PART II.

PREGNANCY.

CHAPTER I.

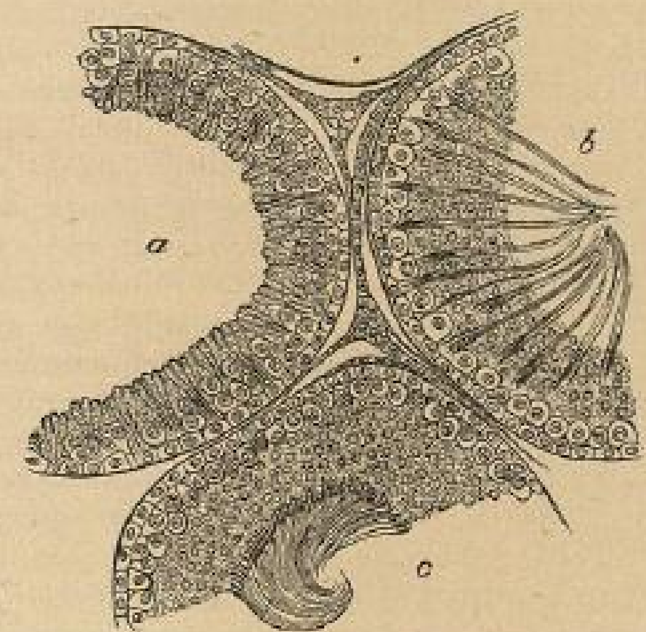
CONCEPTION AND GENERATION.

Generation in the human female, as in all mammals, requires the congress of the two sexes, in order that the semen, the male element of generation, may be brought into contact with the ovule, the female element of generation.

The Semen.—The semen secreted by the testicle of an adult male is a viscid, opalescent fluid, forming an emulsion when mixed with water, and having a peculiar faint odor, which is attributed to the secretions which are mixed with it, such as those from the prostate and Cowper's glands. On analysis it is found to be an albuminous fluid, holding in solution various salts, principally phosphates and chlorides, and an animal substance, spermatin, analogous to fibrin. Examined under a magnifying power of from 400 to 500 diameters, it consists of a transparent and homogeneous fluid, in which are floating a certain number of granules and epithelial cells, derived from the secretions mixed with it, and certain characteristic bodies, the spermatozoa, which are developed from the sperm cells, and which form its essential constituents. The sperm cells are those occupying the tubuli seminiferi of the testicle. Several kinds of sperm cells are described, which receive their name from the position they occupy with regard to the lumen of the tubule (Fig. 44). The cells which are next to the wall of the tubule are called the outer or lining cells. They are more or less flattened in form, and are situated on a distinct basement membrane. Internal to this layer is another, consisting of round cells, the nuclei of which are in a state of proliferation; this is the intermediate layer. Between this and the lumen of the tubule are a number of cells, irregular in shape, amongst which are imbedded the heads of the spermatozoa, the tails of which project into the lumen. The spermatozoa are thought to arise from the middle or proliferating layer in the following manner: the nuclei of the sperm cells proliferate, and from their subdivisions arise the heads of the spermatozoa, the bodies of which originate from the protoplasm of the cells. By the decomposition of the substance in which the heads of the spermatozoa are imbedded, the contained spermatozoa become liberated, and move about freely in the seminal fluid.

As seen under the microscope, the spermatozoa, which exist in healthy semen in enormous numbers, present the appearance of minute particles, not unlike a tadpole in shape. The head is oval and flattened, measuring about $\frac{1}{10000}$ of an inch in breadth, and attached to it by a short intermediate portion is a delicate filamentous expansion or tail, which tapers to a point so fine that its termination cannot be seen by the highest powers of the microscope. The whole spermatozoon measures from $\frac{1}{400}$ to $\frac{1}{600}$ of an inch in length. The spermatozoa are observed to be in constant motion, sometimes very rapid, sometimes more gentle, which is supposed to be the means by which

Fig. 44.



Section of parts of three seminiferous tubules of the rat. *a*. With the spermatozoa least advanced in development. *b*. More advanced. *c*. Containing fully-developed spermatozoa. Between the tubules are seen strands of interstitial cells and lymph spaces. (From a preparation by Mr. A. Frazer.)

they pass upward through the female genital organs. They retain their vitality and power of movement for a considerable time after emission, provided the semen is kept at a temperature similar to that of the body. Under such circumstances they have been observed in active motion from forty-eight to seventy-two hours after ejaculation, and they have also been seen alive in the testicle as long as twenty-four hours after death. In all probability they continue active much longer within the generative organs, as many physiologists have observed them in full vitality in bitchés and rabbits, seven or eight days after copulation. The recent experiments of Haussman, however, show that they lose their power of motion in the human vagina within twelve hours after coitus, although they doubtless retain it longer in the uterus and Fallopian tubes. Abundant leucorrhœal discharges and acrid vaginal secretions destroy their movements, and may thus cause sterility in the female. On account of their mobility, the spermatozoa were long considered to be independent animalcules, a view which is by no means exploded, and has been maintained in modern times by Pouchet, Joulin, and other writers, while Coste, Robin, Kölliker, etc., liken their motion to that of ciliated epithelium. There can be no doubt that the fertilizing power of the semen is due to the presence of the spermatozoa, although some of the older physiologists assigned it to the spermatic fluid. The former view, however, has been conclusively proved by the experiments of Prévost and Dumas, who found that on carefully removing the spermatozoa by filtration the semen lost its fecundating properties.

Sites of Impregnation.—There has been great difference of opinion as to the part of the genital tract in which the spermatozoa and the ovule come into contact, and in which impregnation, therefore, occurs. Spermatozoa have been observed in all parts of the female genital organs in animals killed shortly after coitus, especially in the Fallopian tubes, and even on the surface of the ovary. The fact that fecundation has been proved to occur in certain animals within the ovary, tends to support the idea that it may also occur in the human female before the rupture of the Graafian follicle. In order to do so, however, it is necessary for the spermatozoa to penetrate the proper structure of the follicle and the epithelial covering of the ovary, and no one has actually seen them doing so. Most probably the contact of the spermatozoa and the ovule occurs very shortly after the rupture of the follicle, and in the outer part of the Fallopian tubes. Coste maintains that, unless the ovule is impregnated, it very rapidly degenerates after being expelled from the ovary, partly by inherent changes in the ovule itself, and partly because it then soon becomes invested by an albuminous covering which is impermeable to the spermatozoa. He believes, therefore, that impregnation can only occur either on the surface of the ovary, or just within the fimbriated extremity of the tube.

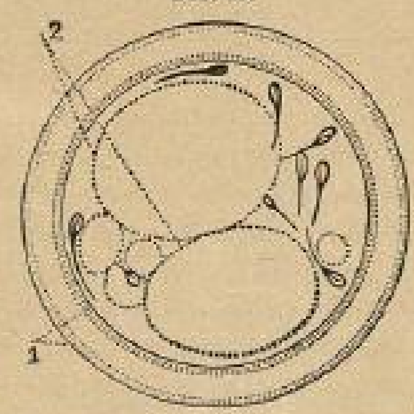
Mode in which the Ascent of the Semen is Effected.—The semen is probably carried upward chiefly by the inherent mobility of the spermatozoa. It is believed by some that this is assisted by other agencies: amongst them are mentioned the peristaltic action of the uterus and Fallopian tubes; a sort of capillary attraction effected when the walls of the uterus are in close contact, similar to the movement of fluid in minute tubes; and also the vibratile action of the cilia of the epithelium of the uterine mucous membrane. The action of the latter is extremely doubtful, for they are also supposed to effect the descent of the ovule, and they can hardly act in two opposite ways. The movement of the cilia being from within outward, it would certainly oppose rather than favor the progress of the spermatozoa. It must, therefore, be admitted that they ascend chiefly through their own powers of motion. They certainly have this power to a remarkable extent, for there are numerous cases on record in which impregnation has occurred without penetration, and even when the hymen was quite entire, and in which the semen has simply been deposited on the exterior of the vulva; in such cases, which are far from uncommon, the spermatozoa must have found their way through the whole length of the vagina. It is probable, however, that under ordinary circumstances the passage of the spermatic fluid into the uterus is facilitated

by changes which take place in the cervix during the sexual orgasm, in the course of which the os uteri is said to dilate and close again in a rhythmical manner.[1]

Impregnation.—The precise method in which the spermatozoa effect impregnation was long a matter of doubt. It is now, however, certain that they actually penetrate the ovule, and reach its interior. This has been conclusively proved by the observations of Barry, Meissner, and others, who have seen the spermatozoa within the external membrane of the ovule in rabbits (Fig. 45). In some of the invertebrata a canal or opening, called the micropyle, exists in the zona pellucida, through which the spermatozoa pass. No such aperture has yet been demonstrated in the ovules of mammals, but its existence is far from improbable. According to the observations of Newport, several spermatozoa penetrate the zona pellucida and enter the ovule, and the greater the number that do so the more certain fecundation becomes. In the lower animals the fusion of the spermatozoa with the substance of the yelk has been observed, and although similar phenomena have not been detected in the human ovum, there is not any doubt but that the further development of the ovum is due to the union of the spermatozoa with the female element.

The length of time which elapses before the fecundated ovule arrives in the cavity of the uterus has not yet been ascertained, and it probably varies under different circumstances. It is known that in the bitch it may remain eight or ten days in the Fallopian tube, in the guinea-pig three or four. In the human female the ovum has never been discovered in the cavity of the uterus before the tenth or twelfth day after impregnation.

FIG. 45.



Ovum of rabbit containing spermatozoa. 1. Zona pellucida. 2. The germ, consisting of two large cells, several smaller cells, and spermatozoa.

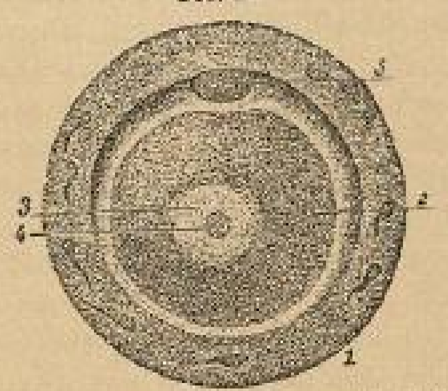
The changes which occur in the human ovule immediately before and after impregnation, and during its progress through the Fallopian tube, are only known to us by analogy, as, of course, it is impossible to study them by actual observation. We are in possession, however, of accurate information of what has been made out in the lower animals, and it is reasonable to suppose that similar changes occur in man. Immediately after the ovule has passed into the Fallopian tube, it is found to be surrounded by a layer of granular cells, a portion of the lining membrane of the Graafian follicle, which was described as the discus proligerus. As it proceeds along the tube these surrounding cells disappear, partly, it is supposed, by friction on the walls of the tube, and partly by being absorbed to nourish the ovule. Be this as it may, before long they are no longer observed, and the zona pellucida forms the outermost layer of the ovule. When the ovule has advanced some distance along the tube, it becomes invested with a covering of albu-

1 "How do the Spermatozoa Enter the Uterus?" By J. Beck, M.D.

minous material, which is deposited around it in successive layers, the thickness of which varies in different animals. It is very abundant in birds, in whom it forms the familiar white of the egg. In some animals it has not been detected, so that its presence in the human ovule is uncertain. Where it exists it doubtless contributes to the nourishment of the ovule.

Coincident with these changes is the disappearance of the germinal vesicle. At the same time the yelk contracts and becomes more solid; retiring from close contact with the zona pellucida, and thus leaving a space, between the outer edge of the yelk and the vitelline membrane, which in some animals is filled with a transparent liquid. Coincident with the shrinking of the yelk, a small granular mass of a rounded form is extruded from the yelk into the clear space beneath the zona pellucida. At a later period another similar mass is extruded. These are the *polar globules* (Fig. 46), and it is thought from observations on the invertebrata that they arise from the germinal vesicle, the remains of which gives origin to a new nucleus, which is known as the *female pro-nucleus*. These changes occur in all ovules, whether they are impregnated or not, but if the ovule is not fecundated, no further alterations occur. Supposing impregnation has taken place by the entrance of a spermatozoon within the zona pellucida of the ovule, a second nucleus is formed by the penetration of a spermatozoon within the yelk, where it loses its tail and becomes transformed into a granular body, the *male pro-nucleus*. After a time the male and female pro-nuclei approach one another and finally fuse to form a new nucleus, and the ovum then receives the name of the *Blastosphere*, or first segmentation sphere.

FIG. 46.



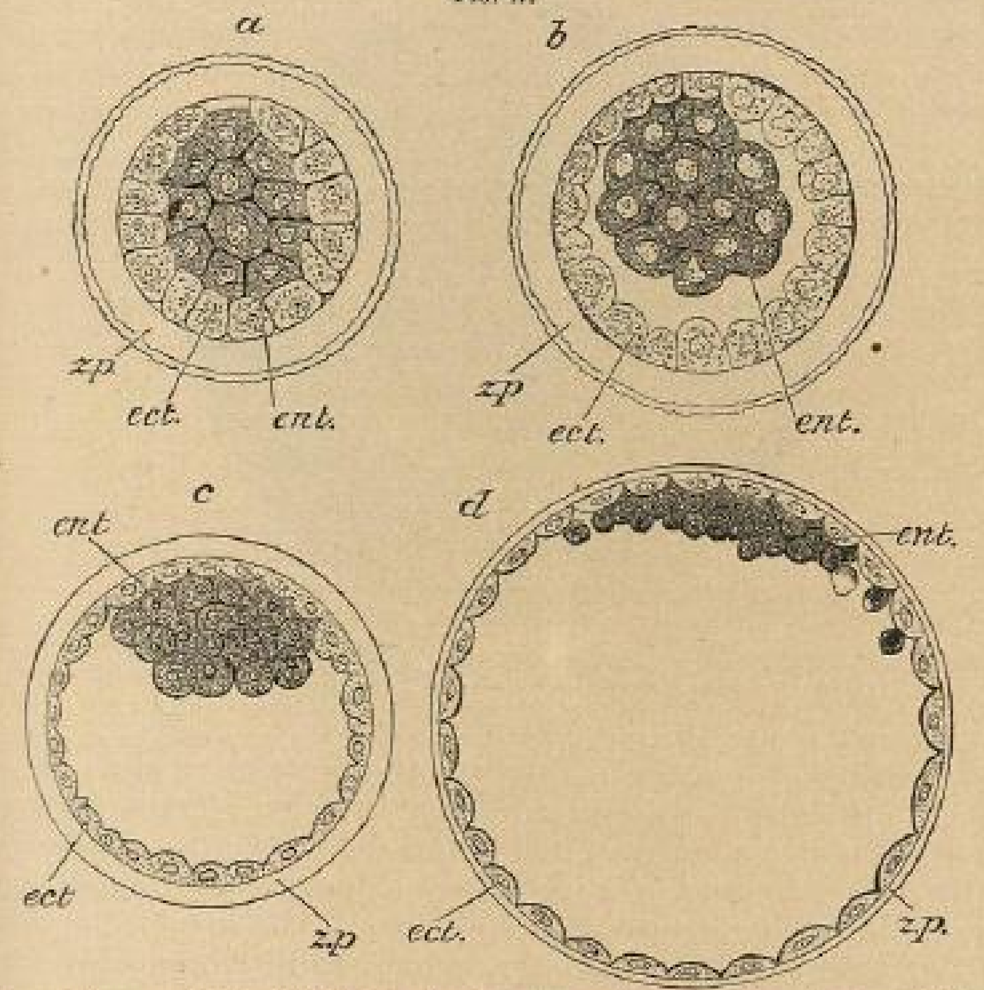
Formation of the "polar globule." 1. Zona pellucida, containing spermatozoa. 2. Yelk. 3 and 4. Germinal vesicle. 5. The polar globule.

After this occurs the very peculiar phenomenon known as the cleavage of the yelk, which results in the formation of the layer of cells from which the fœtus is developed. The segmentation of the yelk (Fig. 47) occupies in mammals the whole of its substance. In birds the cleavage is confined to a small area of the yelk called the cicatricula or blastoderm. Hence the term Holoblastic has been applied to the ova of mammals, Meroblastic to those of birds. It divides at first into two halves, and at the same time the new or first segmentation nucleus becomes constricted in its centre, and separates into two portions, one of which forms a centre for each of the halves into which the yelk has divided. Each of these immediately divides into two, as does its contained portion of the nucleus, and so on in rapid succession until the whole yelk is divided into a number of divisions, each of which consists of a clump of nucleated protoplasm.

By these continuous dichotomous divisions the whole yelk is formed into a granular mass, which, from its supposed resemblance to a mul-

berry, has been named the *muriform body*. When the subdivision of the yelk is completed, its separate parts become converted into a number of cells, each of which consists of a mass of granular protoplasm. These cells unite by their edges to form a continuous lining (Fig. 48), which, through the expansion of the muriform body by fluid which forms in its interior, is distended until it forms a lining to the zona pellucida. This is the *blastodermic membrane*, from which the fœtus is developed. By this time the ovum has reached the uterus, and,

FIG. 47.

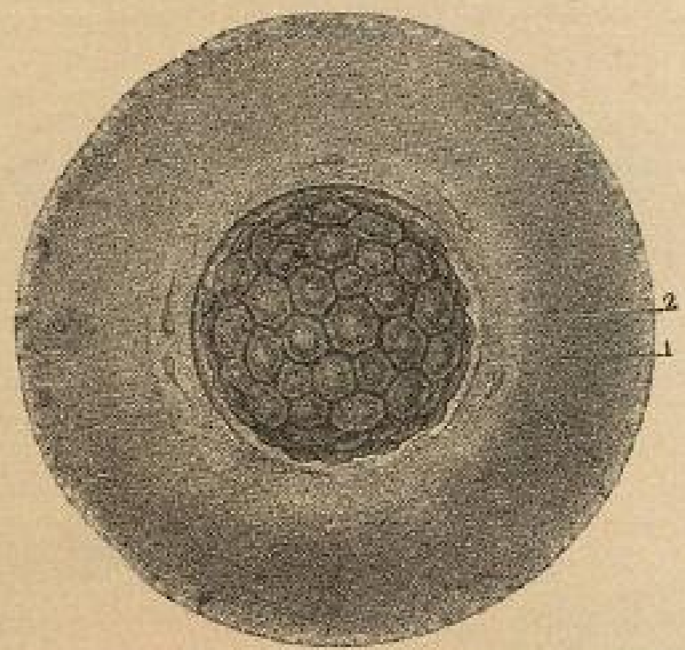


Sections of the ovum of the rabbit during the later stages of segmentation, showing the formation of the blastodermic vesicle. *a*. Section showing the enclosure of entomeres, *ent.*, by ectomeres, *ect.*, except at one spot—the blastopore. *b*. More advanced stage, in which fluid is beginning to accumulate between the entomeres and ectomeres, the former completely enclosed. *c*. The fluid has much increased, so that a large space separates entomeres from ectomeres, except at one part. *d*. Blastodermic vesicle, its wall formed of a layer of ectodermic cells, with a patch of entomeres adhering to it at one part. *z.p.*, *ect.*, *ent.* As before. (After E. v. BENEDEN.)

before proceeding to consider the further changes which it undergoes, it will be well to study the alteration which the stimulus of impregnation has set on foot in the mucous membrane of the uterus, in order to prepare it for the reception and growth of its contents.

Even before the ovum reaches the uterus, the mucous membrane becomes thickened and vascular, so that its opposing surfaces entirely fill the uterine cavity. These changes may be said to be the same in kind, although more marked and extensive in degree, as the alterations which take place in the mucous membrane in connection with each menstrual period. The result is the formation of a distinct membrane, which affords the ovum a safe anchorage and protection, until its connections with the uterus are more fully developed. After delivery, this membrane, which is by that time quite altered in appearance, is at least partially thrown off with the ovum; on which account it has received the name of the *decidua* or *caduca*.

FIG. 48.



Formation of the blastodermic membrane from the cells of the muriform body. 1. Layer of albuminous material surrounding 2. The zona pellucida. (After JOULIN.)

The decidua consists of two principal portions, which, in early pregnancy, are separated from each other by a considerable interspace, which is occupied by mucus. One of these, called the *decidua vera*, lines the entire uterine cavity, and is, no doubt, the original mucous lining of the uterus greatly hypertrophied. The second, the *decidua reflexa*, is closely applied round the ovum; and it is probably formed by the sprouting of the decidua vera around the ovum at the point on which the latter rests, so that it eventually completely surrounds it. As the ovum enlarges, the decidua reflexa is necessarily stretched, until it comes everywhere into contact with the decidua vera, with which it firmly unites. After the third month of pregnancy true union has occurred, and the two layers of decidua are no longer separate. The *decidua serotina*, which is described as a third portion, is merely that part of the decidua vera on which the ovum rests, and where the placenta is eventually developed; it is characterized by its extreme vascularity, which serves the purpose of supplying nutriment to the fœtus through the capillaries of the fœtal placenta.

It is needless to refer at length to the various views which have been held by anatomists as to the structure and formation of the decidua. That taught by John Hunter was long believed to be correct, and down to a recent date it received the adherence of most physiologists. He believed the decidua to be an inflammatory exudation which, on account of the stimulus of pregnancy, was thrown out all over the cavity of the uterus, and soon formed a distinct lining membrane to it. When the ovum reached the uterine orifice of the Fallopian tube it found its entrance barred by this new membrane, which accordingly it pushed before it. This separated portion formed a covering to the ovum, and became the decidua reflexa, while a fresh exudation took place at that portion of the uterine wall which was thus laid bare, and this became the decidua serotina. William Hunter had much more correct views of the decidua, the accuracy of which was at the time much contested, but which have recently received full recognition. He describes the decidua in his earlier writings as an hypertrophy of the uterine mucous membrane itself, a view which is now held by all physiologists.

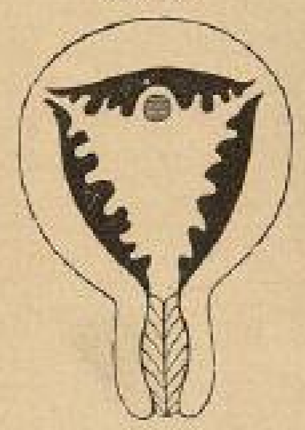
When the decidua is first formed it is a hollow triangular sac lining the uterine cavity (Fig. 49), and having three openings into it those

FIG. 49.

Aborted ovum of about forty days, showing the triangular shape of the decidua (which is laid open), and the aperture of the Fallopian tube. (After COSTE.)

of the Fallopian tubes at its upper angles, and one, corresponding to the internal os uteri, below. If, as is generally the case, it is thick and pulpy, these openings are closed up, and can no longer be detected. In early pregnancy it is well developed, and continues to grow up to the third month of utero-gestation. After that time it commences to atrophy, its adhesion with the uterine walls lessens, it becomes thin and transparent, and is ready for expulsion when delivery is effected. When it is most developed, a careful examination of the decidua enables us to detect in it all the elements of the uterine mucous membrane greatly hypertrophied. Its substance chiefly consists of large round or oval nucleated cells and elongated fibres, mixed with the tubular uterine glands, which are much elongated, lined by columnar ciliated epithelial cells, and contain a small quantity of milky fluid. According to Friedlander, the decidua is divisible into two layers: the inner being formed by a proliferation of the corpuscles of the sub-epithelial connective tissue of the mucous membrane; the deeper, in contact with the uterine walls, out of flattened or compressed gland ducts. In an early abortion the extremities of these ducts may be observed by a lens on the external or uterine surface of the decidua, occupying the summit of minute projections, separated from each other by depressions. If these projections be bisected they will be found to contain little cavities, filled with lactescent fluid, which were first described by Montgomery, of Dublin, and are known as *Montgomery's cups*. They are in fact the dilated canals of the uterine tubular glands. On the internal surface of such an early decidua a number of shallow depressions may be made out, which are the open mouths of these ducts.

FIG. 50.

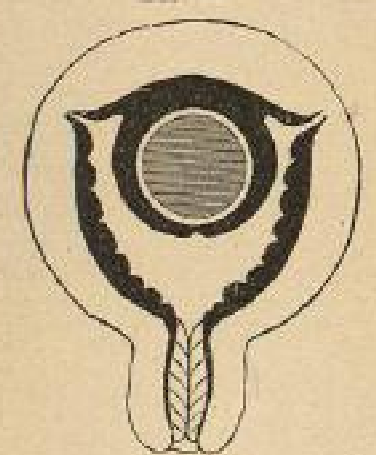


Formation of decidua. (The decidua is colored black, the ovum is represented as engaged between two projecting folds of membrane.)

FIG. 51.

Projecting folds of membrane growing up around the ovum. (After DALTON.)

FIG. 52.



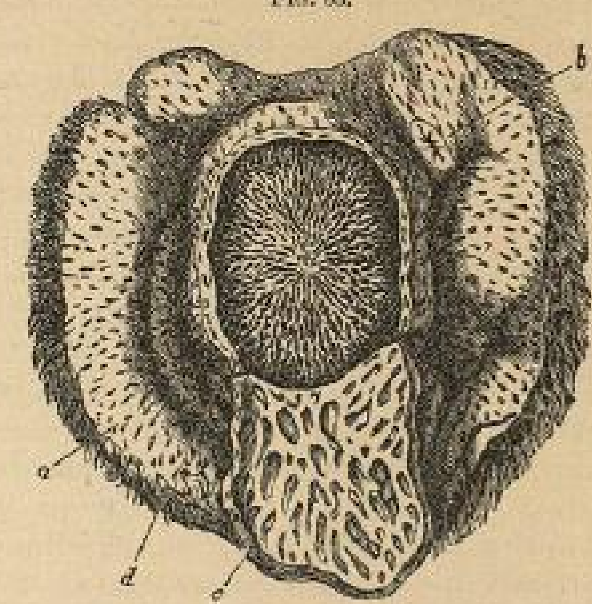
Showing ovum completely surrounded by the decidua reflexa.

The decidua vera is highly vascular, and its vascularity persists till after the seventh month of pregnancy; the decidua reflexa is only vascular during the early part of pregnancy, depending for its vascularity chiefly on the villi of the chorion, and hence losing this with their atrophy.

When the ovum reaches the uterine cavity it soon becomes imbedded in the folds of the hypertrophied mucous membrane, which almost entirely fills the uterine cavity. As a rule it is attached to some point near the opening of a Fallopian tube, the swollen folds of mucous membrane preventing its descent to the lower part of the uterus; in exceptional circumstances, however—as in women who have borne many children, and have a more than usually dilated uterine cavity—it may fix itself at a point much nearer the internal os uteri. According to the now generally accepted opinion of Coste, the mucous membrane at the base of the ovum soon begins to sprout around it, and

gradually extends until it eventually covers the ovum (Figs. 50–52), and forms the decidua reflexa. Coste describes, under the name of the *umbilicus*, a small depression at the most prominent part of the ovum, which he considers to be the indication of the point where the closure of the decidua reflexa is effected. There are some objections to this theory, for no one has seen the decidua reflexa incomplete and in the process of formation, and on examining its external surface, that is, the one farthest from the ovum, its microscopical appearance is identical with that of the inner surface of the decidua vera. To meet these difficulties, Weber and Goodsir, whose views have been adopted by Priestley, contended that the decidua reflexa is "the primary lamina of the mucous membrane, which, when the ovum enters the uterus, separates in two-thirds of its extent from the layers beneath it to adhere to the ovum; the remaining third remains attached, and forms a centre of nutrition." According to this view the decidua vera would be a subsequent growth over the separated portion, and the decidua serotina the portion of the primary lamina which remained attached. In this way the fact of the opposed surfaces of the decidua vera and reflexa being identical in structure would be accounted for. The difficulty which this theory is intended to meet does not seem so great as is supposed, for if, as is likely, it is only the epithelial or internal surface of the mucous membrane which sprouts over the ovum, and not its deeper layers, the facts of the case would be sufficiently met by Coste's view.

FIG. 53.



An ovum removed from uterus, and part of the decidua vera cut away. *a*. Decidua vera, showing the follicles opening on its inner surface. *b*. Inner extremity of Fallopian tube. *c*. Flap of decidua reflexa. *d*. Ovum. (After COSTE.)

Up to the third month of pregnancy the decidua reflexa and vera are not in close contact, and there may even be a considerable interspace between them, which sometimes contains a small quantity of mucous fluid, called the *hydroperione*. This fact may account for the curious circumstance, of which many instances are on record, that a uterine sound may be passed into a gravid uterus in the early months of pregnancy without necessarily producing abortion, and also for the occasional occurrence of menstruation after conception (Figs. 53 and 81). Eventually, by the growth of the ovum, the decidua reflexa comes closely into contact with the vera, and the two become intimately blended and inseparable. The inner surface of the decidua reflexa blends with the outer surface of the chorion, so that at birth the decidua vera, the decidua reflexa, and the chorion are represented by one membrane.

As pregnancy advances the decidua alters in appearance and becomes fibrous and thin. In the later months of utero-gestation fatty degeneration of its structure commences, its vessels and glands are obliterated, and its adhesion to the uterine walls is lessened, so as to prepare it for separation. As we shall subsequently see, this fatty degeneration was assumed by Simpson to be the determining cause of labor at term. After the eighth month, thrombi form in the veins lying underneath the decidua serotina, and at the end of pregnancy they are described by Leopold[1] as having become, to a great extent, obliterated. This, he supposes, may have some effect in inducing the contractions of the uterus in labor.

It was long believed that the entire decidua was thrown off after labor, leaving the muscular coat of the uterus bare and denuded, and that a new mucous membrane was formed during convalescence. According to Robin,[2] whose views are corroborated by Priestley, no such denudation of the muscular tissue of the uterus ever occurs, but a portion of the decidua always remains attached after delivery. After the fourth month of pregnancy, they believe, a new mucous membrane is formed under the decidua, which remains in a somewhat imperfect condition till after delivery, when it rapidly develops and assumes the proper functions of the mucous lining of the uterus. Robin also believes that that portion of the decidua which covers the placental site, the so-called decidua serotina, is not thrown off with the membranes, like the decidua vera and reflexa, but remains attached to the uterine walls, a thin layer of it only being expelled with the placenta, on which it may be observed. Duncan[3] entirely dissents from these views, and does not admit the formation of a new mucous membrane during the later months of utero-gestation. He believes that the greater portion of the decidua is thrown off, but that part remains, and from this the fresh mucous membrane is developed. This view is similar to that of Spiegelberg, who holds that the portion of the decidua that is expelled is the more superficial of the two layers described by Friedlander, composed chiefly of the epithelial elements, while the deeper or glandular layer remains attached to the walls of the uterus. From the epithelium of the glands a new epithelial layer is rapidly developed after delivery. Leopold[4] has shown that the uterine mucous membrane is completely re-formed within six weeks after delivery, and that its regeneration is

[1] Arch. f. Gyn., 1877, Bd. xi., Heft 3, S. 443. "Studien über die Uterus-schleimhaut während Menstruation."
[2] Mémoires de l'Acad. Imp. de Méd., 1861.
[3] Researches in Obstetrics, p. 186 et seq.
[4] Arch. f. Gyn., 1877, Bd. xii., Heft 2, S. 169.

sometimes completed as early as the end of the third week. This theory bears on the well-known analogy of the uterus after delivery to the stump of an amputated limb, an old simile, principally based on the erroneous theory that the whole muscular tissue of the uterus was laid bare. This, as we have seen, is not the case, but the simile so far holds good in that the mucous lining is deprived of its epithelial covering; and this fact, together with the existence of numerous open veins on the interior of the uterus, readily explains the extreme susceptibility to septic absorption, which forms so peculiar a characteristic of the puerperal state.

Before we commenced the study of the decidua we had traced the impregnated ovum into the uterine cavity, and described the formation of the blastodermic membrane by the junction of the cells of the muriform body. We must now proceed to consider the further changes which result in the development of the fœtus, and of the membranes that surround it. It would be quite out of place in a work of this kind to enter into the subject of embryology at any length, and we must therefore be content with such details as are of importance from a practical point of view.

The blastodermic membrane, which forms a complete spherical lining to the ovum, between the yelk and the zona pellucida, soon divides into two layers, of which the external is called the *epiblast*, the internal the *hypoblast*, and between these is subsequently developed a third layer, known as the *mesoblast*. From these three layers are formed the entire fœtus: the epiblast giving origin to the central nervous system, to the superficial layer of the skin, and aiding in formation of the organs of special sense, and of the amnion; the hypoblast forming the epithelial lining membrane of the alimentary and respiratory tracts, and of the tubes and glands in connection with them, and helping in the development of the yelk sac; the mesoblast giving rise to the skeleton, the muscles, the connective tissues, the vascular system, the genito-urinary organs, and taking part in the formation of all the membranes.

Almost immediately after the separation of the blastodermic membrane into layers, one part of it becomes thickened by the aggregation of cells, and is called the *area germinativa*. This is at first round and then oval in shape, and at its margin the first indication of the embryo may be detected in the form of a narrow thickening, the *primitive trace*. This becomes elongated, and stretches in a strap-like form along the centre of the germinal area; it is considered by Balfour to represent the Blastopore of animals, the ova of which undergo invagination to form a Gastrula. Surrounding it are some cells more translucent than those of the rest of the area germinativa, and hence called the *area pellucida* (Fig. 54). In front of the primitive trace two elevated ridges soon arise, the *laminæ dorsales*, which include between them a groove, the medullary groove, and gradually unite posteriorly to form a cavity within which the cerebro-spinal axis is subsequently developed. The medullary groove as it grows backward overlaps the primitive trace, which disappears. The embryo is differentiated from the rest of the blastoderm by a fold anteriorly, which is called the cephalic or head fold. Another fold afterward appears posteriorly, which is called the caudal or tail fold. Laterally, folds also arise. These folds all tend to grow toward the centre of the under surface of what will be the embryo.

The mesoblastic layer of the blastoderm, except that part which forms the axis of the embryo, splits into an upper layer, the somato-pleure, which is beneath the epiblast, and a lower layer, the splanchno-pleure, which lies upon the hypoblast. The space formed by this cleavage of the mesoblast is called the pleuro-peritoneal cavity. The somato-pleure is engaged in the formation of the body walls of the embryo. The splanchno-pleure forms the walls of the alimentary tract.

FIG. 54.

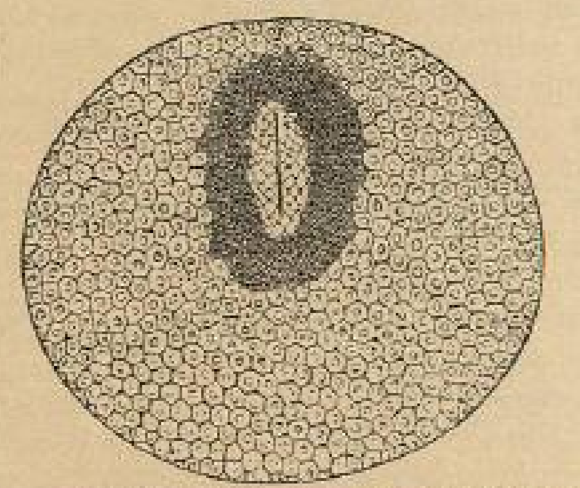


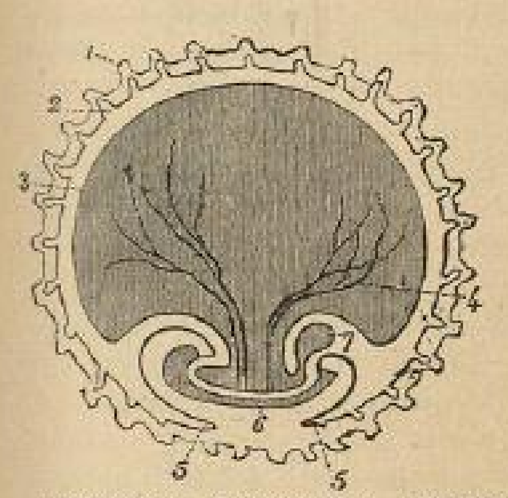
Diagram of area germinativa, showing the primitive trace and area pellucida.

Formation of the Amnion.—Processes arise from the somato-pleure anteriorly, posteriorly, and laterally, which gradually arch over the dorsal surface of the fœtus, until they meet each other and form a complete envelope to it. At the ventral surface these processes are separated by the whole length of the embryo, but they here also gradually approach each other, and eventually surround what is subsequently the umbilical cord, and blend with the integument of the fœtus at the point of its insertion. In this way is formed the *amnion* (Fig. 55), consisting of two layers: the internal, derived from the epiblast, is formed of tessellated epithelial cells; the external, arising from the mesoblast, is formed of cells like those of young connective tissue. Before the folds of the amnion unite, the free edge of each is bent outward and spreads around the ovum, immediately within the zona pellucida, forming a lining to it, termed by Turner the *sub-zonal membrane*, which is connected with the development of the chorion. In man this reflected layer, or *false amnion*, consists only of epiblast, but in some other animals it is probably formed from both the mesoblast and the epiblast, like the true amnion. The amnion is the most internal of the membranes surrounding the fœtus, and will presently be studied more in detail. It soon becomes distended with fluid, the *liquor amnii*, and as this increases in amount it separates the amnion more and more from the fœtus.

During this time the innermost layer of the blastodermic membrane

or hypoblast is also developing two projections at either extremity of the fœtus, and these gradually approach each other anteriorly. As the hypoblast is in contact with the yelk, when these meet they have

FIG. 55.



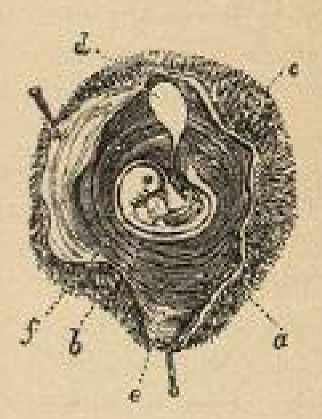
Development of the amnion. 1. Vitelline membrane. 2. External layer of blastodermic membrane. 3. Internal layers forming the umbilical vesicle. 4. Umbilical vessels. 5. Projections forming amnion. 6. Embryo. 7. Allantois.

FIG. 56.

1. Exochorion. 2. External layer of blastodermic membrane. 3. Umbilical vesicle. 4. Its vessels. 5. Amnion. 6. Embryo. 7. Allantois increasing in size.

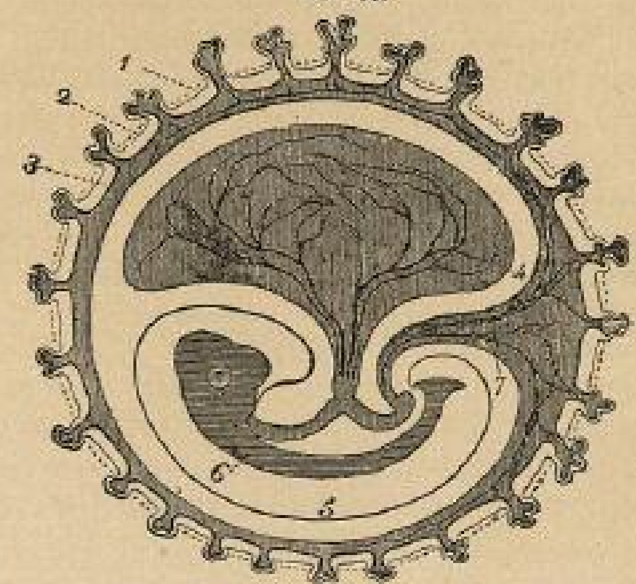
the effect of dividing the yelk into two portions. One, and the smaller of the two, forms eventually the intestinal canal of the fœtus; the other, and much the larger, contains the greater portion of the

FIG. 57.



An embryo of about twenty-five days laid open. *a.* Chorion. *b.* Amnion. *c.* Cavity of chorion. *d.* Umbilical vesicle. *e.* Pedicle of allantois. *f.* Embryo. (After COSTE.)

FIG. 58.



1. Exochorion. 2. External layer of the blastodermic membrane. 3. Allantois. 4. Umbilical vesicle. 5. Amnion. 6. Embryo. 7. Pedicle of allantois.

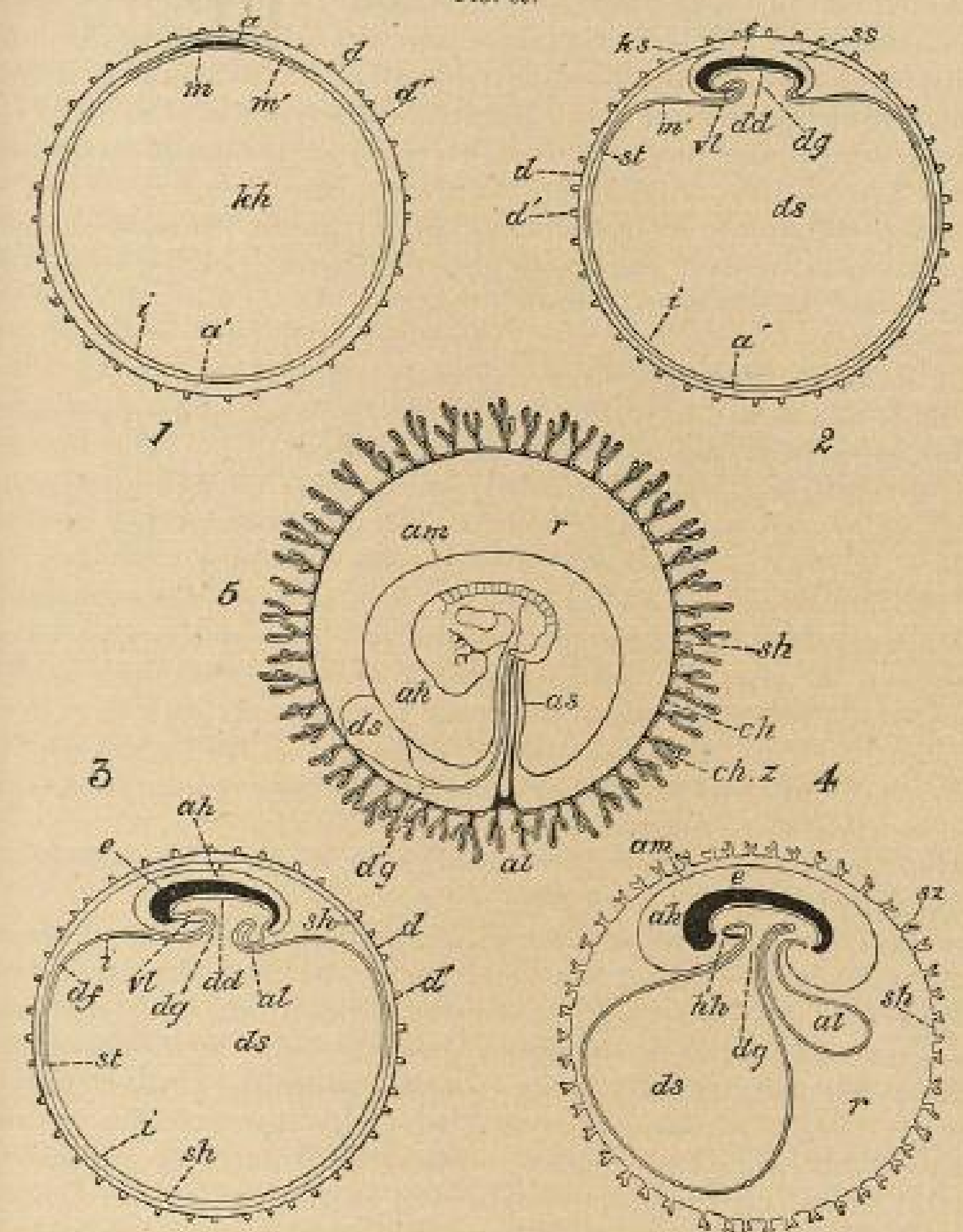
yelk, and forms the ephemeral structure known as the *umbilical vesicle*, from which the fœtus derives most of its nourishment during the early stage of its existence. Its communication with the abdominal cavity of the fœtus is through the constricted portion at the point of division called the *vitelline duct* (Fig. 56). An artery and vein, the *omphalo-mesenteric*, ramify on the vesicle and its duct.

As the amnion increases in size, it pushes back the umbilical vesicle toward the external membrane of the ovum, between which and the amnion it lies (Fig. 57); and when the allantois is developed, it ceases to be of any use, and rapidly shrinks and dwindles away. In most mammals no trace of it can be found after the fourth month of utero-gestation; in some, including the human female, it is said to exist as a minute vesicle at the placental end of the umbilical cord at the full period of pregnancy. The umbilical vesicle is filled with a yellowish fluid, containing many oil and fat globules, similar to the yelk of an egg.

The Allantois.—Somewhere about the twentieth day after conception a small vesicle is formed toward the caudal extremity of the fœtus, which is called the *allantois*. This membrane in mammals is important, as it forms the greater part of the fœtal placenta, a small portion of it remaining inside the body permanently as the bladder. It begins as a diverticulum from the lower part of the intestinal canal, and is hence formed externally by the splanchno-pleural layer of the mesoblast, whilst internally it is lined by the hypoblast. It is at first spherical, but it rapidly develops and becomes pyriform in shape, while by a process of constriction, similar to that which occurs in the vitellus to form the umbilical vesicle, it becomes divided into two parts, communicating with each other, the smaller of them being eventually developed into the urinary bladder. The larger portion, leaving the abdominal cavity along with the vitelline duct, rapidly grows until it comes into contact with the most external ovular membrane, the chorion, over the inner surface of which it spreads. This part consists chiefly of mesoblastic tissue, the hypoblast only passing to the end of the stalk of the allantois, and not following the mesoblast as it spreads over the inner surface of the chorion. The area of the chorion over which the allantois spreads varies in different animals; in man it spreads over the entire surface, but in the rabbit it only occupies one-third of the chorion, the remaining two-thirds being occupied by the yelk sac. This varying distribution of the allantois helps to differentiate the placentation of man and the apes from that of rodents. In the mesoblastic tissue of the allantois, vessels soon develop; namely, the two umbilical arteries, derived from the abdominal aorta, and two umbilical veins, one of which subsequently disappears; these, along with the vitelline duct and the pedicle of the allantois, form the umbilical cord. The main and very important function of the allantois, therefore, is to carry the fœtal vessels up to the inner surface of the sub-zonal membrane. Besides this purpose, the allantois, at a very early period, may receive the excretions of the fœtus, and serve as an excrementitious organ. According to Cazeaux, scarcely a trace of the allantois can be seen a few days after its formation. Its lower part or pedicle, however, long remains distinct, and forms part of the umbilical cord; and traces of it may be found even in adult life in the form of the *urachus*, which is really the dwindled

pedicle, and forms one of the ligaments of the bladder. The cavity of the allantois in the human species is confined chiefly to that part which lies within the body of the fœtus; it is seldom persistent further than the stalk of the allantois.

FIG. 59.



Five diagrammatic figures illustrating the formation of the fœtal membranes of a mammal. In 1, 2, 3, 4, the embryo is represented in longitudinal section. 1. Ovum with zona pellucida, blastodermic vesicle, and embryonic area; 2. Ovum with commencing formation of umbilical vesicle and amnion; 3. Ovum with amnion about to cease, and commencing allantois; 4. Ovum with villous sub-zonal membrane, larger allantois, and mouth and anus; 5. Ovum in which the mesoblast of the allantois has extended round the inner surface of the sub-zonal membrane and united with it to form the chorion. The cavity of the allantois is aborted. This figure is a diagram of an early human ovum. *d.* zona radiata; *d'* and *sz.* processes of zona; *sh.* sub-zonal membrane, outer fold of amnion, false amnion; *ch.* chorion; *ch.z.* chorionic villi; *am.* amnion; *ks.* head fold of amnion; *ss.* tail fold of amnion; *a.* epiblast of embryo; *a'.* epiblast of non-embryonic part of the blastodermic vesicle: *m.* embryonic mesoblast; *m'.* non-embryonic mesoblast; *df.* area vasculosa; *st.* sinus terminalis: *dd.* embryonic hypoblast; *i.* non-embryonic hypoblast; *kh.* cavity of blastodermic vesicle, the greater part of which becomes the cavity of umbilical vesicle *ds.*; *dg.* stalk of umbilical vesicle; *al.* allantois; *e.* embryo; *r.* space between chorion and amnion containing albuminous fluid; *vl.* ventral body wall; *hh.* pericardial cavity. (After KÖLLIKER.)

Between the chorion and amnion is often found an albuminous fluid, with minute filamentous processes traversing it, called by Velpeau the *corps reticulé*, which is not met with until the allantois comes into contact with the chorion, and which seems to be formed out of the tissues of that vesicle. It is analogous to the so-called Wharton's jelly found in the umbilical cord. When first formed it is highly vascular, but the vessels entirely disappear after the placenta is formed, and the remainder of the chorionic villi atrophy. Sometimes it exists in considerable quantities, and, should the chorion rupture at the end of pregnancy, it may escape and give rise to an erroneous impression that the liquor amnii has been discharged. (Fig. 59.)

Before proceeding to consider the fœtal envelopes more at length, it may be useful to recapitulate the structures already alluded to as forming the ovum. In this we find:

1. The *embryo* itself.
2. A fluid, the *liquor amnii*, in which it floats.
3. The *amnion*, a purely fœtal membrane surrounding the embryo, and containing the liquor amnii.
4. The *umbilical vesicle*, containing the greater portion of the yelk, serving as a source of nutrition to the early embryo through the vitelline duct, and on which ramify the omphalo-mesenteric vessels.
5. The *allantois*, a vesicle proceeding from the caudal extremity of the embryo, spreading itself over the interior of the ovum, and serving as a channel of vascular communication between the chorion and the fœtus, through the umbilical vessels.
6. An interspace between the outer layer of the ovum and the amnion, in which is contained the *umbilical vesicle* and *allantois*, and the *corps reticulé* of Velpeau.
7. The outer layer of the ovum, along with the sub-zonal membrane, forming the *chorion* and *fœtal placenta*.

The amnion is the most internal of the two membranes surrounding the fœtus; its origin at an early period of fœtal life has already been described. It is a perfectly smooth, transparent, but tough membrane, continuous with the integument of the fœtus at the insertion of the umbilical cord, round which it forms a sheath. Soon after it is formed it becomes distended with a fluid, the *liquor amnii*, in which the fœtus is suspended and floats. This fluid increases gradually in quantity, distending the amnion as it does so, until this is brought into close proximity to the inner surface of the chorion, from which it was at first separated by a considerable interspace.

The internal surface of the amnion is smooth and glistening, and on microscopic examination it is found to consist of a layer of flattened cells, each containing a large nucleus. These rest on a stratum of fibrous tissue, which gives to the membrane its toughness, and by which it is attached to a layer of gelatinous tissue which separates it from the inner surface of the chorion. This fibrous layer contains muscular fibres which give to the amnion its contractility. It is entirely destitute of vessels, nerves, and lymphatics. The quantity of the liquor amnii varies much at different periods of pregnancy. In the early months it is relatively greater in amount than the fœtus,

which it outweighs. As pregnancy advances, the weight of the fœtus becomes four or five times greater than that of the liquor amnii, although the actual quantity of fluid increases during the whole period of gestation. The amount of fluid varies much in different pregnancies. Sometimes there is comparatively little; while at others the quantity is immense, reaching several pounds in weight, greatly distending the uterus, and thus, it may be, producing difficulty in labor.

At first the liquid is clear and limpid. As pregnancy advances it becomes more turbid and dense, from the admixture of epithelial *débris* derived from the cutaneous surface of the fœtus. In some cases, without actual disease, it may be dark-green in color, and thick and tenacious in consistency. It has a peculiar heavy odor, and it consists chemically of water containing albumin, some urea, and various salts, principally phosphates and chlorides.

The source of the liquor amnii has been much disputed. Some maintain that it is derived chiefly from the fœtus, a view sufficiently disproved by the fact that the liquor amnii continues to increase in amount after the death of the fœtus. Burdach believed that it is secreted by the internal surface of the uterus, and arrives in the cavity of the amnion by transudation through the membrane. Priestley thinks—and this seems the most probable hypothesis—that it is secreted by the epithelial cells lining the membrane, which become distended with fluid, burst, and pour their contents into the amniotic cavity. Gusserow,[1] whose view is adopted by Spiegelberg, maintains that in the latter months of pregnancy the quantity of the liquor amnii is largely increased by the fœtal urine which is passed into the amniotic sac. (See page 137.)

The most obvious use of the liquor amnii is to afford a fluid medium in which the fœtus floats, and so is protected from the shocks and jars to which it would otherwise be subjected, and from undue pressure upon the uterine walls. By distending the uterus it saves it from injury, which the movements of the fœtus might otherwise inflict, and the fœtus is thus also enabled to change its position freely. The facility with which version by external manipulation can be effected depends entirely on the mobility of the fœtus in the fluid which surrounds it. Some have also supposed that it prevents the fœtus, in the early months of pregnancy, from forming adhesions to the amnion. In labor, it is of great service, by lubricating the passages, but chiefly by forming, with the membranes, a fluid wedge, which dilates the circle of the os uteri.

In a few rare cases there is a certain amount of limpid fluid between the chorion and the amnion, separating the two membranes. This is apparently only a more than usually fluid condition of the gelatinous tissue which naturally exists between the chorion and amnion. Occasionally, after the bag of membranes is felt in labor, the chorion alone ruptures, and the spurious liquor amnii is discharged, giving the attendant the impression that the membranes have been ruptured.

[1] Arch. f. Gynäk., Bd. III. S. 241, "Zur Lehre vom Stoffwechsel des Fœtus."

The **chorion** is the more external of the truly fœtal membranes, although external to it is the decidua, having a strictly maternal origin. It is a perfectly closed sac, its external surface, in contact with the decidua, being rough and shaggy from the development of villi (Fig. 56), its internal smooth and shining. As the ovum passes along the Fallopian tube it receives, as we have seen, an albuminous coating, and this, with the zona pellucida, is developed into a temporary structure, the *primitive chorion*. This primitive chorion, as the amnion develops, is reinforced by the layer of epiblast covering the umbilical vesicle externally which separates it from the subjacent mesoblast and hypoblast, and together with the epiblastic layer of the false amnion, with which it is continuous, passes to the primitive chorion, either combining with this, or by pressure causing its absorption and disappearance.

The membrane thus formed is called by Turner the sub-zonal membrane, and by Von Baer the *serous envelope*. From it are developed villi of cellular structure, which at first extend as a ring round the ovum, but eventually cover the whole of its surface. These villi are finger-like projections from the surface of the ovum, which are received into corresponding depressions in the decidua, with which they soon become so firmly united that they cannot be separated without laceration.

As the allantois develops, its mesoblastic layer grows into the space between the embryo and the sub-zonal membrane, and, in the human subject, spreads over the whole of its inner surface, combining with it to form a new membrane, the *true* or *complete chorion*. Each villus now receives a separate artery and vein, the former having a branch to each of the subdivisions into which the villus divides. These vessels are encased in a fine connective-tissue sheath from the allantois, which enters the villus along with them and forms a lining to it described by some as the *endochorion;* the external epithelial membrane of the villus, derived from the epiblast layer of the blastodermic membrane, being called the *exochorion*. The artery and vein lie side by side in the centre of the villus, and anastomose at its extremity; each villus thus having a separate circulation.

As soon as the union of the allantois with the chorion has been effected, the villi grow very rapidly, give off branches, which, in their turn, give off secondary branches, and so form root-like processes of great complexity. In the early months of gestation they exist equally over the whole surface of the ovum. As pregnancy advances, however, those which are in contact with the decidua reflexa shrivel up, and by the end of the second month cease to be vascular, being no longer required for the nutrition of the ovum. The chorion and decidua thus come into close contact, being united together by fibrous shreds, which on microscopic examination are found to consist of atrophied villi. The union between the chorion and the decidua reflexa as pregnancy advances becomes so complete that their line of junction cannot be ascertained, and they together with the decidua vera form one membrane, which on its inner surface is only separated from the amnion, which has spread over it, by a fine layer of gelatinous tissue. The portion of the chorion which is in relationship to the decidua reflexa is known as the *chorion læve*, whilst that in contact with the decidua serotina receives the name of the *chorion frondosum*, and in this portion the villi, instead of dwindling away, increase greatly in size, and eventually develop into the organ by which the fœtus is nourished—the *placenta*.

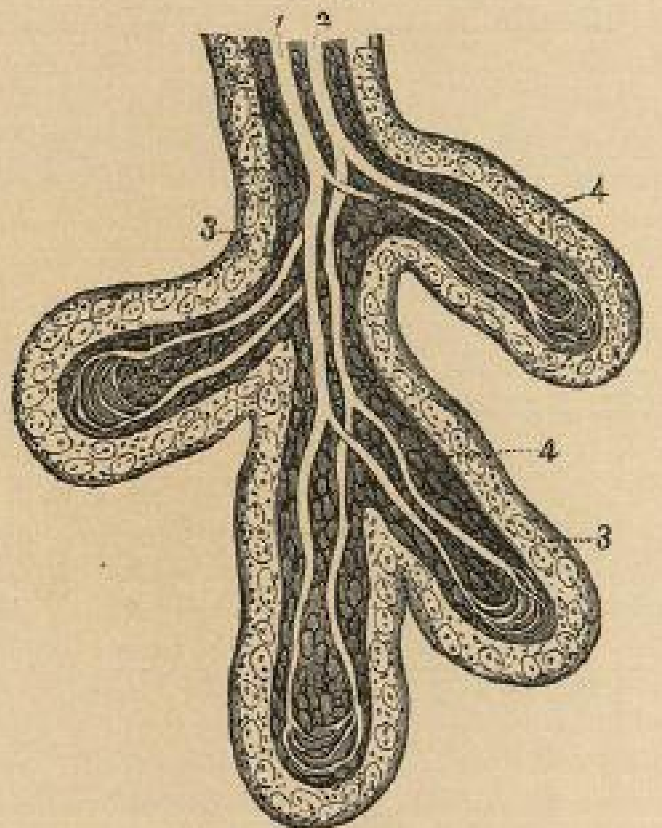
Form of the Placenta.—This important organ serves the purpose of supplying nutriment to, and aërating the blood of, the fœtus, and on its integrity the existence of the fœtus depends. It is met with in all mammals, but is very different in form and arrangement in different classes. Thus, in the sow, mare, and in the cetacea, it is diffused over the whole interior of the uterus; in the ruminants, it is divided into a number of separate small masses, scattered here and there over the uterine walls; while in the carnivora and elephant it forms a zone or belt round the uterine cavity. In the human race, as well as in rodentia, insectivora, etc., the placenta is in the form of a circular mass, attached generally to some part of the uterus near the orifice of one Fallopian tube; but it may be situated anywhere in the uterine cavity, even over the internal os uteri. The form of placentation in man and the apes is known as the meta-discoidal, whilst in rodentia and insectivora the placentation is discoidal. The meta-discoidal placentation is placed ventrally with regard to the embryo, and the allantois extends over the whole of the sub-zonal membrane, whilst in the discoidal variety the placenta is placed dorsally, and the allantois only extends over a portion of the sub-zonal membrane, to the remainder of which the yelk sac is applied. As it is expelled after delivery with the fœtal membranes attached to it, and as the aperture in these corresponds to the os uteri, we can generally determine pretty accurately the situation in which the placenta was placed by examining them after expulsion. The maternal surface of the placenta is somewhat convex, the fœtal concave. Its size varies greatly in different cases, and it is usually largest when the child is big, but not necessarily so. Its average diameter is from six to eight inches, its weight from eighteen to twenty-four ounces, but in exceptional cases it has been found to weigh several pounds. Abnormalities of form are not very rare. Thus, the placenta has been found to be divided into distinct parts, a form said by Professor Turner to be normal in certain genera of monkeys; or smaller supplementary placentæ (*placentæ succenturiæ*) may exist round a central mass. These variations of shape are only of importance in consequence of a risk of part of the detached placenta being left in the uterus after delivery, and giving rise to septicæmia or secondary hemorrhage.

The fœtal membranes cover the whole fœtal surface of the placenta, being reflected from its edges so as to line the uterine cavity, and being expelled with it after delivery. They also leave it at the insertion of the cord, to which they form a sheath. The cord is generally attached near the centre of the placenta, and from its insertion the umbilical vessels may be seen dividing and radiating over the whole fœtal surface.

The maternal surface is rough and divided by numerous sulci, which are best seen if the placenta is rendered convex, so as to resemble its condition when attached to the uterus. A careful examination shows that a delicate membrane covers the entire maternal surface, unites the sulci together, and dips down between them. This is, in fact, the cellular layer of the decidua serotina, which is separated and expelled with the placenta, the deeper layer remaining attached to the uterus. Numerous small openings may be seen on the surface, which are the apertures of the veins torn off from the uterus, as also those of some arteries, which, after taking several sharp turns, open suddenly into the substance of the organ.

As regards the minute structure of the placenta, it is certain that it consists essentially of two distinct portions—one *fœtal*, consisting of

FIG. 60.

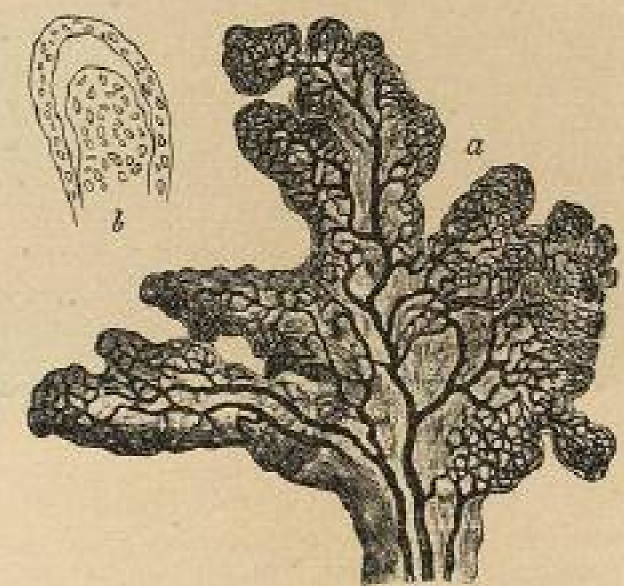


Placental villus, greatly magnified. 1, 2. Placental vessels, forming terminal loops. 3. Chorion tissue, forming external walls of villus. 4. Tissue surrounding vessels. (After JOULIN.)

the greatly hypertrophied chorion villi, with their contained vessels, which carry the fœtal blood so as to bring it into intimate relation with the maternal blood, and thus admit of the necessary changes occurring in it connected with the nutrition of the fœtus; and the other *maternal*, formed out of the decidua serotina and the maternal bloodvessels. These two portions are in the human female so intimately blended as to form the single deciduous organ which is thrown off after delivery. These main facts are admitted by all, but considerable differences of opinion still exist among anatomists as to the precise arrangement of these parts. In the following sketch of the subject I shall describe the views most generally entertained, merely briefly indicating the points which are contested by various authorities.

The fœtal portion of the placenta consists essentially of the ultimate ramifications of the chorion villi, which may be seen on microscopic examination in the form of club-shaped digitations, which are given off at every possible angle from the stem of a parent trunk, just like the branches of a plant. Within the transparent walls of the villi the capillary tubes of the contained vessels may be seen lying, distended with blood, and presenting an appearance not unlike loops of small intestine. The capillaries are the terminal ramifications of the umbilical arteries and veins, which, after reaching the site of the placenta, divide and subdivide until they at last form an immense number of minute capillary vessels, with their convexities looking toward the maternal portion of the placenta, each terminal loop being contained in one of the digitations of the chorion villi. Each arterial twig is accompanied by a corresponding venous branch, which unites with it to form the terminal arch or loop (Fig. 60). The fœtal blood

FIG. 61.



a. Terminal villus of fœtal tuft, minutely injected. *b.* Its nucleated non-vascular sheath. (After FARRE.)

is carried through these arterial twigs to the villi, where it comes into intimate contact with the maternal blood, in consequence of the anatomical arrangements presently to be described; but the two do not directly mix, as the older physiologists believed, for none of the maternal blood escapes when the umbilical cord is cut, nor can the minutest injections through the fœtal vessels be made to pass into the maternal vascular system, or *vice versâ*. In addition to the looped terminations of the umbilical vessels, Farre and Schroeder van der Kolk have described another set of capillary vessels in connection with each villus (Fig. 61). This consists of a very fine network covering each villus, and very different in appearance from the convoluted vessels lying in its interior, which are the only ones which have been usually described. Dr. Farre believes that these vessels only exist in the early months of pregnancy, and that they disappear as pregnancy advances. Priestley[1] suggests that they may not be vessels at all, but lymphatics, which may possibly absorb nutrient material from the mother's blood, and throw it into the fœtal vascular system. The existence of lymphatics, or of nerves, in the placenta, however, has never been demonstrated, and they are believed not to exist.

As generally described, the maternal portion of the placenta consists of large cavities, or of a single large cavity, which contain the maternal blood, and into which the villi of the chorion penetrate (Fig. 62). Into this maternal part of the viscus, the curling arteries of the uterus pour their blood, which is collected from it by the uterine sinuses.

FIG. 62.

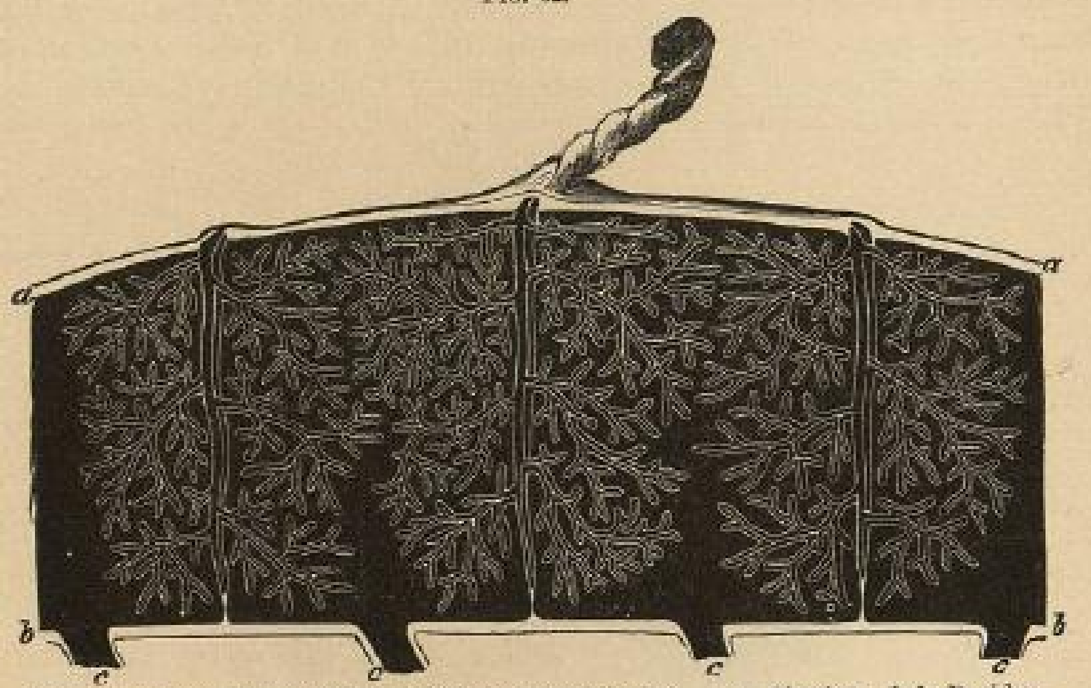


Diagram representing a vertical section of the placenta. *a, a.* Chorion. *b, b.* Decidua. *c, c, c, c.* Orifices of uterine sinuses. (After DALTON.)

The villi of the chorion, therefore, are suspended in a sac filled with maternal blood, which penetrates freely between them, and with which they are brought into very intimate contact. Dr. John Reid believed that only the delicate internal lining of the maternal vessels entered the substance of the placenta, to form the sac just spoken of. Into this the villi project, pushing before them the membrane forming the limiting wall of the placental sinuses, each of them in this way receiving an investment, just as the fingers of a hand are covered by a glove (Fig. 63).

Schroeder van der Kolk and Goodsir (Fig. 64) were of opinion that not only were the maternal bloodvessels continued into the substance of the placenta, but also the processes of the decidua, which accompanied the vessels and were prolonged over each villus, so as to separate it from the lining membrane of the maternal sinuses. Each villus would thus be covered by two layers of fine tissue, one from the internal lining membrane of the maternal bloodvessels, the other from the epithelial cells of the decidua.

[1] The Gravid Uterus, p. 52.

Turner, whose valuable researches on the comparative anatomy of the placenta have thrown much light on its structure, points out that the placentæ of all animals are formed on the same fundamental type,[1] in which the *fœtal portion* consists of a smooth, plane-surfaced vascular membrane, covered with pavement epithelium, which is brought into contact with the *maternal portion*, consisting of a smooth, plane-surfaced vascular membrane covered with columnar epithelium. The fœtal capillaries are separated from the maternal capillaries only by two opposed layers of epithelium. In various animals the placentæ are more or less specialized from the generalized form, in some to a much greater extent than others. In the human placenta the maternal

FIG. 63.

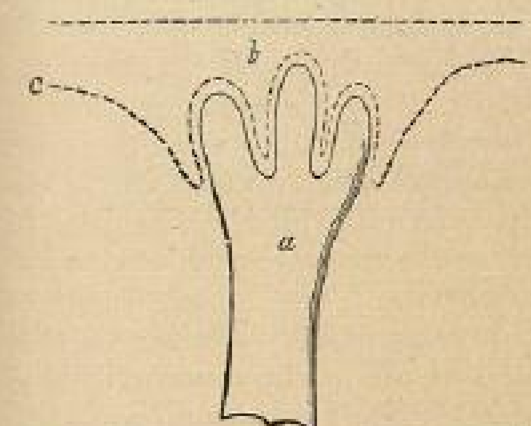
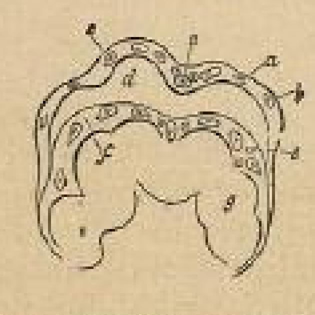


Diagram illustrating the mode in which a placental villus derives a covering from the vascular system of the mother. *a.* Villus having three terminal digitations projecting into *b.* Cavity of the mother's vessel. *c.* Dotted lines representing coat of vessel. (After PRIESTLEY.)

FIG. 64.



The extremity of a placental villus. *a.* External membrane of villus (the lining membrane of vascular system of Weber). *b.* External cells of villus derived from decidua. *c, c.* Nuclei of ditto. *d.* The space between the maternal and fœtal portions of villus. *e.* Its internal membrane. *f.* Its internal cells. *g.* The loop of umbilical vessels. (After GOODSIR.)

vessels have lost their normal cylindrical form, and are dilated into a system of freely intercommunicating placental sinuses, which are, in fact, maternal capillaries enormously enlarged, with their walls so expanded and thinned out that they cannot be recognized as a distinct layer limiting the sinus. Each fœtal chorion villus projecting into these sinuses is covered with a layer of cells distinct from those of the epithelial layer of the villus, and readily stripped from it. These are maternal in their origin, and are derived from the decidua, which sends prolongations of its tissue into the placenta. These cells, he believes, form a secreting epithelium which separates from the maternal blood a secretion, for the nourishment of the fœtus, which is, in its turn, absorbed by the villi of the chorion.

A view not very dissimilar to this has been advanced by Professor Ercolani, of Bologna, who maintains that the maternal portion of the placenta is a new formation, strictly glandular, and not vascular, in its structure. It is formed, he thinks, by the submucous connective tissue of the decidua serotina, and it dips down into the placenta and

[1] Introduction to Human Anatomy, Part 2, and Journ. of Anat. and Physiology, 1877, vol. xi. p. 33.

forms a sheath to each of the chorion villi, which it separates from the maternal blood. This new glandular structure he describes as secreting a fluid, termed the "uterine milk," which is absorbed by the villi of the chorion, just as the mother's milk is absorbed by the villi of the intestines, and it is with this fluid alone that the chorion villi are in direct contact. The sheath thus formed to each villus is doubtless analogous to the layer of cells which Goodsir described as encasing each villus, but is attributed to a new structure formed after conception.

The existence of the maternal sinus system in the placenta is altogether denied by anatomists of eminence whose views are worthy of careful consideration. Prominent amongst these is Braxton Hicks,[1] who has written an elaborate paper on the subject. He holds that there is no evidence to prove that the maternal blood is poured out into a cavity in which the chorion villi float, and he believes that the curling arteries, instead of entering the so-called maternal portion of the placenta, terminate in the decidua serotina. The hypertrophied chorion villi at the site of the placenta are firmly attached to the decidual surface, into which their tips are imbedded. The line of junction between the decidua reflexa and serotina forms a circumferential margin to, and limits, the placenta. The arrangement of the fœtal portion of the placenta on this view is very similar to that generally described, but the villi are not surrounded by maternal blood at all, and nothing exists between them, unless it be a small quantity of serous fluid. The change in the fœtal blood is effected by endosmosis, and Hicks suggests that the follicles of the decidua may secrete a fluid, which is poured into the intervillous spaces for absorption by the villi.

Functions of the Placenta.—It will thus be seen that anatomists of repute are still undecided as to important points in the minute anatomy of the placenta, which further investigation will doubtless clear up. The main functions of the organ are, however, sufficiently clear. During the entire period of its existence it fills the important office of both stomach and lungs to the fœtus. Whatever view of the arrangement of the maternal bloodvessels be taken, it is certain that the fœtal blood is propelled by the pulsations of the fœtal heart into the numberless villi of the chorion, where it is brought into very intimate relation with the mother's blood, gives off its carbonic acid, absorbs oxygen, and passes back to the fœtus, through the umbilical vein, in a fit state for circulation. The mode of respiration, therefore, in the fœtus is analogous to that in fishes, the chorion villi representing the gills, the maternal blood the water in which they float. Nutrition is also effected in the organ, and, by absorption through the chorion villi, the pabulum for the nourishment of the fœtus is taken up. It also probably serves as an emunctory for the products of excretion in the fœtus. Picard found that the blood in the placenta contained an appreciably larger quantity of urea than that in other parts of the body, this urea probably being derived from the fœtus.

[1] Obst. Trans., 1873, vol. xiv. p. 149.

Claude Bernard also attributed to it a glycogenic function,[1] supposing it to take the place of the fœtal liver until that organ was sufficiently developed.

Finally, we find that the temporary character of the placenta is indicated by certain degenerative changes, which take place in it previous to expulsion. These consist chiefly in the deposit of calcareous patches on its uterine surface, and in fatty degeneration of the villi and of the decidual layer between the placenta and the uterus. If this degeneration be carried to excess, as is not unfrequently the case, the fœtus may perish from want of a sufficient number of healthy villi through which its respiration and nutrition may be effected.

The umbilical cord is the channel of communication between the fœtus and placenta, being attached to the former at the umbilicus, to the latter generally near its centre, but sometimes, as in the battledore placenta, at its edge. It varies much in length, measuring on an average from eighteen to twenty-four inches, but in exceptional cases being found as long as fifty or sixty, and as short as five or six inches.

When fully formed it consists of an external membranous layer formed of the amnion, two umbilical arteries, one umbilical vein, and a considerable quantity of a transparent gelatinous substance surrounding the vessels, called Wharton's jelly, which is contained in a fine network of fibres, and is formed from the somato-pleural layer of the mesoblast in the cord. At an early period of pregnancy, in addition to these structures, the cord contains the pedicle of the umbilical vesicle, with the omphalo-mesenteric vessels ramifying on it, and two umbilical veins, one of which soon atrophies and disappears. No nerves or lymphatics have been satisfactorily demonstrated in the cord, although such have been described as existing. The vessels of the cord are at first straight in their course, but shortly they become greatly twisted, the arteries being external to the vein, and in nine cases out of ten the twist is from left to right. Various explanations have been given of this peculiarity, none of them entirely satisfactory. Tyler Smith attributed it to the movements of the fœtus twisting the cord, its attachment to the placenta being a fixed point; this would not, however, account for the frequency with which the spiral turns occur in one direction. Mr. John Simpson attributed it to the greater pressure of the blood through the right hypogastric artery, on account of that vessel having a more direct relation to the aorta than the left. The umbilical arteries give off no branches, and the vein contains no valves, nor can any vasa vasorum be detected in their coats after they have left the umbilicus. The umbilical arteries increase in size after they leave the cord, to divide on the surface of the placenta. This is the only example in the body in which arteries are larger near their terminations than their origin, and the object of this arrangement is probably to effect a retardation of the current of the blood distributed to the placenta. The tortuous course of the vein probably compensates

[1] Acad. des Sciences, April, 1859.

for the absence of valves, and moderates the flow of blood through it.[1]

Distinct knots are not unfrequently observed in the cord, but they rarely have the effect of obstructing the circulation through it. They no doubt form when the fœtus is very small. They may sometimes also be produced in labor by the child being propelled through a coil of the cord lying circularly around the os uteri. The so-called false knots are merely accidental nodosities due to local enlargements of the vessels.

CHAPTER II.

THE ANATOMY AND PHYSIOLOGY OF THE FŒTUS.

It is obviously impossible to attempt anything like a full account of the development of the various fœtal structures, or of their growth during intra-uterine life. To do so would lead us far beyond the scope of this work, and would involve a study of complex details only suitable in a treatise on embryology. It is of importance, however, that the practitioner should have it in his power to determine approximately the age of the fœtus in abortions or premature labors, and for this purpose it is necessary to describe briefly the appearance of the fœtus at various stages of its growth.

1st Month. The fœtus in the first month of gestation is a minute gelatinous and semi-transparent mass, of a grayish color, in which no definite structure can be made out, and in which no head or extremities can be seen. It is rarely to be detected in abortions, being lost in surrounding blood-clots. In the few examples which have been carefully examined it did not measure more than a line in length. It is, however, already surrounded by the amnion, and the pedicle of the umbilical vesicle can be traced into the unclosed abdominal cavity.

2d Month. The embryo becomes more distinctly apparent, and is curved on itself, weighing about sixty-two grains, and measuring six to eight lines in length. The head and extremities are distinctly visible—the latter in the form of rudimentary projections from the body. The eyes are to be seen as small black spots on the side of the head. The spinal column is divided into separate vertebræ. The independent circulatory system of the fœtus is now beginning to form, the heart consisting of only one ventricle and one auricle, from the former of which both the aorta and pulmonary arteries arise. On either side of the vertebral column, reaching from the heart to the pelvis, are two

[1 In some instances the disproportionate length of the vein causes the cord to assume a screw-like form, which may be very regular, as is exhibited to a remarkable degree by one in my possession, in which there are between thirty and forty turns, involving the whole funis, which is of average length in a straight line.—Ed.]

large glandular structures, the *corpora Wolffiana,* which consist of a series of convoluted tubes opening into an excretory duct, running along their external borders, and connected below with the common cloaca of the genito-urinary and digestive tracts. They seem to act as secreting glands, and fulfil the functions of the kidneys before they are formed. Toward the end of the second month they atrophy and disappear, and the only trace of them in the fœtus at term is to be found in the parovarium lying between the folds of the broad ligaments. At this stage of development there are met with in the human embryo, as in that of all mammals, four transverse fissures opening into the pharynx, which are analogous to the permanent branchiæ of fishes. Their vascular supply is also similar, as the aorta at this time gives off four branches on each side, each of which forms a branchial arch, and these afterward unite to form the descending aorta. By the end of the sixth week these, as well as the transverse fissures to which they are distributed, disappear. By the end of the second month the kidneys and supra-renal capsules are forming, and the single ventricle is divided into two by the growth of the inter-ventricular septum. The umbilical cord is quite straight, and is inserted into the lower part of the abdomen. Centres of ossification are showing themselves in the inferior maxillary bones and the clavicle.

3d Month. The embryo weighs from seventy to three hundred grains, and measures from two and a half to three and a half inches in length. The forearm is well formed, and the first traces of the fingers can be made out. The head is large in proportion to the rest of the body, and the eyes are prominent; the mouth is closed by the lips, and is separated by them from the nasal cavity. The umbilical vesicle and allantois have disappeared, and the alimentary canal is now situated entirely within the abdominal cavity. The greater portion of the chorion villi have atrophied, and the placenta is distinctly formed.

4th Month. The weight is from four to six ounces, and the length about six inches. The convolutions of the brain are beginning to develop. The sex of the child can now be ascertained on inspection. Hairs begin to be formed on the head. The muscles are sufficiently formed to produce distinct movements of the limbs. Ossification is extending, and can be traced in the occipital and frontal bones, and in the mastoid processes. The sexual organs are differentiated.

5th Month. Weight about ten ounces. Length, nine or ten inches. Hair is observed covering the head, which forms about one-third of the length of the whole fœtus. The nails are beginning to form, and ossification has commenced in the ischium. The fœtal movements are distinct, and in cases of premature delivery, may continue for some time after the birth of the child.

6th Month. Weight about one pound. Length, eleven to twelve and a half inches. The hair is darker. The eyelids are closed, and the membrana pupillaris exists; eyelashes have now been formed. Some fat is deposited under the skin. The testicles are still in the abdominal cavity. The clitoris is prominent. The pubic bones have begun to ossify.