بسم الله الرحمن الرحيم

FINAL | Lecture #3

GI Embryology (Pt.3)

﴿ وَإِن تَتَوَلَّوْا يَسْتَبْدِلْ قَوْمًا غَيْرَكُمْ ثُمَّ لَا يَكُونُوا أَمْثَالَكُم ﴾

اللهم استعملنا ولا تستبدلنا

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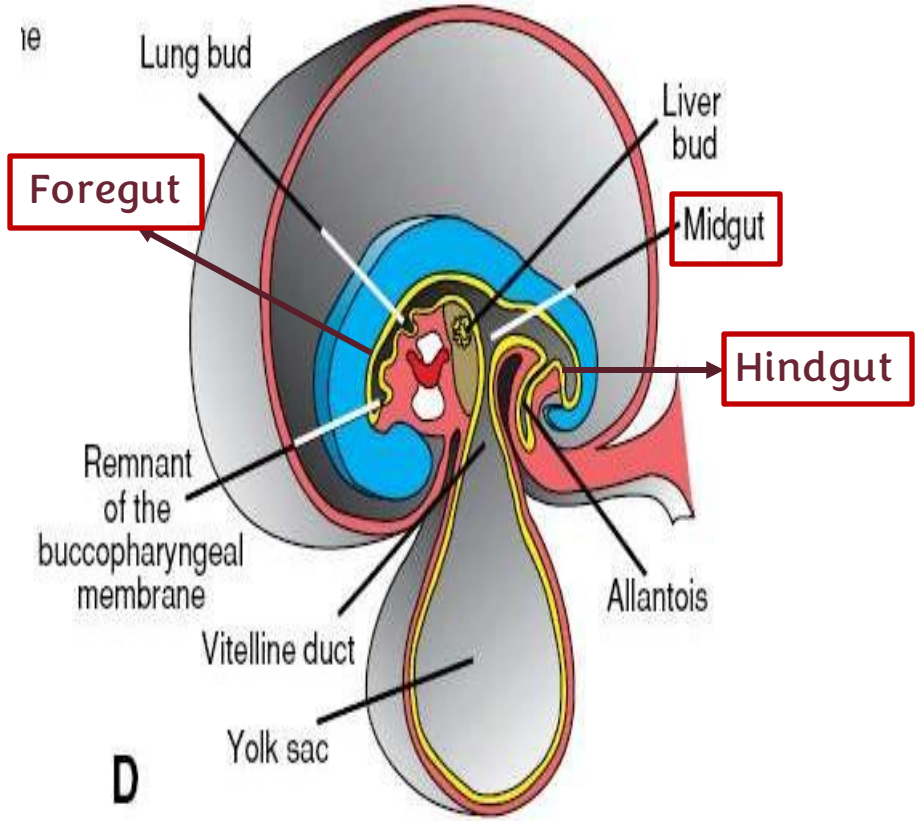
EMBRYOLOGY

GIT Embryology 3

Midgut: slides 3-20
Hindgut: slides 21-28

This file includes everything that was mentioned about midgut and hindgut in the embryo lectures 2+3 ☺

"اللهم افتح عليّ فتوح العارفين، وعلّمني ما ينفعني، وانفعني بما علّمتني، وزدني علماً، واجعلني من عبادك المتقين"

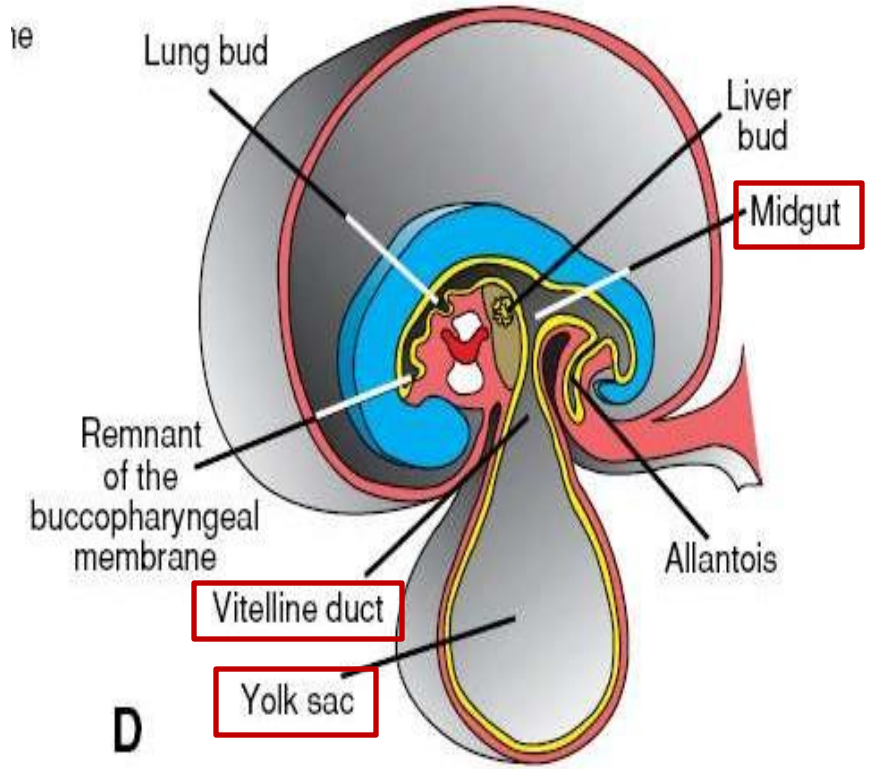


1- Midgut Extension and Blood Supply

- ✓ The midgut starts after the **liver bud** and includes:
  - **Lower half** of the **duodenum**, **jejunum**, **ileum**
  - Parts of the **large intestine** including: **cecum**, **appendix**, **ascending colon** and **proximal (medial) 2/3 of transverse colon.**

- ✓ **The vitelline duct** connects the **yolk sac** with the **midgut** specifically the **ileum** in the embryo.

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

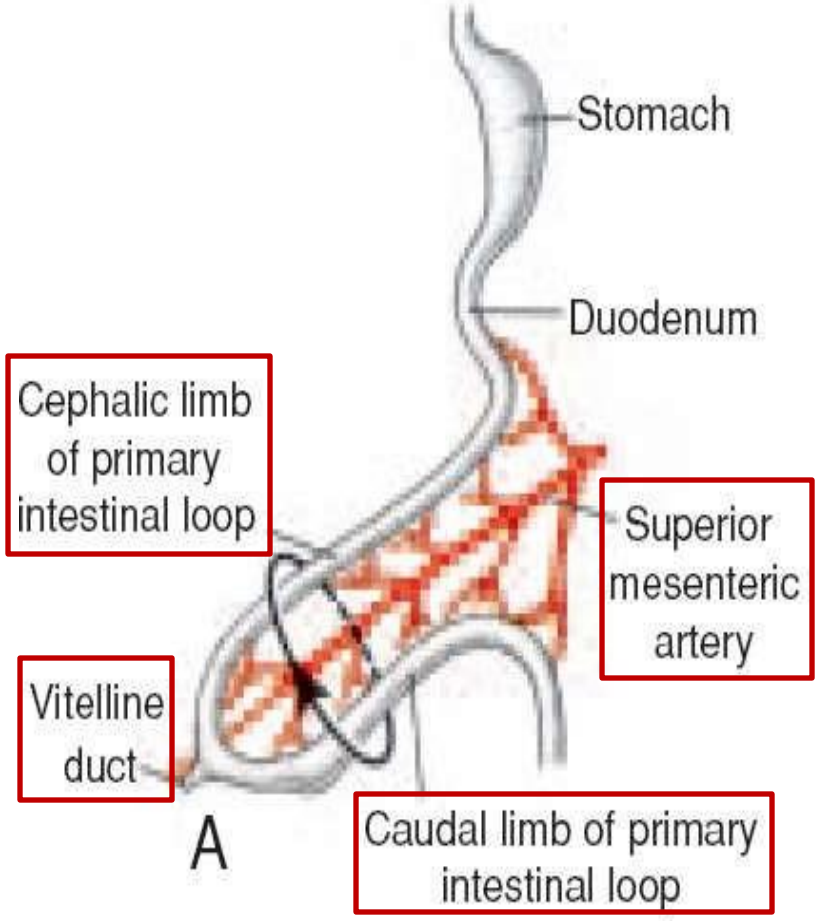


2- Midgut Development Axis

- ✓ Development of the midgut is characterized by **rapid elongation** of the gut and its mesentery, resulting in formation of the **Primary Intestinal Loop**. *Next slide*

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

- ✓ The axis in development is the superior mesenteric artery, we have two parts:
  1-Above the **S.M.A** called: **Cephalic** limb of **primary intestinal loop.**
  2-Below the **S.M.A** called: **Caudal** limb of **primary intestinal loop.**



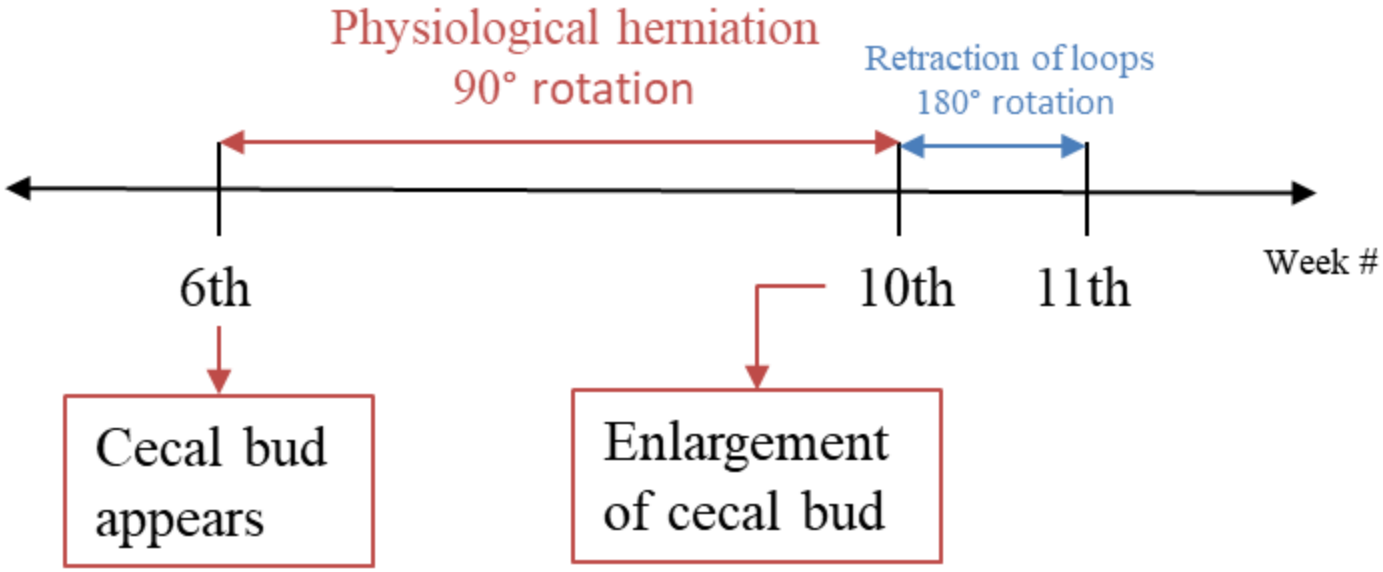
2- Midgut Development Axis

Limb	Develops Into	Growth Rate	Reason
Cephalic limb	- Distal part of the duodenum - Jejunum - Part of the ileum	**Faster** elongation	Becomes the small intestine, which is about 6 meters long
Caudal limb	- Lower portion of the ileum - Cecum - Appendix - Ascending colon - Proximal 2/3 of the transverse colon	**Slower** elongation	Becomes part of the large intestine, which is about 1.5–2.5 meters

3- Development Of Intestinal Loops

✓ The **development** of the **intestinal loop** consists of **two processes:**

A. Physiological herniation
B. Rotation around the intestinal loop



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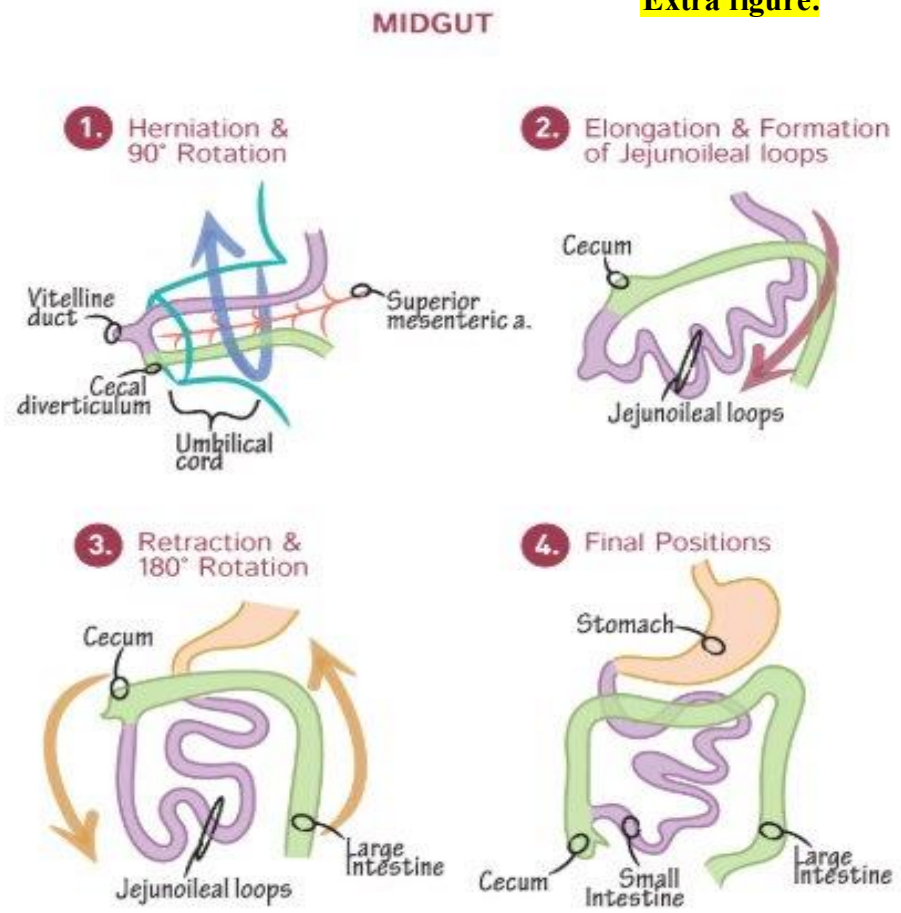


We recommend watching this animation to better imagine the process!

3- Physiological Herniation

- During the **6th week** and **ends** in the **10th week.**

✓ In this process, the intestinal loops, **enter** the extraembryonic cavity in the **umbilical cord** around the superior mesenteric artery and **elongate** there.

✓ This happens due to:

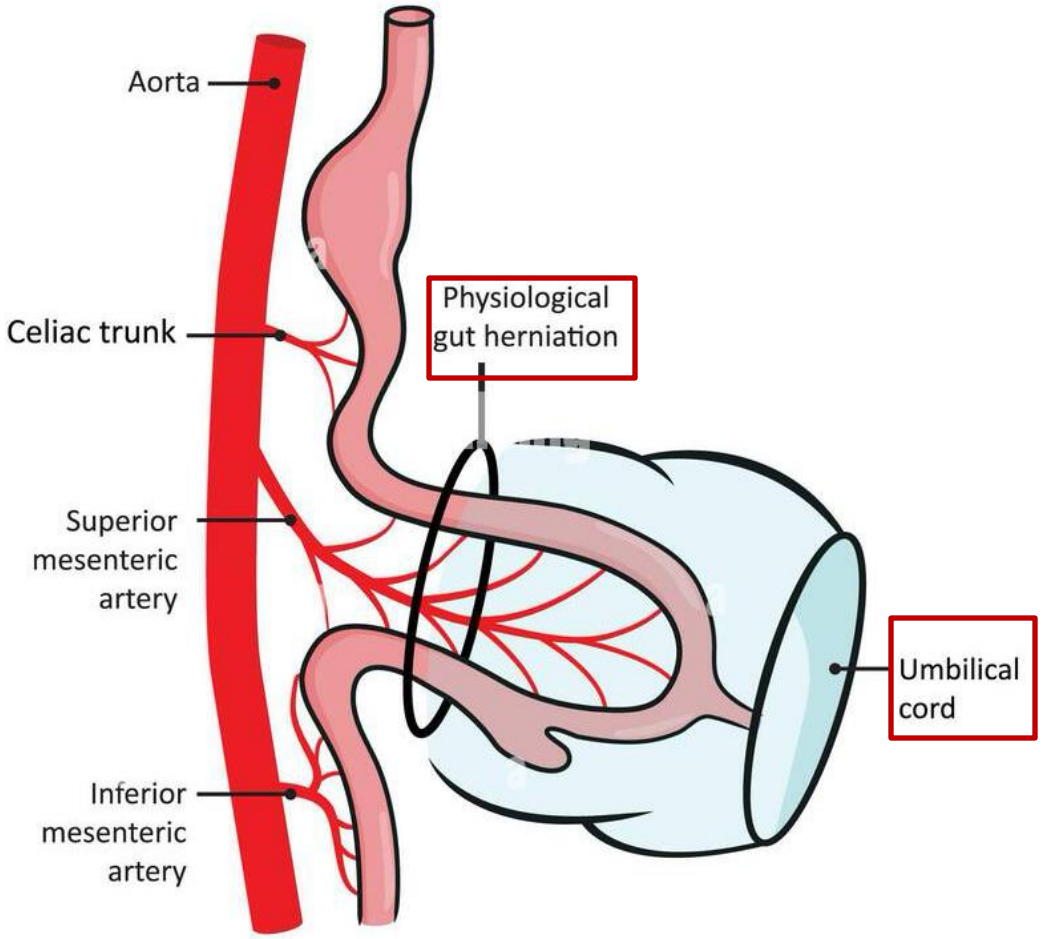
1. The **rapid elongation** of the **proximal** part of the small intestine (particularly the **cephalic** limb).
2. The **engorgement** of the **abdominal cavity** due to:

- The **expansion** of the **liver**.
- The **descent** of the **diaphragm**.

→ As a result, the **abdominal cavity** temporarily becomes too **small** to contain all the intestinal loops, and **they enter the umbilical cord.**

3- Physiological Herniation

Extra figure:



- ✓ By the **10th week**, the **midgut** returns to the abdominal cavity, which has now **enlarged** enough to accommodate **it.**

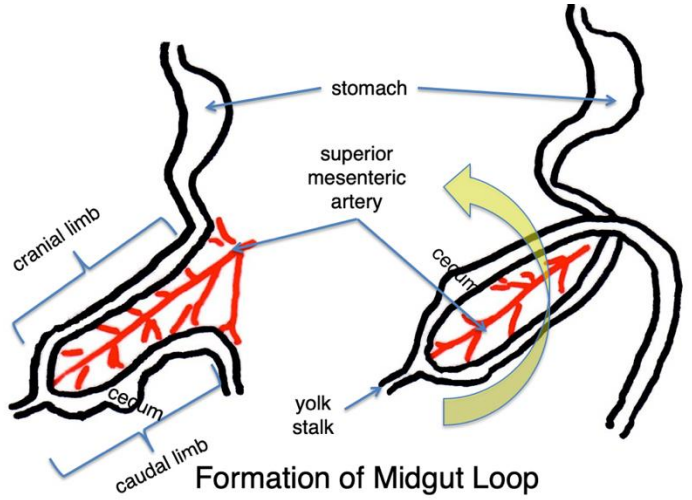
3. Rotation Of The Midgut

- 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, and it's divided into:
  - Rotation during **herniation** (about 90◦)
  - Rotation during **return of the intestinal loops into the abdominal cavity** (remaining 180◦), which happens in *the **end** of the **10th week** beginning of **11th week***

We'll double-check this sentence with the doctor

Extra figure:



Formation of Midgut Loop

✓ The differences between **stomach** and **midgut**:

- Stomach:90° clockwise
- Midgut:270° counterclockwise

4- Retraction of Herniated Loops

- ✓ During the **10th week**, herniated intestinal loops begin to **return** to the **abdominal cavity,** due to:

1. **Regression** of the **mesonephric kidney.**
2. **Reduced upward** growth of the **liver**.
3. **Expansion** of the **abdominal cavity**.

➢ Order and Direction of Return:

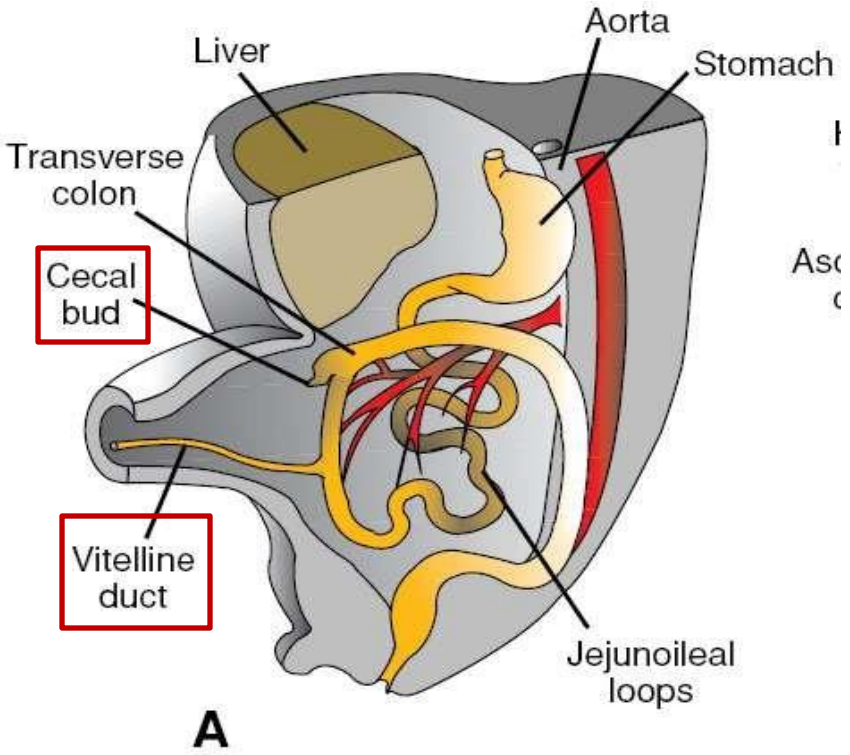
- ✓ **The first part** to re-enter the abdominal cavity is the **proximal** portion of the **jejunum**, , which goes **upwards** and **left** to the **upper left quadrant** and the **ileum** goes to the **lower part** of the **abdomen**.
- ✓ The later returning loops gradually settle more and more to the right.
- ✓ **The last part** to return is the **cecum** and **appendix** (**as the cecal bud**) in **right upper quadrant below liver.**

5- Cecal Bud

- ✓ **The cecal bud** appears at the **6th week**, and at the **10th week** it **enlarges** and forms:
  - **The cecum**
  - **Appendicular diverticulum** → from it forms the **appendicular bud** →eventually forming the **appendix**
  - On the **left side** it forms **transverse colon**

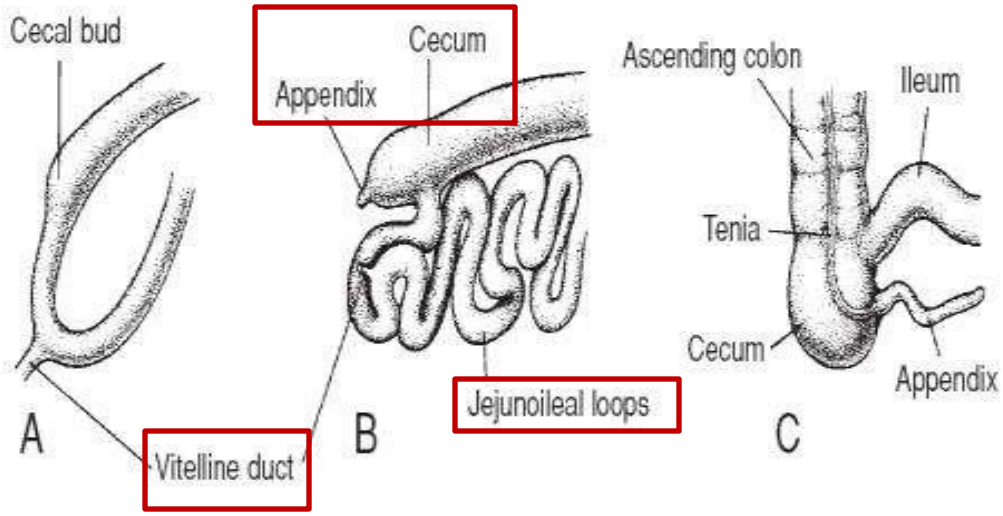
Note: We have asked the doctor regarding the last point, and he emphasized that the transverse colon develops from the cecal bud. The elongation of the cecal bud extends in 2 directions: to the left to form the transverse colon, and downwards to form the ascending colon and appendix. However, most external resources didn't mention that the transverse colon develops from the cecal bud.

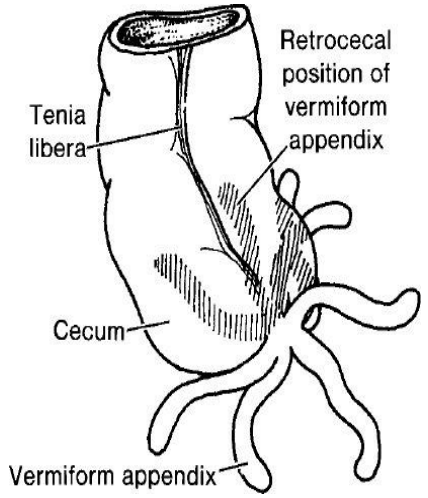
- ✓ Temporarily it lies in the **right upper quadrant** directly **below** the **right lobe of the liver.**



5- Cecal Bud

- ✓ 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** on the **right side.**
- ✓ These positions of the appendix are called **retrocecal (common position) or retrocolic, respectively**





6- Mesenteries of Intestinal Loops

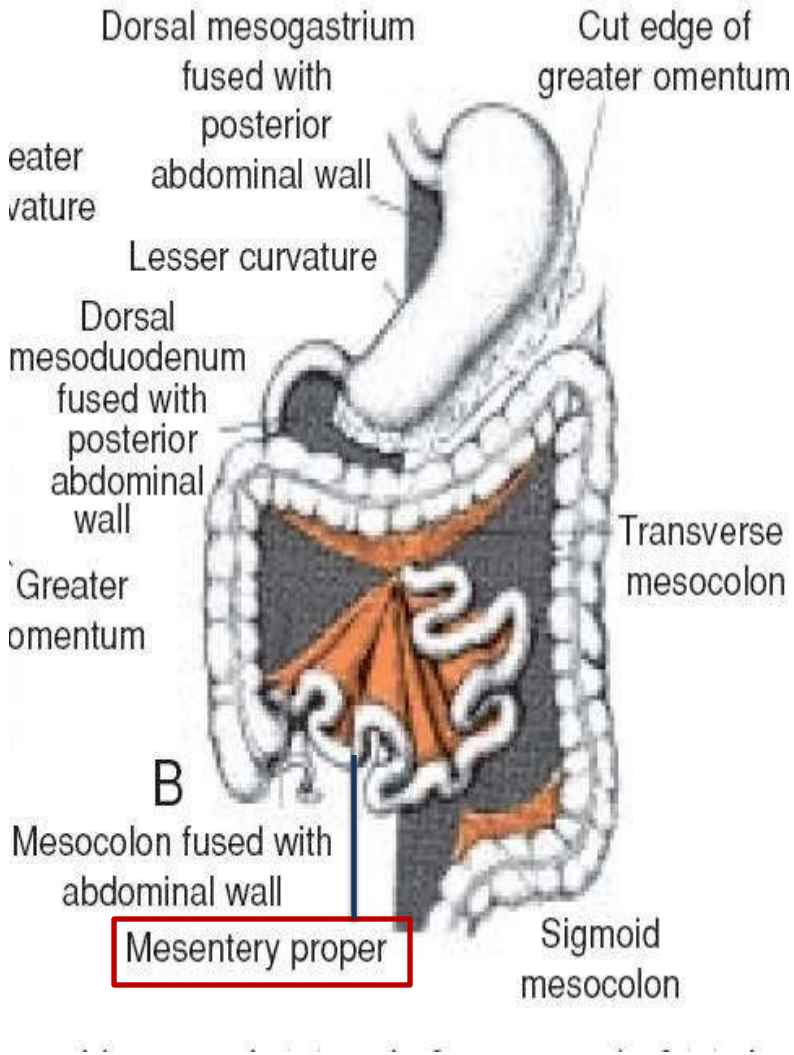
- ✓ Recall that mesentery is formed from:-
  - **Dorsal mesogastrium:**
    - ✓ Greater momentum/ mesentery of small intestine/mesentery of transverse and sigmoid colon/ ligament of the spleen.
  - **Ventral mesogastrium :**
    - ✓ The lesser omentum, ligaments of liver except ligamentum teres.

- ✓ Some organs **have** mesentery (jejunum/ ileum/ mesocolon/sigmoid colon).

- ✓ Some are **retroperitoneal** (ascending and descending colon).
- ✓ The mesentery in these organs **fixes the lateral and anterior walls (absent posterioraly)**

6- Mesenteries of Intestinal Loops

- ✓ The midgut is **suspended** from the **dorsal abdominal wall** by a **short mesentery.**
- ✓ The **mesentery proper** **elongates** towards the posterior abdominal wall and **attaches** to it.
- ✓ 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, and become **fixed** there



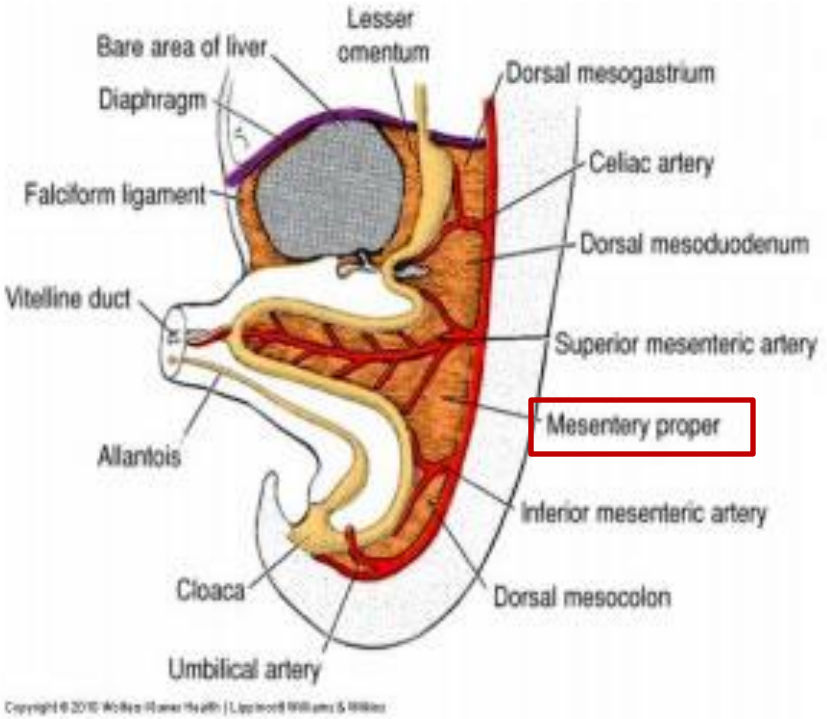
6- Mesenteries of Intestinal Loops

➢ Relation Between Mesenteries

✓ The mesentery of the **jejunoileal loops** is initially **continuous** with that of the **ascending colon.**

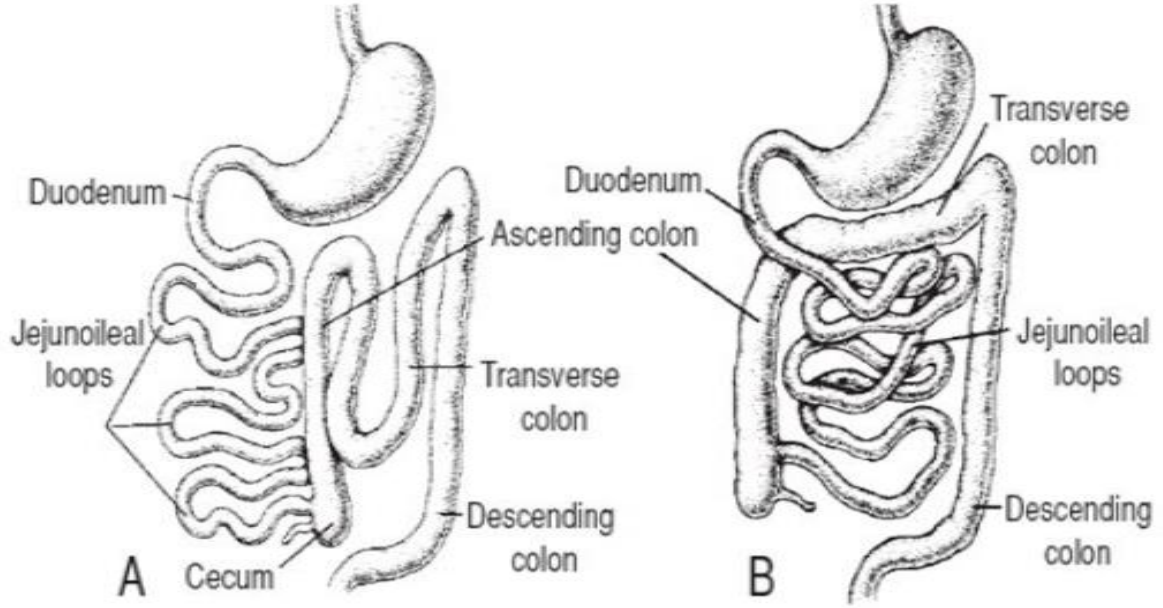
✓ When the mesentery of the **ascending colon (mesocolon)** fuses with the **posterior abdominal wall,** the **jejunum and ileum:**

- **Remain intraperitoneal**
- **Retain their mesentery,** which is:
  - **Fan-shaped**
  - **Contains branches of the superior mesenteric artery**



7- Midgut Abnormalities

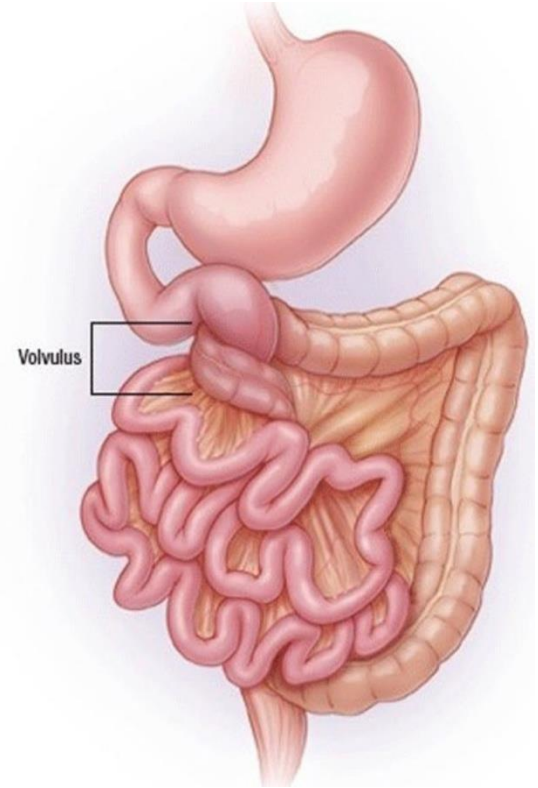
A. Gut rotation defects
   1. Volvulus
   2. Partial rotation
   3. Reverse rotation
   4. Duplications and cycsts
B. Gut atresia and stenosis
C. Body wall defects
   1. Omphalocele
   2. Gastroschisis



A. Represents partial/ abnormal rotation: left-sided colon.
B. Represents reversed rotation: appendix on left.

7- Gut Rotation Defects

- **Abnormal rotation** of the intestinal loop may result in **twisting** of the intestine and a **compromise of the blood supply.**



➢ Volvulus

✓ **twisting** mainly of **small intestines** (jejunum and ileum) due to their **length 6m,** it's like a long balloon that is twisted , results in:

- **Cut of blood supply → degeneration** of the twisted part (**gangrene**)

✓ Some movements & rotations may unwind this volvulus.

✓ **Treatment**: by **surgical intervention**; they **cut** the **degenerated part** & **ligate** the rest

7- Gut Rotation Defects

➢ Partial rotation

- ✓ Results in **left-sided colon.**
- ✓ Normally the primary intestinal loop rotates **270◦ counterclockwise.**

- ✓ Occasionally, rotation is only **90◦**, In this case, the **colon** and **cecum return first** from the **umbilical cord** and **settle** on the **left side** of the **abdominal cavity**
- ✓ The other **intestinal loops return later** and **settle more to the right**.

➢ Reversed rotation

- ✓ occurs when the **primary loop** rotates **90◦ clockwise** rather than **counterclockwise**, the appendix becomes on the **left** side instead of the right.

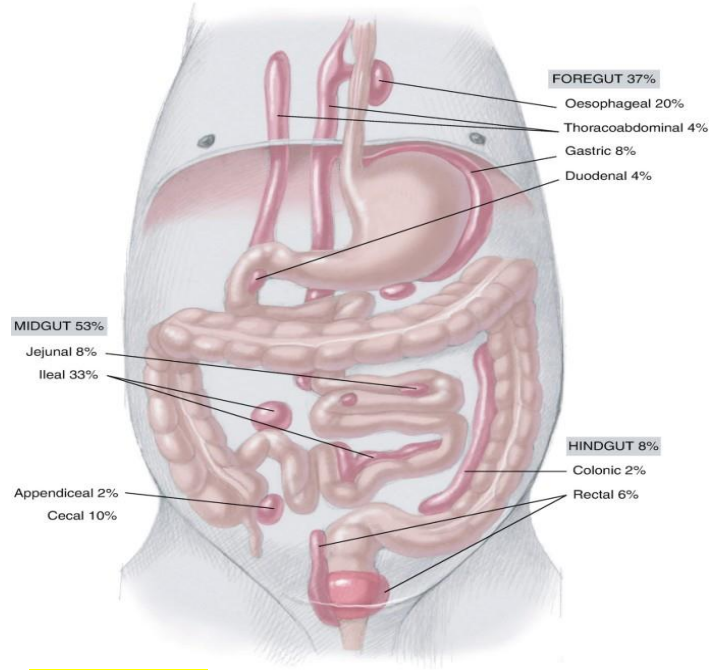
7- Gut Rotation Defects

➢ Duplications and Cysts

✓ may occur anywhere along the length of the gut tube (it happens mainly in the jejunum & ileum)

- **Clinical note:**

✓ **Appendix** or **ascending** colon may be found on the **left** side instead of the right, due to **malrotation**.



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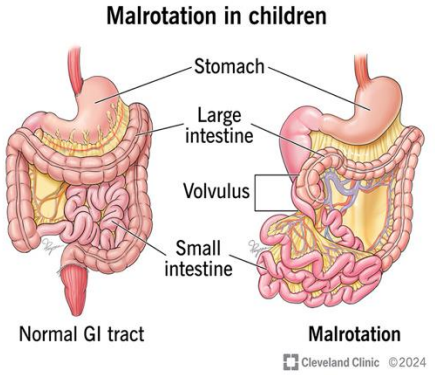

7- Gut Atresia and Stenosis

- ✓ **Atresia** and **stenosis** may occur anywhere along the intestine.
- ✓ Most occur in the **duodenum** (1/1500 births).
- ✓ Atresia in the **upper duodenum** is probably due to a lack of **recanalization** .
- ✓ Normally the duodenum is **filled** with cells, then **recanalization** occurs.

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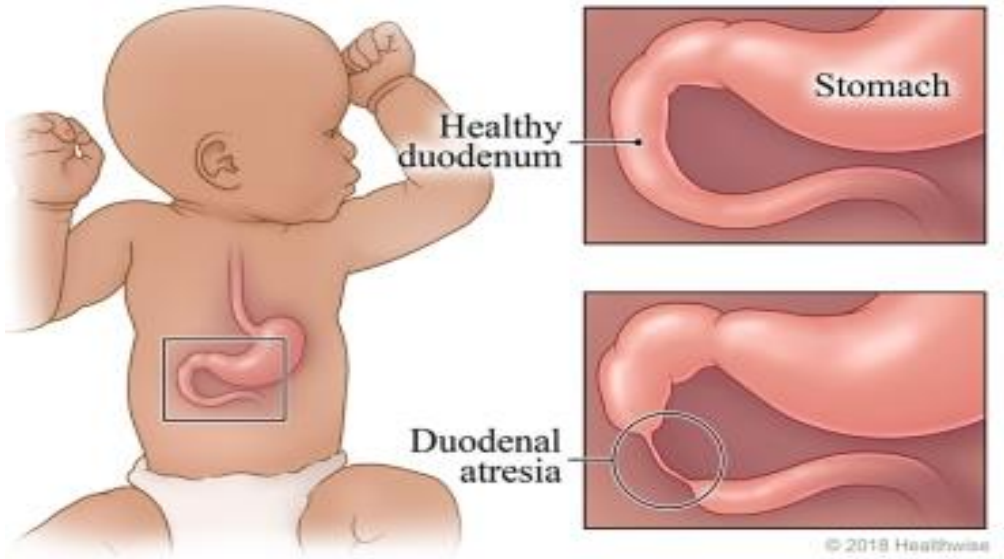


7- Body Wall Defects - Omphalocele

- ✓ **Omphalocele** involves herniation of abdominal viscera through an **enlarged umbilical ring** which is the beginning of umbilical cord in the abdominal wall.
- ✓ The viscera are covered by **amnion** (amniotic fluid).

- ✓ The defect originates from a **failure of the bowel to return** to the body cavity from its physiological herniation which should happen in the **10th week** , rather it stays in the umbilical cord.

7- Body Wall Defects - Omphalocele

✓ **Omphalocele** occurs in **2.5/10,000** births (**rare**) and is associated with :

- **high rate of mortality (25%)**
- **severe malformations**, such as cardiac anomalies **(50%)**
- **neural tube defects (40%).**
- **Chromosomal abnormalities** in live-born infants

➢ **Treatment**:

✓ **Evaluate the small intestine**:

- If **healthy → return it into the abdomen**.
- If **gangrenous → remove the affected part** and **ligate the ends.**

7- Body wall defects - Gastroschisis

- ✓ **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** (it does **not** herniate through the umbilicus)

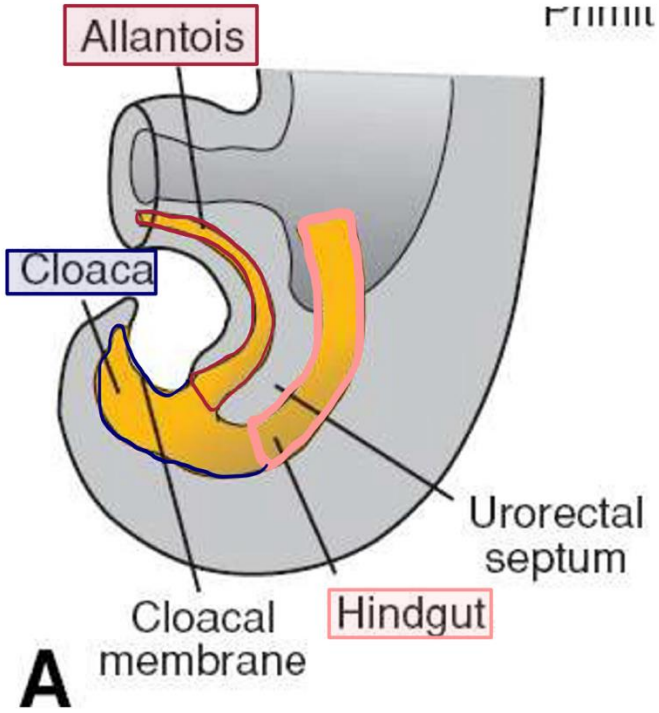
8- Hindgut Extension & Blood Supply

- ✓ **The hindgut** gives rise to the **distal third** of the **transverse colon**, the **descending colon,** the **sigmoid**, the **rectum**, and the **upper part** (half) of the anal canal

- ✓ **Blood supply**: **inferior mesenteric artery**

- ✓ Hind gut is **endodermal except lower half of anal canal ectodermal.**

- ✓ **Allantois**: Between **urinary bladder** & **umbilicus** (must be obliterated),after obliteration it is called **urachus.**



9- Cloaca

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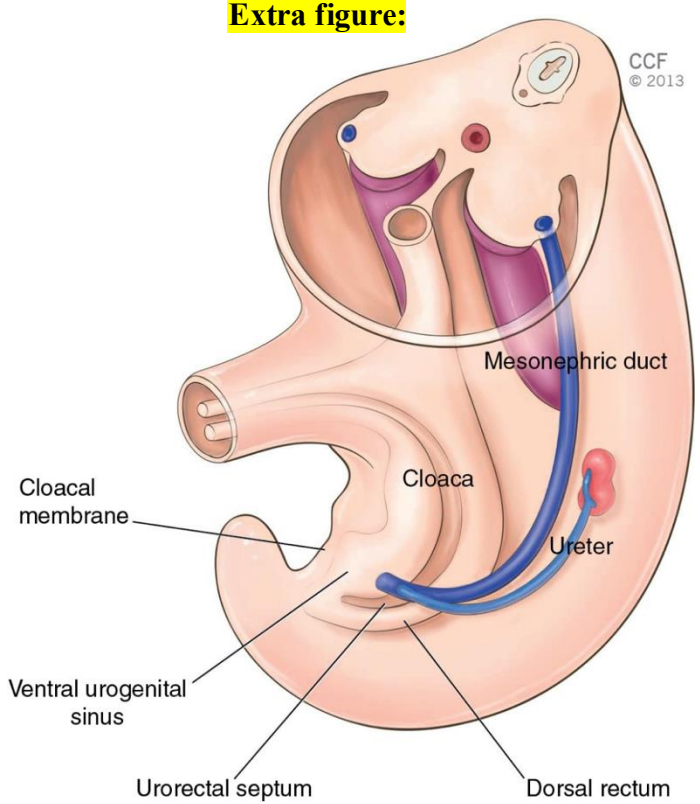


➢ Definition:

- ✓ a **pelvic** cavity prevent during embryonic development.
- ✓ Connected to the **hindgut** & **allantois**

➢ Divisions and Contributions

- **Posterior (upper) part:**
- ✓ Receives the **terminal portion** of the **hindgut.**
- ✓ Forms the **primitive anorectal canal** → contributes to the **hindgut**.
- **Anterior (lower) part:**
- ✓ Receives the **allantois**.
- ✓ Forms the **primitive urogenital sinus** → contributes to **the urogenital system.**

9- Cloaca

➢ Embryological Origin

✓ The cloaca:

- Lined by **endoderm** → therefore, endodermal in origin.
- Its **ventral boundary** (**outer** surface) is covered by **ectoderm**.

✓ The cloacal membrane:

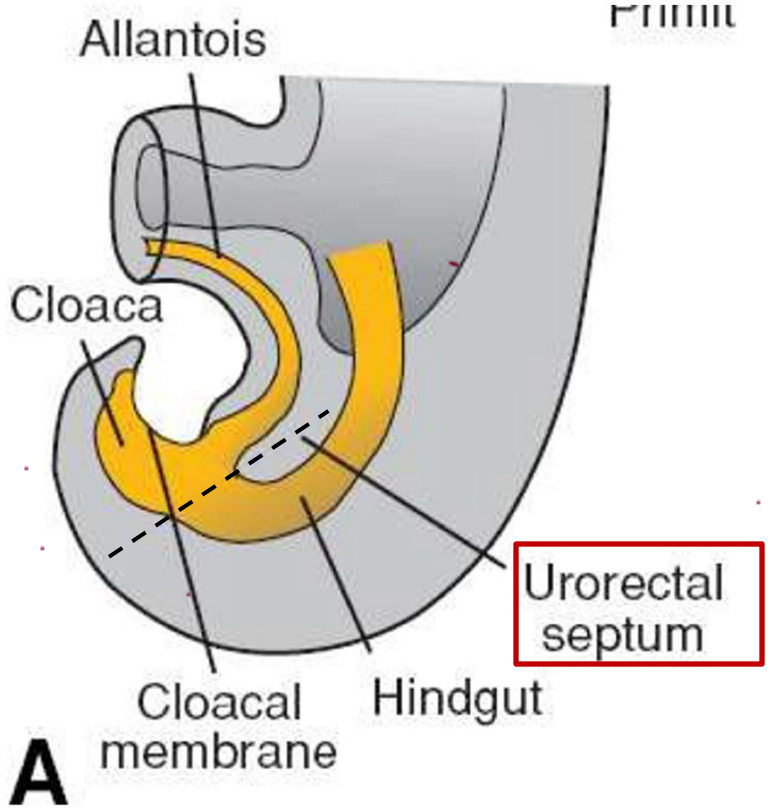
- Its **outer** surface is called the **proctodeum** (**ectodermal** in origin).
- The proctodeum gives rise to the **lower half of the anal canal.**
- Must **rupture** so that the **upper** (**endodermal**) and **lower** (**ectodermal**) **halves of the anal canal can join** together.

10- Urorectal septum

- A layer of mesoderm (mesenchymal structure) **lies** between the **allantois** (urogenital system) and **hindgut**, In other words, it splits the cloaca into two parts.

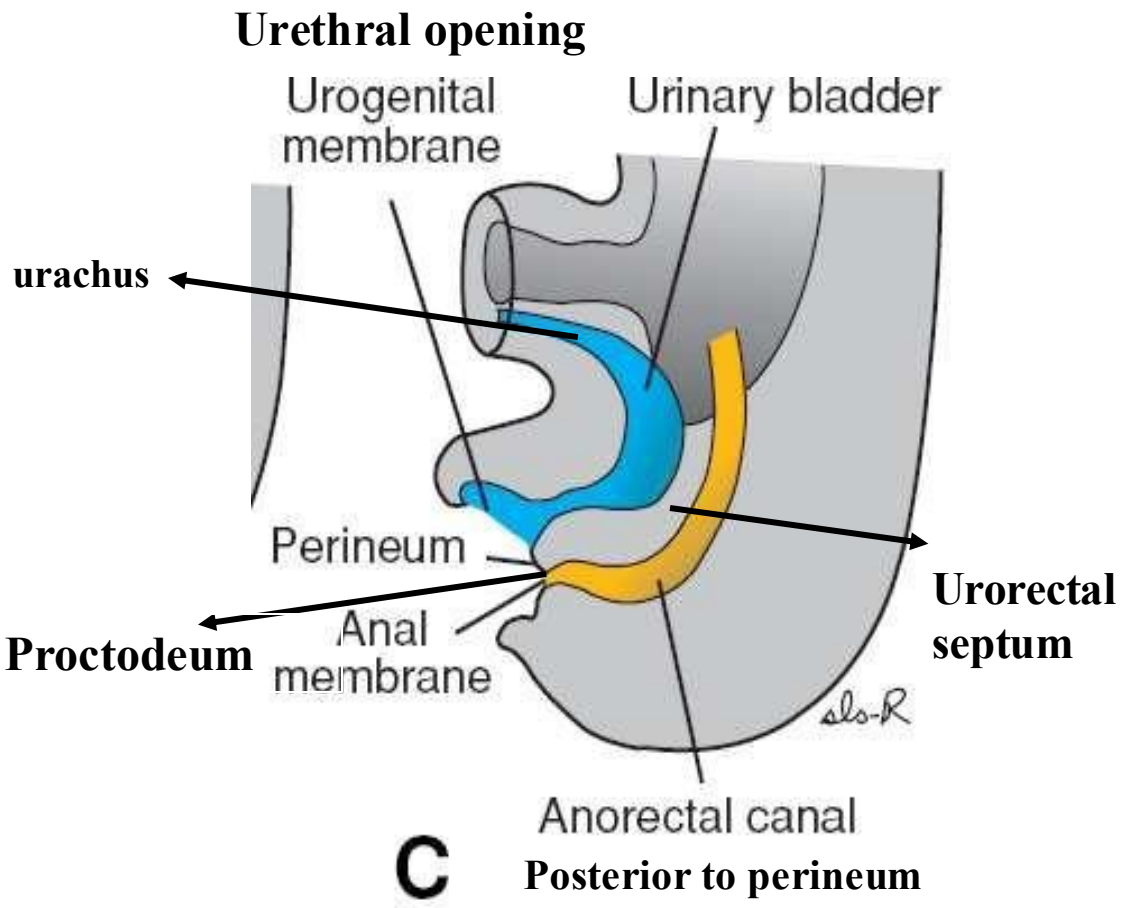
- The tip of it makes the **perineal body** which **separates** the **anal canal** and the **urinary bladder** and **urethra**.

✓ Urorectal septum participates in the formation of the **anal canal** & the **UGS- specifically the urinary bladder.**



11- Caudal part of Anal Canal

Feature	Details
Proctodeum	Formed by proliferation of **ectoderm** at the **caudal** end of the **anal canal**
Function of Proctodeum	Continuation of the anal canal **externally**
Recanalization	Occurs during the **ninth week**
Origin of caudal anal canal	**Ectodermal**
Blood supply (caudal anal canal)	**Inferior rectal arteries** (branches of internal pudendal arteries)
Membrane rupture	Both **anal** and **urogenital membranes** rupture to create openings



12- Pectinate Line

- 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 **simple columnar** to **stratified squamous non keratinized** for upper 1cm & **keratinized epithelium** for the lower 1 cm.

Anal canal epithelium

Upper 2cm		Simple columnar
Lower 2cm	Upper 1cm	Stratified squamous non-keratinized
	Lower 1cm	Stratified squamous keratinized

13- Anorectal Malformations

- ✓ **The junctions between different embryonic origins -transitional zones - always suffer from 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**).
  - The **rectum** may **connect to a part of the urinary tract or the reproductive system through an abnormal passage called a fistula.**
  - **Absence** of the **lower half of the anal canal**
  - **Abnormal position**

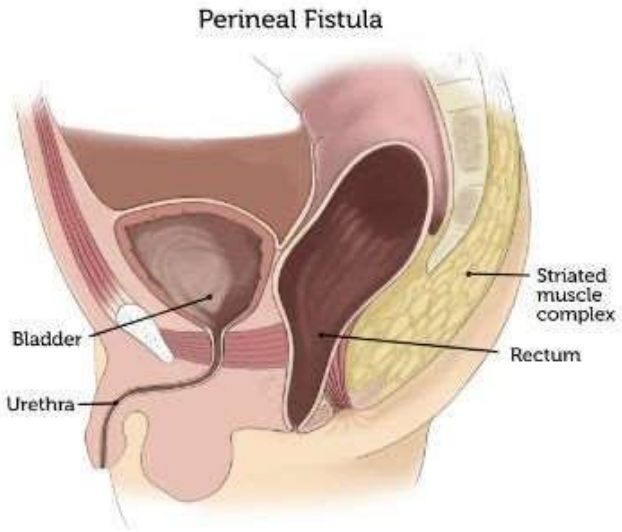
13- Anorectal Malformations

✓ Anorectal malformations, including imperforate anus, can affect male and female babies in different ways:

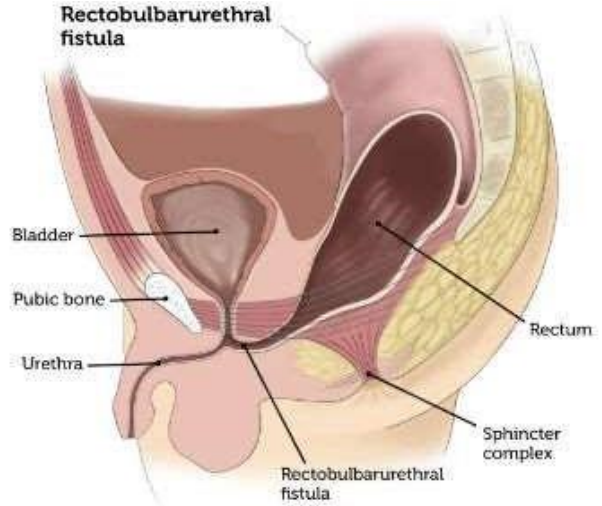
Sex	Common Anorectal Malformations
Male	- Perineal fistula - Rectobulbar urethral fistula - Rectoprostatic fistula - Rectobladder neck fistula
Female	- Rectoperineal fistula - Rectovestibular fistula - Cloaca - Rectovaginal fistula (more common in females)

Note: The urethra has 4 parts: membranous, bulbar, prostatic, and penile, Malformations may affect any of these parts.

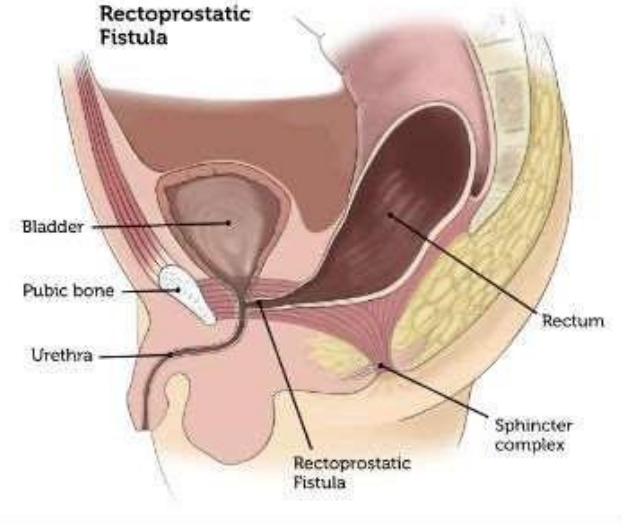
13- Anorectal Malformations



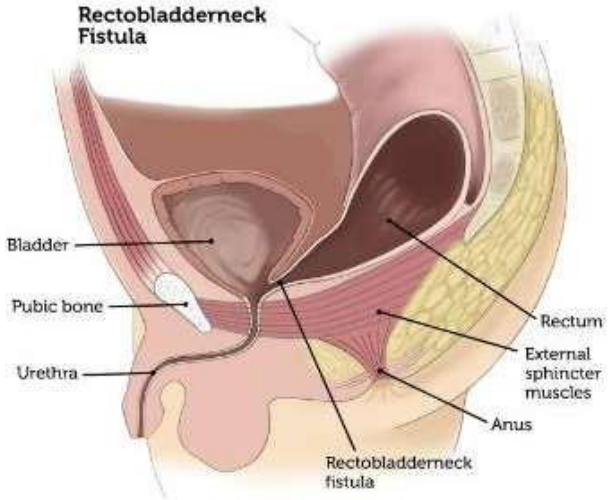
Perineal fistula:
Rectum opened into perineum



Rectobulbarurethral fistula:
Rectum opened into urethral &bulbar membrane



Rectoprostatic fistula :
Rectum opened into prostate



Rectobladderneck fistula:
Rectum opened into urinary bladder neck

For any feedback, scan the code or click on it.

Corrections from previous versions:

Versions	Slide # and Place of Error	Before Correction	After Correction
V0 → V1	11	—	Note added
V1 → V2			

رسالة من الفريق العلمي: