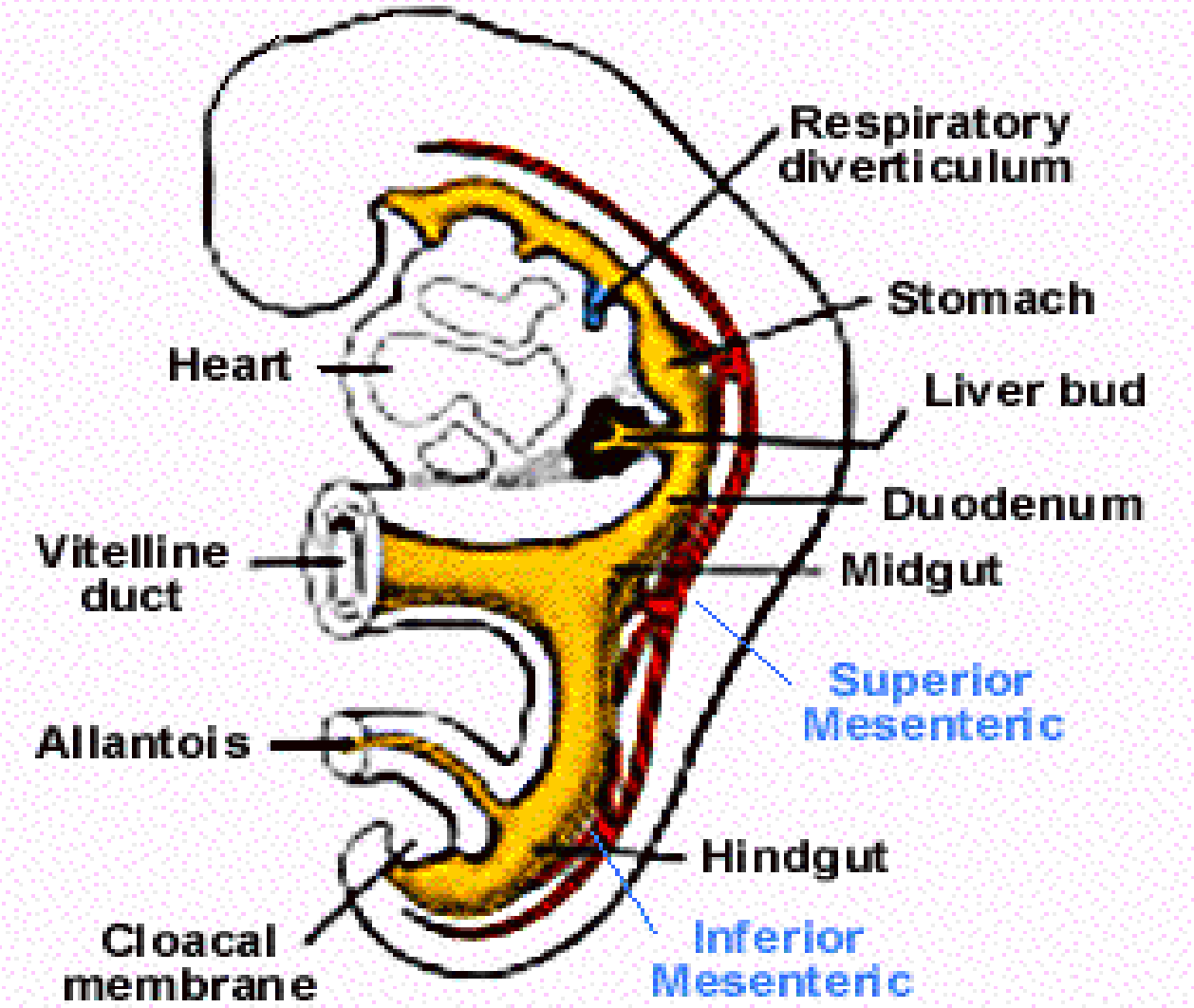
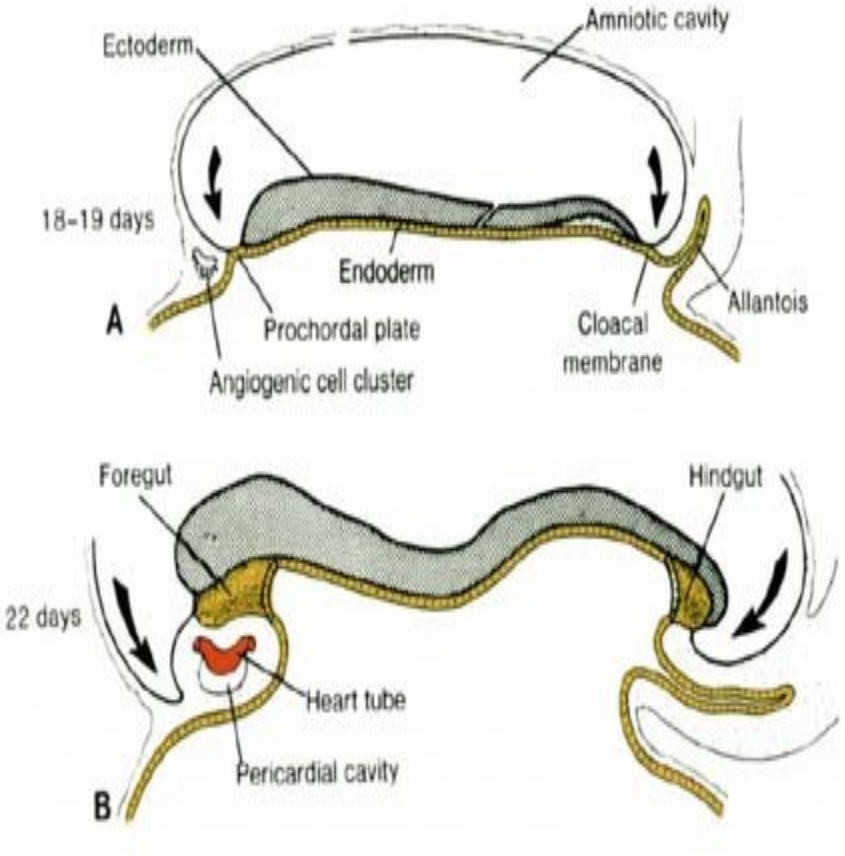
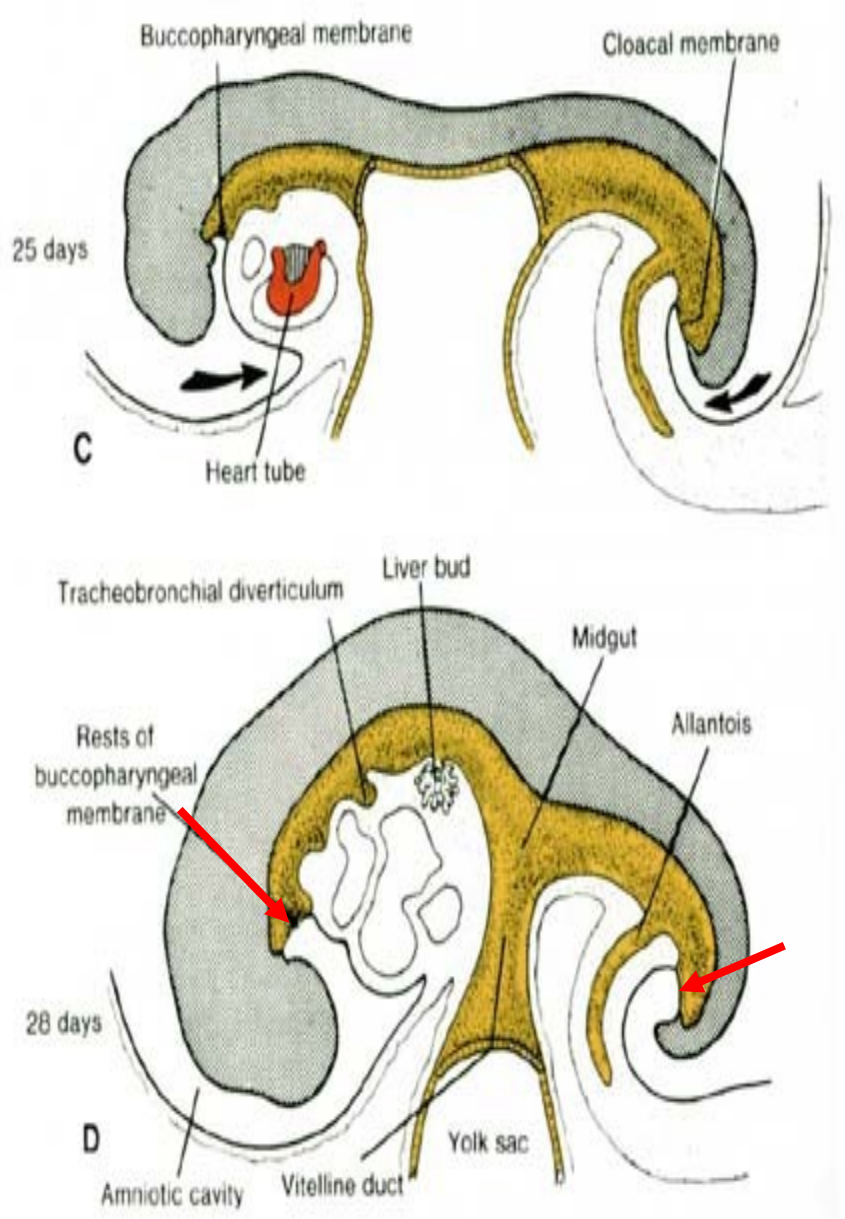
Embryology:
Development of digestive system





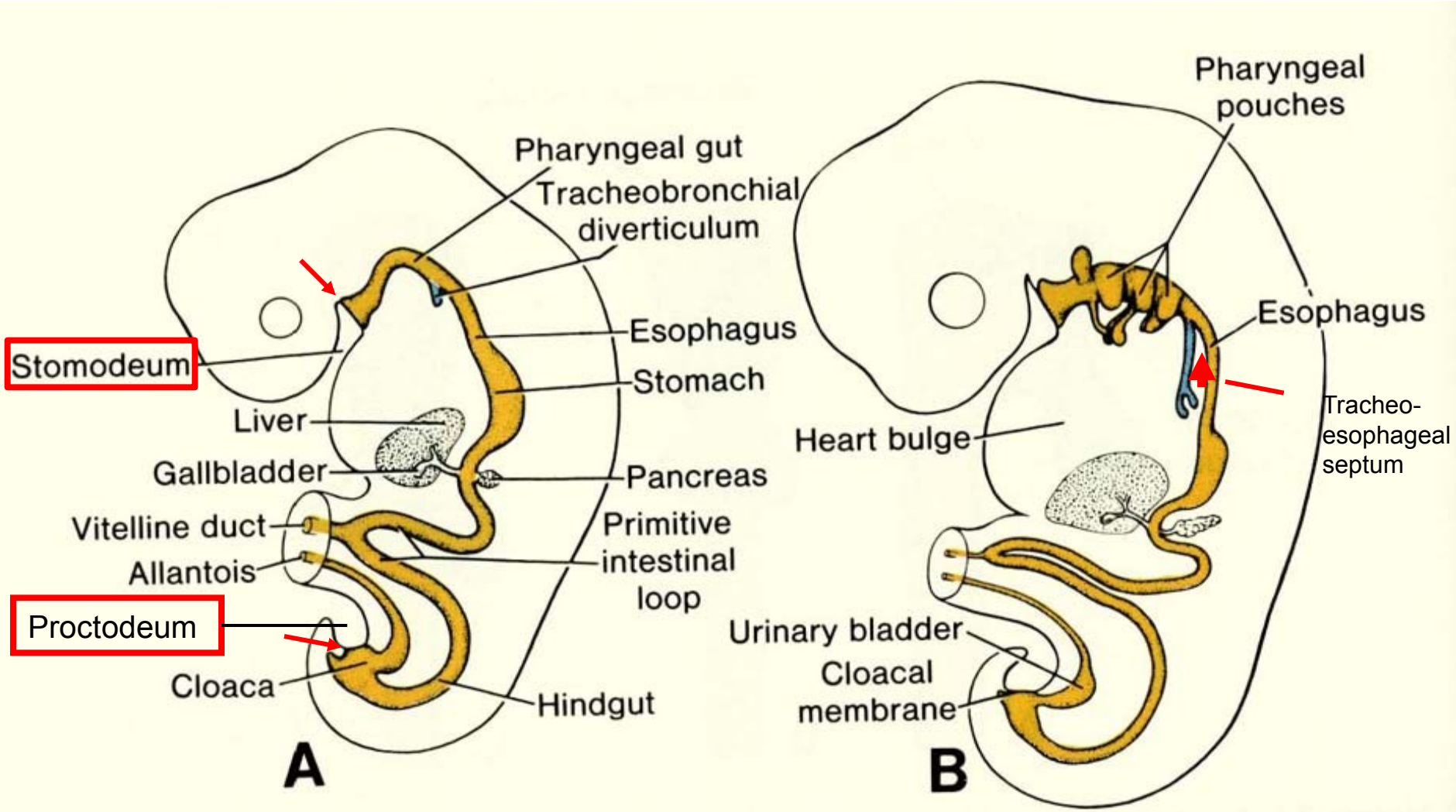


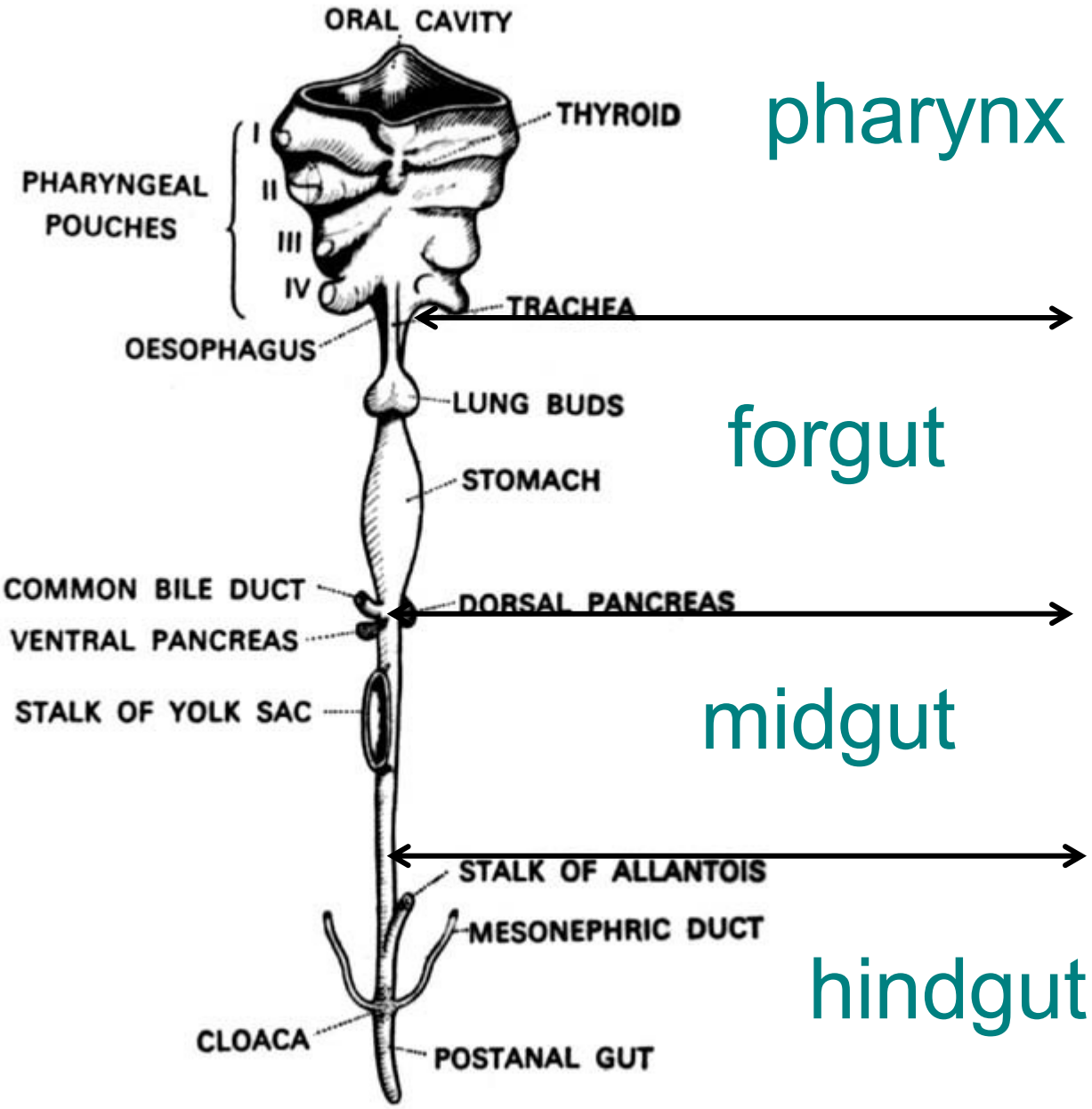
- Embryo folding – incorporation of endoderm to form primitive gut.
- Outside of embryo – yolk sac and allantois.
- Vitelline duct – connects sac + gut

Stomodeum (primitive mouth) ⇨ the oral cavity + the salivary glands

Proctodeum ⇨ primitive anal pit

Primitive gut ⇨ whole digestive tube + accessory glands



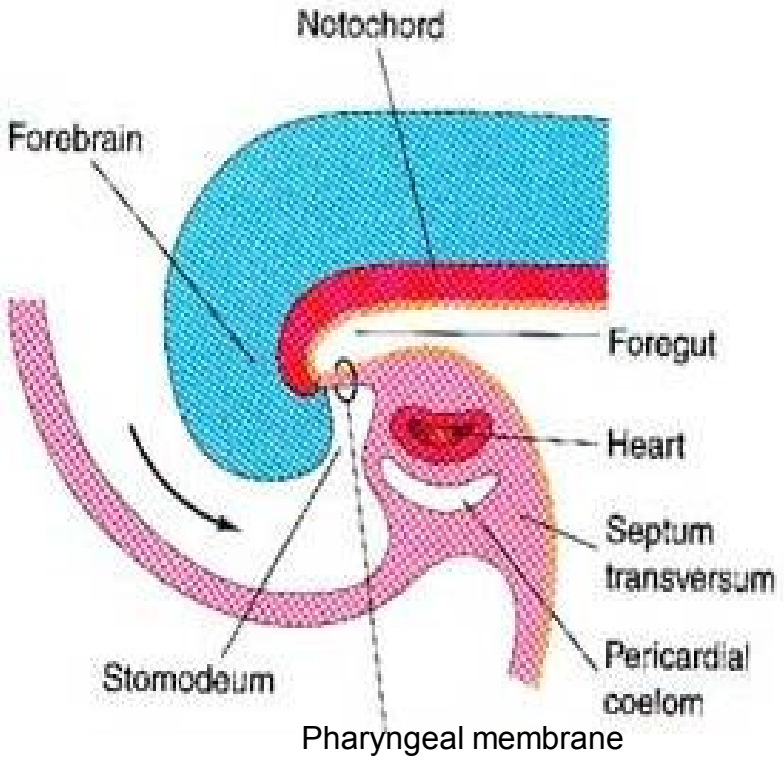

ORAL CAVITY
THYROID
PHARYNGEAL POUCHES
I
II
III
IV
TRACHEA
OESOPHAGUS
LUNG BUDS
STOMACH
COMMON BILE DUCT
DORSAL PANCREAS
VENTRAL PANCREAS
STALK OF YOLK SAC
STALK OF ALLANTOIS
MESONEPHRIC DUCT
CLOACA
POSTANAL GUT
pharynx
forgut
midgut
hindgut

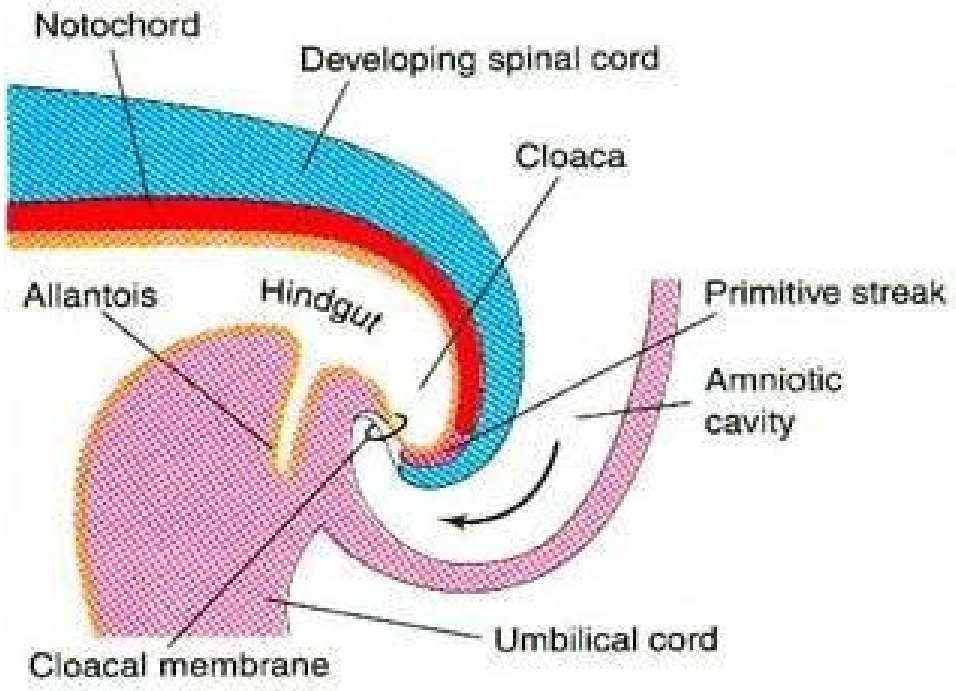
Tissues in GIT

- The epithelium of gut and glandular cells of associated glands of the gastrointestinal tract develop from endoderm
- The connective tissue, muscle tissue and mesothelium derive from splanchnic mesoderm
- The enteric nervous system develops from neural crest

primitive gut

foregut from pharyngeal membrane ⟷ **midgut** above ductus omphalomesentericus and yolk sack ⟷ **hindgut** to cloacal membrane



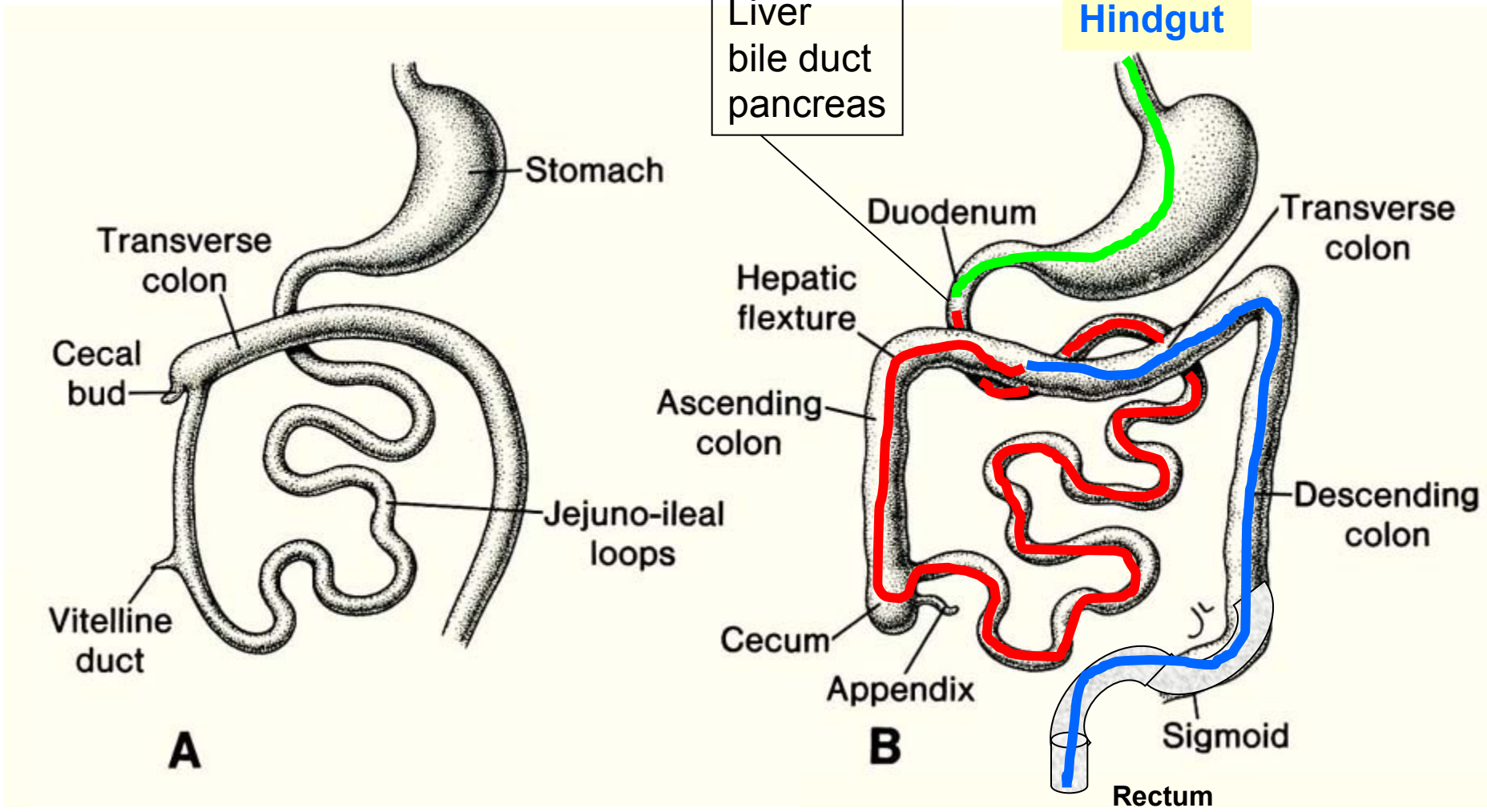


Derivatives of

foregut – pharynx, (+ respiratory diverticle), esophagus
stomach, cranial arm of duodenum
(+ liver, gall bladder pancreas),

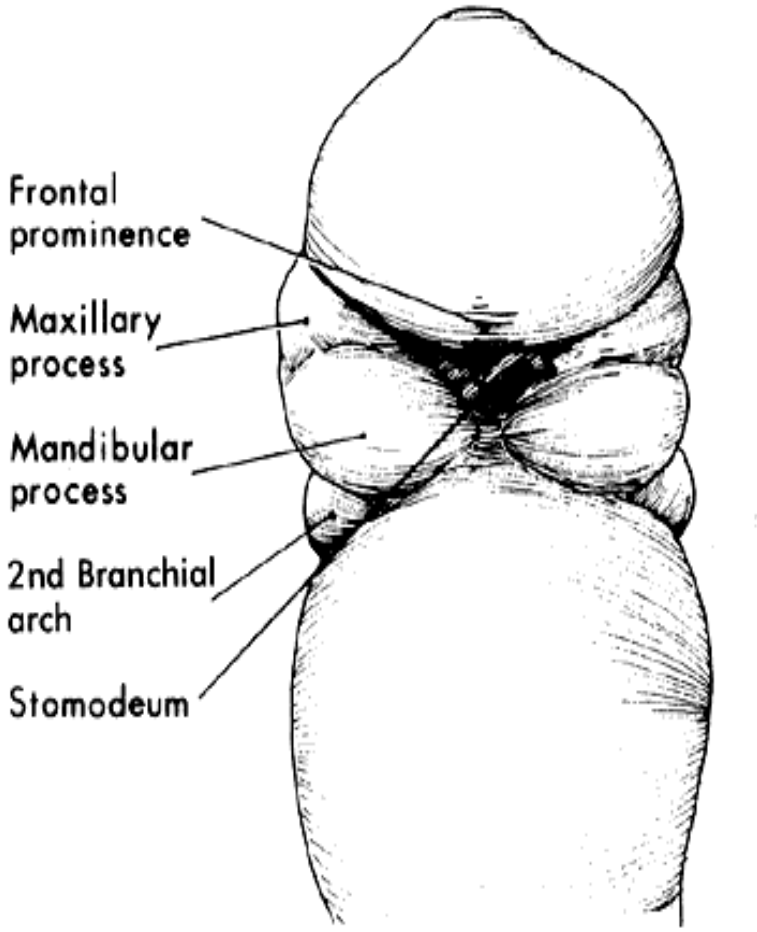
midgut – caudal arm of duodenum, small intestine and part of large intestine (cca 1/3 of colon transv.)

hindgut – the rest of large intestine, rectum, upper part of the anal canal


Foregut
Midgut
Hindgut
Liver
bile duct
pancreas
Stomach
Transverse
colon
Cecal
bud
Jejuno-ileal
loops
Vitelline
duct
A
Duodenum
Transverse
colon
Hepatic
flexture
Ascending
colon
Descending
colon
Cecum
Appendix
Sigmoid
Rectum
B

Oral cavity

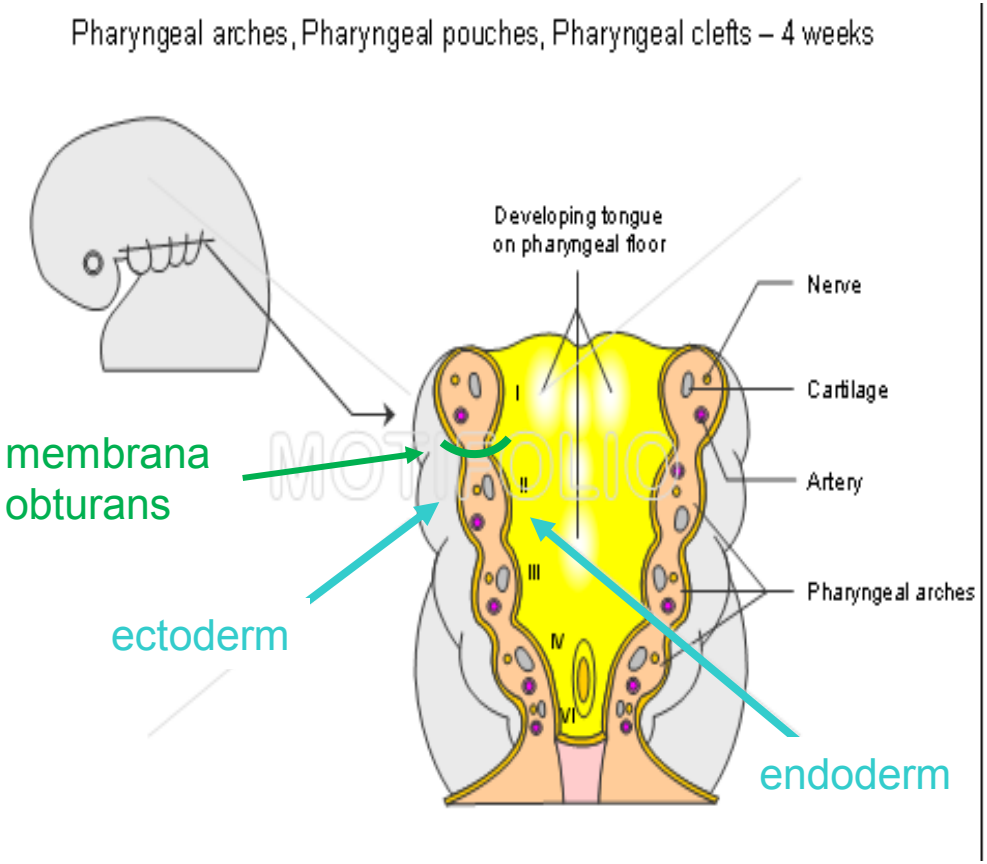
- primitive mouth pit – **stomodeum**
- lined with ectoderm
- surrounded by:
  - processus frontalis (single)
  - proc. maxillares (paired)
  - proc. mandibulares (paired)
- pharyngeal membrane (it ruptures during the 4th week, primitive gut communicates with amniotic cavity)



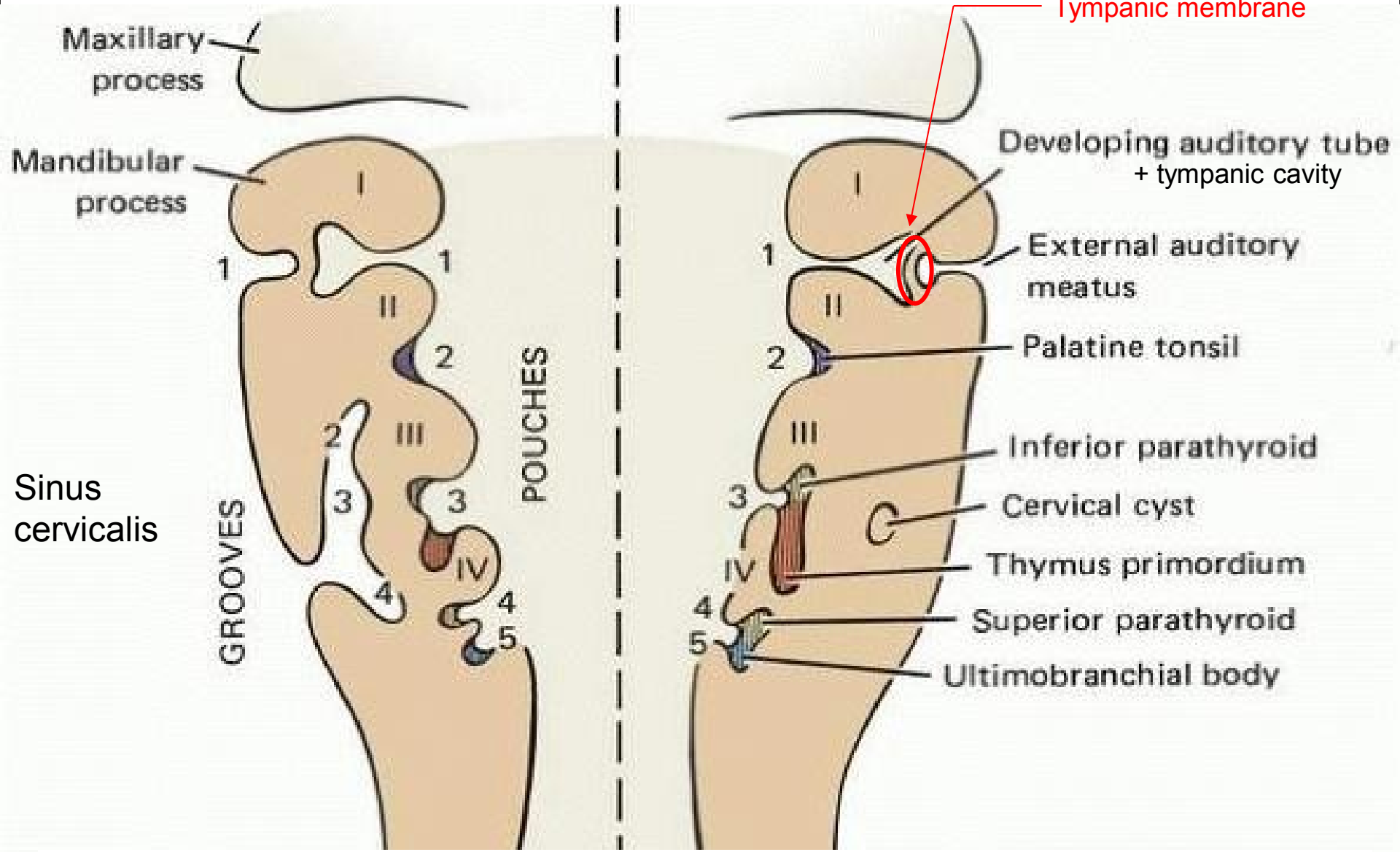
Pharyngeal (branchial) apparatus

Pharyngeal arches

- appear in weeks 4 - 5
- on the ventral side of the pharyngeal gut;
- each arch contains cartilage, nerve, aortic arch artery and muscle;
- pharyngeal clefts and pouches are located between the arches;
- membrana obturans



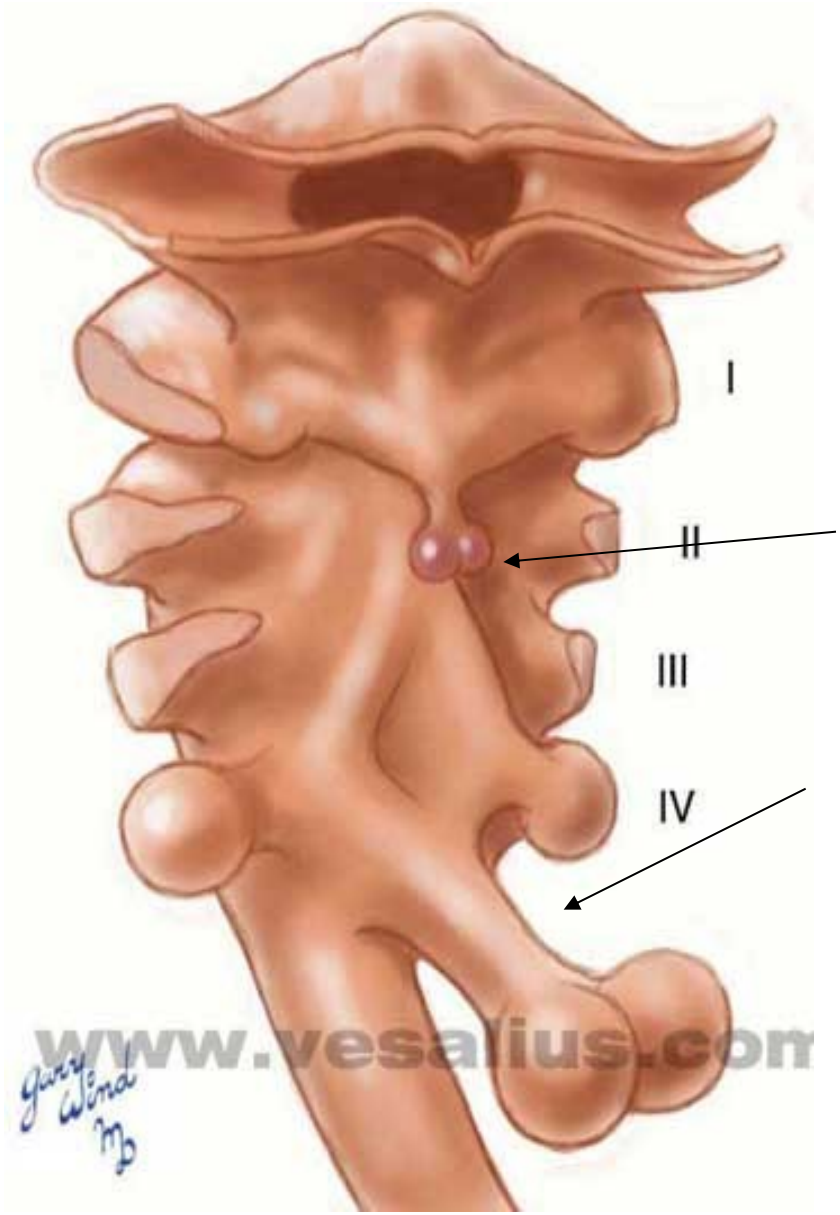
Fate of pharyngeal pouches and clefts



Sinus cervicalis

Esophagus development

below respiratory diverticle,
behind larynx and trachea

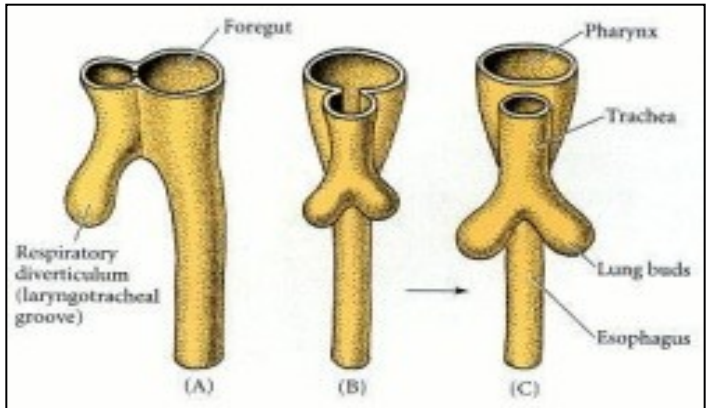


primitive pharynx

thyroid gl.

laryngotracheal diverticle
(respiratory diverticle)

esophagus

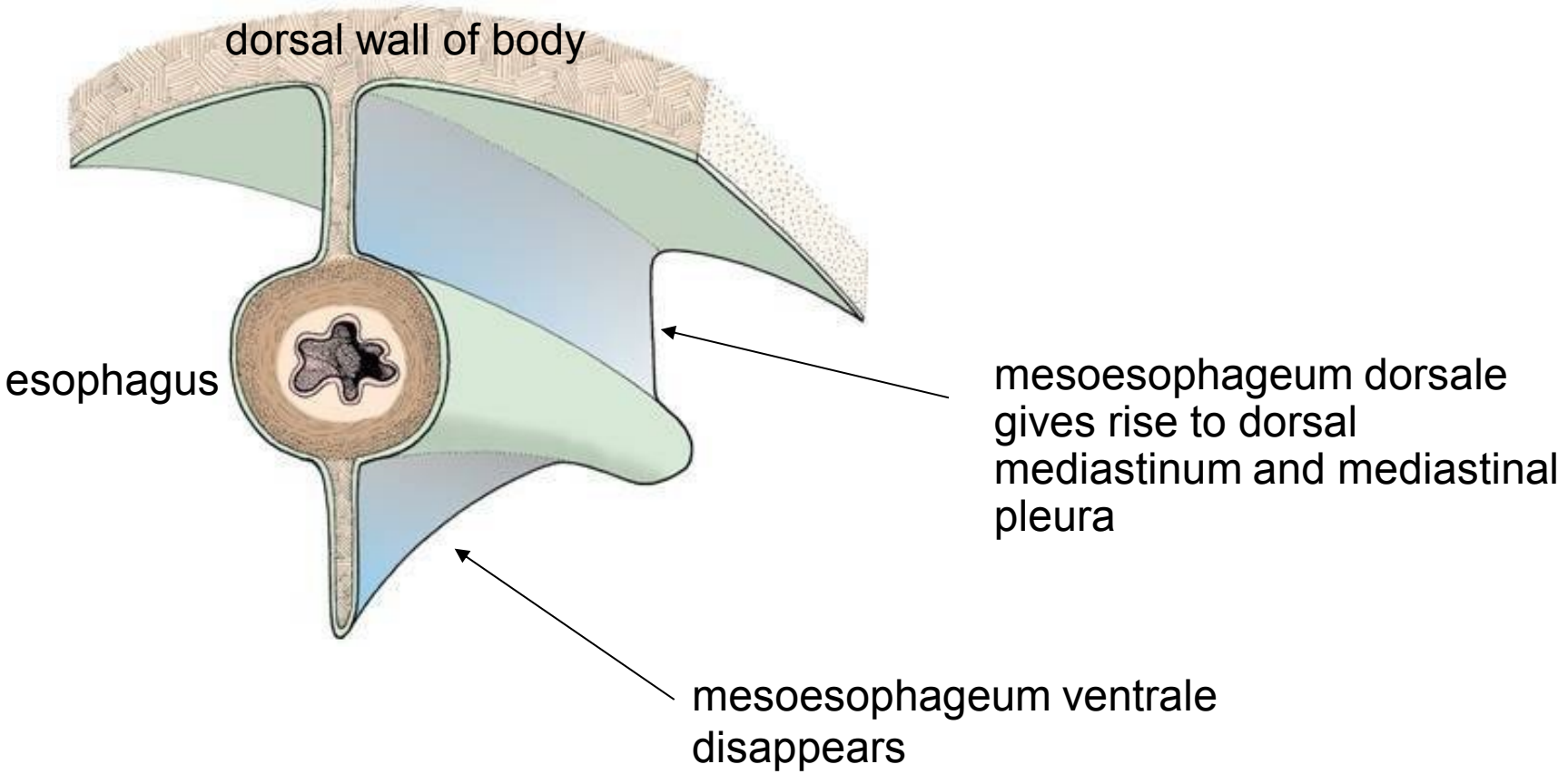


Esophagus development

- differentiation of epithelium from endoderm
- during the 8th week endoderm proliferates and temporarily closes esophageal lumen
- other tissues and structures in the wall arise from splanchnic mesoderm

Mesenteries – suspensory duplicature derived from mesoderm and mesenchyme (a fold of tissue that attaches organs to the body wall)

mesooesophageum



Teratology

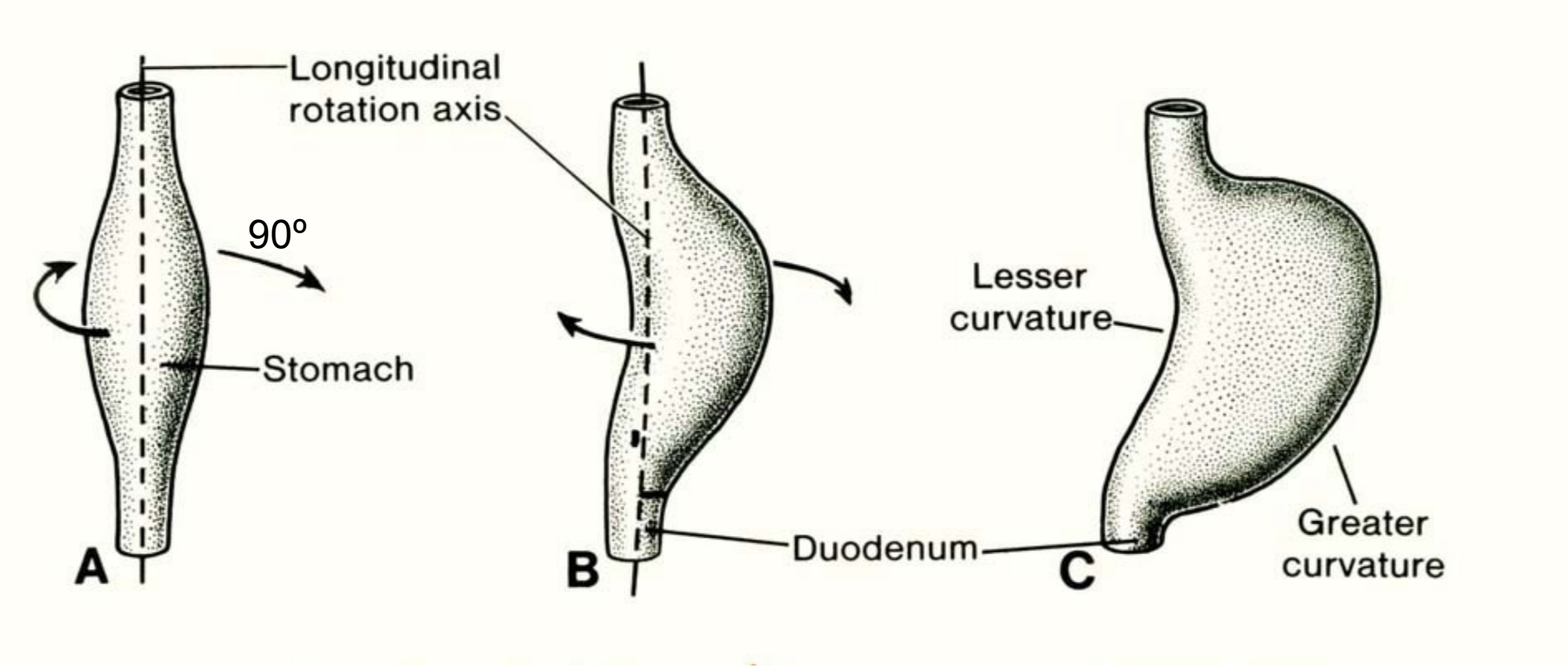
Esophageal atresia – failure of recanalization or septum deviation

Susp.: polyhydramnios, fetus cannot swallow

Esophageal stenosis – narrow lumen, incomplete recanalization

Tracheoesophageal fistula – defect in septum

Stomach development

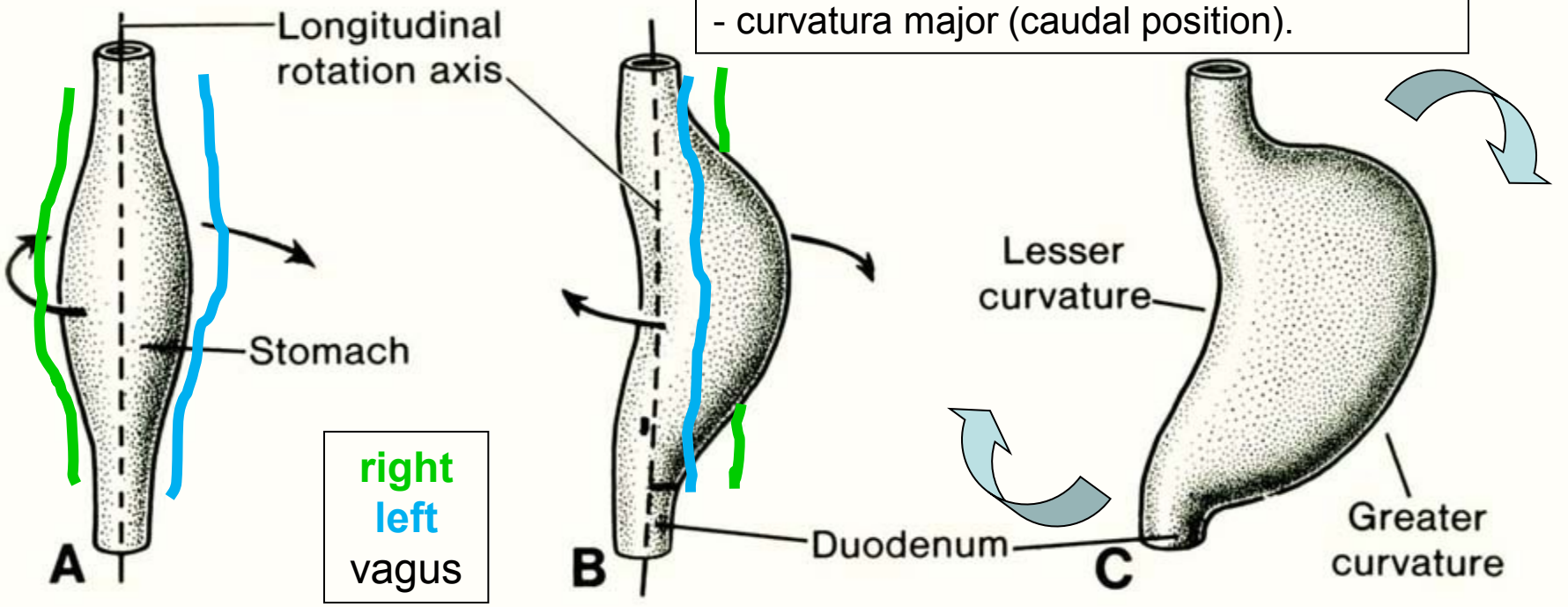


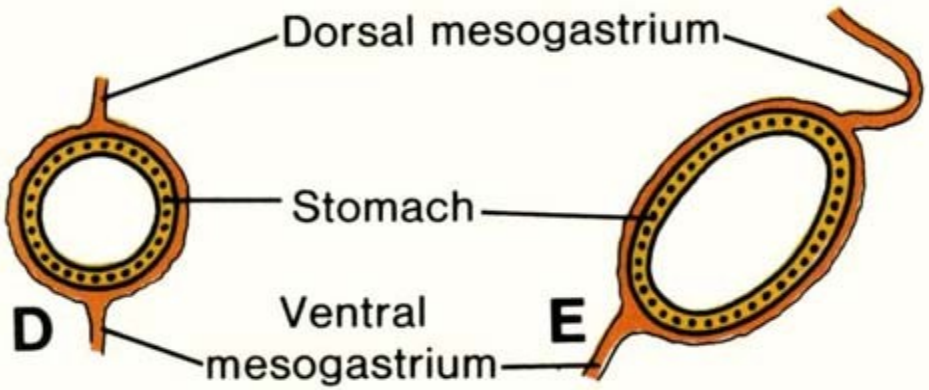
- in the 4th week – spindle dilatation of distal forgut in median plane
- endoderm – epithelium and glandular cells
- splanchnic mesoderm – other tissues of stomach wall

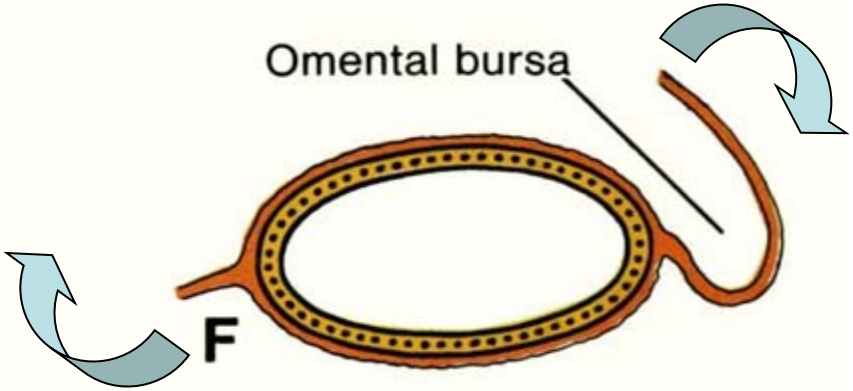
Rotation around longitudinal axis:
- left side → ventrally,
- right side → dorsally.

Uneven growth of ventral and dorsal wall:
- curvatura minor (to the right),
- curvatura major (to the left).

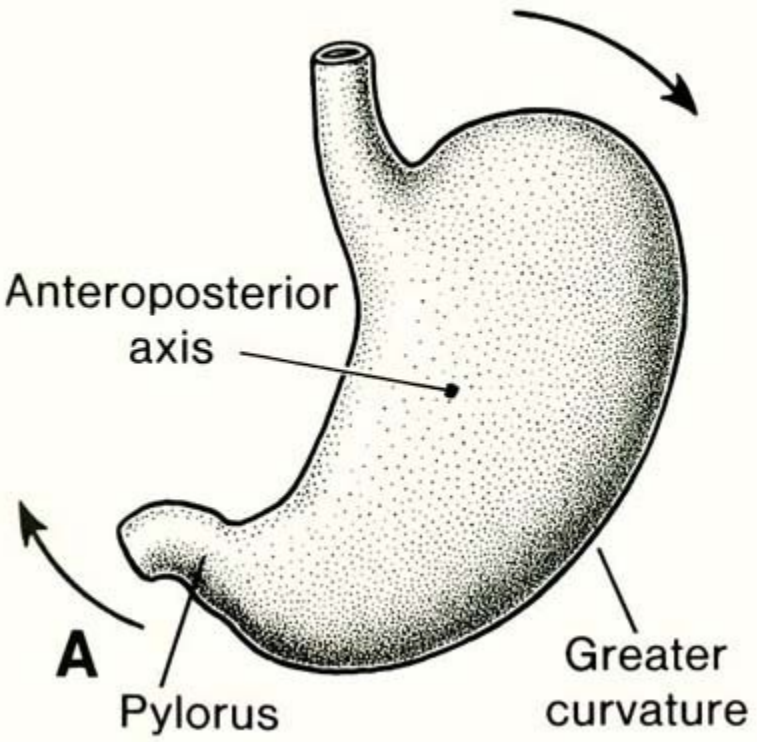
Rotation around sagital axis :
- curvatura minor (cranial position),
- curvatura major (caudal position).

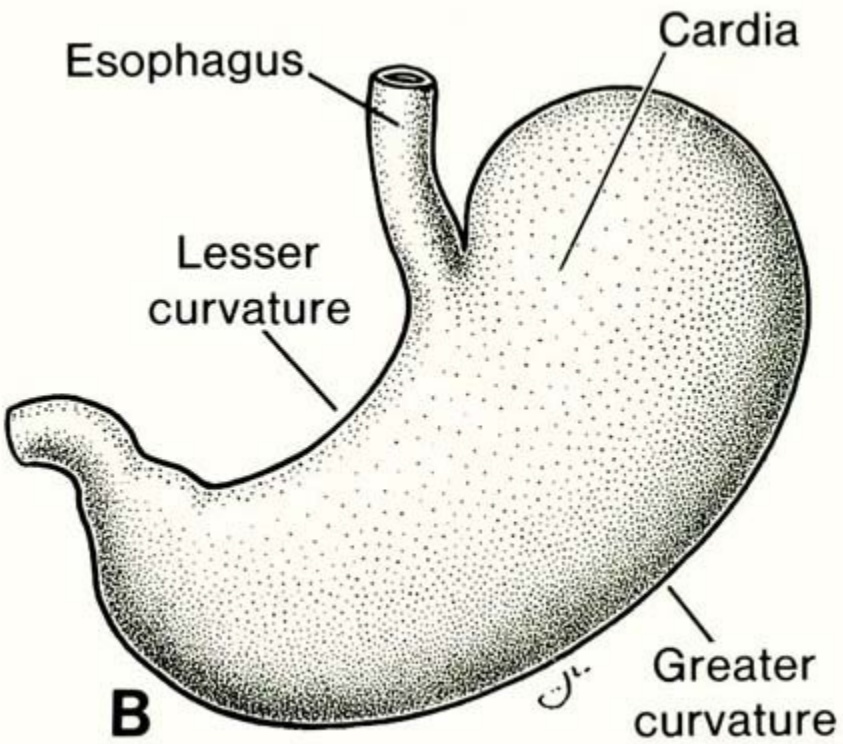






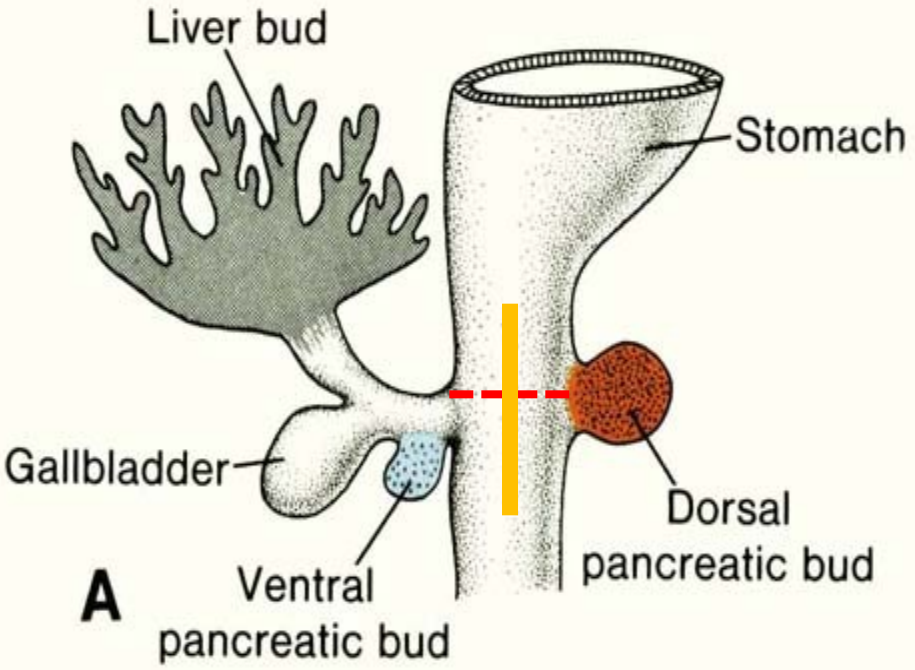
Sagital rotation axis

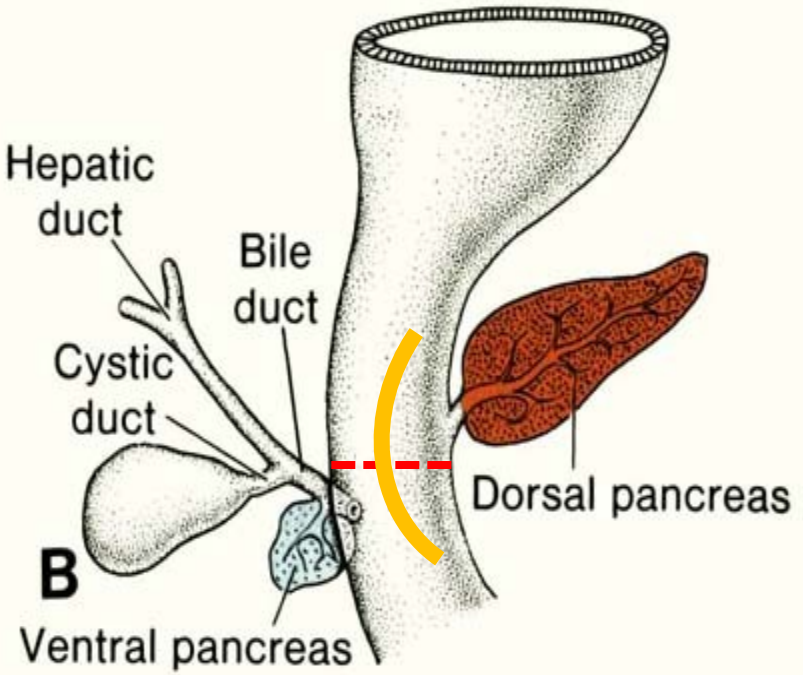




foregut | midgut

duodenum





DUODENAL LOOP

Teratology

Pyloric stenosis – muscular hypertrophy, unknown etiology

Duodenal stenosis – incomplete recanalization

Duodenal atresia – polyhydramnios

vomiting

Midgut

The derivatives

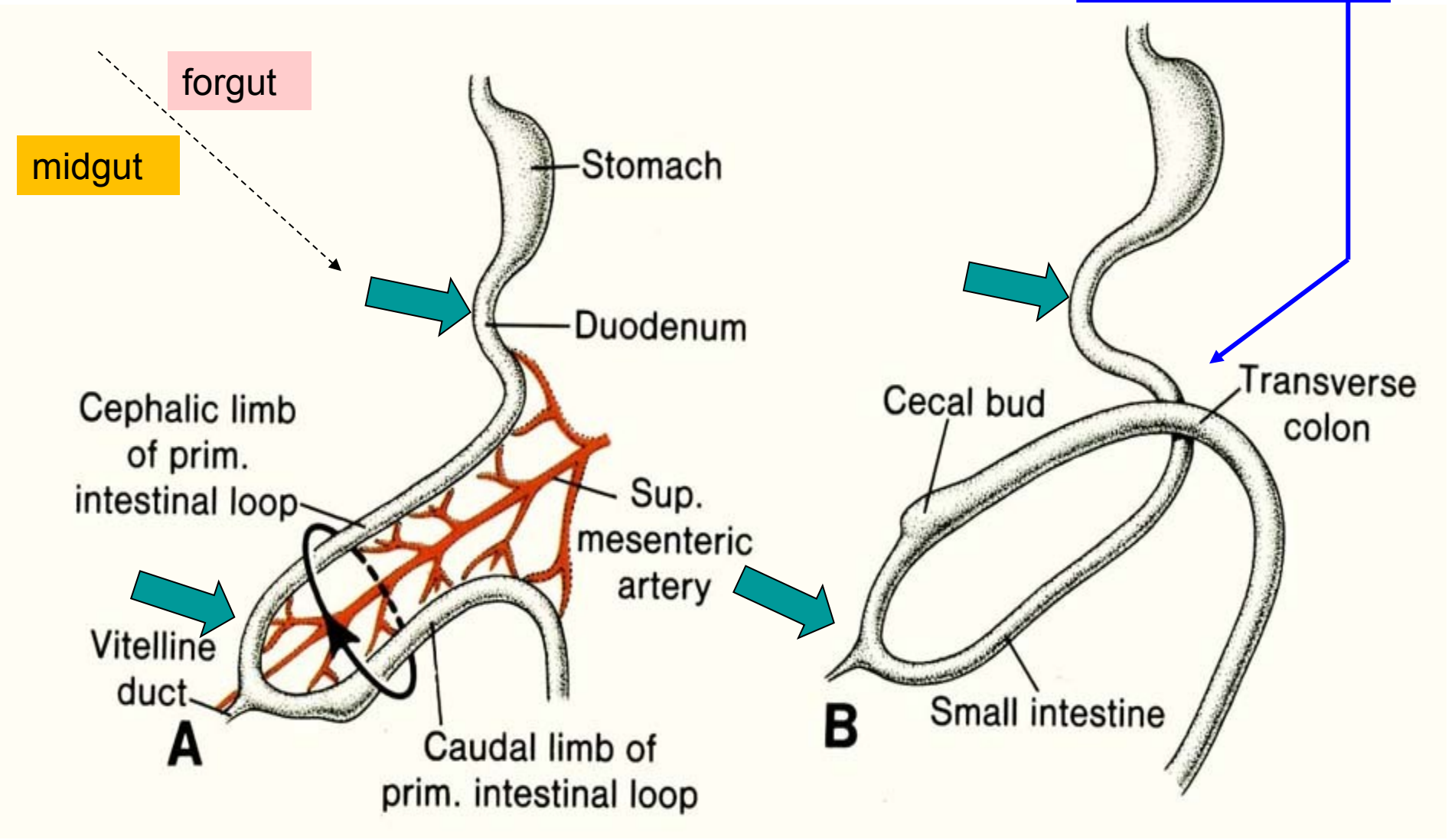
- the distal duodenum, jejunum, and proximal ileum +
- the distal ileum, cecum, appendix, ascending colon, and proximal 2/3 of transverse colon.

the midgut grows faster than the embryo, creating:

- **duodenal loop**
- **umbilical loop**

Duodenal loop and umbilical loop

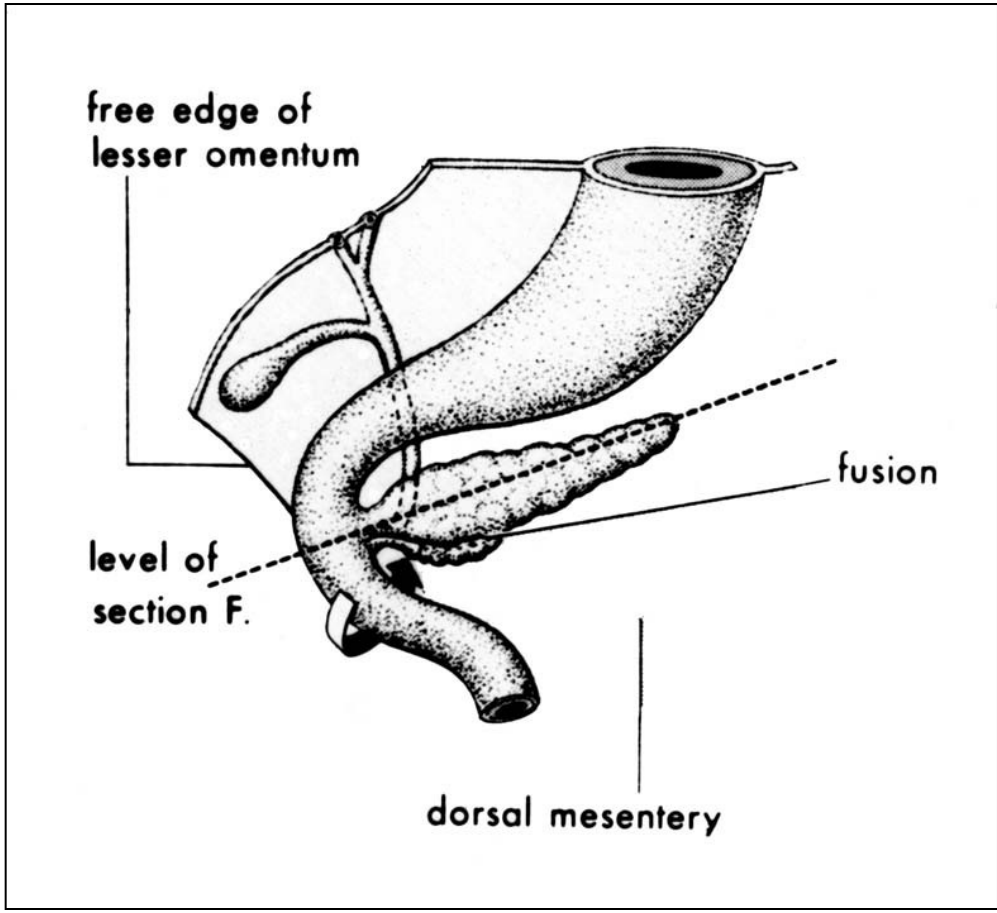
Flexura duodenojejunalis



Umbilical loop herniates into the umbilical cord (**physiologic herniation**, in week 6-10)

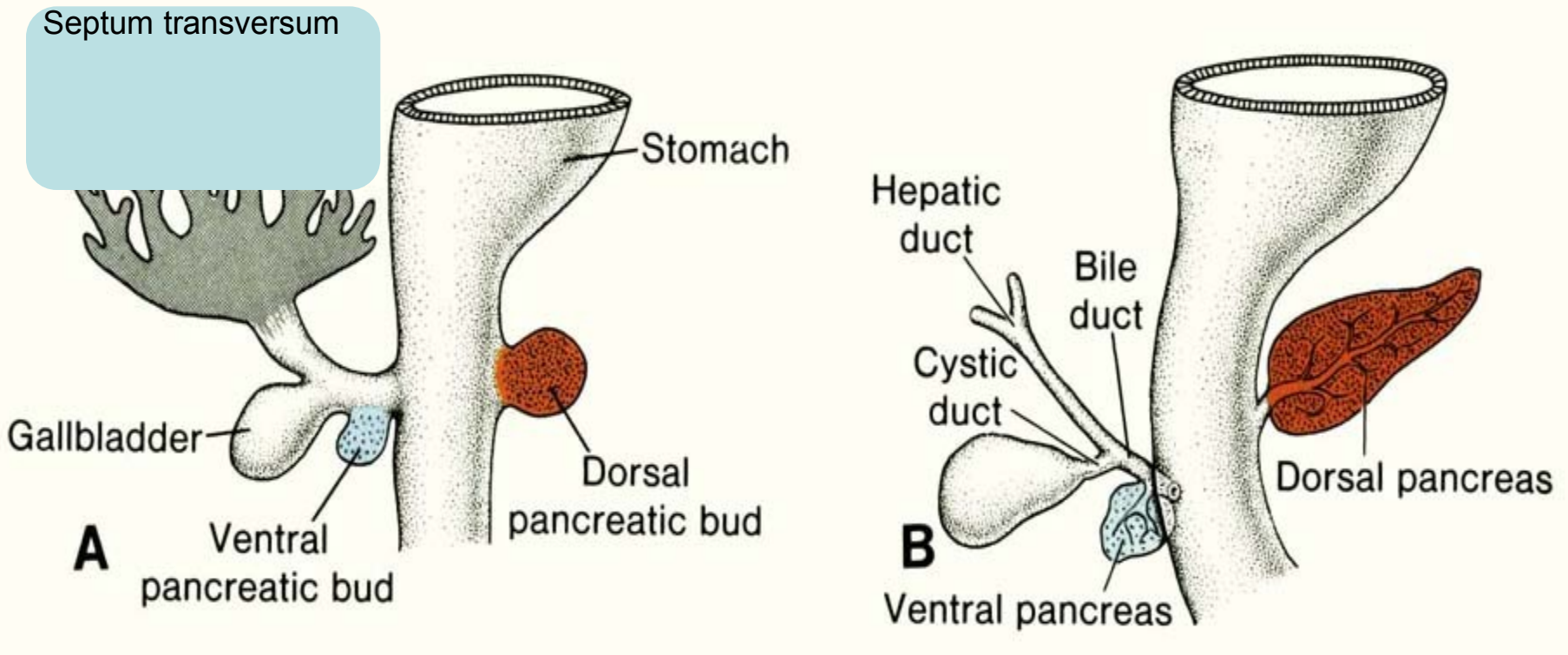
Duodenum development

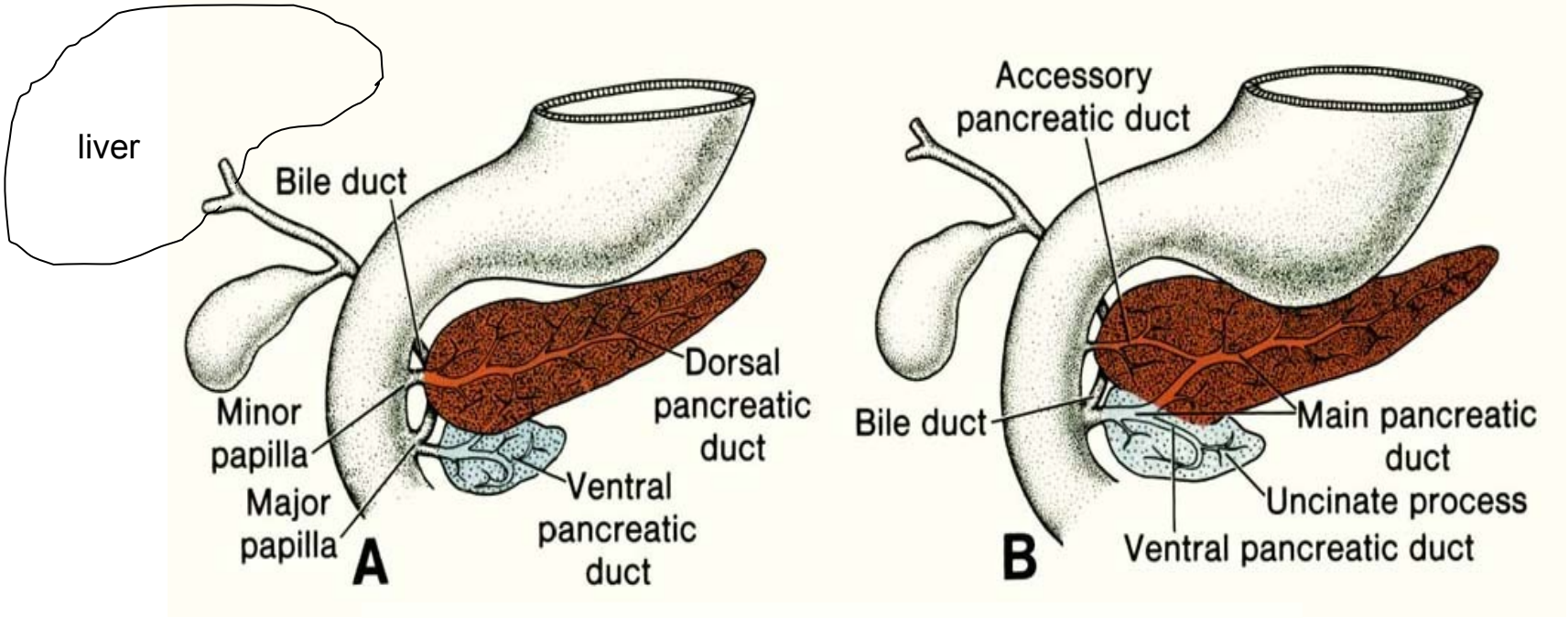
- **Duodenal loop** – 2 limbs:
  upper limb (from foregut)
  lower limb (from midgut)
- Week 5 – 8, duodenum is temporarily obliterated
- On top of loop – diverticles (for liver, gallbladder, pancreas)



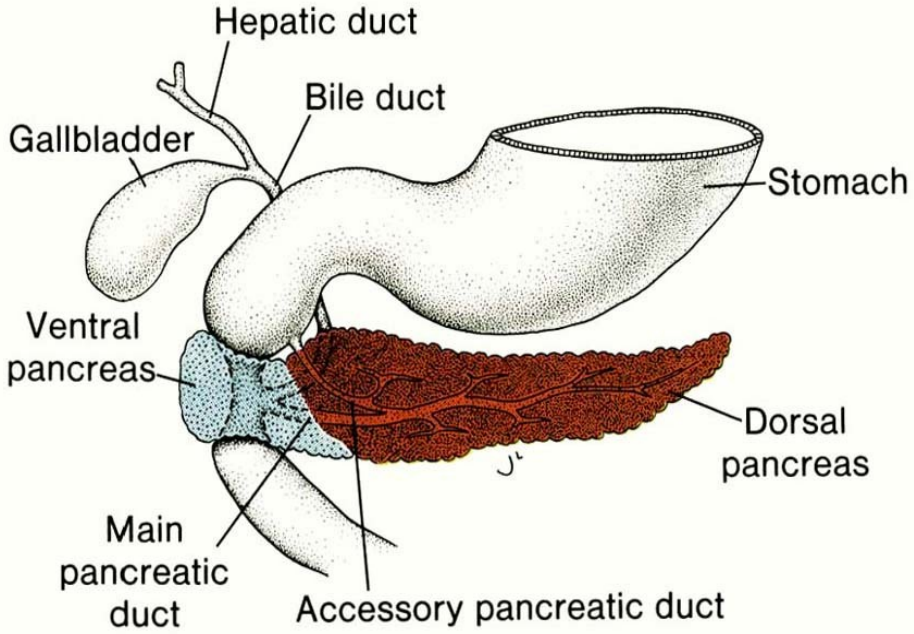
Liver, gall bladder, pancreas

The liver bud (hepatocystic diverticle) appears at the distal end of the foregut (week 4) and divides into hepatic and cystic diverticles, later ventral pancreatic bud and dorsal pancreatic bud (week 5). Both pancreatic buds meet and fuse (week 6).



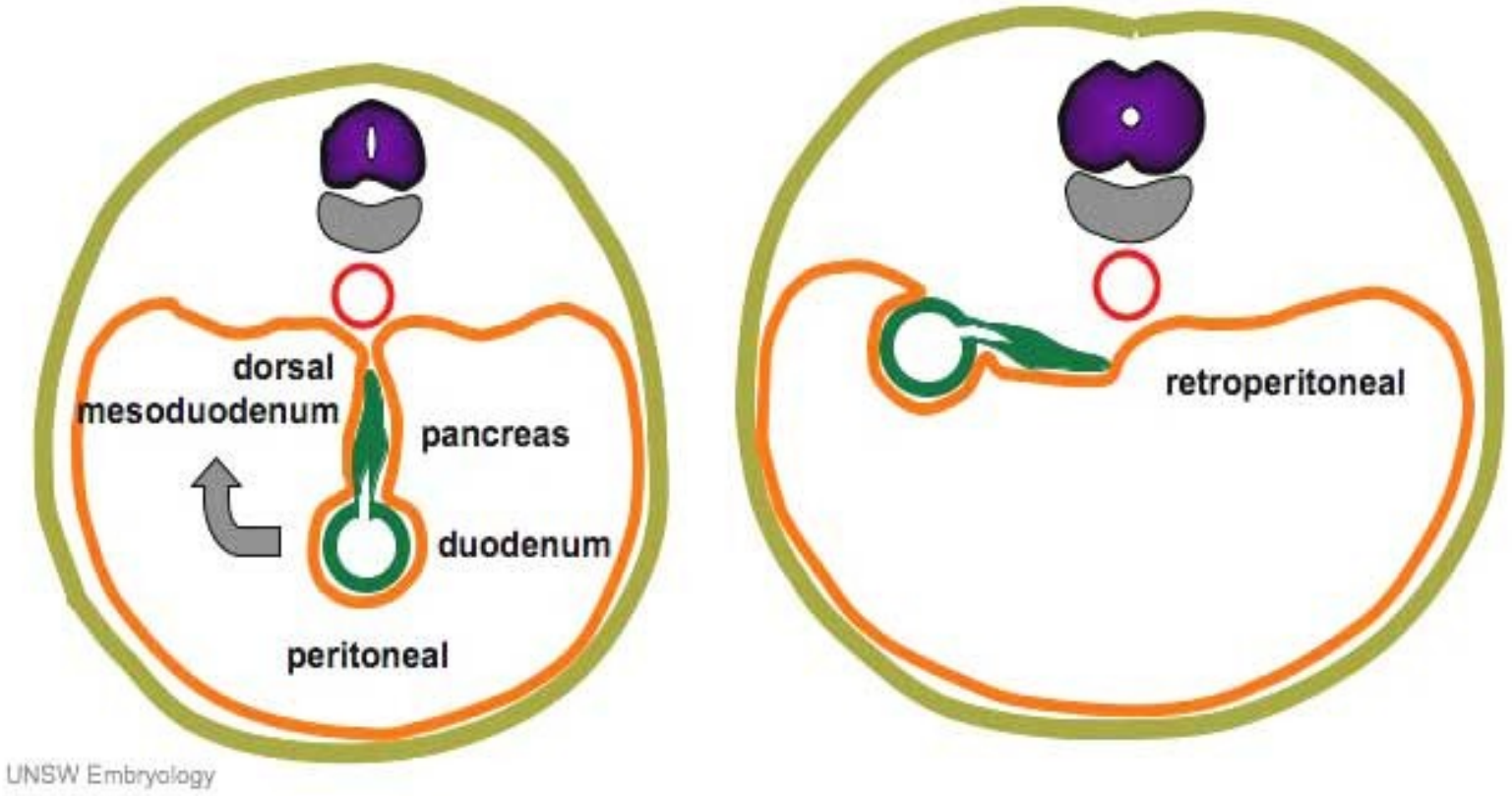


Liver:
week 6 – blood
week 12 - bile



Pancreas:
Week 10 - insulin

Due to rotation of stomach, mesenteries and umbilical loop, duodenal loop changes its position (from front to the right) and becomes retroperitoneal organ (together with pancreas)

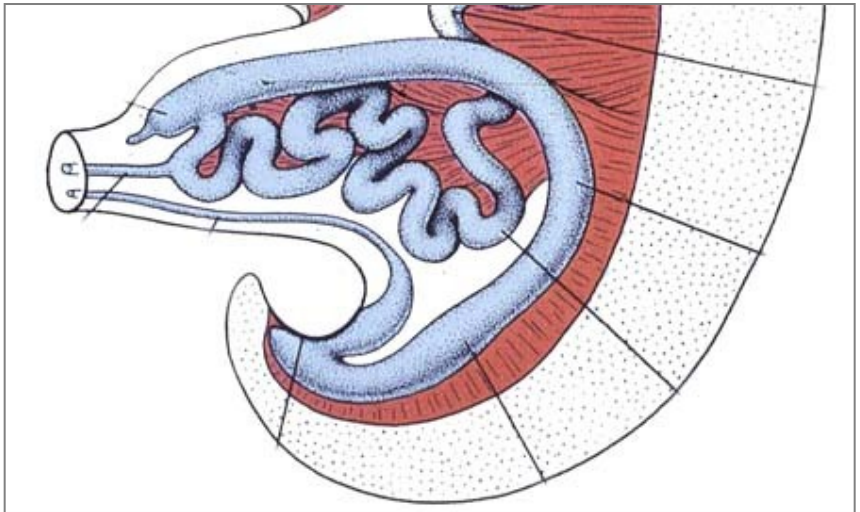


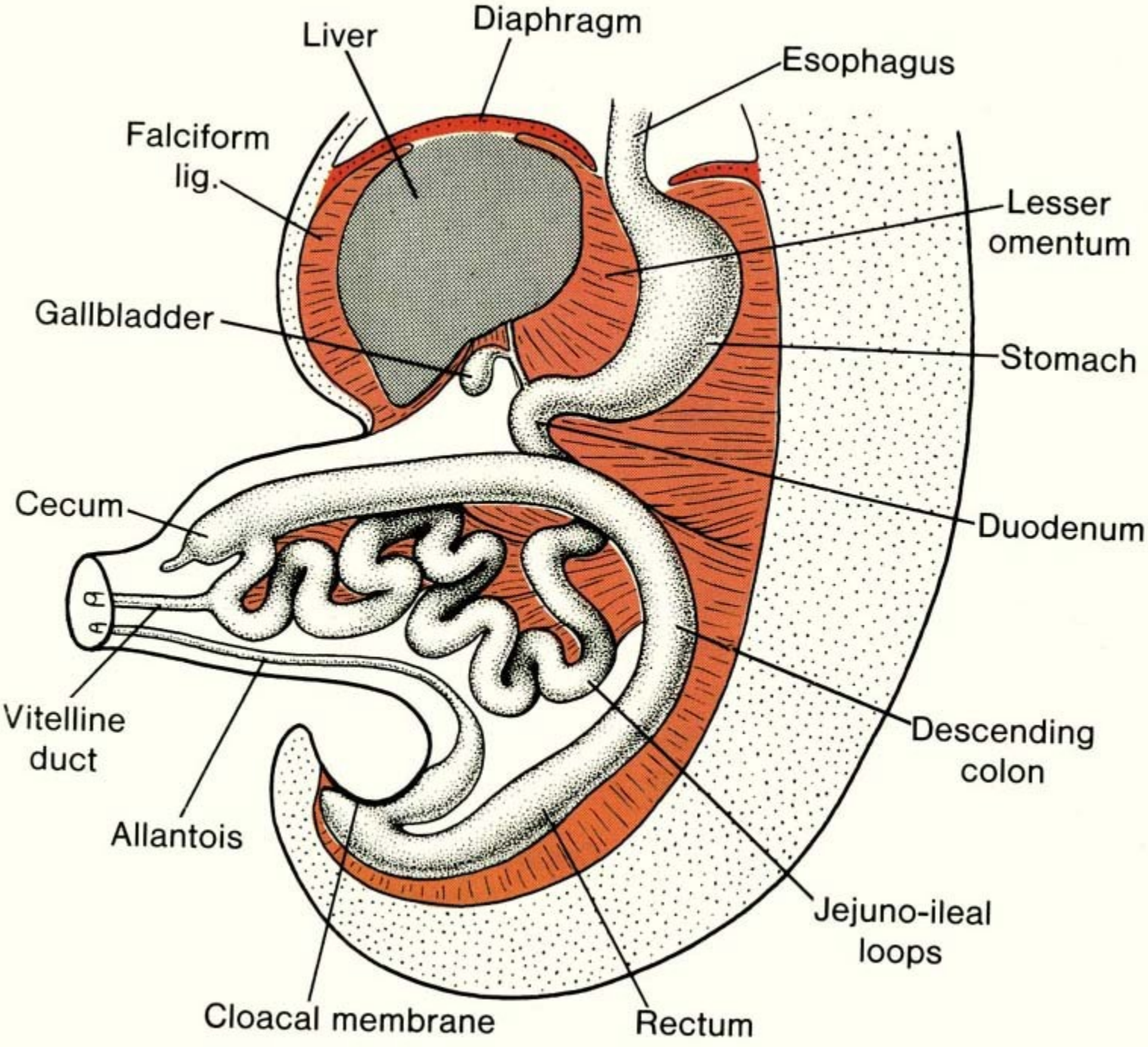
Spleen

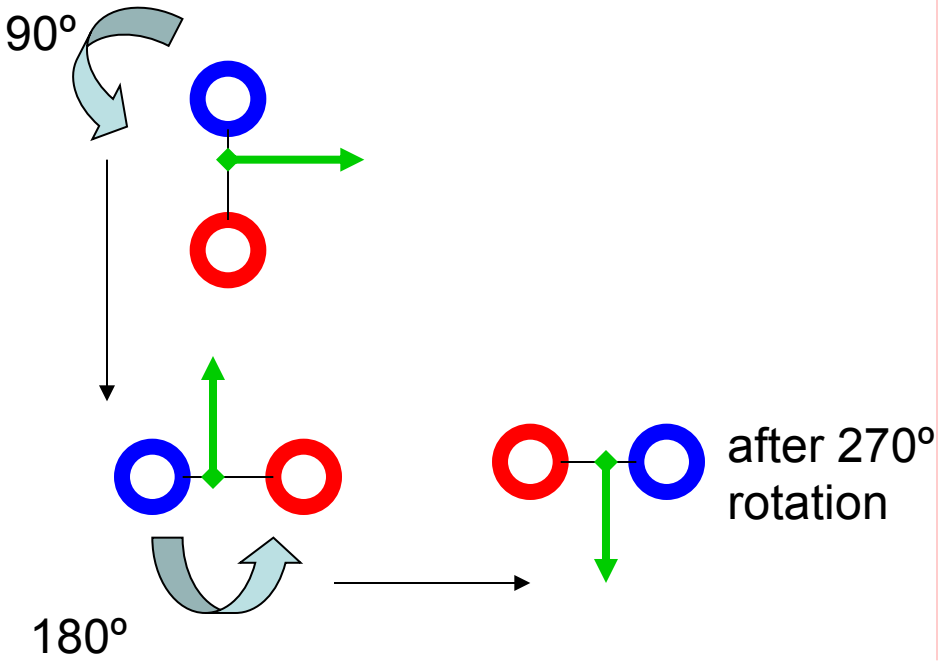
- derives from mass of cells in dorsal mesogastrium during week 5

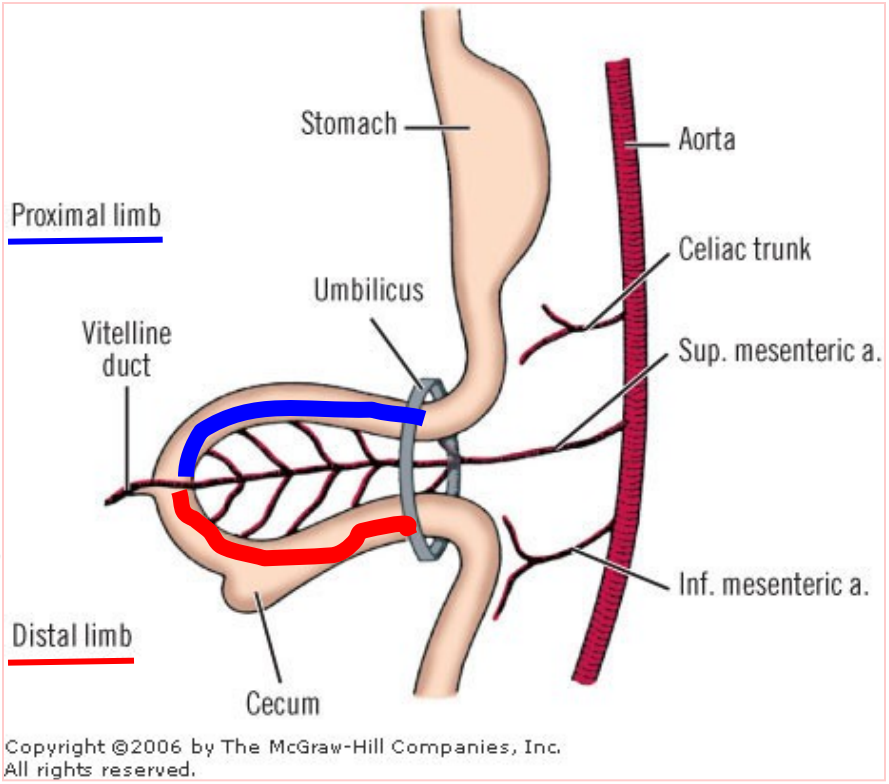
Intestines development

- Umbilical loop – 2 limbs:
  cranial – jejunoileal limb (jejunum, major part of ileum)
  caudal – ileocecal limb (rest of ileum, caecum + appendix, colon ascendens and 2/3 of colon transversum)
- A. mesenterica sup. – axis of rotation
- week 6 – physiologic herniation into the umbilical cord, week 10 – reposition into abdominal cavity




Liver
Diaphragm
Esophagus
Falciform lig.
Lesser omentum
Gallbladder
Stomach
Cecum
Duodenum
A A
Vitelline duct
Descending colon
Allantois
Jejuno-ileal loops
Cloacal membrane
Rectum





- In the umbilical cord, the midgut loop rotates 90° counter-clockwise direction around the axis of the superior mesenteric artery.
- Upon returning, the gut undergoes another 180° counter-clockwise rotation, placing the cecum and appendix near the right lobe of the liver.
- The total rotation of the gut is 270°.

Hindgut

The distal end of the hindgut – the cloaca.

Derivatives of the hindgut: the distal 1/3 of the transverse colon, descending colon, sigmoid colon, rectum and upper part of anal canal (above the pectinate line).

Teratology

Umbilical hernia cong.
Cong. omphalocele
Intestinal stenosis or atresia – polyhydramnios, vomiting
Anal atresia +fistula(e)

Teratology

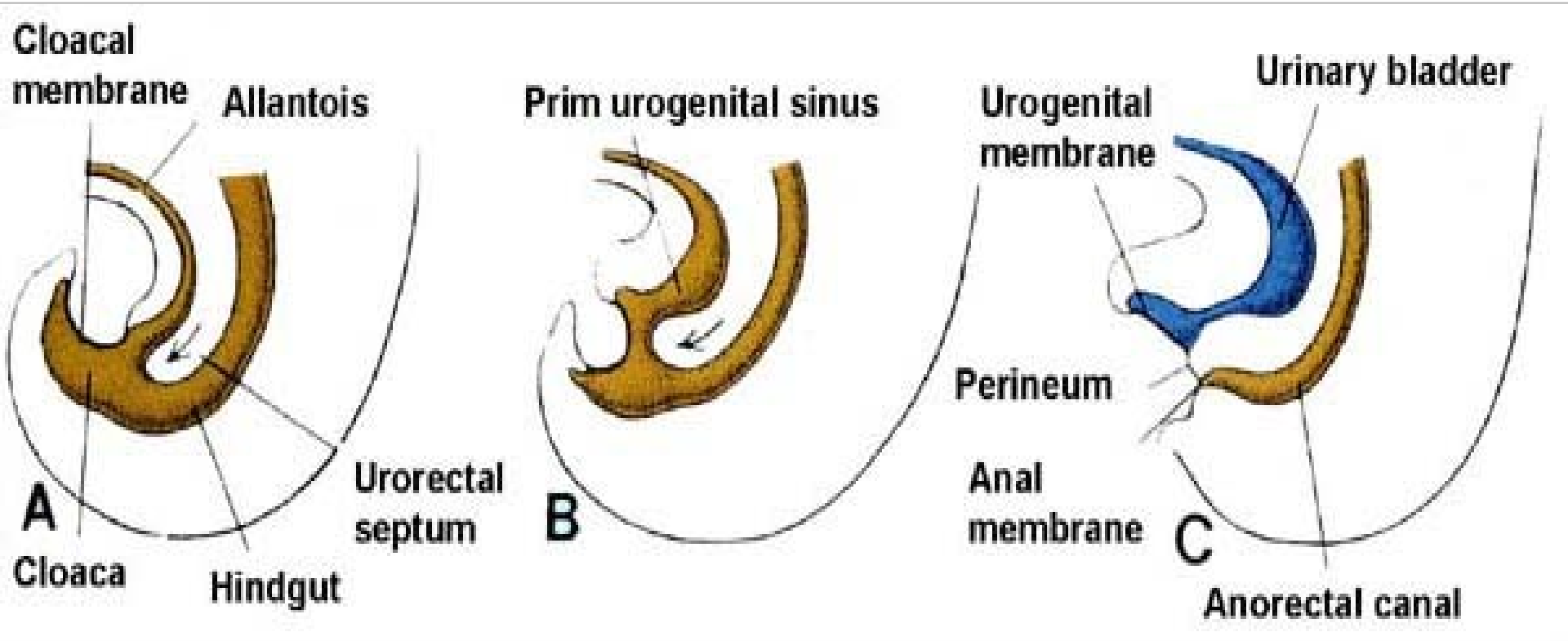
Umbilical hernia cong.
Cong. omphalocele
Intestinal stenosis or atresia – polyhydramnios, vomiting

Anal atresia +fistula(e)

Division of the cloaca - urorectal septum divides the cloaca into a ventral urogenital sinus and a dorsal **anorectal canal**.

The **cloacal membrane** breaks down during the 7th week.

Distal to the pectinate line (site of the former cloacal membrane), the epithelium of the anal canal derives from ectoderm of **proctodeum** (primitive anal pit)

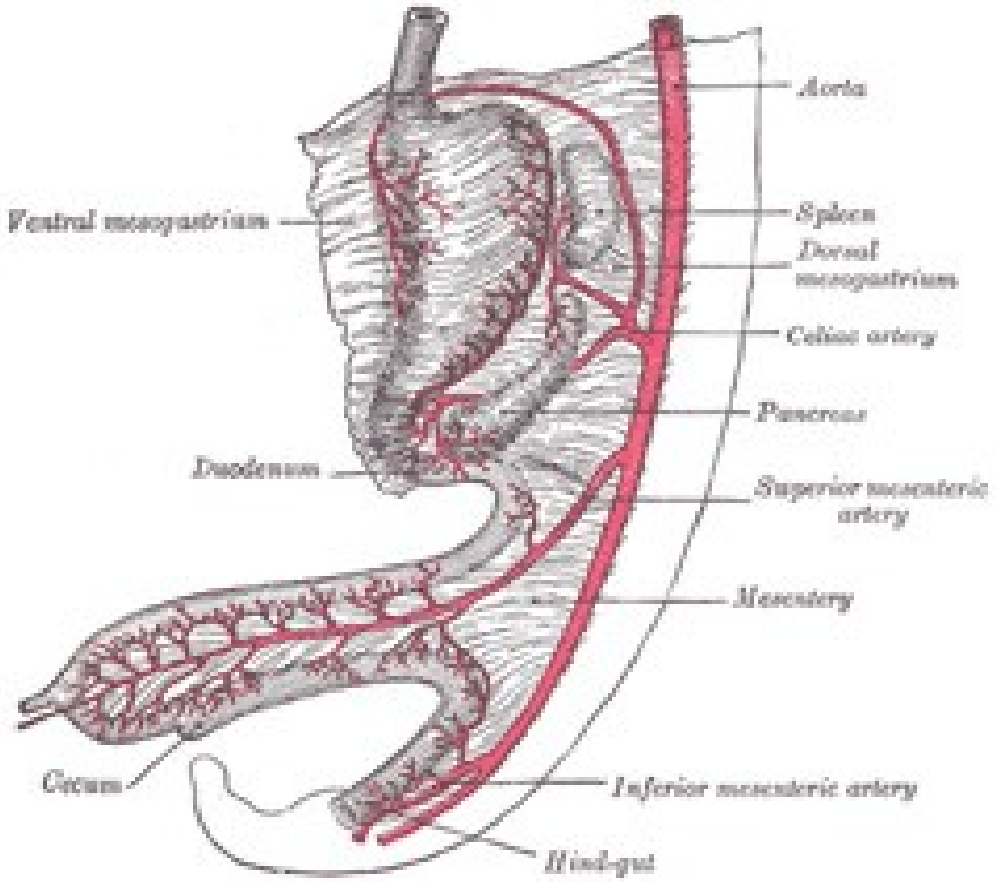


Mesenteries

- double layer of peritoneum enclosing organs and connecting them to the body wall

Ventral mesentery exists only in region of distal part of esophagus, stomach (lesser omentum) and upper part of duodenum

Dorsal mesentery forms dorsal meso-gastrium (greater omentum), dorsal mesoduodenum, mesentery proper (jejunum, ileum)



Thank you for your attention

Structures derived from Arches

ARCH	Nerve	Muscles	Skeletal Structures	Ligaments
1 (maxillary/mandibular)	trigeminal (V)		malleus, incus	ant lig of malleus, sphenomandibular ligament
2 (hyoid)	facial (VII)		stapes, styloid process, lesser cornu of hyoid, upper part of body of hyoid bone	stylohyoid ligament
3	glossopharyngeal (IX)		greater cornu of hyoid, lower part of body of hyoid bone	
4 & 6	superior laryngeal and recurrent laryngeal branch of vagus (X)		thyroid, cricoid, arytenoid, corniculate and cuneform cartilages	

Structures derived from Pouches

Each pouch is lined with endoderm and generates specific structures.

POUCH	Overall Structure	Specific Structures
1	tubotympanic recess	tympanic membrane, tympanic cavity, mastoid antrum, auditory tube
2	intratonsillar cleft	crypts of palatine tonsil, lymphatic nodules of palatine tonsil
3	inferior parathyroid gland, thymus	
4	superior parathyroid gland, ultimobranchial body	