
بسم الله الرحمن الرحيم

GUT DEVELOPMENT

The epithelium of the digestive system and the parenchyma of its derivatives originate in the endoderm;

Connective tissue, muscular components, and peritoneal components originate in the mesoderm. **Depends upon reciprocal interactions between the gut endoderm (epithelium) and its surrounding mesoderm.**

The gut system extends from the oropharyngeal membrane to the cloacal membrane and is divided into the

Pharyngeal gut,

Foregut,

Midgut, and

Hindgut.

The pharyngeal gut gives rise to the pharynx and related glands

.The epithelial liver cords and biliary system growing out into the septum transversum ,

differentiate into parenchyma. Hematopoietic cells , the Kupffer cells, and connective tissue cells originate in the mesoderm.

The pancreas develops from a ventral bud and a dorsal bud that later fuse to form the definitive pancreas .

Annular pancreas, causing constriction of the gut

The midgut forms the primary intestinal loop.

Connection with the yolk sac through the vitelline duct.

During the sixth week >>>> **Physiological herniation.**

During the 10th week, it returns into the abdominal cavity.

270° counterclockwise.

Remnants of the vitelline duct, failure of the midgut to return to the abdominal cavity, malrotation, stenosis, and duplication of parts of the gut are common abnormalities.

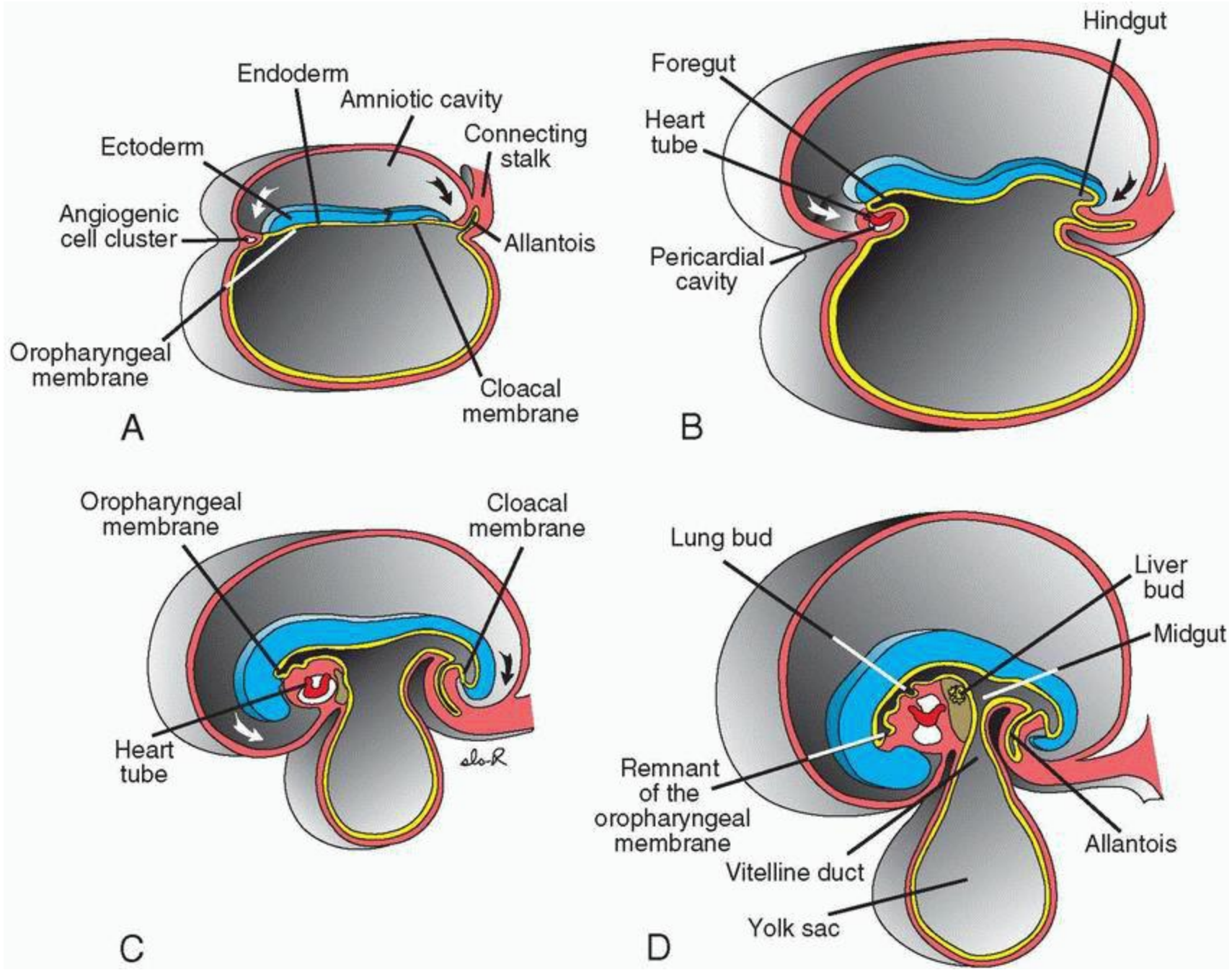
The hindgut gives is up to the upper part of the anal canal;

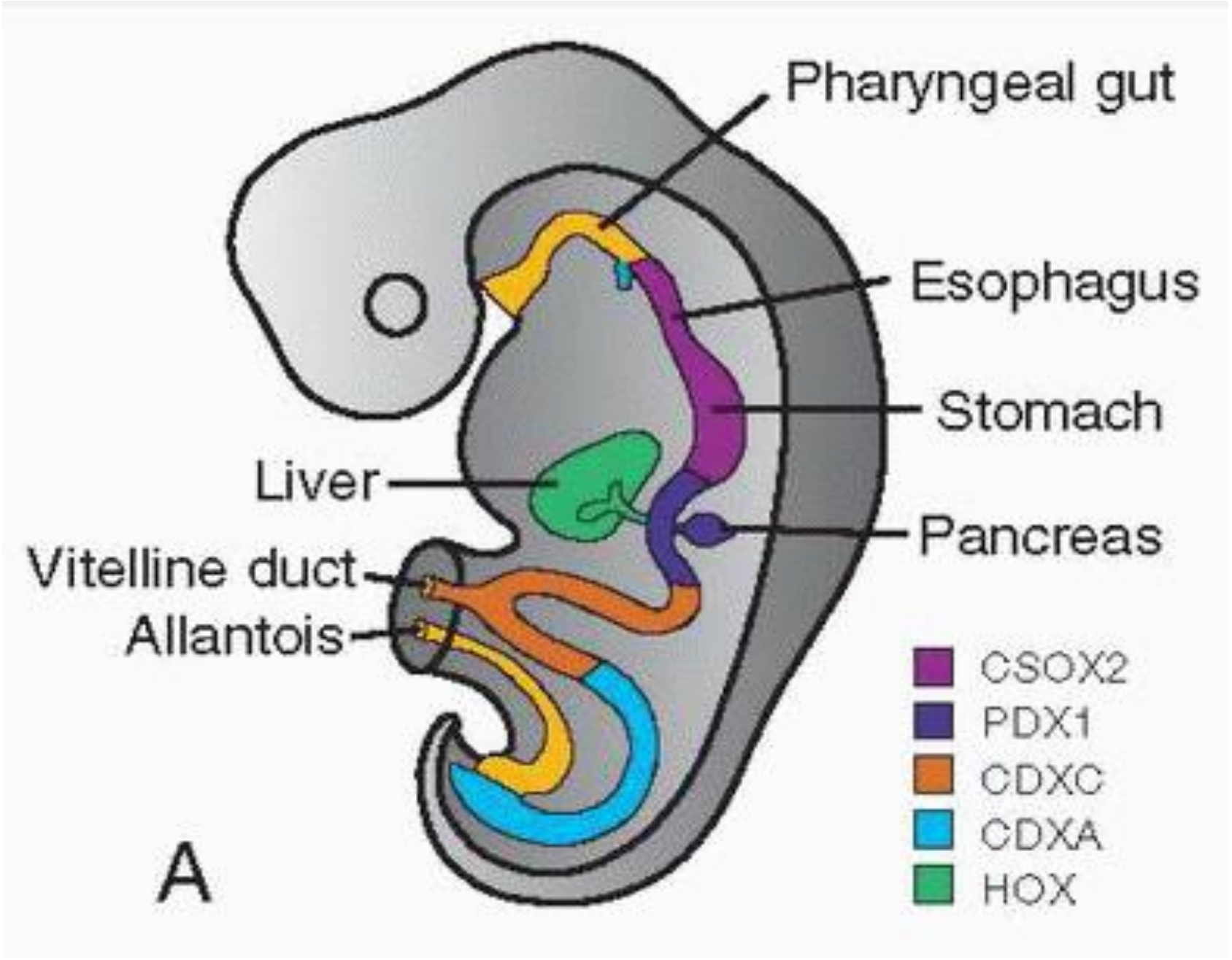
the distal part >>>>> Ectoderm.

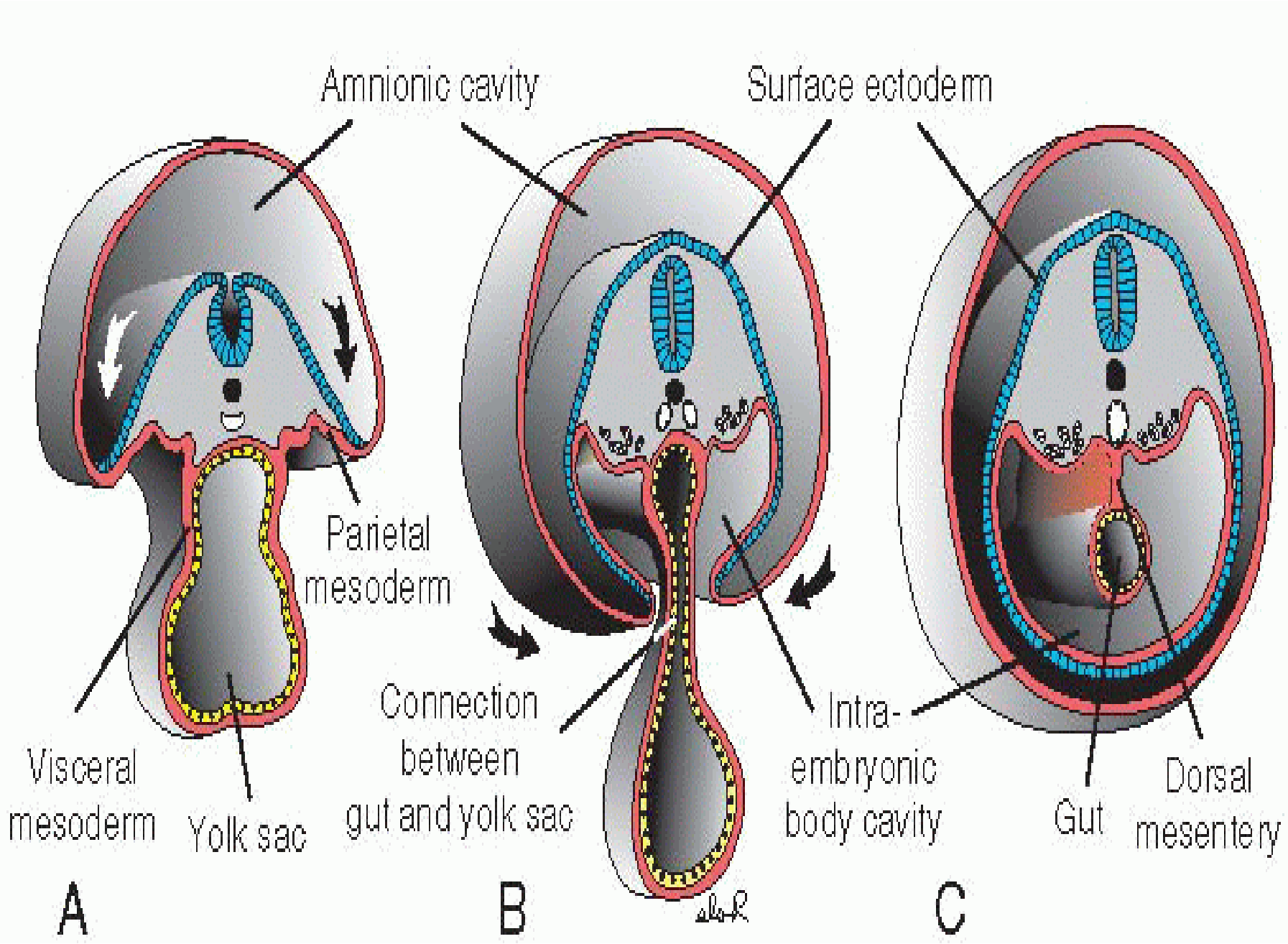
The hindgut enters the posterior region of the cloaca (future anorectal canal),

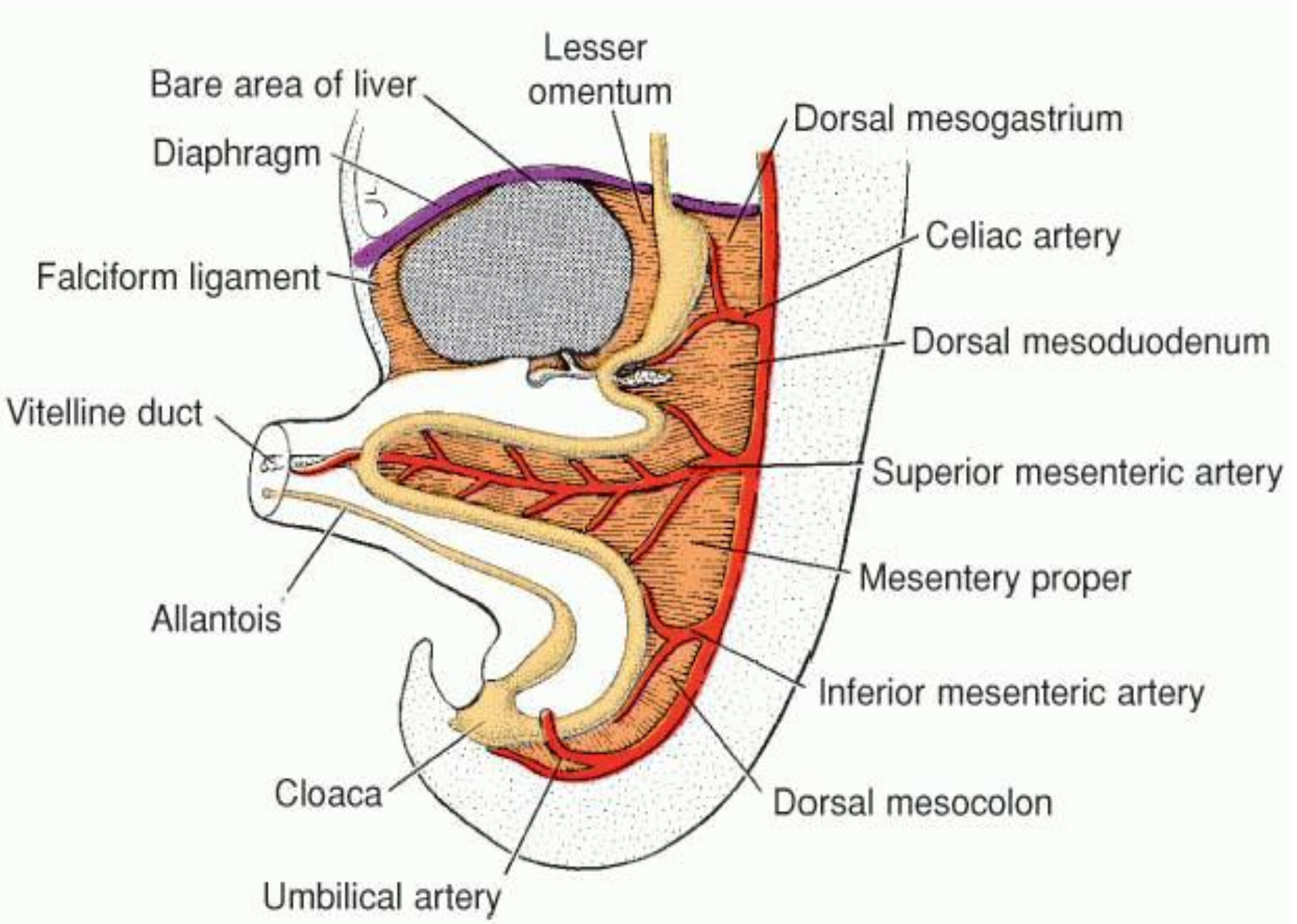
Abnormalities in the size of the posterior region of the cloaca shift the entrance of the anus anteriorly, causing rectovaginal and rectourethral fistulas and atresias .

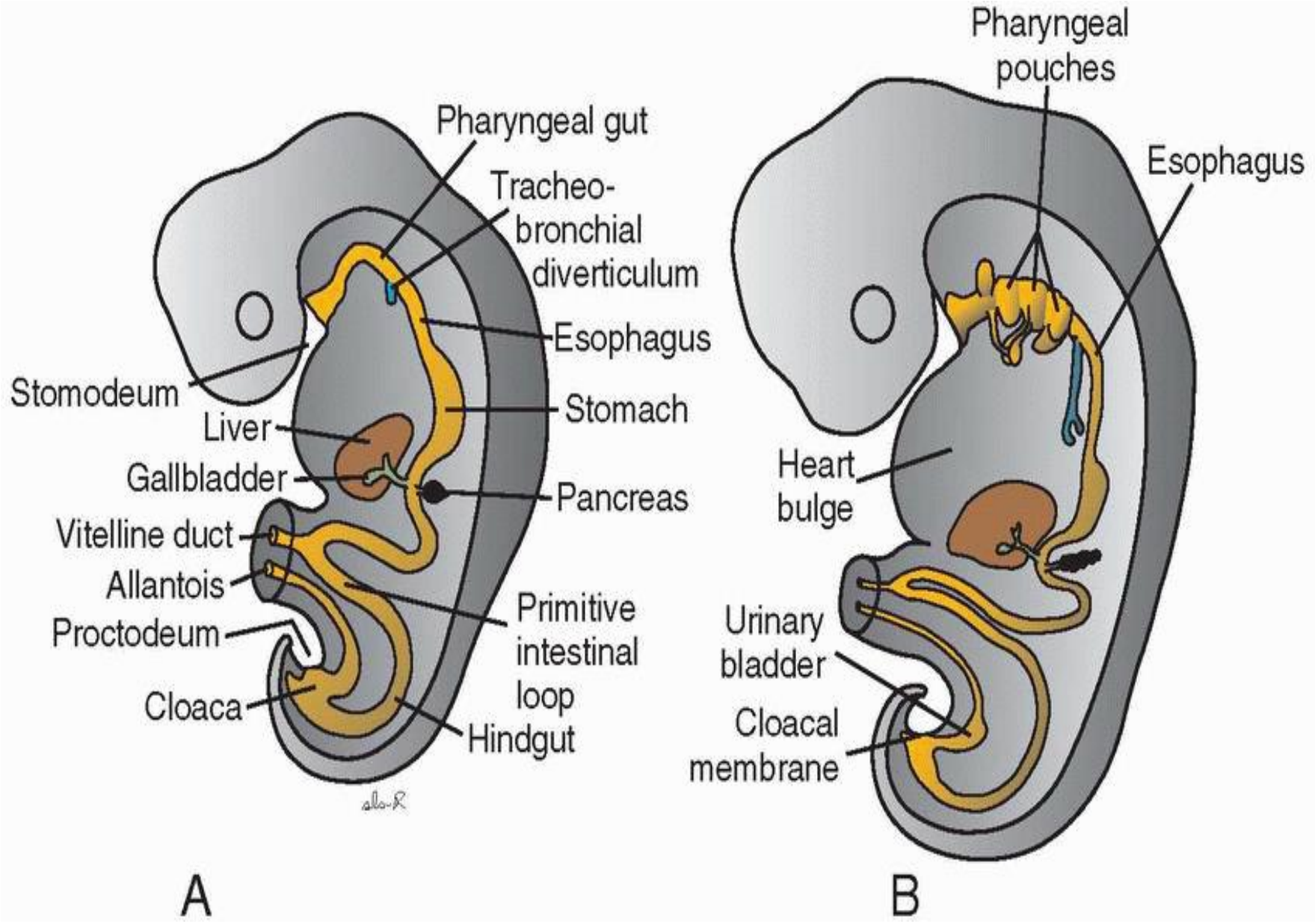
- The anal canal itself is derived from endoderm (cranial part) and ectoderm (caudal part).
- The caudal part is formed by invaginating ectoderm around the proctodeum.
- **Vascular supply to the anal canal reflects its dual origin.**

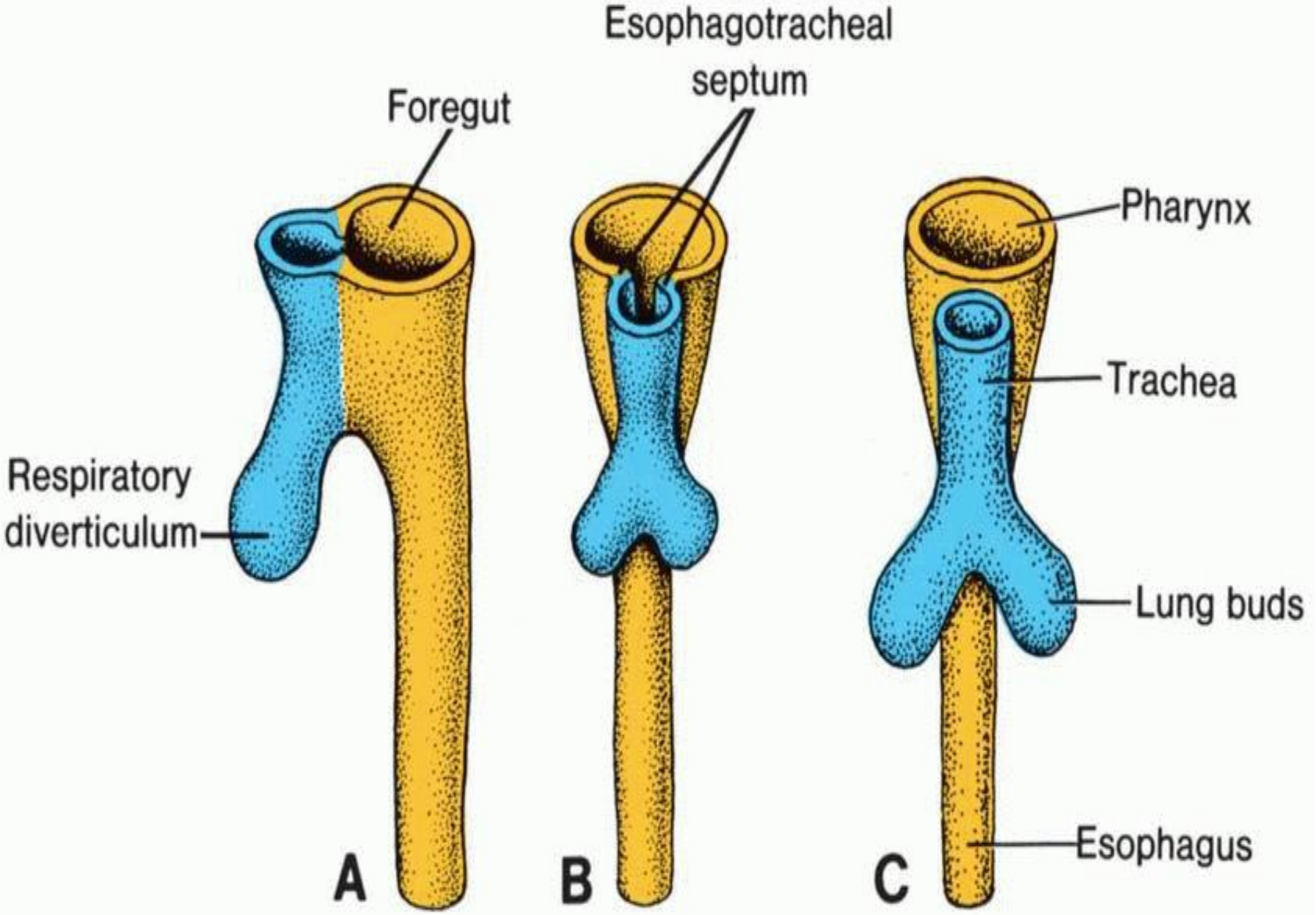

Endoderm
Amniotic cavity
Ectoderm
Connecting stalk
Angiogenic cell cluster
Allantois
Oropharyngeal membrane
Cloacal membrane
A
Hindgut
Foregut
Heart tube
Pericardial cavity
B
Oropharyngeal membrane
Cloacal membrane
Heart tube
C
Lung bud
Liver bud
Midgut
Remnant of the oropharyngeal membrane
Allantois
Vitelline duct
Yolk sac
D

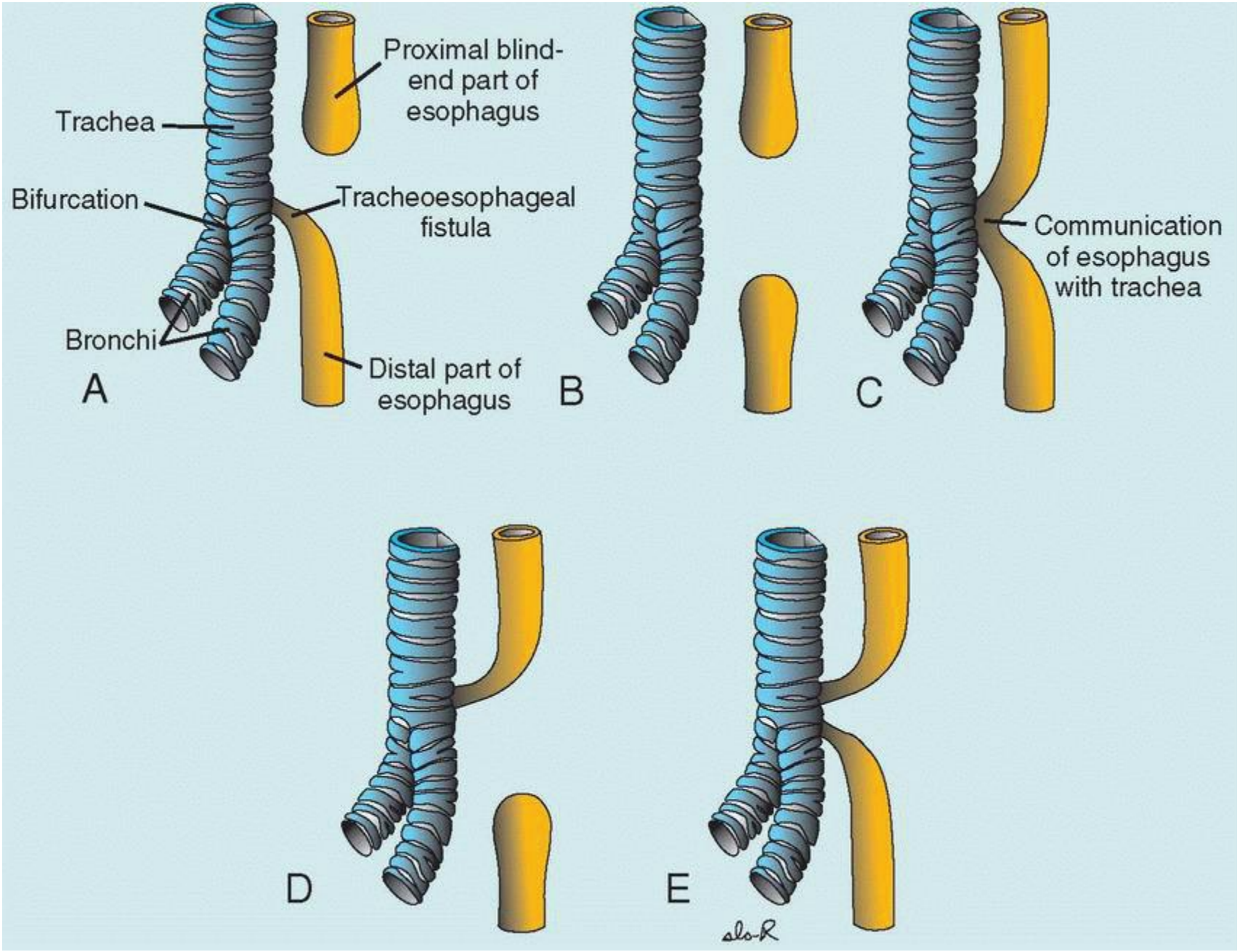

Pharyngeal gut
Esophagus
Stomach
Liver
Pancreas
Vitelline duct
Allantois
CSOX2
PDX1
CDXC
CDXA
HOX
A

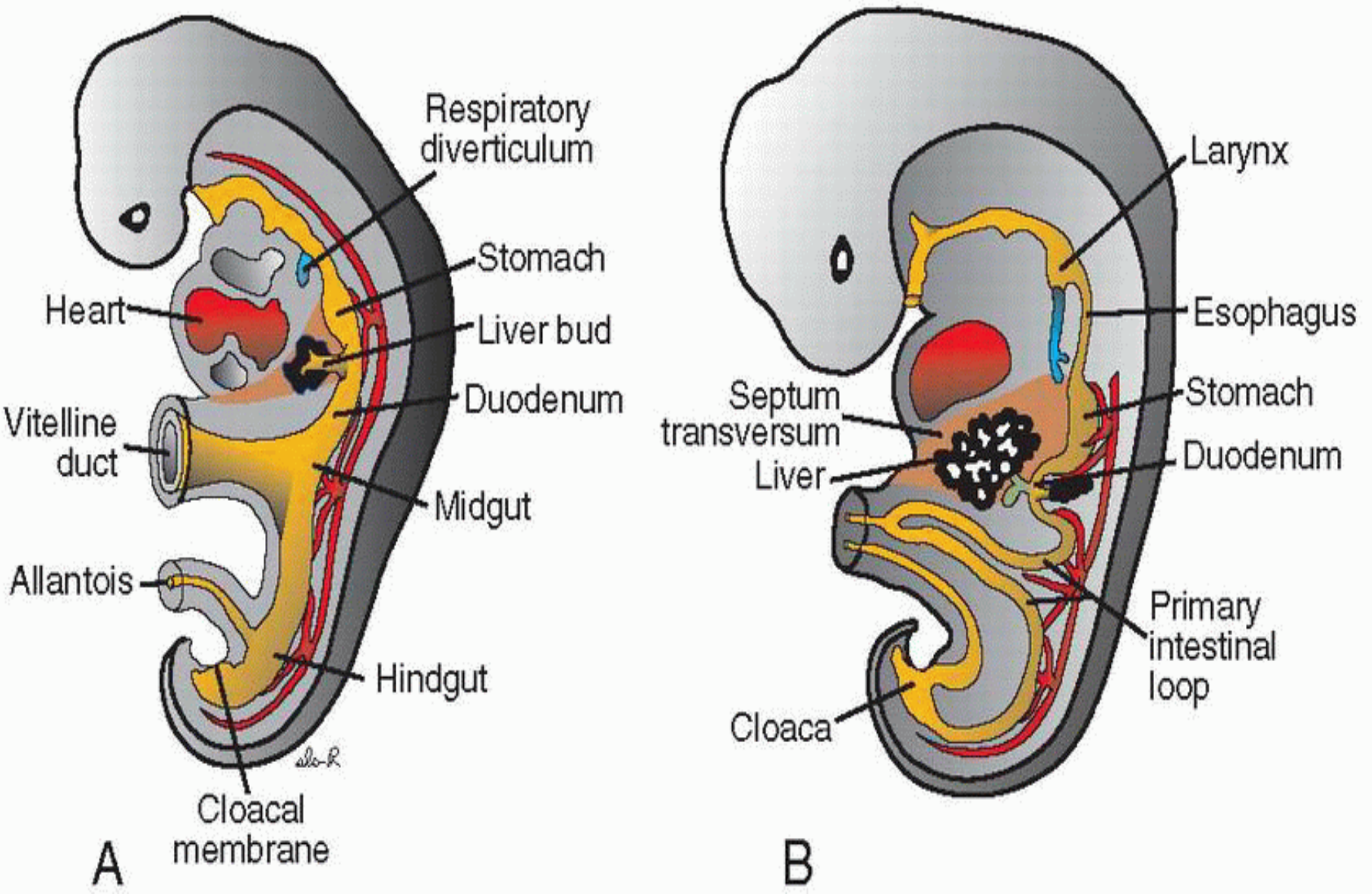

Amnionic cavity
Surface ectoderm
Parietal mesoderm
Visceral mesoderm
Yolk sac
Connection between gut and yolk sac
Intra-embryonic body cavity
Gut
Dorsal mesentery
A
B
C

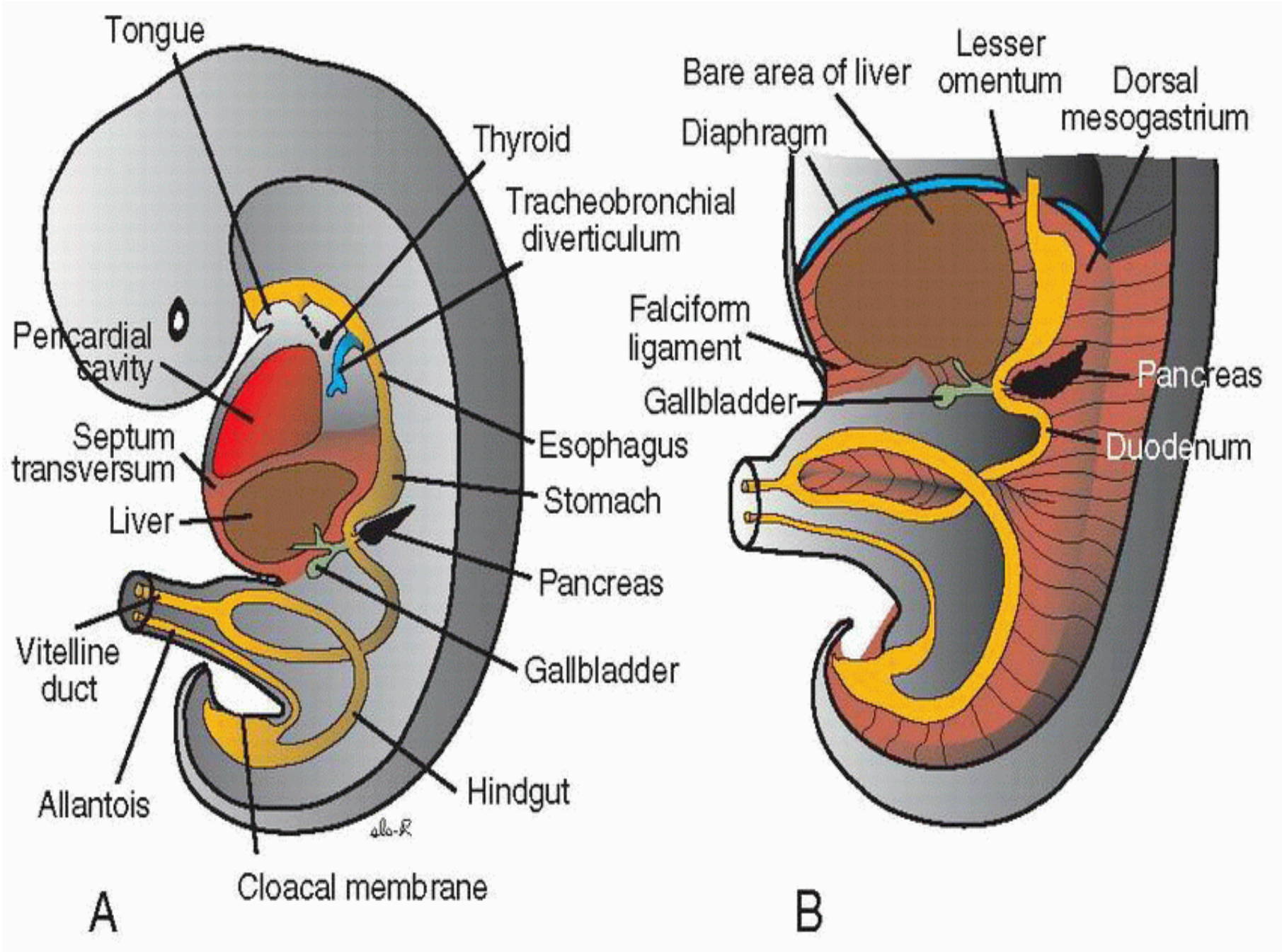

Bare area of liver
Lesser omentum
Dorsal mesogastrium
Diaphragm
Celiac artery
Falciform ligament
Dorsal mesoduodenum
Vitelline duct
Superior mesenteric artery
Mesentery proper
Allantois
Inferior mesenteric artery
Cloaca
Dorsal mesocolon
Umbilical artery

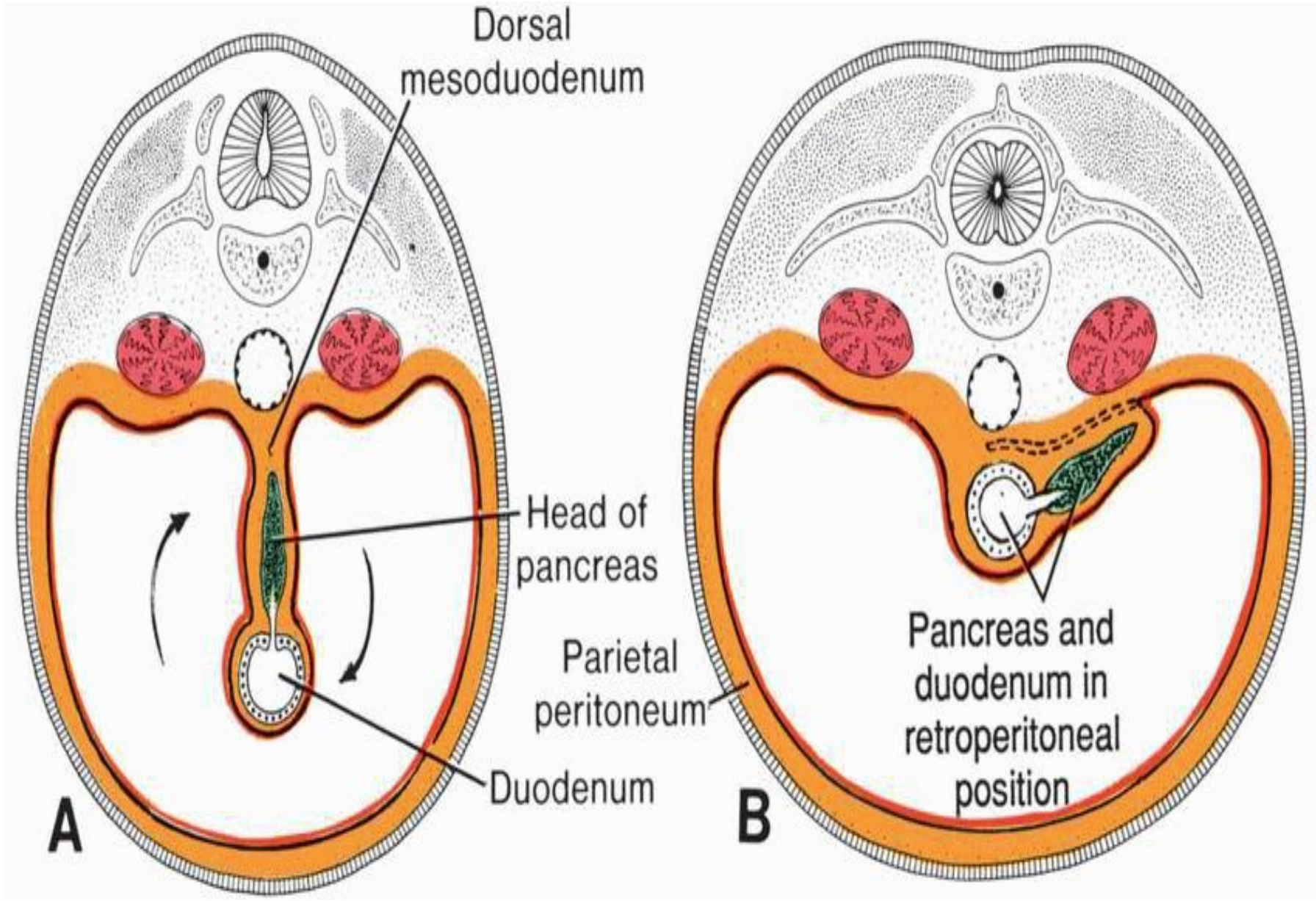

Pharyngeal gut
Tracheo-
bronchial
diverticulum
Esophagus
Stomodeum
Stomach
Liver
Gallbladder
Pancreas
Vitelline duct
Allantois
Primitive
intestinal
loop
Proctodeum
Cloaca
Hindgut
A
Pharyngeal
pouches
Esophagus
Heart
bulge
Urinary
bladder
Cloacal
membrane
B

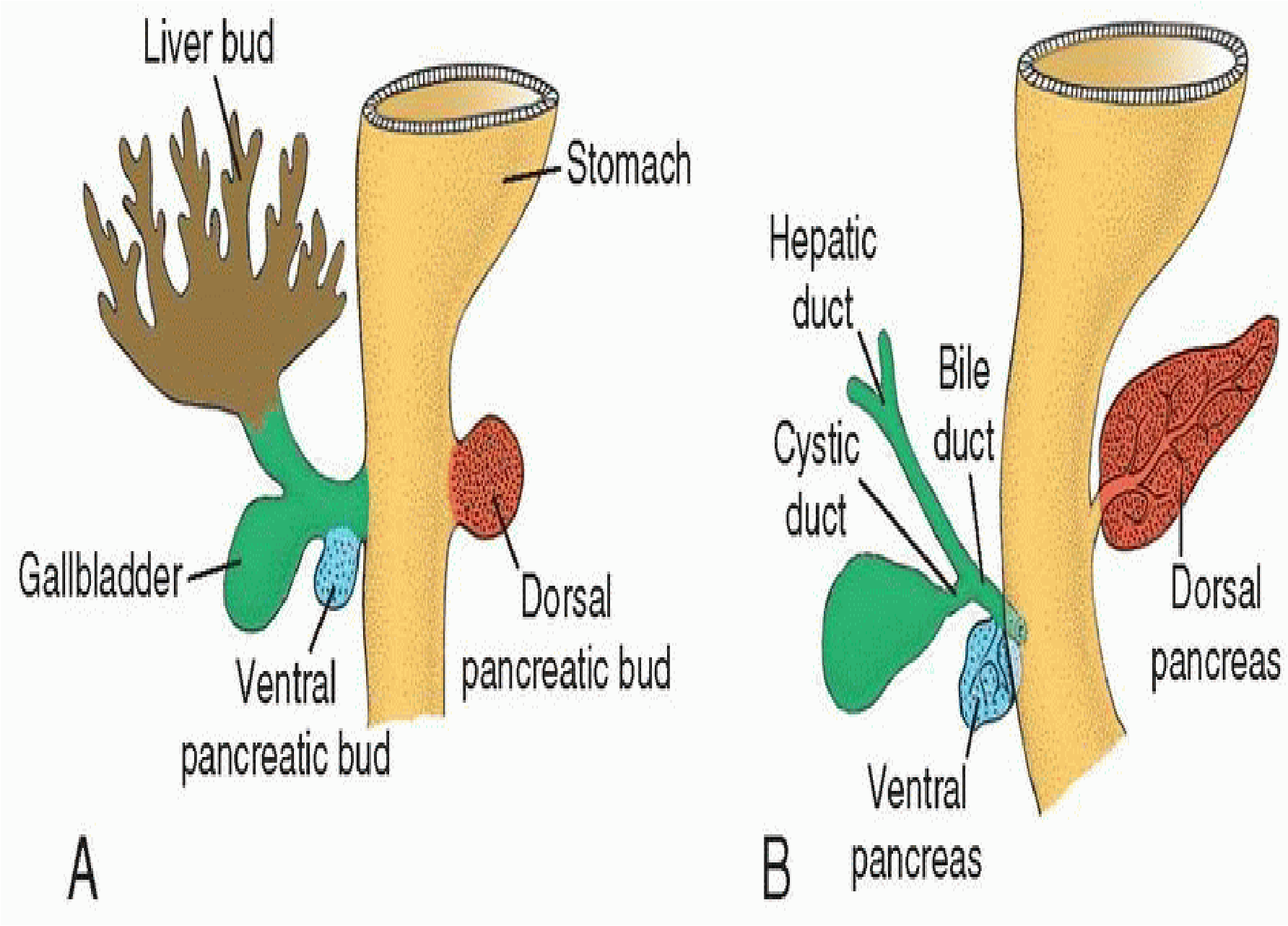

Esophagotracheal
septum
Foregut
Pharynx
Trachea
Respiratory
diverticulum
Lung buds
Esophagus
A
B
C

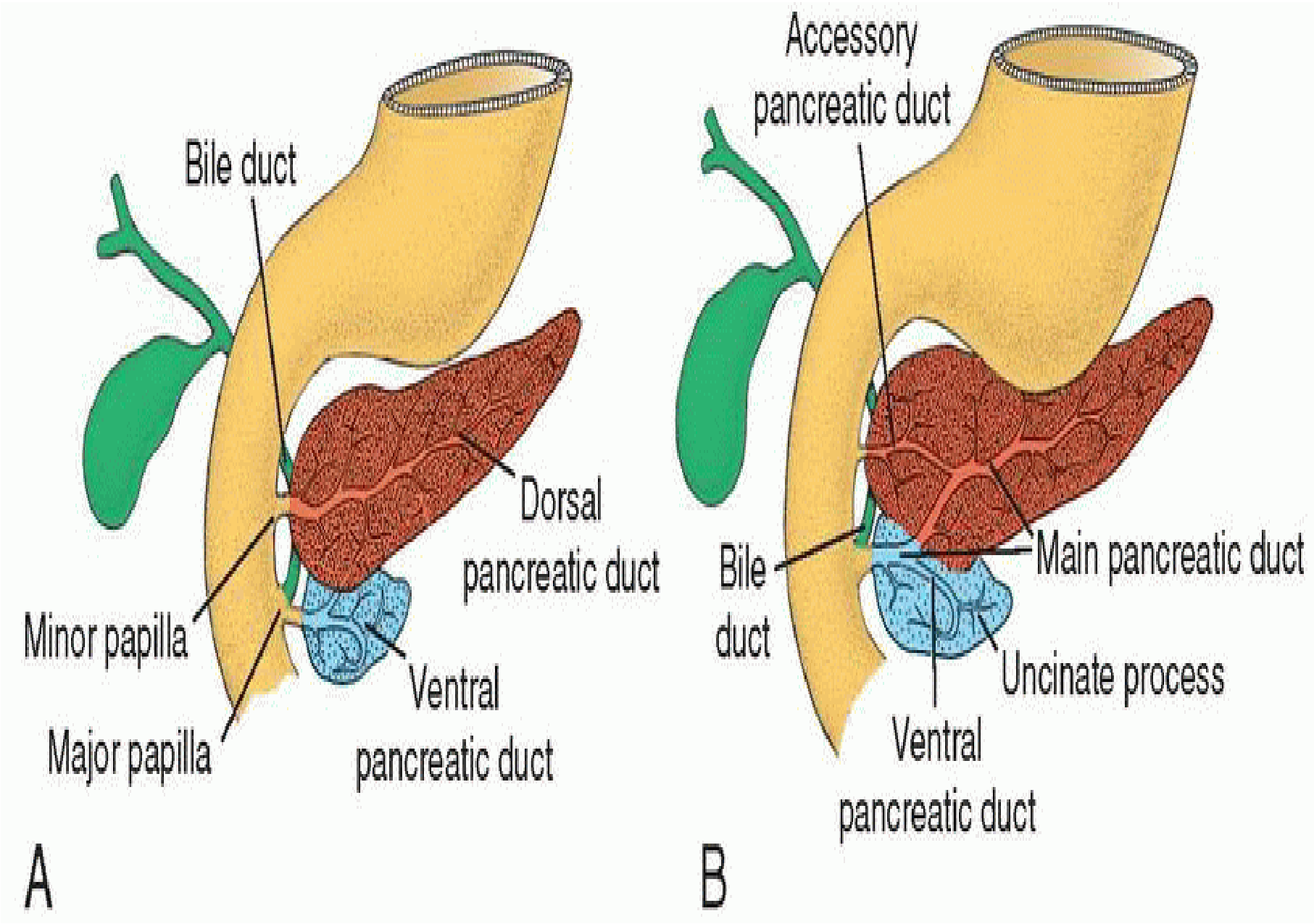

Proximal blind-end part of esophagus
Trachea
Bifurcation
Tracheoesophageal fistula
Bronchi
Distal part of esophagus
A
B
C
Communication of esophagus with trachea
D
E

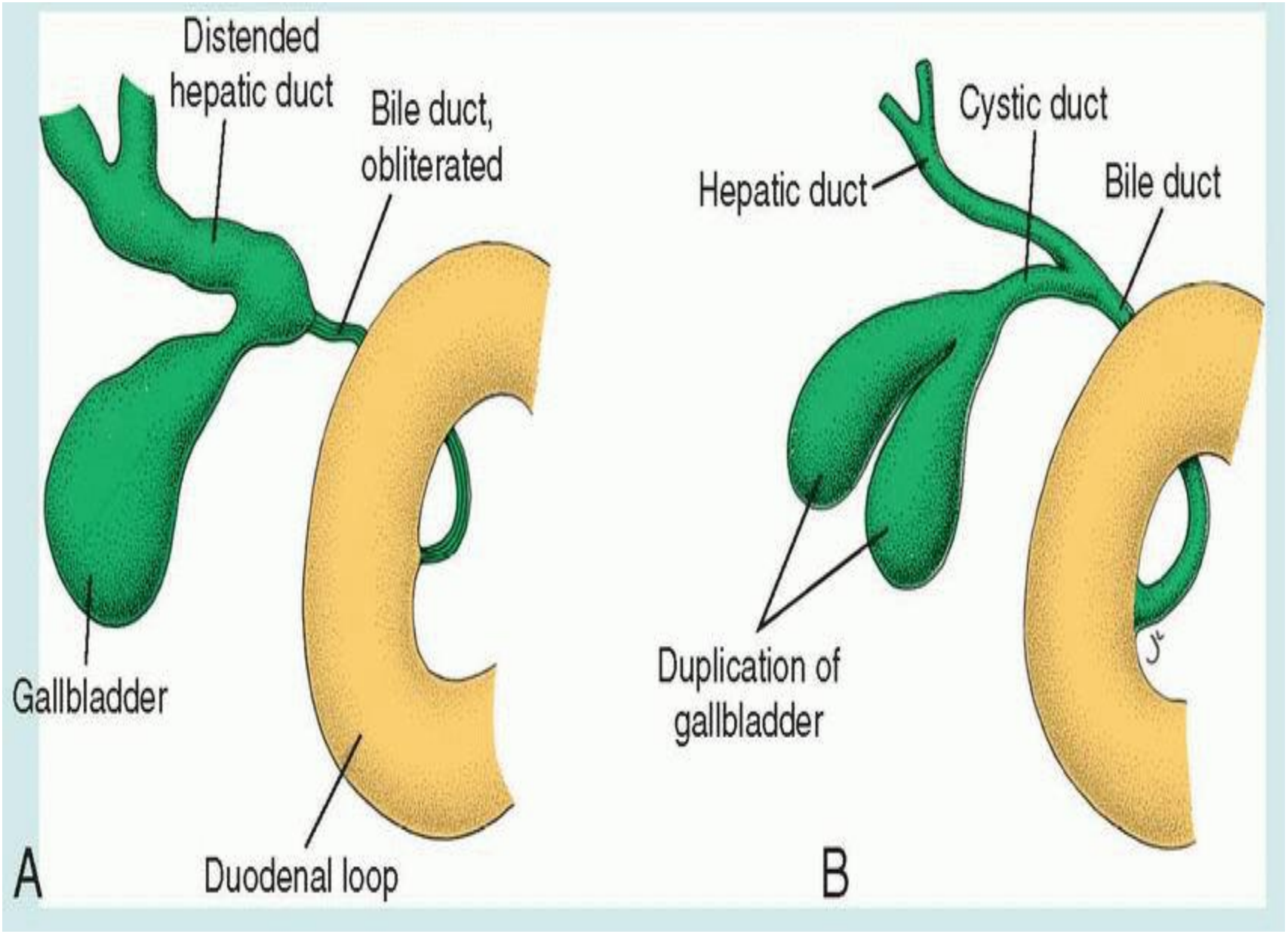

Respiratory diverticulum
Stomach
Heart
Liver bud
Duodenum
Vitelline duct
Midgut
Allantois
Hindgut
Cloacal membrane
A
Larynx
Esophagus
Septum transversum
Stomach
Liver
Duodenum
Primary intestinal loop
Cloaca
B

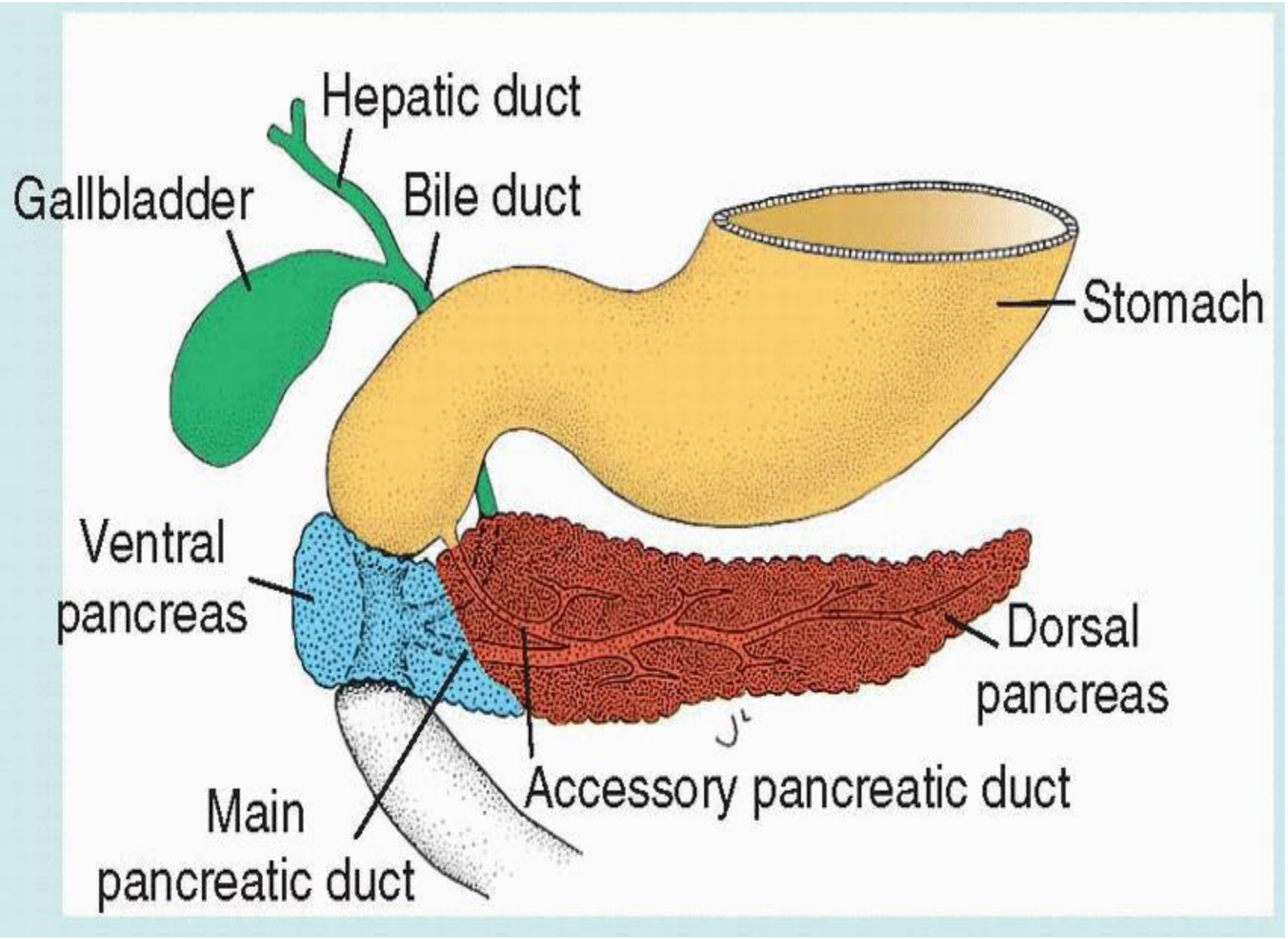

Tongue
Thyroid
Tracheobronchial diverticulum
Pericardial cavity
Septum transversum
Liver
Esophagus
Stomach
Pancreas
Gallbladder
Vitelline duct
Allantois
Hindgut
Cloacal membrane
A
Bare area of liver
Lesser omentum
Dorsal mesogastrium
Diaphragm
Falciform ligament
Gallbladder
Pancreas
Duodenum
B

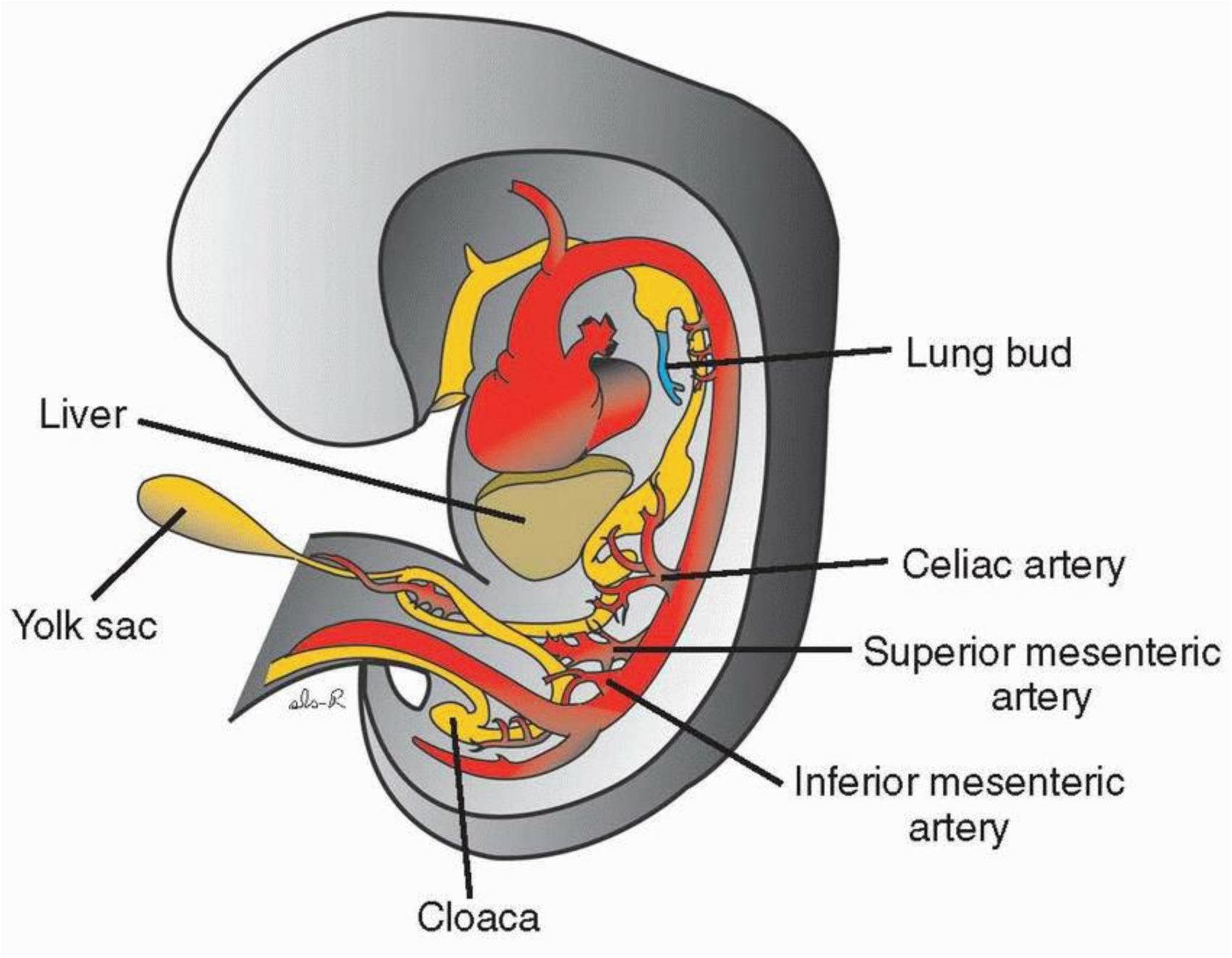

Dorsal
mesoduodenum
Head of
pancreas
Parietal
peritoneum
Duodenum
A
Pancreas and
duodenum in
retroperitoneal
position
B

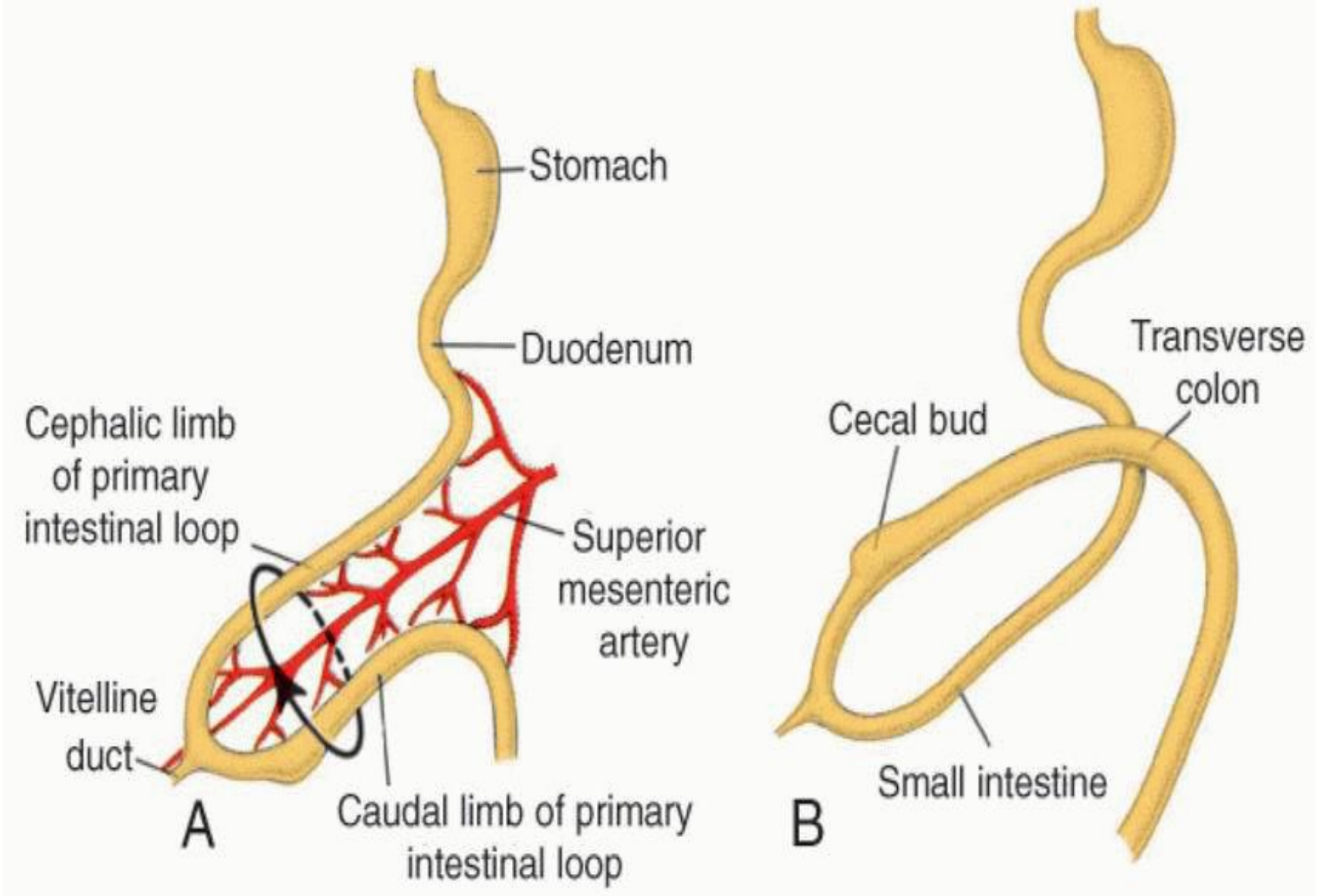

Liver bud
Stomach
Gallbladder
Ventral pancreatic bud
Dorsal pancreatic bud
A
Hepatic duct
Bile duct
Cystic duct
Dorsal pancreas
Ventral pancreas
B

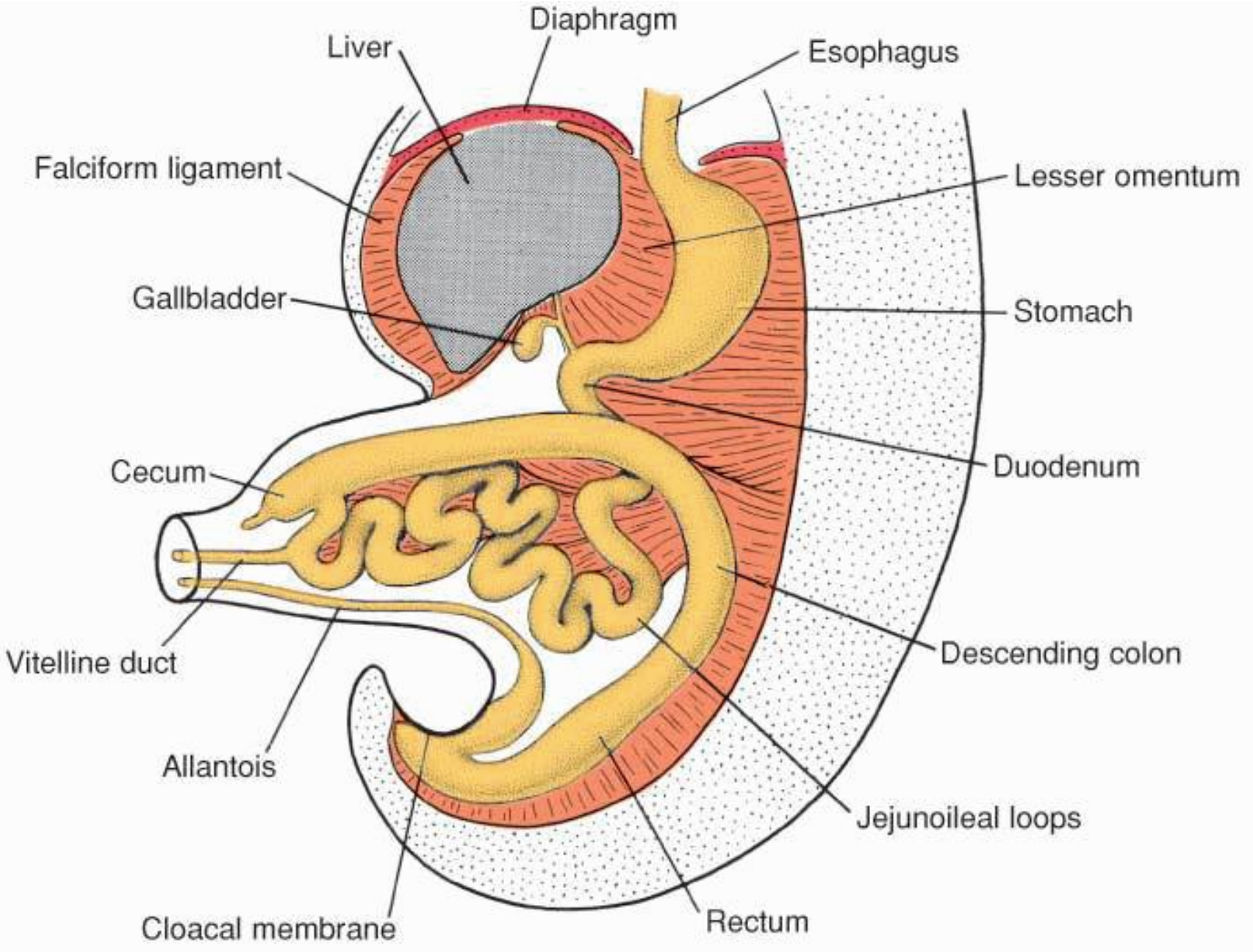

Bile duct
Dorsal pancreatic duct
Minor papilla
Ventral pancreatic duct
Major papilla
A
Accessory pancreatic duct
Main pancreatic duct
Bile duct
Uncinate process
Ventral pancreatic duct
B

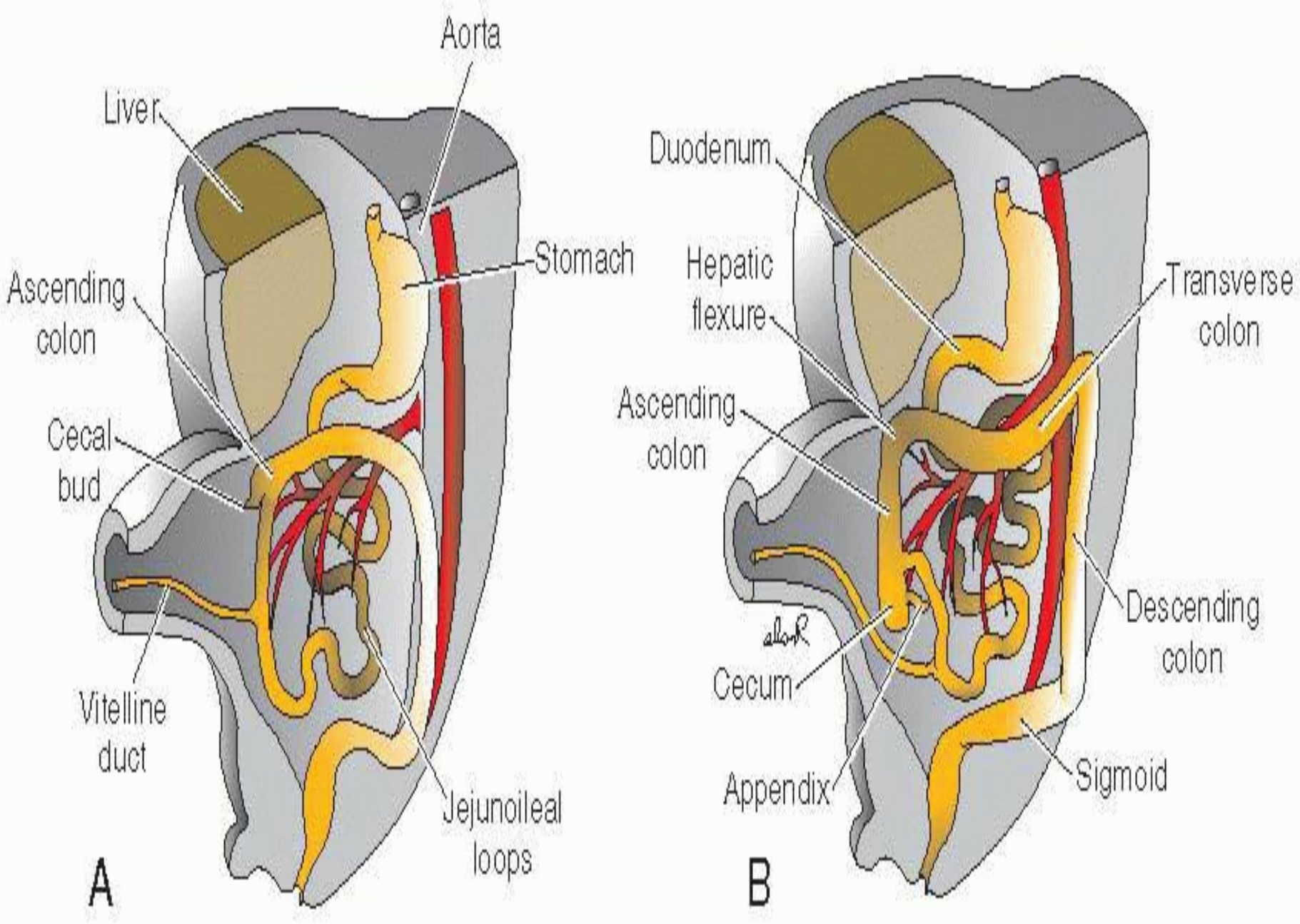

Distended hepatic duct
Bile duct, obliterated
Gallbladder
Duodenal loop
A
Cystic duct
Hepatic duct
Bile duct
Duplication of gallbladder
B

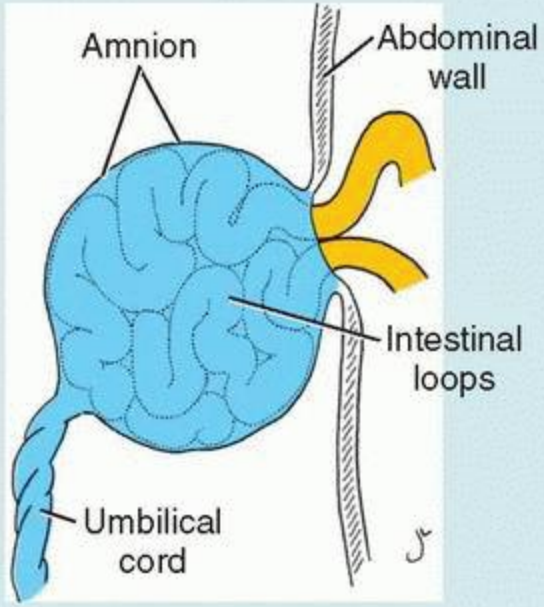

Hepatic duct
Gallbladder
Bile duct
Stomach
Ventral pancreas
Dorsal pancreas
Accessory pancreatic duct
Main pancreatic duct


Lung bud
Liver
Yolk sac
Celiac artery
Superior mesenteric artery
Inferior mesenteric artery
Cloaca

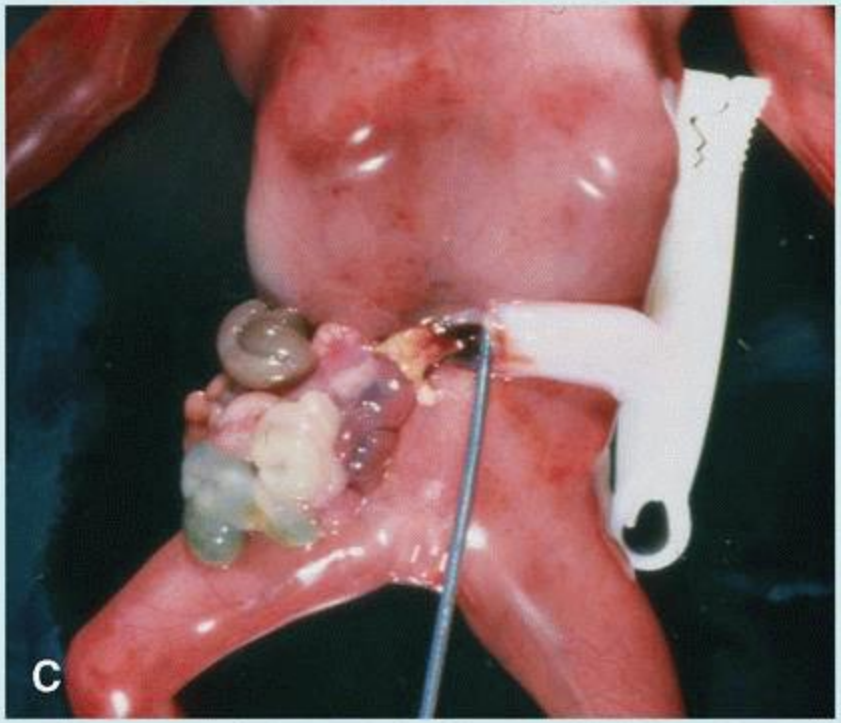

Stomach
Duodenum
Cephalic limb of primary intestinal loop
Superior mesenteric artery
Vitelline duct
Caudal limb of primary intestinal loop
A
Transverse colon
Cecal bud
Small intestine
B

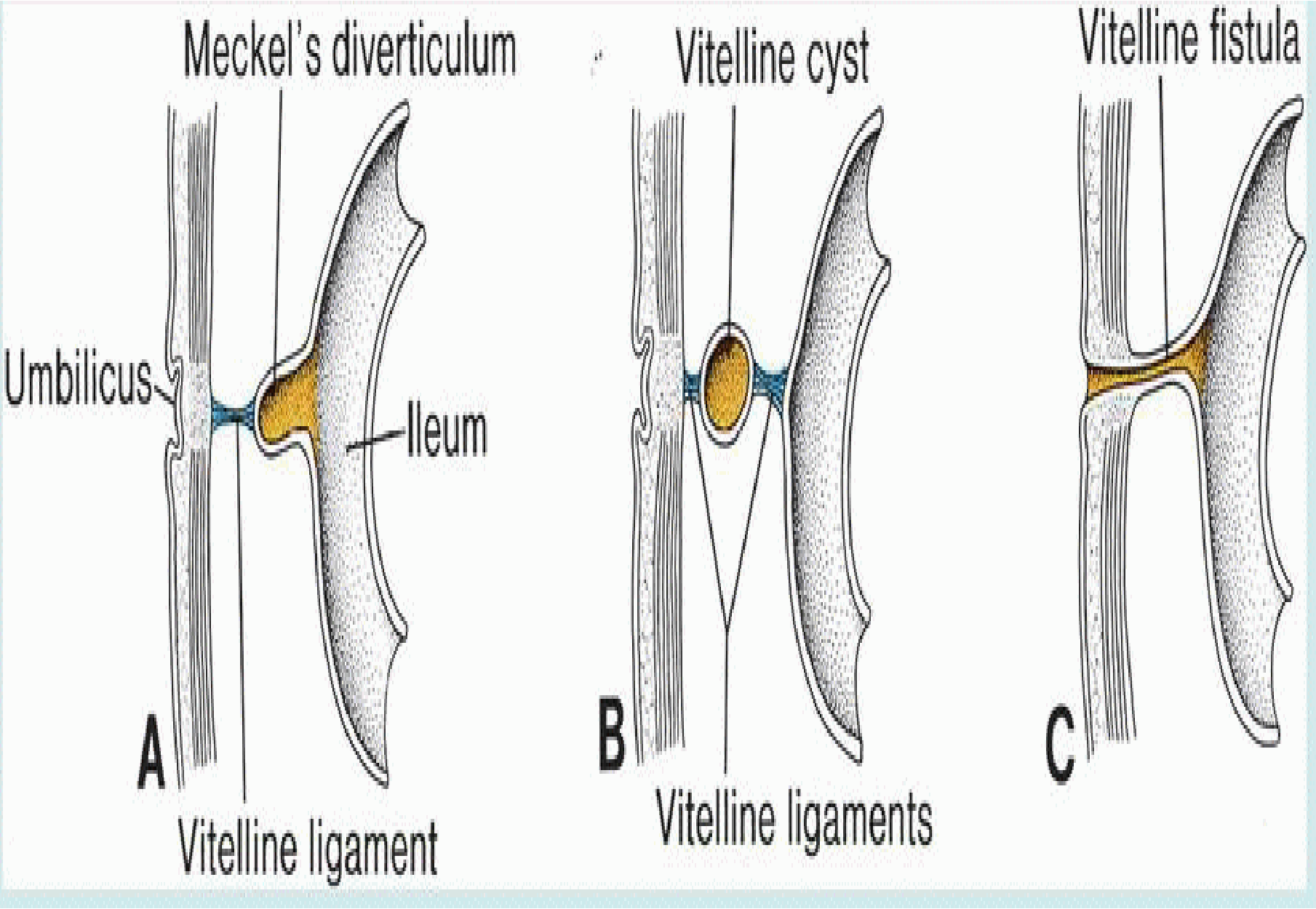

Diaphragm
Liver
Esophagus
Falciform ligament
Lesser omentum
Gallbladder
Stomach
Duodenum
Cecum
Descending colon
Vitelline duct
Allantois
Jejunoileal loops
Cloacal membrane
Rectum


Aorta
Liver
Stomach
Ascending colon
Cecal bud
Vitelline duct
Jejunoileal loops
A
Duodenum
Hepatic flexure
Transverse colon
Ascending colon
Descending colon
Cecum
Appendix
Sigmoid
B

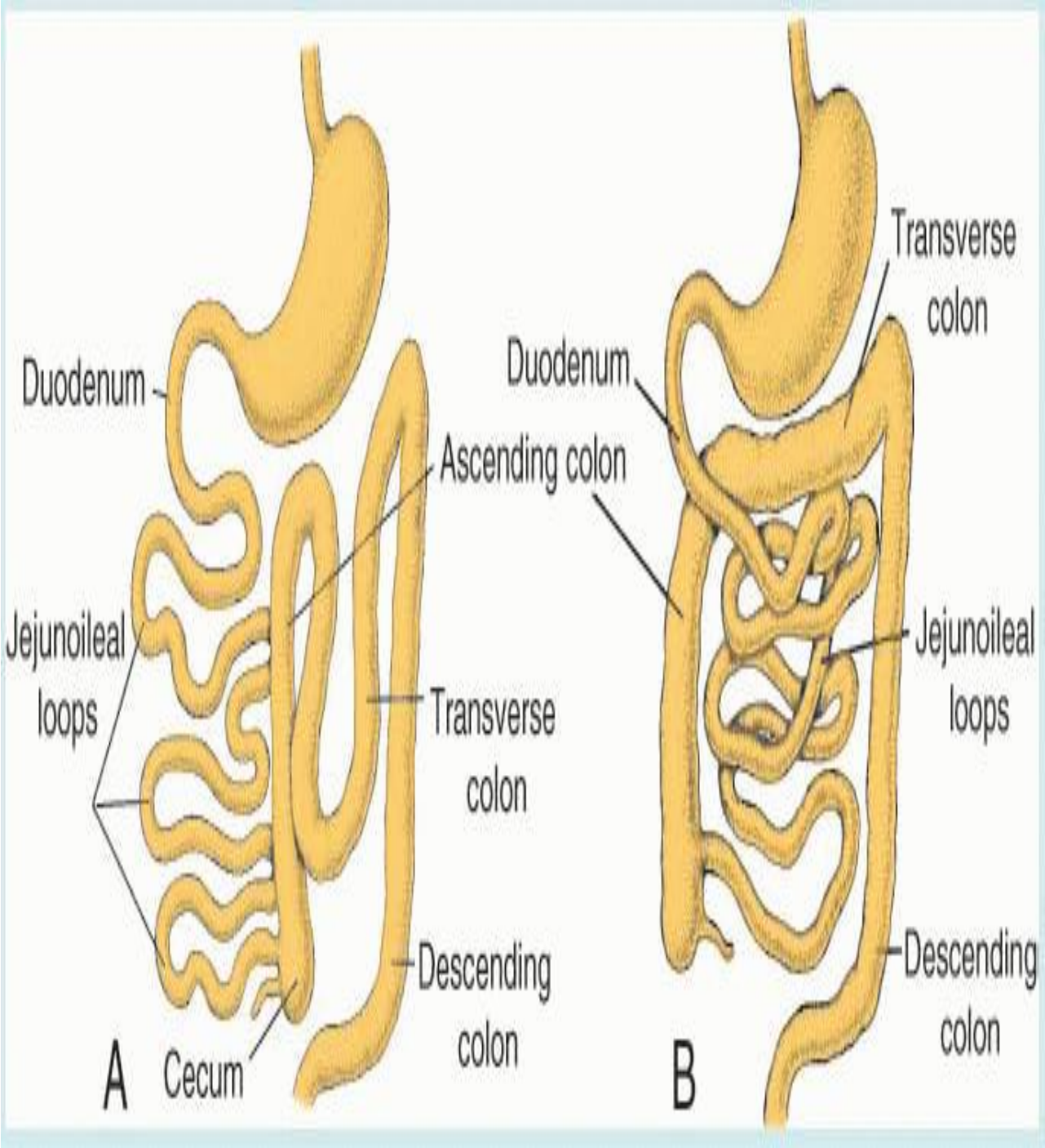

Amnion
Abdominal wall
Intestinal loops
Umbilical cord
A

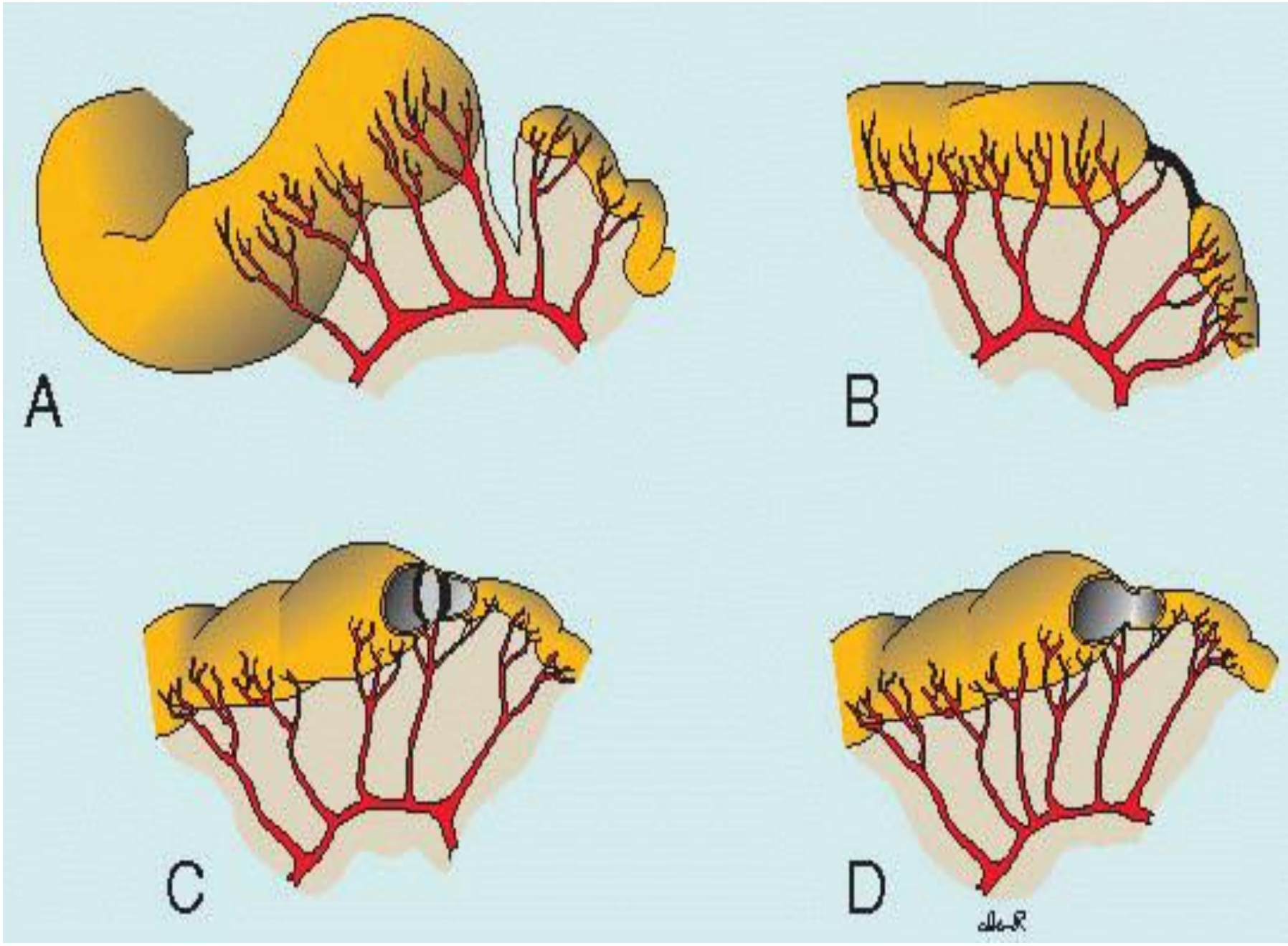

B

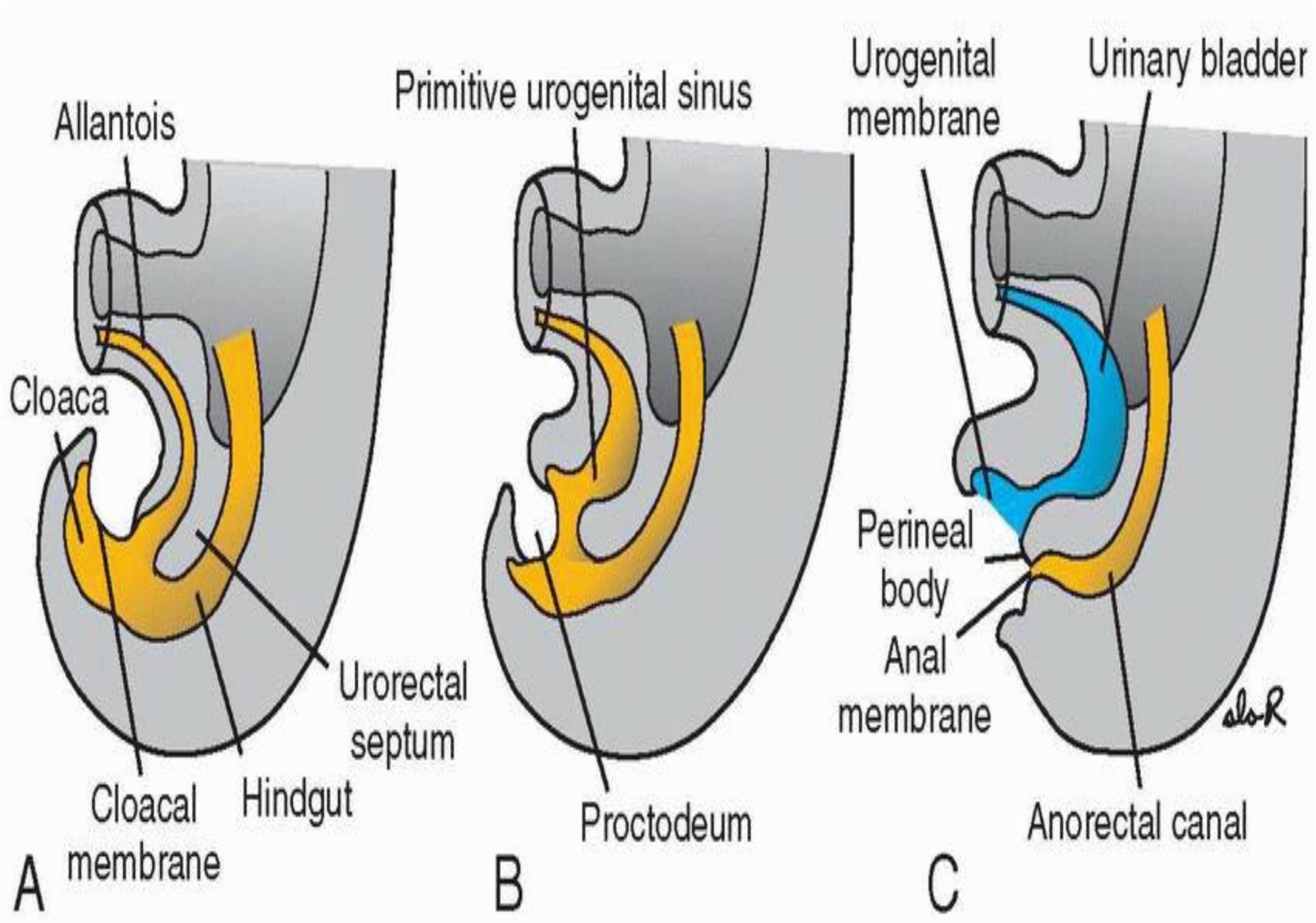

C

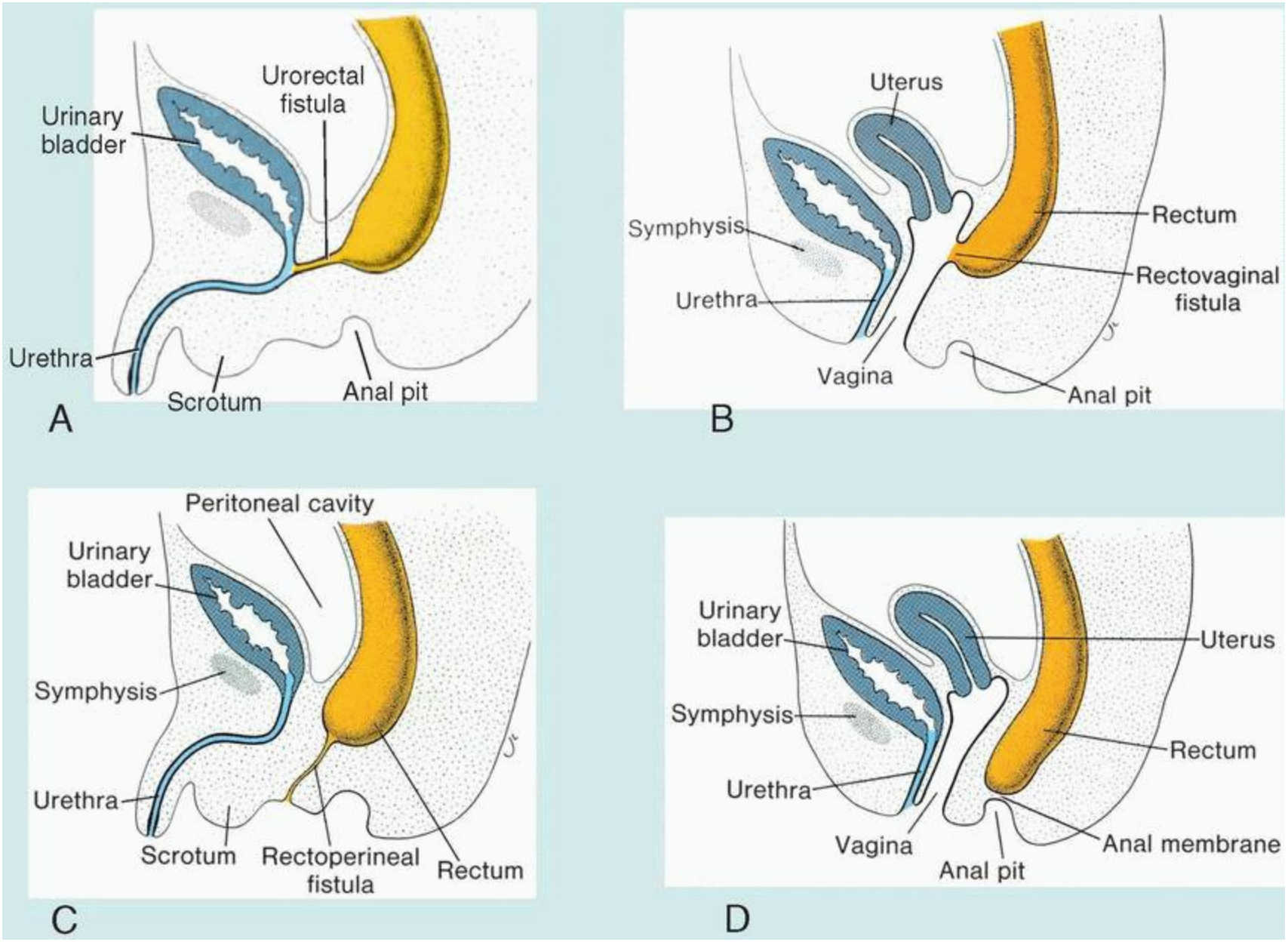

Meckel's diverticulum
Umbilicus
Ileum
A
Vitelline ligament
Vitelline cyst
B
Vitelline ligaments
Vitelline fistula
C

Abnormal rotation of the primary intestinal loop. The colon is on the left side of the abdomen, and the small intestinal loops are on the right. The ileum enters the cecum from the right. B. The primary intestinal loop is rotated 90° clockwise (reversed rotation). The transverse colon passes behind the duodenum.




A
B
C
D


Allantois
Cloaca
Urorectal septum
Cloacal membrane
Hindgut
A
Primitive urogenital sinus
Proctodeum
B
Urogenital membrane
Urinary bladder
Perineal body
Anal membrane
Anorectal canal
C


Urinary bladder
Urorectal fistula
Urethra
Scrotum
Anal pit
A
Uterus
Symphysis
Rectum
Rectovaginal fistula
Urethra
Vagina
Anal pit
B
Peritoneal cavity
Urinary bladder
Symphysis
Urethra
Scrotum
Rectoperineal fistula
Rectum
C
Urinary bladder
Uterus
Symphysis
Rectum
Urethra
Vagina
Anal membrane
Anal pit
D

THANKS

Out growth (Fore brain) > Optic Vesicle

This induce lens placode in surface ectoderm

Opening get narrowed > Optic stalk

Lens placode > Fall in cup

Choroid fissure > ophthalmic artery Branch , the Hyaloid artery > Form Central artery of retina

Out cup > Pigmented Layer

Inner Layer > Neural layer

At rim both layers of cup form iris and ciliary body

Neuroectoderm over iris form pupillae muscle

Neural crest over ciliary body > Ciliary muscle

- Lens hollow at start > Posterior cells elongates
- Surrounding mesenchyme > Eye Layer
- Cornea become transparent
- Ant and posterior chamber forms when ciliary body start forming Aqueous Humor.
- Fibrous Tissue of gelatinous tissue form > V. Body
- Eye lid > fold in ectoderm
- Mesenchyme over cornea > conjunctiva
- Conjunctival sac + Surrounding Mesenchyme
- > L. Gland
- AT 7 month Lid separate

Eye

OPTIC CUP AND LENS VESICLE

Form outpocketings of the forebrain, the optic vesicles. These vesicles subsequently come in contact with the surface ectoderm and induce changes in the ectoderm necessary for lens formation.

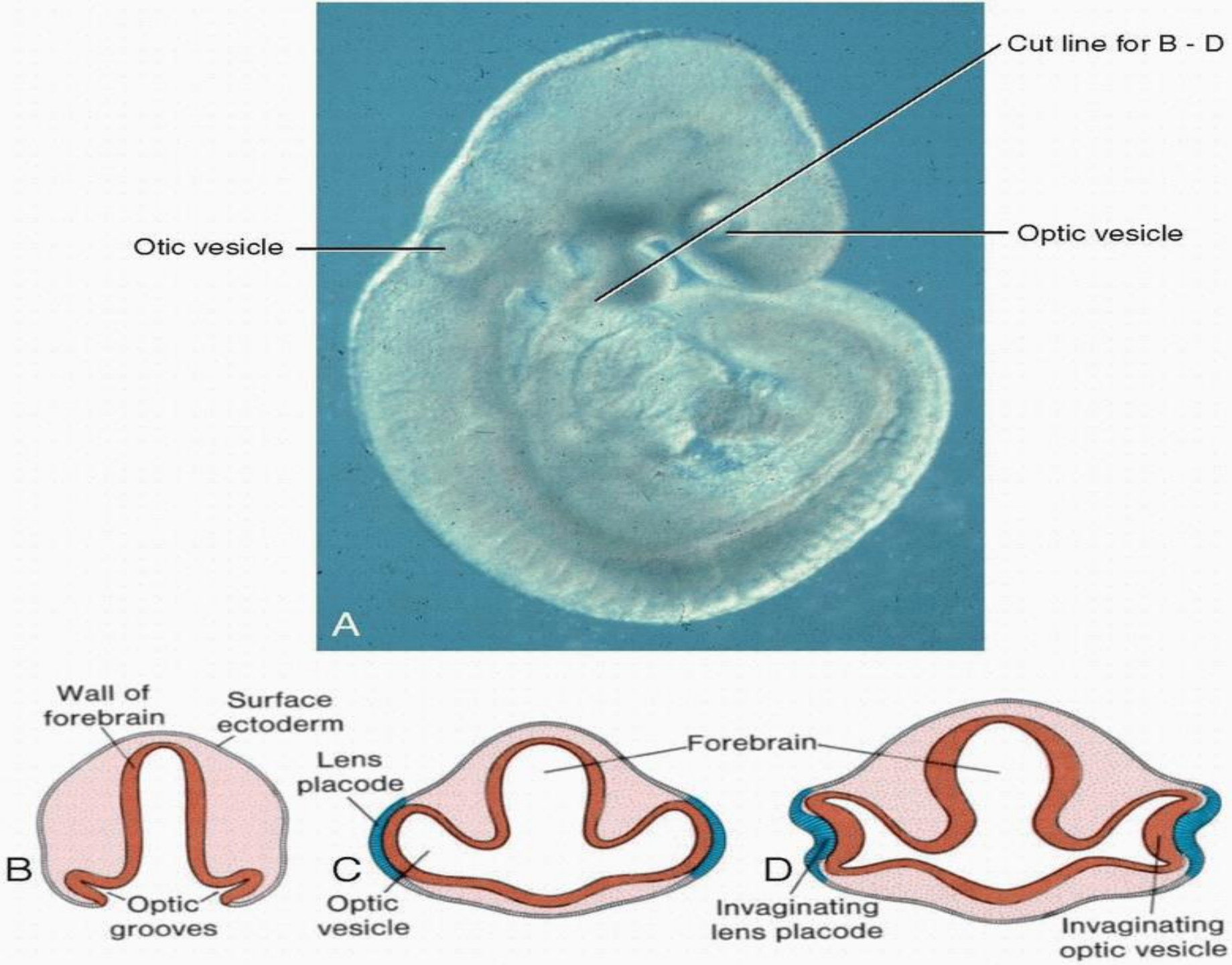
Optic vesicle >>>>> The double-walled optic cup.

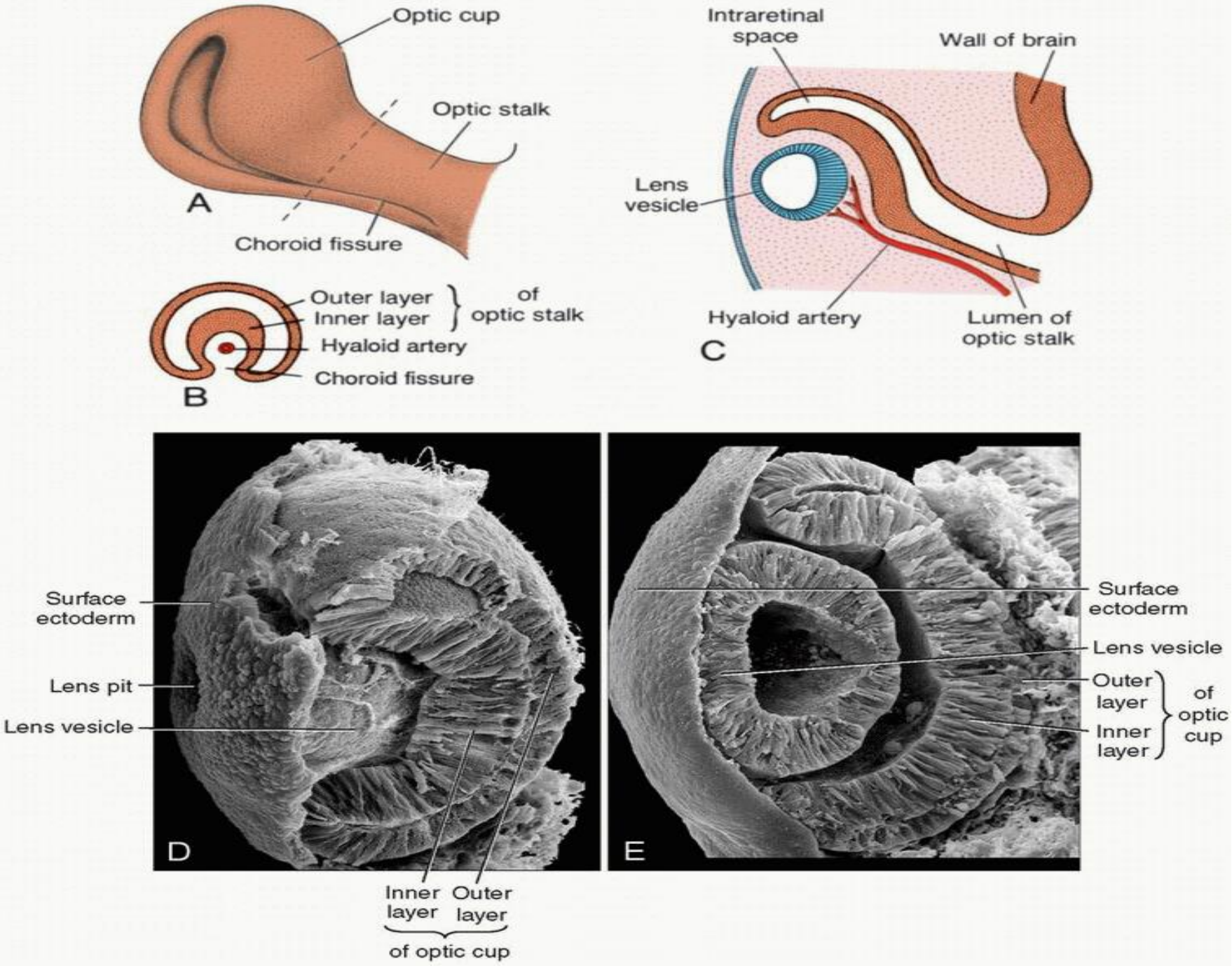
The inner and outer layers

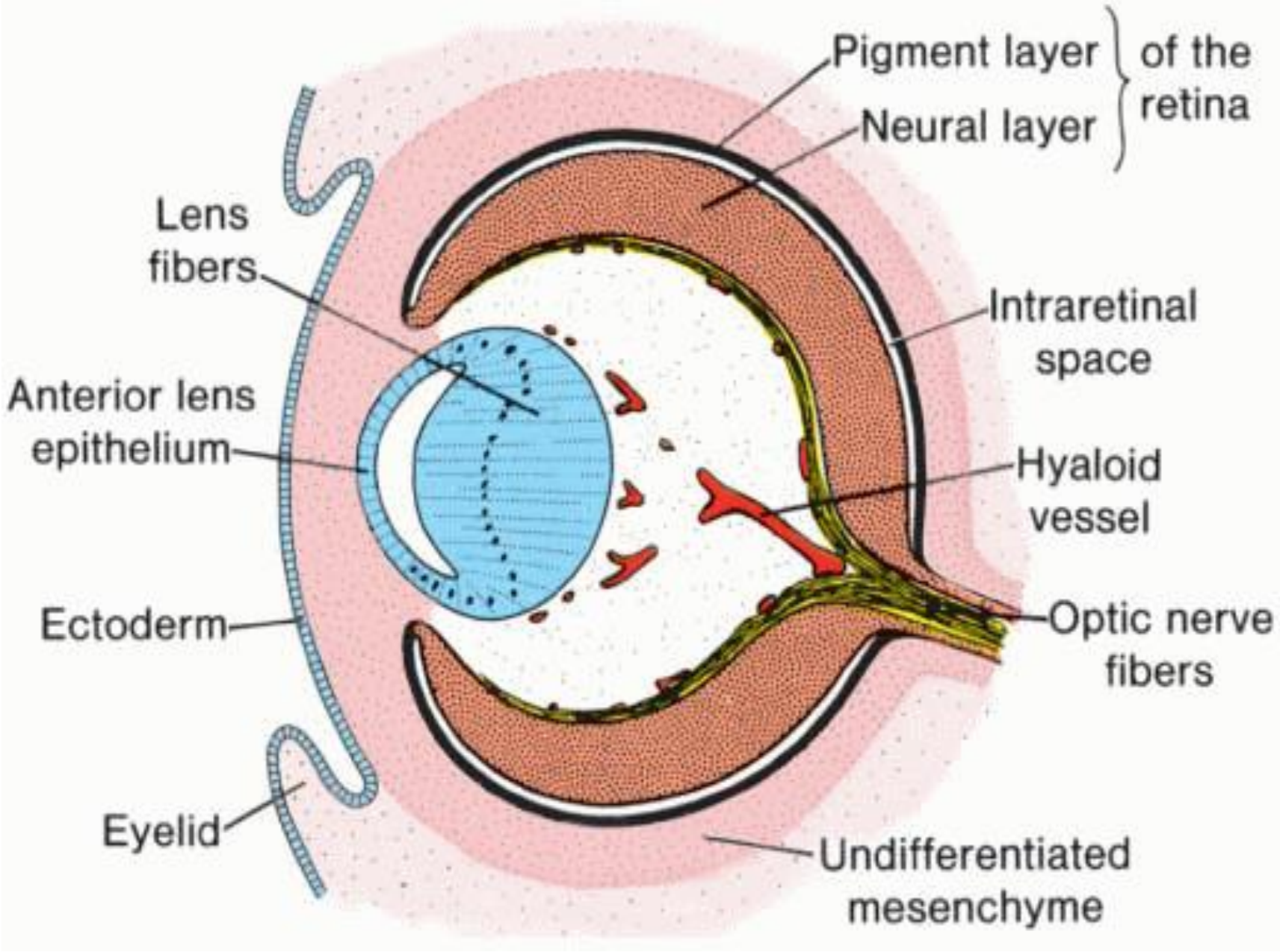
Two layers appose each other.

Invagination forms the choroid fissure.

Formation of this fissure allows the hyaloid artery
During the seventh week, the lips of the choroid fissure fuse, and the mouth of the optic cup becomes a round opening, the future pupil.


Cut line for B - D
Otic vesicle
Optic vesicle
A
Wall of forebrain
Surface ectoderm
B
Optic grooves
Lens placode
Forebrain
C
Optic vesicle
D
Invaginating lens placode
Invaginating optic vesicle


Optic cup
Optic stalk
A
Choroid fissure
Outer layer
Inner layer
of optic stalk
Hyaloid artery
Choroid fissure
B
Intraretinal space
Wall of brain
Lens vesicle
Hyaloid artery
Lumen of optic stalk
C
Surface ectoderm
Lens pit
Lens vesicle
D
Inner layer
Outer layer
of optic cup
Surface ectoderm
Lens vesicle
Outer layer
Inner layer
of optic cup
E


Pigment layer
Neural layer
of the retina
Lens fibers
Intraretinal space
Anterior lens epithelium
Hyaloid vessel
Ectoderm
Optic nerve fibers
Eyelid
Undifferentiated mesenchyme

- Cells of the surface ectoderm, initially in contact with the optic vesicle, begin to elongate and form the lens placode .
- This placode subsequently invaginate and develops into the lens vesicle.
- During the fifth week, the lens vesicle loses contact with the surface ectoderm
- And lies in the mouth of the optic cup.

- **RETINA, IRIS, AND CILIARY BODY**
- The outer layer of the optic cup, which is characterized by small pigment granules, is known as the **pigmented layer of the retina**. Development of the inner (neural) layer of the optic cup is more complicated.
- The posterior 80%, differentiate into light-receptive elements, **rods and cones .**

Adjacent to this photoreceptive layer is the mantle layer, which, as in the brain, gives rise to neurons and supporting cells, including the outer nuclear layer, inner nuclear layer, and ganglion cell layer .

Axons converge toward the optic stalk, which develops into the optic nerve .

Hence, light impulses pass through most layers of the retina before they reach the rods and cones.

- Meanwhile, the region between the optic cup and the overlying surface epithelium is filled with loose mesenchyme . The sphincter and dilator pupillae muscles form in this tissue.
- These muscles develop from the underlying ectoderm of the optic cup.
- In the adult, the iris is formed by the

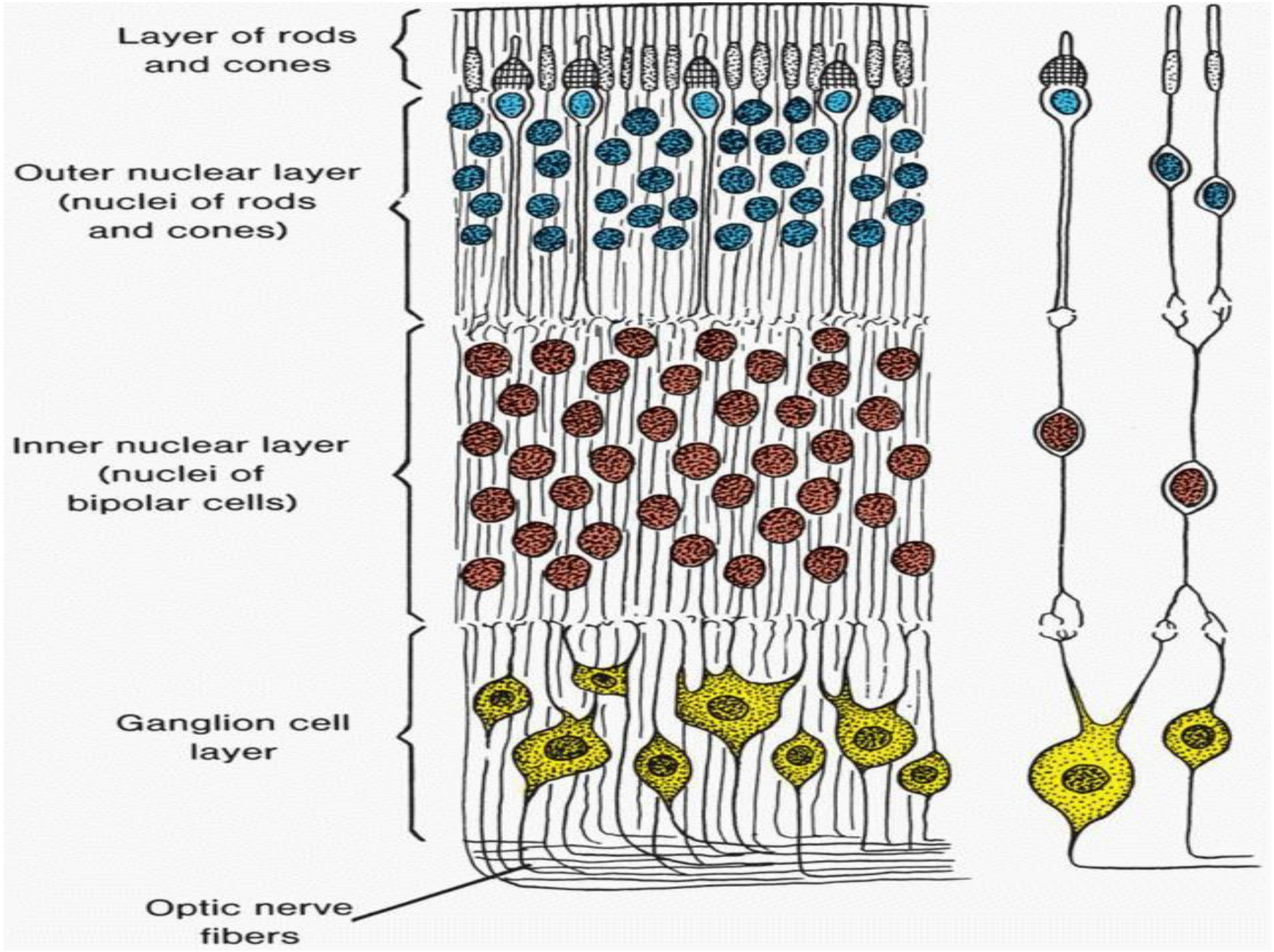
1. Pigment-containing external layer,
2. Unpigmented internal layer of the optic cup,
3. and a layer of richly vascularized connective tissue that contains the pupillary muscles.

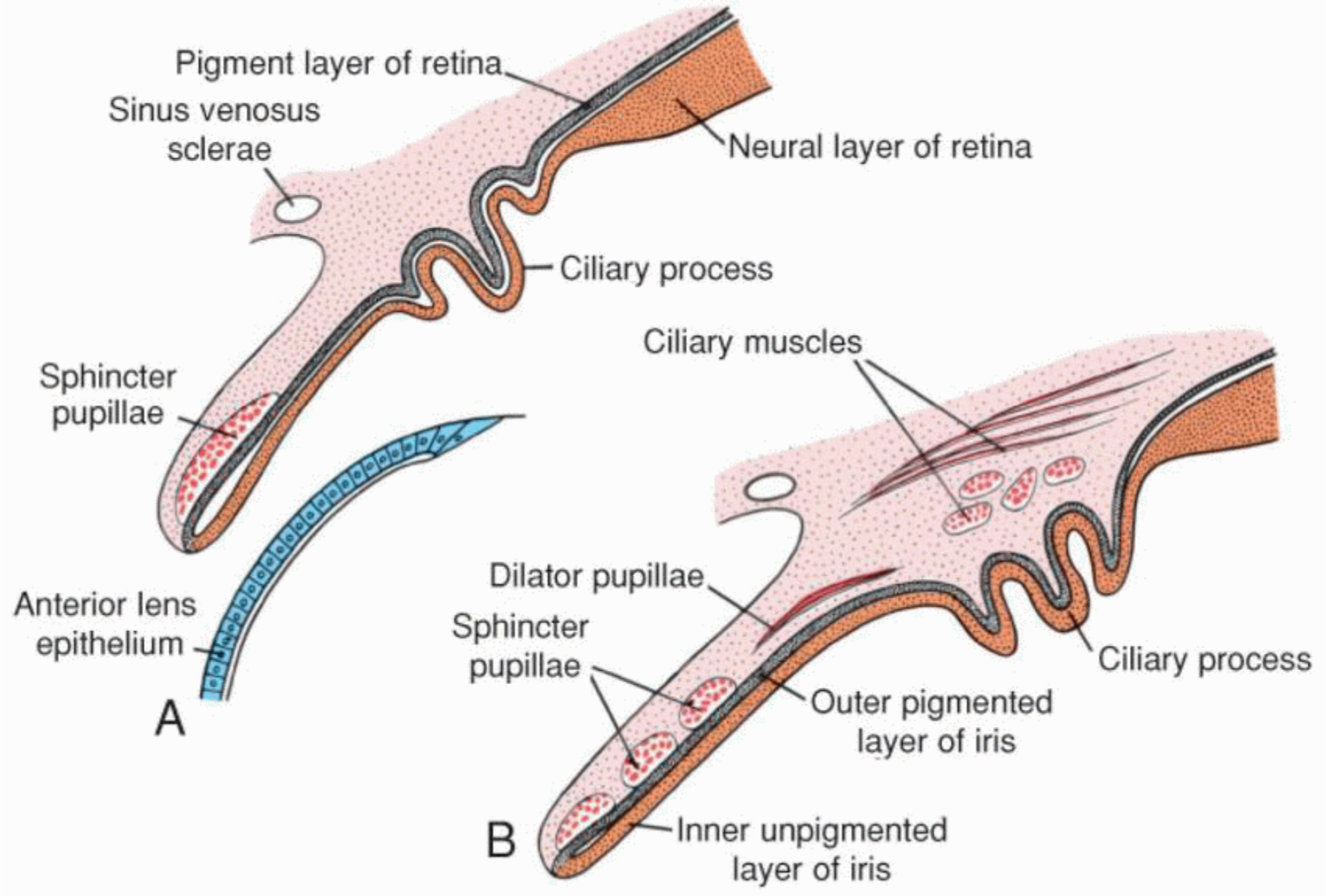
The pars ciliaris retinae is easily recognized by its marked folding .

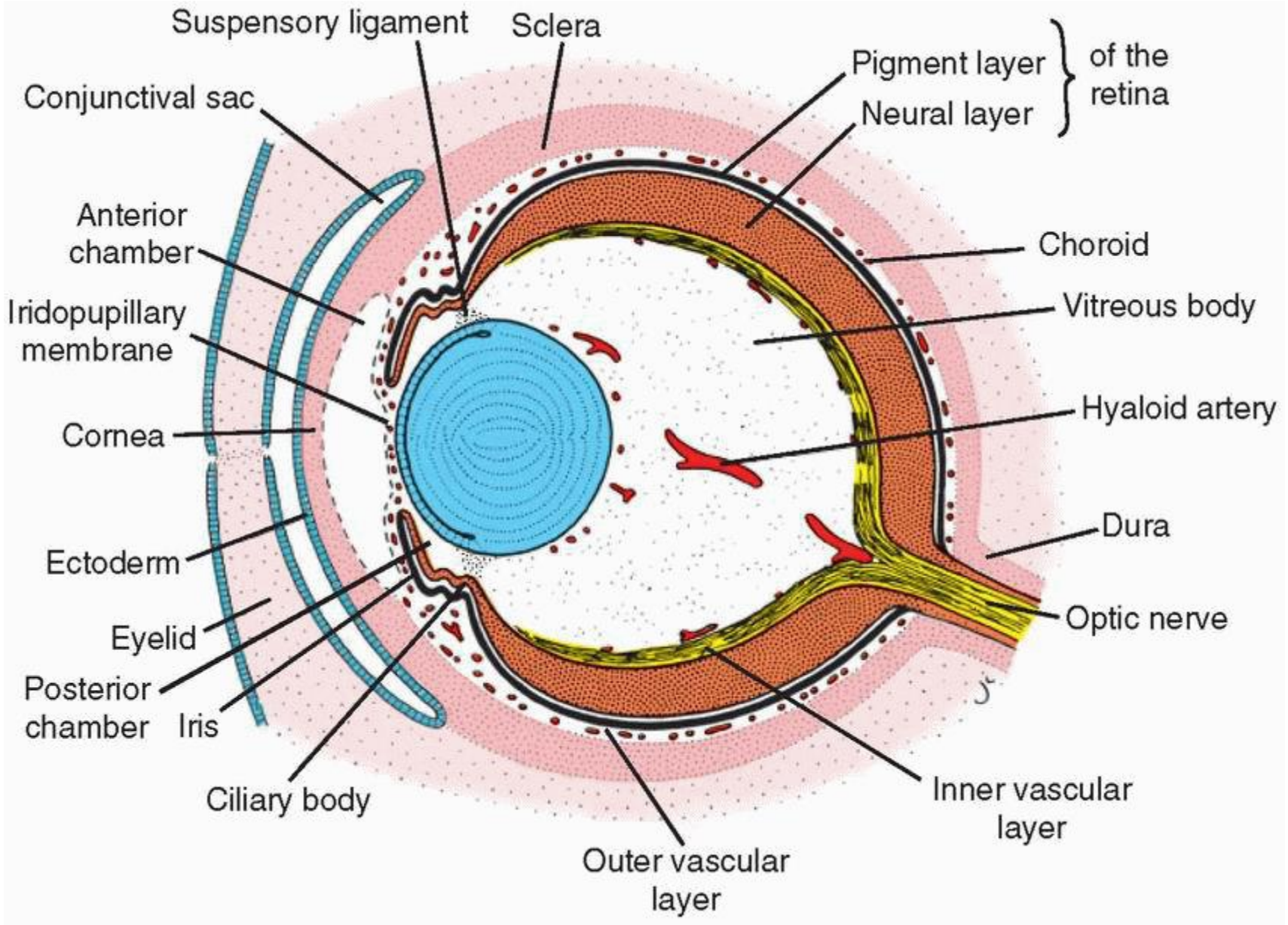
Externally, it is covered by a layer of mesenchyme that forms the ciliary muscle;

On the inside, it is connected to the lens by a network of elastic fibers, the suspensory ligament or zonula .

- The anterior fifth of the inner layer, the pars ceca retinae, remains one cell layer thick. It later divides into the pars iridica retinae, which forms the inner layer of the iris, and the pars ciliaris retinae, which participates in formation of the ciliary body.


Layer of rods and cones
Outer nuclear layer (nuclei of rods and cones)
Inner nuclear layer (nuclei of bipolar cells)
Ganglion cell layer
Optic nerve fibers


Pigment layer of retina
Sinus venosus sclerae
Neural layer of retina
Ciliary process
Sphincter pupillae
Anterior lens epithelium
A
Ciliary muscles
Dilator pupillae
Sphincter pupillae
Ciliary process
Outer pigmented layer of iris
B
Inner unpigmented layer of iris


Suspensory ligament
Sclera
Pigment layer
of the retina
Neural layer
Conjunctival sac
Anterior chamber
Choroid
Iridopupillary membrane
Vitreous body
Hyaloid artery
Cornea
Dura
Ectoderm
Optic nerve
Eyelid
Posterior chamber
Iris
Ciliary body
Inner vascular layer
Outer vascular layer

LENS

- Shortly after formation of the lens vesicle, cells of the posterior wall begin to elongate anteriorly and form long fibers that gradually fill the lumen of the vesicle . By the end of the seventh week, these primary lens fibers reach the anterior wall of the lens vesicle. Growth of the lens is not finished at this stage, however, since new (secondary) lens fibers are continuously added to the central core.

- **CHOROID, SCLERA, AND CORNEA**
- At the end of the fifth week, the eye primordium is completely surrounded by **loose mesenchyme** . This tissue soon differentiates into an inner layer comparable with the pia mater of the brain and an outer layer comparable with the dura mater. The inner layer later forms a highly vascularized pigmented layer known as the choroid; the outer layer develops into the sclera and is continuous with the dura mater around the optic nerve .

- Differentiation of mesenchymal layers overlying the anterior aspect of the eye is different. The anterior chamber forms through vacuolization and splits the mesenchyme into an inner layer in front of the lens and iris, the iridopupillary membrane, and an outer layer continuous with the sclera, the substantia propria of the cornea .

The anterior chamber itself is lined by flattened mesenchymal cells. Hence, the cornea is formed by (a) an epithelial layer derived from the surface ectoderm,

(b) the substantia propria or stroma, which is continuous with the sclera, and

(c) an epithelial layer, which borders the anterior chamber.

The iridopupillary membrane in front of the lens disappears completely. The posterior chamber is the space between the iris anteriorly and the lens and ciliary body posteriorly.

- The anterior and posterior chambers communicate with each other through the pupil and are filled with fluid called the aqueous humor produced by the ciliary process of the ciliary body. The clear aqueous humor circulates from the posterior chamber into the anterior chamber providing nutrients for the avascular cornea and lens.

- From the anterior chamber, the fluid passes through the scleral venous sinus (canal of Schlemm) at the iridocorneal angle where it is resorbed into the blood-stream. Blockage of the flow of fluid at the canal of Schlemm is one cause of glaucoma.

VITREOUS BODY

Mesenchyme not only surrounds the eye primordium from the outside but also invades the inside of the optic cup by way of the choroid fissure.

Here it forms the hyaloid vessels, which during intrauterine life supply the lens and form the vascular layer on the inner surface of the retina .

- In addition, it forms a delicate network of fibers between the lens and retina. The interstitial spaces of this network later fill with a transparent gelatinous substance, forming the vitreous body . The hyaloid vessels in this region are obliterated and disappear during fetal life, leaving behind the hyaloid canal.

OPTIC NERVE

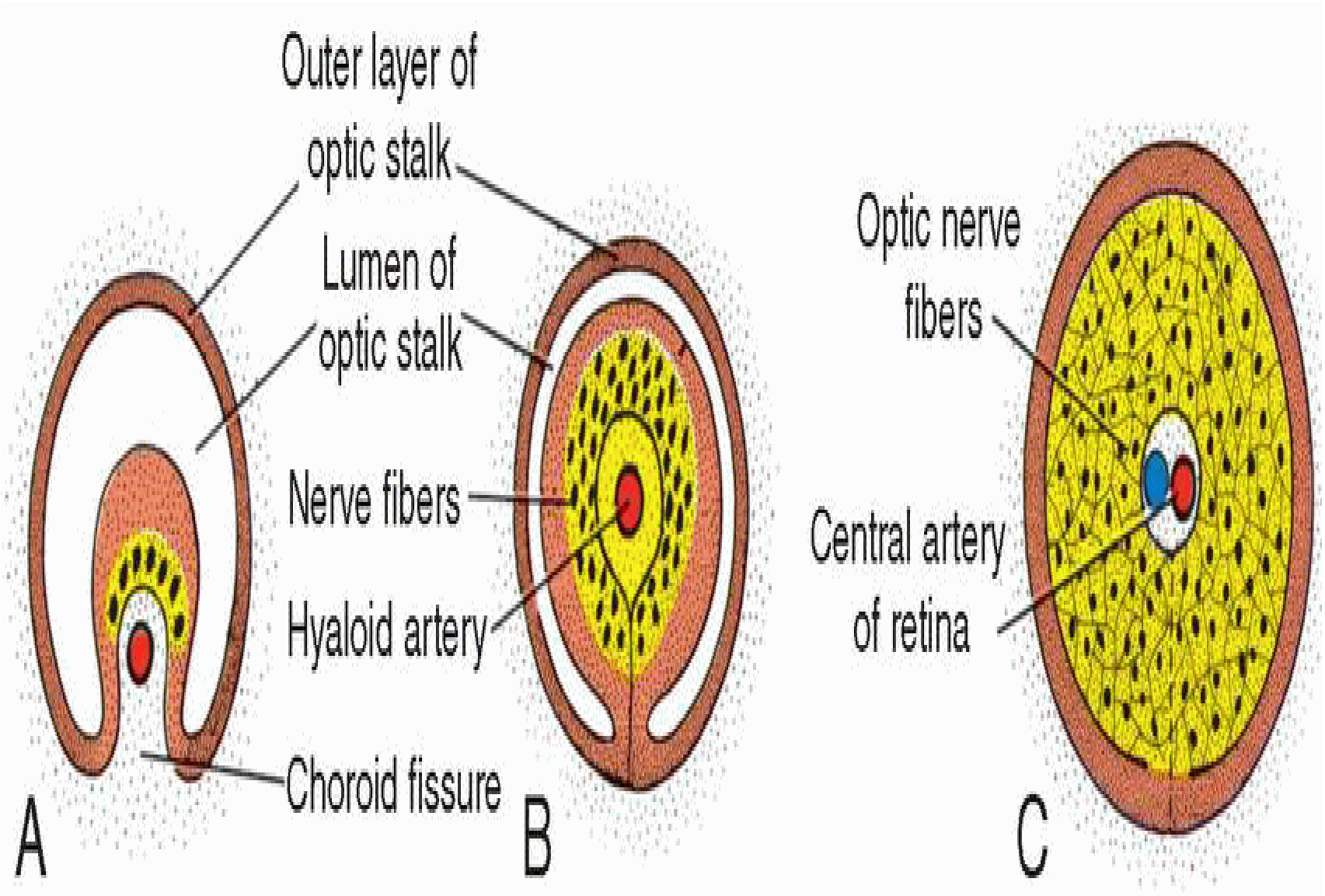
The optic cup is connected to the brain by the optic stalk, which has a groove, the choroid fissure, on its ventral surface .

In this groove are the hyaloid vessels. The nerve fibers of the retina returning to the brain lie among cells of the inner wall of the stalk .

During the seventh week, the choroid fissure closes, and a narrow tunnel forms inside the optic stalk .

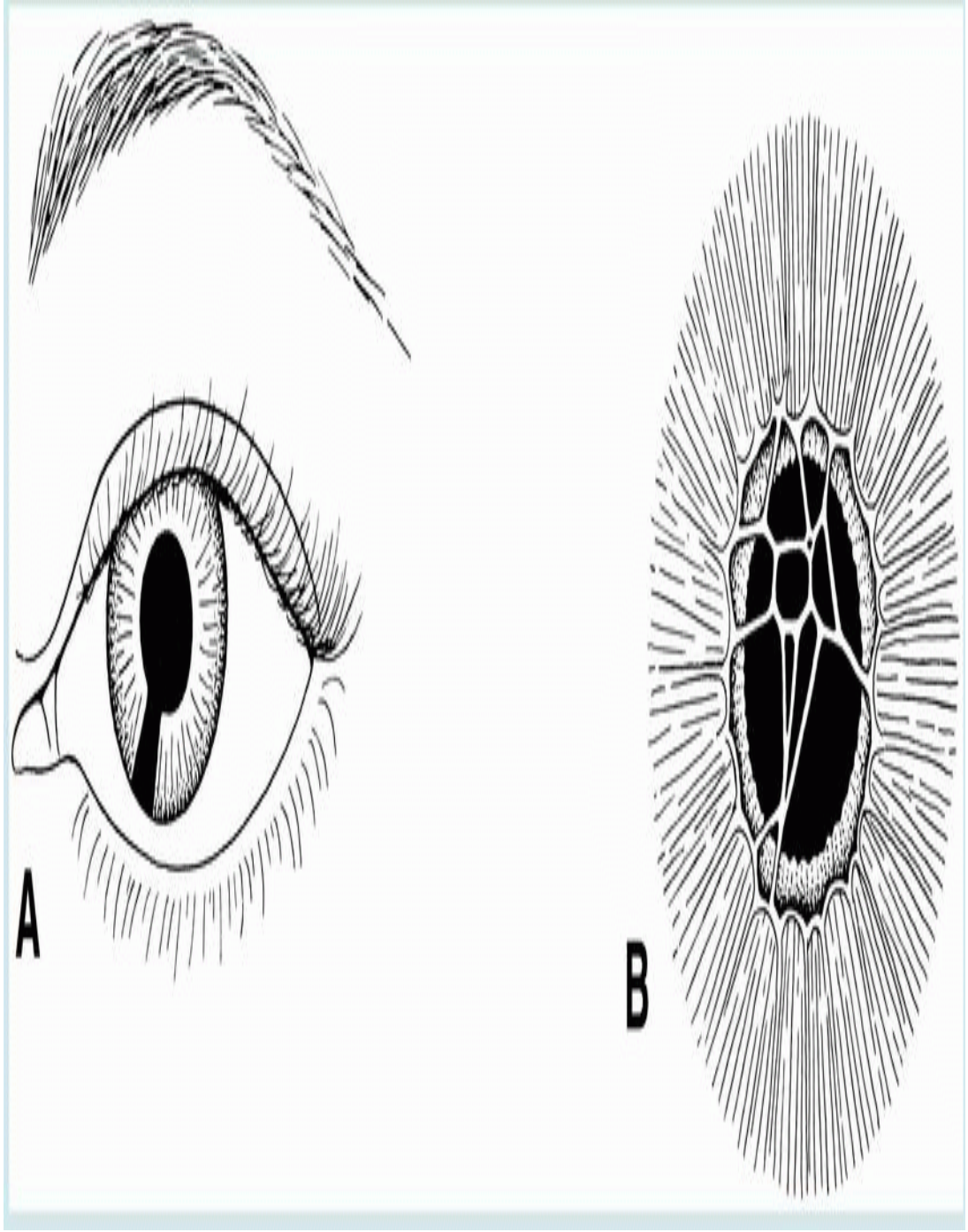
As a result of the continuously increasing number of nerve fibers, the inner wall of the stalk grows, and the inside and outside walls of the stalk fuse . Cells of the inner layer provide a network of neuroglia that support the optic nerve fibers.

The optic stalk is thus transformed into the optic nerve. Its center contains a portion of the hyaloid artery, later called the central artery of the retina. On the outside, a continuation of the choroid and sclera, the pia arachnoid and dura layer of the nerve, respectively, surround the optic nerve.

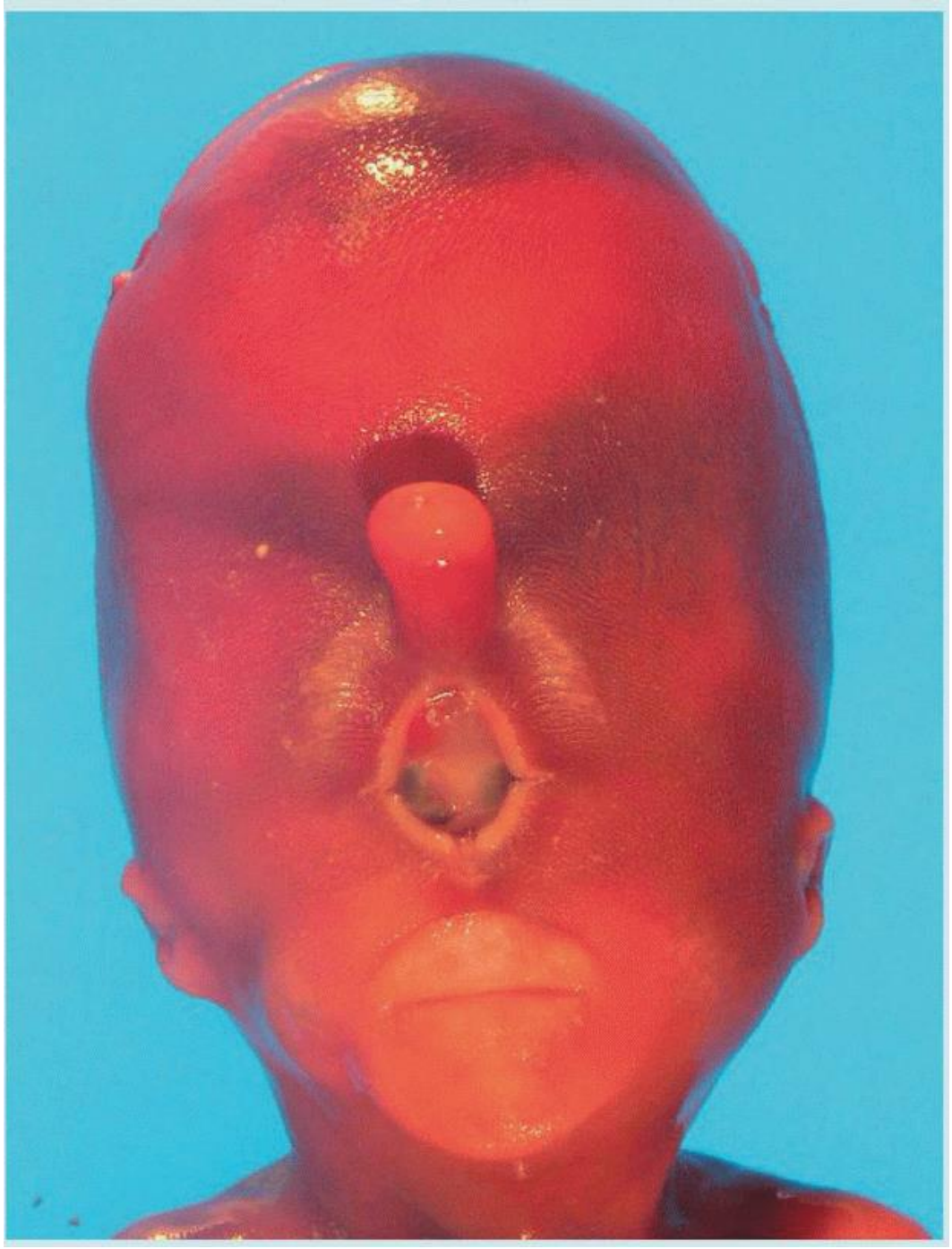

Outer layer of optic stalk
Lumen of optic stalk
Nerve fibers
Hyaloid artery
Choroid fissure
A
B
Optic nerve fibers
Central artery of retina
C

A. Coloboma iris.

B. Persistence of the iridopupillary membrane.



- Patient with aririidia (absence of the iris) which can be due to mutations in PAX6



THANKS