of the placenta, of the utero-placental vessels, and decidua. These last retain for a time an impaired connection with the uterus. The fœtal portion has perished with the embryo; the maternal portion, as a uterine structure, lingers on. This is especially the case in early abortion, where the cause appears to have had its origin in the embryo. The developmental attraction ceasing, the uterus itself is passing into retrogressive atrophy. Contracting upon itself, its capacity diminishes, and so soon as its walls press upon the contained ovum, the diastaltic function is excited, and active contractions —labour-pains—setting in, complete the detachment and expulsion of the ovum.

There is an interesting illustration of this theory in that case of twin-pregnancy in which one embryo perishes at an early period of gestation whilst the other lives on. The dead ovum is not cast off, because the development of the uterus is kept up by the stimulus of the living embryo. The placenta of the dead fœtus runs into fatty metamorphosis, maintaining only a very slight vascular connection with the uterus.

If, on the other hand, the fatty degeneration begin in the decidua, as it is likely to do when the mother is diseased, the fœtal circulation soon suffers. The altered tissue of the decidua is unfitted for osmosis, the blood brought to it is poor, and so the circulation of the embryo suffers secondarily. In this case, which, it may be presumed, is seen in syphilised women, abortion occurs at an earlier period than is generally the case when the cause is embryonic.

2. *The relation to hæmorrhage.*—In many cases the affection proceeds with unequal rapidity in different portions of the placenta. The affected portions differ from normal placenta in consistency; they are no longer spongy and yielding, but more or less solid, and the vascular connections with the uterus have become partially weakened. Hence, under the peristaltic movements of the uterus, the diseased portions of the placenta failing to keep in uniform relation, the weakened vascular connections break, and, the severance extending to the healthier vessels, hæmorrhage follows, and commonly abortion results.

In some cases, however, where the affection is more general, the circulation may be so far arrested before the placenta is cast that, when expulsion occurs, there may be very little hæmorrhage. The placenta then falls like an etiolated leaf from a tree.

Fatty degeneration of the placenta may explain some cases of hæmorrhage during gestation which are attributed to placenta prævia.

'It has long been discussed,' says Ercolani, 'whether the alterations of the placenta were the effect or the cause of the death and destruction of the embryo. Most moderns concur in holding that these alterations are the cause of the death of the fœtus, but some seek to honour the dictum of Aristotle that the death of the fœtus is the cause of the alterations in its involucra and placenta.' In some cases undoubtedly, clinical observation does not avail to determine if the disease had begun in the fœtus or in the placenta. On the other hand, numerous cases establish the fact that most of the diseases described may arise and make some progress during the life of the fœtus. This fact it is that invests the study with so much interest, physiological and pathological.

The consensus of opinion in favour of Robert Barnes's proposition, much contested at the time of its enunciation, that fatty degeneration is a cause of hæmorrhage and apoplexy, seems conclusive. Bailly does not admit that apoplexy occurs in healthy tissue. Robin says apoplexy is the necessary consequence of fatty degeneration. His view is adopted by Charpentier. Ercolani distinctly recognises it. He says the pathological cause of hæmorrhages which had hitherto escaped observation is the fatty degeneration of the cells of the serotina. This, he says, explains the frequency of abortion by hæmorrhage in the early months. Ercolani points out that Robert Barnes was the first to describe this change.[1]

The *etiology* of fatty degeneration.—One hypothesis, advocated by Druitt,[2] is that the process is a normal one preparatory

[1] 'Ad ogni modo credo che Barnes (1853) e Robin (1854) fossero i primi a fare speciale parola di questa lesione patologica, che indicarono, come ho detto, coi nomi di alterazione grassosa o di degenerazione fibro-grassosa della placenta.' This statement is necessary in vindication of priority. Dr. More Madden, in article 'Diseases of the Placenta,' in *Quain's Dictionary*, 1882, has the following passage:—'The late Sir James Simpson, Virchow, and Dr. Druitt, as well as some earlier writers, have discussed the nature of this affection, on which more light has since been thrown by Dr. Barnes's papers in the 34th and 36th vols. of the *Medico-Chirur. Transactions*.' The facts are that Barnes's *Memoirs* were published in 1851 and 1853, that Simpson referred to the subject in a very imperfect manner in 1856, and that Druitt avowedly followed the researches of Barnes, his *Memoir* being read at the Medico-Chirurgical Society in 1853. Dr. Madden has cordially admitted to us that he had fallen into error. But the *Dictionary* continues to be issued without correction; hence the call for this vindication.

[2] *Med.-Chir. Trans.* 1853.

to the detachment of the placenta at labour. This may be called a physiological heresy. If, as we have seen, the constant effect of the change were to destroy the functional capacity of the tissues affected, the fœtus could not live. And in proportion as the term of gestation advances, the fœtus, growing at an accelerated rate, requires more and more blood and more placenta. The facts are, as stated in Robert Barnes's first 'Memoir,' that a slight degree of granular change is seen in every placenta, but in no such degree as can by any stretch of theory be considered favourable to detachment.

The part in which the normal fatty change is most common is round the margin of the placenta. The atrophy of the superfluous villi on that part of the chorion not wanted for placenta is effected by fatty degeneration.

The separation of the placenta is an abrupt violent mechanical process.

We believe that the fatty villi around the margin of the placenta observed by Druitt are chiefly degeneration of those villi which could not contract proper relation with the decidua, and therefore become atrophied like those villi which grow at a distance from the placenta.

The inflammatory hypothesis.—This is probably true of a certain number of cases, but it has not been clearly proved. Ercolani maintains that it is nothing but a hyperplasia of the cellular element of the parenchyma of the villi, which may be simple or complicated with fibroma of the glandular organ (serotina). That hyperplasia enters as an important factor in many cases we have no doubt. But the change demonstrably affects the fœtal vessels as well as their chorionic investment, and in some cases begins in the coats of these vessels.

A frequent cause is—(1) Original defective vital force of the embryo; (2) another is defective nutritive value of the mother's blood; (3) a third cause may be a compound of faults of the blood and tissues of mother and child.

Cystic degeneration of the chorion; myxoma (Virchow).

Hydatidiform degeneration of the placenta.—Vesicular mole (*Blasenmole, Traubenmole,* Germ.: ὑδατίς, -ιδος, a watery vesicle, Galen). This, of all the diseases to which the placenta is liable, is most obviously chorionic. It is not a very frequent disease, but there is no other disease the general appearance of which is so familiar. Specimens are found in most museums. When advanced there is no overlooking it. In its incipient stages, in some cases of very early abortion, we have, however, known it escape detection, until the chorion was examined with

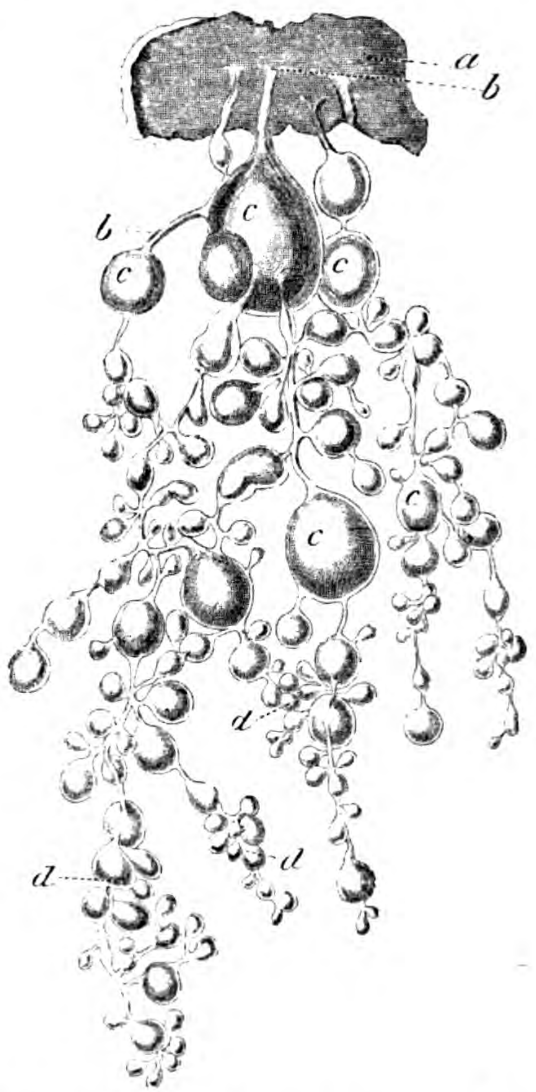


FIG. 109.—Branch of hydatiginous placenta as seen by naked eye. (Ercolani.)

a. Chorion. *b*, *b*. Trunks and branches of villi. *c*, *c*. Hydatiginous vesicles. *d*, *d*. Branches of vesicles.

a lens or a low power of the microscope. The names 'vesicular mole' and '*Blasenmole*' describe sufficiently the appearance presented to the naked eye. This is represented in fig. 109. A study of this figure will dispose of one error frequently associated—namely, that the hydatidiform mole is constructed on the pattern of a bunch of grapes. The difference is this: the grape-bunch consists of a central stalk giving off rami and twigs, each of which bears a simple berry; the mole consists of a membrane or bladder for basis, the chorion, from the surface of which a new generation of cysts is formed, each one of which has the property of developing one or more daughter-cysts. Berry grows out of berry, and the stalks do not unite berries with principal stems, but berries with berries, and lastly with a central mother-cyst. The nearest similitude is found in the growth of the cactus or prickly-pear, in which plants, from each leaf or stalk, new stalks bud out, which in

FIG. 110.—Terminal extremity of a hypertrophic chorion-villus. (Ercolani.)
d, d. Epithelial neoplasms springing from surface of villus.

their turn give off other stalks. It is a process of germination or continuous budding. The German name 'Traubenmole' should therefore be discarded.

We may here dispose of another error suggested by the name 'hydatid-mole' sometimes used. It was at one time considered that the vesicles were true hydatids; and it is related that Percy (1811), believing in this, chivalrously defended the chastity of two women who were delivered of hydatid moles. He saw in the vesicles signs of life. No one since his time has witnessed this, so that his cases remain in their isolation appealing to credulity.

It is nevertheless true, that real hydatids may make their way into and through the uterine wall. No tissue in the body is absolutely secure against their attack. Braxton Hicks and Hewitt relate examples.

To form a clear conception of the origin and nature of this disease we must return to the structure and development of the young chorion-villi. These grow or increase by bud-like processes (see fig. 111)—pyriform, clavate or fusiform, the narrow part connecting them like a stalk with the end or side of the villus; or sometimes the extremity of a villus appears enlarged,

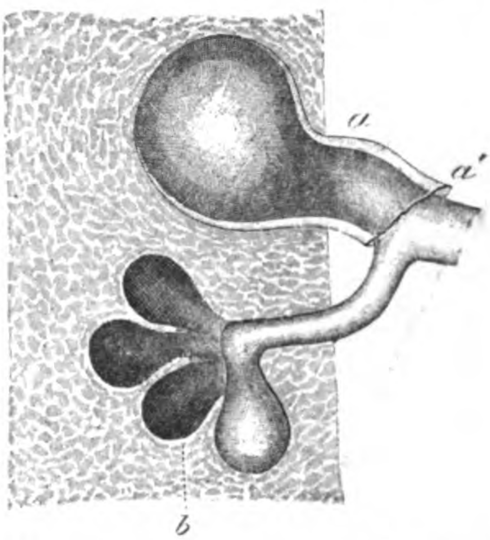


FIG. 111.—Showing budding growth of chorion-villi.

a. Chorion-investment of villus. *a'*. Villus chorion peeled off. *b*. Budding of villus.

and divided into a number of lobes, no contraction of a part resembling a stalk; sometimes the processes have a vesicular appearance, and still there is no disease. In perhaps the earliest ovum (lent us by Dr. Sharpey) which we have had an opportunity of examining—probably not four weeks old—the termination of every villus exhibited a simple or compound lobular appearance, or distinct projection; and some villi had processes from their sides. At a later stage of growth, instead of the clavate or fusiform processes, there are seen cylinders of greater or less length, but still bearing a resemblance to the primitive shape in the dilated extremities. These are young villi. Often upon these again, secondary processes, or buds, may be observed. Inasmuch as the rapid growth of the fœtus towards the term of gestation is ever calling for increased expansion of placenta, fresh villi are constantly forming. These buds are accordingly seen on the villi of placentas approaching maturity; but they are far less frequent than in early ova.

Now it appears that under the influences of a perverted developmental force, these buds, instead of growing into villi, carrying blood-vessels, may dilate into true vesicles or hydatidiform cysts. Such a perverted growth necessarily involves the destruction of the placenta as a respiratory organ, and the consequent death of the embryo. Having examined a great number of ova of different epochs, we have become familiar with various appearances which can neither be referred to healthy villi nor to hydatidiform degeneration. We have noted bodies attached to villi which, although evidently of the same origin as the ordinary budding villi, were yet so different in some of their characters as clearly to have failed as villi, and which, nevertheless, were not recognised as hydatidiform cysts. We are disposed to regard these as marking an intermediate stage or transition into cystic degeneration.[1]

The more advanced stage is thus described by Paget: 'Certain of the proper villi of the chorion deviating from their cell-form, and increasing disproportionately in size, form cysts which remain connected by the gradually elongated and hypertrophied tissue of the villi. On the outer surface of the new-formed cysts, each of which would, as it were, repeat the chorion and surpass its powers, a new vegetation of villi sprouts out of the same structure as the proper villi of the chorion. In this begins again a similar development of cysts, and so on *ad infinitum*. Each cyst, as it enlarges, seems to lead to the wasting of the cells around it; and then moving away from the villus in which it was formed, it draws out the base of the villus, which strengthens itself, and forms the pedicle on which the cyst remains suspended.' The disease presents a curious example of a structure endowed with independent formative force continuing to grow—a pure parasite—for itself alone, having ousted the original parasite, the embryo.

The cystic degeneration generally attacks all the chorion-villi, including those not destined to form placenta. Michael

[1] 'On the Diseases of the Placenta,' *Brit. and Foreign Med.-Chir. Review*, 1854-5-6.

describes a case in which a patch of cystic chorion-villi [1] grew at a distance from placenta, which itself was healthy.

In many cases the diseased villi send processes far into the wall of the uterus, the cystic growth extending along the maternal tissues. This might be expected since the normal villi shoot into these sinuses (see fig. 112). The difference is, that along with the cysts there penetrates neoplastic matter, and the growth is more active, leading in some cases to strong, even inseparable union. R. Cory gives a most interesting example, in which cystic villi penetrated deeply not alone into the interior wall, but also into a polypoid fibroma projecting

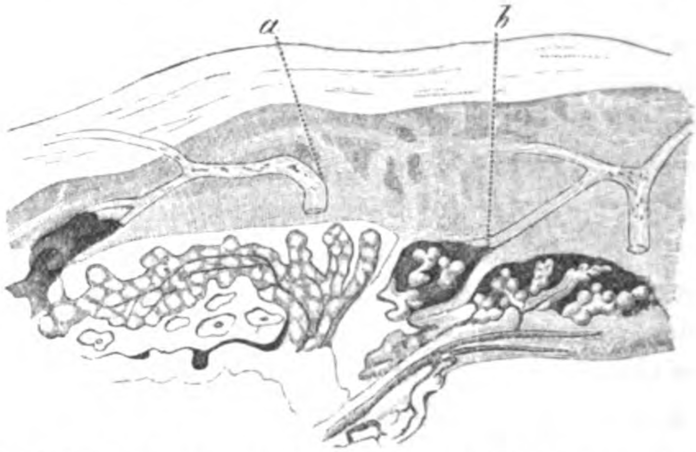


FIG. 112.—To show penetration of chorion-villi into uterine sinuses. (Schrœder van der Kolk.)

a. Vessel. *b.* Villi in uterine sinus.

into the cavity of the uterus. The patient died of hæmorrhage. A similar case [2] is recorded by R. Barnes; a fibroid tumour also coexisted. This patient also died.

Two conditions are constantly found in connection with this cystic degeneration: hypertrophy of the decidua as well as of the chorionic tissue, and fatty degeneration. Ercolani says there is a remarkable neoplasm of the epithelium of the chorion-villi. Wedl and Robin described the affection as a dropsy of the villi, but this view Ercolani denies. He also denies Virchow's theory adopted by Hennig, that it consists in a myxoma of the villi. It must, however, be admitted, that tissue in all respects resembling myxoma is constantly found in the mucous tissue between the central vessel and the epithelium of the

[1] *Beale's Archives*, No. IV. [2] *Obstetr. Trans.* vol. XX.

villus. Virchow and H. Müller attribute the origin of the hydatidiform change in the villi to this morbid thickening of the decidua, thus assigning a maternal cause.

The *causes* of hydatidiform degeneration are obscure. It occurs in young and apparently healthy women. We have known several instances of women bearing one or more healthy children at term, then a hydatid mole, to be followed by healthy pregnancies, and this to the same husband; and we have in some instances been able to exclude with reasonable certainty all suspicion of syphilis on either side. Nor could we, in many cases, detect evidence of other diathesis. Still it may well be that syphilis, by affecting the decidua, may now and then be a predisposing factor. In several cases there has been a complication with Bright's disease or albuminuria. Dr. Woodman narrated cases,[1] and some we ourselves observed, in which it seemed clear that the kidney disease existed before the gestation began. Looking at the coincidence of three forms of dropsy—anasarca in the mother, cystic dropsy of the placenta, and dropsy of the fœtus—it seems probable that there existed a causative relation. On the other hand, in many cases no albuminuria has been detected; and in some cases it is certain that albuminuria arises under the influence of the mole-pregnancy, as it does in normal pregnancy.

Dr. Hugh Thomas relates[2] a case in which a hydatidiform mass, weighing $3\frac{3}{4}$ lbs., was removed from the uterus. Complicating jaundice disappeared when the uterus was emptied.

Two theories in this connection have to be discussed, on account of their clinical and medico-legal relations. The one is, that the cystic change starts from the death of the embryo; the other is, that the change may start in a portion of the placenta left adherent to the uterus after an ordinary labour. These two theories have, to some extent, a common basis. Both postulate that the change is independent of the embryo. If we arrive at a definite opinion upon the validity of either of these theories, we shall have gone far to solve both. Let us first examine the evidence in support of the theory that the disease follows upon the death of the embryo. The theory is supported by Mikschik and Graily Hewitt.

Presumptive evidence in favour is drawn from the general

[1] *Obst. Trans.* [2] *Brit. Med. Journ.* 1883.

rule that where hydatidiform degeneration is extensive, no embryo can be found. But it must not be assumed that this is universal. There is a specimen in St. Thomas's Museum showing a four months' embryo with hydatidiform placenta; the amnion is apparently healthy.

In opposition to this argument, moreover, there are well-authenticated cases of living children having been born in association with vesicular disease of the placenta. Thus Perfect relates that he was called to a case with excessive discharge of waters, and lingering labour. The child large, lived. The mother got up in ten days. The placenta, he says, had a particularity 'which I never before or since remember to have observed, for part of its external surface was vascular and divided into small lobes, and the other part of a jelly-like substance spread with vesicles filled with water.' The woman informed Perfect that from the second month of her being with child to the time of her labour she had frequently discharges of water coming away involuntarily.

Villers[1] relates that a woman first passed hydatids, then a fœtus 10 inches long and of more than five months' development. Its heart-beat was faintly heard shortly before delivery. The umbilical cord ended in a few loose threads, which sank in the midst of a mass of hydatids. A flap of membrane adhered so tightly to the uterus that he had to leave it behind. The woman died of metritis.

E. Martin, of Berlin,[2] relates three cases. In case 1, abortion occurred at the end of the third month; an embryo was found answering to this date; the chorion-villi were affected with hydatidiform degeneration. In case 2 labour set in at the eighth month with hæmorrhage; the child was living; many parts of the placenta showed large vesicles filled with clear fluid on the outer surface, with spaces of healthy placenta. Case 3 was similar. Bleeding preceded labour at the end of the eighth month; child dead-born; vesicles of various sizes were found in the placenta.

Krieger tells an instructive history in point.[3] A woman was delivered prematurely of a child, which died immediately. The placenta was in hydatidiform degeneration, excepting a

[1] Schmidt's *Jahrb.* band 39. [2] *Monatsschr. f. Geburtsk.* band xxix.
[3] *Monatsschr. f. Geburtsk.* 1864.

piece the size of a dollar. The fœtus was dropsical, its kidneys very large; the mother was also œdematous towards the end of gestation, urine not albuminous. In her next pregnancy she bore a child also premature and dropsical; a large portion of the placenta was hydatidiform, but the greater half normal; the child quickly died; the mother was œdematous. In her third pregnancy she was again œdematous; labour was induced; the child, born also quickly, died dropsical; there were some bladders on the border of the placenta, the rest was healthy.

The cognate theory that ordinary placenta left *in utero* may undergo cystic degeneration is more difficult to disprove; and, it may be added, not less difficult to prove. How do we know, for example, that the cystic disease observed in a given placenta began after the death of the embryo? It is convenient to state a case as it is presented in practice. A woman is delivered of a child at term. After the lapse of three months or more a vesicular mole is discharged. There is evidence more or less satisfactory that the whole of the after-birth did not come away at the labour; and it is inferred that the portion then left underwent the cystic change. Perhaps the husband was absent; the question of chastity arises. Is the theory of cystic conversion of retained placenta to be adopted, or must we conclude that the mole is the product of a new conception? Ruysch, Burns, Ramsbotham, and Murphy affirmed the occasional occurrence of this *post-partum* conversion. Morgagni, most sagacious of pathologists, concluded that wherever the change is observed it began before the expulsion of the child. Our own observations lead us to adopt Morgagni's opinion.

1. The cases of live children in connection with cystic placenta prove that the death of the embryo is not a necessary factor. 2. The history of cases proves that the disease in many cases begins early and proceeds rapidly to the development of large moles. 3. We have demonstrated the existence of the disease in ova not exceeding six weeks old. 4. There is this remarkable circumstance: the cystic formation is almost invariably found developed over the entire superficies of the ovum. The significance of this is clear. The change began so early as to attack the whole system of shaggy villi covering

the chorion, preventing the atrophy of part which takes place in normal course when the placenta proceeds to concentration in a limited area. There is no concentration of villi or vessels towards an umbilical cord in those cases in which no embryo is found. The inference is that the early disorganisation of the chorion-villi killed the embryo whilst yet minute and soft, so that it easily disappears by fatty liquefaction. We have seen this in process. The absence of embryo in most cases is thus accounted for. If the change proceeds less rapidly, as it does in exceptional cases, the embryo may survive and grow, and under the stimulus of its growth may maintain or produce a sufficient amount of working placenta.

We think, therefore, that the hypothesis of conversion of mature placenta must be rejected. Still there is a plausible explanation of the case we have stated consistent with the woman's chastity. It is found in the history of twin-gestations. One ovum may proceed to normal development, the other may pass into cystic degeneration, its embryo being destroyed. The healthy ovum, child and placenta, may be born and the cystic ovum may be retained for awhile. The retention of the mole after the expulsion of the healthy placenta may be accounted for by the known intimacy of growth of the cystic mole to the uterus by penetration into its walls. Where this explanation cannot be applied, we are thrown back upon the conclusions, either that the cystic change began before the expulsion of the child, or that it is the product of a conception subsequent to the labour.

Hall Davis relates a case [1] of twin-conception in which one child was found connected with a normal placenta, and the other ovum was converted into a vesicular mole, without an embryo. Hildebrandt [2] relates a case in which one ovum fell into hydatidiform degeneration, whilst a twin ovum did not, but contained a fœtus very dropsical.

Montgomery cites the following historical case. A lady four or five months pregnant expelled a quantity of hydatids, and subsequently, at the proper time, gave birth to a living child, who developed into the celebrated Béclard. Is it not possible that in this case there was a twin conception, one ovum falling into degeneration and being expelled, whilst the other, healthy,

[1] *Obst. Trans.* [2] *Mon. f. Geburtsk.* 1861.

went through normal development? This conjecture is strengthened by Ingleby's case. 'A woman after long-continued hæmorrhage passed a diseased placenta of the hydatidiform appearance, but without any apparent fœtus; the os uteri closed, and to the surprise of all parties, the patient was delivered a few weeks afterwards of a mature child and secundines.'

The clinical evolution of hydatidiform degeneration of the placenta.—At the beginning the course of the gestation is hardly to be distinguished from that of an ordinary gestation. As it goes on, close observation may discover that the rate of evolution of the uterus and abdomen differs from the normal. The size of the uterus, for example, does not tally with that which would be expected on calculation. Presently, perhaps at the end of two or three months, discharges of blood, or water tinged with blood, occur. If minutely examined, vesicles may sometimes be found floating in the discharges. Abortion may occur within a few weeks; the ovum may pass in a mass; and unless examined by lens or microscope, the vesicular change may escape detection. We believe this event is not uncommon. In other cases, water and blood discharges recur; the abdomen and uterus enlarge, but not with the regular progression of normal gestation. At last, suddenly in some cases, profuse hæmorrhage sets in with pain, and the mole may be expelled compressed into the shape of the uterine cavity, and presenting a solid mass made up of hyperplastic decidua, infiltrated with blood, and the chorion degenerated into vesicles. Moles in this state differ in appearance from the specimens in museums. In these latter, the chorion-villi and cysts are floated out. In some recent moles, all the parts are compressed into a mass, and the vesicles may not be detected until specially sought for. But generally some may be seen cropping up on the surface. On cutting into the mass, a cavity is opened lined with a smooth serous membrane, the amnion.

In other cases the mass loses cohesion even in the uterus; the decidual connective tissue has broken up under fatty degeneration, the diseased villi fall apart, portions break off and are expelled with blood and water, likened not inaptly to red-currant juice with vesicles swimming in it. Discharges of this kind recur at uncertain intervals, with pain, the bulk of the uterus varying in size. At length, under the usual signs of labour, the remains of the mole are expelled. When the disease has gone on for several months, the quantity of fluid and vesicular masses discharged may be very great, amounting to three or four quarts or more. In some cases, all the mole is not expelled, but hæmorrhages go on, resisting ergot, expression, and calling for removal by the hand. The patient may sink under the loss of blood; but the uterus fairly emptied, the subsequent course of things resembles that of normal labour—the uterus contracts, undergoes involution, and the breasts secrete milk.

The woman is exposed in an unusual degree to the accidents of puerpery. Metritis, perimetritis, thrombosis, phlegmasia dolens, septicæmia, may set in; and these complications are especially probable in those cases in which the detachment of the diseased chorion is imperfect, owing to villi penetrating the uterine sinuses and thus growing into the uterine wall.

Recurrence of the disease.—In some cases the disease recurs. Thus it recurred three times in Krieger's patient. Mr. Osborn relates (1865) a most interesting case of a young woman, apparently healthy, who in four successive pregnancies was delivered of a vesicular mole. It is remarkable that her first two pregnancies were due to one man, and the next two to another man. This history favours the hypothesis that the cause is not primarily embryonic.

Treatment.—The treatment falls within the general rules relating to abortion. As soon as we get distinct evidence of vesicular formation, hæmorrhages and watery discharges occurring, the conclusion is justifiable that abortion must take place. If on examination the cervix is found open, it will generally be desirable to remove the ovum by the finger. Under chloroform, this operation can generally be carried out. But in those cases in which the diseased chorion sends offshoots into the walls of the uterus, complete detachment even by the hand is not always possible. Ramsbotham, Robert Barnes, and Waldeyer relate cases of this kind in which no line of demarcation between placenta and uterus could be felt. In one of Robert Barnes's cases the wall of the uterus was softened, more brittle, so that it was difficult to avoid lacerating it. The patient recovered.

The greatest care is necessary in these cases. It should be accepted as a rule to detach so much as will come away with reasonable force, and to leave the rest. It is better to encounter the possible reproach that 'a bit of the after-birth was left behind,' than to risk lacerating the uterus. A second or third attempt may be made after a day or two to bring away what was left. And under the ecbolic action of ergot, quinia, and digitalis, the uterine muscle contracting may compress the intruded vesicles, and they will disappear by fatty metamorphosis and absorption, or with the lochia. It will generally be useful to paint the inside of the uterus with tincture of iodine and glycerine (1 in 5) once a week for a few weeks afterwards.

Is there a prophylactic treatment?—We know at present of no rational basis for such treatment. Where the disease has once occurred, the general indication is to promote in every way the health, local and constitutional, of the subject. Reflecting that in many cases, at least, hyperplasia of the decidua enters as a factor, the mucous membrane of the uterus may be usefully painted with iodine, carbolic acid, and glycerine.

Moles.—The term is generally employed to signify solid substances expelled from the uterus. Substances more or less solid are cast out under symptoms resembling those of true abortion. It becomes important to determine whether or no a given mass so expelled be the product of conception—that is, whether the process be one of true abortion.

The substances included under the general term of moles are: 1, *blood-clots*, still retaining all the elements of blood, except a part of its serum; 2, *fibrin-clots*, the serum, globules, and colouring-matter being in great part expressed (these are sometimes called fleshy moles); 3, *decidual tissue* thickened with condensed blood; 4, *an early ovum*, the decidua greatly thickened by infiltrated blood; 5, *a more advanced ovum*, the chorion and decidua both consolidated by condensed blood; 6, *the hydatidiform or vesicular mole*; and, 7, *a fibroid polypus or tumour.*

To these we must add the 'fibrinous polypus' and the 'placental polypus,' mostly observed after ordinary abortion or labour.

The first point to establish is the presence or absence of ovular structures.

1 and 2. Blood or fibrin-clots sometimes present thin glistening membrane, suggesting amnion. But this is not enough to prove that the mole is of embryonic origin. On teasing the clot, we find nothing but blood-constituents and fibrin in a state of fibrillation.

3. Decidual tissue, again, may, with or without blood, be compacted into a mass, or free as shreds. But unless we detect by the microscope chorion-villi, the mole must be regarded as exclusively of uterine origin.

4 and 5. Ova, early or advanced, are identified by two distinctive characters: the presence of chorion-villi, and a cavity lined by a smooth serous membrane—the amniotic sac. Generally, also, there is the embryo; but in early ova and the vesicular moles no embryo may be found.

6. The hydatidiform mole is recognised by the vesicular structure.

7. The fibroid polypus is distinguished by its solidity, by its texture, and by the absence of chorion-villi. We have been summoned to attend the wife of a colleague for abortion. What was considered to be the ovum had passed. This substance was as large as a hen's egg. It was a fibrous polypus. Had the lady been single, or not living with her husband, her chastity might have been impeached. There was the apparent *pièce de conviction.*

INDEX.

END OF THE FIRST VOLUME.

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