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A Human Embryo of Streeter Age Group XX

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= Abstract =A human embryo was obtained from a total hysterectomy specimen of a 31-year old woman. This embryo was serially sectioned and studied with special reference to its developmental stage.

The developmental characteristics of the eight key organs in this embryo corresponded well to the age group XX. The embryo was 23 mm in crown-rump length, and was 55 days old on the basis of the last menstrual period. The digestive tract was well-developed, and the dorsal and ventral pancreases were thought to be fused with each other. The development of the respiratory system was in normal commencement, having branched more than three times. The mesonephroi and metanephroi were also well-developed and the lumen of the ureter was visible. The heart was composed of four chambers and almost all of the valves present in the normal adult heart were also noted. The telencephalon was relatively small, and the ventricles of the brain were narrow.

Key Words: ***Embryo, Development, Streeter age group***

INTRODUCTION

Progressive research on human embryology is essential and of practical value to understand the normal relationships of body structures and the causes of congenital malformations. The methods that have been employed in the course of earlier studies to determine the age of embryos, however, proved inaccurate and a different approach was sought.

Solving this problem, George L. Streeter (1948, 1951) established the concept of "Developmental Horizon" from his own experiences on Carnegie embryological collections. He divided the developmental stages of human embryos into 23 arbitrary stages or "horizons" on the basis of developmental state of the internal organs, and described them according to the age groups.

Observations of an embryo specimen obtained from a uterus operated for bicornual pregnancy suggested that the embryo belonged to the age group XX of the Streeter's developmental horizon, and the characteristic features of the major organs of the embryo are described in this report.

CASE REPORT

A 31-year-old woman was operated for a total anterior hysterectomy with left adnexectomy for cornual pregnancy at the Seoul National University Hospital in April 30, 1983. The last menstrual period of the patient was February 19, 1983. During the gross examination of the hysterectomy specimen, an embryo (S83-4919) was incidentally found and immediately fixed with 10% formalin. The embryo was then embedded in paraffin, sectioned sagittaly to obtain 188 slides in 7 μm thickness, and stained with hematoxylin-eosin.

External Appearance: The embryo measured 23 mm in crown-rump (CR) length. The external appearance of the embryo was deduced from reconstruction as the photograph of the gross specimen was unavailable. The digits of the hands were short and noticeably webbed, projecting over the heart. Notches were visible between the digital and toe rays, and the tail was stubby, but still noticeable. The scalp vascular plexus and the knee bending were not yet prominent. Since the eyelids were not fused the eyeballs remained open.

The Digestive System: The digestive tract was

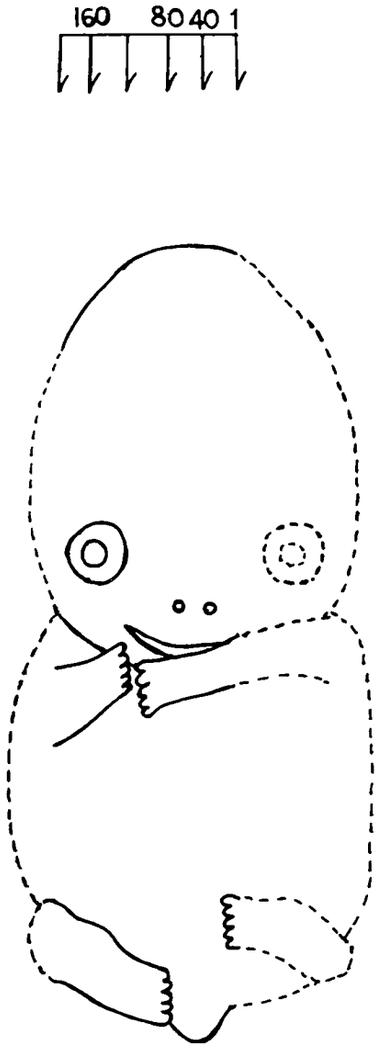


Fig. 1. Schematic reconstruction of the embryo in this report. The number represents the number of section slide.

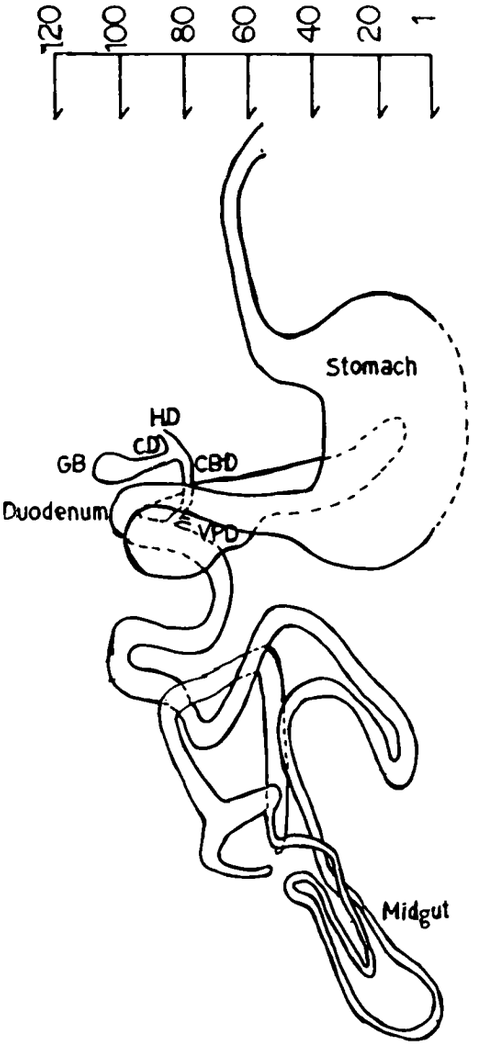


Fig. 2. Schematic reconstruction of digstive system of the embryo. CBD: common bile duct CD: Cystic duct, GB: Gallbladder, HD: hepatic duct, VPD: ventral pancreatic duct.

in the state of physiological umbilical herniation. Throughout the length of the digestive tube were four layers seen, and the covering epithelium was composed of pseudostratified columnar cells. At the bottom of the oral cavity the foramen cecum was observed, and the pharynx was compressed dorsoventrally. The esophagus had reached to its final length, and its covering epithelium was in the phase of cribriform plate (Plate 1 and 2). The stomach was shifted to the left and rotated 90 degrees clockwise about its long axis. Connecting the spleen and the stomach, the dorsal mesogastrium was seen along the greater curvature of the stomach. The common hepatopancreatic duct began from the C-shaped duodenal loop and was divided into the ventral pancreatic duct and the common bile duct. The latter branched again into the hepatic and the pancreatic ducts. The orifice of the dorsal pancreatic duct was not noted, suggesting that the ventral duct has fused and anastomosed with the dorsal duct (Plate 3). The liver filled most of the abdominal cavity and was in an active hemopoietic phase. The midgut was totally herniated and rotated 270 degrees counterclockwise around the axis of the superior mesenteric artery. This seemingly overrotation beyond the normal 90 degrees might have occurred inadvertently during the process of embedding. The cecal diverticulum and the appendix were observed near the midgut loop (Plate 4). The urorectal septum has grown caudally toward the cloacal membrane in the hindgut, completely dividing the cloaca into the cecum and the

urogenital sinus. The anal membrane was still persistent (Plate 5). The parotid glands were seen in both sides of the cheek, and the ducts of the submaxillary glands had begun to form knob-like branches (Plate 6).

The Respiratory System: The three-lobed right lung was larger than the two-lobed left lung. The trachea at No. 86 plane was bifurcated into the main bronchi, each further branching out into the segmental bronchi: ten on the right lung, eight on the left lung. Since the segmental bronchi continued to branch out further, formation of more than three ramifications were noted. Although there were no cartilaginous rings around the trachea, the condensation of the mesenchymal tissue differentiating towards the cartilage could be seen. The epithelium of the trachea and bronchi were lined with pseudostratified columnar epithelial cells with dark nuclei, but cilia were not found (Plate 7).

The Urogenital System: At the posterior abdominal wall, the metanephroi were observed to have S-shaped lumen in their renal vesicles. The ureters started from the metanephroi, descended along the posterior abdominal wall, and were attached to the superolateral side of the urinary bladder (Plate 8).

The adrenal glands were located in the anterosuperior side of the metanephroi, and the mesonephroi at the anteroinferior side. The mesonephric ducts started from the posterolateral portion of the mesonephroi. Crossing the ureters anteriorly, they descended medially, and then opened into the medial portion of the urinary bladder posteroinferiorly to the ureteric buds (Plate 9).

Running along with the mesonephric ducts, the paramesonephric ducts were seen, but upon descending to the level of the inferior margin of the mesonephroi they disappeared with their lumina obliterated (Plate 10).

Although the gonads anterior to the mesonephroi were composed of several cord-like structures, it was difficult to determine whether the cords were continuous or discontinuous with the surface epithelium. Therefore, the sex of the embryo remained uncertain (Plate 11).

The urorectal septum descended completely,

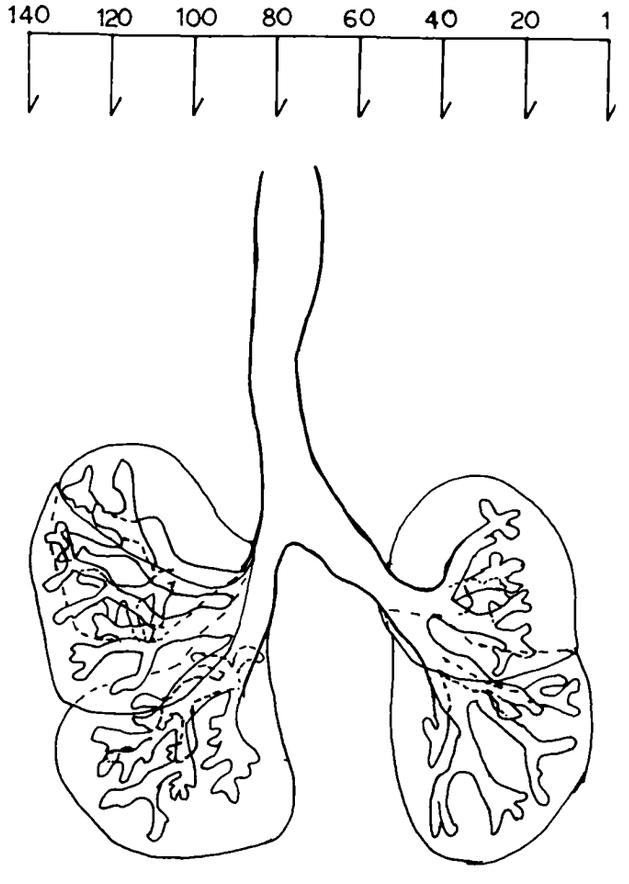


Fig. 3. Schematic reconstruction of the lungs of the embryo.

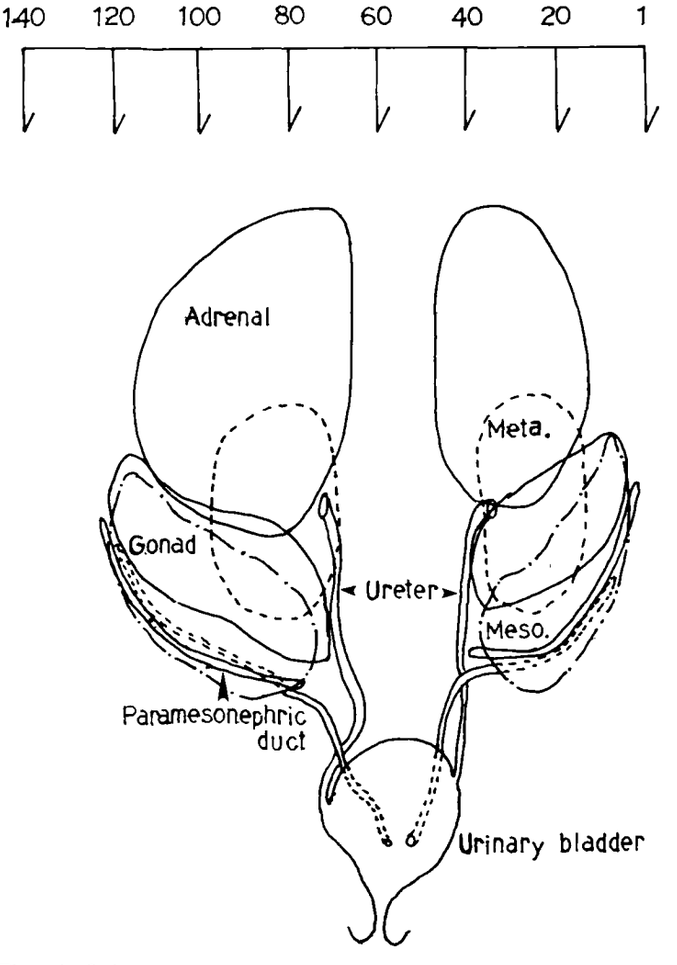


Fig. 4. Schematic reconstruction of urogenital system of the embryo. Meso: mesonephros, Meta: metanephros.

and the urogenital membrane had been already ruptured. The superior portion of the urogenital sinus continued with the allantois which was connected to the umbilical cord.

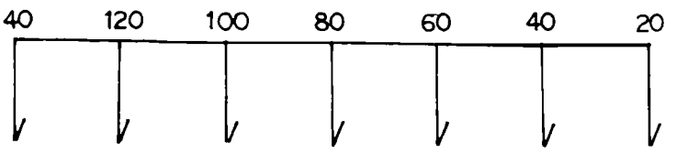
The Cardiovascular System: The heart was composed of four chambers: the right and left atria at the posterior side, and the right and left ventricles at the anterior portion of the heart.

The atria appearing like a C-shaped sac were continuous with each other through a large interatrial foramen. The septum primum and secundum were not clearly distinguishable. The right and left ventricles were separated completely by the interventricular septum. There were a number of trabeculae as well as cross-striations in the ventricular wall. The aorta and pulmonary artery were connected with the left and right ventricles, respectively, and the aortic and pulmonary valves were seen on their base (Plate 12). The mitral and tricuspid valves were also found attached to the papillary muscle by chorda tendinae. On the same plane with the tricuspid valve the inferior vena cava was seen, and the superior vena cava was found on the more right sections.

The sinus venosus was located in the posterior portion of the left atrium, soon opening into the right atrium (Plate 13).

The Central Nervous System: There were three flexures in the brain of the embryo: cephalic, pontine and cervical flexures, dividing the brain into the telencephalon, diencephalon, mesencephalon, metencephalon and myelencephalon. Two lateral ventricles were observed in the telencephalon, communicating with the 3rd ventricle through the interventricular foramen of Monro. A thick mantle layer was recognizable around the interventricular foramen of Monro, appearing to differentiate into the corpus striatum. Except for the corpus striatum, the cerebral hemisphere was almost entirely composed of ependymal layers. The choroid plexuses of the medial wall of the lateral ventricles were also found, lined with several ependymal layers. The 4th ventricle was located in the posterior portion of the 3rd ventricle. The choroid plexus of the 4th ventricle was lined with one ependymal layer, unlike those of the lateral ventricles. At the roof of the 4th ventricle the cerebellar primordium was seen (Plate 14).

The lateral ventricles bulged inward in the ventral portion and formed the olfactory bulbs from which arose the olfactory nerves (Plate 15). The optic chiasm and the hypophysis were seen at the ventral part of the diencephalon (Plate 16). Along the stalk of the optic nerve, ependymal arrangement



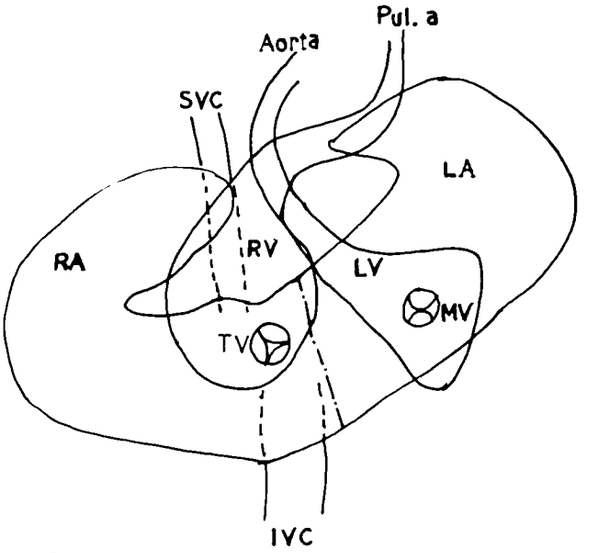


Fig. 5. Schematic reconstruction of the heart of the embryo. IV: inferior vena cava, LA: left atrium, LV; left ventricle, MV: mitral valve, RA: right atrium, RV: right ventricle, SVC: superior vena cava, TV: tricuspid valve.

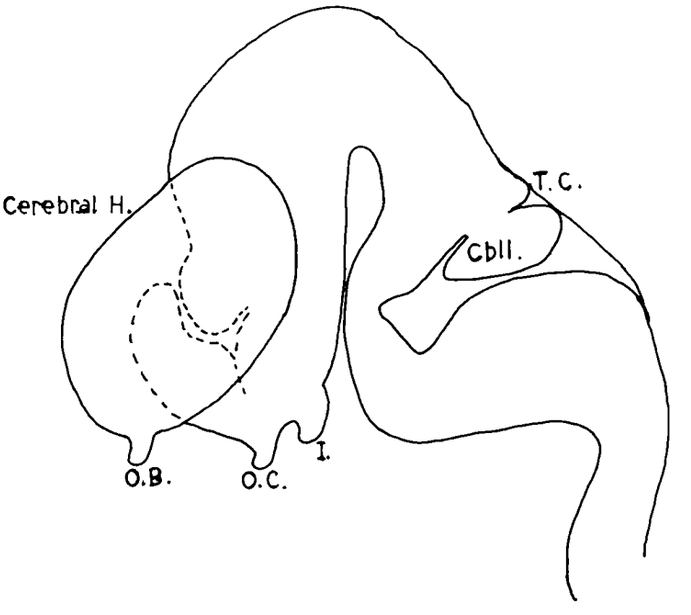


Fig. 6. Schematic reconstruction of the central nervous sytem of the embryo. Cbll: cerebellum, I: infundibulum, O.B.: olfactory bulb, O.C.: optic chiasm, T.C.: tentorium cerebelli.

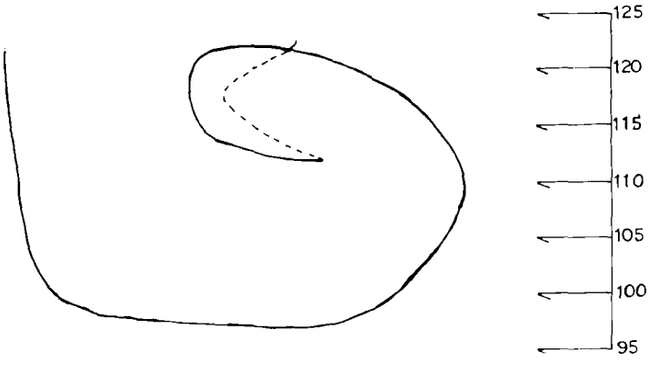


Fig. 7. Schematic reconstruction of the cochlea of the embryo.

was partially retained (Plate 17). At the midline of the eye, the cornea appeared to be composed of a thin layer of loose mesoderm, the primitive corneal body (Plate 18). In the retina, the pigment epithelium was fixed to the choroid and the proliferation and subsequent migration of the primary nuclear layer gave rise to the inner nuclear layer.

The neurohypophysis was surrounded by the adenohypophysis and a persistent remnant of the stalk of Rathke's pouch was noted passing through the sphenoid bone (Plate 19).

The cochlea was well-developed and its covering epithelium consisted of 6 to 7 layers. Since the reconstruction of the cochlea showed that the tip was very long and had turned two times, the cochlea was determined to be in the transitional stage. The trigeminal and vestibular ganglia were in the anterior area of the semicircular canal, and the cochlear ganglia were located in the superior portion of the cochlea (Plate 20).

Other Organs: The adrenal gland consisted of three different types of cells, forming the medulla and the fetal and permanent cortices. The cells of the permanent cortex had smaller nuclei than those of the fetal cortex, and their cytoplasm was basophilic whereas in the fetal cortex, the cytoplasm was eosinophilic. The permanent cortex surrounded the fetal cortex which was penetrated by small and spindle-shaped medulla cells with dark nuclei.

The thyroid gland was a fenestrated plate with some formation of vascularization. The parathyroid glands and the thymus could not be identified, because the anterior lower neck portion was partly lost during the preparation process. In the nose the vomeronasal organ was seen to have a broad oral end, and a caudal end of a shallow blind sac. The femur had a fibrous zone (Plate 21). The basal layer of the epithelial lining of the oral cavity was much proliferated, forming the dental buds, all of which were in the bud stage (Plate 22). The surface ectodermal cells of the skin of the breast was proliferated and had formed downgrowths into the underlying mesenchymal tissue (Plate 23).

DISCUSSION

The overall microscopic observation of this case was summarized in view of eight key organs on which was the basis for establishing a proper developmental horizon.

The cornea was a thin layer of loose mesoderm, coinciding with the age group XIX of Streeter's developmental horizon. Along the stalk of the optic nerve, ependymal arrangement was partially retained and it corresponded to the age group XX. Since the cochlea with the tip long turned two times, it was in the transitional stage, along falling into the age group XX.

In the sphenoid bone, the persistence of the long slender stalk of the hypophysis rendered the embryo as belonging to group XX. The broad opening of the oral end and the shallow and closed blind sac of the caudal end of the vomeronasal organ corresponded to group XX.

The duct of the submaxillary gland began to form knob-like branches, but it was difficult to differentiate whether they were branches or primary buddings. Therefore, the submandibular glands were decided to belong between the group of XX and XXI. The S-shaped lumen in the renal vesicle was conspicuous and the fibrous zone of the femur was not very distinct from the osteoblast zone, these two observations also suggested group XX.

Besides the key organs aforementioned, several other developmental features were noteworthy. The observation that the dorsal and ventral pancreatic ducts appeared to have been fused suggested that the embryo is in approximately the eighth week of development, supported by the fact that the ducts do fuse at about the eighth week. Also, the condensation of the mesenchymal tissue differentiating towards the cartilage around the trachea was seen and this feature is also one of the findings during the eighth week of development.

During the fourth to seventh weeks of development, the urorectal septum divides the cloaca into the anorectal canal and the primitive urogenital sinus. In this embryo, the urorectal septum had descended completely, indicating that the embryo

was at least in the seventh week of development or more. In the adrenal glands, a considerable mass of cells had accumulated and were already beginning to be arranged into cords with sinusoids; this finding is indicative of the seventh week of age, particularly in its later phase. In the middle of the eighth week, the cells of the thyroid gland become arranged in cords with infiltrating vascular mesenchyme in between. Since the thyroid gland was a fenestrated plate form in this case the embryo was at the early eighth week.

All of the above observations other than the characteristics of the eight key organs coincided with the age group XX of the Streeter's developmental horizon, suggesting that the embryo was 8 weeks old.

REFERENCES

Streeter GL. Developmental horizon in human embryos. Description of age groups XV, XVII and XVIII, being the third issue of a survey of the Carnegie collection. Contrib. to Embryol. 1948, 32:113-203

Streeter GL. Developmental horizon in human embryos. Description of age groups XIX, XX, XXI, XXII and XXIII, being the fifth issue of a survey of the Carnegie collection. Contrib. to Embryol. 1948, 32:165-196

LEGENDS FOR PLATES

Plate 1. (No. 54) The foramen cecum (C), pharynx, esophagus (E) and thyroid gland (T). H & E, X40.
Plate 2. (No. 63) The esophagus (E). The esophagial lumen shows cribriform pattern. H & E, X40.
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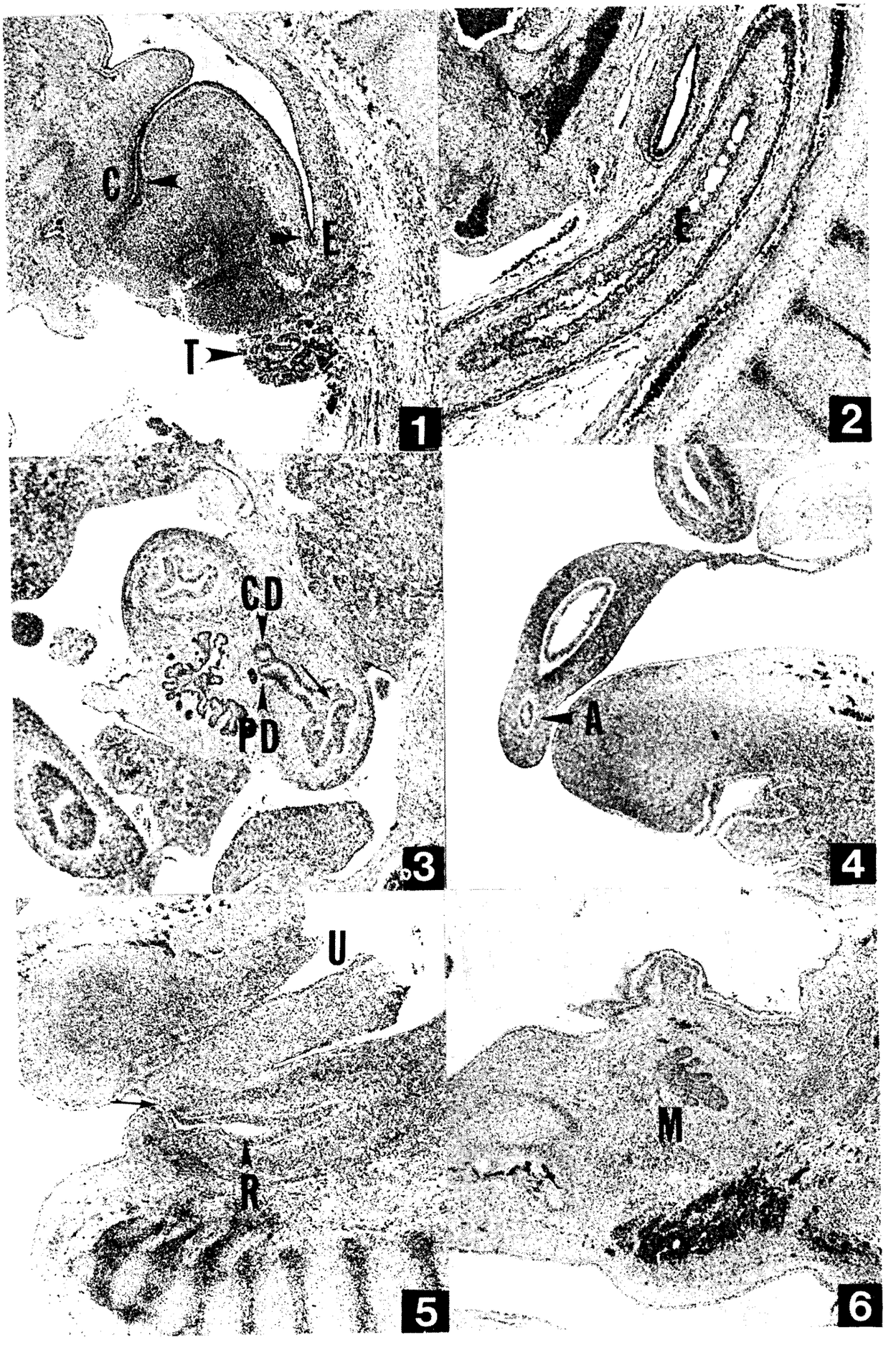
Plate 19. (No. 56) The pituitary gland (P). The adenohypophysis has left a long slender stalk passing through the sphenoid bone (arrow). H & E, X40.
Plate 20. (No. 123) The trigeminal ganglion (t), vestibular ganglion (V) and semicircular canal (S). H & E, X40.
Plate 21. (No. 142) The femur. The femur has a fibrous zone which is not very distinct from the osteoblast zone. H & E, X100.
Plate 22. (No. 83) The dental buds (arrow). H & E, X40.
Plate 23. (No. 122) The right breast (arrow). The skin of the breast is proliferated and penetrating the underlying mesenchymal tissue. H & E, X40.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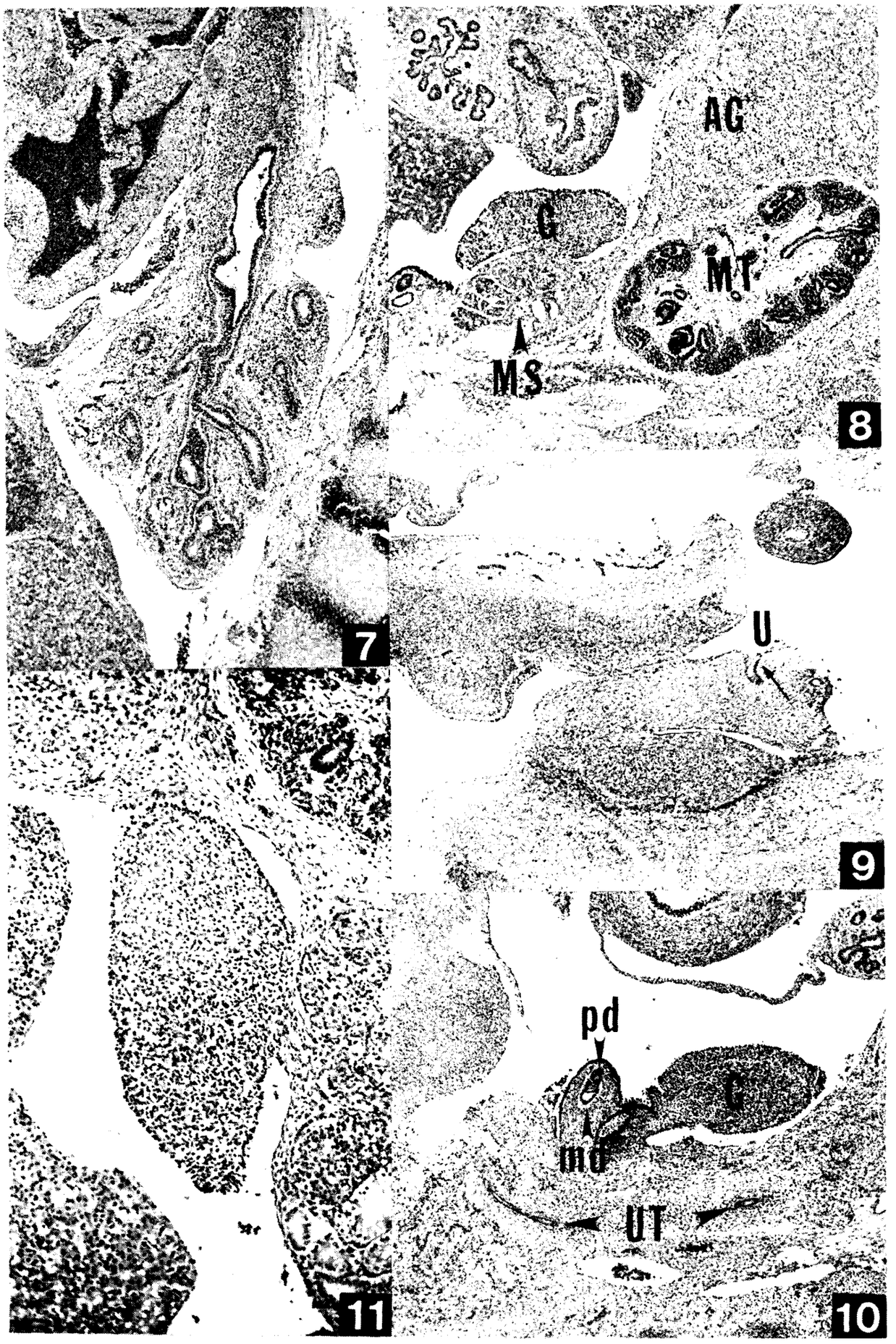
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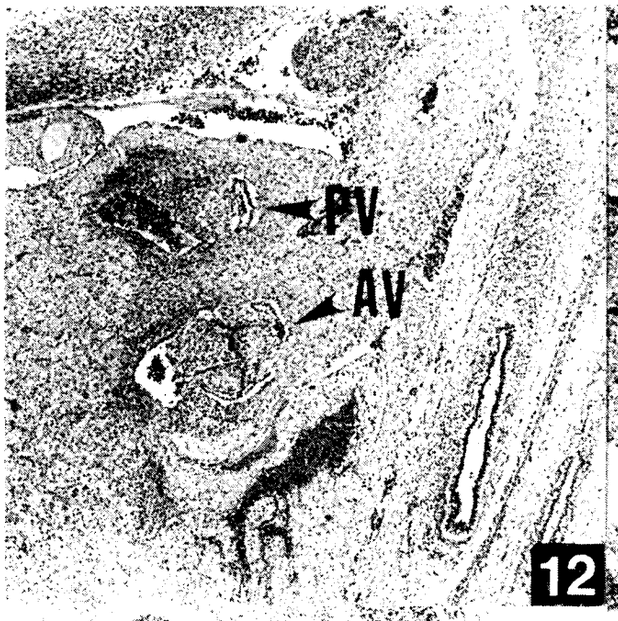

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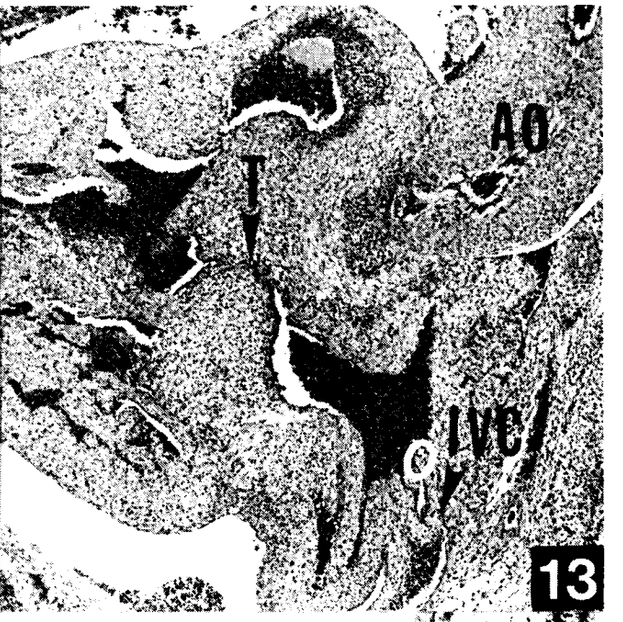

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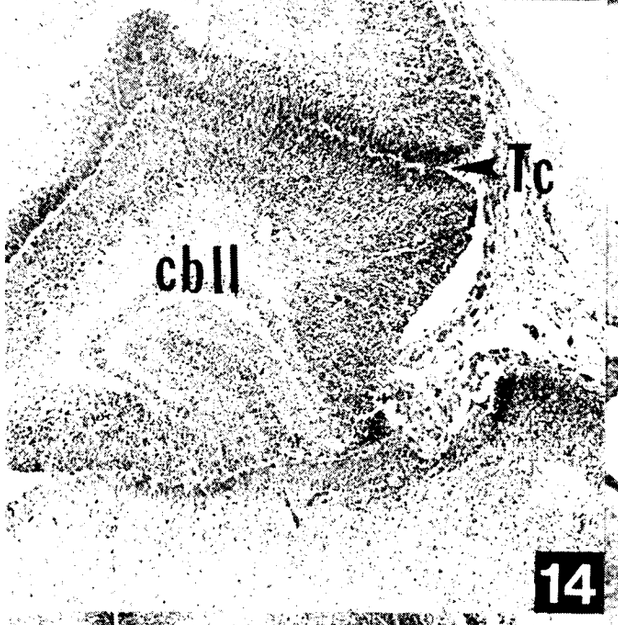

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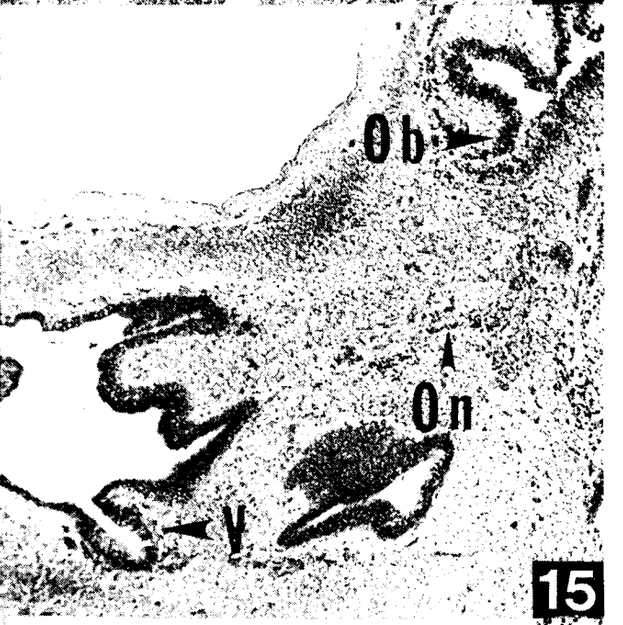

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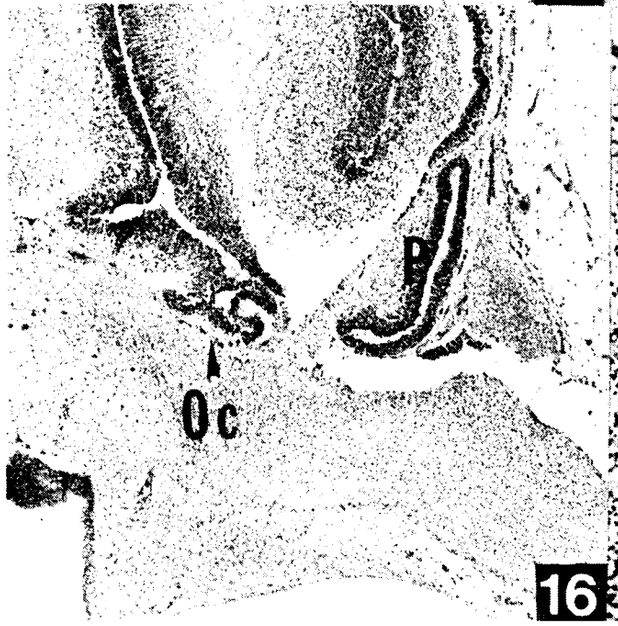

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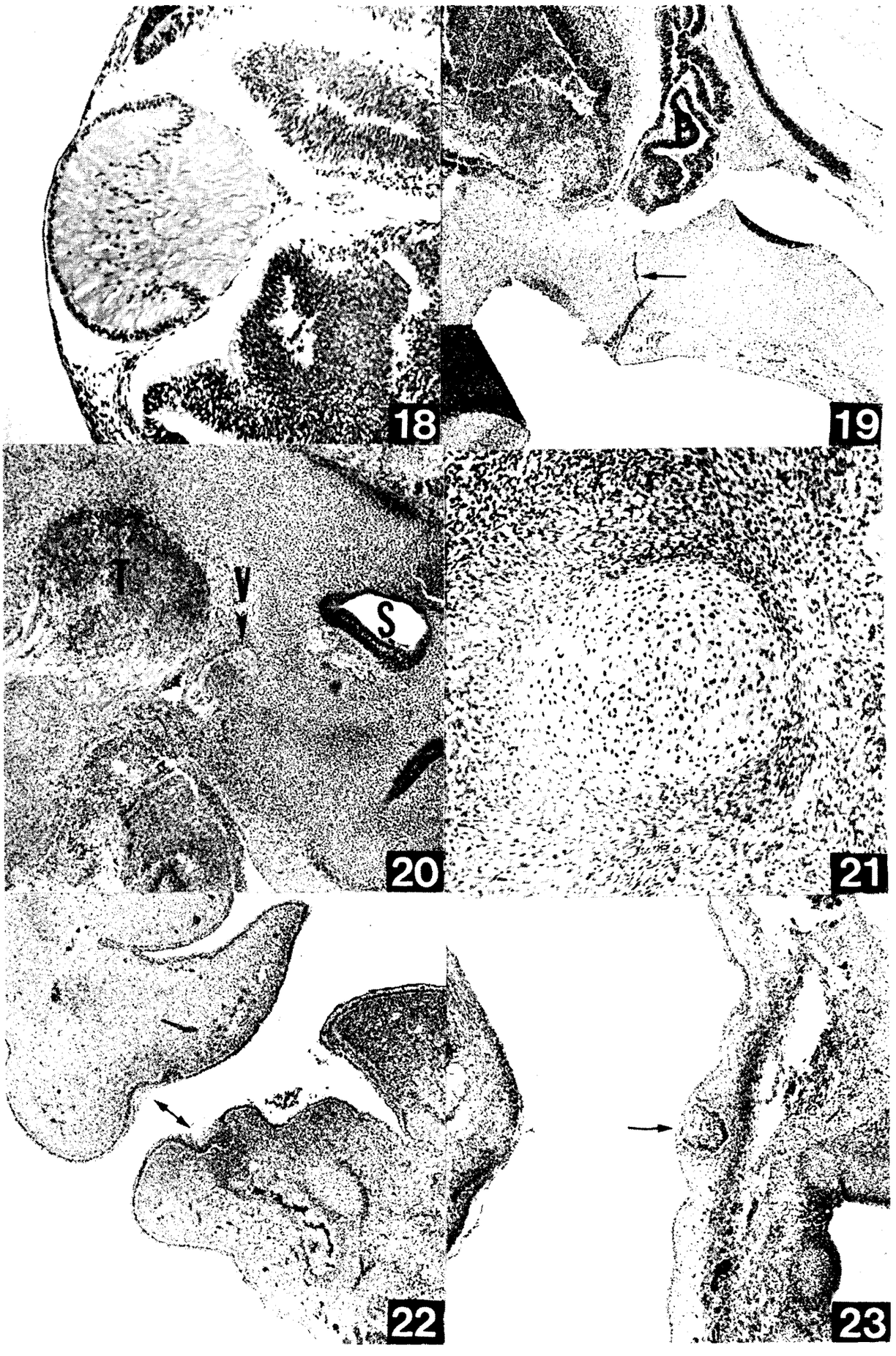
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사람배아(Streeter 연령군 XX)의 1예

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지제근 · 김영태

저자들은 31세 여자의 쌍각자궁 적출표본에서 23 mm 크기의 배아를 관찰하고 이를 시상면에 평행하게 7 μm 두께의 연속종단절편 188매를 만든 다음 H-E 염색을 하여 관찰한 결과 본 배아가 Streeter 연령군에서 제20군에 해당한다고 판단되었는데 그동안 우리 나라 문헌상 이러한 연령군이 없어 그 희유성에 비추어 기술한다.

본 배아는 현미경적으로 다음의 특징을 가졌다.

즉 소화기관은 비교적 잘 발달되었고 배측 및 복측 췌장은 서로 유합되어 있었고 폐는 3회 이상 분지되었고 중신과 후신도 잘 발달되어 요관의 내강도 잘 보였다. 심은 4개의 방(chamber)으로 되어 있고 성인에서 보는 모든 판막 구조가 다 잘 보였다. 종뇌는 비교적 작고 뇌실도 약간 정상에 비하여 크고 뇌에는 5부분의 분절이 정상 발달하고 있었다.