DEVELOPMENT OF PANCREAS AND SMALL INTESTINE

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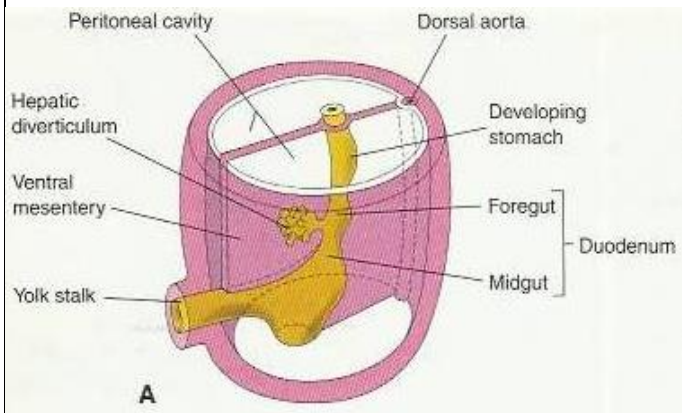
OBJECTIVES

❖ ***At the end of the lecture, the students should be able to :***

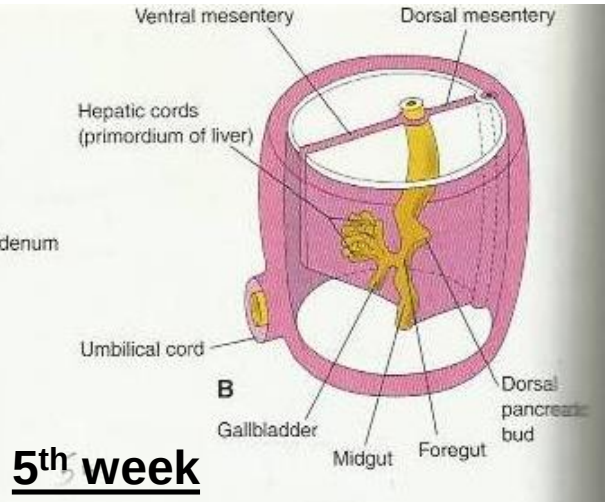
- Describe the development of the duodenum.
- Describe the development of the pancreas.
- Describe the development of the small intestine.
- Identify the congenital anomalies of the duodenum, pancreas, and the small intestine :

DEVELOPMENT OF THE DUODENUM

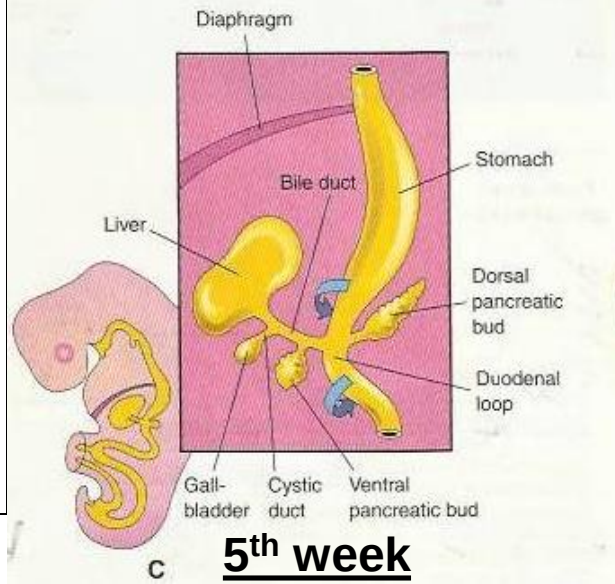
- **Early in the 4th week,the duodenum develops from the endoderm of primordial gut of :**
- Caudal part of foregut.
- Cranial part of midgut & from :
- Splanchnic mesoderm.
- The junction of the 2 parts of the gut lies just below or distal to the origin of bile duct (D).



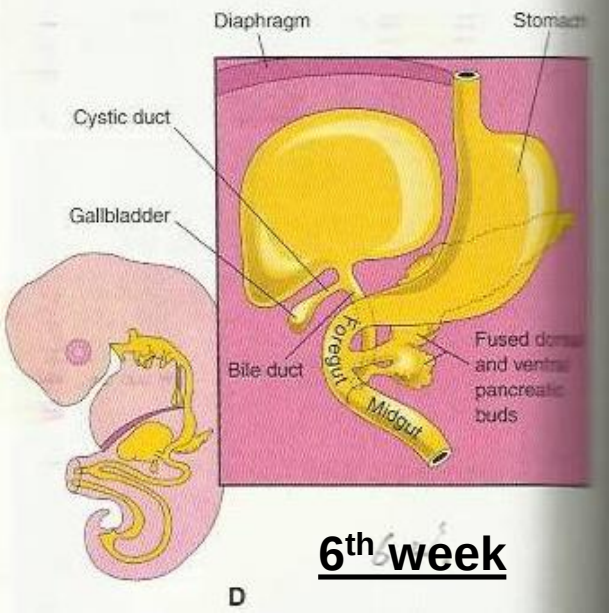
4th week



5th week



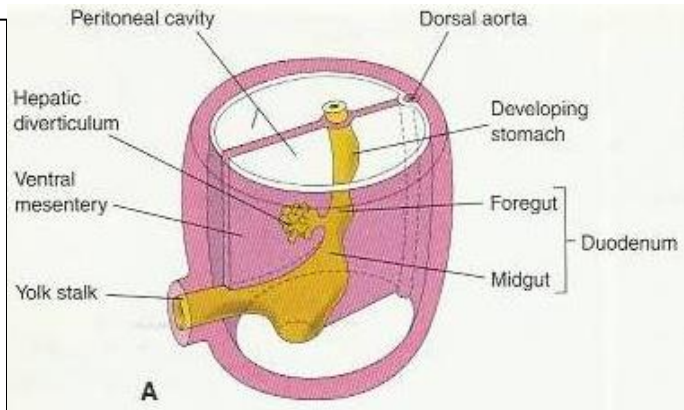
5th week



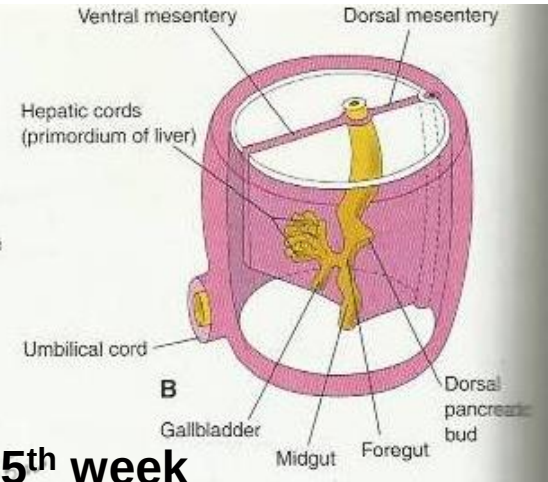
6th week

DEVELOPMENT OF THE DUODENUM

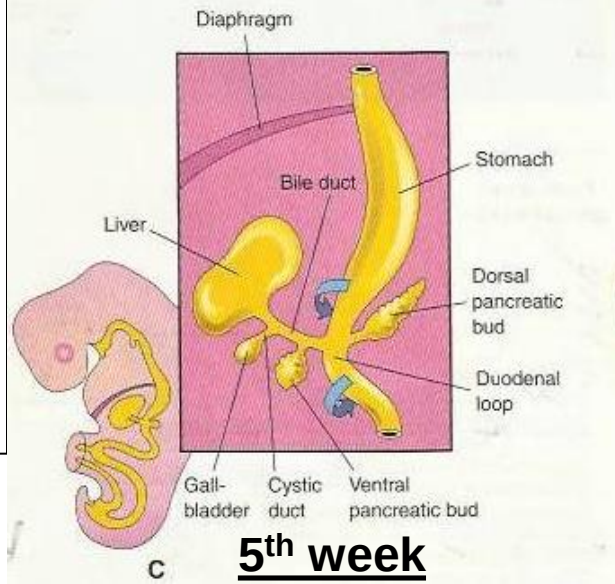
- **The duodenal loop** is formed and projected ventrally, forming **a C-shaped loop.**
- **The duodenal loop** is rotated with the stomach to the right and comes to lie on the posterior abdominal wall retroperitoneally with the developing pancreas.



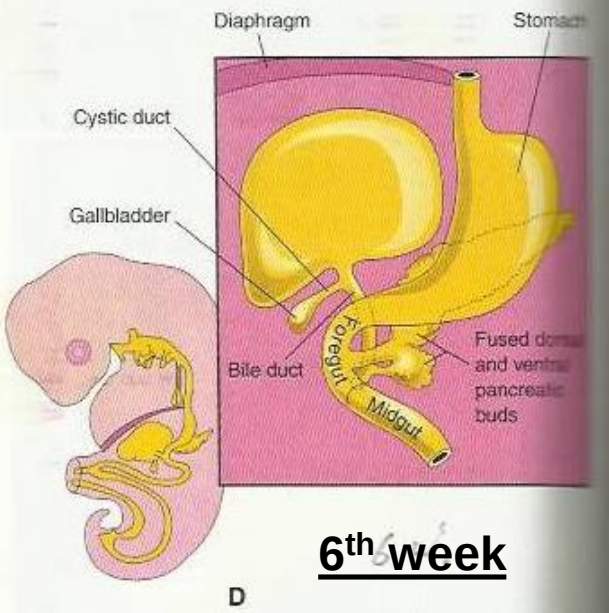
4th week



5th week

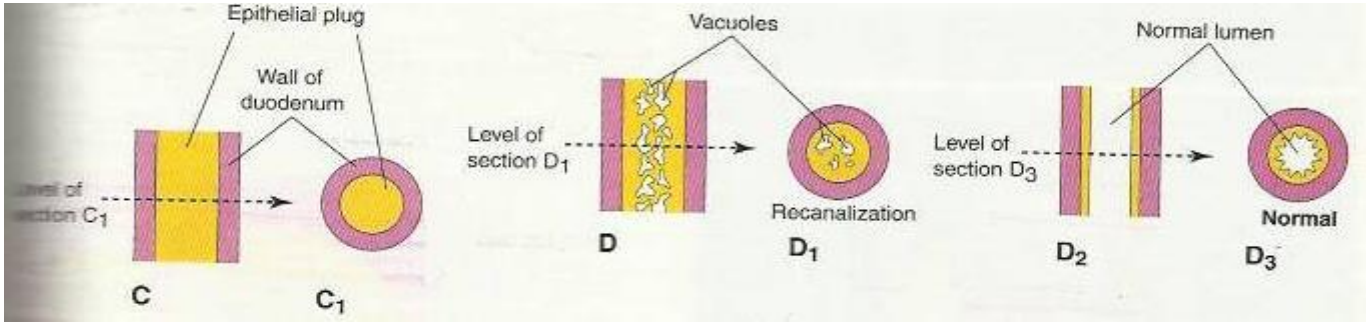


5th week



6th week

DEVELOPMENT OF THE DUODENUM

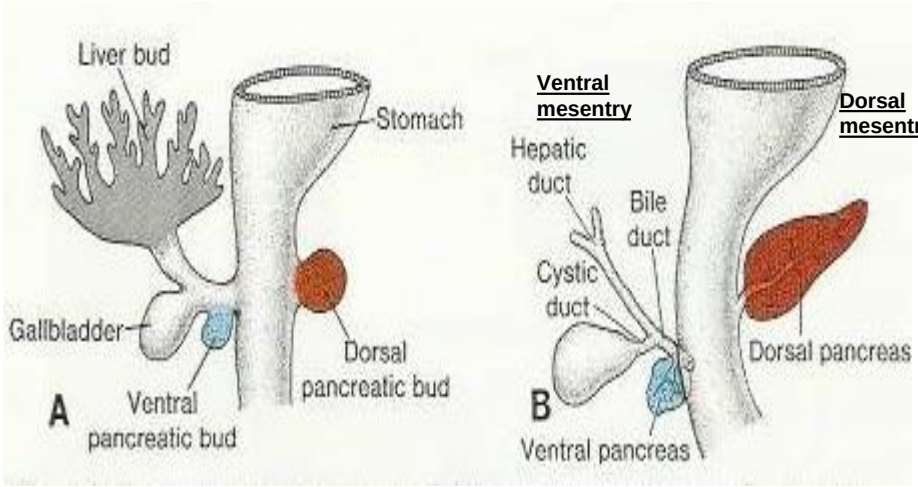


- During 5th & 6th weeks, the lumen of the duodenum is temporarily obliterated because of proliferation of its epithelial cells.
- Normally degeneration of epithelial cells occurs, so the duodenum normally becomes recanalized by the end of the embryonic period.

Congenital anomalies

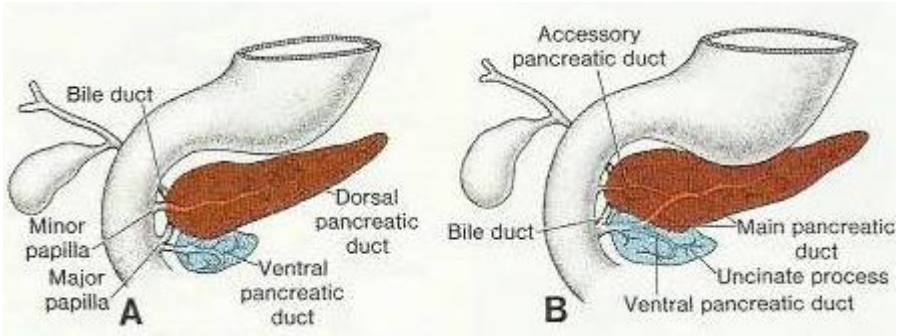
- **Duodenal stenosis;** results from incomplete recanalization of the duodenum.
- **Duodenal atresia;** leads to complete occlusion of the duodenal lumen, due to failure to reformation of the lumen, (autosomal recessive inheritance).

DEVELOPMENT OF PANCREAS



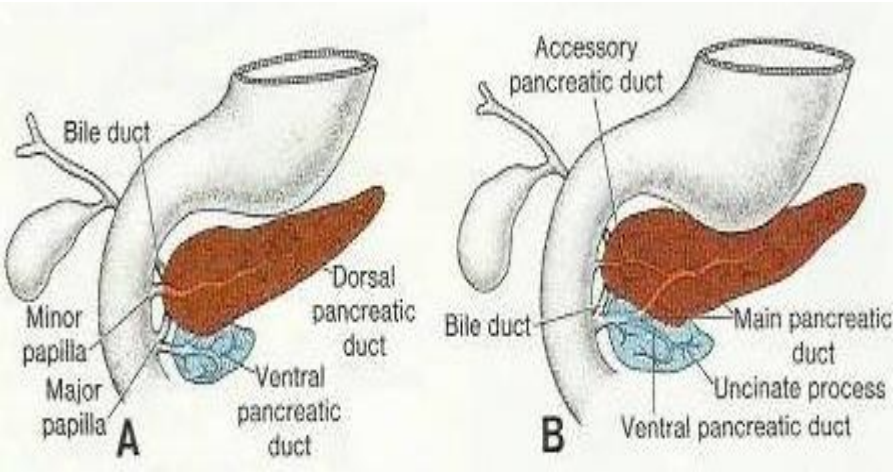
- The pancreas develops from 2 buds arising from the endoderm of the caudal part of foregut :
- **A ventral pancreatic bud ;** which develops from the proximal end of hepatic diverticulum (forms the liver & gall bladder).
- **A dorsal pancreatic bud ;** which develops from dorsal wall of duodenum, slightly cranial to the ventral bud.
- **Most of pancreas** is derived from the dorsal pancreatic bud.

DEVELOPMENT OF PANCREAS



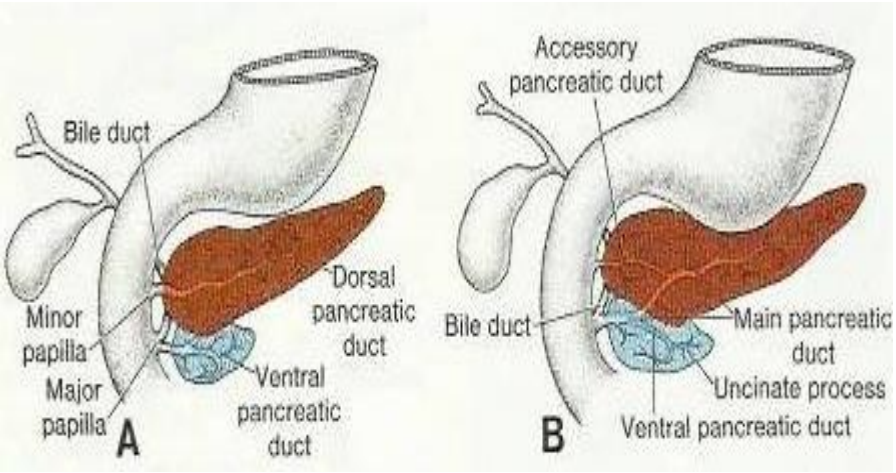
- When the duodenum rotates to the right and becomes C-shaped, the <u>ventral pancreatic bud</u> moves dorsally to lie below and behind the dorsal bud.
- Later the 2 buds fused together and lying in the dorsal mesentery.

DEVELOPMENT OF PANCREAS



- **The ventral bud forms :**
- Uncinate process.
- Inferior part of head of pancreas.
- **The dorsal pancreatic bud forms :**
- Upper part of of head.
- Neck.
- Body &
- Tail of panc

DEVELOPMENT OF PANCREAS



- **The main pancreatic duct is formed from :**
- The duct of the ventral bud.
- The distal part of duct of dorsal bud.
- **The accessory pancreatic duct is derived from :**
- Proximal part of duct of dorsal bud.
- **The parenchyma of pancreas** is derived from the endoderm of pancreatic buds.
- **Pancreatic islets** develops from parenchymatous pancreatic tissue.
- **Insuline secretion** begins at 5th month of pregnancy.

Congenital anomalies

- **Accessory pancreatic tissue**; located in the wall of the stomach, duodenum, or ileal diverticulum.
- **Anular pancreas**; a thin flat band of pancreatic tissue surrounding the second part of the duodenum, causing duodenal obstruction

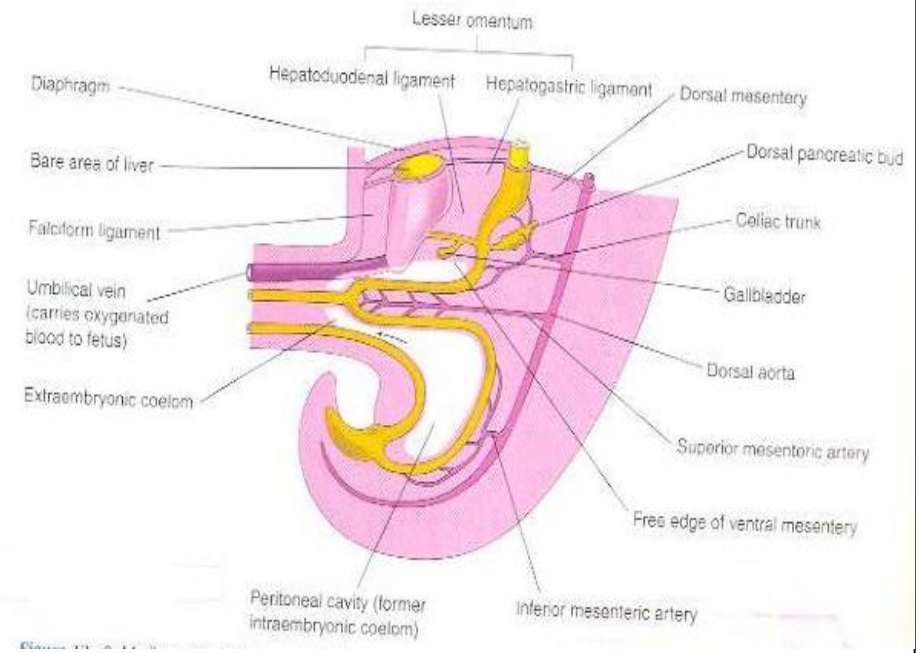
DEVELOPMENT OF SMALL INTESTINE

- **Derivatives of cranial part of the midgut loop :**
- Distal part of the duodenum (proximal part of duodenum is developed from caudal part of foregut).
- Jejunum.
- Upper part of the ileum.
- **Derivatives of the caudal part of midgut loop :**
- Lower portion of ileum.
- Cecum & appendix.
- Ascending colon and proximal 2/3 of transverse colon.
- **So, the small intestine is developed from :**
- **Caudal part of foregut.**
- **All midgut.**
- **Midgut is supplied by** superior mesenteric artery (artery of midgut).

STAGES OF DEVELOPMENT OF SMALL INTESTINE

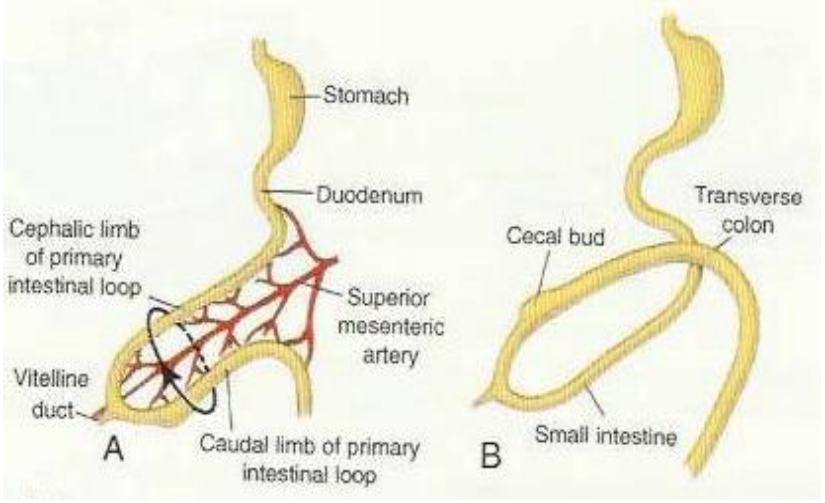
- Preherniation stage.
- Stage of physiological umbilical hernia.
- stage of rotation of midgut loop.
- Stage of reduction of umbilical hernia.
- Stage of fixation of various parts of intestine.

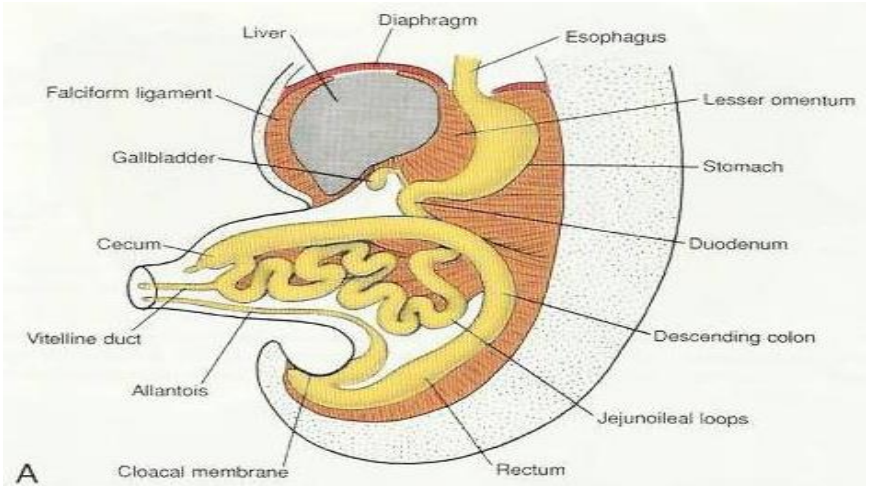
Development of midgut loop



- **At the beginning of 6th week,** the midgut elongates to form a venteral U-shaped **midgut loop.**
- **Midgut loop communicates with the yolk sac by vitelline duct or yolk stalk.**
- **As a result of rapidly growing liver, kidneys & gut** the abdominal cavity is temporarily too small to contain the developing rapidly growing intestinal loop.
- So ,Midgut loop projects into **the umbilical cord** …this is called **physiological umbilical herniation (begins at 6th w.).**

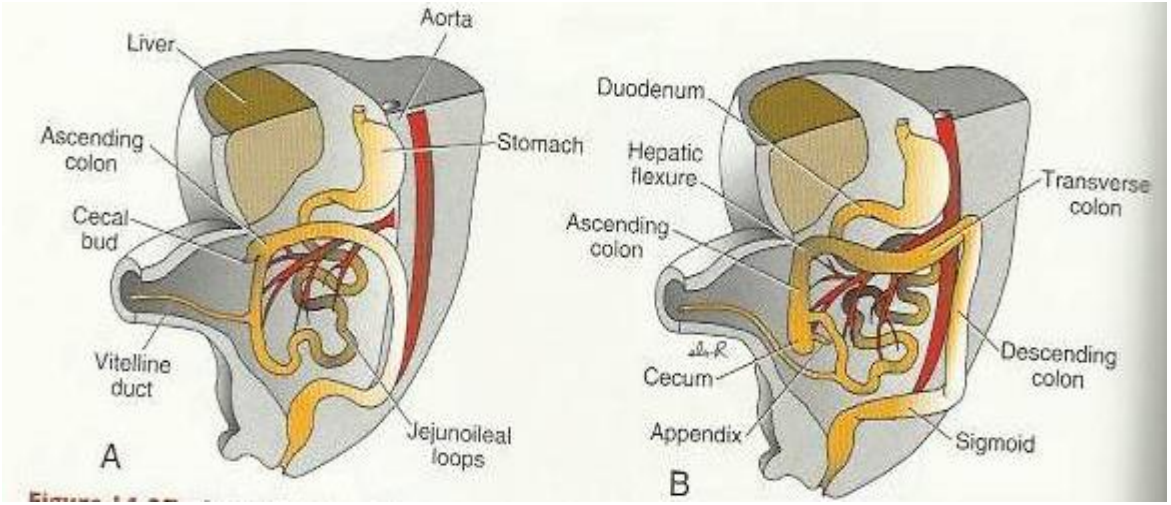
ROTATION OF THE MIDGUT LOOP





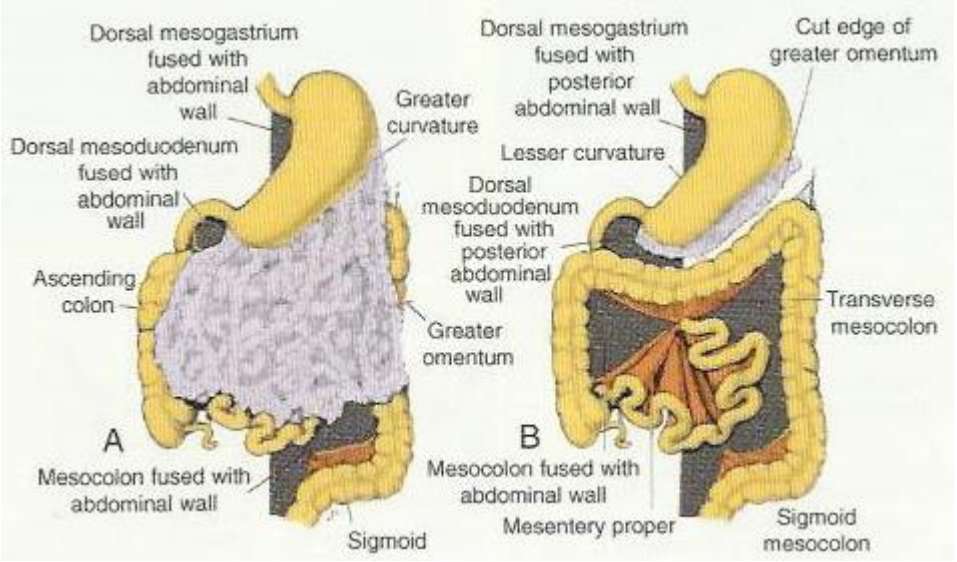
- Midgut loop has a cranial limb & a caudal limb.
- Midgut loop rotates around the axis of the superior mesenteric artery.
- Midgut loop rotates first 90 degrees to bring the cranial limb to the right and caudal limb to left during the physiological hernia.
- The cranial limb of midgut loop elongates to form the intestinal coiled loops (jejunum & ileum).
- This rotation is counterclockwise and it is completed to 270 degrees, so after reduction of physiological hernia it rotates to about 180 degrees.

RETURN OF MIDGUT TO ABDOMEN



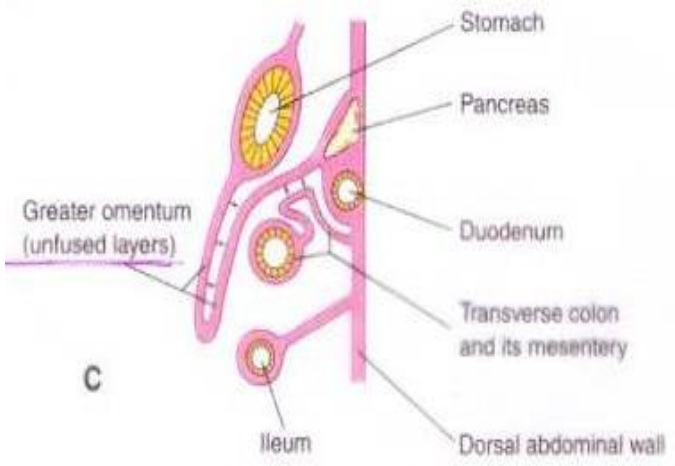
- During 10th week, the intestines return to the abdomen due to regression of liver & kidneys, and expansion of abdominal cavity. It is called **reduction of physiological midgut hernia.**
- Rotation is completed and the coiled intestinal loops lie in their final position in the left side.
- The cecum at first lies below the liver, but later it descends to lie in the right iliac fossa.

FIXATION OF VARIOUS PARTS OF INTESTINE

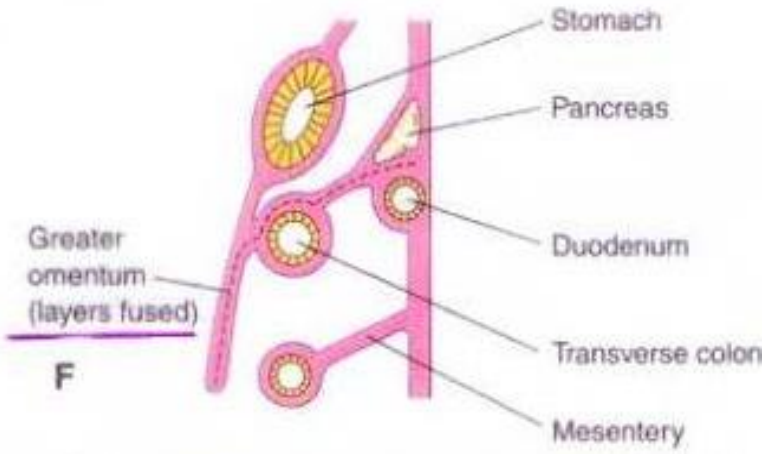


- **The mesentry of jejunoileal loops** is at first continuous with that of the ascending colon.
- When the mesentry of ascending colon fuses with the posterior abdominal wall, **the mesentry of small intestine** becomes fan-shaped and acquires a new line of attachment that passes from duodenojejunal junction to the ileocecal junction.

Fixation of various parts of intestines



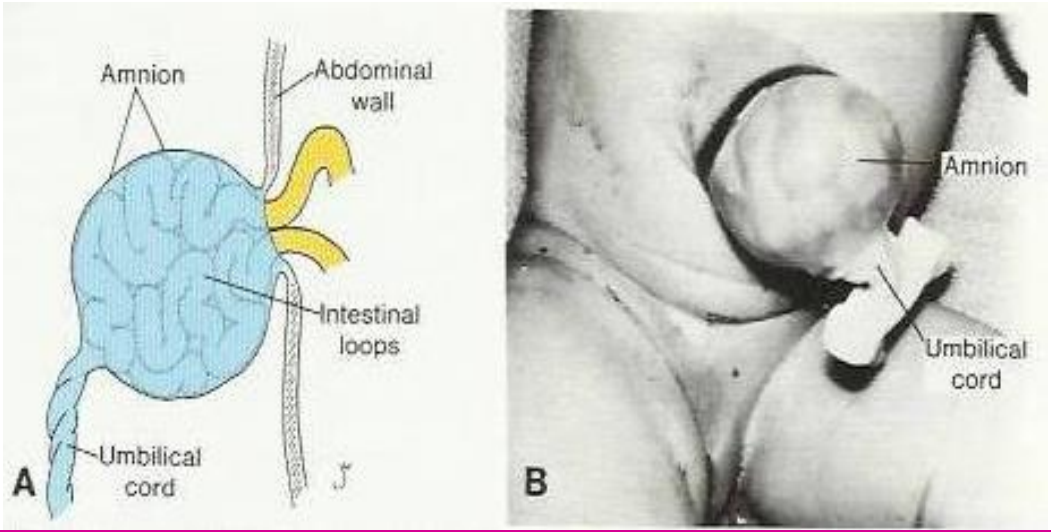
Intestines prior to fixation



Intestines after fixation

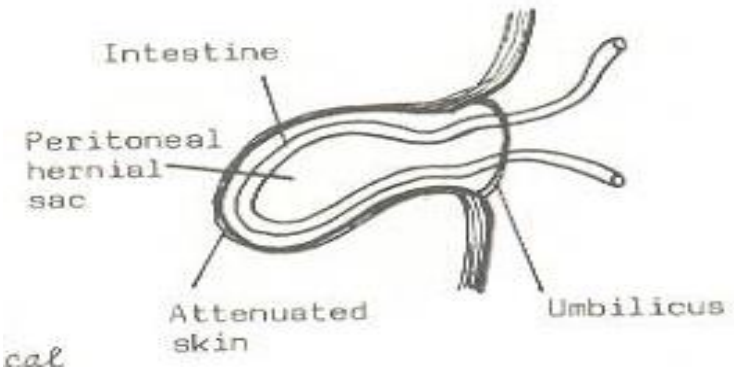
- The enlarged colon presses the duodenum & pancreas against the posterior abdominal wall. **C & F**
- Most of duodenal mesentery is absorbed, so most of duodenum (except for about the first 2.5 cm derived from foregut) & pancreas become retroperitoneal. **C & F**

Congenital Omphalocele



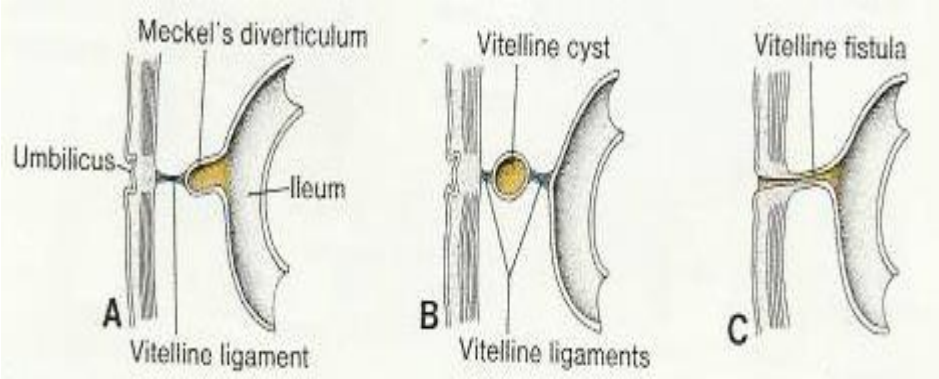
- It is a persistence of herniation of abdominal contents into proximal part of umbilical cord due to failure of reduction of physiological hernia to abdominal cavity at 10th week.
- Herniation of intestines occurs in 1 of 5000 births – herniation of liver & intestines occurs in 1 of 10,000 births.
- It is accompanied by small abdominal cavity.
- The hernial sac is covered by the epithelium of the umbilical cord, the amnion.
- Immediate surgical repair is required.

Umbilical Hernia



- The intestines return to abdominal cavity at 10th week, but herniated through an imperfectly closed umbilicus.
- It is a common type of hernia.
- The herniated contents are usually the greater omentum & small intestine.
- The hernial sac is covered by skin & subcutaneous tissue.
- It protrudes during crying, straining or coughing and can be easily be reduced through the fibrous ring at umbilicus.
- Surgery is performed at age of 3-5 years.

Ileal (Meckel) Diverticulum



- It is one of the most common anomalies of the digestive tract, present in about 2% -4% of people, more common in males.
- It is a small pouch from the ileum, and may contain small patches of gastric & pancreatic tissues causing ulceration, bleeding or even perforation.
- It is the remnant of proximal part **nonobliterated part of yolk stalk** (or vitelline duct).
- **It arises from antimesenteric border** of ileum,1/2 meter from ileocecal junction.
- It sometimes becomes inflamed and causes symptoms that mimic appendicitis.
- It may be connected to the umbilicus by a fibrous cord, and the middle portion forms a cyst or may remain patent forming **the fistula** so, faecal matter is carried through the duct into umbilicus.

SUMMARY

- **The foregut gives rise to** :
- Duodenum (proximal to the opening of the bile duct).
- Pancreas.
- Biliary apparatus.
- **The pancreas develops from :**
- Dorsal & ventral pancreatic buds that form **the endodermal lining of the foregut.**

SUMMARY

- **The midgut gives rise to The small intestine :**
- Duodenum (distal to bile duct).
- Jejunum & ileum.
- **Physiological umbilical hernia :**

  The midgut forms a U-shaped intestinal loop that herniated into the umbilical cord during 6^{th} week.
- **Omphalocele** results from failure of return of the intestine into the abdomen.
- **Ileal diverticula** are common; however, only a few of them become inflamed and produce pain.

THANK YOU