

Development of the Glands

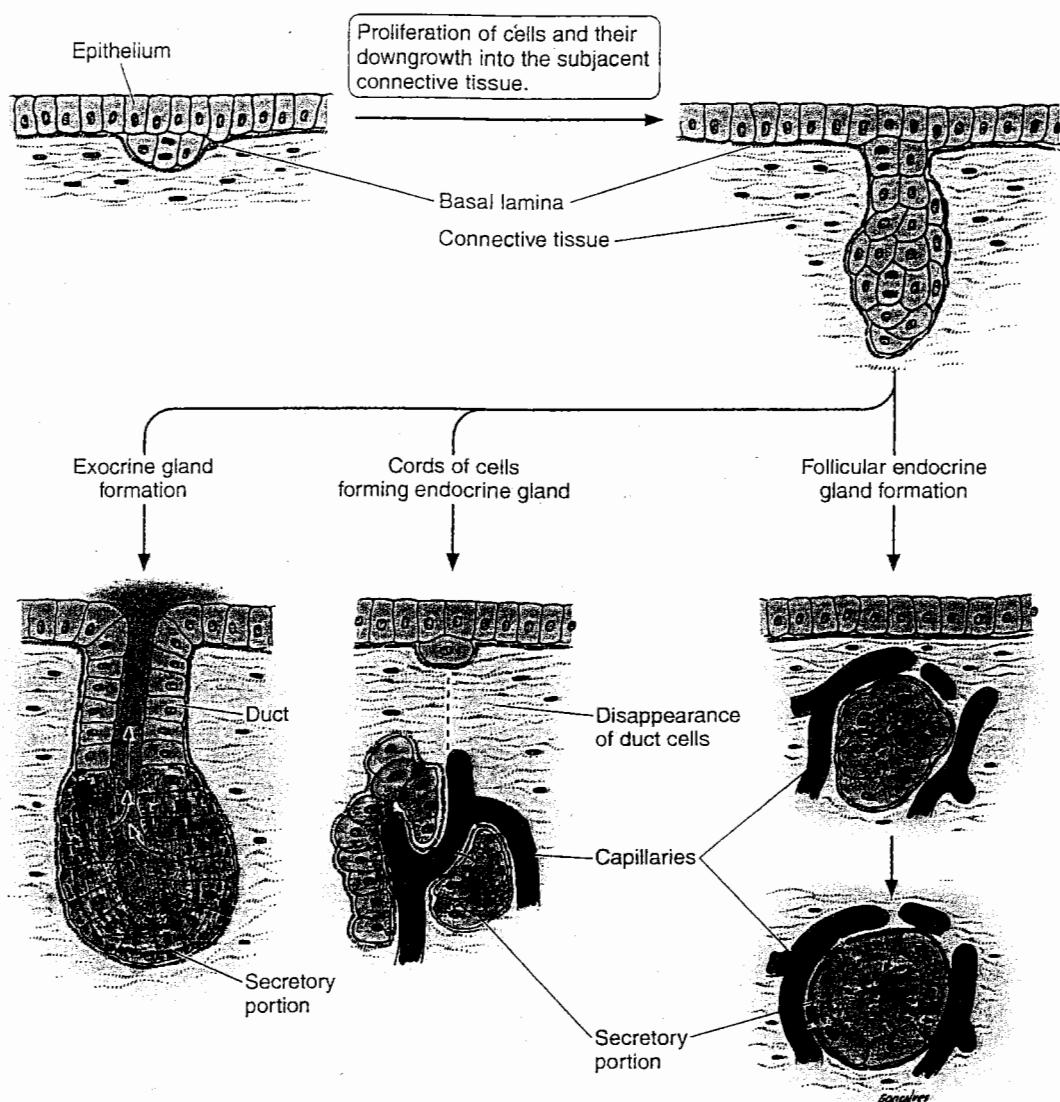


Figure 4-21. Formation of glands from covering epithelia. Epithelial cells proliferate and penetrate the connective tissue. They may—or may not—maintain contact with the surface. When contact is maintained, exocrine glands are formed; without contact, endocrine glands are formed. The cells of endocrine glands can be arranged in cords or in follicles. The lumen of the follicles accumulates secretion; cells of the cords store only small quantities of secretions in their cytoplasm. (Redrawn and reproduced, with permission, from Ham AW: *Histology*, 6th ed. Lippincott, 1969.)

Types of Glandular Epithelia

The epithelia that form the glands of the body can be classified according to various criteria. Unicellular glands consist of isolated glandular cells, and multicellular glands are composed of clusters of cells. An example of a unicellular gland is the **goblet cell** of the lining of the small intestine (Figure 4-20) or of the respiratory tract. The term “gland,” however, is usually used to designate large, complex aggregates of glandular epithelial cells, such as in the salivary glands and the pancreas.

Glands arise during fetal life from covering epithelia by means of proliferation and invasion of the epithelial cells into the subjacent connective tissue, followed by further differentiation

(Figure 4-21). **Exocrine** (Gr. *exo*, outside, + *krinein*, to separate) glands retain their connection with the surface epithelium from which they originated. This connection is transformed into tubular ducts lined with epithelial cells through which the glandular secretions pass to reach the surface. **Endocrine** (Gr. *endon*, within, + *krinein*) glands are glands whose connection with the surface is lost during development. These glands are therefore ductless, and their secretions are picked up and transported to their site of action by the bloodstream rather than by a duct system.

Two types of endocrine glands can be recognized based on the arrangement of their cells. The endocrine cells may form anastomosing cords interspersed between dilated blood capillaries (eg, adrenal gland, parathyroid, anterior lobe of the pituitary; Figure 4-21)

Development of the Mouth:

mouth is formed from 2 sources

1 - depression on stomodaeum lined with ectoderm

2 - cephalic end of foregut lined with endoderm

The 2 parts separated by buccopharyngeal membrane

- during 3rd week of development depression on stomodaeum the membrane disappeared.

- if the membrane persists a pharyngostoma

Extends: - body of sphenoid bone

- soft palate

- inner surface of mandible inferior to incisor teeth

* Structures situated in the mouth anterior to the plane are derived from ectoderm. e.g.: epithelium of

- hard palate

- sides of the mouth

- lips

- enamel of teeth

* Structures situated in the mouth post-inferior to the plane are derived from endoderm. e.g.: epithelium of the

- tongue

- floor of the mouth

- palatoglossal & palatopharyngeal folds

- soft palate

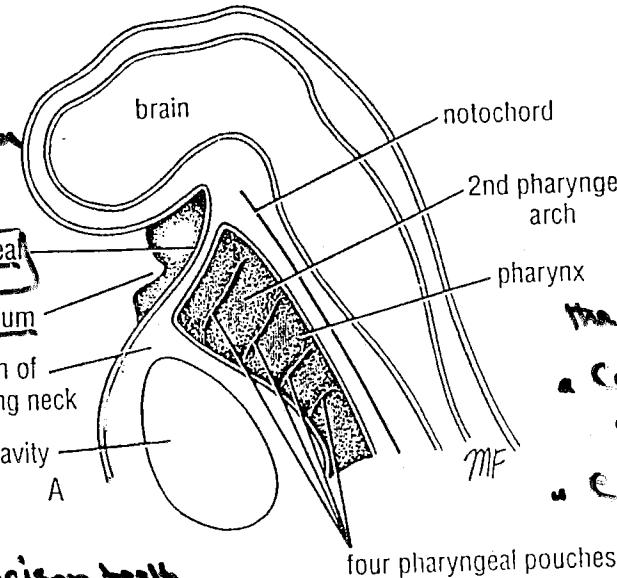
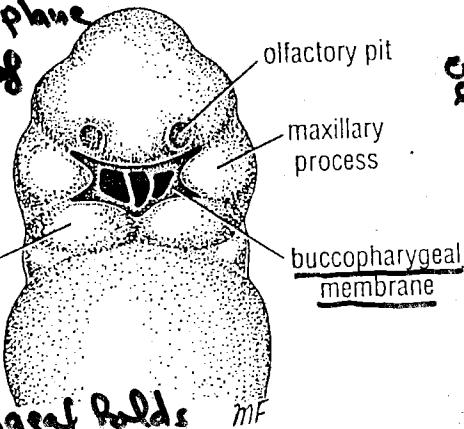


Figure 11-74 A. Sagittal section of the embryo showing the position of the buccopharyngeal membrane. B. The face of the developing embryo showing the buccopharyngeal membrane breaking down.



Development of Salivary gland

during the 7th week of development it arises as

Solid outgrowths of cells from the wall of developing mouth. Cells grow into underlying mesenchyme

"Epithelial buds"

↓ branching
replication

Solid ducts

↓ canalization

Form secretory acini

↓ canalization

Surrounding mesenchyme
condensed forms

• capsule of the gland

• Sept divide the gland into lobes and lobules

- The ducts and acini of the parotid gland are derived from ectoderm
- Submandibular and sublingual glands are derived from endoderm

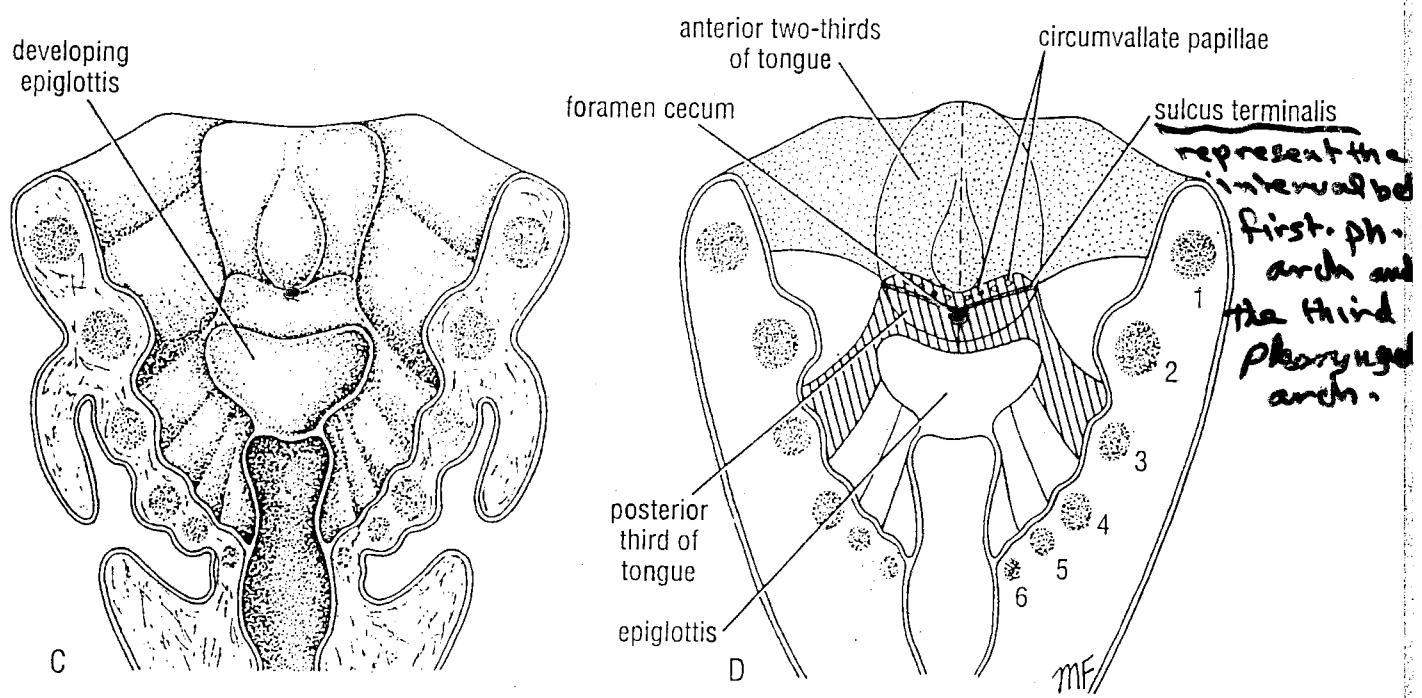
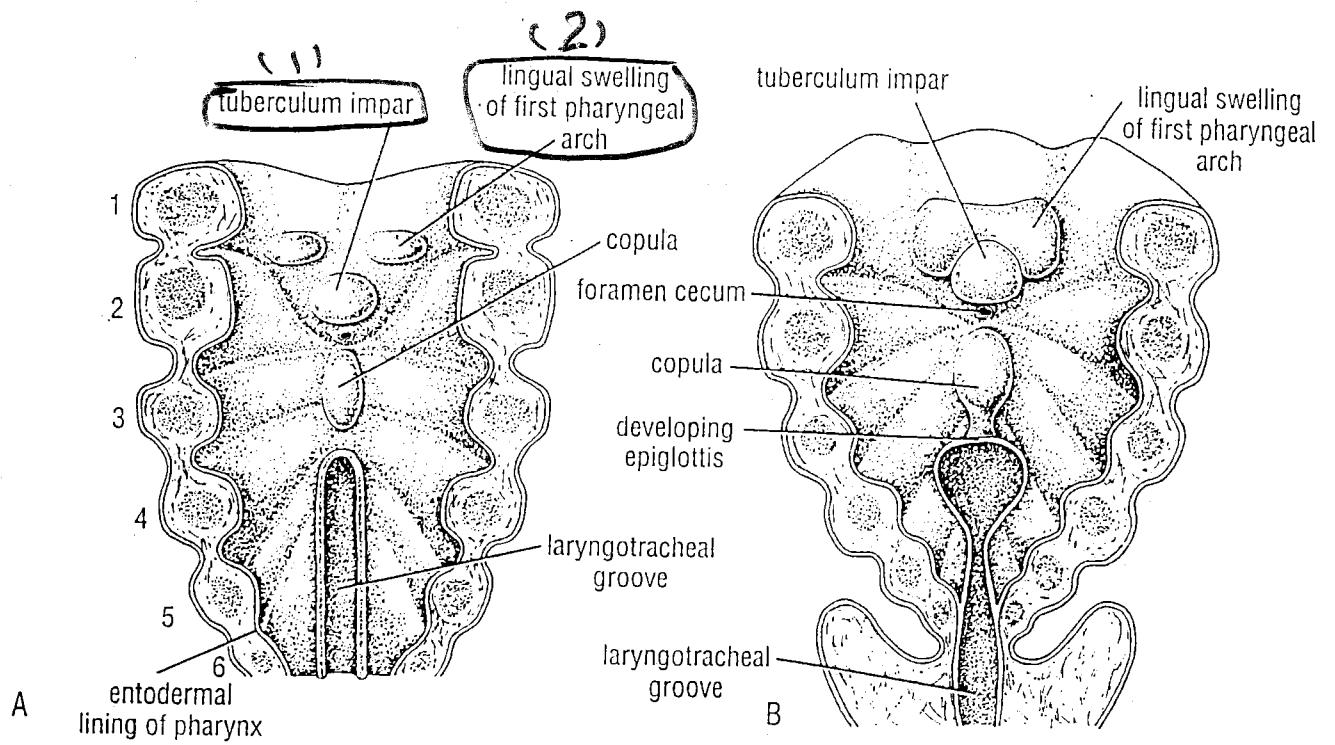


Figure 11-75 The floor of the pharynx showing the stages in the development of the tongue.

- (1) 4th Week, median swelling called (tuberculum impar) appears in the floor of pharynx → entodermal
- (2) another swelling on each side of tuberculum impar called (lateral Lingual Swelling) (derived from first pharyngeal arch).
 - the lateral lingual swelling enlarge and grow medially and fuse with each other with the tuberculum impar → forms the Ant. 2/3 of the tongue
 - So it is developed from 1st. pharyngeal arch → innervated by Lingual n. of mandibular n.
- (3) Second median Swelling called Copula appears in the floor of the Pharynx behind the tuberculum impar → it extends forwards on each side of tuberculum impar → it becomes V shaped, → the copula disappeared after 16 weeks.

Development of The Pharynx

- The pharynx develops in the neck from the endoderm of the foregut

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

- The mesenchyme on each side becomes split up into 5-6 → pharyngeal arches

- Each arch forms a swelling on the surface of embryo and on the wall of the foregut.

- As a result of the swelling a series of grooves or clefts are seen on the surface of embryo between the arches → pharyngeal

- Similar grooves are seen on the lateral wall of the foregut → pharyngeal pouches

- The foregut at this level is known as the pharynx

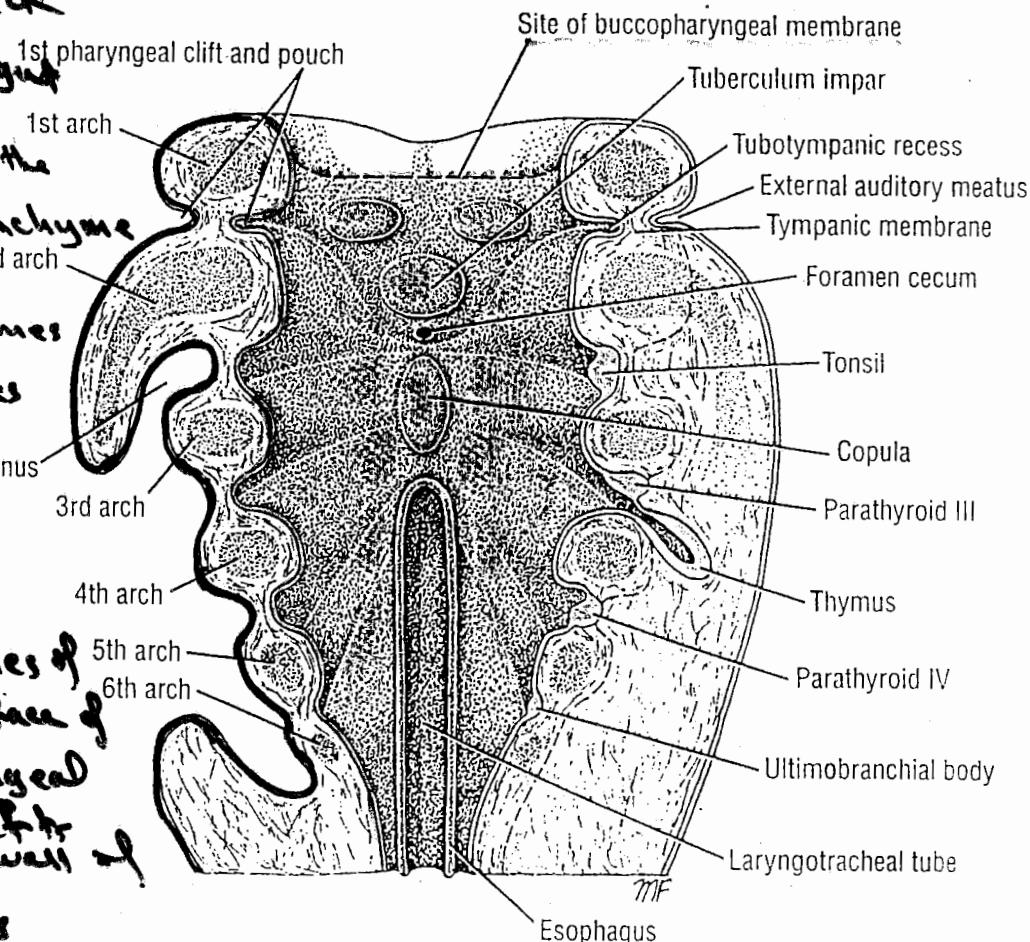


Figure 11-80 The pharynx showing the fate of the pharyngeal clefts and pouches. Left, The great downgrowth of the second pharyngeal arch, burying the pharyngeal clefts. Right, The structures formed from the different pharyngeal pouches.

Development of the Abdominal Wall

190 CHAPTER 4 The Abdomen: Part I—The Abdominal Wall

= Following Segmentation of the mesoderm, lat. mesoderm split into

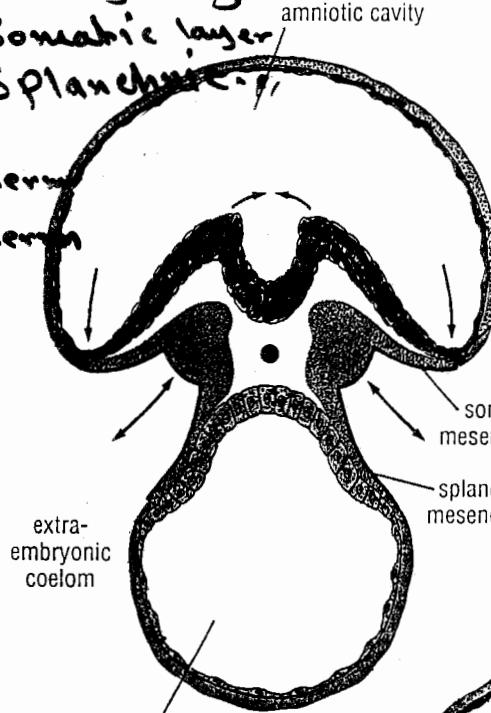
- Somatic layer

amniotic cavity

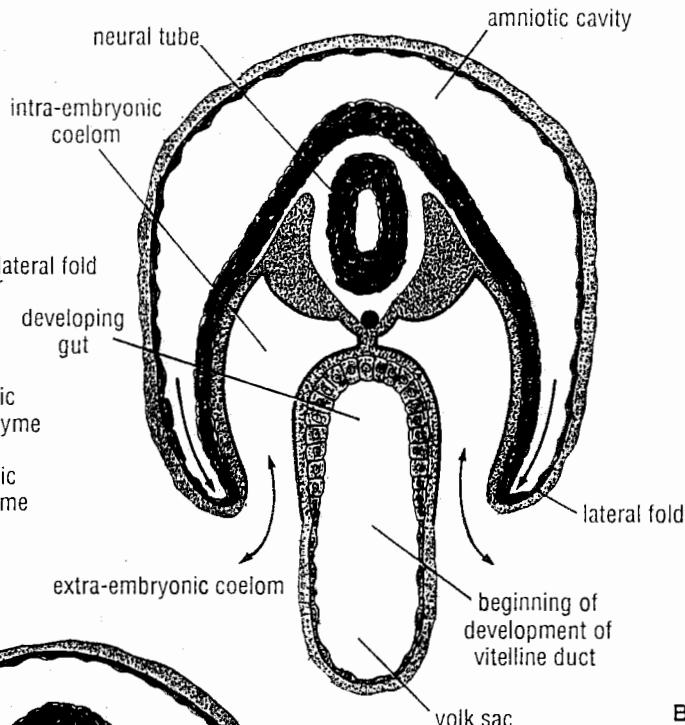
- Splanchnic

+
ectoderm

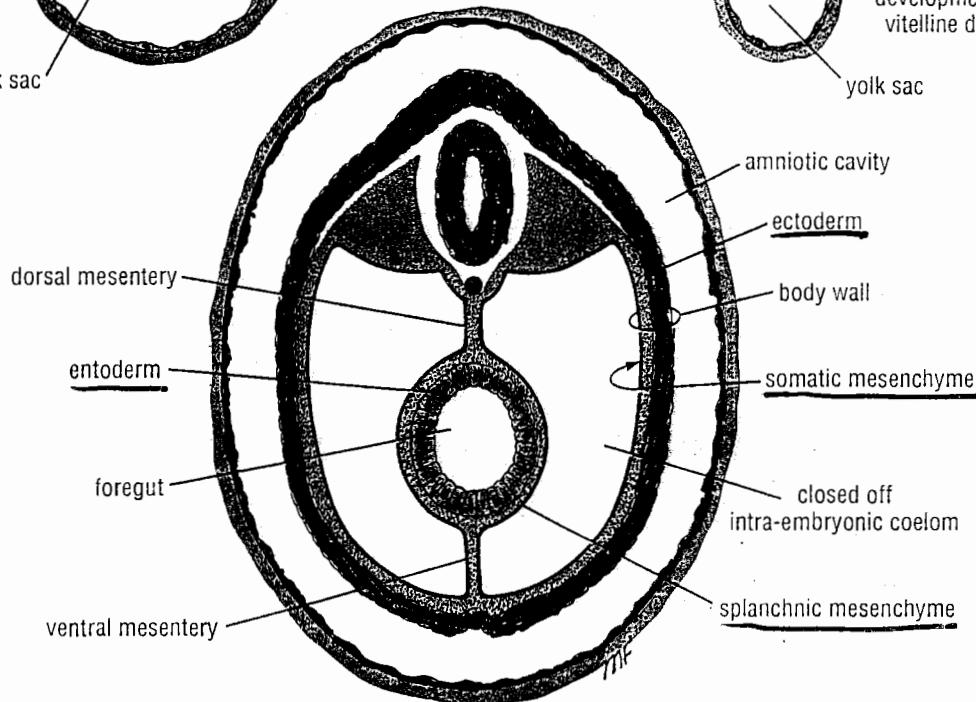
entoderm



A



B



C

Figure 4-36 Transverse sections through the embryo at different stages of development showing the formation of the abdominal wall and peritoneal cavity. **A.** The intra-embryonic coelom in free communication with the extra-embryonic coelom (double-headed arrows). **B.** The development of the lateral folds of the embryo and the beginning of the closing off of the intra-embryonic coelom. **C.** The lateral folds of the embryo finally fused in the midline and closing off the intra-embryonic coelom or future peritoneal cavity. Most of the ventral mesentery will break down and disappear.

- Ant. Abd. wall muscles derived from Somatopleuric mesoderm & retain their segmental innervation from Ant. rami of spinal nerves.
- The Somatopleuric mesoderm split tangentially into three layers forming Ext. oblique int. & transversus
- rectus abdominis retains indications of its segmental origin (presence of tendinous intersections.)
- Finally, the ant. abd. wall closes in the midline at 3 months by fusion of the rectus muscle in the midline forms the linea alba and on either side of it the rectus muscles lie within their rectus sheaths.

Development of the umbilical cord and the umbilicus.

The amnion and chorion fused,
the amnion encloses the body stalk and yolk sac with their blood vessels
form the tubular umbilical cord.

Basic Anatomy 191

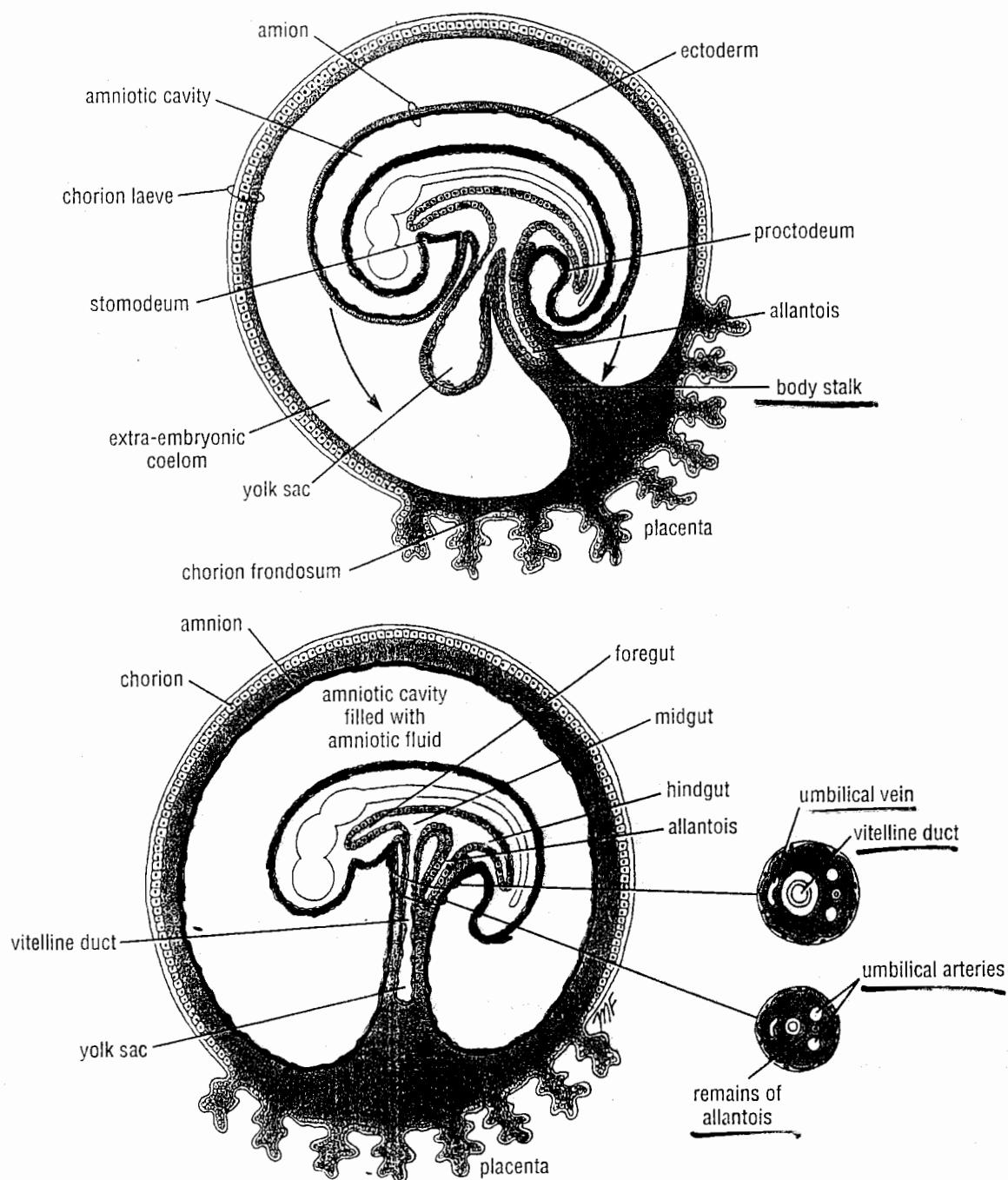


Figure 4-37 The formation of the umbilical cord. Note the expansion of the amniotic cavity (arrows) so that the cord becomes covered with amnion. Note also that the umbilical vessels have been reduced to one vein and two arteries.

- The mesenchymal core of the cord forms the loose conn. tissue (Wharton's jelly). Embedded in it are:
 - remains of yolk sac
 - vitelline duct
 - remains of allantois
 - umbilical blood vessels
- 2 arteries carries deoxygenated blood from fetus to chorion (placenta).
- 2 veins convey O₂ blood from placenta to fetus. The rt vein soon disappears.

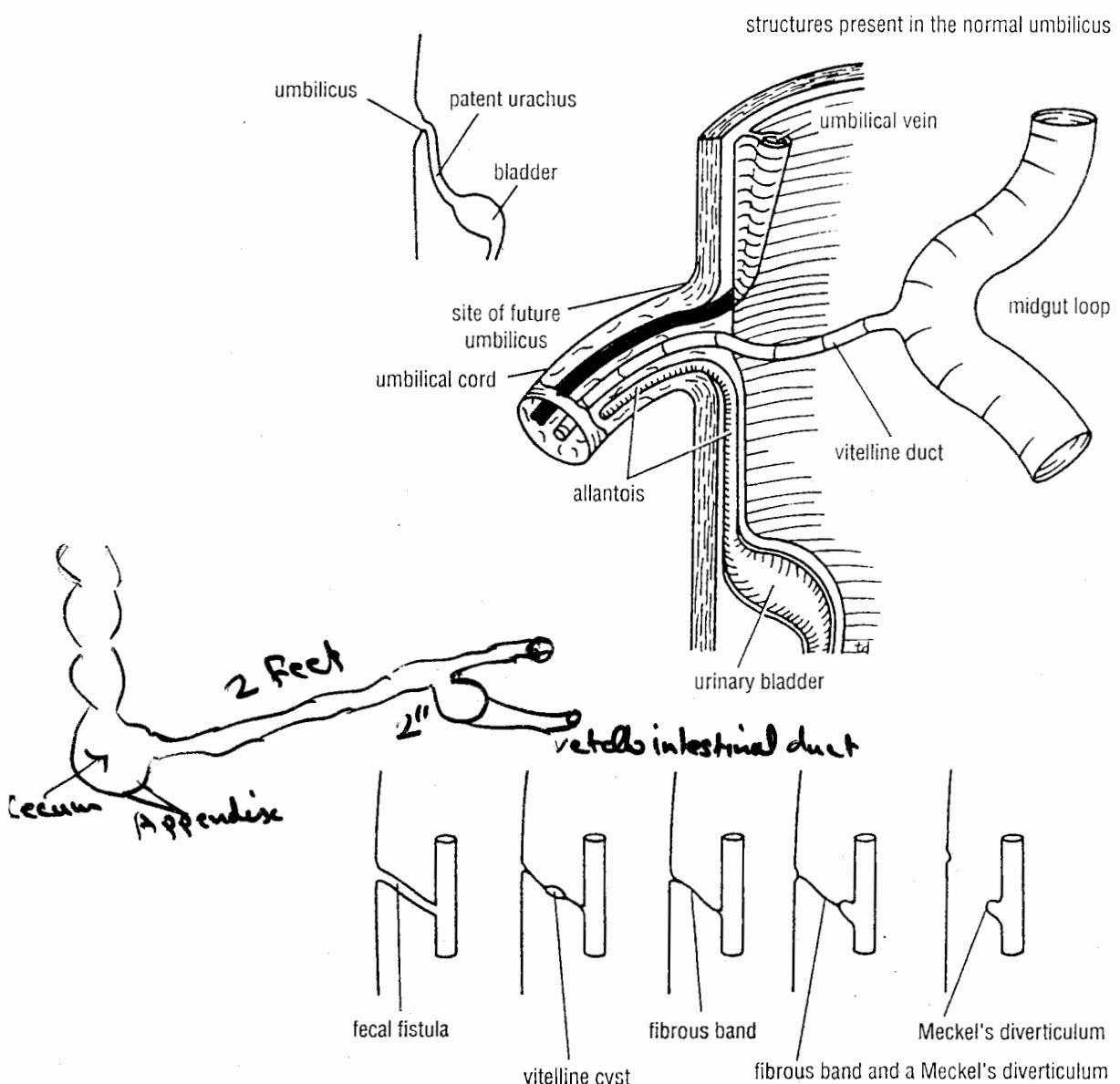


Figure 4-38 Umbilicus and some common congenital defects.

(continued)

VITELLOINTESTINAL DUCT

The vitelline duct in the early embryo connects the developing gut to the yolk sac. Normally, as development proceeds, the duct is obliterated, severs its connection with the small intestine, and disappears. Persistence of the vitellointestinal duct can result in an umbilical fecal fistula (Fig. 4-38). If the duct remains as a fibrous band, a loop of bowel can become wrapped around it, causing intestinal obstruction (Fig. 4-38).

Meckel's diverticulum is a congenital anomaly representing a persistent portion of the vitellointestinal duct. It occurs in 2% of patients (Fig. 4-38), is located about 2

ft. (61 cm) from the ileocolic junction, and is about 2 in. (5 cm) long. It can become ulcerated or cause intestinal obstruction.

UMBILICAL VESSEL CATHETERIZATION

The umbilical cord is surrounded by the fetal membrane, **amnion**, and contains **Wharton's jelly**. Embedded in this jelly are the remains of the vitellointestinal duct and the allantois, and the single umbilical vein and the two umbilical arteries (Fig. 4-39). The vein is a larger thin-walled vessel and is located at the 12 o'clock position when facing the umbilicus; the two arteries,

(continues)

- present in 2% of people
- 2 feet from ileocecal junction
- 2" long
- contains gastric or pancreatic tissue
- remains of vitellointestinal duct of embryo

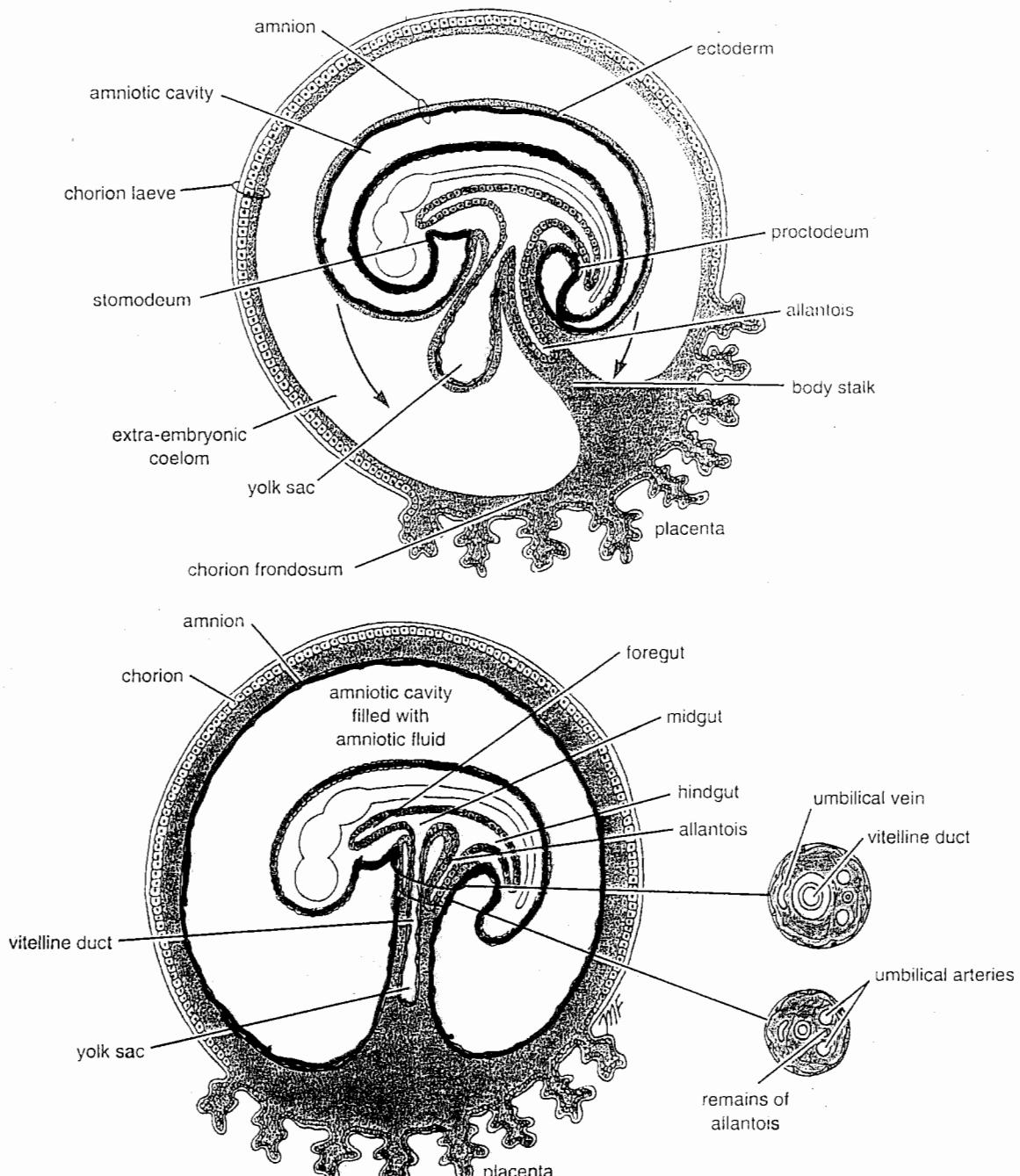


Figure 19-20 The formation of the umbilical cord. Note the expansion of the amniotic cavity (arrows) so that the cord becomes covered with amnion. Note also that the umbilical vessels have been reduced to one vein and two arteries.

- later with development of head, tail & lateral folding of embryo the wide area of communication becomes restricted to the small area within the umbilical cord.

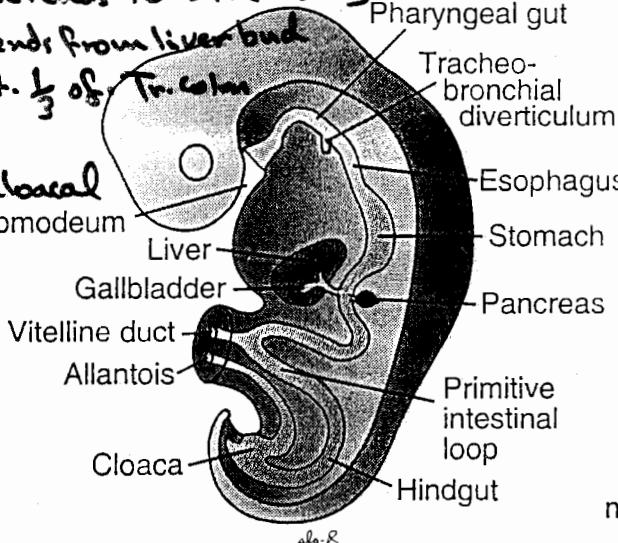
Primitive gut ← pharyngeal gut (Pharynx)
 foregut
 mid gut
 hind gut

274 PART II : SPECIAL EMBRYOLOGY

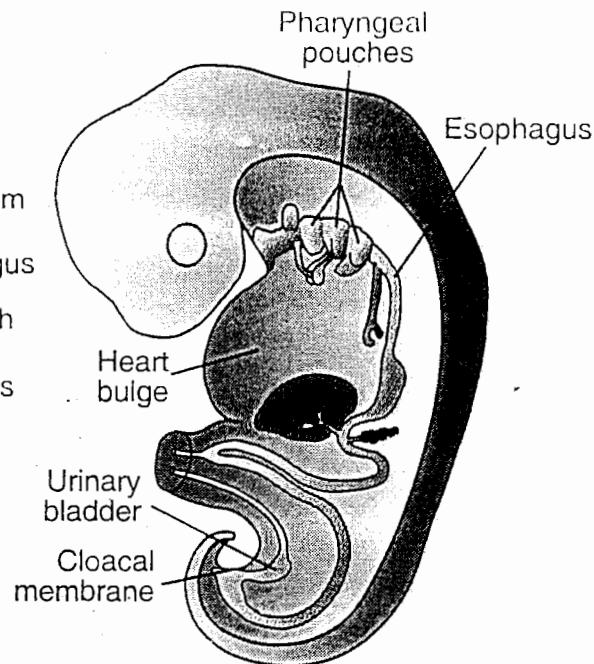
- pharynx : extends from buropharyngeal membrane to tracheobronchial diverticulum
- foregut : caudal to pharyngeal tube
extends to liver outgrowth

- Midgut: extends from liver bud
to lat. $\frac{1}{3}$ of Tr. colon

- Hindgut:
extends to cloacal membrane



A



B

Figure 13.4. 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.

Development of the esophagus:-

- develops from a narrow part of the foregut that succeeds the pharynx
- first it is short then
when the heart & diaphragm descends it elongate rapidly

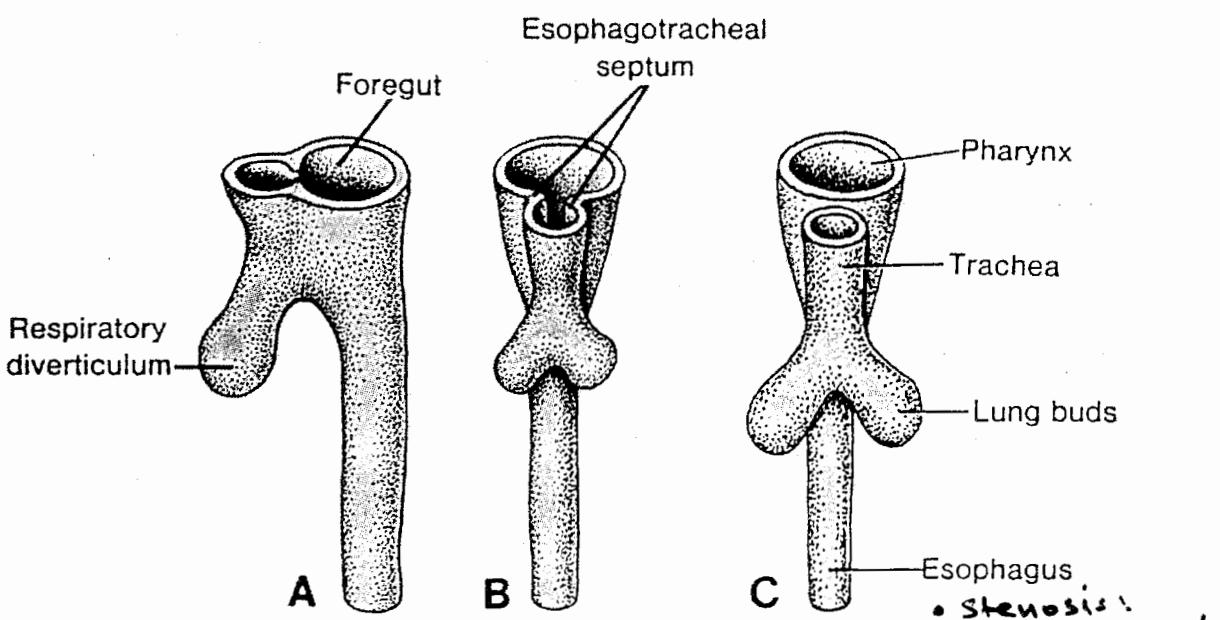
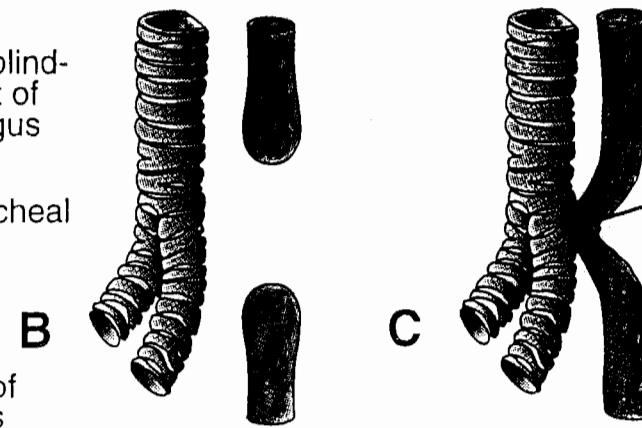
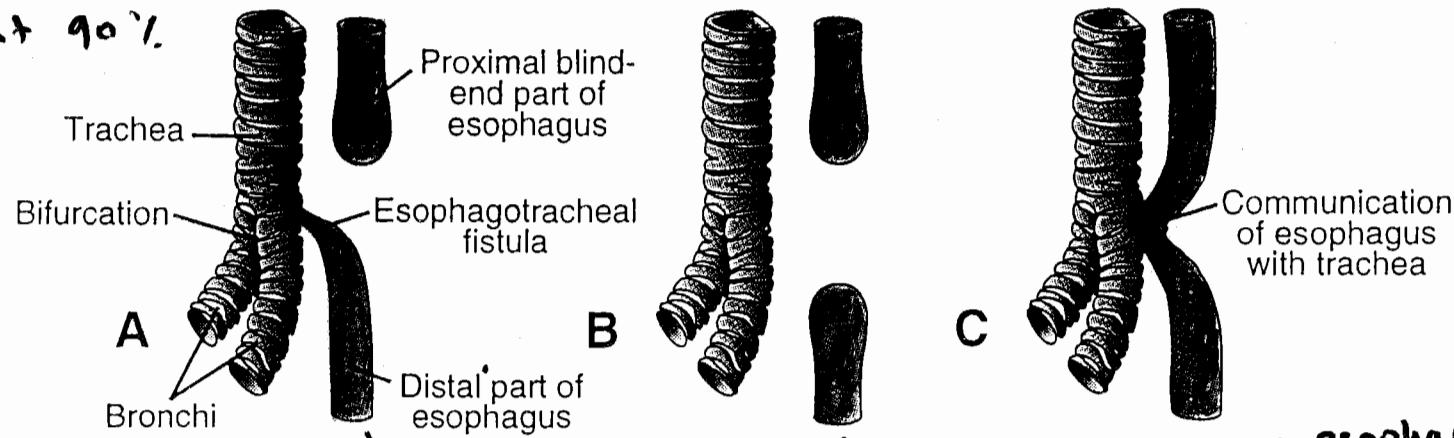


Figure 13.5. Successive stages in development of the respiratory diverticulum and esophagus through partitioning of the foregut. A. At the end of the third week (lateral view). B and C. During the fourth week (ventral view).

Esophageal atresia with or without tracheoesophageal fistulas:

occur in 1/3000
births

- most frequent 90%.

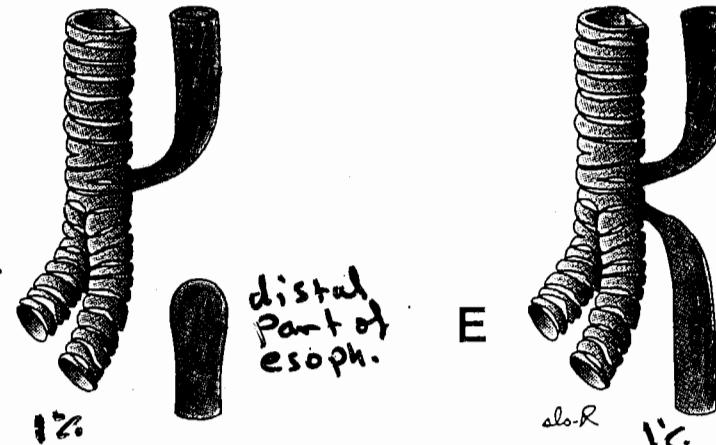


4% of cases
no fistula

4%. No esophageal atresia

- These abnormalities are associated with other birth defects

- 33% of these cases with cardiac anomalies
- other abnormalities
 - anal atresia
 - cardiac defects
 - TE Fis & esoph-atresia
 - Renal anomalies D
 - Limb defects
- unknown cause



- abnormal shortness of esophagus
→ esophageal hiatus hernia
in the diaphragm
↓
esophagitis

Complications of TEFs

- Polyhydramnios**
- Pneumonia**
- air in the stomach → distention during crying**

Figure 12.3. Various types of esophageal atresia and/or tracheoesophageal fistula.
 A. The most frequent abnormality (90% of cases) occurs with the upper esophagus ending in a blind pouch and the lower segment forming a fistula with the trachea. B. Isolated esophageal atresia (4% of cases). C. H-type tracheoesophageal fistula (4% of cases). D and E. Other variations (each 1% of cases).

Development of Peritoneum & Peritoneal cavity

The Abdominal Wall, the Peritoneal Cavity, the Retroperitoneal Space, and the Alimentary Tract

709

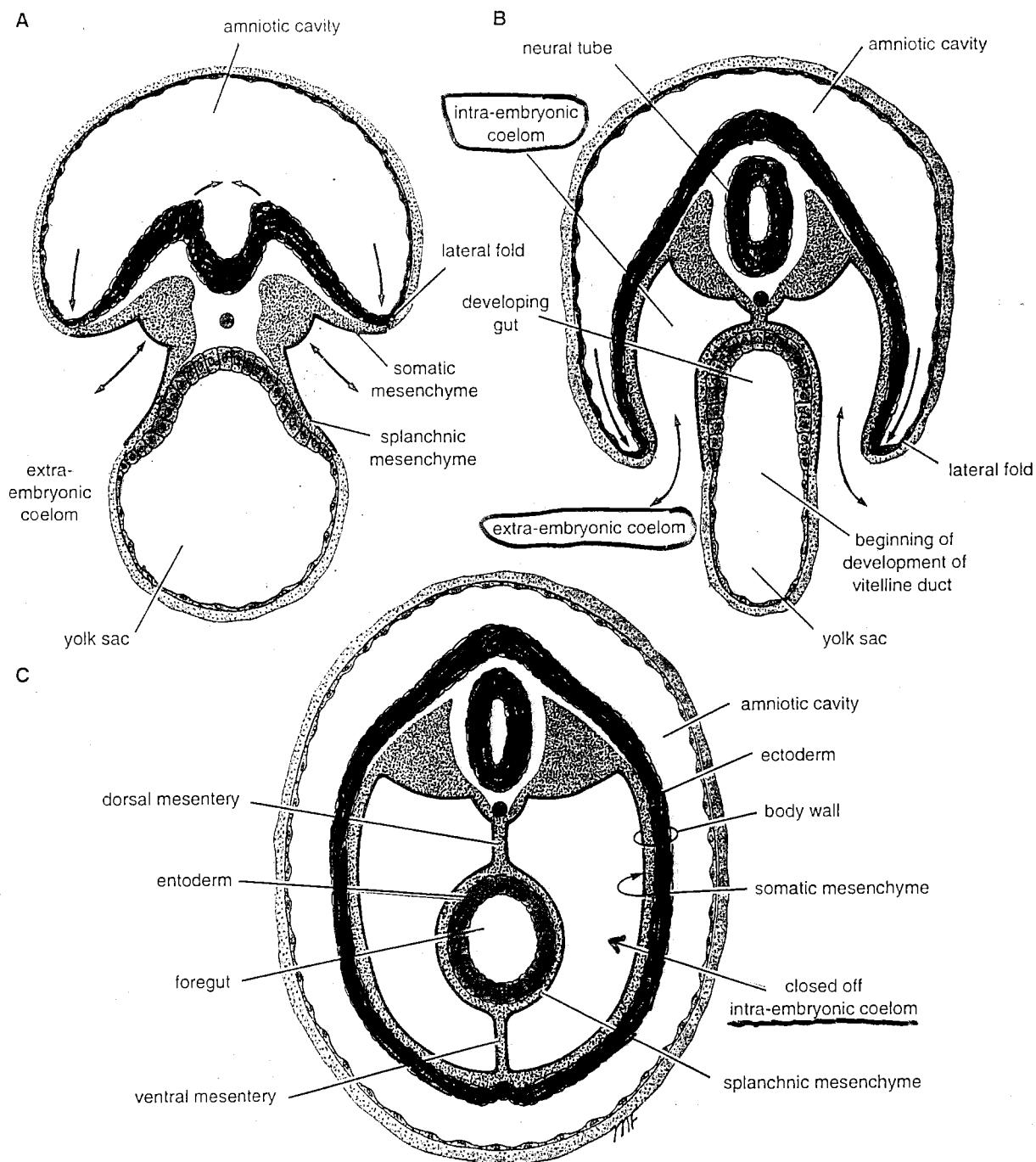


Figure 19-19 Transverse sections through the embryo at different stages of development showing the formation of the abdominal wall and peritoneal cavity. **A.** The intraembryonic coelom in free communication with the extraembryonic coelom (double-headed arrows). **B.** The development of the lateral folds of the embryo and the beginning of the closing off of the intraembryonic coelom. **C.** The lateral folds of the embryo finally fused in the midline and closing off the intraembryonic coelom or future peritoneal cavity. Most of the ventral mesentery will break down and disappear.

- Intraembryonic Coelom is formed between the Somatic & Splanchnic layers of lateral mesoderm.
- Peritoneal Cavity derived from the embryonic Coelom situated caudal to Septum transversum.
- In early Stage: Peritoneal Cavity in Free Communication with Extraembryonic Coelom.

Development of the esophagus:-

- develops from narrow part of the foregut that succeeds the pharynx
- first it is short then when the Heart & diaphragm descend it elongate rapidly

The Abdominal Wall, the Peritoneal Cavity, the Retroperitoneal Space, and the Alimentary Tract 755

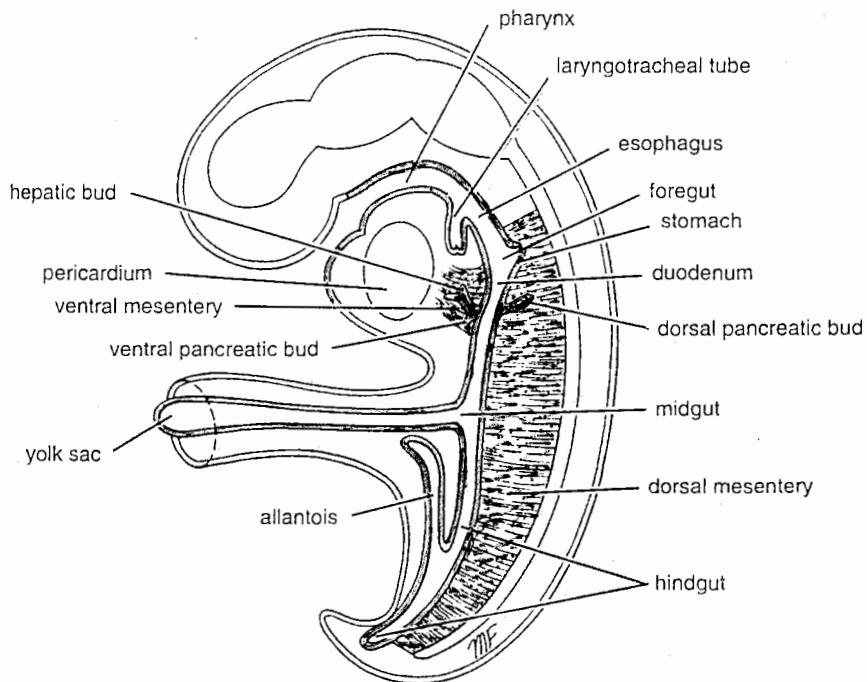
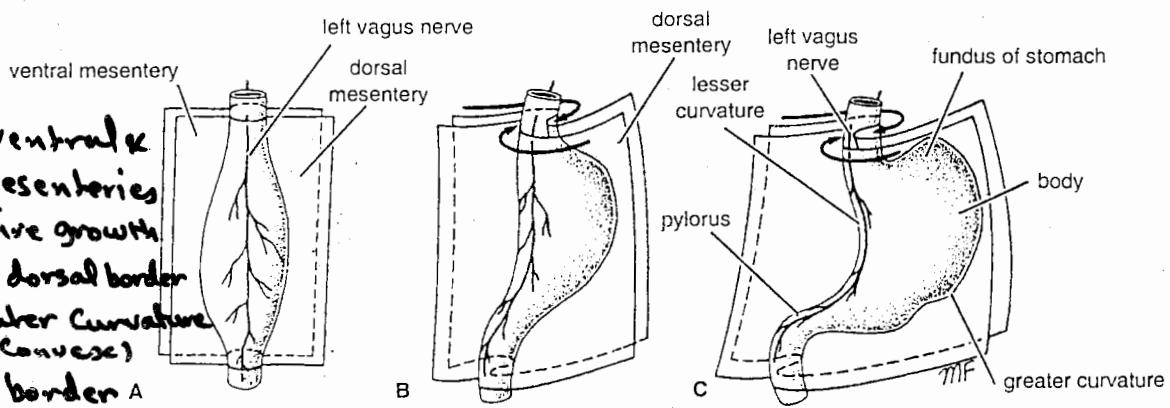


Figure 19-71 The foregut, midgut, and hindgut. The positions of the ventral and dorsal mesenteries, the hepatic bud, and the ventral and dorsal pancreatic buds are also shown.

Development of Stomach:-

develops as dilatation of the foregut.



- it has ventral & dorsal mesenteries
- very active growth along the dorsal border
- Greater Curvature (convex)
- anterior border A become concave → Lesser curvature
- Stomach has Ant & Post. Surfaces after rotation to the right (due to great growth of the Rt lobe of the liver)
- before rotation it has Rt & Lt surfaces + Rt & Lt Vagi

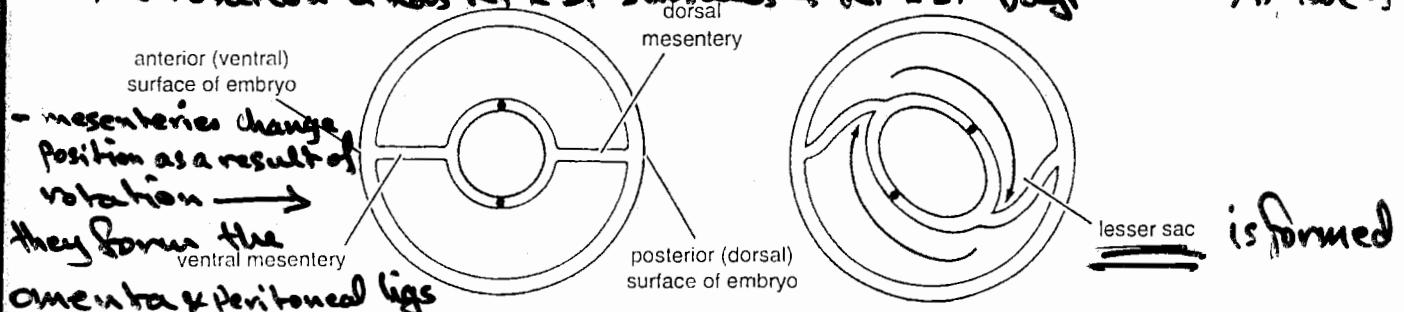


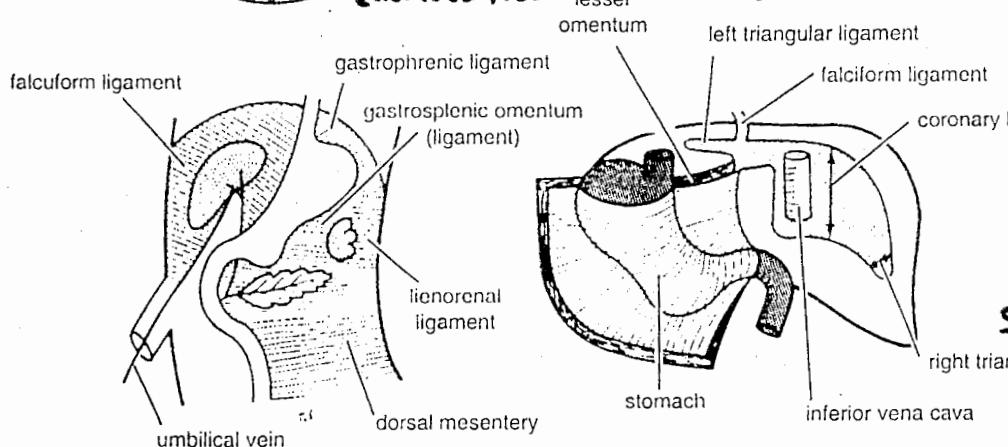
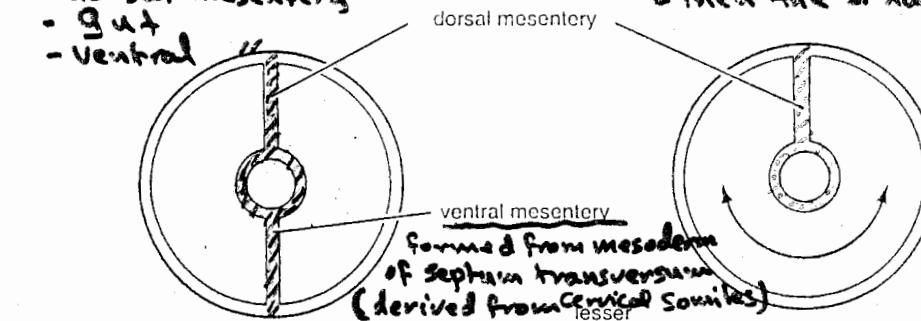
Figure 19-72 Development of the stomach in relation to the ventral and dorsal mesenteries. Note how the stomach rotates so that the left vagus nerve comes to lie on the anterior surface of the stomach. Note also the position of the lesser sac.

Pyloric Stenosis is Congenital hypertrophy: common in infant 3-6 wks

- In early development the Peritoneal cavity divided into 2 halves by:-

- dorsal mesentery
- gut
- ventral

- then the 2 halves are in free communication



dorsal mesentery formed from

- fusion of splanchnopleuric mesoderm on two sides of embryo

- extends from post. abd. wall to the Post. border of abd. part of gut.

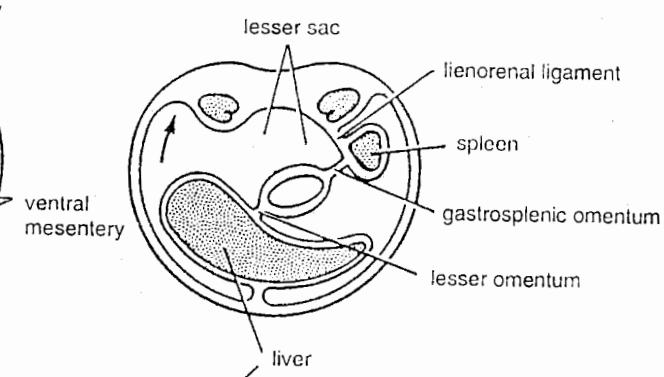
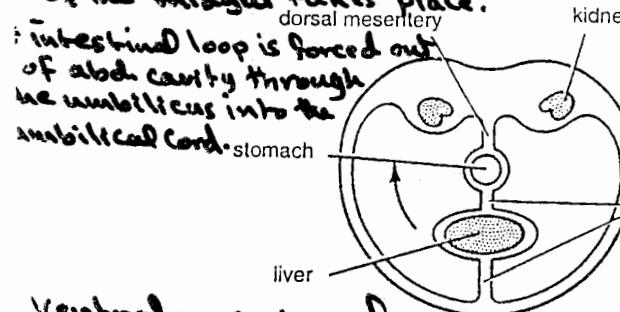
It forms the

1. gastro splenic lig
2. gastraphrenic lig
3. splenorenal lig
4. greater omentum
5. mesenteries of small & large intestine.

Figure 19-28 Ventral and dorsal mesenteries and the organs that develop within them.

During 6 wks of development:-

the capacity of abd. cavity becomes greatly reduced due to great entanglement of Liver & Kidney → So physiological herniation of the midgut takes place.



Ventral mesentery forms the

falciform lig

lesser omentum

lesser omentum

coronary lig

triangular lig of Liver

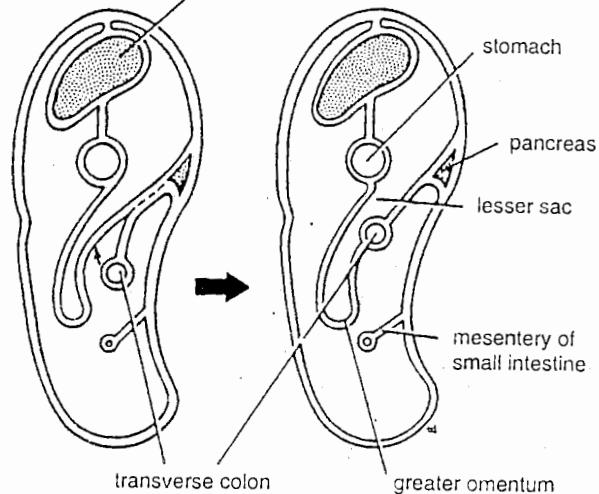
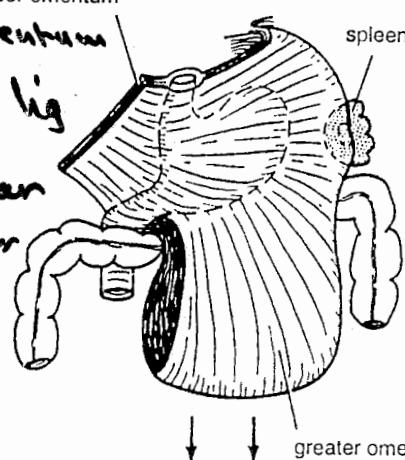


Figure 19-29 The rotation of the stomach and the formation of the greater omentum and lesser sac.

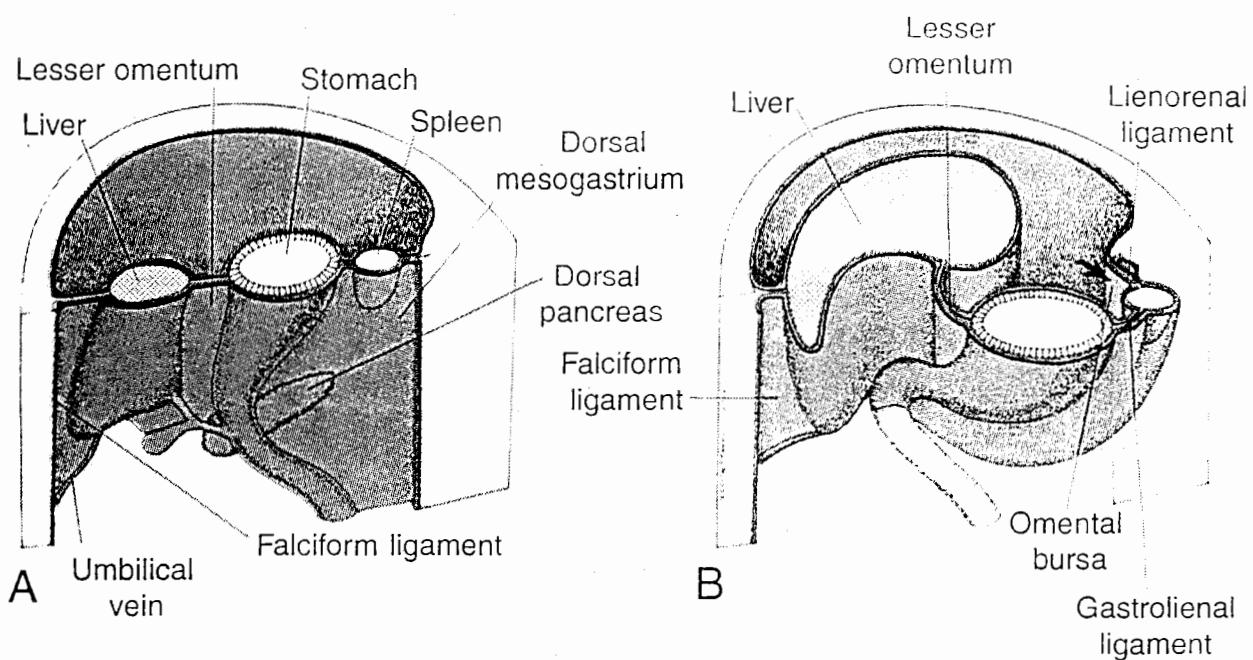


Figure 13.9. A. The positions of the spleen, stomach, and pancreas at the end of the fifth week. Note the position of the spleen and pancreas in the dorsal mesogastrium. B. Position of spleen and stomach at the 11th week. Note formation of the omental bursa or lesser peritoneal sac.

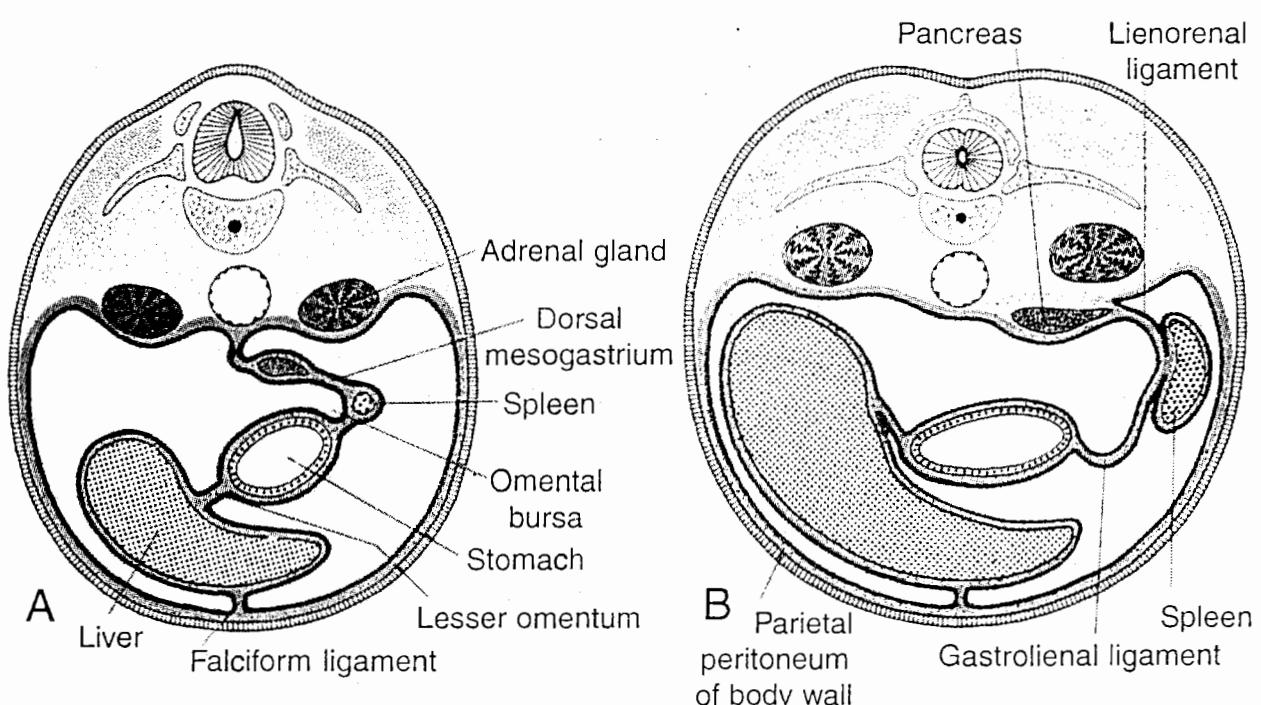


Figure 13.10. Transverse sections through the region of the stomach, liver, and spleen, showing formation of the lesser peritoneal sac, rotation of the stomach, and position of the spleen and tail of the pancreas between the two leaves of the dorsal mesogastrium. With further development, the pancreas assumes a retroperitoneal position.

Formation of Lesser & Greater Peritoneal Sacs:-

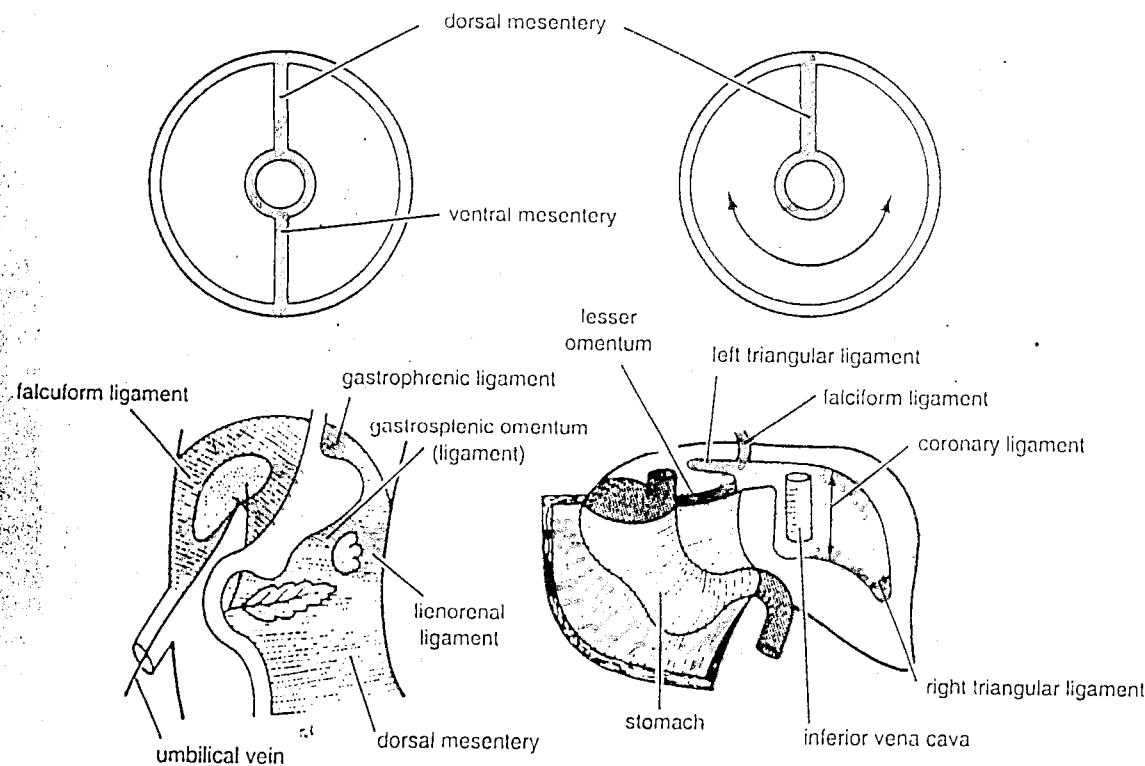
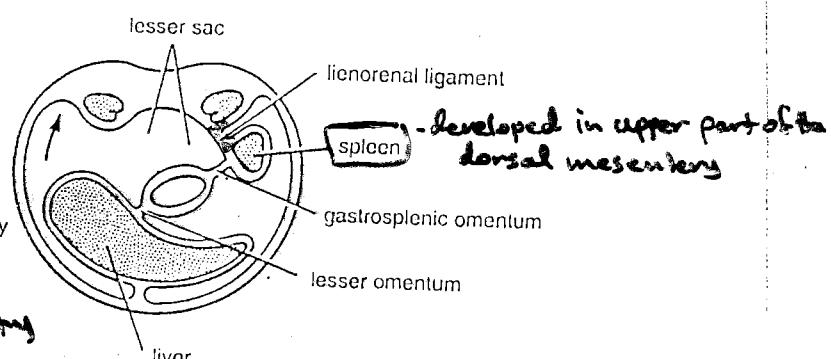
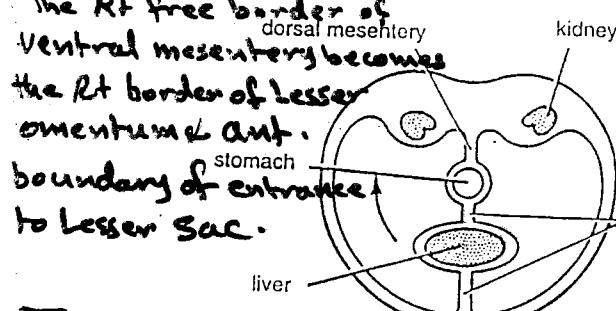


Figure 19-28 Ventral and dorsal mesenteries and the organs that develop within them.

extensive growth of the Rt. lobe of Liver pulls the ventral mesentery to the Rt →
causes rotation of the Stomach & did.
So the upper Rt part of peritoneal cavity becomes incorporated into Lesser Sac.

The Rt free border of ventral mesentery becomes the Rt border of Lesser omentum & ant. boundary of entrance to Lesser Sac.



The remaining part of peritoneal cavity is the Greater Sac

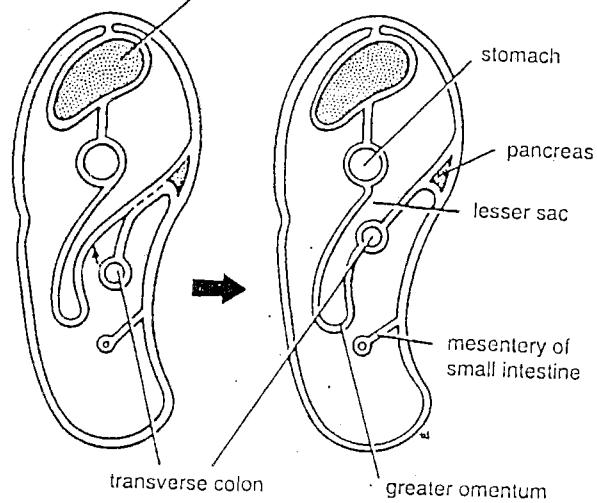
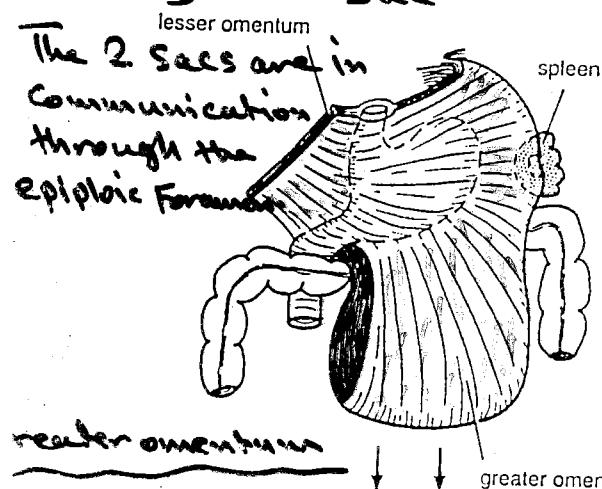
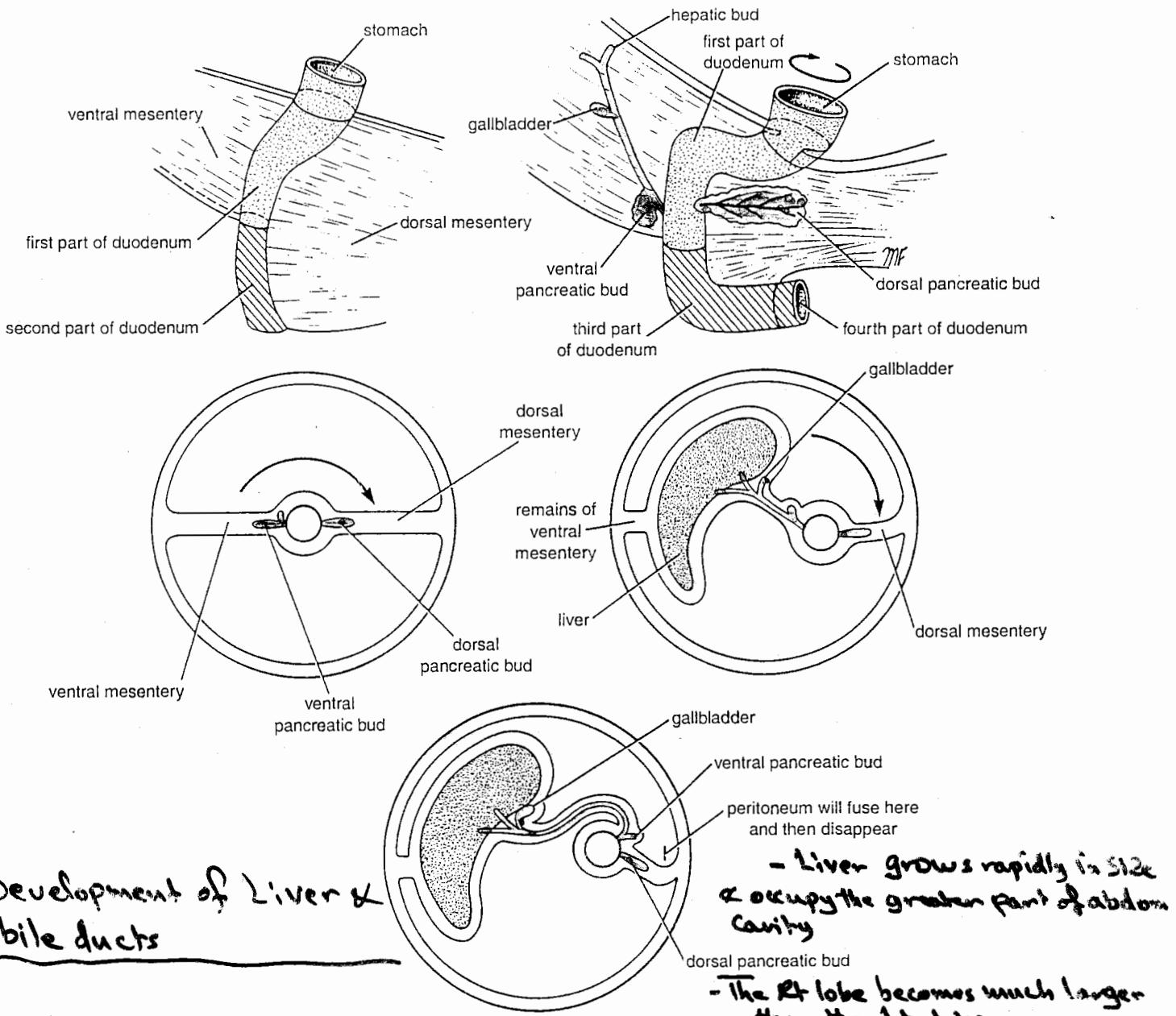


Figure 19-29 The rotation of the stomach and the formation of the greater omentum and lesser sac.

It is formed as a result of rapid & extensive growth of dorsal mesentery ~~tethered~~ to the Spleen
it extends from greater curvature of stomach to post. abd. wall Sup. to transv. mesentery
continued growth it reaches inf. as an apron-like double layer of peritoneum Ant. to the transverse colon.

- later the Post. layer of the omentum fuses é transverse mesocolon.



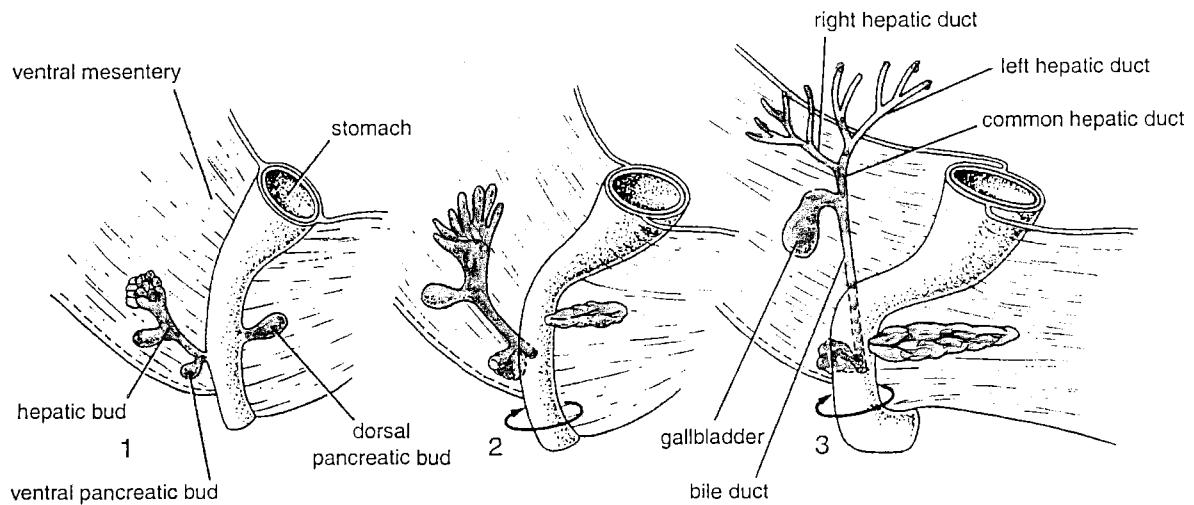
Development of Liver & bile ducts

Figure 20-20 Development of the duodenum in relation to the ventral and dorsal mesenteries. Stippled area, foregut; crosshatched area, midgut.

- Liver arises from the distal end of foregut as a solid bud of entodermal cells
- Site of origin lies at the apex of the loop of developing d.d. Corresponding to the point halfway along the 2nd part of fully formed d.d.
- Hepatic bud grows anteriorly into mass of splanchnic mesoderm called (septum transversum)
- end of bud divides into Rt & Lt branches from which columns of entodermal cells grow into vascular mesoderm form Liver Sinusoids (broken the vitelline & umbilical veins in Septum transversum)
- Columns of entodermal cells → Liver cords
- Connective tissue of Liver is formed → mesenchyme of Septum transversum
- The main hepatic bud & its Rt & Lt terminal branches → become canalized & form common hepatic ducts & left hepatic duct



Figure 20-18 Longitudinal sonogram of the upper part of the abdomen showing the lumen of the gallbladder. (Courtesy of Dr. M.C. Hill.)



Development of gallbladder & cystic duct

- G. Bladder develops from hepatic bud as a solid outgrowth of cells
- End of the outgrowth expands forming the G. bladder
- narrow stem remains as the cystic duct
- Later the G. bladder & cystic duct become canalized
- cystic duct opens into common hepatic duct → form bile duct
- biliary atresia → failure of bile duct to canalize during development

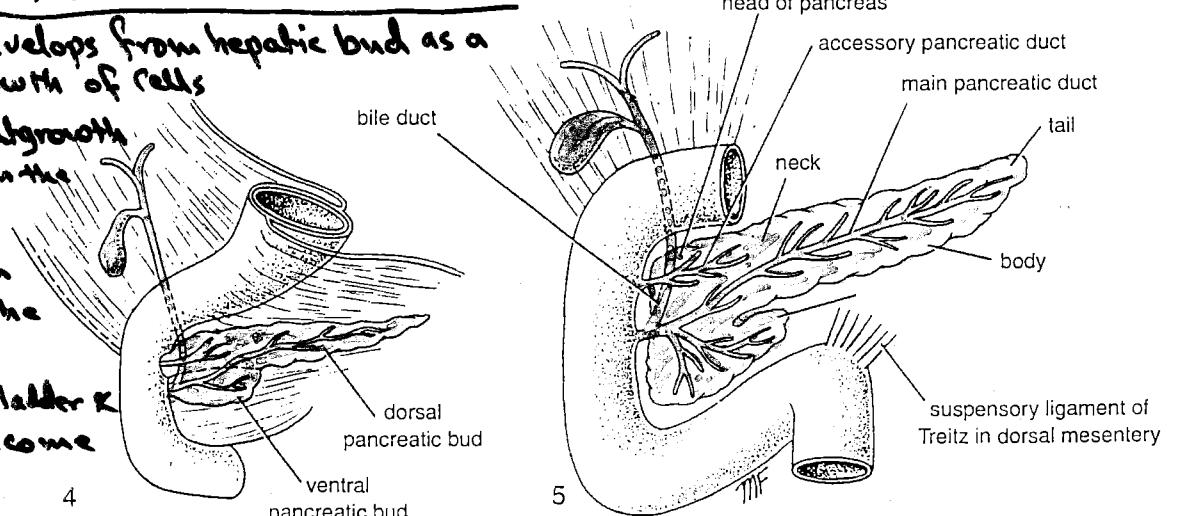


Figure 20-19 The development of the pancreas and the extrahepatic biliary apparatus.

CLINICAL CORRELATES

Liver and Gallbladder Abnormalities

Variations in liver lobulation are common but not clinically significant. Accessory hepatic ducts and duplication of the gallbladder (Fig. 13.18) are also common and usually asymptomatic. However, they become clinically important under pathological conditions. In some cases the ducts, which pass through a solid phase in their development, fail to recanalize (Fig. 13.18). This defect, extrahepatic biliary atresia, occurs in 1/15,000 live births. Among patients with extrahepatic biliary atresia, 15 to 20% have patent proximal ducts and a correctable defect, but the remainder usually die unless they receive a liver transplant.

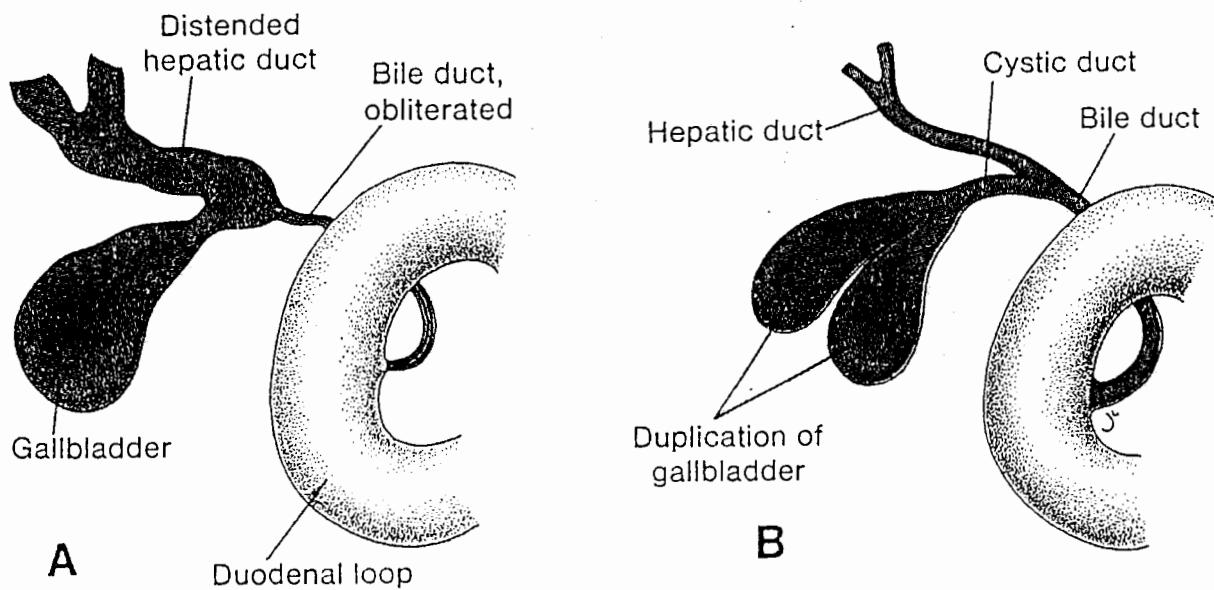


Figure 13.18. A. Obliteration of the bile duct resulting in distention of the gallbladder and hepatic ducts distal to the obliteration. B. Duplication of the gallbladder.

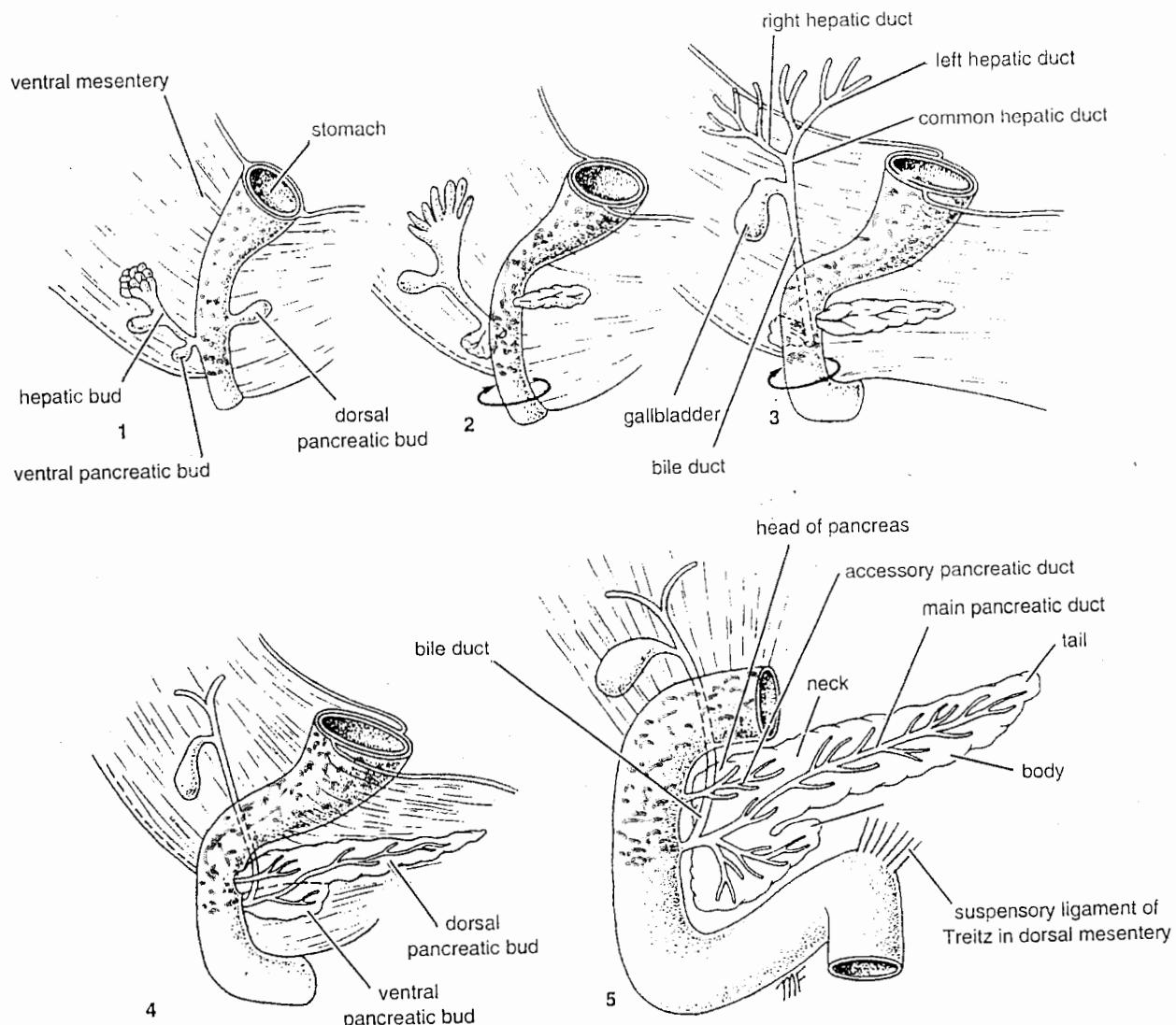


Figure 19-73 The development of the pancreas and the extrahepatic biliary apparatus.

Development of duodenum

- is formed from most caudal portion of foregut ~ cephalic end of midgut
- it grows rapidly form a loop
- it has mesentery extends to post. abd. wall & is part of dorsal mesentery
- small part of ventral mesentery attached to — Ventral border of first part of d.d. and the upper half of the 2nd part of d.d.
- When the Stomach rotates, the d.d. loop is forced to rotate to the Rt. So 2nd, 3rd and part of 4th part adhere to post. abdominal wall
- Now peritoneum behind d.d. disappears
- Some smooth muscle & fibrous tissue & belong to dorsal mesentery remains as suspensory lig. of d.d. (lig. of Treitz) fixes the terminal part of d.d. & prevent it from moving inferiorly.
- The Liver and pancreas arise as entodermal buds from the developing d.d.

EMBRYOLOGY OF THE GASTROINTESTINAL TRACT

Development of the Pancreas:-

The pancreas develops from a **dorsal** and **ventral** bud of entodermal cells that arise from the foregut. The dorsal bud originates a short distance above the ventral bud and grows into the dorsal mesentery. The ventral bud arises in common with the hepatic bud, close to the junction of the foregut with the midgut (Fig. 20-19). A canalized duct system now develops in each bud. The rotation of the stomach and duodenum, together with the rapid growth of the left side of the duodenum, results in the ventral bud's coming into contact with the dorsal bud, and fusion occurs (Fig. 20-25).

Fusion also occurs between the ducts, so that the **main pancreatic duct** is derived from the entire ventral

Pancreatic duct & the distal part of dorsal
 ~ ~ .

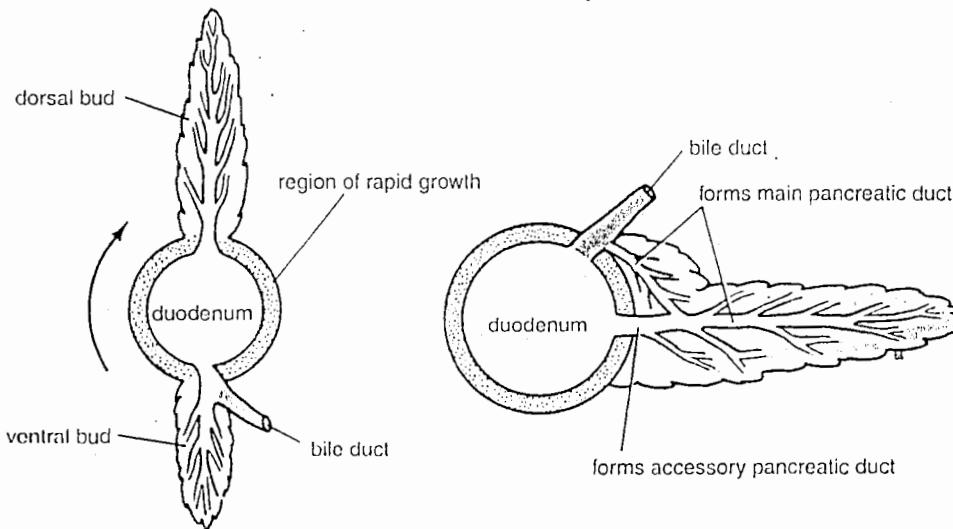


Figure 20-25 The rotation of the duodenum and the unequal growth of the duodenal wall lead to the fusing of the ventral and dorsal pancreatic buds.

- The main pancreatic duct joins the bile duct & enters the 2nd part of d.d.
- The proximal part of the dorsal pancreatic duct may persist → accessory duct.
It may or may not open into the d.d.
- growth of entodermal cells continue → fusion of ventral & dorsal pancreatic buds extend into surrounding mesenchyme as columns of cells → columns give off side branches which later become canalized → forming collecting ducts
- Secretory acini appear at ends of ducts.

- Pancreatic islets arise as small buds from developing ducts

Later these cells vitelline duct sever their connection
yolk sac
duct system → form

isolated group of cells

Start to secrete insulin & glucagon
at about 5th month. allantois
proctodeum

Ventral pancreatic bud formed
• head of pancreas (inf. part)
• uncinate process

Dorsal pancreatic bud formed

Sup. part of head

• neck

• body

• tail of pancreas

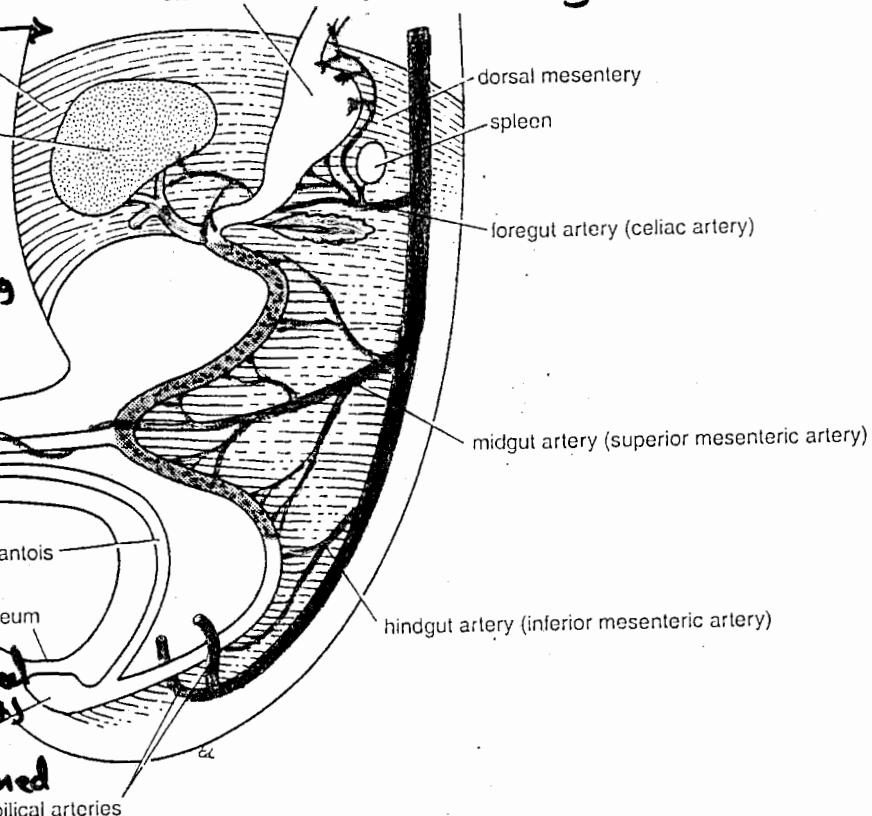


Figure 20-28 Formation of the midgut loop (shaded). Note how the superior mesenteric artery and vitelline duct form an axis for the future rotation of the midgut loop. Note also the formation of the spleen in the dorsal mesentery.

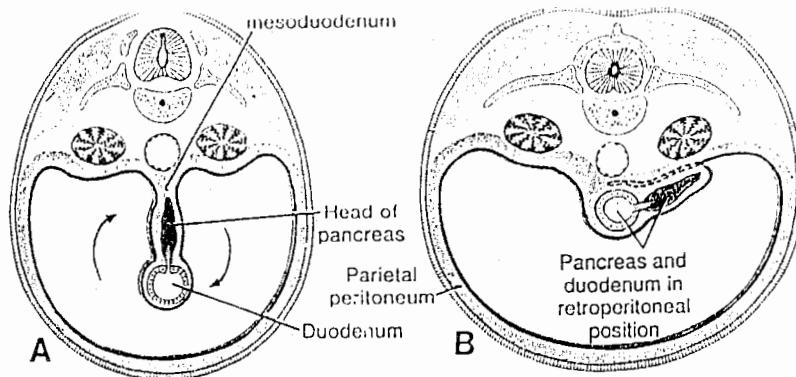


Figure 13.16. Transverse sections through the region of the duodenum at various stages of development. At first the duodenum and head of the pancreas are located in the median plane (A), but later they swing to the right and acquire a retroperitoneal position (B).

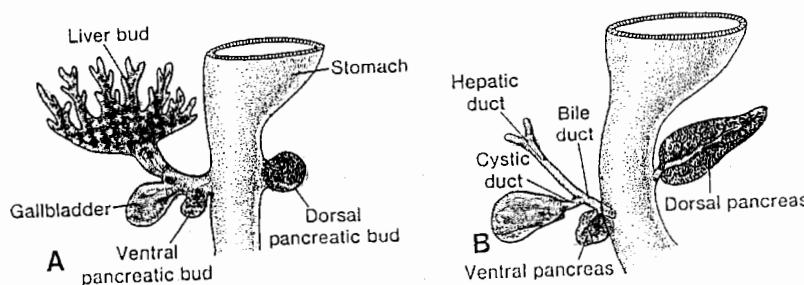


Figure 13.19. Stages in development of the pancreas. A. 30 days (approximately 5 mm). B. 35 days (approximately 7 mm). Initially the ventral pancreatic bud lies close to the liver bud, but later it moves posteriorly around the duodenum toward the dorsal pancreatic bud.

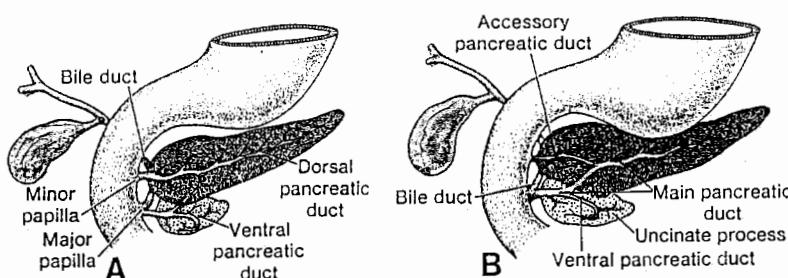


Figure 13.20. A. Pancreas during the sixth week of development. The ventral pancreatic bud is in close contact with the dorsal pancreatic bud. B. Fusion of the pancreatic ducts. The main pancreatic duct enters the duodenum in combination with the bile duct at the major papilla. The accessory pancreatic duct (when present) enters the duodenum at the minor papilla.

pancreas. Insulin secretion begins at approximately the fifth month. Glucagon- and somatostatin-secreting cells also develop from parenchymal cells. Splanchnic mesoderm surrounding the pancreatic buds forms the pancreatic connective tissue.

CLINICAL CORRELATES

Pancreatic Abnormalities

The ventral pancreatic bud consists of two components that normally fuse and rotate around the duodenum so that they come to lie below the dorsal pancreatic bud. Occasionally, however, the right portion of the ventral bud migrates along its normal route but the left migrates in the opposite direction. In this manner the duodenum is surrounded by pancreatic tissue, and an **annular pancreas** is formed (Fig. 13.21). The malformation sometimes constricts the duodenum and causes complete obstruction.

Accessory pancreatic tissue may be anywhere from the distal end of the esophagus to the tip of the primary intestinal loop. Most frequently it lies in the mucosa of the stomach and in Meckel's diverticulum, where it may show all of the histological characteristics of the pancreas itself.

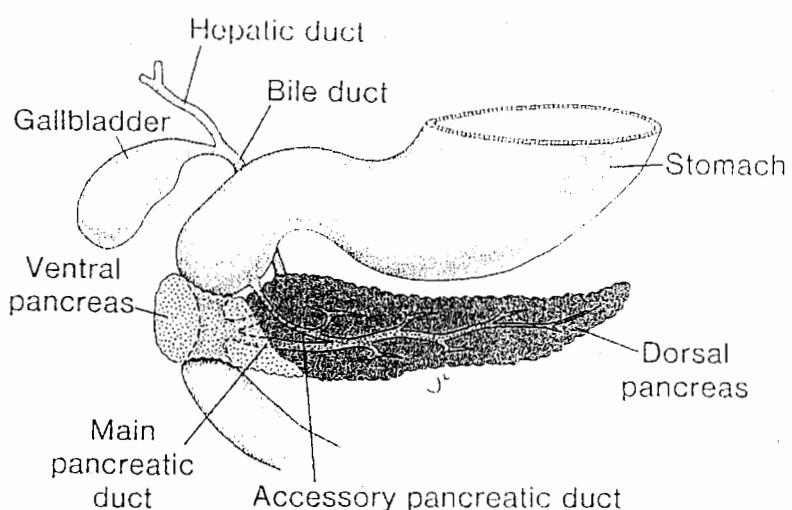


Figure 13.21. Annular pancreas. The ventral pancreas splits and forms a ring around the duodenum, occasionally resulting in duodenal stenosis.

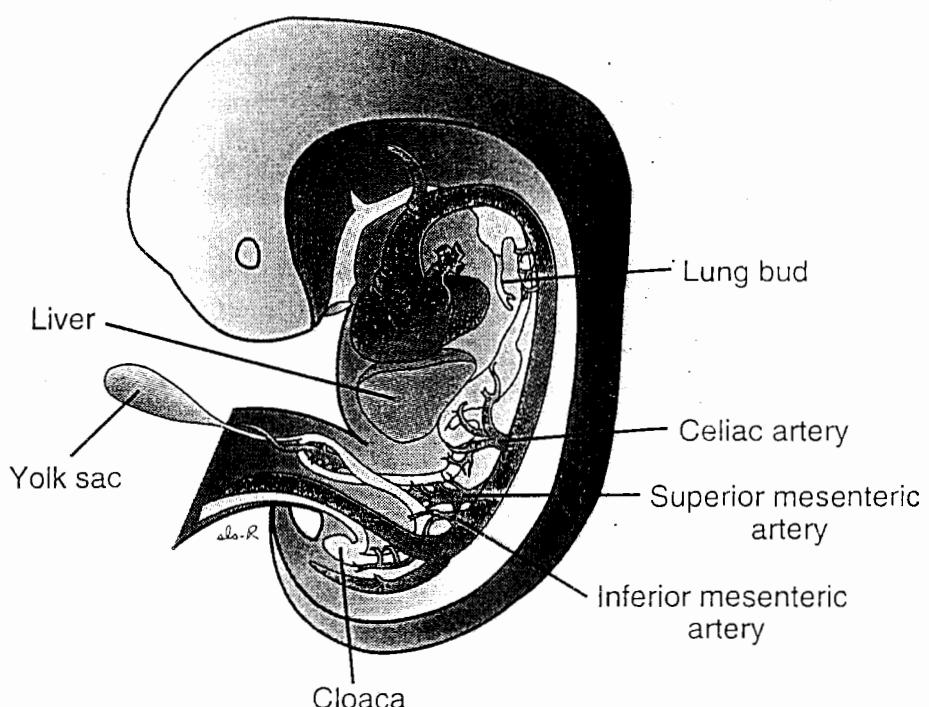


Figure 13.22. Embryo during the sixth week of development, showing blood supply to the segments of the gut and formation and rotation of the primary intestinal loop. The superior mesenteric artery forms the axis of this rotation and supplies the midgut. The celiac and inferior mesenteric arteries supply the foregut and hindgut, respectively.

transverse colon with the distal third. Over its entire length the midgut is supplied by the superior mesenteric artery (Fig. 13.22).

Development of the midgut is characterized by rapid elongation of the gut and its mesentery, resulting in formation of the primary intestinal loop (Figs. 13.22 and 13.23). At its apex the loop remains in open connection with the yolk sac by way of the narrow vitelline duct (Fig. 13.22). The

Development of the Midgut

- distal to the d.d., small intestine, large intestine → distal 1/3 of Tr. colon
- midgut increases rapidly in length & forms a loop to open umbilicus (vitelline duct) → open umbilicus

The Abdominal Wall, the Peritoneal Cavity, the Retroperitoneal Space, and the Alimentary Tract

757 Widley
open umbilicus

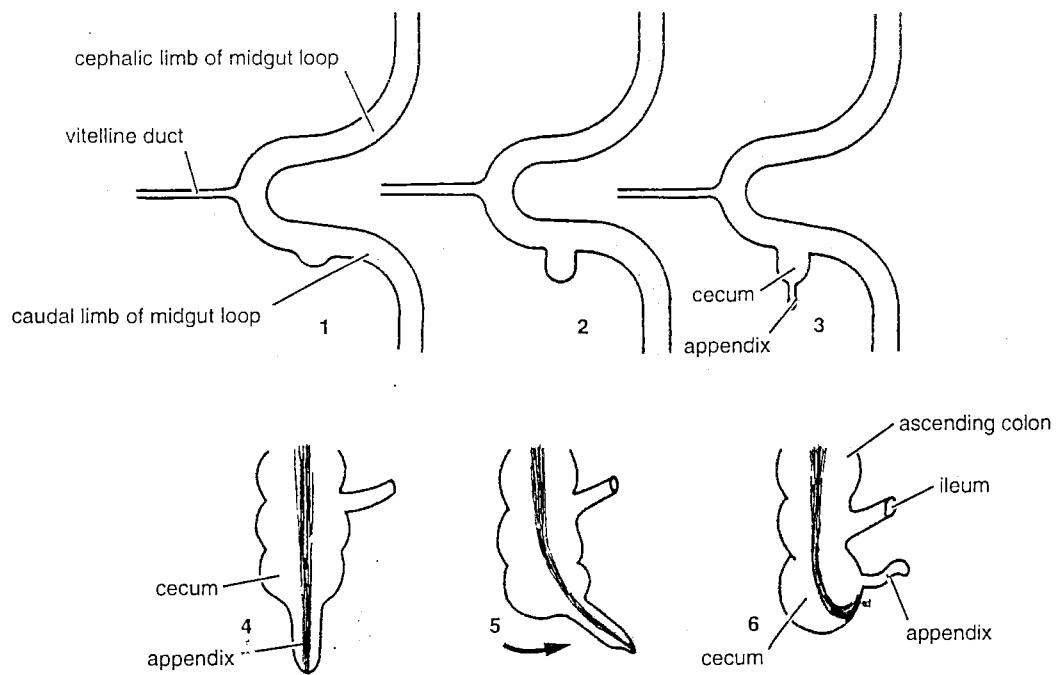


Figure 19-74 Stages in the development of the cecum and appendix. The final stages of development (stages 4, 5, and 6) take place after birth.

aspect, a counterclockwise rotation of approximately 90° occurs (Fig. 19-75). Later, as the gut returns to the abdominal cavity, the midgut rotates counterclockwise an additional 180°. Thus, a total rotation of 270° counterclockwise has occurred (Fig. 19-76).

The rotation of the gut results in part of the large intestine (transverse colon) coming in front of the superior mesenteric artery and the second part of the duodenum; the third part of the duodenum comes to lie behind the artery. The cecum and appendix come into close contact

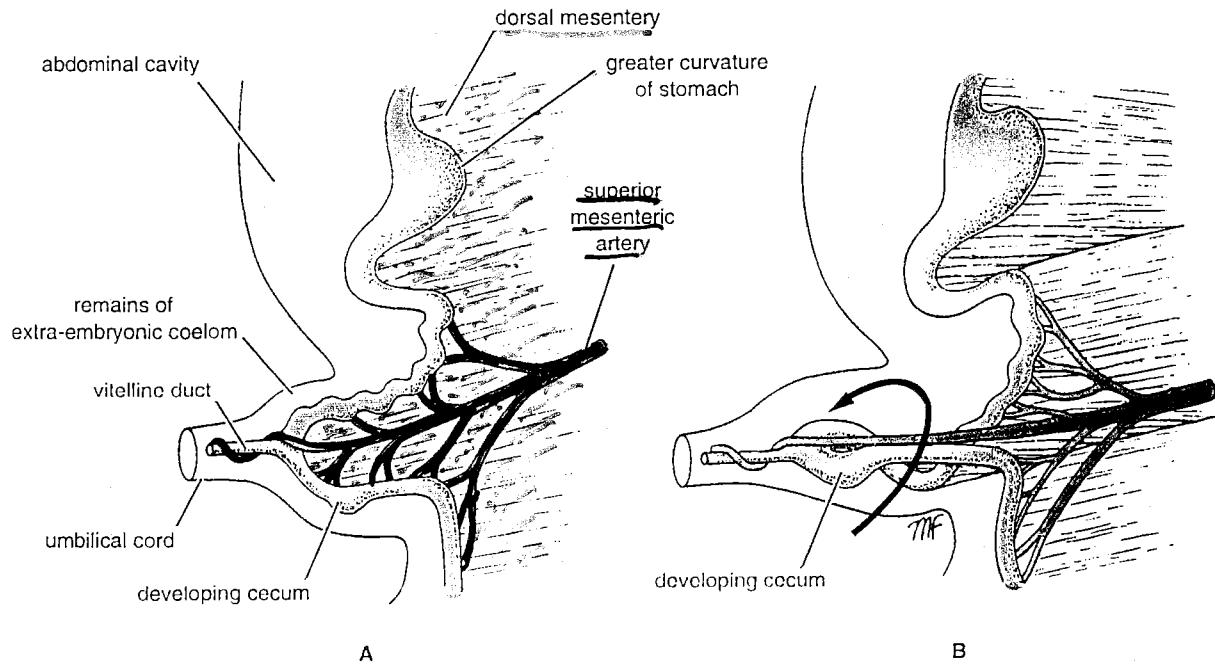
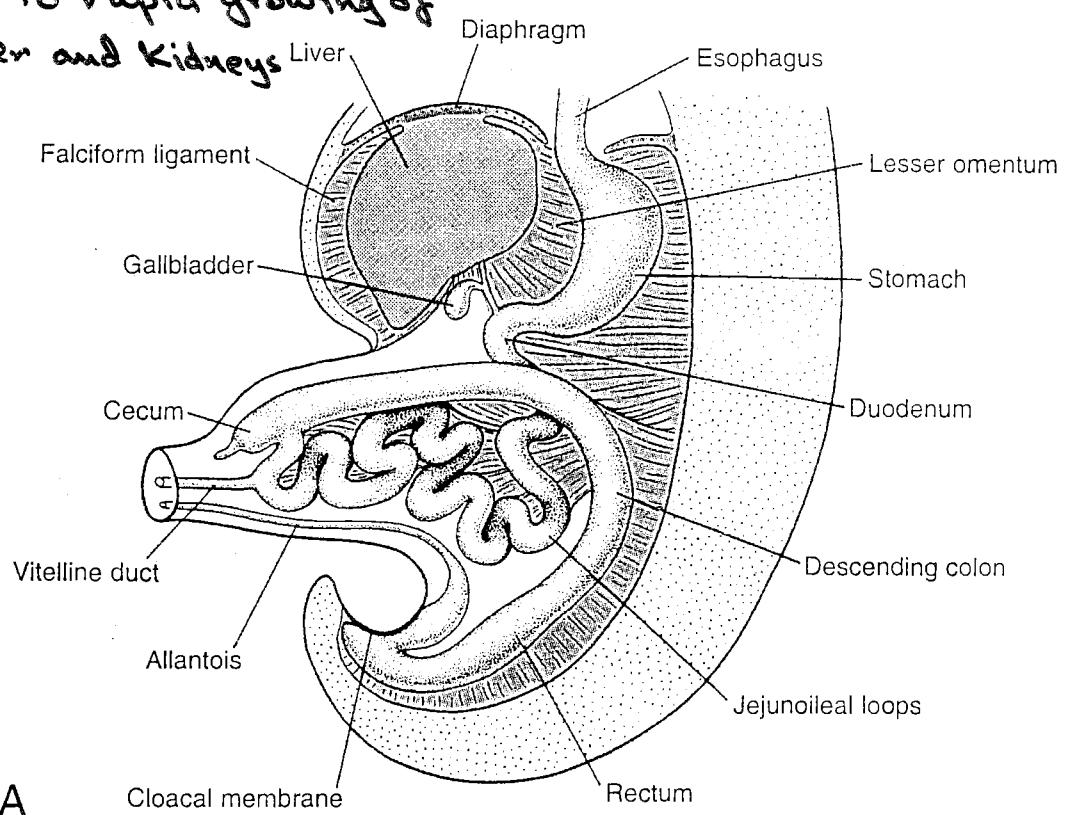


Figure 19-75 Left side views of the counterclockwise 90° rotation of the midgut loop while it is in the extraembryonic coelom in the umbilical cord.

- dorsal mesentery also elongates & passing through it from the aorta to yolk sac the vitelline arteries → here it forms the Superior mesenteric artery → supplies the midgut & its derivatives

3- Midgut Loop → physiological herniation into the umbilical cord due to rapid growing of Liver and Kidneys



A

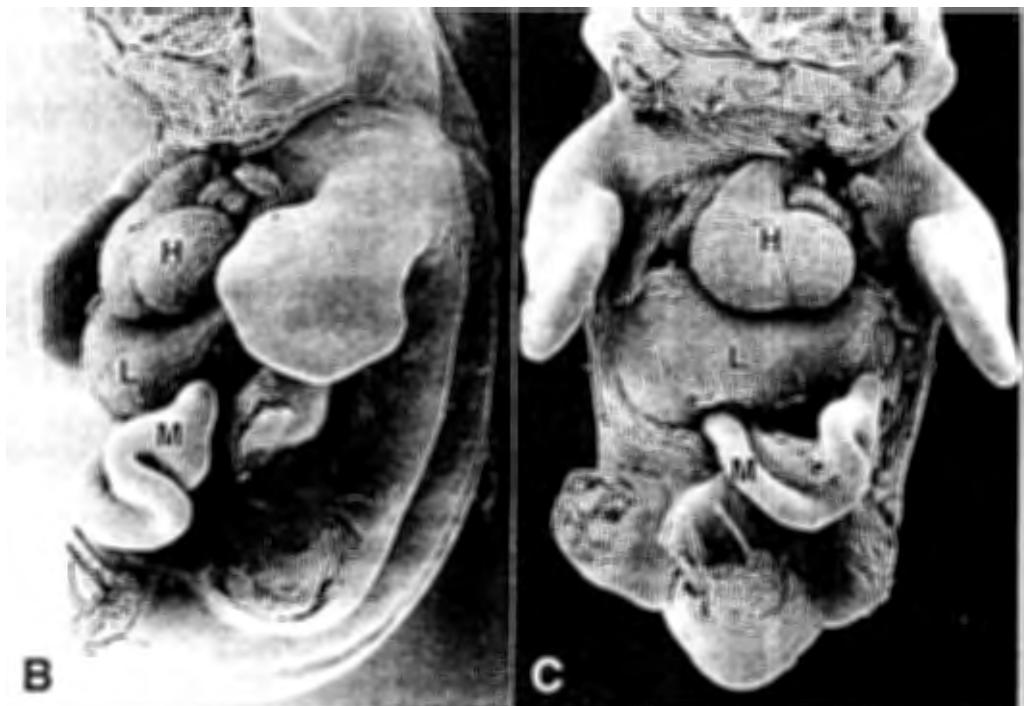


Figure 13.24. Umbilical herniation of the intestinal loops in an embryo of approximately 8 weeks (crown-rump length, 35 mm). Coiling of the small intestinal loops and formation of the cecum occur during the herniation. The first 90° of rotation occurs during herniation; the remaining 180° occurs during the return of the gut to the abdomen.

- diverticulum appears at caudal end of bowel loop This (continues on page 291)
- first the diverticulum is conical → later the upper part expands & form the cecum
the lower part remains rudimentary → forms the appendix
- after birth the cecum wall grows unequally → appendix comes to lie on its medial side
- the cephalic end of the loop of gut becomes greatly elongated & coiled → forms Jejunum

Rotation of the Midgut Loop in the Umbilical Cord and its return to the abdominal cavity

- The midgut in the umbilical cord rotates around the axis (Sup. mesenteric artery + Vitelline duct)

a counter-clockwise rotation
90°.

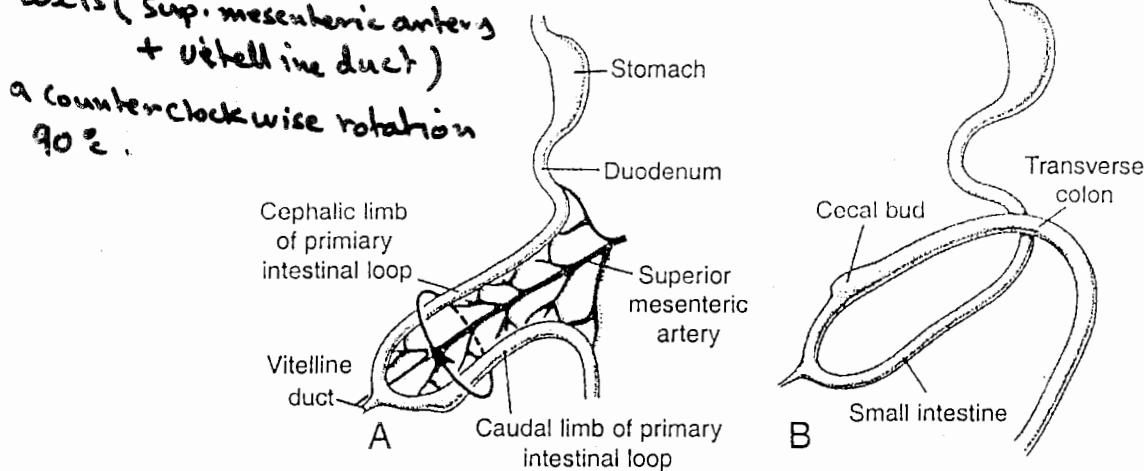


Figure 13.23. A. Primary intestinal loop before rotation (lateral view). The superior mesenteric artery forms the axis of the loop. Arrow, counterclockwise rotation. B. Similar view as in A, showing the primary intestinal loop after 180° counterclockwise rotation. The transverse colon passes in front of the duodenum:

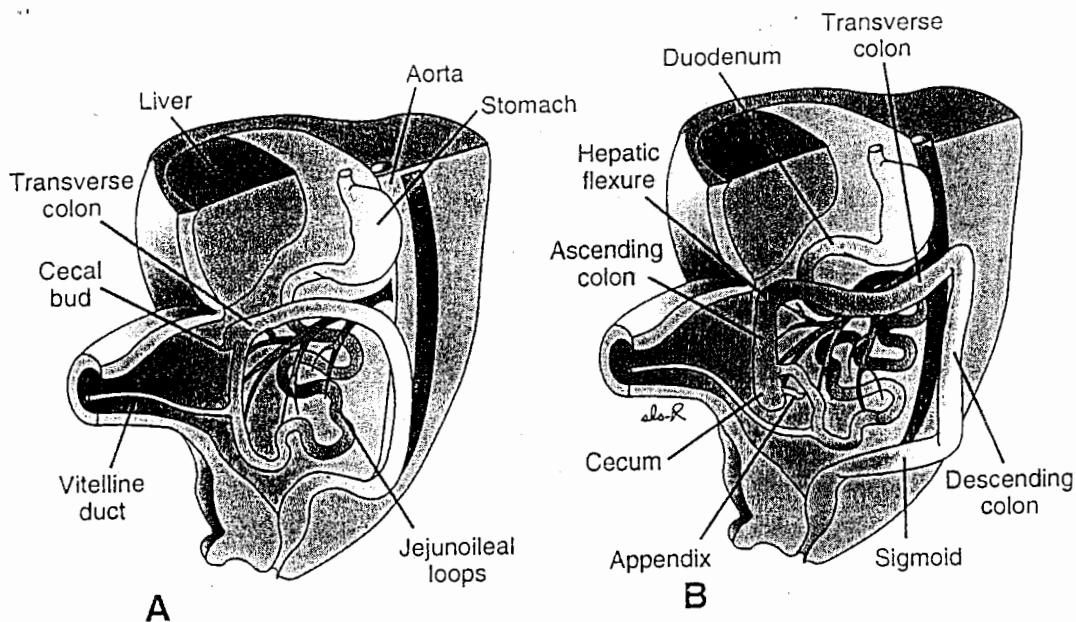


Figure 13.25. A. Anterior view of the intestinal loops after 270° counterclockwise rotation. Note the coiling of the small intestinal loops and the position of the cecal bud in the right upper quadrant of the abdomen. B. Similar view as in A, with the intestinal loops in their final position. Displacement of the cecum and appendix caudally places them in the right lower quadrant of the abdomen.

- Later as the midgut returns to the abdominal cavity it rotates counterclockwise an additional 180°.

Thus the total rotation 270° counterclockwise.

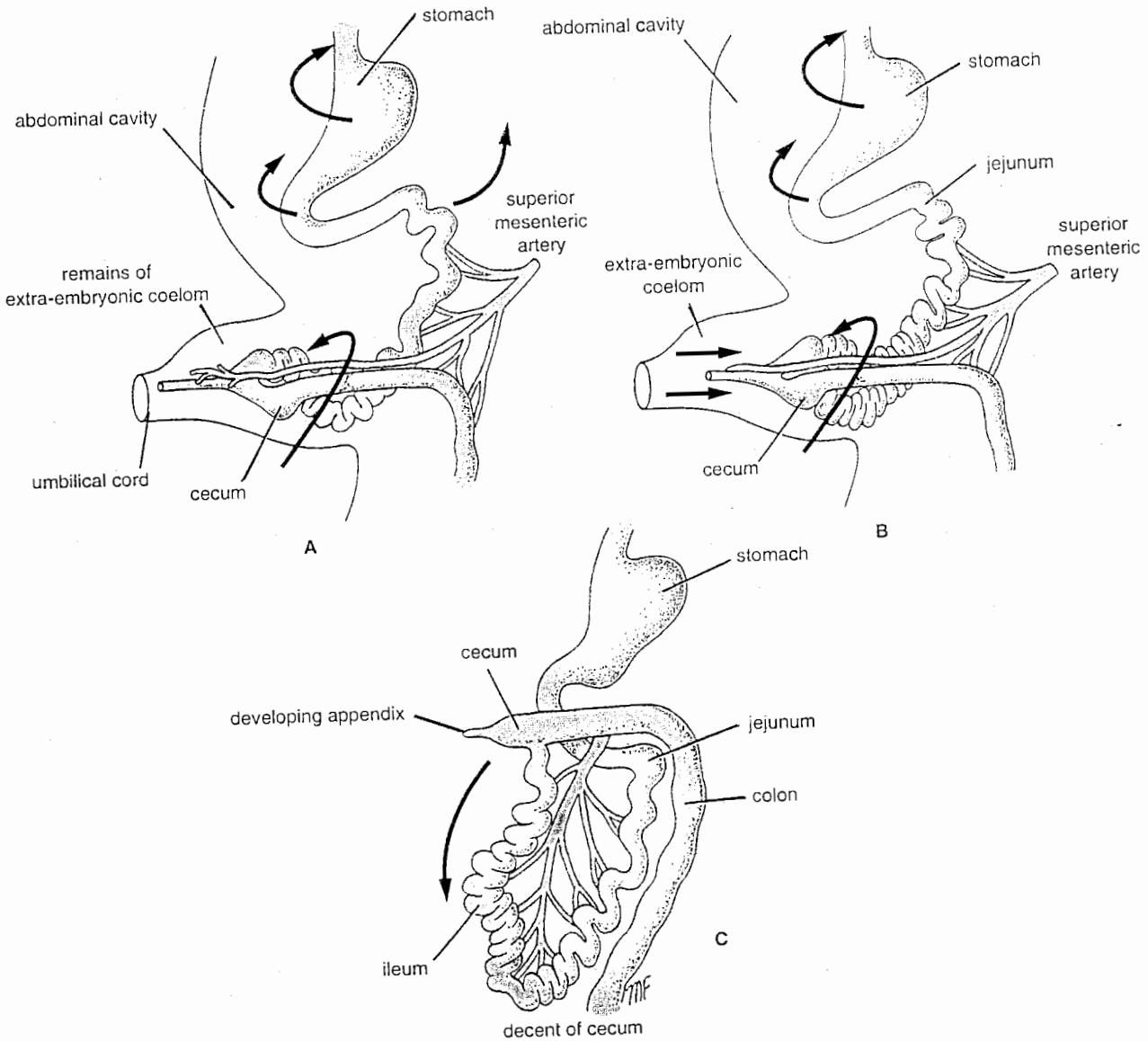


Figure 19-76 Left side views (**A, B**) of the counterclockwise 180° rotation of the midgut loop as it is withdrawn into the abdominal cavity. **C.** The descent of the cecum takes place later.

Results of rotation of the midrib :-

- Tr. colon lies in front of the Sup. mesenteric artery and 2nd part of d.d.
 - Third part of d.d. lies behind the Sup. mesenteric artery.
 - Cecum or appendix comes into contact w/ Rt lobe of the Liver
Later they descend into Rt. iliac fossa SO - Ascending Colon and } formed
- Rt colic flexure are }
 - Large gut after rotation lie laterally and encircle the centrally placed small gut.
 - Primitive mesenteries of → duodenum } fuses with parietal peritoneum or Ascending Colon } the post. abd. wall → descending Colon becomes retroperitoneal organs
 - Primitive mesenteries of → jejunum } persist as mesentery of small intestine ileum } Tr. mesoileum and Tr. colon } Sigmoid mesentery

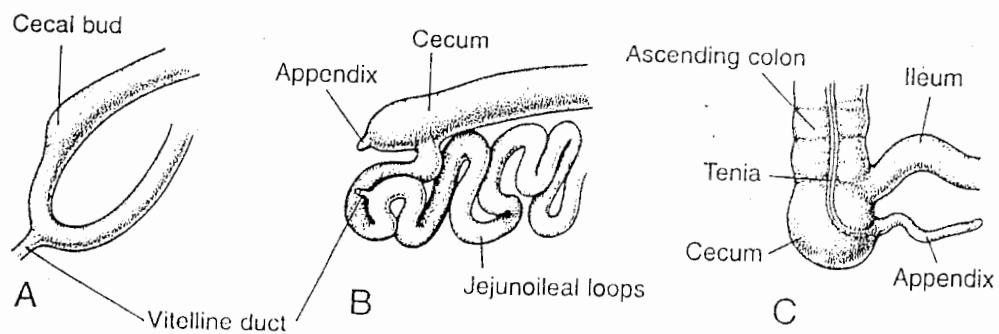


Figure 13.26. Successive stages in development of the cecum and appendix. A. 7 weeks. B. 8 weeks. C. Newborn.

- as the midgut returns to the abdominal cavity, the vitelline becomes obliterated and severs its connection with the gut.

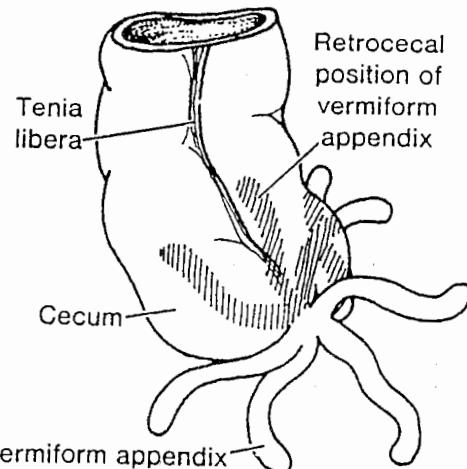


Figure 13.27. Various positions of the appendix. In about 50% of cases the appendix is retrocecal or retrocolic.

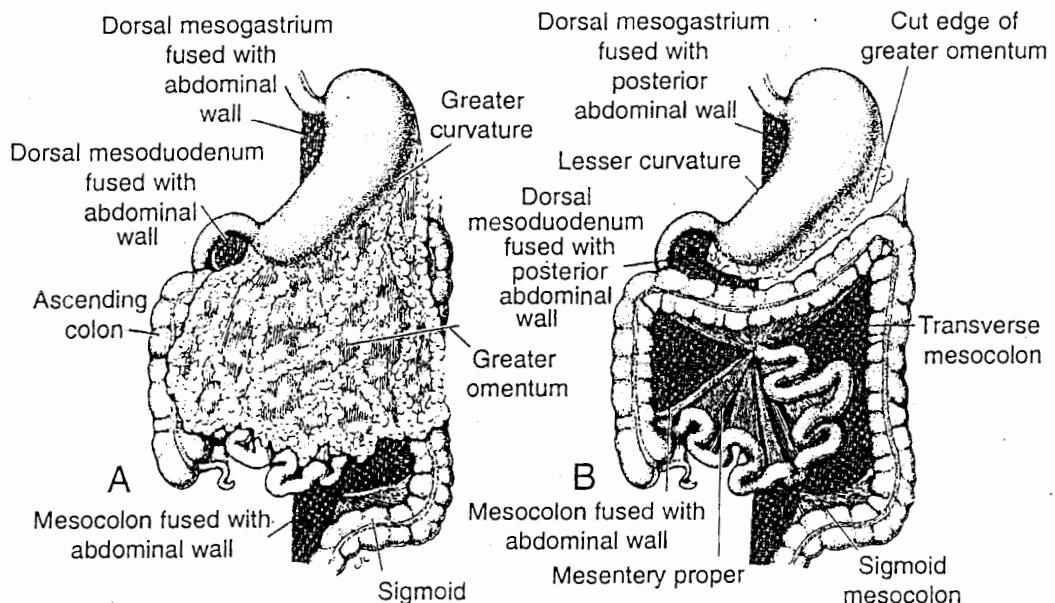
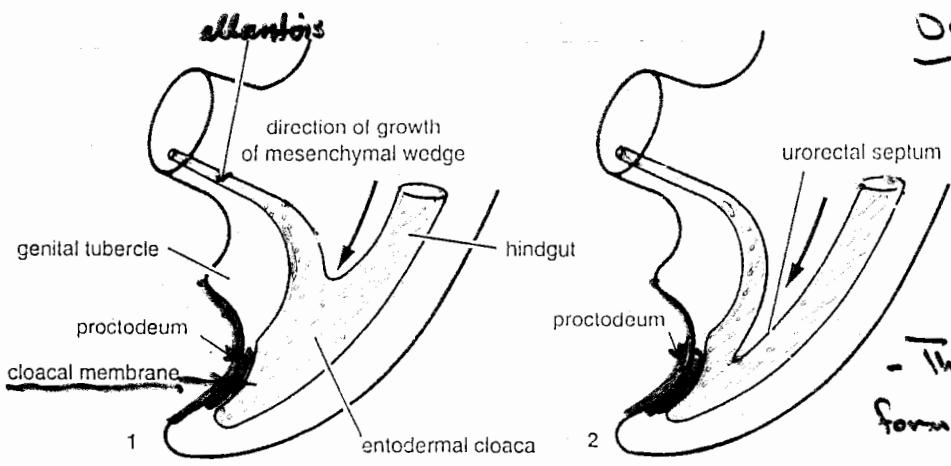
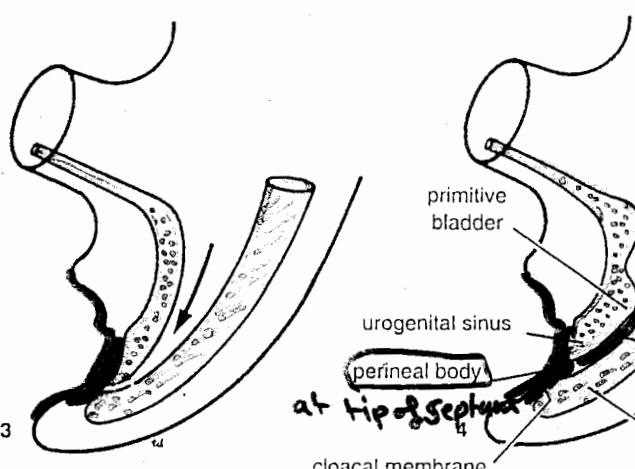


Figure 13.28. Frontal view of the intestinal loops with (A) and after removal of (B) the greater omentum. Gray areas, parts of the dorsal mesentery that fuse with the posterior abdominal wall. Note the line of attachment of the mesentery proper.



Development of Hindgut

- distal $\frac{1}{3}$ of Tr. Colon
- descending Colon
- Sigmoid colon
- upper part of anal Canal



- The endoderm of hindgut also forms the lining of bladder & urethra

- Terminal portion of hindgut enters the post. region of Cloaca → Primitive anorectal Canal.

- allantois enters into the first portion of the Cloaca → Urogenital Sinus.

Cloaca is an endoderm lined cavity covered ventrally by surface ectoderm.

Cloacal membrane: lies

between endoderm & ectoderm

- urorectal septum: is an emerging mesoderm separates between allantois & hindgut
- at the end of 7th week the cloacal membrane ruptures → creating
- anal opening of hindgut &
- ventral opening for urogenital Sinus
- between the 2 forms Perineal body

- proliferation of ectoderm closes the most caudal region of anal canal
- Ninth week the ectodermal region recanalizes forming the ectodermal part of anal canal

ventral mesentery

vitelline duct

yolk sac

junction between the endodermal & ectodermal parts of anal canal is delineated by

Pectinate line just

below the anal column. the epithelium changes

from Columnar to Stratified Sq. epitheli...

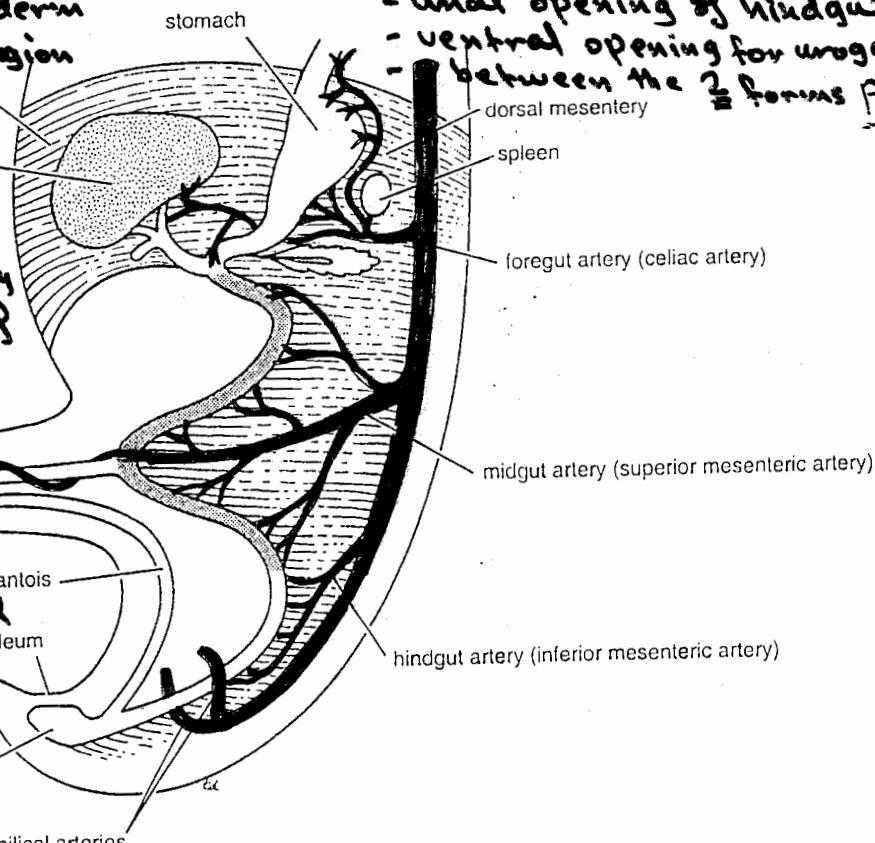


Figure 19-78 Formation of the midgut loop (shaded). Note how the superior mesenteric artery and vitelline duct form an axis for the future rotation of the midgut loop.

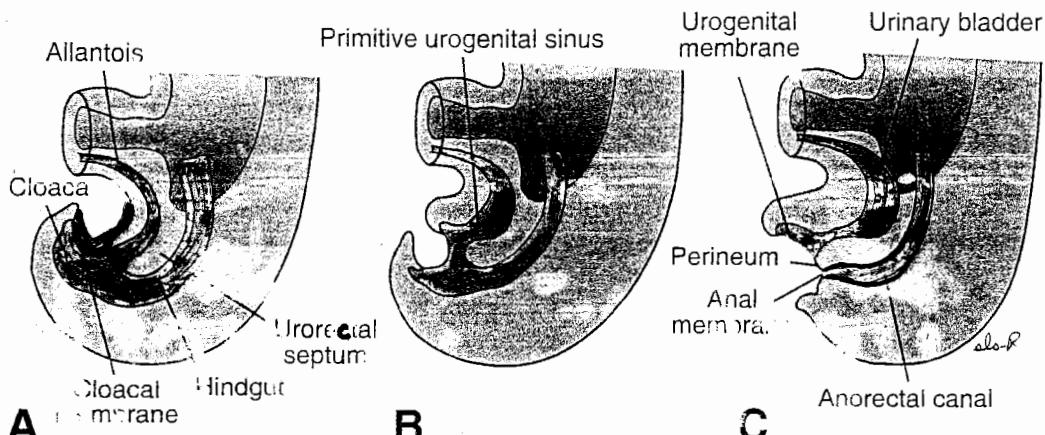


Figure 14.31. Cloacal region in embryos at successive stages of development. **A.** The hindgut enters the posterior portion of the cloaca, the future anorectal canal; the allantois enters the anterior portion, the future urogenital sinus. The urorectal septum is formed by merging of the mesoderm covering the allantois and the yolk sac (Fig. 14.1D). The cloacal membrane, which forms the ventral boundary of the cloaca, is composed of ectoderm and endoderm. **B.** As caudal folding of the embryo continues, the urorectal septum moves closer to the cloacal membrane, although it never contacts this structure. **C.** Lengthening of the genital tubercle pulls the urogenital portion of the cloaca anteriorly; breakdown of the cloacal membrane creates an opening for the hindgut and one for the urogenital sinus. The tip of the urorectal septum forms the perineal body.

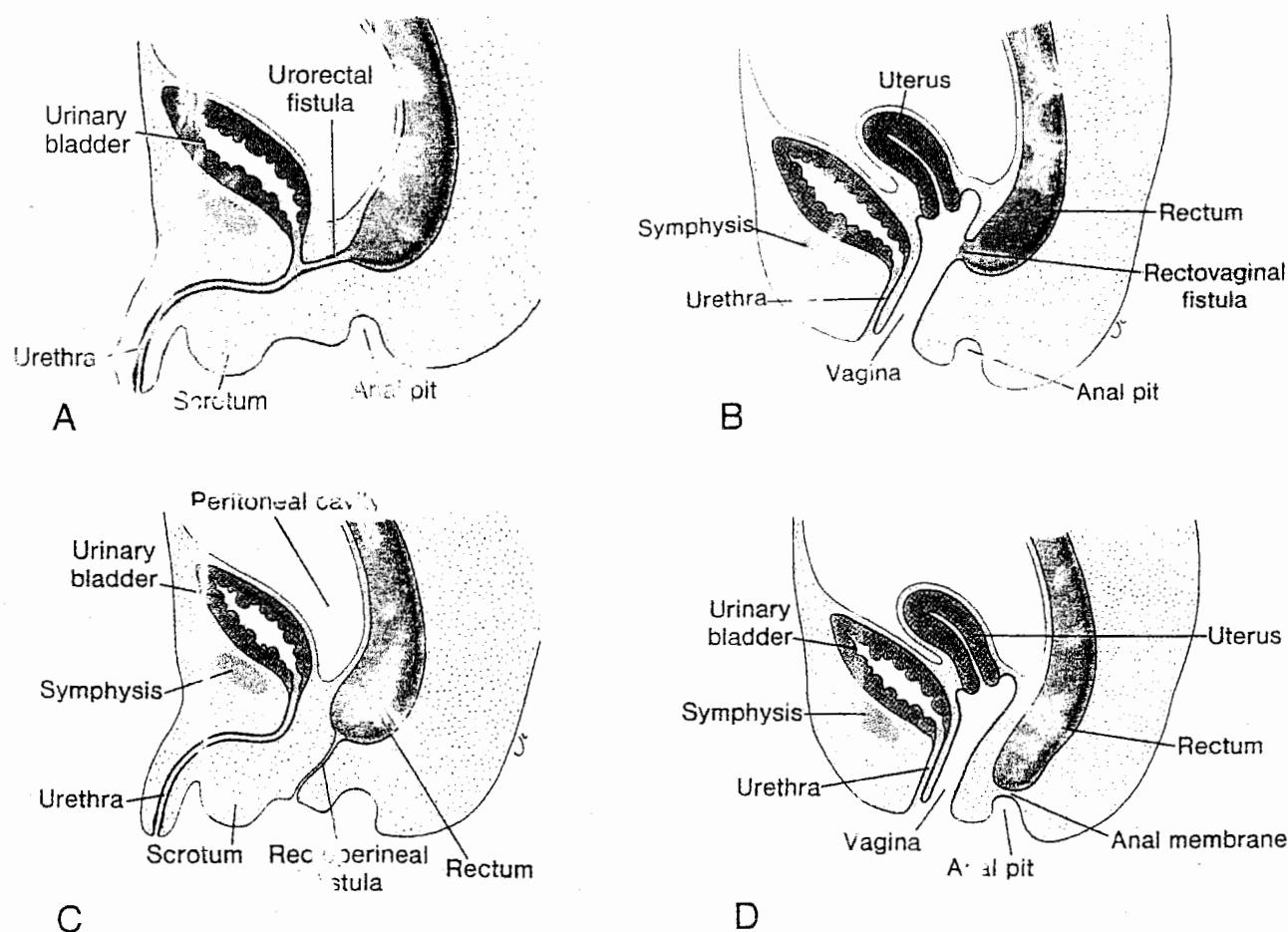


Figure 14.37. Urorectal (**A**) and rectovaginal (**B**) fistulas that result from incomplete separation of the hindgut from the urogenital sinus by the urorectal septum. These defects may also arise if the cloaca is too small, which causes the opening of the hindgut to shift anteriorly. **C.** Rectoperineal (rectoanal atresia). These defects probably result from vascular accidents involving the caudal region of the hindgut, resulting in atresias and fistulas. **D.** Imperforate anus resulting from failure of the anal membrane to break down.

tract. This abnormality is known as an umbilical fistula, or vitelline fistula (Fig. 13.30C). A fecal discharge may then be found at the umbilicus.

Gut Rotation Defects

Abnormal rotation of the intestinal loop may result in twisting of the intestine (**volvulus**) and a compromise of the blood supply. Normally the primary intestinal loop rotates 270° counterclockwise. Occasionally, however, rotation amounts to 90° only. When this occurs, the colon and cecum are the first portions of the gut to return from the umbilical cord, and they settle on the left side of the abdominal cavity (Fig. 13.31A). The later returning loops then move more and more to the right; resulting in left-sided colon.

Reversed rotation of the intestinal loop occurs when the primary loop rotates 90° clockwise. In this abnormality the transverse colon passes behind the duodenum (Fig. 13.31B) and lies behind the superior mesenteric artery.

* **Duplications of intestinal loops and cysts** may occur anywhere along the length of the gut tube. They are most frequently found in the region of the ileum, where they may vary from a long segment to a small diverticulum. Symptoms usually occur early in life, and 33% are associated with other defects, such as intestinal atresias, imperforate anus, gastroschisis, and omphalocele. Their origin is unknown, although they may result from abnormal proliferations of gut parenchyma.

Gut Atresias and Stenoses

Atresias and stenoses may occur anywhere along the intestine. Most occur in the duodenum, fewest occur in the colon, and equal numbers occur in the jejunum and ileum (1/1500 births). Atresias in the upper duodenum are probably

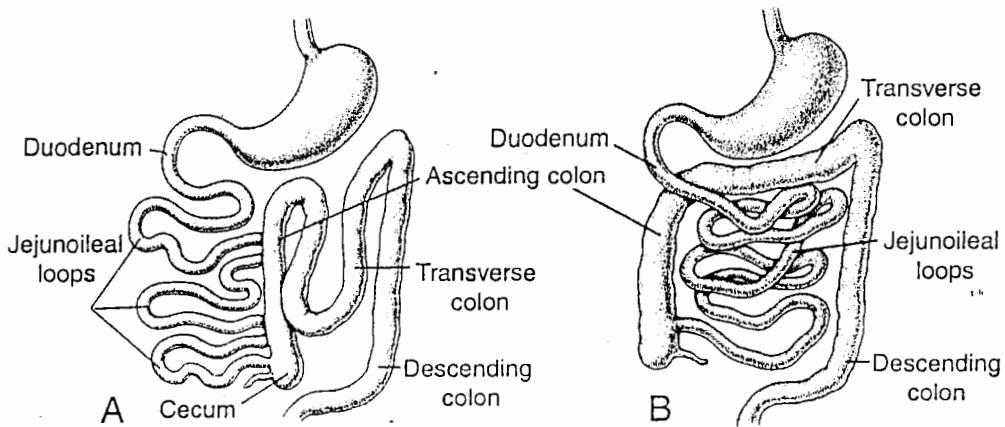


Figure 13.31. A. Abnormal rotation of the primary intestinal loop. The colon is on the left side of the abdomen, and the small intestinal loops are on the right. The ileum enters the cecum from the right. B. The primary intestinal loop is rotated 90° clockwise (reversed rotation). The transverse colon passes behind the duodenum.

Body wall defects

- 1- **Omphalocele** : umbilical hernia through umbilical ring (physiological hernia)
 - covered by amnion
 - occurs in 2.5 / 10,000 births
 - high rate of mortality - 50% c cardiac anomalies
 - 50% c chromosomal abnormalities
- 2- **Gastroschisis** : hernia through the region of the umbilical

- Testis descends through the Pelvis & inguinal Canal during the 7th & 8th months of fetal life.
- The normal stimulus for the descent of testis is testosterone which secreted by fetal testis
- The testis follows the gubernaculum & descends behind the processus vaginalis which pulls down its ducts, blood vessels, nerves and lymphatic vessels.
- The testis reaches its final position in the Scrotum by the end of the 8th month.
- As the spermatic cord crosses the inguinal canal acquired the 3 faciai coverings

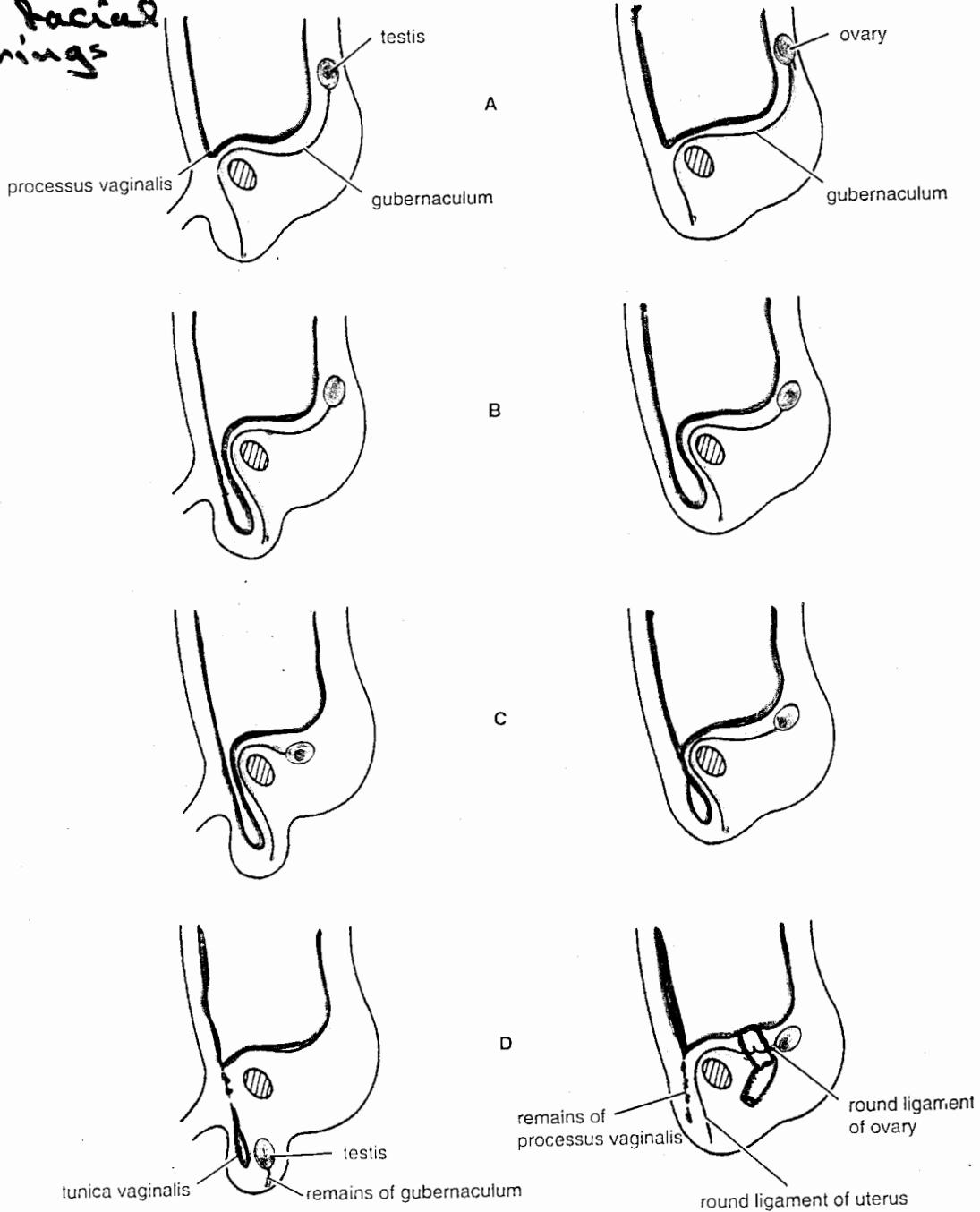


Figure 19-16 Origin, development, and fate of the processus vaginalis in the two sexes.
Note the descent of the testis into the scrotum and the descent of the ovary into the pelvis.

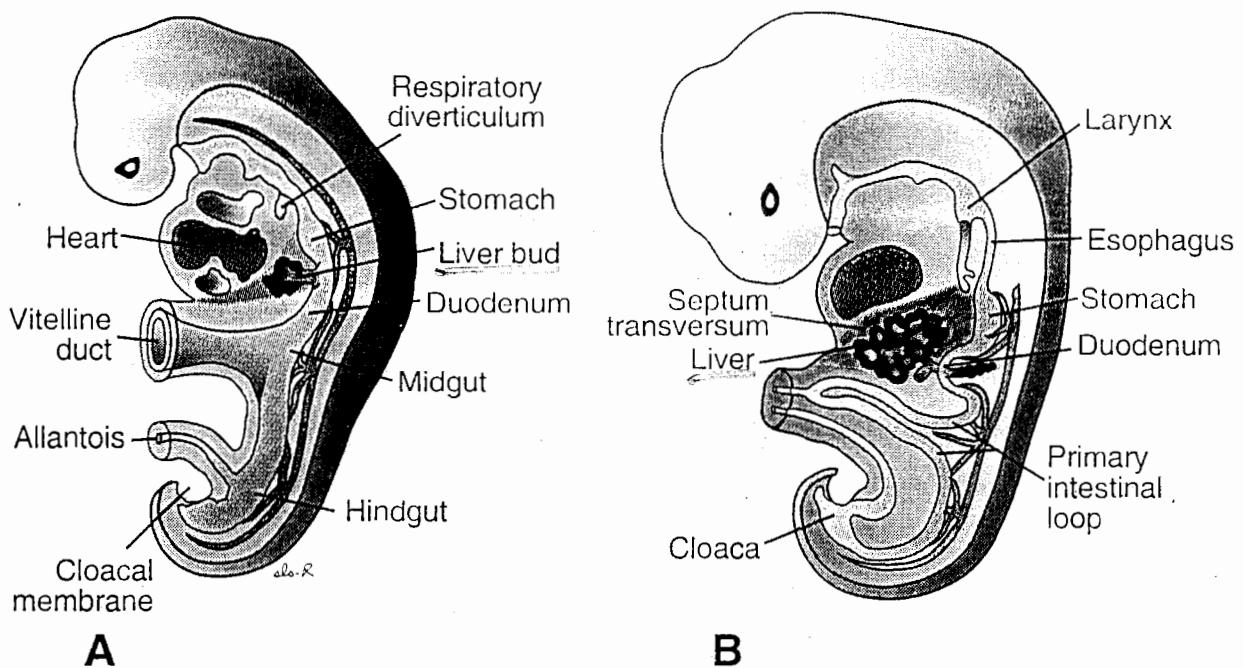


Figure 13.13. A. A 3-mm embryo (approximately 25 days) showing the primitive gastrointestinal tract and formation of the liver bud. The bud is formed by endoderm lining the foregut. B. A 5-mm embryo (approximately 32 days). Epithelial liver cords penetrate the mesenchyme of the septum transversum.

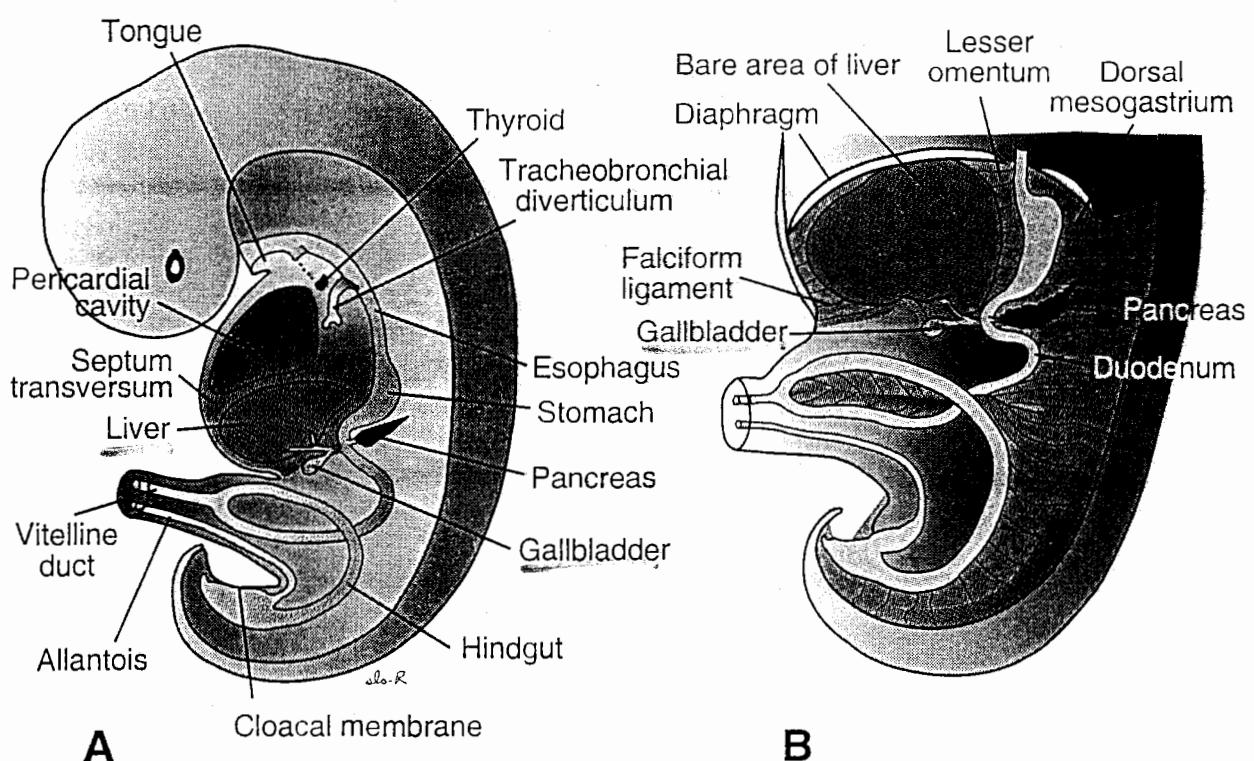


Figure 13.14. A. A 9-mm embryo (approximately 36 days). The liver expands caudally into the abdominal cavity. Note condensation of mesenchyme in the area between the liver and the pericardial cavity, foreshadowing formation of the diaphragm from part of the septum transversum. B. A slightly older embryo. 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.