



GI ANATOMY

3



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In this color are important notes mentioned by the doctor.

PELVIC COLON

Begins as a continuation of the descending colon left side of pelvic brim (inlet of pelvis), at the ending point of descending colon.

- Parts of the pelvic colon:
 - **Sigmoid colon.**
 - **Rectum.**
 - **Upper part of the anal canal.**

The anal canal is divided into two parts that differ in their origin, innervation and blood supply...

Upper half: is a continuation of the rectum, as its origin is from the endoderm.

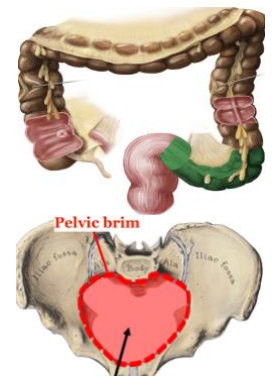
Lower half: originate from the ectoderm.

SIGMOID COLON

- The sigmoid colon is 10-15 inch (25 to 38 cm) long (it varies between individuals).
- It is a part of large intestine in pelvic cavity.
- **Begin: left side of the pelvic brim (inlet of the pelvis).**
- **End: it becomes continuous with the rectum in front of the third sacral vertebra (mid of the sacrum).** the sacrum is one bone with 5 vertebra.

- **Parts:**
 - **Lateral limb** → contains lower left colic artery.
 - **Medial limb** → contains superior rectal artery (the continuation of inferior mesenteric artery).
 - **Free margin** → **curved to right of mid line** (From left to right).
 - **Root (mesentery)** → **has an inverted V shape attachment.**

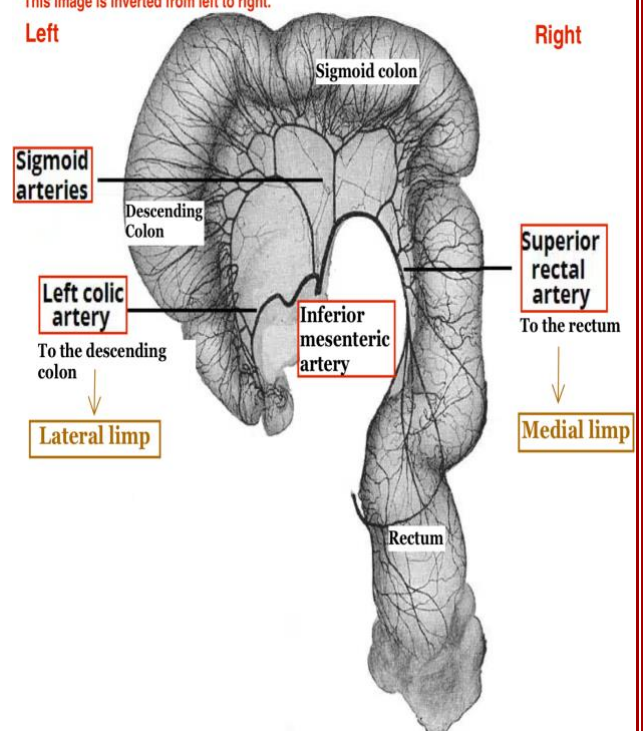
- The sigmoid colon is mobile and hangs down into the pelvic cavity in the form of a loop. It is attached to the posterior pelvic wall by the fan-shaped sigmoid mesocolon.



This image is inverted from left to right.

Left

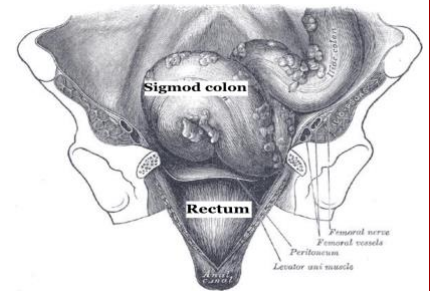
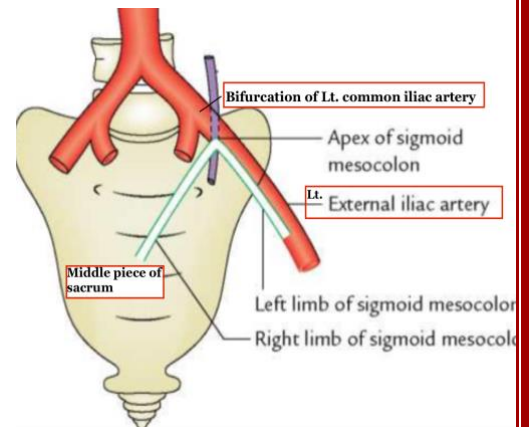
Right



Attachment of the root of mesocolon:

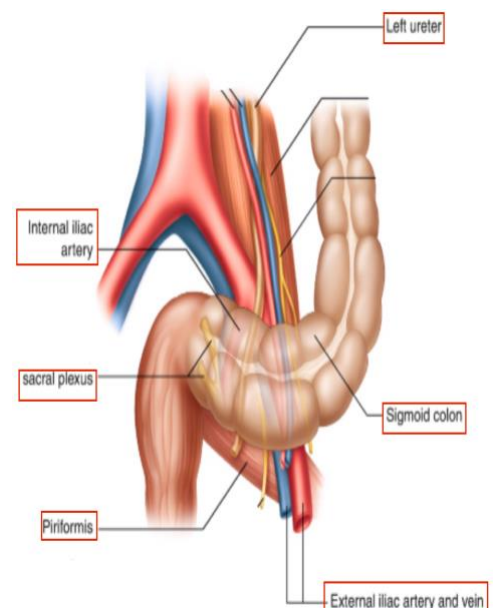
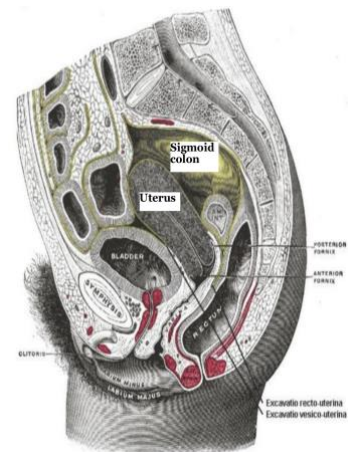
- **Medially: middle piece of sacrum.**
- **Laterally on the left side: Bifurcation of left common iliac artery** (attached to its facia).
- **Most laterally: Middle of left external iliac artery.**

Sigmoid colon has the same characteristics as the large intestine which are: tenia coli, appendices epiploicae and mesentery. **The appendices epiploicae (omental appendages) are very long in the sigmoid colon.**

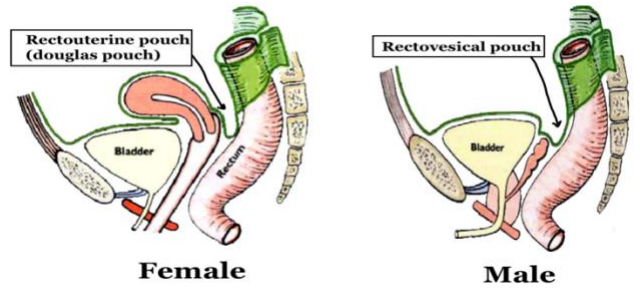


RELATIONS OF SIGMOID COLON:

- **Left:**
 - Left external iliac vessels (the most lateral attachment of the mesocolon of the sigmoid).
 - Lateral wall of pelvis and Vas defferance or ovary.
- **Right:** Small intestines (usually ilium).
- **Superior:** Coils of small intestine.
- **Inferior:** In male: urinary bladder. In female: uterus.
- **Posteriorly:** rectum, sacrum, lower coils of the terminal part of the ileum, Sacral plexus (going out of the foramen of sacrum), Left periformis muscle (which originates from the upper 3 pieces of the sacrum), Left Ureter, Left external iliac vessels, Left internal common iliac artery (the external is in front of the internal common iliac artery).
 - Small intestines are seen above and on the right side of the sigmoid colon, and can be seen on the left and the posterior side.



The sigmoid colon usually occupies the rectovesical pouch in males and the rectouterine pouch in females. And internal hernia cannot happen there because it's open ☹️



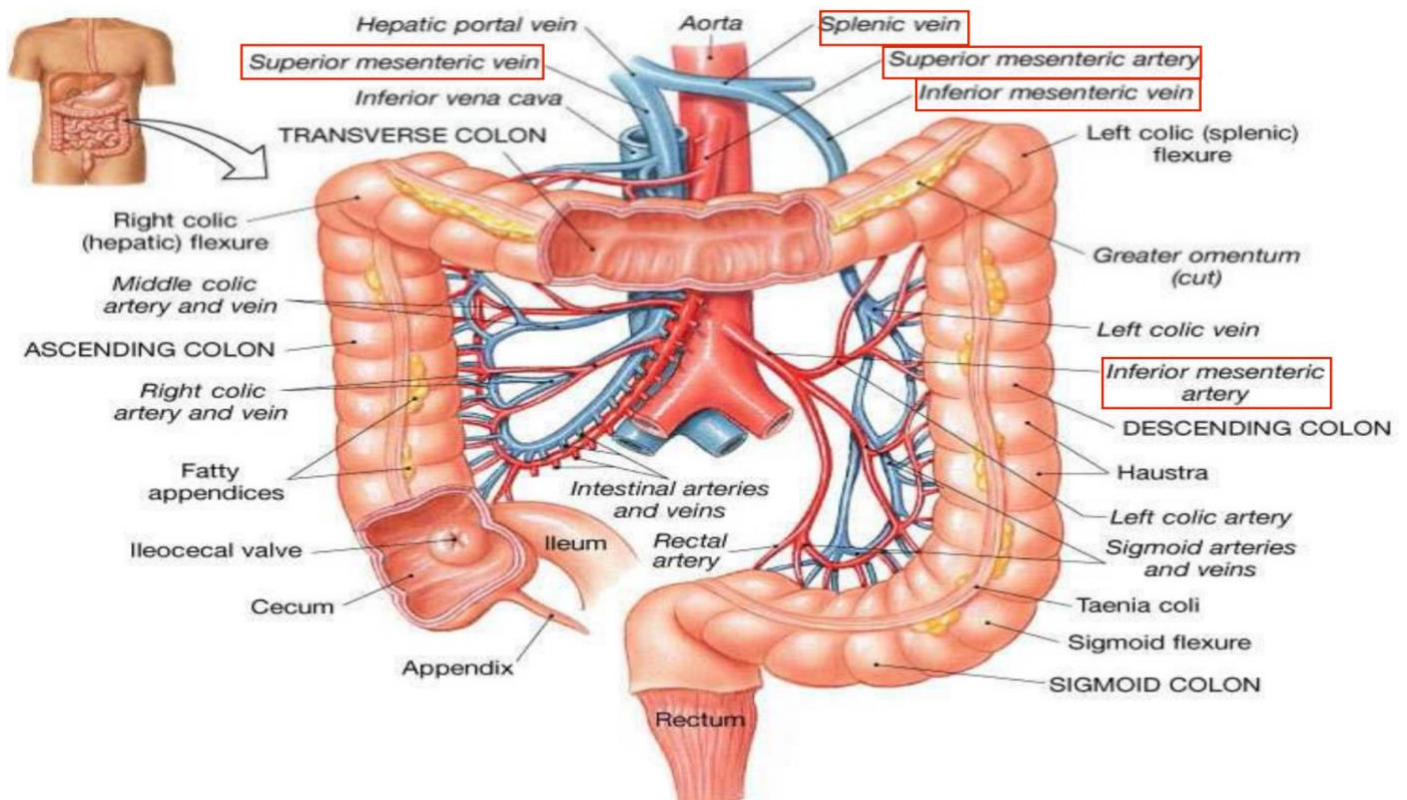
BLOOD SUPPLY OF SIGMOID COLON

- **Arteries:** Sigmoid branches of the inferior mesenteric artery (since the sigmoid colon is hindgut).

Hindgut = inferior mesenteric

The **most superior sigmoid artery** anastomoses with the descending branch of the **left colic artery** (remember lower left colic artery is in the lateral limb of the sigmoidal mesocolon, also it supplies the descending colon).

- **Veins:** The veins drain into the **inferior mesenteric vein** → to the splenic vein → to the portal venous system.



- Notice that the veins are always outer or lateral to the arteries (see superior and inferior mesenteric arteries and veins)

LYMPH DRAINAGE OF SIGMOID COLON

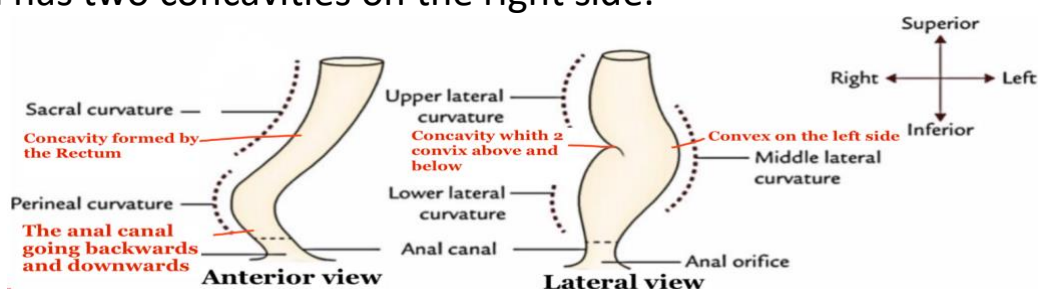
- The lymph drains into nodes along the course of the sigmoid arteries → the **inferior mesenteric nodes** (around the origin of inferior mesenteric artery).

NERVE SUPPLY OF SIGMOID COLON

- The sympathetic and parasympathetic nerves from the **inferior hypogastric plexuses**. (Plexus means it has sympathetic and parasympathetic fibers).
- **Parasympathetic innervation:** starts from S2,3 and 4 spinal nerves → forms the pelvic splanchnic nerves → the inferior hypogastric plexuses.
- **Sympathetic innervation:** starts from L1 and 2 spinal nerves → to the inferior mesenteric ganglia → from the inferior hypogastric plexuses and get distributed with the blood vessels.

RECTUM

- The rectum is about **5 inch** (13 cm) long.
- **Begins in front of (beyond) the third sacral vertebra** as a continuation of the sigmoid colon.
- **Ends 1 inch in front of (beyond) the tip of the coccyx** by piercing the pelvic diaphragm and becoming continuous with the anal canal.
 - beyond is more precise than in front of, it means below and backwards not directly in front.
- The lower part of the rectum is dilated to form the **rectal ampulla** (a reservoir for stool).
- The rectum deviates to the left, but it quickly returns to the median plane. On lateral view, the rectum follows the anterior concavity of the sacrum before bending downward and backward at its junction with the anal canal.
- In the anterior-posterior view, the rectum is concave as the sacrum (the rectum starts from the mid of the sacrum and ends 1 in. beyond coccyx).
- In the lateral view, the rectum **عامل زي الأربعة ٤** convex to the left side and has two concavities on the right side.

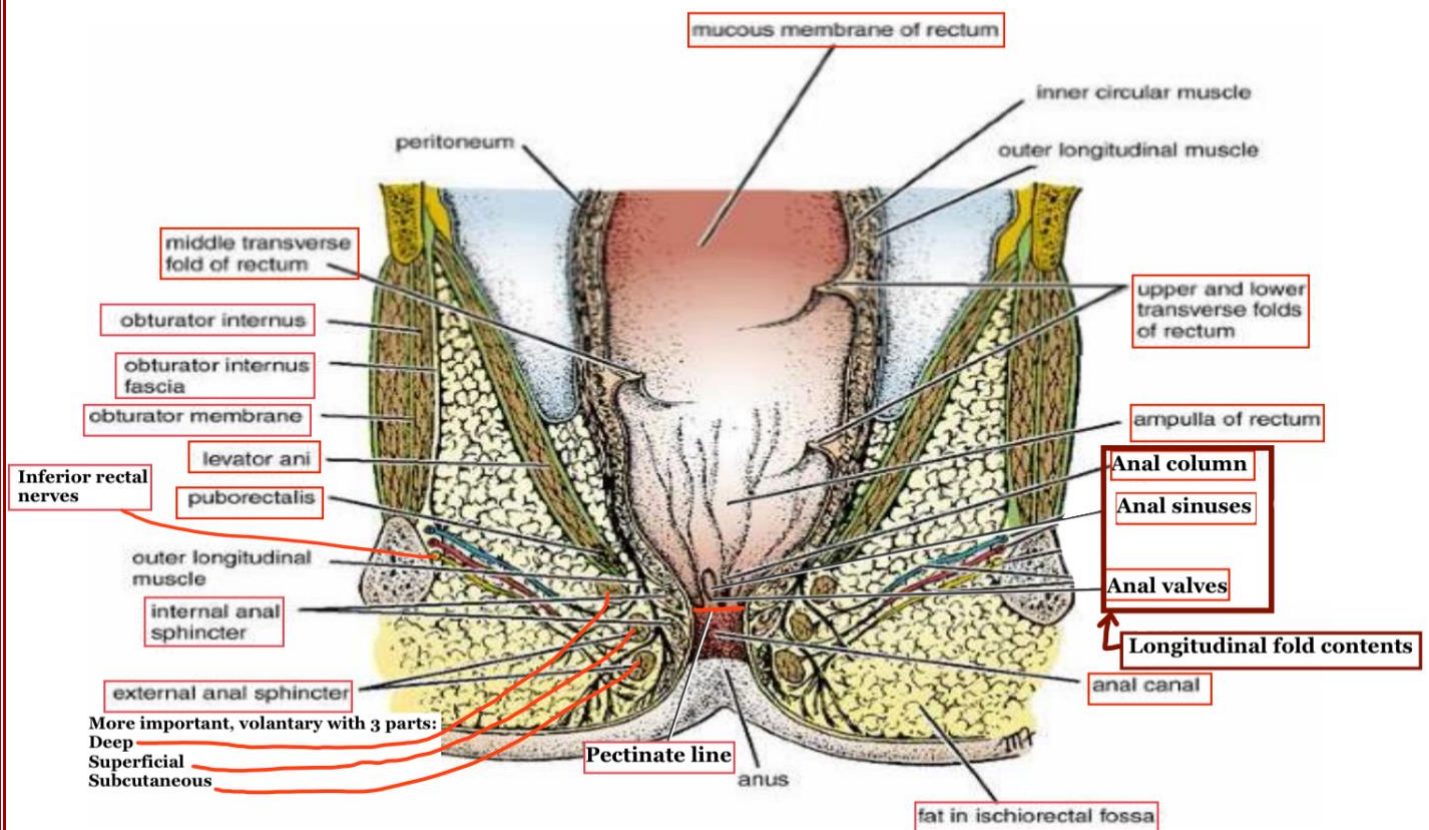
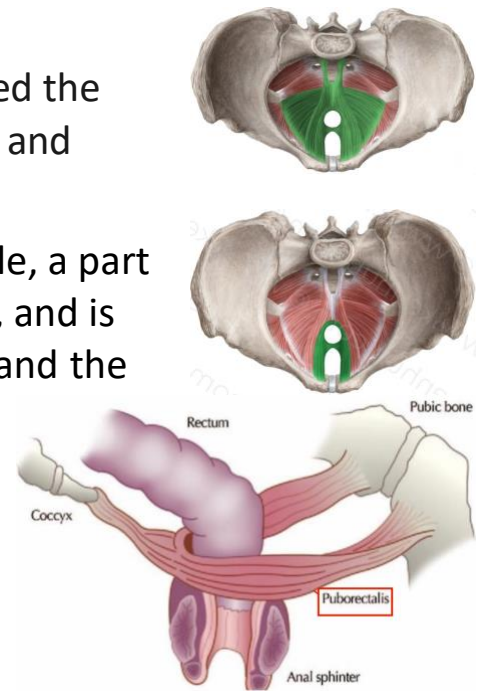


- The **puborectalis** portion of the **levator ani muscles** forms a **sling** at the junction of the rectum with the anal canal and pulls this part of the bowel forward, producing the anorectal angle.

- **Levator ani muscle:** a very important muscle called the diaphragm of the pelvis, it stabilizes the abdominal and pelvic organs in the pelvic cavity.

- **Puborectalis muscle:** a U shaped **voluntary** muscle, a part of the levator ani muscle, originate from the pubis, and is inserted around the junction between the rectum and the anal canal, **it defines the junction between the rectum and anal canal.**

It forms an angle with a muscular sling curving around the anorectal junction and pulling it forward, and it is a very important muscle in the process of defecation.



- The mucus membrane of the rectum is formed from simple columnar epithelium with goblet cells.

- The anal canal is separated to upper and lower halves by the **pectinate line**.

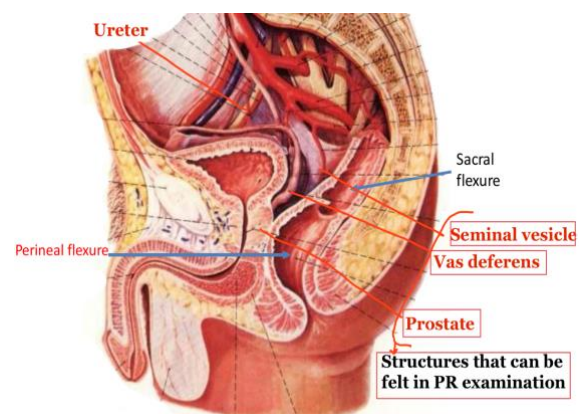
- The rectum has two types of folds:
 - **Transverse folds:** three in number, 2 are on the left side (upper and lower) and one on the right (middle). They are formed by: mucosa, submucosa and inner circular muscle, they form the rectal ampulla to store stool.
 - **Longitudinal folds contain:**
 - 1- **Anal columns:** vertical folds.
 - 2- **Anal valves:** junctions between the anal columns
 - 3- **Anal sinuses:** pockets formed by the anal valves.
- The rectum has two types of sphincters:
 - **Internal anal sphincter:** non-voluntary, formed by thickening of the inner circular smooth muscle.
 - **External anal sphincter: voluntary** with somatic innervation from the **inferior rectal nerves** and the loss of control in this sphincter causes incontinence. Has three parts: **deep, superficial and subcutaneous.**
- On the lateral sides of the anal canal, there is **ischiorectal fossa** (between the ischial tuberosity, and the rectum and the anal canal) forms a wedge shape surrounded by the **obturator internus and its fascia** from the **lateral** side, on the **medial** side by the **levator ani muscle**, and its **base** is formed by **skin**. This fossa is **filled with fat** to give space for descending feces during defecation.

The ischiorectal fossa is crossed by the **inferior rectal nerve and vessels**. The ischiorectal fossa has a dangerous **disadvantage:** the skin on the base or lower cm of the anal canal can get infected, especially because the latter is keratinised and has hair follicles and sweat glands, leading to the formation of **abscesses**, which can form **sinuses** and open to the outside, or form **fistulas** and open into the rectum and anal canal, the problem here is that even if it was treated it can reoccur and get back.

PR EXAMINATION (PER RECTAL EXAMINATION)

An internal examination of the rectum, where the physician insert their index in the anal canal and palpate the structures anterior to the rectum.

A question suggested by the doctor: in per rectal examination in male what structures can be felt anterior to the index?

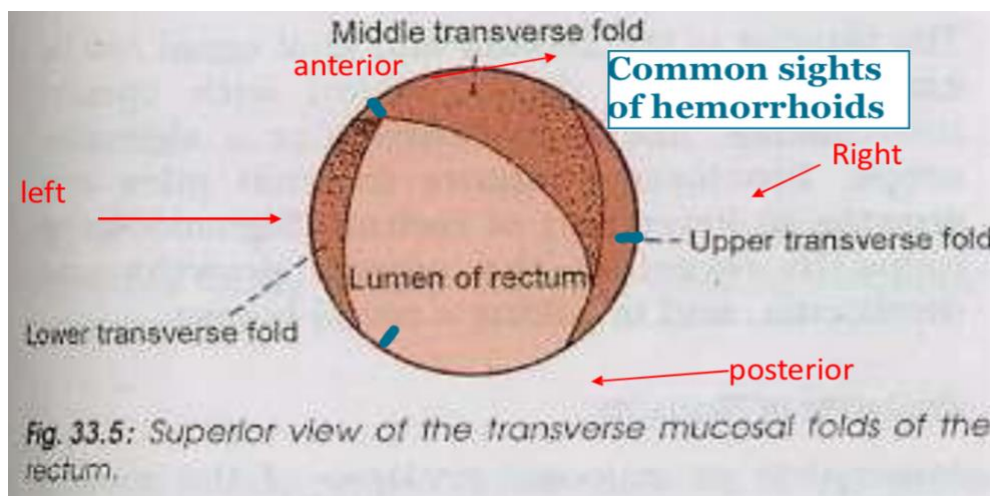


There are 3 structures that can be palpated during PR examination in a male: the most important one is the prostate, vas deferens can be felt especially if there was calcification, also the seminal vesicle can be felt. The ureter CANNOT be felt because it opens into the urinary bladder which is far from the rectum.

▪ From an inferior view to the anus, the mucosa with the lumen of the rectum can be seen. And it is represented in a clockwise manner as you can see in the pic below, it is used to determine the site of structures there, for example: **the most common sites to see hemorrhoids coming out of the rectum**, where piles (hemorrhoids) are often seen in the **3, 7 and 11** o clock in that circle.

Also **transverse folds** of the rectum, can be seen here. They are **2 upper and lower folds on the left side, and the middle fold is on the right side.**

Mucosal folds: the transverse or horizontal folds or Houston' valve: upper fold projects from right, middle fold projects from anterior and right wall, lowest fold projects from left wall. (The doctor didn't mention this)

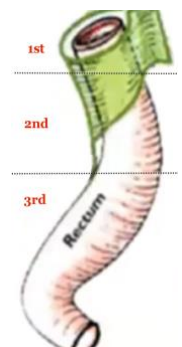


The peritoneum of the rectum is divided into 3 parts:

1- first third : covers the anterior and lateral surfaces the same as the descending colon (fixed in the posterior abdominal wall, retroperitoneal).

2- middle third : only the anterior surface and it forms the pouches.

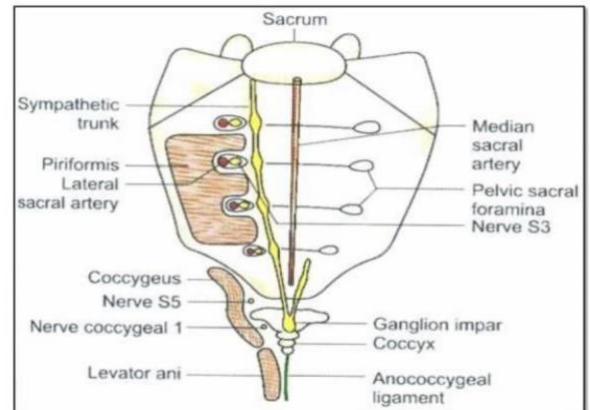
3- lower third : devoid of peritoneum (found in the pelvis) surrounded by connective tissue only.



RELATIONS OF THE RECTUM:

- **Posteriorly:**

The rectum is in contact with the sacrum and coccyx - the piriformis (its origin) - levator ani muscle - the sacral plexus (from the sacral foramina) - the sympathetic trunks – lateral sacral arteries - Coccygeus muscle and anococcygeal body (the last two weren't mentioned by the doctor).

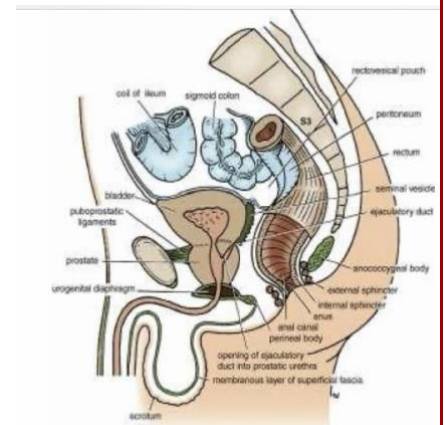


- **Anteriorly:**

- **In males:**

1. The upper two thirds of the rectum: covered by peritoneum and related to the sigmoid colon and coils of ileum (which occupy the rectovesical pouch).

2. The lower third of the rectum: devoid of peritoneum. Related to: the posterior surface of the bladder, termination of the vas deferens, seminal vesicles on each side, prostate and to the perineal body most inferiorly in front of the anal canal (perineal body is formed by fibrous connective tissue).



We have 3 parts of the urethra in males :

A- Prostatic urethra (in the urethra)

B- Membranous urethra (between two membranes).

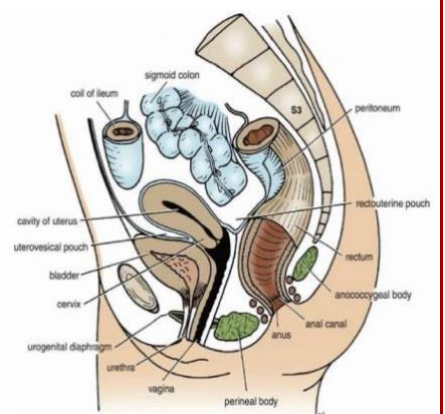
C- Penile urethra.

- **In females:**

1. The upper two thirds of the rectum:

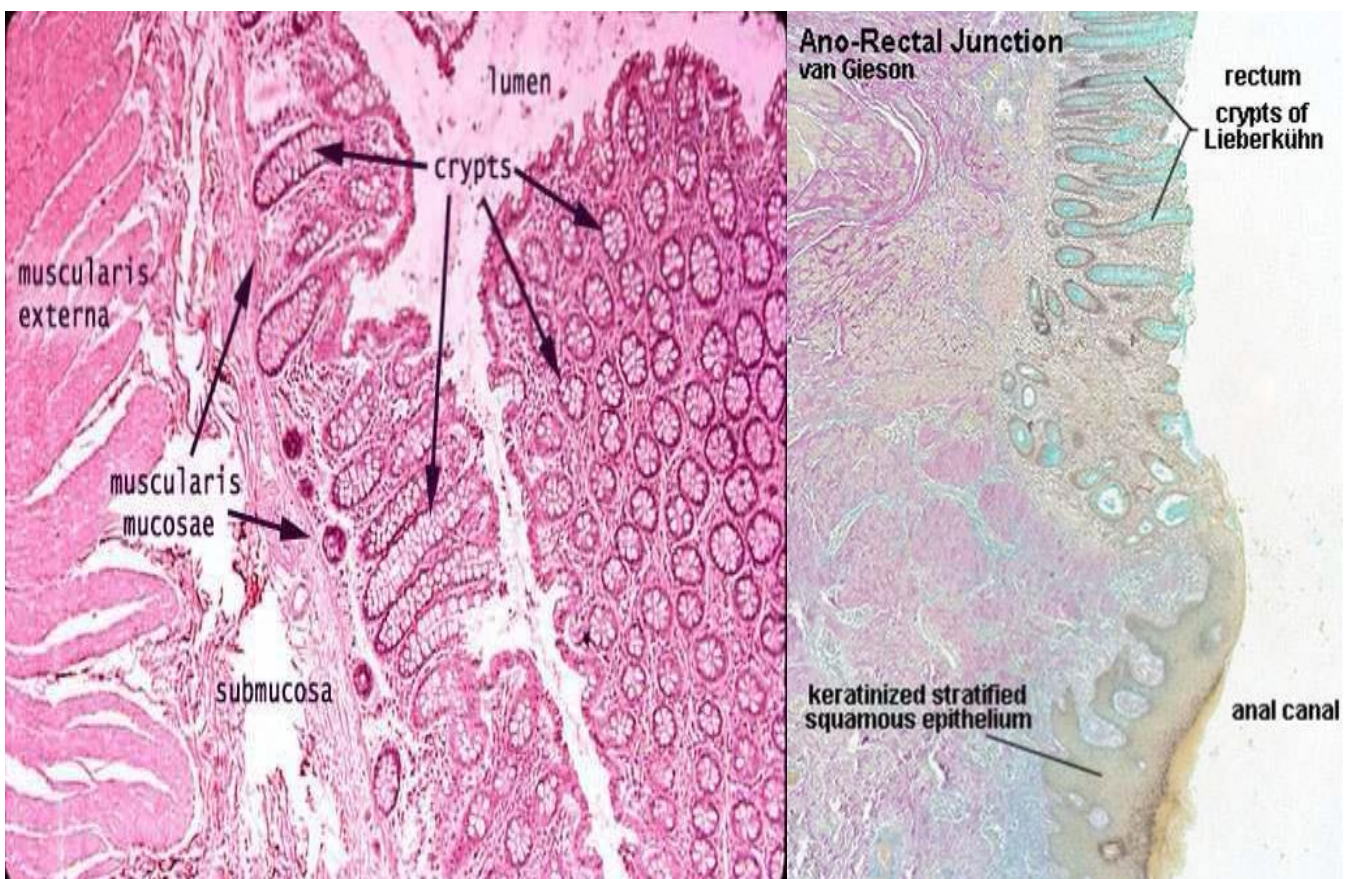
Covered by peritoneum, related to the sigmoid colon and coils of ileum (which occupy the rectouterine pouch (pouch of Douglas)).

2. The lower third of the rectum: devoid of peritoneum, related to the posterior surface of the vagina, the lower part of the uterus (its posterior wall) and the perineal body.



HISTOLOGY OF RECTUM

- It has the same layers as the previous colon (mucosa, submucosa, muscularis externa and serosa or adventitia).
- It has **transverse and longitudinal folds**.
- The lamina propria is filled with **crypts of Lieberkühn** to lubricate the feces and secrete mucus.
- The inner circular layer of muscularis externa forms the internal sphincter of the anal canal.
- The **muscular coat** of the rectum is arranged in:
 - 1- **outer longitudinal layer of smooth muscle.**
 - 2- **inner circular layer of smooth muscle.**
- The three **taenia coli of the sigmoid colon** however, come together so that the longitudinal fibers form a broad band on the anterior and posterior surfaces of the **rectum** → **No taenia coli**.
- **Transverse folds** of the rectum (semicircular permanent folds) → is formed by the **mucous membrane of the rectum + the inner circular muscle layer**.



BLOOD SUPPLY OF THE RECTUM

- **Arteries:** The superior, middle and inferior rectal arteries supply the rectum.

1- The superior rectal artery

- It is a direct continuation of the inferior mesenteric artery and is the chief artery supplying the mucous membrane.

- It enters the pelvis by descending in the root of the sigmoid mesocolon (it is related to the mucous membrane) and divides into right and left branches, which pierce the muscular coat and supply the mucous membrane.

- They anastomose with one another and with the middle and inferior rectal arteries.

2- The middle rectal artery

- It is a small branch of the anterior division of the internal iliac artery.

- It is distributed mainly to the muscular coat.

3- The inferior rectal artery

- It is a branch of the internal pudendal artery (from the internal iliac artery) in the perineum.

- Supplies the lower half of the anal canal.

- It anastomoses with the middle rectal artery at the anorectal junction.

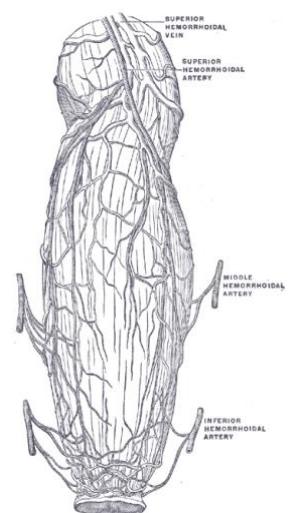
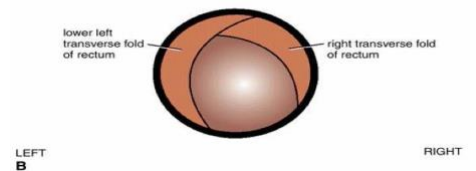
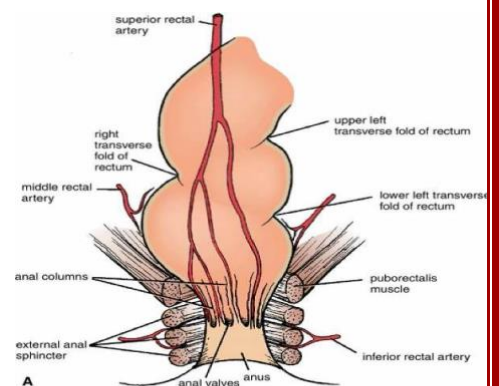
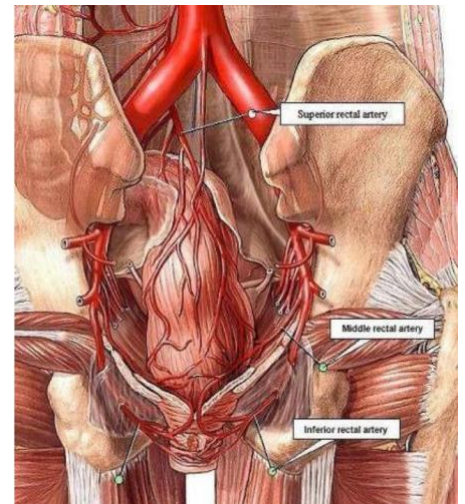
- **Veins:** the veins of the rectum correspond to the arteries (superior, middle and inferior rectal veins).

1- The superior rectal vein

- A tributary of the portal circulation and drains into the inferior mesenteric vein → to portal vein (portal circulation).

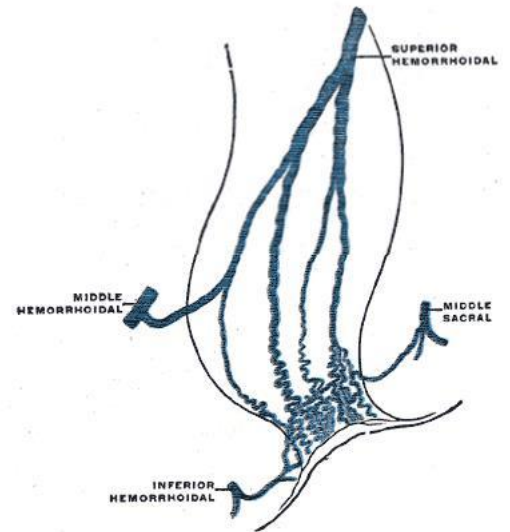
2- The middle rectal vein → to the internal iliac vein → IVC → right atrium of the heart (systemic circulation).

3- inferior rectal vein → internal pudendal veins → IVC → right atrium of the heart (systemic circulation).



- The union between the rectal veins forms an **important portal systemic anastomosis.**

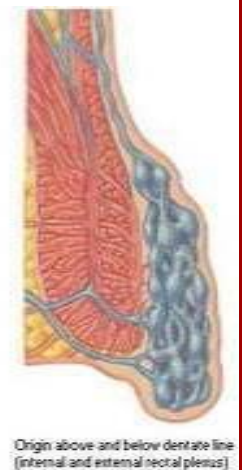
When there is portal hypertension due to blockage in the liver, the portal vein won't be able to drain its blood into the liver, instead; the venous blood coming from the rectum through the superior rectal vein (portal circulation) will go back and anastomose with the middle and inferior rectal veins (systemic circulation), and blood will collect there to cause hemorrhoids (piles).



- The hemorrhoidal plexus (or rectal venous plexus) surrounds the rectum, and communicates in front with the vesicle venous plexus in the male, and the uterovaginal plexus in the female. A free communication between the portal and systemic venous systems is established through the hemorrhoidal plexus. (The doctor didn't read this).

Hemorrhoids can be subcutaneous (external) or high up (internal).

- If the enlarged vein was superior → internal hemorrhoids.
- If it the enlarged vein was inferior or middle → external hemorrhoids.



LYMPH DRAINAGE OF RECTUM

- the upper part drain → into the pararectal nodes → then into inferior mesenteric nodes.
- the lower part follow the middle rectal artery → to the internal iliac nodes.

NERVE SUPPLY OF RECTUM

- The nerve supply is from the sympathetic and parasympathetic nerves from the inferior hypogastric plexuses. The same as the sigmoid colon (parasympathetic from S2,3,4 and sympathetic from L1,2 inferior mesenteric ganglia).
- The rectum is sensitive only to stretch.

PAST PAPERS

All of the following statements concerning the sigmoid colon are correct EXCEPT:

- A) It has parasympathetic innervations from sacral nerves.
- B) The blood supply from inferior mesenteric artery.
- C) It has inverted V shape mesentery.
- D) It ends in front of the mid of sacrum.
- E) The medial limb of its mesentery contains left colic artery.

ANSWER: E

V2

Edits in this color in pages 4, 6 (the pectinate thing was removed), 7

The pic in page 6

Past paper question was added