

ADVANTAGES OF SAGITTAL SECTIONS OF PIG EMBRYOS FOR A MEDICAL EMBRYOLOGY COURSE¹

WILLIAM F. ALLEN

*From the Department of Anatomy of the University of Oregon Medical School,
Portland, Oregon*

EIGHT FIGURES

The writer has recently been impressed with the superiority of sagittal sections over transverse sections for most of the laboratory work of medical students in embryology. By the time the ordinary student has familiarized himself with the various turns found in a transverse series and has determined the direction required to follow forward or backward one of the three or four sections of the same organ found in a single transverse section, a considerable portion of the short time allotted for this course has elapsed. Since the time is insufficient for the student making graphic or wax reconstructions of the various systems, the little knowledge obtained by student, when only transverse sections are supplied, is usually acquired from a study

¹ It is assumed in most medical embryological laboratories that pre-medical students have had work in maturation, fertilization, segmentation and the early development of the main systems in some vertebrate. The aim of a medical course then is to obtain in as short time as possible a fairly comprehensive understanding of the formation of the various structures and organs of the body. To accomplish this the student should have access to a number of different stages of human embryos and their placenta, and to a collection of cleared embryos that will show the formation of the skeleton. In our laboratory every two students are supplied with a slide box containing a longitudinal and a transverse series of a 6 mm. pig embryo, a transverse section of a 12 mm. pig, twelve specially selected transverse sections of a 25 mm. pig and two 15 mm. pigs for dissection of the viscera, central nervous system and the cranial nerves. The writer is an advocate of the method of taking up the laboratory work from the standpoint of one system at a time, rather than attempting the study of all systems simultaneously.

of the laboratory models or from his general didactic instruction rather than from a study of his transverse sections.

It must be admitted, however, that for certain special studies, as for example, the origin and distribution of the cranial and spinal nerves, the organs arising from the branchial arches, certain relationships of the heart chambers and the formation of the vertebrae, transverse sections should be consulted. To amplify further, a transverse section through the otocyst of a 6 or 12 mm. pig embryo, which is a more or less frontal section through the rhombencephalon, affords an excellent view of the cranial nerves and their ganglia. Likewise certain transverse sections in the trunk region, especially of 20 and 25 mm. embryos, will give excellent pictures of the spinal nerve components and the various elements that go to make up a vertebra.

All of the illustrations for this paper were taken from a single sagittal series of a 6 mm. pig embryo, belonging to a student's loan set.

ALIMENTARY CANAL

A study of the development of the alimentary canal and the formation of its appendages is one of the first studies that can be made satisfactorily from an examination of a sagittal series of a 6 mm. pig. If the student will examine a median sagittal section through the pharynx region he will be able to follow the course of the digestive tract from the oral cavity to the branching off of the lung bud, and from especially favorable sections (fig. 1) this tube can be seen in section from the oral cavity to the outbudding of the dorsal pancreas. From its dorsal wall the following protuberances have appeared, enumerated from before backward: Rathke's pocket (*R.P.*) and its relationship to the infundibulum, Sessel's pocket (*S.P.*) and the dorsal pancreas (*D.Pan.*) The following ventral evaginations are shown: Thyroid gland (*Thyr.*) situated near the external carotid artery, the trachea bud (*Tr.*) from its origin to its separation into the two bronchi, the gall bladder (*G.Bl.*) and the hepatic portion of the liver (*Liv.*). The student should make an outline sketch of this section, incorporating in it the above mentioned portions of the alimentary canal. An examination of a few following sec-

tions brings us to the section from which figure 2 was drawn. From such a section the student can supply the cephalic arm of the intestinal loop (*Int.*) to his drawing of the digestive tract, and a few sections more (fig. 3) will supply a large portion of the caudal arm of the intestinal loop and the caudal end of the intestine (*Int.*) nearly to the cloaca. This section (fig. 3) also shows the position of the distal end of the ventral pancreas (*V.Pan.*), which can be readily followed from adjacent sections to its origin from the intestine at the point of the budding off of the gall bladder. When the caudal portion of the intestine has been added to the drawing of the digestive tract, the student has obtained a very satisfactory picture of the embryonic digestive tube and a number of its appendages from a study of three sagittal sections of a 6 mm. pig embryo. The cloaca end of the alimentary canal can also be studied from this series but will be taken up under the next subdivision.

URINARY SYSTEM

Any of the lateral sections of this 6 mm. sagittal pig series will show the extent and structure of the mesonephros. From figure 4, which is a sagittal section through the cephalic end of the mesonephros, it is clear that the mesonephros (*Meson.*) is composed of collecting tubules, glomeruli and a mass of undifferentiated mesenchyme.

In most sagittal series of pig embryos the extreme lateral sections are almost as perfect transverse sections through the tail or cloaca region as those from a frontal series and are far superior to corresponding sections from a transverse series. It is apparent that a few perfectly true transverse sections through the cloaca region will give the student a very clear conception of the relationship of the various ducts of the embryonic kidney; while it is equally true that nothing can be more confusing than an equal number of oblique transverse sections through this region. In figure 5, which is a more lateral section of the same sagittal series as figures 1 to 4 we have a nearly transverse section through the cephalic end of the cloacal (*Cl.*) expansion of the intestine. In this section both of the mesonephric or

Wolffian ducts are cut transversely and the left one (*L.W.D.*) is about to empty into the cloaca. It is from this region in a 7 mm. pig that the metanephric ducts or ureters bud off from the mesonephric or Wolffian ducts. Ventrally the allantois (*Al.*) is leaving the cloaca to enter the umbilicus. A more lateral section (fig. 6), which is through a more caudal region of the cloaca than figure 5, shows the left mesonephric or Wolffian duct *L.W.D.* emptying into the cloaca. In a still more lateral section (fig. 7) the right mesonephric or Wolffian duct (*R.W.D.*) will be seen terminating in the cloaca, which is rapidly diminishing in size to become the postgut in figure 8 (*P.G.*). In figures 6 to 8 the allantois (*Al.*) has entered the umbilicus with the umbilical blood vessels and is situated midway between the two umbilical arteries.

BLOOD VESSELS

Sagittal sections are especially useful for a study of the general arrangement of the principal blood vessels, which in general run for long distances in a longitudinal direction.

Veins

A slightly lateral sagittal section (fig. 4) furnishes an excellent view of the main venous trunks of a 6 mm. pig. The right atrium (*R.At.*), ventricle (*R.Ven.*) and the conus or bulbus arteriosus are seen in their correct position. This section is a little to the right of the atrio-ventricular opening. The sinus venosus (*S.V.*) will be seen opening into the right atrium, its orifice being partly guarded by the sinu-atrial valves (*S.A.V.*) The endothelial lining of the heart chambers is clearly shown and the cardiac muscle is in an early stage of its histogenesis.

From figure 4 it is clear that the sinus venosus receives the entire venous blood from the embryo and the entire arterial supply from the fetal placenta. Entering the sinus venosus from above, the short right ductus Cuvieri or common cardinal vein (*R.D.C.*) is formed from the union of the right anterior cardinal vein (*R.A.C.V.*), with the right posterior cardinal vein (*R.P.C.V.*). The former comes from the head and neck and the

latter collects the intersegmental veins (*Ints.V.*) from the body walls, the mesonephric veins from the mesonephros and a sub-cardinal vein (*Sub. C.V.*) traversing the ventral surface of the mesonephros. From below the left ductus Cuvieri or common cardinal vein (*L.D.C.*) joins the sinus venosus, and after curving around the lower and left side of the pharynx it takes origin from the union of anterior and posterior cardinal veins from the left side of the body. Not far from its termination in the sinus venosus the left ductus Cuvieri receives the left umbilical vein (fig. 1, *L.Umb.V.*). The terminal portion of this vein probably represents the terminal portion of the original omphalo-mesenteric vein. From the rear the sinus venosus is continuous with a large sinusoid (*S*), which might be designated as a part of the ductus venosus, but which probably represents an enlargement of the original proximal or terminal portion of the right omphalo-mesenteric vein. Sinusoid (*S*) collects the portal or common omphalo-mesenteric vein (*P.V.*) and the right umbilical vein (*R.Umb.V.*) from the rear, the former being somewhat more dorsal in position. Toward the median line sinusoid (*S*) is continuous with a large transverse sinusoid, the ductus venosus, which extends transversely through the cephalic end of the liver to communicate with the left umbilical vein. The position of the ductus venosus is shown in figures 2 and 3 (*D.V.*) to be more dorsal on the right side than on the left, which has doubtless been brought about by the difference in level of its two terminal connections, sinusoid (*S*) and the sinus venosus on the right side and the left umbilical vein and left ductus Cuvieri on the left side.

A comparison of the two umbilical veins reveals the left one to be slightly the larger. After entering the lower left corner of the liver the left umbilical, pursues a fairly straight course through the first half of the liver, to finally bend dorsad and cephalad to terminate in the left ductus Cuvieri (fig. 1, *L.D.C.*). As previously stated the left umbilical vein is also in direct communication with the sinus venosus through the ductus venosus. The opening of the left umbilical vein into the left ductus Cuvieri is fully as large as its communication with the ductus venosus, so that the blood in the left umbilical vein would have an option

of two ways of reaching the sinus venosus and the heart. Also the blood in the right side of the liver, collected in sinusoid (*S*) could easily find its way into the sinus venosus by way of the ductus venosus and the left ductus Cuvieri. The right umbilical vein will be seen in the lateral sagittal sections 5 and 6 (*R. Umb.V.*) to traverse the lateral wall of the abdomen a little below the level of the mesonephros and to enter the umbilicus in the region of the cloaca. Likewise corresponding sections on the left side of this embryo would show a similar distribution of the left umbilical vein. Upon entering the umbilicus the umbilical veins are situated laterally to their corresponding arteries (figs. 5 and 6), but soon assume a caudal position (fig. 7, *R.Umb.V.* and *R.Umb.A.*). A still more lateral section (fig. 8 shows the umbilical veins have united more distally in the umbilicus to form a common umbilical vein (*Umb.V.*).

In addition to the connection between the two umbilical veins through the liver, the ductus venosus, there is a smaller anastomosing vein between the two umbilicals behind the liver. It appears (figs. 2 and 3, *A.V.*) in the mesenchyme directly below the pancreas, midway between the liver and the cephalic arm of the intestinal loop.

The portal vein (fig. 3, *P.V.*), representing in part the combined omphalo-mesenteric veins, occupies a general median position a little to the right of the digestive tract. In figure 3 it will be seen passing between the dorsal and the ventral pancreas to enter the caudal surface of the liver slightly median and dorsal to the right umbilical vein. These two veins are portrayed in figure 4 as anastomosing inside the liver, the common trunk after expanding into sinusoid (*S*) enters the sinus venosus from the rear. A short distance behind the dorsal pancreas (fig. 1) the portal vein takes origin from the union of the superior mesenteric vein with the omphalo-mesenteric vein. The former (*Mes.V.*) comes from the caudal region and the latter (fig. 2, *O.M.V.*) passes dorsad in front of the cephalic arm of the intestinal loop and represents the original right omphalo-mesenteric vein. At the junction of the omphalo-mesenteric vein with the superior mesenteric vein to form the portal vein,

a small branch is received from the region of the pancreas. It likely represents a persisting portion of the original left omphalo-mesenteric vein. There is a communicating vein between the portal and subcardinal veins.

Arteries

Excepting in the extreme cephalic and caudal extremities of a 6 mm. pig embryo the originally paired dorsal aortae have fused and formed a median longitudinal trunk of considerable size, the aorta. Most any median sagittal section of this series (fig. 3) will show long stretches of the aorta (*Ao.*) situated below the notochord and extending out laterally beyond the limits of the spinal cord. In figure 4 a portion of the original right dorsal aorta, now the right internal carotid artery (*Ao.*), is present in connection with the third branchial artery. Figures 1 and 2 show the intersegmental arteries (*Ints.A.*) to be well-advanced. It will be seen from figures 2 and 3 that the omphalo-mesenteric artery (*O.M.A.*) takes origin from the aorta from three stems, which soon unite in a single trunk that passes ventrally between the two arms of the intestinal loop. The bulbus or conus arteriosus (*C.A.*) and the ventral aorta (*V.Ao.*) are cut more or less longitudinally in figures 1, 2 and 3. In figure 2 the basal portion of the third, fourth and the sixth or fifth right branchial arteries are present in connection with the ventral aorta, and nearly the entire course of the right sixth or fifth branchial artery (*Br.A. 5*) can be followed from the ventral aorta to the right dorsal aorta. In figure 3 a considerable of the right fourth branchial artery (*Br.A. 4*), especially the distal portion terminating in the right dorsal aorta, is seen between the third and fourth branchial clefts. A similar portion of the right third branchial artery (*Br.A. 3*) empties into the right dorsal aorta or external carotid artery (*Ao.*) in figure 4. In figure 1 a small portion of the right external carotid artery (*E.Car.A.*) appears in the region of the thyroid gland. The pulmonary and subclavian arteries are not shown in any of the sections figured. They are best followed in transverse sections.

CENTRAL NERVOUS SYSTEM

In most any median sagittal section of a 6 mm. pig embryo, as figure 1, the primary, secondary and tertiary segmentation of the neural tube can be readily distinguished. The neuromeres (*Neuro.*) or primary segments are clearly defined in the medulla region. Concerning the secondary segments of the brain region, the forebrain occupies all the space in front of the dotted line between the cavities (*Dien.*) and (*Mes.*), the midbrain corresponds to the division (*Mes.*) and the remaining portion of the brain behind the mesencephalon (*Met.* and *My.*) represents the hindbrain. The tertiary segments- telencephalon (*Tel.*), diencephalon (*Dien.*), mesencephalon (*Mes.*), metencephalon (*Met.*) and myelencephalon (*My.*) are well-differentiated in this section. The boundry line between the diencephalic and telencephalic segments, as determined by Johnston for early embryos, is a line between the velum transversum (*V.T.*) and the postoptic recess (*P.O.R.*) or between the caudal borders of the interven-tricular foramen and the optic chiasma for later stages. The following diverticula appear in the basal plate of the diencephalon- mamillary recess (*M.R.*), infundibular recess (*I.R.*), post-optic recess (*P.O.R.*) and the preoptic recess (shown in front of the postoptic recess and the optic chiasma thickening). In the telencephalon the expansion of the hemispheres (*C.H.*) is apparent, but is more conspicuous in more lateral sections (fig. 3). The roof plate of the rhombencephalon (metencephalon and myelencephalon) is for the most part reduced to one layer of flattened cells, the mesoderm outside is vascular and there is considerable stained coagulum within the fourth ventricle, giving every indication that the roof plate (tela chorioidea) has attained the function of producing cerebro-spinal fluid. The cervical (*Cer.F.*) and cephalic (*Ceph.F.*) flexures are prominent in this section, but the pontine flexure (*Pon.F.*) is barely visible. Concerning the histogenesis of the central nervous system (figs. 1 to 4) show an early differentiation of the neural tube into ependymal, mantle and marginal layers, and the germinal cells are proliferating rapidly about the ventricles and the central canal.

SOMITES

To illustrate the early differentiation of the somites into myotome and sclerotome, the extreme lateral sections of this series, which are nearly transverse sections through the tail, are especially valuable, for the reason that the caudal somites are in a much more elementary state than the cephalic somites. In such a section (fig. 8) the central cavity of the right somite is filled with spindle-shaped cells that migrated from the walls of the somite. From the somite on the opposite or left side of this section it will be seen that this migration took place mainly from the median and ventral walls of the somite. These diffuse spindle-shaped cells, the future sclerotome (*Scl.*), are about to migrate medially to envelop the notochord and the spinal cord to form the skeletal axis. The outer or more dense portion, the myotome (*Myo.*) has differentiated into myoblasts and muscle fibrils in a more cephalic region (fig. 3, *Myo.*). Also the neighboring sclerotomes (*Scl.*) have differentiated into dense and diffuse portions, preparatory to the formation of the membranous vertebrae. It is obvious that later stages are necessary for the further study of the development of the vertebrae and trunk muscles.

PLATE 1

EXPLANATION OF THE FIGURE

1 Median sagittal section of a 6 mm. pig embryo (Class series No. 4, U. O. M.S.). This section shows the cephalic end of the digestive tract and diverticula from the oral cavity to the dorsal pancreas, and is a median sagittal section through the brain. It passes through the left side of the heart, displays the left umbilical vein terminating in the left ductus Cuvieri and shows the origin of the portal vein from the superior mesenteric and omphalo-mesenteric veins
 X 26

ABBREVIATIONS

<i>Ao.</i> , aorta	<i>My.</i> , myelencephalon
<i>Ceph.F.</i> , cephalic flexure	<i>Neuro.</i> , neuromeres
<i>Cer.F.</i> , cervical flexure	<i>Oes.</i> , oesophagus
<i>C.H.</i> , cerebral hemispheres or pallium	<i>O.M.V.</i> , omphalo-mesenteric vein
<i>Coe.</i> , coelom	<i>P.C.</i> , posterior commissure
<i>C.Q.</i> , corpora quadrigemina	<i>Per.C.</i> , pericardial cavity
<i>Crb.</i> , cerebellum	<i>Phar.</i> , pharynx
<i>Dien.</i> , diencephalon	<i>Pon.F.</i> , pontine flexure
<i>D.Pan.</i> , dorsal pancreas	<i>P.O.R.</i> , postoptic recess
<i>E.Car.A.</i> , external carotid artery	<i>P.V.</i> , portal vein
<i>End.C.</i> , endocardial cushion	<i>R.P.</i> , Rathke's pocket
<i>G.Bl.</i> , gall bladder	<i>Som.</i> , somatopleure
<i>Int.</i> , intestine	<i>S.P.</i> , Sessel's pocket
<i>I.R.</i> , infundibular recess	<i>Sp.Cd.</i> , spinal cord
<i>Isth.</i> , isthmus	<i>Spl.</i> , splanchopleure
<i>L.At.</i> , left atrium	<i>S.Tr.</i> , septum transversum
<i>L.D.C.</i> , left ductus Cuvieri	<i>Tel.</i> , telencephalon
<i>Liv.</i> , liver	<i>Tela.</i> , tela chorioidea
<i>L.Umb.V.</i> , left umbilical vein	<i>Thyr.</i> , thyroid
<i>L.Ven.</i> , left ventricle	<i>T.P.</i> , tuberculum posterius
<i>Mes.</i> , mesencephalon	<i>Tr.</i> , trachea bud
<i>Mes.V.</i> , superior mesenteric vein	<i>Umb.</i> , umbilicus
<i>Met.</i> , metencephalon	<i>V.Ao.</i> , ventral aorta
<i>M.R.</i> , mamillary recess	<i>V.T.</i> , velum transversum

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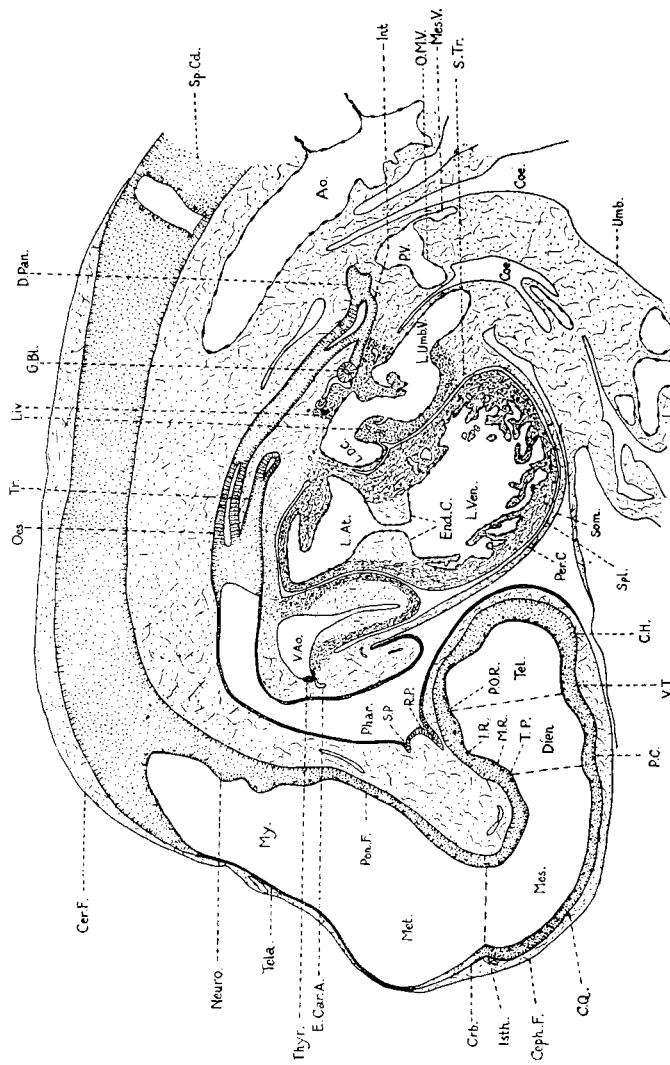


PLATE 2

EXPLANATION OF THE FIGURE

Sagittal section 111 microns to the right of figure 1, introduced to show: the cephalic arm of the intestinal loop, the ductus venosus, the anastomosing vein between the umbilical veins behind the liver, position of the omphalo-mesenteric vein and the aorta, source of the omphalo-mesenteric artery, and course of the sixth or fifth branchial artery. $\times 26$

ABBREVIATIONS

<i>Ao.</i> , aorta	<i>Liv.</i> , liver
<i>A.V.</i> , anastomosing v. between umb. v-s	<i>L.Ven.</i> , left ventricle
<i>Br.</i> , bronchus bud	<i>Mes.</i> , mesencephalon
<i>Br.A.3</i> , third branchial artery	<i>Met.</i> , metencephalon
<i>Br.A.4</i> , fourth branchial artery	<i>Neuro.</i> , neuromeres
<i>Br.A.5</i> , sixth or fifth branchial a.	<i>O.M.A.</i> , omphalo-mesenteric artery
<i>Coe.</i> , coelom	<i>O.M.V.</i> , omphalo-mesenteric vein
<i>Crb.</i> , cerebellum	<i>Per.C.</i> , pericardial cavity
<i>Dien.</i> , diencephalon	<i>Phar.</i> , pharynx
<i>D.Pan.</i> , dorsal pancreas	<i>P.V.</i> , portal vein
<i>D.V.</i> , ductus venosus	<i>R.P.</i> , Rathke's pocket
<i>G.Bl.</i> , gall bladder	<i>S.P.</i> , Sessel's pocket
<i>Int.</i> , intestine	<i>Sp.Cd.</i> , spinal cord
<i>Ints.A.</i> , intersegmental artery	<i>Sp.G.</i> , Spinal ganglion
<i>L.At.</i> , left atrium	<i>Tel.</i> , telencephalon
<i>L.D.C.</i> , left ductus Cuvieri	<i>Umb.</i> , umbilicus
	<i>V.Ao.</i> , ventral aorta

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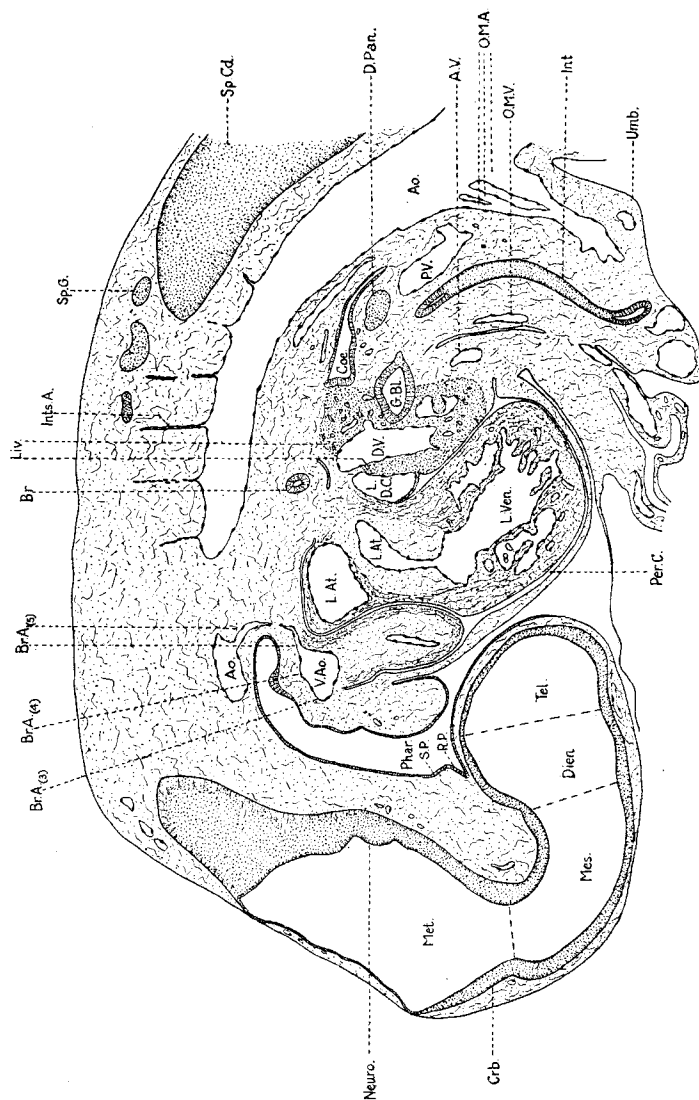


PLATE 3

EXPLANATION OF THE FIGURE

3 Sagittal section 113 microns to the right of figure 2. It shows part of the caudal arm of the intestinal loop and the caudal end of the intestine to the cloaca, the relation of the dorsal pancreas to the ventral pancreas, entire length of the portal vein from its source to its termination in sinus (*S*) within the liver, the ductus venosus and the anastomosing vein between the two umbilical veins behind the liver, nearly all of the aorta, parts of the third, fourth and sixth or fifth branchial arteries, and several of the cephalic myotomes and sclerotomes.
 × 26

ABBREVIATIONS

<i> Ao.</i> , aorta	<i> Liv.</i> , liver
<i> A.V.</i> , anastomosing v. between umb.	<i> Mes.</i> , mesencephalon
<i> V-S</i>	<i> Myo.</i> , myotome
<i> Br.</i> , bronchus bud	<i> Neuro.</i> , neuromeres
<i> Br.A.3</i> , third branchial artery	<i> O.M.A.</i> , omphalo-mesenteric artery
<i> Br.A.4</i> , fourth branchial artery	<i> Per.C.</i> , pericardial cavity
<i> Br.A.5</i> , sixth or fifth branchial a.	<i> Phar.</i> , pharynx
<i> Br.C.2</i> , second branchial cleft	<i> P.V.</i> , portal vein
<i> Br.C.3</i> , third branchial cleft	<i> R.At.</i> , right atrium
<i> C.A.</i> , conus or bulbus arteriosus	<i> R.Ven.</i> , right ventricle
<i> Coe.</i> , coelum	<i> Scl.</i> , sclerotome
<i> Dien.</i> , diencephalon	<i> Sp.Cd.</i> , spinal cord
<i> D.Pan.</i> , dorsal pancreas	<i> Sp.G.</i> , spinal ganglion
<i> D.V.</i> , ductus venosus	<i> S.Tr.</i> , septum transversum
<i> G.Bl.</i> , gall bladder	<i> Tel.</i> , telencephalon
<i> Int.</i> , intestine	<i> Tela.</i> , tela chorioidea
<i> L.D.C.</i> , left ductus Cuvieri	<i> V.Pan.</i> , ventral pancreas

ADVANTAGES OF SAGITTAL SECTIONS

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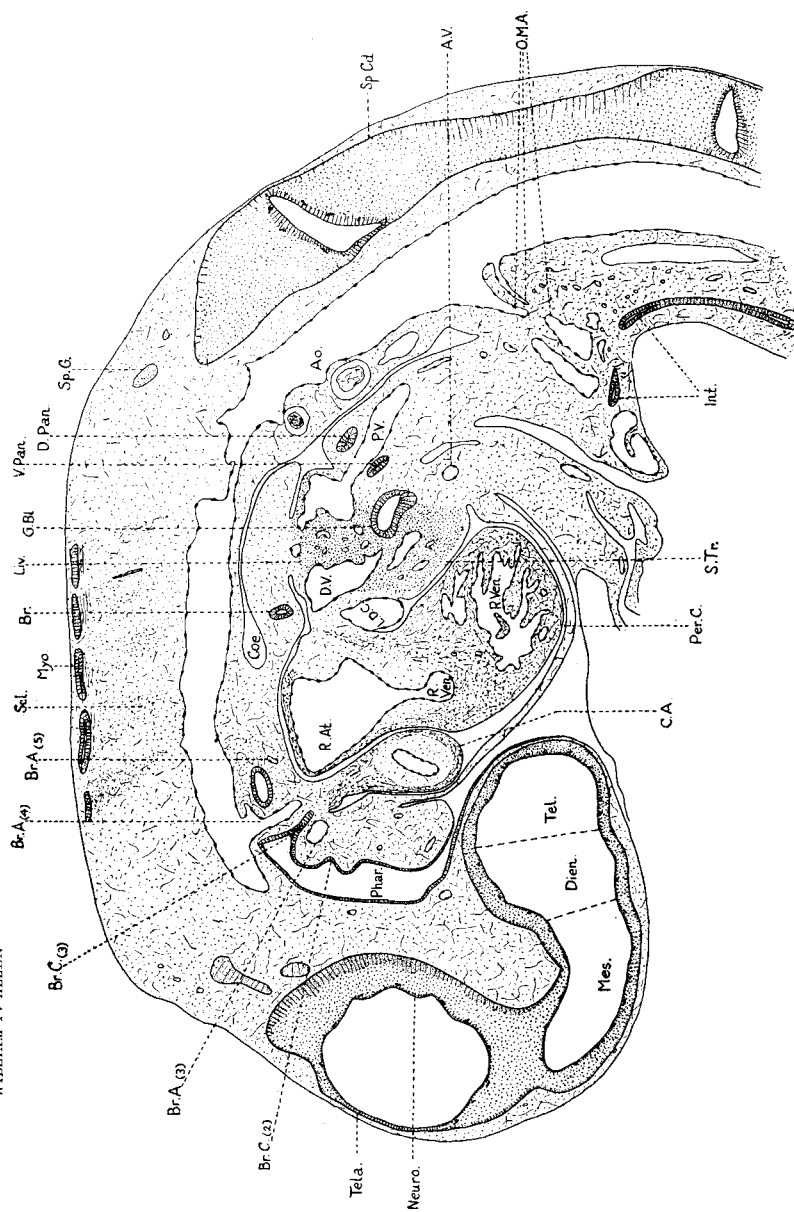


PLATE 4

EXPLANATION OF THE FIGURE

4 Sagittal section 180 microns to the right of figure 3, which is considerably to the right of the median line, passing through the entrance of the sinus venosus into the right atrium. It shows nearly all of the principal veins of the right side, the portal vein and the left ductus Cuvieri emptying into the sinus venosus; also a portion of the original right dorsal aorta, now the right internal carotid artery, is present in connection with the third branchial artery. $\times 26$

ABBREVIATIONS

<i>Am.</i> , amnion	<i>Phar.</i> , pharynx
<i>Ao.</i> , aorta	<i>P.V.</i> , portal vein
<i>Br.A.3</i> , third branchial artery	<i>R.A.C.V.</i> , right anterior cardinal vein
<i>Br.C.1</i> , first branchial cleft	<i>R.At.</i> , right atrium
<i>Br.C.2</i> , second branchial cleft	<i>R.D.C.</i> , right ductus Cuvieri
<i>Br.C.3</i> , third branchial cleft	<i>R.P.C.V.</i> , right posterior cardinal vein
<i>C.A.</i> , conus or bulbus arteriosus	<i>R.Umb.V.</i> , right umbilical vein
<i>C.H.</i> , cerebral hemisphere or pallium	<i>R.Ven.</i> , right ventricle
<i>Coe.</i> , coelom	<i>S.</i> , large sinusoid emptying into the sinus venosus
<i>Gl.</i> , glomerulus	<i>S.A.V.</i> , sinu-atrial valves
<i>Ints.V.</i> , intersegmental vein	<i>Som.</i> , somatopleure
<i>L.D.C.</i> , left ductus Cuvieri	<i>Spl.</i> , splanchnopleure
<i>Liv.</i> , liver	<i>Sub.C.V.</i> , subcardinal vein
<i>Meson.</i> , mesonephros	<i>S.V.</i> , sinus venosus
<i>Myo.</i> , myotome	<i>Umb.</i> , umbilicus
<i>Ot.</i> , otocyst	
<i>Per.C.</i> , pericardial cavity	

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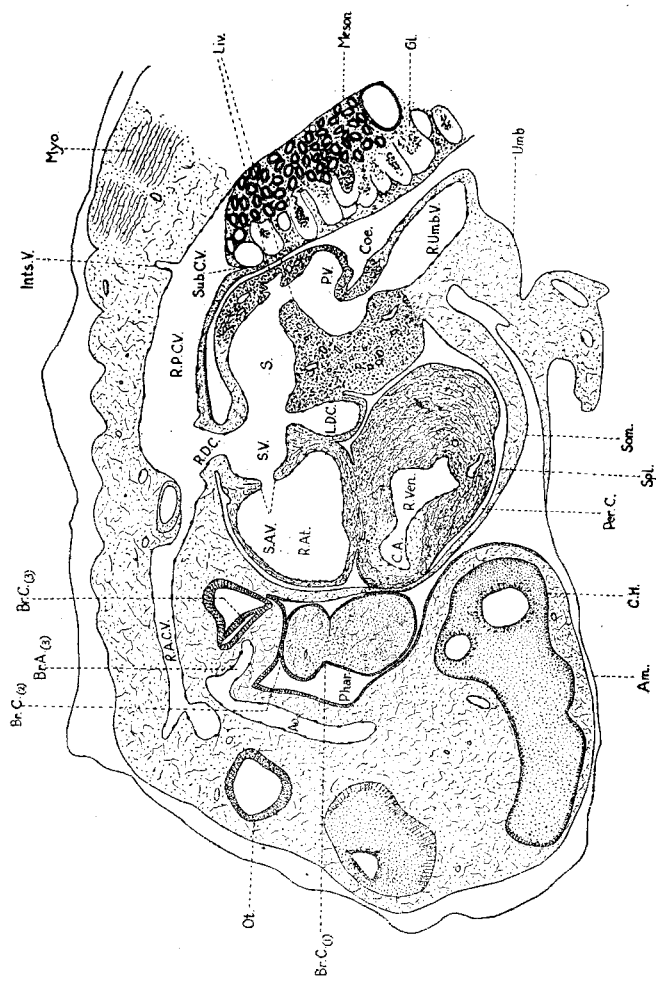


PLATE 5

EXPLANATION OF THE FIGURE

5 Sagittal section considerably lateral to those from which figures 1 to 4 were drawn. This section is a sagittal section through the right mesonephros and the right umbilical vein, but a nearly transverse section through the tail region at the level of the beginning of the umbilicus and cloaca. Note that the left umbilical artery and vein have entered the umbilicus and the right artery and vein are entering it. Observe that the cloaca, mesonephric or Wolffian ducts are cut in transverse section and the allantois is in connection with the cloaca. $\times 26$

6 Sagittal section but 50 microns to the right of figure 5. Observe that the allantois has lost its connection with the cloaca and is situated midway between the umbilical arteries in the umbilicus; also that the left mesonephric or Wolffian duct has joined the cloaca. $\times 26$

ABBREVIATIONS

<i>Al.</i> , allantois	<i>Nc.</i> , notochord
<i>Cl.</i> , cloaca	<i>R.Umb.A.</i> , right umbilical artery
<i>L.Umb.A.</i> , left umbilical artery	<i>R.Umb.V.</i> , right umbilical vein
<i>L.Umb.V.</i> , left umbilical vein	<i>R.W.D.</i> , right Wolffian or mesonephric
<i>L.W.D.</i> , left Wolffian or mesonephric	duct
duct	<i>Sp.Cd.</i> , spinal cord
<i>Meson.</i> , mesonephros	<i>Umb.</i> , umbilicus
<i>Myo.</i> , myotomes	

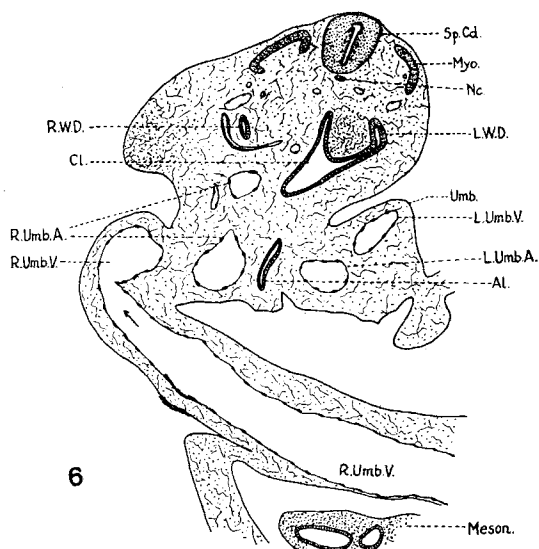
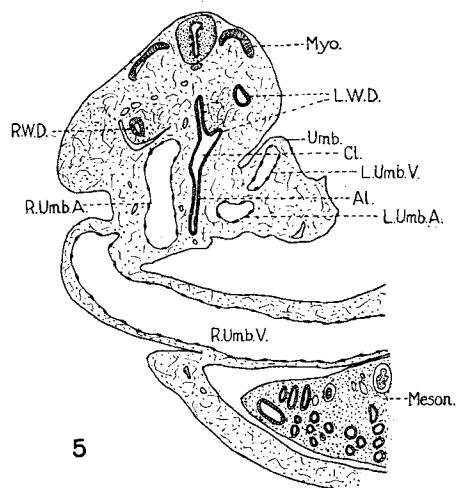


PLATE 6

EXPLANATION OF THE FIGURES

7 Sagittal section 200 microns to the right of figure 6, a more caudal section through the embryo and a more ventral or distal section through the umbilicus. Observe that the umbilicus has nearly lost connection with the embryo, that the umbilical veins are situated behind their corresponding arteries and are about to anastomose. The right mesonephric or Wolffian duct will be seen terminating in the cloaca, which has become much reduced in caliber. $\times 26$.

8 Sagittal section 220 microns lateral to figure 7, a more caudal transverse section of the embryo and a more distal transverse section of the umbilicus. Note that the umbilical veins have united in a common vein and the reduction in size of the digestive tract from the cloaca to a small postgut. $\times 26$

ABBREVIATIONS

<i>Al.</i> , allantois	<i>R.Umb.V.</i> , right umbilical vein
<i>Cl.</i> , cloaca	<i>R.W.D.</i> , right mesonephric or Wolffian duct
<i>L.Umb.A.</i> , left umbilical artery	<i>Scl.</i> , sclerotome
<i>L.Umb.V.</i> , left umbilical vein	<i>Umb.</i> , umbilicus
<i>Myo.</i> , myotome	<i>Umb.V.</i> , umbilical vein (in umbilicus)
<i>P.G.</i> , postgut	
<i>R.Umb.A.</i> , right umbilical artery	

