Development Of The Digestive System

Dr. Mustafa Saad
(2020)

- During the 4th week of development, the ***Primordial Gut*** is formed (Fig. 1). At this time the cranial end is closed by the oropharyngeal membrane and the caudal end is closed by the cloacal membrane.

- Most of the epithelium and glands of the digestive system are derived from the endoderm of the primordial gut. The epithelium of the cranial and caudal ends, however, are derived from the ectoderm of the stomodeum (future mouth) and proctodeum (anal pit) respectively. The other layers of the wall are derived from the surrounding mesoderm.

- Portions of the gut tube and its derivatives are suspended from the dorsal and ventral body walls by **mesenteries -** double layers of peritoneum that encloses an organ and connects it to body walls.

- Divisions of the Primordial Gut:

→ The primordial gut is divided into three parts *According to their blood supply*

1. ***Foregut***: mostly by Celiac artery
2. ***Midgut***: by Superior Mesenteric artery
3. ***Hindgut***: by Inferior Mesenteric artery

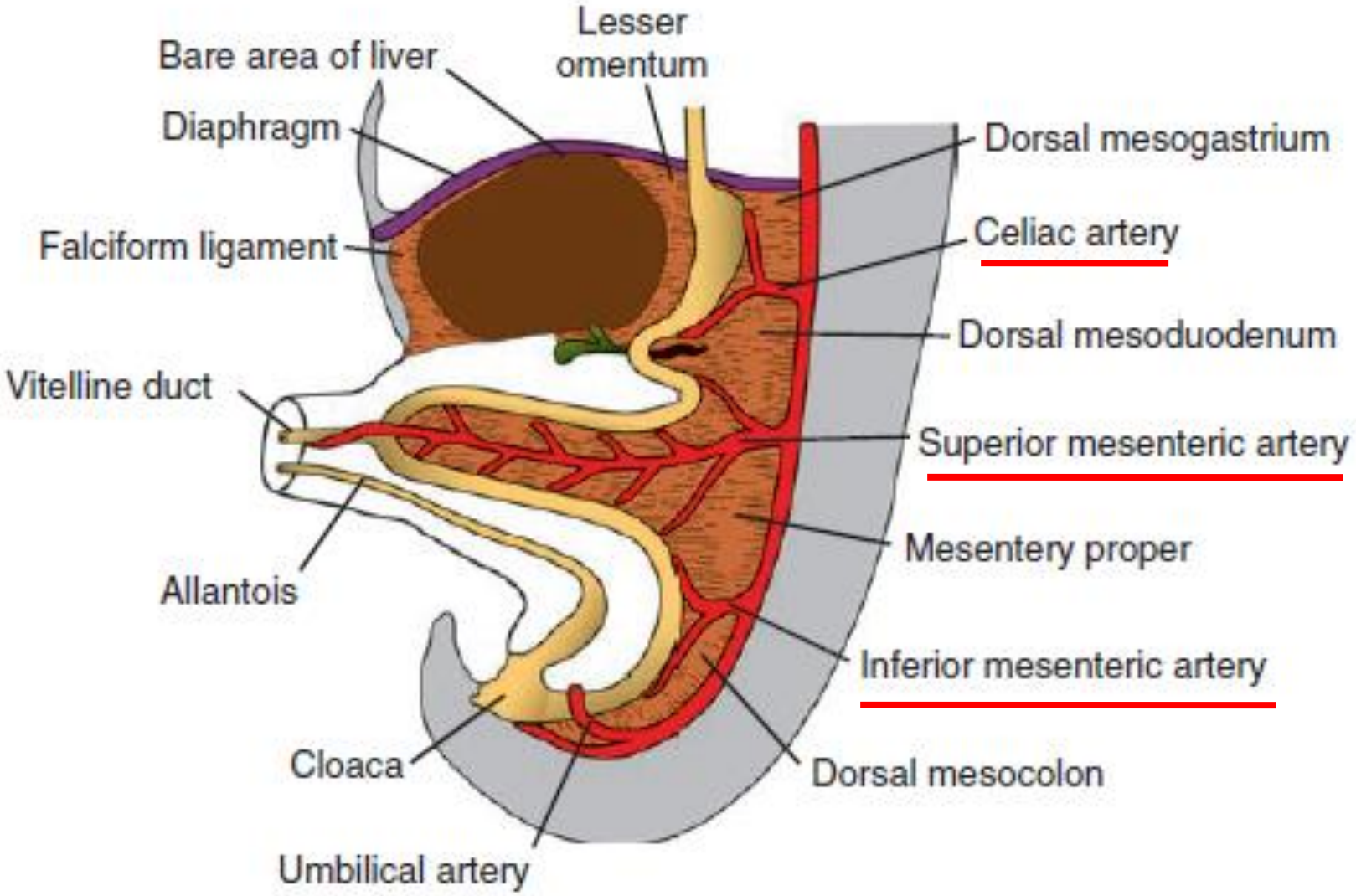


Fig.1: The Primordial Gut.

The Foregut

The foregut gives rise to

1. Pharynx
2. Lower respiratory tract
3. ***Esophagus and stomach***
4. ***Duodenum proximal to bile duct opening***
5. ***Liver, biliary apparatus and pancreas***

Celiac artery

The Esophagus

- By the end of the 4th week, the laryngotracheal diverticulum arises from the cranial part of the foregut. The tracheoesophageal septum soon appears and grows to divide this region of the foregut into a ventral laryngotracheal tube and a dorsal pharynx and esophagus (Fig. 2).

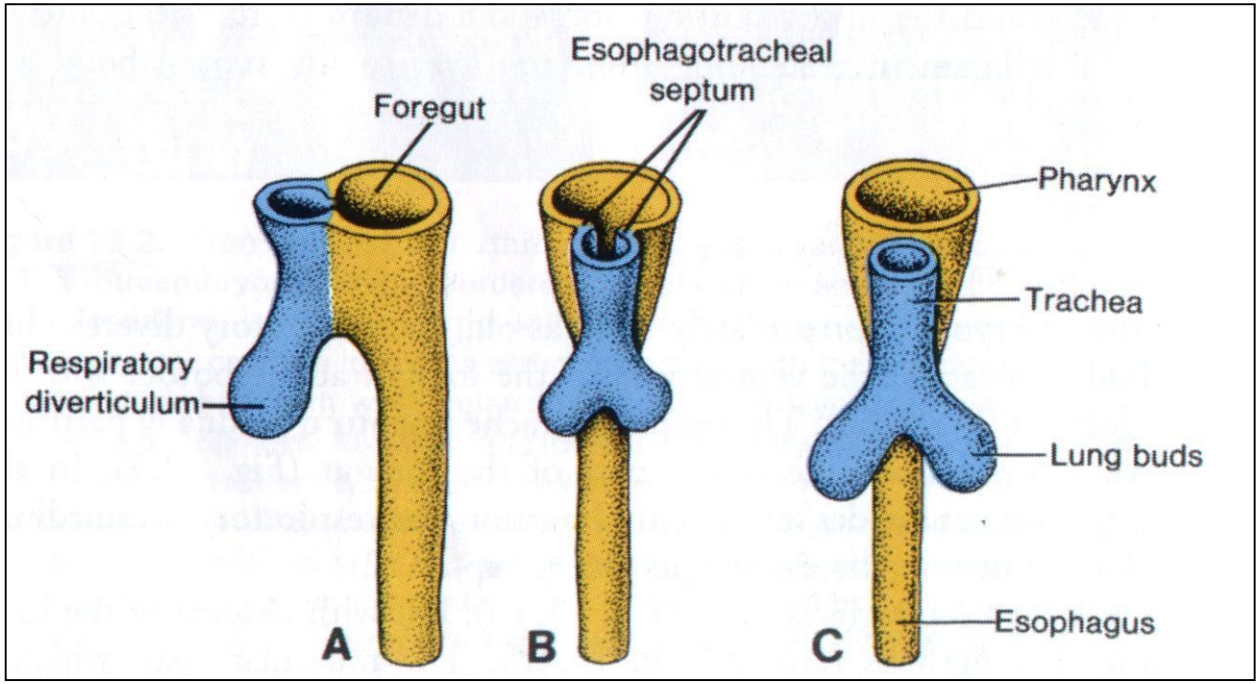
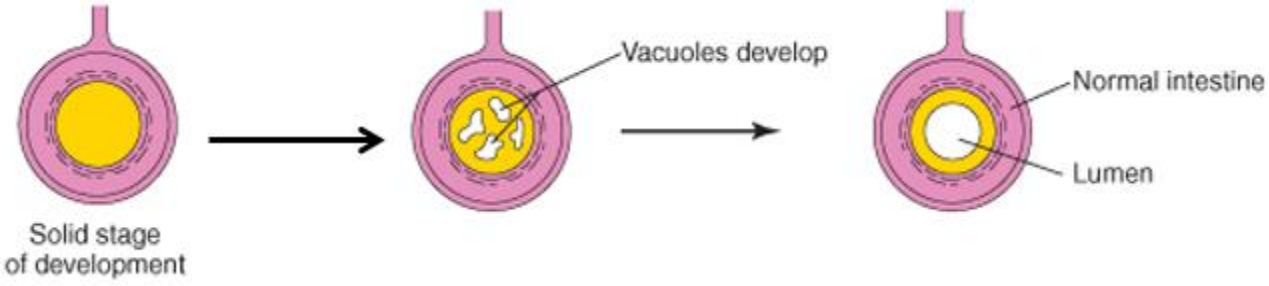


Fig.2: The development of the esophagus

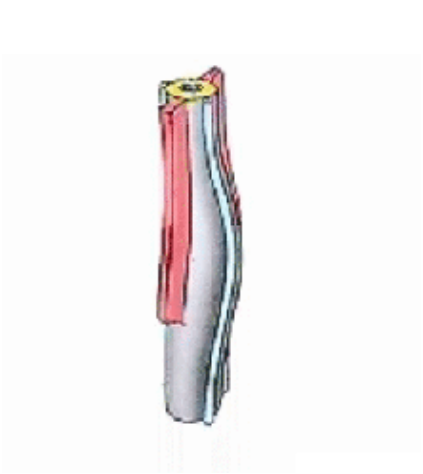
- Initially the lumen of the esophagus is obliterated by epithelial proliferation. Later, recanalization of the lumen occurs. Abnormality of this process may cause atresia (complete closure) or stenosis (partial obstruction) of the esophagus



The Stomach

- During the 4th week, a slight dilation appears in the foregut. This is the primordial stomach. This dilation will broaden ventrodorsally. The dorsal border of this dilation grows more rapidly forming the greater curvature, while the ventral border forms the lesser curvature. As this happens, the stomach will rotate (Fig 3).

- During its development, the stomach is attached to the posterior and anterior abdominal wall by the dorsal and ventral mesogastrium respectively.



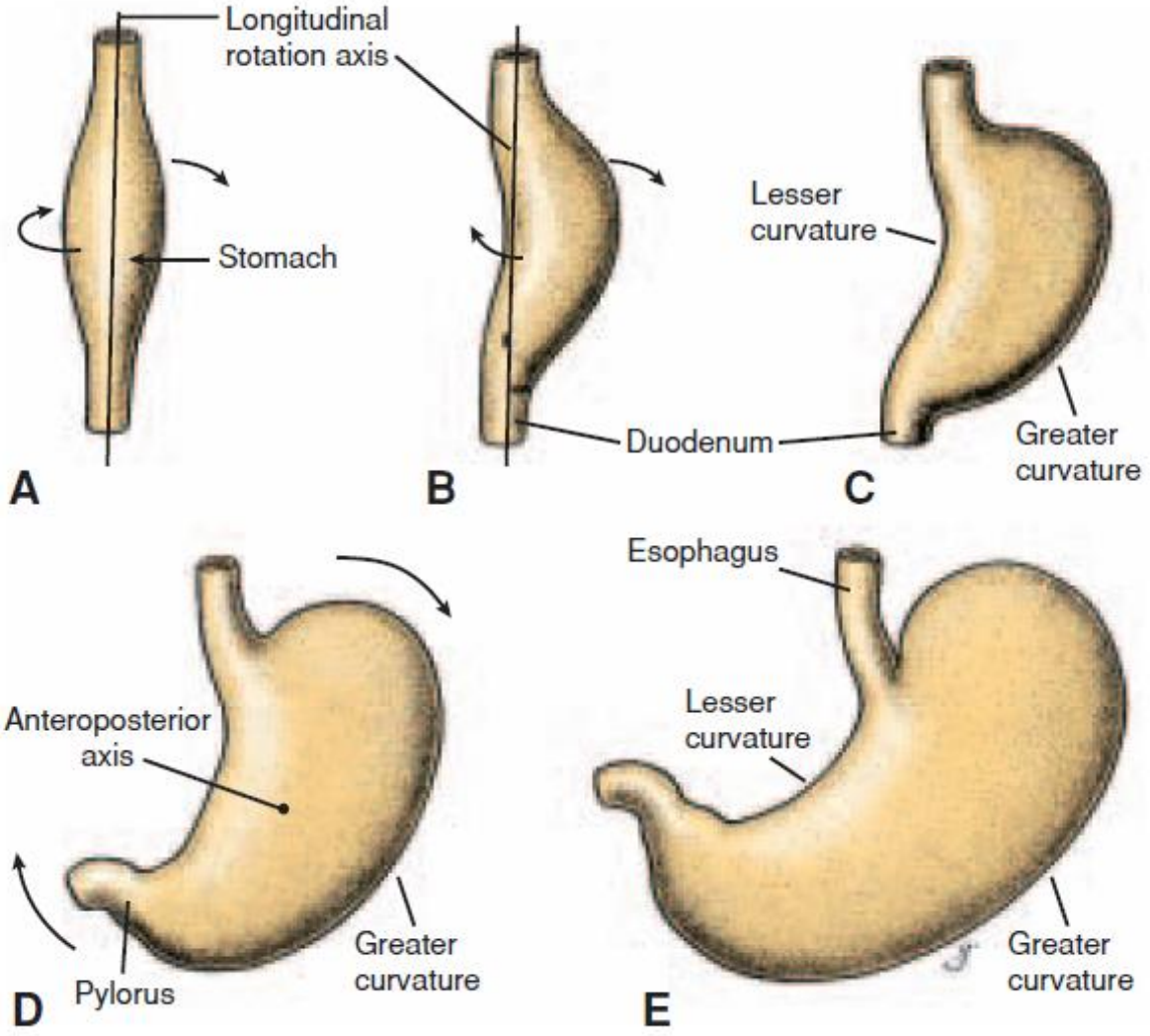


Fig.3: The development and rotation of the stomach

Results of the rotation of the stomach:

1) The ventral border (lesser curvature) will move to the right and the dorsal border (greater curvature) will move to the left.

2) The cranial end of the stomach will move inferiorly and to the left. The caudal end will move superiorly and to the right.

3) The left surface of the stomach will become its anterior surface, while the right will become the posterior surface. This is why the left vagal trunk supplies the anterior surface of the stomach and the right vagal trunk supplies its posterior surface.

The Omental Bursa (Lesser Sac)

- Isolated clefts first appear in the dorsal mesogastrium (Fig. 4). These clefts fuse together to form a single cavity – the lesser sac. As the stomach rotates and enlarges, the lesser sac will also enlarge. It will hang down over the intestines forming the greater omentum. The lesser sac continues to communicate with the peritoneal cavity through the omental (epiploic) foramen which is located at the origin of the sac.

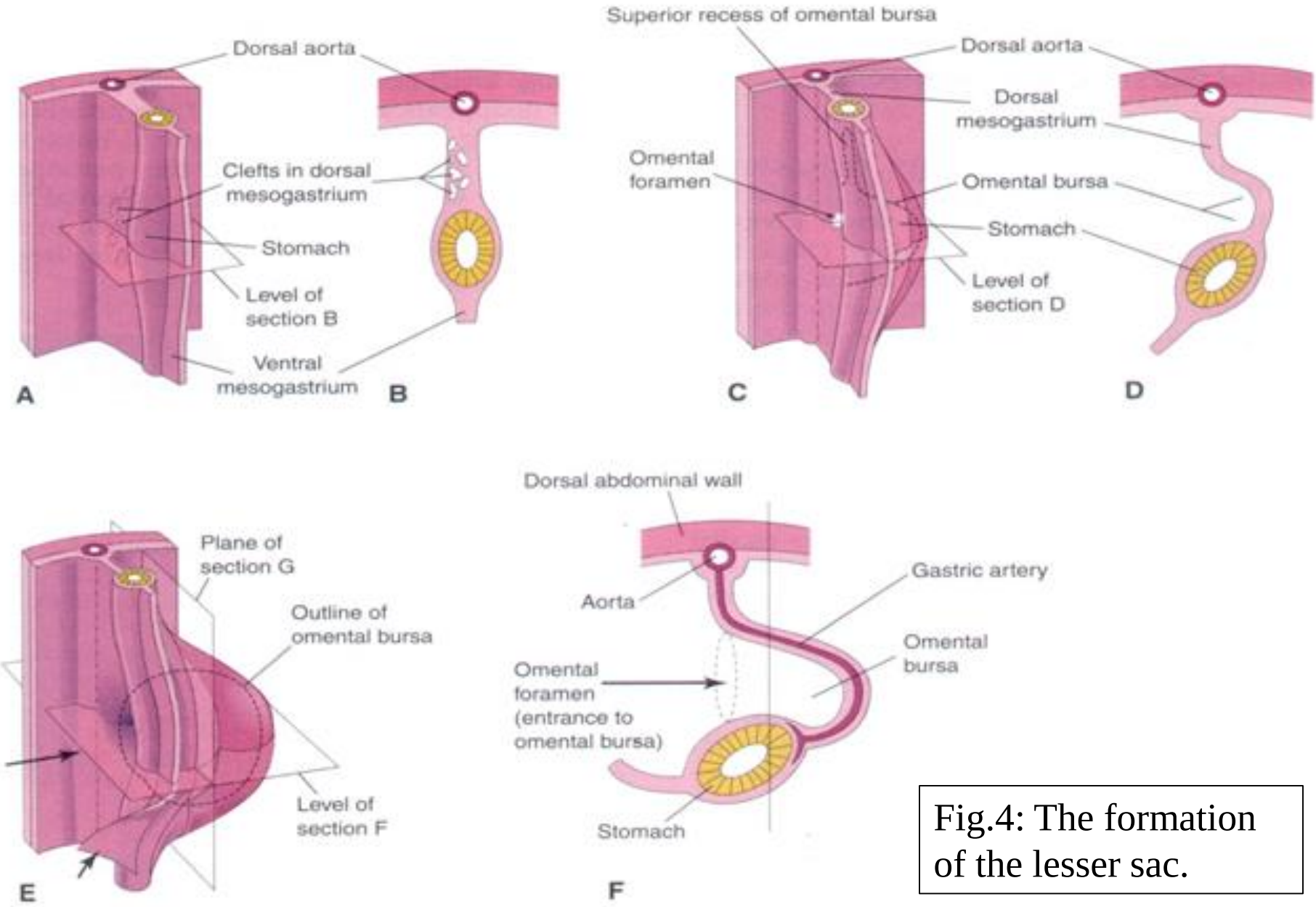


Fig.4: The formation of the lesser sac.

The Duodenum

- The duodenum develops from the distal end of the foregut and the proximal end of the midgut (that's why it's supplied by branches of both celiac and superior mesenteric arteries). It grows to form a C-shaped loop that's directed ventrally. As the stomach rotates, the loop of the duodenum will rotate with it to become directed to the right (Fig. 5).

- Initially the lumen is obliterated, but is later recanalized. Abnormality of the recanalization may result in either stenosis or atresia.

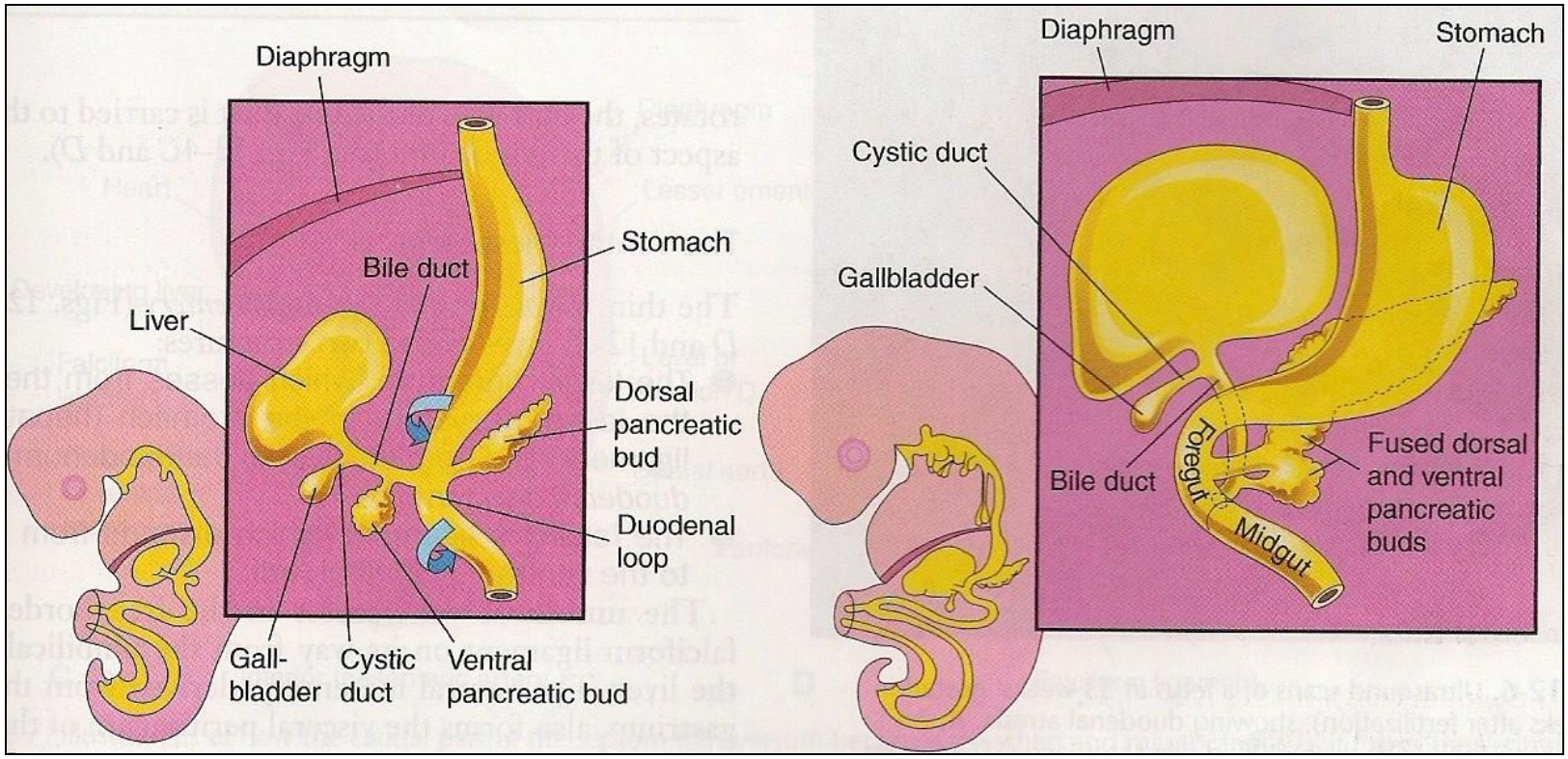


Fig.5: The development of the duodenum

The Liver and Biliary Apparatus

- During the 4th week, a ventral outgrowth arises from the distal end of the foregut. This is the hepatic diverticulum (Fig. 6). It divides into a cranial and a caudal part. The cranial part is the primordium of the liver. It grows towards and into the septum transversum (future diaphragm).
- The caudal part of the hepatic diverticulum will form the gallbladder and the extrahepatic biliary system; this system is first occluded but, later, becomes recanalized.

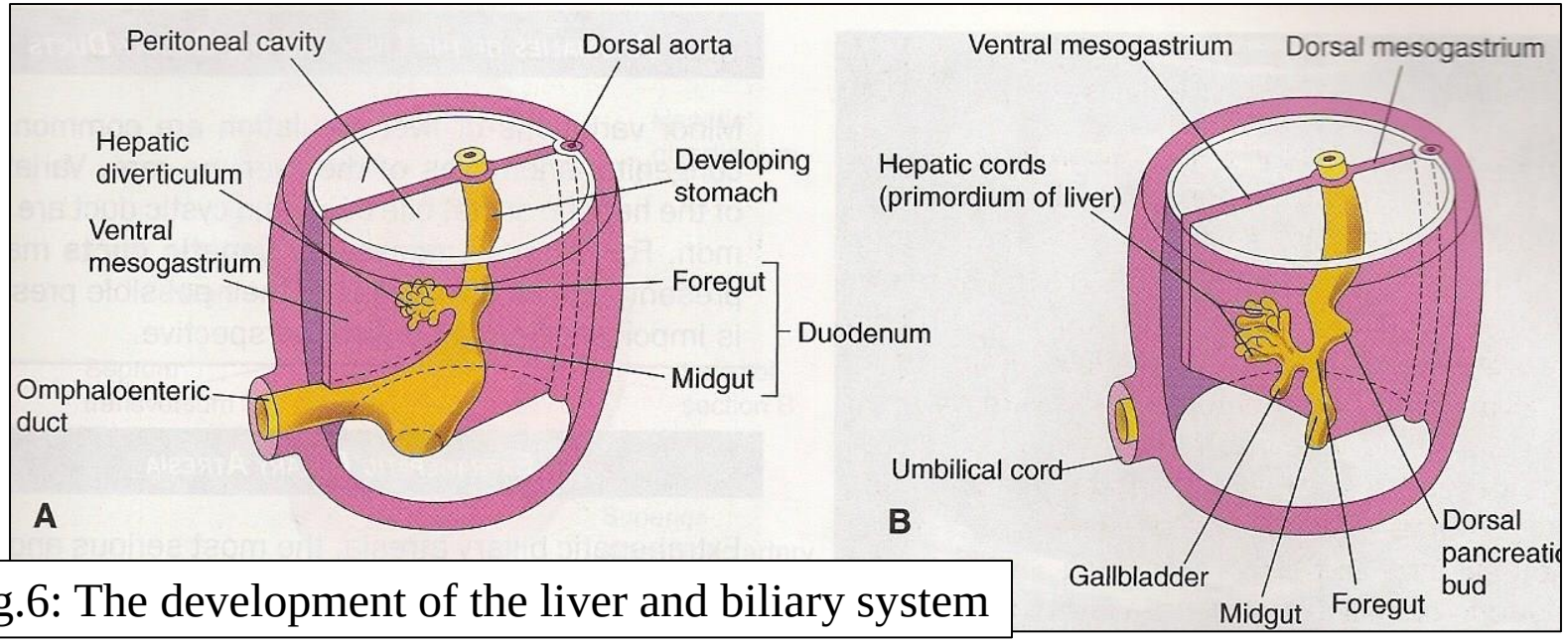


Fig.6: The development of the liver and biliary system

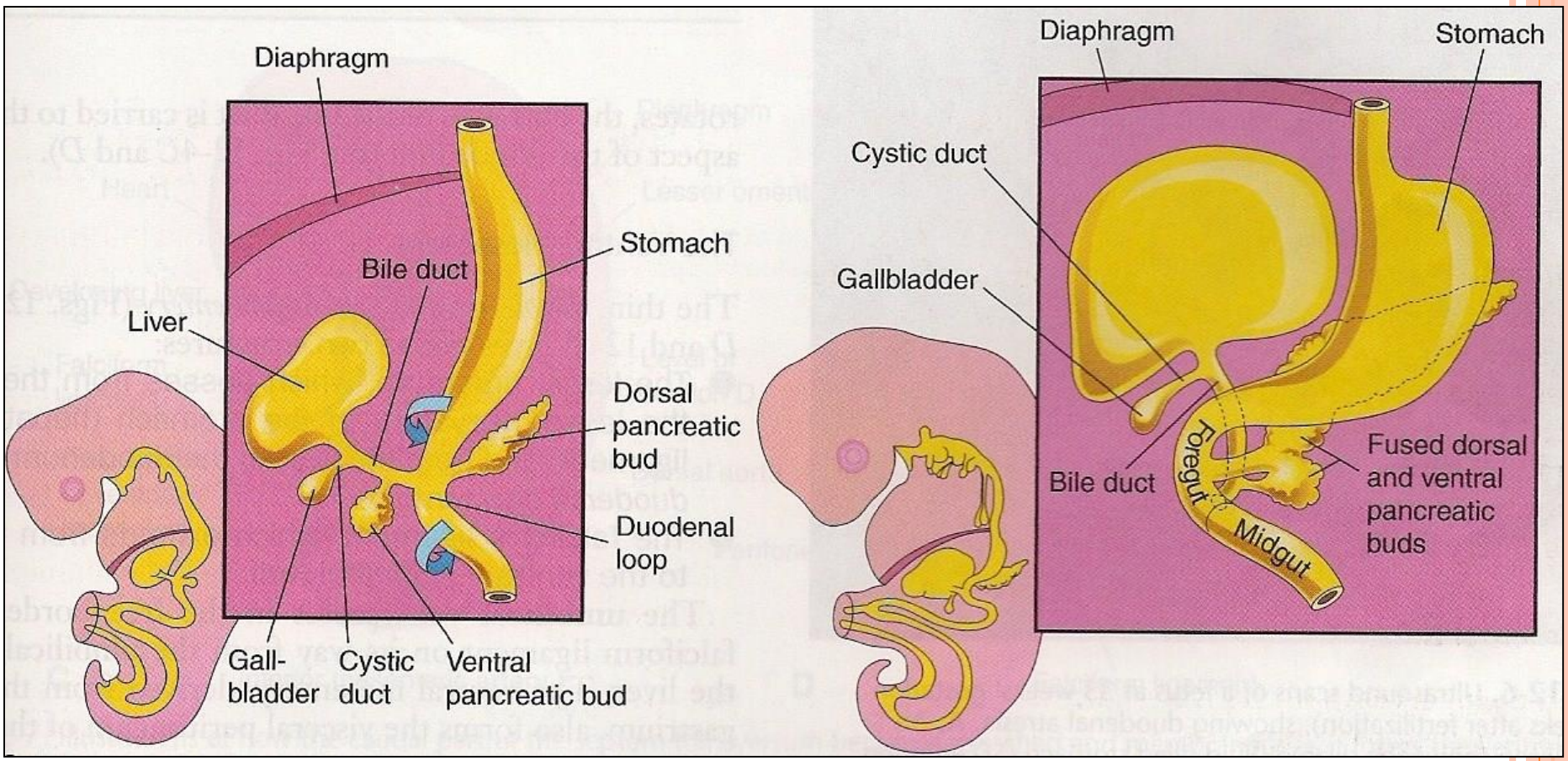


Fig.6: The development of the liver and biliary system (continued)

- The liver grows between the two layers of the ventral mesogastrium. As this happens, the ventral mesogastrium will be divided into three regions (Fig.7):

1. The part between the lesser curvature of the stomach and the liver. This will form the lesser omentum.
2. The part between the liver and the anterior abdominal wall. This will form the falciform ligament.
3. A part that covers the entire liver except for a small area in which the liver contacts the diaphragm (the bare area of the liver).

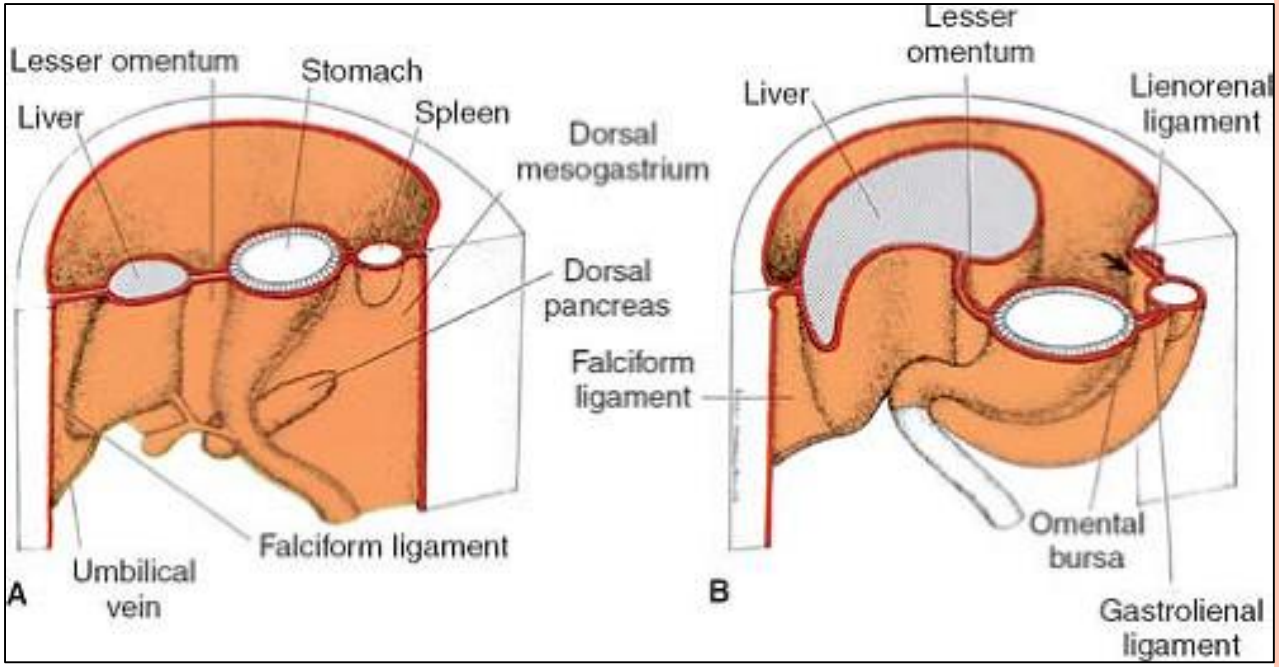


Fig.7: Derivatives of the ventral mesogastrium.

The dual embryological origin of the liver

1. The endoderm of the foregut forms:
   - Hepatocytes
   - Intrahepatic biliary system

2. Septum transversum (mesoderm) forms:
   - Fibrous tissue
   - Hematopoietic tissue
   - Kupffer cells

The Pancreas

- A ventral and a dorsal pancreatic bud arise from the caudal part of the foregut (Fig. 6 and 8). As the stomach and duodenum rotate, the ventral bud rotates to become posterior to the dorsal bud with which it later fuses to form the pancreas. The duct of the ventral bud fuses with the distal part of the duct of the dorsal bud to form the main pancreatic duct. The proximal portion of the duct of the dorsal bud usually disappears; it may, however, remain as the accessory pancreatic duct.

- An uncommon but important anomaly of the pancreas is the **anular pancreas** (Fig. 8). Here the ventral bud is bifid, and both parts fuse with the dorsal bud to form a ring of pancreatic tissue around the duodenum. This condition may cause obstruction of the duodenum.

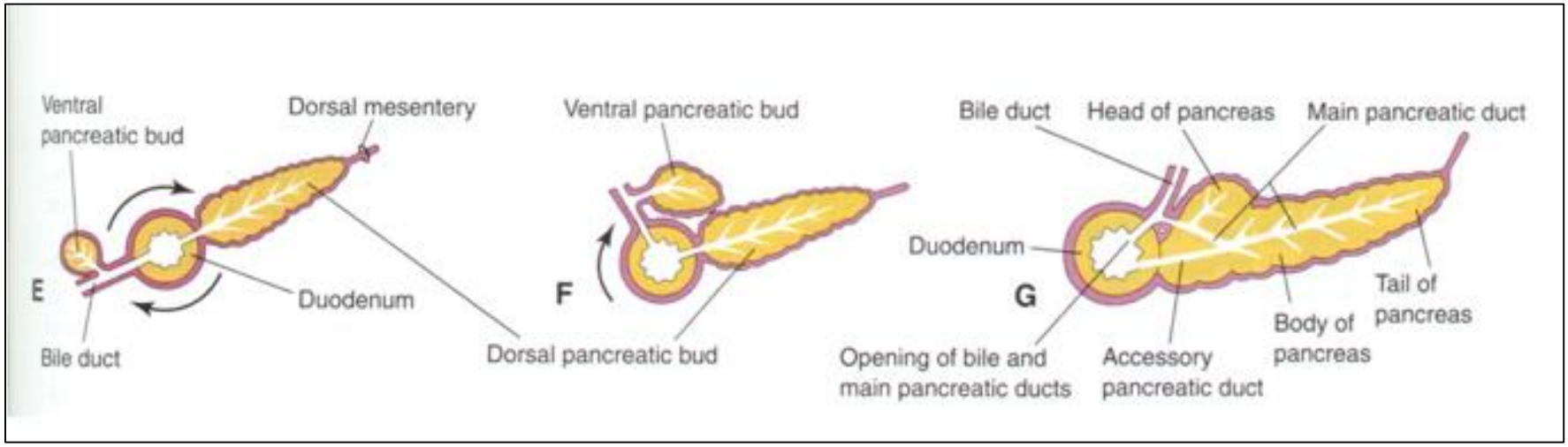
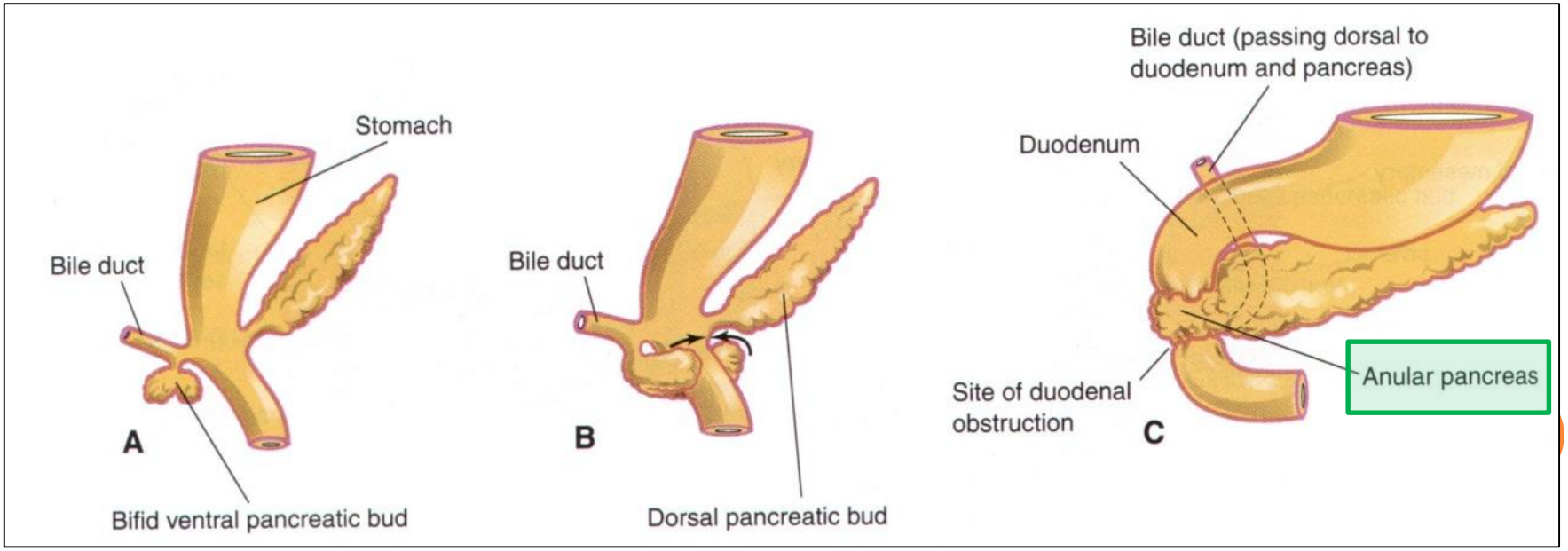


Fig.8: Above, the normal development of the pancreas. Below, anular pancreas.



The Midgut

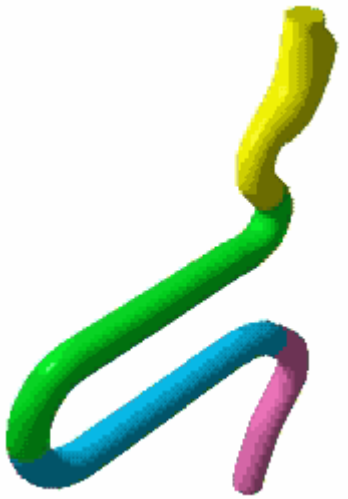
The midgut gives rise to

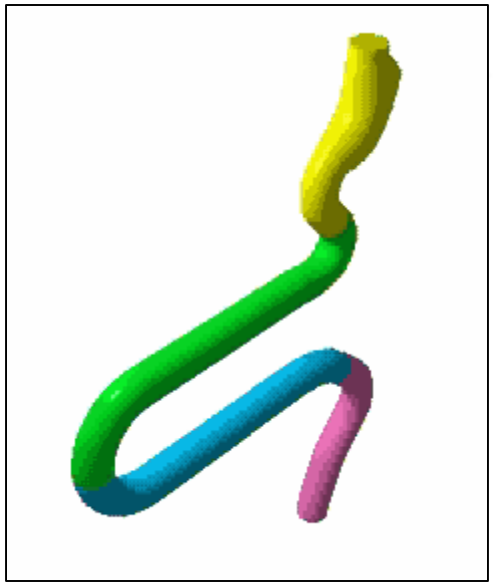
1. Duodenum distal to the bile duct opening
2. Ileum and jejunum
3. Cecum and appendix
4. Ascending colon and the right ½ to $^{2}/_{3}$ of the transverse colon

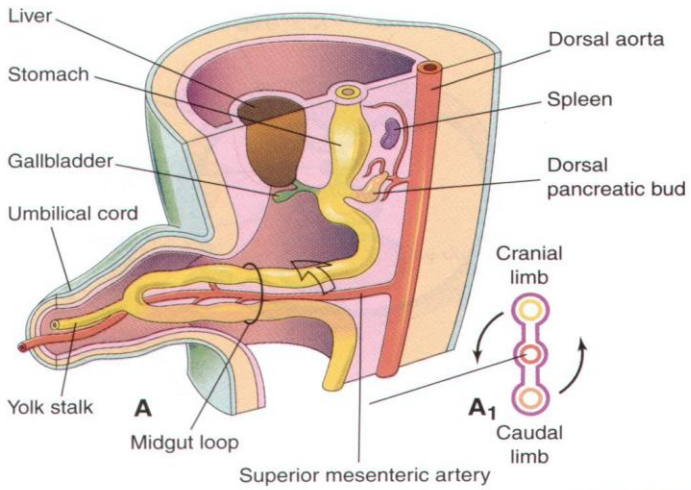
Superior mesenteric artery

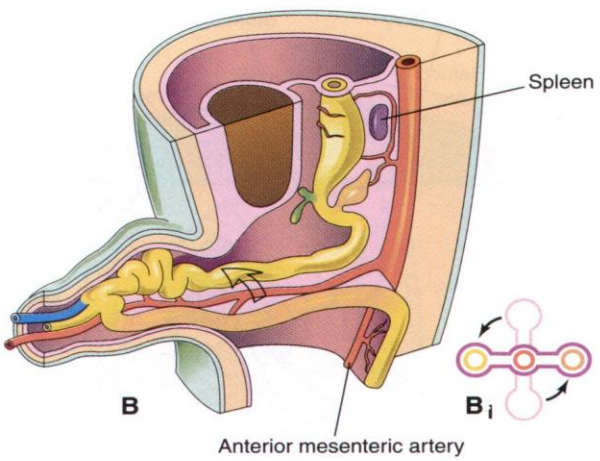
The Midgut Loop

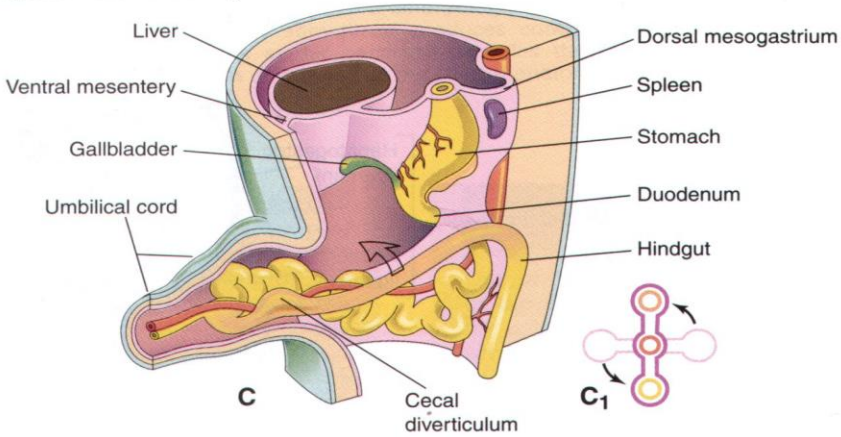
- The midgut forms a loop that's directed ventrally (Fig. 9). This loop will form the small intestine and parts of the large intestine. Because the abdominal cavity is initially small, the midgut loop will pass into the umbilical cord. This is called **Physiological Umbilical Herniation** (meaning that it's normal). As the loop grows it will rotate so that the small intestine comes to the left and the large passes to the right. During this time, the abdominal cavity has enlarged and the loop will return to the inside of the body (by the 10^{th} week).

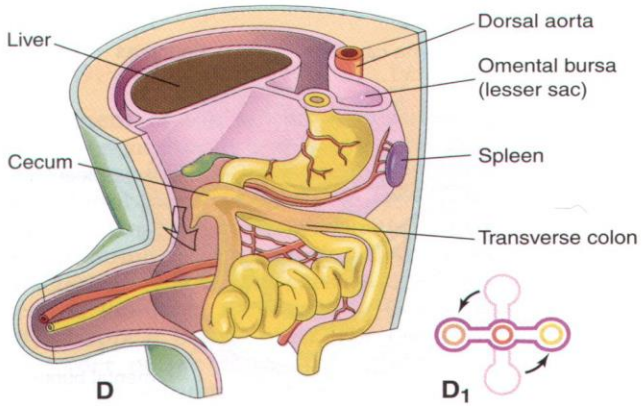












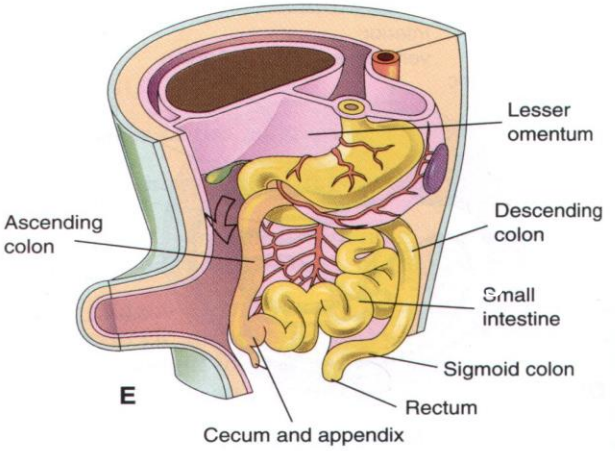
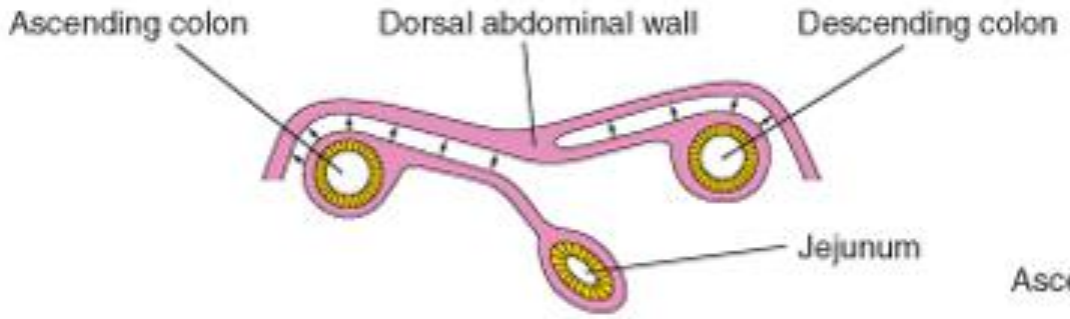


Fig.9: The Midgut Loop

Return of the midgut loop (Fig.10)

- Pushes some of the abdominal structures against posterior abdominal wall: part of the duodenum, the pancreas, ascending and descending colon
- Peritoneum behind these structure disappear
- These structures become Retroperitoneal



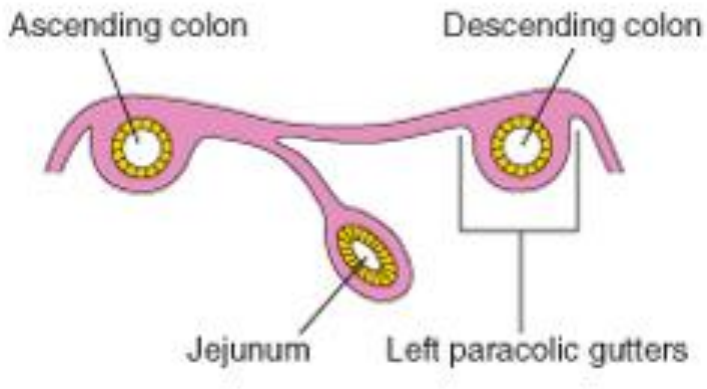


Fig.10: Return of the midgut loop.

Cecum and Appendix

- Diverticulum in the midgut loop → Cecum
- Blind-ending tube from the cecum → Appendix
- Appendix: Retrocecal, Retrocolic or Pelvic

The Hindgut

The hindgut gives rise to

1. Left $^{1}/_{3}$ to ½ of the transverse colon
2. Descending colon, Sigmoid colon and Rectum
3. Upper part of anal canal

Inferior mesenteric artery

4. Epithelium of Urinary bladder and part of the urethra

The Cloaca

- ✓ The distal end of the hindgut is dilated and it's called the cloaca and it's closed by the cloacal membrane (Fig. 11). This part is later divided by a mesenchymal partition called the urorectal septum. This septum divides the cloaca into a ventral urogenital sinus (which forms the urinary bladder and urethra) and a dorsal part that forms the rectum and the upper part of the anal canal. The site of fusion of the septum with the cloacal membrane is the perineal body.

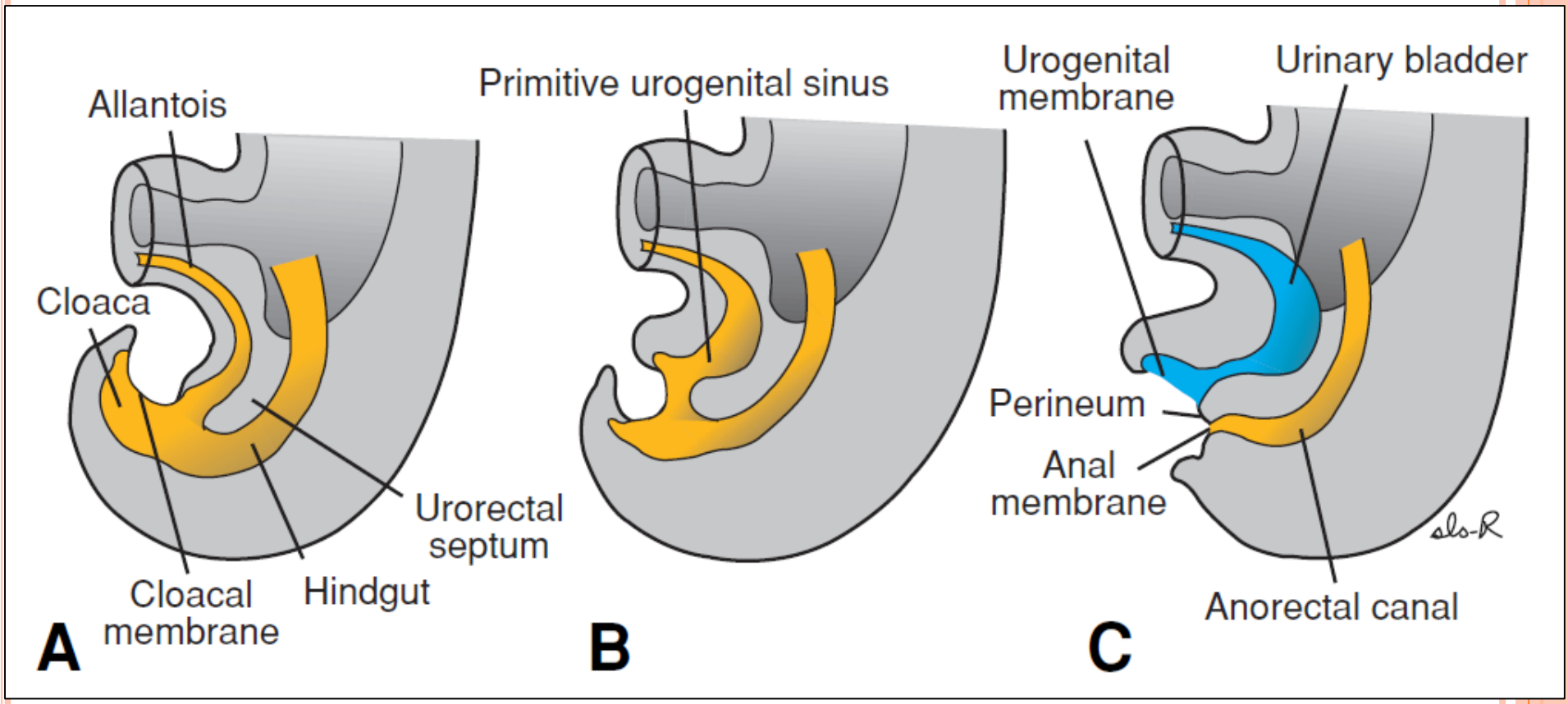


Fig.11: The cloaca and its derivatives

The Anal Canal

- The dorsal part of the cloacal membrane is the anal membrane. Mesenchymal proliferation will raise the surface ectoderm around it forming an ectodermal pit called the anal pit (proctodeum). At the deep end of this pit the anal membrane is located. This will soon rupture allowing the anal canal to communicate with the outside (Fig.12).

- The anal canal, therefore, has a dual origin. The upper part is derived from the endoderm of the hindgut (the cloaca); whereas, the lower part is derived from the ectoderm of the proctodeum. This dual origin is of great clinical importance.

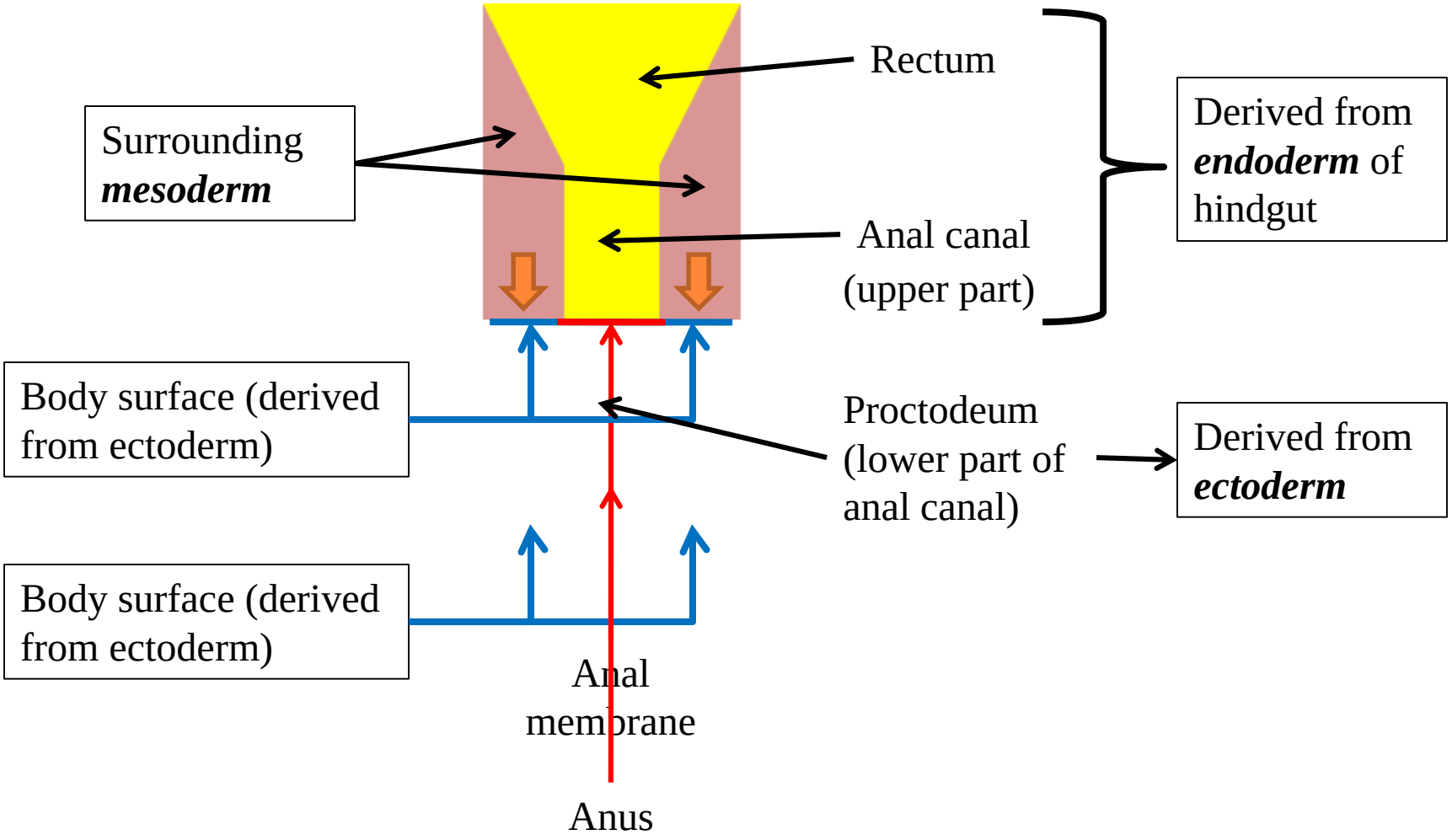


Fig.12a: The formation of the anal canal (interactive animation).

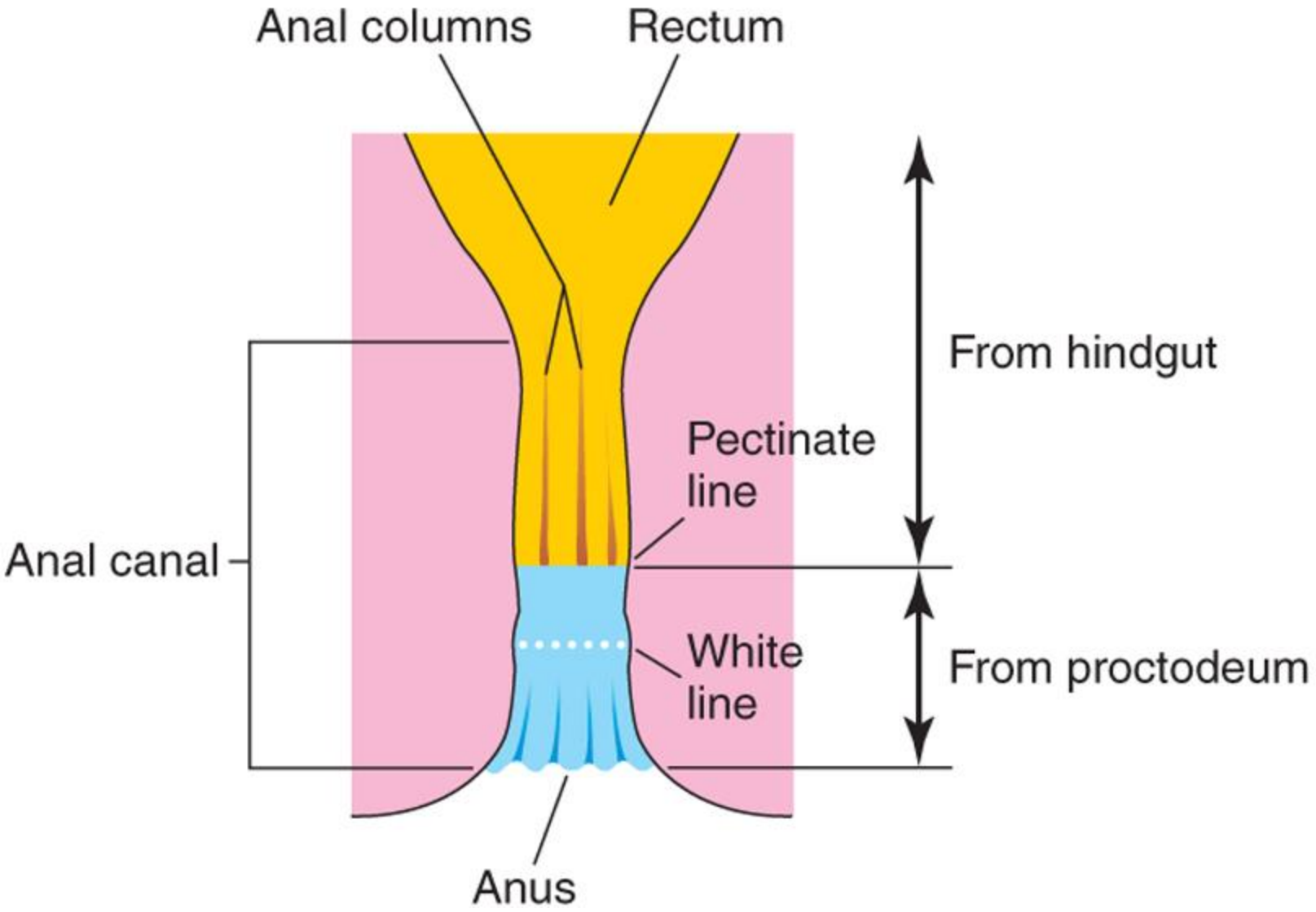


Fig.12b: The formation of the anal canal

Thank You
&
Good Luck