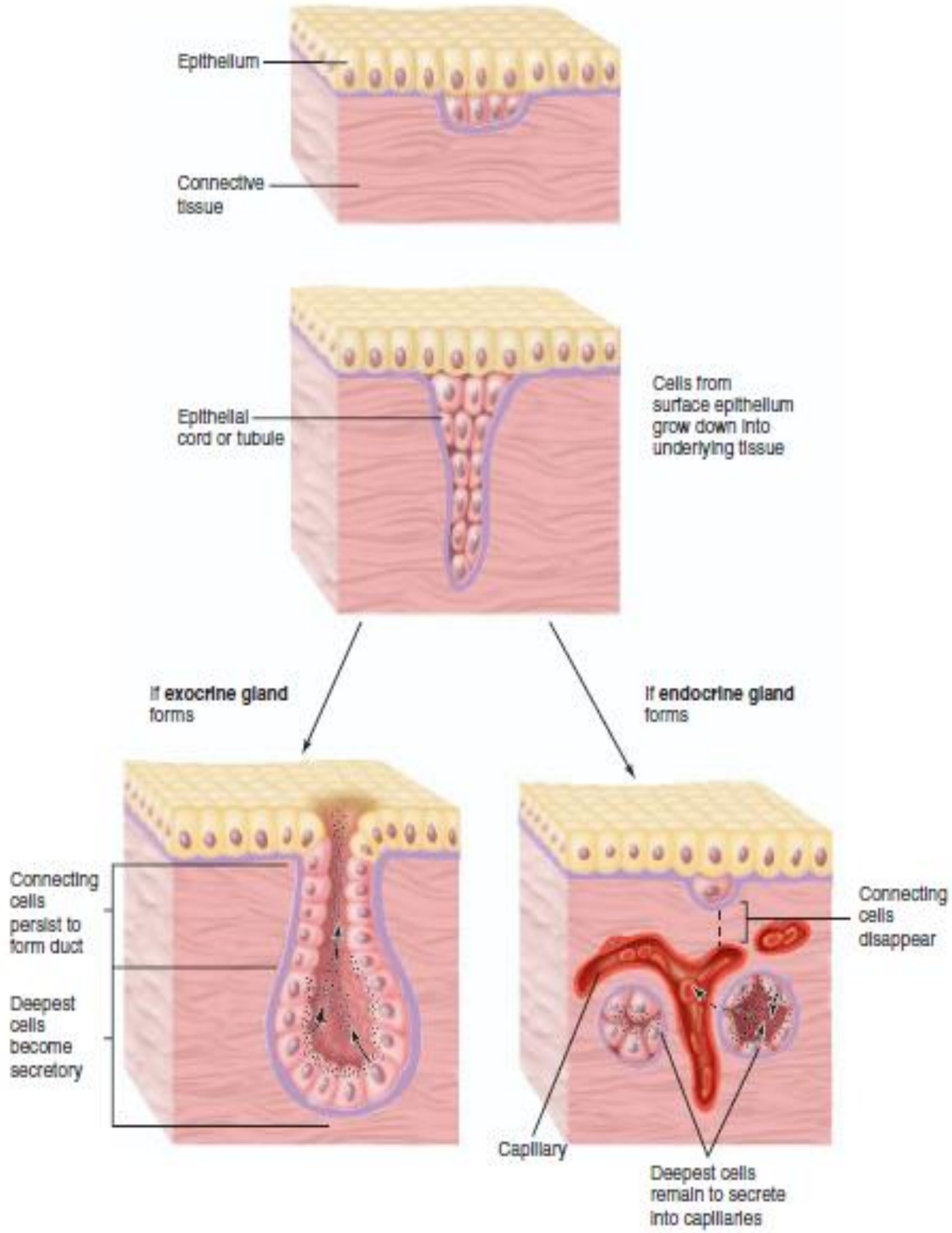
Embryology of the GI tract

Development of the glands

1. How the epithelial tissue cells proliferate and penetrate the connective tissue:

A. Endocrine glands without contact with the surface is formed , notice the amount of cells

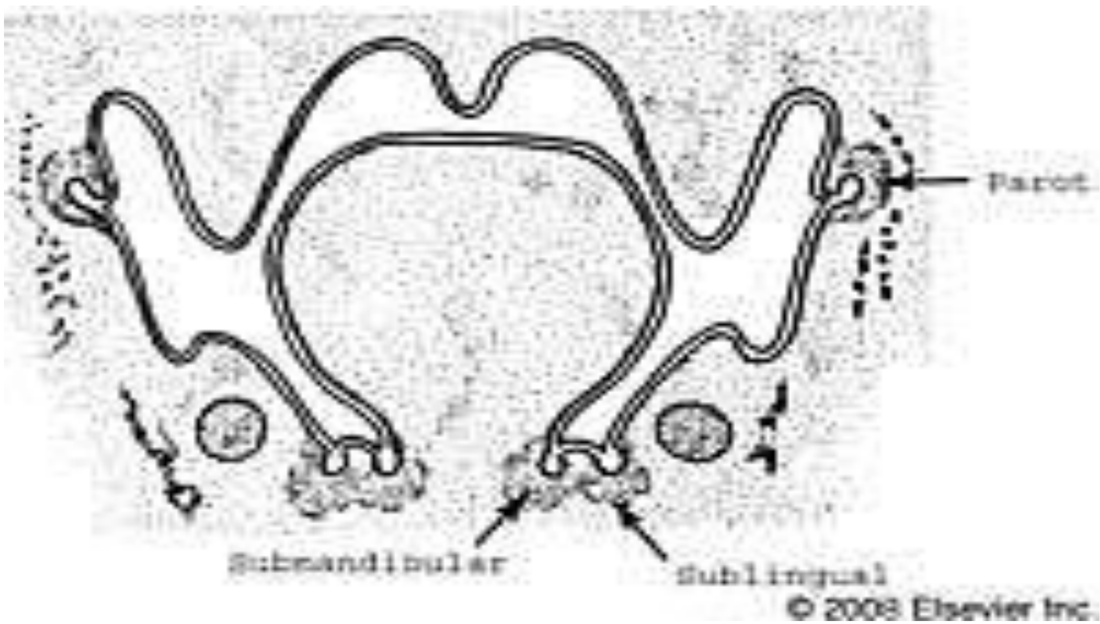
B. Exocrine glands maintain contact with the surface by ducts and are formed.



Development of the glands

- Study the development of salivary glands and how the duct and acini of the parotid gland are derived from ectoderm

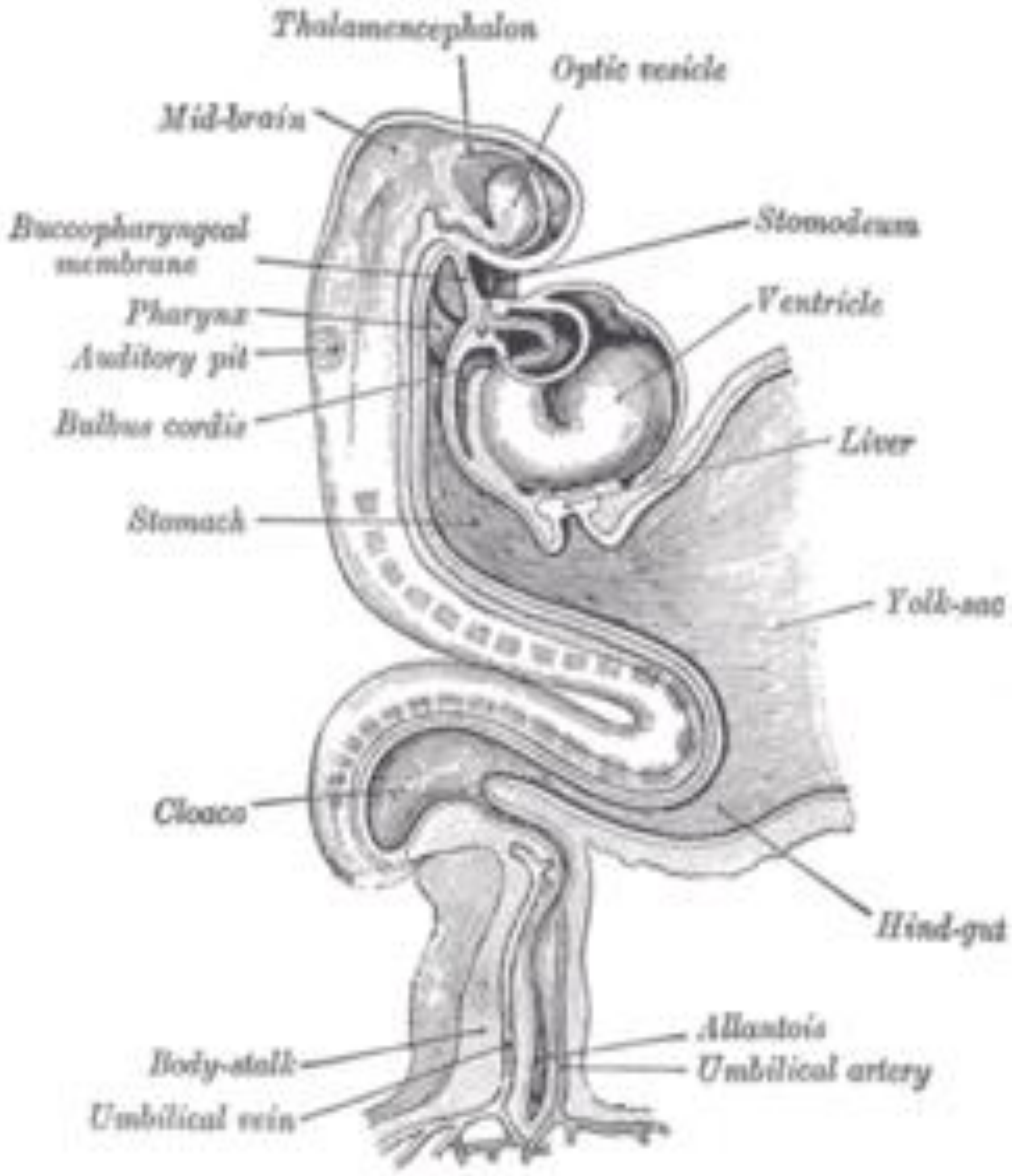
- Submandibular and sublingual glands are derived from endoderm



Development of the mouth

- Study how the mouth is formed from 2 sources and notice that the hard palate, sides of the mouth, lips and enamel of the teeth developed from ectoderm

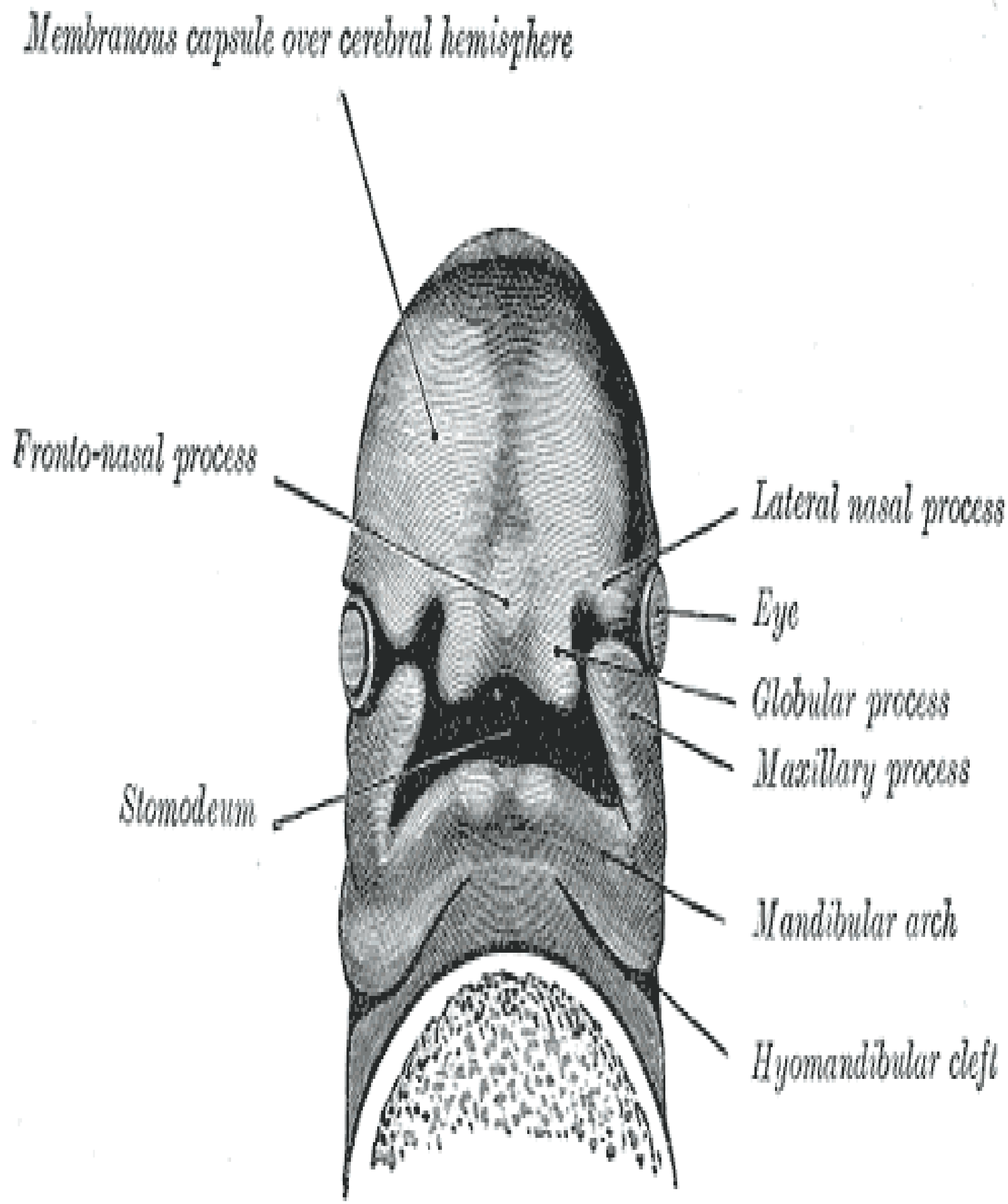
- Study how the floor of the mouth, tongue and soft palate and palatoglossal and palatopgaryngeal folds are developed from endoderm



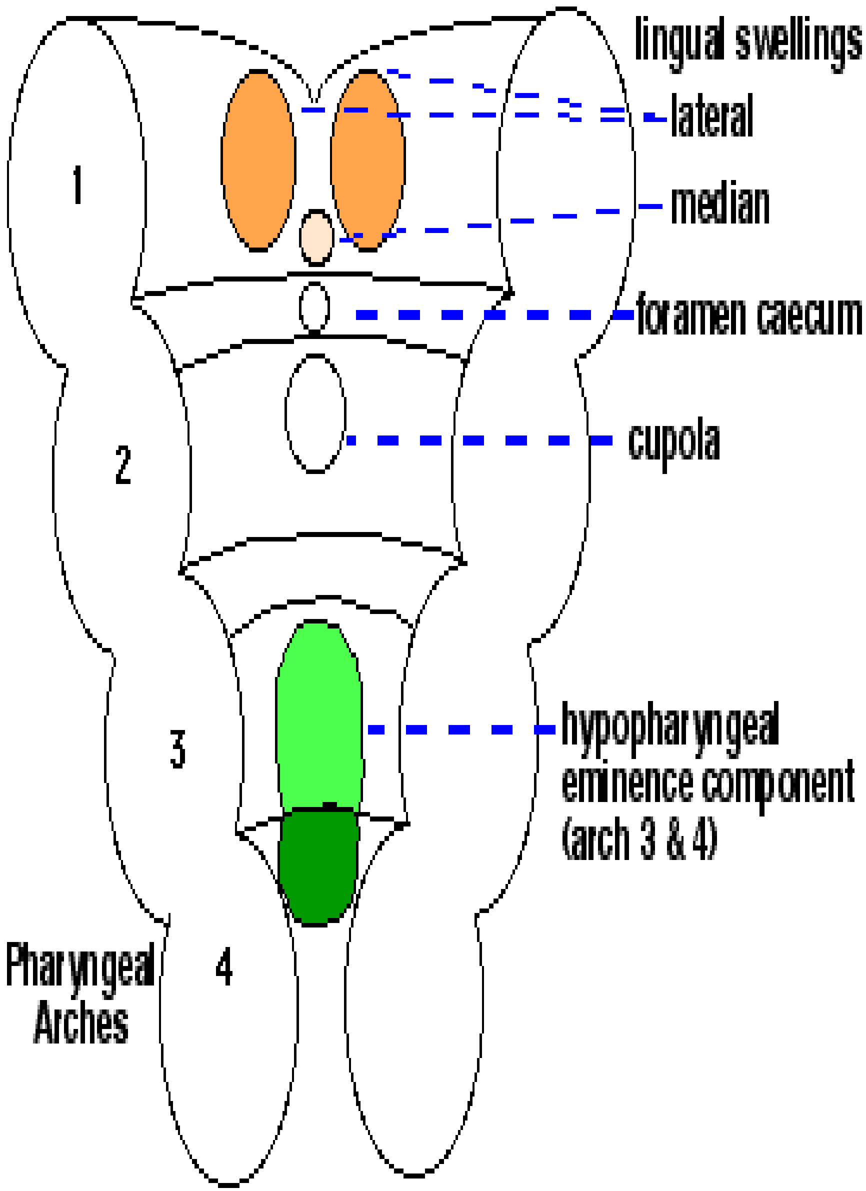
Development of the mouth

Study the development of the tongue and notice:

1. Tuberculum impar (endoderm)
2. Lateral lingual swelling (developed from the first pharyngeal arch)
3. Second median swelling (copula)
4. The third pharyngeal arch from the posterior third of the tongue
5. The sulcus terminalis represent the interval between the first and third pharyngeal arches.

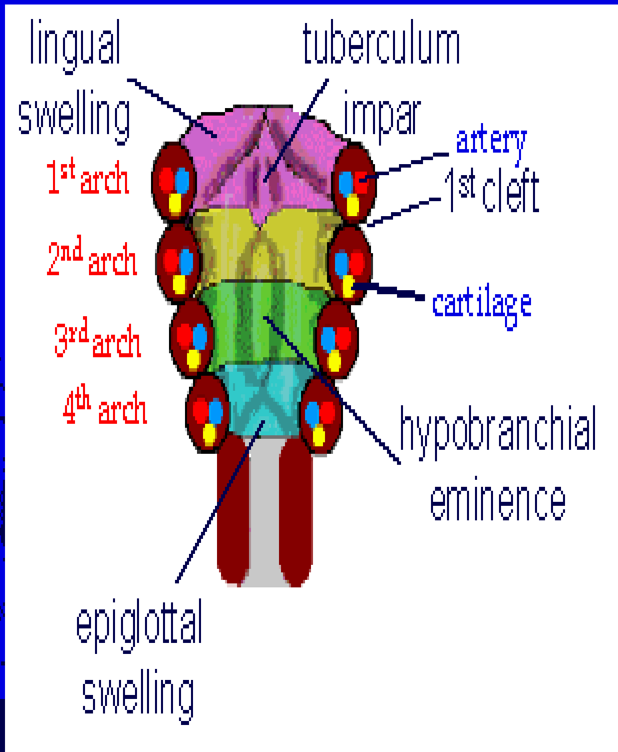


Development of the Tongue (part 1)

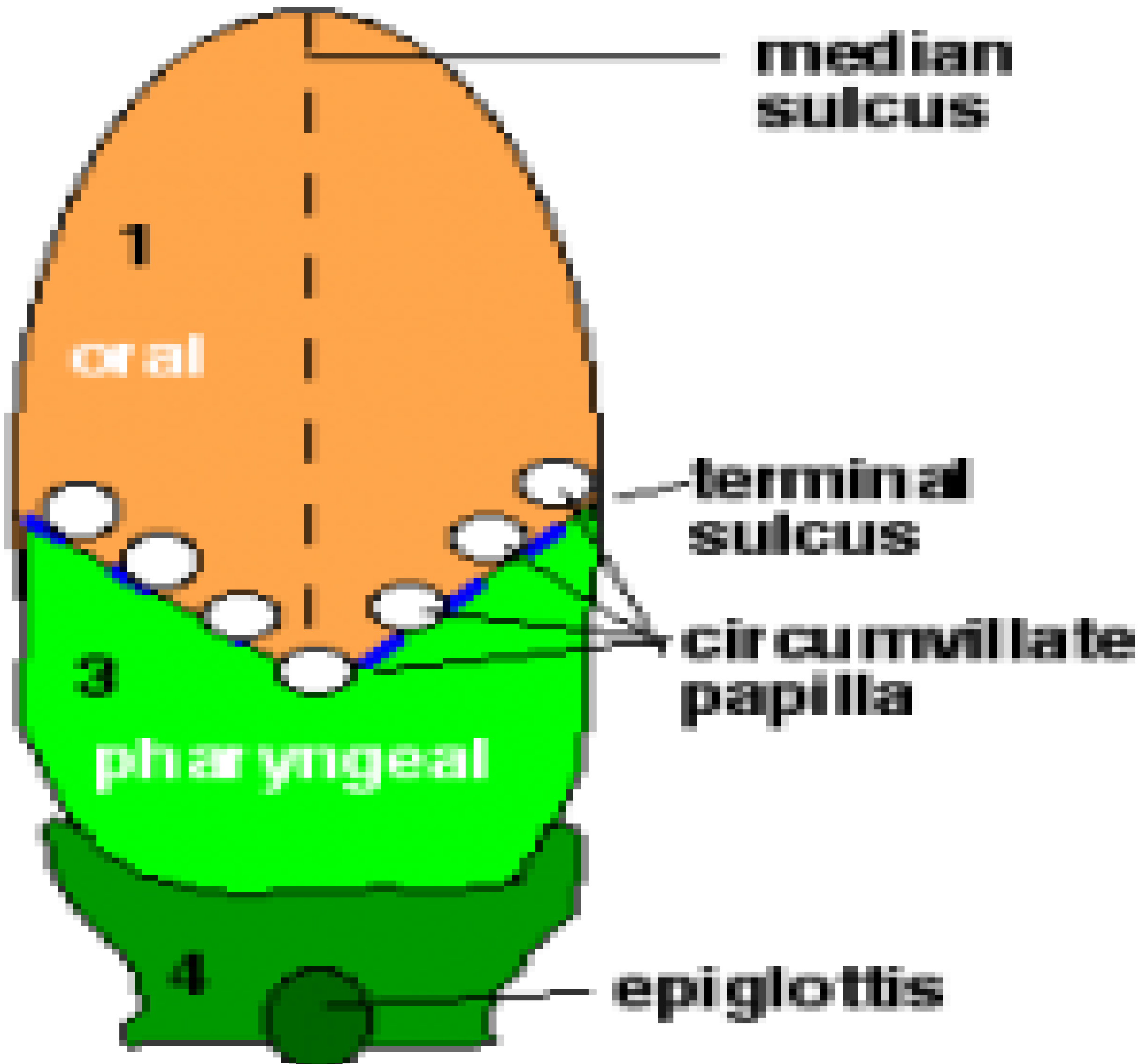


Development of the Tongue

- Tongue develops where the stomodeum and pharynx meet.



Development of the Tongue (part 3)

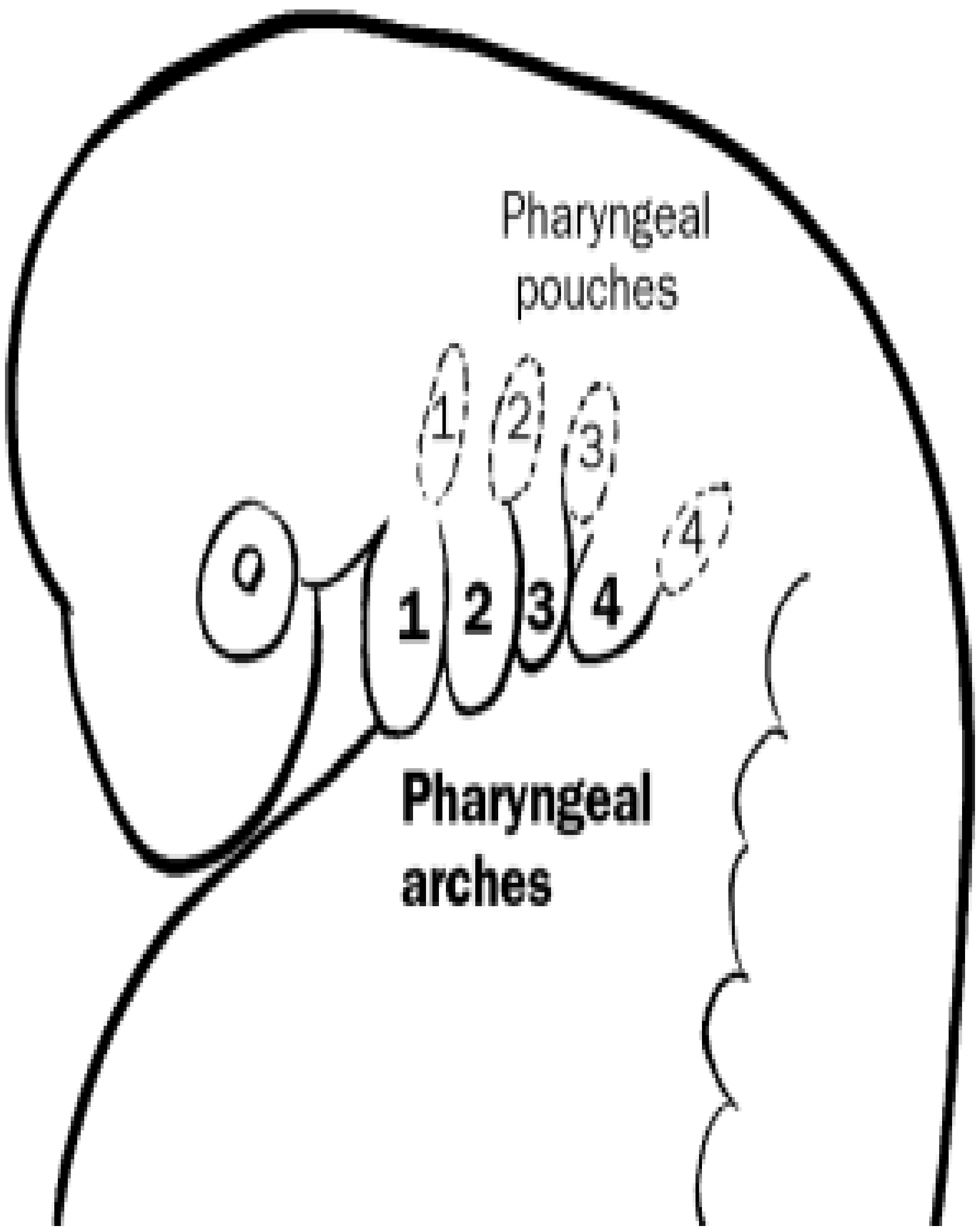


Development of the pharynx

- The student should study the development of the pharynx in the neck from the endoderm of the foregut.

- How the endoderm is separated from the surface ectoderm by a layer of mesenchyme

- How the mesenchyme on each side becomes split up into (5-6) pharyngeal arches



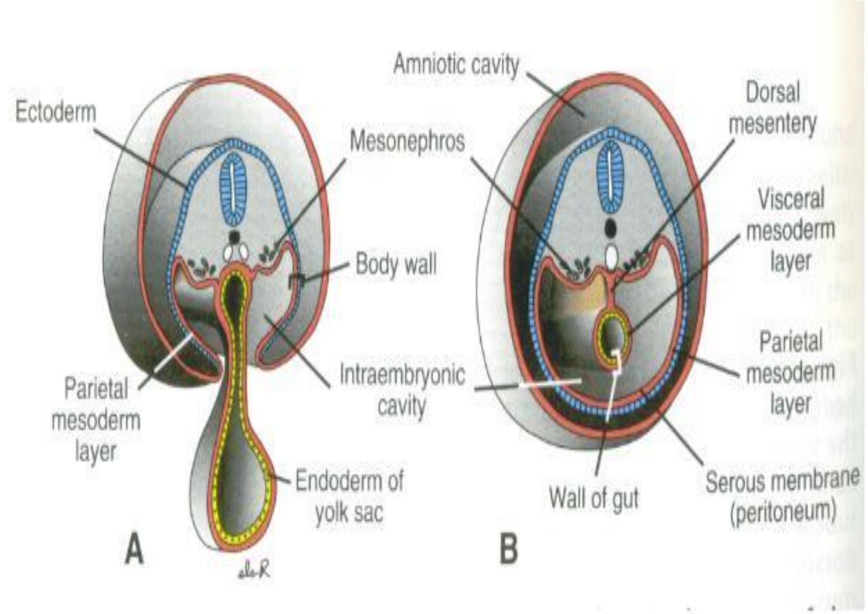
Development of the anterior abdominal wall and abdominal muscles

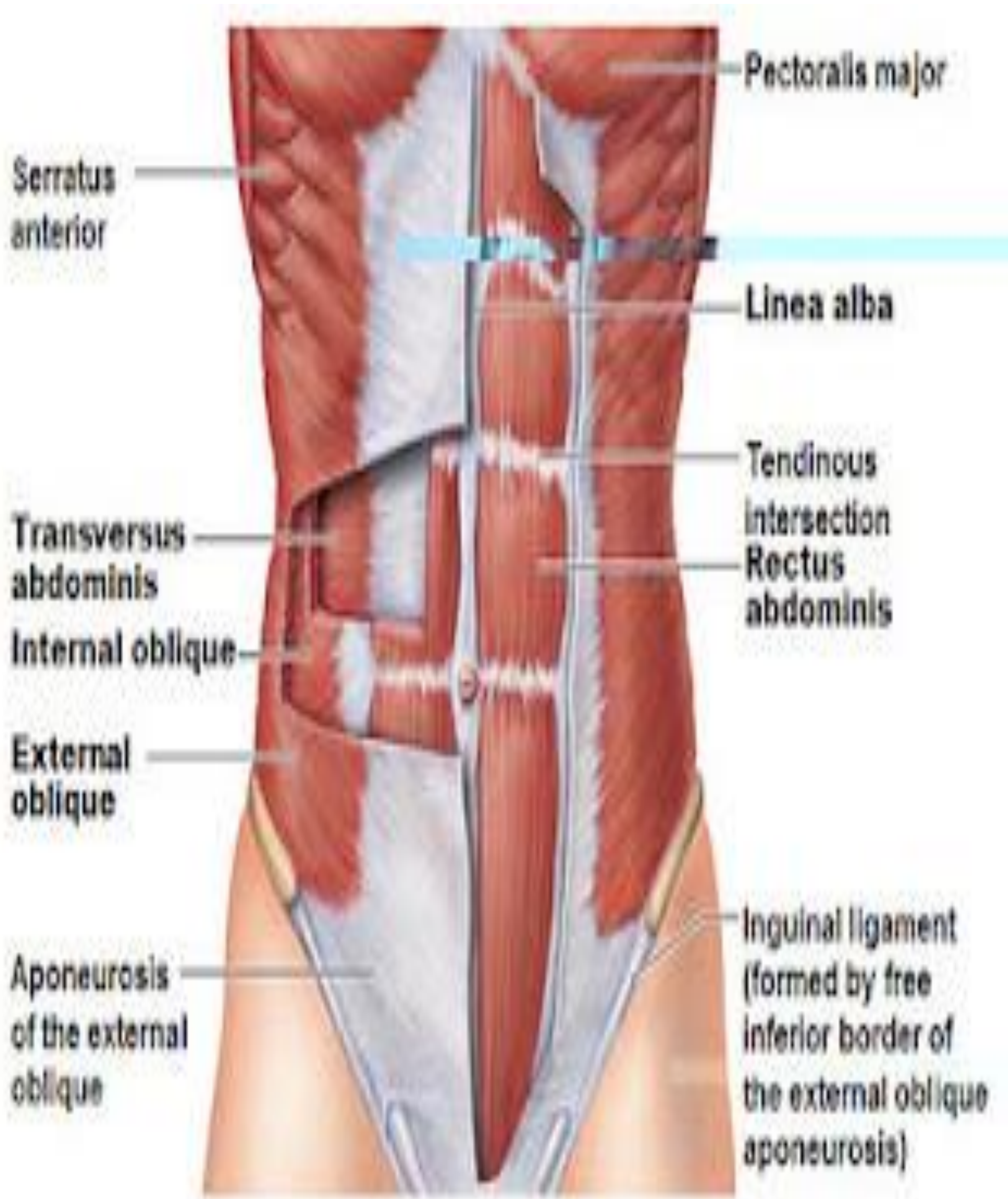
Lateral Plate Mesoderm Further Divides into Somatopleuric mesoderm and Splanchnopleuric mesoderm.

1. Development of ectoderm
2. Development of endoderm
3. Segmentation of the mesoderm as the lateral mesoderm split into somatic and splanchnic mesoderm
4. How the anterior abdominal muscles is developed from the somatopleuric mesoderm
5. How the rectus abdominis is developed inside the rectus sheath and how the linea alba in midline is developed

Somatopleuric mesoderm becomes parietal mesoderm which form serous membranes that line the peritoneal, pleural, and pericardial cavities.

Splanchnopleuric mesoderm becomes visceral mesoderm which form serous membranes that line each organ.

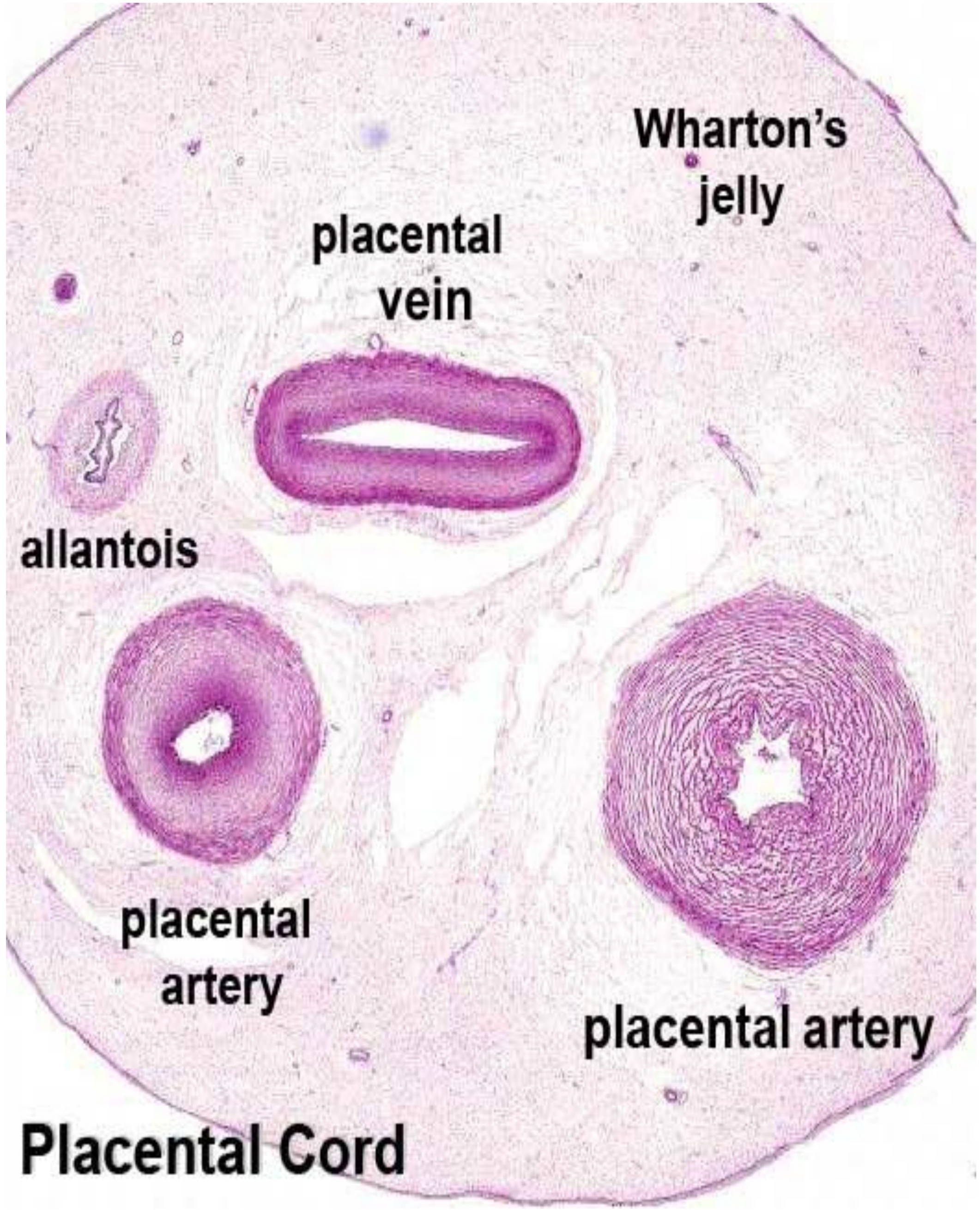



Pectoralis major
Serratus anterior
Linea alba
Tendinous intersection
Transversus abdominis
Rectus abdominis
Internal oblique
External oblique
Inguinal ligament (formed by free inferior border of the external oblique aponeurosis)
Aponeurosis of the external oblique

Development of the umbilical cord and the umbilicus

1. How the body stalk and yolk sac with their blood vessels form the tubular umbilical cord

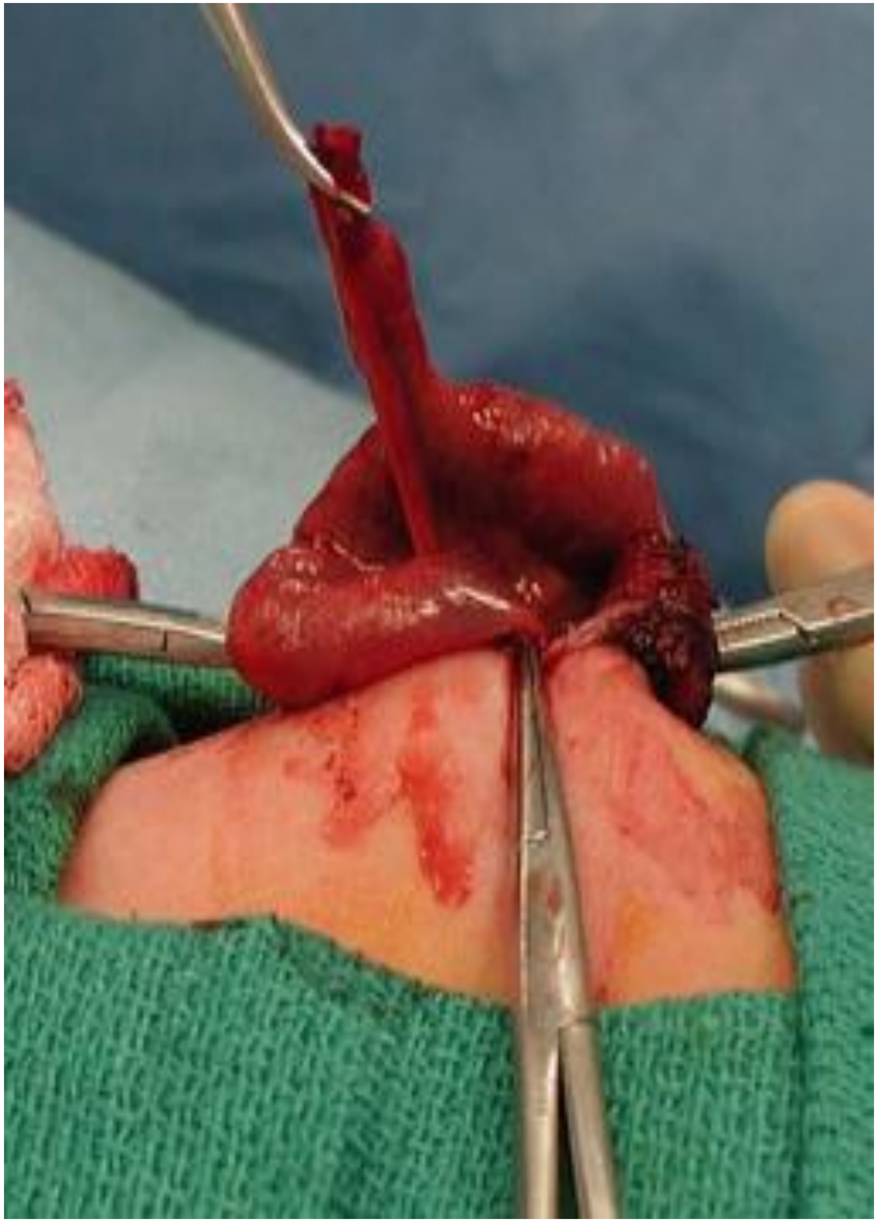
2. Notice the loose connective tissue in the umbilical cord contains vitteline duct, remains of yolk sac , remains of alluntois, umbilicak vessels (arteries and veins)



Clinical points

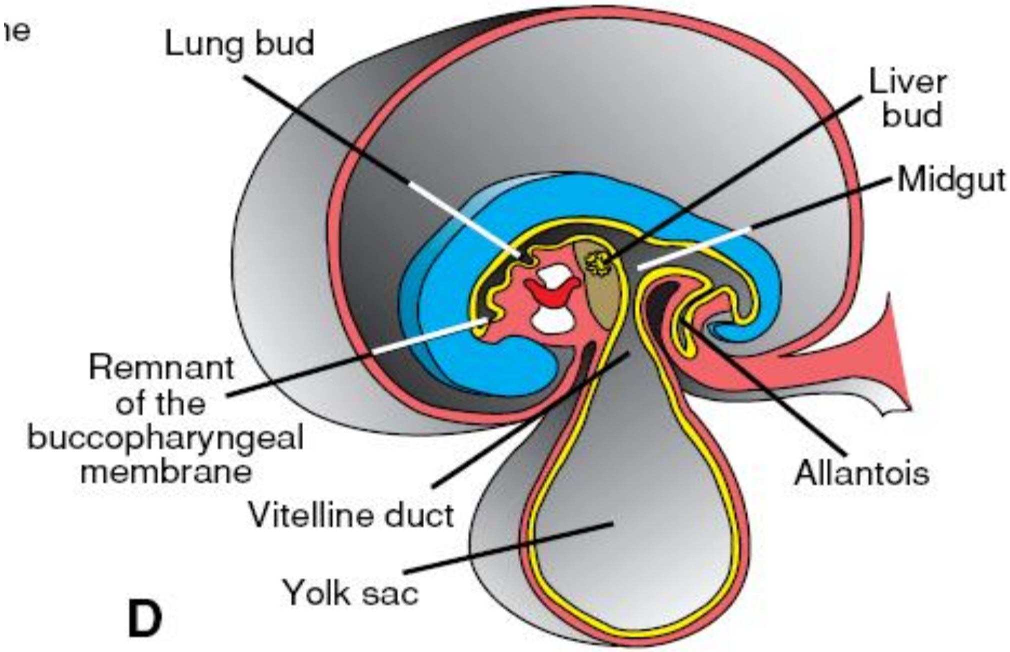
Study the following :

1. The Meckel's diverticulum
2. The persistence of vitellointestinal duct which causes umbilical fecal fistula

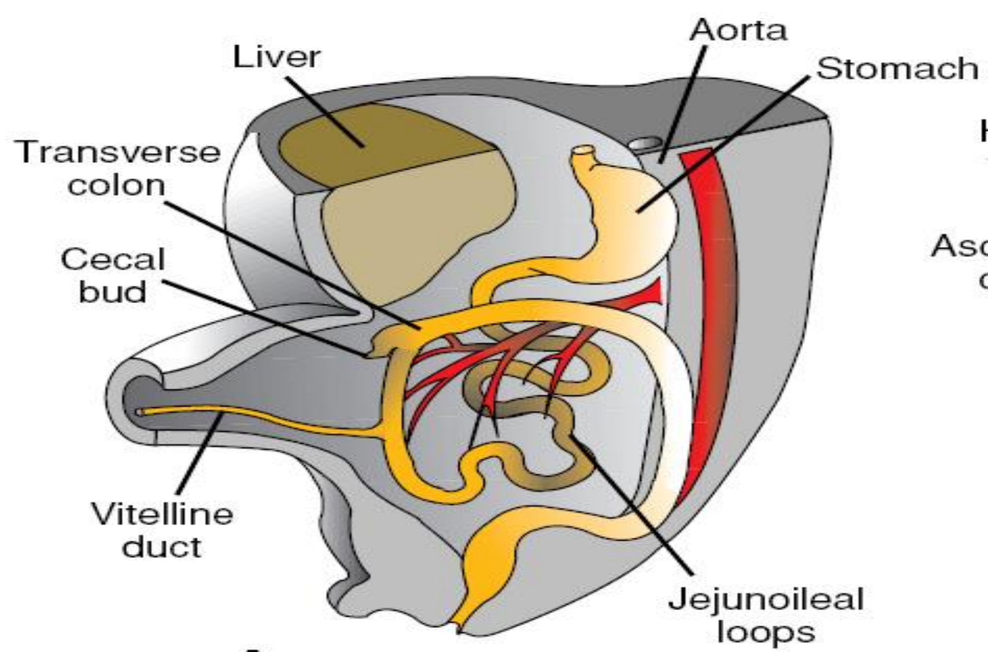


Development of the primitive gut which is divided into pharyngeal gut (pharynx)

1. **Foregut: extends to liver bud**
2. **Midgut : extends from liver bud to lateral third of transverse colon**
3. **Hindgut: extends from lateral third of the T-colon to the cloacael membrane**



D



A

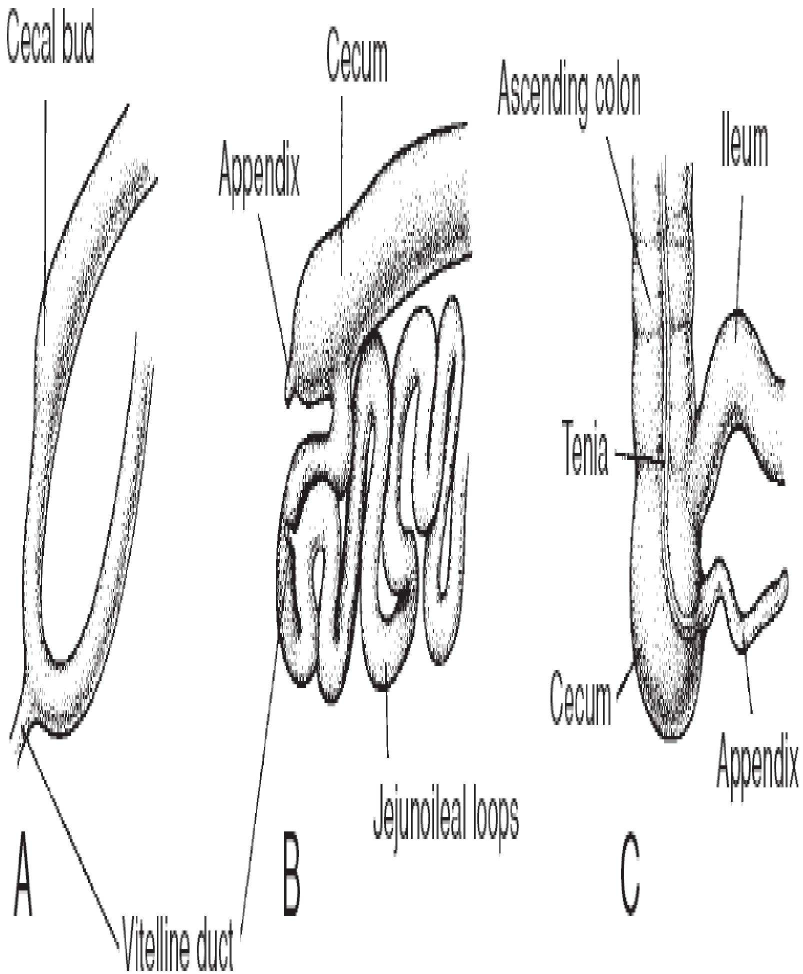
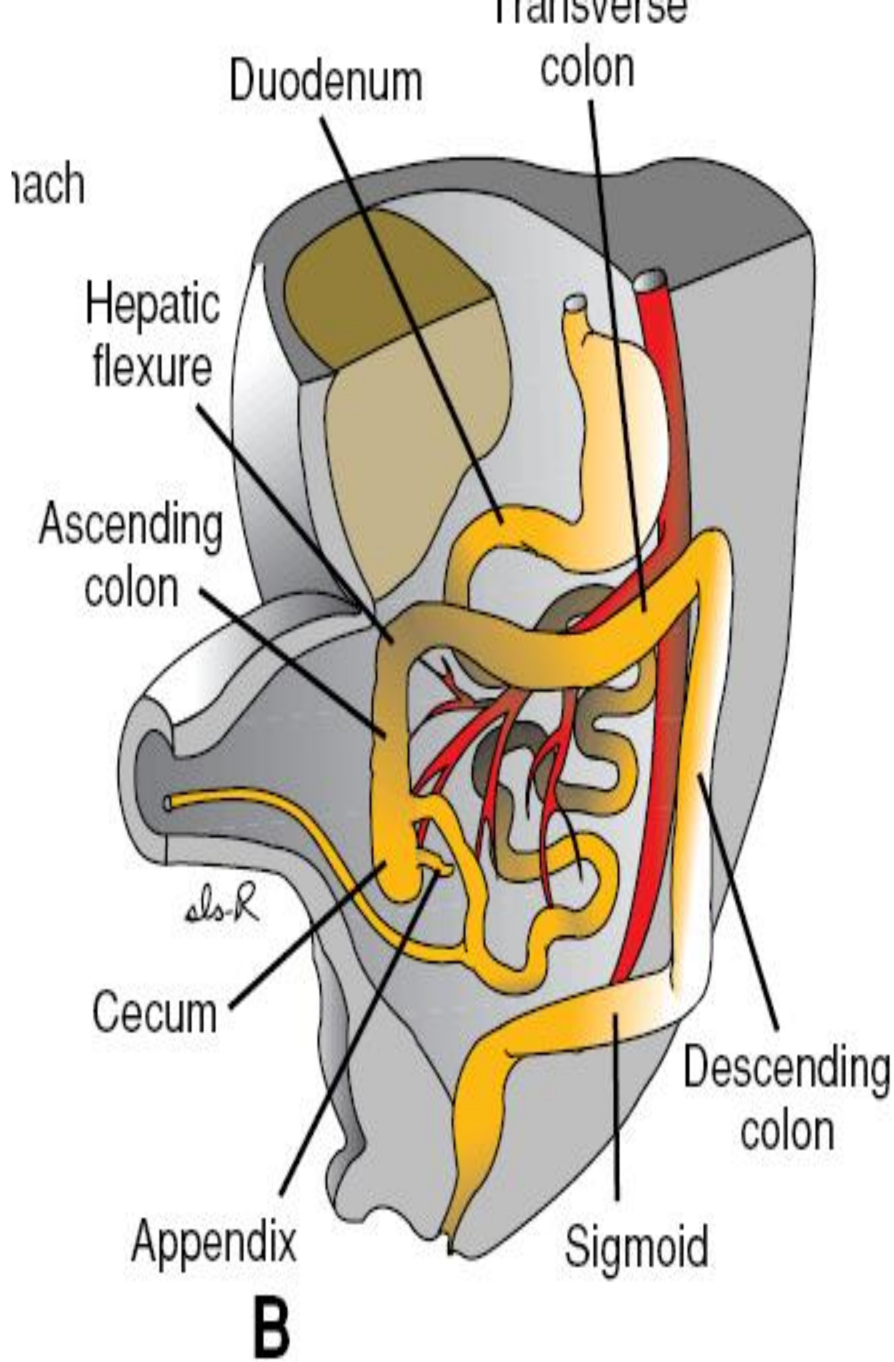


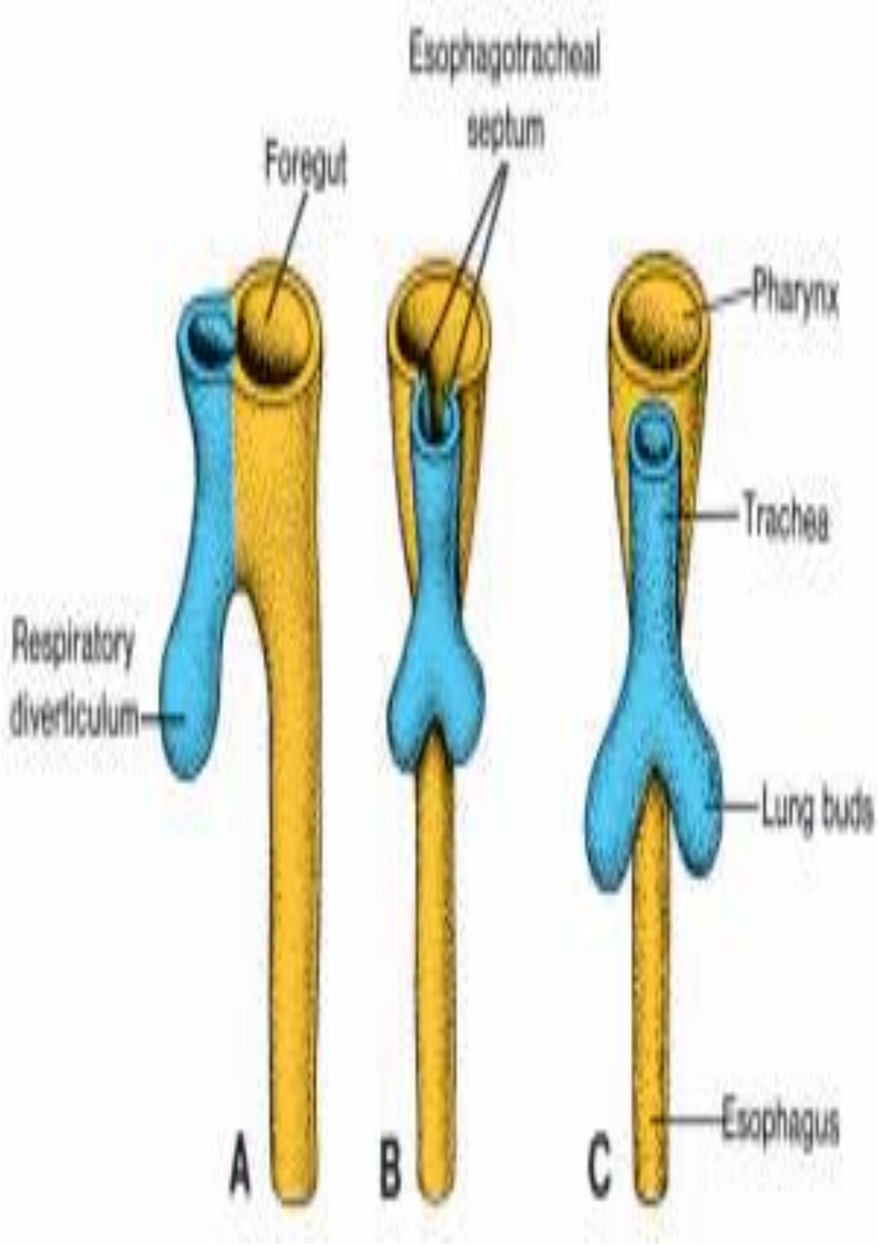
Figure 13.28 Successive stages in development of the cecum and appendix. **A.** 7 weeks. **B.** 8 weeks. **C.** Newborn.

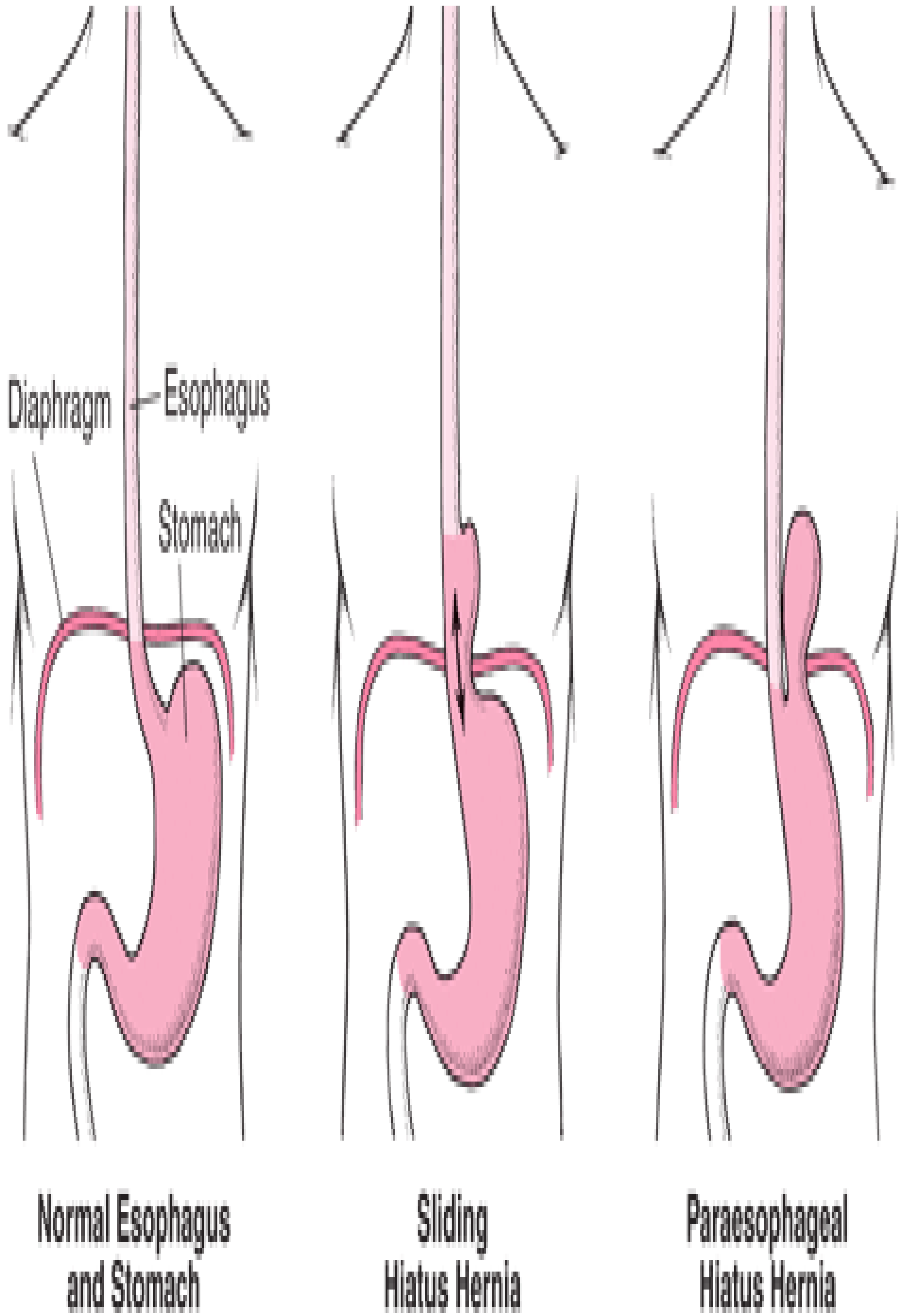


Development of the esophagus

Study how it is developed as a part of foregut :

1. **First it is short and then elongate rapidly downwards**
2. **Study the clinical abnormalities (fistula)**





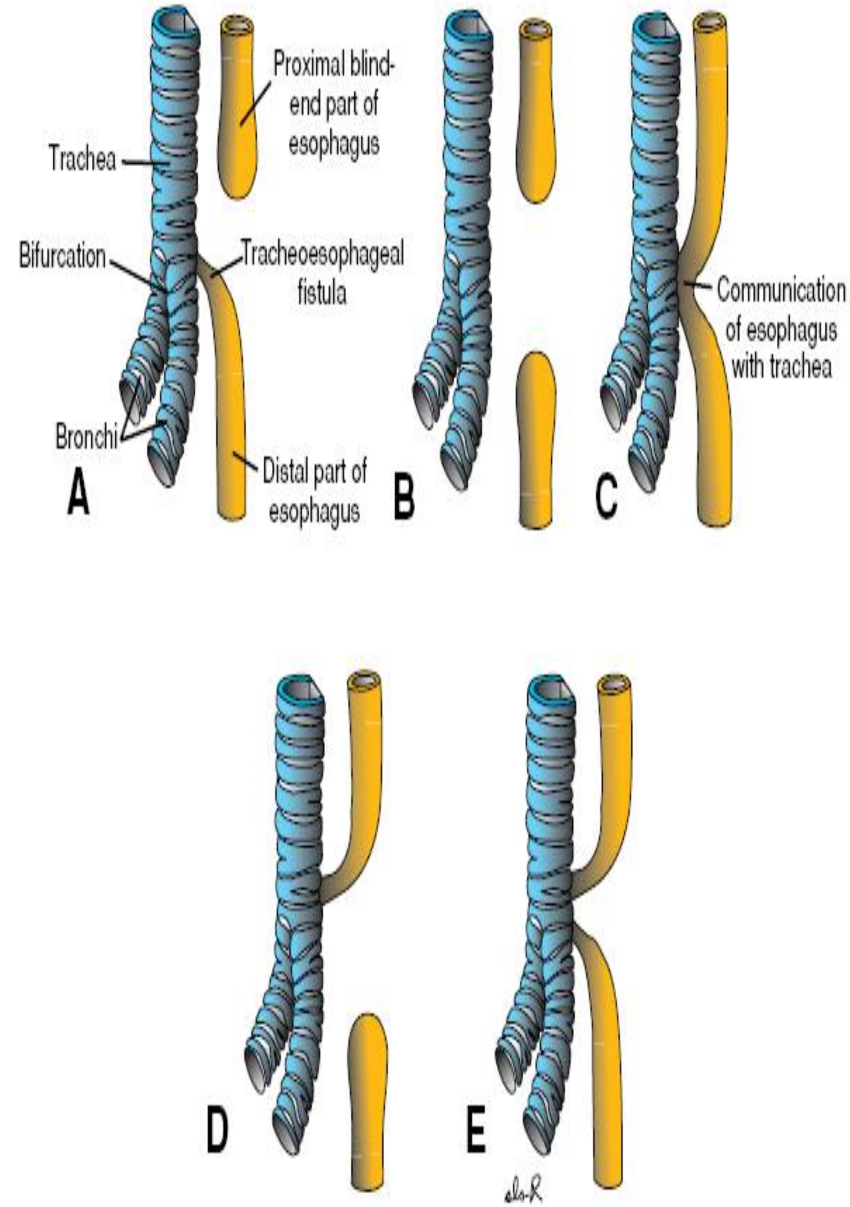


Figure 13.7 Variations of esophageal atresia and/or tracheoesophageal fistula in order of their frequency of appearance: **A,** 90%; **B,** 4%; **C,** 4%; **D,** 1%; and **E,** 1%.

Development of the stomach

1. Study how the stomach from the greater and lesser curvature as a result of rapid growth of dorsal mesentery and slow growth of ventral mesentery
2. As a result of rotation of the stomach of the right side it forms the anterior and posterior surfaces and the right and left vagi become anterior and posterior
3. As a result of rotation the mesenteries form the omenta (lesser and greater omentum) and ligaments of the stomach
4. The dorsal mesentery forms the ligaments of the stomach and mesenteries of small and large intestines as greater omentum.
5. The ventral mesenteries forms the liver ligaments

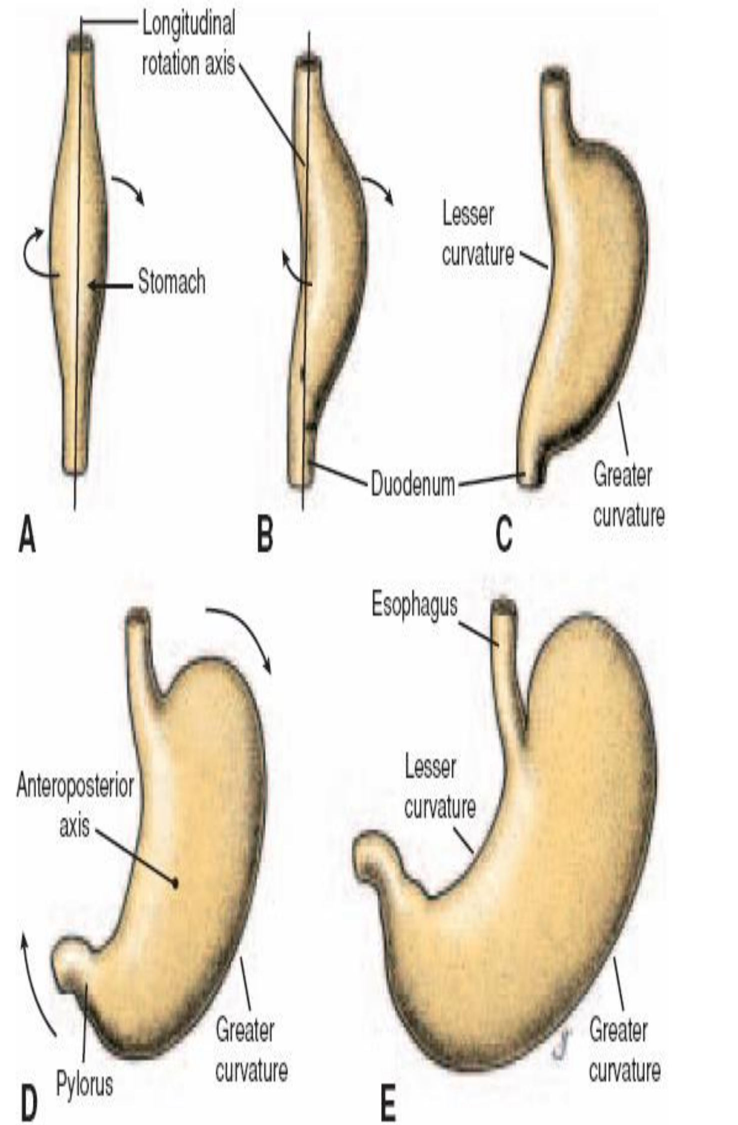
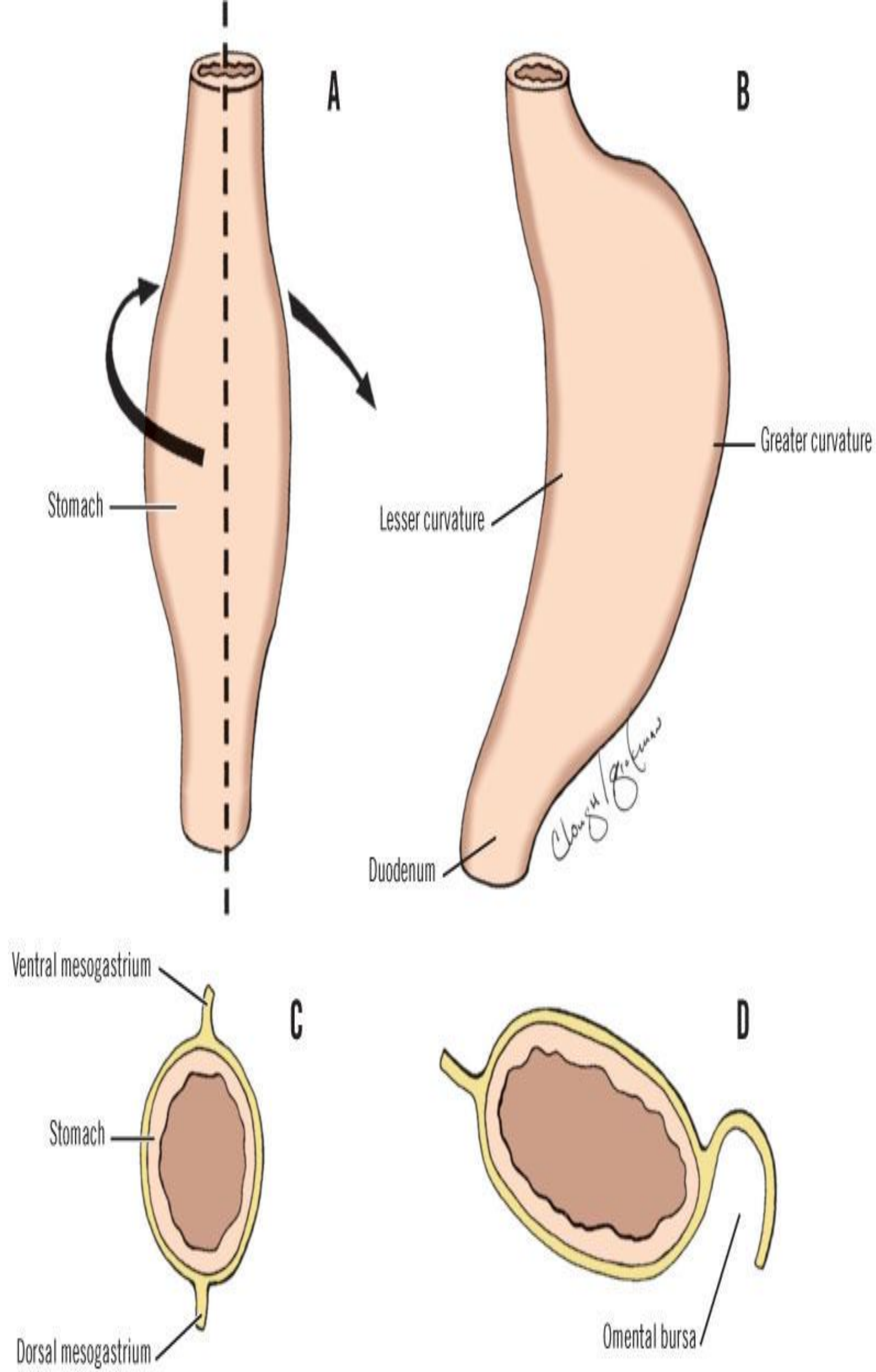


Figure 13.8 A, B, and **C.** Rotation of the stomach along its longitudinal axis as seen anteriorly. **D** and **E.** Rotation of the stomach around the anteroposterior axis. Note the change in position of the pylorus and cardia.

Note: during 6 weeks of development the capacity of abdominal capacity is greatly reduced due to great enlargement of liver and kidneys so physiological herniation of mid gut results



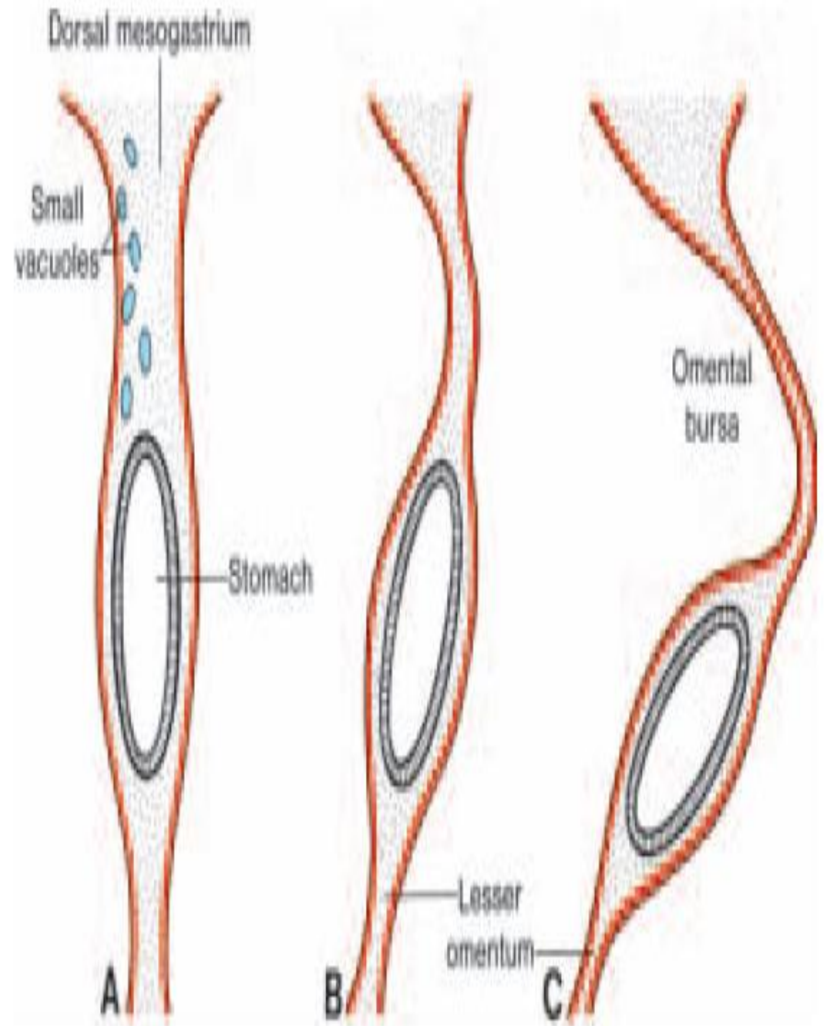


Figure 13.9 A. Transverse section through a 4-week embryo showing intercellular clefts appearing in the dorsal mesogastrium. **B** and **C.** The clefts have fused, and the omental bursa is formed as an extension of the right side of the intraembryonic cavity behind the stomach.

Development of greater and lesser sac of peritoneum

1. Observe the extensive growth of the right lobe of the liver which pulls the ventral mesentery to the right side

2. Observe the rotation of the stomach and the duodenum

3. Observe the right free border of ventral mesentery becomes the right border of the lesser omentum

4. Observe the greater sac the remaining part of the peritoneal cavity

5. Observe the epiploic foramen

6. Observe the formation of the greater omentum as a result of rapid and extensive growth of the dorsal mesenteries

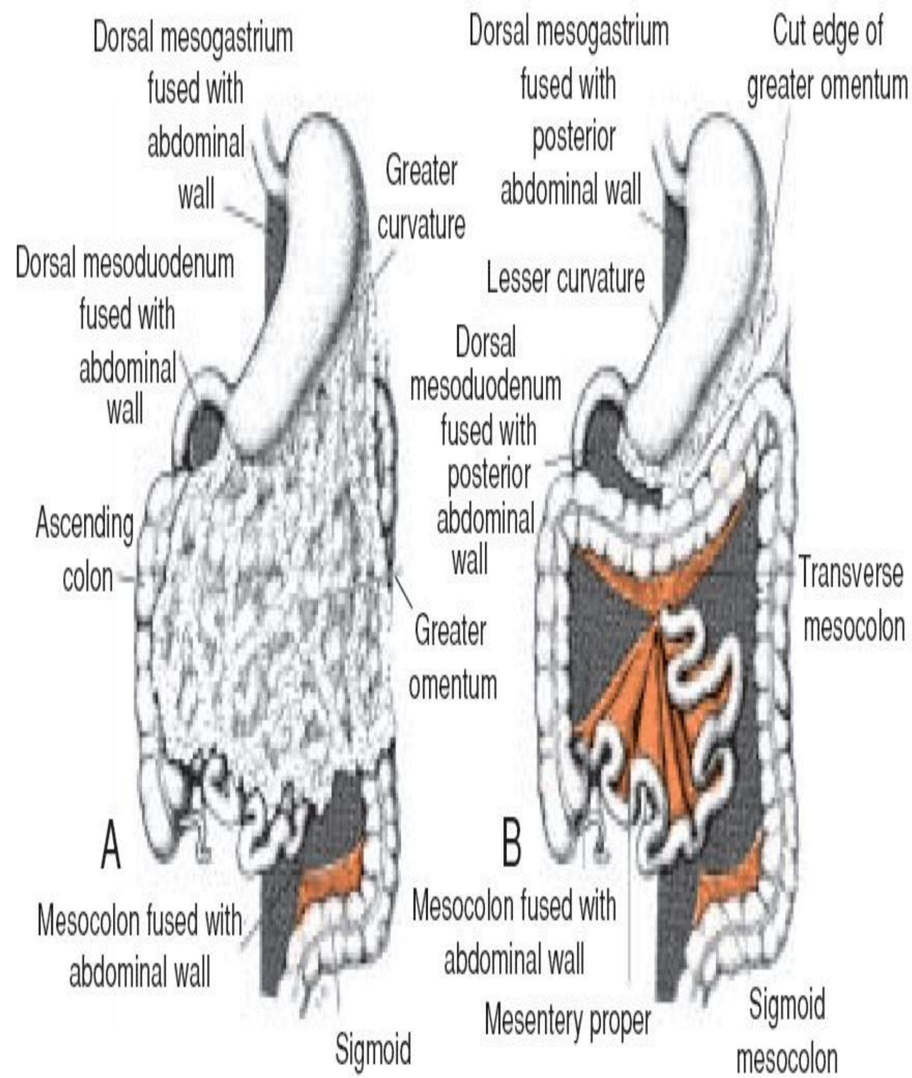
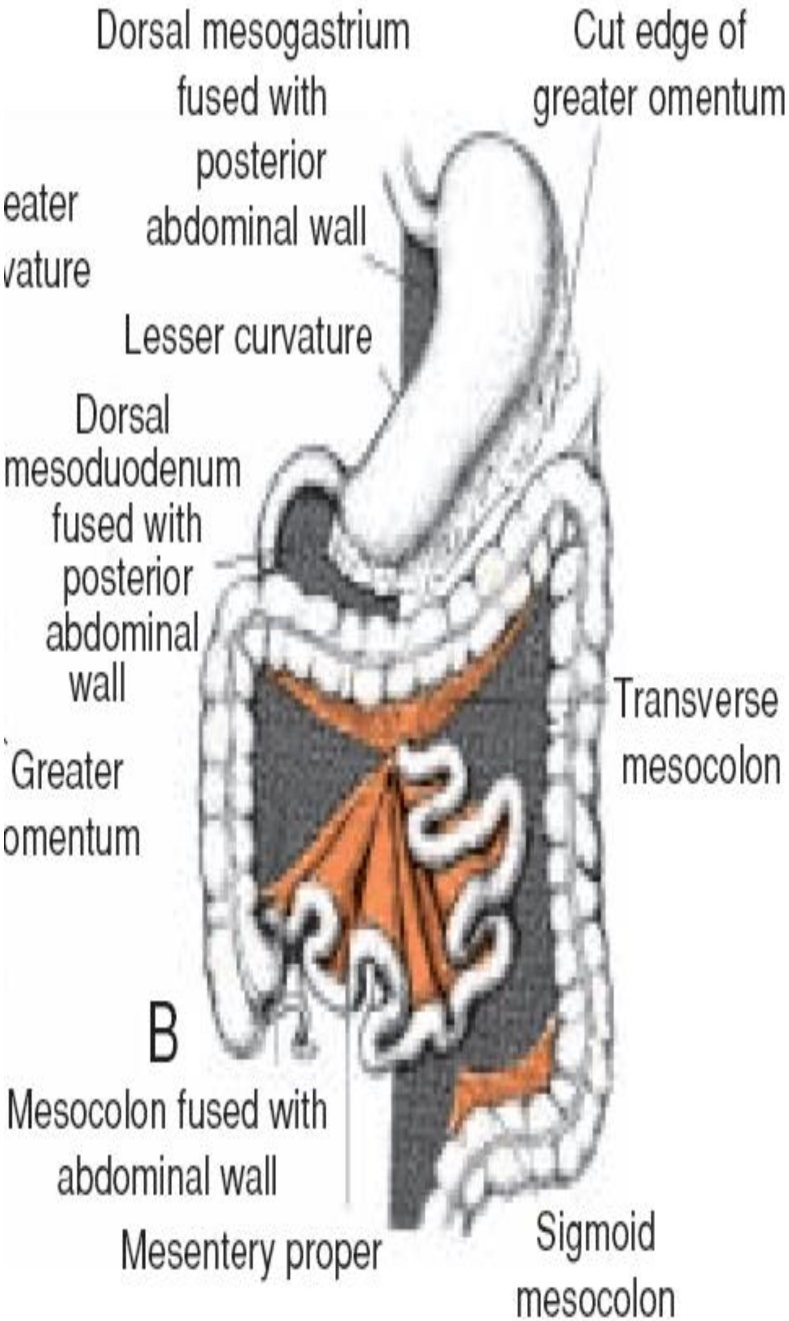


Figure 13.30 Frontal view of the intestinal loops with (**A**) and after removal of (**B**) the greater omentum. *Gray areas*, parts of the dorsal mesentery that fuse with the posterior abdominal wall. Note the line of attachment of the mesentery proper.



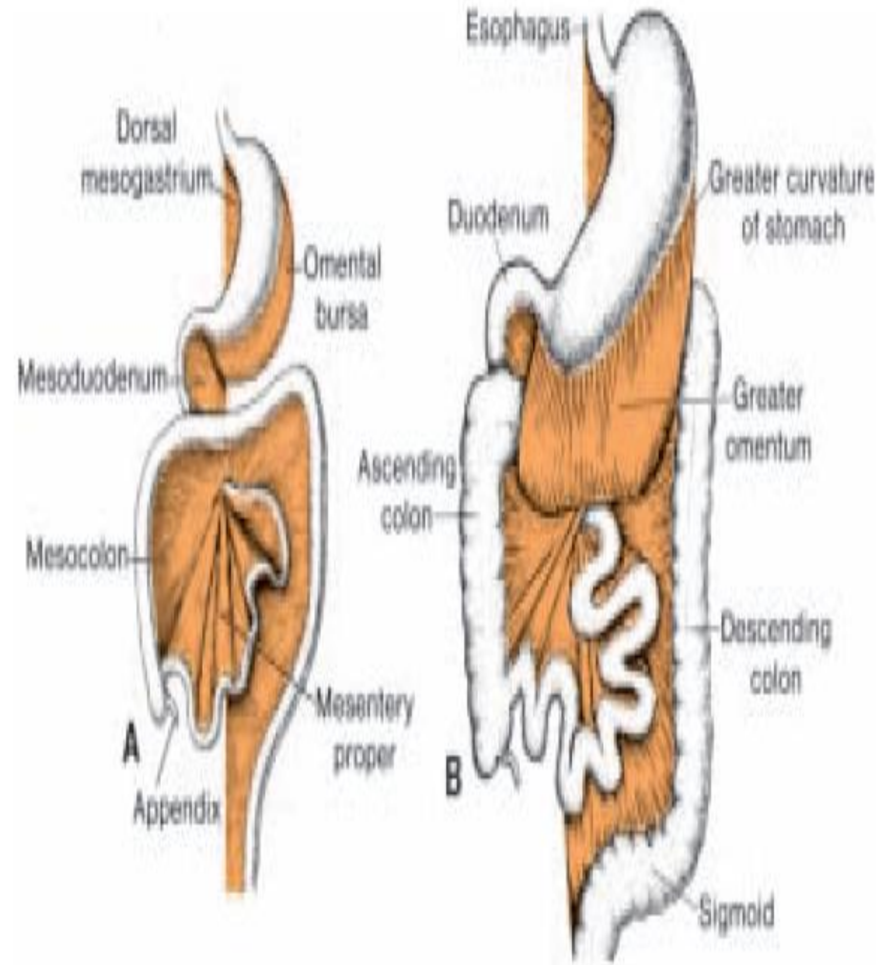
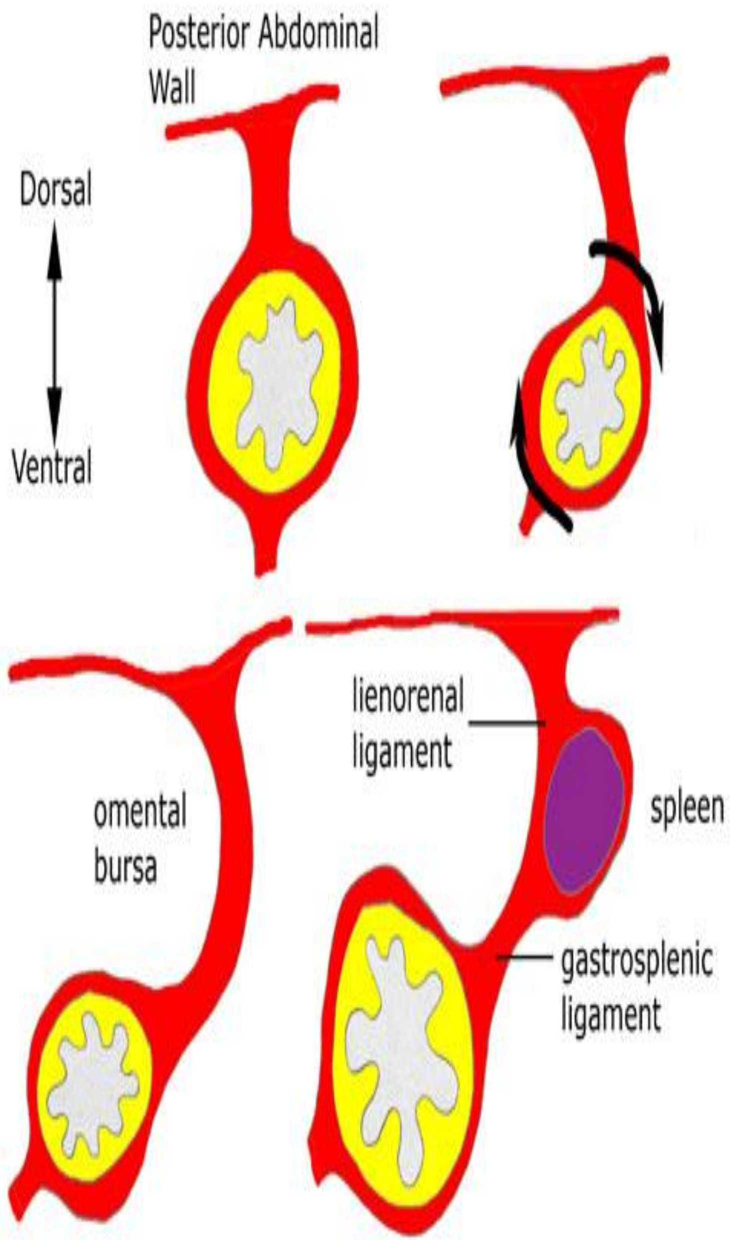
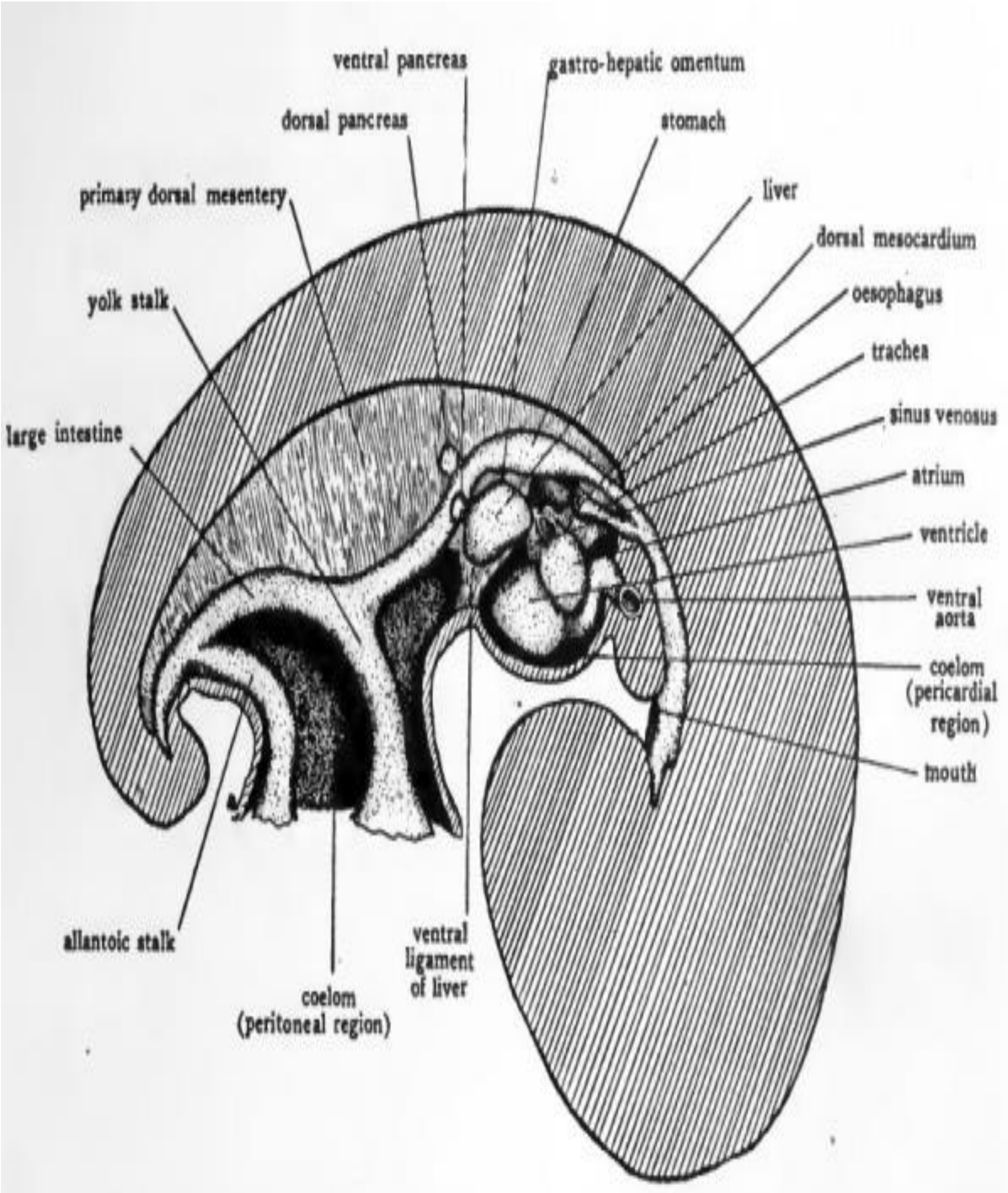


Figure 13.12 A. Derivatives of the dorsal mesentery at the end of the third month. The dorsal mesogastrium bulges out on the left side of the stomach, where it forms part of the border of the omental bursa. **B.** The greater omentum hangs down from the greater curvature of the stomach in front of the transverse colon.

Transverse Section Stomach





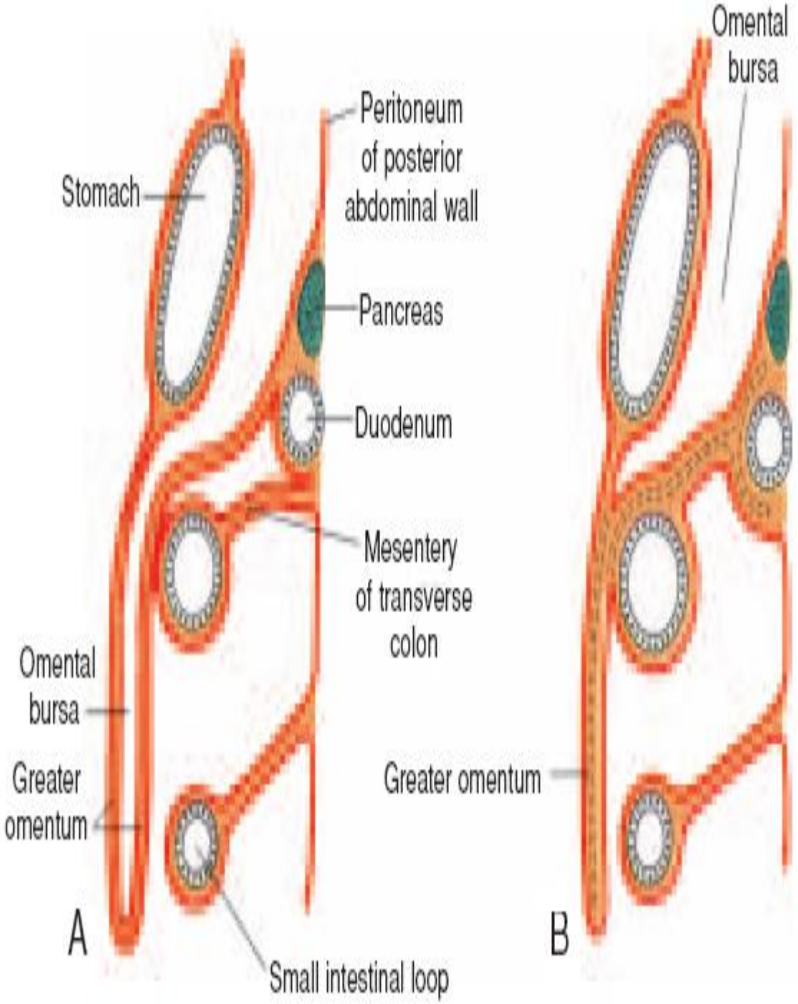


Figure 13.13 A. Sagittal section showing the relation of the greater omentum, stomach, transverse colon, and small intestinal loops at 4 months. The pancreas and duodenum have already acquired a retroperitoneal position. **B.** Similar section as in **A,** in the newborn. The leaves of the greater omentum have fused with each other and with the transverse mesocolon. The transverse mesocolon covers the duodenum, which fuses with the posterior body wall to assume a retroperitoneal position.

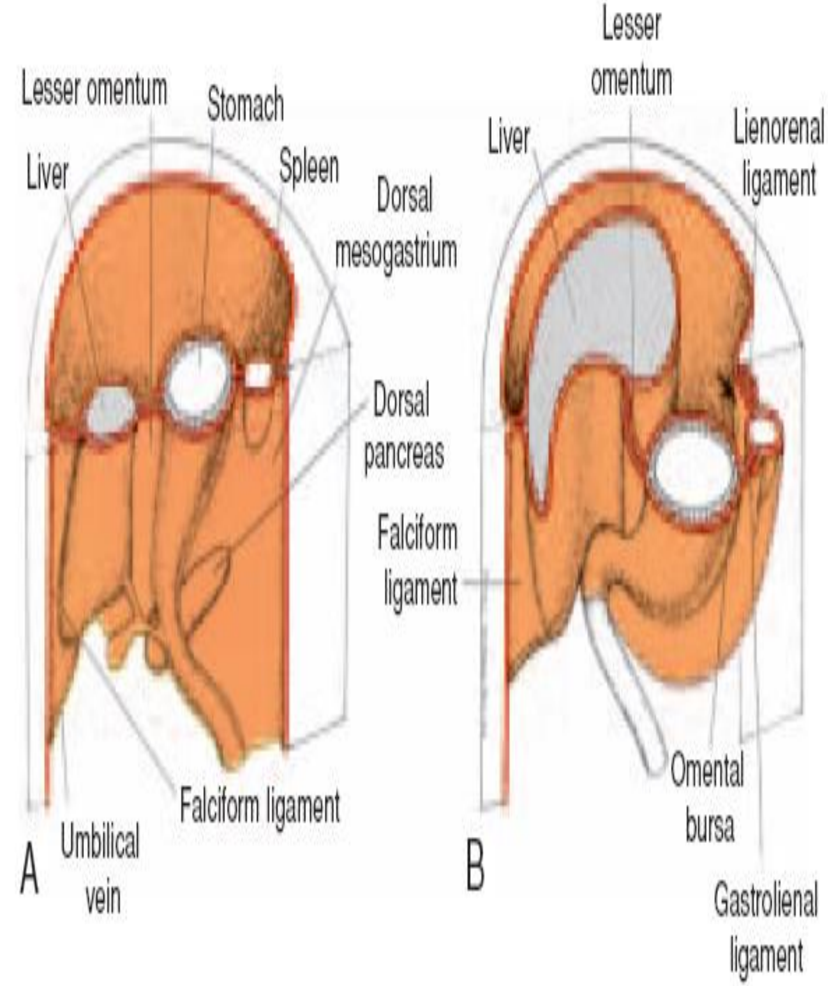


Figure 13.10 A. The positions of the spleen, stomach, and pancreas at the end of the fifth week. Note the position of the spleen and pancreas in the dorsal mesogastrium. **B.** Position of spleen and stomach at the 11th week. Note formation of the omental bursa or lesser peritoneal sac.

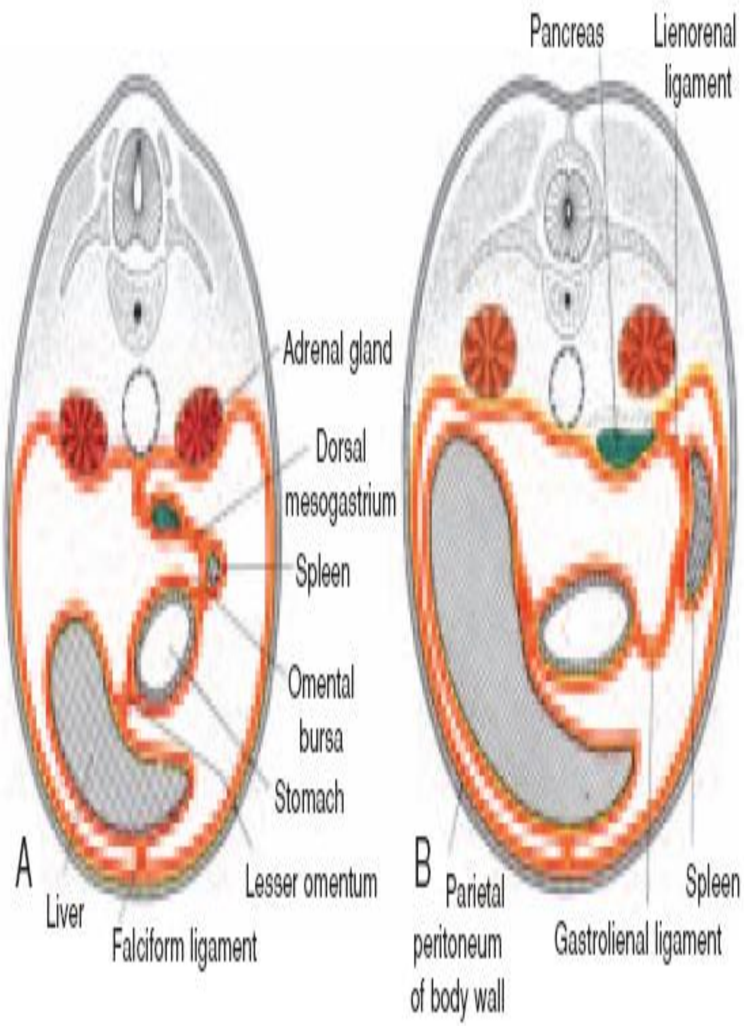


Figure 13.11 Transverse sections through the region of the stomach, liver, and spleen, showing formation of the lesser peritoneal sac, rotation of the stomach, and position of the spleen and tail of the pancreas between the two leaves of the dorsal mesogastrium. With further development, the pancreas assumes a retroperitoneal position.

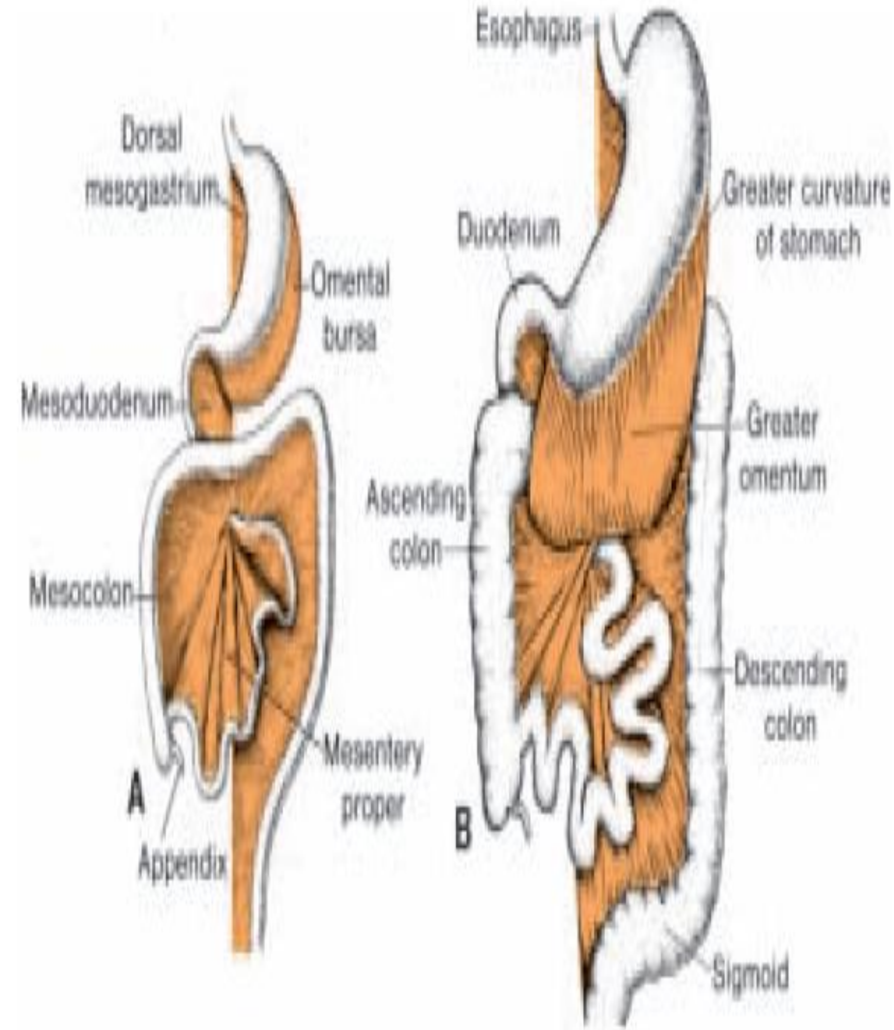


Figure 13.12 A. Derivatives of the dorsal mesentery at the end of the third month. The dorsal mesogastrium bulges out on the left side of the stomach, where it forms part of the border of the omental bursa. **B.** The greater omentum hangs down from the greater curvature of the stomach in front of the transverse colon.

Development of the liver and bile duct

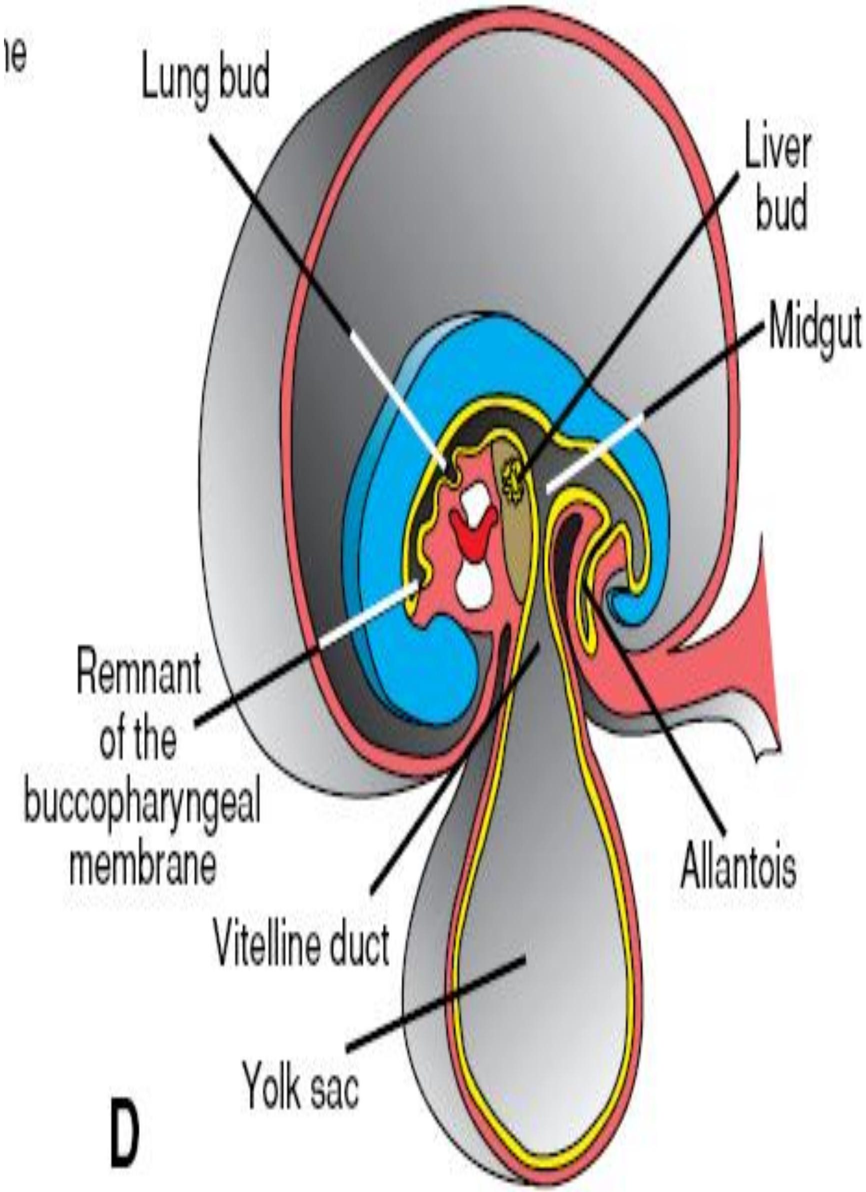
1. Observe the liver bud at the distal end of foregut. It is entodermal cells lies at the apex of the loop of developing duodenum (mid of the second part of duodenum)

2. Observe that the liver bud grows into mass of splanchnic mesoderm called (septum transversum)

3. Observe that the end of liver bud divides into right and left

4. Endodermal cells grow into vascular mesoderm which forms liver cords and liver sinusoids

5. Formation the ducts by canalization (hepatic ducts)



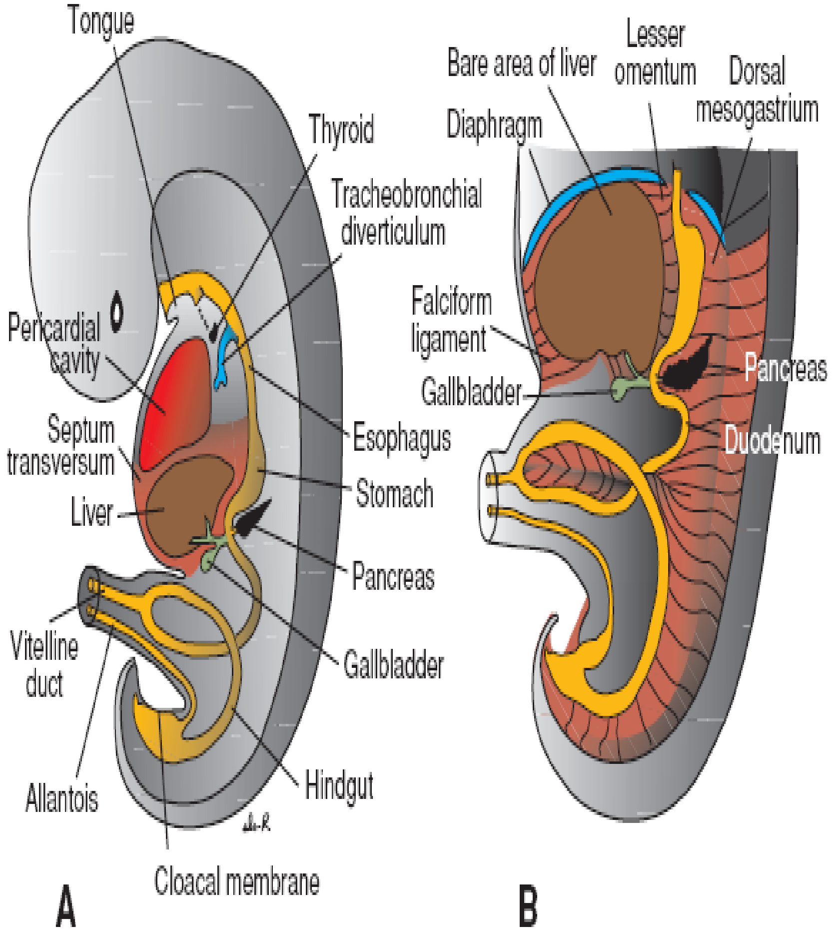


Figure 13.15 A. A 9-mm embryo (approximately 36 days). The liver expands caudally into the abdominal cavity. Note condensation of mesenchyme in the area between the liver and the pericardial cavity, foreshadowing formation of the diaphragm from part of the septum transversum. **B.** A slightly older embryo. Note the falciform ligament extending between the liver and the anterior abdominal wall and the lesser omentum extending between the liver and the foregut (stomach and duodenum). The liver is entirely surrounded by peritoneum except in its contact area with the diaphragm. This is the bare area of the liver.

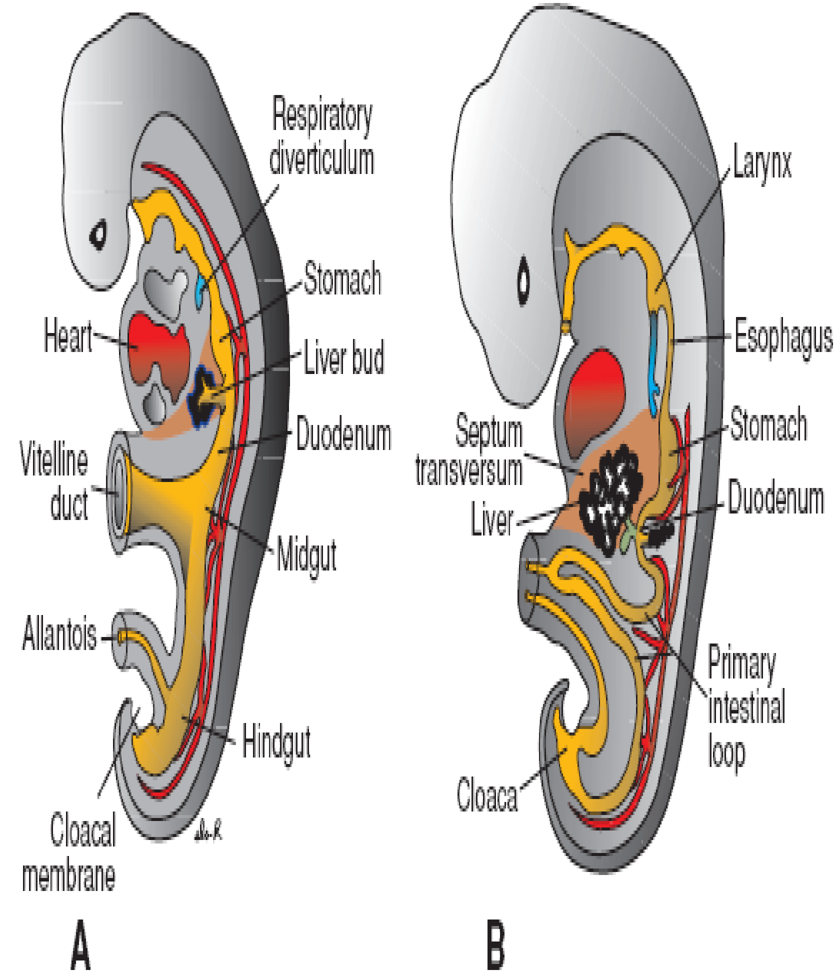


Figure 13.14 A. A 3-mm embryo (approximately 25 days) showing the primitive gastrointestinal tract and formation of the liver bud. The bud is formed by endoderm lining the foregut. **B.** A 5-mm embryo (approximately 32 days). Epithelial liver cords penetrate the mesenchyme of the septum transversum.

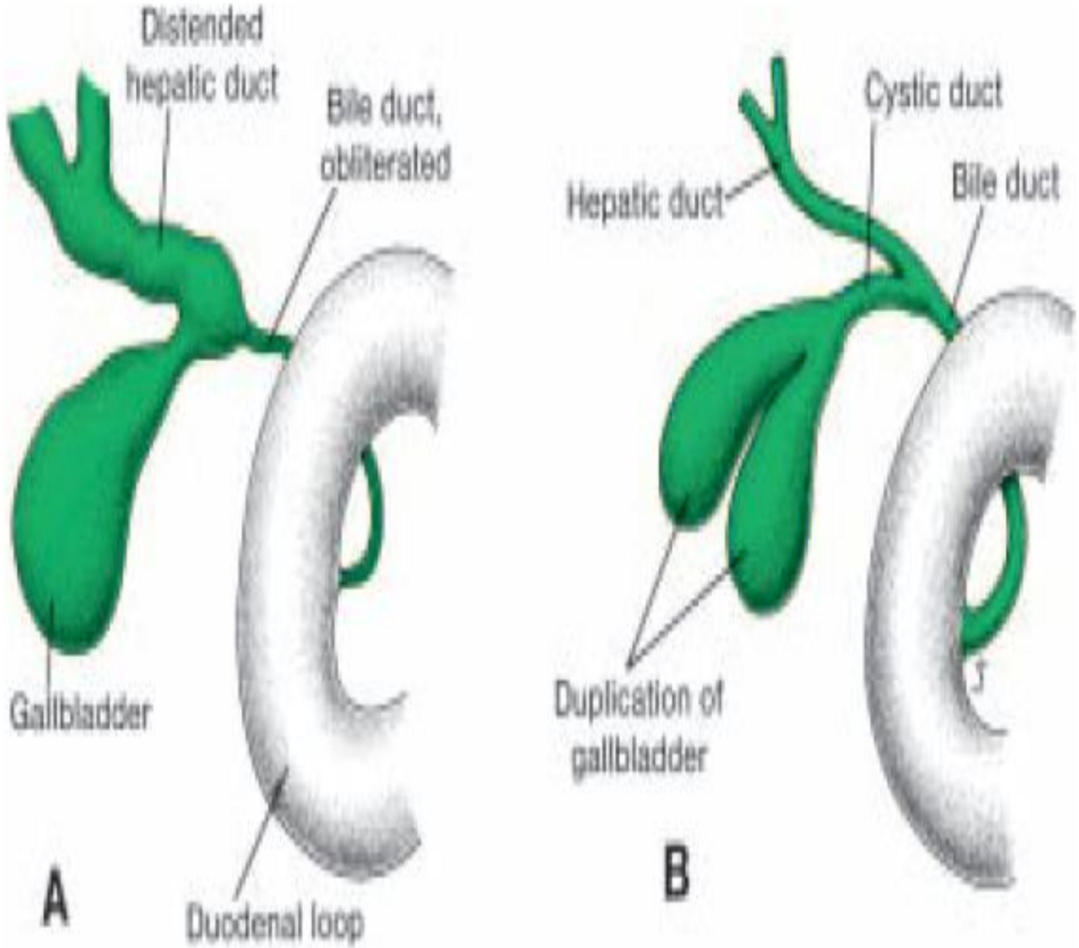


Figure 13.20 A. Obliteration of the bile duct resulting in distention of the gallbladder and hepatic ducts distal to the obliteration. **B.** Duplication of the gallbladder.

Development of gallbladder and cystic duct

1. **Observe the end of hepatic bud expands forming gallbladder and the remains duct forms cystic duct**

2. **Billiary atresia → failure of bile duct formation**

3. **Observe some clinical abnormalities in liver and gall bladder**

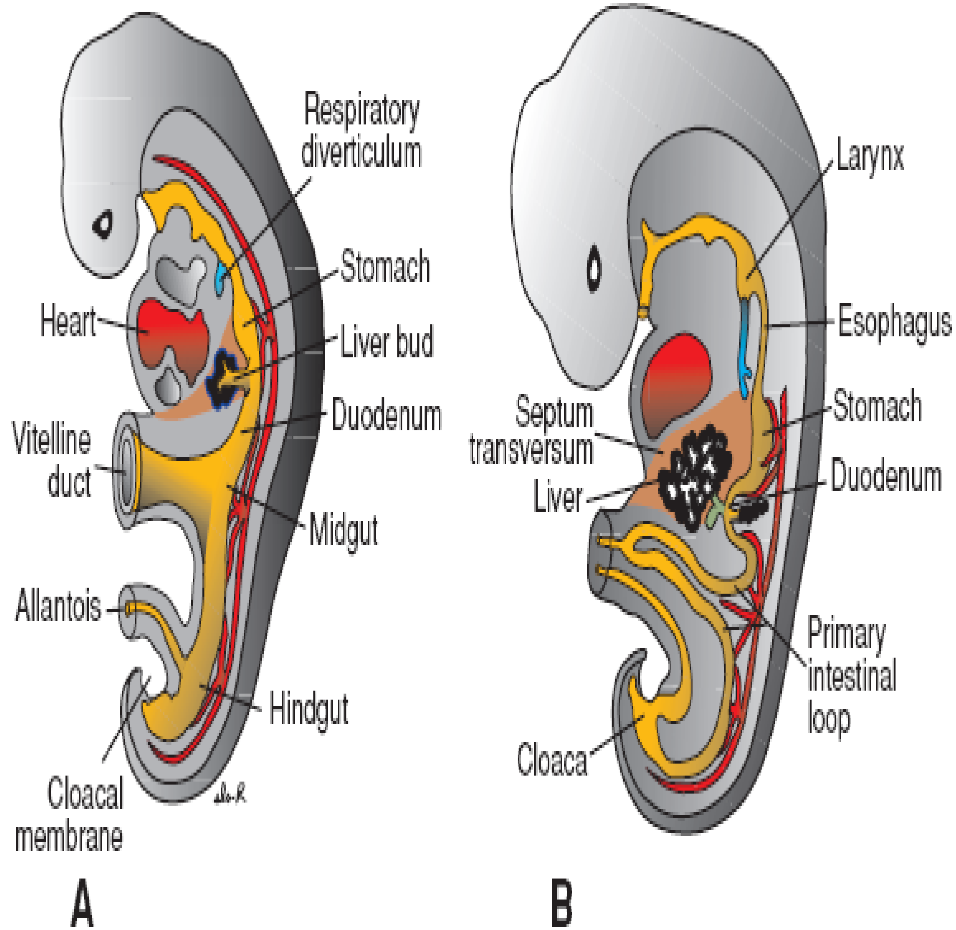


Figure 13.14 A. A 3-mm embryo (approximately 25 days) showing the primitive gastrointestinal tract and formation of the liver bud. The bud is formed by endoderm lining the foregut. **B.** A 5-mm embryo (approximately 32 days). Epithelial liver cords penetrate the mesenchyme of the septum transversum.

Development of duodenum

1. **How it is formed from the most caudal part of foregut and cephalic end of midgut**
2. **Observe the dorsal and ventral mesenteries and the rotation of the stomach which forced the duodenum to rotate to the right side so parts of the duodenum is formed.**
3. **Observe the disappearance of peritoneum behind the duodenum so it is retroperitoneum**
4. **Observe the site of ligament of tritz which fixes the terminal part of duodenum**

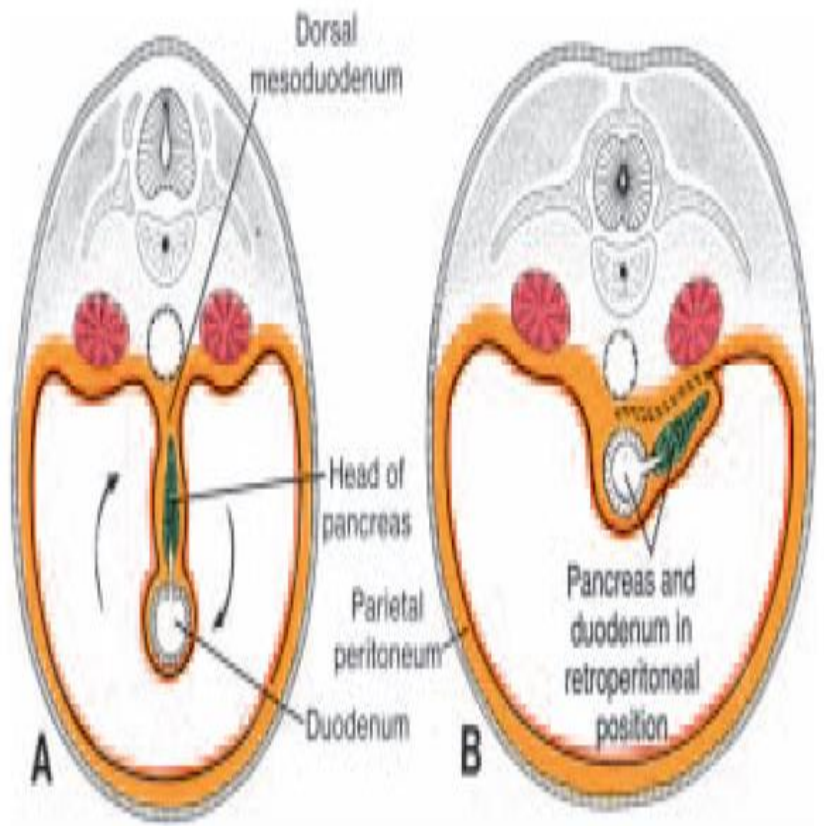


Figure 13.17 Transverse sections through the region of the duodenum at various stages of development. At first the duodenum and head of the pancreas are located in the median plane (**A**), but later they swing to the right and acquire a retroperitoneal position (**B**).

Figure 13.18 Upper portion of the duodenum showing the solid stage (**A**) and cavity formation (**B**) produced by recanalization.

Development of the pancreas

1. Observe that the development from the dorsal and ventral bud of entodermal cells that arise from the foregut

2. Observe that as a results of rotation of the stomach and duodenum, with the rapid growth of the left side of duodenum the ventral bud becoming into contact with the dorsal bud and fusion occurs.

3. Observe the development of islets of langerhans from small buds from developing duct → these from group of cells secretes insulin as glucagon (at 5th mouth)

4. Ventral pancreatic bud formed head of pancreas (inferior part) uncinate process

5. Dorsal pancreatic bud formed
   a. Superior part of head
   b. Neck
   c. Body
   d. Tail of pancreas

5. some of pancreatic abnormalities :
   a. Annular pancreas
   b. Duodenal stenosis

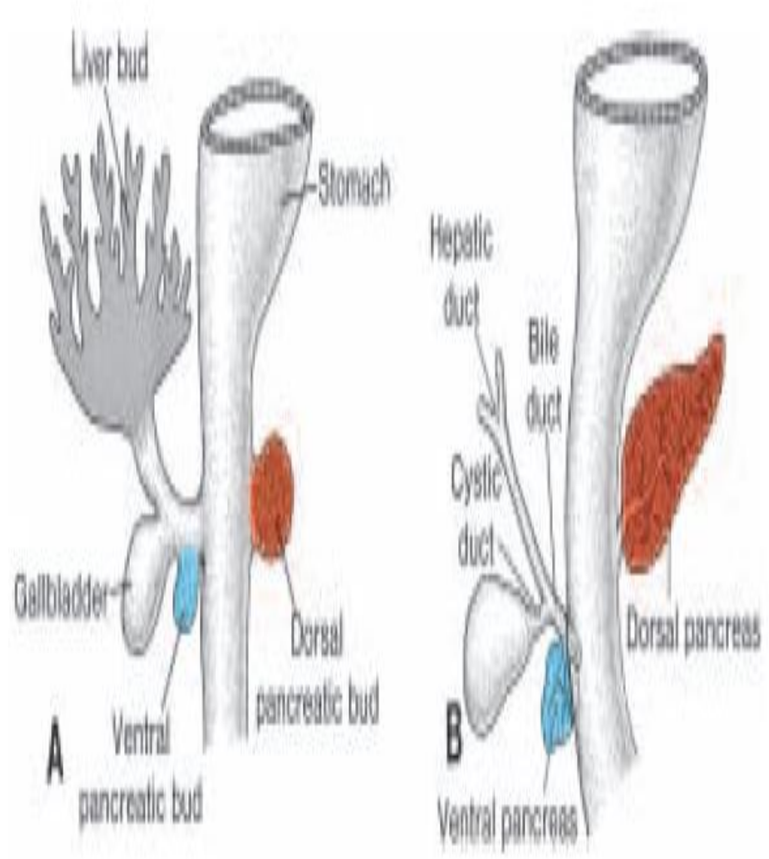


Figure 13.21 Stages in development of the pancreas. **A.** 30 days (approximately 5 mm). **B.** 35 days (approximately 7 mm). Initially the ventral pancreatic bud lies close to the liver bud, but later it moves posteriorly around the duodenum toward the dorsal pancreatic bud.

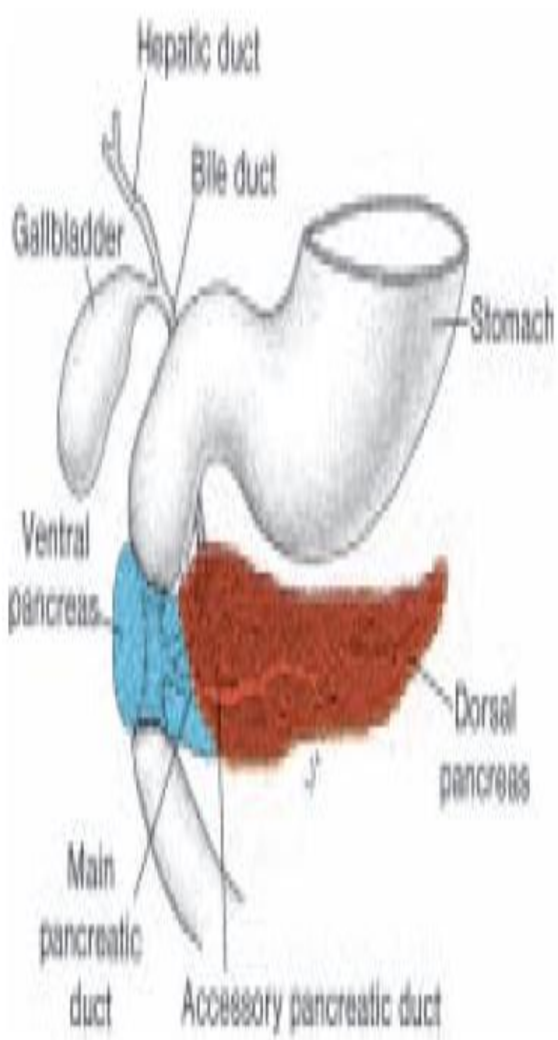


Figure 13.23 Annular pancreas. The ventral pancreas splits and forms a ring around the duodenum, occasionally resulting in duodenal stenosis.

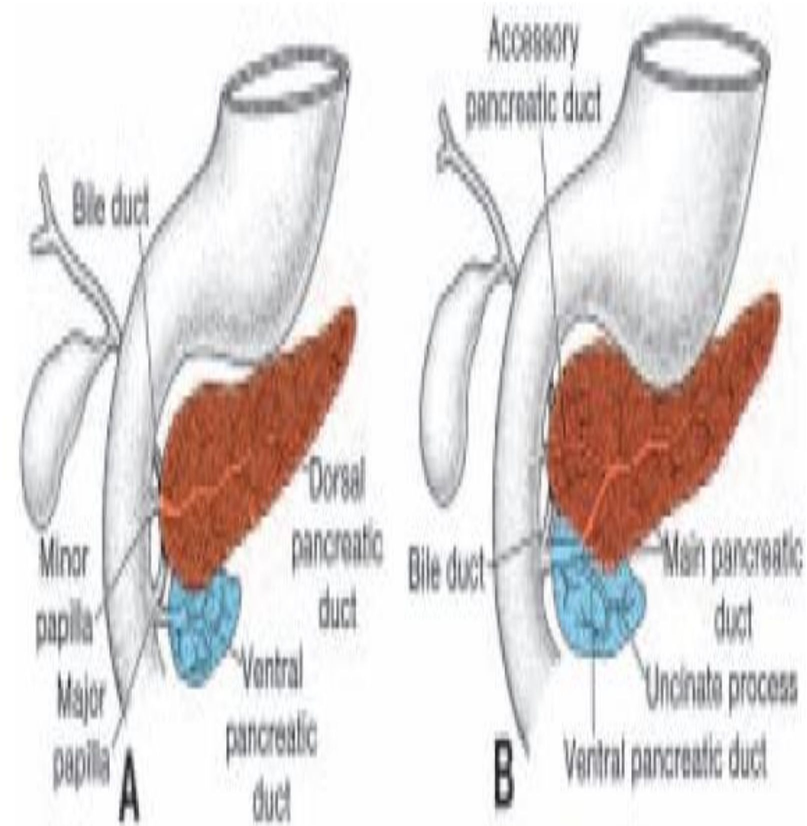


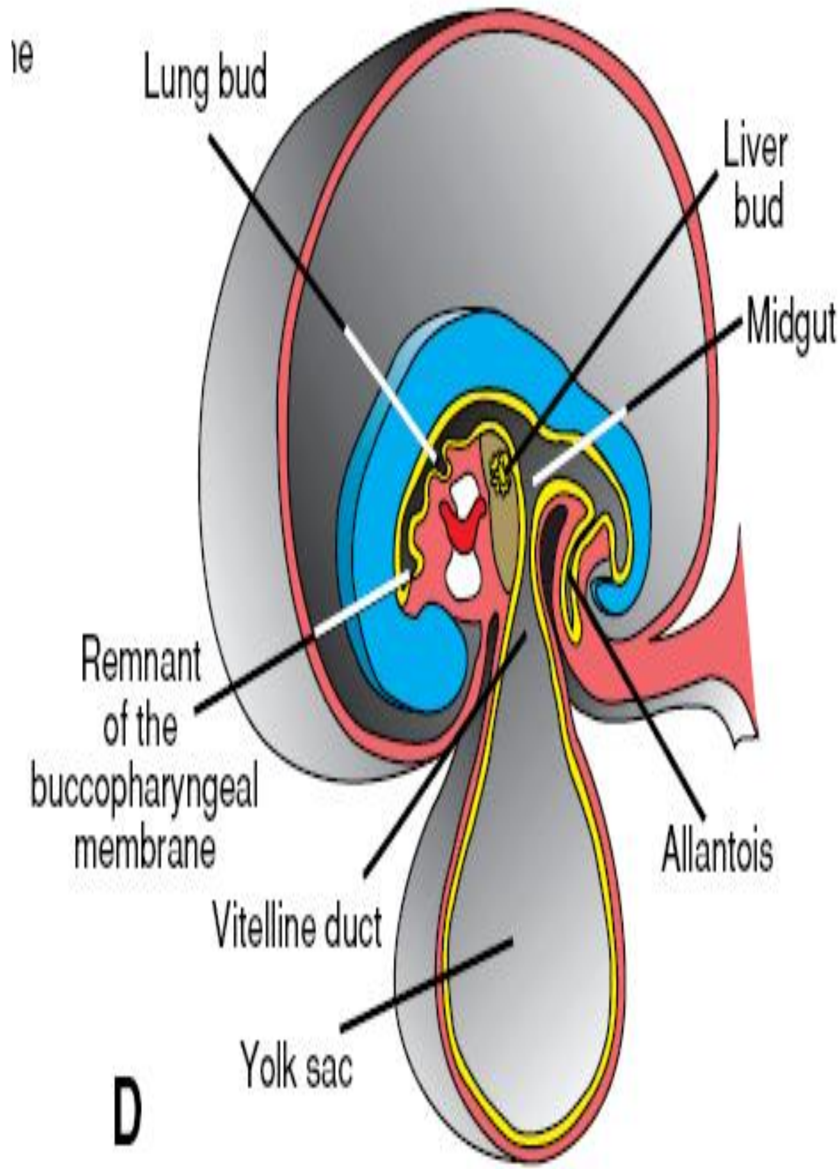
Figure 13.22 A. Pancreas during the sixth week of development. The ventral pancreatic bud is in close contact with the dorsal pancreatic bud. **B.** Fusion of the pancreatic ducts. The main pancreatic duct enters the duodenum in combination with the bile duct at the major papilla. The accessory pancreatic duct (when present) enters the duodenum at the minor papilla.

Development of the Midgut

1. **It includes the distal part of duodenum, small intestines , large intestines till the distal third of transverse colon**

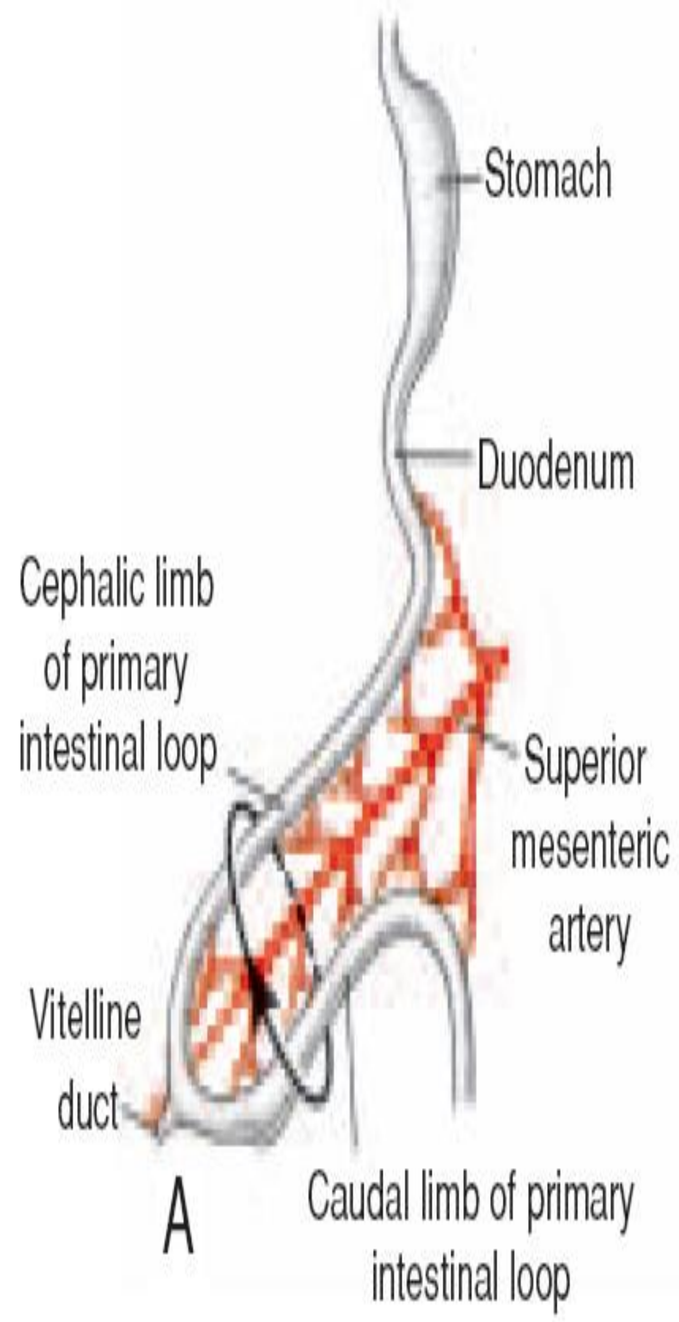
2. **Observe how the midgut increased rapidly in length forms a loop to the apex the vitelline duct which also open to the widely open umbilicus**

3. **Observe how the dorsal mesentery also elongates and passing through it from the aorta to the yolk sac, the vitelline arteries which fuse and form the superior mesenteric artery which is the blood supply to midgut and its derivatives**



In the development of midgut loop

1. Study the physiological hernia in the umbilical cord
2. Study the development of cecum and appendix
3. Study the development of jejunum and ileum
4. Study how the midgut loop in the umbilical cord rotates around the axis (superior mesenteric artery and vitelline duct) a counter clock wise rotation 90 degrees
5. Later the midgut as it returns to the abdominal cavity it rotates counter clock wise an additional 180 degrees so the total rotation is 270 degrees counter clock wise



After rotation of the midgut observe the following results:

1. Transverse colon lies in front of superior and 2nd part of duodenal mesenteric artery
2. Third part of duodenum lies behind the superior mesenteric artery
3. Cecum and appendix comes into right iliac fossa so:

A. Ascending colon and

B. B. right colic flexure are formed

4. Large gut after rotation lie laterally and encircle the centrally placed small gut

5. Primitive mesentery of:

a. Ascending colon and descending colon by which they fuse with parietal peritoneum on the posterior abdominal wall → become retroperitoneal organs

6. Primitive mesenteries of :

a. Jejunum

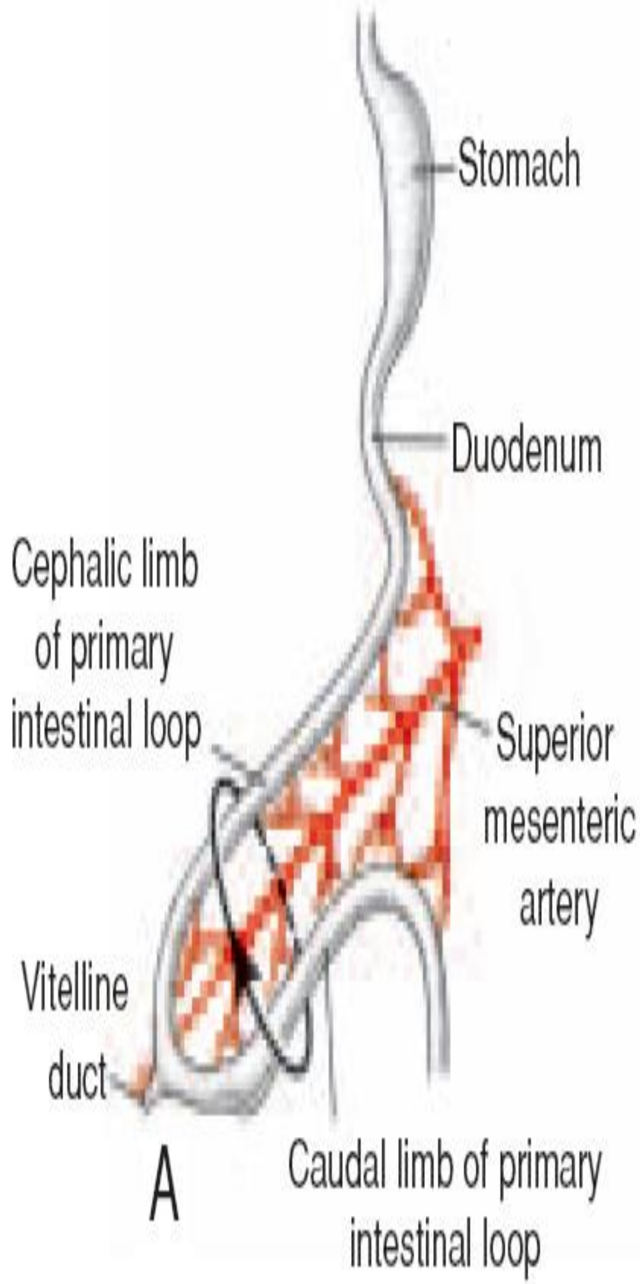
b. Ileum

c. Transverse colon

d. Sigmoid colon

Persist as mesentery of small intestine, transverse colon sigmoid mesocolon

7. As the midgut returns to the abdominal cavity, the vitteline becomes obliterated and severs its connection with the gut



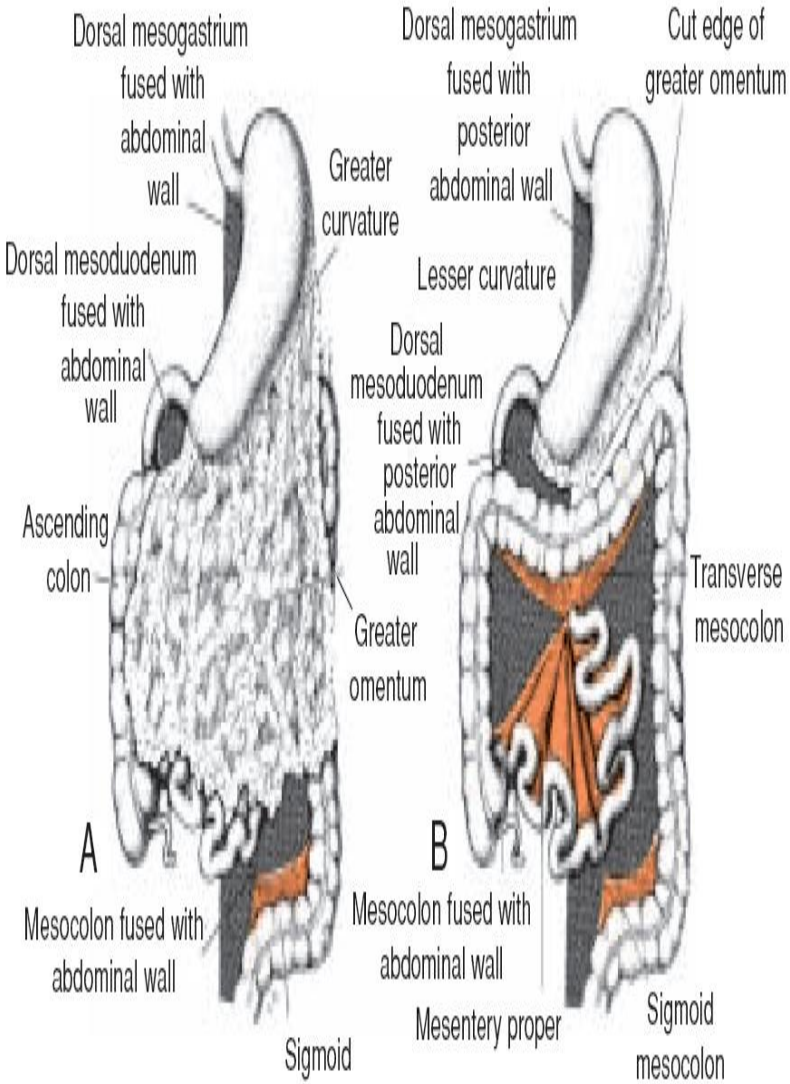
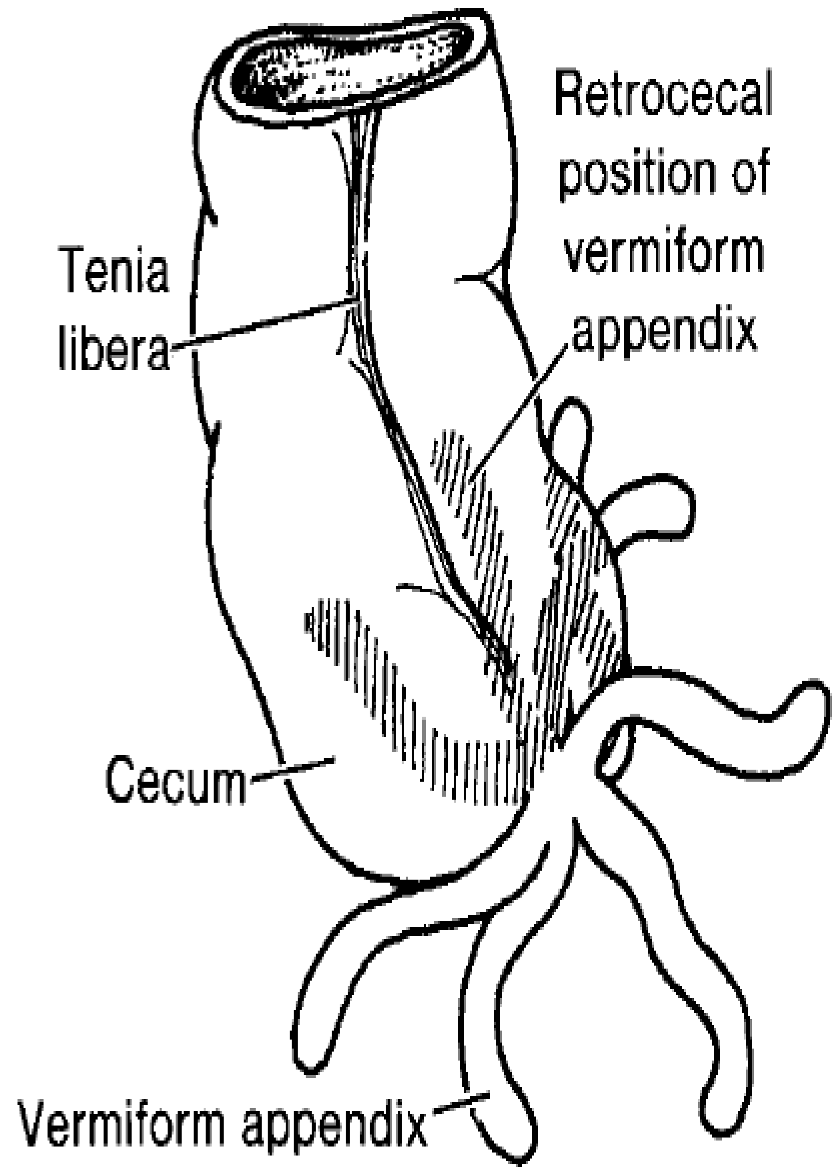


Figure 13.30 Frontal view of the intestinal loops with (**A**) and after removal of (**B**) the greater omentum. *Gray areas*, parts of the dorsal mesentery that fuse with the posterior abdominal wall. Note the line of attachment of the mesentery proper.



Study the gut rotation defects

1. **Study the gut atresias and stenoses**

2. **Study the body wall defects:**

   a. Omphalocele: umbilical hernia through umbilical ring (physiological hernia)

   It is covered by amnion

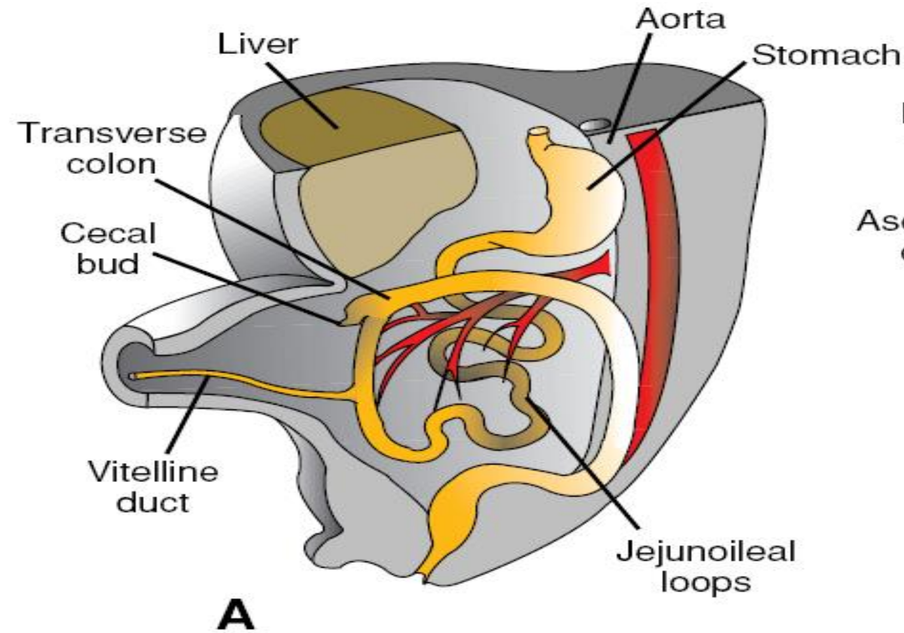
   occurs in 2.5/10000 births

   it has high rate of mortality

   it has 50% with cardiac abnormalities

   50% with chromosomal abnormalities

   b. gastroschisis : hernia through the region of right umbilical vein



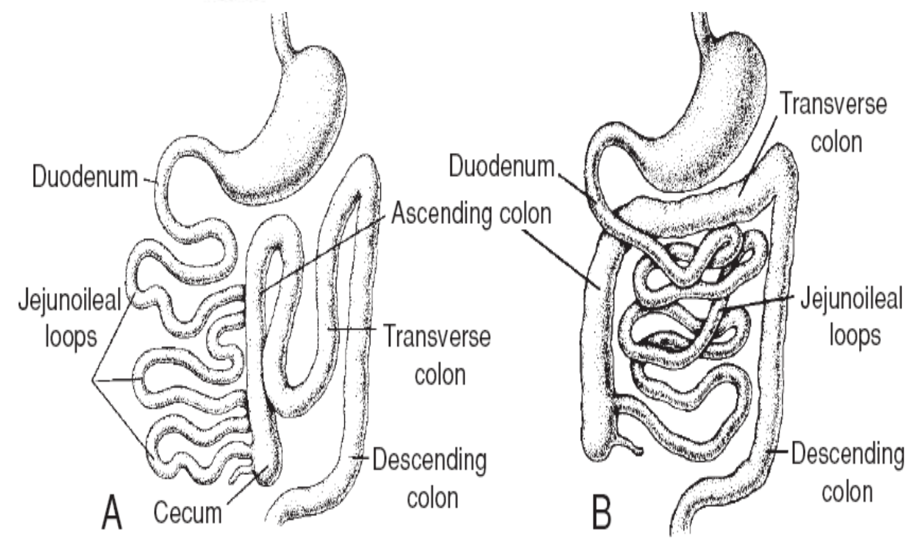


Figure 13.33 A. Abnormal rotation of the primary intestinal loop. The colon is on the left side of the abdomen, and the small intestinal loops are on the right. The ileum enters the cecum from the right. **B.** The primary intestinal loop is rotated 90° clockwise (reversed rotation). The transverse colon passes behind the duodenum.

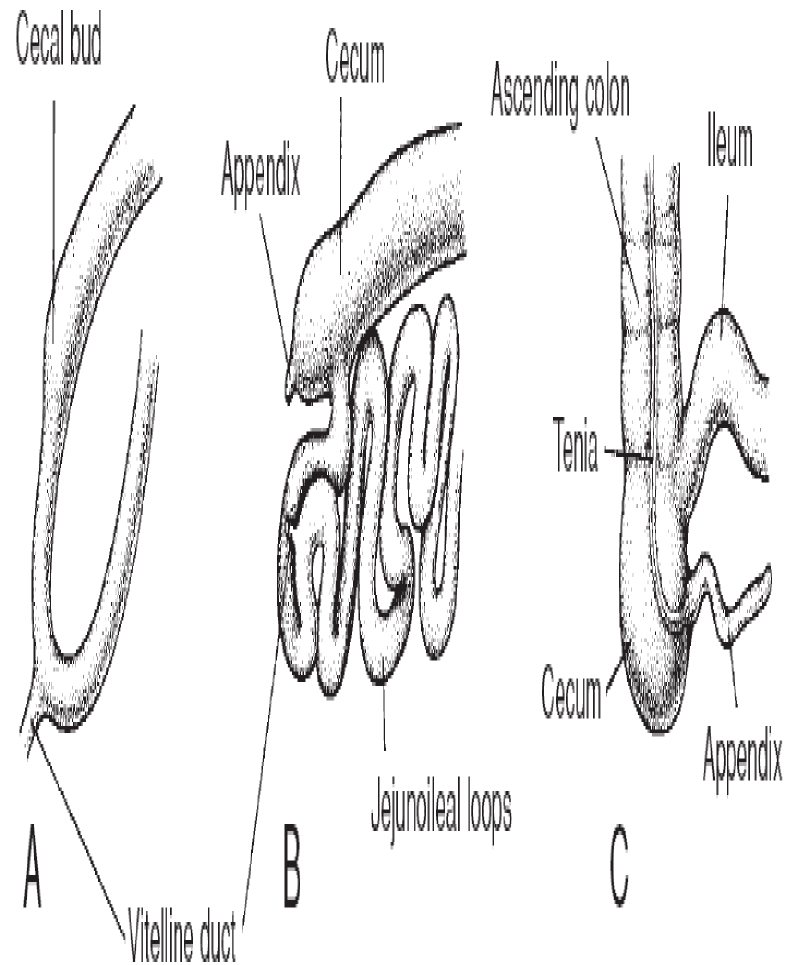
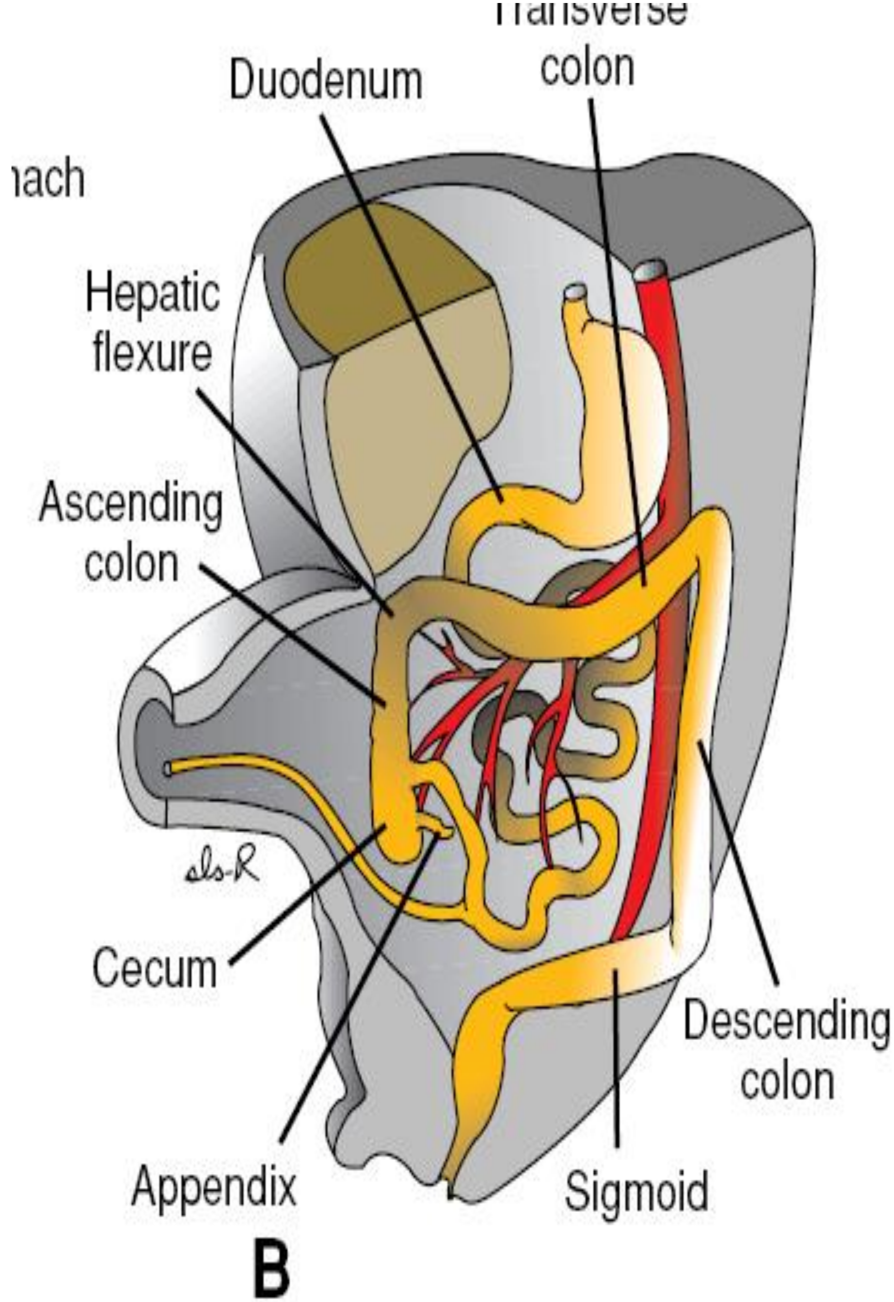


Figure 13.28 Successive stages in development of the cecum and appendix. **A.** 7 weeks. **B.** 8 weeks. **C.** Newborn.

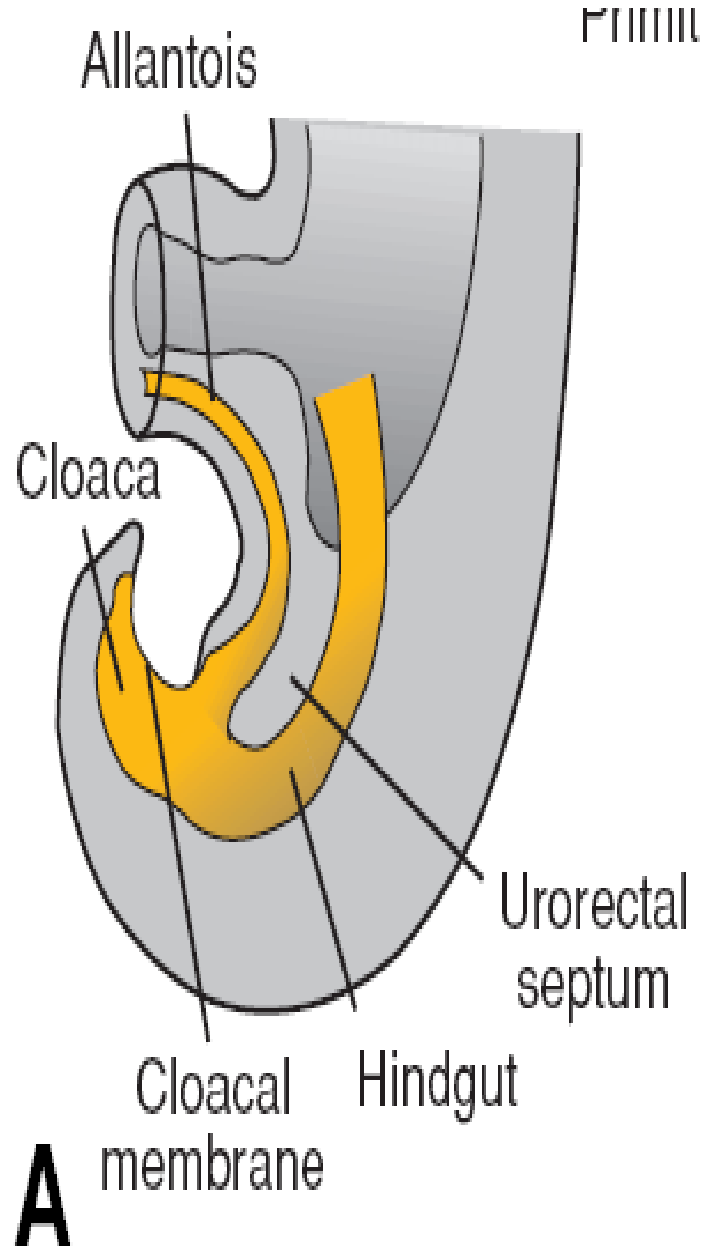


Development of hindgut

➢ It includes the distal third of transverse colon descending and sigmoid colons and upper part of anal canal

➢Observe the following points:

1. The inferior mesenteric artery is the blood supply to the hindgut
2. The endoderm of the hindgut also forms the lining of bladder and artheria
3. The terminal portion of hindgut enters the post region of cloaca which forms the primitive anorectal canal
4. Cloaca is an endodermal lined cavity covered ventrally by surface ectoderm
5. Allantois enters into anterior portion of the cloaca forms urogenital sinus
6. Cloacal membrane lies between endoderm and ectoderm
7. Urorectal septum is an emerging mesoderm and ectoderm between allantois and hindgut



In development of hindgut notice:

1. At the end of 7th week the cloacal membrane is ruptured which creates the following:

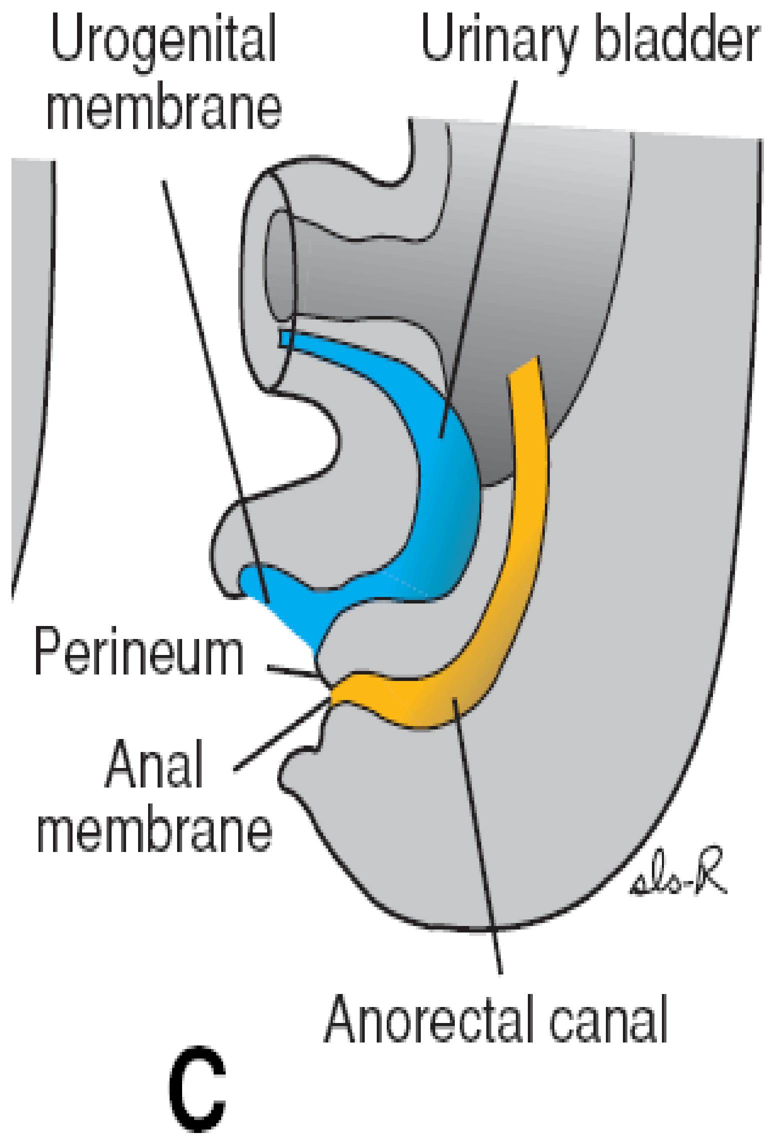
A. Anal opening of hindgut

B. Ventral opening for urogenital sinus

C. Between the 2 forms perineal body

2. Observe that proliferation of ectoderm closes the most of caudal region of the anal canal then at ninth week of development the ectodermal part of anal canal

3. Pectinate line lies at the junction between the endoderm and ectoderm part of anal canal



Abnormalities in the development of hindgut:

➢Explain the following:

1. Different types of fistula :
   a. Urorectal fistula
   b. Rectovaginal fistula
2. Rectoanal atresia or fistula
3. Imperforated anus