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TWO ACARDIAC ACEPHALIC FŒTUSES.

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THE ANATOMY AND NATURE OF TWO ACARDIAC ACEPHALIC FŒTUSES.

(See Plates VIII, IX, X, and XI.*)

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(1) *The nature of the fœtuses.*—Although no records are to be found of fœtuses exactly identical with those described here, they belong to a well-known class, of which Ballantyne has collected all that is known up to the present date ('Diseases and Deformities of the Fœtus,' vol. i, p. 165, 1892). Interest in them is enhanced by the fact that they show lesions similar to those produced by hatching chicks under abnormal conditions of temperature and position (Dareste, 'Recherches sur la production artificielle des monstruosités,' 2nd edition, 1892). One of the specimens (see Plate VIII), the larger, is that of a full-time fœtus, for the centres are present in the lower ends of the femora. For the opportunity of dissecting this specimen I am indebted to Dr. Lewers. The other specimen is much younger, and corresponds in size and development to a fifth month normal fœtus (Plate IX). Both were females.

These acardiac fœtuses, perhaps better known as allantoidal parasites, belong, as is well recognised, to the series of double monsters. Between a very partial anterior or posterior dichotomy of the blastoderm and a complete division to form fully-developed twins every stage is known, and these parasitic fœtuses belong to the latter end of the series, the division being complete, except the

* All the Plates, except Plate IX and the description, except when mentioned otherwise, refer to the larger specimen.

posterior end of the blastoderm, which afterwards helps to form the allantois. The placenta remains in common, and the parasite draws its blood-supply directly from the placental circulation of the host twin. The parasite is reared and nourished as a bud on the placental circulation of the host. Its circulation is reversed ; the impure blood from an umbilical artery of the host enters the parasite by a single umbilical or hypogastric artery, and is returned to the circulation of the host by a single umbilical vein. The circulation in the parasite is dependent on the heart of the host. There is here the experiment made of rearing a human being as a bud (Plate XI).

The outstanding lesions in a parasitic fœtus are those of imperfect, arrested, and abnormal segmentation, and these lesions may be due in some degree to the abnormal circulation. But from experimental work we know that pathological processes antedate the appearance of an active circulation. The formation of blood islands and the fusion of these into blood-vessels, and the incursion of these vessels to form the leading blood-stems of the body are vitiated. We know, too, that unequal division of segmenting frog ova made artificially leads to formations similar to parasitic fœtus. I therefore regard a parasitic fœtus as the product of the lesser and imperfect part of a twin blastoderm. The origin of the condition is to be sought in the very earliest stages of segmentation of the ovum. Inquiry into the condition of the mother during the weeks following conception might throw some light on the cause.

Besides the similarity in the nature of their circulation, another character in which both specimens agreed was in the condition of the connective tissue of the body. In both it was thickly infiltrated with mucoid jelly-looking material, and greatly hypertrophied in amount. In both the thyroid gland was absent. The veins and arteries were equally thickly coated. Leucocytes were extremely abundant in theconnective tissue and in the blood-vessels—

almost equal in number, or even the leucocytes predominated. Open, loose forms of adenoid tissue occurred abundantly throughout the tissues of the larger fœtus; and in the smaller, lymphatic glands were abundant and in normal positions.

The type of segmentation, the extent to which it has been perverted, is sharply contrasted in the two specimens. In the smaller fœtus (Plate IX) the appearance suggests that the cell or cells of the blastoderm that go to the formation of the anterior half of the trunk were blasted, and arrested in development in the blastodermic stage. The body begins with the first dorsal segment; all the segments in front of that, cervical and cephalic, have never been formed, and hence the absence of the foregut and all its derivatives, of the brain, heart, head, and teeth. Three little processes, shown in Plate IX, surround a depression, probably the stomodæum, and may represent the fronto-nasal, maxillary, and mandibular processes. A small fragmentary mass of fibrous tissue containing bone may represent the basis of the skull. The arm-buds show three segments representing the hand, forearm, and arm, but are short, imperfect, and unshapen. The posterior half of the trunk, from the first dorsal segment onwards, is perfectly developed, each segment producing its neurons and visceral parts perfectly; the only point to be observed as abnormal is the condition of marked inversion of the feet. In the bigger fœtus segmentation has been arrested at both extremities of the body; there is a marked condition of hydrocephalus; vertebræ are imperfectly separated from each other; so are the ribs; the arms are rudimentary; the buds of the hinder extremities, owing to the arrest of the segmentation posteriorly, are left in contact, and a symelian extremity is produced.

(2) *External appearance.*—Both fœtuses present the appearance of inflated commas. The larger measured 40 cm. from end to end, and 17 cm. from back to front. After having been in spirit for some time it weighed

1600 grammes. The small specimen measured half the dimensions, and a quarter of the weight of the larger.

The larger fœtus on its right side presents no opening or structure whatsoever, but on the dorsal margin, where the body meets the conjoined lower extremities, there is a depression which may represent the anal pit or blastopore, and at the bottom of which terminal fibres from the spinal cord and its sheath end. On looking at the left aspect of the fœtus a number of features are to be noted. Near the centre of the cephalic end of this aspect is a wide pit, bounded dorsally by the two eyeballs, which lie side by side, ventrally by imperfectly developed lips and gums that contain the well-developed crowns of all the milk-teeth and the germ of the first permanent molars. Broadly speaking, the skull in front of the coronal suture is almost undeveloped; the fronto-nasal and maxillary processes have been arrested in development, and hence nearly all the bones of the face are absent. The mandibular arch is well formed and complete. The buccal cavity ends blindly behind in a narrow recess containing a small conical tongue, covered with filiform papillæ, and evidently representing the tuberculum impar only, the V-shaped fissure containing the foramen cæcum being situated at its base. This cavity, which represents the primitive buccal cavity and part of the pharynx, terminates blindly at a piece of cartilage evidently representing the hyoid bone. The œsophagus, or more correctly speaking, the foregut, begins blindly at the hyoid. Above the eyes is seen the representative of an eyelid, and at the left extremity of the buccal cavity a fold of skin, in the position of, and evidently representing, the external ear. There is no such process on the right side, and neither on the one side nor on the other is there any trace of an auditory meatus, nor an internal ear. Behind the mouth, and overlapping the umbilical cord as it escapes from the abdomen, is a great flabby fold or process of skin, which may represent an arm-bud, for the vertebral end of the scapula terminates in its posterior dorsal portion, but

the anterior part is attached to the mandibular arch. It contains no definite structure; I failed to discover nerves entering it; it contains merely an amorphous mass of soft fibrous tissue. It is the extensor aspect of its symelian extremity that is seen in viewing the left side of the fœtus.

It will be observed that the fœtus is asymmetrical. The right side of the cephalic extremity especially has become so enlarged that it has thrust the face, the mouth, and the umbilicus almost to the centre of the left side. This asymmetry is mainly due, as may be seen in Plate VIII, to the cephalic part of the neural canal having become distended and burst through the skull wall. It protrudes as a great hernia on the right side, and has thrust the skull, tongue, and thoracic organs to the left side. The skull rests like a small cap on the left side of the great cerebral vesicle. The shoulder girdle of the right side lies on the dura mater over the dilated brain vesicle.

3. *The circulatory system.*—Although nothing is known of the placenta of these fœtuses, yet there can be little doubt, reasoning from the arrangement found in similar specimens, that the relation of the circulatory system of the "allantoidal parasite" to the host fœtus was something essentially like the arrangement sketched in the lower right corner of Plate XI. The form of the heart and the arrangement of blood-vessels are incompatible with an independent circulation in the parasite. There are certain very remarkable and abnormal features in its circulatory apparatus. In the first place, it is nourished on impure venous blood; the placenta, the parasite, and the hind-quarters of the "host" fœtus are supplied with the same quality of blood. In the second place, the circulation in part is reversed; the blood enters the body by a single umbilical artery, and leaves it by a single umbilical vein. The umbilical artery on entering the abdominal cavity gives off three branches (Plate XI), which supply the alimentary canal and septum transversum (diaphragm), and then ends in a median dorsal vessel

(aorta) opposite the seventeenth segment (tenth dorsal). At the point of entrance into the aorta the blood-current divides in two, one current passing backwards in a normal direction into the femoral vessels, the other passing forward in the aorta towards the cephalic extremity of the fœtus. The aorta gives off segmental vessels, and ends opposite the fifth segment (fifth cervical) by giving off a vessel clearly representing the vertebral, and two others, which probably represent the right and left carotid arteries, the right being the larger, and dividing into an external and internal branch. The aorta has no direct connection with the heart. All the structures developed from the second, third, and fourth arches are either absent or present in the most incomplete form; probably the arteries of those arches were never formed, or, if they were, disappeared subsequently; at any rate the heart showed no trace of an aorta, nor could it pump blood into the arteries. The arterial system, from a physiological point of view, may be regarded as part of the host fœtus.

One peculiar character is the presence of a single umbilical artery, giving off mesenteric branches. The explanation of this feature probably lies in the segmentation being arrested at the twentieth vertebra (first lumbar), and hence the hypogastric arteries (in this case conjoined) would arise before the mesenteric arteries are given off, that is, supposing the hypogastric arteries to represent the continuation of the aorta backwards, a theory now commonly accepted. It is possible, however, that the umbilical artery may represent in part, at any rate, the omphalo-meseraic. In the smaller fœtus it is the left hypogastric artery that is present, and the mesenteric arteries arise from the dorsal aorta. The heart is relatively a very small three-chambered organ. Its position is shown in Plate VIII, lying under the brain capsule, close to the hyoid bone, thus retaining a very early embryonic position. The auricular cavity (sinus venosus ?), lying embedded in the septum transversum, has very thin walls and no valves (Plate XI). The ventricle has a

very thick wall, a minute cavity communicating with the auricle by an opening 2 mm. in diameter. The ventricle lies within a serous sac, the pericardium. A third chamber, represented actual size in Plate X, but exaggerated in Plate XI, is obscure in its nature. It is filled with a meshwork of bands, with no distinct cavity, and communicates with the auricle by an opening which allows an ordinary pin to be passed through it, and with the ventricle by a foramen still smaller, and which may have been produced artificially, as its lumen is not distinct. A vessel leaves this chamber and becomes larger as it passes backwards to the base occipital region, where it ends. The small chamber may represent the bulbus arteriosus, and this vessel the primitive ventral aorta, but no communication could be traced between it and the carotid or vertebral branches of the dorsal aorta. With this doubtful exception, the heart is wholly a venous structure, and has no connection with the arterial system, and, as far as it was functional, could only have assisted in forcing the blood along the veins to the placenta. The heart in this case serves the placenta, and not the fœtus. In the smaller fœtus the heart and cephalic arteries were absent.

It is not an easy matter to identify the trunks of the venous system (Plate XI). In the diaphragm (septum transversum) three great veins meet to form the umbilical vein. The posterior one represents the right, or perhaps both posterior cardinal veins, for it receives the vertebral branches of both right and left cardinals. The anterior one may represent both, but more probably the right jugular, and the trunk running from the auricle to the junction of the cardinal and jugular probably represents the duct of Cuvier of the right side. The vein which joins the duct of Cuvier in the neighbourhood of the heart comes mostly from the right aspect of the head over the forebrain, and may represent an external jugular vein. The vein from the alimentary canal joined the duct of Cuvier in the diaphragm.

The outstanding features of the circulation then, are these :

(1) The heart, if functional at all, drives the blood along the veins into the placenta.

(2) It has lost, or never had, a connection with the dorsal aorta, through absence or obliteration of the arteries of the visceral arches.

(3) The main arterial and venous trunks seem all to belong to the right side, those of the left being absent.

In the smaller fœtus the umbilical vein is the left, and its nature is quite obscure. It ends in the left cardinal vein. It runs outside the peritoneum and probably represents the left umbilical vein.

4. *The umbilical cord.*—Its length is not known. Microscopical sections show only one artery and one vein; there is no trace of another vessel, or of the cavity of the allantois. The tunica intima of the artery is enormously hypertrophied, and the lumen almost obliterated. Its muscular coat is extremely thick, the longitudinal fibres being especially marked. The occlusion of the artery is probable that which normally occurs. The wall of the vein is also thick, and the clot that occupies its lumen shows a considerable proportion of leucocytes, probably one to every fifty red blood-corpuscles ; the substance of the cord and its epithelial covering, two irregular layers of cells, are normal in appearance, and it is remarkable that the subcutaneous tissue all over the body shows a remarkable resemblance to Wharton's jelly, macroscopically and microscopically.

5. *Capillary lymphatic circulation.*—The dropsical condition of such fœtuses, the hypertrophied and mucoid subcutaneous tissue, the large cysts that occur throughout this tissue, such as the one shown in Plate VIII—and in this case there were several more, all on the right side—the dilatation of the neural canal with fluid, are commonly regarded as the mechanical results of an imperfect circulatory apparatus. Such a dropsy occurs in fœtuses with a perfect circulatory apparatus. Smith and Birmingham

('Journ. Anat. and Phys.,' vol. xxiii) in a case they examined found no evidence of a lymphatic system, and ascribed the condition to this defect. In the small fœtus the lymphatic glands were well developed. It is improbable that the condition is the result of any simple mechanical cause; it is much more probably, as Dareste's research would lead one to suppose, that there is from the very first some grave lesion in the normal physiology of the cell. The presence of the parasitic fœtus itself is part of the disease. The condition of the arterial system of this fœtus is in conformity with Dareste's observations in the chick. There is a disturbance in the formation of the blood-islands of the area vasculosa; the contents of those islands, in a normal development, reach the embryo by the formation of a vessel which grows into the embryo to form the aorta, the posterior part first, the anterior part, which joins the heart, being formed later. In a dropsical chick this formation is disturbed, and the failure of the aorta to join the heart in this fœtus may be the result of such a primitive maldevelopment of the blood-islands. The neural canal begins to dilate as soon as the neural ridges fold to form it. Too little is known of the manner of secretion and absorption of the cerebro-spinal fluid within the neural canal to hazard an opinion as to the cause of the hydrops, but its early appearance is distinctly against any simple mechanical obstruction.

The extent to which the subcutaneous tissue has hypertrophied and become distended, and its cystic formation may be seen from Plate VIII. Microscopic sections of this tissue, cut in paraffin and stained with carmine and methyl blue, show that it has much the appearance of the substance of the umbilical cord. There are numerous branching connective-tissue cells; fibres are present evidently free from cells; it is impossible to recognise in section the larger arteries from the larger veins; both have very thick walls, the tunica adventitia being markedly hypertrophied. It is doubtful if they contain muscle-cells, although within the tunica adventitia and

outside the tunica intima there is a layer of fusiform nuclei such as occur in non-striated muscle. Small rods of cells with a scarcely recognisable lumen probably represent arterioles. At several points these small vessels break up in trabecular tissue, in the manner usually ascribed to arterioles in the spleen. The capillary system appears to be represented by the dilated irregular spaces of this trabecular tissue. In the neighbourhood of blood-vessels there are numerous leucocytes, and in the neighbourhood of certain round spaces, evidently the beginnings of veins, are colonies of leucocytes arranged in compartments that radiate round the centre space. Leucocytes are being formed. Giant-cells containing four to five highly stained large nuclei may be seen, and stages between these broken-down giant-cells, and free and scattered leucocytes. Red blood-corpuscles are seen only in the larger blood-vessels. Here, then, there seems to be a very primitive arrangement of tissue ; it is impossible to distinguish microscopically the capillary spaces from the lymph spaces ; at any rate they are in free communication. With the exception of three or four quite small glands in the mesentery, nothing of the lymphatic system was apparent to the naked eye. One would not expect the ordinary arrangement of thoracic ducts in such a fœtus, and if one were present it would be almost impossible to detect it among the fibrous tissue of the prevertebral region. No lymphatic duct was seen, but it may easily have escaped even minute search. But lymphoid tissue was abundant, not only throughout the subcutaneous tissue, but numerous follicles occurred in the submucous coat of the intestine, stomach, and trachea. Teased preparations of the bone-marrow from the lower end of the femur, stained in logwood, showed the Haversian space crowded with rounded cells with large round deeply stained nuclei. Amongst these cells, but much less numerous, were rounded unstained cells containing hæmoglobin. The fusiform bone corpuscles, with oval nuclei, could be seen within the spicules of

bone, and a layer of similar but irregular corpuscles were ranged round the walls of the Haversian spaces. There was no trace of the spleen, thymus, thyroid, or tonsil. There was much evidence that leucocytes were being produced abundantly. It is also of interest to note, in connection with the hæmopoietic functions of this fœtus, that the liver was not formed, and the kidney very small.

6. *Signs of arrested and abnormal segmentation.*—Segmentation, a process that appears so early in the life of the blastoderm, had been interrupted and taken place irregularly. Evidence of that is seen in the imperfectly separated laminæ of the fourth and fifth cervical vertebræ (Plate VIII). Again, it is seen in the third and fourth and the fifth, sixth, and seventh dorsal vertebræ. It is also seen in the imperfect cleavage of the seventh and eighth ribs. Segmentation posteriorly has been arrested at the twelfth dorsal vertebra, the sacral cartilage lying over the united pelvic bones being wedge-shaped, and unsegmented. The vertebræ corresponding to the lumbar, sacral, and coccygeal regions are undifferentiated, and it is from the sides of this part of the body that the leg buds spring. The limb buds when they appear are not separated but in continuity, and hence the symelian extremity. It has been already seen that development was arrested at the cephalic extremity of the fœtus, the frontal bones being small, the bones formed in the fronto-nasal and maxillary processes being absent. The structures derived from all the visceral arches, with the exception of those derived from the mandibular, are only partially developed or absent.

7. *The respiratory and alimentary tracts and derivatives* (see Plate X).—The buccal cavity has been described with the external configuration. It ends in a blind recess, thrust over to the left side, and in this recess lies a papilla representing the tongue. There is no trace of the palate, nor upper teeth, but in the lower gum lie the dental sacs of all the milk teeth, the crowns of the incisors being

completely formed. The enamel germs of the permanent teeth are also present. On the floor of the mouth, between the gum in front and the small tongue behind, was a median fold, the frænum linguæ, and on each side a fold, in the substance of which were five little buds of the size of millet seeds, lying closely one behind the other, evidently the "Anlagen" of the sublingual and submaxillary salivary glands. Nothing of the parotid gland was seen.

The tongue is fixed on an irregular piece of cartilage, seen in the anterior end of the foregut in Plate X, representing the hyoid bone. It was joined on the left side by a cartilaginous stylo-hyoid ligament. Muscles passed between the hyoid and mandible (mylo-hyoid and genio-hyoid) and were pulled out into long bands over the greatly distended cephalic vesicle. The genio-glossus is small but developed. When a microscopic examination was made of the foregut it was seen to have the structure of trachea and not œsophagus. There is a connective-tissue coat; well-developed cartilages forming two thirds of a circle; greatly developed submucous coat with large mucous glands opening into the trachea by widely dilated mouths. They also seemed to suffer from hydrops. The cilia of the lining epithelium are very evident. There is no trace seen of an œsophagus in such a section. On what appears to be the dorsal aspect of the foregut, but which, owing to the asymmetry of the fœtus, is in reality the ventral, there is a diverticulum ending in a solid string, which branches irregularly, and is lost in the connective tissue lying above the diaphragm and inside a curve of the jugular vein. I identify this as the "Anlage" of the lung, but a microscopic examination of the tissue in which the process ends shows only irregular spaces, many of them venous or lymphatic, and none of them with a characteristic epithelial lining. There is no pleural cavity. Between the basis cranii and the peritoneal cavity there is a considerable septum of connective tissue; the part bounding the peritoneal cavity contains muscle and the auricle of the heart, and represents the

diaphragm. The looser tissue in which the lung bud ends is the "Anlage" of the mesoblastic tissue of the lung and connective tissue of the neck and thorax.

As the foregut passes through the diaphragm it dilates. In part the dilatation is probably stomach, but in part of it at least, villi are distinctly present, and it must be regarded as belonging to the duodenum. In the diaphragm, or rather just as it enters the diaphragm, there is a slight fusiform enlargement, and this is undoubtedly stomach. If that is so the stomach is entirely developed within the septum transversum, and part of the duodenum too. A bud of very small size has grown into the septum from the foregut between the gastric and duodenal enlargements. There is another smaller process of the alimentary canal arising at the point at which the foregut leaves the diaphragm to enter the small peritoneal cavity. It lies in the substance of the diaphragm, and may represent one of the pancreatic buds. The gut is bound closely to the left wall of the small peritoneal cavity by a short mesentery. There is an opening in the peritoneal cavity at the umbilicus, through which the umbilical vessels escaped, and through this opening, which may have been caused by pulling on the cord, the cavity of the peritoneum communicated with that of the amnion. There is no trace in the peritoneum of any diverticulum which might have become the pleura. The gut is divided into an anterior and posterior part, having evidently been broken across at a very early stage, as the ends that ought to be in continuity are conical and closed. There are two cæcal diverticula at the proximal end of the posterior division of the gut. The larger of these has a valvular mouth, and represents the ileum; the smaller is the cæcum. Another very small diverticulum occurs on the posterior portion of the gut; it has probably no morphological significance. The gut has broken across or failed to develop at the point at which the yolk-sac was attached. The rupture in the gut may be due to the abnormal development of the intra-abdominal part of the

umbilical artery. The hind gut terminates in an enlarged cæcal extremity, covered on its ventral aspect by peritoneum ; it is embedded dorsally in connective tissue within the cavity of the pelvis, but it has no continuity with any tissue or structure in its neighbourhood ; it could be removed from its natural bed with great ease. It terminated over an inch from the anal depression. The lining cells of the great gut were distended with mucus, merely their outlines being visible. In the small gut the villi were present, and in stomach, small intestine, and great intestine, the usual tubular glands were seen. Solitary follicles were abundant, and there were a few lymphatic glands in the mesentery. In the smaller fœtus the gut began blindly ; the foregut and its derivatives were absent ; there was no liver, no pancreas, no spleen. There were two cæcal processes, one probably representing Meckel's diverticulum. The rectum was normal.

8. *The genito-urinary system.*—This system was well and normally developed in the smaller fœtus, the suprarenal bodies being very large. In the larger fœtus, besides the anal depression shown in Plate VIII, there was no evidence of external genital organs. No trace of bladder, urachus, or allantois could be found either in the abdomen or in the umbilical cord. If they had been formed they must have completely disappeared. The kidney lay in front of the twelfth or thirteenth vertebræ (fifth and sixth dorsal). The right kidney lay to the outer side of the ventral aspect of the posterior cardinal vein ; the left kidney on the left wall of the peritoneal cavity at some distance from the cardinal vein. The renal arteries were derived from the umbilical ; the veins joined the posterior cardinal. The left kidney is the more instructive of the two. The short ureter is seen to join a duct leaving the ovary (the Wolffian duct), the kidney being known to be derived embryologically from the Wolffian duct, and hence the connection. The ureter and its pelvis are represented on the right side by a membranous sac, which is closed, and almost equals the

kidney in size, into the centre of which it protrudes. A section through the right kidney shows the pelvis in the centre, made up of spindle-cells, many with the rod-like nuclei of non-striated muscle; the outer coat, which here and there runs into the substance of the kidney, is undoubtedly muscular. In the centre of the kidney, surrounding the pelvis, are densely packed tubules of various sizes, and some of the larger can be seen perforating the pelvis. The outer half of the kidney is composed of cortex, the greater part of which is made up of glomeruli; the tubules are but slightly convoluted; glomeruli are being formed under the capsule; no loops of Henle could be distinguished.

The hilum of the supra-renal body, which opened on the surface turned towards the kidney, was seen on section to be lined with large cells, many of them apparently encapsulated, grouped in alveoli, each alveolus being surrounded by a circular sinus. The cells in the alveoli stained more deeply than those of the cortex, which ran in irregular rows towards the surface, except where secondary radiations took place round veins. The central alveolar groups evidently represent the sympathetic "Anlage." The renal ganglion was very large.

The genital glands lay within the peritoneal cavity suspended by a mesentery, and showed the typical structure of fœtal ovaries. The ova were large, many were in a process of division; others were being encapsulated by the round-celled and fusiform-celled stroma. The ova were especially large and closely packed towards the hilus or attachment of the mesovarium. In the mesovarium lay many Wolffian tubules, with very thick walls made up of fusiform short cells and lined by a single layer of non-ciliated epithelium. A hydatid body, belonging to the Wolffian tubular system, projected over the caudal pole of the ovary. The Wolffian duct was present in it proximal part only; it ended and became lost in a slight band of fibrous tissue.

9. *Bones and ligaments.*—In monsters of this kind the

hind limbs are commonly developed, while the fore-limbs are not present or only partially developed. That is so in this case, and the limbs of the left side are less well developed than those of the right. The fore-limbs are represented only by the shoulder-girdles (Plate VIII). The supra-scapular cartilage is large, and sends a process into a fibro-muscular band representing the teres major. The infra-spinous part of the scapula is well developed; the supra-spinous part is absent; the spine is present and ends in an acromion process. The process is connected by a ligamentous band with a bone which may be a clavicle or primitive form of coracoid reaching the sternum. This coracoid is bound closely to the proximal end of the right sternal bar by fibrous tissue, while at its outer end it is in cartilaginous continuity with that part of the scapula representing the glenoid cavity. This bone undoubtedly occupies the same position as the meta-coracoid of the ornithorhynchus. But it must not be forgotten that the shoulder-girdle has been raised by, and stretched out upon, the greatly distended brain capsule, and this distension may not only have altered the shapes of the bones but altered their primitive relationships. The prolonged end of the scapular spine may represent the clavicle. There is, however, a small nodule of cartilage lying below the position of the glenoid cavity, and connected by ligamentous bands with the surrounding bones, one of which may be the costo-coracoid ligament. This cartilaginous nodule may represent the coracoid or humerus. It was surrounded by a loose mass of friable connective tissue in which some vessels and nerves ended.

In the shoulder-girdle of the left side there is a large dorsal piece of cartilage, the supra-scapular. It has in its ventral part a round plate of bone developing in it, and this plate of bone is in continuity with—although a line of union is quite visible—an oblong plate of bone developed in membrane. Its lower (ventral) end is suspended in fibro-muscular bands representing the pectoralis major,

sterno-mastoid, and sterno-hyoid muscles. The proximal end of the sternum is not developed.

The pelvic girdle has fused into a solid piece, under the truncated sacral-like termination of the vertebral column. The part belonging to the right side is double the size of that belonging to the left. The limbs have united so that the extensor surfaces form a combined dorsal surface, great trochanter of femur lying against great trochanter, and external condyle against external condyle. The two ossa innominata have fused together; the gluteal surfaces form the dorsal aspect; the ischia are united; the cartilaginous pubic rami form one mass. A foramen, representing the combined great sacro-sciatic foramina, allows two great sciatic nerves to escape together from the pelvis.

Fibula is turned towards fibula. In the right leg the tibia is much larger than the fibula, and enters alone into the formation of the knee-joint, which is furnished with a normal ligamentous apparatus. But the left tibia and fibula are of equal size and enter equally into the formation of the knee-joint, a plate of fibro-cartilage, evidently the "Anlage" of the semilunar cartilages separating the femur from the lower two bones. The feet are united along their fibular (outer) borders, the soles forming a continuous plantar surface. It is difficult to separate the os calcis of one side from that of the other; they are closely bound by fibrous tissue (Plate VIII). The os calcis in its distal part has undergone division or dichotomy. The left is undivided. The astragalus is present on both sides and shows no trace of division. In front of the astragalus and right division of the os calcis of the right limb are three blocks of cartilage representing the scaphoid and inner two cuneiform, which support two digits, the great toe and the second. The great toe has undergone dichotomy. The other division of the right os calcis carries two digits, one a great toe, the other a second, but in this case the great toe has not undergone dichotomy. The left foot is made

up of os calcis, astragalus, scaphoid, internal and middle cuneiforms, two digits, the great toe dividing as shown in Plate VIII. The right leg, although only one tibia and fibula are present, carried two sets of extensor muscles, in agreement with the divided foot.

The vertebræ, ribs, and sternum.—There is evidence of nineteen vertebræ, the nineteenth being a composite sacral-looking body, with fused nodules of bone embedded in its cartilage. The two sides are not symmetrical. For instance, on the right side, between the bodies of the second and third vertebræ, a nodule of bone is intercalated with a corresponding lamina and nerve, representing a vertebra wanting on the opposite side. The irregularities in the complete segmentation of the laminæ of one side do not show an exact correspondence with the irregularities of the opposite side. The neural plates of the atlas are connected ventrally by a cartilaginous mass of tissue, in which is situated, adherent to the body of the axis, a nodule of bone representing the body of the atlas. At the body of the tenth vertebra evidence of two ossific centres for each body appear; at the thirteenth segment the centres are separated by a mesial band of cartilage which passes from one intervertebral cartilage to another. The bodies of the fourteenth and fifteenth vertebra have a centre on each side and one in the middle, three in all for each body. The sixteenth vertebra is present only on the right side. The body of the 17th vertebra has only one centre, the eighteenth two, and the nineteenth shows evidence of five centres in all, one central and four lateral.

The fifth, sixth, and seventh vertebræ carried small spicular ribs, connected by cartilage with the transverse processes. The transverse processes were perforated by the vertebral artery. The eighth to the sixteenth vertebræ carried ribs, the three posterior failing to reach the sternum, as shown in Plate VIII. On the left side the sixth and seventh vertebræ carried spicules, representing ribs; the eighth to the fifteenth carried larger, although

irregularly developed, ribs. On the left side there was no sternal bar. The sternal bars were unfused in the smaller fœtus.

The skull.—The two parietal bones and supra-occipital are readily identified. The right exoccipital is shown in Plate VIII, but no bone representing the left exoccipital was recognised, unless a small nodule over the atlas represents it. The form and connections of the inferior mandible are remarkable. The two halves are completely united at the symphysis by bone. Alveolar borders have risen up in the neighbourhood of the symphysis and form six dental pits. The jaw is flattened on the brain capsule, its symphysis being pulled out into a beak by a wide band of fibres, which ends in the subcutaneous tissue. On the left side the mandible ends in a flat plate of bone overlying a reticulated plate of bone representing the left half of the sphenoid. This mandibular plate is evidently the palato-quadrate bone. A foramen separates it from the thicker horizontal part of the mandible, which abuts against that part of the sphenoid lying beneath the opening for the eye. A nodule of bone situated in a recess beneath and behind the palato-quadrate, and continuous through fibrous tissue with the mandible, is probably the malleus. The squamous and petrous parts of the temporal are also represented. On the right side the proximal end of the mandible terminates in a nodular composite plate, corresponding evidently to the elements on the left side. The sphenoid is represented by a complicated reticulated plate of bone on each side, the lateral halves being connected under the jaw by a fibro-cartilaginous plate. This is due to the fact that the brain capsule has broken through the skull at the space occupied by the right petrous bone, thrusting the basi-occipital, the basi-sphenoid, and ali-sphenoid of the left side away from the ali-sphenoid and squamous part of the temporal on the left. The body of the pre-sphenoid has been stretched into a flat plate of bone, lying in fibro-cartilage, under the optic foramen.

A thin fibrous septum separates one optic foramen from the other. Immediately over this septum is a thin capsule of cartilage, containing the two olfactory bulbs. Above these, again, are two small plates of cartilage, one containing a nodule of bone representing the frontal.

The nervous system.—Unfortunately the central nervous system was scarcely in a state for microscopical examination, and such an examination would have been very difficult, for there was great distortion in its cephalic part, and at places distension had been so great that merely the fibrous tissue of the membranes represented the wall of the cerebral vesicle. Both olfactory bulbs and both optic vesicles were present, lying in contact, but each had its own stalk. A mass of epithelial *débris* within the eyeball was probably the remains of the lens. A mass of fibrous tissue connected the buccal cavity and the base of the skull, but no structure was identified as pituitary body. Not one of the motor cranial nerves was seen, but the fifth and ninth were made out, both being very small and irregular. It was found impossible to trace out the fifth nerve owing to the complication of structures in which it lay. The ninth nerve ended superficially on the two tubercles representing the basal parts of the tongue. No trace of auditory nerve or capsule was seen. There were twenty pairs of spinal nerves (Plate X). The posterior root ganglia were well developed, so were the ganglia of the sympathetic system. The anterior roots were very small, varying from one fourth to one half of the posterior roots. The neural canal in the spinal cord contracted as it approached the sacral end; in the cervical region it measured 10 mm. in diameter.

The nerves of the right side attain a much more extensive development than on the left. The first seven nerves on the right side form a plexus. From the loops between nerves I-II-III-IV pass off three trunks to end in the greatly distended scalp of the right side. They represent the large and small occipital and great auricular.

On the left side nerves I-V united into a single small trunk which ended as the great occipital. It sent branches towards, but not quite to, the area of skin surrounding the primitive buccal cavity. The phrenic nerve arose from the loop between I-II. A large trunk was formed by V-VI-VII and passed out to end in the muscles and connective tissue round the shoulder girdle. Nerves VIII-XIV are intercostal and small. The roots of the middle numbers of this group are horizontal; the roots of the upper ascend, the roots of the lower descend. Nerve XV ends as the external cutaneous, but also sends a twig to XVI, which with XVII, XVIII, and XIX, form the anterior crural and obturator nerves.

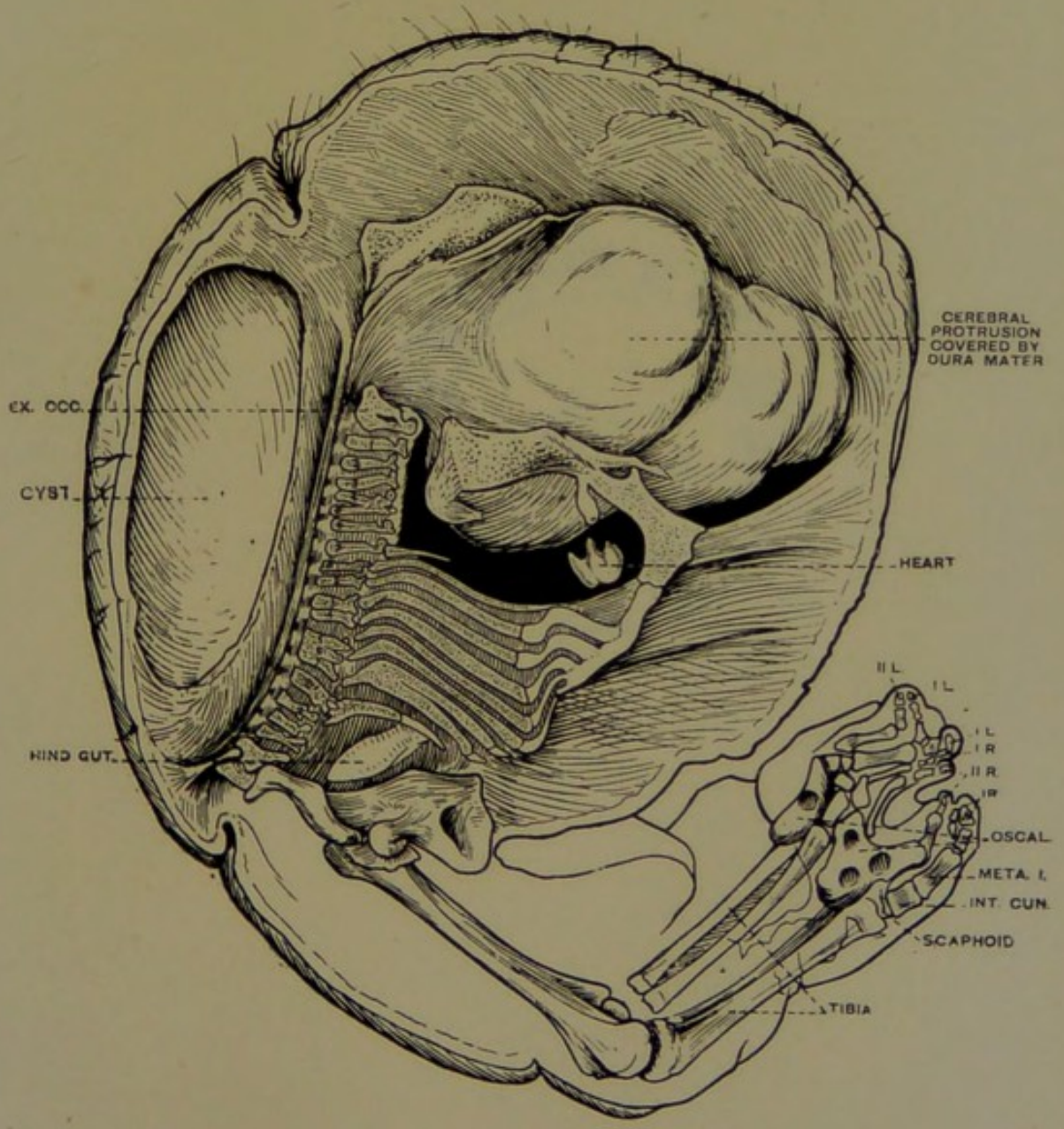
A twig from XIX and XX ends as cutaneous nerves in the region of the anal depression; XVIII and XIX send also a considerable trunk to join with nerves from the right side to form the sciatic nerve which passes through the single sacro-sciatic foramen. On the left side nerves V and VI are small and end in the muscles connected with the shoulder; VII-XIII are intercostal; XIV represents in distribution the last dorsal nerve; XV and XVI are large trunks, and end as the anterior crural nerve of the left side; XVII and XVIII send off the great sciatic nerve and cutaneous branches to the skin of the thigh region; XIX is small and terminates in the skin near the anal pit.

The muscular system.—Not a single muscle was clearly differentiated from the surrounding connective tissue. They were arranged in ill-defined sheets; at some points the muscles became fused and inseparable from the subcutaneous tissue; deep muscles disappeared in parts of their course in bands of tissue; all the trunk muscles were represented, but attempts to keep accurate records of their arrangements were given up.

DESCRIPTION OF PLATE VIII,

Illustrating Mr. A. Keith's paper on the Anatomy and Nature of two Acardiac Acephalic Fœtuses.

The larger fœtus with the skin and subcutaneous tissue dissected away on the right side to show the cerebral and osseous systems.



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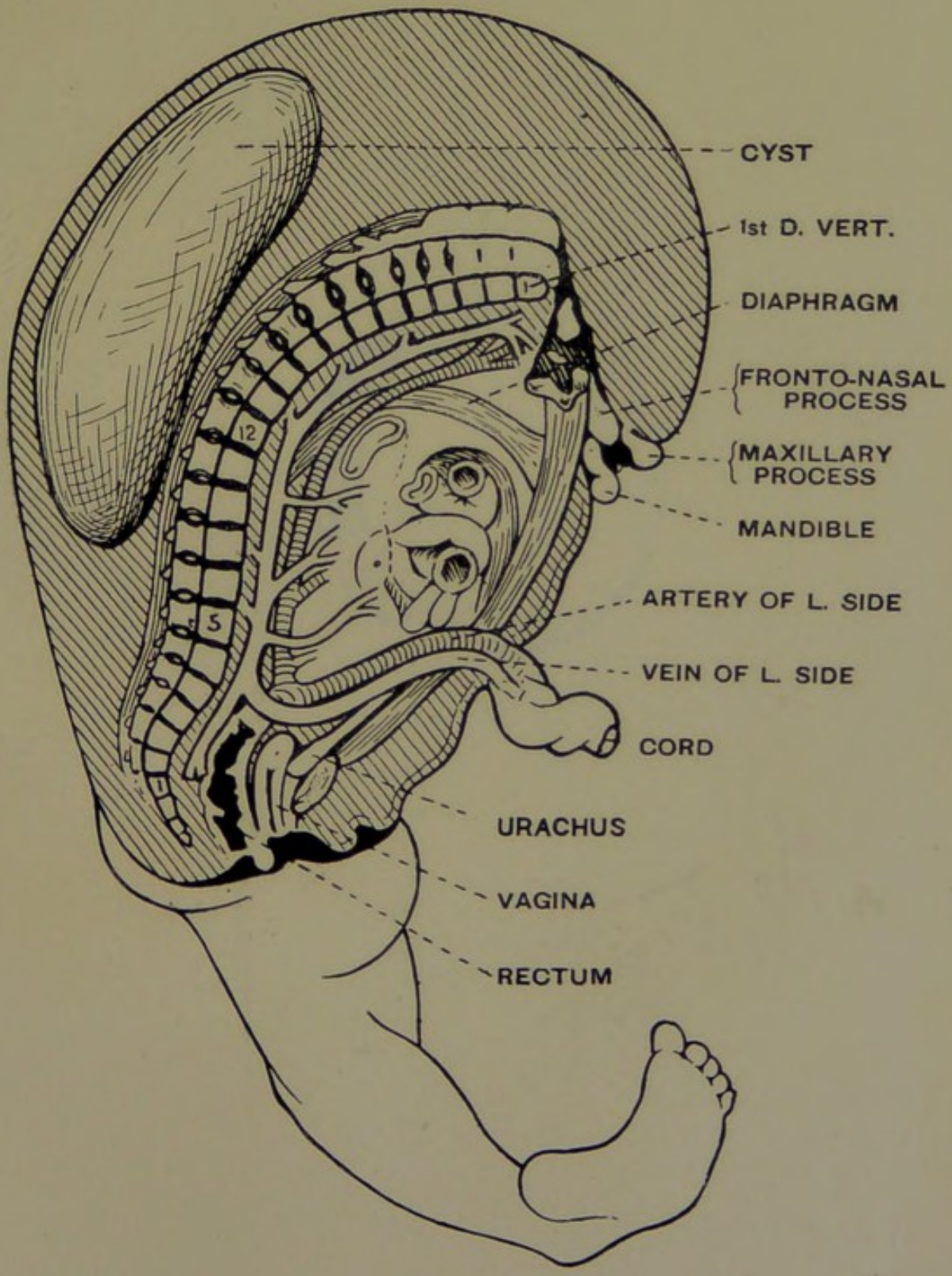
DESCRIPTION OF PLATE IX,

Illustrating Mr. A. Keith's paper on the Anatomy and Nature of two Acardiac Acephalic Fœtuses.

A mesial section of the smaller fœtus.



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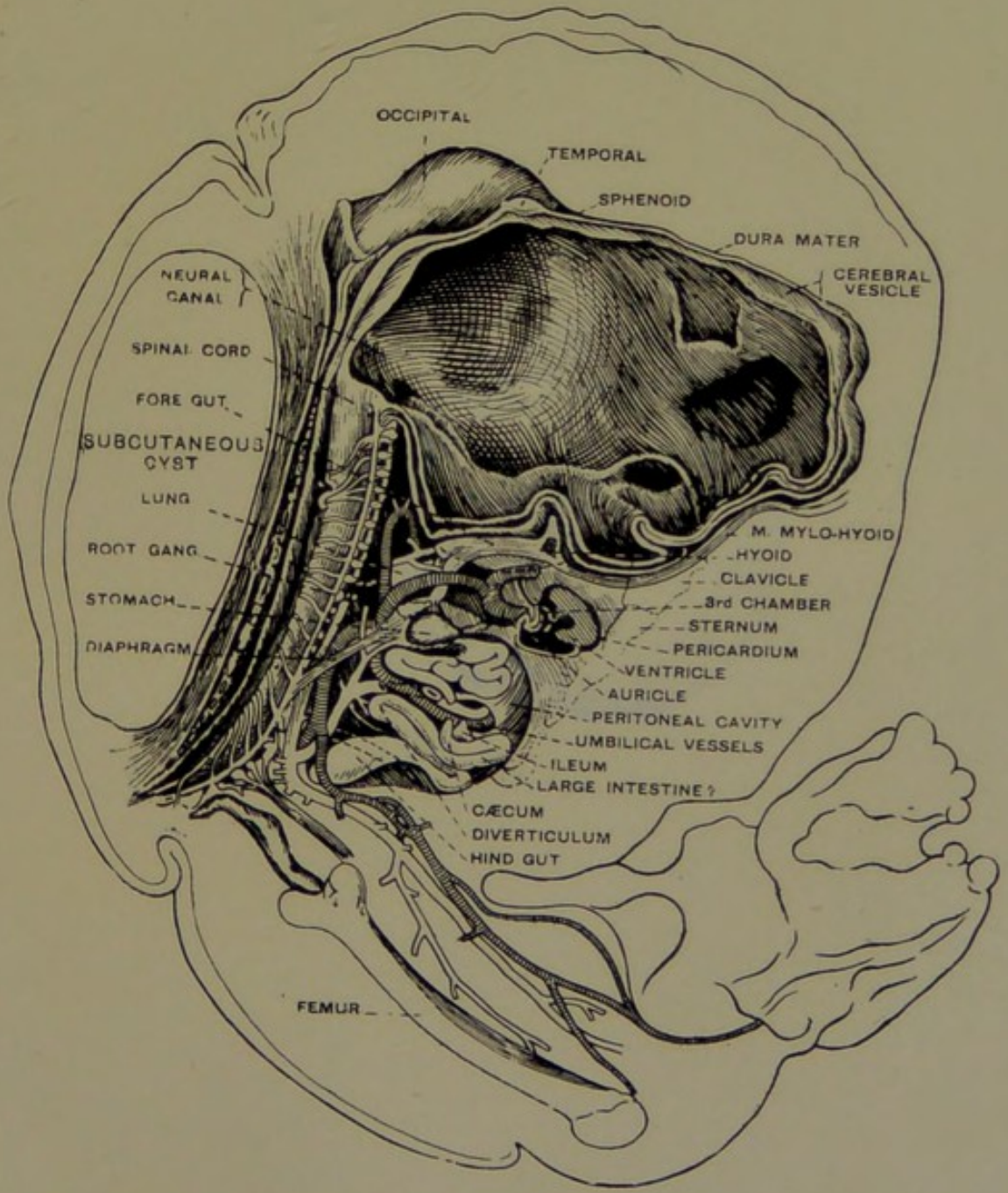
DESCRIPTION OF PLATE X,

Illustrating Mr. A. Keith's paper on the Anatomy and Nature of two Acardiac Acephalic Fœtuses.

Dissection of the larger fœtus to show the position of the heart an arrangement of vessels. The cerebral vesicle is shown in section.



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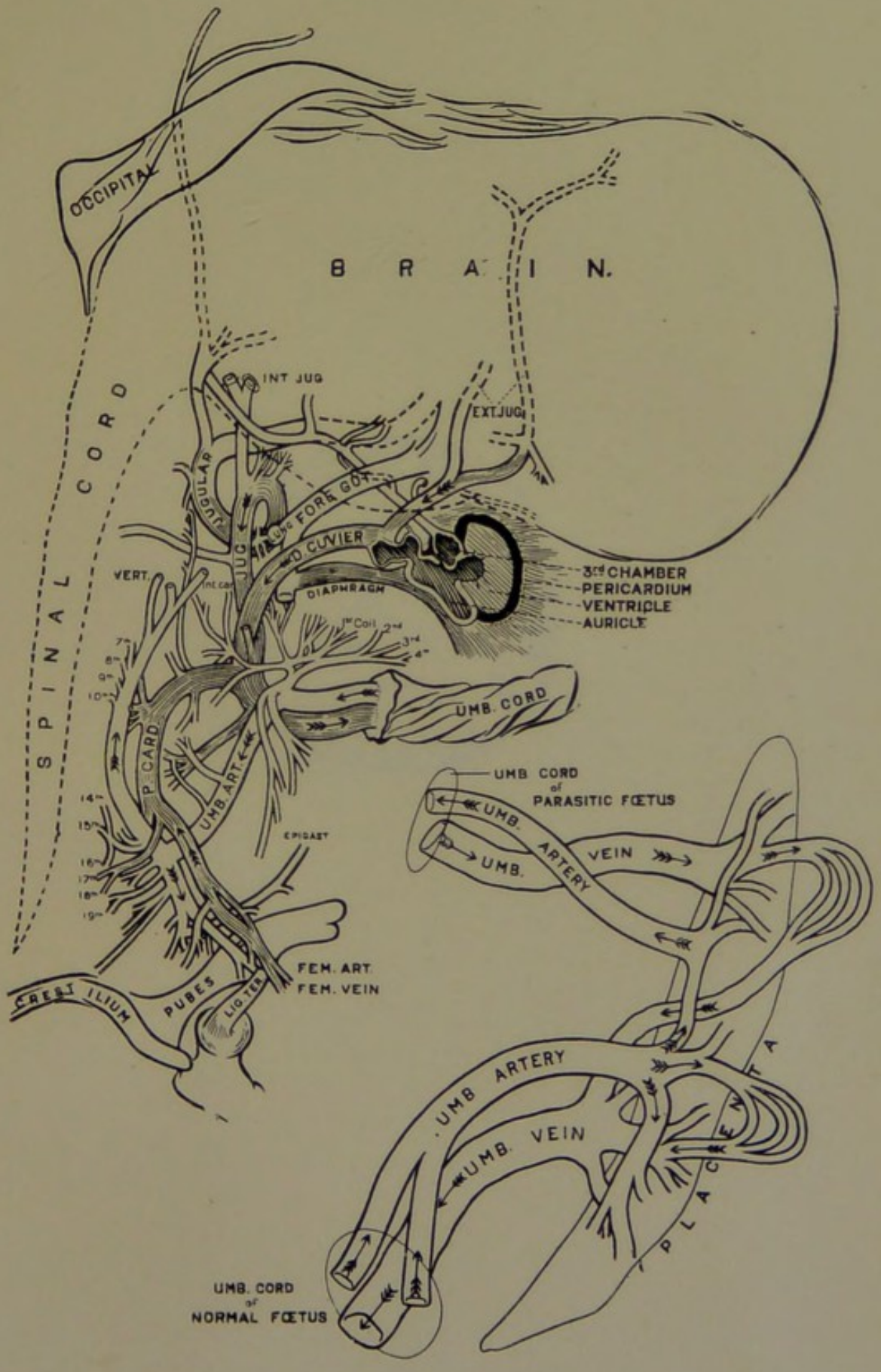
DESCRIPTION OF PLATE XI,

Illustrating Mr. A. Keith's paper on the Anatomy and Nature of two Acardiac Acephalic Fœtuses.

The vascular system of the larger fœtus. In the right hand lower corner the probable connection between the placental circulations of the "host" and "parasite" is shown.



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