the pericardial cavity and pleural cavities are formed in the same way. The anterior mesentery of the intestine has never existed in the human embryo, and it is therefore needless to explain its mode of disappearance.

My statements are based in great part on embryos Nos. III. and XII., and since No. XII. is such a perfect specimen it is well for me to describe it in greater detail. The embryo is about the same age as Kollmann's[35] embryo Bulle, which unfortunately was never fully published. No. III. is an embryo given me by Professor His. This embryo had been torn from the umbilical vesicle, and was injured in different portions of the body. Yet the head end of it is fairly well preserved, and it is of value in determining the growth of the body walls covering the heart.

*Embryo 2.1 mm. Long.*—The history of embryo No. XII. is as follows: "The woman from whom the ovum was obtained is twenty-three years of age and has been married for three years. She is a very intelligent woman, and her statements are reliable. Her menstrual periods recur every thirty days. She had been married some time before she became pregnant, and after passing two periods aborted July 6th, 1893. She was unwell the 5th of October and again on the 7th of November, this last period lasting five days. She passed her next period and on December 18th aborted the ovum."*

The ovum was hardened in strong alcohol without opening it first, and when it came into my hands its dimensions were $18 \times 18 \times 8$ mm., that is, it was slightly flattened. It was completely covered with long villi. It was carefully opened, care having been taken not to injure the embryo in any way. The cœlom was filled with a clear fluid, and many firm shreds of a fibrin-like body which obscured the embryonic vesicle greatly. With much difficulty the embryo could be outlined, and these drawings proved to be of great service in making the reconstruction. The portion of the chorion to which the embryo was attached and the embryo were stained in carmine and embedded in paraffin. The whole was cut into sections, at right angles to the body, $10\ \mu$ thick.

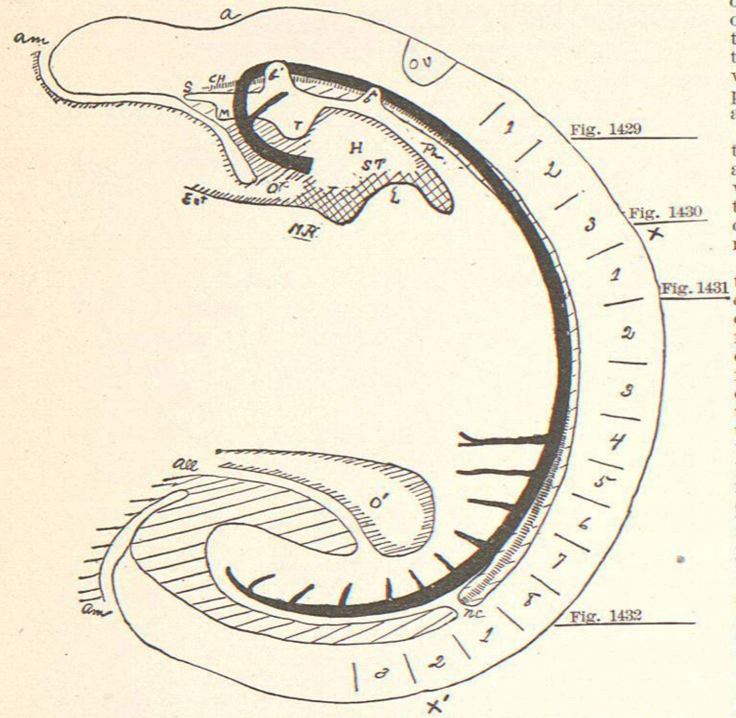


FIG. 1428.—Outline Drawing of a Sagittal Section of the Model of Embryo No. XII. Enlarged 50 times. The heavy line is the aorta. The muscle plates are numbered for occipital, cervical, and dorsal regions, respectively. The mesoderm is striated. *am*, Amnion; *a*, border between forebrain and midbrain; *x* and *x'*, extent of closure of spinal canal; *S*, Seessel's pocket; *ch*, chorda; *b'* and *b"*, first and second branchial pockets; *o v*, otic vesicle; *m*, mouth; *T*, thyroid; *H*, pericardial space; *ph*, pharynx; *ent*, entoderm; *S T*, septum transversum; *l*, liver; *n c*, neurenteric canal; *all*, allantois.

Every other section was enlarged 100 times and drawn on wax plates 2 mm. thick, and from them the model of the embryo was made. The model gives the whole central nervous system, the entoderm throughout its extent, the blood-vessels, and the muscle plates.

The shape of the neural tube is given in the diagrammatic outline. It was closed only along the middle of the body, being open in front down to the beginning of the fourth muscle plate. From the beginning of the fourth plate to the beginning of the fourteenth it was closed, and from there on again it was open. In the figure the portions between $x$ and $x'$ indicate to what extent the tube is closed. In Figs. 1429 and 1430 the tube is nearly closed, while in Fig. 1432 the tail end of the tube is just beginning to separate from the ectoderm. The cephalic end of the tube already clearly outlines the forebrain, the mid-brain, and the hind-brain; the constriction, Fig. 1428, *a*, indicates the junction between the first two. On the ventral side of the fore-brain there are two marked pockets, one on either side, just behind the neuropore, which are no doubt the primary optic vesicles. It shows that in the human embryo these are fully outlined before the brain has separated itself from the ectoderm. Farther behind, very near the dorsal median line and about in the middle of the head, there is a short pocket of thickened ectoderm, the otic vesicle. Toward the hinder end of the embryo the spinal cord communicates by means of a solid band of cells with the entoderm (Fig. 1432). At no point in this communication is there a canal, so it must be viewed as the last remnant of the neurenteric canal. The location is opposite the twelfth muscle plate, or in the neighborhood of what will later on be the position of the first rib. The chorda dorsalis extends to the neurenteric canal, but not beyond it. There is no chorda in the tail end of the embryo.

Throughout the central nervous system, immediately about the central canal, there are many karyokinetic figures, showing that the specimen was excellently preserved. In the greater portion of the neural tube the tissue is already marked by two zones, a central one rich in nuclei, and a peripheral containing none. This corresponds with the description already made familiar to us by His.

The general shape of the whole central nervous system is very unlike that of any other young human embryo ever published. It circumscribes the greater portion of a circle, while in the other human embryos of this size it makes more of a straight line. I think that it is probable that this specimen represents the normal, as it was not injured nor handled in any way before it was cut into sections.

The entoderm, as the figures show, is already divided into fore-gut, mid-gut, and hind-gut. The fore-gut makes the pharynx, from which there are four diverticula

* Letter from Dr. Ellis, January 7th, 1894.





on the dorsal side, one on the ventral side, and two near the mouth. The four on the dorsal side mark the first two branchial pockets on either side of the embryo; the two in front are Seessel's pocket and the entodermal portion of the mouth; while the one on the ventral side of the pharynx is the beginning of the median portion of the thyroid gland (Fig. 1429, *t*).

At the junction of the pharynx with the umbilical vesicle there is a large diverticulum into the septum transversum (Fig. 1430 *l*), the beginning of the liver.

Within the tail end of the embryo, behind the neurenteric canal, the hind-gut is enlarged considerably, and from it the entodermal canal of the allantois arises.

The whole umbilical vesicle is covered with blood-vessels which communicate with the veins and arteries of the embryo. Near the origin of the liver there are two veins which collect the blood from the umbilical vesicle and then enter the heart. These are the omphalomesenteric veins. They with a number of their branches are shown in sections in Fig. 1430, *v*. The heart itself is broken, but there is enough of it left to show that it is bent upon itself and contains a large cavity at the point where the veins entered it. From the heart two arteries arise and pass in front of the first branchial pocket, and each follows the course as shown in black in the reconstruction. The aortæ do not unite, but each sends a number of segmental branches to the umbilical vesicle along the tail end of the embryo. These are, of course, temporary; they may be called collectively the omphalomesenteric arteries. As the permanent omphalomesenteric artery arises more aboral than any of these, it is easy to understand that most of them must degenerate.

The sections show that there are fourteen muscle plates, all of which are hollow and do not in any way communicate with the body cavity in general. Kollmann, who described an embryo of this same age, numbers them from before backward, but I think that they can be designated more definitely. Froriep[36] showed that in all amniotic vertebrates there were a number of muscle plates and dorsal ganglia formed in the occipital region, and studied their fate in the chick and in the cow's embryo. Platt[37] has also followed the order of the origin of the muscle plate in the chick, and found that the first division of the mesoderm was between the third and fourth occipital plates. The first three or four of these segments communicate in the chick, according to Dexter,[38] with the cœlom, and Bonnet[39] has found also that the same is true in the sheep. Bonnet's figures (compare his Plate IV.) show that a sheep's embryo of the same stage as embryo XII. has muscle plates much more sharply outlined than the human. In order to locate the muscle plates more definitely I have made every effort to count the spinal ganglia in embryo XII., but with no definite result. It is impossible for me to define the spinal ganglia, as often they are represented by a few cells only, then again as a band of cells they extend over several segments. The same is true in the occipital region. Had I been able to number them definitely it would still have been impossible to number the muscle plates from them, for His[40] has shown that there is an occipital ganglion in the human embryo as well as in the lower animals.

The fact that the muscle plates reach to the otic vesicle in embryo XII., as well as in Kollmann's embryo Bulle, indicate that the first plates must belong to the occipital region, and I have found that there are three occipital muscle plates in embryo No. II.[41] Moreover, there is every indication of a degeneration of the first two plates in XII., so on this account I am inclined to number them as they are numbered in Fig. 1428. I do not think that any of them ever communicate with the pericardial cavity as Bonnet found them in the sheep. The cavities in all of the other plates are small, and they are separated by a large mass of mesoderm from the cœlom. This all confirms my view.

The chorda extends from Seessel's pocket to the neurenteric canal.

There are also a few segmental ducts, some completely and some partly separated from the ectoderm, as was the case in Kollmann's embryo. The ducts are small, and extend over one or two sections only, and occasionally one of them is arising at several different points between a given two segments. They are present on both sides between the first and second cervical segments, second and third segments, third and fourth segments, fourth and fifth segments, and only on the left side in the region of the fifth and sixth cervical segments.

The cœlom of this embryo is especially instructive. A sagittal section of the embryo and ovum is given in Fig. 1433. This embryo, when drawn connected with the ovum, is very similar to Graf Spee's embryo Gle. as shown in Fig. 1427. It is very easy for us to conceive the von Spee embryo converted into this embryo, for about all the change that is necessary is that the embryo grow somewhat and bend upon itself. In so doing the attachment of the umbilical vesicle becomes smaller as the amnion encircles the body of the embryo more. The position of the neurenteric canal, the shape of the allantois, and the formation of the pericardial cavity, all show that the curving must be a normal one.

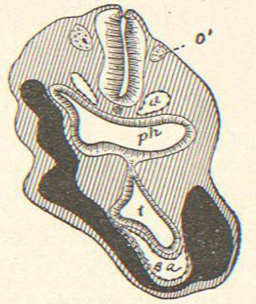


FIG. 1429.

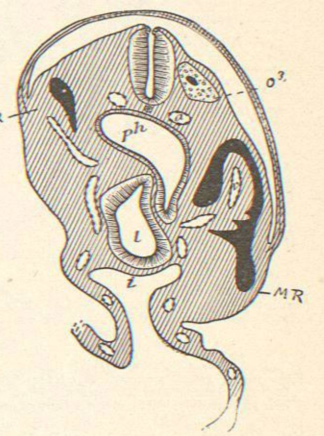


FIG. 1430.

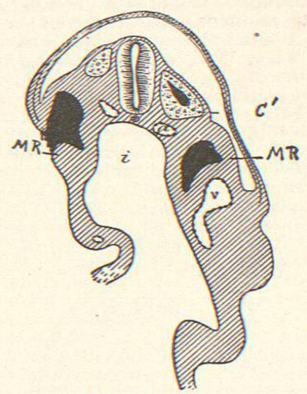


FIG. 1431.

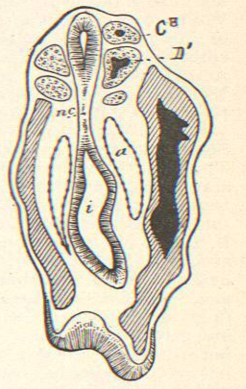


FIG. 1432.

FIGS. 1429-1432.—Sections through Embryo No. XII., as indicated by the Lines in Fig. 1428. Enlarged 50 times. The black is the cœlom within the body. $O^1$ and $O^3$, First and third occipital muscle plates; $C^1$ and $C^8$, first and eighth cervical muscle plates; $D^1$, first dorsal muscle plate; *a*, aorta; *v*, omphalomesenteric vein; *t*, thyroid; *l*, liver; *ph*, pharynx; *i*, intestine; *n c*, neurenteric canal; *MR*, membrana reuniens.

Nearly all other young embryos of this stage, or a little older, which have been published show a straighter body or even a curve in the opposite direction. I have also in my collection two embryos of this stage, Nos. I. and XV., which had been taken out of the chorion and torn from the umbilical vesicle, and both of them are straight

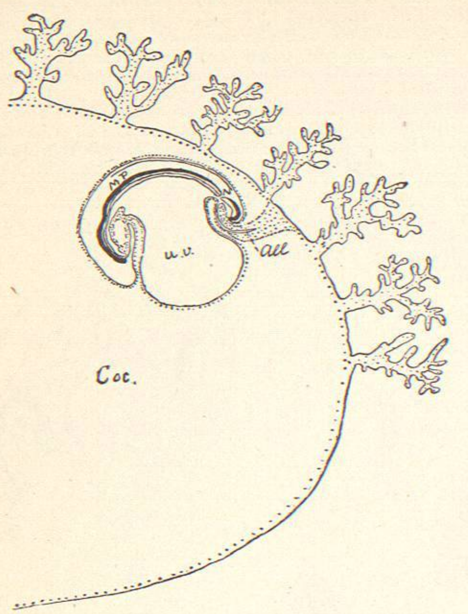


FIG. 1433.—Sagittal Section of the Ovum with Embryo No. XII. Attached. Enlarged 10 times. *Coe*, Cœlom; *u v*, umbilical vesicle; *all*, allantois; *MP*, medullary plate.

like Kollmann's embryo Bulle and His's[42] embryo L. It is difficult to conceive how my embryo XII. could possibly be torn out of its membranes without straightening it. We need only recall our experience in hardening embryos of lower animals to be reminded how easily a curved embryo is straightened when it is handled the least bit roughly before it is hardened.

His, in his great monograph on human embryos, emphasizes a curve in the back of the embryo just the reverse of the one given in Fig. 1433. I refer to embryos Sch., BB., and Lg., as well as to Minot's embryo 195.[43] The fact that this inverted bend in the back is not constant (His's Rf., for instance), and that it occurs at the time when any tension upon the umbilical vesicle could produce it, makes me believe that it is an artifact. This view was suggested to me a number of years ago, when I was removing young dogs' embryos from the uterus, and unwittingly distorted a number of them in this very way before they were hardened. The middle of the back is the weakest part of the embryo's body, and the umbilical vesicle is attached to it. Under these conditions the simple weight of the vesicle is sufficient to bend the back of the embryo as pictured by His.

To return to the cœlom. At the hinder end of the embryo the cœlom dips into the body overlapping the hindgut in the neighborhood of the neurenteric canal, as shown in Fig 1432. This cavity communicates with its fellow on the opposite side through an opening between the umbilical vesicle and the allantois, marked *O* in Fig. 1428. This communication has already been described by His[44] for an embryo somewhat older. If, now, the point *O* in Fig. 1428 is approximated toward *NC*, with a flexion of the embryo at the same time, this communication is easily explained. In other words, as the hind-gut is being separated from the umbilical vesicle, a groove-like portion of the cœlom is also included in the body of the embryo. At the hinder portion of the embryo, on either side, the cœlomic grooves extend deeper into the body of the embryo, and communicate with each other around the aboral side of the stem of the umbilical vesicle. This communication is shown well by His in Fig. I. B, Plate VI. of his "Atlas," as well as in the same figure, page 299 of Minot's "Embryology." Excellent profile views showing this point are given in all the embryos figured on Plate IX. of His's "Atlas."

I emphasize this point in order to exclude the ventral mesentery for this portion of the embryo. The fact that this mesentery could never have existed in the human embryo is also proved by a careful examination of His's models of human embryos made by Ziegler.

As we pass toward the head in embryo XII. the cœlomic groove communicates freely with the extra-embryonic cœlom until the region of the membrana reuniens is reached. This is shown in Fig. 1431, *MR*, with the membrana reuniens complete on one side, but not yet united on the other. The membrana reuniens extends up to the heart, and separates the pericardial cavity from the extra-embryonic coelom, then crosses the ventral median line to return on the opposite side of the embryo. Throughout the extent of the membrana reuniens there is a great increase of mesodermal tissue, which encircles completely the beginning of the liver, as Fig. 1430 shows. A portion of this mesodermal tissue has been described by His as the septum transversum.[45] According to His only that portion of the mesodermal tissue is septum transversum which lies between the posterior part of the pericardial cavity (*Parietelhöhle*), the wall of the intestine, and the point where the veins enter the heart. It extends across the body, and has within it the beginning of the liver. In transverse section this region is shown in Fig. 1430. Now the pericardial cavity communicates by means of a long canal on either side, with the peritoneal cavity, and the omphalomesenteric vein hangs into this, attached to a kind of mesentery, as Fig. 1430 shows. Lower down, near the communication (Fig. 1431), there is an indication of the beginning of the umbilical vein, which unites with the omphalomesenteric vein through the membrana reuniens. The two canals which communicate with the extra-embryonic cœlom are the pleural cavities, and the membrana reuniens aids to separate them from the peritoneal.

All of the tissues from the diaphragm to the opening of the liver duct into the duodenum arise from the septum transversum and the membrana reuniens; the stomach from the fore-gut, the liver from the liver diverticulum, and the diaphragm from the septum transversum and the membrana reuniens. The Cuvierian duct must also have arisen in the membrana reuniens, in order to pass around the outside of the body cavity to reach the cardinal and jugular veins, as pictured by His[46] for the human embryo.

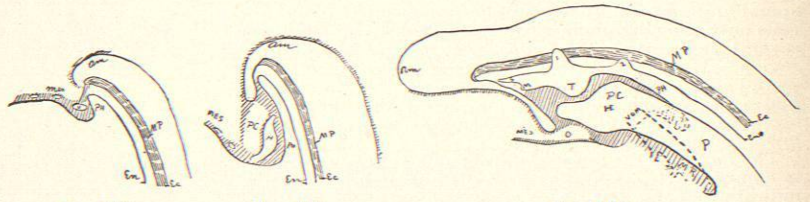

FIG. 1434. FIG. 1435. FIG. 1436.

FIGS. 1434–1436.—Three Stages to Show the Development of the Blastodermic Layers at the Head End of the Embryo. Fig. 1434, Count Spee's Embryo Gle. Fig. 1435, Embryo No. III. Fig. 1436, Embryo No. XII. *V*, Vein; *ph*, pharynx; *am*, amnion; *MP*, medullary plate; *p c*, pericardial cavity; *S*, Seessel's pocket; *m*, mouth; *t*, thyroid; *1* and *2*, first and second branchial pockets; *p*, pleural cavity; *m r*, membrana reuniens; *vom*, omphalomesenteric vein, which is expressed as a dotted line; *O*, communication between right and left body cavities on the ventral side of the umbilical vesicle.





In the further development of the pleural and pericardial cavities the Cuvierian veins give us our best landmark, as they define the point where the pleural cavity is to be separated from the pericardial. And it really seems as if the greater portion of the diaphragm is formed from the portion of the septum transversum on the ventral side of the vein and from the membrana reuniens, rather than from the portion immediately in front of the intestine. In other words, there is a horseshoe-shaped ridge of tissue around the neck of the embryo to the ventral side of the pericardial and pleural cavities and parallel to them. The median portion is composed of the septum transversum, and each wing of the *shoe* is the membrana reuniens, one on either side of the embryo. Its general direction in this stage is parallel with the long axis of the embryo, and within each wing there is an omphalomesenteric vein.

*Origin of Pericardial Cavity.*—With the pericardial cavity opening into the extra-embryonic cœlom on either side as a basis, it is possible to trace back the pericardial cavity to its origin. Figs. 1428 and 1436 show that the ventral wall of the pericardial cavity is composed mostly of mesoderm. This is the portion of the membrana reuniens which is composed of mesoderm, as the sections, Figs. 1430 and 1431, show. An earlier stage is shown in the diagrammatic Fig. 1435. It is taken from embryo No. III. In this specimen, since the ectoderm of the amnion has not reached completely around the body, as both the sagittal and transverse sections show (Figs. 1435 and 1437), it is evident that the pericardial space is first covered on the ventral side with mesoderm and later the ectoderm is added when the amnion begins to close over the head. In embryo III. the canals communicating between the pericardial space and the extra-embryonic cœlom are not as long as in embryo XII., and the ventral walls of the pericardial space are composed wholly of mesoderm. This indicates that the growth of this wall was first by a union of the mesoderm, which was followed by the ectoderm of the amnion to complete the body wall. The process is shown in Figs. 1434 to 1436. Fig. 1434 is a hypothetical stage between Graf Spee's embryo Gle. and my embryo No. III. As the process from Graf Spee's embryo continues, the blood-vessels reach the body to form the heart, as indicated by the outlines marked *v* in Fig. 1434. The mesoderm of the amnion then unites with that of the umbilical vesicle, and the first pericardial space is formed. This is not wholly an imaginary stage, for it is based upon Bonnet's observations upon the sheep,[47] as well as Cadiat's upon the chick.[48] In a sagittal section of a sheep's embryo of about the same stage (Plate III., Figs. 16–20, c CB) Bonnet gives a similar fold, and after the pericardial walls are well formed he gives an illustration of a stage in which it still communicates with the extra-embryonic cœlom (Plate IV., Fig. 17, KC). With Graf Spee's embryo Gle. and with Bonnet's observations upon the sheep as a starting-point, it is not difficult to interpret Figs. 1434–1436.

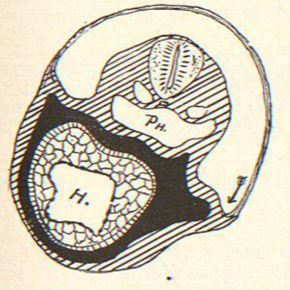


FIG. 1437.—Section through the Head of Embryo No. III. Enlarged 55 times. *Ph*, Pharynx; *H*, heart. The arrow in the amniotic cavity indicates the direction of the future growth of the amnion to complete the ventral body wall.

*Extension of the Amnion.*—After the stage of embryo XII. is passed the amnion rapidly envelops the whole body and soon passes out over the cord. The next stage after No. XII. which I have studied is No. XIX. I have very perfect photographs of this specimen, and the sections are all good, although the nervous system is macerated. The embryo has rotated in the amnion, throwing the cord to the right side with the left side toward the observer. It would have been impossible to obtain a view of the right side of the embryo without cutting the cord. The outlines of this embryo and ovum are given in Fig. 1438. Two sections through the body are given in Figs. 1439 and 1440.

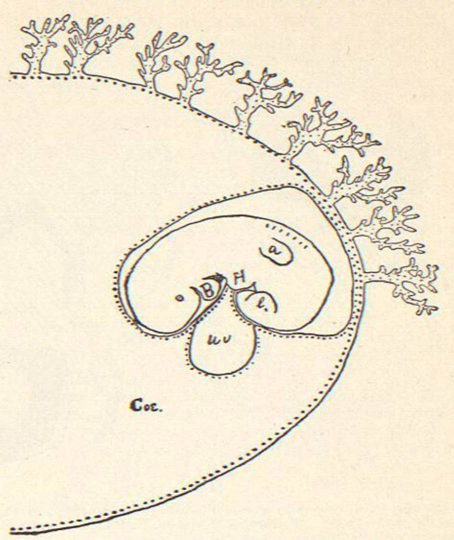


FIG. 1438.—Ovum and Embryo No. XIX. Enlarged 5 times. Just half of the ovum is shown. *a*, Arm; *l*, leg; *H*, heart; *u v*, umbilical vesicle; *B*, branchial arch.

The amnion has become separated from the body with the exception of the part about the cord and also that along the right side of the body, over the heart. The arrow in Fig. 1437 shows how the amnion on that side is extended over the ventral body wall to make the condition shown in Fig. 1440. No doubt the cause of this is the rotation of the body, throwing the cord to its right side and the amnion with it. In nearly all young embryos the cord is on the right side.[49] With the exception of the four instances mentioned below, the rotation has always been so as to throw the left side of the body away from the chorion, and in all of these specimens the amnion must have swept over the body from left to right, as shown in the figures. I find a similar illustration by His in his great monograph.[50]

*Absence of a Ventral Mesentery.*—After the septum transversum has been formed as it is in embryo XII., there is on its ventral side a pretty sharp groove, which indicates that the umbilical vesicle is being constricted at this point.

It is generally believed that the ventral mesentery of the intestine extends to the umbilicus, and that ultimately the round ligament of the liver represents its remnant after most of it has disappeared. This theory is expressed by two diagrams in Minot's "Embryology," page 767. As the liver begins to grow, and while the heart is being pushed down in front of it, the ventral end of the septum transversum is turned down to the umbilicus. While this is taking place the stem of the umbilical vesicle becomes relatively smaller and smaller, but there is no union between the umbilical vesicle and the septum transversum as expressed in Minot's diagram. The first stage of this process is shown in my Fig. 1436, and its successive stages are shown in His's "Atlas," Plate IX. In all six embryos pictured on that plate the successive stages are represented, and in none of them is the umbilical vesicle attached to the septum transversum to form a ventral mesentery. From these embryos of His we can pass to embryo XIX., in which the umbilical

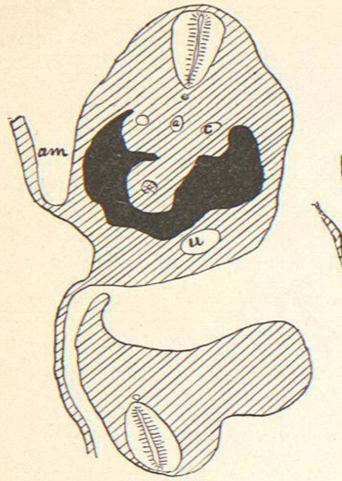


FIG. 1439.

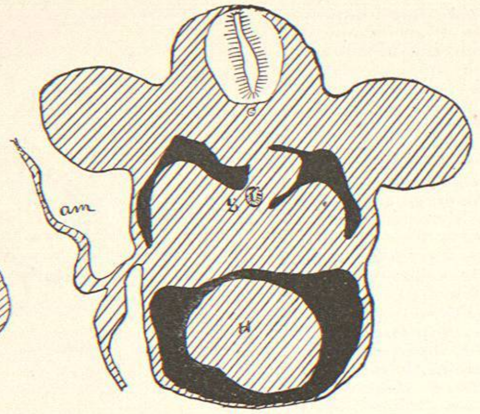


FIG. 1440.

FIGS. 1439 and 1440.—Section through Embryo XIX. to Show the Attachment of the Amnion to the Side of the Body. Enlarged 25 times. *Am*, Amnion; *S*, stomach; *H*, heart; *c*, cardinal vein; *u*, umbilical vein; *a*, aorta.

vesicle communicates by a round canal with the intestine, and the tube is completely encircled with a space which extends to the liver, thus cutting off any possible ventral mesentery at that point. The same thing is shown, but in a later stage, in Fig. 1442, *O*, but a new process has already taken place to complicate matters.

In embryo XII. there is just a beginning of an umbilical vein in the membrana reuniens. In Kollmann's embryo the vein is more marked.[51] The vein extends out into the somatopleure, far away from either the intestine or the median line. This same position is again shown in His's embryos BB. and Lr. on Plate IX. in his "Atlas." The left umbilical vein becomes the more prominent, and as the body wall is developed more and more it moves around toward the ventral median line. This movement takes place in common with the movement of the amnion over the body from left to right, as shown in Fig. 1440. In embryo No. II., however, the liver has nearly reached the umbilicus, and the vein has almost moved around to the ventral median line, as shown both in the reconstruction and the sections (Figs. 1442, 1437–1451). After the vein has moved around the body to its ventral surface, and after the liver moves away from the umbilicus up to the permanent diaphragm, it is easy to explain the formation of the round and broad ligaments of the liver as a secondary formation, but not as a remnant of a ventral mesentery. It might be called a portion of the septum transversum, as it is directly continuous with it. A ventral mesentery does exist between the abdominal walls and the liver, and extends only slightly below the liver. It is always slightly to the left of the median line, and is in direct connection with the septum transversum (Fig. 1442, *O* and *ST*).

*Cœlom of Embryo No. II.*—After the body cavity is beginning to separate from the extra-embryonic cœlom, the next important stage is the one after the separation is complete, as from now on the adult body cavities are formed by a simple division and expansion of the cavities already within the body. This stage is represented in embryos XVIII., II., and IV. All of these embryos are nearly of the same size, the successive stages being in the order they are given. No. XVIII. is somewhat distorted in the middle of the body, while No. IV. is slightly macerated. No. II. is a perfect specimen, and has been already described by me several years ago.[52] I shall confine my description of it to the body cavity.

The external form of the embryo within the ovum is given in Fig. 1441. The position of the umbilical vesicle, as well as the extent of the amnion and the relation of the umbilical vesicle and amnion to the chorion, are all given. The umbilical cord is large and lies on the left side of the body, while in most embryos already published it is upon the right side. The cord is short, and midway between the embryo and its attachment to the chorion it shows a decided enlargement. The umbilical vesicle is large, measuring 5 × 7 mm., and is located between the head end of the embryo and the chorion.

The amnion has not grown very much, still leaving a great space between it and the chorion, the extra-embryonic cœlom (compare with Fig. 1438). Within it hangs this large umbilical vesicle, the lumen of which no longer connects with the alimentary canal. The separation is now complete. Around the stem of the vesicle the extra-embryonic cœlom communicates freely with the body cavity, as shown in Fig. 1442. This figure is from a reconstruction, and shows the general extent of the body cavity within the embryo. It encircles the heart, and then extends to the lungs and over them and to the stomach, over the intestines, and out into the cord. A cast of the whole cavity is also given,

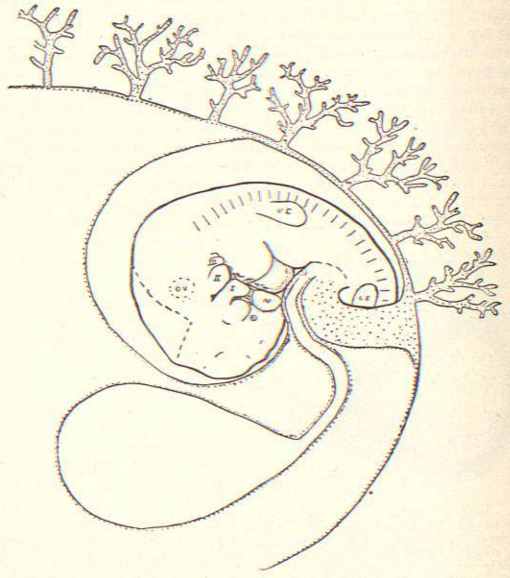

FIG. 1441.—Embryo No. II. Attached to the Chorion. Enlarged 5 times. Just half of the ovum is shown. *o v*, Optic vesicle; *U E*, upper extremity; *L E*, lower extremity; *N*, nose: *I*, *II*, *III*, branchial arches.

showing the slit on the dorsal side for the mesentery of the intestine, and the grooves on either side of this for the Wolffian bodies. There are also grooves in the cast





for the veins, and the place where the Cuvierian duct enters the heart is marked *V*. The sagittal section of

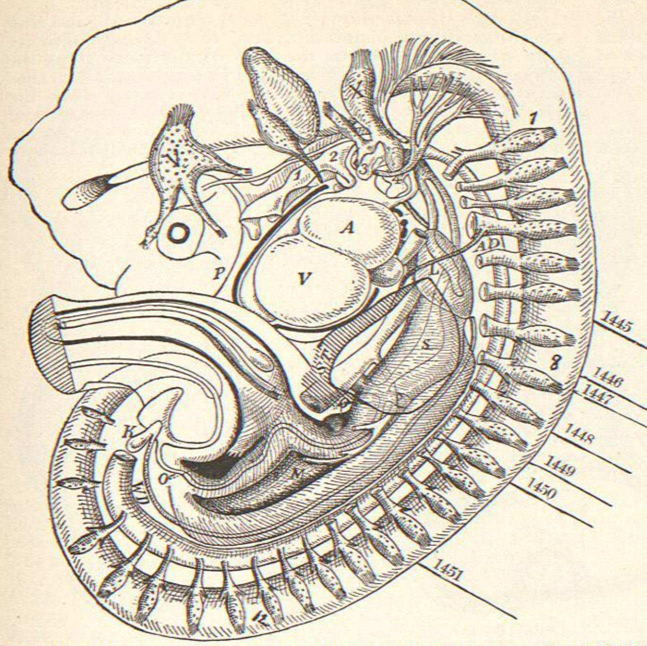


FIG. 1442.—Reconstruction of Embryo No. II. Enlarged 17 times. *V* and *X*, Fifth and tenth cranial nerves; *1*, *2*, *3*, and *4*, cast of the branchial pockets; *1* and *8*, first and eighth cervical nerves, from the fourth the phrenic arises; *12*, twelfth dorsal nerve; *A*, auricle; *V*, ventricle; *L*, lung; *S*, stomach; *P*, pancreas; *W D*, Wolffian body; *K*, kidney; *M*, mesentery; *S T*, septum transversum; *O*, openings which communicate with the peritoneal cavity of the opposite side. The black line around the heart marks the pericardial cavity.

the peritoneal cavity is given in Fig. 1444. The striated line indicates where the cavity crosses the median line of the body, while the other lines outline the cavity beyond. *Lp.* outlines the lesser peritoneal cavity. Figs. 1445–1451 give the extent of the peritoneal cavity in different portions of the embryo, as indicated by the lines in Fig. 1442.

It is not difficult now to imagine the body cavity of embryo XII. converted into the one just described. In that embryo the heart is high in the neck on the oval and dorsal side of the septum transversum. In this embryo it is on the ventral and oral side of the septum transversum, but still above the eighth cervical nerve. The septum transversum has already received its nerve supply from the fourth cervical nerve, as pointed out in the early part of the century by von Baer. This movement of the septum transversum is accompanied by a movement of all the other organs on their way into the thorax and abdomen of the future individual. In the rotation the Cuvierian duct acts much as the fixed point about which the cœlom is bent. The figures all illustrate this beautifully. But as the heart has rolled over the liver, and the septum transversum has undergone a quarter-revolution, the Cuvierian ducts and all have moved away from the head. This is by no means the end of the excursion of the septum transversum, as its dorsal end must move down and beyond the twelfth dorsal segment (compare Fig. 1442).

The pericardial cavity surrounds the whole heart, as the various figures show. The cavity is traversed only where the large veins enter, and where the aorta leaves the heart. The cavity completely surrounds the bulbus aortæ to its origin (Figs. 1444–1447) in the ventricle. On the dorsal side of the heart the pericardial cavity is separated by a bridge for the transmission of the veins to the heart. Between the bulbus aortæ and the entrance of the veins into the heart the pericardial cavity crosses the median line as three distinct openings, as expressed by the black areas in front of the trachea in Fig. 1442. On the dorsal side of the heart on either side of the lungs the pericardial cavity communicates with the pleural cavities by means of two openings (Fig. 1445), each of which is about 0.1 × 0.5 mm. in diameter. Farther on, the pleural cavities extend as two slits which encircle the lobes of the liver and separate them from the alimentary canal on the one hand and from the body wall on the other (Figs. 1446–1449). The two pleural cavities do not communicate with each other around the lungs, leaving for them both a dorsal and a ventral mesentery.

This appearance of the cœlom about the lungs and the liver can be explained by the lungs and liver both growing into the two pleural cavities of embryo XII., and this has often made me think that the membrana reuniens of embryo XII. is the main origin of what is called septum transversum in embryo II. If this proves to be the case, then the lower end of the membrana reuniens will form the ventral end of the diaphragm, and not the reverse. A stage between embryos XII. and XVIII. (Fig. 1453) is required to elucidate this point.

In the neighborhood of the stomach the peritoneal cavity on either side of it has become asymmetrical, as Fig. 1448 shows. The mesentery has become bent to the left side, leaving a diverticulum from the right side which extends oralward to the tip of the lung (Figs. 1446 and 1447) to form the beginning of the lesser peritoneal cavity.[53] Further aboralward the cavities become symmetrical again (Figs. 1449, 1450), and then unite along the ventral median line, as shown in Fig. 1451. The ventral mesentery shown in Fig.

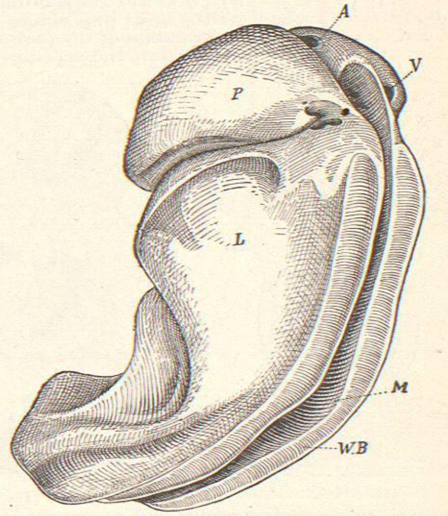


FIG. 1443.—Cast of the Body Cavity of Embryo No. II. Enlarged 22 times. *A*, Position of the aorta; *V*, position of the vein; *M*, position of the mesentery; *W B*, position of the Wolffian body; *P*, pericardial cavity; *L*, cœlom over liver.