



GIT BLOCK EMBRYOLOGY TEAM



DEVELOPMENT OF PANCREAS AND SMALL INTESTINE

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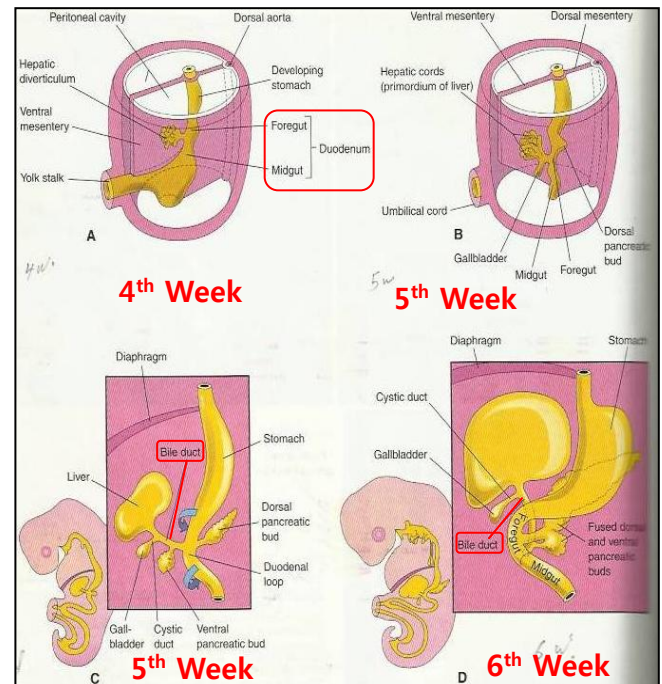
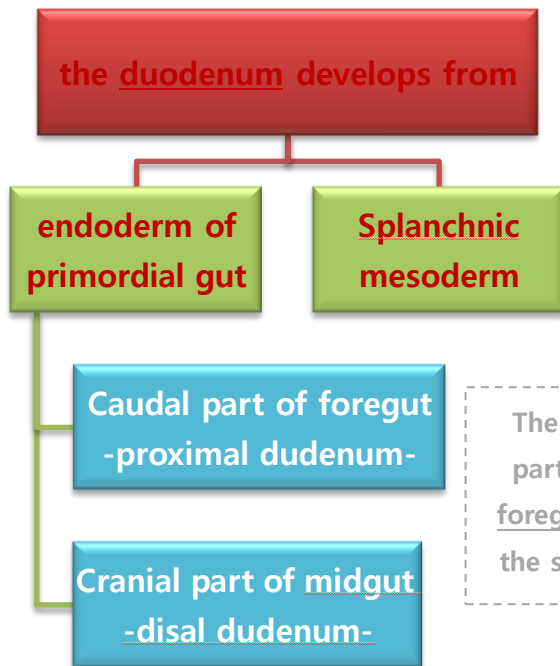
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N.B. Red & Yellow: Important!

1) DEVELOPMENT OF THE DUODENUM

❖ Early in the 4th week



❖ The junction of the 2 parts of the gut lies just below or distal to the origin of bile duct.

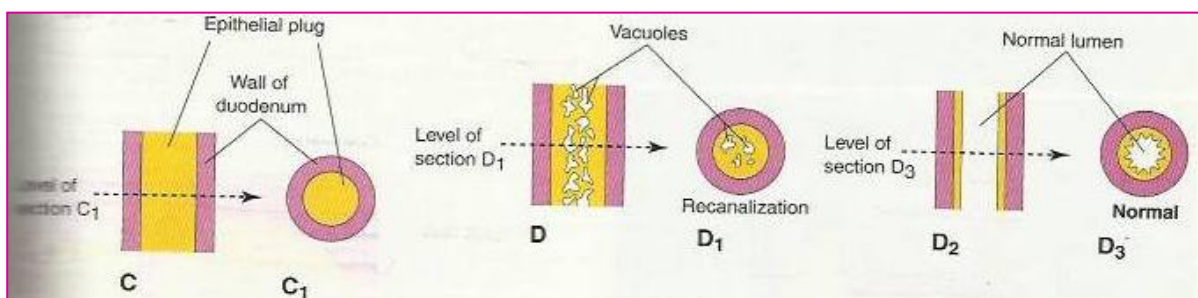
❖ **The duodenal loop is:**

- 1) Formed and projected ventrally, forming a C-shaped loop.
- 2) Rotated with the stomach to the right → comes to lie on the posterior abdominal wall retroperitoneally with the developing pancreas.

❖ **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. (End of 8th week of fertilization)



Embryonic period: period during the first 8 weeks of fertilization (or 10 weeks of gestation)
Fetal period: from the end of the embryonic period → birth

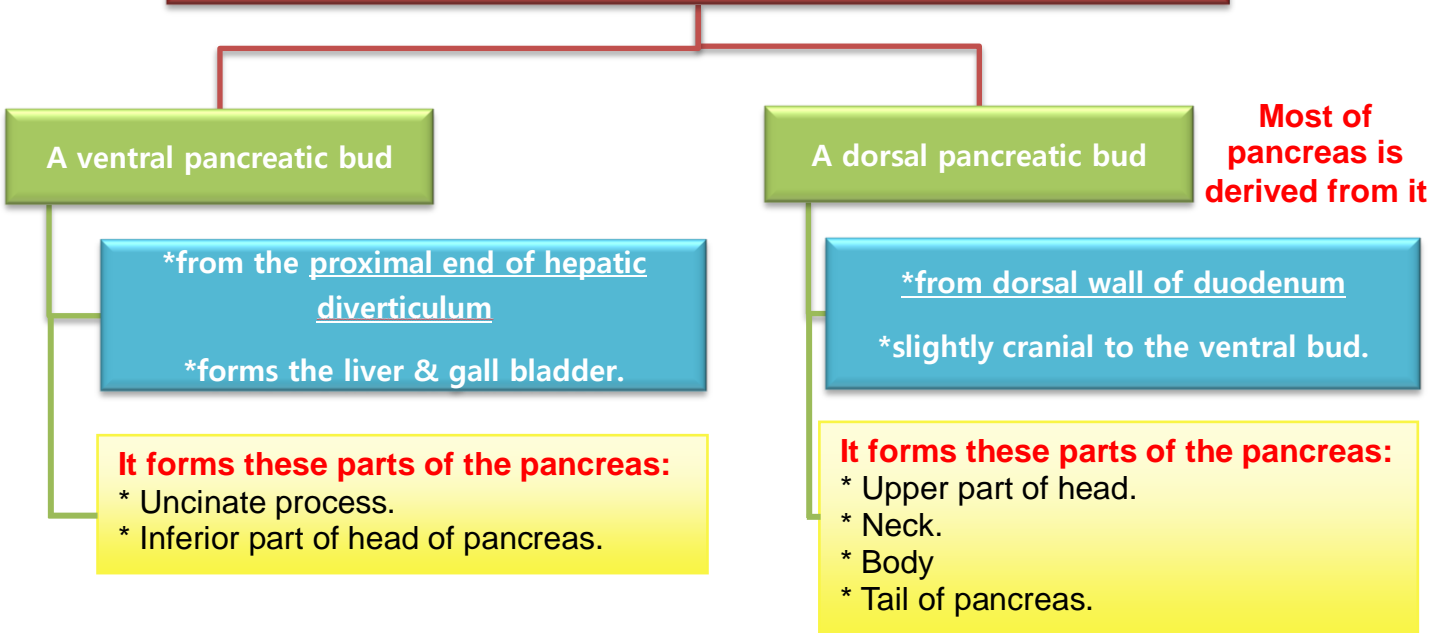
Congenital anomalies of the duodenum

1) Duodenal stenosis	2) Duodenal atresia (autosomal recessive inheritance).
Results from: incomplete recanalization of the duodenum.	Results from: failure of recanalization → occlusion of the duodenal lumen

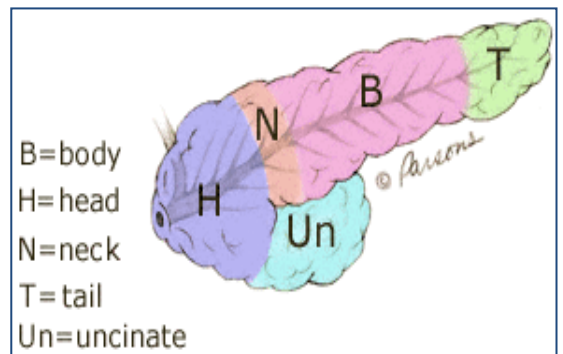
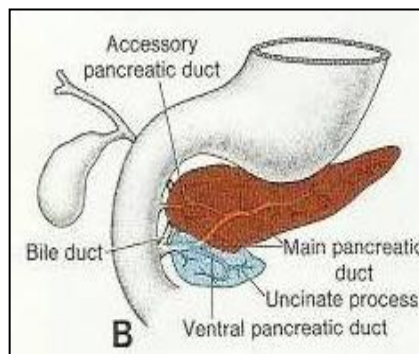
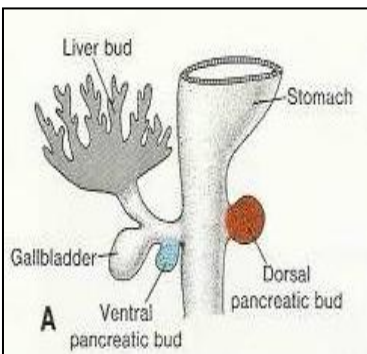


2) DEVELOPMENT OF PANCREAS

2 buds arising from the endoderm of the caudal part of foregut (Pic A)



- When the duodenum rotates to the right and becomes C-shaped → the **ventral pancreatic bud** moves dorsally → lies **below and behind** the dorsal bud. (Pic B)
- Later the 2 buds fuse together → lie in the dorsal mesentery.



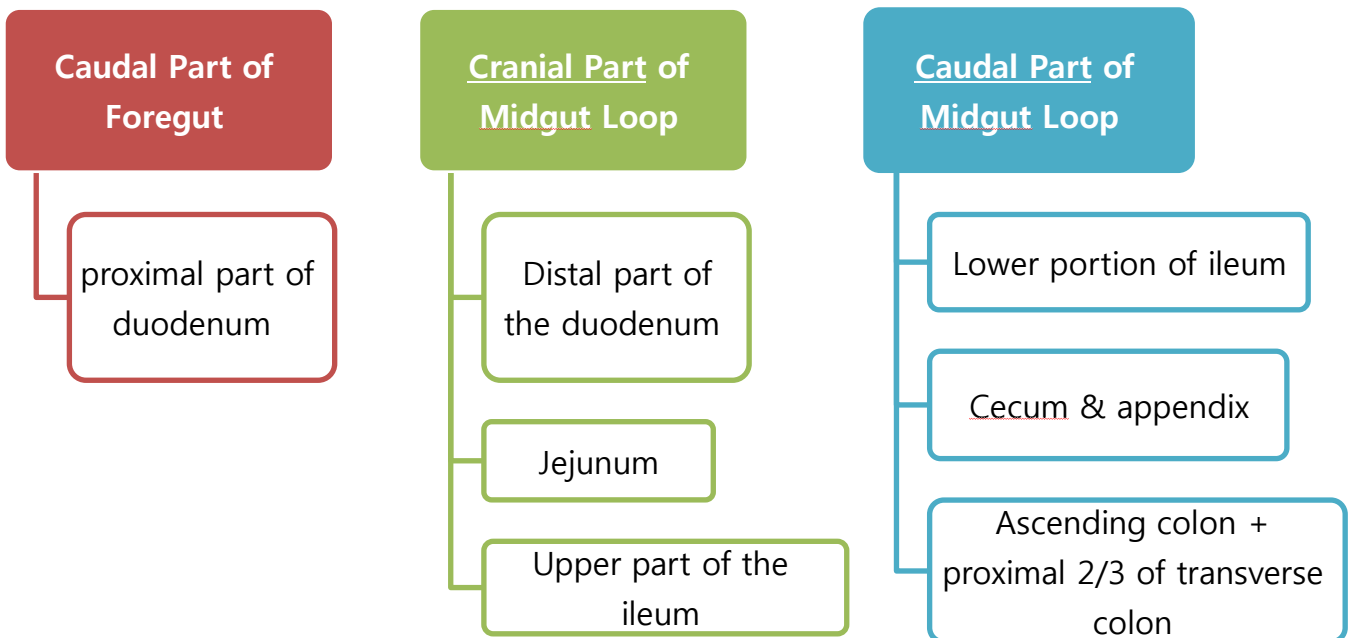
Pancreatic structure	Derived from
The main pancreatic	1) The duct of the ventral bud 2) The distal part of duct of dorsal bud
The accessory pancreatic duct	Proximal part of duct of dorsal bud
The parenchyma of pancreas	The endoderm of pancreatic buds
Pancreatic islets	Parenchymatous pancreatic tissue

❖ Insuline secretion begins at 5th month of pregnancy.

Congenital Anomalies of The Pandreas	
1) Accessory pancreatic tissue	2) Anular pancreas
located in the wall of the stomach <u>or</u> duodenum	A thin flat band of pancreatic tissue surrounding the second part of the duodenum. Causing: duodenal obstruction.



3) DEVELOPMENT OF SMALL INTESTINE



❖ So, the small intestine is developed from :

- 1) Caudal part of foregut.
- 2) All midgut.

N.B. Midgut is supplied by superior mesenteric artery (artery of midgut).

Stages of Development of Small Intestine

- 1 • Preherniation stage.
- 2 • Stage of physiological umbilical hernia
- 3 • Stage of rotation of midgut loop.
- 4 • Stage of reduction of umbilical (physiological midgut) hernia.
- 5 • Stage of fixation of various parts of intestine.

❖ Stage of physiological umbilical hernia (begins at 6th week):

- The Midgut loop communicates with the yolk sac by: vitelline duct or yolk stalk.
- The midgut elongates to form a ventral U-shaped midgut (intestinal) loop.
- 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 (Physiological umbilical herniation).

❖ Stage of 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.
- **Counterclockwise** Rotations:
 - 1) 90° : at stage of physiological hernia
Why? To bring the cranial limb to the right and caudal limb to left.
*The cranial limb of midgut loop elongates to form the **intestinal coiled loops (jejunum & ileum)**.
 - 2) 180° : After reduction of physiological hernia
- So It is completed to **270 degrees** (90 + 180)

❖ Stage of Reduction of Physiological Hernia: (return of midgut to abdomen. 10th week)

- The intestines return to the abdomen due to: regression of liver & kidneys + expansion of abdominal cavity.
- Rotation is completed and the coiled intestinal loops lie in their final position in the left side.
- The caecum at first lies below the liver, but later it descends to lie in the right iliac fossa.

[Video: Rotation of midgut, from our beloved leader, Samiha Aljetaily
http://www.youtube.com/watch?v=AscKR_cQExY]

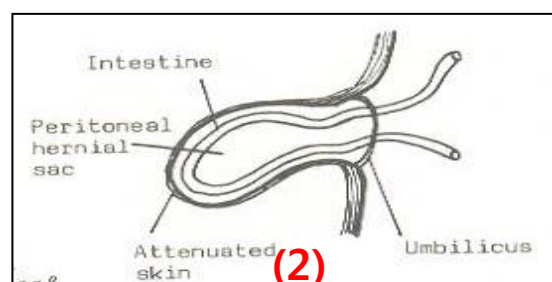
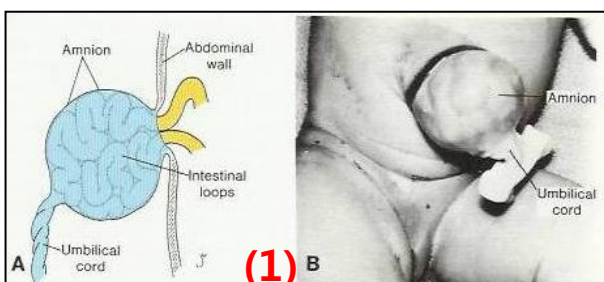
❖ **Stage of Fixation of Various Parts of Intestine**

- The mesentery of jejunioileal loops is at first continuous with that of the ascending colon.
- When the mesentery of ascending colon fuses with the posterior abdominal wall → the mesentery of small intestine becomes fan-shaped and acquires a new line of attachment (that passes from duodenojejunal junction to the ileocecal junction).
- The enlarged colon presses the duodenum & pancreas against the posterior abdominal wall.
- Most of duodenal mesentery is absorbed, so most of duodenum (except for about the first 2.5 cm derived from foregut) & pancreas become retroperitoneal.

Not important

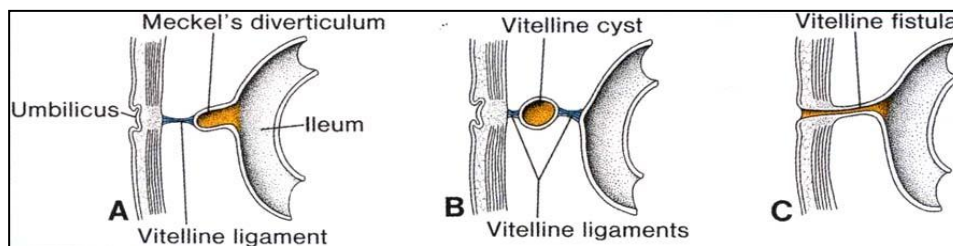
Anomalies of the stages of development of small intestine

	1) Congenital Omphalocele	2) Umbilical Hernia
Cause	Failure of reduction of physiological hernia to abdominal cavity at 10 th Week.	The intestines return to abdominal cavity at 10 th week, but herniated through an imperfectly closed umbilicus
Cover of The hernial sac	Epithelium of the umbilical cord (the amnion)	skin & subcutaneous tissue
Content	*Intestines or *Liver & intestines	Greater omentum & small intestine.
When it appears	At birth	After birth
How common it is	*Herniation of intestines: 1 of 5000 births. *Herniation of liver & intestines: 1 of 10,000 births.	a common type of hernia
surgical repair	Immediate surgical repair is required.	Surgery is performed at age of 3-5 years
Other information	*Persistence of herniation of abdominal contents into proximal part of umbilical cord *Accompanied by small abdominal cavity	*It protrudes during crying, straining or coughing. *Can be easily reduced through fibrous ring at umbilicus.



3) Ileal (Meckel's) 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 (ectopic gastric mucosa)
- It arises from **antimesenteric border of ileum**, 1/2 meter from ileocecal junction.
- It is the remnant of **proximal part nonobliterated part of yolk stalk (or vitelline duct).**
- It Causes: ulceration, bleeding or even perforation (**severe rectal bleeding and fainting attack**).
- Only a few become inflamed and produce pain and symptoms that mimic appendicitis (tenderness in the right iliac region).
- It may be:
 - 1) Connected to the umbilicus by a fibrous cord, and the middle portion forms a cyst.
 - 2) May Remain patent forming the **fistula** so, fecal matter is carried through the duct into umbilicus.
- A child with this condition **should be operated on**, the diverticulum is excised and cut ends of ileum are joined by an end- to- end anastomosis.



Dr. Sanaa's 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 develop from the endodermal lining of the caudal part of foregut.

❖ 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 herniates into the umbilical cord during 6th 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

Time Table

4th Week	Beginning of development of the duodenum
5th Week	Temporarily obliteration of the lumen of the duodenum
6th Week	* Temporarily obliteration of the lumen of the duodenum * Stage of physiological umbilical hernia
End of Embryonic Period	Recanalization of the duodenum
10th Week	Stage of Reduction of Physiological Hernia
5th Month	Insulin secretion begins



N.B Questions about anomalies of small intestine may come as scenarios

E.G. 1) A mother brings in her 8-month-old baby to the pediatrician because he has a small sac protruding from his umbilicus. The mother said he has always been healthy. She noticed the hernia a few hours ago while he was crying loudly.

* What is the cover of the baby's hernial sac?

Skin & subcutaneous tissue.

Dr. Sanaa's Questions:

1. Which part of the pancreas does the ventral pancreatic bud form?

- A) Upper part of the head.
- B) Lower part of the head.
- C) Body.
- D) Tail.

2. Which artery does the midgut loop rotate around its axis?

- A) Splenic artery.
- B) Inferior mesenteric artery.
- C) Superior mesenteric artery.
- D) Celiac trunk.

3. Which structure does the cranial limb of midgut loop form?

- A) The liver.
- B) The pancreas.
- C) The duodenum.
- D) The jejunum & ilium.

4. The umbilical hernia is:

- A) Uncommon type.
- B) Resulting from imperfect closed umbilicus.
- C) Covered by the epithelium of umbilical cord.
- D) Not easily reduced at the umbilicus.

5. The congenital omphalocele is:

- A) A small pouch from the ileum.
- B) Covered by the epithelium of the umbilical cord.
- C) An abdominal wall defect.
- D) Covered by skin.

6. The Meckel's diverticulum :

- A) Is a duodenal pouch.
- B) Arises from the mesenteric border of the ileum.
- C) Is a remnant of the proximal nonobliterated part of yolk stalk.
- D) Is a physiological hernia of intestine.

Answers:

- 1) B
- 2) C
- 3) D
- 4) B
- 5) B
- 6) C



Best of Luck!