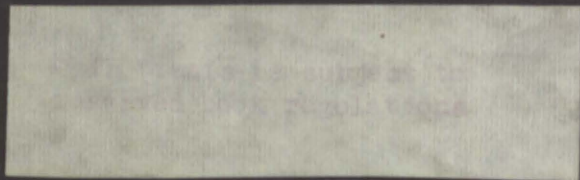
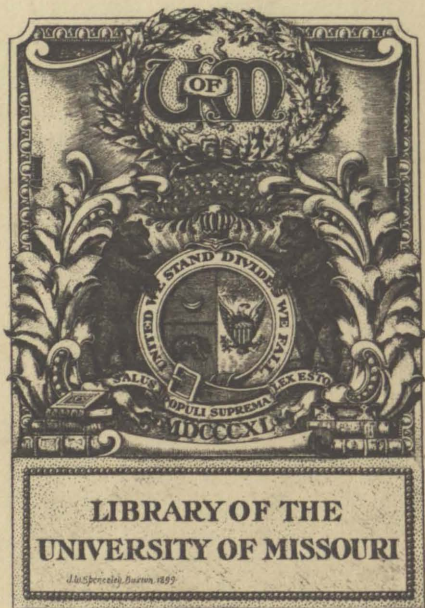


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THE ARTERIAL SYSTEM OF A  
PIG EMBRYO 21.6 MM. IN LENGTH.

By

John Isaac Appleby, A. B.

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SUBMITTED IN PARTIAL FULFILLMENT OF THE  
REQUIREMENTS FOR THE DEGREE OF  
MASTER OF ARTS

in the

GRADUATE SCHOOL

of the

UNIVERSITY OF MISSOURI

1918.



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## THE ARTERIAL SYSTEM OF A PIG EMBRYO 21.6 MM. IN LENGTH.

This paper is one of a series describing the anatomy of a pig embryo of about 20 mm. in length, which work was undertaken several years ago in the Department of Anatomy of The University of Missouri under the supervision of Dr. Franklin P. Johnson\*. For the present work, pig embryo No. 1.23 of the Missouri Embryological collection, was used, which measured 21.6 mm. before sectioning. It was fixed in Zenkers solution, cut in transverse sections ten microns in thickness and stained with alum cochineal and orange G.

In securing the proper data for the complete description of the 20 mm. pig embryo, several methods were used. Graphic reconstructions of the whole arterial system were made, which have served as a basis for the present description. Wax models were also made when it was deemed necessary to show views of certain vessels in their third dimensions. For the most part the reconstructions have been compared with the dissections of post-natal pigs of only a few days old, the arterial systems of which are virtually the same as in the adult.

\* The heart of the 20 mm. pig embryo was described by T. F. Wheeldon in 1914; the digestive system by L. H. Rutledge in 1916.



The graphic reconstructions mentioned in the above paragraph include the following:-

(1) All the vessels of the left side of the body viewed from the left.

(2) A frontal reconstruction including all the arteries of the trunk and limbs.

(3) A mid-sagittal view of the tongue and adjoining structures.

(4) A lateral view of the nasal and mouth cavities, the semi-circular canals and various parts of the membranous labyrinth, the trachea and oesophagus, and related arteries.

(5) A graphic reconstruction of the chondroskeleton in the region of the trunk which showed the segmental vessels.

(6) A was reconstruction made by D.R. Thorn which has aided greatly in making clear the relations of the segmental vessels to other segmental structures. The author desires to express his thanks to Mr. Thorn for the use of this model.

In describing most of the paired vessels, I have described only those of the left side and have mentioned the right side only where it was necessary to make the description complete, or where notable points of difference exist. In the visceral region both sides of the embryo were described.



In the following description I have considered first, the ascending aorta and its branches; second, the aortic arch and its branches; and third, the descending aorta and its branches. The relations of the various vessels have been determined from the graphic reconstructions, dissections and wax models, and to a large extent by a study of the transverse sections of the embryo.

#### A -- AORTA ASCENDENS.

The ascending aorta ( A. Asc. Figs. 1, 2,) springs from the left at the level of the fourth rib, courses cephalad and dorsally, crosses the median line and swings over to the right side. It passes without demarcation into the aortic arch at the level of the lower border of the second rib. In its short course two prominent vessels are given off; the right and left coronary arteries. These have been described by Wheeldon. ( '14.)

#### B --ARCUS AORTAE.

The aortic<sup>arch</sup> ( Arc. A. Figs. 1,2,5, ) in the 20 mm. pig embryo has reached virtually its adult condition. It begins at the level of the second rib, a short distance to the right of the median line,



being the direct continuation of the ascending aorta. It curves dorsally and caudally completing the formation of the arch. Close to the articulation of the left second rib with the second thoracic vertebra it passes over without demarcation into the descending aorta. ( A. Desc. Figs. 1,2,5,)

In considering the branches of the aortic arch attention should be called to certain fundamental differences which exist between the vessels of the pig and man. In the adult pig as well as in the 20 mm. pig embryo there are two branches of the aortic arch; first, the bracio-cephalic and second, the left sub-clavian ( the common trunk for the vertebral, the left bracial and the dorsal arteries as described by Sisson ('14.)). The former which takes the place of the innominate and left common carotid arteries of man, gives rise to the right subclavian and an artery from which both carotids arise; the latter is identical with the human left subclavian.

#### 1.--Arteria braciocephalica.

The braciocephalic artery springs from the highest curvature of the aortic arch, ventral to the trachea and slightly to the <sup>left of</sup> median line.

( Fig. 1, 2, ) it is a very short branch, extend-





ing through a few sections. It terminates by dividing into two vessels, the bi-carotid trunk ( Art. bicarot Fig. 1, 2, 5, ) and the right subclavian artery ( art. subclav. R. Figs. 1,2,5,)

(a) Arteria bicaroticus-- The bicarotid artery ( art. bicarot. Figs. 1, 2, 5, ) is a short trunk which extends cephalad, ventral to the trachea and medial to the vagi and recurrent nerves, and the jugular veins. It lies in the median plane of the body and has no homologue in the human.

(1) Thymic artery-- The thymic artery ( art. thym. Fig. 1) is an exceedingly small unpaired median vessel, which arises from the ventral aspect of the bicarotid trunk cephalad to the right subclavian. In its first part it runs slightly cephalad and ventrally; in its distal parts it runs slightly caudad and ventrally. It extends between the unfused lobes of the thymus gland and passing beyond this organ terminates in the tissue cephalad to the pericardium. There is some doubt as to the actual identity of this above-named vessel; but due to its close relation to the thymus I have been led to the conclusion that it may come to supply this organ.

Although most of its branches extend beyond the



thymus into the tissue above the pericardial cavity, some extend into the gland.

The thyreocidea ima has been considered but since it is more closely related to the thymus than the thyreoid it is apparently a different vessel.

#### A'--ARTERIAE CAROTIDES COMMUNES.

The difference between the origin of the common carotid arteries in the pig and man has been alluded to above. Owing to the fact that in the human the right common carotid is a branch of the innominate while the left springs directly from the aortic arch, the two are of unequal lengths. In the pig however they are symmetrical vessels. ( art. carotid.comm. Figs. 1, 3, 5, )

#### 1.--Arteria carotis communis sinistra.

The left common carotid artery courses cephalad from its origin at the base of the neck. Branches from the common carotid artery supply the neck, head and face including some of the most important arteries of the brain. In its first part it lies ventrally to the trachea and oesophagus; in its proximal parts it lies laterally to these structures. It is closely related to the vagus nerve and jugular vein throughout its entire course. It terminates at the level of the developing hyoid bone( Reichert's cartilage)



by dividing into internal and external carotids. In its course it gives off a single branch, arteria thyroidea superior (art. carot. comm. sin. Figs. 1,2, )

According to Tandler ( '06.) the common carotid artery in pig embryos divides in the region of the neck after giving off the superior threoid artery. The division is generally as follows:--the stem divides into two prominent vessels of unequal size; the larger, which is the external carotid, courses anteriorly and medially; the smaller runs cranialward and soon divides into the internal carotid and occipital arteries. Sometimes the occipital artery arises independently so that the common carotid divides into three branches(vgl. Fig. 3,1, ).

(a) Arteria thyroidea superior--The superior thyreoid artery arises in the 20 mm. pig embryo from the common carotid artery. It gives off branches to the laryngeal muscles. A small branch which reaches the lateral lobe of the thyreoid gland at its most cephalic point, and a small terminal branch which courses caudally between the vagi and the recurrent nerves. The later branch can be followed for a considerable distance along the vagus nerve and may be



called arteria comes nervi vagi.

### 1<sup>1</sup>-- ARTERIA CAROTIS EXTERNA.

The first part of the external carotid artery lies ventral to the internal carotid artery and lateral to the oesophagus. It begins at the level of the interior border of the hyoid cartilage, courses cephalad and ventrally and terminates by dividing into the internal maxillary and the posterior auricular arteries. The external carotid is an important artery which gives rise to several vessels in the region of the face, although not a very long vessel itself( art. car. ext. Figs.1,2,)

Thyng('14.) in describing the external carotid artery in a human embryo 17.8 mm in length states; " This artery is a short stem which terminates by dividing into five branches:- the superior thyreoid, the occipital, the lingual, the external maxillary, and the posterior auricular arteries."

(a) Arteria laryngealis superior -- The superior laryngeal artery arises from the ventral wall of the external carotid artery just above the bifurcation of the common carotid. It extends caudally, lying ventral to the common carotid artery. It





breaks up into branches which supply the laryngeal muscles. In man this vessel supplies the thyroid gland as well. It is known as the superior thyroid artery, of which the superior laryngeal artery is a branch.

(b) *Arteria Lingualis*.-- The lingual artery (art. ling. Fig. 1, 2, 4) arises from the external carotid a short distance cephalad to the superior laryngeal artery on a level with the cartilage of the hyoid bone (art. sup. laryng. Fig. 1, 2, ). It passes anteriorly in the ventral part of the tongue, terminating near its tip. At its origin it is situated laterally and superficially, runs toward the median line and follows the back part of the styloglossal muscle in the root of the tongue. Its distal portion runs in the dorsum of the tongue in close proximity to the hypoglossal nerve.

His ('87 ) states that the lingual artery is among the first branches of the external carotid artery to form. Thyng ('14.) states in his description of the lingual arteries in a 17.8 mm human embryo that the lingual runs medially to the tongue and gives off a branch to the submaxillary gland.

(1) *Arteria Lingualis Dorsalis*.-- The dorsal



lingual artery; the smaller of the two collateral branches of the lingual artery; arises in the posterior ventral portion of the tongue; courses dorsally and terminates after running only a short distance in the dorsal part of the tongue. ( a. ling. dors. Figs.1.3.)

(2) Arteria sublingualis.----- The sublingual artery arises from the lingual a short distance inferiorly and anteriorly to the dorsal lingual artery. It courses in the ventral portion of the tongue medial to Meckel's cartilage and terminates near the median line, close to its fellow on the opposite side. (a. sub. ling. Figs. 1, 4, ).

Sisson ('14) mentions in his description of the adult pig that a branch of the lingual supplies the submaxillary gland. The above-described sublingual artery of the 20 mm. pig embryo probably supplies the submaxillary gland as in the adult.

(a) Arteria submentalis. --- Under this term is described a small branch which arises from the proximal portion of the sublingual artery. ( a. subment. Figs. 1, 3, 4, ) It is distributed to the mucous membrane of the lower lip. One small branch, probably muscular, arises from it and extends into the deeper structures.



posterior to the parent vessel. The description is in agreement with that of Bisson's for the horse, in which the submental is shown to be a branch of the sublingual, supplying the mylo-hyoid muscle.

(c) *Arteria maxillaris externa*. The external maxillary artery arises from the external carotid cephalad to the lingual artery (art. ext. max. Fig. 1,3,4.). Its proximal part runs laterally and anteriorly to the hyoid cartilage, while the distal part courses caudally. A small twig continues anteriorly and soon breaks up in surrounding tissue while the main portion turns caudally and breaks up in a plexus. From this plexus emerge two definite branches.

Tandler ('03) recognized the external maxillary artery in pig embryos 17 mm. in length. Bisson ('14) states that the external maxillary artery is small and is distributed chiefly to the submaxillary gland, the pharyngeal lymph glands, and the masseter and the panniculus.

(1) *Arteria angularis*.-- The angular artery (art. angl. Fig. 1.) in the 20 mm. pig embryo arises from the distal end of the external maxillary artery dorsal to Meckel's cartilage and terminates



above the mouth in the subcutaneous tissue of the face. During its rather long and sinuous course, several plexus formations are to be noted which indicate that the artery is still in the process of formation. In one or two areas it exists as a double vessel( Fig. 1.).

Sisson in describing the external maxillary artery of the adult pig states that the branches of the artery are not distributed to the face.

(2) *Arteria labialis inferior*(?).-- There is to be mentioned another artery which is a branch of the external maxillary artery; this branch I am unable to identify definitely. It arises from the terminal portion of the last plexus formation of the parent vessel. It is distributed in the same region that is supplied by the submental artery. It corresponds to the inferior labial artery of man which springs from the front of the external maxillary about the level of the lower angle of the mouth. It also supplies the structures of the lower lip, and the neighboring tissues.

(d) *Arteria maxillaris interna*.-- The fourth branch of the external carotid artery is the internal maxillary artery which presents some important points





of interest. ( art. int. max. Figs. 1,3,4, ) In my discussion I have considered the artery in its true adult stage. However, it has not completely taken on the adult characteristics.

The internal maxillary artery arises from the external carotid in the region of the superior ramus of the mandible; a short distance cephalad to the external maxillary and close to what is probably the auriculo-temporal nerve. In its first part it consists of two distinct vessels which course very close together in connection with numerous capillary twigs. This condition is confined only to the left side; the trunk on the right side is a single vessel showing a probable further development. The artery courses anteriorly following the curvature of the roof of the mouth and pharynx and terminates by dividing into three branches. ( Fig. 1,3,4, )

It is interesting to note that it is in this stage or a slightly younger, that the internal maxillary artery is definitely formed. Tandler ('02) has described the manner in which the formation of the internal maxillary artery takes place. In human embryos of 17, 19, and 23 mm. in length he has shown how the stapedia artery arises from the dorsal persisting portion of the <sup>second</sup> aortic arch, and



is continued forward as a longitudinal anastomosis between the second and first arches. The part played by the first aortic arch in the formation of the internal maxillary artery, according to Tandler is not definitely understood. The stapedial artery immediately upon arising from the internal carotid, passes thru the rudiment of the stapes. At a later stage it passes thru the limbs of that ossicle. The stapedial artery gives off two trunk<sup>s</sup>, a superior and inferior. The superior passes forward on the medial aspect of the Gasserian ganglion to the roof of the orbit as the supra-orbital; the inferior divides below the Gasserian ganglion into an infraorbital branch which runs forward mesial to the mandibular root of the ganglion, and a mandibular branch which accompanies the mandibular nerve. The mandibular branch is joined by an anastomosis with the external carotid, and later, when the stapedial artery becomes obliterated, this anastomosing vessel becomes the internal maxillary. Thus the original branches of the stapedial become the branches of the internal maxillary artery.

If reference be made to the Figures 1,3,4, it will be easily seen that the anastomosis between the internal carotid artery and the stapedial artery has become obliterated and that the stapedial( or int. maxillary) is solely a branch of the external carot-



id .

Sisson ('14) has described the following branches of the internal maxillary artery of the pig;-the inferior alveolar artery, the middle meningeal artery, the buccinator artery, the infraorbital artery and the palatine artery.

(1) Arteria alveolaris inferior.-- The inferior alveolar artery arises from the proximal portion of the internal maxillary, from a capillary network . ( art. inf. alveo. Figs. 1, 3, 4. ) It follows a course anteriorly and accompanied by the nerve and vein of the same name behind Meckel's cartilage. It terminates in the region of the lower lip, close to the median line. According to Tandler( '02) the inferior alveolar artery represents the remaining descending trunk of the stapedia artery.

(2) Arteria meningeal media.-- The middle meningeal (art. mening. Figs. 1, 3, 4,) is a small vessel in the 20 mm. pig embryo. It is closely related to what is probably the buccinator nerve and the sphenoid bone and particularly to the stapes; it arises from the internal maxillary artery a short distance anteriorly to the inferior alveolar; courses cephalad and in close proximity to the stapes and Reichert's cartilage and enters the cranial cavity.



The middle meningeal as stated in a previous paragraph originally was a part of the anastomosing branch of the stapedia, the connection with the internal carotid degenerating and the main part continuing cephalad as the middle meningeal.

(3) *Arteria temporalis profunda*. -- The deep temporal artery ascends as three separate vessels within the temporal muscle. These supply the temporal muscle and regions close to the orbit of the eye and superficial layers of the skin in the frontal region. (art. temp. prof. Figs. 1, 3, ).

In the human there are two deep temporal arteries on each side; a posterior and <sup>an</sup> anterior are present in this embryo. Note the lateral view of the reconstruction and note the numerous short branches in the region where the deep temporal is given off.

(4) *Arteria infraorbitalis*.-- The infraorbital artery, one of the terminal arteries of the internal maxillary, arises in the region of the inferior part of the eye within the palate. It enters the orbit and terminates in the surrounding tissues, (art. infra. orb. Figs. 1, 3, 4, †). One small branch is given off to the inferior oblique muscle of the eye, being similar in this respect to that of men.





(5) *Arteria sphenopalatina*.-- The sphenopalatine arises in the posterior part of the palate from a large plexus; along with the infraorbital artery, the posterior superior alveolar, and the deep palatine arteries. ( art. sphen. pal. Figs. 1, 3, 4, ) It is a small vessel which runs laterally to the nasal cavity and extends into the inferior concha. It terminates anteriorly close to the mucous membrane of the palate.

(a) *Artery of the septum*.-- The artery of the septum is a small, short branch of the sphenopalatine artery. ( art. sept. Figs. 1, 3, 4, ). It is to be seen as a small twig which has as yet not pierced the nasal septum.

(6) *Arteria alveolaris superior posterior*.-- The origin of the posterior superior alveolar artery is described above. It descends in the region of the infra-temporal fossa. Branches from it supply the structures lateral to the maxilla and the mouth cavity. ( art. alv. sup. post. Figs. 1, 3, 4, ).

(7) *Arteria palatina major*.-- The last of the branches terminal/which are given off from the internal maxillary is the deep palatine artery. ( Art. pal. Maj. Figs.



1, 3, 4, ) It accompanies the internal palatine nerve and is distributed to the lateral and anterior portions of the palate, which ramifies close to its mucous membrane .

In a dissection of a post-natal pig this branch was found to supply the mucous membrane of the hard palate.

(e) Arteria auricularis posterior.

The last terminal branch of the external carotid is the posterior auricular. It arises a short distance cephalad to the internal maxillary artery and is directed dorsally, passing behind the ear. ( art. auriculo. post. Figs. 1, 3, 4, ). It terminates in small capillary twigs around the superficial structures of the external ear including muscular areas.

According to Sisson('14) the posterior auricular artery is long and relatively large; it gives off the posterior meningeal.

Thyng ('14) states that the posterior auricular is a large vessel which having given off the stylo-mastoid branches curves laterally behind the primary external acoustic meatus and passes dorsally.



There arises in close connection with the posterior auricular artery, a branch of the external carotid which is distributed to the internal or deeper portions of the ear. ( Figs. 1, 3, )

## A<sup>2</sup> ARTERIA CAROTIS INTERNA.

The second prominent artery which arises from the common carotid is the internal carotid, which supplies the major portion of the brain through the numerous vessels. ( art. carot. int. Figs. 1, 2, 3, 4, ) It extends cephalad from the common carotid closely related to the vagus nerve and dorsal to the pharynx. It lies mesial to the auditory tube and courses ventrally to the cochlea, following in a way the general direction of the flexure of the myelencephalon and the metencephalon. It pierces the chondrocranium and enters the skull cavity bending gradually toward the median line, passes medially to the cranial nerves and bifurcates, later<sup>ally</sup> to the diencephalon, into caudal and cephalic divisions. The cephalic portion comes <sup>be</sup> the posterior communicating artery; the caudal, the common cerebral artery.

According to Sisson('14) the internal carotid artery arises by a common stem with the occipital. After giving off a large meningeal branch it passes thru the foramen lacerum and forms with the one on the opposite side a rete mirabile.



A similar division of the internal carotid artery into cephalic and caudal branches is described by Thyng and Tandler.

(a) *Arteria occipitalis*.-- The occipital is a very small artery in the 20 mm. pig embryo. It arises from the proximal portion of the internal carotid artery and courses only a short distance cephalad and dorsally. Due to extreme smallness it is of little importance at this stage. It terminates in small twigs in the muscles of the neck below the chondro-cranium. There are two other branches which arise cephalad to the occipital, which may be concerned with the formation of the adult occipital artery. ( art. occip. Figs. 1, 4, )

In a dissection of a post-natal pig I have found the occipital artery to be large and prominent, being as described by Tandler ('02) one of the terminal branches of the common carotid artery.

(b) *Arteria tympanicus*.-- The tympanic artery springs from the internal carotid in the region of the inferior part of the internal ear. ( art. tym. Figs. 1,4, ). In its first part, the course is cephalad and medial to the Eustachian tube and lateral to the cochlea. It is continued cephalad, entering the cranial cavity by way of what is probably the





mastoid foramen; and courses laterally to the inferior part of the myelencephalon and terminates in close proximity to the temporal bone.

(b) The artery to the hypophysis.--

The hypophyseal artery arises from the anterior aspect of the internal carotid lateral to the inferior curvature of the diencephalon and dorsal to the hypophysis. The artery as found here is similar to the one present in the human (art. hyp. Figs. 1, 3, 4).

1. ARTERIA CEREBRI COMMUNIS.

The common cerebral artery of the 20 mm. pig embryo is one of the cephalic divisions of the internal carotid. It gives rise to several important <sup>vessels</sup> in the diencephalon and telencephalon. The cerebral artery as I have termed it is in reality a common stalk from which the following arteries arise: anterior choroidal, ophthalmic, middle and anterior cerebrals, and nasals.

A dissection of this region in an adult pig was made, which showed the same relations as does the 20 mm. pig embryo.

The cerebral artery arises from the internal carotid in the posterior, inferior region of the diencephalon along the lateral border and bends forward following the inferior border of the diencephalon. (com. cereb. art. Figs. 1, 4,).



The above description of the cerebral artery confirms the observation of Mall(04) and Thyng ('14),  
<sup>state</sup> who/that in the human the anterior and middle cerebra-  
 ls arise by a common stalk.

(a) Arteria choroidea anterior--

The anterior choroidal artery arises from the proximal portion of the common cerebral artery, continues anteriorly between the optic thalamus and the telencephalon and terminates in the beginning choroid plexus of the lateral ventricle.(art. ant. chor. Figs. 1,4,).

The anterior choroidal artery as described by Mall('04) and Thyng ('14) is a branch of the internal carotid, It is evident that they have regarded the common cerebral as the internal carotid.

(b) Arteria ophthalmica-- The ophthalmic artery arises from the common cerebral artery in the region of the lateral inferior portion of the diencephalon and medial to the upper part of the eye. It extends laterally coursing in close connection with the optic nerve. It enters the orbit and close to the eyeball gives off three terminal branches, the central artery of the retina and medial lateral rami. (art. opht. Figs.I, 4,)

Sisson ('14) describes the artery in the horse



as a branch of the internal maxillary artery.

(I) Central artery of the retina--

One of the terminal branches of the ophthalmic artery is the central artery of the retina. (art. ret. Figs. I, 4, ). It pierces the retina and terminates in the vitreous humor of the eye. It breaks into small branches diverging radially in all directions.

The medial and lateral rami course around the eyeball and terminate in the tissue of the orbit.

(c) Arteria cerebri media--- The middle cerebral artery commences in the region of the inferior part of the diencephalon and the telencephalon. It extends approximately to the mid point of the lateral surface of the telencephalon. (art. cerebri. med. Figs. I, 4, ).

From that portion of the common cerebral between the origin of the ophthalmic and middle cerebral arteries a number of small branches arise which course parallel with the middle cerebral over the lateral surface of the telencephalon. (Fig. 1.) I am unable to state the identity of these arteries.

The above description of the middle cerebral is in complete agreement with those of Mall (04) and Thyng (114).



(d) *Arteria cerebri anterior*-- The anterior cerebral artery arises from the common cerebral artery in the region ventral to the telencephalon, follows a course medial to the cerebral hemisphere between the lobes very close to the median line. anastomosing with its fellow on the opposite side it continues as a single vessel. A dissection of the anterior cerebral arteries of a post-natal pig showed that similar conditions exist as are found in man. This anastomosis completes anteriorly the circle of Willis and probably remains as the anterior communicating artery found in the adult. (*art. cerebri. ant.* Figs. 1, 4, )

(e) The nasal artery.-- The nasal artery, as I have described it, presents a rather complicated arrangement in regard to its distribution and branches. I am in some doubt as to this artery which I have called the nasal artery. (*art. nas.* Fig. 1, ). Sisson states that the large infraorbital artery extends to the snout and replaces the superior labial and the lateral nasal arteries in part. The observations made by him in describing the adult condition make me hesitate to call this artery the nasal, even tho it is distributed to the snout.

The nasal artery runs ventrally and inferiorly to the telencephalon, and passing out of the





cranial cavity, extends anteriorly in the snout to its termination. It is situated near the median plane and terminates superficially in the snout at the level of the inferior meatus. It gives off the following branches,

(1) *Arteria ethmoidalis posterior.*

The posterior ethmoidal artery springs from the dorsal aspect of the nasal artery ventrally to the most cephalic part of the telencephalon. It pursues a course caudally parallel with but in the opposite direction to the nasal branch. ( art. ethm. post. Figs. 1, ) It penetrates the cranial cavity and follows the olfactory nerve. It terminates by breaking up into small twigs which supply the tissues in this region.

(2) *Arteria ethmoidalis anterior.-*

The anterior ethmoidal artery arises from a stalk in common with the posterior ethmoidal artery. It is continued anteriorly and laterally in the snout, running parallel with the parent vessel. It terminates close to the corresponding portion of the parent vessel in the epithelium of the nasal cavity. ( art. ethm, ant. Figs. 1, )

The nasal artery and its branches as described above differs from the nasal artery of the pig in the



adult stage as described by Sisson. This author shows the nasal artery to be a branch of the infra-orbital( a branch of the internal maxillary ). There is however, no connection between the infra-orbital artery of the 20 mm. pig embryo, which is relatively small, and the nasal artery.

## 2.-ARTERIA COMMUNICANS POSTERIOR.

The caudal division of the internal carotid artery is the posterior communicating artery. (art. post. comm. 1, 3, 5, ). It is given off ventrally and laterally to the diencephalon. It courses dorsally and anastomoses with the basilar artery in the region of the ventral curvature of the mesencephalon. Its distal part is close to the oculomotor nerve.

### (a) Posterior choroidal artery.--

The posterior choroidal artery springs from the posterior communicating artery a short distance above the origin of the latter. ( art. post. chor.) It is directed over the lateral surface of the diencephalon, superiorly, and terminates between the posterior part of the telencephalon and the diencephalon. These observations are in accordance with Thyng ('14).



## (b) Arteries of the mesencephalon--

Several arteries in the region of the mesencephalon arise from the posterior communicating artery and are distributed to the mesencephalon and diencephalon. They spread radially over the lateral surface of the mid brain and are comparatively large.

Mall '04 has made a study of these branches and concludes that they are concerned in the formation of the posterior cerebral artery.

## 3

## A . Arteria basilaris.--

The basilar artery is formed by the confluence of the right and left vertebral arteries which meet at an acute angle at the lower border of the pons. It continues ventrally to the brain as far as the mesencephalon where it is joined by the right and left posterior communicating arteries. (art. bas. Figs 1, 3, 4, 6, ).

(a) Rami ad pontem.-- The pontine arteries are represented by seven pairs of small branches which come off the basilar at right angles and pass over the lateral surface of the pons, supplying the latter structures and regions. (ram. pont. Figs. 1, 3, )

Little or no mention has been made of the pontine arteries in the literature. Mall ('04) says,



in describing the branches of this region, that a group of arteries between the superior cerebellar and the optic vesicle represent the transverse pontine artery.

(b) *Arteria cerebelli inferior posterior*.-- The posterior inferior cerebellar artery arises from the medial portion of the basilar artery close to the roots of the twelfth nerve. (art. post. inf. cereb. Figs.1, 3, ). Passing medially to the auditory nerves, it ascends to the posterior portion of the cerebellum. It supplies the adjacent regions of the brain, giving off a small branch to the fourth ventricle.

(1). *Arteria auditiva interna*.-- The internal auditory artery arises from the posterior cerebellar very close to the auditory nerve and follows it to the ear. ( art.aud.int. Figs.1, 3, 4, ).

Sisson ('14) in describing this artery in the horse says that it comes from the basilar, but often it may arise from the posterior inferior cerebellar.

(2). *arteria cerebelli superior*.-- The superior cerebellar artery springs from the basilar near its anterior termination .(art. cereb.





sup. 1,4,). It passes laterally to the cerebellum, which portion of the brain it supplies. The artery arises as a single trunk but soon breaks up into several branches, which course posteriorly and laterally.

According to Mall ('03) there are a number of branches in the upper part of the mid brain which are destined to become the superior cerebellar artery. Thyng ('14) describes the superior cerebellar artery as a branch of the basilar artery which arises a short distance caudad to the trochlear nerve. Its branches over-lie the isthmus and the metencephalon.

#### Circulus arteriosus (Willisi).

The circle of Willis is formed in the 20.mm pig embryo as follows: The basilar artery anastomoses with the two posterior communicating arteries which extend anteriorly and ventrally from the internal carotid. Then follows the common cerebral artery, a branch of the internal carotid, to the point where the anterior cerebral is given off. The anterior cerebral artery extends anteriorly and unites with its fellow on the opposite side, completing the circle of Willis.

#### II Arteriae subclaviae.

The right subclavian which has been previously mentioned is one of the terminal divisions of



of the braciocephalic trunk. (r.a. subcl. Figs. 1, 2, 5, ). The left subclavian artery arises from the aorta directly, similar to the arrangement in man. (l.a. subcl. Figs. 1, 2, 5, ). In other respects the two arteries are similar.

The left subclavian artery arises from the aortic arch; in its first part it courses cephalad a short distance to reach the region opposite the first rib, it then curves caudally around the anterior border of the first rib. It soon takes a lateral course entering the medial aspect of the fore limb. It is closely related to the nerves of the brachial plexus and the vein of the corresponding name. According to Sisson (14) in its course in the fore limb it inclines forward and, crossing the humerus, is continued as the median artery.

(a) Arteria vertebralis.

The vertebral artery arises as the first branch of the subclavian trunk between what is probably the anterior scalene and the longus colli muscles. It springs from the superior, posterior portion of the trunk. Its termination is at the lower border of the pons by uniting with its fellow on the opposite side to form the basilar artery. (a. vert. Figs. 1, 2, 3, 4, 5, 6, )



The first part of the artery runs cephalad and dorsally between the two above named muscles, to the sixth cervical vertebra. It is closely related to the sympathetic nerve fibers in this region and lies dorsal to the internal jugular veins. In the second part of its course it runs cephalad thru the foramina of the transverse processes of the cervical vertebrae. In the third part it bends medially and follows the neural tube into the cranial cavity. Lying ventrally to the medulla and medially to the roots of the hypoglossal nerve it unites with its fellow of the opposite side. (Fig 6 ).

A few spinal branches are given off from the vertebral which pass out at the roots of the spinal nerves and in one or two instances anastomosing branches with the anterior spinal artery were made out, corresponding in a general way to the arrangement found in man.

Several small vessels arise from the cranial portion of the vertebral artery which probably represent meningeal branches.

(1) Arteria spinalis anterior.--

The anterior spinal artery arises in close connection with the anastomoses of the vertebral and basilar



arteries. (a. ant. spin. Figs. 1, 2, 3, 4, 5, 6, 7, ). Extending caudally and medially, it unites at the level of the foramen magnum with its fellow of the opposite side ventral to the spinal cord. The single vessel thus formed continues caudally in the piamater to the termination of the cord. It is joined in its course by branches of the dorsal segmental arteries.

The above description of the anterior spinal artery confirms the observation of His ('86) Sterzi ('04) and Evans ('09, '12)

(b) Truncus thyreocervicalis.-

The thyreocervical trunk arises from the superior, proximal portion of the subclavian artery, a short distance distal to the vertebral artery. It passes cephalad, laterally to the trachea and oesophagus, and vagus nerve, and dorsally to the internal jugular veins, ventral to the vertebral, and laterally to the common carotid artery. (a. thy. cerv. Figs. 1, 2, 5, ) It is a short branch which gives off two arteries to the cervical region.

(1) Arteria thyreidea inferior.--

The inferior thyroid artery is the largest branch of the thyreocervical trunk, which is closely related to the vagus nerve throughout its entire course. It pass-





es cephalad and terminates in the inferior portion of the thyroid gland. (a. inf. thy. Figs. 1, 2, ).

(2) Arteria cervicalis ascendens.--

The ascending cervical artery arises in common with the inferior thyroid artery, courses in close relation with the scalenus anterior and longus capitis, lies close to the phrenic nerve and dorsal to the internal jugular vein. It supplies the numerous muscles in the deep cervical region. (a. cerv. asc. Figs. 1, 2, ).

(b) Truncus costocervicalis.---

The costo-cervical trunk arises from the subclavian artery at right angles to the vertebral and runs dorsally and caudally. The trunk, after a short course, divides into terminal branches which supply the upper segments of the thoracic wall and cervical regions.

(trunc.cost.cerv. Figs 1, 2, 5, ).

(1) Ramus profunda.-- The deep cervical artery is a branch of the costocervical trunk which runs dorsally in its first part to reach the neck muscles. (ram. prof. Figs. 1, 2, ) It then turns cephalad and ramifies in the deeper muscles of the cervical region, especially the semi-spinalis muscle. It extends well cephalad, terminating a short distance caudal to the beginning of the occipital bone.



The only branch given off the deep cervical artery worth of mention is that which passes through the second intercostal space.

(d) Arteria intercostalis dorsalis---

From the costocervical trunk arises the dorsal intercostal artery which gives off the third, fourth, and fifth intercostal arteries. Each of these arise at regular intervals on either side. The dorsal intercostal artery courses dorsal to the aorta and ventral to the vertebral bodies. It terminated by giving off the last superior intercostal artery, opposite the fifth intercostal space. (a. inter. dors. Figs. 1,2,).

(1) Arteria intercostalis.---There is given off at each thoracic segment through which the dorsal intercostal artery courses, an intercostal branch. Each of these divides into a posterior and an anterior branch. A small branch from the posterior ramus anastomoses with the anterior spinal artery and the main portion of the posterior trunk extends laterally to the neural process.

On the right side the last intercostal anastomoses with the first aortic intercostal by a short communicating branch. With this exception the two sides are similar (Figs. 2,).

According to Jisson ('14) there is a common trunk for the costocervical and vertebral arteries.



## (e). Arteria mammaria interna.--

The internal mammary artery springs from the inferior wall of the subclavian artery immediately below the origin of the thyrocervical trunk. It courses caudad, medial to the ribs and gradually pushes ventrally. It terminates as the superior epigastric artery. It gives off in its extensive course, through the thoracic wall, several small branches at irregular intervals. ( a. mamm. int. Figs , 1, 2,5, )

In the adult human and in other mammals branches are given off to the thymus, bronchi, diaphragm, and pericardium, but in this embryo I. am unable to find any of them.

## (I). Arteria epigastrica superior.--

The superior epigastric artery is the direct continuation of the internal mammary artery. It terminates in the anterior body wall in the muscle close to the anterior portion of the thirteenth rib. The musculophrenic artery, the lateral terminal branch of the internal mammary artery of the adult, has apparently not yet formed. ( a. sup. inf. Figs. 1,2, 5, ).

## (f) Arteria thoracoacromialis.---

The <sup>o</sup>th<sub>^</sub>rac<sub>o</sub>-acromial artery is a small and somewhat extensive vessel in its distribution. It arises from the subclavian near what is probably the anterior



border of the subscapular muscle. It courses dorsally and sends its branches to that muscle. Branches from this artery supply the pectoral and supraspinatus muscles. (a. thor. acr. Figs. 2, ).

(g) Arteria brachialis.--

The brachial artery is the continuation of the subclavian artery through the axilla out to the proximal portion of the upper limb. It is difficult to mark out any definite division. However, there is a division which is present. Sisson ('14) in considering the limb arteries of the upper region makes no differentiation, but calls the entire vessel which arises from the aortic arch the brachial artery. (Figs 1, 2, 5, ). The following branches are given off.

(1) Arteria ulnaris. --- The ulnar artery is one of the terminal branches of the brachial artery. It descends along the medial border of the radius terminating near the tip of the fore limb. (a. ra. Figs 1, 2, ).

(2) Arteria radialis---- The radial artery, the second terminal branch of the brachial arises laterally to the humerus under cover of the muscles of this region. It descends on the lateral surface of the radius in close proximity with the radial





nerve. It supplies branches to the muscles of the distal portion of the fore limb and terminates near the end of the limb. Terminal branches are sent to the carpus and digits. (a. ra. Figs 2.).

#### A. AORTA THORACALIS.

The thoracic aorta begins in the region of the fourth thoracic vertebra, a short distance to the left of the median line. As it courses caudally it gradually extends into the median plane of the body. At the level of the lower margin of the eleventh thoracic vertebra it goes over into the abdominal aorta. On the left side it is in direct contact with the pleural cavity and lying dorsally to it is the oesophagus. (aor. thor.).

#### DUCTUS ARTERIOSUS.

The atrial duct or the remaining left sixth aortic arch springs from the pulmonary trunk and reaches the thoracic aorta, in the upper part. In the 20mm. pig embryo the atrial duct is almost the size of the aorta itself. (d. arteo. Figs 1,2,5, ).

I Arteria pulmonalis.-- The pulmonary artery arises from the middle of the atrial duct, a short distance to the left of the median line and in the region opposite the second intercostal space. The short trunk splits and reunites at regular



intervals, forms in certain positions a double vessel. It eventually divides permanently sending out branches which follow the bronchi. The manner in which the pulmonary arteries divide and follow the bronchi has been shown and described by Rutledge ('15), Thesis University of Minnesota.

(1) Aortae intercostales.--

The intercostal arteries arise from the dorsal wall of the aorta as single short trunks, pass cephalad and dorsally and bifurcate into the right and left intercostal arteries. Each winds around the vertebral bodies to reach the intercostal spaces and divides into ventral and dorsal rami. Five intercostal arteries arise from the thoracic aorta. (aa. int. Figs. 1,2,5,7.)

(a) Rami anteriores.--The ventral branches (aa. rami. Figs. 1,2,5,7,) cross the intercostal space toward the angle of the rib above and are continued forward in the intercostal spaces. They are accompanied by the corresponding nerve and vein. Near the head of the ribs, they are crossed by the sympathetic nerve and lie behind the intercostal muscles. The anterior ramus of the right first aortic intercostal artery anastomoses with the corresponding ramus of the last intercostal artery of the costocervical trunk. No corresponding anastomosis can be seen on the left side. (Fig. 2.).



(b) Rami posteriores .-- The posterior rami are given off, in the region caudal to the neck of the corresponding rib, from the intercostal artery. They pass laterally to the neural processes, closely connected with the spinal ganglia.

(Cor. rami. Figs 1, 2, 5, 7, ).

(1) Rami spinalis.-- Spinal rami are given off which anastomose with the anterior spinal artery. (spin. rami. Figs. 1, 2, 5, 7, ).

## 2. Nephric segmentals.--

The nephric segmental arteries arise from the lateral wall of the aorta. (nep. seg. Figs. I, 5, ). A consideration of these arteries will be made in connection with the abdominal aorta, as the greater number arise from the latter.

## D. AORTA ABDOMINALIS.

The abdominal aorta is the continuation of the thoracic aorta. It begins immediately below the diaphragm at the level of the eleventh thoracic vertebra and courses caudad a little to the left of the median line. (A. Abdom. Figs I, 2, 5, ) It divides opposite the lower margin of the fifth lumbar vertebra into the two umbilical arteries. It gives off parietal and visceral branches .



## (I)-Rami parietalis.--

(a) Arteriae intercostales.-- Since in the pig there are fourteen ribs, thirteen intercostal arteries are present. Of these the first is a separate branch of the costocervical trunk. The next four arise from the superior intercostal artery, also a branch of the costocervical trunk. The next five (sixth to tenth inclusively) arise from the thoracic aorta, while the last four (eleventh to thirteenth inclusively) arise from the abdominal aorta. The abdominal aorta also gives off the subcostal artery which courses in the tissue immediately below the fourteenth rib.

(aa inter, Figs 1, 2, 5, 7, )

(b) Arteriae lumbales.-- The lumbar arteries are similar to the dorsal segmental arteries in that they arise from the dorsal aspect of the aorta and come off as single vessels. They are segmental in their arrangement and are in series with the intercostal arteries. Five are present in the 20 mm. pig embryo, all of which arise from the abdominal aorta. From their origin they pass dorsally and laterally across the front and sides of the lumbar vertebra. Each artery is crossed by the sympathetic trunk. A posterior ramus is given off which is fairly well developed, but the anterior ramus is just beginning to form.





Small muscular rami are given off which extend toward the anterior spinal artery, but anastomoses are not apparent. (aa. lumb. Figs. 1, 2, 5, ).

(c) Dorsal sacral and caudal segmental arteries.---(sacr. segm. Figs. 1, 2, 5, ) Under this title are included a number of paired segmental vessels which are distributed to the sacral and caudal segments. They are small and irregular arteries arising in a characteristic manner. The first three arise from a common trunk which proceeds from the last lumbar artery. Of these the second and third arise from the latter vessel in common. The next three or four pairs arise from a common trunk which is a branch of the caudal artery. The sacral and caudal segmental vessels are more highly developed anteriorly, but become less and less distinct when traced caudally. A true segmental arrangement of the last eight is doubtful.

(d). Arteria caudalis.-- The caudal artery is a long and slender vessel which arises from the posterior wall of the lower end of the abdominal aorta. It extends caudally, lying just ventrally to the bodies of the vertebra. It terminates in the tail near its tip. It gives off branches which have been described above. (a. caud. Figs. 1, 2, 5, ).



(2) Rami Viscerales.

(a) Nephric segmentals.--The lateral segmental branches of the aorta arise at irregular intervals and are concerned with the arterial blood supply of the woffian body and suprarenal gland. (neph. seg. Figs. 1,5,). The greater portion of the lateral segmental arteries arise from the abdominal aorta, but a few arise from the thoracic aorta. The three lateral segmentals which arise from the thoracic aorta and the cephalic part of the abdominal aorta pass through the suprarenal gland in their course to the Woffian body. Four Nephric segmentals arise from the abdominal aorta with a similar course to those of the thoracic aorta.

Nine additional segmentals arise from the abdominal aorta below those previously mentioned and are distributed to the woffian body. The more caudal the branches, the more ventrally they are given off the aorta.

The branches of the upper series as described by Evans are originally many and come off in close relation to the suprarenal. In a 10mm. embryo the suprarenal glands are supplied by branches from the sixth to eighth segments, but eventually with the relation descent of the suprarenal they acquire branches



from the nephric segmental arteries at lower and lower levels.

(b) *Arteria renalis*.-- The renal artery arises from the lateral and dorsal aspect of the abdominal aorta, <sup>a</sup> short distance caudad to the fourteenth rib. ( *a. ren.* Figs.1,5, ). Reaching the kidney it divides into two terminal branches which supply the anterior and posterior portions of the kidney.

(c) *Arteria phrenica inferior* (?)-- The inferior phrenic artery arises from the aorta by a common stalk with the renal artery immediately caudad to the diaphragm; extends from the aorta laterally and caudally over the dorsal portion of the kidney to enter the diaphragm. (*a.phren. inf.* Fig.1,).

It probably corresponds with the phrenico-abdominal artery described by Sisson ('14), which he states arises on either side a little in front of the renal arteries. It divides into two branches which go to the costal part of the diaphragm and the abdominal muscles.

(c) *Arteria coeliaca*.

The coeliac artery (*a. coe.* Figs 1, 2, 5, ) arises from the ventral wall of the aorta immediately caudal to the aortic orifice of the diaphragm. It is a short vessel which runs anteriorly, terminating in



several visceral branches. As it passes anteriorly it courses between the suprarenals.

(1) *Arteria lienialis*.-- The splenic artery ( *a. len.* Figs. 1, 2, ) is one of the main branches given off the coeliac artery. It passes to the left in a more or less tortuous course behind the stomach and along the upper border of the pancreas to reach the spleen which it supplies.

(2) *Arteria gastroepiploica sinistra*.-- The gastro-epiploic artery is a terminal branch of the splenic artery. ( *a.gastro.epip. sin.* Figs. 1, 2, ). It arises in front of the spleen and courses ventrally close to the left end of the greater curvature of the stomach. It passes toward the median line breaking up into a network of capillaries close to the termination of the right gastro-epiploical artery. There is no definite anastomoses between the two arteries however at this stage.

(3) *Arteria hepatica*. -- The hepatic artery ( *a.hep.* Figs. 1,2, ) runs along the upper border of the head of the pancreas to the right, and the upper border of the duodenum. It then passes cephalad to reach the portal hepatis. After it reaches the portal hepatis in close connection with the portal





vein , it divides into right and left branches.

(a) Arteria gastrica dextra.--- The right gastric artery arises from the short stem which is common for both the right and left gastric arteries. This short common stem arises from the hepatic artery. The right gastric artery is directed caudally , in its first part it lies opposite the lesser curvature of the stomach . (a. gastro. dex. Figs 1, 2, ). Its termination is in close connection with the wall of the cardia of the stomach. It is very short and is probably just beginning of form.

Sisson ('14) describes the anterior gastric artery as a branch of the hepatic artery which is probably the same artery as described above.

(b) Arteria gastrica sinistra.-- The left gastric artery is a much better developed vessel than the right gastric artery, (a. gastro.sin. Figs.1,2) It continues cephalad and reaches the lesser curvature of the stomach close to the oesophagus terminating in this region.

Sisson ('14) describes a similar common trunk for the right and left gastric arteries in the horse.

(c) Arteria gastroduodenalis.-- The gastroduodenal artery arises from the hepatic artery in the region cephalad to the duodenum and the panc-



reas and curves over the posterior surface of the duodenum to reach the omentum. ( a. gastro. duo. Figs. 1, 2, ). Here it runs to the left, running parallel to the greater curvature of the stomach and terminates by dividing into the right gastro-epiploic artery and the pancreaticoduodenal artery.

(1). Arteria gastrøepiploica dextra.--

The right gastro-epiploic artery is the larger of the two terminal branches of the gastroduodenal artery. It passes from the right to the left along the greater curvature of the stomach and terminates near the termination of the left gastro-epiploic artery. (a. gastro.epip. dex. Figs 1, 2, ).

(2). Arteria pancreaticoduoden. superior.-- This artery runs a short distance to the right supplying the superior part of the pancreas on the right side. ( a. panc.duo. Figs 1,2, ).

The right hepatic artery courses in close relation to the hepatic and cystic ducts and to the right of the portal hepatis. Here it divides into two branches; one of which swings around toward the median line accompanying the branches of the portal vein and the other, the cystic artery , which runs ventrally



and caudally. The latter vessel soon bifurcates into the anterior and posterior branches. ( Figs.1,2, ) The anterior branch passes caudad between the ventral portion of the liver and the common bile duct, while the posterior branch passes close to the cystic duct. The left termination of the hepatic artery runs to the left of the portal hepatis giving off one or two branches to the left lobe of the liver. ( Figs 1,2, ).

(e) Arteria mesenterica superior.--

The superior mesenteric artery springs from the front of the abdominal aorta about a segmental space below the coeliac axis opposite the eleventh intercostal space. ( a. mesen. sup. Figs. 1, 2, 5, ) It passes obliquely caudad and ventrally; inferior to the pancreas and enters the mesentery in which it continues to descend.

Thyng ('14) describes the superior mesenteric artery as coming off the abdominal aorta opposite the twelfth dorsal segmental artery.

(1) Arteria pancreaticoduodenalis inferior.-- The inferior pancreaticoduodenal artery arises from the superior mesenteric artery in its proximal portion, close to the mesial portion of the pancreas which it supplies. I am unable to trace any branches from it to the duodenum at this stage.



(f) *Arteria mesenterica inferior.*--

The third unpaired visceral branch of the abdominal aorta is the inferior mesenteric artery. It arises only a short distance above the bifurcation of the abdominal aorta into the umbilical arteries. ( *a. inf. mes.* Figs 1, 2, ) It is much smaller than the other two visceral trunks. It passes ventrally for a short distance and divides into a caudal and cephalic branch.

(1) *Arteria colica sinistra.*--- The left colic artery passes cranially and dorsally a short distance to the colon which it supplies. ( *a. coli. sin.* Figs 1, 2 , )

(2) *Arteria haemorrhoidalis.*--The haemorrhoidal artery is the caudal division of the inferior mesenteric artery which courses dorsal to the rectum which it supplies. ( *a. haemor.* Figs. 1,2, ).

(g) *Artery to the genital bud.*--

The genital artery arises from the lateral surface of the aorta, a short distance cephalad to the third lumbar artery. ( *a. genital.* Figs 1,2, ). It is a well developed vessel which courses ventrally and medially to the Woffian body. Upon reaching the genital ridge it courses cephalad in this structure.

(h) *Arteria umbilicalis.*





The umbilical arteries arise from the terminal end of the aorta at the level of the fourth lumbar segment. They pass out obliquely into the umbilical cord gradually increasing in size. ( a. umb. Figs 1, 2 , ).

(i) Arteria hypogastrica.--The hypogastric artery in the 20 mm. pig embryo arises from the proximal portion of the umbilical artery. It diverges laterally and passes under the wing of the sacrum, terminating medially to the ischium.

(a ) Arteria pudenda interna.-- The internal pudendal artery arises from the anterior portion of the hypogastric artery; courses medially and terminates posteriorly to the ischial arch. It is accompanied by the pudic nerve.( a : puden. int.Fig.1,2

(b) Arteria haemorrhoidalis inferior.- The inferior haemorrhoidal artery arises from the hypogastric artery laterally to the rectum. It courses toward the median line supplying the structures in the region of the rectum and the allantois. ( a . haemorrh. inf. Figs 1, 2, ).

(J) Arteria iliaca externa.

The external iliac artery arises from the lateral surface of the aorta a short distance cephalad



to the point of its bifurcation. It courses laterally toward the hind limb and divides into two prominent vessels, the inferior hypogastric and the femoral arteries ( a.iliac. ext. Figs 1, 2, ). The external iliac artery resembles the adult condition as found in the 20 mm . pig embryo.

Anteriorly the vessel is covered by the inferior portion of the Woffian body and the ureter; posteriorly it lies in relation to the fourth and fifth lumbar vertebra and the posterior cardinal veins. It is continued into the limb as the femoral artery.

(1) Arteria epigastrica inferior.--

The inferior epigastric artery arises from the external iliac artery. ( a. epigast. inf. Figs 1, 2, ). It extends in a lateral direction and in its distal part takes a cephalic course within the anterior abdominal wall.

(2) Arteria femoralis. -- The femoral artery is the main trunk of the thigh. ( a. fem. Figs. 1, 2, ). It begins at about the level of <sup>the</sup> forming pubic bone and is accompanied by the corresponding vein. It is directed laterally and caudally in the proximal portion of the lower limb. The artery courses as far as the tibia where it divides into the posterior and



and anterior tibial arteries.

(a) Arteria tibialis posterior. --

The posterior tibial artery is the smaller of the two terminal arteries of the femoral artery . ( a. tib. post. Figs 1,2, ). It becomes superficial in its course over the medial surface of the tibia, and terminates near the tip of the hind limb.

(b) Arteria tibialis anterior.--

The anterior tibial artery lies deep in the region of the proximal part of the tibia; but its distal part crosses over the lateral surface of the limb terminating near the end. ( a. tib. ant, Figs 1,2, ). The terminal branches of the lower limb as found in the adult pig have not formed in the 20 mm. pig embryo. There are a few branches which are given off both the anterior and posterior tibial arteries which are probably muscular branches.



## ABBREVIATIONS

- A. Asc.--AORTA ASCENDENS.
- Arc.A.--ARCUS AORTAE
- A. bracio.--Arteria braciocephalica
- A. bicarot.-- Arteria bicaroticus
- A. thym. ---Thymic artery
- A. carot. comm--- --Arteriae carotides communes
- A. carot. comm. sin.--Arteria carotis communis sinistra
- A. carot. ext.--Arteria carotis externa
- A. ling. ---- Arteria lingualis
- A. ling. dors.--Arteria lingualis dorsalis
- A. sub. ling.-- Arteria sublingualis
- A. subment.--- Arteria submentalis
- A. ext. max. -- Arteria maxillaris externa
- A. ang. ---- Arteria angularis
- A. lab. inf.--Arteria labialis inferior
- A. int. max.-- Arteria maxillaris interna
- A. inf. alveo.---Arteria alveolaris inferior
- A. mening. med.-- Arteria meningea media
- A. temp. prof. ---Arteria temporalis profunda
- A. infra. orb.--- Arteria infraorbitalis
- A. spheno.pal.--- Arteria sphenopalatina
- A. sept.-----Arteria of the septum
- A. alv. sup. post.--Arteria alveolaris superior post.





- A. pal. maj. ---Arteria palatine major.
- A. auriculo. post.-- Arteria auricularis posterior
- A. carot. int . ----Arteria carotis interna
- A. occip. -----Arteria occipitalis
- A. hyp. -----The artery to the hypophysis
- A. cerebi.comm. --- Arteria cerebri communis
- A. ant. chor. ---Arteria choroidea
- A. ophth. ---Arteria ophthalmica
- A. ret. ----Central artery of the retina
- A. cerebri, med. --- Arteria cerebri media
- A. cerebri, ant. ----Arteria cerebri anterior
- A. nas.-----Arteria nasalis
- A. ethm. post. --- Arteria ethmoidalis posterior
- A. ethm. ant.-Arteria ethmoidalis anterior
- A. post. comm.-- Arteria communicans postefior
- A. post. chor. ---Arteria choroidea posterior
- A. bas. --- Arteria basilaris
- Ram. pont.---- Rami ad pontem
- A. post. inf. cereb.---- Arteria cerebelli inferior post  
erior
- A. aud. int. ---- Arteria auditiva interna
- A. cereb. sup. ---- Arteria cerebelli superior
- L. subcl. A. ----- Arteria subclavia sinistra
- A. vert. ----- Arteria vertebralis
- A. ant. spin. ---- Arteria spinalis anterior
- A. cerv. asc. --- Arteria cervicalis ascendns
- A. thy. cerv.-Truncuc thyreocervicalis



A. inf. thy. --- Arteria thyreoidea inferior  
 Trunc. cost. cev. --- Truncus costocervicalis  
 Ram. prof. --- Rami profunda  
 A. inter. dors. --- Arteria intercostalis dorsalis  
 A. mamm. int. ---- Arteria mammaria interna  
 A. sup. inf. epi. Arteria epigastrica superior  
 A. thr. acr.----- Arteria thoracoacromialis  
 A. bra. ---- Arteria brachialis  
 A. ul. ----- Arteria ulnaris  
 A. ra. -----Arteria radialis  
 Aor. thor. ---- AORTA THORACALIS  
 D. arteo.---- DUCTUS ARTEROSIS  
 A. pulm. ---- Arteria pulmonalis  
 Aa int.----- Arteriae intercostales  
 Aa rami.----- Rami anteriores  
 Spinal.ram. --- Rami spinalis  
 A. Abdom. --- AORTA ABDOMINALIS  
   Nep. seg. ---- Nephric segmentales  
 Aa. inter.---- Arteriae intercostales  
 Aa. lumbales.--- Arterias lumbales  
 Sacr. seg. -----Sacral segmentals.  
 A. cau. -----Arteria caudalis  
 Neph. seg. ----- Nephric segmentals.  
 A. ren. ----- Arteria renalis  
 A. phren. inf. ---Arteria phrenica inferior



- A. coe. ----- Arteria coeliaca  
 A. len.----- Arteria lenialis  
 A. gastro epip. sin. ---- Arteria gastroepiploica sinist  
 A. hep. ----- Arteria hepatica  
 A. gastro. dex. --- Arteria gastrica dextra  
 A. gastro. sin. ---- Arteria gastrico sinistra  
 A. gastro. duo. ----- Arteria gastroduodenalis  
 A. gastro. epip. ---- Arteria gastroepiploica  
 A. panc. duo.sup.-----Arteria pancreaticoduoden. sup.  
 A. mesen. sup. ---- Arteria mesenterica superior  
 A. coli. sin. ----- Arteria colica sinistra  
 A. genital. ----- Artery of the genital bud  
 A. haemor. ----- Arteria haemorrhoidalis  
 A. umb. ----- Arteria umbilicalis  
 A. hypo. ----- Arteria hypogastrica  
 A. puden. int. ---- Arteria pudenda interna  
 A. haemor. inf. --- Arteria haemorrhoidal inferior  
 A. iliac. ext. ----- Arteria iliaca externa  
 A. epigast. inf. --- Arteria epigastrica inferior  
 A. fem. ----- Arteria femoralis  
 A. tib.post. ----- Arteria tibialis posterior  
 A. tib. ant.----- Arteria tibialis anterior



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Fig.-1. The figure represents all of the arteries of the left side.

Fig. I

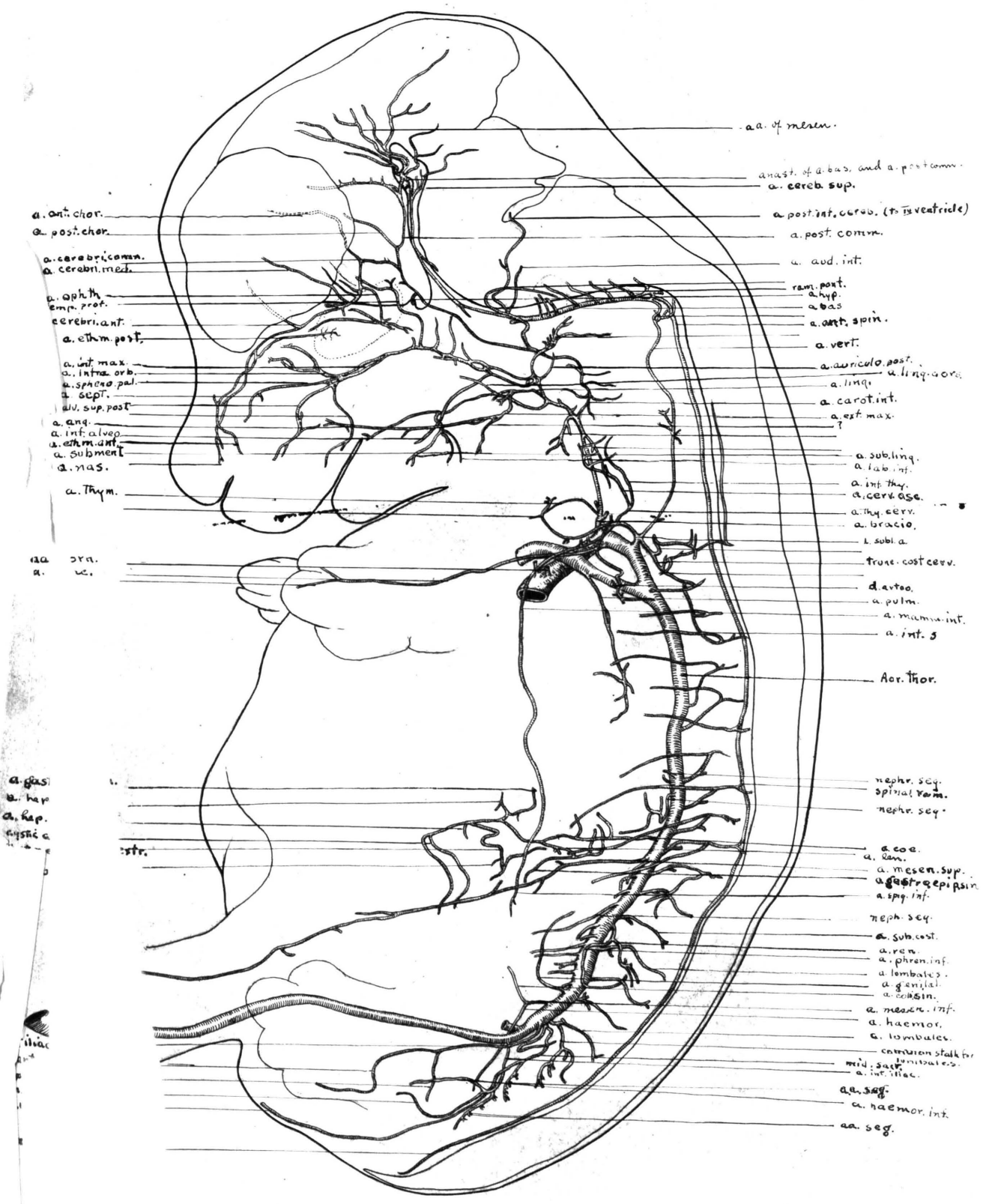




Fig-2. A graphic reconstruction of the 20 mm. pig embryo as viewed from the ventral surface. The dotted aerea represents the digestive system, trachea represented with shaded lines, lungs, liver, Woffian body, and genital bud are all represented merely in outline, pancreas in represented in the dotted aerea.

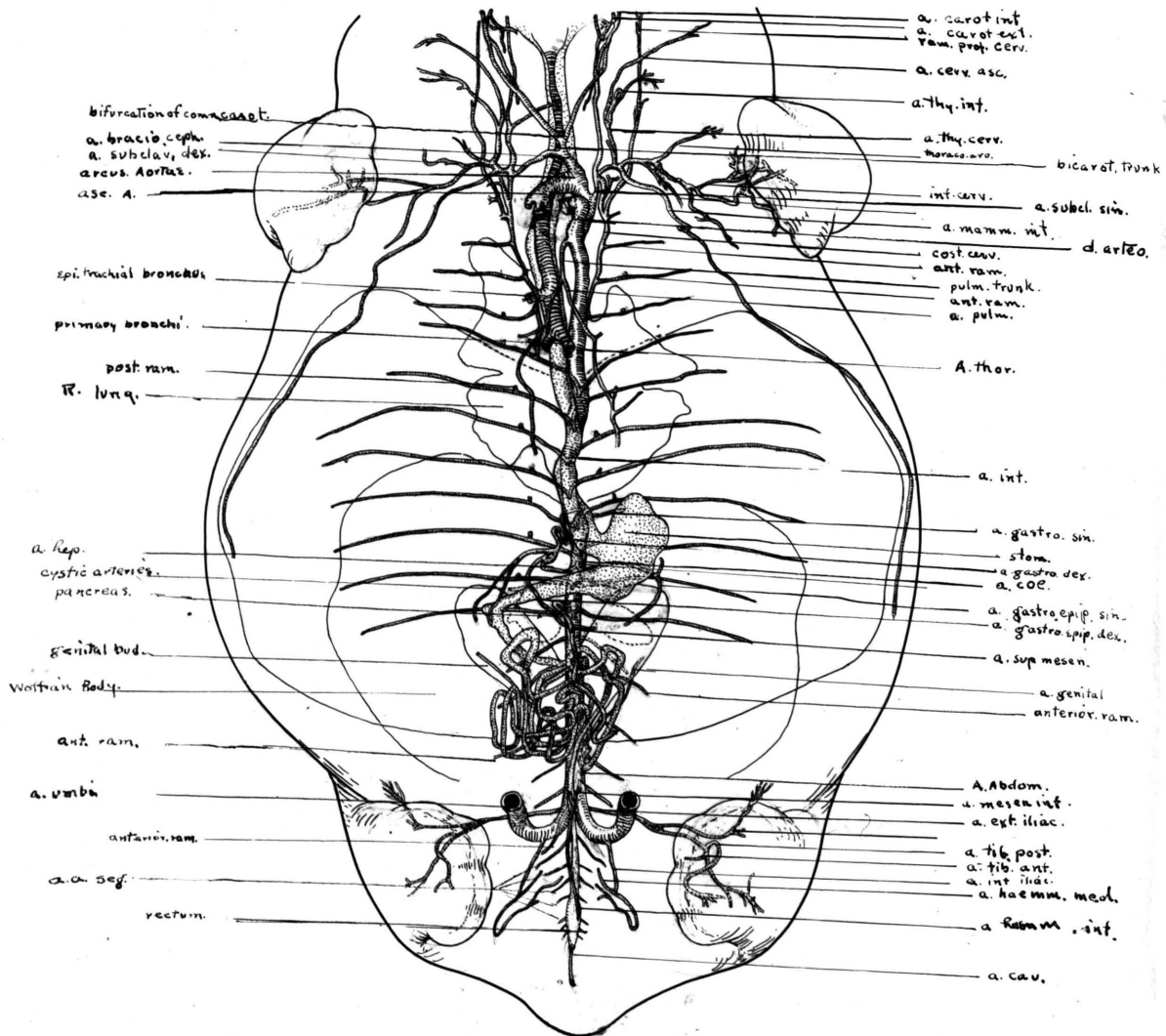




Fig. 3. A graphic reconstruction of the arteries of the head viewed as a mid-sagittal surface. Made particularly for the arterial relations of the tongue and the eye.

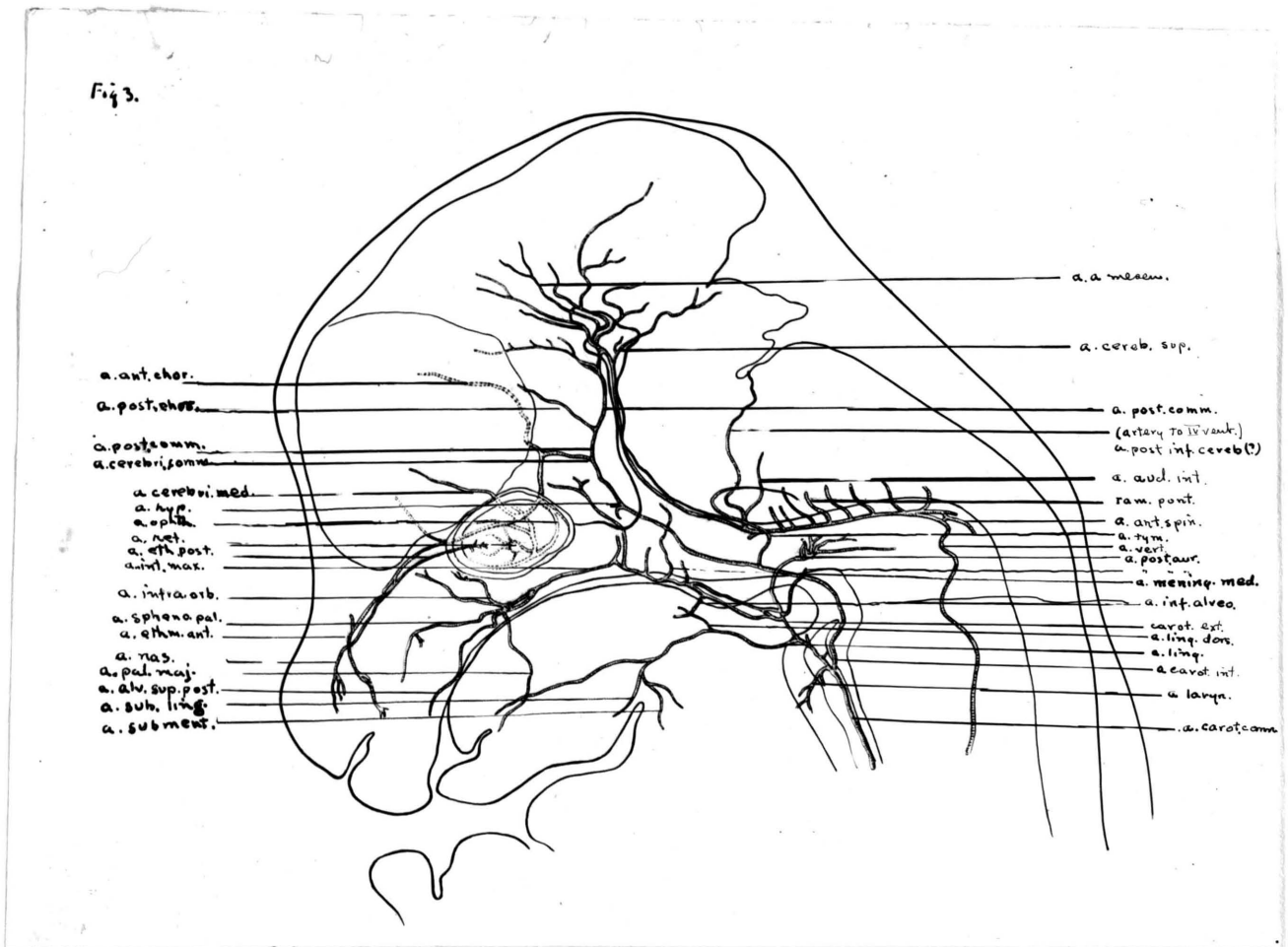






Fig.-4. Figure 4 represents the arteries of the head with a reconstruction of the nasal cavities, mouthcavity and the membranous labyrinth.

Fig 4

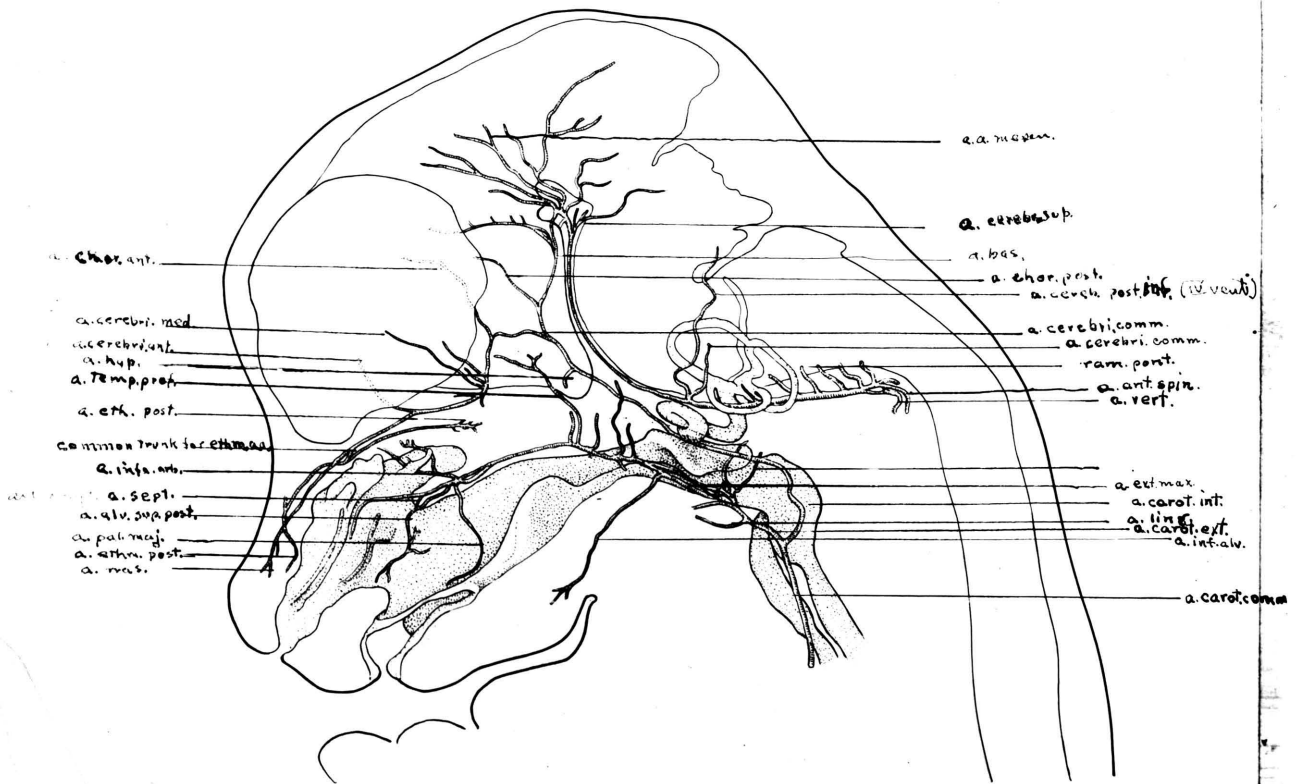




Fig. 5. The condro-skeletal reconstruction of the trunk, showing the arteries of this region in relations to the skeleton.

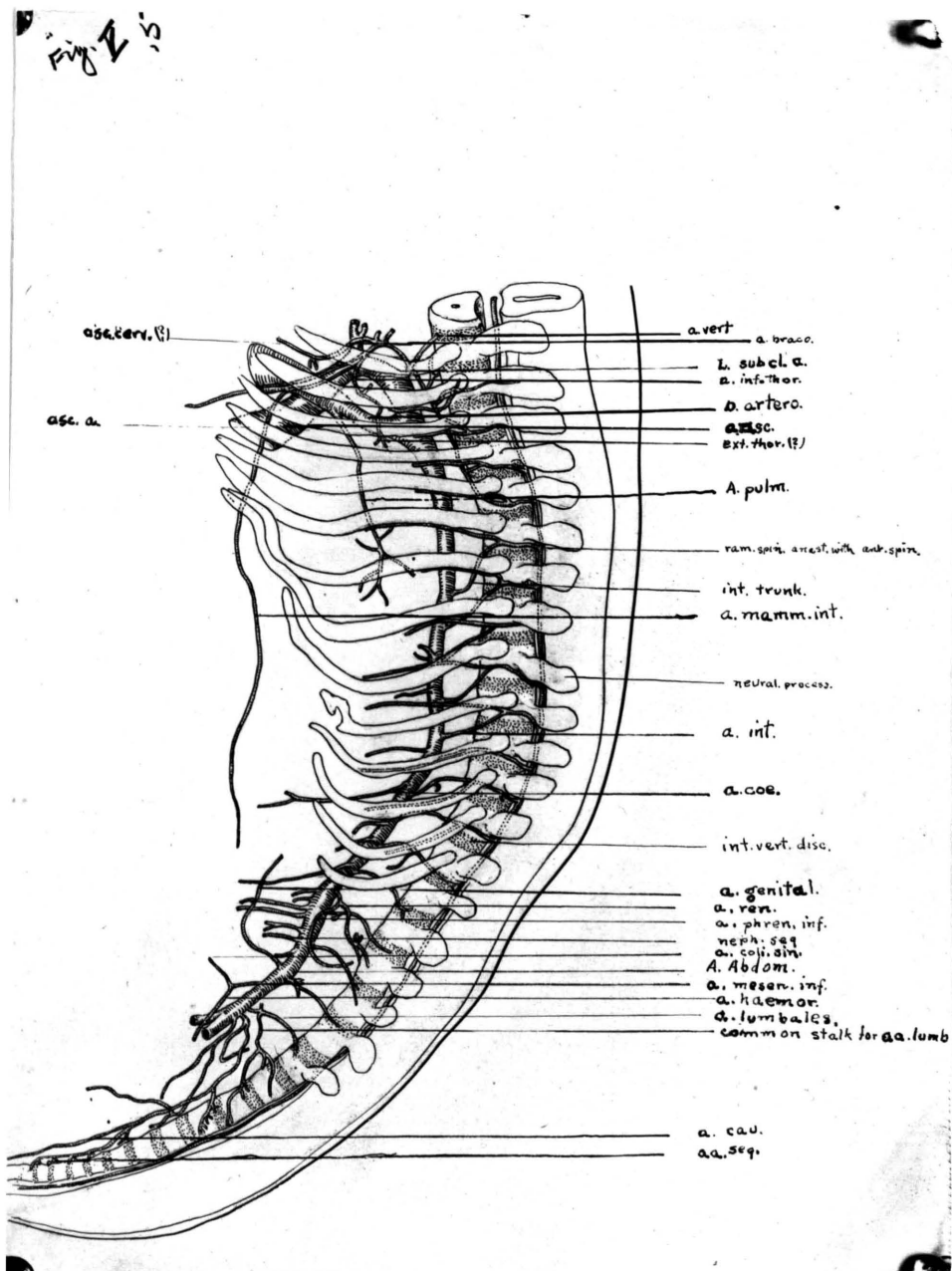




Fig. 6. This figure represents a wax reconstruction of the union of the two vertebral arteries and the anterior spinal artery with the formation of the basilar artery.

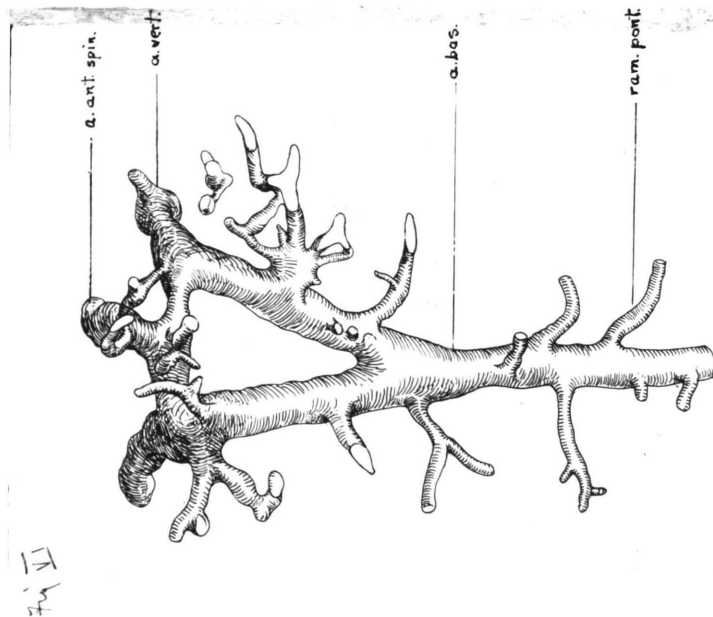
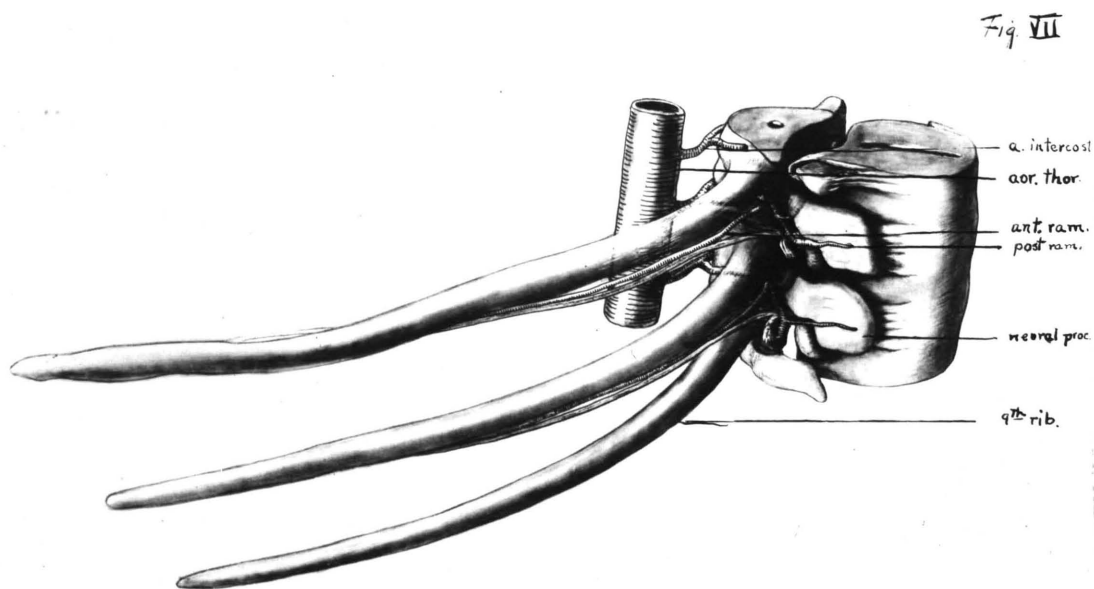


Fig. 7. This is a wax reconstruction made by Mr. D.R. Thorn, which shows three adjacent thoracic segments with related structures. The ribs are No. 7, 8, and 9.





UNIVERSITY OF MISSOURI  
COLUMBIA

DEPARTMENT OF ANATOMY

May 15, 1918

To the Faculty of the Graduate School,  
University of Missouri.

**Sirs:-**

I hereby certify that I have read  
the thesis entitled "The Arterial System of a Pig Embryo  
21.6mm. in Length" submitted by John Isaac Appleby, A.B.,  
to the Department of Anatomy in partial fulfillment of the  
requirements for the Degree of Master of Arts, and that  
it meets with my approval.

Signed

*Franklin P. Johnson*

Associate Professor of Anatomy.

FPJ  
REF


















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University of Missouri - Columbia



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