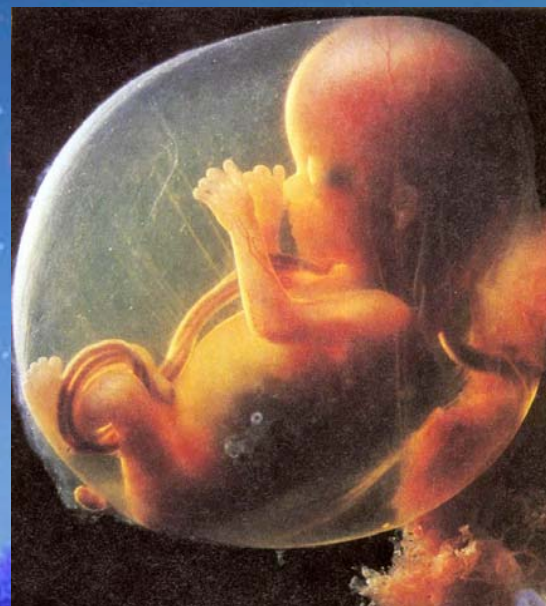
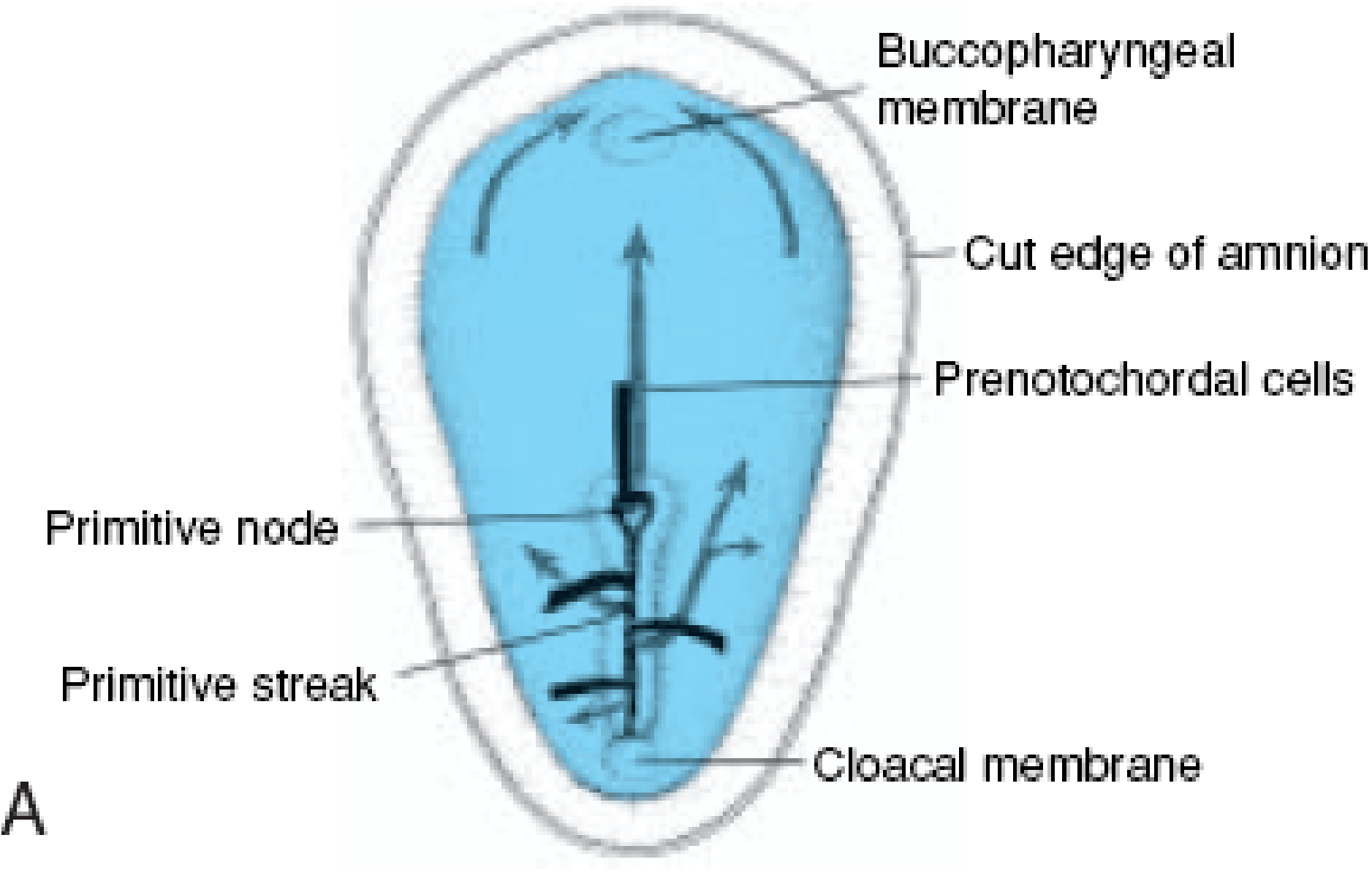
HUMAN EMBRYOLOGY

Department of Histology and Embryology
Jilin University

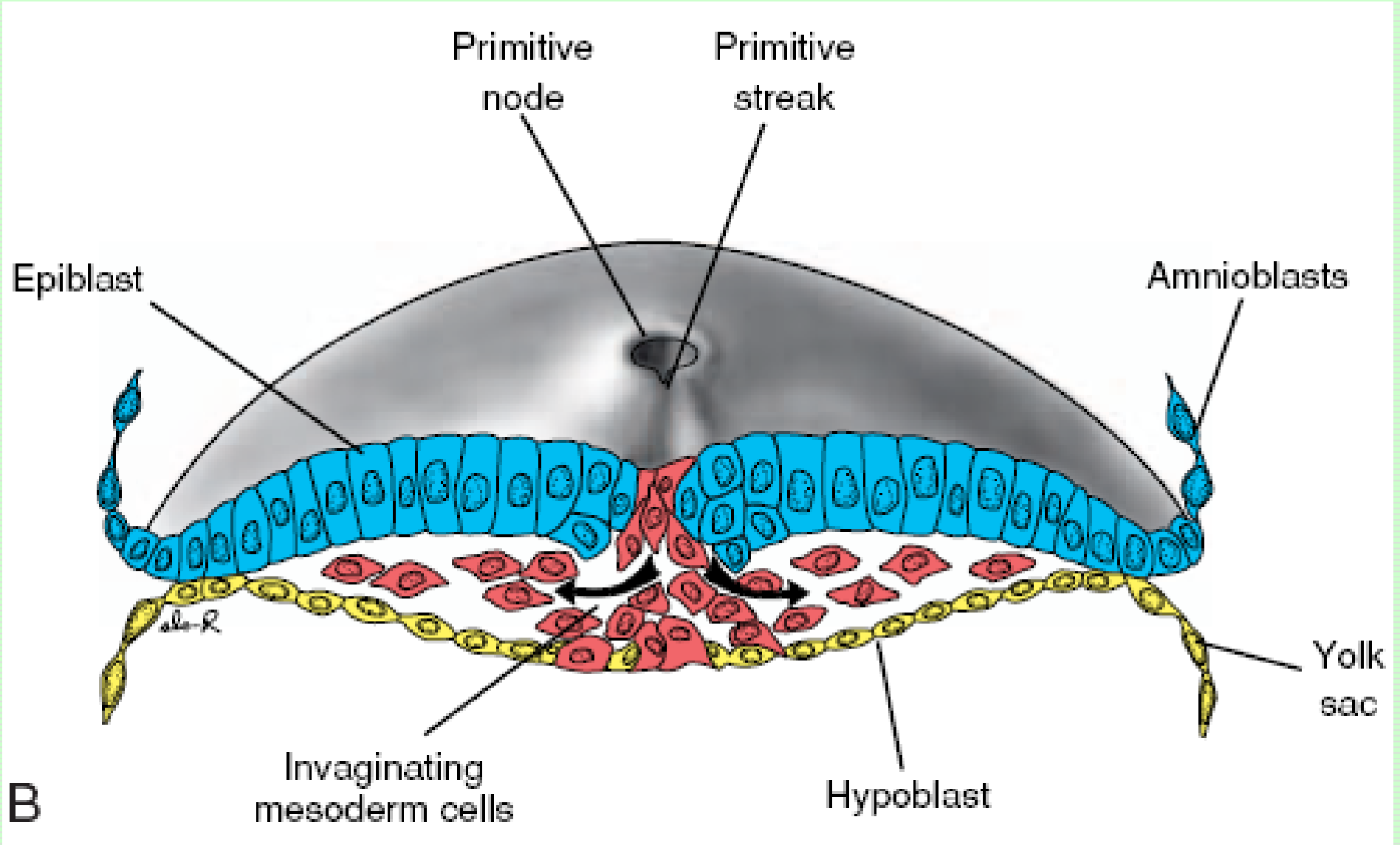


Chapter 2

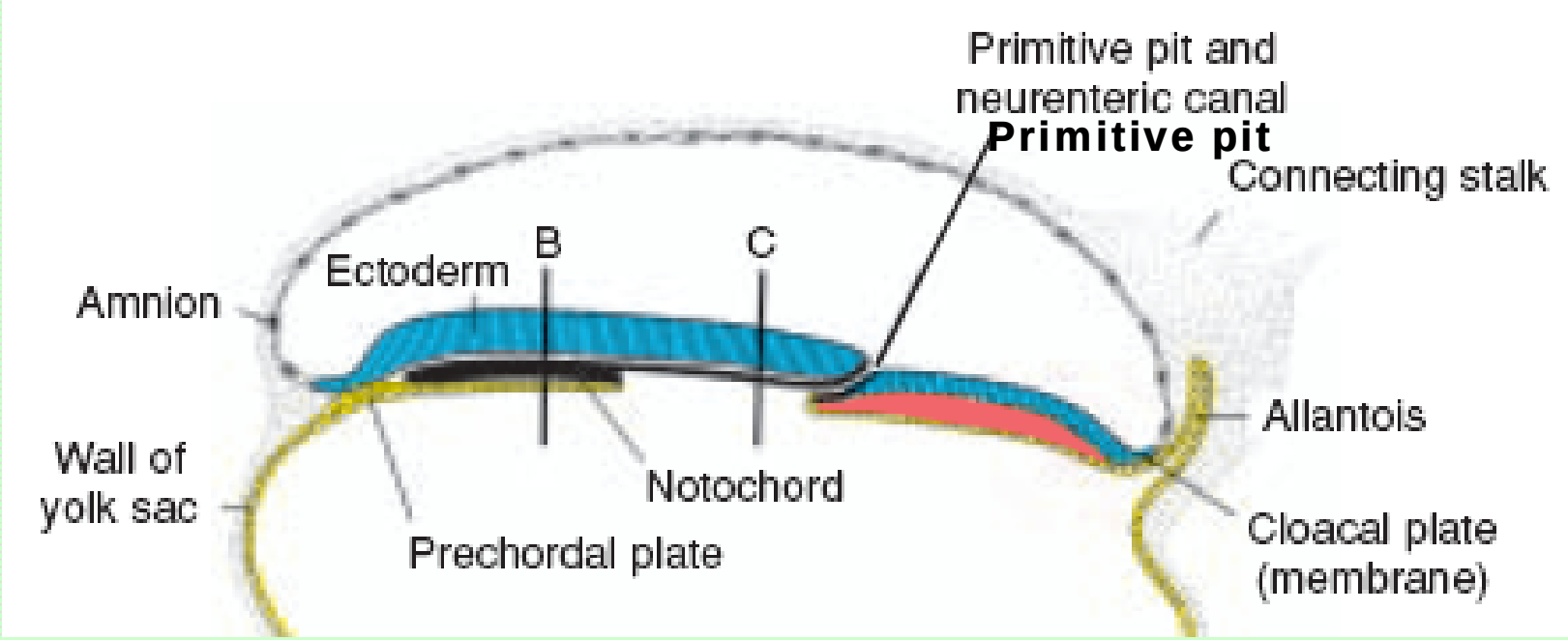
General Embryology
Fourth week:
The derivatives of trilaminar germ disc



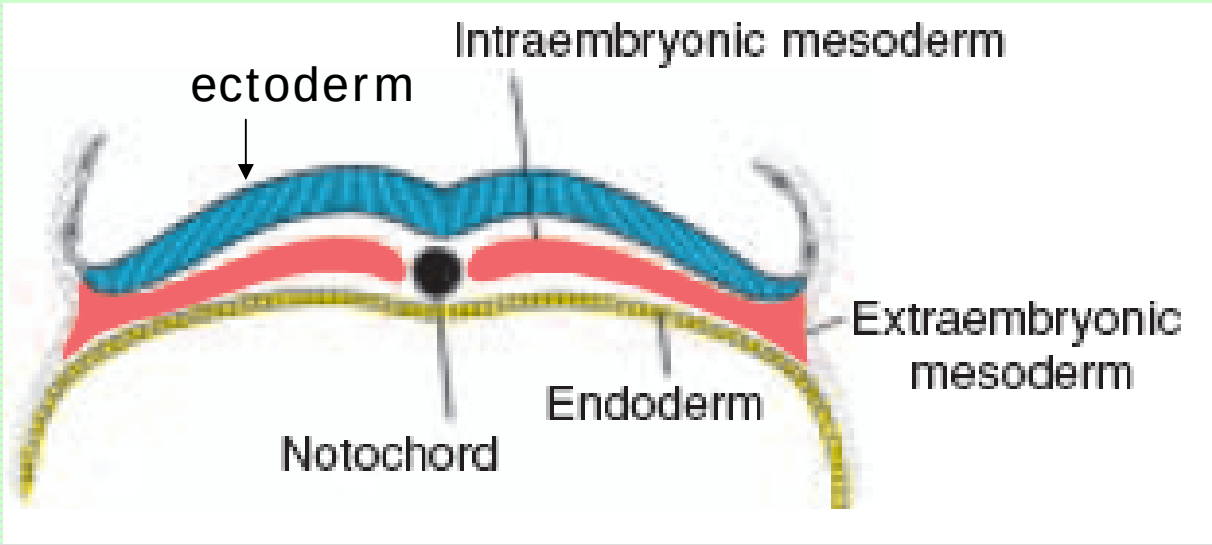
Dorsal side of the germ disc. At the beginning of the third week of development, the ectodermal germ layer has the shape of a disc that is broader in the cephalic than the caudal region.



Cross section shows formation of trilaminar germ disc



Drawing of a sagittal section through a 17-day embryo. The most cranial portion of the definitive notochord has formed.



Schematic view showing the definitive notochord.

horizon =ectoderm

hillside fields =neural plate

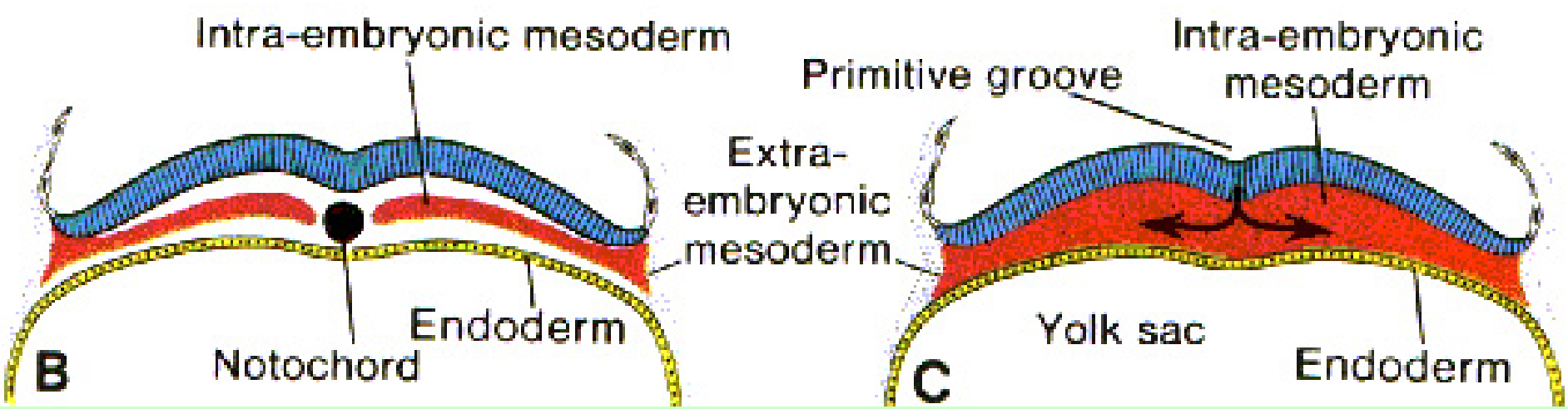
mountain peaks =neural folds
valley =neural groove

Cave sinks into mountain =neural tube

7.1 Derivatives of the Ectodermal Germ Layer

1) Formation of neural tube

- Notochord induces the overlying ectoderm to thicken and form the neural plate.

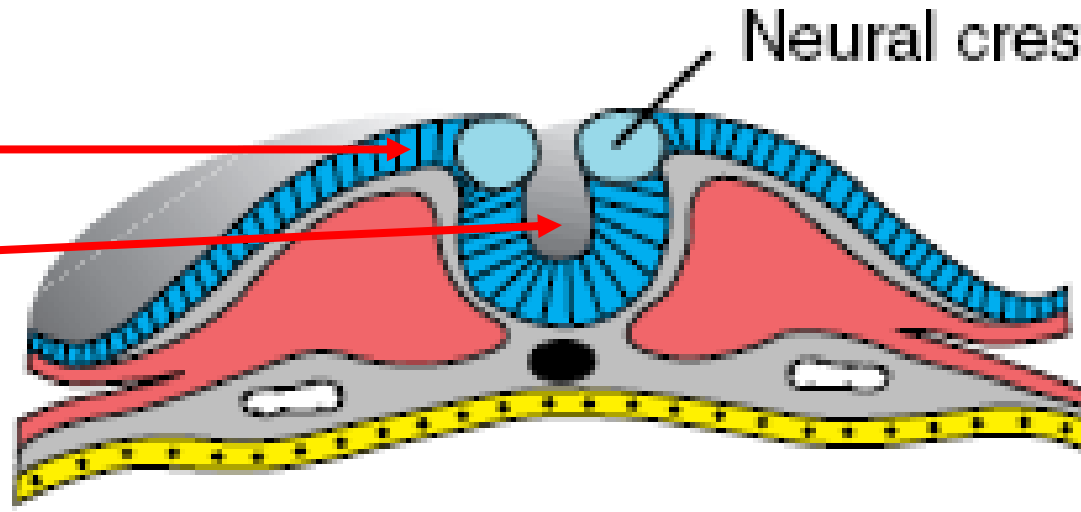


Cross section

Animation of formation of neural plate

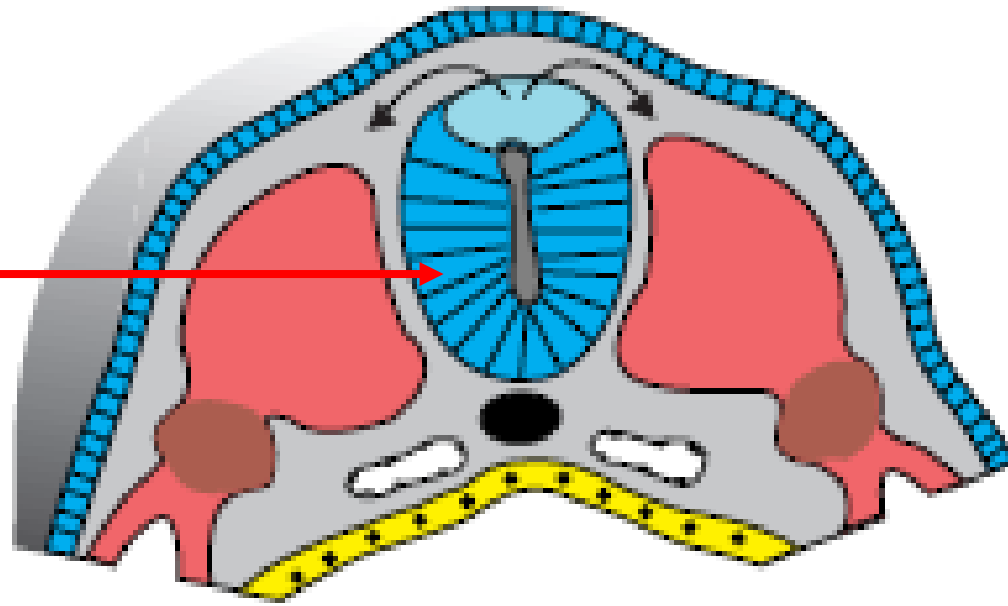
When notochord is forming, primitive streak is shorten. At meanwhile, neural plate is induced to form cephalic to caudal end, following formation of notochord.

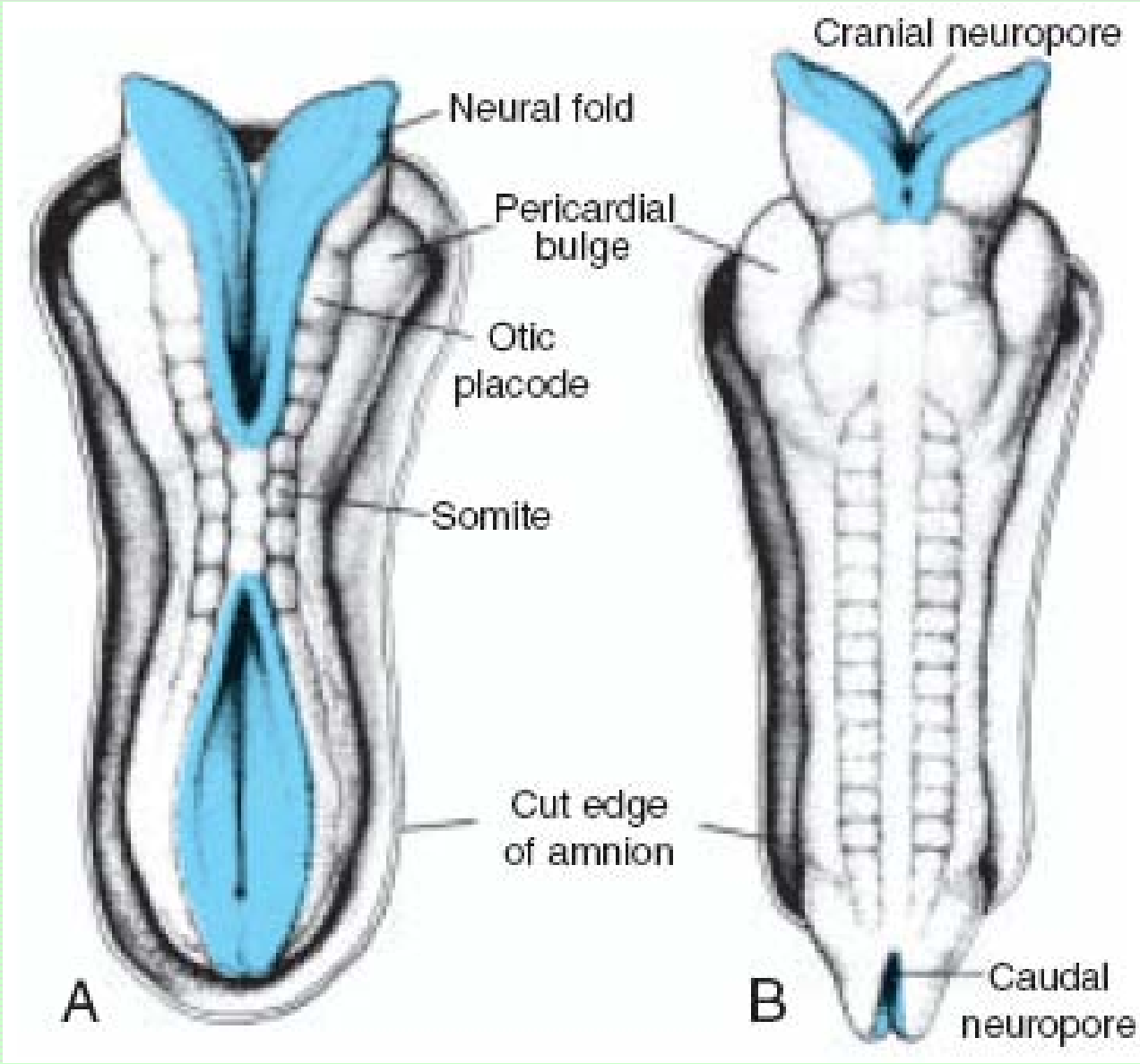
- By the end of 3rd week, neural folds and neural groove are formed.
- Neural folds fuse in the midline, beginning in cervical region and proceeding cranially and caudally.
- Neural tube is formed & invade into the embryo body.



A

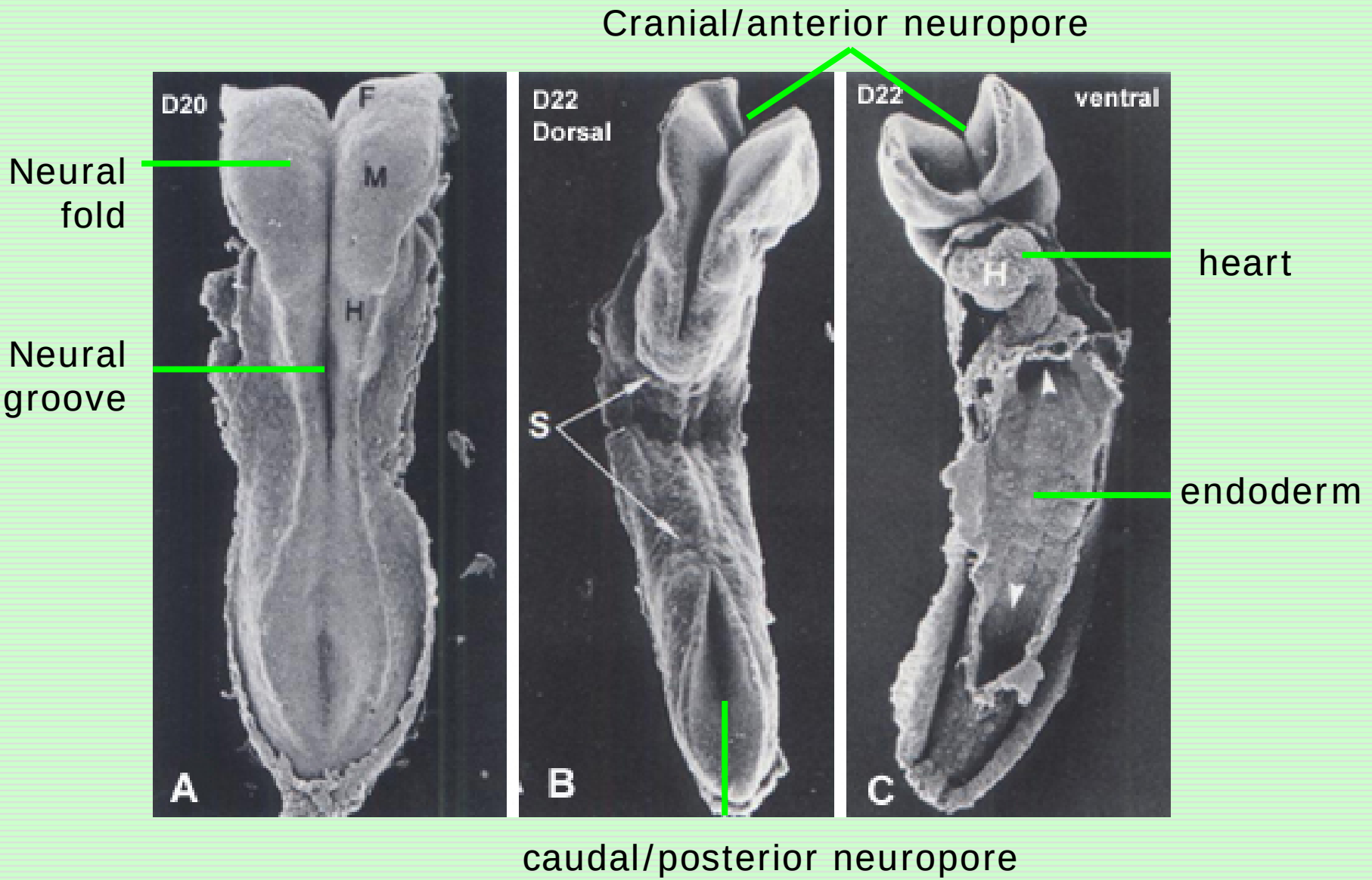
Cross section



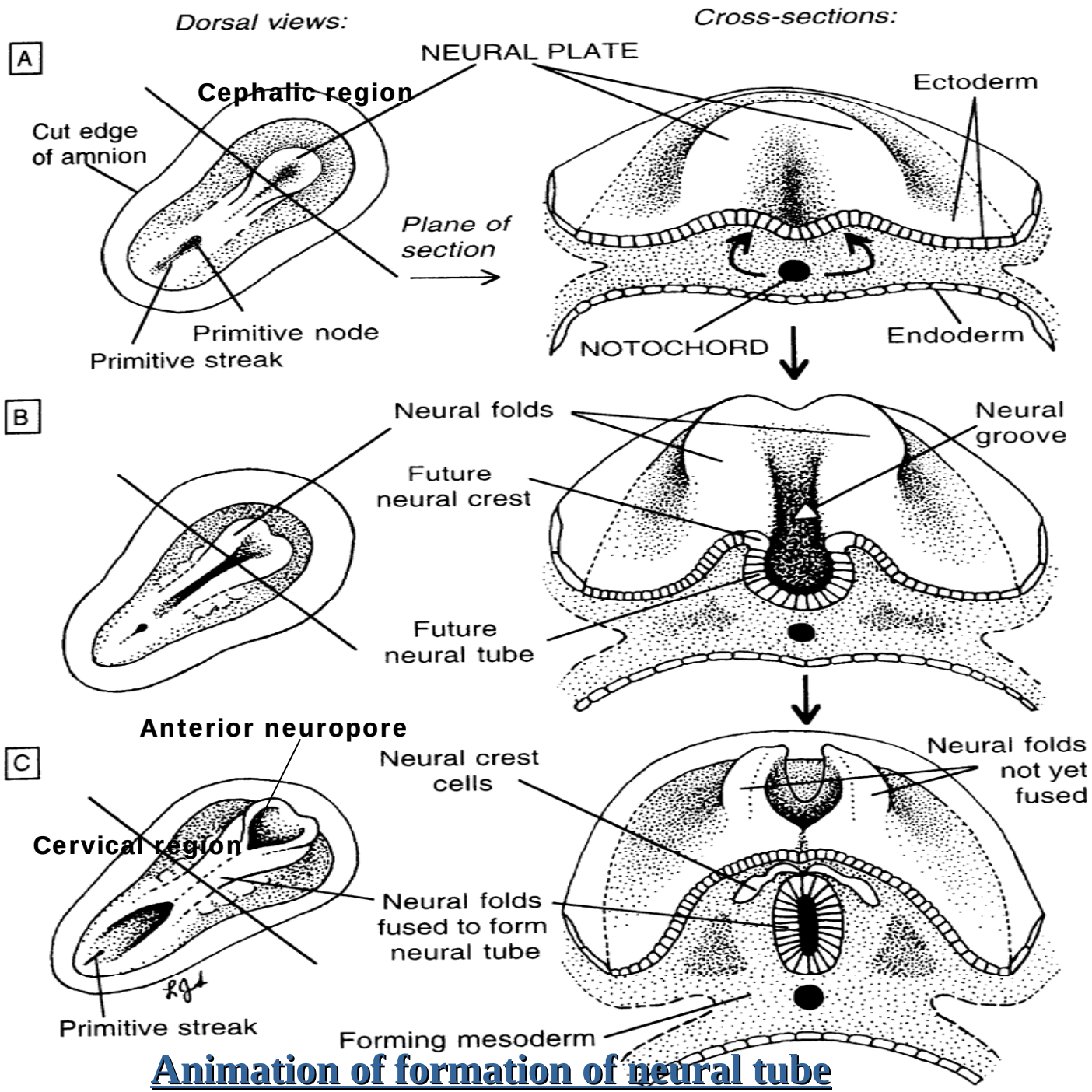


A. Dorsal view of a human embryo at approximately day 22.

B. Dorsal view of a human embryo at approximately day 23. The nervous system is in connection with the amniotic cavity through the cranial and caudal neuropores.



A. Scanning electron micrograph of a mouse embryo at 20 days in dorsal view. B & C. Dorsal (B) and ventral (C) views of a mouse embryo at 22-day.



Animation of formation of neural tube

- Closure of the cranial neuropore occurs at approximately day 25 (18- to 20-somite stage)
- Unclosing of cranial neuropore causes anencephalic child or meningocele.

A. Anencephalic child in dorsal and ventral view. The anencephalic child appears demented expression. The meninges exposes to outer environment because the skin and skull originating from the ectoderm aren't formed.

B. Patient with a severe defect resulting in meningocele. If the most of the anterior neruopore is closed, the meninges will bulge from the remained small pore.

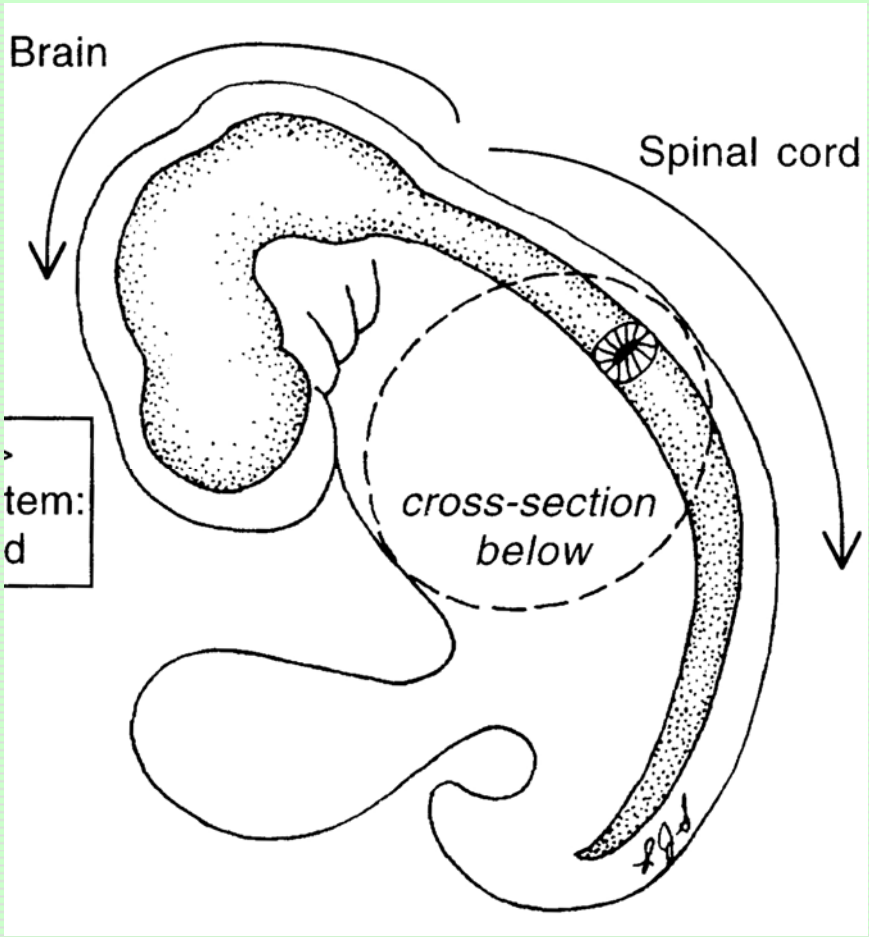
- posterior neuropore closes at day 27 (25-somite stage)
- Unclosing of posterior neuropore results in rachischisis or meningomyelocele.

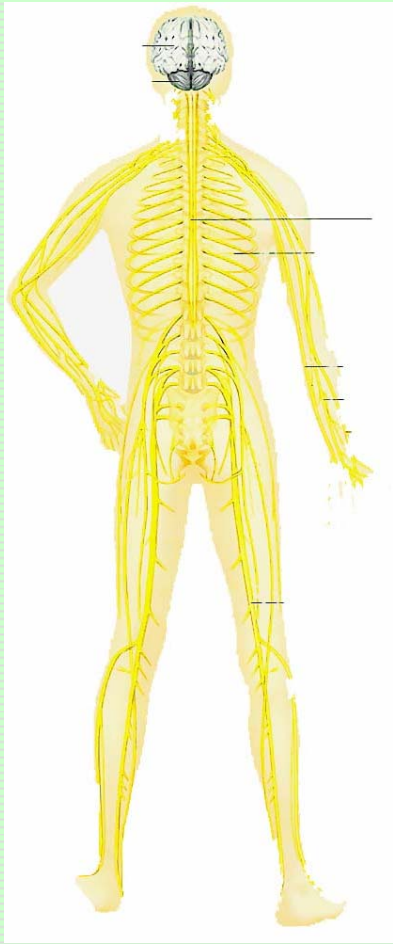
A. Patient with a severe defect in which the neural folds failed to elevate throughout the lower thoracic and lumbosacral regions, resulting in cleft spine.

B. Patient with a large meningomyelocele in dorsal and lateral view. Meninges and myelon bulges from unclosed pore because skin and backbone which should cover myelon aren't formed.

- anencephalic child
  - an-: no, without
- meningocele
  - Meninges
  - -cele: cavity, bulge, tumor, protrude, rupture
- Rachischisis: cleft spine
  - Rhachis: vertebral column
  - Schistasis: cleft
- meningomyelocele
  - -myelo: myelon/spinal cord

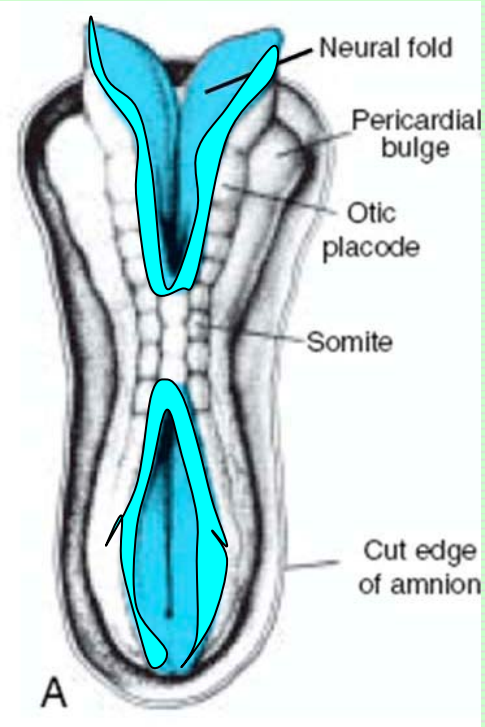
- Broader cephalic portion derivatizes into brain vesicle.
- Narrow caudal portion derivatizes into spinal cord.
- The canal develop into cerebral ventricle and central canal.



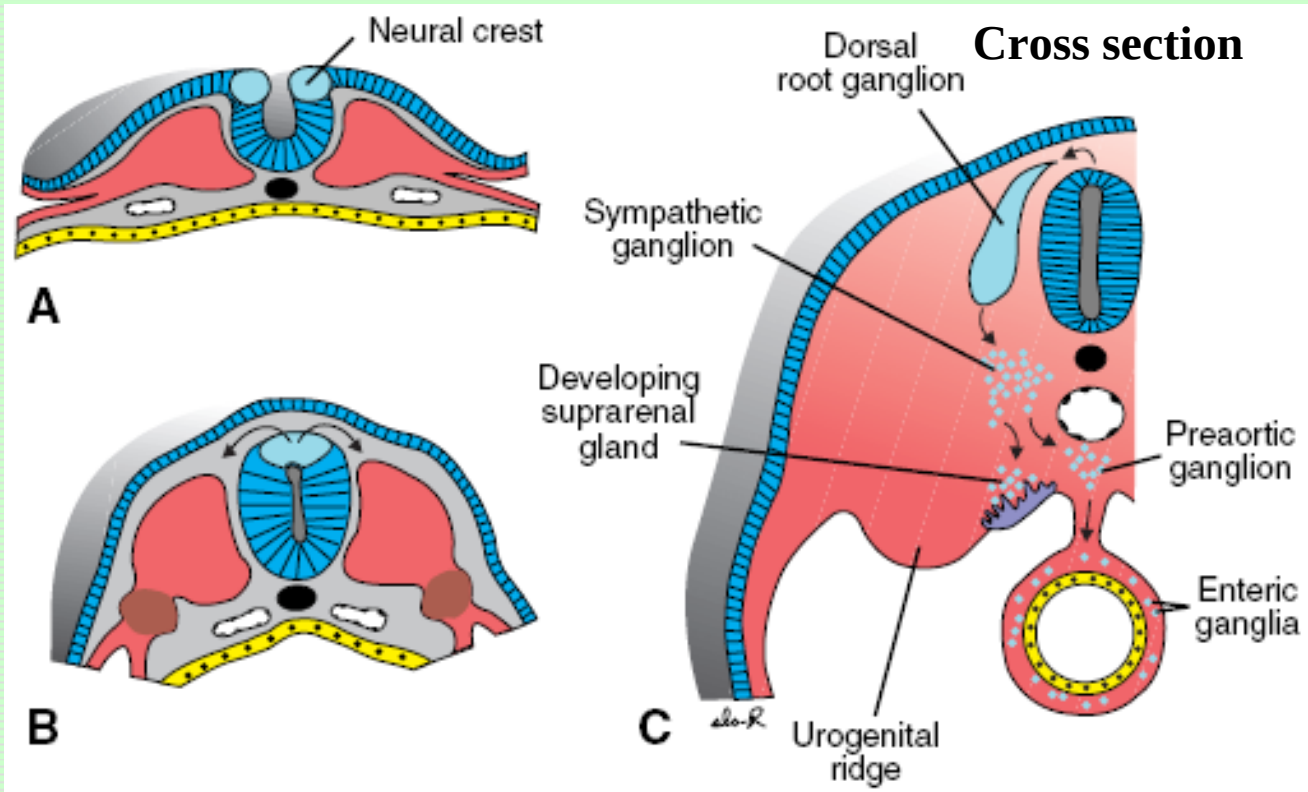


2) Formation of neural crest

- Two columns of crest cells on edges of neural folds are generated.
- Crest cells column leave neural folds after closure of neural tube
- migrate into mesoderm, locating dorsal of neural tube
- begin to dissociate from each other.
- The neural crest form peripheral nervous system, melanocytes in skin, endocrine cells in adrenal gland medulla.

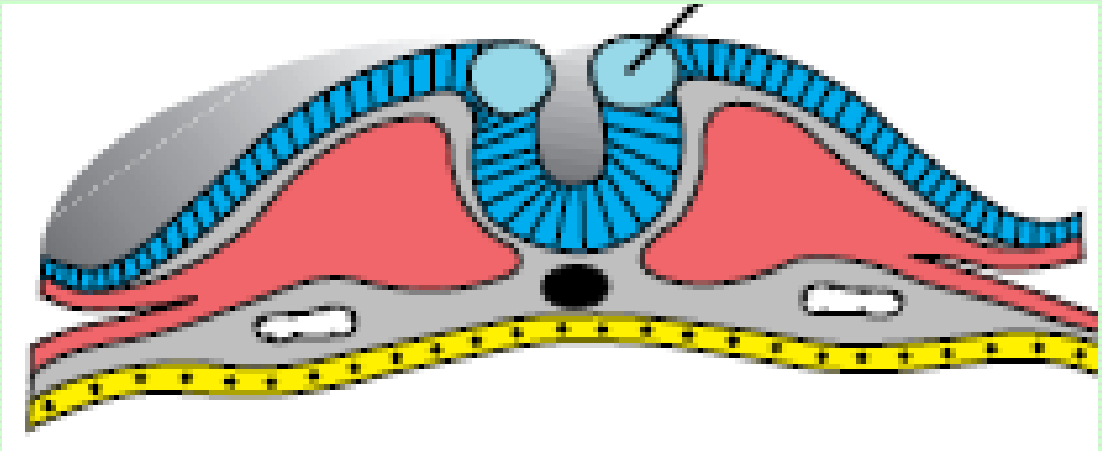


Dorsal view



3) Ectoderm covering body surface

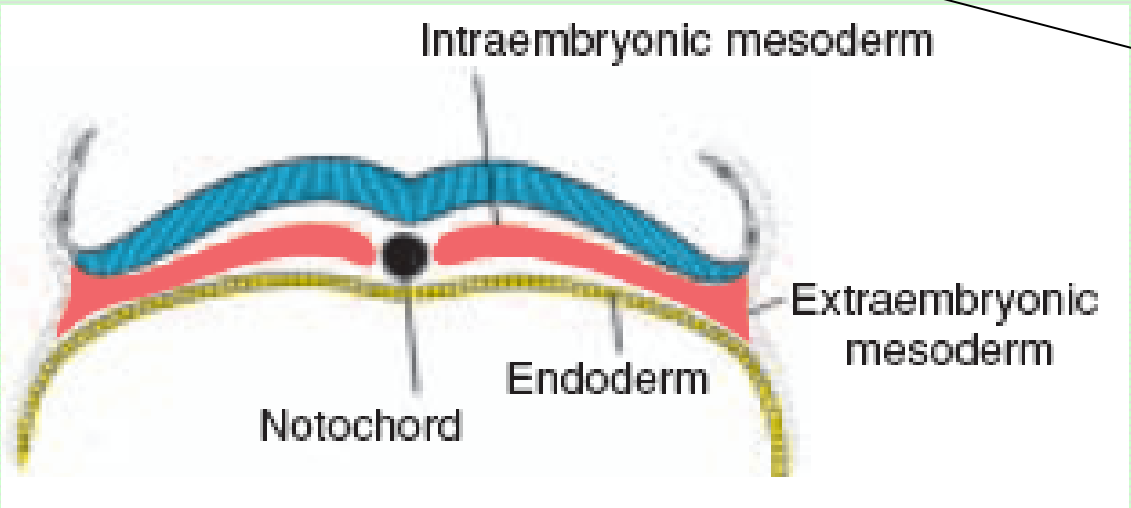
- epidermis and appendant structures of the skin, subcutaneous glands.
- pituitary/adenohypophysis , mammary glands, and enamel of teeth, epithelium of oral cavity, nasal cavity and anus, corneal epithelium and lens.

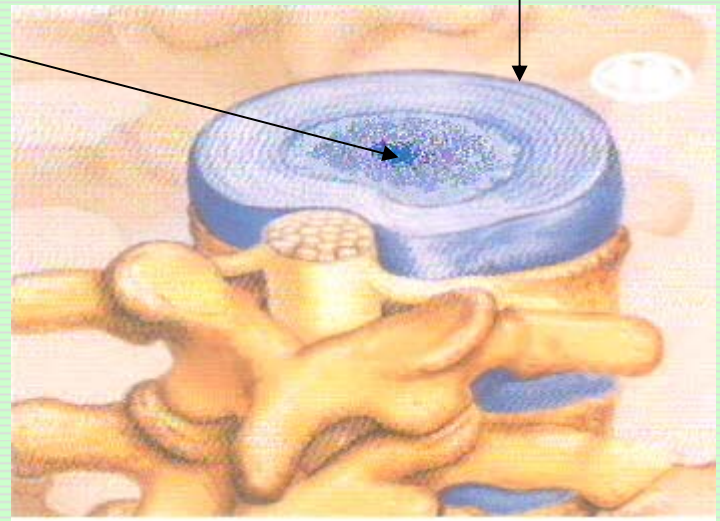


7.2 Derivatives of the Mesodermal Germ Layer

1) Axial mesoderm

- Notochord induces the formation of neural plate and derivatives into nucleus pulposus in the center of the intervertebral discs



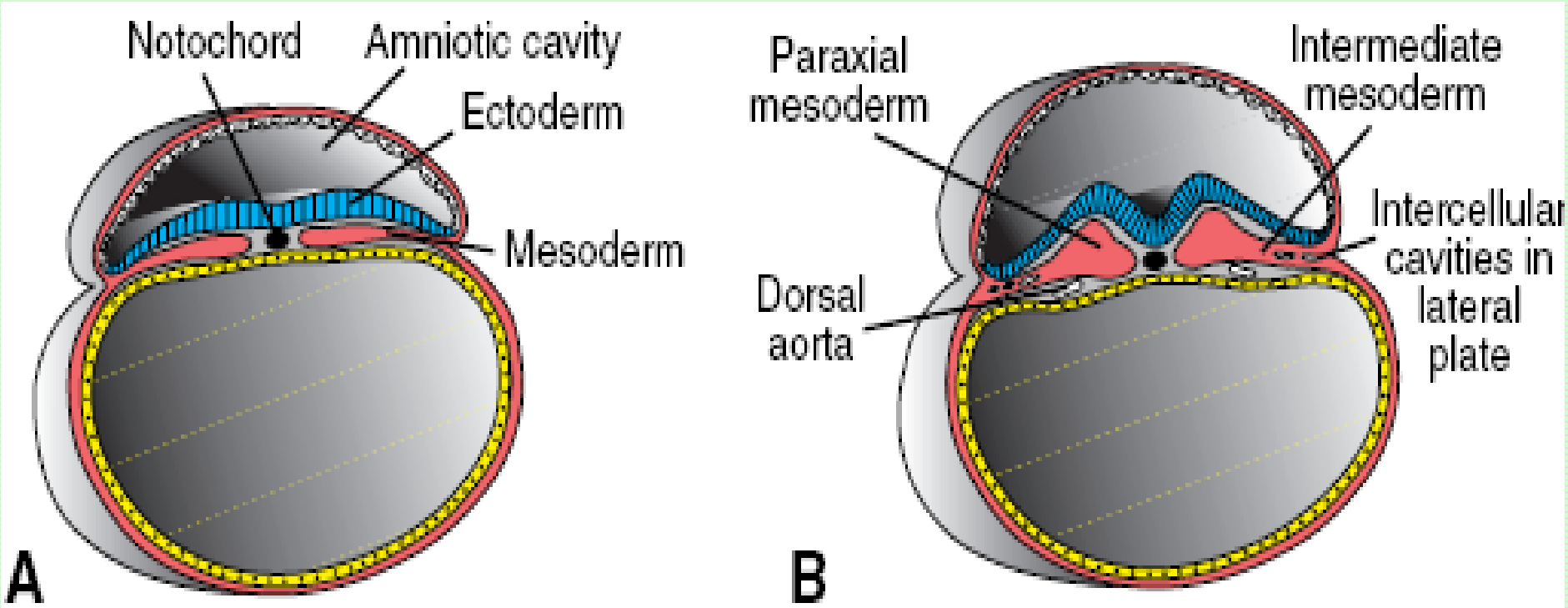


Transverse sections showing development of the mesodermal germ layer.

7.2 Derivatives of the Mesodermal Germ Layer

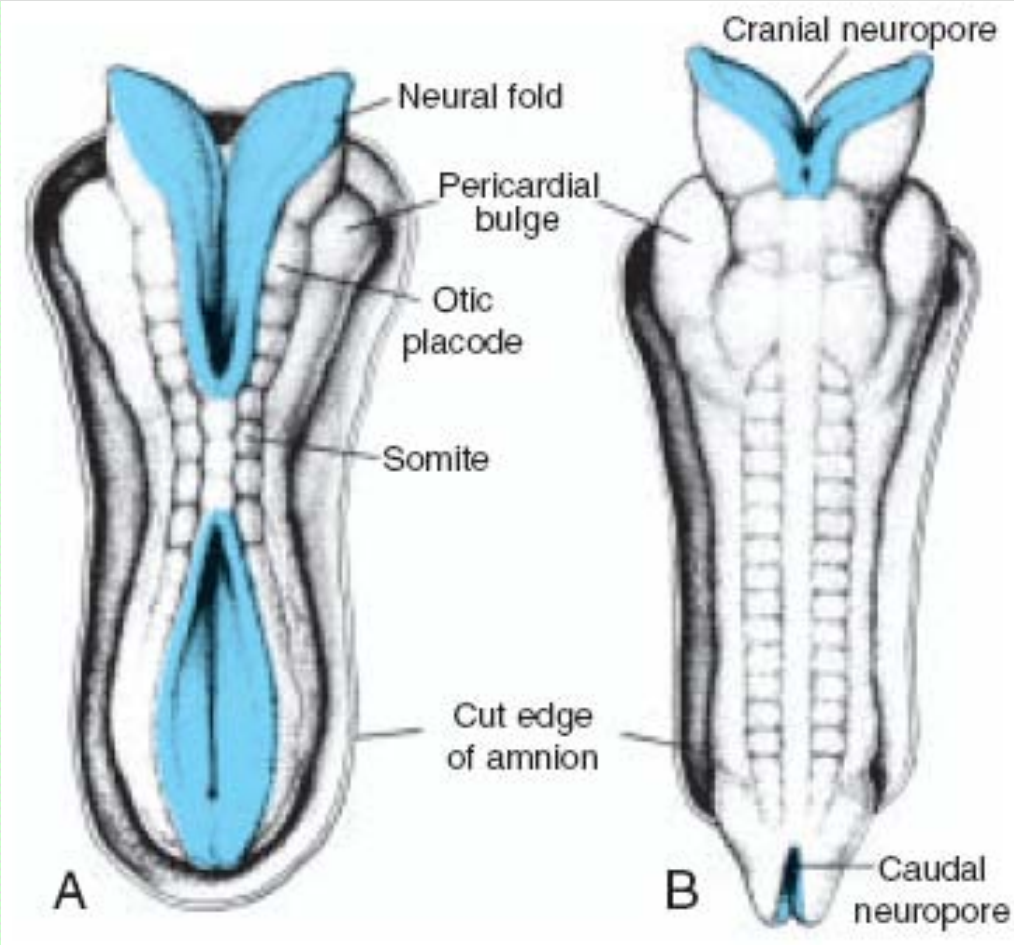
2) Paraxial mesoderm

- Initially, mesodermal germ layer form a thin sheet.
- By 17th day, cells close to midline proliferate and form some thickened somitomeres, called paraxial mesoderm.



Transverse sections showing development of the mesodermal germ layer.

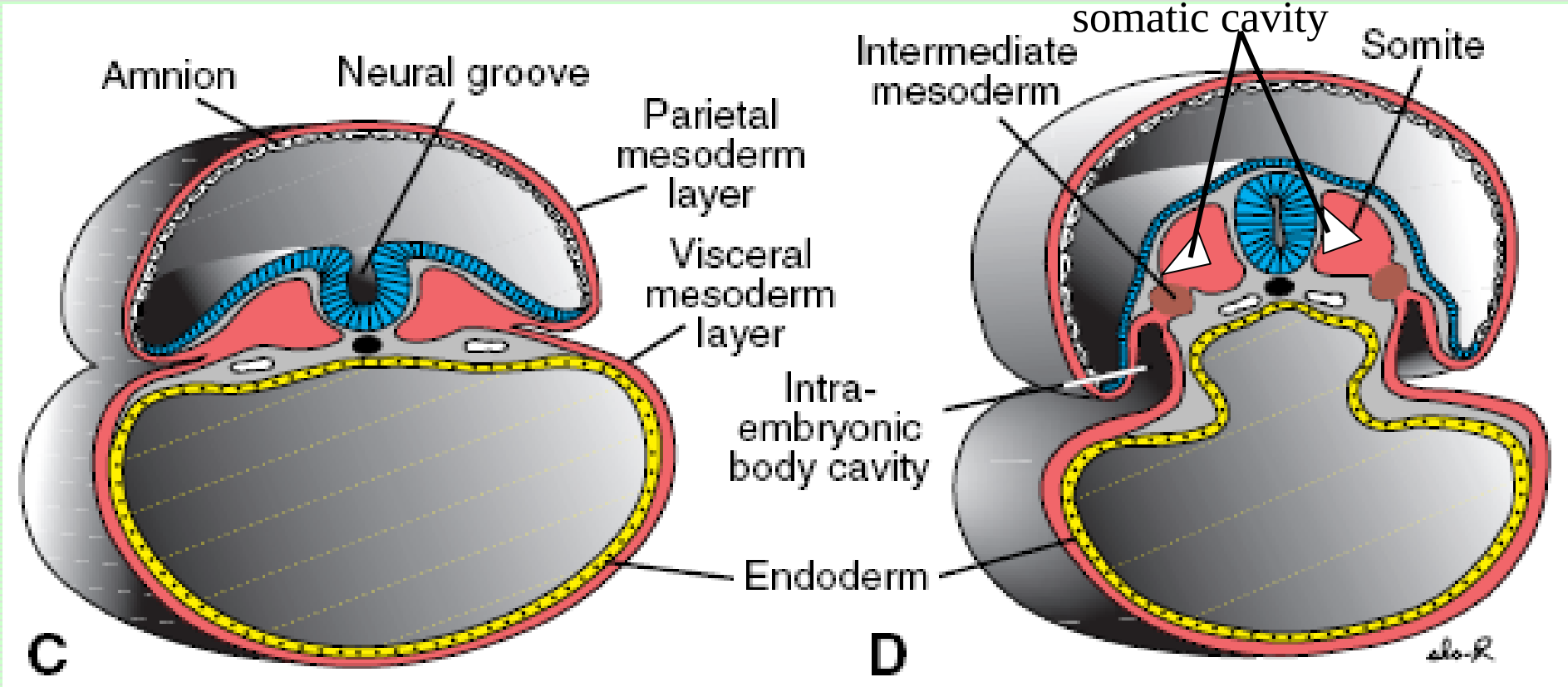
- Somitomeres appear from cephalic region to caudal region.
- Somitomeres further organize into somites.



Because somites protrude from mesoderm covered by ectoderm, shape of somite can be seen on dorsal surface of embryonic body.

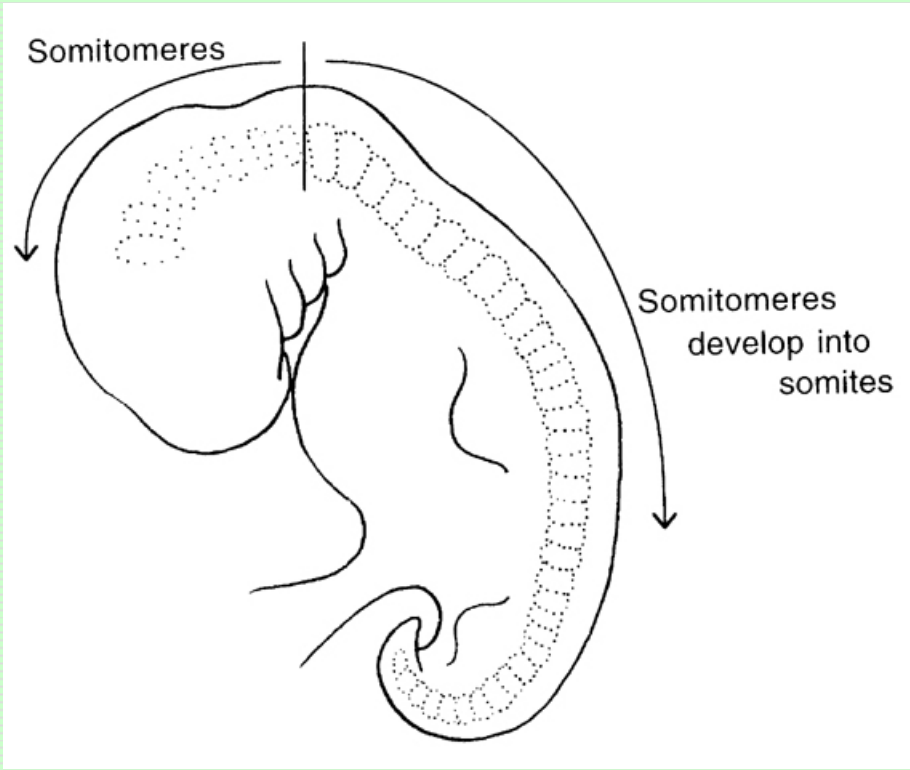
Dorsal view showing development of the somites

- The somite presents triangle in cross section with a central somatic cavity.



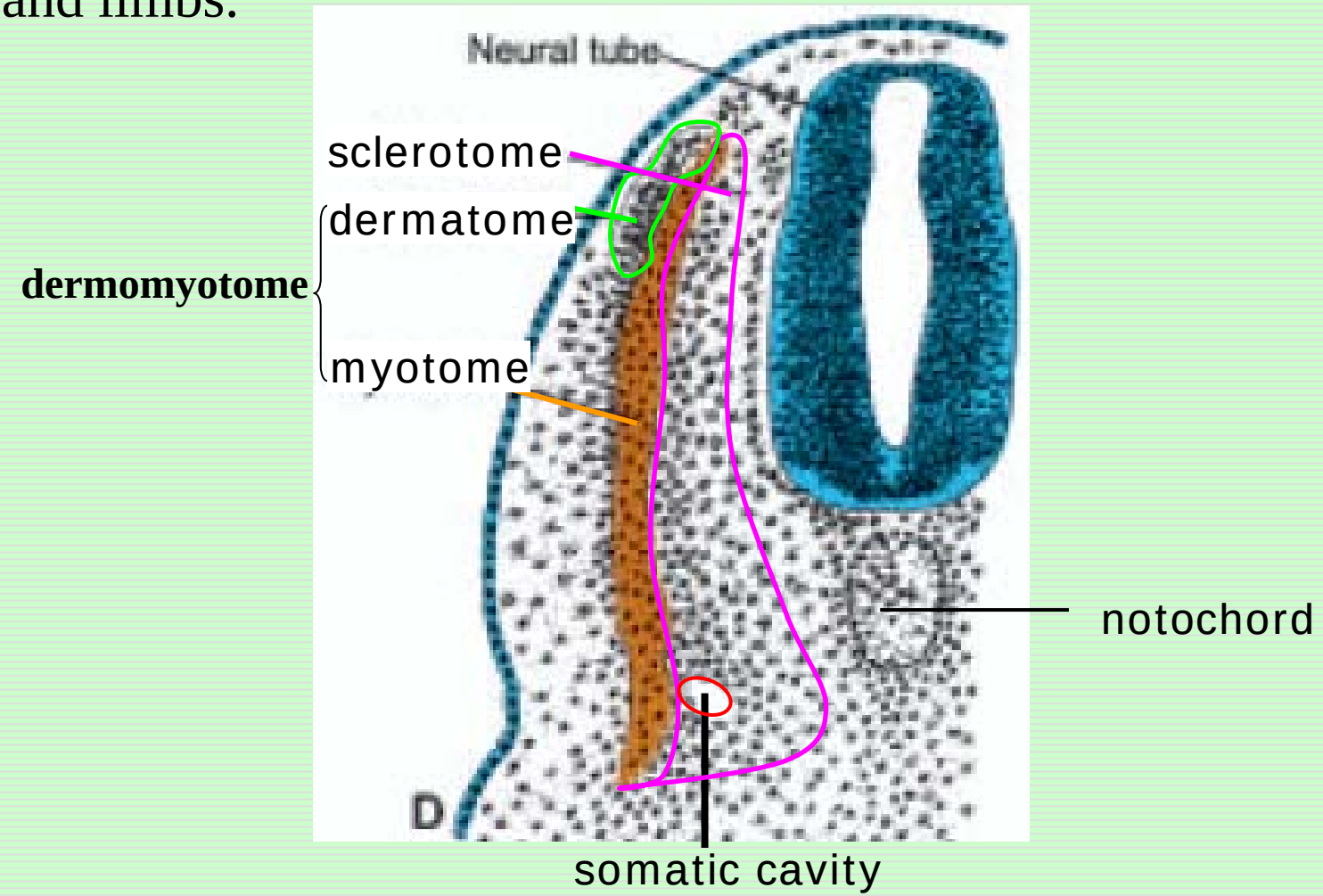
Transverse sections showing development of the mesodermal germ layer.

- At the end of the fifth week, 42 to 44 pairs somites are present.



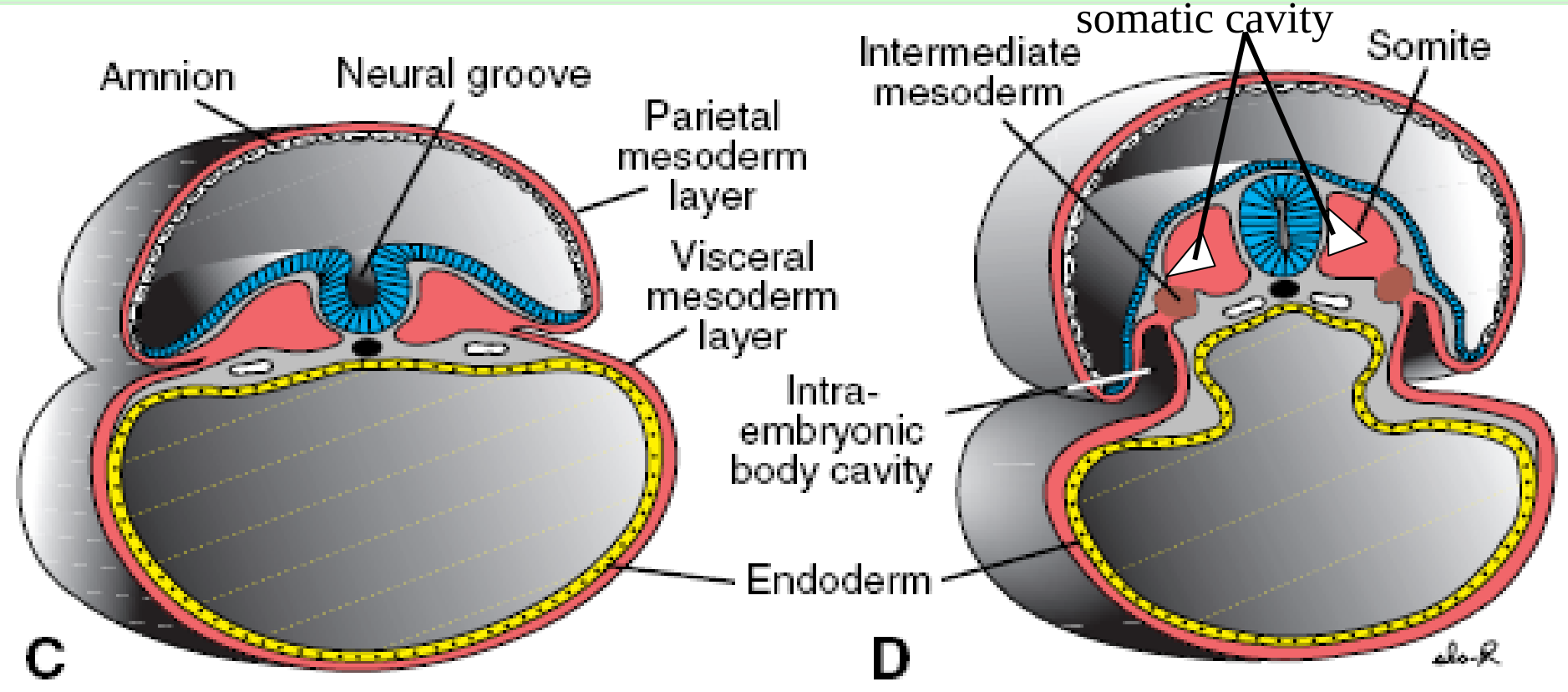
Lateral view

- Inner and ventral sclerotome form axial skeleton including vertebral column, ribs and some skull in head.
- Lateral dermatome form dermis and subcutaneous tissue of skin.
- Medially myotome contributes to all skeletal muscles of body, head and limbs.



3) Intermediate mesoderm

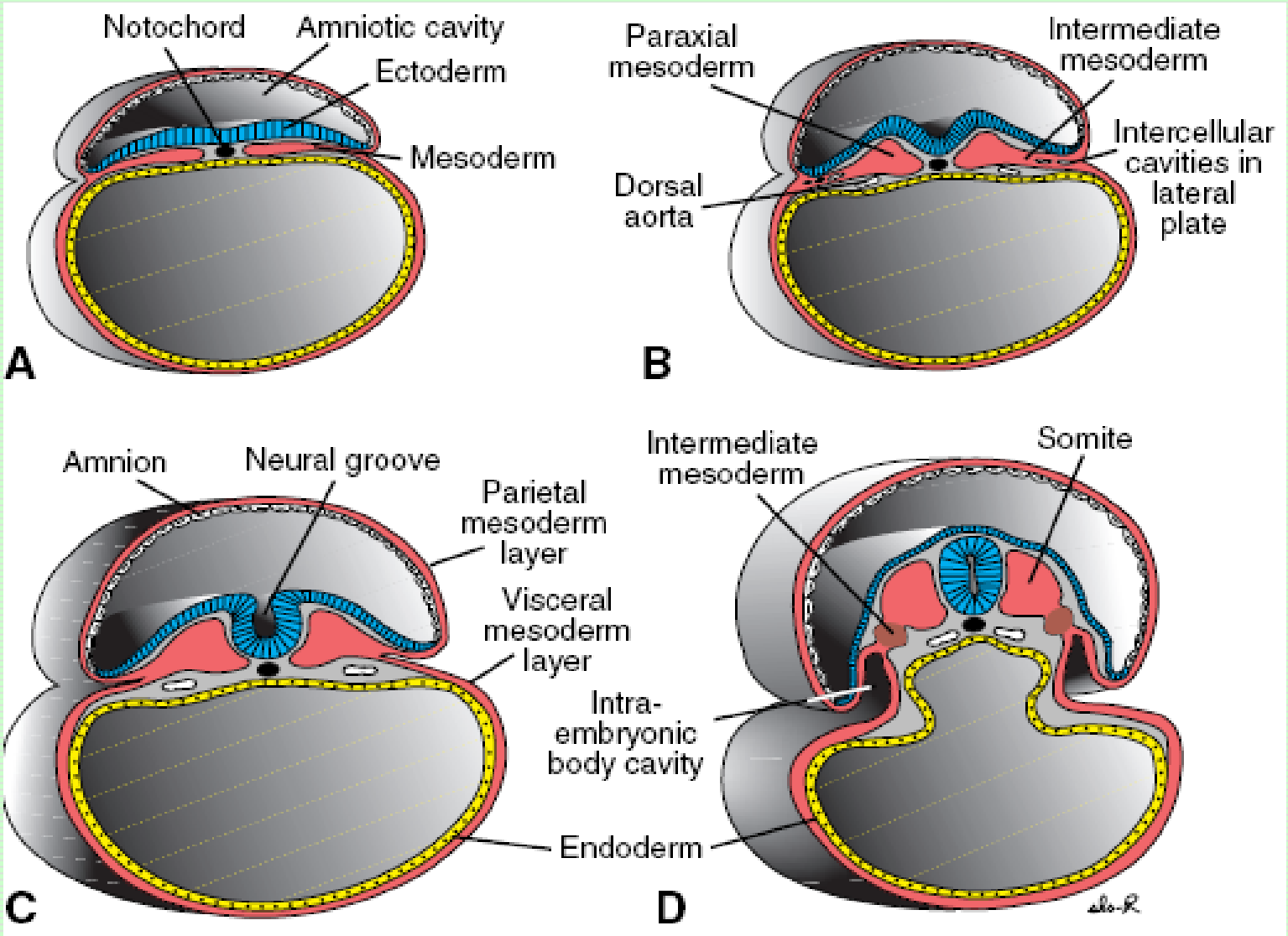
- Intermediate mesoderm connects paraxial mesoderm with the lateral plate
- It differentiates into urinary system and gonads.



Transverse sections showing development of the mesodermal germ layer.

4) Lateral plate mesoderm

- Somatic/parietal mesoderm is continuous with mesoderm covering amnion
- Splanchnic/visceral mesoderm is continuous with mesoderm covering yolk sac.
- Intraembryonic cavity is continuous with extraembryonic cavity on each side.



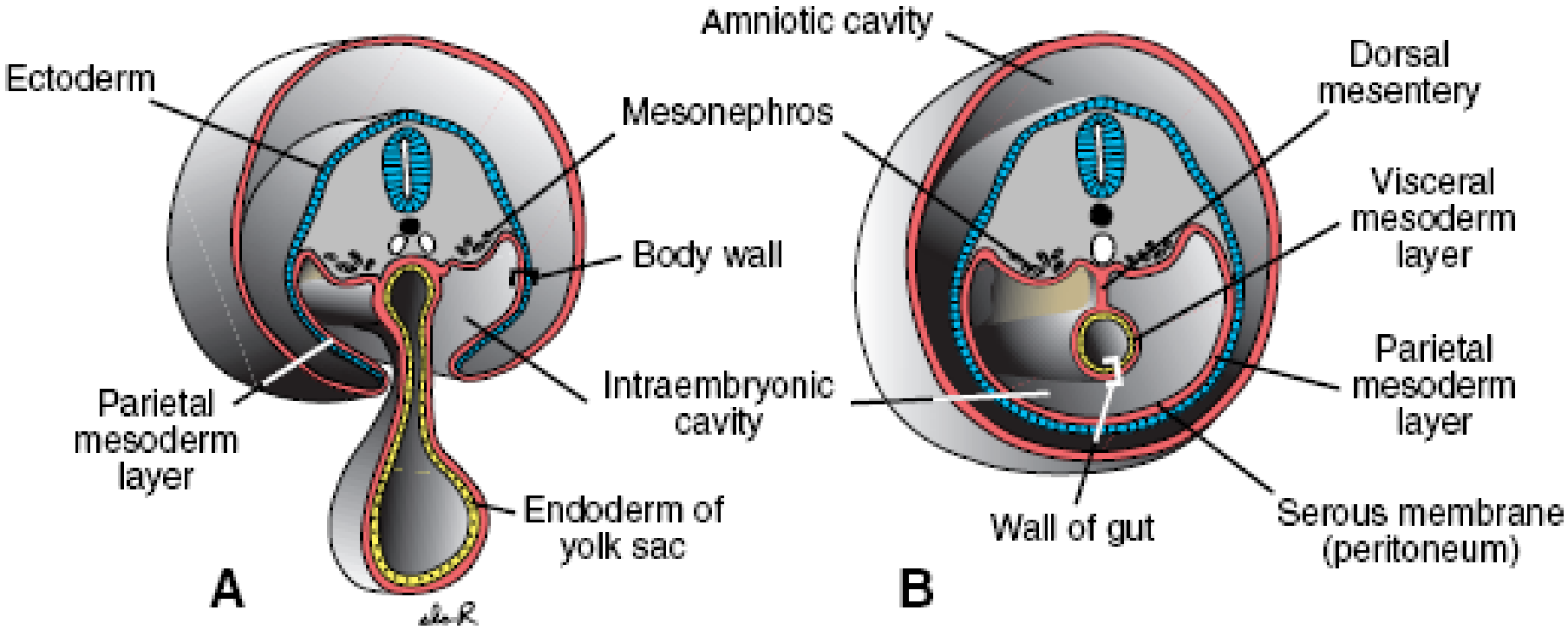


Figure 5.13 A. Transverse section through a 21-day embryo in the region of the mesonephros showing parietal and visceral mesoderm layers. The intraembryonic cavities communicate with the extraembryonic cavity (chorionic cavity). **B.** Section at the end of the fourth week. Parietal mesoderm and overlying ectoderm form the ventral and lateral body wall. Note the peritoneal (serous) membrane.

Following the formation of ventral and lateral body wall, the intraembryonic cavity is separated from the extraembryonic cavity and enclosed.

- The parietal mesoderm will form:
  - most connective tissue and smooth muscle of body wall
  - tissues of limbs including cartilage, bones and girdles
  - parietal layer of pleural membrane, cardiac pericardium and peritonium.
- The visceral mesoderm layer will form:
  - smooth muscle and connective tissue of endoderm-linked organs,
  - cardiovascular system
  - visceral layer of pleural membrane, cardiac pericardium and peritonium.
- The intraembryonic cavity will form:
  - peritoneal, pleural, and pericardial cavities.

4) Blood and blood vessels

- **blood islands in extraembryonic splanchnopleuric mesoderm surrounding the wall of the yolk sac at 3rd week .**

Sagittal midline section

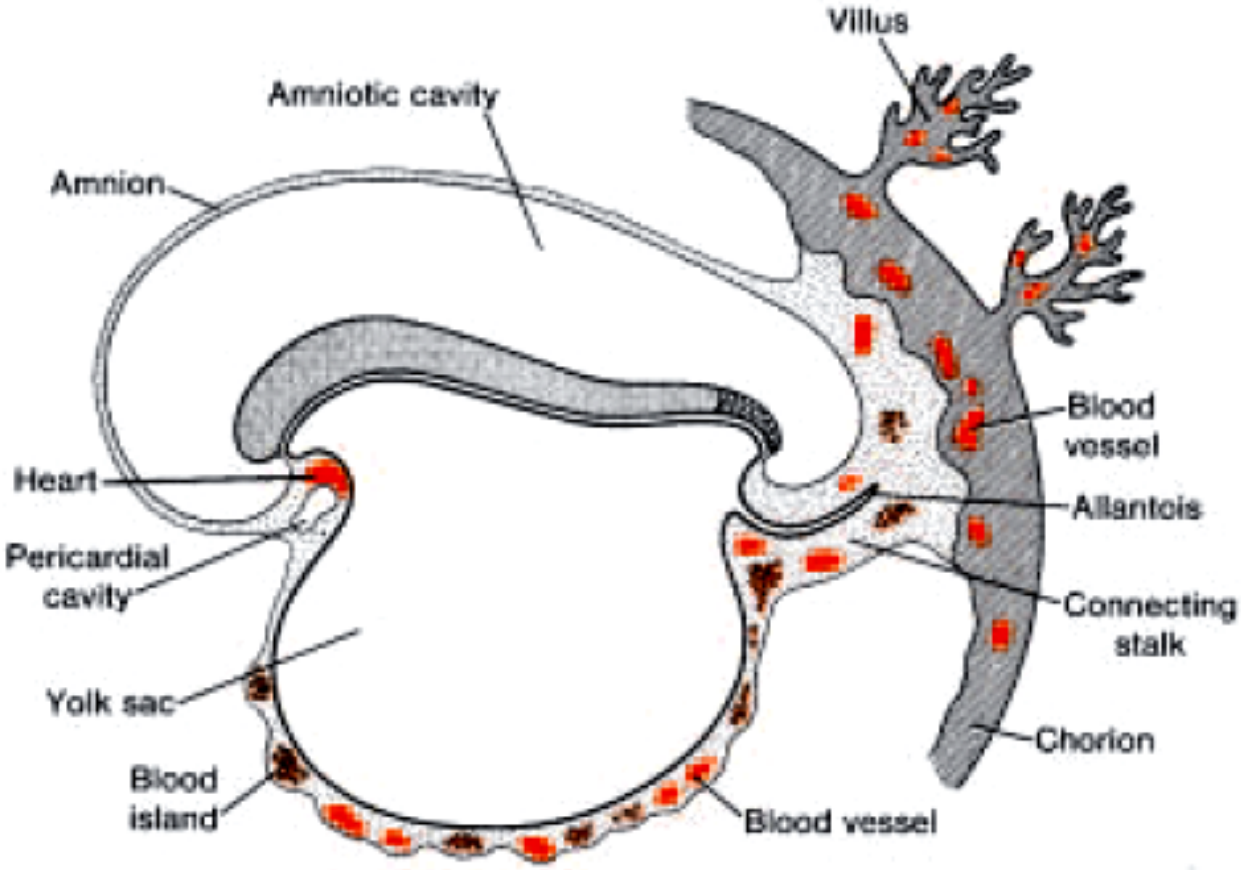
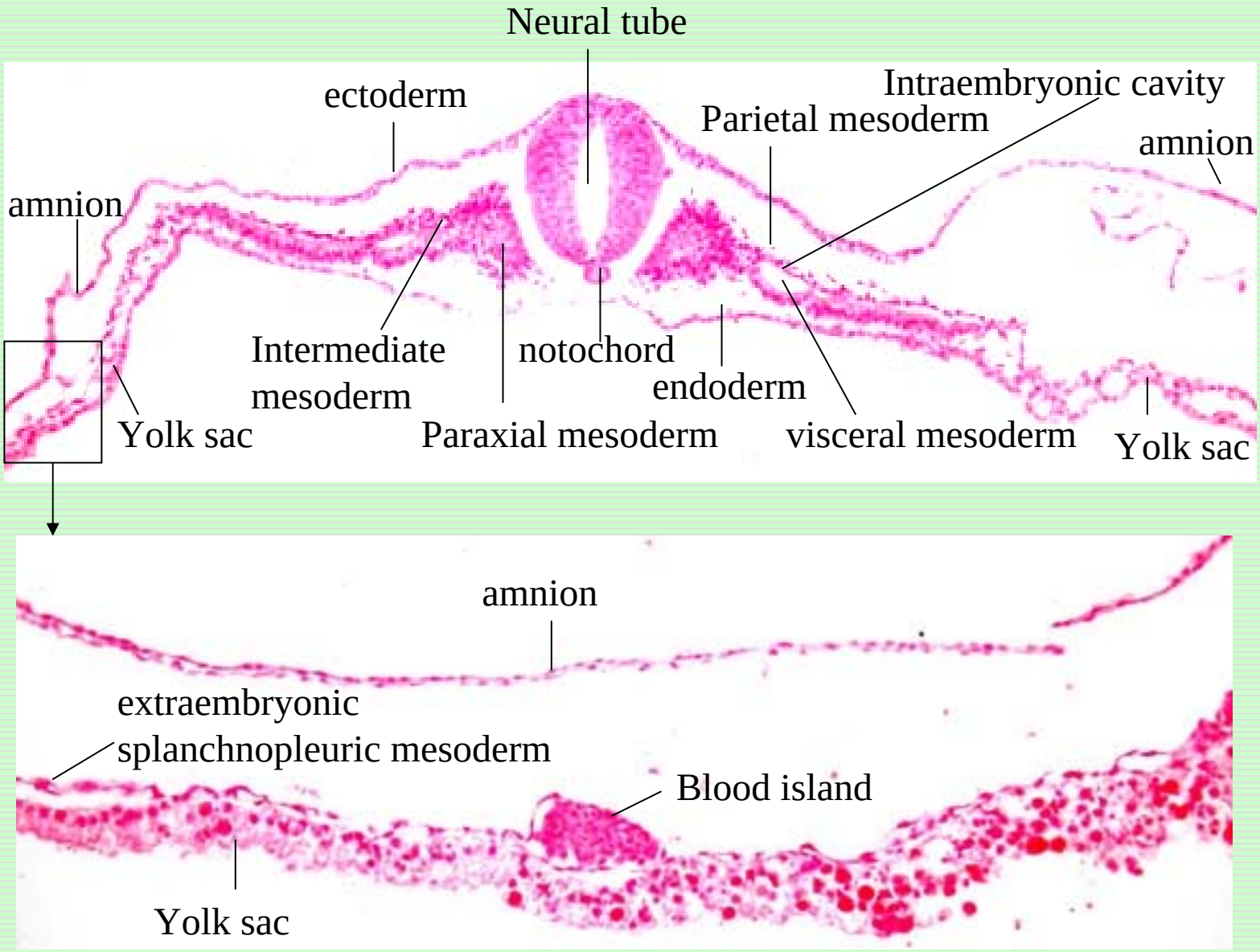
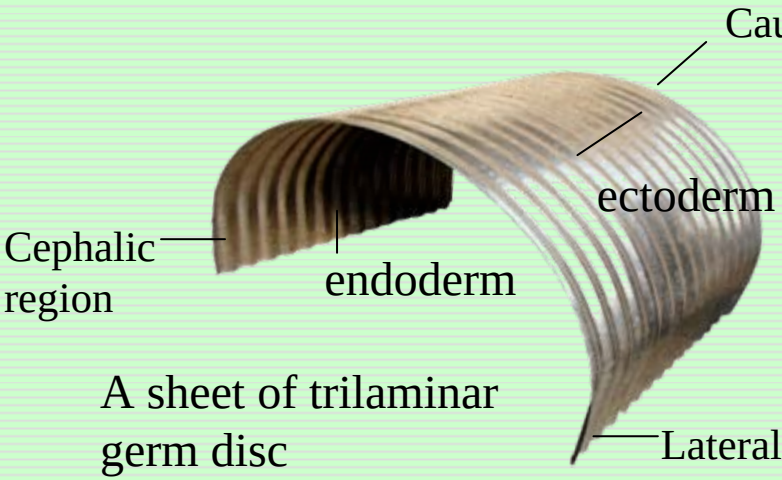


Figure 5.15 Extraembryonic blood vessel formation in the villi, chorion, connecting stalk, and wall of the yolk sac in a presomite embryo of approximately 19 days.

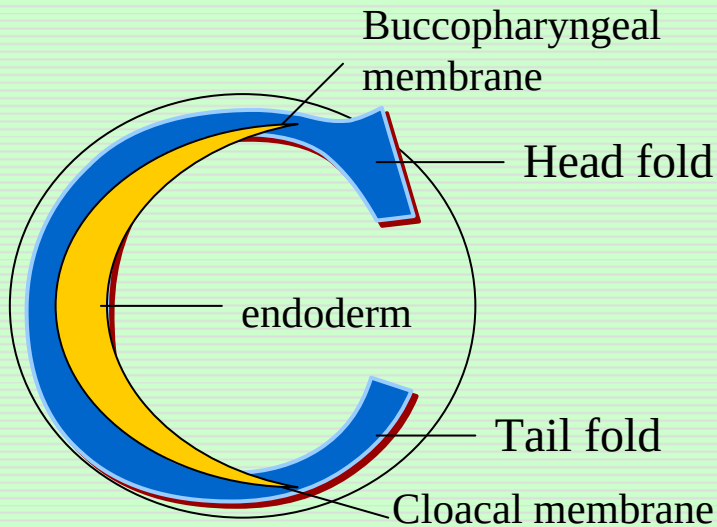


Derivative of chicken trilaminar germ disc

7.3 Derivatives of the Endodermal Germ Layer



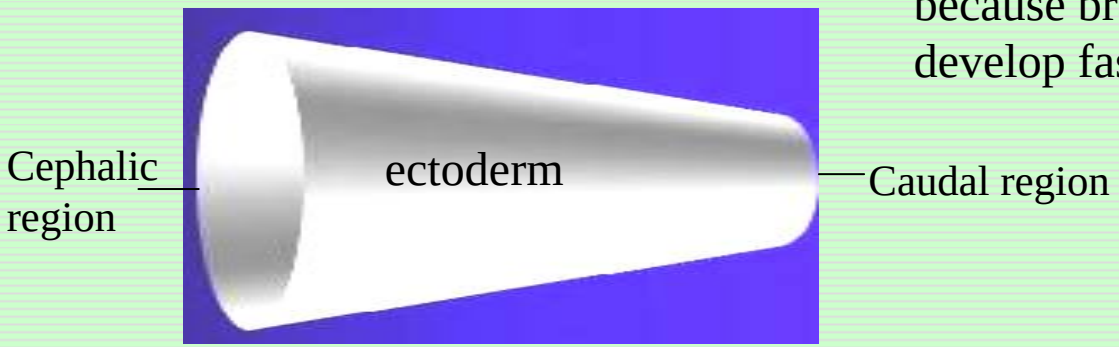
A sheet of trilaminar germ disc



The larger plane circles around the smaller plane.

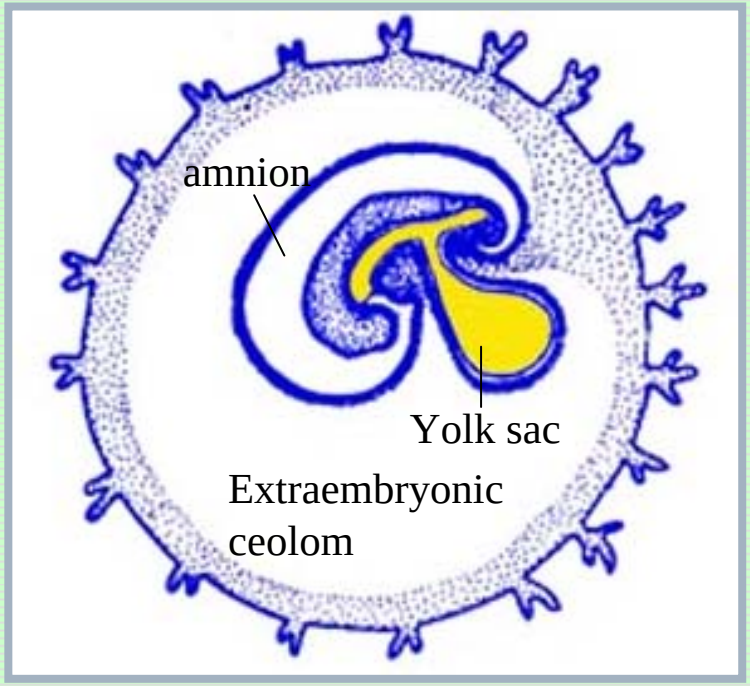
The cephalic end develops faster than the caudal end.

Coiled embryonic body is formed because brain vesicle and somites develop faster than endoderm.

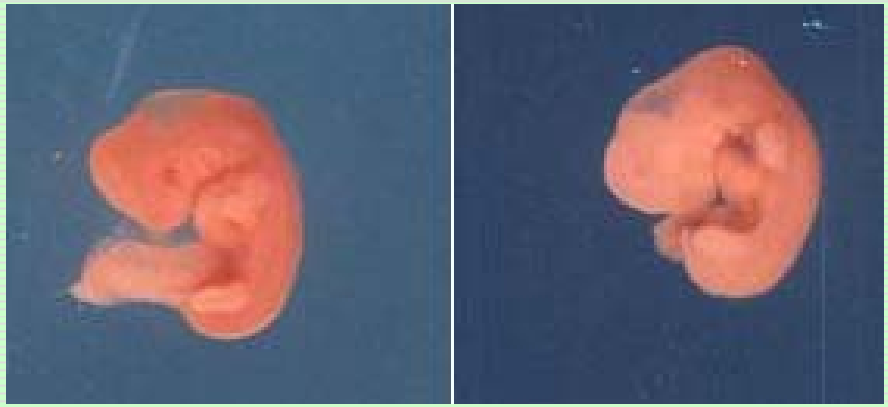


circular cone-shaped embryo

- With rapid growth of brain vesicles & somites, embryonic disc begins to bulge into amniotic cavity
- fold cephalocaudally, forming head fold, tail fold & lateral folds, and obtains a round appearance, like letter C.



Sagittal midline section



Lateral view

derivation of endoderm and shape of embryo

- An endoderm-lined cavity: foregut, midgut, hindgut. gastrointestinal tract derives from endodermal germ layer, the roof of the yolk sac.
- The buccopharyngeal and cloacal membrane is absorbed, establishing an open connection between amniotic cavity and mouth-primitive gut-anus.
- The midgut temporarily communicates with the yolk sac by vitelline duct. This duct is wide initially, but with further established ventral body wall of the embryo, it becomes narrow and much longer, and is obliterated much later.

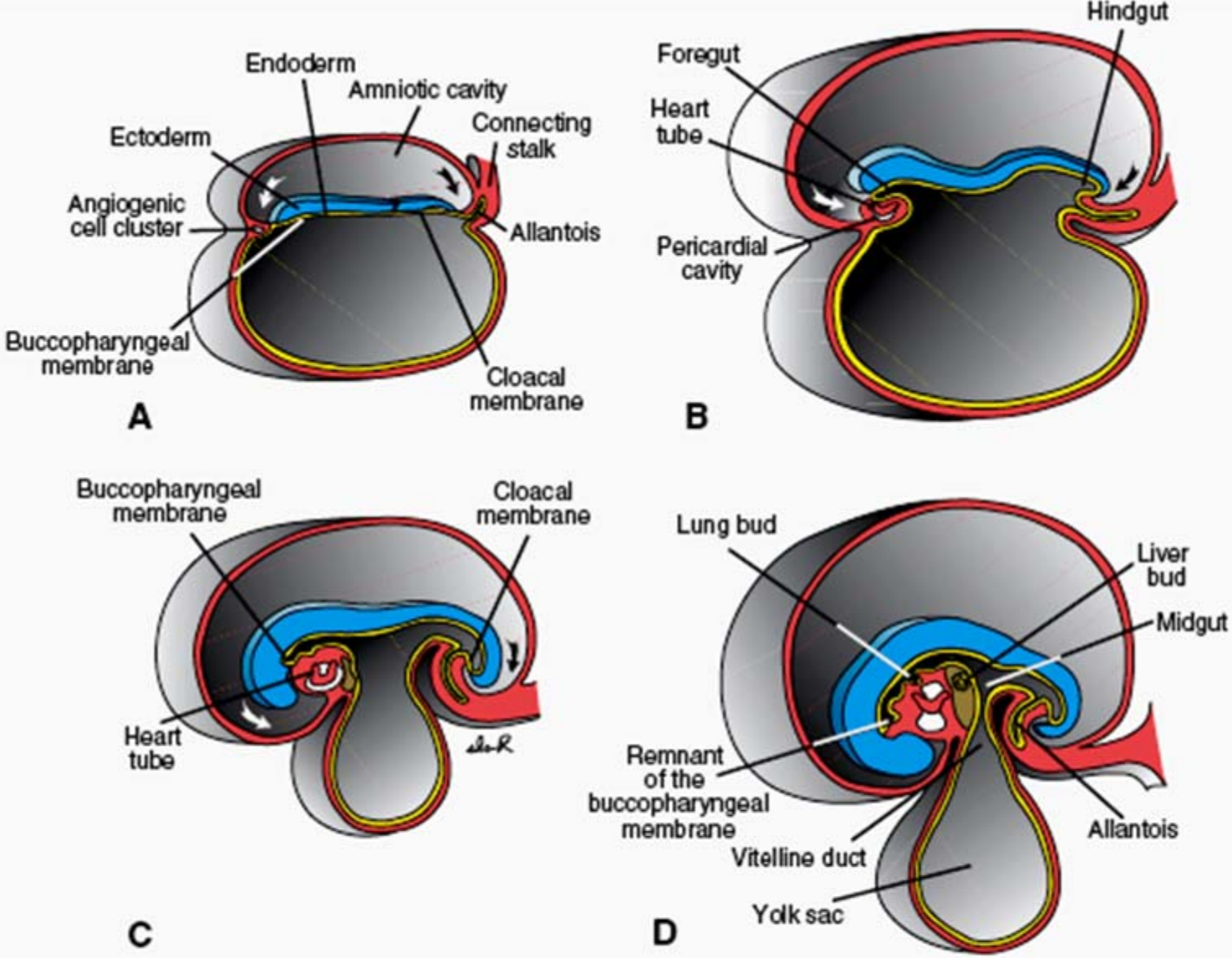


Figure 5.16 Sagittal midline sections of embryos at various stages of development to demonstrate cephalocaudal folding and its effect on position of the endoderm-lined cavity. **A.** Presomite embryo. **B.** Embryo with 7 somites. **C.** Embryo with 14 somites. **D.** End of the first month. Note the angiogenic cell clusters in relation to the buccopharyngeal membrane.

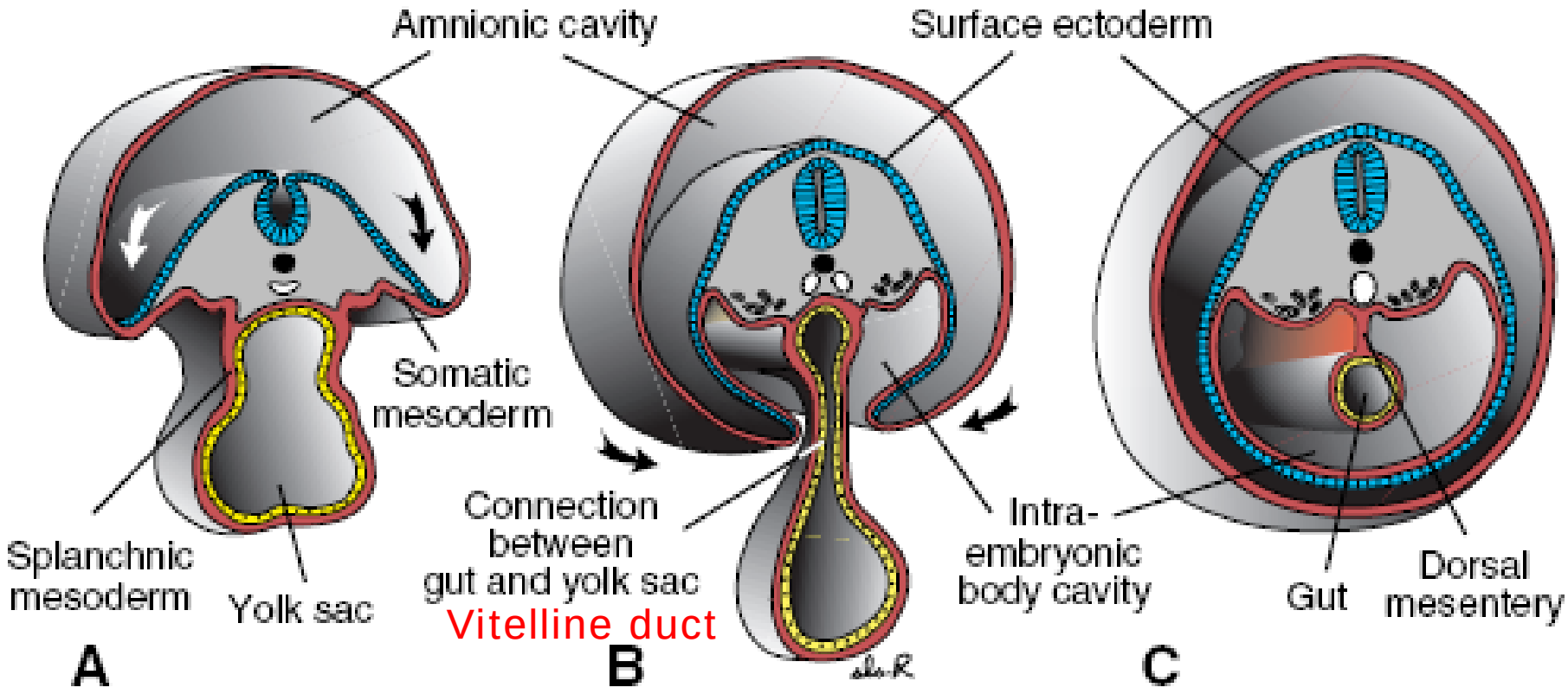


Figure 5.17 Transverse sections through embryos at various stages of development to show the effect of lateral folding on the endoderm-lined cavity. **A.** Folding is initiated. **B.** Transverse section through the midgut to show the connection between the gut and yolk sac. **C.** Section just below the midgut to show the closed ventral abdominal wall and gut suspended from the dorsal abdominal wall by its mesentery.

- A small portion of vitelline duct persists, forming Meckel's or ileal diverticulum.
- Only middle portion of vitelline duct forms enterocystoma or vitelline cyst.
- Vitelline duct remains open over its entire length, forming an umbilical fistula or vitelline fistula. A fecal discharge may then be found at the umbilicus.

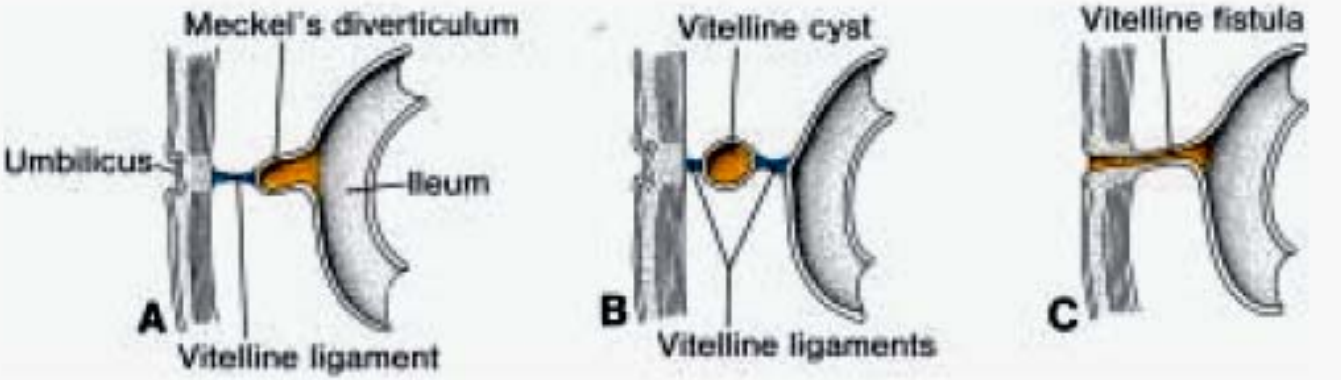


Figure 13.32 Remnants of the vitelline duct. **A.** Meckel's, or ileal, diverticulum combined with fibrous cord (vitelline ligament). **B.** Vitelline cyst attached to the umbilicus and wall of the ileum by vitelline ligaments. **C.** Vitelline fistula connecting the lumen of the ileum with the umbilicus.

The endodermal germ layer gives rise to primitive digestive tract.

- **(a) the epithelial lining of the digestive tract, digestive glands including liver and pancreas, respiratory tract and lung;**
- **(b) the epithelium of the thyroid, parathyroids;**
- **(c) the epithelium of the tonsils and thymus;**
- **(d) the epithelial lining of the urinary bladder and urethra.**

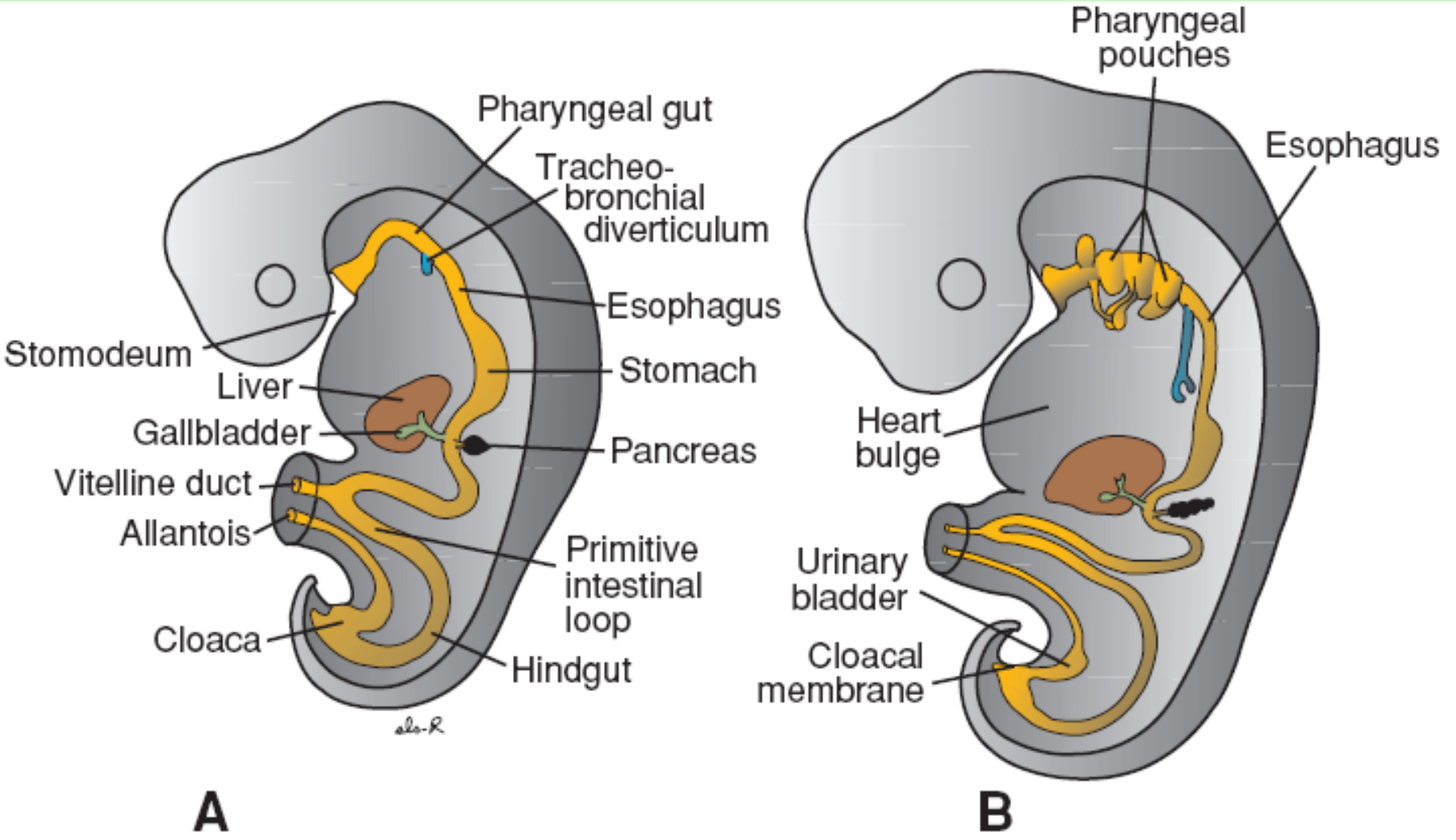
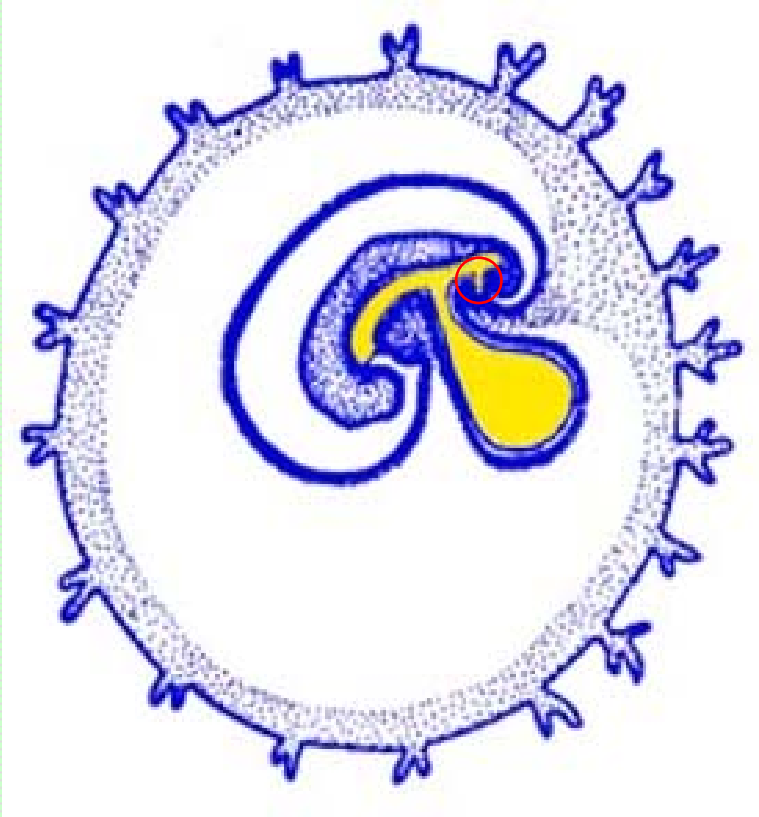
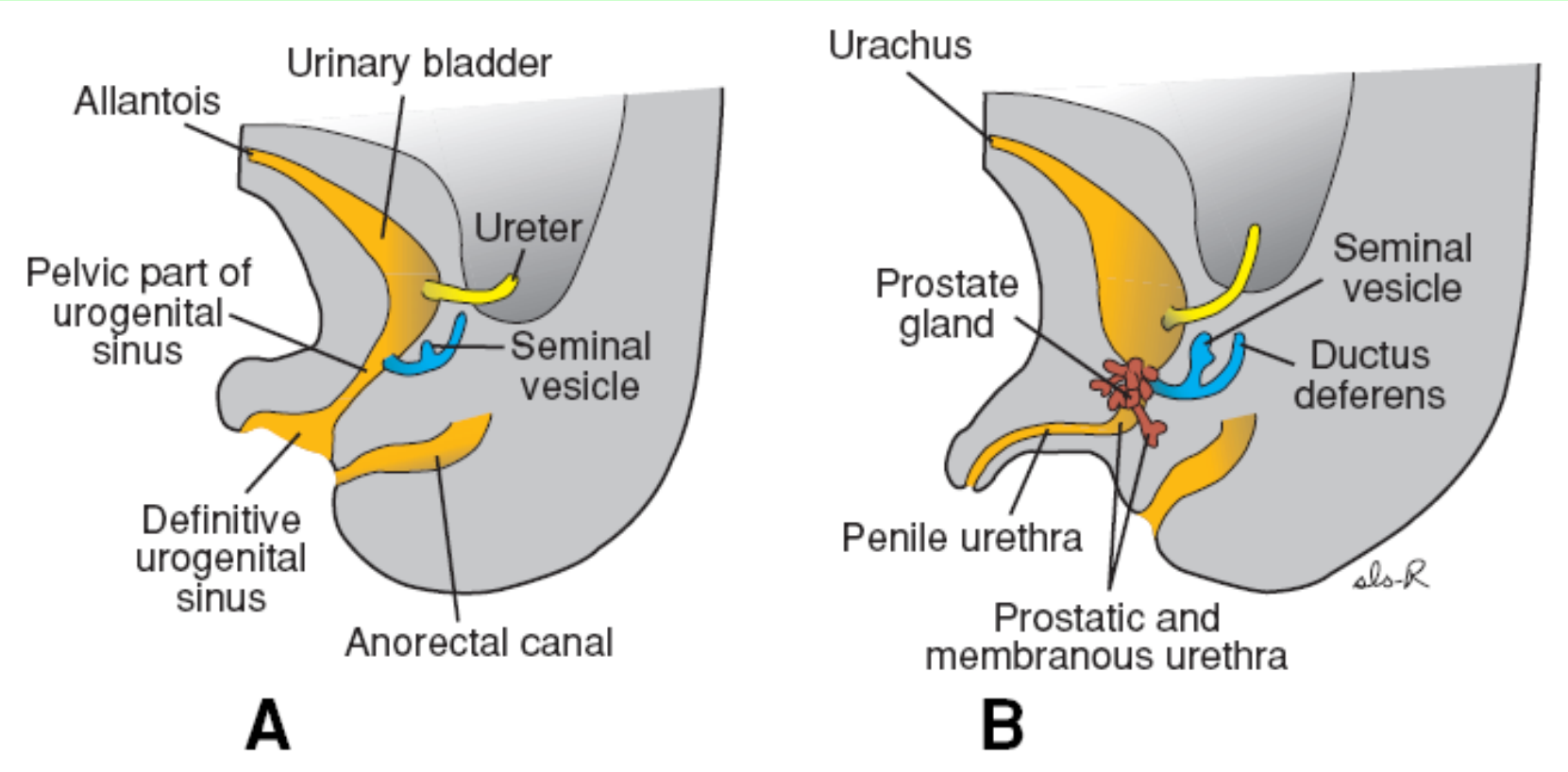


Figure 13.5 Embryos during the fourth **(A)** and fifth **(B)** weeks of development showing formation of the gastrointestinal tract and the various derivatives originating from the endodermal germ layer.

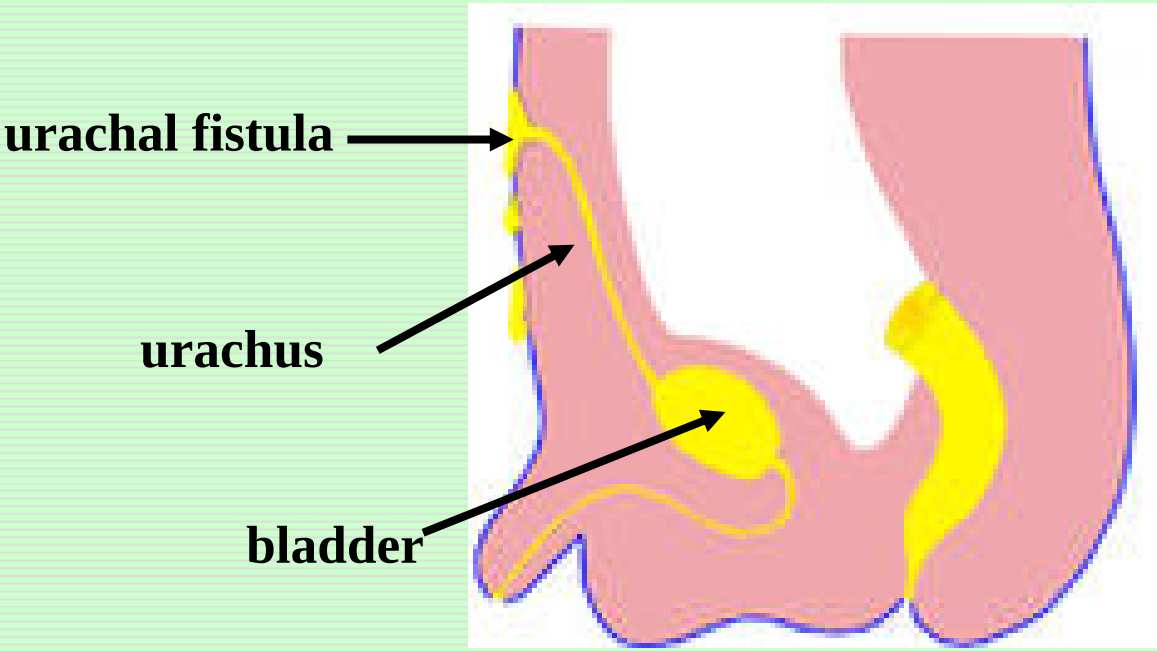
- the posterior wall of the yolk sac forms a small diverticulum called allantois that extends into the connecting stalk

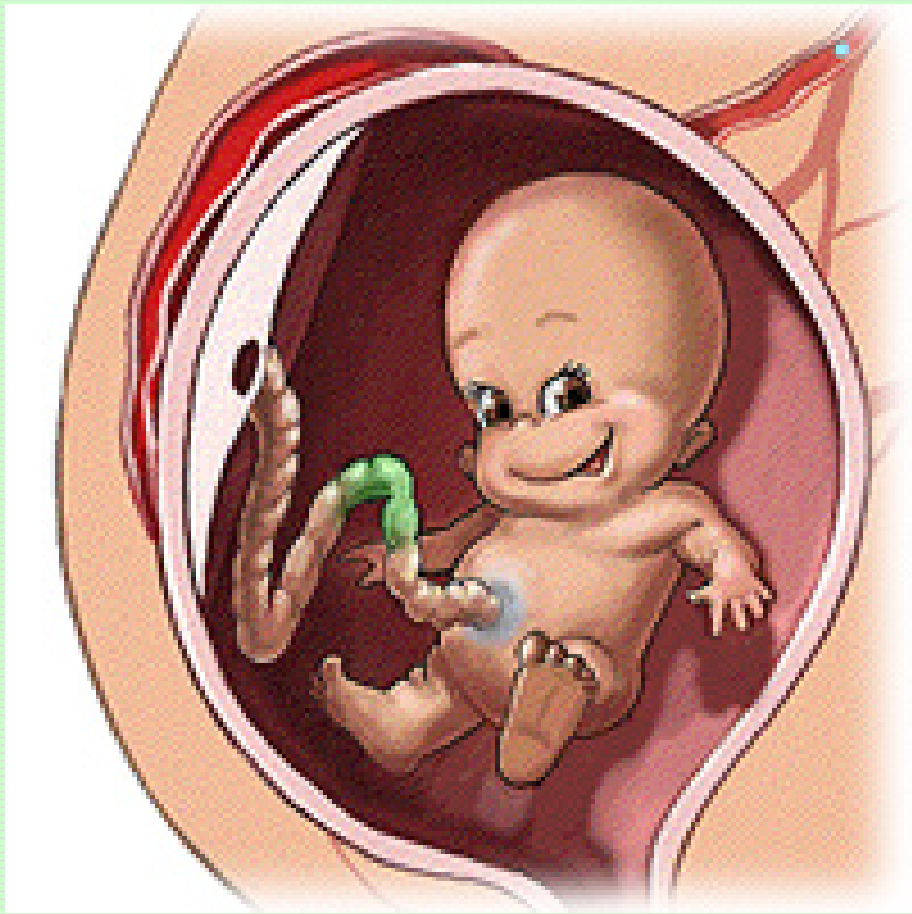


- The proximal portion of the allantois is included into the embryonic body, where it forms the a part of bladder.
- The distal portion of the allantois remains in the body stalk.



- Distal portion of allantois is obliterated to form urachus.
- If the urachus remains open over, urachal fistula is formed. A urinary discharge may then be found at the umbilicus.
- urachal diverticulum ; urachal cyst.





From fertilization to birth 1 & 2

- By 5th week, yolk sac duct, allantois, and umbilical vessels are packed by amnion.
- From 3rd to 8th week, primordium of eye, era and nose and developing limbs can been seen on surface of embryo, which obtains a human image.

Key points

- **The differentiated direction of three germs**
- **The causes of kinds of malformations mentioned in this chapter**