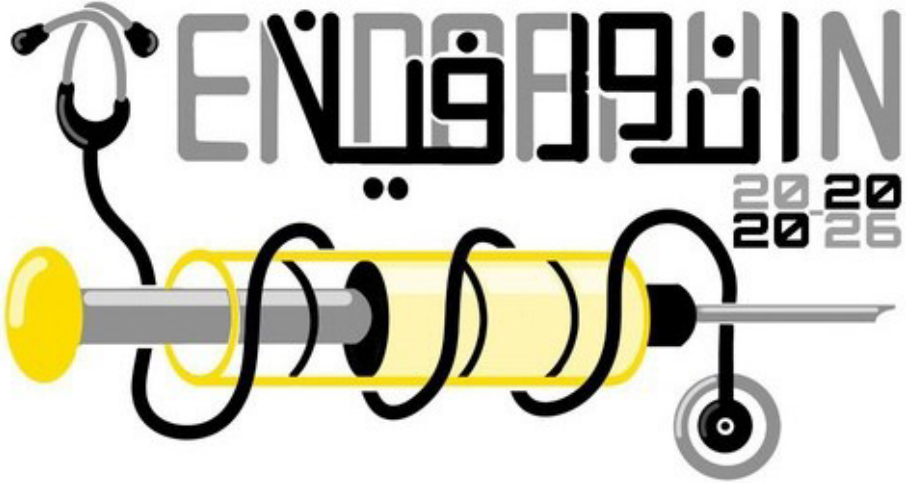
Anatomy



Sheet: 3

Lecture title: Development of foregut

Date:

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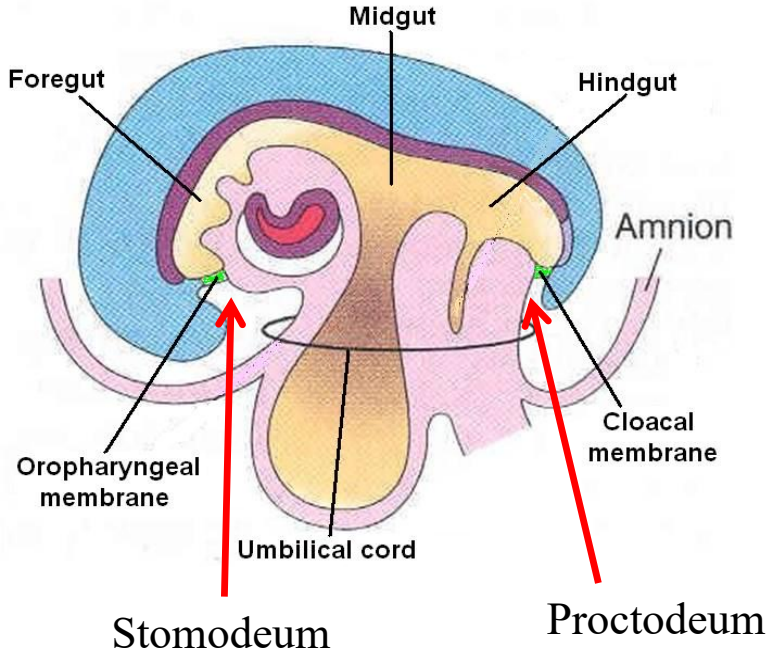
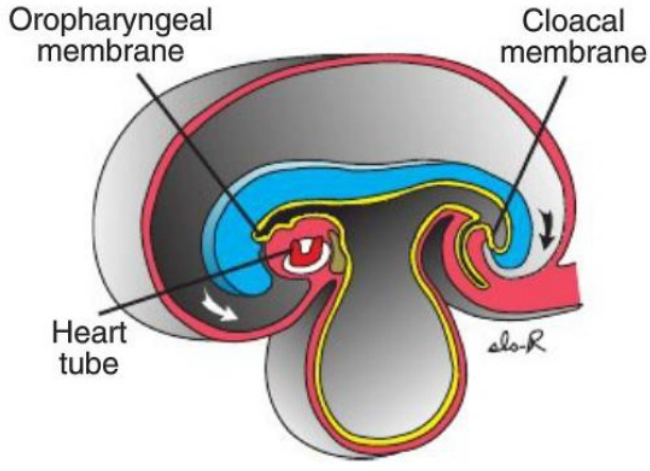
Development of Foregut

Dr. Refat AboGhazleh

- The endoderm of the primordial gut gives rise to most of the epithelium and glands of the digestive tract

- The **muscles, connective tissue** and other layers of the wall of the tract are derived from the **splanchnic mesoderm**





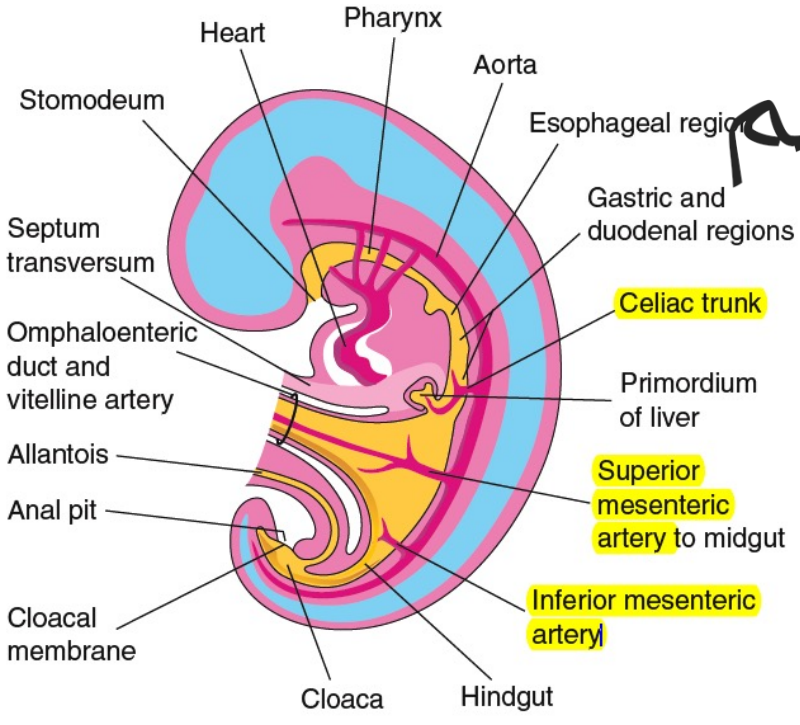
Folding of the embryo leads to:

Development of the primitive gut tube:

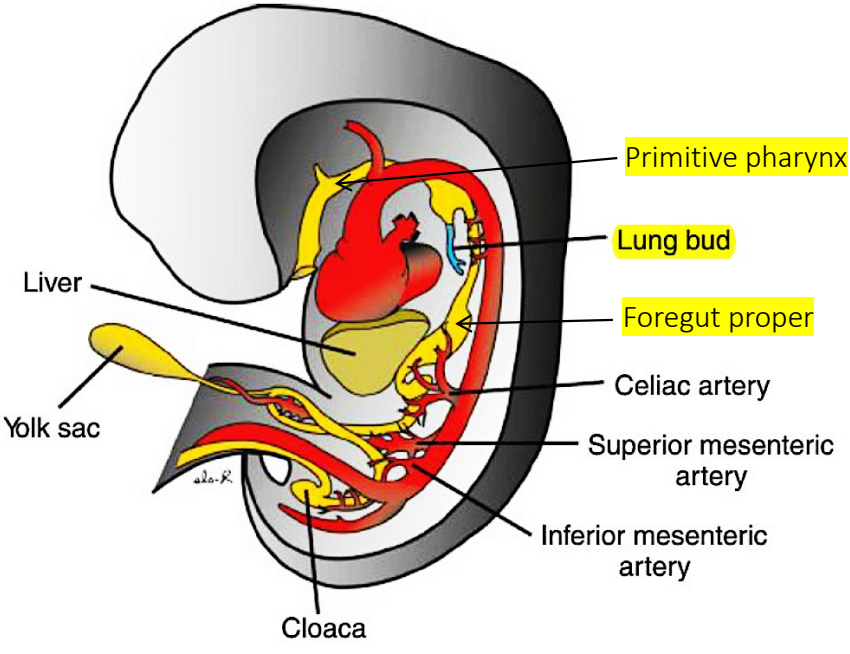
- It extends from the **oral membrane** to the **cloacal membrane**.

It is divided into:

1. **Foregut**: from pharynx to the 2nd part of duodenum.
2. **Midgut**: from 2nd part of duodenum to the junction between right 2/3 & left 1/3 of transverse colon.
3. **Hindgut**: the remaining part of large intestine.



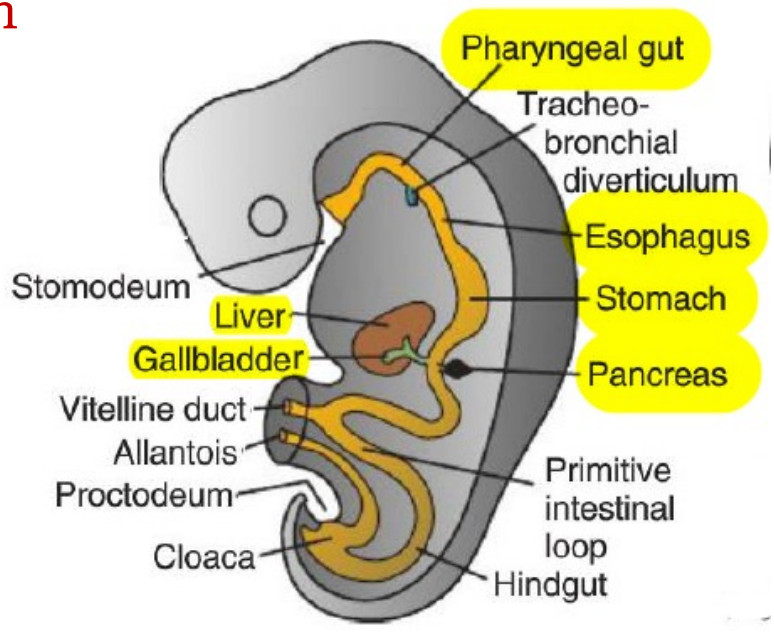
- Each part of the **developing gut** receives a branch of the **aorta**:
  - **Celiac trunk** supplies the foregut & its derivatives.
  - **Superior mesenteric artery** supplies the midgut & its derivatives.
  - **Inferior mesenteric artery** supplies the hindgut & its derivatives.



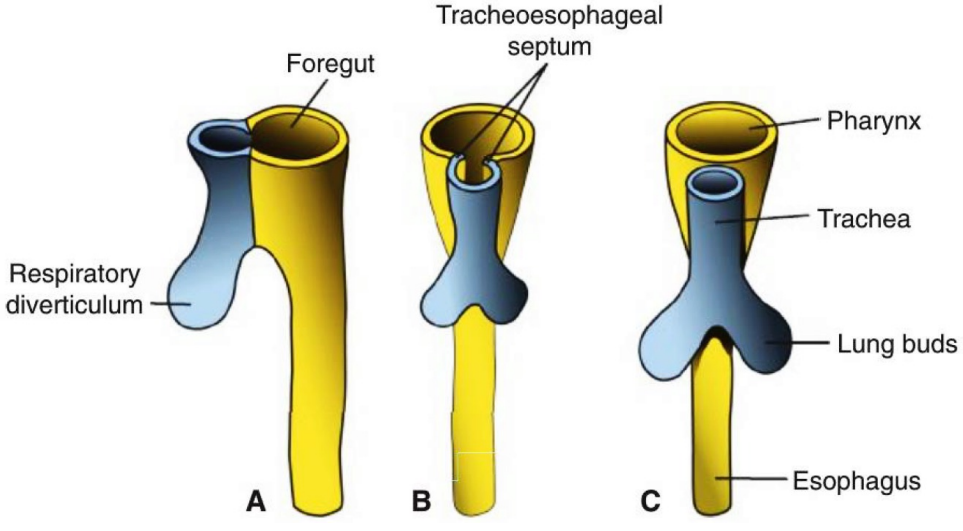
- Development of the respiratory diverticulum from the floor of the foregut, divides the foregut into **two parts:**
- Part cranial to diverticulum is the **primitive pharynx**
- Part caudal to diverticulum is the **foregut proper**

The Foregut Derivatives

- Primordial pharynx and its derivatives
- Lower respiratory tract (larynx, trachea, bronchi & lungs)
- Derivatives of foregut proper:
  - Esophagus
  - Stomach
  - Proximal half of duodenum
  - Liver & biliary apparatus
  - Pancreas

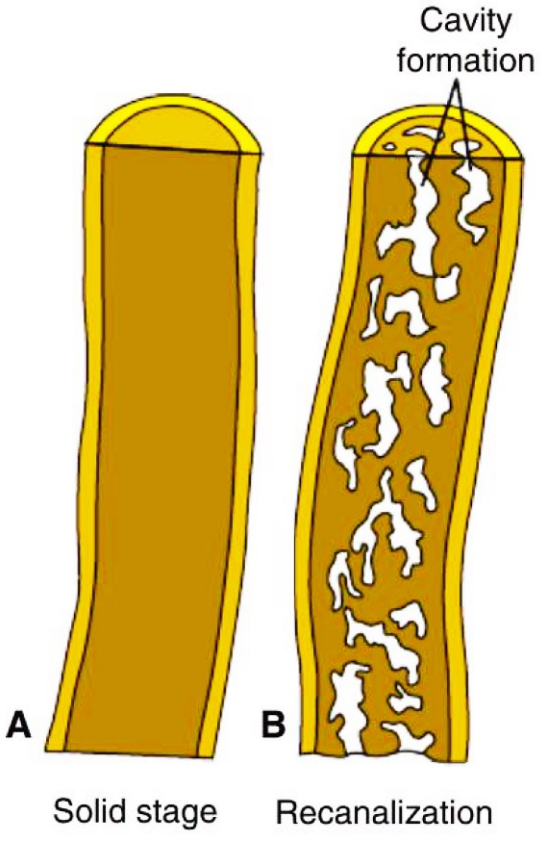


Development of Esophagus



- **Esophagus** develops from the foregut immediately **caudal to** the **primitive pharynx**.
- The **tracheo-esophageal septum** separates it from the developing **trachea**.
- Initially short in length, elongates rapidly due to growth and descent of heart and lungs.
- Reaches its final relative length by 7^{th} week.

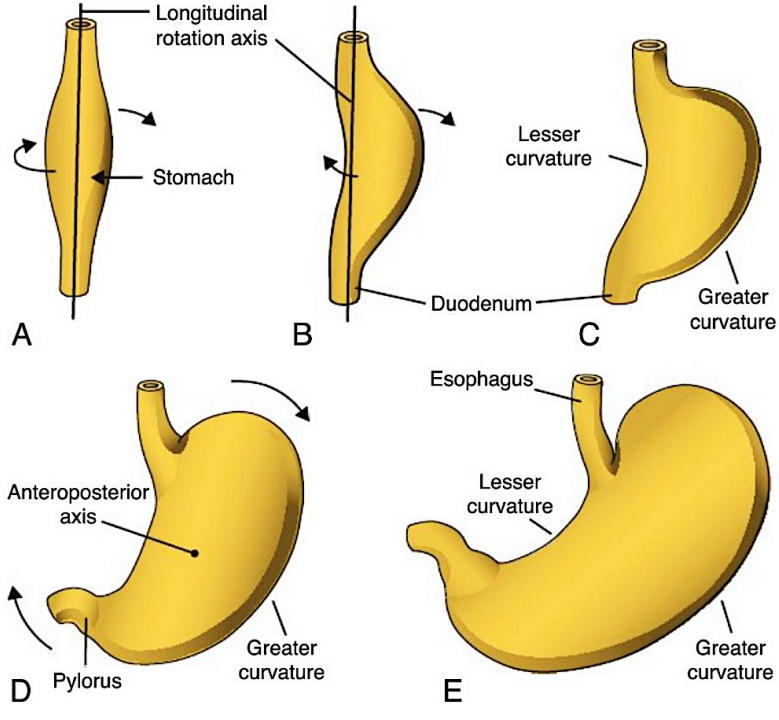
- The epithelial cells proliferate and obliterate the lumen (partly or completely) but temporarily
- Recanalization normally occurs by the end of 8th week.
- Incomplete recanalization of the esophagus leads to narrowing of the lumen (**Esophageal stenosis**).



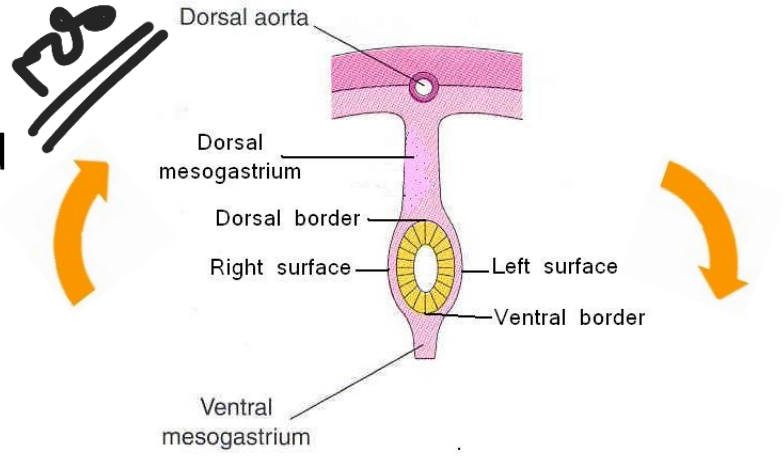
- **Epithelium & glands**:
  - Derived from **endoderm**
- **Striated muscles:**
  - Derived from the **mesenchyme** in the 4^{th} and 6^{th} pharyngeal aches.
- **Smooth muscles** (mainly in the inferior third):
  - Derived from the surrounding splanchnic mesenchyme.

Development of Stomach

- In the middle of the 4th week, a fusiform dilatation appears in the caudal part of the foregut that indicates the site of future **stomach.**
- The dilatation oriented in the midline, enlarges and broadens ventrodorsally
- During next 2 weeks:
  - The dorsal border grows much faster and forms the **greater curvature**
  - The ventral border forms the **lesser curvature.**

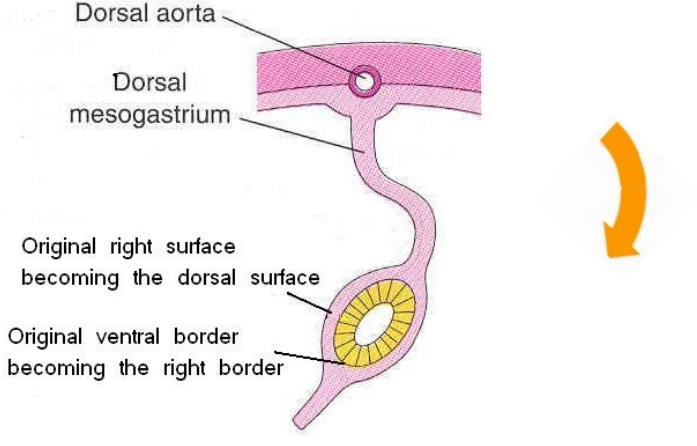


- As stomach enlarges, it slowly rotates 90 degrees, **clockwise** around its longitudinal axis

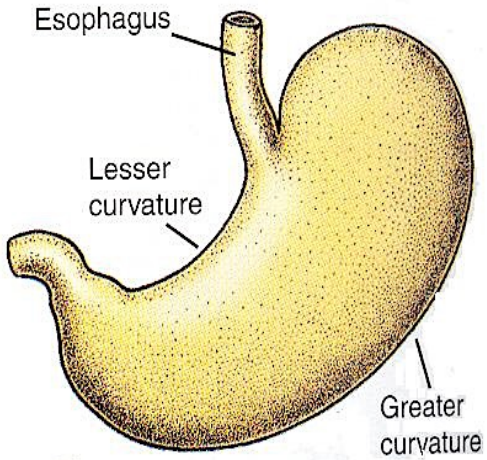


As a result, the:

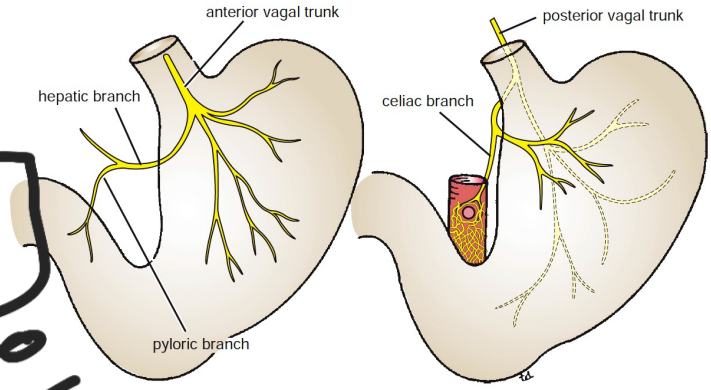
- **The ventral border** moves to the right and the **dorsal border** to the left.
- The **right side** becomes the dorsal surface and the **left side** becomes the ventral surface.



- **Before rotation**, the two ends of the stomach are in the median plane.
- **During rotation**:
  - The **cranial end** moves to the left and slightly inferiorly
  - The **caudal end** moves to the right and superiorly
- **After rotation**, stomach assumes its final position with its long axis almost transverse to the long axis of the body.

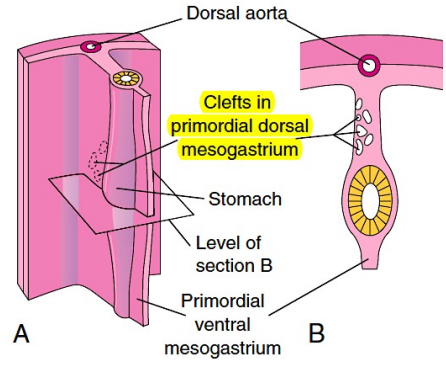


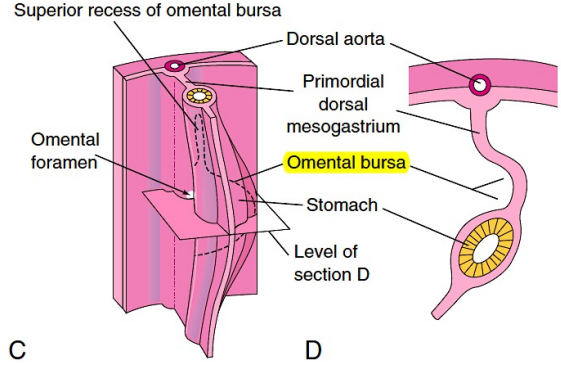
This rotation and growth explains why the **left vagus nerve** supplies the anterior wall of the adult stomach, and the **right vagus nerve** innervates its posterior wall.

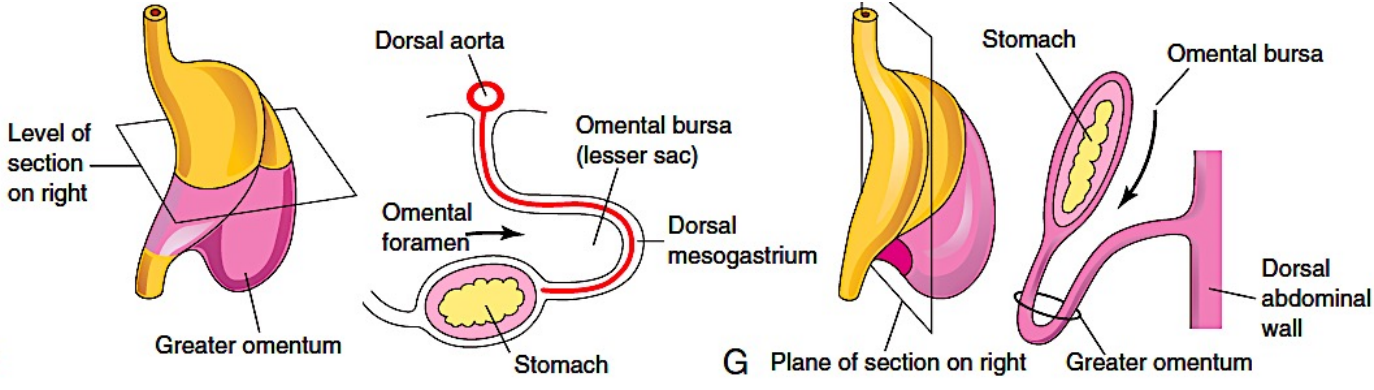


Omental Bursa (Lesser Sac)

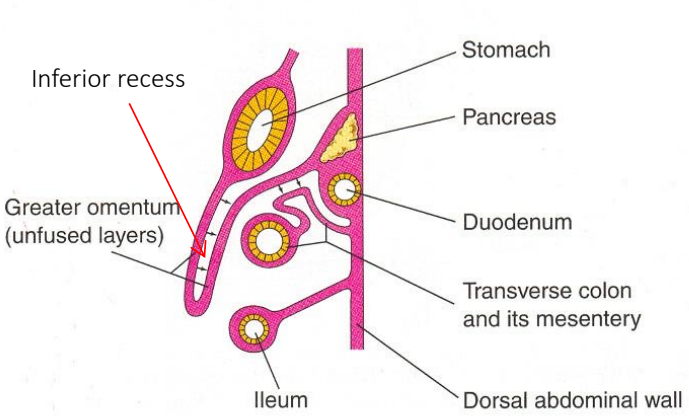
- Begins as small isolated clefts in the dorsal mesogastrium, that soon join to form a single cavity.
- Rotation of stomach pulls the dorsal mesogastrium to the left thus enlarging the cavity.
- The bursa expands transversely and cranially and lies between the stomach and the posterior abdominal wall.

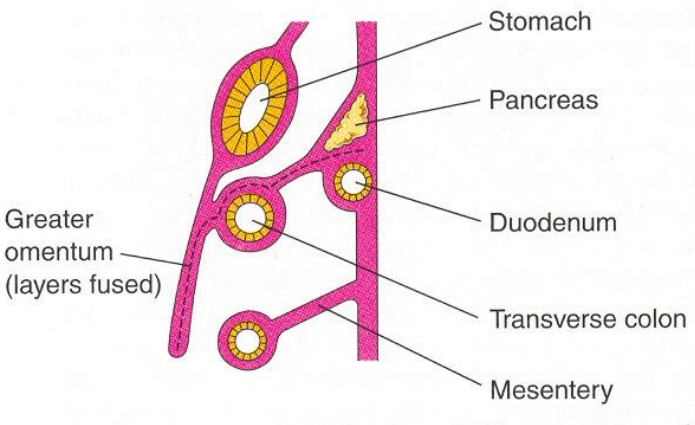


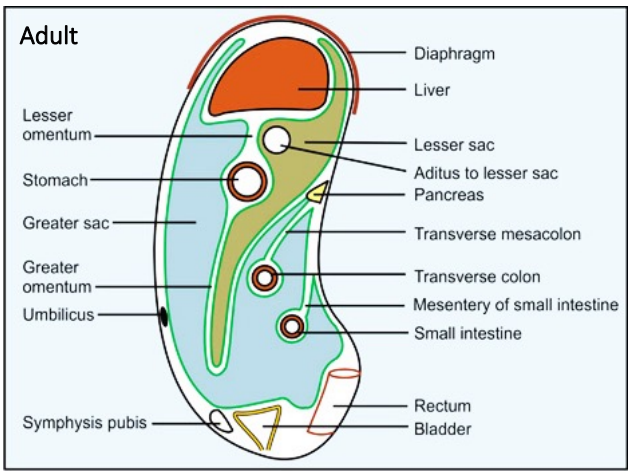




- The **superior part** of the bursa is cut off as the diaphragm develops.
- The **inferior part** grows within the 4-layered greater omentum forming the inferior recess of the omental bursa
- The inferior recess later on **closes** down because of fusion of the layers of the greater omentum.



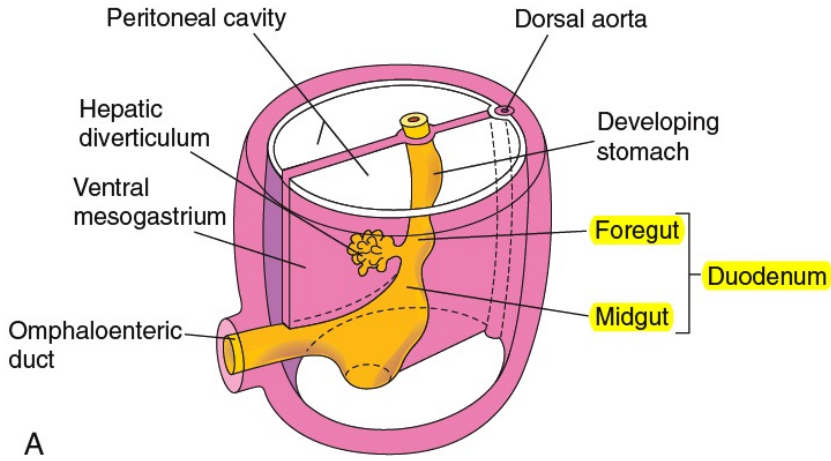


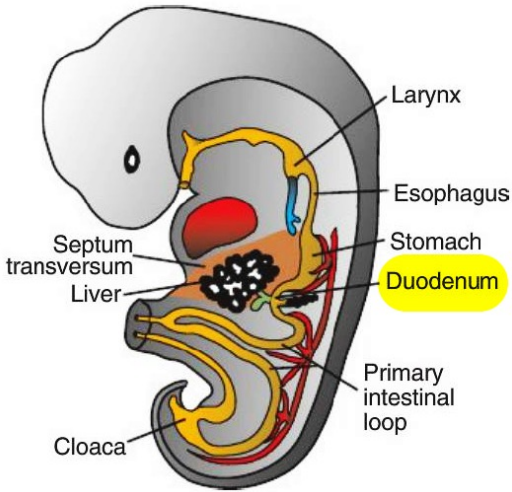


Development of Duodenum

- Early in the 4th week, the duodenum develops from the:
- **Caudal part of foregut.**
- **Cranial part of midgut**

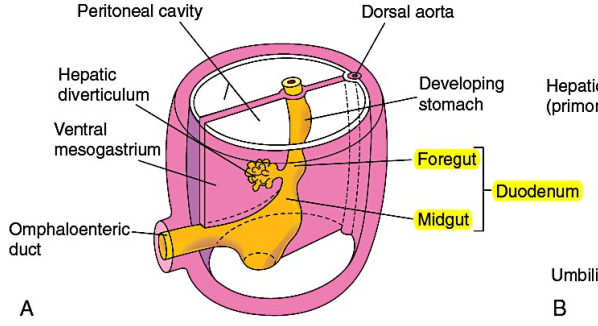
- The junction of the two parts is directly distal to the origin of the liver bud.



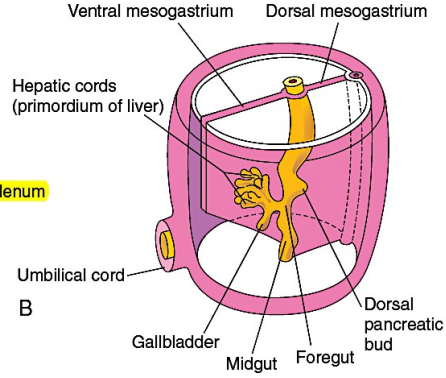


Because of its derivation from the **foregut** and **midgut**, the duodenum is supplied by branches of both the **celiac** and **superior mesenteric arteries.**

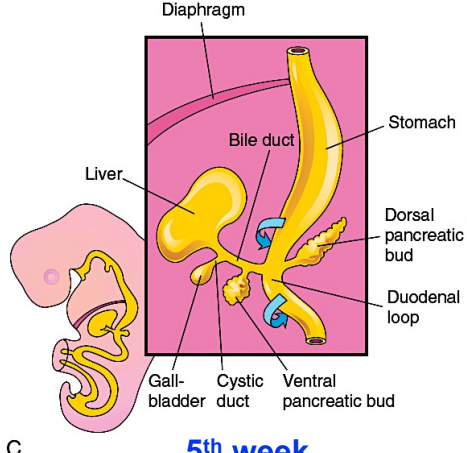
- **The duodenal loop** is formed and projected ventrally, forming **a C-shaped loop** (C).
- **The duodenal loop** is <u>rotated</u> with the stomach <u>to the right</u> and comes to lie on the posterior abdominal wall **<u>retroperitoneally</u>** with the developing **pancreas.**



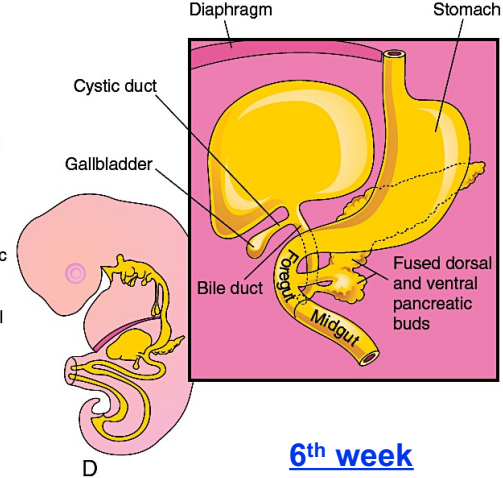
4th week



5th week



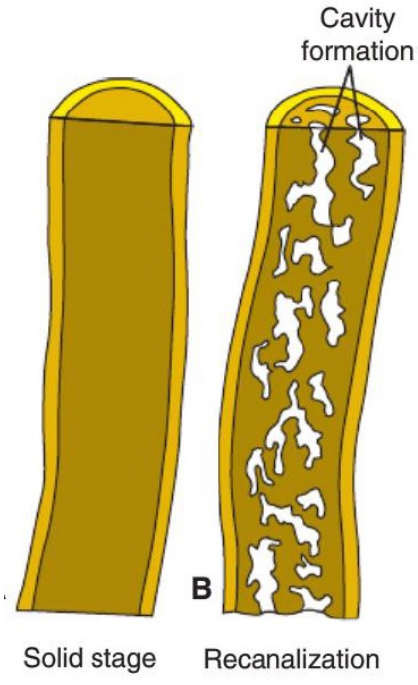
5th week



6th week

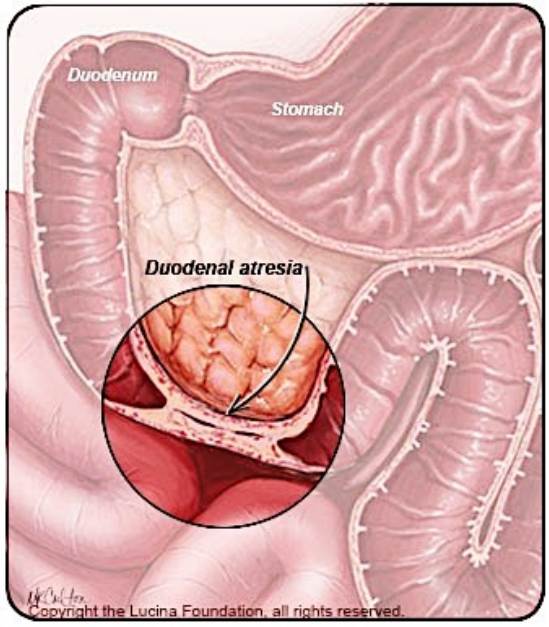
- During 5th & 6th weeks, the lumen of the duodenum is temporarily obliterated because of proliferation of its epithelial cells.

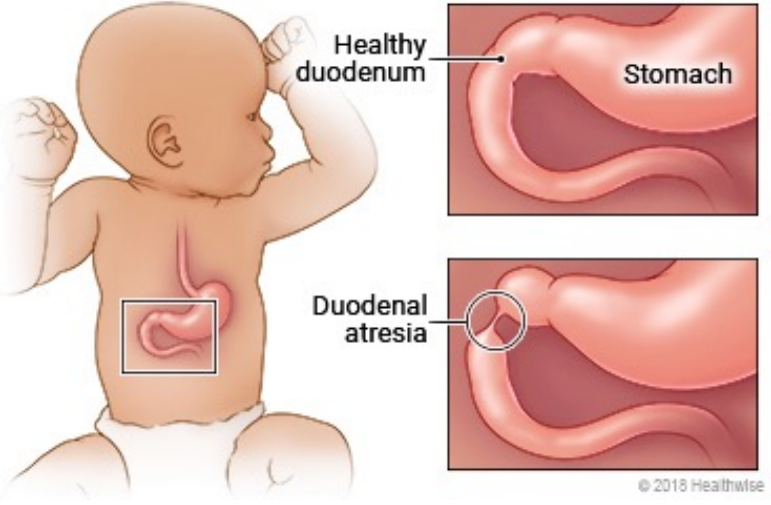
- Normally degeneration of epithelial cells occurs, so the duodenum normally becomes **recanalized** by the end of the embryonic period.



Congenital anomalies

- **Duodenal stenosis**; results from incomplete recanalization of the duodenum.
- **Duodenal atresia**; results from failure of recanalization leading to complete occlusion of the duodenal lumen, (autosomal recessive inheritance).

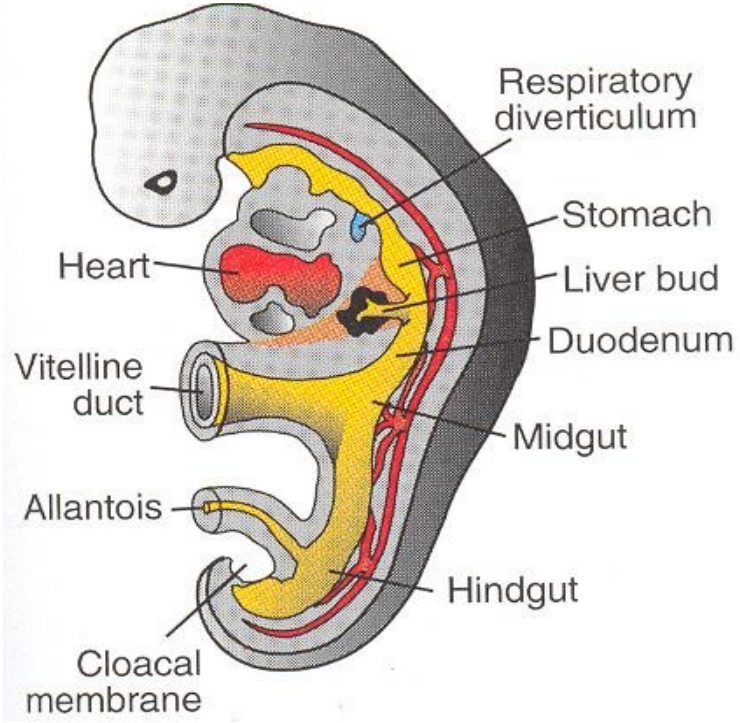




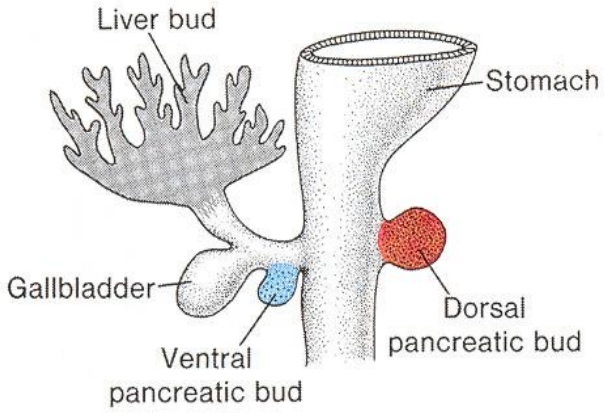
Development of Liver

- Liver appears in 4th week, as a **ventral bud** called **hepatic diverticulum**, from the caudal part of the foregut.

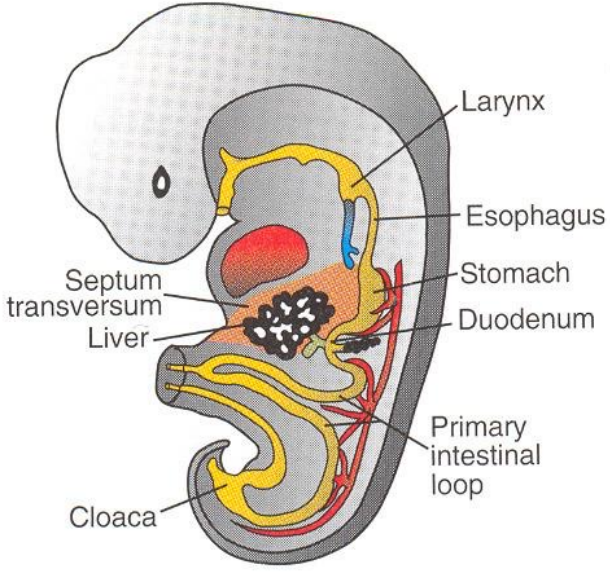
- The bud grows into the **septum transversum** (which is forming the ventral mesentery in this region) and divides into two parts.



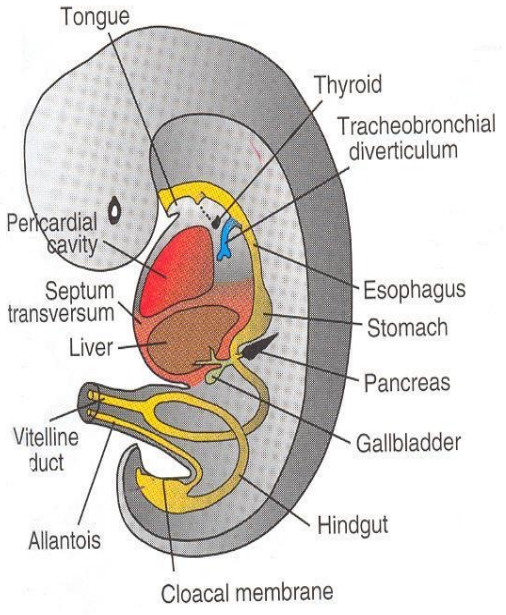
- The larger **cranial part** is **primordium of liver**,
  the smaller caudal part gives rise to the **gall bladder** and **cystic duct.**



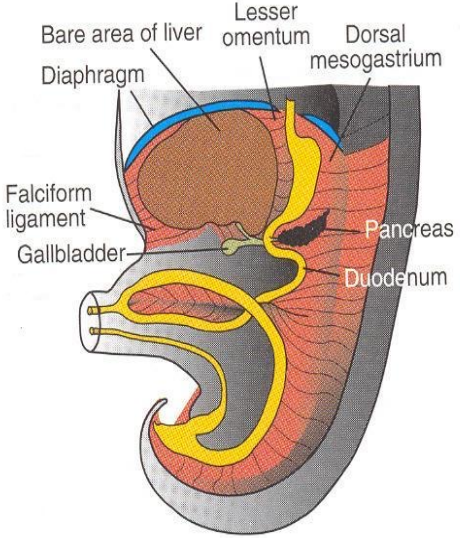
- The endodermal cells of the hepatic bud proliferate and give rise to **hepatic cords** and the epithelial lining of the intrahepatic portion of the biliary system.
- The hepatic cords anastomose around the hepatic sinusoids.



- The liver grows rapidly and in 5-10th weeks fills a large part of the abdominal cavity.
- By 9th week, the liver forms about 10% of total body weight .
- Initially the right and left lobes are of the same size, later right lobe grows larger.



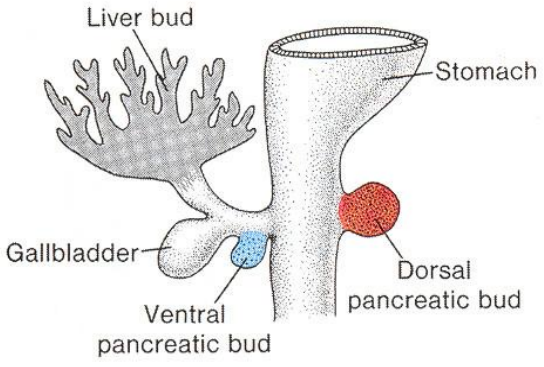
A 9-mm embryo [~ 5 wks]

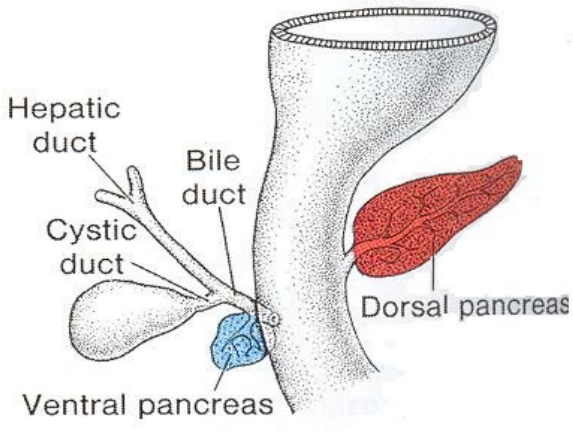


- **Liver cords** differentiate into the parenchyma (liver cells) and form the lining of the biliary ducts.
- The hepatic cords and the epithelial lining of the intrahepatic portion of the biliary system are derived from **endoderm.**
- The fibrous tissue, hematopoietic tissue and Kupffer cells are derived from the mesenchyme of the septum transversum.
- The **hepatic sinusoides** derived from vitelline veins.
- Hematopoiesis begins during 6th week, giving dark color to liver
- The hepatic cells begins to form bile during the 12th week.

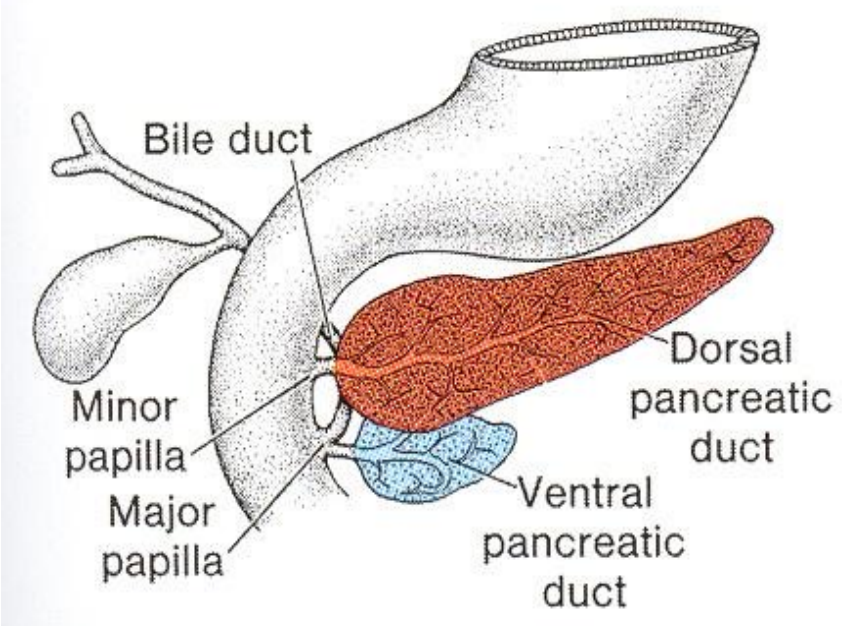
Development of Biliary Apparatus

- The small caudal part of the hepatic diverticulum becomes the **gall bladder**, and the stalk of the diverticulum forms the cystic duct.
- The stalk connecting the hepatic & cystic ducts to the duodenum becomes the **bile duct**, and opens on the ventral aspect of the duodenum.



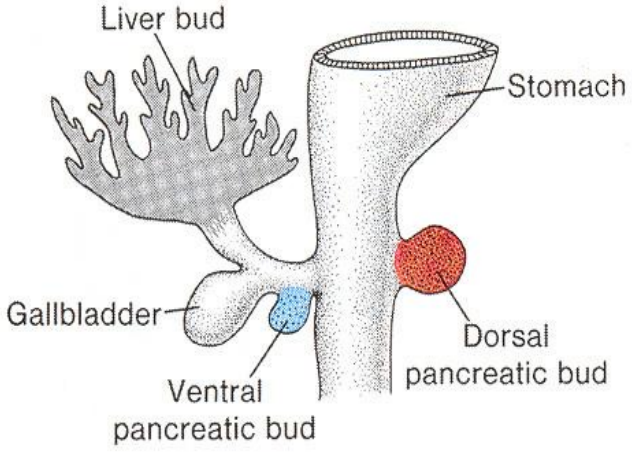


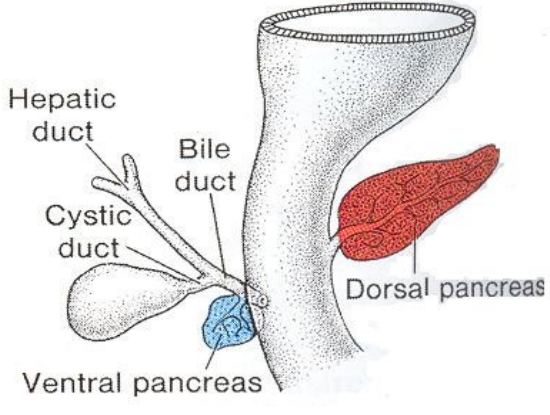
- Later, due to rotation of duodenum, the opening comes to lie dorsally.
- The ducts become occluded initially, but are later canalized.
- After 13th week, **bile** entering the duodenum gives the **meconium** (first intestinal discharges of neonate) a dark green color.



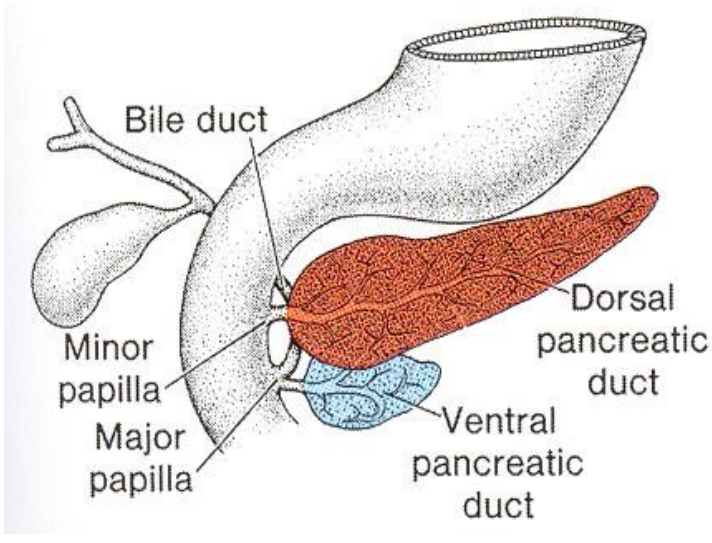
Development of Pancreas

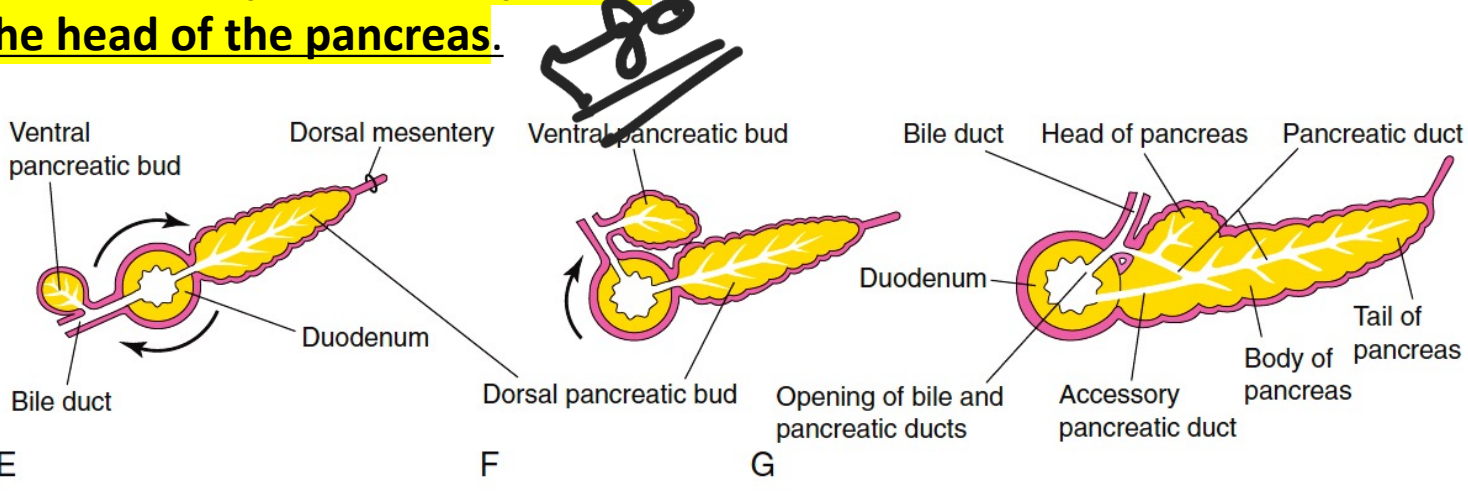
- **Pancreas** begins to appears as two buds, **dorsal** and **ventral**, from the caudal part of the foregut (region developing into duodenum) that grow within the dorsal and ventral mesenteries, respectively.
- The **dorsal bud** is larger, appears first and lies cranial to the smaller ventral bud.
- The **dorsal bud** forms most of the pancreas

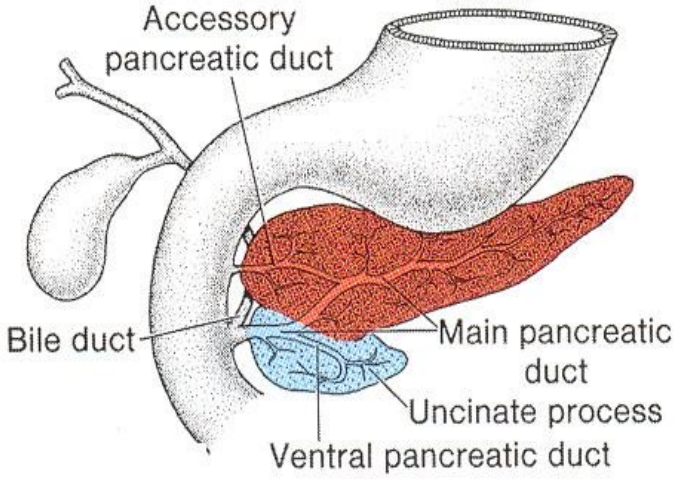




- The rotation of stomach and duodenum carry the **ventral bud** dorsally along with the bile duct.
- The ventral bud comes to lie posterior to the dorsal bud and later fuses with it and their ducts anastomose.
- The **ventral pancreatic bud** forms the **uncinate process** and **part of the head of the pancreas**.







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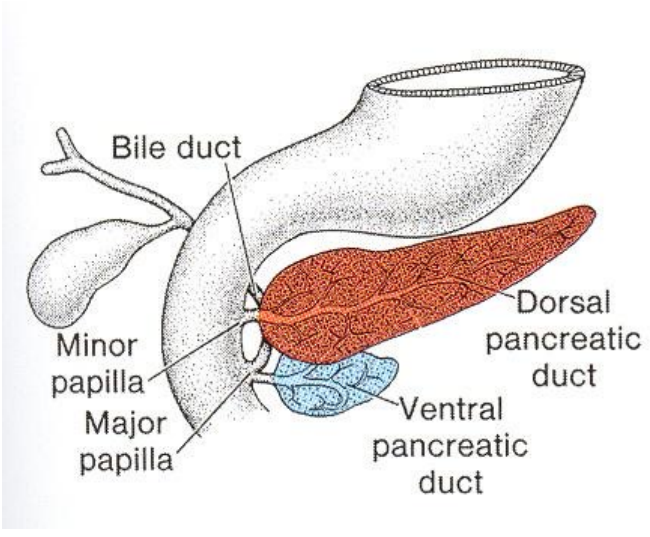
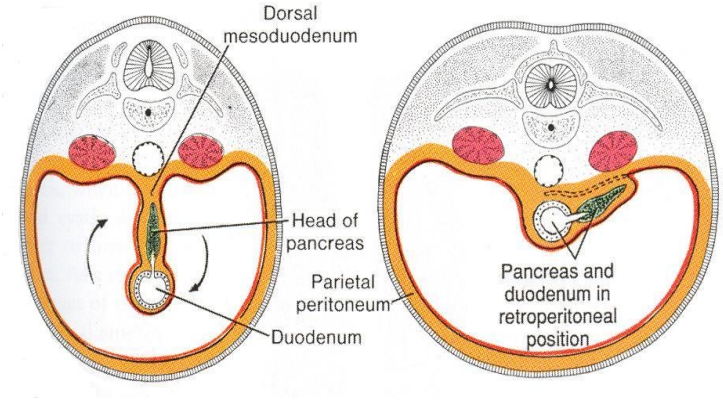
- The duct of **ventral bud** and distal part of the duct of the **dorsal bud** form the **main pancreatic duct** that opens on the major duodenal papilla.
- In ~ 9% of people, the proximal part of the duct of the **dorsal bud** persists as an accessory pancreatic duct that opens separately on minor duodenal papilla.

- Finally pancreas comes to lie horizontally along the posterior abdominal wall in a **retroperitoneal position**.



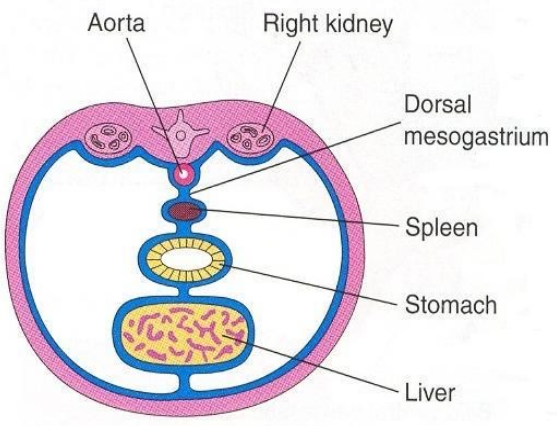


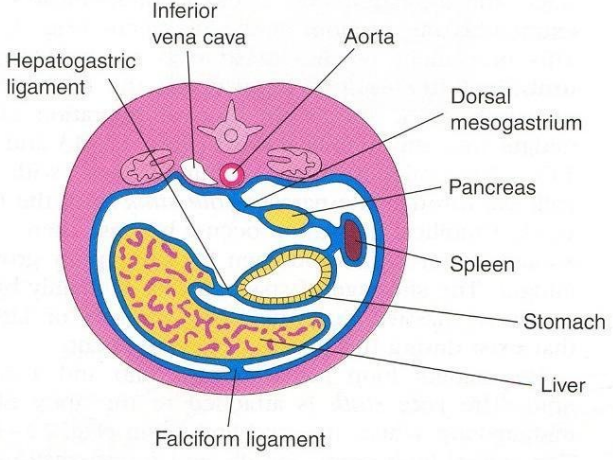
Histogenesis of Pancreas

- The parenchyma of pancreas is derived from **endoderm** of pancreatic buds which forms a network of tubules.
- **Acini** begin to develop early in the fetal period from cell clusters around the ends of these tubules.
- Some cells get separated from the tubules and form the **pancreatic islets.**
- The connective tissue sheath and interlobular septae develop from the surrounding **splanchnic mesoderm.**
- Glucagon and somatostatin secreting cells differentiate before the insulin secreting cells
- Insulin secretion begins by 10 weeks

Development of Spleen

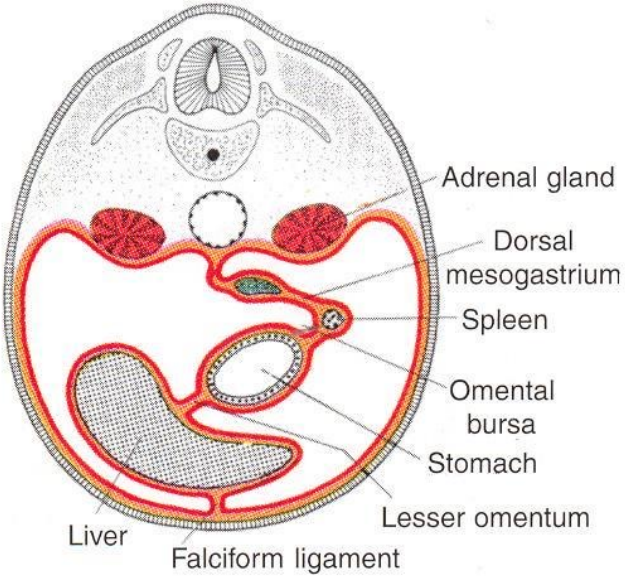
- Spleen develops from the mesenchyme within the dorsal mesogastrium
- Begins to develop in 5th week and attains its shape early in fetal life
- Is lobulated initially but lobules normally disappear before birth
- Spleen functions as a hematopoietic organ until late fetal life, but retains its potential for blood cell formation even in adult life.





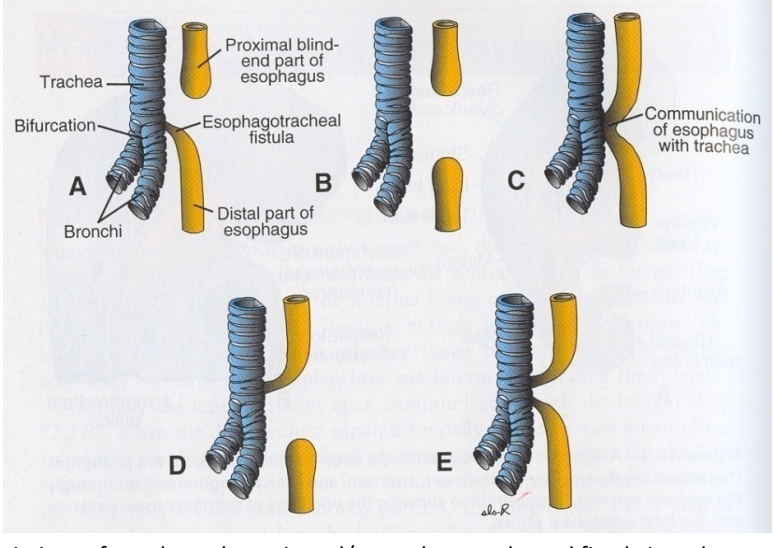
Derivatives of Mesenteries of the Foregut

- **Dorsal Mesoesophagus**: Crura of the diaphragm
- **Ventral Mesoesophagus:** disappears completely.
- **Dorsal Mesogastrium:**
  - Lienorenal ligament
  - Gastrosplenic ligament
- **Ventral Mesogastrium:**
  - Lesser omentum
  - Visceral peritoneum of the liver
  - Falciform ligament of the liver
- **Dorsal mesentery of the duodenum**: persists in the proximal part (one inch) as hepatoduodenal ligament
- **Ventral mesentery of the duodenum:** disappears almost completely

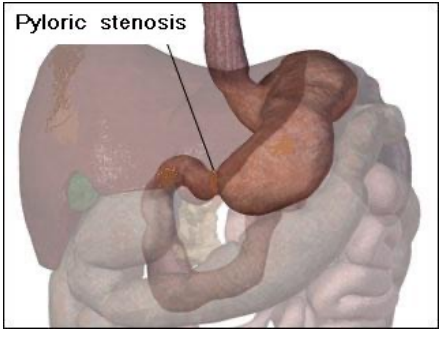


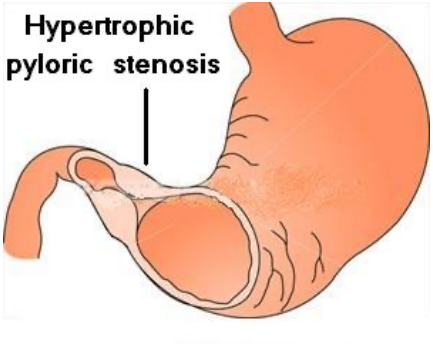
Anomalies Related to the Development of the Foregut

- **Tracheo-esophageal fistula**
- **Esophageal atresia**.
- **Esophageal stenosis** usually involves the distal segment.
- **Short esophagus:** may give rise to hiatus hernia
- **Congenital hypertrophic pyloric stenosis**
- Variations in the shape of stomach
- **Malrotation of stomach**



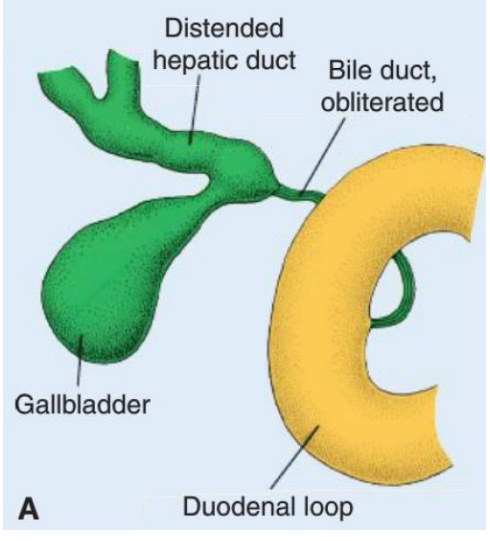
Variations of esophageal atresia and/or tracheoesophageal fistula in order of their frequency of appearance: (A) 90%, (B) 4%, (C) 4%, [D] 1%, and (E) 1%.



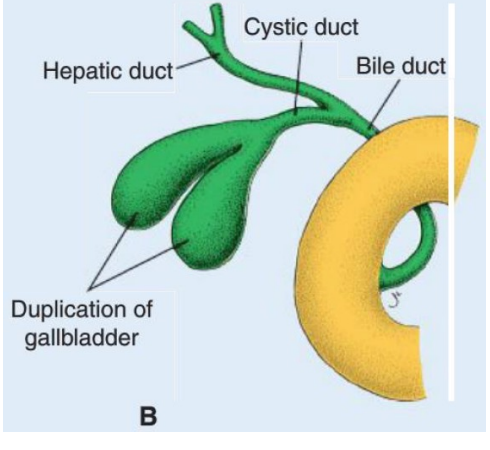


Anomalies Related to the Development of Liver & Gall Bladder

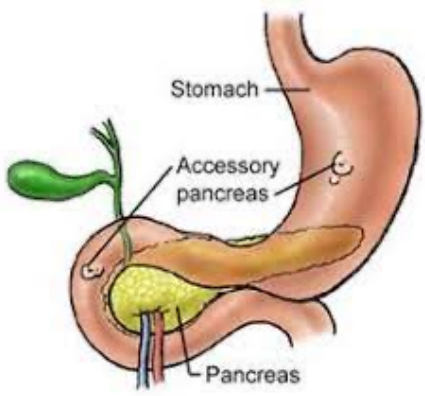
- Anomalies of liver are rare.
- Variations in hepatic ducts, cystic and bile ducts are common and clinically significant.



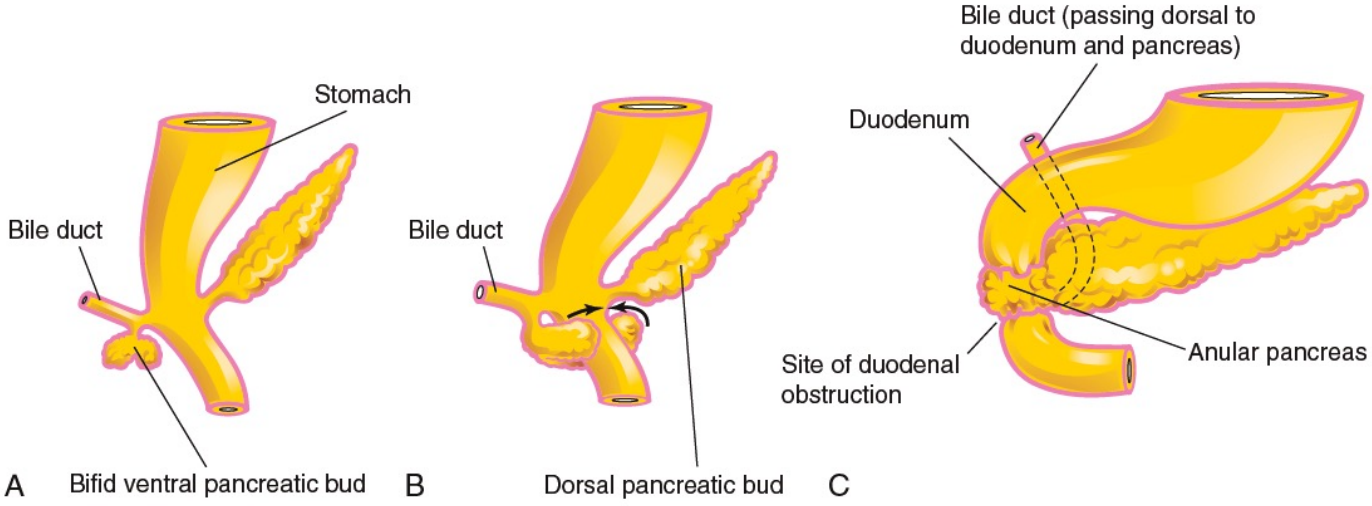
- Extrahepatic biliary atresia is the most common serious anomaly. Jaundice develops soon after birth. If uncorrected surgically leads to death



Anomalies Related to the Development of Pancreas & Spleen



- **Accessory pancreatic tissue**
- **Annular pancreas**
- **Accessory splenic tissue**



A and B, The probable basis of an annular pancreas. C, An annular pancreas encircling the duodenum. This birth defect produces complete obstruction (atresia) or partial obstruction (stenosis) of the duodenum.

Thank You

References

- Before We are Born, Essentials of Embryology and Birth Defects, Keith L. Moore© 2016, Elsevier. Ninth Edition.
- Langman’s Medical Embryology, T.W. Sadler© 2019, Walters Kluwer. Fourteenth Edition.
- Larsen's Human Embryology, Gary C. Schoenwolf © 2015, Elsevier. Fifth Edition.