The Seoul Journal of Medicine
Vol. 28, No. 4:383-391, December 1987

A Human Embryo of Streeter Age Group XV

Je G. Chi and Weon Seo Bark

Department of Pathology, College of Medicine, Seoul National University, Seoul 110, Korea

= Abstract =A human embryo was serially sectioned and was reconstructed with 327 sections. The length of the embryo was estimated to be 6.9 mm. The age of the embryo was determined by the developmental status of the internal organs in terms of selected definable characteristics. Discernible morphological features of the embryo included closure of the lens vesicle, separation of the otocyst from the skin ectoderm, endolymphatic appendage, bronchi in the primary stage, thickening of the olfactory disk, dorsal and ventral pancreatic buds, and a narrow atrio-ventricular canal with an incompletely formed interventricular septum. The above observations strongly suggested that this embryo developed normally and should be classed in age group XV of Streeter's developmental horizon.

Key words: ***Embryo, Streeter age group***

INTRODUCTION

In studies of the human embryology, numerous descriptions of human embryos relating to their age have been made. However, there was no universal and rational criteria for the estimation of accurate developmental age of the embryo, especially in the early stages of the embryonal development. The measurement of the crown-rump (CR) length and time since the last menstrual period (LMP) are usual methods for the estimation of the age of the embryo, but are not always accurate. In 1948 Streeter at the Carnegie Institute introduced a more reliable method of measuring gestational age based on the strong relationship between the embryonic age, size of the embryo,and the developmental status of main organs. He introduced the concept of the "developmental horizon" or "age group" by dividing the embryological stages into I to XXIII with 2 to 3 days interval according to the developmental status of internal organs, based on the precise correlation in the main features of organogenesis.

In this study, a human embryo was sectioned serially, observed microscopically, and its major organ systems reconstructed. This human embryo was found to belong to age group XV of Streeter's developmental horizon based on advancing morphological features observed in the progressive development of major organs.

CASE REPORT

A human embryo (ESR #93) was obtained incidently from a hysterectomy specimen, and was fixed in 10% neutral formalin solution and embedded in paraffin. The history on the mother was not available. This embryo was sectioned serially from the anterior to posterior direction in 7 micrometer thickness. A total of 327 coronal sections was obtained and stained with hematoxylin and eosin. A portion of the head was artificially lost (Fig. 1).

External appearance

The external appearance of the embryo was deduced from the reconstruction as shown in Fig. 1. The C-shaped embryo showed severe caudal and cephalic flexions, and the lower part of the embryo was twisted to the right side. Other features characterizing the external form of the embryo were a clearly visible cervical sinus, well-developed branchial arches, and prominent arm buds. The heart was prominent in the ventral wall of thorax and the liver was located at the lower margin of the heart. The crown-rump (CR) length of embryos of Streeter's horizon XV collection range from 6.5 mm to 8.5 mm; this embryo under study measured 6.9 mm, but the true length might be longer because of the severe cephalic and caudal flexions.

Central nervous system and sensory organs

There were cerebral evagination and optic vesicles in the prosencephalon. The choroid plexus

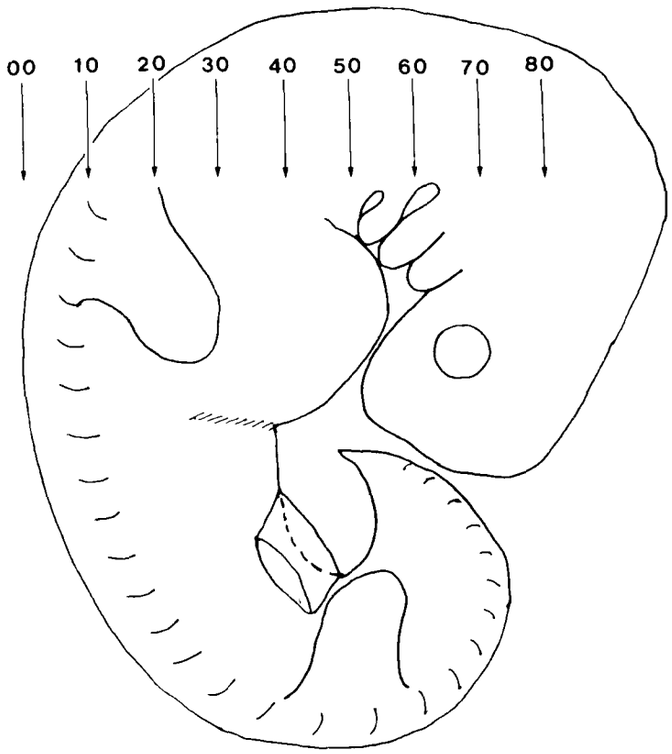


Fig. 1. Schematic reconstruction of the embryo in this report. Number represents the number of section slide. The 1st and 2nd branchial clefts are seen.

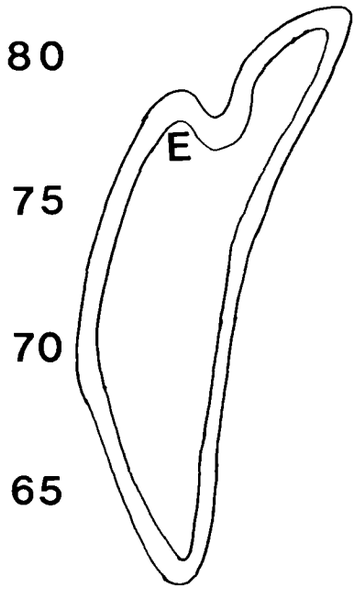


Fig. 2. Schematic reconstruction of the left ear vesicle. Posterior view.
E: endolymphatic appendage.

was seen in the ventricle, and the roof of the fourth ventricle was lined by the single-layered cells (Plate 1,2). The Rathke's pouch having evaginated from the pharynx was growing toward the ventral aspect of the prosencephalon. The neural portion had not developed (Plate 3). The basal plate of the neural tube had proliferated and the dorsal root ganglia had originated from the neural crest throughout the length of the spinal part of the neural tube (Plate 4). The trigeminal, vestibulocochlear, facial, glossopharyngeal and vagus nerves developed from the brain part of the neural tube. The cranial and spinal roots of the vagus nerve arose from different origin and joined into one nerve (Plate 5,6).

In the eye, the right lens vesicle was closed and was detaching from the skin ectoderm, but the left lens vesicle was in the closing process (Plate 7,8). No pigment granules were seen in the outer layer of the retina. The lumen of the optic vesicle was continuous into the ventricle. The choroid fissure was seen, and the vessel that was thought as the hyaloid artery was located in that fissure (Plate 9). The statoacoustic ganglion was located in the ventral position of the optic vesicle (Plate 10). The facial nerve left the statoacoustic ganglion and innervated the second branchial (hyoid) arch (Plate 10). The otic vesicle showed an elongated endolymphatic appendage (Fig. 2 & Plate 11). On each side of the frontal prominence and just above the stomodeum a local thickening of the surface ectoderm, the nasal placode, was seen (Plate 12). However, the shallow depression of the nasal placode could not be seen.

Respiratory system

In the ventral portion of the foregut the trachea branched from the esophagus and divided into two main bronchi. The primary bronchi extended dorsally beside the esophagus, but had not yet subdivided into secondary bronchi. The endodermal lining of the laryngotracheal tube was different from the surrounding splanchnic mesenchymal tissue, but the mesenchymal tissue had not yet differentiated. The pulmonary vessel had not developed.

Digestive system

The stomodeum contained a well-formed tongue and the foramen cecum was continuous with the thyroglossal duct. The thyroid gland was situated in the floor of the pharynx (Plate 13). In the foregut, the stomach was formed and the lumen of the stomach was wider than that of any other GI tract. The gallbladder, ventral and dorsal pancreatic

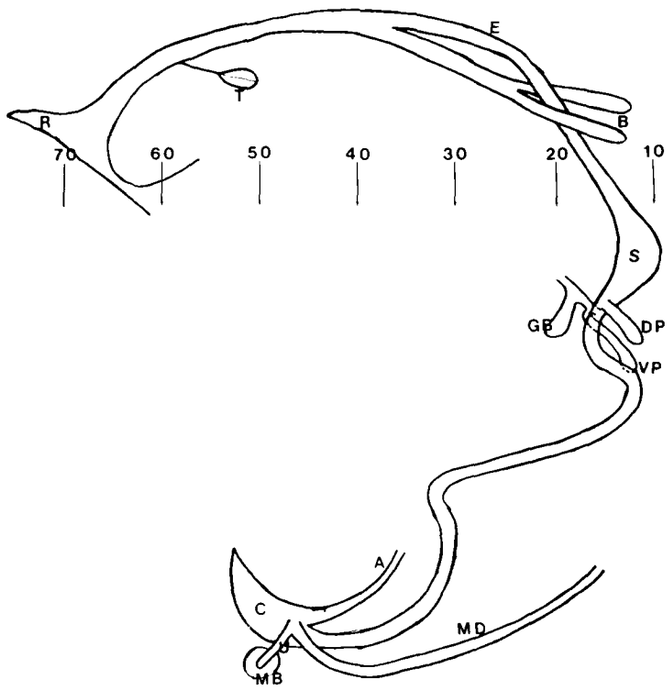


Fig. 3. Schematic reconstruction of the digestive, respiratory and urogenital system of the embryo. Lateral view
A: allantois, B: bronchi, C: cloaca, DP: dorsal pancreas, E: esophagus, GB: gall bladder, MB: mesonephric blastoma, MD: mesonep9hric duct, R: Rathke's pouch, S: stomach, T: thyroid, U: ureteric bud, VP: ventral pancreas

buds, and bile duct were seen in the duodenal portion of GI tract (Plate 14,15,16). The remaining portion of gastrointestinal tract reflected ventrally (Fig. 3 and Plate 17). The rectum was connected to the cloaca to which the mesonephric duct and metanephric duct were connected as well.

Cardiovascular system

The primary heart showed development of the chambers with further subdivision into two atria and two ventricles. The ventricles showed interventricular canal and the trabeculae (Plate 18). The endocardial cells could be distinguished from the myocardial cells (Plate 18). The endocardial cells could be distinguished from the myocardial cells (Plate 19). The truncus arteriosus was connected to the aortic sac (Plate 20). The primitive left ventricle was continuous with the atrium through the atrioventricular canal and the endocardial cushions were bulging on the dorsal and ventral walls of the canal (Plate 21). The sinus venosus was located under the atrium. The umbilical vein and the vitelline vein entered into the liver (Plate 22,23). The umbilical vein passed through the abdominal wall to enter into the umbilical cord, but the vitelline vein passed through the mesentery. Aortic arches III and IV were arising from aortic sac, passed through the branchial arches III and IV, respectively, and connected into the dorsal aorta. Aortic arches I and II had disappeared. The dorsal aortas were paired in upper portion, and joined caudally In the umbilical cord two umbilical arteries, one umbilical vein, and the allantois were seen (Plate 17).

Urogenial system

The mesonephros was seen throughout the abdomen in the back portion and the mesonephric duct extended caudally into the cloaca (Fig. 3). The metanephric duct (ureteric bud) arose from the connecting site between the cloaca and the mesonephric duct. The mesenchymal tissue surrounding the metanephric duct was induced and differentiated into metanephric tissue (Plate 24). The genital ridge was seen in the upper portion of the abdomen beside the mesonephric ridge and the cells showed active proliferation (Plate 25).

DISCUSSION

The crown-rump (CR) length of this embryo was estimated to be 6.9 mm. Since the CR length of Streeter age group XV ranges from 6.5 mm to 8.5 mm in 82% and 7.0 mm to 7.8 mm in 42%, this embryo seemed to belong to horizon XV under the consideration of the severe flexion. Streeter described five distinguishing external in this age group: closure of the lens vesicle, shallow central depression of the olfactory placode, appearance of the subsegment from the two-segmented hyoid bars, active transformation of the arm bud, and elevation of the ectoderm caused by somite formation and underlying spinal ganglia. Reconstruction showed the closure of the lens vesicles, and the thickening of the olfactory placode.

The absence of pigmentation in the outer layer of the retina and the neural lobe of the hypophysis ruled out age group XVI. The observation of a narrow atrio-ventricular canal with an incompletely formed interventricular septum is consistent with with Streeter's description of the advancing characteristics of the heart for age group XV. The facts that the lens vesicles were closed and the ventral pancreas had formed placed this embryo is group XV as well (Streeter 1948; Chi and Chee 1986). However, the thickened but flattened olfactory placode, the absence of the primary intestinal loop,

and absence of the pulmonary vessel and the cecum are the findings that are expected to be seen in embryos of Streeter's age group XIV embryo (Streeter 1948; Chi *et al.* 1983). Overall, based on the aforementioned characteristics it was quite difficult to assign an age group of this embryo because we had no photograph of the gross specimen and the intermingling of characteristics that existed between Streeter age groups XIV and XV. This embryo could be classified as an embryo in early stage of Streeter age group XV or a transitional stage from age group XIV to XV.

REFERENCES

Chi JG, Chee HK. A human embryo of Streeter age group XV. Seoul J. Med. 1986, 27:39-46

Chi JG, Choi MR, Lee HK. A human embryo of Streeter age group XIV. Seoul J. Med. 1983, 24:329-336

Streeter GL. Developmental horizons in human embryo. Description of age group XV, XVI, XVII and XVIII, being the third issue of a survey of the Carnegie collection. Contri. to Embryol. 1948, 32:113-203

= 국문초록 =

사람배아(Streeter 연령군XV)의 1예

서울대학교 의과대학 병리학교실

지제근 · 박원서

자궁적출로 절제된 자궁에서 우연히 발견된 6.9 mm의 태아를 얻어 연속절편하고 이를 현미경으로 관찰하고 재구축하여 그 발생학적 특징을 기술하였다. 본 배아는 발생학적으로 정상발육을 하고 있었으며 형태학적으로는 렌즈소포의 폐쇄, olfactory placode의 형성, endolymphatic duct의 형성, ureteric bud의 출현, 복축과 배측 체장, primary stage의 bronchi 등이 특징이었다. 이상의 소견을 종합하여 이 재료는 정상발육의 배아였고, 연령군은 Streeter의 제 15군의 초기에 속하는 것으로 판단되었다.

Plate 1. The roof of fourth ventricle (arrow). The vestibulocochlear nerve (VIII) and the trigeminal ganglion (V) are seen. X40 (#82)

Plate 2. The choroid plexus (arrow) in the fourth ventricle. X40 (#80)

Plate 3. The Rathke's pouch (R). The optic stalk (OS) is also seen. X100 (#76)

Plate 4. The proliferative basal layer (B) and the dorsal root ganglion (G) are seen. X100 (#27)

Plate 5. The cranial roof of vagus nerve. X100 (#74)

Plate 6. The spinal root of vagus nerve. X100 (#70)

Plate 7. The right lens vesicle (L) and otic vesicle. The lens vesicle is in closing process. X100 (#67)

Plate 8. The left lens vesicle and otic vesicle. The lens vesicle is in closing process. X100 (#67)

Plate 9. The left otic vesicle. The vessel thought as the hyaloid artery is seen (arrow). X100 (#63)

Plate 10. The right otic vesicle with statoacoustic ganglion (G). The facial nerve is seen (arrow). X100 (#87)

Plate 11. The left otic vesicle. The endolymphatic appendage (arrow) is seen. X100 (#78)

Plate 12. The nasal placode outlined by arrowheads is thickened but does not show shallow depression. X100 (#58)

Plate 13. The thyroid gland (rrow). The lumen of the gland is remained. X100 (#55)

Plate 14. The gallbladder (GB) is connected to liver through the hepatic duct. The connecting site of dorsal pancreas to duodenum is seen (arrowhead). X100 (#17)

Plate 15. The bile duct (BD) and dorsal pancreas (DP) are seen. X100 (#16)

Plate 16. The ventral pancreas VP) originating from the bile duct is seen. The dorsal pancreas is also seen (DP). D:duodenum. X100 (#15)

Plate 17. The ventral reflection of gastrointestinal tract (arrowhead). The allantois (AL), umbilical arteries (A) and vein (V) are seen. X40 (#30)

Plate 18. The heart. The interventricular canal and two atria are seen. X80 (#41)

Plate 19. The trabeculae of the heart. The endocardial cells (arrows) can be distinguished from the vacuolated myocardial cells. X400 (#41)

Plate 20. The truncus arteriosus (T). The aortic sac (AS) and left fourth aortic arch (arrow) are seen. X40 (#48)

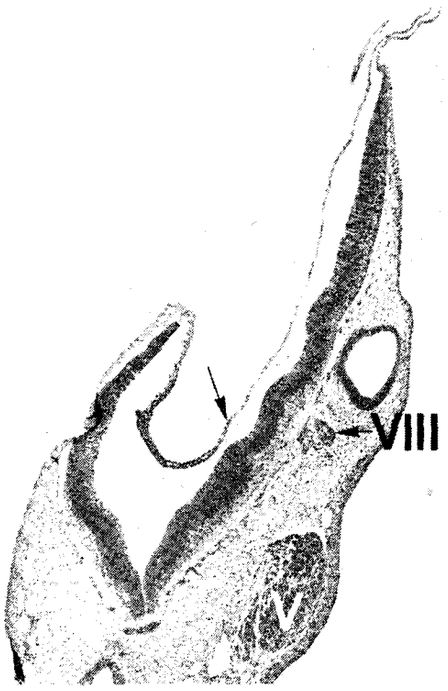
Plate 21. A: The atrioventricular canal and endocardial cushion (arrows). X40 (#39) B: Close up view of the endocardial cushion. X400 (#39)

Plate 22. The vitelline vein (V). The dorsal (DP) and ventral pancreas (VP) are seen. X100 (#12)

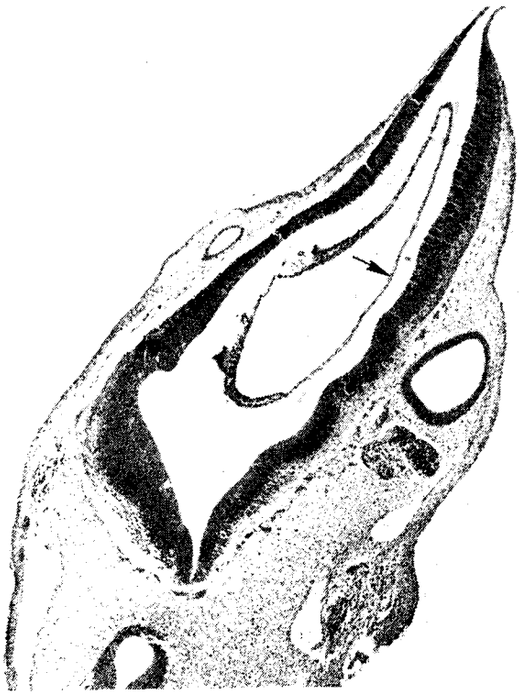
Plate 23. The umbilical vein (UV) passes through the abdominal wall. X40 (#21)

Plate 24. The metanephric duct (MD) and metanephric blastema (MB) are seen. C: cloaca. X100 (#5)

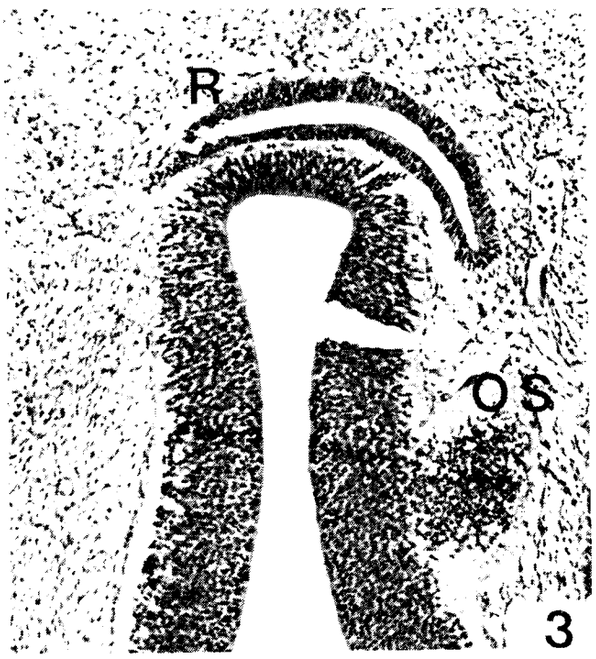
Plate 25. The genital ridges (arrows) are seen. DA: dorsal aorta, B: primary bronchi. X100 (#41)



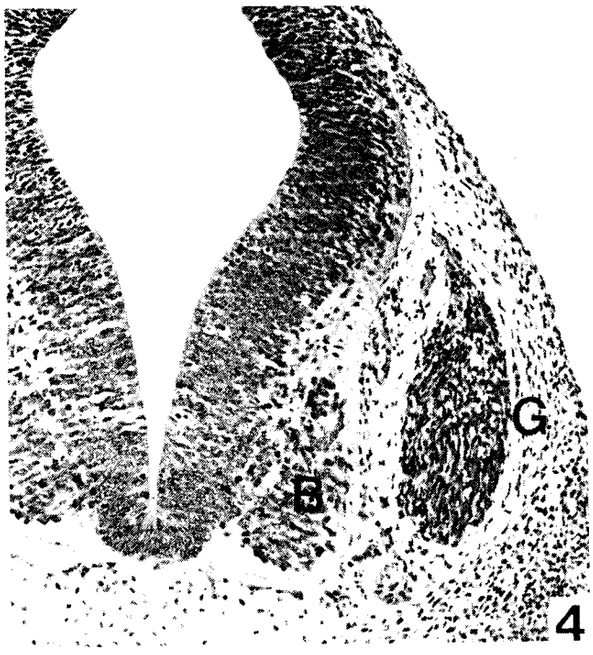
1



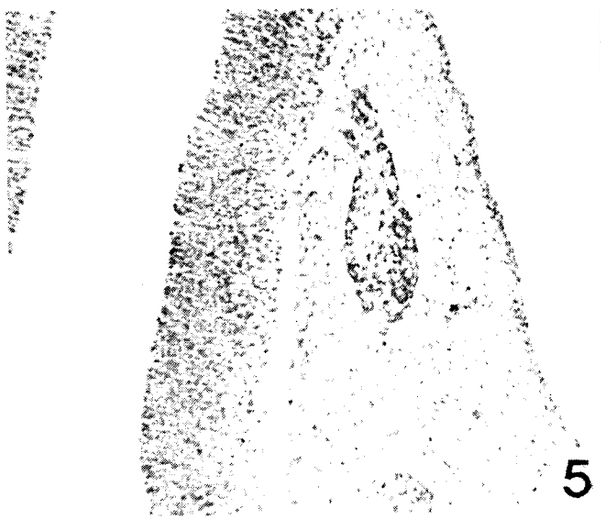
2



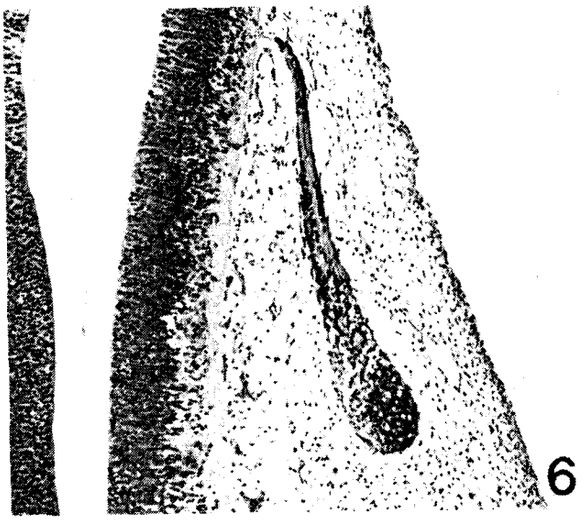
3



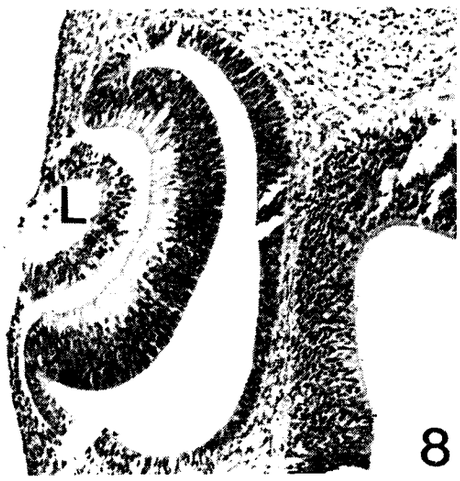
4



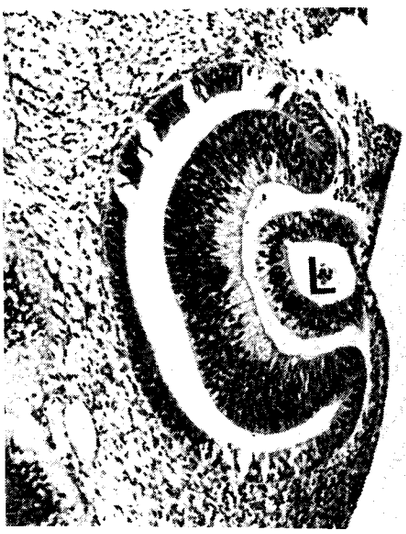
5



6



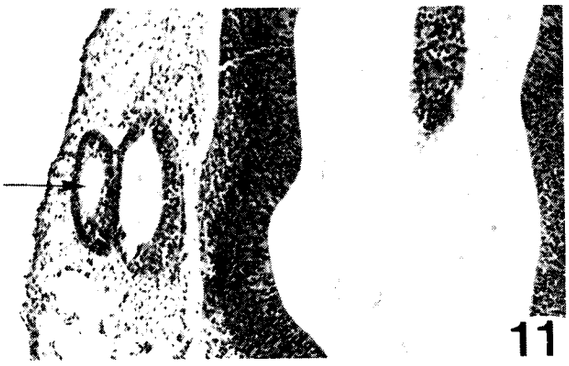
8



7

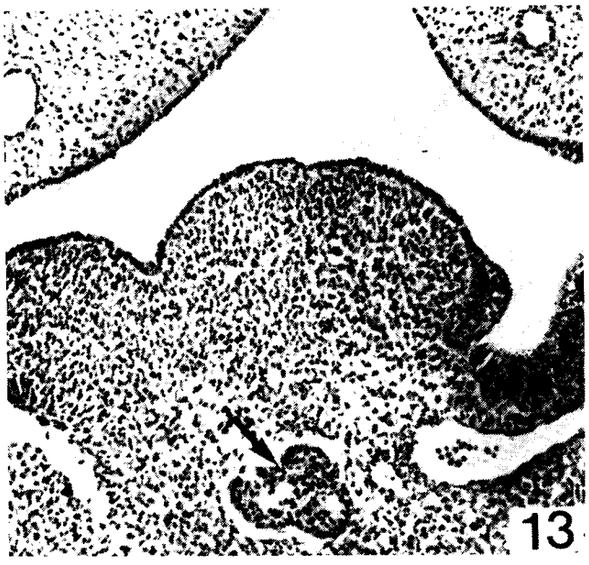
9

10



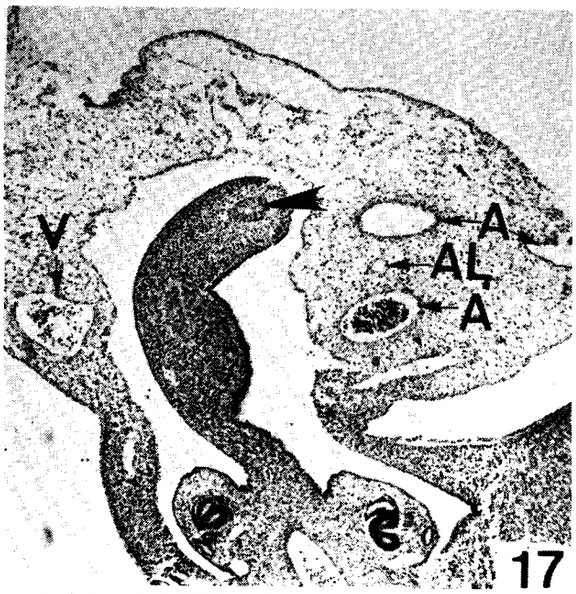
11

12



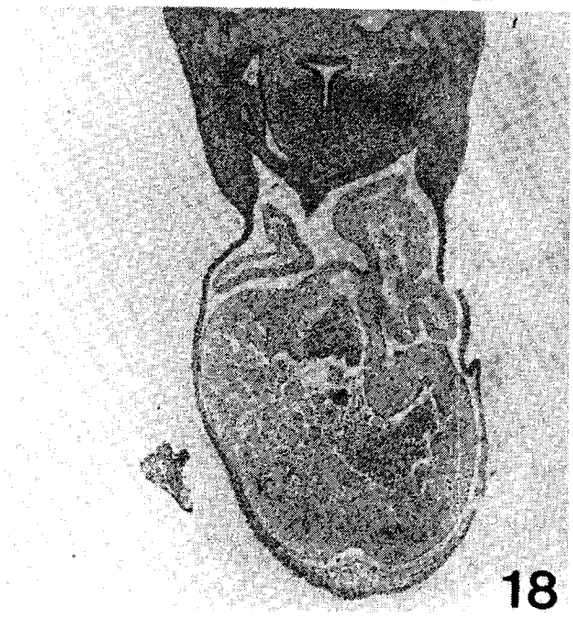
13

14

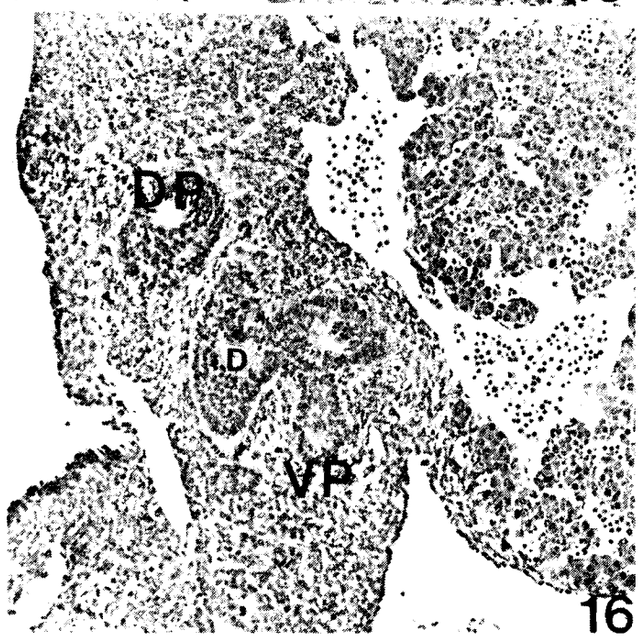


17

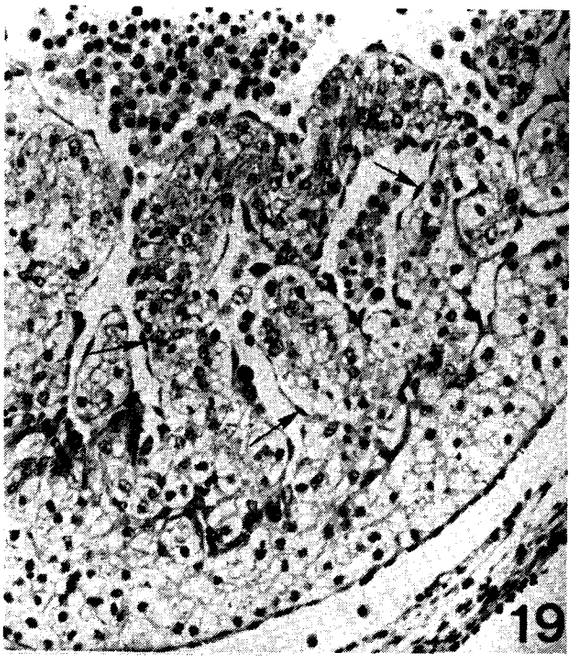
15



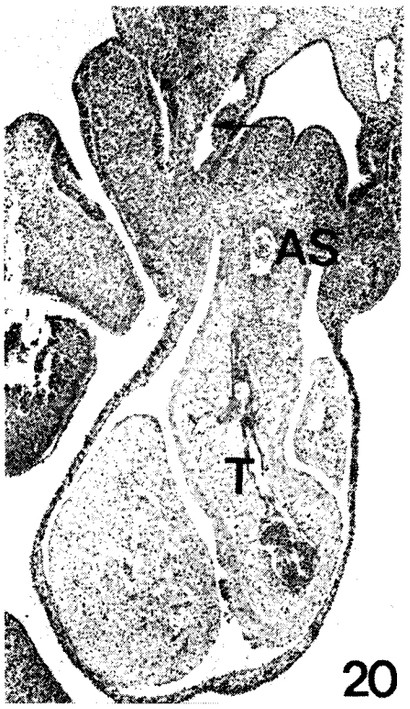
18



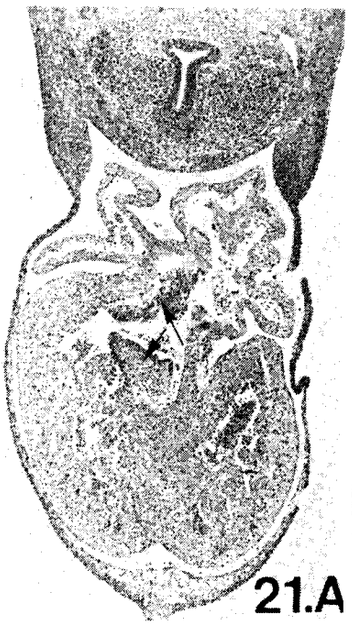
16



19

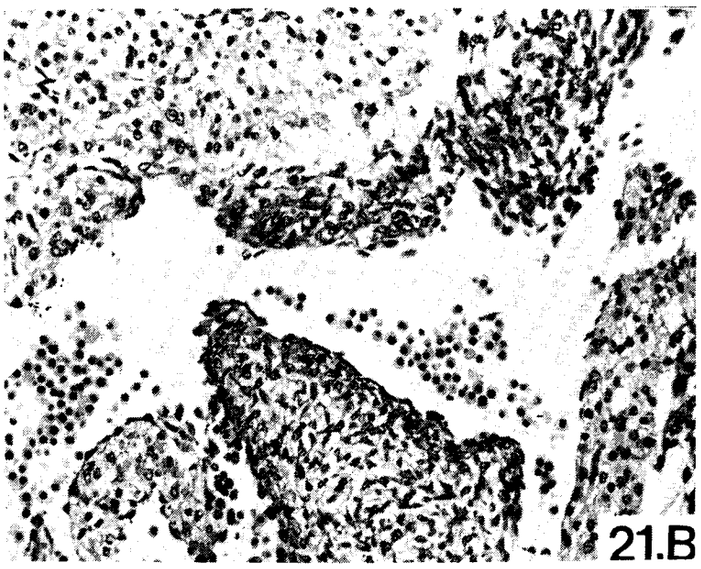


20



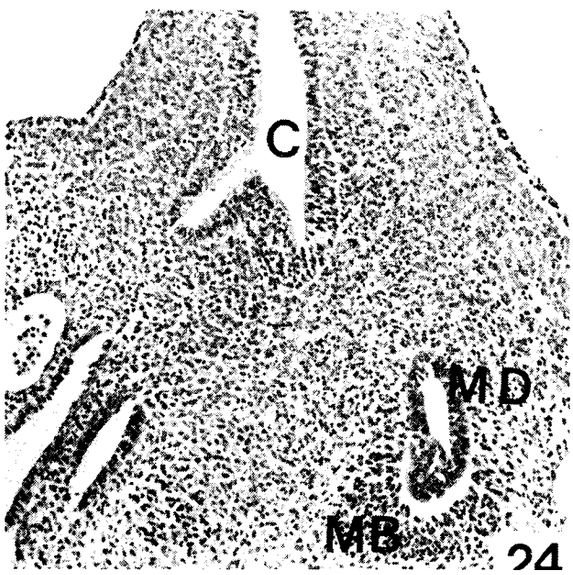
21.A

22

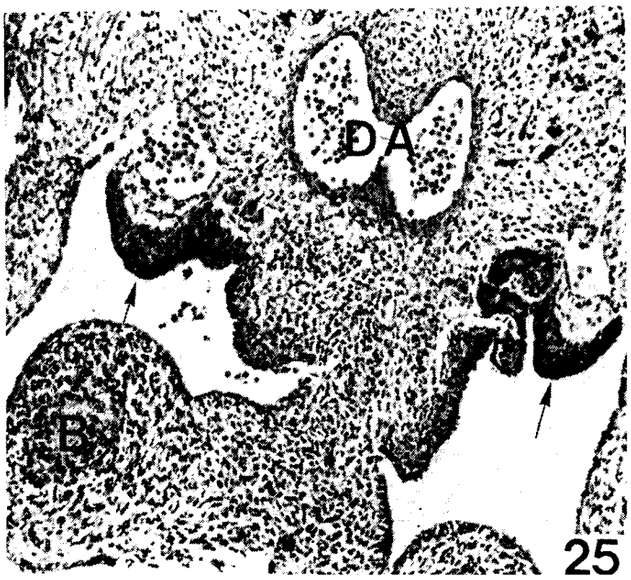


21.B

23



24



25