Outlines of
Early Development

R. W. Johnstone

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FOR OBSTETRIC STUDENTS

BY

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WITH A PREFACE

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PREFACE

THE following concise and careful sketch of the early life history of the human ovum has been written at my request, in order to supply the students in my class of Obstetrics with a simple and connected outline of the facts of Embryology essential to a good understanding of the science of Midwifery.

Owing to the difficulty of obtaining human ova in the earliest stages of development much of what is described as occurring in man, has not been proved; it is merely a deduction from what is known to occur in other animals. A knowledge of this comparative embryology is undoubtedly necessary to the complete comprehension of human development, but the elements of the subject may quite legitimately be presented without reference to it. In the following pages this has, for the sake of simplicity, been done, and, therefore, some points upon which there is really some dubiety have been described dogmatically. In these cases the view most generally held has been adopted.

I have always been in the habit of illustrating and supplementing my lectures by printed slips and diagrams, and Dr Johnstone has extended and elaborated this idea in this excellent presentment of the subject.

I trust that these pages will enable the student to bestow a more leisured attention to the subject than is possible in the classroom.

J. HALLIDAY CROOM.

AUTHOR'S NOTE

THE author wishes to record his indebtedness to Professor Bryce of Glasgow for the use of two of his figures, as well as to Messrs Longmans, Green & Co., for the blocks of these figures from Quain's Anatomy. He is also very much indebted to Dr Lochhead, the author of the brilliant chapters on the placenta in Marshall's "Physiology of Reproduction," for kindly reading the proofs and making several valuable suggestions.

OUTLINES OF EARLY DEVELOPMENT

FERTILISATION.

THERE is reason to believe that normally the human spermatozoon and ovum meet in the Fallopian tube, towards its ovarian end.

The human spermatozoon is a small cell, measuring only $\frac{1}{300}$th of an inch in length. It has a flat oval head, and behind this a cylindrical body ending in a long tail which constitutes four-fifths of its whole length. A long axial fibre runs the whole length of the body and tail, and outside this is a sheath arranged like a spiral spring. It is believed that the head is armed with a sharp edge whereby it can cut its way through the envelope of the ovum. The spermatozoon propels itself by rotatory lashings of its long tail, and is capable of attaining a speed of one-eighth of an inch per minute. It is killed by strong acids or alkalies and by high temperatures. At body heat, and in the faintly alkaline secretions of the uterus and tubes it can exist for at least fourteen days. Whether it can retain its fertilising power as long, is doubtful.

The human ovum is an almost spherical cell about $\frac{1}{120}$th of an inch in diameter. As it escapes from the Graafian follicle at the time of rupture, it is probably surrounded by the cells of the discus proligerus immediately adjacent to it—the so-called corona radiata. Inside this is a thin membrane delicately striated radially. This is the zona pellucida, and the striations are thought to be very fine pores. Inside the zona pellucida there is a minute space—the perivitelline space—and then the ovum proper with its delicate outer envelope, the vitelline membrane.

The outer portion of the cytoplasm is usually clear protoplasm, the more central portion, known as the deutoplasm, is full of granules of a fatty and albuminous nature.

Lying eccentrically within the deutoplasm is the nucleus or germinal vesicle, with a single nucleolus or germinal spot.

On its escape into the peritoneal cavity the ovum is either caught in the tentacles of the ovarian fimbria of the tube, or swept into the mouth of the tube by the ciliary lymph current. The cilia lining the tube and uterus all work in the one direction —from the ovarian end of the tube towards the os externum—and hence there is a constant current tending to sweep the ovum into the uterus and through it to the vagina. The spermatozoon has to make its way against the current, but of this it is easily capable owing to the propellor action of its tail.

Before it is ready for fertilisation, the ovum has to go through a process of maturation—a process which the male element has passed through before it is set free. The ovum divides twice, giving off first one polar body and then a second. By this means it loses half its chromosomes.

When the spermatozoon meets the ovum it cuts its way through the zona pellucida and vitelline membrane by means of its head cap. The tail becomes absorbed, but the head and body pass in and fuse with the nucleus of the ovum, forming the so-called segmentation nucleus. In this way the fertilised ovum is furnished with the characteristic number of chromosomes, each element, the male and the female, contributing half. Thereafter the process of mitosis goes on rapidly.

FORMATION OF THE GERMINAL LAYERS

The ovum now divides into two, four, eight, sixteen cells, and so on until a little ball of cells is formed like a bramble or mulberry, and known as the **morula** (*see* Fig. 1). Some of the cells in the inside of the morula then become vacuolated and run

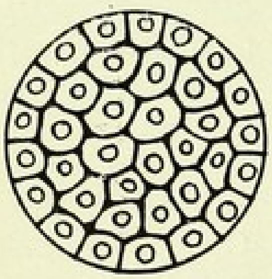

Fig. 1.—Diagram of the Morula stage.

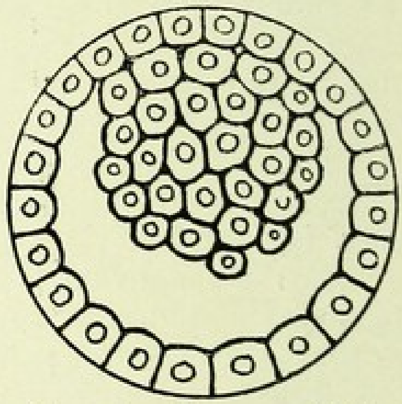

Fig. 2.—Diagram of the Blastocyst.

together to form a space full of fluid. In this way the solid morula is changed into the **blastocyst**, with the bulk of its cells projecting into the inside of the cyst like a knob. This knob is the **inner or formative cell mass** (*see* Fig. 2). The outer layer surrounding the blastocyst is destined to form the epithelial part of the **chorion**, and as it has nothing to do with the formation of the actual embryo, it is called the **extra-embryonic ectoderm**. It is also called the **trophoblast**, because its function is associated solely with the growth and nutrition of the ovum.

The lower cells of the inner or formative cell mass now become flattened out and differentiated into a separate layer—the **entoderm** —which grows round in such a way as to form a little closed sac inside the blastocyst—the **yolk sac** (*see* Fig. 3).

The next step is that in the centre of the inner cell mass there appears a little space filled with fluid, very much as happened in the formation of the blastocyst. This space is the **amniotic cavity,** and the cells lining it become flattened out into a definite layer, especially over the floor of the cavity where they form the **embryonic ectoderm.** The amnion is thus a closed sac from the very beginning.

It is in this embryonic ectoderm and the entoderm of the yolk sac immediately below it that the future embryo develops, and, therefore, this area is called the **embryonic area** (*see* Fig. 3).

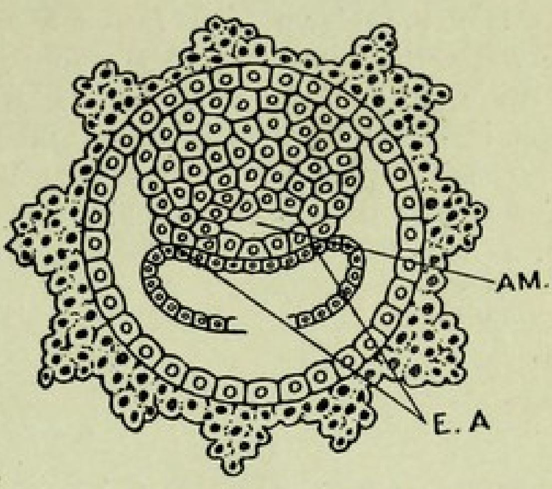

FIG. 3.—Diagram shewing formation of endothelial yolk sac, and earliest appearance of amniotic space (AM). The early outgrowths of trophoblast are also indicated. E.A. marks the extent and position of the embryonic area.

The third germinal layer —the **mesoderm**—now begins to appear as a growth of cells starting from the sides of the embryonic area between the embryonic ectoderm and the entoderm. The mesoderm early divides into two leaves, one spreading over the entoderm of the yolk sac, the other growing round the inside of the extra-embryonic ecto-

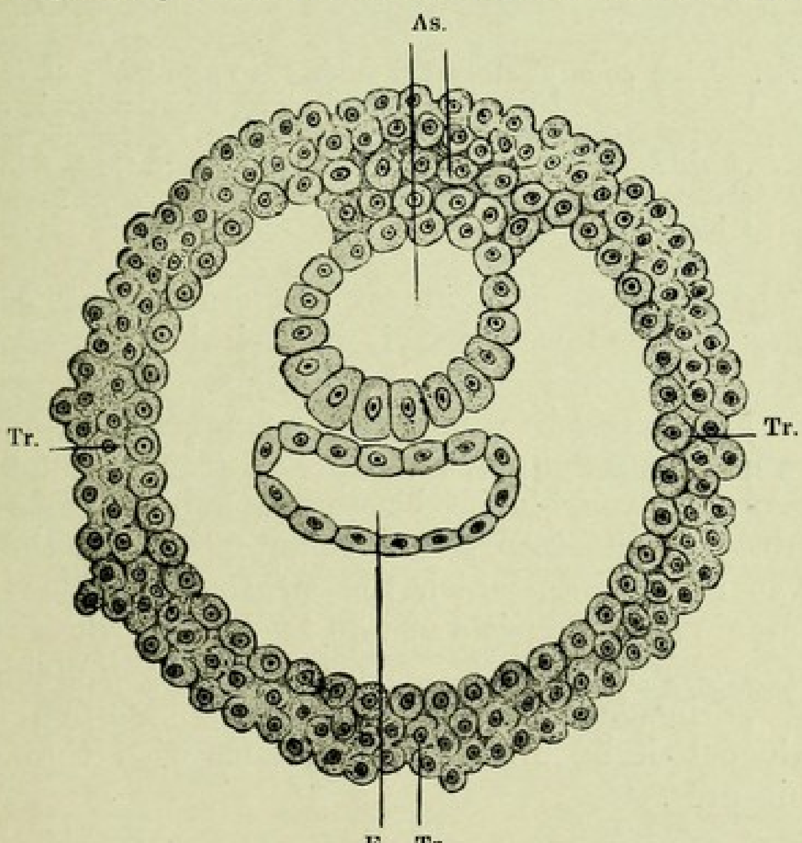

FIG. 4.—Diagram of later stage of the Blastocyst. As. Amniotic space. Tr. Trophoblast. E. Entodermal yolk sac. (From *Quain's Anatomy*, by kind permission of Prof. T. H. Bryce.)

derm. The inner leaf of mesoderm forms the **splanchnopleure.** The outer leaf is known as the **somatopleure**, and unites with the extra-embryonic ectoderm to form the primitive chorion. The space between the splanchnopleure and the somatopleure is the origin of the cœlom or body cavity.

The mesoderm also forms a specially thick mass of tissue between the hind end of the embryonic area and the primitive chorion, known later as the **belly stalk,** or **abdominal pedicle.** This is of importance in the formation of the umbilical cord, as the embryonic blood vessels, afterwards to be the umbilical vessels, are developed in this mesoderm, while the tissue itself forms the so-called Wharton's jelly (*see* Fig. 5).

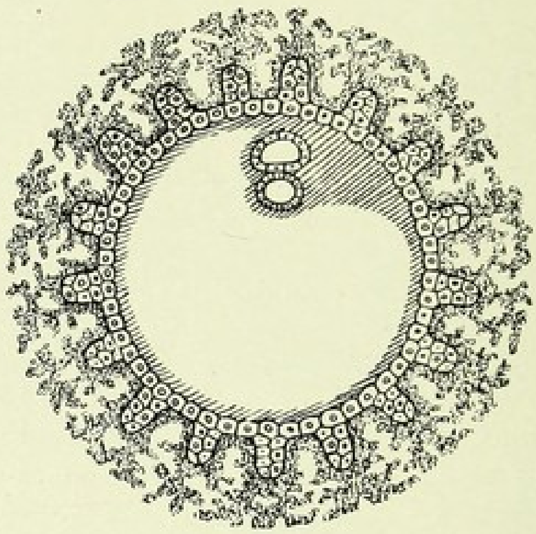

Fig. 5.—Diagram of blastocyst showing the outgrowths of the trophoblast. The mesoblast (shaded) lines the inside of the trophoblast thus forming the chorion, surrounds the outside of both amnion and yolk sac, and attaches the embryo to the chorion by the thickened part—the "belly stalk."

The chorion and amnion are structures of such vast importance to the fœtus, that it is desirable to recapitulate what we have learned as to their origin.

The chorion consists of two layers—the trophoblast outside and the somatopleure inside. The trophoblast is the outermost layer of the blastocyst and is made up of extra-embryonic *ectoderm.* The somatopleure is the outer of the two leaves into which the *mesoderm* divides.

The amnion also consists of two layers, but their relative positions are reversed, the *mesoderm* being outside, and the *ectoderm* inside. The ectoderm of the amnion is true embryonic ectoderm, directly continuous with that of the embryonic area.

THE EARLY DEVELOPMENT OF THE EMBRYO.

If the ovum at this stage be looked at from above, the embryonic area appears as a small shaded oval. The shading is due to an increased growth of cells, because here the three germinal layers—embryonic ectoderm, mesoderm, and entoderm are in contact. At one end a patch of darker shading indicates a still greater growth of cells. Running forward from this is a band—the **primitive streak**—in the centre of which lies a darker line—the **primitive groove**. At the far (anterior) end of the primitive groove there is a dark spot—Hensen's node—from which still another streak runs forward—the head process. Later in front of the primitive streak a thickened band of ectoderm appears, broadening out posteriorly. The edges of this band rise up to form two folds, which meet anteriorly. The groove between them is the **medullary groove**, and ultimately they fold over and unite to form the **neural canal** (*see* Fig. 6).

Along the line of the primitive streak all three germinal layers are in contact. Superficial to it is the amnion, and below it is the yolk sac. The embryonic area is the only part of the ovum which has to do with the subsequent development of the embryo; the other parts of the blastodermic vesicle become subservient as nutritive or supporting structures.

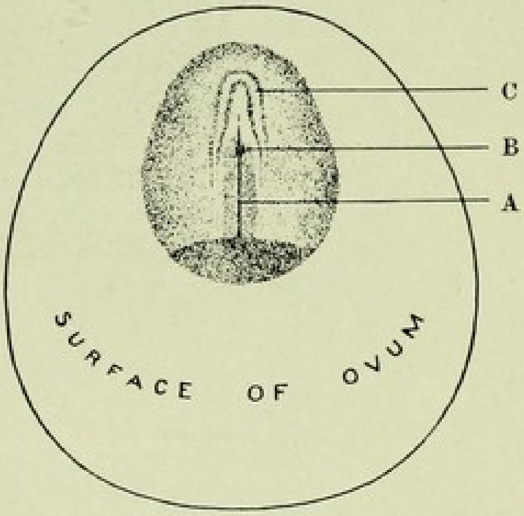

FIG. 6.—Shewing embryonic area. A, Primitive groove. B, Hensen's node. C, Medullary folds.

At this stage, and for the first three weeks of its existence, the embryo is a "flat disc floating on the surface of the yolk sac" (M'Murrich). There then occurs the "folding off" of the embryo. The amniotic cavity enlarges, and dips down over the two ends of the embryo forming a head and a tail fold. It also dips round the sides and bends them in so that the embryo forms a sort of tube, open along its lower side. The inside of this tube is of course just a portion of the original yolk sac folded off from the rest. As the "folding off" process goes on, the ventral surface of the embryo becomes entirely closed in, except at one point where the interior of the embryonic tube is in communication with the yolk sac. The part of the yolk sac thus included in the embryo forms the future alimentary tract. The yolk sac at this stage is termed the **umbilical vesicle**, and the canal joining it to the gut of the embryo—the **vitelline duct.**

As the vitelline duct is being formed by the constriction of the neck of the yolk sac, a small diverticulum appears in the hind part of the embryonic gut. This is the **allantois**, an entodermal tube, that bores its way along the mesoderm of the belly-stalk, but fails to reach as far as the chorion (*see* Figs. 7, 8, 9).

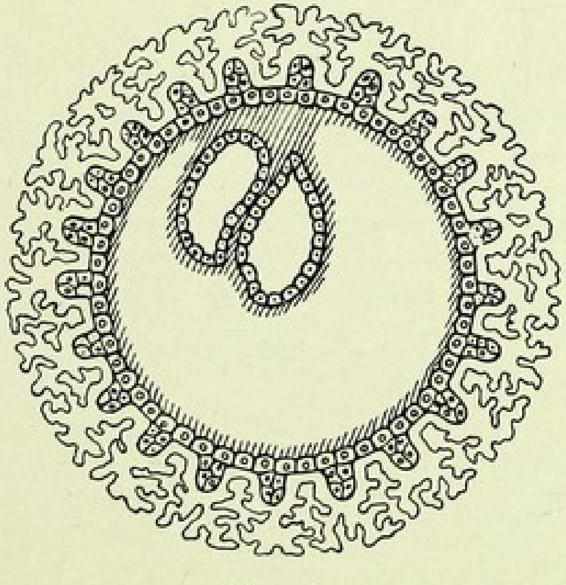

Fig. 7.

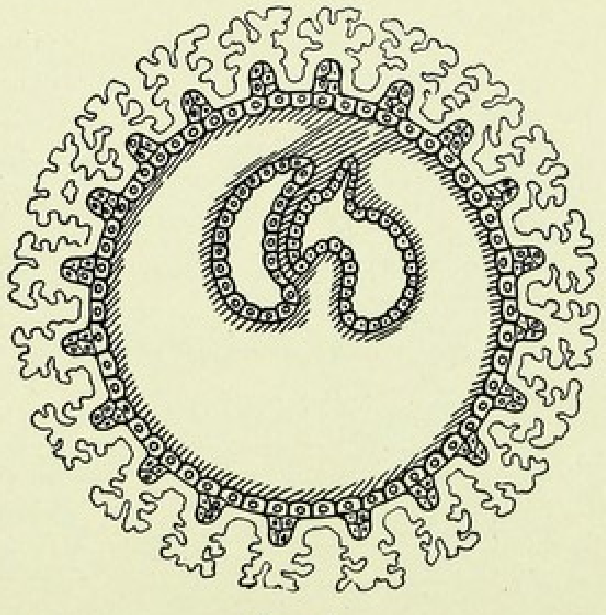

Fig. 8.

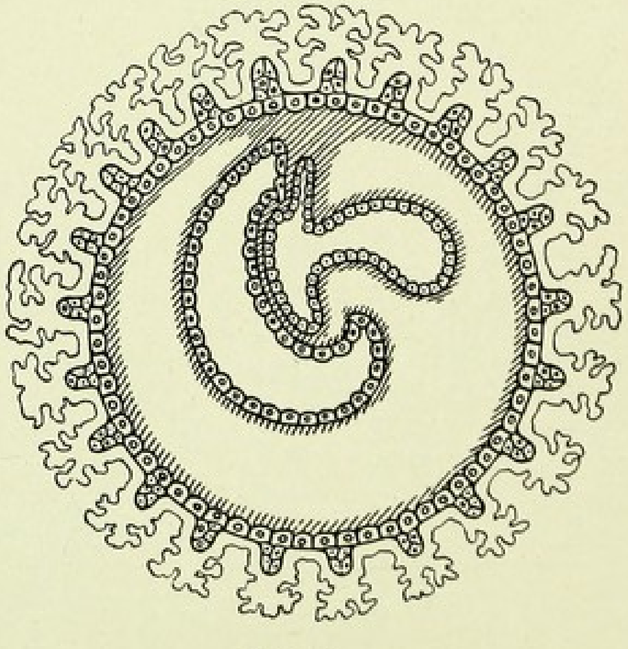

Fig. 9.

Figs. 7, 8, and 9.—Diagrams showing the process of the "folding off" of the embryo. The amniotic cavity is to the left, the entodermal cavity or yolk sac to the right. The yolk sac becomes partly constricted to form the primitive gut, from the hind end of which the allantois is observed growing out towards the chorion. The embryo in these diagrams is much too large in proportion to the size of the ovum.

In reptiles and birds the allantois is an organ of immense importance, and spreads round the inside of the trophoblast to form the placenta. Through it the respiratory exchanges between the embryo and the air take place. In man it is of little importance and never reaches any great development, being represented merely by this blind tube in the belly-stalk. Its intra-embryonic part becomes the bladder, and the urachus represents its original communication with the umbilical cord.

The steady advance of the amnion round the sides and front of the embryo causes the vitelline duct and yolk sac to be swung into contact with the belly-stalk, and ultimately they become incorporated with the belly-stalk in the **umbilical cord.** We see, therefore, that the umbilical cord consists of (1) the mesodermic belly-stalk (Wharton's Jelly), with (2) the umbilical vessels developed in it, (3) the rudimentary allantois, and (4) the vitelline duct and what remains of the yolk sac.

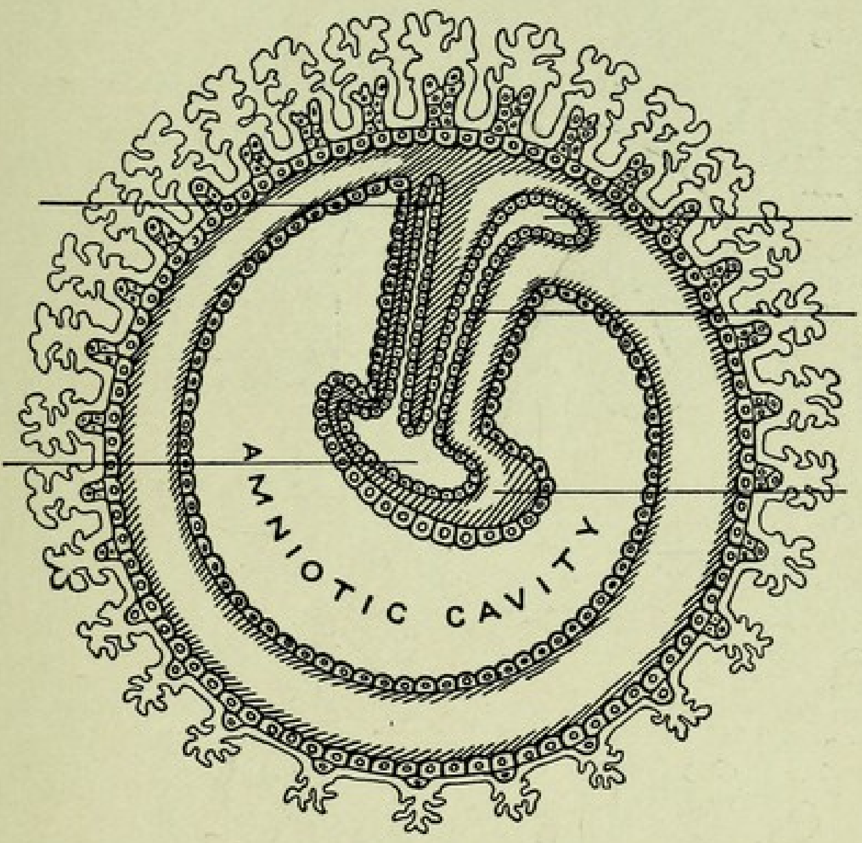

Fig. 10.

These all get bound together by the growth of the amnion, in a covering of embryonic ectoderm. The vessels are originally two arteries and two veins, but the veins fuse together into one giving us the usual arrangement at birth of two arteries and one vein. At first the umbilical cord is attached to the embryo at the hinder end of its body, but later the caudal part of the embryo develops more rapidly, and at birth the umbilicus is situated at or near the middle of the body. The umbilical cord is generally fully developed by the sixth week (*see* Fig. 10).

By the closing in of the sides of the embryo, a part of the space between the splanchnopleure and the somatopleure gets shut off to form the future pleuro-peritoneal cavity. The rest

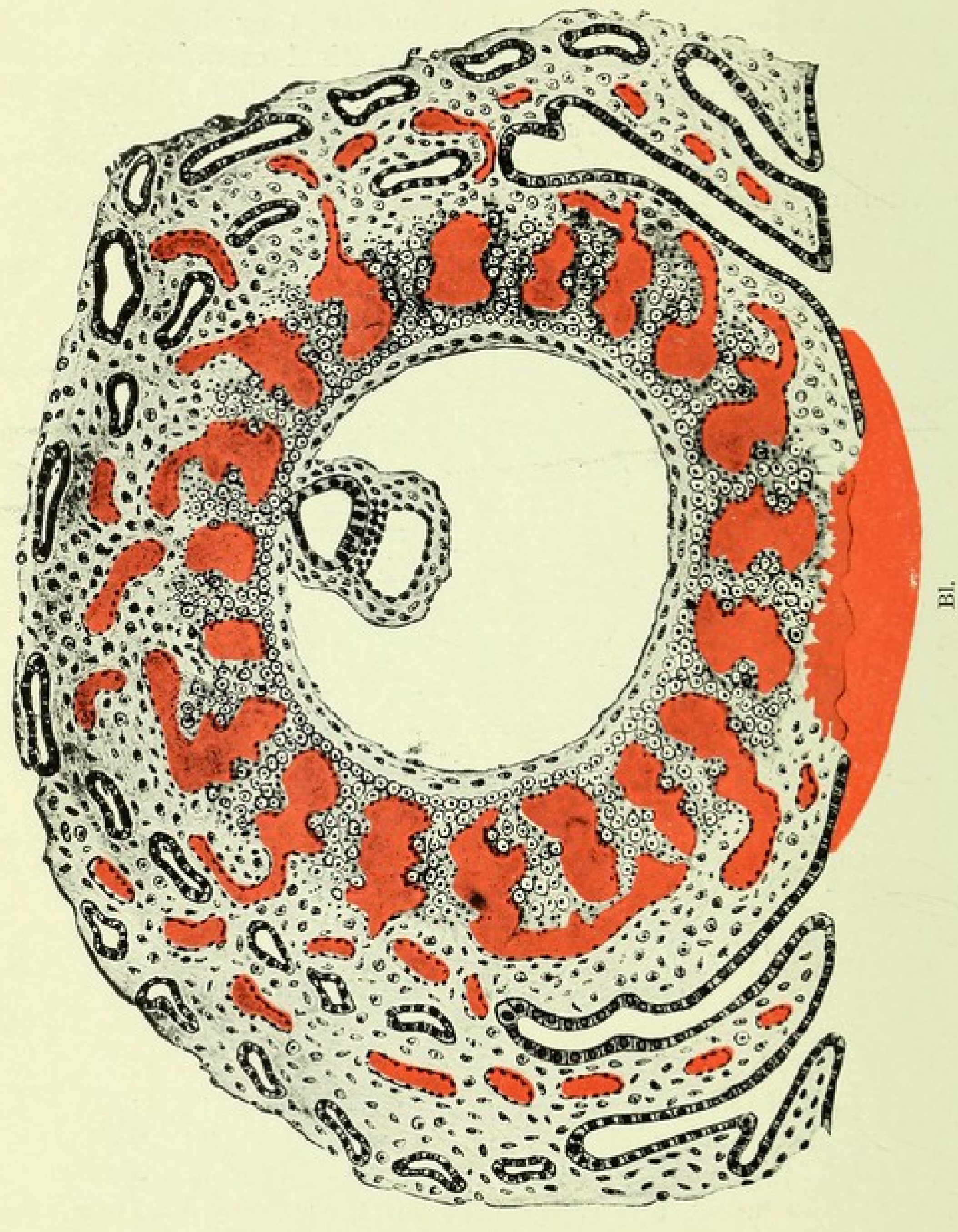

FIG. 11.—Diagram of human ovum embedding itself in the decidua. The surface of the decidua is below, and glands are seen opening upon it at the sides. Bl. indicates the bloodclot at the point of entrance of the ovum. The trophoblast, partly cellular, partly plasmodial (syncytium), is seen invading the decidua, and opening up the dilated capillaries. The extravasated blood occupies the spaces or blood lacunæ between the strands of trophoblast. The mesoblast forms the inner layer of the chorion and surrounds the amnion and yolk sac. Between the amnion and yolk sac is the embryonic area in which the three germinal layers are in contact. (From *Quain's Anatomy*, by kind permission of Prof. T. H. Bryce.)

of the space between the amnion and the chorion soon becomes obliterated by the growth of the amnion, and the two membranes remain in contact thereafter. In most cases they can be readily separated at birth.

The growth of the amnion is in part due to its becoming filled with a clear fluid—the **liquor amnii**. This fluid appears very soon after the amniotic space is formed, and in the second month it rapidly increases in quantity, and distends the amniotic sac. The origin of the fluid is doubtful. During pregnancy its function is largely to act as a protection to the embryo. During labour it has other functions as well.

To summarise, we now have the ovum surrounded by chorion, with the amnion inside it and in contact with it. Inside the amnion, floating in the liquor amnii, is the embryo in the form of a bent tube, attached near its tail end to the chorion by the developing umbilical cord.

As it is not proposed to follow the development of the embryo further in detail, it may be as well just to summarise the destinies of the various layers. The Ectoderm forms :—The epidermis, hair, nails, skin glands, dental enamel ; the whole nervous system, the nervous parts of the sense organs, and the lens of the eye ; the mucosa of the mouth, nose, and lower part of the rectum.

The Mesoderm forms :—The connective tissues, including bone and teeth, except the enamel ; the muscles, striped and unstriped ; the circulatory system ; the blood ; the lymphatic system ; the serous membranes ; the kidneys and ureters ; the internal organs of generation.

The Entoderm forms :—The mucosa of the alimentary tract, except the parts mentioned ; the epithelium of the glands connected with it, such as liver, pancreas, etc. ; the epithelium of the larynx, trachea and lungs ; the epithelium of the bladder and urethra.

THE EMBEDDING OF THE OVUM.

We must now return to the ovum as it lies in the ovarian end of the Fallopian tube, where it has been fertilised by the spermatozoon. Its further passage along the tube into the uterus is believed to occupy seven days, and by the time it reaches the uterus it has developed to the stage of a small blastocyst. The outer covering of the blastocyst is the extra-embryonic ectoderm, or as it is usually called, the trophoblast. (*See p.* 8). The term trophoblast is used to indicate that it has a nutritive function only, and is not engaged in the actual formation of the embryo.

We must now look more closely at the structure of this trophoblast. Even in the earliest known human ovum, which was just about seven days old, it was found to consist of two layers. The inner layer consists of cells with large pale nuclei, arranged more or less regularly like a columnar epithelium. The arrangement becomes more regular as development goes on. This is known as the **cyto-trophoblast** or **Langhans' layer.** Outside this is a thick investment of loose vacuolated undifferentiated protoplasm, with numerous small deeply-staining nuclei throughout it, but *with no divisions into cells.* The inner part has numerous spaces in it, formed by vacuolation, but in the outer portions the vacuolations have become more numerous and larger, and have run together in such a way that the whole layer is, as it were, "spun out" into a sort of open sponge-work. This is the **plasmodi-trophoblast** or **syncytium** (*see* Fig. 5).

This syncytium has the power of destroying other tissues. Probably it does so by secreting a ferment which digests them. The result is that when the ovum comes to rest in the uterus, it proceeds at once to eat its way through the surface epithelium into the substance of the endometrium.

The syncytium simply digests and dissolves the tissues in its immediate neighbourhood, and so the ovum eats its way deeper and deeper into the endometrium. Ultimately it is altogether buried, and the point of entrance becomes sealed up by bloodclot that later becomes organised. In the substance of the endometrium the ovum eats out a small "implantation cavity" for itself, which is filled with maternal blood escaped from the capillaries opened up by the destructive advance of the syncytium.

Thus we have the ovum completely embedded, lying free in a tiny cavity in the mucous membrane lining the uterus—a cavity full of blood, in which the ovum lies bathed, and from which it presumably absorbs nourishment by osmosis through its trophoblast (*see* Fig. 11).

THE DECIDUA.

As a result of impregnation the mucous membrane of the uterus undergoes certain changes in structure, and is henceforth known as the **decidua.** Recent researches indicate that the fertilised ovum may enter the uterus at any stage of the menstrual cycle. The surface of the endometrium may not be quite smooth, and the ovum may possibly be arrested by some ridge or projection of the surface. Here it embeds itself, and the destructive and invasive action of the syncytium is soon followed by a reaction on the part of the uterus. This reaction is characterised by a rapid transformation of the small, primitive, connective tissue cells of the stroma of the endometrium into large oval or polygonal "epithelioid" cells with large pale oval nuclei. These are the decidual cells, and they are probably thrown out as a line of defence against the advance of the syncytium (Turner). The glands of the endometrium become enlarged and dilated, the capillaries distended with blood, and the whole membrane becomes markedly thickened and soft and œdematous.

Instead of being only about one-eighth of an inch thick, it swells until it may even be as much as half an inch in depth. In this growth the glands take a very active share, and increase so much in length that in order to accommodate themselves, they become folded backwards and forwards in their middle parts. The effect of this is to make the middle portion of the decidua full of distended gland spaces, whereas the more superficial portion contains only the mouths and necks of the glands, supported in a stroma packed with the decidual cells. If a section be made through the decidua, it thus appears to be divided into three layer

—the superficial part being compact in structure, and hence known as the **superficial compact layer,** while the deeper part is known as the **spongy layer.** The deepest part of all, immediately next the muscle wall, contains only the blind ends of the glands (many of which actually penetrate the muscle) and is sometimes described as a third layer—**deep compact layer** (*see* Fig 12).

For purposes of description the decidua is divided further into three parts according to its relationship to the ovum. The part on which the embedded ovum rests is called the **decidua basalis** (or to give it the older name, the **decidua serotina**). The part superficial to it, *i.e.*, shutting it off from the cavity of the uterus, is called the **decidua reflexa,** or the **decidua capsularis.**

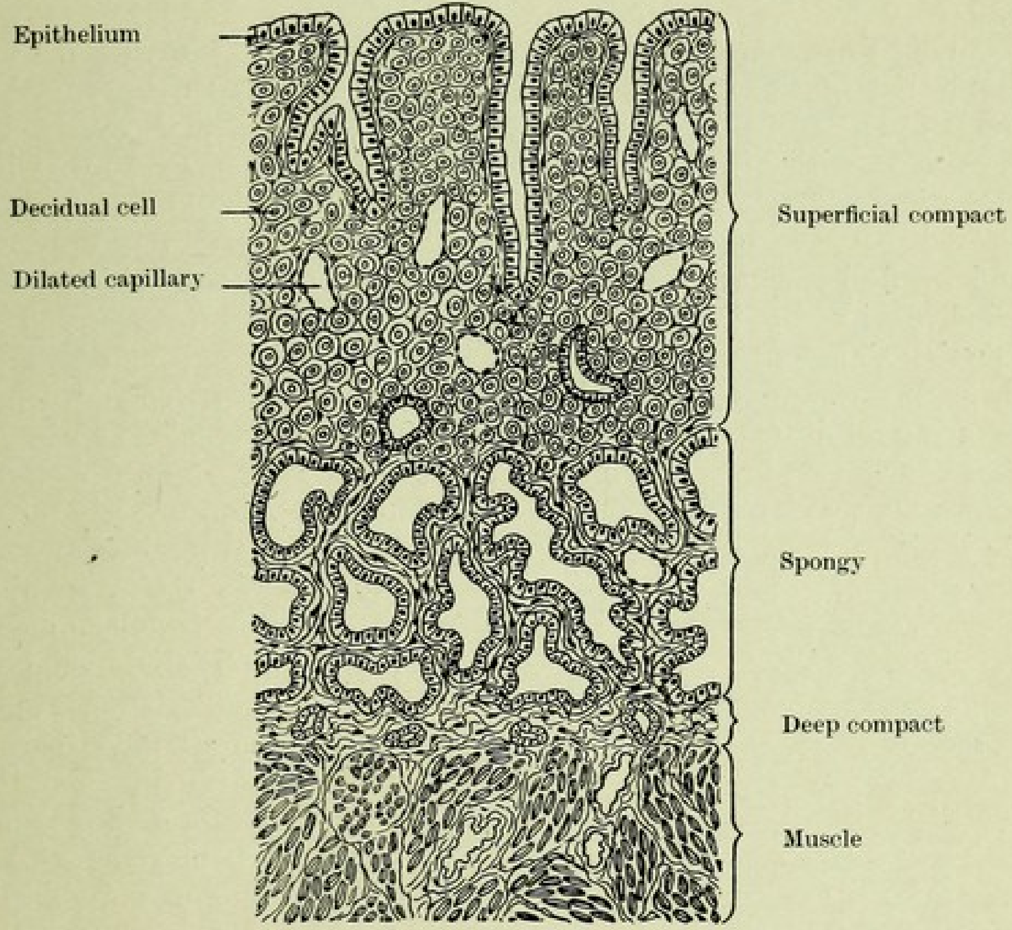

Fig. 12.—Diagram of section through decidua vera.

(Neither term is correct, and until a correct one is adopted, it is best to keep to the older name "reflexa.") Lastly, the decidua lining the rest of the cavity of the uterus is called the **decidua vera.**

Now the ovum imbeds itself about the middle depth of the decidua, just where the superficial compact is passing into the spongy layer, therefore the decidua reflexa only presents on section the appearances of the superficial compact layer, while the decidua serotina presents the spongy layer and the deep compact layer. The decidua vera, on the other hand, presents all three layers on section. Very early in pregnancy the glands degenerate, and disappear, all except their blind ends. They therefore take no part in the formation of the placenta.

As the ovum grows and projects more and more into the cavity of the uterus, the decidua reflexa becomes thinned out, and ultimately, when the ovum occupies the whole of the cavity, as it does after the end of the third month, the reflexa and the vera fuse into one. Previous to this the columnar epithelium covering the decidua has given place to a layer of flatter cells. The further growth of the ovum causes a pressure atrophy of the fused membranes, and by the time of labour they constitute only a very thin membrane.

THE DEVELOPMENT OF THE PLACENTA.

The first step in the development of the placenta is the formation of the chorionic villi by which the little ovum attaches itself to the walls of the implantation cavity. At first, the cavity is filled with irregular outgrowths of the syncytium, with necrotic endometrium more or less dissolved by its action, and by effused maternal blood. Soon the necrotic endometrium disappears, and we find the ovum attaching itself to the walls of this blood-filled cavity by more or less regular moorings (*see* Fig. 11). Langhans' layer sends out definite buds, which grow outwards through the syncytium, and in so doing become invested with a covering of it (*see* Figs. 5, 7, 8, 9, 10). These buds, consisting thus of the two layers of the trophoblast, grow out in all directions across the cavity to the surface of the decidua, and as they do so they give off lateral branches, until their structure becomes as complex as the branching of a tree. Next, the mesoblast lining the inside of the trophoblast sends out projections which grow along the inside of the epithelial branches and form what may be called a "core." This mesoblastic core grows out to the very tips of the epithelial branches—or, as they are now called, the **chorionic villi.** In the mesoblastic core the embryonic blood-vessels develop, and these become directly continuous with the vessels of the belly-stalk or future umbilical cord, and so with the circulation of the embryo (*see* Fig. 13).

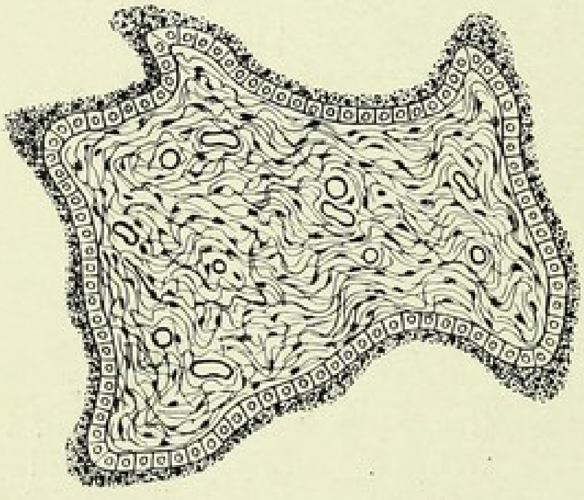

FIG. 13.—Diagram of early villus on section, showing the two epithelial layers and the connective tissue core containing capillary vessels.

As they grow, the villi eat into and open many capillary vessels in the decidua, and the blood pours out of these into the spaces between the villi, and into the vacuolated spaces in the early trophoblastic spongework. In this way the space between the chorion and the decidua (**chorio-decidual space**) becomes subdivided into an enormous number of smaller spaces, the **intervillous spaces,** and through them the blood very slowly circulates. These spaces are lined with syncytium—being, in fact, merely the spaces between the villi; but although it is not a vascular endothelium, the blood does not coagulate in contact with it (*see* Fig. 11).

At first the villi develop all over the surface of the ovum, and attach it to the decidua reflexa as well as the serotina. But as the ovum grows the reflexa becomes more and more thinned out, and the blood supply to it more and more meagre.

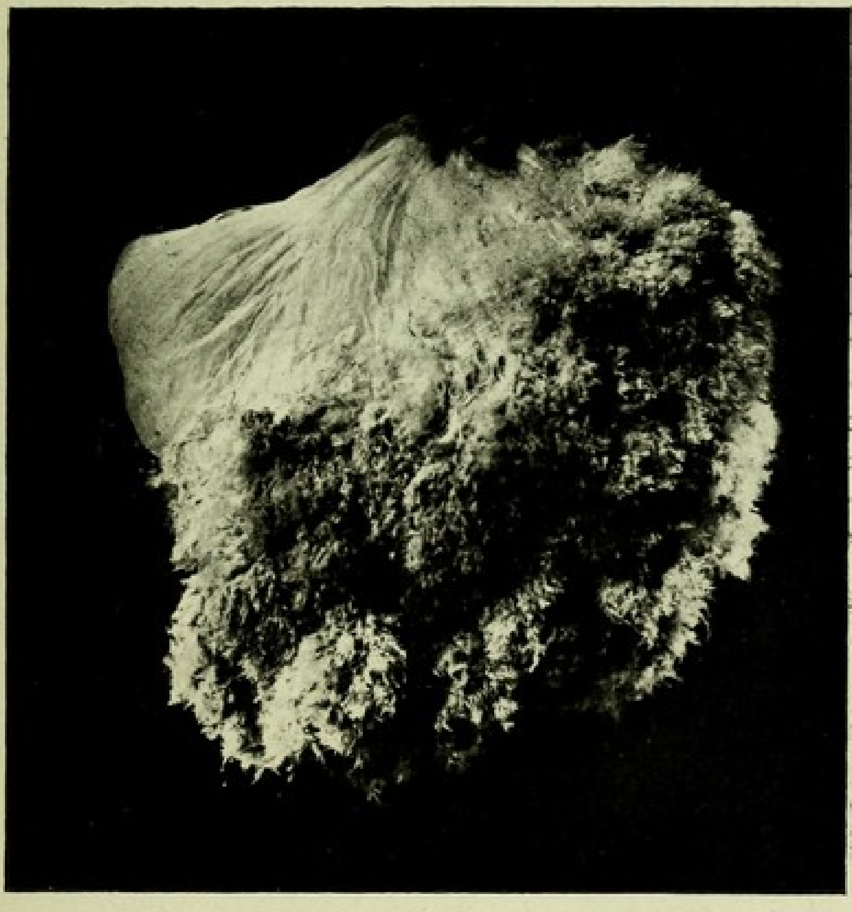

Fig. 14.—Photograph of human ovum showing the chorion frondosum and the chorion læve. (From a specimen in the Obstetrical Museum, University of Edinburgh.)

Hence the villi attached to it become gradually of less and less nutritive value to the ovum, and they gradually atrophy (*see* Fig. 10). Ultimately they disappear altogether, and the surface of the chorion becomes divided into the two areas—the **chorion læve** or smooth chorion in contact with the decidua reflexa, and the **chorion frondosum** or shaggy chorion in contact with the decidua serotina. In this chorion frondosum the villi increase and multiply to a great extent, as the blood supply to the decidua serotina is very free (*see* Fig. 14).

The placenta consists of the chorion frondosum, the decidua serotina (or basalis), and, between the two, the chorio-decidual space containing maternal blood. It will be observed from what has been said, that the placenta is in its earliest stages diffused all over the ovum, but that it later becomes restricted to one area—the decidua serotina. The diminution in area is, however, more than made up for by the greater specialisation of growth in that area.

The process of restriction to the serotinal area is a gradual one, first becoming obvious about the middle of the second month. By the end of the third month it is complete, the placenta is purely discoidal in shape, and its mature structure fully developed. The placental area has grown to one quarter or even one third of the area of the uterine wall, and this proportion it maintains to the end.

The villi of the placenta are generally described as being of two kinds. This division refers to function only. Some are primarily "fastening" or "anchoring" in their function. These pass right down to the *surface* of the decidua. There they attach themselves firmly by an outgrowth of the cells of Langhans' layer laterally on both sides. The majority of the villi are nutritive in function (so-called "terminal" villi), and these do not, as a rule, reach the decidual surface, but divide and branch in a complex way and lie bathed in the maternal blood slowly circulating through the intervillous spaces. The primary stems of the villi, where they come off from the chorion, are fairly thick by the time they are full grown; the terminal branches, on the other hand, are very delicate. The whole villus from trunk to tip is very freely vascularised, by delicate capillaries for the most part, which communicate with the vessels on the surface of the chorion and so with the umbilical vessels (*see* Fig. 15).

By the time the placenta is fully developed, the decidua serotina is reduced to a very thin and degenerated layer. The maternal blood enters the placenta by the small arteries of the decidua, which are continuous with the spiral arteries of the uterine wall, and leaves it by veins continuous with those in the uterine muscle. During the growth of the placenta these vessels enlarge greatly; hence the large sinuses of the placental site that are a source of possible bleeding after the separation of the placenta. At the very edge of the placenta the decidua sends in a projecting shelf under the surface of the chorionic membrane. This "subchorionic decidua" greatly strengthens the attachment of the placenta to the uterine wall, as well as delimiting its area.

To recapitulate the structure of a villus—it consists of two layers of epithelium, the syncytium outside, and Langhans' layer inside. Within these the mesoblastic core consists of delicate connective tissue in which lie the fœtal blood vessels (*see* Fig. 13). Under normal conditions there is **no mixture of fœtal and maternal blood**; all the metabolic and respiratory exchanges taking place through (1) the walls of the fœtal capillaries, (2) the delicate mesoblastic core, (3) Langhans' layer, and (4) the syncytium.

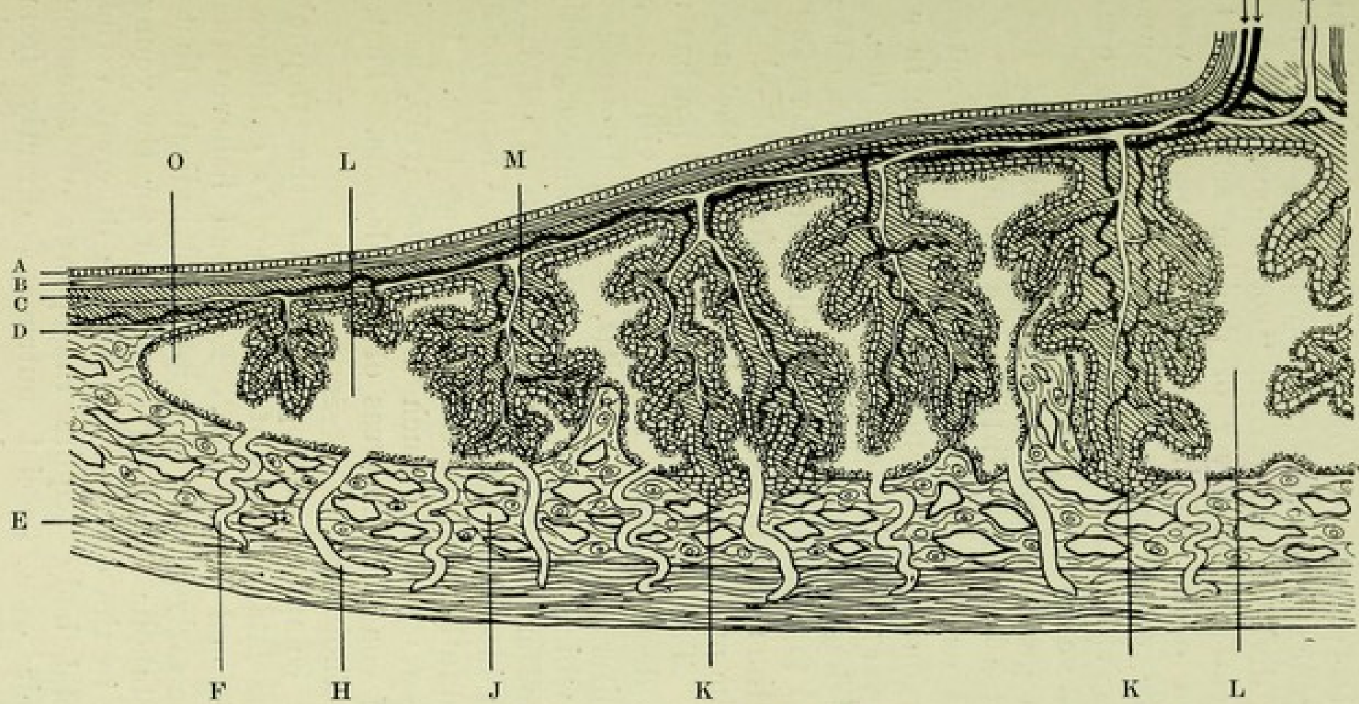

FIG. 15—Diagram of section through placenta and wall of uterus. A. Epithelium of amnion. B. Mesoblastic connective tissue layer of amnion. C. Mesoblastic connective tissue layer of chorion, with branches of umbilical vessels. D. "Subchorionic decidua." E. Muscular wall of uterus. F. Maternal artery. H. Maternal vein. J. Maternal blood sinus on section. K. Fastening villus attaching itself to surface of decidua by proliferation of Langhans' layer. L. Intervillous space—one of the innumerable subdivisions of the chorio-decidual space. M. Villus showing core containing vessels, covered by Langhans' layer and syncytium. O. Marginal sinus.

The placenta at term is a roundish, flat organ, about nine inches in diameter, and three-quarters of an inch in thickness at the centre. It becomes thinner at the edges where it passes with direct continuity into the chorion læve. The fœtal surface is covered with amnion, a smooth, shining membrane that can be stripped off up to the insertion of the umbilical cord. Below it is the somewhat roughened surface of the chorion, with the branches of the umbilical vessels. Frequently a large vein runs round the outer margin of the placenta; more often it is only visible in parts of the circumference. The maternal surface is dark and fleshy in appearance, and divided into several "cotyledons." The surface consists of the attenuated layer of decidua serotina. If the placenta be torn open and held under a stream of water, its substance can be recognised as consisting of the innumerable branches of the villi. If the maternal surface be examined closely, numerous vessels will be seen opening upon it.

The placenta generally weighs about one-sixth of the body weight of the fœtus—usually a little over a pound.

Microscopical examination of the full term placenta shows that it has undergone some degeneration—a fact quite in consonance with the very limited span of its functional use. Thus Langhans' layer has altogether disappeared, and even the syncytium is reduced to a thin covering to the villi. Here and there even the syncytium disappears, and the fœtal blood is then separated from the maternal blood only by the endothelium of the fœtal capillaries. The superficial part of the decidua has undergone a fibrinous degeneration. In many of the villi the vessels have become obliterated by endarteritis, leading to a necrosis of the epithelium, which in its turn has caused the coagulation of the maternal blood around the tips of the villi. These tiny clots become organised into little masses of fibrin, and form the minute infarcts so constantly seen in the placenta at term. In some diseases this process goes on much more extensively, leading to the infarction of considerable areas of the placenta. That, however, is always pathological.

The almost complete disappearance of the trophoblastic epithelium in the later months of the placenta's existence must have some functional significance. Lochhead believes that the exuberance of the early growth of trophoblast indicates that it has selective and metabolic functions to perform for the young cells of different sorts in the embryo. Later the different varieties of cells in the fœtal body acquire the power of selecting and metabolising their own special nutriment directly from the maternal blood. Hence the intervention of the trophoblast becomes less and less necessary, and it gradually disappears.

State of Development of Fœtus at Each Period of Four Weeks.

An exact determination of the age of any fœtus or embryo requires very close examination. A rough estimate may be formed from consideration of the following table.

At the end of the Fourth Week. The embryo is much curved, head and tail being close together. It measures about half-an-inch, and weighs twenty grains. The brain and cord are enclosed, and eye and ear vesicles are visible. The buds of the limbs are visible. The heart is prominent and is beginning to divide into four chambers.

At the end of the Eighth Week. The embryo is about an inch long, and sixty grains in weight. The head has a human shape. The tail has nearly disappeared. The hands and feet are beginning to appear, and eyes and ears and nose are recognisable. The external genitals are visible, but sex is not distinguishable.

At the end of the Twelfth Week. The embryo is about three and a half inches long, and weighs about four hundred and fifty grains. The intestines are enclosed in the abdomen, and the umbilical cord is beginning to shew spiral turns. Sex can be determined by the presence or absence of the uterus. Most of the bones are beginning to shew centres of ossification.

At the end of the Sixteenth Week. The fœtus is now five inches long, when measured from end to end, and weighs about four ounces. Sex is clearly defined. Lanugo is appearing.

At the end of the Twentieth Week. The fœtus is seven to eight inches long, and the weight about eight and a-half ounces. The head is relatively very large. Vernix caseosa may be seen. The cord is about a foot long.

At the end of the Twenty-Fourth Week. The fœtus is twelve inches long, and weighs about one and a-half pounds. Fat begins to be deposited under the skin. Hair appears on the head.

At the end of the Twenty-Eighth Week. The length is about fourteen and a-half inches, and the weight about two and a-half pounds. The eyelids are open, and the pupillary membrane is disappearing. The body is covered with fine hair—lanugo. The intestines contain meconium.

A child born at this time very seldom survives, but every effort should be made to save it.

At the end of the Thirty-Second Week. The fœtus is nearly sixteen inches long, and weighs about three and a half pounds. The hair on the scalp is thicker. The nails do not reach the ends of the fingers.

A child born at this period may survive if very carefully reared.

At the end of the Thirty-Sixth Week. Length, seventeen and a-half inches; weight, five and a half pounds. The subcutaneous fat has increased, and the face is less wrinkled and the body more rotund.

A child born at this time has a very fair chance of survival if cared for.

At the Fortieth Week. Length, twenty inches; weight, seven pounds. The nails reach to the ends of the fingers, the skin is pink and smooth. There is less lanugo, but copious vernix caseosa. The diameters of the head are normal. In the male the testicles are in the scrotum.

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