TABLE IV.—EMBRYOS OF THE FOURTH WEEK.

Number.	Observer.	Length of embryo.	Dimensions of umbilical vesicle.	Dimensions of ovum.	Time between last period and abortion.	Probable age.	References, or from whom obtained.
1	No. CXVI	6.5 mm.		28 × 20 × 10 mm.	55 days.	27 days.	Dr. Ryan, Springfield, Ill.
2	No. II	7.0 mm.	7.0 × 4.5 × 4.5 mm	25 × 25 mm.	52 days.	24 days.	Dr. C. O. Miller, Baltimore.
3	Stubenrauch (II.)	7.0 mm.			51 days.	23 days.	Inaug. Dis., München, 1889.
4	No. XVIII	7.0 mm.		18 × 18 mm.			Dr. Douglas, Nashville, Tenn.
5	His (B.)	7.0 mm.	4 mm	25 × 22 mm.			Anat. mensch. Embryonen.
6	His (Stt.)	7.75 mm.		21 × 17 mm.	57 days.	27 days.	Anat. mensch. Embryonen, 8, 74.
7	His (XVII.)	8.5 mm.		20 × 12 mm.			Anat. mensch. Embryonen.
8	Meyer	8.0 mm.	5 mm.	45 mm.	28 days.	28 days.	A. f. m. A., 36.
	Average	7.34 mm.	5.3 × 4.5 × 4.5 mm.	26 × 19 × 10 mm.		26 days.	

TABLE V.—EMBRYOS OF THE FIFTH WEEK.

Number.	Observer.	Length of embryo.	Dimensions of umbilical vesicle.	Dimensions of ovum.	Time between last period and abortion.	Probable age.	References, or from whom obtained.
1	Ecker	10.0 mm.			60 days.	32 days.	Icon. Physiol., 28.
2	No. LXXXVIII	10.0 mm.	4.0 mm	30 × 28 × 15 mm			Dr. Brumm, Detroit.
3	His (XCVIII.)	10.3 mm.		35 × 25 mm			Anat. mensch. Embryonen.
4	No. CIX	11.0 mm.		30 × 30 mm.			Dr. Cushing, Baltimore.
5	His (Br.)	11.0 mm.	5.0 × 4.5 mm	30 × 27 mm.	61 days.	33 days.	Anat. mensch. Embryonen.
6	His (XCVII.)	11.0 mm.		30 × 25 mm.			Anat. mensch. Embryonen.
7	His (Rg.)	11.5 mm.	5.5 × 4.5 mm	30 × 27 mm.			Anat. mensch. Embryonen.
8	His (Sl.)	12.5 mm.	6.0 × 5 mm	30 × 27 mm.			Anat. mensch. Embryonen.
9	His (XIX.)	12.8 mm.	5.0 × 4.5.	40 × 32 mm.			Anat. mensch. Embryonen.
10	No. XXXV	13.0 mm.			37 days.	37 days.	Dr. C. O. Miller, Baltimore.
11	His (M. 2)	13.0 mm.			64 days.	36 days.	Anat. mensch. Embryonen.
12	His (Br. 2)	13.6 mm.	6.0 × 4.5 mm	35 × 28 mm.	63 days.	35 days.	Anat. mensch. Embryonen, 9, 74.
	Average	11.6 mm.	5.2 × 4.6 × 4.5 mm.	32 × 27 × 15 mm.		34.6 days.	

TABLE VI.—EMBRYOS OVER FIVE WEEKS OLD.

Number.	Observer.	Length of embryo.	Dimensions of umbilical vesicle.	Dimensions of ovum.	Time between last period and abortion.	Probable age.	References, or from whom obtained.
1	His (Dr. 1)	15.0 mm.	6.0 × 5.5 mm	45 × 40 mm.			Anat. mensch. Embryonen.
2	His (S. 2)	15.0 mm.	5.5 × 4.5 mm	35 × 28 mm.			Anat. mensch. Embryonen.
3	His (Lhs.)	17.0 mm.			51 days.		Anat. mensch. Embryonen.
4	No. CVI	17.0 mm.			54 days.		Dr. Gardner, Baltimore.
5	No. XVII	18.0 mm.		40 × 30 × 20 mm.			Dr. Cottrell, Louisville, Ky.
6	No. XLII	18.0 mm.		35 mm.			Dr. Wills, Los Angeles, Cal.
7	No. CXLIV	18.0 mm.		40 × 30 × 30 mm			Dr. Watson, Baltimore.
8	No. V	18.5 mm.		40 × 30 mm.			Dr. Kittridge, Nashua, N. H.
9	No. XXVIII	19.0 mm.		50 × 30 × 20 mm	47 days.		Dr. Sewall, Denver, Col.
10	No. LXXXI	20.0 mm.		65 × 55 × 35 mm.			Dr. Branham, Baltimore.
11	No. XCIV	20.0 mm.		50 × 40 × 30 mm.			Dr. Knill, Detroit, Mich.
12	No. XXII	20.0 mm.	5.0 × 2 × 2 mm	35 × 30 × 30 mm.			Dr. Snively, Waynesboro, Pa.
13	Minot	22.0 mm.			53 days.		Minot's Embryology, 392.
14	His	22.0 mm.			56 days.		Anat. mensch. Embryonen.
15	No. LVII	23.0 mm.		30 mm.			Dr. Howard, Cleveland, Ohio.
16	His (Wt.)	23.0 mm.		55 × 50 mm.			Anat. mensch. Embryonen.
17	No. LXXII	23.0 mm.		40 × 30 mm.			Dr. Arthur, Baltimore.
18	No. XXVII	23.0 mm.		30 mm.			Dr. Thayer, Baltimore.
19	His (Lp.)	23.0 mm.		55 × 50 mm.			Anat. mensch. Embryonen.
20	No. XXXI	24.0 mm.		50 × 30 × 30 mm	66 days.		Dr. Ballard, Baltimore.
21	No. VI	24.0 mm.			77 days.		Dr. C. O. Miller, Baltimore.
22	No. CXXVII	24.0 mm.		60 × 45 × 40	84 days.		Dr. A. T. Gundry, Baltimore.
23	No. CXXVIII	24.0 mm.		50 × 40 mm.	76 days.		Dr. Lupton, Baltimore.
24	No. CXVIII	25.0 mm.			94 days.		Dr. Booker, Baltimore.
25	His. (Dr. 2)	25.0 mm.		45 × 40 mm			Anat. mensch. Embryonen.
26	No. XCIX	27.0 mm.		40 mm	75 days.		Dr. Carr, Durham, N. C.
27	No. XLV	28.0 mm.		40 × 35 × 20 mm.			Dr. Douglas, Nashville, Tenn.
28	No. XXVI	30.0 mm.			75 days.		Dr. Simon, Baltimore.
29	Minot	32.0 mm.			68 days.		Human Embryology, 398.
30	No. LXXIX	32.0 mm.		50 × 50 × 50 mm.	91 days.		Dr. Briggs, Blackville, S. C.
31	No. CXXIX	32.0 mm.			65 days.		Dr. Gundry, Baltimore.
32	No. CXLV	33.0 mm.		60 × 50 × 40 mm	78 days.		Dr. Watson, Baltimore.
33	No. LII	33.0 mm.		40 × 30 × 15 mm.			Dr. Gavin, Baltimore.
34	No. XCVI	44.0 mm.			84 days.		Dr. Spencer, San Francisco.
35	No. XCV	46.0 mm.		68 × 50 × 50 mm	83 days.		Dr. Watson, Baltimore.
36	No. CV	48.0 mm.			83 days.		Dr. Watson, Baltimore.
37	No. XXX	60.0 mm.			77 days.		Dr. Snively, Waynesboro, Pa.
38	No. XCII	70.0 mm.			90 days.		Dr. Ballard, Baltimore.
39	No. XLIX	70.0 mm.			65 days.		
40	No. XXIII	70.0 mm.			65 days.		Dr. Snively, Waynesboro, Pa.
41	No. XXXIV	80.0 mm.			104 days.		Dr. Ellis, Elkton, Md.
42	No. CXLVI	95.0 mm.			115 days.		Dr. Watson, Baltimore.
43	No. CXVII	100.0 mm.			101 days.		Dr. Ballard, Baltimore.
44	No. CXXXVIII	112.0 mm.			127 days.		Dr. Watson, Baltimore.
45	No. CXLIX	130.0 mm.			125 days.		Dr. Hoen, Baltimore.
46	No. XCVIII	160.0 mm.			125 days.		Dr. Atkinson, Baltimore.
47	No. XLVI	135.0 mm.			143 days.		Dr. Taylor, Baltimore.
48	No. CXXI	210.0 mm.			190 days.		Dr. Ballard, Baltimore.

TABLE VII.—EXTREME AND AVERAGE MEASUREMENTS IN MILLIMETRES OF THE EMBRYO AND ITS APPENDAGES, AS OBTAINED FROM TABLES I. TO VI.

Week.	Measurement.	Length of embryo.	Greatest dimensions of the umbilical vesicle.	Greatest dimensions of the chorion.	Probable age in days.
Second	Extreme *	0.19 to 1.54	0.19 to 1.8	3 to 10	10 to 14
	Average	0.79	1.14	7.2	12
First half of third	Extreme	2.1 to 3	1.5 to 3	5.7 to 18	12 to 15
	Average	2.41	2.22	11.7	14
Second half of third	Extreme	3.2 to 6	2.5 to 4	14 to 30	14 to 23
	Average	4.67	3.3	22	19.5
Fourth	Extreme	6.5 to 8	4 to 7	18 to 45	23 to 28
	Average	7.34	5.3	26	26
Fifth	Extreme	10 to 13.6	4 to 6	30 to 40	32 to 37
	Average	11.6	5.2	32	34.6
	Extreme	15 to 19	5.5 to 6	35 to 50	
	Average	17.3	5.7	41	
	Extreme	20 to 24		30 to 65	
	Average	22.5		47	
	Extreme	25 to 28		40 to 45	
	Average	26		42	
	Extreme	30 to 48		40 to 68	
	Average	37		54.5	

* The extreme measurements of the umbilical vesicle and chorion are the greatest measurements in each case.

ical specimens are obtained which may prove to be of the greatest practical value. *The best and most convenient method of preserving young embryos is to place the unopened ovum, with the least possible handling, in a large quantity of very strong alcohol.* The alcohol of druggists is in no case too strong, and, according to my experience, is as a rule too weak. Often the ovum is wrapped in a towel and then placed in a small quantity of alcohol and water. This may be a method of preserving museum specimens, but it practically ruins every embryo which is preserved in this way. When an ovum is placed in, say, four ounces of strong alcohol, the water of the ovum dilutes the alcohol to a proper strength.

Those physicians who have the proper opportunities should place the specimen as soon as possible, and without opening the ovum, in seventy-per-cent. alcohol, *i.e.*, absolute alcohol reduced by volume to seventy per cent. At the end of a day or two it should be placed in fresh alcohol of the same strength. An excellent method for preserving embryological specimens is to place the membranes, blood and all in a weak solution (five to ten per cent.) of formalin.

A second convenient method is to place a specimen in quite a large quantity of Müller's fluid, to be changed once or twice during the first few days, after which it may be preserved in the same fluid indefinitely. The embryo is fully hardened in about a month, and then it can be washed in water for a day or two, after which it is to be preserved in seventy-per-cent. alcohol.

Ten per cent. nitric acid is a convenient and a most excellent method. The ovum is to be placed in four or six ounces of a ten-per-cent. solution and opened while in the fluid, care being taken not to injure the embryo. According to its size (if not over an inch long), it should remain in the acid for from thirty minutes to two hours. At the end of this time it is to be placed in seventy-per-cent. alcohol.

Another excellent method is to employ saturated aqueous corrcsive sublimate. The specimen is to be treated as in the ten-per-cent. HNO_3, only it is to remain in the sublimate longer. These specimens are then to be preserved in seventy-per-cent. alcohol.

There are many other methods, but if any of the above are employed there will be a sufficient supply of material to aid the study of human embryology. It is really wonderful to see what progress has been made in this study when we consider how difficult it is to obtain good material. Some of the most important discoveries have been made in the careful study of a few well-preserved human embryos, as a glance at the many papers of His and at the excellent text-book of Minot will show.

A great work is done when the specimens are once obtained, but in order to make it complete they must be placed in the hands of a specialist, who can devote all his energies as well as all the additional necessary expense to these the most precious of embryological specimens.

Franklin P. Mall.

EMBRYOS, HUMAN, PATHOLOGICAL.—This article is based upon the study of fifty pathological human ova which have been collected by me during the past six years. All of the embryos, with but one exception, have been cut into serial sections, thus permitting of a more careful study than is possible from that of the external appearances alone. As far as possible, I have obtained additional data from the physicians who sent me the specimens; these have proved to be of much value in determining the age of them. Sections were also made of the uterine moles, as well as of nearly all of the embryonic membranes sent me. It is almost needless to state that while I was collecting the pathological specimens a considerably greater number of normal ones came into my possession. These have also been cut into serial sections, and they have been constantly used for comparison in studying the pathological ova.

The material at my disposal justifies a much more extensive account than I give. The illustrations could also, with advantage, be much more numerous. In the present article, my aim is to describe in a connected way the specimens as briefly as possible.*

The scattered literature relating to pathological human embryology is very extensive, and in general of not much value. From the numerous communications relating to young pathological embryos, two groups of papers stand out prominently—those of His and those of Giacomini. The more general article by His is published in Virchow's "Festschrift," vol. i., and that by Giacomini, is in Merkel und Bonnet's "Ergebnisse der Anatomie," vol. iv. The results of these two authors I have used as a basis after confirming many of their statements. In general, I am able to confirm all of His' statements, while I find some of Giacomini's obscure. Giacomini's numerous publications are mostly on single specimens, which are usually very young. The nature of his problem, as well as the limited amount of material at his disposal, is a sufficient excuse for any misinterpretation he may have made. His latest paper,[1] published shortly before his death, shows the marked influence the studies of the normal, by Graf Spee and others, have had upon his ideas.

Any change which may take place in the embryo after it is well formed, that is, after the second week, is easily recognizable, provided it has not gone too far. Specimens of this sort can be divided into two great groups:

* A more detailed description of the embryos referred to will be found in an article by me in the Welch "Festschrift," and in Johns Hopkins Hospital Reports, vol. ix.

(1) those in which the embryo is primarily affected and (2) those in which the chorion is primarily affected. In the first group the embryo is affected and the chorion normal, while in the second group the chorion is diseased and the embryo partly or wholly strangulated, due to its impaired nutrition. The earliest stages, His' nodular forms, are among the most interesting. Since all of them are vesicular, it might be better to call them vesicular forms. In all of them there is a vesicle which shows many of the characteristics of the umbilical vesicle with blood islands embedded within its walls. The fact that the blood and the blood-vessels arise in the umbilical vesicle makes it very certain that the vesicular forms represent the remnants of very early embryos. There have now been studied a sufficient number of young normal embryos to establish the time the blood-vessels grow from the embryo to the chorion. This is at the end of the second week, and the vesicular forms must represent embryos younger than two weeks, for in none of them have the blood-vessels reached the villi of the chorion. Between the time of the formation of blood in the walls of the umbilical vesicle and that of their growth into the chorion lies the important stage of the formation of the body of the embryo. Early normal specimens which Peters,[2] Eternod,[3] Siegenbeek van Heukelom[4] and Graf Spee[5] have recently published indicate that the vesicular stages are formed before the body of the embryo is outlined, and also in many instances hand-in-hand with the formation of the amnion. If we can use the same reasoning with the vesicular forms which we do with the older ones, then the vesicular must be due to arrested development of earlier and much younger stages than we have as yet been able to study. If the amnion is formed by an invagination of the layer of the embryonic vesicle, as I have previously asserted,[6] then the explanation of a number of the vesicular forms is very easy. But the recent publication of a very young normal embryo by Peters speaks against this. Yet the persistence of an epithelial layer over the vesicle in the vesicular forms, as well as its invagination, indicates that in the specimen I previously described the ectoderm must have broken out of its natural boundaries from a stage like Peters', or that this ectodermal plate upon the umbilical vesicle represents a stage before the formation of the amnion. Either explanation is plausible, but the first appears to me to be the more likely, for recently Selenka has described an ovum of Hylobates concolors in which the amnion almost communicates with the exterior of the ovum.[7] The ovum Selenka describes is about 1 cm. in diameter with an umbilical vesicle measuring 1 mm.

From all appearances the epithelial covering of the chorion of early human ova is formed long before the amnion and embryo are outlined. Judging by the early stages of other mammals, the epithelial covering of the chorion in man must be produced as Rauber's layer is formed in them. While the ovum is still wandering down the uterine tube, its epithelial covering, or Rauber's layer, is undoubtedly still smooth, and only grows into villi when the cavity of the uterus is reached. Then the syncytial layer is formed, and as evidence accumulates it becomes more and more probable that it is embryonic in origin. I have in my collection a young normal ovum from a tubal pregnancy in which the syncytial layer is very extensive, and is growing against a blood clot on one side and against normal tubal epithelium on the other. At certain points its syncytial layer has destroyed the lining epithelial cells of the tube and is in direct contact with the subepithelial tissue. The growth of the syncytial layer could be interpreted as growing from the epithelial cells of the tube to the chorion and from it to the blood clot and the lining cells of the tube on the opposite side of the ovum; but why this roundabout and improbable way of explanation when the direct is so much easier? Moreover, the characteristics of the syncytial layer are so decidedly "embryonic" that it is not difficult to separate it from tubal epithelium when the two come in contact. Even the nests of partly destroyed tubal cells are very unlike the cells of the syncytial layers.

The quantity of syncytium may be either increased or diminished. In the former instance the buds of syncytium arise from all portions of the villi as well as from the chorion proper. When there are numerous buds arising directly from the chorion the epithelial cells often become piled up until the layer is considerably more than two cells deep. The double layer of syncytial cells is also present on the inside of the amnion in a specimen (CXLII.) in which the syncytial cells "ate" through the membranes to the embryo.

The force of the growth of the syncytium may be terrific. It destroys whatever comes in front of it. It grows best when it comes in contact with mother's blood, as a study of numerous specimens shows. Its reaction upon other cells is also terrific, for whenever leucocytes come in contact with the syncytium their nuclei fragment, and they disintegrate. When the syncytium forms great masses of cells, so great that its nutrition becomes impaired, the centres of the masses become necrotic. We have here, again, all of the reactions of a parasite battling for its existence. When the growth of the ovum is retarded by the destruction of the embryo, excessive inflammation of the uterus, or other causes, the syncytium may attack the tissues of the chorion and destroy it in part. This kind of attack is favored most by leucocytic infiltration of the mesoderm of the chorion, as well as by fibrous degeneration of its walls. Yet such an attack is rare, for it appears as if the simple mesoderm of the chorion belongs to the most resistant of tissues. Under certain circumstances it can continue to grow almost by itself, for a long time resisting syncytium, leucocytes, and bacteria.

The embryologists of the early part of this century described within the cœlom of the ovum a delicate network of fibrils, the nature of which is not definitely known. This structure, the magma reticulare, is fairly well marked in normal ova and finally disappears when the amnion reaches the chorion. This is its story under normal conditions. When, however, the amnion fails to reach the chorion in due time the magma reticulare may become fluid, or in other instances it is converted into a granular mass, or magma granulare. On the other hand, the magma reticulare may be greatly increased in pathological ova of about the fourth week, with or without a diseased chorion. When this condition continues the magma reticulare may become only partly granular, as a number of my specimens show.

At the first appearance one is inclined to consider the magma reticulare as being composed of fibrin. In order to test this question, I collected a number of fresh specimens, both normal and pathological, hardened them in alcohol and then stained them by means of Weigert's fibrin stain. In no instance did the fibrils of the magma hold the stain. These tests, then, are only negative, giving us no insight as to the nature of the fibrils of the magma.

Not only is the amount of magma found in the cœlom excessive, but it may also extend through the amnion and reach the embryo. In other instances, when the embryo remains normal until the sixth week, a magma reticulare may form primarily in the amniotic cavity and ultimately become granular. Whether or not the reticular magma undergoes disintegration to form the granular remains to be shown. It is, however, noteworthy that usually either one or the other exists, but intermediate stages with both present are not rare.

In nearly all instances there are scattered throughout the magma numerous cells with relatively small nuclei and a considerable quantity of protoplasm, showing all the characteristics of the blood corpuscles of the embryo. These are the migrating cells of His. In all pathological specimens it is found that the migrating cells penetrate all of the tissues of the embryo; in fact, all of the tissues and spaces within the chorion. My specimens show all of the intermediate stages between blood-vessels filled with blood, with few migrating cells in the tissues, to

empty blood-vessels with the tissues stuffed with migrating cells. These stages, together with the common morphological appearances of the blood corpuscles and the migrating cells, force the conclusion that the latter are blood corpuscles within the tissues.

It appears as if the blood corpuscles of the embryo have great power to migrate within the blood spaces before the heart is formed. In pathological embryos, when the circulation is retarded or arrested, the corpuscles leave the blood-vessels to form conditions which may be termed inflammation of the embryo. As the blood cells leave the blood-vessels to wander through the tissues, the blood-vessels continue to grow in diameter as well as in extent, for I have numerous specimens in which the aorta is distended and empty, while in other instances capillary vessels without blood within them, have grown into the villi of the chorion.

Arrested Development of the Embryo with Continued Growth of the Ovum.—The specimens which come under this group vary in so many respects that it is impossible for me to consider them from any standpoint except that of their approximate ages when their development was first arrested. Before doing this, I worked through the specimens from many other standpoints—their size, their membranes, and the condition of their tissues—only with unsatisfactory results. The general shape of the embryos, and their organs, however, gave me a clew to their ages when development was arrested; and when they are considered from this standpoint the results are fairly satisfactory. Knowing the time at which the development of the embryos was arrested, the other factors—tissues of the embryo, chorion, and time of the abortion—can easily be taken into consideration. Moreover, in all instances I have repeatedly compared the pathological specimens with the normal, my cabinet being well supplied with numerous sets of serial sections of both.

There are in my collection two specimens of arrest of development at the beginning of the second week (Nos. CXV. and CXXXVI.). A glance at the table shows that one of these specimens is a two-weeks' embryo in a four-weeks' ovum; the other a four-weeks' embryo in a two-weeks' ovum. In one the development of the embryo was arrested at the beginning of the second week, but the chorion continued to grow two weeks longer before the abortion; in the other the reverse is the history.

Specimen CXXXVI. appeared to be pathological before it was cut open, but it was found filled with an increased quantity of magma, within which could be seen a nor-

Table I.—Arrested Development of the Embryo.*

Number.	Dimensions of ovum.	Length of embryo.	Time between last period and abortion.	Remarks.
		Two to Three Weeks.		
CXXXVI	14 × 11 × 6 mm.	5 mm.	56 days.	Magma reticulare increased.
CXV	30 × 27 × 22 mm.	3 mm.	56 days.	Magma reticulare greatly increased.
		Three to Four Weeks.		
CL	35 × 30 × 10 mm.	5 mm.		
CXXII	20 × 16 × 6 mm.	5 mm.	65 days.	Amnion has reached chorion.
CX	46 × 30 × 30 mm.	8 mm.	82 days.	Amnion has reached chorion. Embryo very much macerated.
CXLI	40 × 30 × 20 mm.	8 mm.	78 days.	Magma reticulare within cœlom.
XCVII	33 × 30 × 15 mm.	9 mm.	61 days.	Magma reticulare increased.
CIV	35 × 35 × 15 mm.	12 mm.	35 days.	Magma reticulare greatly increased.
		Four to Five Weeks.		
LX	....	8 mm.		
CXXXV	105 × 65 × 65 mm.	9 mm.	....	Amnion has reached the chorion.
CLXI	50 × 25 × 25 mm.	10 mm.	83 days.	
CXXXIII	32 × 32 × 32 mm.	11 mm.	65 days.	Magma reticulare greatly increased.
LIV	....	11 mm.		
LXIX	70 × 40 × 20 mm.	13 mm.	....	Amnion has reached the chorion.
CXXXII	42 × 30 mm.	15 mm.	89 days.	Amnion has reached the chorion.
		Five to Six Weeks.		
CXXXVII	60 × 50 × 30 mm.	16 mm.	86 days.	Cord filled with a reticular mass.
LXXXI	65 × 55 × 35 mm.	20 mm.	84 days.	
CXLII	50 × 40 × 30 mm.	20 mm.	129 days.	Syncytium within cavity of amnion.
		Six to Seven Weeks.		
XCIV	50 × 40 × 30 mm.	20 mm.		
CXXVIII	50 × 43 mm.	20 mm.	76 days.	
		Seven to Nine Weeks.		
CLII	70 × 42 × 38 mm.	31 mm.	70 days.	
LXXIX	50 × 50 × 50 mm.	32 mm.	91 days.	
CXXIV	90 × 75 × 50 mm.	35 mm.	126 days.	

* The Roman numbers given the embryos correspond with the record numbers in the cabinet of human embryos in the Anatomical Laboratory of Johns Hopkins University.

mal embryo of the fourth week. Since I had never seen a chorion too small for its embryo, I had my doubts about the accuracy of my observation until the specimen was cut into serial sections. Then, to my surprise, I found an embryo practically normal of the four-weeks' stage to correspond with the menstrual history. The chorion, however, is markedly thickened, with villi, and not in cells. Both chorion and villi contain a great number of blood-vessels which are overfilled with blood. The syncytium is very extensive, large buds arising from all parts of the villi as well as from the chorion itself. Comparing it with normal specimens, the syncytium is excessive in quantity, which may account for the good nutrition of the embryo. The large amount of embryo blood also speaks for this. The trouble in this specimen seems to lie with the mesoderm of the chorion, which prevented it from expanding sufficiently. This condition was compensated by an excessive growth of the syncytium, which gave sufficient nutrition to the embryo. The entire vascular system of the embryo, umbilical vesicle, and chorion is overdistended and the peritoneal cavity of the embryo is also filled with blood. Finally, however, the equilibrium between embryo and chorion was overthrown, resulting ultimately in the abortion. This inequality is also expressed by the excessive quantity of magma within the cœlom.

The second specimen in which there was an arrest of development at the beginning of the second week is No. CXV. Here the development of the embryo is arrested and the chorion has continued to grow. This variety of abnormality is very common, and it is fairly easy to interpret the various steps by which it is brought about. Not only are specimens of this kind easy to interpret, but we have in them the key through which we shall ultimately obtain data regarding the very earliest human embryos. If an ovum four weeks old have within it an embryo two weeks old, why may not an ovum three weeks old have within it an embryo one week old? All the specimens reported in this article speak most decidedly in favor of this hypothesis. In general, this embryo is an exaggerated two-weeks' stage with a four-weeks' amnion and chorion. The great quantity of pus encircling the chorion and cutting off its nutrition, with a consequent atrophy of the syncytium, cuts off also the nutrition of the embryo, thus gradually causing its death. The overthrow of the equilibrium between the embryo and uterus is indicated by the great quantity of magma within the cœlom as well as within the amnion. The effect of strangulation of the embryo is beautifully shown within its tissues. The form of the central nervous system is extremely simple, like that of an embryo two weeks old, but it is larger and it is solid. Peripheral nerves are not present. The heart is simple, completely filled with blood; the blood-vessels have mostly disappeared. The umbilical vesicle is relatively small and filled with a solid mass of entoderm cells. Its communication with the body is almost entirely cut off. Within the body there is neither liver nor alimentary canal left. The peritoneal cavity communicates very freely with the extra-embryonic cœlom; there is no pericardial cavity. Traces of myotomes and Wolffian bodies are still left. Throughout the embryo and the magma of the cœlom and amnion there are scattered cells with all the characteristics of embryo blood corpuscles. These are undoubtedly the migrating cells already described by His.[8] In this specimen we see the later stage of this process; and, judging by all the conditions present, its duration must have been about two weeks. His describes a similar stage, differing only in that the time between the death of the embryo and the abortion is four weeks more than in No. CXV.

The two specimens described above indicate that there has been an arrest of development of some portions of the ovum and give some hints regarding the physiology of some of the groups of tissues. In No. CXV. the primary lesion was undoubtedly the endometritis, which deprived the ovum of its proper nutrition. The second portion of Table I. gives better data regarding the primary lesion as well as the probable duration of the secondary changes within the embryo.

Judging by the general appearance of specimen No. XCVII., it might be considered normal with the exception of the excessive magma reticulare. Sections show, however, that the chorion is fibrous and the embryo is infiltrated with migrating cells which have also invaded the entire cœlom. The age of this specimen, if determined by the embryo and its organs, is not over twenty-eight days, while the menstrual history calls for at least thirty-one days. We have, therefore, to do in this specimen with an embryo which has undergone pathological changes for at least three days. The chorion is fibrous, and I am inclined to locate the primary trouble in it. The chorion is the least changeable of all the embryonic tissues, and, therefore, it may follow that a slight alteration in it produces grave consequences. The early changes in the process of degeneration of an embryo are beautifully shown in this specimen. The central nervous system is greatly dilated, the boundaries of the abdominal viscera are obscured, and the vascular system is greatly dilated. The entire embryo is filled with migrating cells which show all the characteristics of embryo blood corpuscles.

A stage slightly in advance of the above is shown in specimen No. CIV. Here, however, the membranes appear normal, but the walls of the umbilical vesicle are fibrous, the magma is greatly increased and granular, and the embryo is macerated and straightened. The changes within the embryo are much more in advance than in XCVII., the liver tissue being entirely obscured. The vascular system is undoubtedly blocked, and the migrating cells have invaded all of the tissues, including the umbilical cord, to the chorion.

In both of the above specimens the embryos must have been strangulated sufficiently to cause their death, thus permitting the blood corpuscles to leave the vascular system to invade the tissues and the cœlom. In specimen CXXII. the primary lesions were not so severe, the embryo continued to grow but not develop, and the amnion continued to dilate until it met the chorion. The primary trouble here again appears to be a fibrous change in the chorion. The central nervous system is distended, the vascular system is dilated, and the aorta is empty. The tissues of the embryo are partly filled with migrating cells. Specimens CX. and CXLI. show the same process two or three weeks later. The specimens came from the same woman, who was suffering from leucorrhœa, and in general show the same characteristics. They are both embryos four weeks old which had been retained in the uterus another four weeks after strangulation.

In Nos. CX. and CXLI. the villi of the chorion are almost destroyed, and the chorionic walls are converted into a fleshy mass invaded by leucocytes. The embryos are atrophied, the organs are obliterated, and the vascular systems are distended. That the process was slow is indicated by the amnion having reached the chorion and the general form of the embryo and its tissues corresponding with that of CXXII. The uterine trouble of the mother, the extreme changes of the chorion in both specimens with almost identical changes in both embryos, prove, as much as these specimens can prove, that there was a gradual stangulation of the embryo due to inflammation of the uterine mucous membrane, first affecting and then destroying the villi of the chorion.

The specimens in my collection of embryos of the fifth week lack the data of those of the fourth week, yet something can be made out of them. Undoubtedly the youngest of this group is No. CXXXIII. The villi of the chorion appear normal but have little syncytium at their tips. Between the villi, upon the chorionic walls, there is an excessive quantity of syncytium. The cœlom is completely filled with an excessive quantity of magma, in which lies the embryo greatly cramped and closely enveloped by the amnion. Terrific changes have taken place within the embryo. In every respect this embryo is like No. XCVII., only it is a few days older. The mi-

grating cells have invaded the entire embryo and at numerous points they were leaving the body to enter the cavity of the amnion. At these points the epithelium of the embryo is exfoliated. Specimen CLXI., whose abortion was caused by repeated attempts on the part of the mother, aids materially in locating the beginning of the pathological changes in the ovum. While there is great activity in the leucocytes and syncytium on the outside of the chorion, there is more activity of the migrating cells within the embryo, and this latter condition must be viewed as being secondary.

The other embryos of the fifth week indicate that a slower process has taken place in them. The history of one of them, and the dimensions of the chorion of others, also speak for this. The least changed of all the specimens is No. CXXXII. The history of the specimen as well as the dimensions of the chorion indicate that this specimen must have been alive but did not grow to any marked extent during three weeks preceding the abortion. The organs of the embryo are about normal in form and structure, with a small number of migrating cells in the tissues and peritoneal cavity. Specimens LX. and LIV. show slight tissue changes in advance of CXXXII. More marked changes occur in LXIX., which, judging by the size of the chorion, must have been undergoing pathological changes for a number of months before the abortion. In No. LXXXII. the villi of the chorion are considerably atrophied, while in LXIX. they are entirely wanting, with fibrous chorionic walls. The embryo itself is atrophic and much macerated. The central nervous system is distended, the sharp contour of the organs is lost, and the vascular system is distended. Migrating cells have invaded all the tissues, including the peripheral nerve bundles and the umbilical cord.

While most extreme changes will take place in several weeks in pathological embryos of the fourth week, in embryos of the fifth week months are required to produce corresponding changes. In specimen LXIX. the slow process must have been at work for months, producing all sorts of tissue abnormalities, from multiple papilliform growths of the entire epithelial covering of the body to an atrophied head. In specimen CXXXV. this process of tissue change and organ destruction is still more advanced. The primary lesion of this specimen must also have been in the chorion. The villi are all destroyed while the chorion remains as a thin fibrous membrane infiltrated with leucocytes and a few nests of syncytial cells. The entire chorion is very large, lined by an amnion, and is filled with a jelly-like substance which hardened to the consistence of glycerin-jelly in formalin. The atrophic embryo shows the usual nervous system with the head end of it completely destroyed. The outline of the organs and peritoneal cavity is also very indefinite, the entire embryo being filled with migrating cells. The vascular system is more definite than are other portions of the embryo, it no doubt having functioned longest. The head end of the embryo has become greatly atrophied, its front end being converted into a mucoid mass. The eyes have sunken deep into the head but the lenses continued to develop into hard pearls composed of lens fibres. The front end of the chorda is expanded into a large mucoid tumor on either side of which there is a large cartilaginous tumor. All this shows that development ceased long before the ovum was aborted, but that tissues already established continued to grow and to degenerate into all sorts of masses.

In addition to the groups of embryos of the third, fourth, and fifth weeks, there are several specimens of later date which show that the changes in form and structure are not likely to occur when there is an arrest of development in later stages. Specimen LXXXI. seems to have its primary trouble in the chorion, it being fibrous and invaded by leucocytes as well as syncytium. The amniotic cavity is greatly distended and the embryo is macerated with an ulcerated crest on top of its head. The whole specimen suggests death and destruction of tissues without any indication of further growth of any of the parts.

Specimen CXLII. also shows the great resistance of an older embryo that has been dead for several months before the abortion. The syncytium has also been active, having eaten into the walls of the chorion and its villi and having entered the cavity of the amnion. Here these cells form their characteristic double layers again and also invade the tissues of the thickened amnion.

Embryo CXXVIII. is a perfect normal specimen with a normal chorion of about the sixth week, but the history shows that it must be older. The peculiarity of this specimen is the delicate reticulum of fibrils over the embryo within the amnion. It may be that this is the beginning of the granular magma frequently found with the amnion of older pathological ova. Of this same date I have another embryo, XCIV., with fibrous degeneration, as well as some leucocytic infiltration of the chorion. The embryo is normal in form and the amnion is packed with a mass of granular magma. There are many indications of destruction of the tissues of the embryo, but none of growth and regeneration.

No. LXXIX. is similar to XCIV. but older. It also has leucocytic (also syncytial) invasion of the chorion, necrosis of the tissues of the embryos and so on. The epithelial covering of the embryo has partly fallen off, but at the border line of the exfoliation there appears to be an attempt at regeneration. Its lines are not ragged, but the regenerating border is elevated and rounded. There are no cell figures. No. CLII., much like LXXIX., shows a more advanced stage of degeneration. In this specimen the cause of the strangulation of the embryo is to be found in the endometritis, which gradually cut off the nutrition of the chorion, and later aided in destroying the villi.

Among these specimens I may mention here a remarkable one, CXXIV., in which the nutrition must have been impaired some time during the second month of pregnancy. The entire duration of this pregnancy must have been at least four months. The large chorion has on one side of it a small placenta which is infiltrated with leucocytes. The quantity of syncytium is normal but appears necrotic, a change which may have taken place immediately before the abortion. Between the chorion and amnion there is a large cœlom. The walls of the amnion are greatly thickened. The umbilical cord is thin and greatly twisted. The general form of the embryo is nearly normal, but there are club hands and club feet. The external ear is also rudimentary and pointed. If this specimen is compared with a normal embryo of the fourth month it is seen at once how much too small and how distorted this embryo is. In this instance it is interesting to note that accompanying this abnormal embryo there is a diseased placenta, a distended extra-embryonic cœlom, and a very thin umbilical cord.

Embryos with Slight Abnormality.—In addition to embryos CXXVIII. and XCIV. described above, I have several specimens in my collection with slight abnormalities which could not greatly affect the further growth and nutrition of the embryo. No. VI. is undoubtedly a normale embryo, as it was obtained by inducing abortion seventy-seven days after the beginning of the last menstrual period. Its tissues all appear normal with the exception of a small vesicle on the ventral side of the lower tip of the spinal cord. This vesicle is lined with one layer of cylindrical cells; other embryos of the same stage, in my collection, do not possess it. A pathological embryo of about the same age, No. LXXXI., has a similar dilatation at the lower tip of the spinal cord.

There are in my collection three specimens of hernia of the liver (X., XCIV., XXX.). Embryo in X. is stumpy and poorly shaped, but the tissues appear normal. No. XCIV. is abnormal while XXX. is normal.

DEGENERATION OF THE EMBRYO, LEAVING ONLY THE UMBILICAL CORD.—This remarkable group of specimens caused me a great deal of trouble, and not until studying them again and again could I make anything of them. With but one exception (LXXVII.) they were all found in ova which otherwise appeared normal. The main data are given in Table II.: