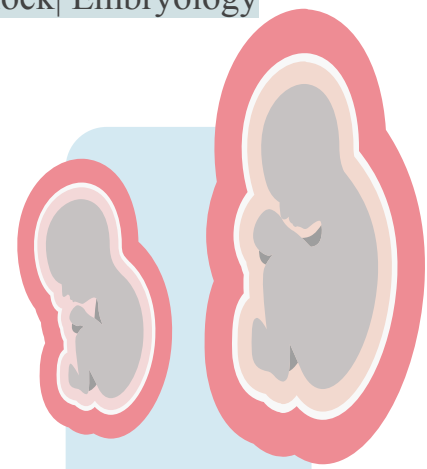
Development of the Pancreas and Small Intestines

Gastrointestinal & Nutrition Block| Embryology



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Objectives :

- 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

Content:

- The development of the duodenum.
- The development of the pancreas.
- The development of the small intestine
- The congenital anomalies of the duodenum, pancreas, and the small intestine

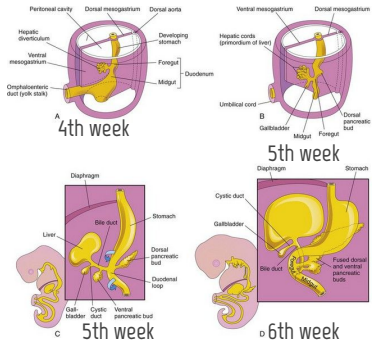
Development of duodenum

Early in week 4, Duodenum develops from;

1- The **Endoderm** of Primordial Gut of:
A. Caudal part of **foregut**.
B. Cranial part of **midgut**.

2- Splanchnic Mesoderm.

The duodenal loop is formed and projected ventrally, forming a **C-shaped loop (C)**.



The **junction** of the 2 parts of the gut lies just below or distal to the origin of bile duct (C &D).

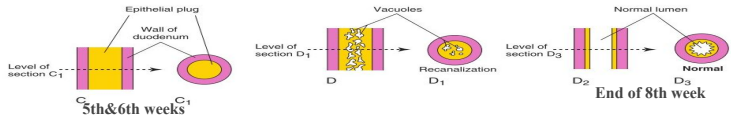
The duodenal loop is rotated (Clockwise) with the stomach to the right and comes to lie on the **posterior abdominal wall** retroperitoneally with the developing Pancreas

During weeks 5th & 6th

the lumen of the duodenum is temporarily obliterated because of proliferation of its **epithelial cells**.

End of week 8th

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

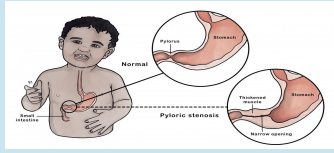


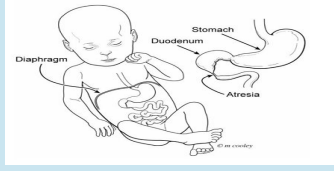
Dr's Note:
Embryonic period : starts after fertilization until the end of week 8
Fetal period: starts from week 9 until labor

Congenital anomalies of the duodenum

Duodenal stenosis: results from **incomplete** recanalization of duodenum.

Duodenal atresia: results from **failure** of recanalization leading to <u>complete occlusion</u> of the duodenal lumen, (autosomal recessive inheritance).



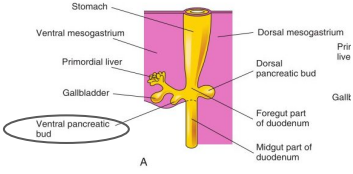


Development of the pancreas

The pancreas develops from **2 buds** arising from the endoderm of the **<u>caudal</u>** <u>part of foregut</u>:

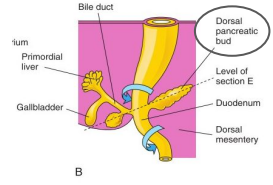
1

A Ventral Pancreatic Bud: which develops from the proximal end of hepatic diverticulum (forms the liver & gallbladder).



2

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 bud because it's larger

Development of the pancreas

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

Dorsal Bud

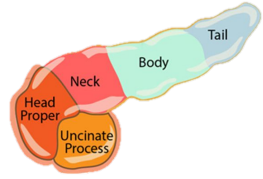
1 → 2 → 3 → 4

1. Upper part of head of pancreas.
2. Neck
3. Body
4. Tail of pancreas

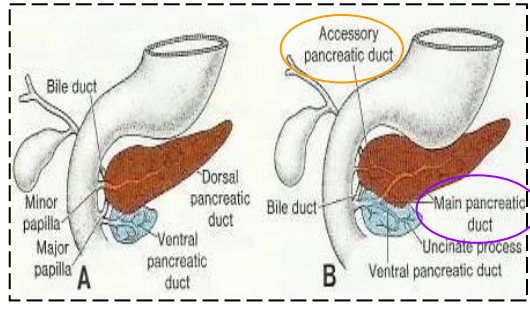
Ventral Bud

1 → 2

1. Uncinate process
2. Inferior part of the head of the pancreas



- **The Main Pancreatic Duct is formed from:**
  - The duct of the **ventral** bud.
  - The <u>distal part</u> of duct of **dorsal** bud.
- **The Accessory Pancreatic Duct is derived from:**
  Proximal part of duct of dorsal bud.

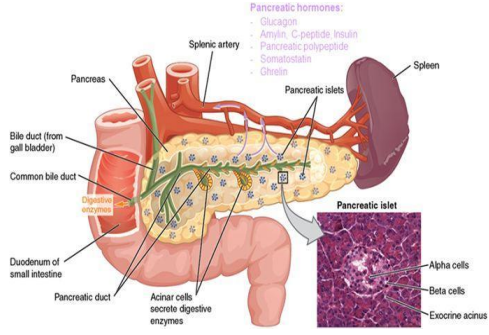


Development of the pancreas

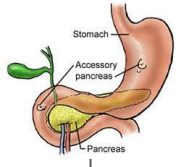
- **The Parenchyma of Pancreas (Acinar Cells)** is derived from the **<u>endoderm</u>** of **pancreatic buds.**

- **Pancreatic islets** develops from **parenchymatous** pancreatic **tissue** to secrete insulin.

- **Insulin secretion** begins during early fetal period (**10 week**) (3 months) very important.
- **Glucagon** is detected at **15 weeks**

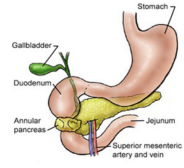


Congenital anomalies of pancreas



Accessory pancreatic tissue

Rare, located in the wall of the stomach or duodenum.



Annular pancreas

a thin flat band of pancreatic tissue surrounding the second part of the duodenum, causing **duodenal obstruction**.

Development of the 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 :

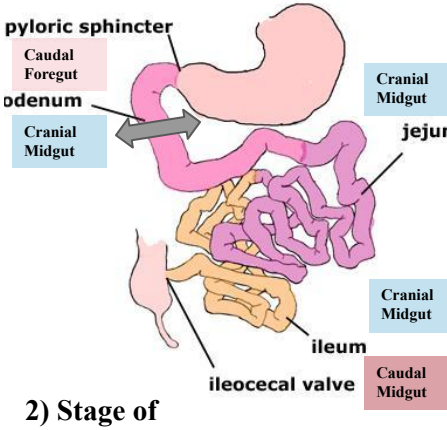
- **Lower portion of Ileum.**
- **Cecum & Appendix.**
- **Ascending Colon + Proximal 2/3 of Transverse Colon.**

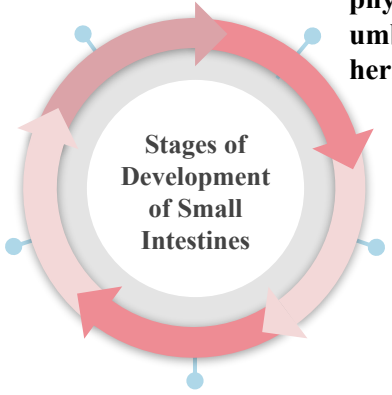
So, the Small Intestine is developed from :

1) **Caudal part of Foregut**

2) **All Midgut** (whether it's cranial or caudal)

- Midgut is supplied by **superior mesenteric Artery** (artery of midgut)





1) **Pre-herniation stage.**

2) **Stage of physiological umbilical hernia.**

3) **Stage of rotation of midgut loop.**

4) **Stage of reduction of umbilical hernia.**

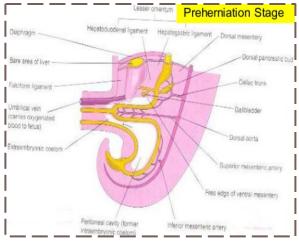
5) **Stage of fixation of various parts of intestine.**

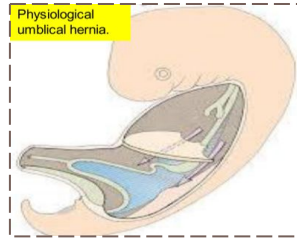
Development of the small intestine

Stage 1 and 2

Development of midgut loop:(Stages of Pre-herniation & Physiological Umbilical Hernia:)

- **At the beginning of 6th week**, the midgut elongates to form a **ventral 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.)**.

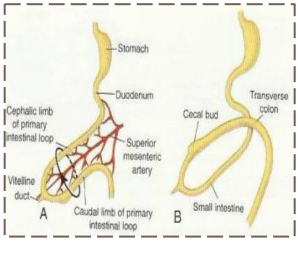


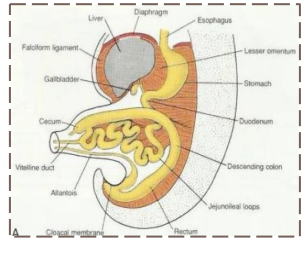


Stage 3

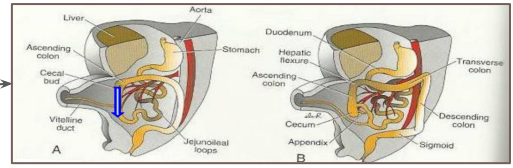
Rotation of the Midgut Loop:

- 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**.





Development of the small intestine



Stage 4

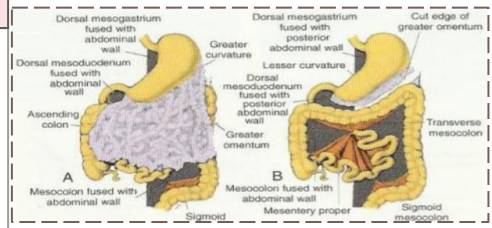
Return of the Midgut to the Abdomen **During Week 10 (Important)**

- **Reduction of the physiological Midgut hernia:** when 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.

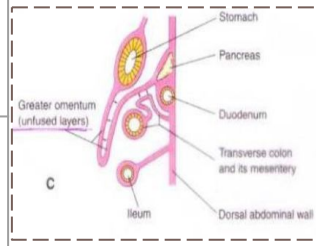
Stage 5

Fixation of Various Parts of Intestines:

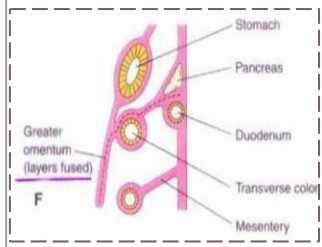
- The Mesentery of Jejunoileal loops is at first continuous with that of the ascending colon.
- When the mesentery of ascending colon fuses with the posterior abdominal wall, **the mesentery of small intestine becomes fan-shaped** and acquires a new line of attachment to posterior abdominal wall that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



- The enlarged colon presses the duodenum & pancreas against the posterior abdominal wall. (pic.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. (pic. C & F)
- The duodenum is the most fixed part of small intestine and has no mesentery, only partially covered by peritoneum (Retroperitonial).



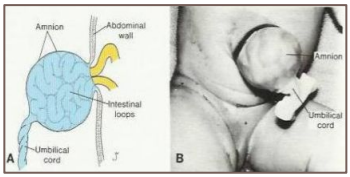
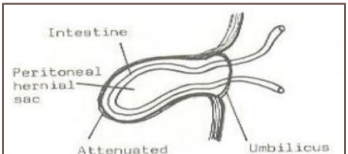
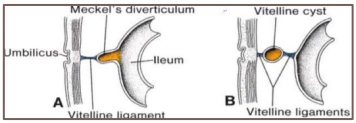
Intestines prior to fixation



Intestines after fixation

Congenital Anomalies

مهمة جدا لا يخلو اختبار واحد منهم : Dr

Congenital Omphalocele	Congenital Umbilical Hernia	Ileal (Meckel's) Diverticulum (Male Dr. focused on this one)
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.**	The intestines **return to abdominal cavity at 10th** week, but herniate through an **imperfectly closed umbilicus.** **It is a common type of hernia.**	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.**
Herniation of **intestines** occurs in 1 of 5000 births – herniation of **liver & intestines** occurs in 1 of 10,000 births.	The herniated contents are usually **the greater omentum & small intestine.**	may contain small patches of **gastric & pancreatic issues causing ulceration, bleeding or even perforation**.
It is accompanied by **small abdominal cavity.** • The hernial sac is covered by the **epithelium of the umbilical cord/or the amnion.** Important • Immediate surgical repair is required.  	The hernial sac is covered by **skin & subcutaneous tissue**. It protrudes during crying, straining or coughing and can be easily reduced through fibrous ring at umbilicus. Important • Surgery is performed at age of **3-5 years**.  	• It is the **remnant of proximal part non-obliterated part of yolk stalk (or vitelline duct).** • It arises from **antimesenteric border of ileum**, 1/2 meter (2 feet) from ileocecal junction. • It is sometimes becomes **inflamed** and causes symptoms that **mimic appendicitis.** • It may be **connected to the umbilicus by a fibrous cord, or the middle portion forms a cyst or may remain patent forming the fistula** so, faecal matter is carried through the duct into umbilicus.  

Summary

From Slides

- The foregut gives rise to:
  A. Duodenum (proximal to the opening of the bile duct).
  B. Pancreas.
  C. 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 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.

- Yolk stalk: A narrow tube present in the early embryo that connects the midgut of the embryo to the yolk sac outside the embryo through the umbilical opening.

- It is usually obliterated, but a remnant of it may persist: most commonly as a finger-like protrusion from the small intestine known as Meckelis diverticulum.

• Ileal diverticula are common; however, only a few of them become inflamed and produce pain.

MCQs

From Slides

1) Which part of the pancreas the ventral pancreatic bud forms ?

Upper part of the head.

B)Lower part of the head.

C) body

D) tail

2)Which artery the midgut loop rotates around its axis ?

A) Splenic artery

B)Inferior mesenteric artery

C)superior mesenteric artery

D) celiac trunk

3) The cranial limb of midgut loop gives rise :

A) the liver

B) the pancreas

C) the stomach

D) the jejunum & ilum

4) The umbilical hernia is:

A) uncommon type

B) Resulting from imperfect closed umbilicus.

C) Covered by the epithelium of umbilical cord

D) Not be 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

MCQs

1) In what direction is the duodenal loop rotated?

A)To the right | B)To the left | C)Upward | D)Downward

2) Most of pancreas is derived from?

A)The ventral pancreatic bud | B)The dorsal pancreatic bud. | C)Accessory pancreatic tissue | D)Pancreatic islets

3) The enlarged …… presses the duodenum & pancreas against the posterior abdominal wall.

A)Stomach | B)Esophagus | C)Colon | D)Tongue

4) The midgut loop communicates with the yolk sac by?

A)Oral cavity | B)Duodenum | C)Pancreas | D)vitelline duct or yolk stalk

5) Ileal (Meckel's) Diverticulum arises from?

A)The dorsal pancreatic bud | B)Ventral pancreatic bud | C)Duodenal atresia | D)Antimesenteric border of ileum

Answers:
1)A
2)B
3)C
4)D
5)D

This Lecture is done by:

 Omar Ayman Banjar

 Lama alsuliman

Team Leaders

- Khalid Alanezi
- Waad Alqahtani