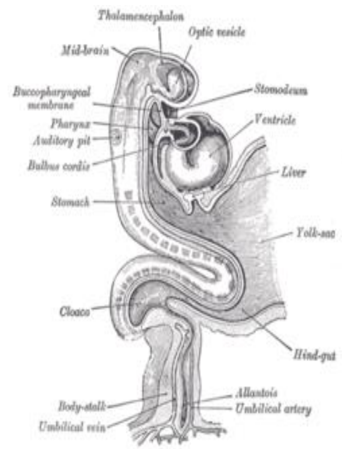
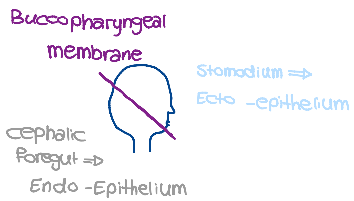
Gi tract embryology 1

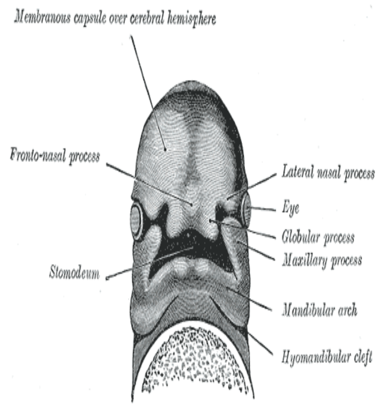
Development of the oral cavity

- The mouth has 2 sources of development:
- 1. depression in the stomodeum (lined with ectoderm)
- 2. cephalic end of the foregut(lined with endoderm)
- These two points are separated by the buccopharyngeal membrane
- During the 3rd week of development the membrane disappears





- If the membrane persists (we create an imaginary line), it will extend to:
- Body of sphenoid
- Soft palate
- Inner surface of the mandible, inferior to the incisor teeth
- Structures that are anterior to this plane are ectodermic in origin(epithelium) like:
- Hard palate
- Sides of the mouth
- Lips
- Enamel of the teeth



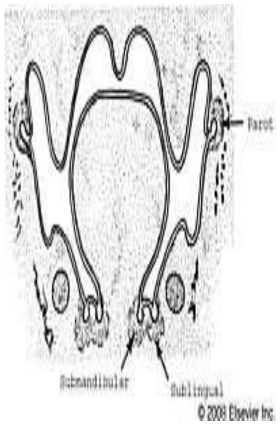
- Structures situated posterior to this plane are derived from endoderm:
- Tongue
- Soft palate → فاصل بين H&S معناها رخو
- Palatoglossus and palatopharyngeal folds
- Floor of the mouth

Development of the salivary glands

- During the 7th week it arises as a solid outgrowth of cells from the walls of the developing mouth ⇐ parotid Ecto; S.M, S.L Endo
- These cells will grow into the underlying mesenchyme
- The epithelial buds will go through repeated branching to form solid ducts
- The ends of these ducts will form the secretory acini, and they will both go through canalization

بيبدوا كتراكيب مصمتة

بعدين بنفرغوا



- The surrounding mesenchyme will condense to form:
- The capsule of the gland
- Septa that divide the gland into different lobes and lobules

- The ducts and acini of the parotid gland are both derived from the ectoderm

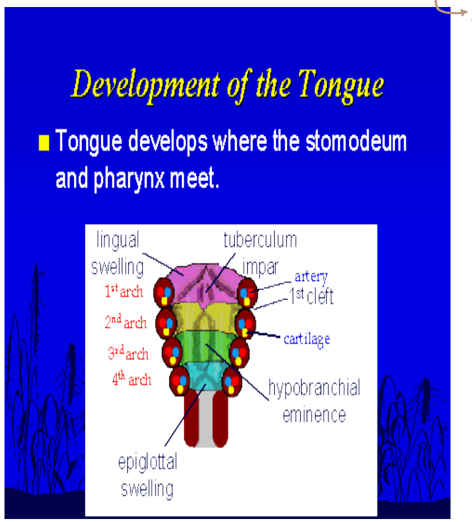
- Submandibular and sublingual glands are derived from the endoderm

Tongue

Tongue → 5 swellings → 2 lateral; 3 middle → Tuberculum impar, Copula (HBE), Epiglottal

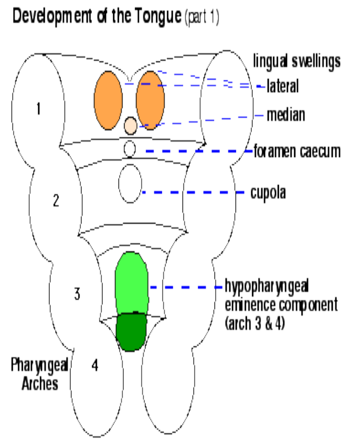
1st pharyngeal arch; 2nd, 3rd, 4th; posterior 4th

- The tongue appears in embryos of approximately 4 weeks in the form of two **lateral lingual swellings and one medial swelling, the tuberculum impar**
- These three swellings originate from the first pharyngeal arch.
- A second median swelling, the **copula, or hypobranchial eminence,** is formed by mesoderm of the second, third, and part of the fourth arch.
- Finally, a third median swelling, formed by the posterior part of the fourth arch, marks development of the epiglottis.



process of tongue development.

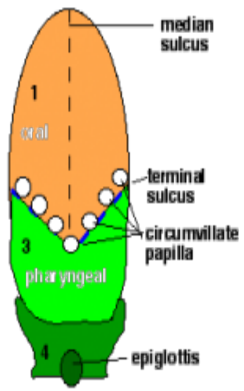
- Immediately behind this swelling is the **laryngeal orifice, which is flanked by the arytenoids swellings**
- As the lateral lingual swellings increase in size, they overgrow the tuberculum impar and merge, forming the anterior two-thirds, or body, of the tongue → 1st arch
- Since the mucosa covering the body of the tongue originates from the first pharyngeal arch, **sensory innervation to this area is by the mandibular branch of the trigeminal nerve.** → lingual N.
- The body of the tongue is separated from the posterior third by a V-shaped groove, the **terminal sulcus**



- The posterior part, or root, of the tongue originates from the second, third, and part of the fourth pharyngeal arch.
- The fact that **sensory innervation to** this part of the tongue is supplied by the **glossopharyngeal nerve indicates that** tissue of the third arch overgrows that of the second.
- The epiglottis and the extreme posterior part of the tongue are innervated by the **superior laryngeal nerve, reflecting their development from the fourth** arch.

↳ so, 1st arch ⇒ lingual
3rd arch ⇒ glossopharyngeal
& it overgrows 2nd arch
4th arch ⇒ superior laryngeal
occipital somites ⇒ Hypoglossal

Development of the Tongue (part 3)

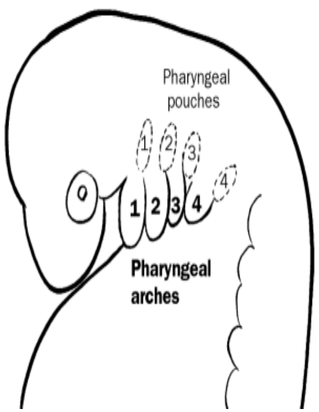


- Some of the tongue muscles probably differentiate in situ, but most are derived from myoblasts originating in **occipital somites.**
- Thus, tongue musculature is innervated by the **hypoglossal nerve.**
- **Special sensory innervation (taste)** to the anterior two thirds of the tongue is provided by the **chorda tympani**
- **branch of the facial nerve, while the posterior third is supplied by the glossopharyngeal** nerve.

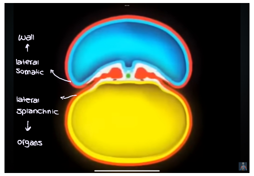
Development of the pharynx

- The pharynx develops in the neck from the endoderm of the foregut
- The endoderm is separate from the surface ectoderm by mesenchyme
- The mesenchyme in each side splits up to 5-6 arches
- Each arch forms a swelling on the surface of the walls of the foregut
- As a result of these swellings a series of clefts are seen between the arches....pharyngeal clefts
- Similar grooves are found on the lateral walls of the foregut.....pharyngeal pouches
- The foregut on this level is known as the pharynx

forming the arches



Development of the anterior abdominal wall



- Following the segmentation of the mesoderm, the lateral mesoderm divides into:
- Somatic layer
- Splanchnic layer
- Both lined by endo and ectoderm

- The ant. Abdominal wall is derived from the somatoplueric mesoderm and they retain their innervation from the ventral rami of the spinal nerves

we have muscles

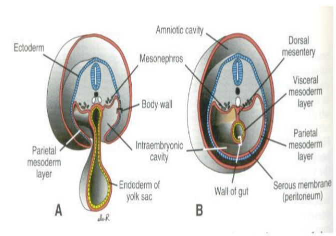
- The somatoplueric mesoderm then tangentially divides into three layers:
- Ext. oblique
- Int. oblique
- Trans. abdominus

See... the muscles

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

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

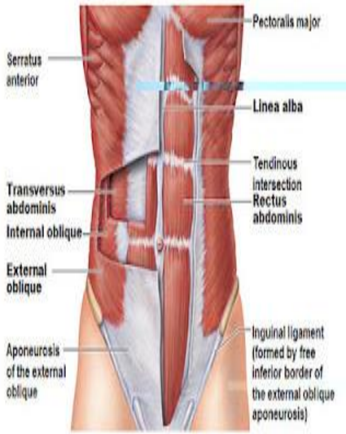
Splanchnopleuric mesoderm becomes visceral mesoderm which form serous membranes that line each organ.



- The rectus abdominus muscle retains the indications of the segmental origin (the presence of tendinous intersections)

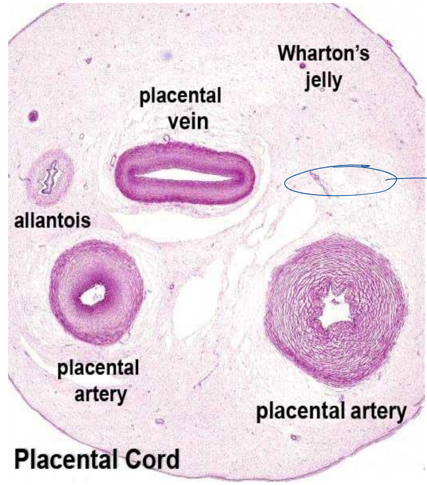
- Finally the abd. Wall right and left sides of mesenchyme fuses together at 3 months into the midline to form the linea alpa.

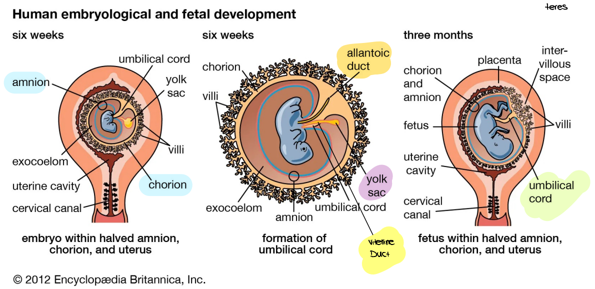
- On either side of the lina alpa the rectus muscles lies within their rectus sheaths



Development of the umblicus and the umblical cord

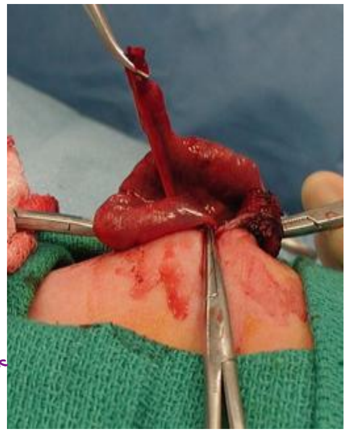
- The amnion and the chorion fuse together
- The amnion encloses the body stalk and the yolk sac with their blood vessels to form the tubular umbilical cord
- The mesenchyme core of the cord (whartons jelly) form a loose connective tissue which embed the following:
- Remains of yolk sac
- Vittelline duct
- Remains of allantois
- Umbilical blood vessels
- We have 2 arteries that carries deoxygenated blood from the fetus to the chorion (placenta)
- 2 veins carry oxygenated blood from the placenta
- , but the right vein will soon disappear → obliterated ligamentum teres





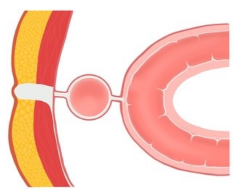
Vitelline Duct Abnormalities

- In 2 to 4% of people, a small portion of the **vitelline duct persists, forming** an outpocketing of the ileum, **Meckel's diverticulum or ileal diverticulum**
- In the adult, this diverticulum, approximately 40 to 60 cm from the ileocecal valve on the antimesenteric border of the ileum, does not usually cause any symptoms. → 2 feet
- However, when it contains heterotopic pancreatic tissue or gastric mucosa, it may cause ulceration, bleeding, or even perforation. → 2 types of heterotopic tissues (gastric, pancreatic)



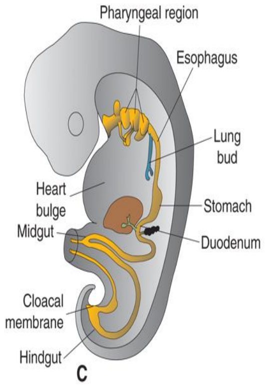
- Sometimes both ends of the vitelline duct transform into fibrous cords, and the middle portion forms a large cyst, an **enterocystoma, or vitelline cyst**

Omphalomesenteric duct cyst



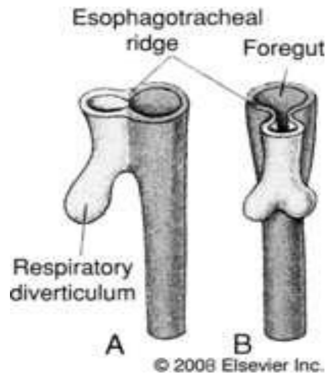
Formation of the Lung Buds

- When the embryo is approximately 4 weeks old, the **respiratory diverticulum (lung bud) appears as** an outgrowth from the ventral wall of the foregut
- The location of the bud along the gut tube is determined by signals from the surrounding mesenchyme, including fibroblast growth factors (FGFs) that "instruct"the endoderm.
- Hence **epithelium of the** internal lining of the larynx, trachea, and bronchi, as well as that of the lungs, is entirely of **endodermal origin.**
- The **cartilaginous, muscular, and connective tissue components** of the trachea and lungs are derived from **splanchnic mesoderm** surrounding the foregut



6-1C Lung bud initiation and branching

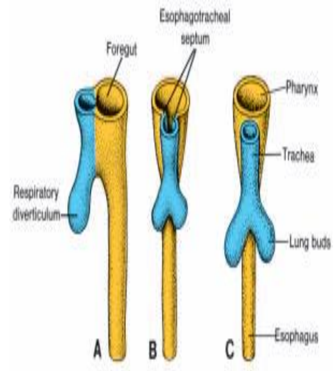
- Initially the lung bud is in open communication with the foregut
- When the diverticulum expands caudally, however, two longitudinal ridges, the **tracheoesophageal ridges, separate it** from the foregut
- Subsequently, when these ridges fuse to form the **tracheoesophageal septum, the foregut is divided into a** dorsal portion, the **esophagus, and a ventral portion, the trachea and lung buds**
- The respiratory primordium maintains its communication with the pharynx through the **laryngeal orifice**



GI embryology 2

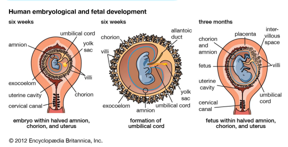
The Foregut

- At first the esophagus is short
- but with descent of the heart and lungs it lengthens rapidly
- The muscular coat, which is formed by surrounding splanchnic mesenchyme, is striated in its upper two-thirds and innervated by the vagus;
- the muscle coat is smooth in the lower third and is innervated by the splanchnic plexus.



Esophageal Abnormalities

- **Esophageal atresia** and/or **tracheoesophageal fistula** results either from spontaneous posterior deviation of the **tracheoesophageal septum** or from some mechanical factor pushing the dorsal wall of the foregut anteriorly
- In its most common form the proximal part of the esophagus ends as a blind sac, and the distal part is connected to the trachea by a narrow canal just above the bifurcation
- Other types of defects in this region occur much less frequently
- Atresia of the esophagus prevents normal passage of amniotic fluid into the intestinal tract, resulting in accumulation of excess fluid in the amniotic sac (**polyhydramnios**).



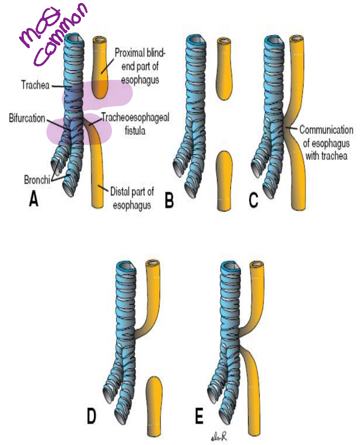


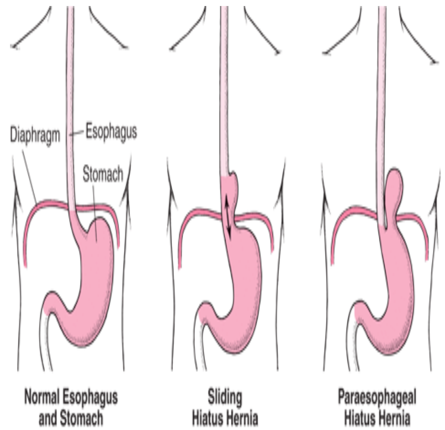
Figure 13.7 Variations of esophageal atresia and/or tracheoesophageal fistula in order of their frequency of appearance: A, 90%; B, 4%; C, 4%; D, 1%; and E, 1%.

هاي موضوع

- In addition to atresias, the lumen of the esophagus may narrow, producing **esophageal stenosis**, usually in the lower third
- Stenosis may be caused by incomplete recanalization, vascular abnormalities, or accidents that compromise blood flow

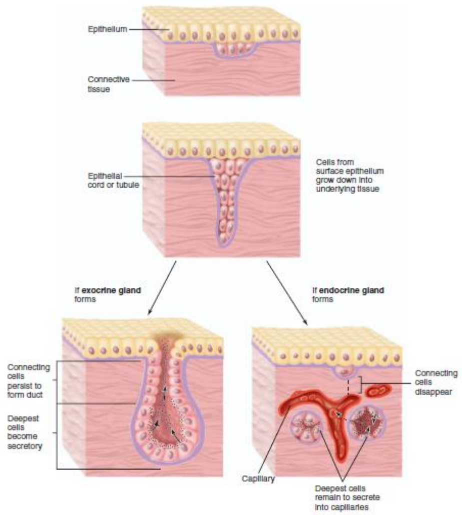
وهاي موضوع ثاني

- Occasionally the esophagus fails to lengthen sufficiently and the stomach is pulled up into the esophageal hiatus through the diaphragm.
- The result is a **congenital hiatal hernia**



Development of the glands

- Most glands are formed during development by proliferation of epithelial cells so that they project into the underlying connective tissue
- Some glands retain their continuity with the surface via a duct and are known as **EXOCRINE GLANDS, as they maintain contact with the surface**
- Other glands lose this direct continuity with the surface when their ducts degenerate during development. These glands are known as **ENDOCRINE** glands, and they lose contact with the surface.
- Endocrine glands are either arranged in cords or follicles



STOMACH

- The stomach appears as a fusiform dilation of the foregut in the fourth week of development
- During the following weeks, its appearance and position change greatly as a result of the different rates of growth in various regions of its wall and the changes in position of surrounding organs
- Positional changes of the stomach are most easily explained by assuming that it rotates around a longitudinal and an anteroposterior axis

* posterior wall grows faster
⇒ left G.curvature

-2 types of rotation:-

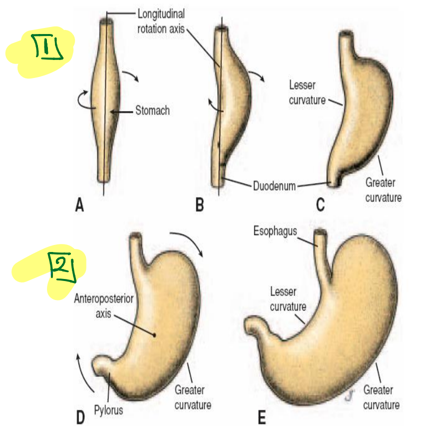
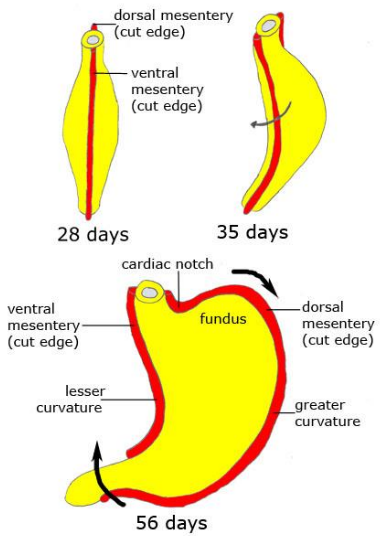


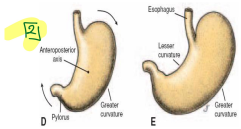
Figure 13.8 A, B, and **C.** Rotation of the stomach along its longitudinal axis as seen anteriorly. **D** and **E.** Rotation of the stomach around the anteroposterior axis. Note the change in position of the pylorus and cardia.

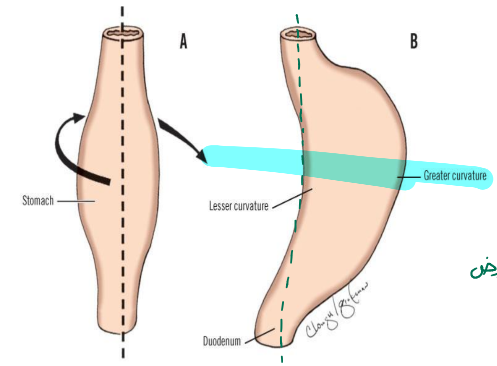
Relate to vagus n. ←

- The stomach rotates 90◦ clockwise around its longitudinal axis, causing its left side to face anteriorly and its right side to face posteriorly
- Hence the left vagus nerve, initially innervating the left side of the stomach, now innervates the anterior wall
- similarly, the right vagus nerve innervates the posterior wall
- During this rotation the original posterior wall of the stomach grows faster than the anterior portion, forming the **greater** and **lesser curvatures**

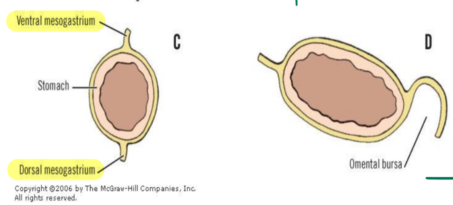


- The cephalic and caudal ends of the stomach originally lie in the midline,
- but during further growth the stomach rotates around an anteroposterior axis, such that the caudal or **pyloric part** moves to the right and upward and the cephalic or **cardiac portion** moves to the left and slightly downward
- The stomach thus assumes its final position, its axis running from above left to below right.

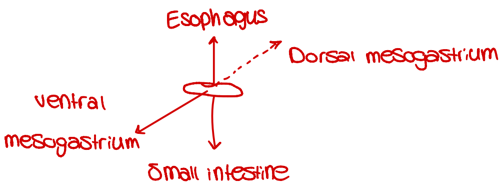




⇒ Both Sphincters at the same line
مش حصلك المفروض



→ مش منطقية هاي



- Since the stomach is attached to the dorsal body wall by the **dorsal mesogastrium** and to the ventral body wall by the **ventral mesogastrium** its rotation and disproportionate growth alter the position of these mesenteries.

Formation of the lesser sac between 2 layers of greater omentum.

- Rotation about the longitudinal axis pulls the dorsal mesogastrium to the left, creating a space behind the stomach called the **omental**
- **bursa** (**lesser peritoneal sac**)
- This rotation also pulls the ventral mesogastrium to the right.

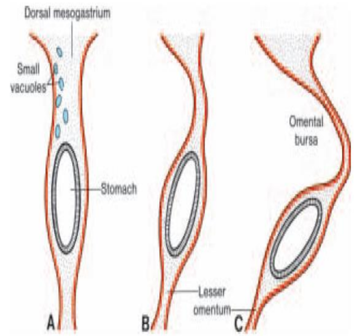
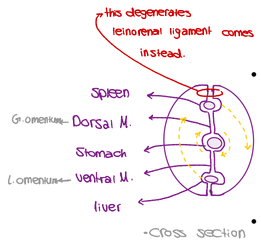
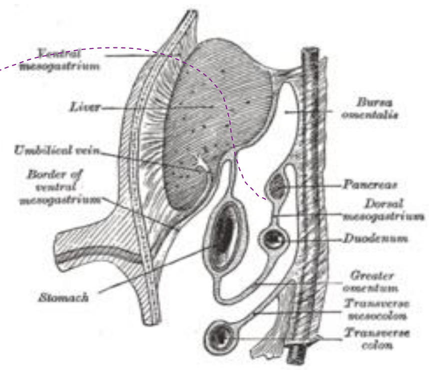


Figure 13.9 A. Transverse section through a 4-week embryo showing intercellular clefts appearing in the dorsal mesogastrium. B and C. The clefts have fused, and the omental bursa is formed as an extension of the right side of the intraembryonic cavity behind the stomach.



- As this process continues in the fifth week of development, the spleen primordium appears as a mesodermal proliferation between the two leaves of the dorsal mesogastrium → in the lesser sac? No!
- With continued rotation of the stomach, the dorsal mesogastrium lengthens, and the portion between the spleen and dorsal midline swings to the left and fuses with the peritoneum of the posterior abdominal wall
- The posterior leaf of the dorsal mesogastrium and the peritoneum along this line of fusion degenerate



- The spleen, which remains intraperitoneal, is then connected to the body wall in the region of the left kidney by the **lienorenal ligament** and to the stomach by the **gastrolienal ligament**
- Lengthening and fusion of the dorsal mesogastrium to the posterior body wall also determine the final position of the pancreas.

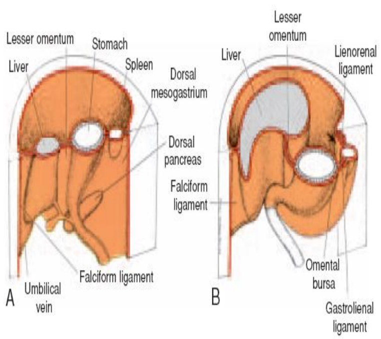
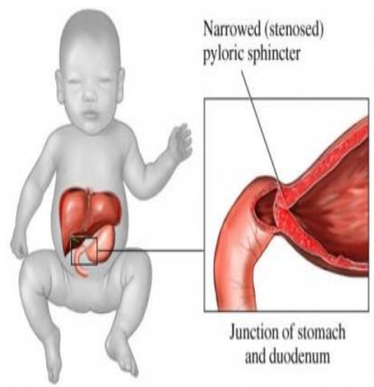


Figure 13.10 A. The positions of the spleen, stomach, and pancreas at the end of the fifth week. Note the position of the spleen and pancreas in the dorsal mesogastrium. B. Position of spleen and stomach at the 11th week. Note formation of the omental bursa or lesser peritoneal sac.

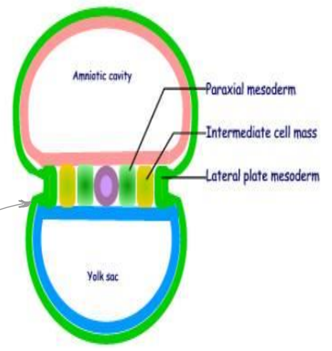
- **Pyloric stenosis** occurs when the circular and, to a lesser degree, the longitudinal musculature of the stomach in the region of the pylorus hypertrophies
- One of the most common abnormalities of the stomach in infants, pyloric stenosis is believed to develop during fetal life.(3-6) weeks



هاد المفروض كان قبل 🙂

ماشي عنه عارفينه

- At the end of the third week, intraembryonic mesoderm on each side of themidline differentiates into a paraxial portion, an intermediate portion, and a lateral plate
- When intercellular clefts appear in the lateral mesoderm, the plates are divided into two layers: the **somatic mesoderm layer** and the **splanchnic mesoderm layer.**
- The latter is continuous with mesoderm of the wall of the yolk sac

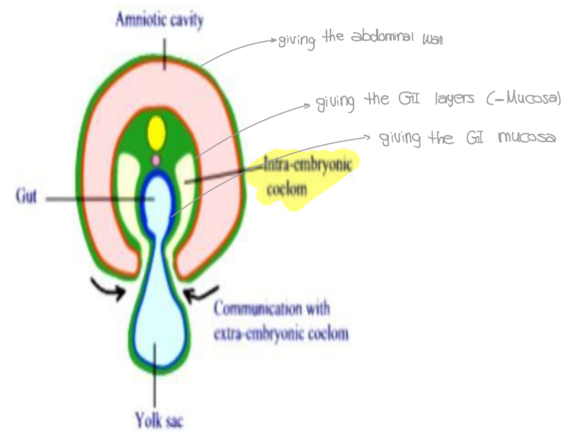


- The space bordered by these layers forms the **intraembryonic cavity (body cavity).**
- **The peritoneal cavity is derived from the intraembryonic coleam caudal to the septum transversum**

First step of Diaphragm development ← يفصل بين thoracic & Abdominal

- At first the right and left sides of the intraembryonic cavity are in open connection with the extraembryonic cavity, but when the body of the embryo folds cephalocaudally and laterally, this connection is lost

→ Oblitration of the vitelline



Retroperitoneal زي كأنهم كلهم ← وبعدين بعملوا invagination

- Initially the foregut, midgut, and hindgut are in broad contact with the mesenchyme of the posterior abdominal wall
- By the fifth week however, the connecting tissue bridge has narrowed, and the caudal part of the foregut, the midgut, and a major part of the hindgut are suspended from the abdominal wall by the **dorsal mesentery**

Extension of dorsal mesentery

- the **dorsal mesentery** extends from the lower end of the esophagus to the cloacal region of the hindgut
- In the region of the stomach it forms the **dorsal mesogastrium** or **greater omentum;** in the region of the duodenum it forms the dorsal **mesoduodenum;** and in the region of the colon it forms the **dorsal mesocolon.**

نغير للاسم حسب المكان عشان الطلاب يدرسوا اشي زيادة

- Dorsal mesentery of the jejunal and ileal loops forms the **mesentery proper.**

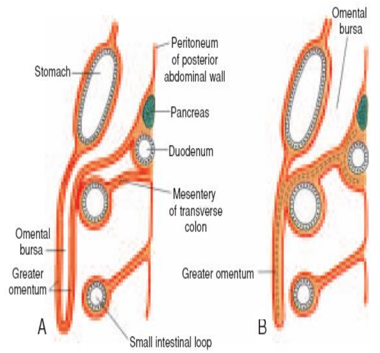
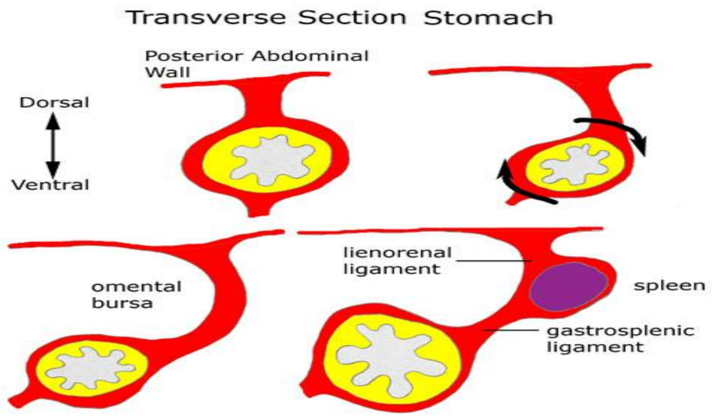


Figure 13.13 A. Sagittal section showing the relation of the greater omentum, stomach, transverse colon, and small intestinal loops at 4 months. The pancreas and duodenum have already acquired a retroperitoneal position. **B.** Similar section as in **A**, in the newborn. The leaves of the greater omentum 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.



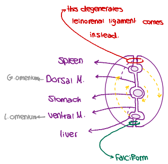
location

- **Ventral mesentery,** which exists only in the region of the terminal part of the esophagus, the stomach, and the upper part of the duodenum

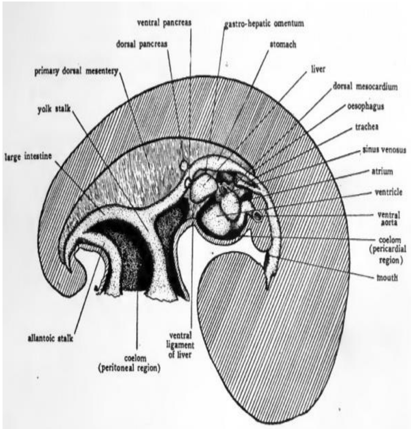
origin

contents

- is derived from the **septum transversum.** Growth of the liver into the mesenchyme of the septum transversum divides the ventral mesentery into



- (*a*) the **lesser omentum,** extending from the lower portion of the esophagus, the stomach, and the upper portion of the duodenum to the liver,
- and (*b*) the **falciformligament,** extending from the liver to the ventral body wall,and the coronary and the triangular ligaments



- Since the stomach is attached to the dorsal body wall by the **dorsal mesogastrium** and to the ventral body wall by the **ventral mesogastrium**
- its rotation and disproportionate growth alter the position of these mesenteries.
- Rotation about the longitudinal axis pulls the dorsal mesogastrium to the left, creating a space behind the stomach called the **omental bursa** (**lesser peritoneal sac**

Formation of lesser sac #2

- As a result of rotation of the stomach about its anteroposterior axis, the dorsal mesogastrium bulges down
- It continues to grow down and forms a double-layered sac extending over the transverse colon and small intestinal loops like an apron
- This double-leafed apron is the **greater omentum**

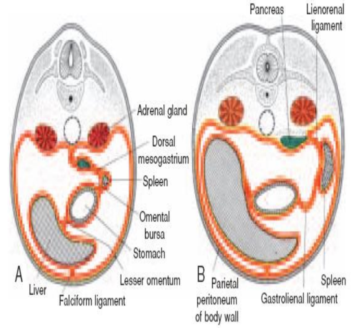


Figure 13.11 Transverse sections through the region of the stomach, liver, and spleen, showing formation of the lesser peritoneal sac, rotation of the stomach, and position of the spleen and tail of the pancreas between the two leaves of the dorsal mesogastrium. With further development, the pancreas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

- later its layers fuse to form a single sheet hanging from the greater curvature of the stomach
- The posterior layer of the greater omentum also fuses with the mesentery of the transverse colon

So, at the end ⇒ the greater omentum Starts @ the G. curvature & ends @ the transverse mesocolon

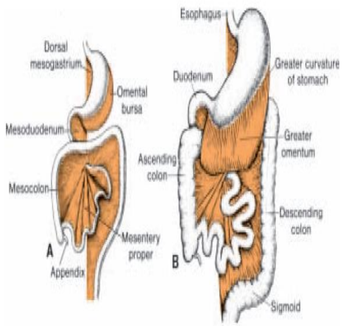


Figure 13.12 A. Derivatives of the dorsal mesentery at the end of the third month. The dorsal mesogastrium bulges out on the left side of the stomach, where it forms part of the border of the omental bursa. **B.** The greater omentum hangs down from the greater curvature of the stomach in front of the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

- The **lesser omentum** and **falciform ligament** form from the ventral mesogastrium, which itself is derived from mesoderm of the septum transversum.

Structures from the ventral omentum

- When liver cords grow into the septum, it thins to form (*a*) the peritoneum of the liver, (
- *b*) the **falciform ligament,** extending from the liver to the ventral
- body wall,
- and (*c*) the **lesser omentum,** extending from the stomach and upper duodenum to the liver

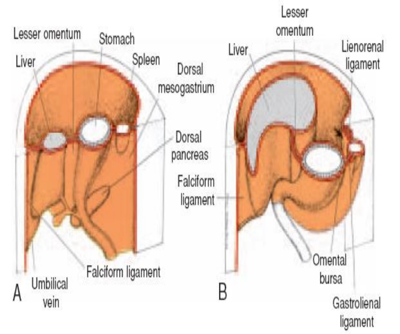


Figure 13.10 A. The positions of the spleen, stomach, and pancreas at the end of the fifth week. Note the position of the spleen and pancreas in the dorsal mesogastrium. **B.** Position of spleen and stomach at the 11th week. Note formation of the omental bursa or lesser peritoneal sac.

obliterates to teres

contents of the ventral mesentery

- The free margin of the falciform ligament contains the umbilical vein
- which is obliterated after birth to form the **round ligament of the liver** (**ligamentum teres hepatis**).
- The free margin of the lesser omentum connecting the duodenum and liver (**hepatoduodenal ligament**) contains the bile duct, portal vein, and hepatic artery (**portal triad**).
- This free margin also forms the roof of the **epiploic foramen of Winslow,** which is the opening connecting the omental bursa (lesser sac) with the rest of the peritoneal cavity (greater sac)

LIVER AND GALLBLADDER

- The liver primordium appears in the middle of the third week as an outgrowth of the endodermal epithelium at the distal end of the foregut
- This outgrowth, the **hepatic diverticulum,** or **liver bud,** consists of rapidly proliferating cells that penetrate the **septum transversum,** that is, the mesodermal plate between the pericardial cavity and the stalk of the yolk sac
- While hepatic cells continue to penetrate the septum, the connection between the hepatic diverticulum and the foregut (duodenum) narrows, forming the **bile duct**
- A small ventral outgrowth is formed by the bile duct, and this outgrowth gives rise to the **gallbladder** and the **cystic duct**

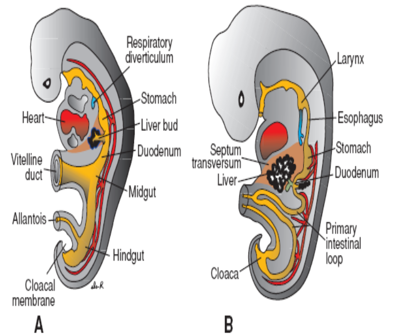


Figure 13.14 A. A 3-mm embryo (approximately 25 days) showing the primitive gastrointestinal tract and formation of the liver bud. The bud is formed by endoderm lining the foregut. **B.** A 5-mm embryo (approximately 32 days). Epithelial liver cords penetrate the mesenchyme of the septum transversum.

Formation of liver parts :-

[1] Sinusoids

- During further development, epithelial liver cords intermingle with the vitelline and umbilical veins, which form hepatic sinusoids

[2] Hepatocytes

[3] Bile duct lining

- Liver cords differentiate into the **parenchyma (liver cells)** and form the lining of the biliary ducts.

[4] Kupffer cells & CT

- **Hematopoietic cells, Kupffer cells,** and **connective tissue cells** are derived from mesoderm of the septum transversum.

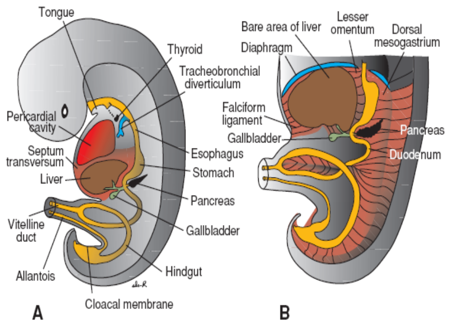


Figure 13.15 A. A 9-mm embryo (approximately 36 days). The liver expands caudally into the abdominal cavity. Note condensation of mesenchyme in the area between the liver and the pericardial cavity, foreshadowing formation of the diaphragm from part of the septum transversum. **B.** A slightly older 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.

Liver and Gallbladder Abnormalities

- Variations in liver lobulation are common but not clinically significant, **Accessory hepatic ducts** and **duplication of the gallbladder** 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
- This defect, **extrahepatic biliary atresia,** occurs in 1/15,000 live births.
- 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

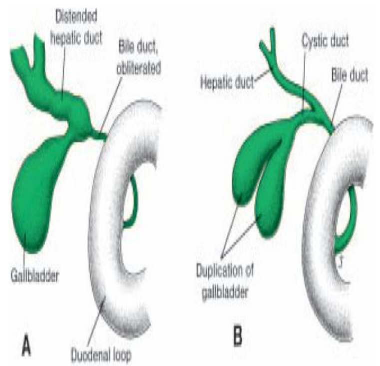


Figure 13.20 A. Obliteration of the bile duct resulting in distention of the gallbladder and hepatic ducts distal to the obliteration. **B.** Duplication of the gallbladder.

- Another problem with duct formation lies within the liver itself; it is **intrahepatic biliary duct atresia** and **hypoplasia**
- This rare abnormality (1/100,000 live births) may be caused by fetal infections.
- It may be lethal but usually runs an extended benign course.

DUODENUM

- The terminal part of the foregut and the cephalic part of the midgut form the Duodenum
- The junction of the two parts is directly distal to the origin of the liver bud
- As the stomach rotates, the duodenum takes on the form of a C-shaped loop and rotates to the right ⇒ right concavity
- This rotation, together with rapid growth of the head of the pancreas, swings the duodenum from its initial midline position to the left side of the abdominal cavity

- The duodenum and head of the pancreas press against the dorsal body wall, and the right surface of the dorsal mesoduodenum fuses with the adjacent peritoneum.
- Both layers subsequently disappear, and the duodenum and head of the pancreas become fixed in a **retroperitoneal position** → duodenum, → pancreas
- The entire pancreas thus obtains a retroperitoneal position.
- The dorsal mesoduodenum disappears entirely except in the region of the pylorus of the stomach, where a small portion of the duodenum (**duodenal cap**) retains its mesentery and remains intraperitoneal

- Dorsal mesoduodenum → Remains ⇒ intraperitoneal; → Disappears ⇒ Retroperitoneal

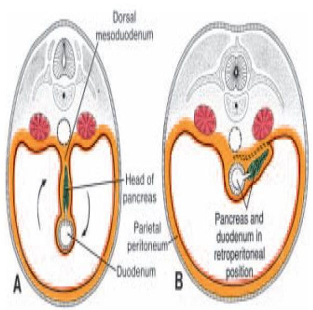


Figure 13.17 Transverse sections through the region of the duodenum at various stages of development. At first the duodenum and head of the pancreas are located in the median plane (A), but later they swing to the right and acquire a retroperitoneal position (B).

All tubes undergo this process

- During the second month, the lumen of the duodenum is obliterated by proliferation of cells in its walls.
- However, the lumen is recanalized shortly thereafter
- Since the **foregut** is supplied by the **celiac artery** and the midgut is supplied by the **superior mesenteric artery,** the duodenum is supplied by branches of both arteries (Blood supply)

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

PANCREAS

Stomach rotation
90° clock wise :
[1] C-Shaped duodenum
[2] Fusion of pancreatic buds

- The pancreas is formed by two buds originating from the endodermal lining of the duodenum
- Whereas the **dorsal pancreatic bud** is in the dorsal mesentery, the **ventral pancreatic bud** is close to the bile duct
- When the duodenum rotates to the right and becomes C-shaped, the ventral pancreatic budmoves dorsally in a manner similar to the shifting of the entrance of the bile duct
- Finally the ventral bud comes to lie immediately below and behind the dorsal bud
- Later the parenchyma and the duct systems of the dorsal and ventral pancreatic buds fuse

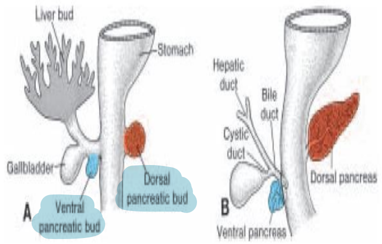


Figure 13.21 Stages in development of the pancreas. **A.** 30 days (approximately 5 mm). **B.** 35 days (approximately 7 mm). Initially the ventral pancreatic bud lies close to the liver bud, but later it moves posteriorly around the duodenum toward the dorsal pancreatic bud.

- The ventral bud forms the **uncinate process** and inferior part of the head of the pancreas
- The remaining part of the gland is derived from the dorsal bud.

Formation of the pancreatic ducts

- The **main pancreatic duct** (of **Wirsung**) is formed by the distal part of the dorsal pancreatic duct and the entire ventral pancreatic duct
- The proximal part of the dorsal pancreatic duct either is obliterated or persists as a small channel, the **accessory pancreatic duct** (of **Santorini**).
- In the third month of fetal life, **pancreatic islets** (of **Langerhans**) develop from the parenchymatous pancreatic tissue and scatter throughout the pancreas

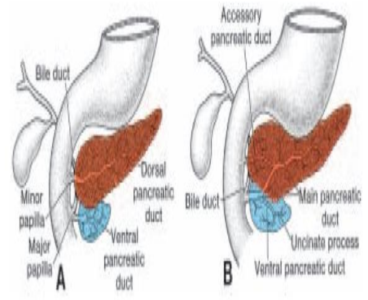


Figure 13.22 A. Pancreas during the sixth week of development. The ventral pancreatic bud is in close contact with the dorsal pancreatic bud. **B.** Fusion of the pancreatic ducts. The main pancreatic duct enters the duodenum in combination with the bile duct at the major papilla. The accessory pancreatic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

- **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

Pancreatic Abnormalities

* head
uncinate

- 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
- The malformation sometimes constricts the duodenum and causes complete obstruction

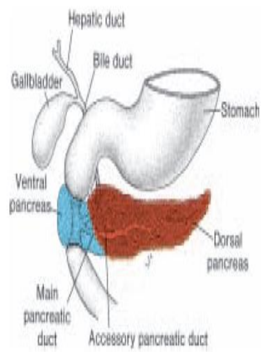


Figure 13.23 Annular pancreas. The ventral pancreas splits and forms a ring around the duodenum, occasionally resulting in duodenal stenosis.

- **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.

Ectopic pancreatic tissue

Gi Embryology 3

Midgut

Connections :
1 with dorsal wall
2 with yolk sac

- the midgut is suspended from the dorsal abdominal wall by a short mesentery and communicates with the yolk sac by way of the **vitelline duct or yolk stalk**

Blood supply

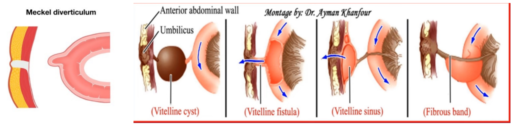
- Over its entire length the midgut is supplied by the **superior mesenteric artery**

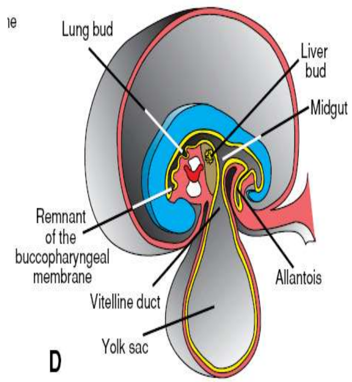
Development

- Development of the midgut is characterized by rapid elongation of the gut and its mesentery, resulting in formation of the **primary intestinal loop**

- At its apex, the loop remains in open connection with the yolk sac by way of the narrow **vitelline duct**

↓ if not completely obliterated





الحد الفاصل بين
Fore & mid
⇒ Ampulla of vater

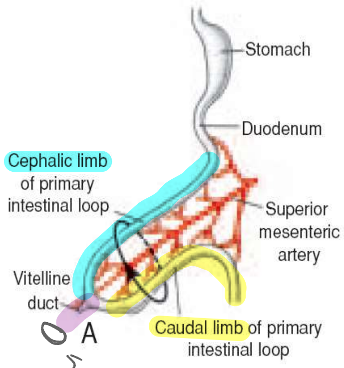
- In the adult the midgut begins immediately distal to the entrance of the bile duct into the duodenum

- terminates at the junction of the proximal two-thirds of the transverse colon with the distal third.

- The cephalic limb of the loop develops into the distal part of the duodenum, the jejunum, and part of the ileum.

- The caudal limb becomes the lower portion of the ileum, the cecum, the appendix, the ascending colon, and the proximal two-thirds of the transverse colon.

Primary intestinal loop
→ cephalic limb
→ caudal limb



PHYSIOLOGICAL HERNIATION

- Development of the primary intestinal loop is characterized by rapid elongation, particularly of the cephalic limb. → SI is longer

- As a result of the rapid growth and expansion of the liver, the abdominal cavity temporarily becomes too small to contain all the intestinal loops, and they enter the extraembryonic cavity in the umbilical cord during the sixth week of development (**physiological umbilical herniation)**

ROTATION OF THE MIDGUT

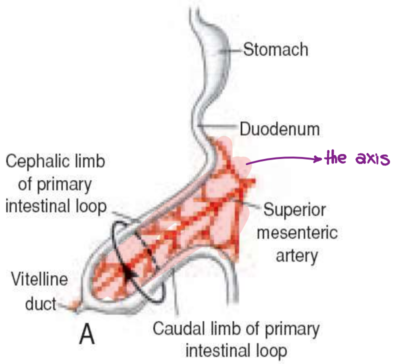
- Coincident with growth in length, the primary intestinal loop rotates around an axis formed by the **superior mesenteric artery**
- When viewed from the front, this rotation is counterclockwise, and it amounts to approximately 270◦ when it is complete

  ← زي كأنها 90° clock wise

- Even during rotation, elongation of the small intestinal loop continues, and the jejunum and ileum form a number of coiled loops
- The large intestine likewise lengthens considerably but does not participate in the coiling phenomenon.
- Rotation occurs during herniation (about 90◦) as well as during return of the intestinal loops into the abdominal cavity (remaining 180◦)

  umbilical cord

  herniation step ⇒ 90° ccw
  post-herniation ⇒ 180° ccw
  } Σ 270° ccw



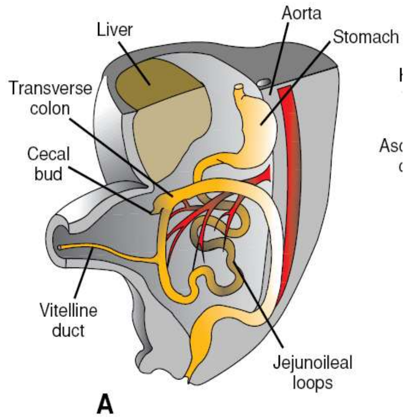
RETRACTION OF HERNIATED LOOPS

- During the 10th week, herniated intestinal loops begin to return to the abdominal cavity.

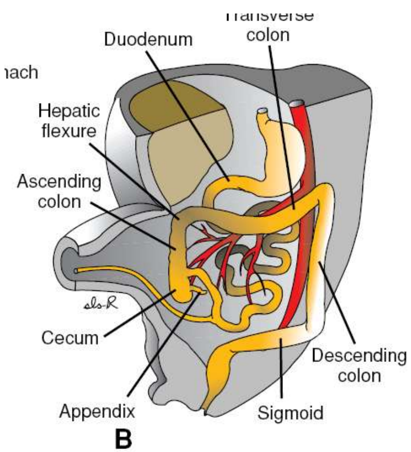
  → So, herniation process takes 4 weeks

- is thought that regression of the mesonephric kidney, reduced growth of the liver, and expansion of the abdominal cavity play important roles.
- The proximal portion of the jejunum, the first part to reenter the abdominal cavity, comes to lie on the left side
- The later returning loops gradually settle more and more to the right.

  → correct orientation
  But... cecum is upwards



- The **cecal bud, which appears** at about the sixth week as a small conical dilation of the caudal limb of the primary intestinal loop, is the last part of the gut to reenter the abdominal cavity.
- Temporarily it lies in the right upper quadrant directly below the right lobe of the liver
- From here it descends into the right iliac fossa, placing the **ascending colon and hepatic flexure on the right side of the abdominal** cavity



- During this process the distal end of the cecal bud forms a narrow diverticulum, the **appendix**
- Since the appendix develops during descent of the colon, its final position frequently is posterior to the cecum or colon.

  this is why appendix is retrocecal

- These positions of the appendix are called **retrocecal or retrocolic, respectively**

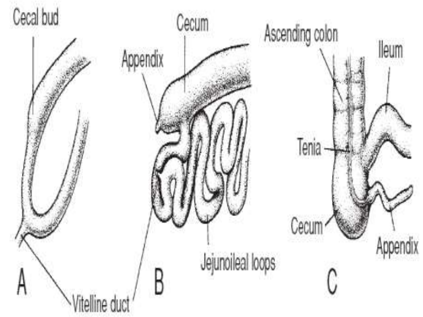


Figure 13.28 Successive stages in development of the cecum and appendix. **A.** 7 weeks. **B.** 8 weeks. **C.** Newborn.

MESENTERIES OF THE INTESTINAL LOOPS

Changes of mesentery during primary intestinal loop development:
- twisting
- merging with PAW at Des & Asc

- The mesentery of the primary intestinal loop, the **mesentery proper, undergoes** profound changes with rotation and coiling of the bowel.
- When the caudal limb of the loop moves to the right side of the abdominal cavity, the dorsal mesentery twists around the origin of the **superior mesenteric artery**
- Later, when the ascending and descending portions of the colon obtain their definitive positions, their mesenteries press against the peritoneum of the posterior abdominal wall *

* Becoming retroperitoneal

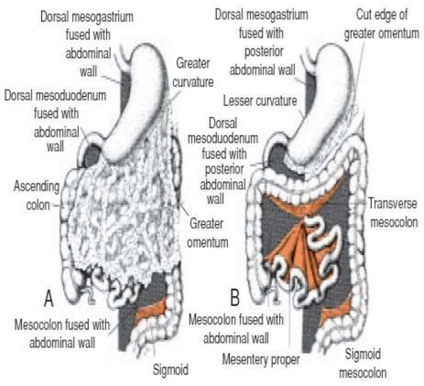
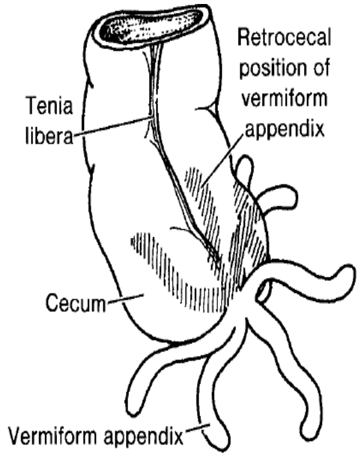


Figure 13.30 Frontal view of the intestinal loops with (**A**) and after removal of (**B**) the greater omentum. *Gray areas*, parts of the dorsal mesentery that fuse with the posterior abdominal wall. Note the line of attachment of the mesentery proper.

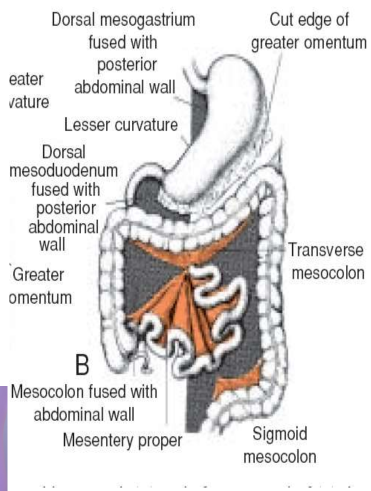
- After fusion of these layers, the ascending and descending colons are permanently anchored in a retroperitoneal position.
- The appendix, lower end of the cecum, and sigmoid colon, however, retain their free mesenteries ← Remain intraperitoneal
- The fate of the transverse mesocolon is different. It fuses with the posterior wall of the greater omentum but maintains its mobility. → 4 layers
- Its line of attachment finally extends from the hepatic flexure of the ascending colon to the splenic flexure of the descending colon

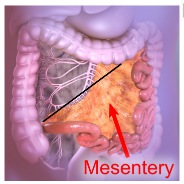
Extension of trans. mesocolon



- The mesentery of the jejunoileal loops is at first continuous with that of the ascending colon
- When the mesentery of the ascending mesocolon fuses with the posterior abdominal wall, the mesentery of the jejunoileal loops obtains a new line of attachment that extends from the area where the duodenum becomes intraperitoneal to the ileocecal junction

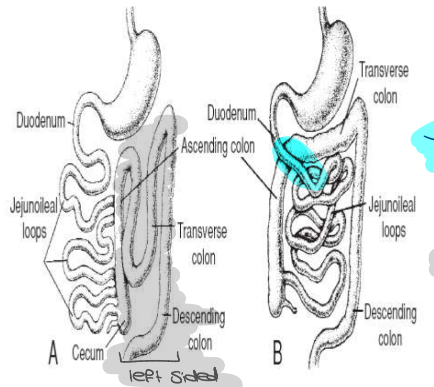
Separation of the mesentery between retroperitoneal Ascending colon & intraperitoneal ilium





Gut Rotation Defects

- [1] **Abnormal rotation of the intestinal loop may result in twisting of the intestine (volvulus) and a compromise of the blood supply.**
- [2] Normally the primary intestinal loop rotates 270◦ counterclockwise. Occasionally, however, rotation amounts to 90◦ only. بتنعكس الاتجاهات
- 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
- The later returning loops then move more and more to the right, resulting in **left-sided colon.**



→ transverse passes behind duodenum

هون اذا لفت 90° clockwise

و هون اذا لفت 90° ccw

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.

- **Reversed rotation of the intestinal loop occurs when the primary loop** rotates 90◦ clockwise
- In this abnormality the transverse colon passes behind the duodenum 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

→ Mostly associated with vitelline

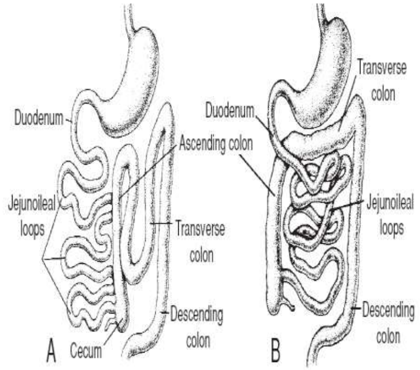


Figure 13.33 A. Abnormal rotation of the primary intestinal loop. The colon is on the left side of the abdomen, and the small intestinal loops are on the right. The ileum enters the cecum from the right. **B.** The primary intestinal loop is rotated 90° clockwise (reversed rotation). The transverse colon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

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 due to a lack of recanalization

Body Wall Defects

هون الأمعاء ما رجعت بالمرة ←

- **Omphalocele** involves herniation of abdominal viscera through an enlarged umbilical ring.
- The viscera, are covered by amnion.
- The origin of the defect is a failure of the bowel to return to the body cavity from its physiological herniation
- Omphalocele occurs in 2.5/10,000 births and is associated with a high rate of mortality (25%) and severe malformations, such as cardiac anomalies (50%) and neural tube defects (40%).
- Approximately half of live-born infants with omphalocele have chromosomal abnormalities.

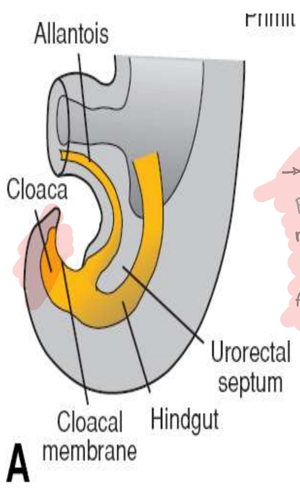
- **Gastroschisis** is a herniation of abdominal contents through the body wall directly into the amniotic cavity.
- It occurs lateral to the umbilicus usually on the right

- Not covered by Amnion
- Doesn't enter the umbilical cord

Hindgut

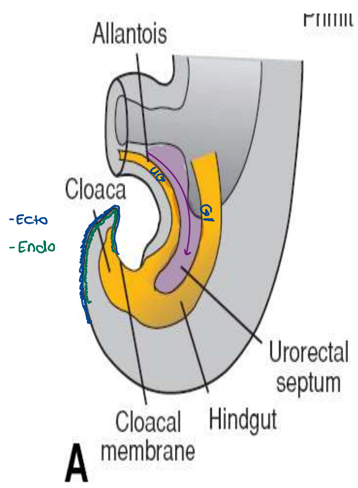
- The hindgut gives rise to the distal third of the transverse colon, the descending colon, the sigmoid, the rectum, and the upper part of the anal canal.
- The endoderm of the hindgut also forms the internal lining of the bladder and urethra
- The terminal portion of the hindgut enters into the posterior region of the cloaca, the primitive **anorectal canal; the allantois enters into the anterior** portion, the primitive **urogenital sinus**

Recall: Endoderm of Foregut gave RS ←



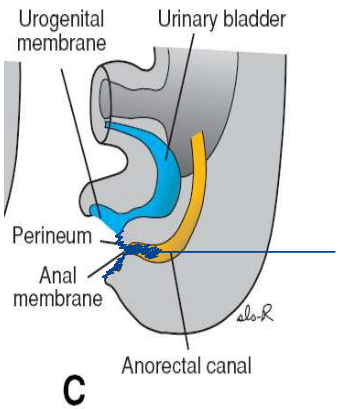
→ Notice. presence of the tail means ⇒ closed urethra & anus
Among degeneration → Both open

- The cloaca itself is an endoderm-lined cavity covered at its ventral boundary by surface ectoderm.
- This boundary between the endoderm and the ectoderm forms the **cloacal membrane**
- A layer of mesoderm, the **urorectal septum, separates** the region between the allantois and hindgut.
- This septum is derived from the merging of mesoderm covering the yolk sac and surrounding the allantois



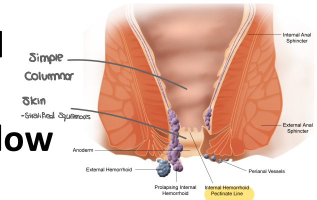
tail Degeneration ⇒

- At the end of the seventh week, the cloacal membrane ruptures, creating the anal opening for the hindgut and a ventral opening for the urogenital sinus.
- Between the two, the tip of the urorectal septum forms the perineal body
- proliferation of ectoderm closes the caudalmost region of the anal canal. بتسكر
- During the ninth week, this region recanalizes يرجع تفتح
- Thus, the caudal part of the anal canal originates in the ectoderm, and it is supplied by the **inferior rectal arteries**, branches of the **internal pudendal arteries**



proliferation of the ectoderm closing the anal canal
⇓
After recanalization... the lower part will be covered by ectoderm
→ Stratified squamous
↳ Blood supply follows the ectodermal origin

The junction between the endodermal and ectodermal regions of the anal canal is delineated by the **pectinate line, just below the anal columns**



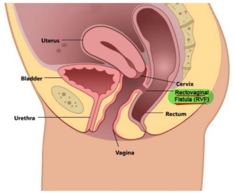
- At this line, the epithelium changes from columnar to stratified squamous epithelium.

What are anorectal malformations?

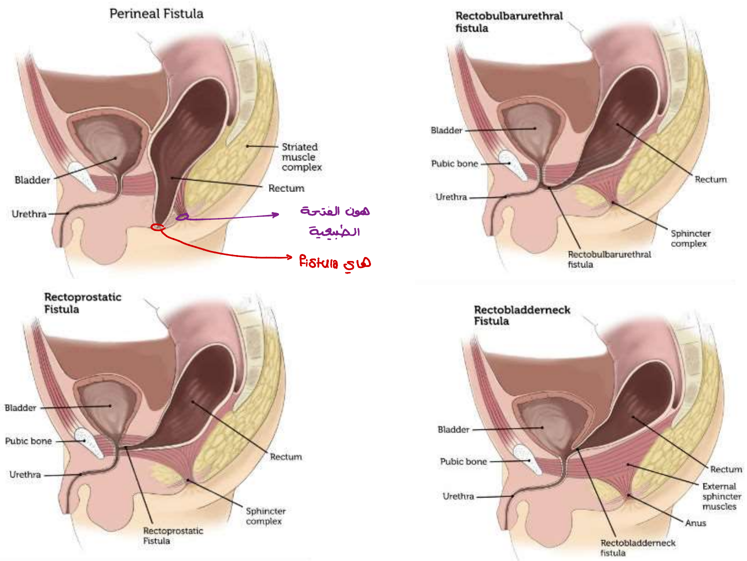
- Anorectal malformations are birth defects in which the anus and rectum (the lower end of the digestive tract) don't develop properly. They occur in an estimated 1 in 4,000 newborns and can range from mild to complex.
- Anorectal malformations include several different abnormalities, including:
- The anal passage may be narrow.
- A membrane may be present over the anal opening.
- The rectum may not connect to the anus (imperforate anus). Atresia
- The rectum may connect to a part of the urinary tract or the reproductive system through an abnormal passage called a fistula.

Fistula
Variation
♀ vs. ♂
Due to urogenital variations

- **Types of anorectal malformations:**
- Anorectal malformations, including imperforate anus, can affect male and female babies in different ways.
- In boys, the main anorectal malformations are perineal fistula, rectobulbarurethral fistula, rectoprostatic fistula and rectobladderneck fistula.
- In girls, the main anorectal malformations are rectoperineal fistula, rectovestibular fistula and cloaca.
- A type of anorectal malformation called imperforate anus can occur in both boys and girls.

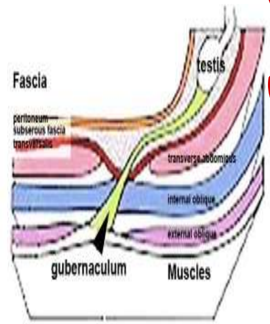


Types of anorectal malformations



Testis

- Toward the end of the second month, the **urogenital mesentery attaches the** testis and mesonephros to the posterior abdominal wall
- Prior to descent of the testis, this band of mesenchyme terminates in the inguinal region between the differentiating internal and external abdominal oblique muscles.
- Later, as the testis begins to descend toward the inguinal ring, an extra-abdominal portion of the gubernaculum forms and grows from the inguinal region toward the scrotal swellings.
- When the testis passes through the inguinal canal, this extra-abdominal portion contacts the scrotal floor



وهاي نفس الاشي

- Normally, the testes reach the inguinal region by approximately 12weeks gestation, migrate through the inguinal canal by 28 weeks, and reach the scrotum by 33 weeks
- The process is influenced by hormones, including androgens and MIS
- Independently from descent of the testis, the peritoneum of the abdominal cavity forms an evagination on each side of the midline into the ventral abdominal wall.
- This evagination, the **processus vaginalis, follows the course of the** gubernaculum testis into the scrotal swellings
- Hence the processus vaginalis, accompanied by the muscular and fascial layers of the body wall, evaginates into the scrotal swelling, forming the **inguinal canal**