ANATOMY

بسم الله الرحمن الرحيم

FINAL | Lecture 5

Rectum, Anal Canal & Posterior Abdominal Wall (Pt.2)

﴿ وَإِن تَتَوَلَّوْا يَسْتَبْدِلْ قَوْمًا غَيْرَكُمْ ثُمَّ لَا يَكُونُوا أَمْثَالَكُم ﴾

اللهم استعملنا ولا تستبدلنا

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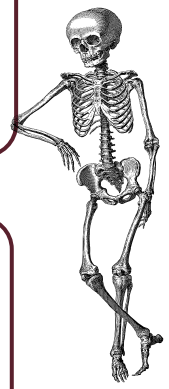
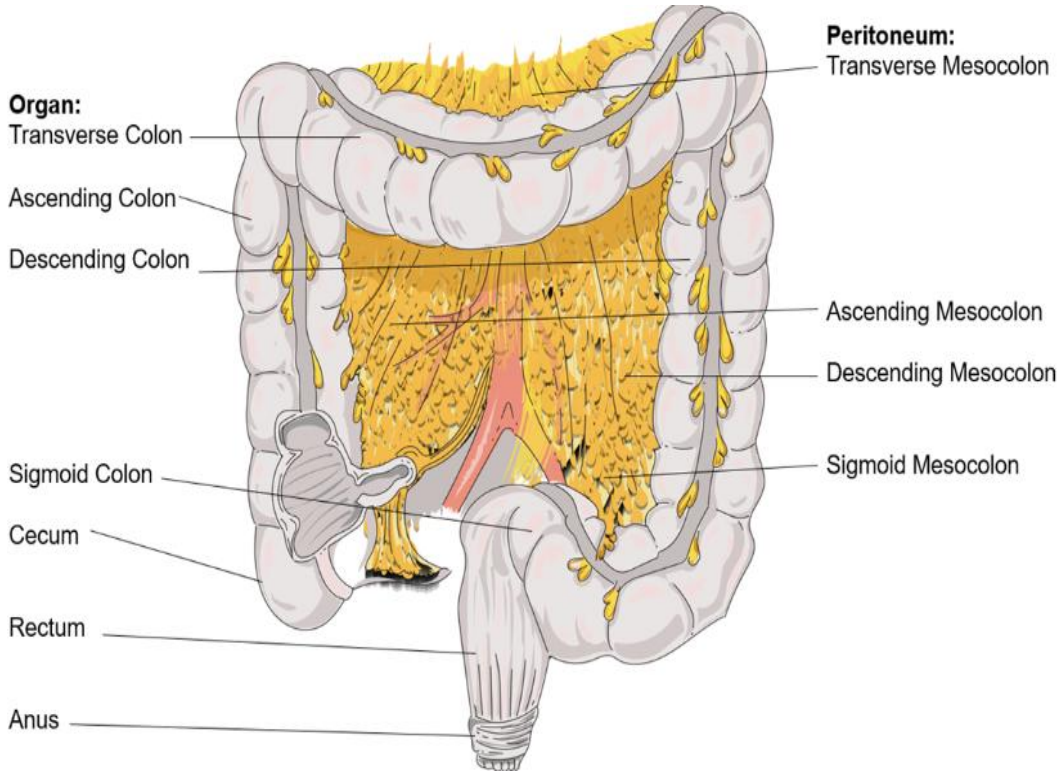


Click the key for a quiz on the last lecture

1 – Pelvic Mesocolon

Parts of the pelvic mesocolon:

1. Sigmoid colon
2. Rectum
3. Anal canal



2 – Sigmoid architecture

Location & Description

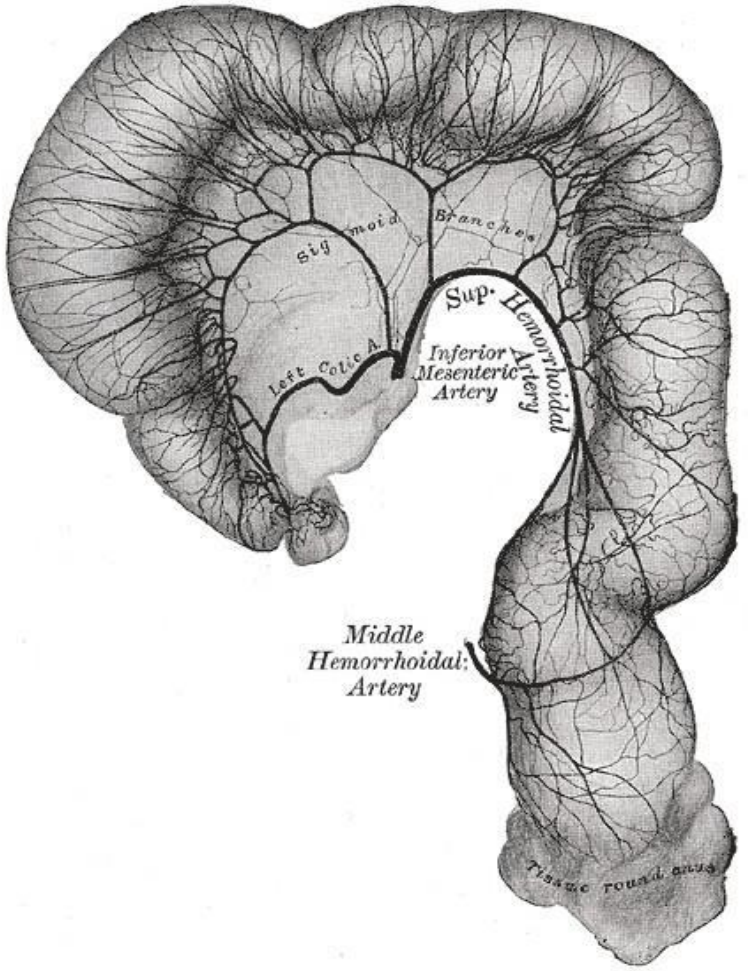
- ✓ The sigmoid colon is 10 - 15 in. (38 cm) long.
- ✓ It is a part of large intestine in pelvic cavity.
  - ✓ The sigmoid colon is an intraperitoneal organ
  - ✓ Has a mesocolon called sigmoid mesocolon

Begin: (inlet of the pelvis on the left side, it's a continuation of the descending colon)

End: in the pelvis in front of the middle piece of sacrum, it continues as rectum).

Parts:

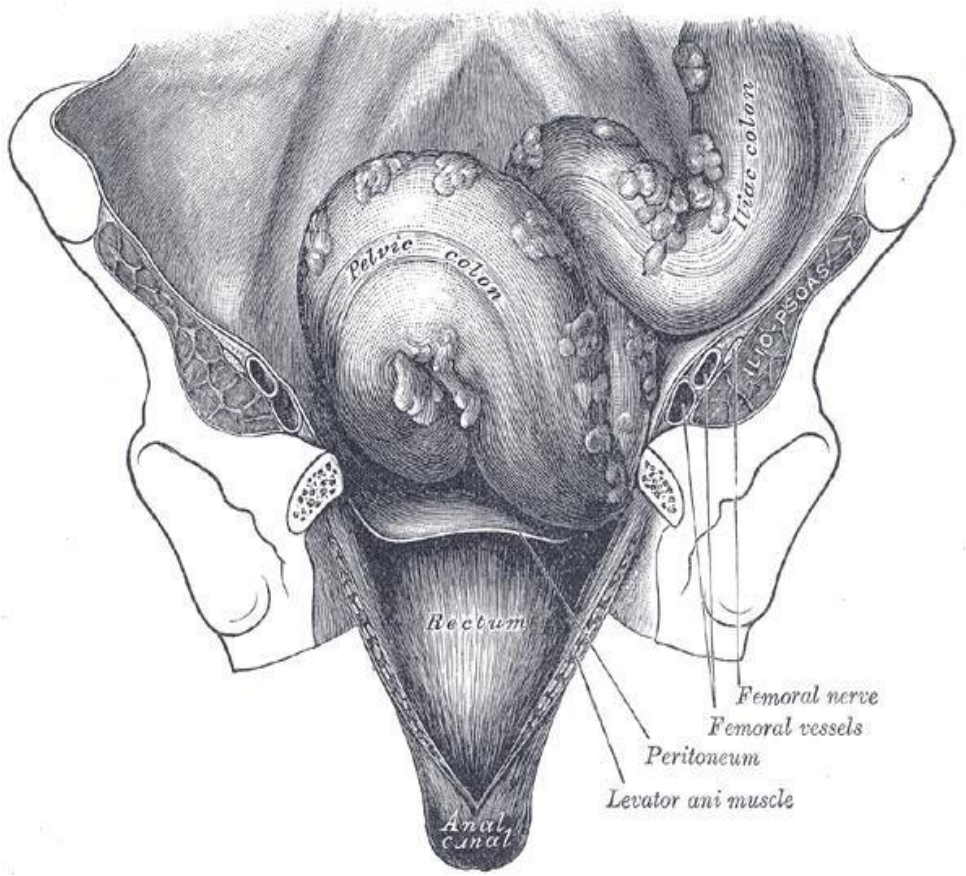
- ✓ Lateral limb contains Lt. colic artery
- ✓ Medial limb is continuation of the inf mesenteric artery that continues as the sup rectal artery
- ✓ Free margin 38cm starts from the left inlet to the of mid sacrum
- ✓ Root which is mesentery attachment



2 – Sigmoid Architecture

- ➢ Attachment of the root of mesocolon:
- ✓ Starts at middle piece of sacrum.
- ✓ Goes towards the Lt.common iliac artery.
- ✓ Then ends at the adventitia of the of Lt.Ext.iliac artery.

- What distinguishes the sigmoid colon is the **appendices epiploicae** (numerous pads of fat).



3 – Relations of the Sigmoid

- ✓ As we can see in the image, we have symphysis pubis anterior, the rectum posterior and the anal canal.
- ✓ It's a mid-section in female because we can see the uterus and the vagina.
- ✓ Inside Douglas pouch (rectouterine pouch) we can find the sigmoid and the small intestine

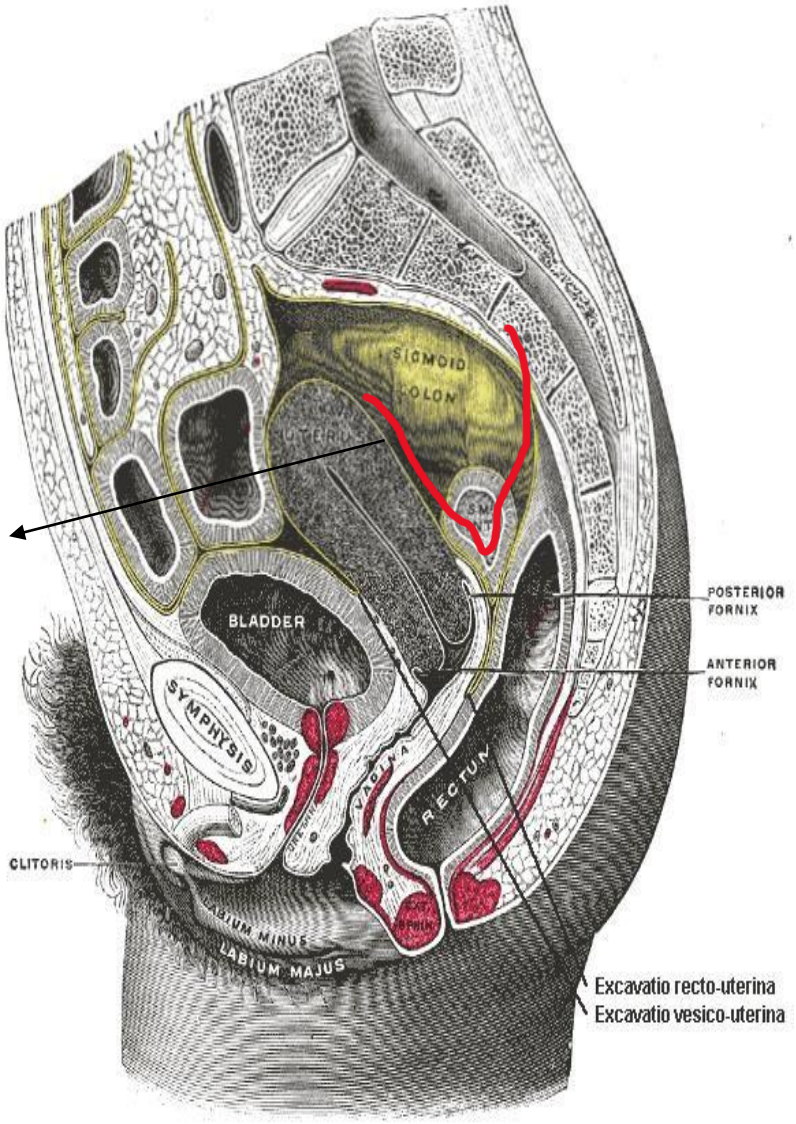
- ➢ Relations to the sigmoid colon:
- ✓ **Left:**

1. Lft ext iliac vesseles
2. Lat wall of pelvis
3. Vas defferance (male) Ovary (female)

- ✓ **Right and sup:**
- Small intestine

- ✓ **Inferior:**
- In male urinary bladder, in female uterus

Douglas pouch



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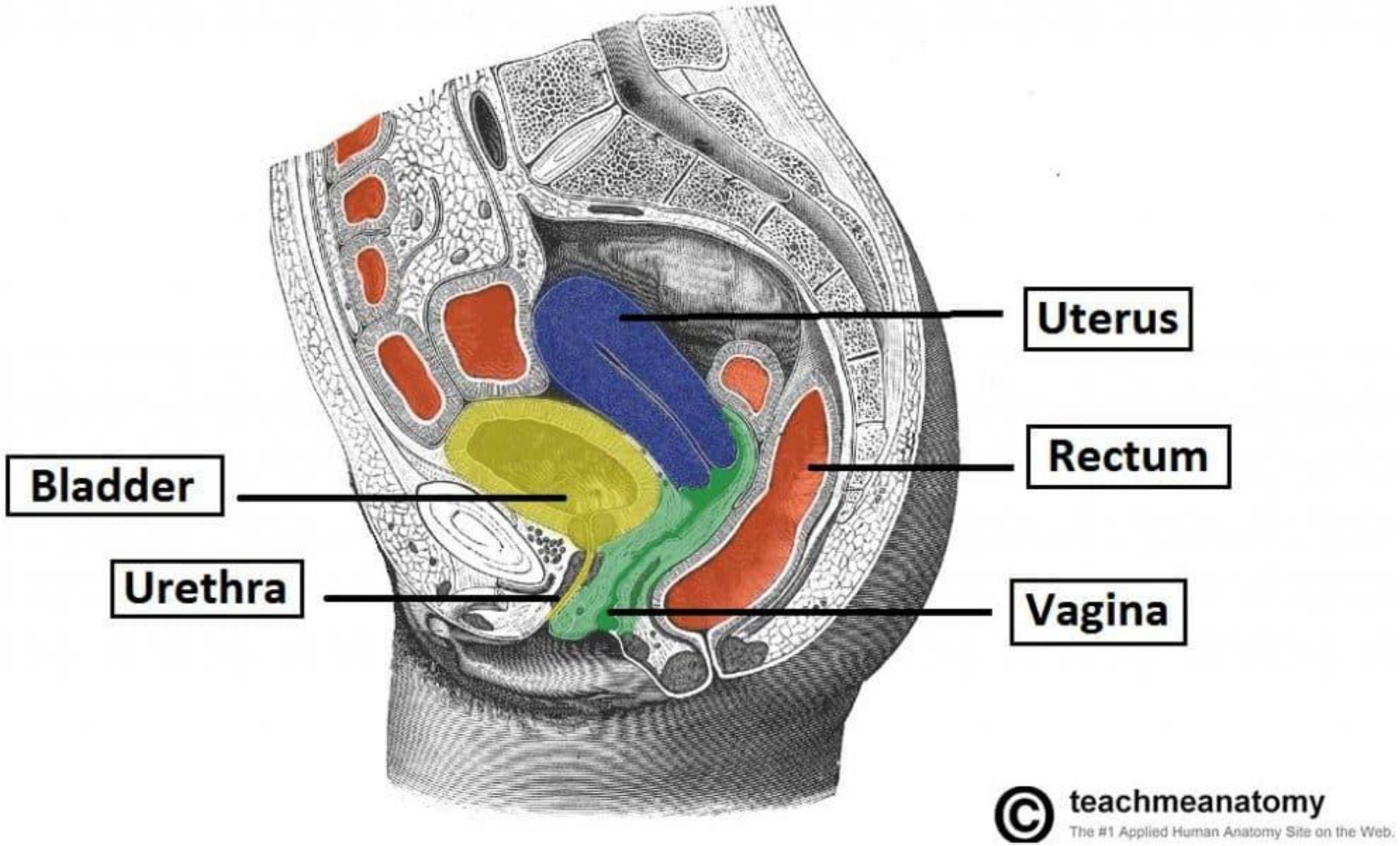


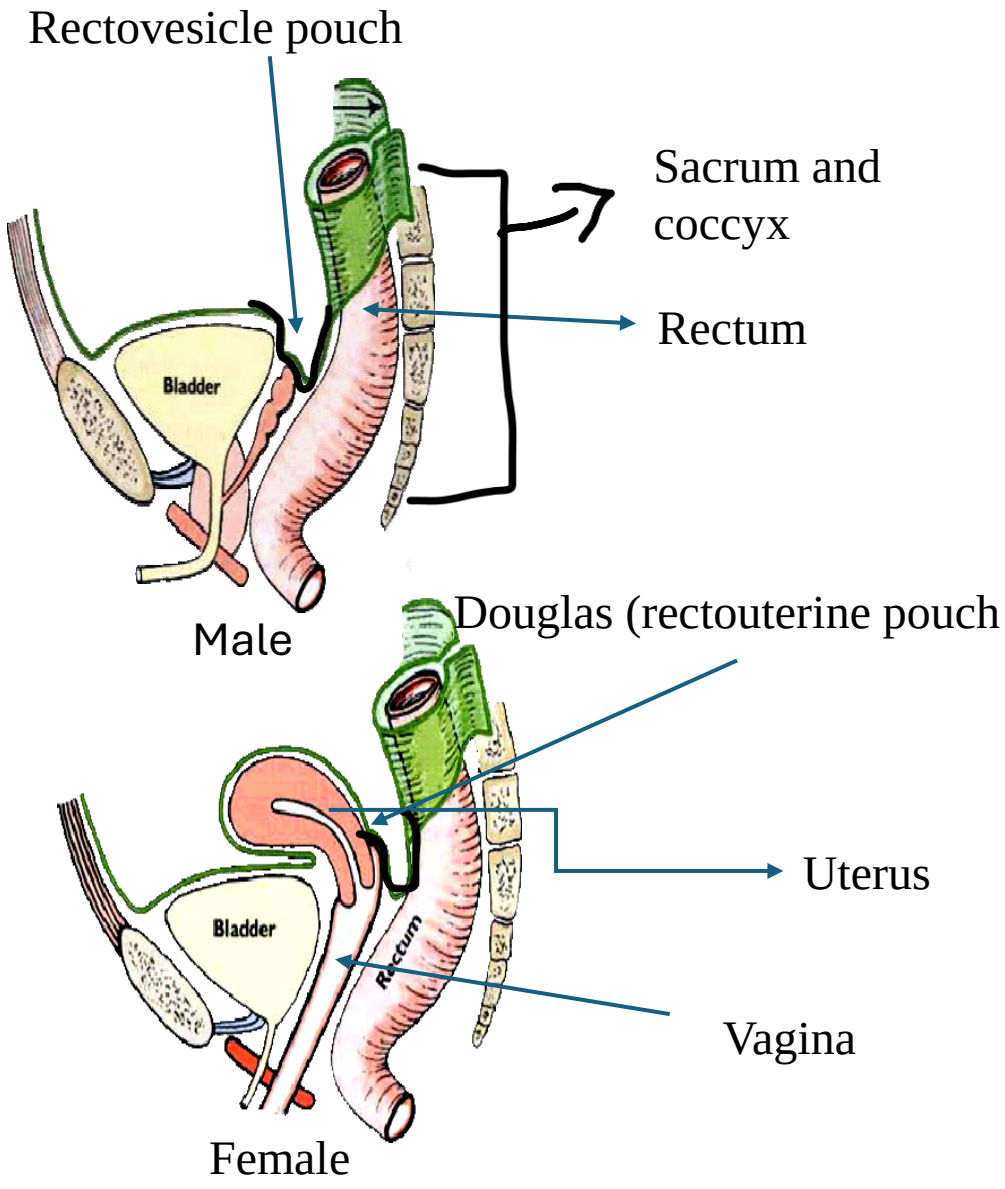
3 – Relations of the Sigmoid

Posteriorly:

1. The rectum
2. the sacrum.
3. coils of the ileum
4. Sacral plexus of nerves
5. Lt.periformis muscle
6. Lt. external iliac vessels
7. Lt.Ureter
8. Lt. internal iliac artery

✓ The sigmoid colon usually occupies the **rectovesical pouch in males** and the **rectouterine pouch in females**

✓ Beneath this pouch we can see the seminal vesicle and the ejaculatory duct that opens in the prostatic urethrae



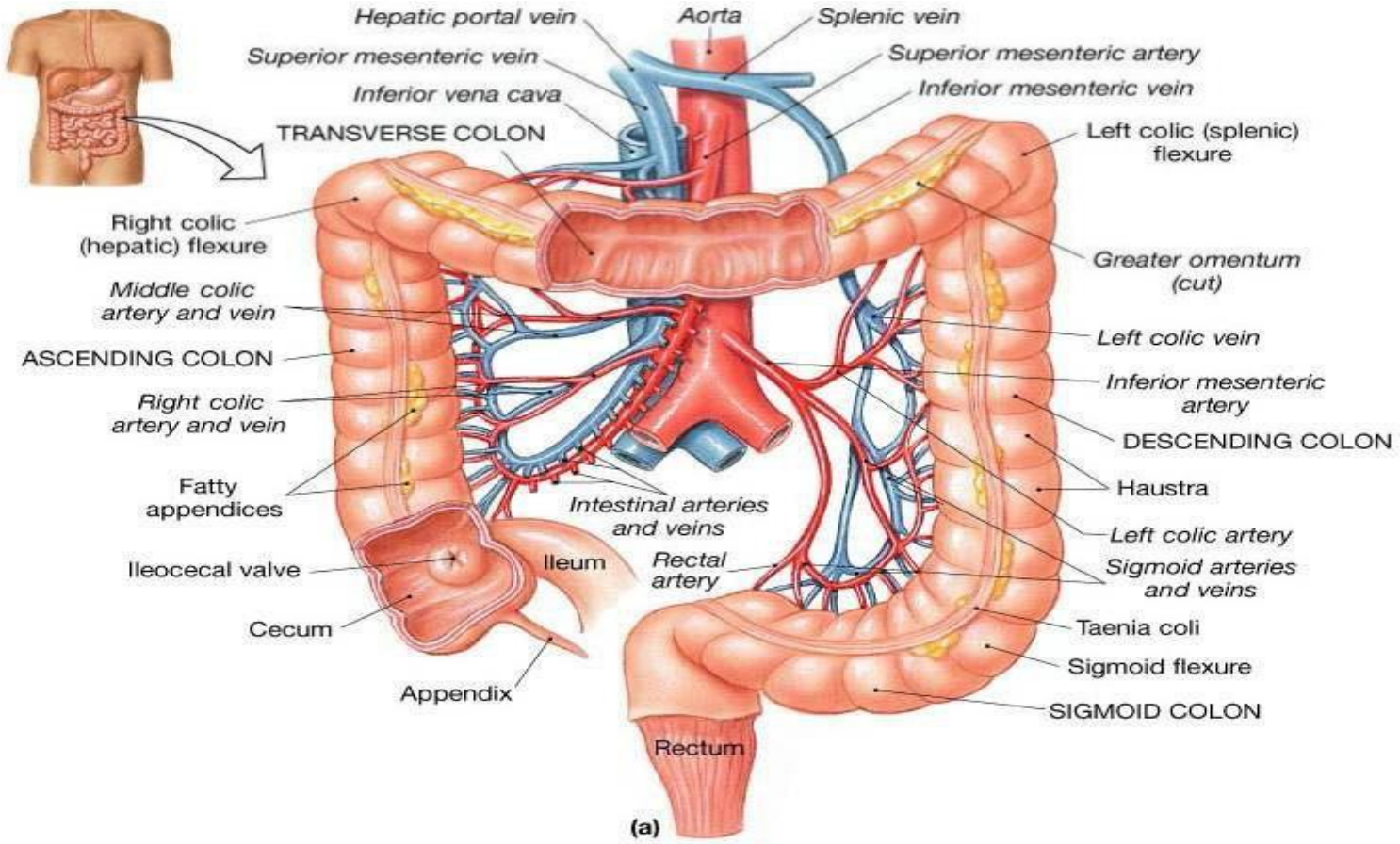
3 – Sigmoidal Blood Supply

✓ **<u>Arteries</u>**

1. Sigmoidal artery
2. Left colic artery

✓ The sigmoid colon is a part of the hind gut, so the blood supply is from branches of the inf. mesenteric artery.

✓ Note that the arteries are medial to the veins thus the veins are lateral to the arteries.



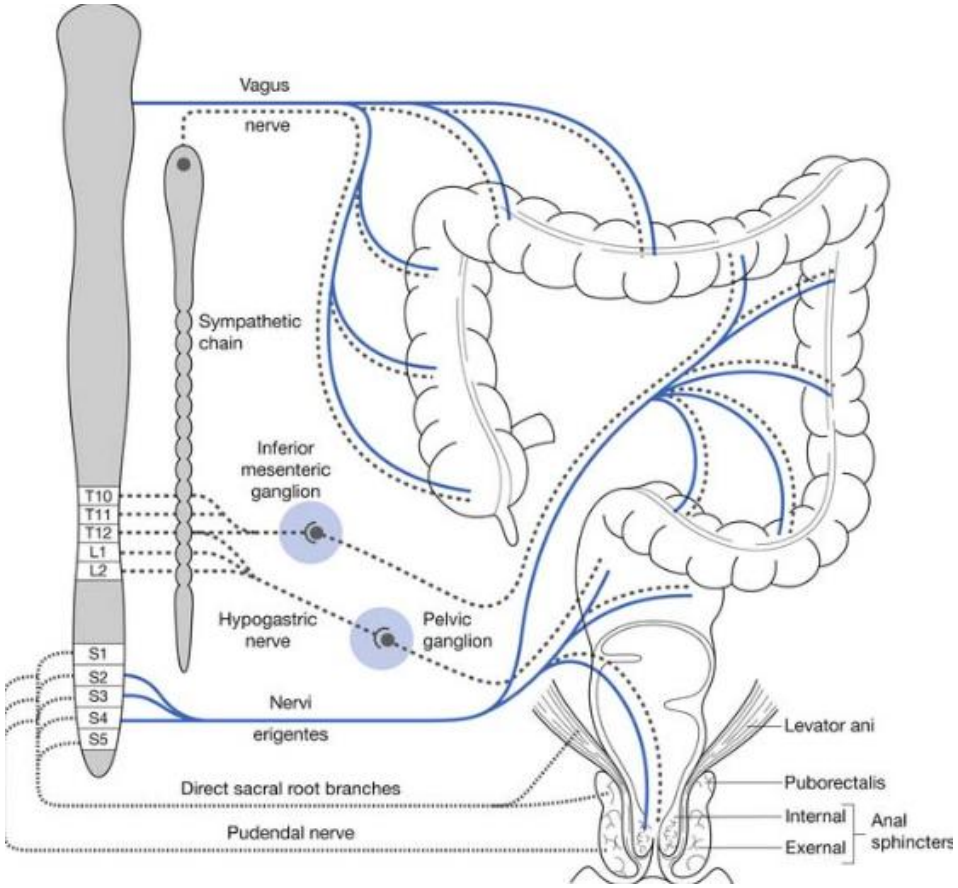
4 – Sigmoidal Lymph Drainage and nerve supply

- ✓ Lymphatic drains into inf mesenteric lymph nodes → sup mesenteric → celiac → cisterna chyli → Lft thoracic duct.

- ✓ The sympathetic and parasympathetic nerves from the inferior hypogastric plexuses

- ✓ The sympathetic originates from L1-L2 and the splanchnic goes towards the inf mesenteric ganglia, the post ganglionic is called the hypogastric plexus which carries the sympathetic and the parasympathetic

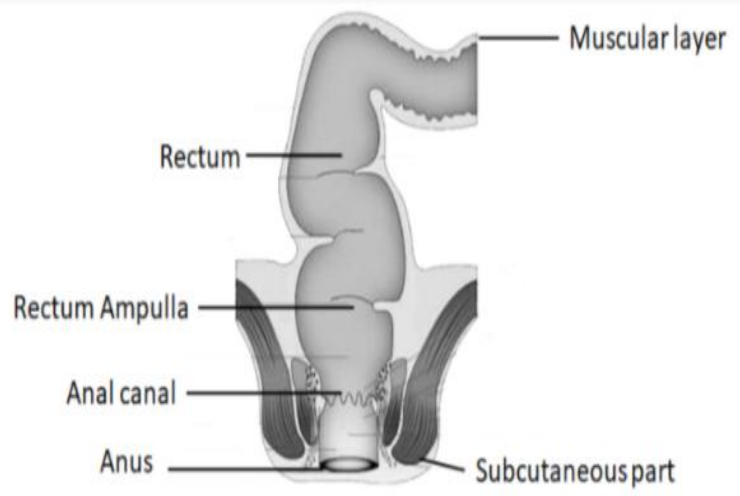
- ✓ The parasympathetic is derived from pelvic splanchnic nerve originating from S2,3,4, NOT THE VAGUS, the vagus ends at the lateral third of the transverse colon.



5 – Rectum architecture

Location and Description

- ✓ The rectum is about 5 in. (13 cm) long
- ✓ begins in front of the middle piece of the sacrum as a continuation of the sigmoid colon.
- ✓ ends one inch beyond the tip of the coccyx
- ✓ The rectum shares many characteristics with the upper half of the anal canal, they have the same blood supply, venous drainage, lymphatic drainage and same innervation
- ✓ But the lower 2cm of the anal canal is different, we divide the anal canal into two parts, 2cm each, upper and lower.
- ✓ **The puborectalis portion of the levator ani muscles** forms a sling around junction between the rectum and the anal canal, the anorectal junction (important in defecation)
- ✓ The lower part of the rectum is dilated to form the **rectal ampulla; it is considered a reservoir of stool**.

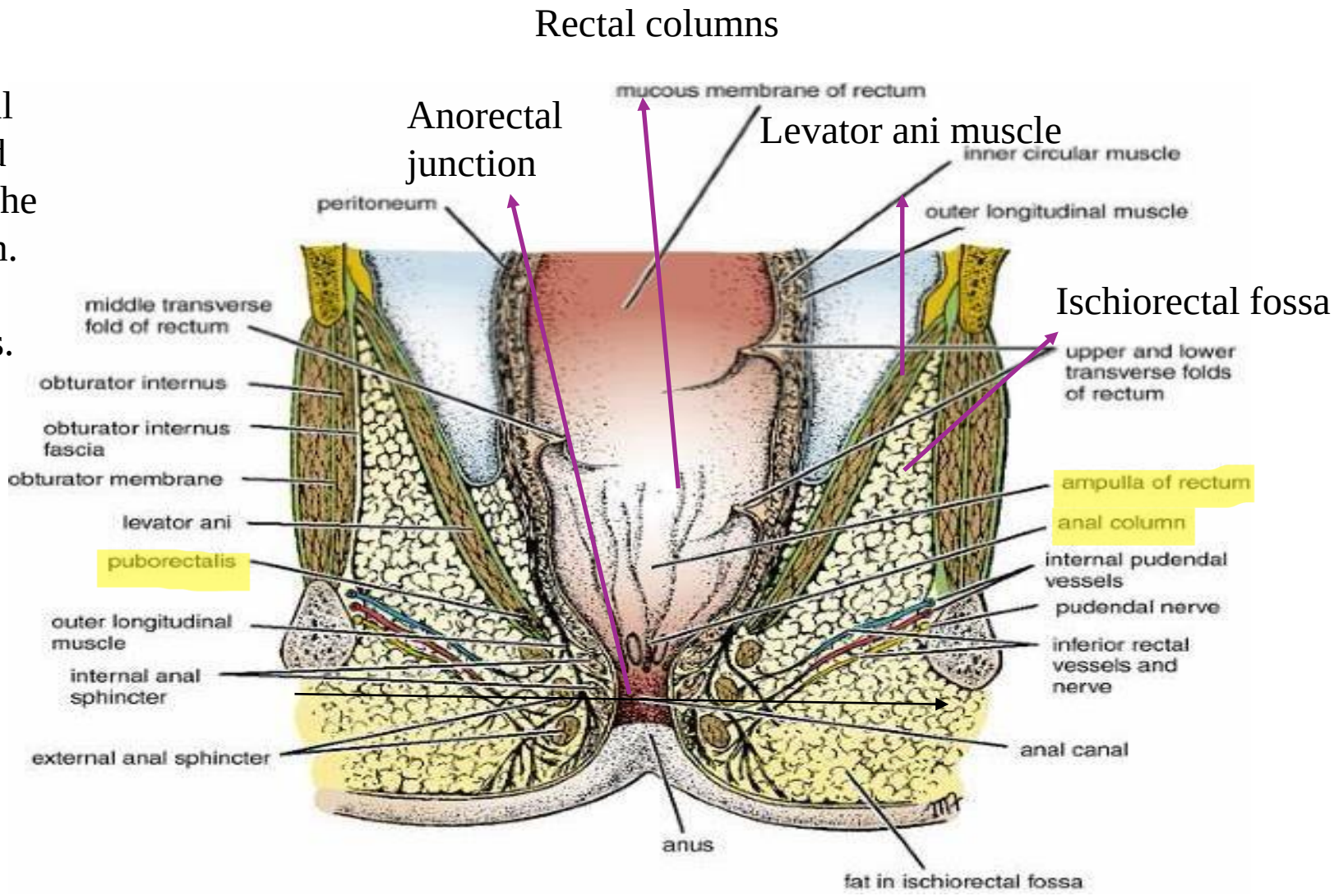


5 – Rectum architecture

- ✓ On both sides of the rectum and the anal canal we have the ischiorectal fossa and it's filled with fat; it gives dilatation in the rectum and anal canal during defecation. On the other hand, it can get infected resulting in an abscess, perianal abscess.

- ✓ Anorectal junction: the junction between the rectum and the anal canal.

- ✓ Longitudinal folds called rectal columns which continue as anal columns, which at their end they make anal valves (end) and anal sinuses (pocket)



5 – Rectum architecture

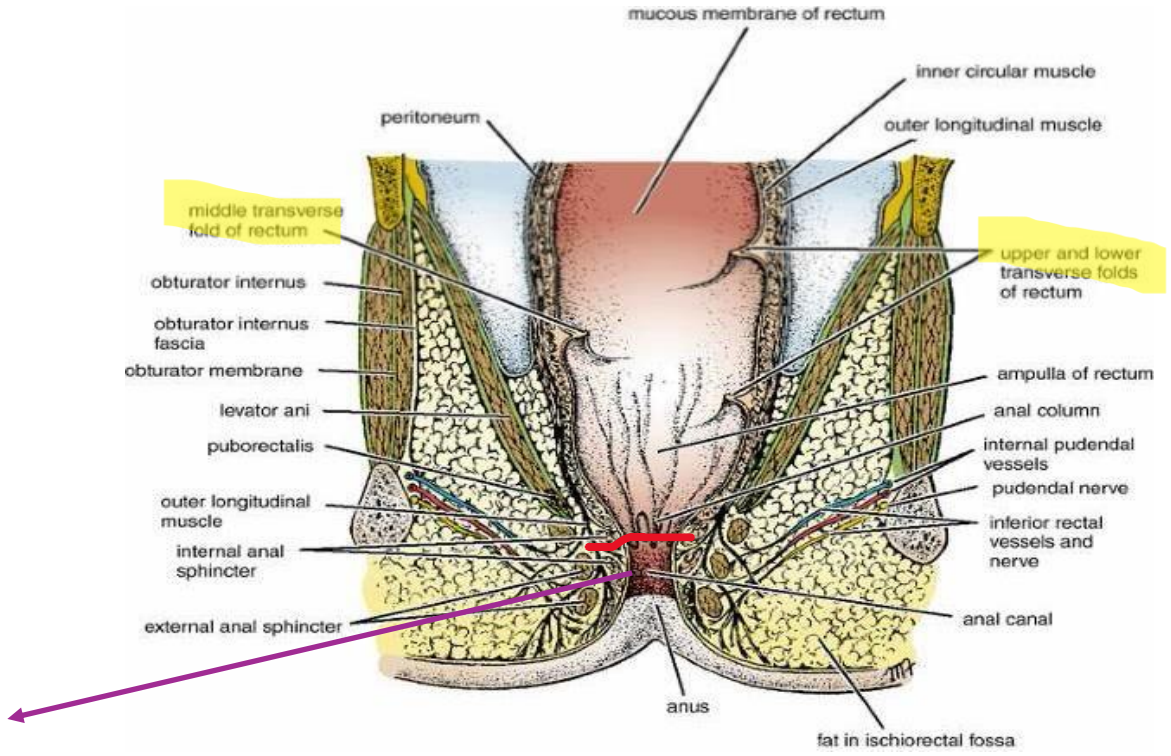
- ✓ **The upper half (2 cm) of the anal canal resembles the rectum.**
- ✓ The lower half (2 cm) is different:
  - The upper cm: stratified squamous non-keratinized.
  - The lower cm: stratified squamous keratinized.

The origin from embryo:

- ✓ **Upper 2cm: Endothelium (endoderm)**
- ✓ **Lower 2cm: Ectoderm.**

- ✓ The transverse folds are the reason behind the concavity on the right and left sides

- ✓ Pectinate line, which divides the upper 2cm from the lower 2cm (upper half from the lower half of the anal canal) it lies directly below the valves mentioned in the previous picture



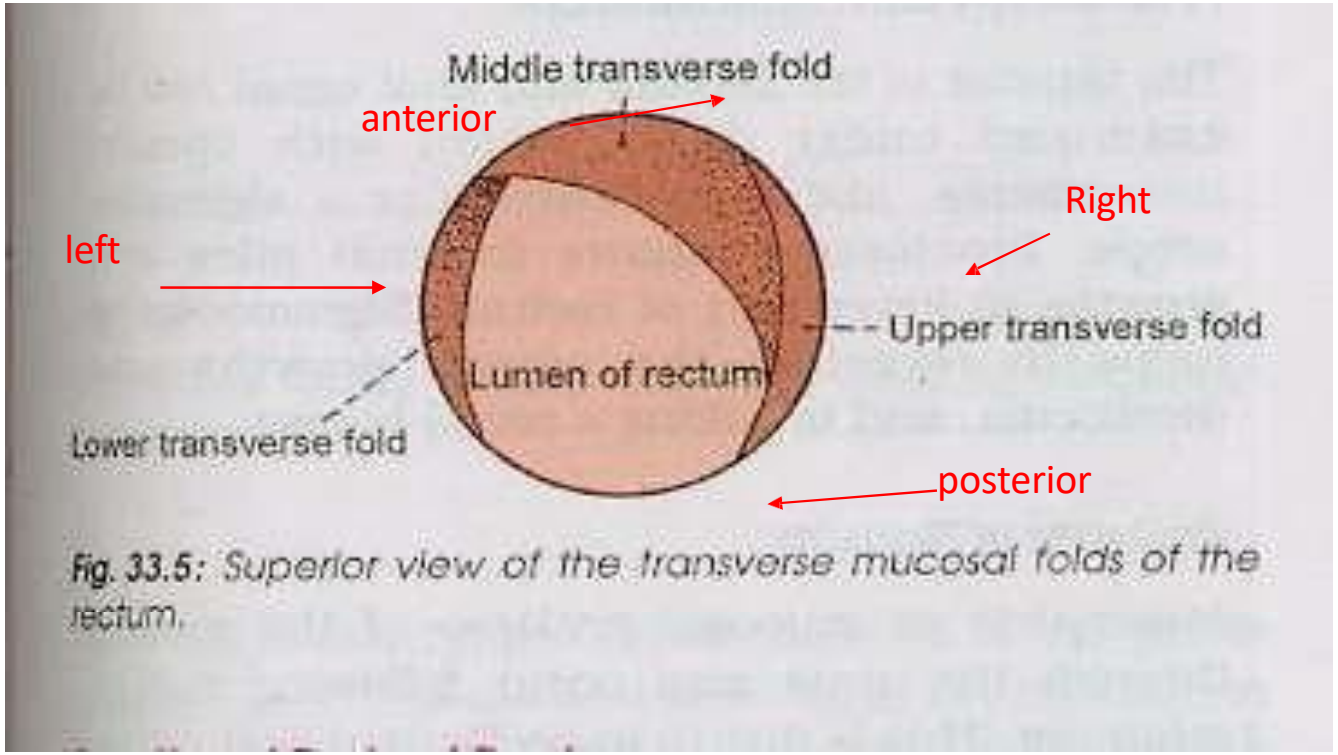


Fig. 33.5: Superior view of the transverse mucosal folds of the rectum.

- ✓ This picture shows the transverse folds that have been mentioned before.

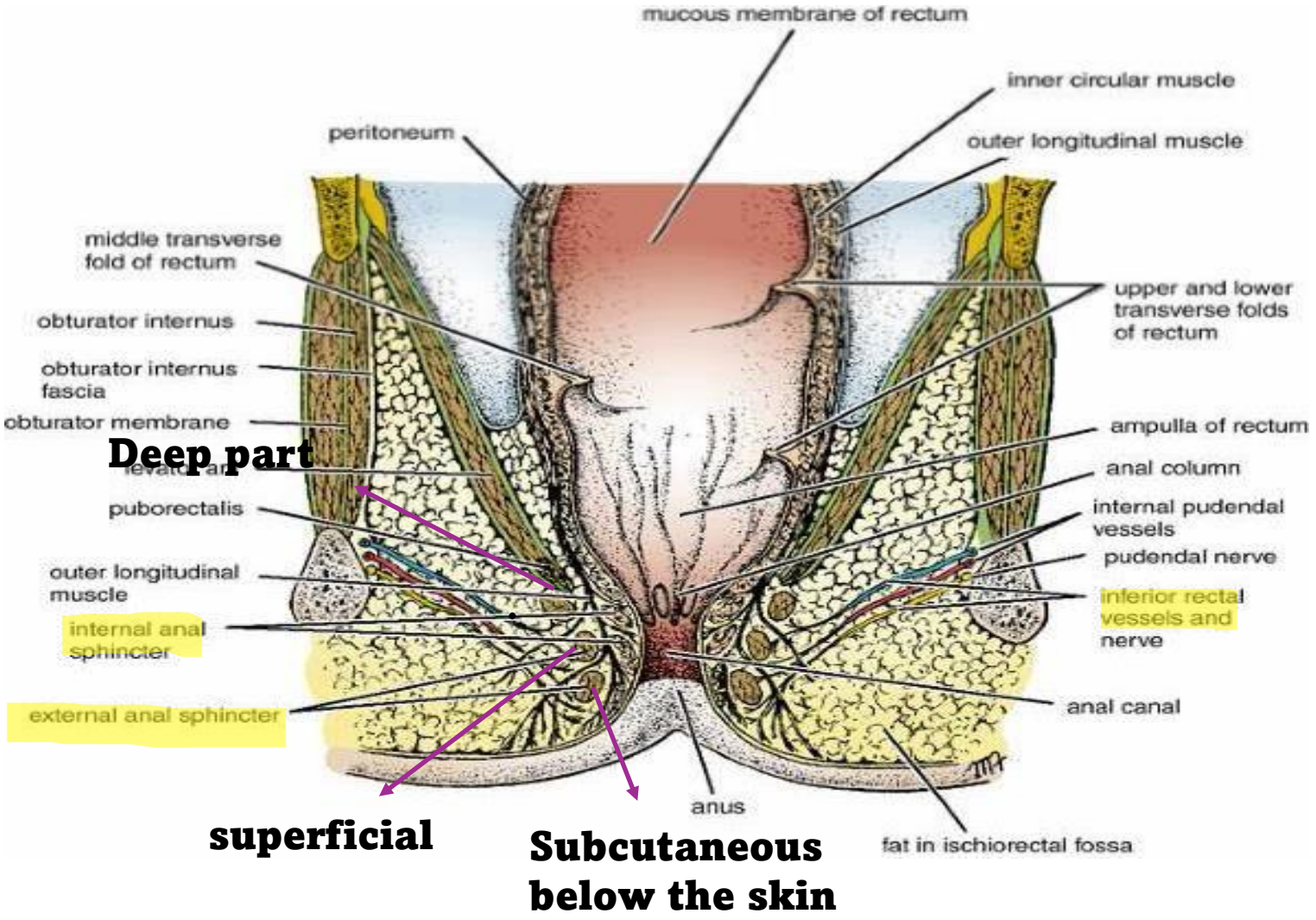
6 – Anal Sphincters

- ✓ Internal anal valve is within the submucosa
- ✓ It's involuntary so innervated by sympathetic and parasympathetic.

- ✓ External anal sphincter, we have 3 of them and are supplied by inferior rectal vessels and nerves S4 (voluntary)

- ✓ An injury to S4 results in incontinence, uncontrolled defecation

- ✓ The voluntary is more important since it controls defecation
- ✓ The involuntary "ملوش دعوة"



7 – Rectal Curves

- ✓ The rectum is anteriorly concave, has the concavity of the sacrum.
- ✓ If we look at the rectum from the left side, we find two concavities
- ✓ From the right side one concavity.
- ✓ The lining epithelium of the colon is simple columnar with goblet cells.

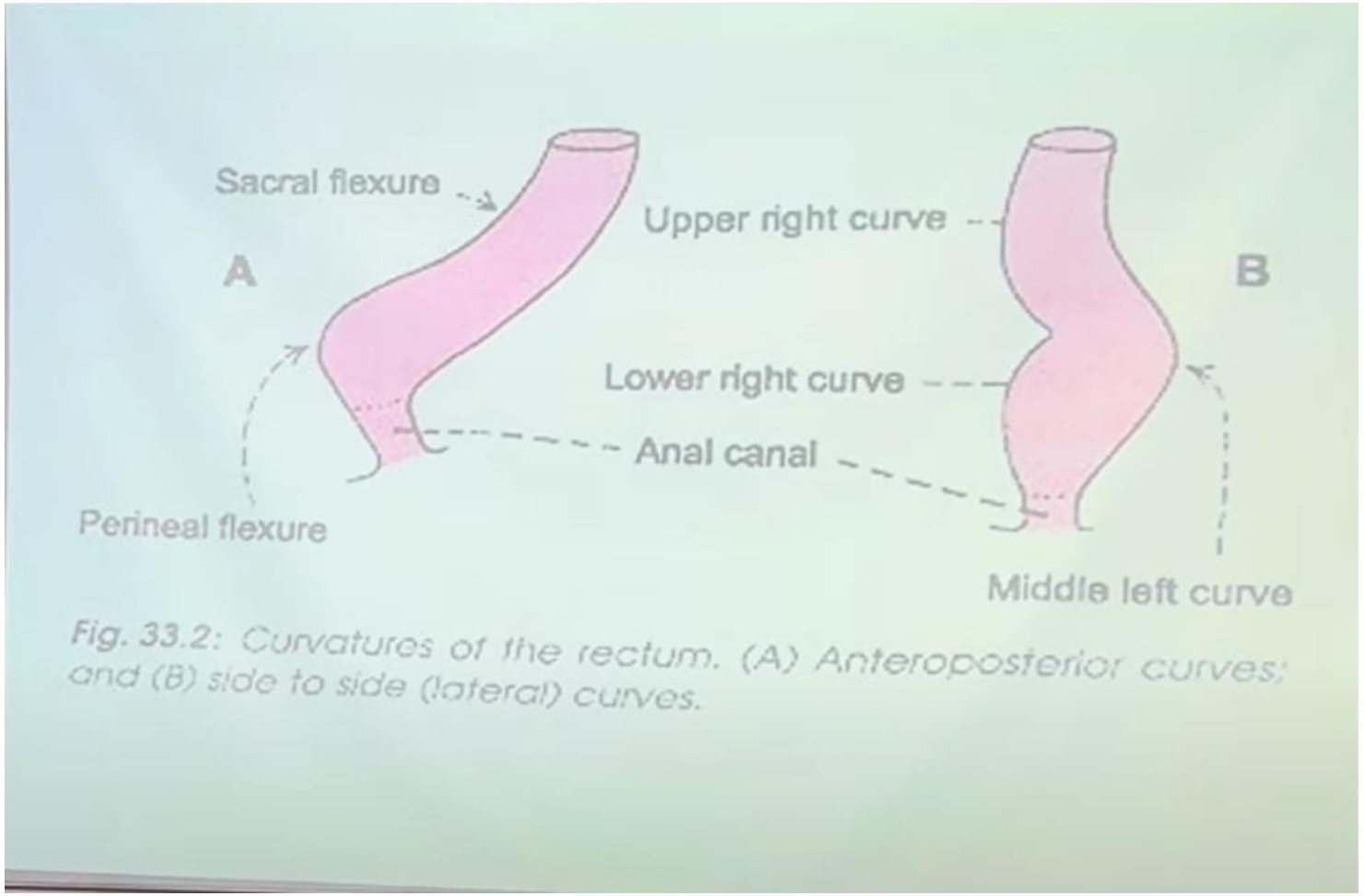


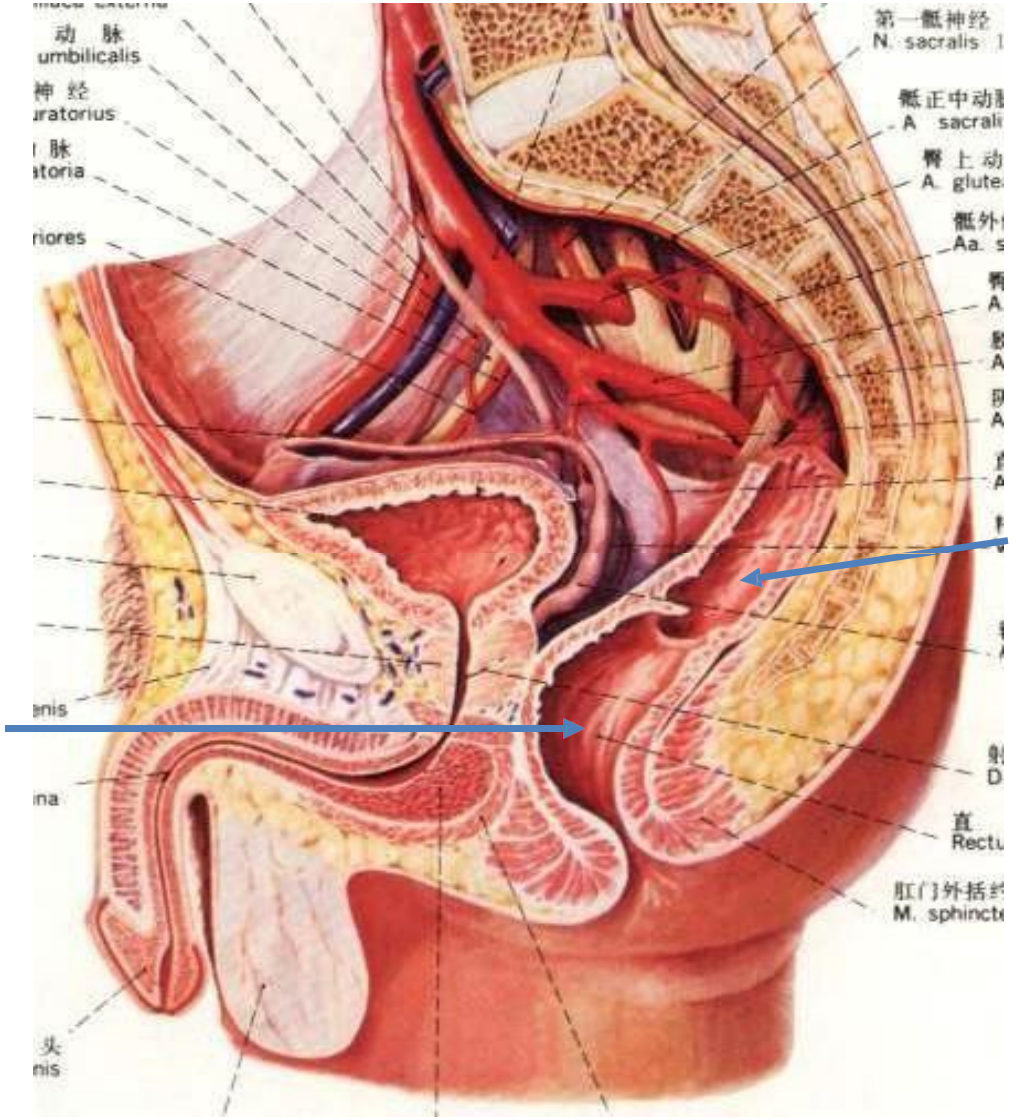
Fig. 33.2: Curvatures of the rectum. (A) Anteroposterior curves; and (B) side to side (lateral) curves.

8 – Rectal Examination

✓ Bare rectal examination:

- The examinator puts his finger inside the anal canal and to the rectum and starts palpating the anterior wall sensing the urinary bladder, the seminal vesicle, the vas deference and the prostate.

- This examination is very important for the prostate in males.
- So, if a patient who's above 50 went the emergency, you should do this examination because in old age it becomes firm due to fibrosis instead of soft also in malignancy it becomes a very hard object.



9 – Rectum & peritoneum

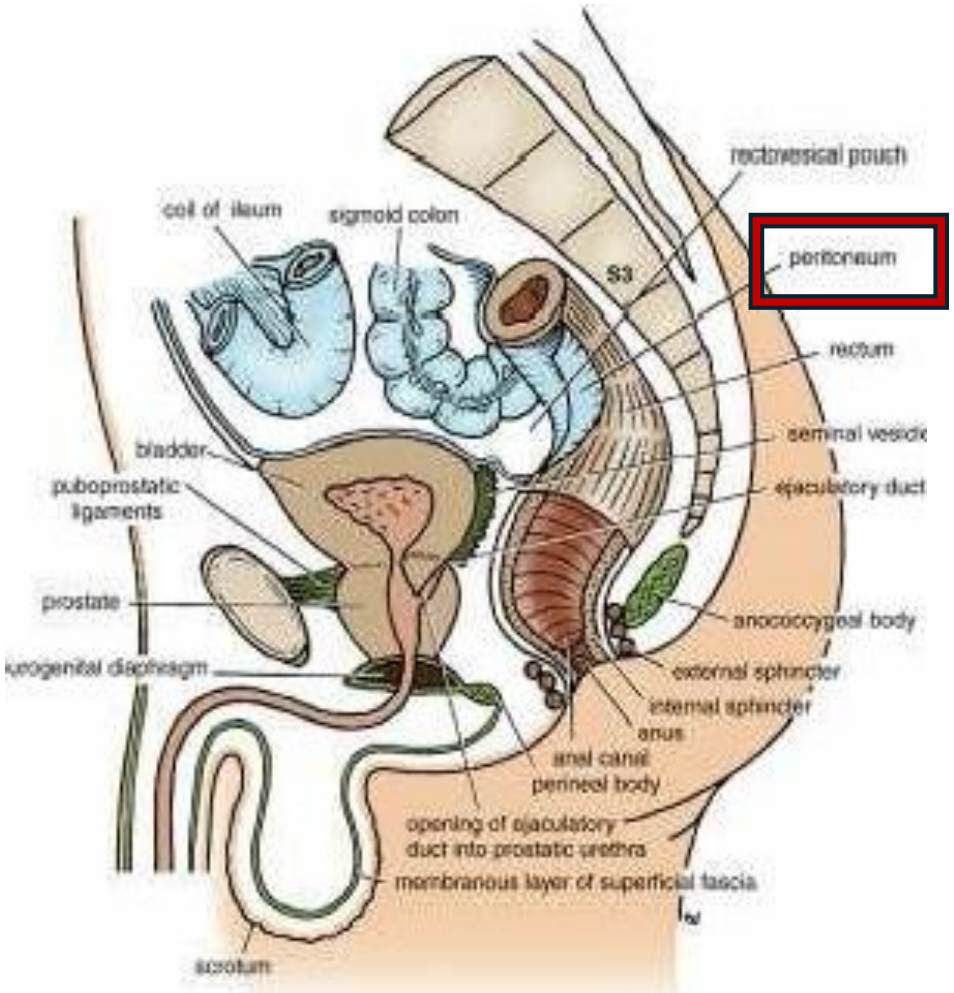
- ✓ The rectum is divided into three parts:

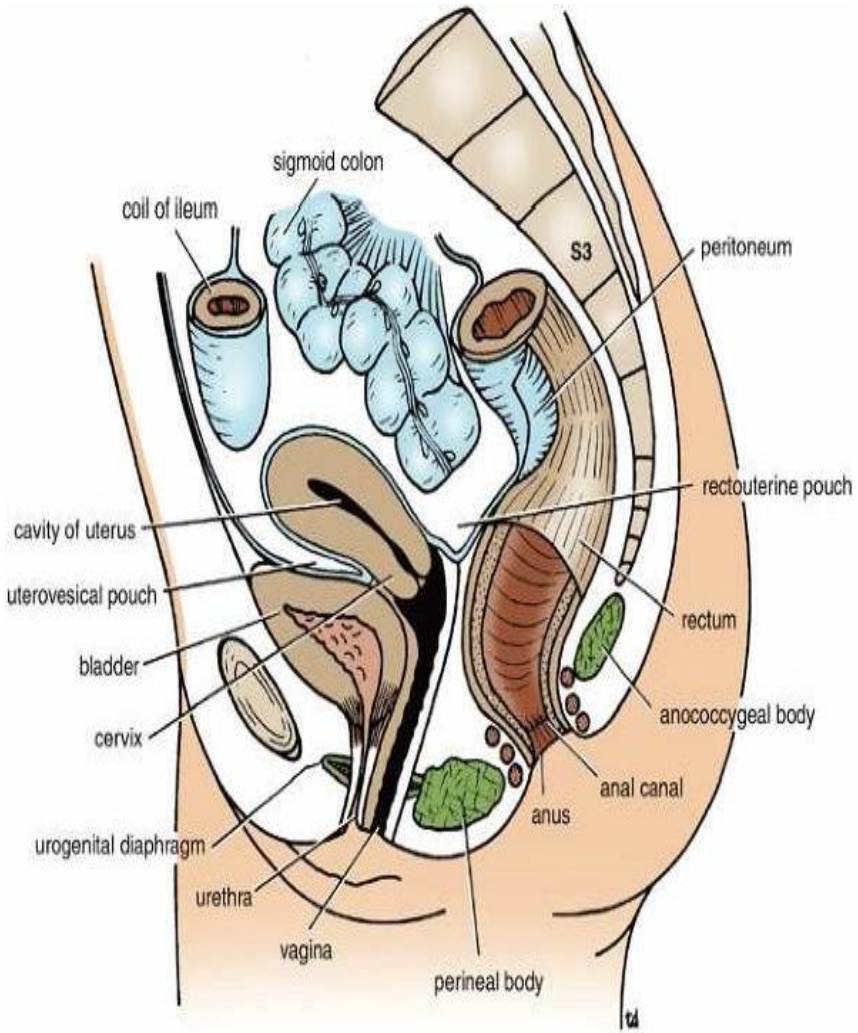
1. Upper third is covered by peritoneum from the anterior and two sides (like the descending colon).
2. middle third only the anterior is covered by peritoneum (which makes the pouches, douglas in females and rectovesicle in males)
3. the lower third is devoid of peritoneum.

10 – Relations of Rectum

Anterior relations:

Sex	Region	Peritoneal Covering	Structures
Male	Upper two-thirds	Covered by peritoneum	Rectovesical pouch, sigmoid colon, coils of ileum
	Lower third	Not covered by peritoneum	Urinary bladder, vas deferens, seminal vesicles, prostate
Female	Upper two-thirds	Covered by peritoneum	Sigmoid colon, ileum, rectouterine pouch (pouch of Douglas)
	Lower third	Not covered by peritoneum	Posterior surface of the vagina


rectovesical pouch
coil of ileum
sigmoid colon
S3
peritoneum
rectum
bladder
puboprostatic ligaments
prostate
urogenital diaphragm
anococcygeal body
external sphincter
internal sphincter
anus
anal canal
perineal body
opening of ejaculatory duct into prostatic urethra
membranous layer of superficial fascia
scrotum


sigmoid colon
coil of ileum
S3
peritoneum
rectouterine pouch
cavity of uterus
uterovesical pouch
bladder
cervix
rectum
anococcygeal body
anal canal
anus
urogenital diaphragm
urethra
vagina
perineal body

10 – Relations of rectum

✓ Posterior relations (***same for males and females)*** :

1. Sacrum.
2. Coccyx.
3. Origin of piriform, coccygeus and levator ani muscles.
4. Sacral plexus.
5. Sympathetic chain.
6. Lateral sacral arteries.

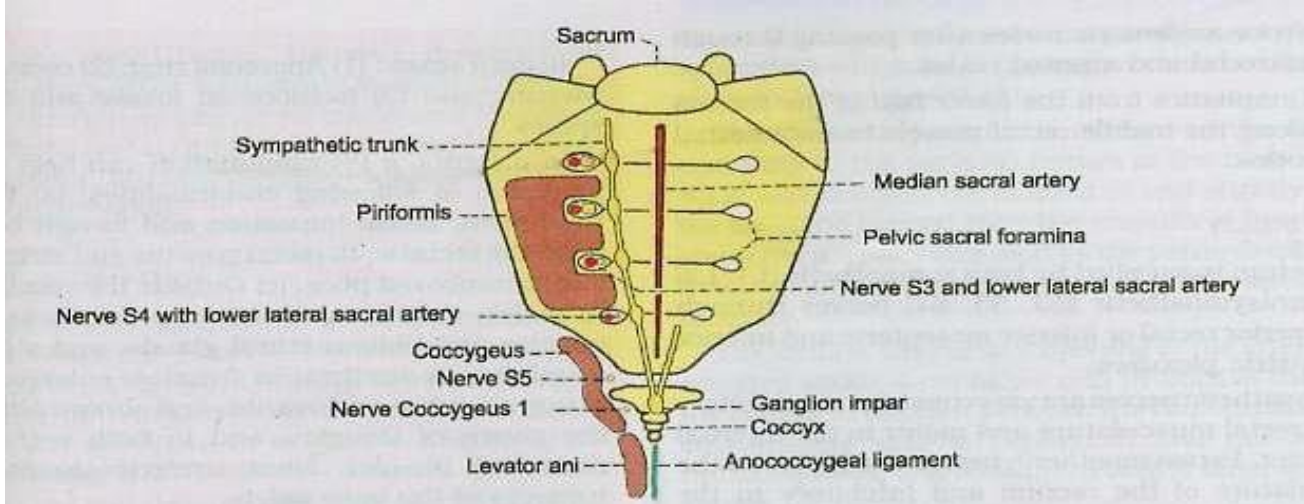


Fig. 33.4: Posterior relations of the rectum (below the level of the middle of the third piece of the sacrum).

11 - Blood supply of rectum

1.Superior rectal artery:

-continuation of inferior mesenteric artery.
-supplies the **rectum** and the **upper part of the anal canal**.

2.middle rectal artery:

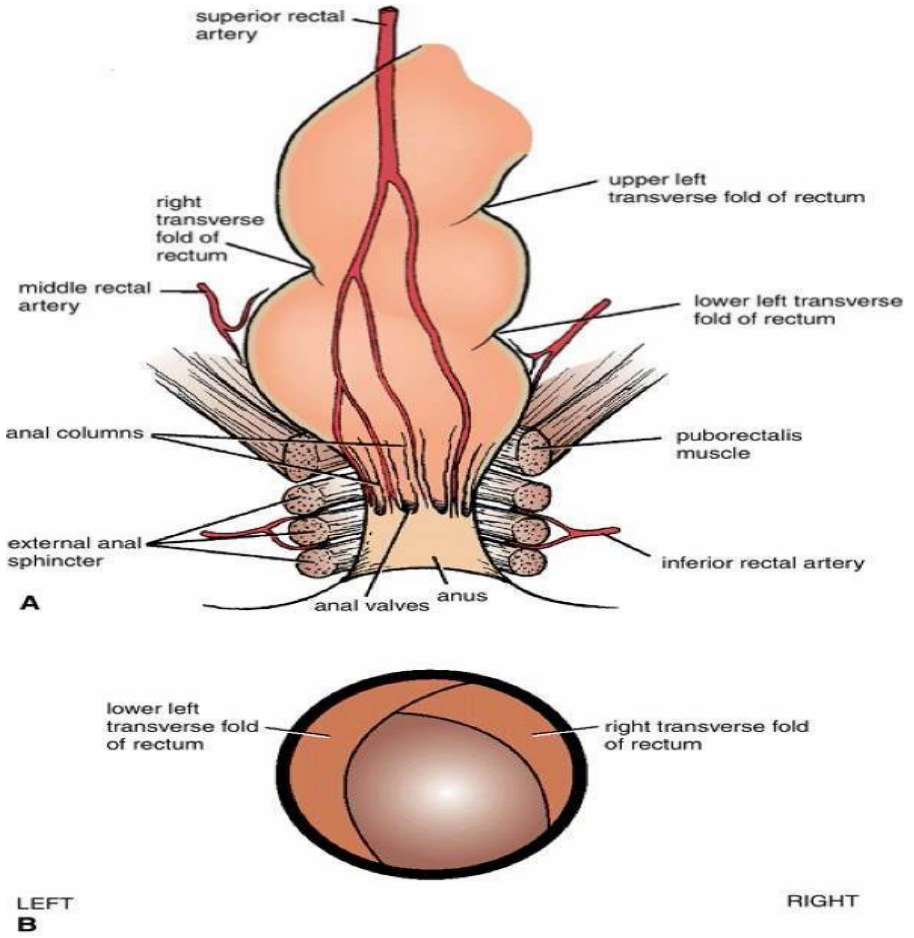
-branch of internal iliac artery.
-supplies the lower part of anal canal

3.Inferior rectal artery:

-branch of internal pudendal artery (branch of internal iliac)
-supplies the lower part of anal canal

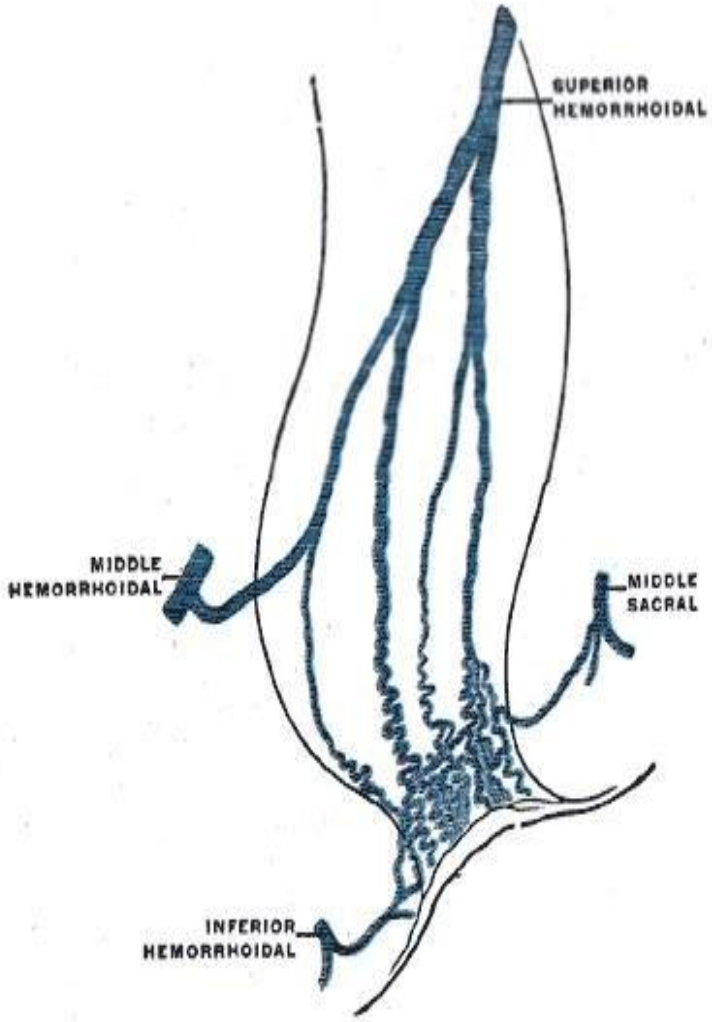
11 - Blood supply of rectum

- ✓ The superior, middle and inferior rectal arteries supply the rectum.
- ✓ There are anastomoses between these arteries.
- ✓ The **lower part of the anal canal** is supplied by the **middle and inferior rectal arteries**, which are branches of the internal iliac artery.

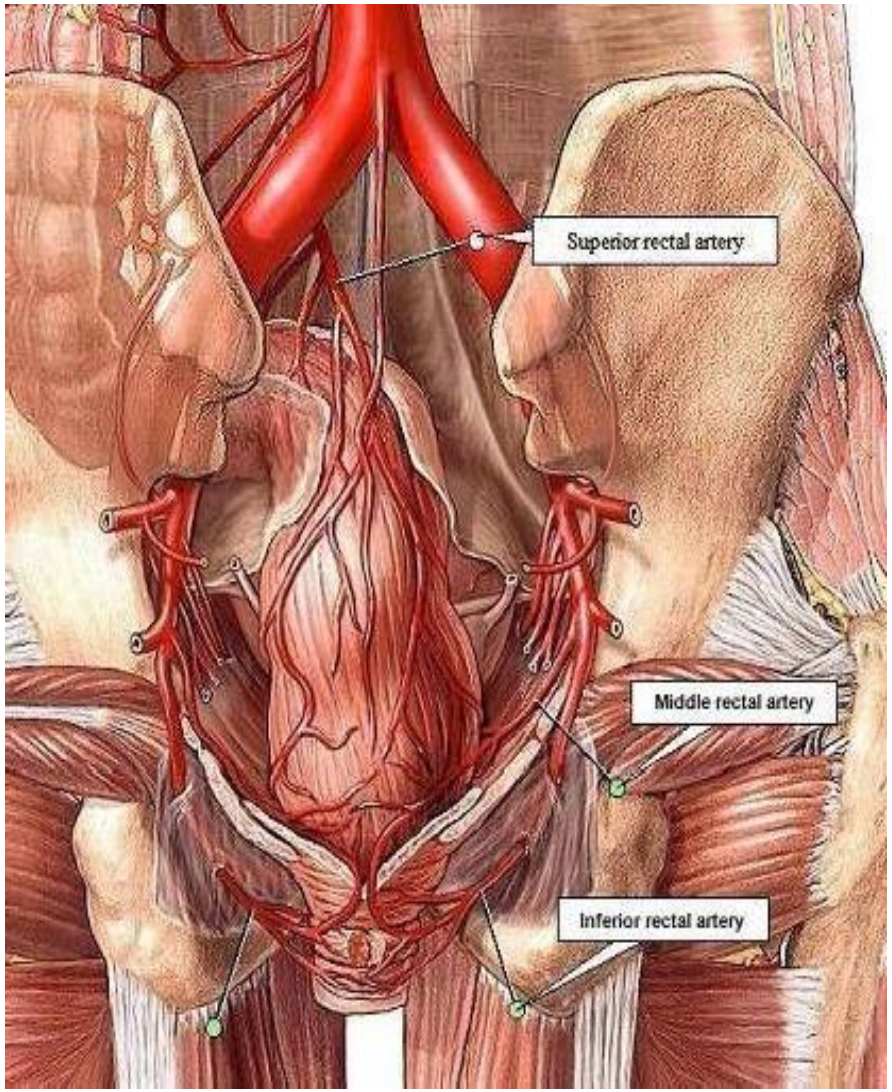


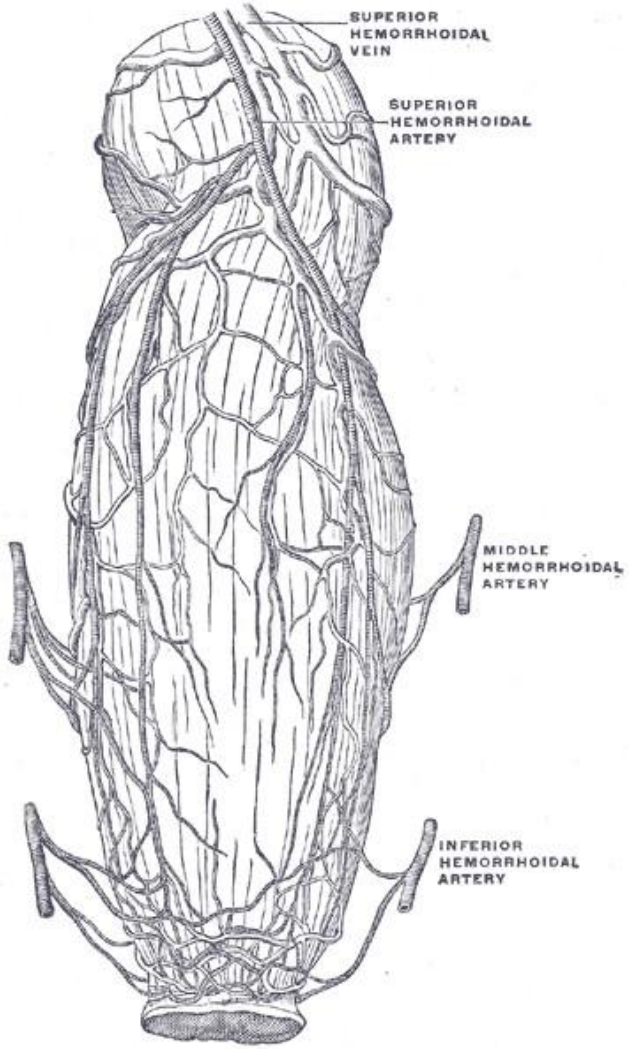
11 - Blood supply of rectum

- ✓ The superior rectal vein drains into the inferior mesenteric vein, which drain into splenic vein, which in turn drains into the portal vein (→ part of the **portal circulation**).
- ✓ The middle and inferior rectal veins drain into the internal iliac vein and internal pudendal vein, respectively, which ultimately drain into the inferior vena cava to the heart (→ part of the **systemic circulation**).
- ✓ There is an anastomosis between the portal and systemic venous systems.
- ✓ In cases of portal hypertension**,** blood may be redirected through these anastomosis (porto-systemic anastomosis), resulting in **hemorrhoids** (also called **piles**).



11 - Blood supply of rectum



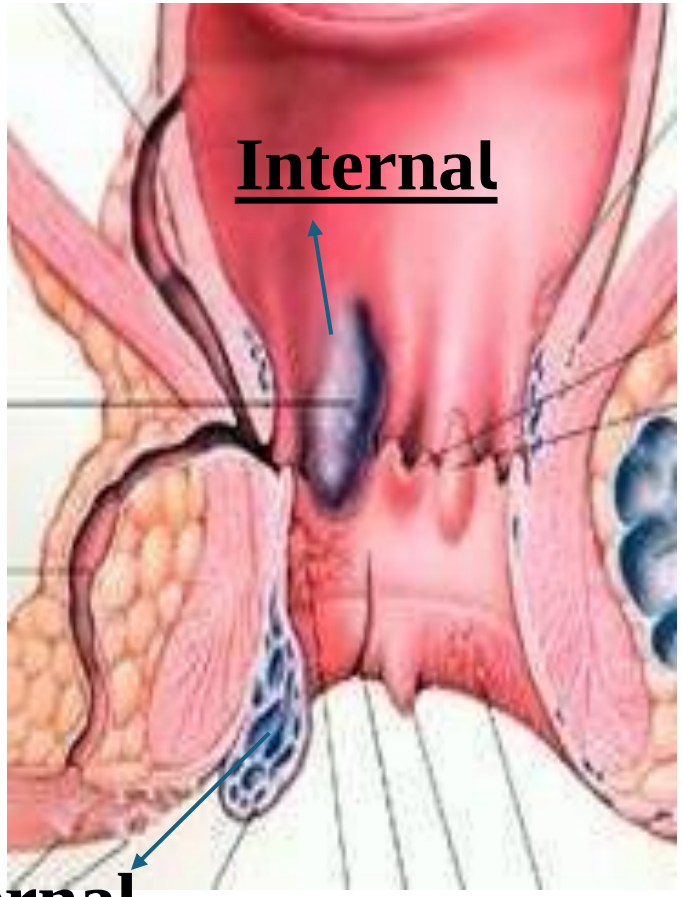


11 - Blood supply of rectum

❖ The hemorrhoidal plexus (rectal venous plexus).

- ✓ The superior rectal vein is involved in the formation of internal hemorrhoids, which occur in the upper part of the anal canal. These hemorrhoids are painless → innervated by ANS.
- ✓ they become painful in stage IV, when they prolapse with defecation outside the anus.
- ✓ The inferior rectal is involved in the formation of external hemorrhoids, which occur subcutaneously and it's painful→ innervated by S4 (somatic).

Hemorrhoids: dilatation, tortious and engorgement of blood in the vein, which can be internal or external.



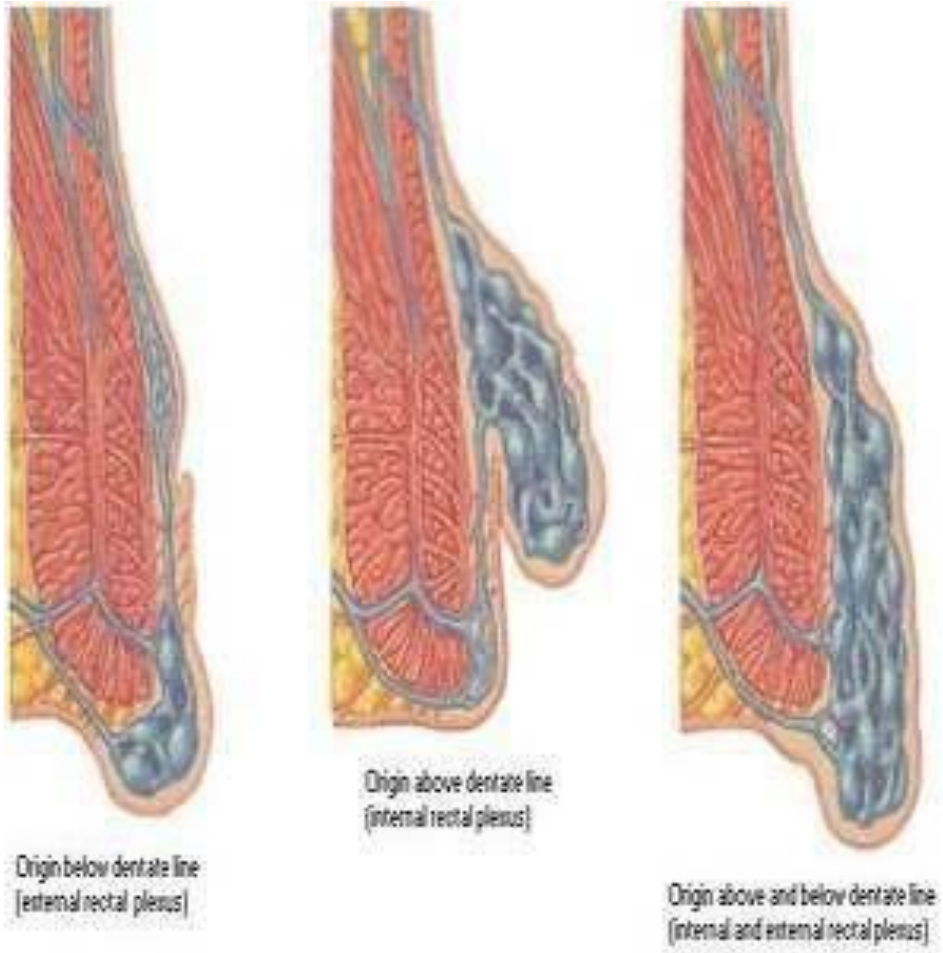
- **Internal hemorrhoids (piles)**

- **External hemorrhoids**

11 - Blood supply of rectum

✓ Causes of hemorrhoids:

1. Congenital weakness of the venous walls.
2. Chronic constipation and cough.
3. Pregnancies.
4. Portal hypertension → porto-systemic anastomoses.
5. Cancer in the rectum.



12 – Supply of rectum

Lymph drainage:

- ✓ Rectum & upper part of anal canal → para-aortic lymph nodes (inferior mesenteric → superior mesenteric → celiac → thoracic duct).
- ✓ Lower half of anal canal → superficial inguinal lymph nodes (on femoral triangle).

Nerve supply:

- ✓ Same as sigmoid
- ✓ innervated by inferior hypogastric plexuses:
  -sympathetic (L1&2) synapse in inferior mesenteric ganglia.
  -parasympathetic (S2,S3,S4) pass directly to the rectum without synapsing.

13 - Anal canal

- ✓ It is 4 cm in length.
- ✓ It is divided by the pectinate line *(located in the end of sinuses and valve of anal column)* into:
  - ✓ Upper 2 cm – continuous with the rectum.
  - ✓ Lower 2 cm.
- ✓ Anorectal Junction contains:
- ✓ The puborectalis muscle, which separates the rectum from the anal canal.
- ✓ A portion of the internal anal sphincter.
- ✓ The deep part of the external anal sphincter.

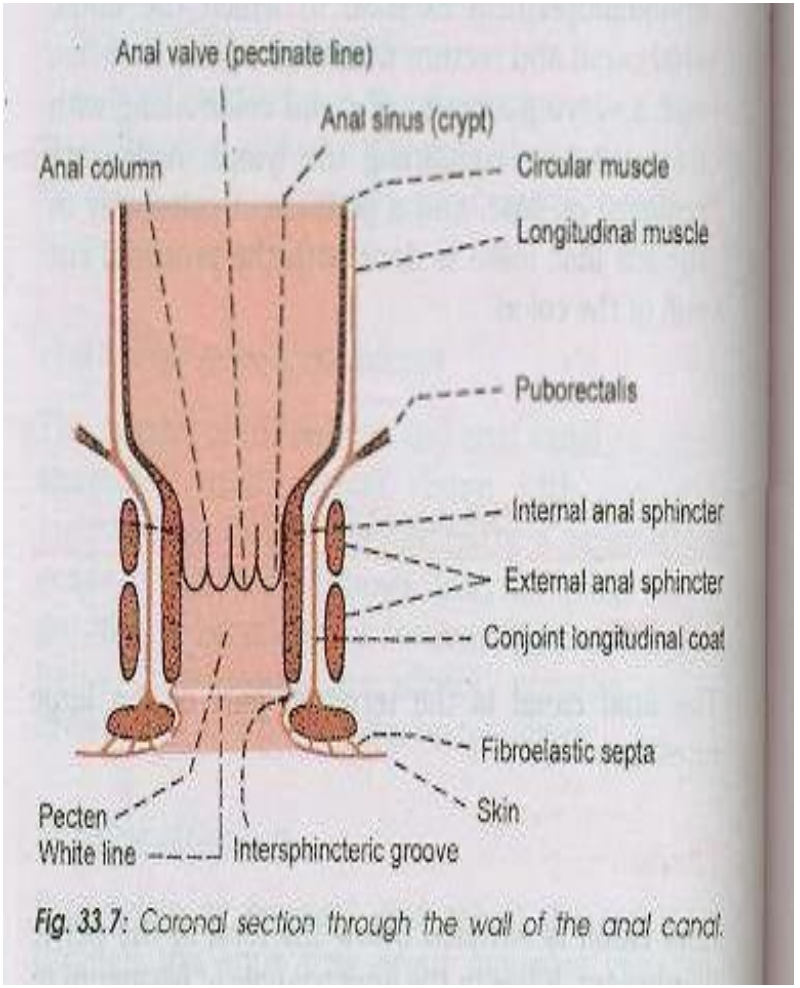


Fig. 33.7: Coronal section through the wall of the anal canal.

13 - Anal canal

- ✓ Any injury to the anorectal junction, especially involving the deep part of the external anal sphincter (voluntary sphincter) or the puborectalis muscle, can lead to incontinence.
- ✓ Injury to internal anal sphincter doesn’t cause incontinence (not voluntary).

Incontinence refers to the inability to control the voluntary discharge of urine or feces.

13 - Anal canal

- ✓ The lower half of the anal canal is divided by the white line into:

1. Upper 1 cm: lined by stratified squamous non-keratinized epithelium.
2. Lower 1 cm: lined by stratified squamous keratinized epithelium, which contains hair follicles, sebaceous glands, and sweat glands.

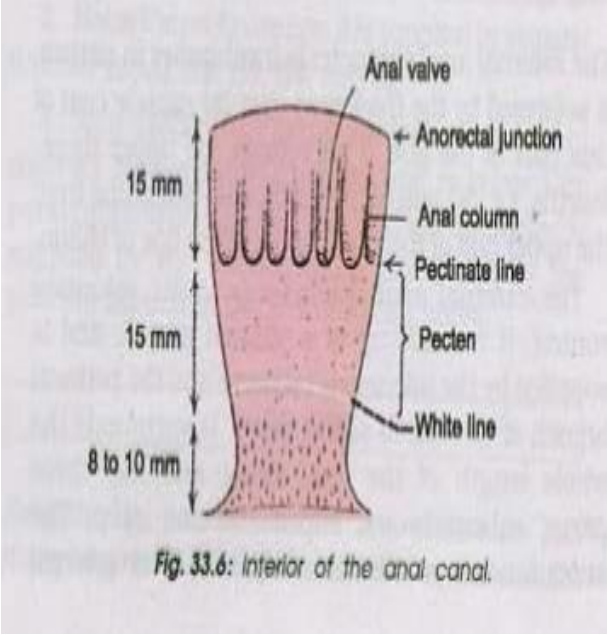
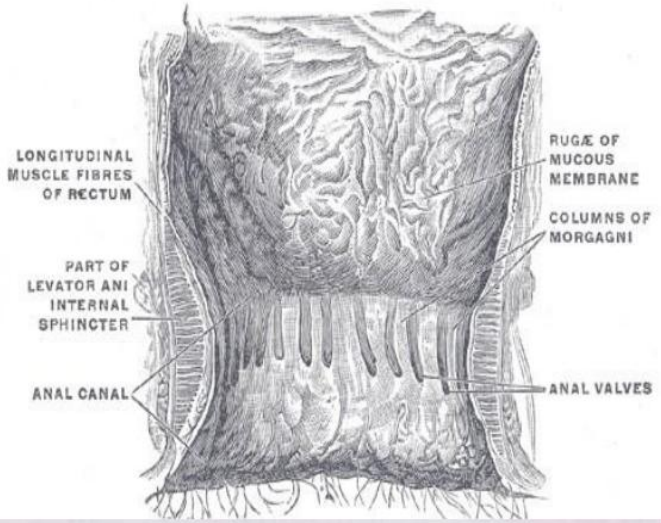


Fig. 33.6: Interior of the anal canal.



14 - Relations of Anal canal

Anteriorly

In male

- perineal body
- membranous urethra
- bulb of penis (penile)

In female

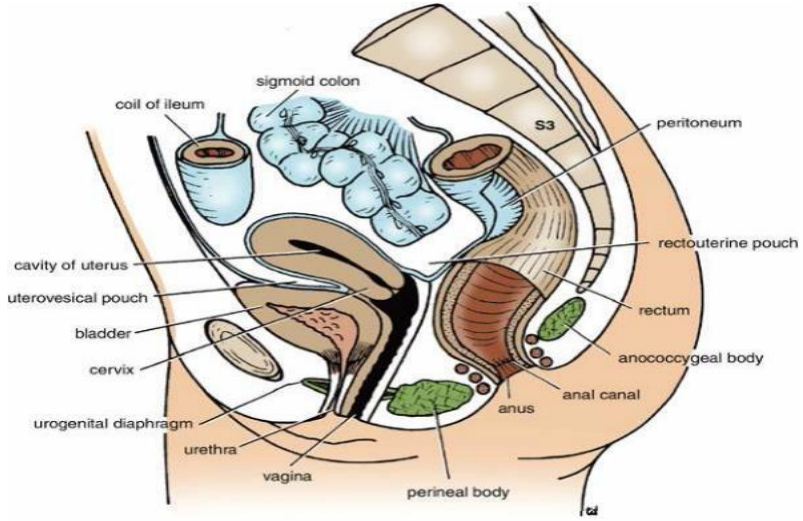
- lower end of the vagina
- Perineal body

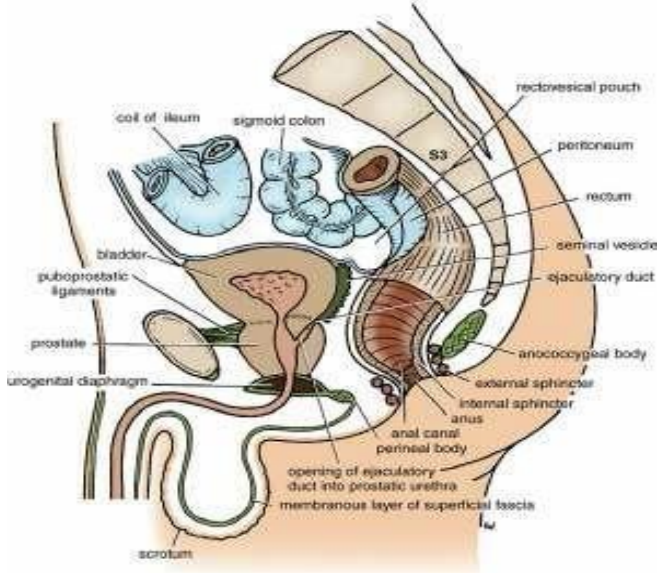
Posteriorly

- anococcygeal ligament
- tip of the coccyx

laterally

- ischiorectal fossae.





✓ Voluntary sphincter surrounds the anal canal.

15 - Musculature of the Anal canal

1. internal anal sphincter (involuntary)
2. External anal sphincter (voluntary) has three parts:

- ✓ Subcutaneous part.
- ✓ Superficial part: the only one that makes an attachment.
- ✓ Deep part: no attachment and related to anorectal junction.

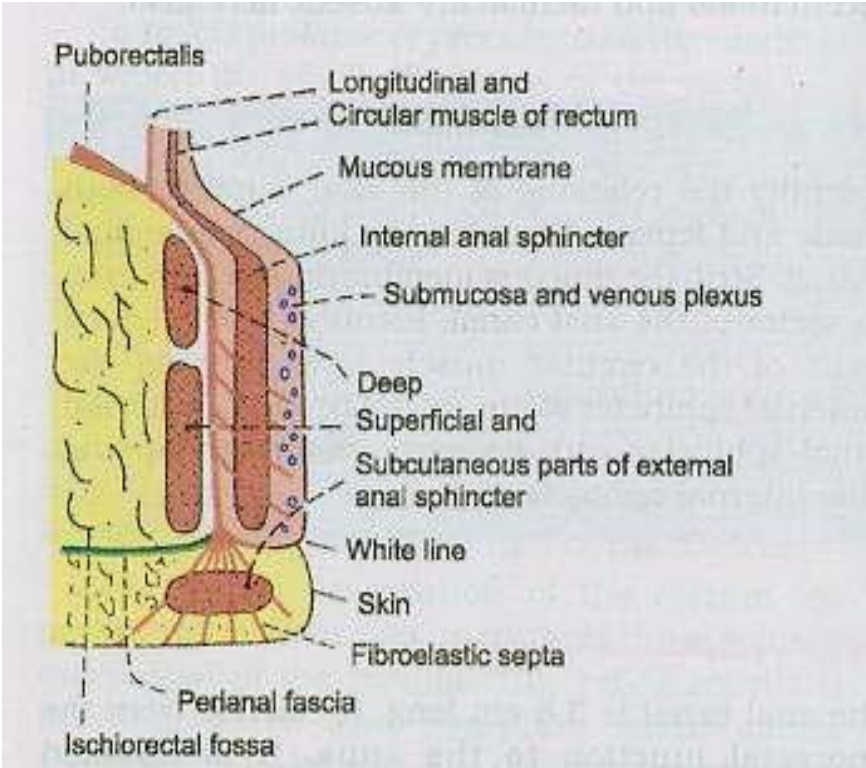


Fig. 33.8: Coronal section through the anal canal.

16 - Supply of Anal canal

Arterial supply:

- ✓ middle & inferior rectal arteries (branches from internal iliac) supply the lower half.
- ✓ Upper half is related to rectum and is supplied by superior rectal artery
- ✓ An anastomoses exist between the upper & lower half.

Nerve supply:

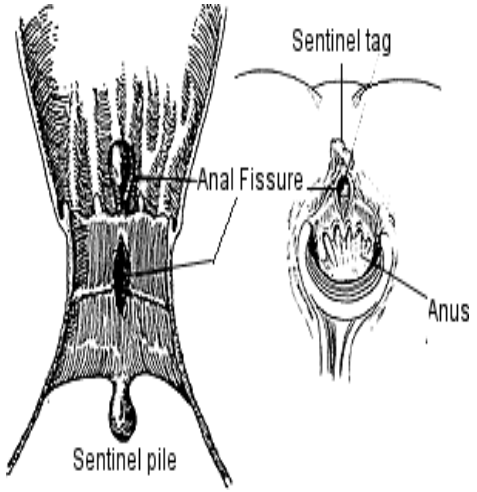
- ✓ Upper half: autonomic, sensitive for stretch
- ✓ Lower half: S4, painful and voluntary.

- ✓ Venous & lymphatic drainage: same as rectum

17 – Clinical Complications of Anal canal

Anal fissure:

- ✓ One of the disadvantages of the anal columns is that the anal valves and anal sinuses can trap hard pieces of feces, which may lead to the formation of a longitudinal ulcer, known as an anal fissure.
- ✓ This condition is very painful because the fissure may extend into the lower part of the anal canal, it's treated by surgery.



Perianal abscess:

- ✓ In ischiorectal fossa
- ✓ Abscess (even in the brain) = treated by drainage, because it is accumulation of bacteria (pus).
- ✓ Recurrence is common (dirty area).

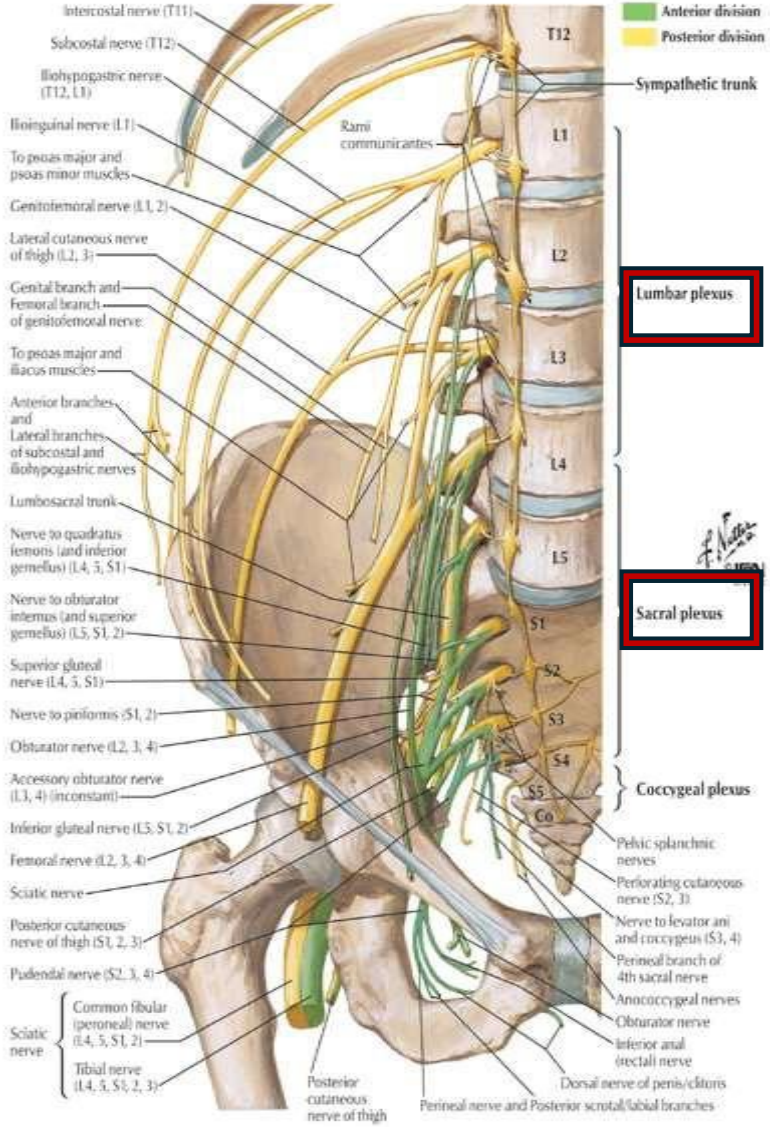
18 – Nerves on the Posterior Abdominal Wall

lumbar plexus:

- ✓ A network of nerve fibers coming from L1, L2, L3, and a part of L4 (**upper part of L4**).
- ✓ It lies within the psoas major muscle(“comes from”), in the abdomen. And the nerves relationship is either medial, or lateral, or through the psoas major.
- ✓ Lumbar plexus give rise to branches such as iliohypogastric, ilioinguinal (**those emerge from L1**), and while ilioinguinal is sensory to the scrotum, the iliohypogastric goes to the skin above the symphysis pubis, supplying the lower abdomen.
- ✓ Another branch is the lateral cutaneous nerve of the thigh, it goes to the skin on the lateral side, and it originates from L2 and L3.

sacral plexus:

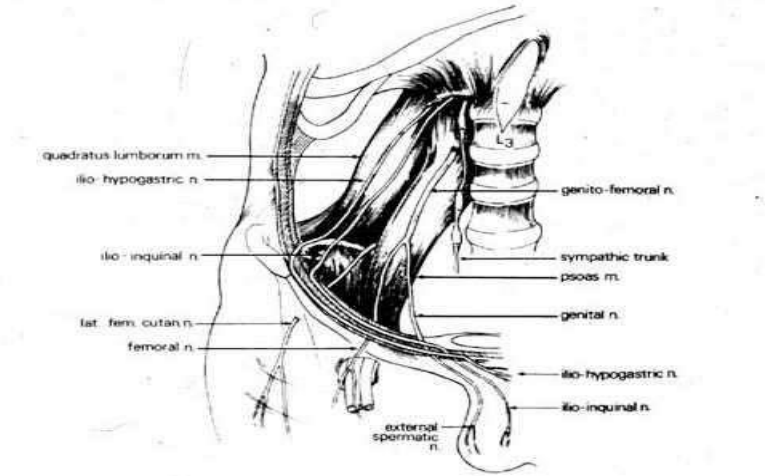
- ✓ On the other hand, sacral plexus arise from the **lower part of L4** and L5, and then sacral nerve.
- ✓ L4 and L5 together are called lumbosacral trunk.

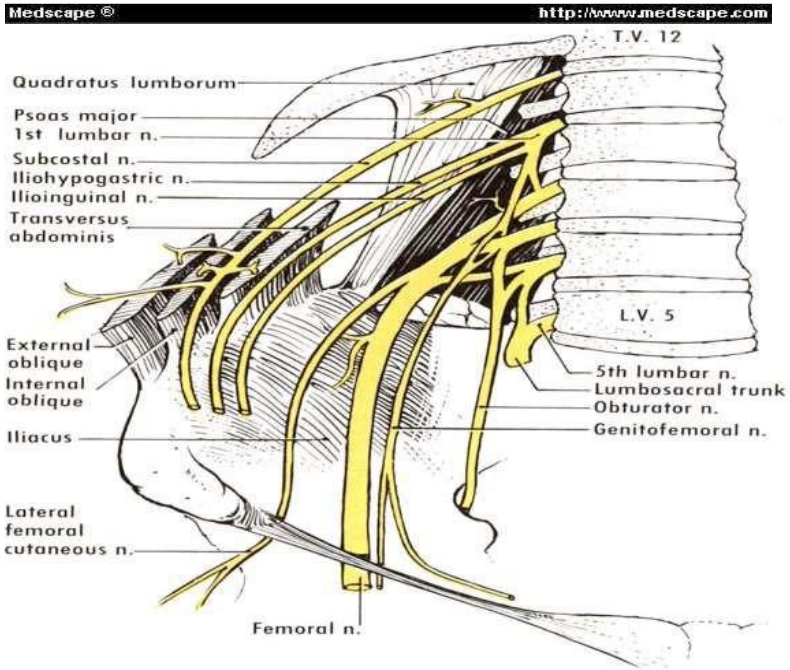


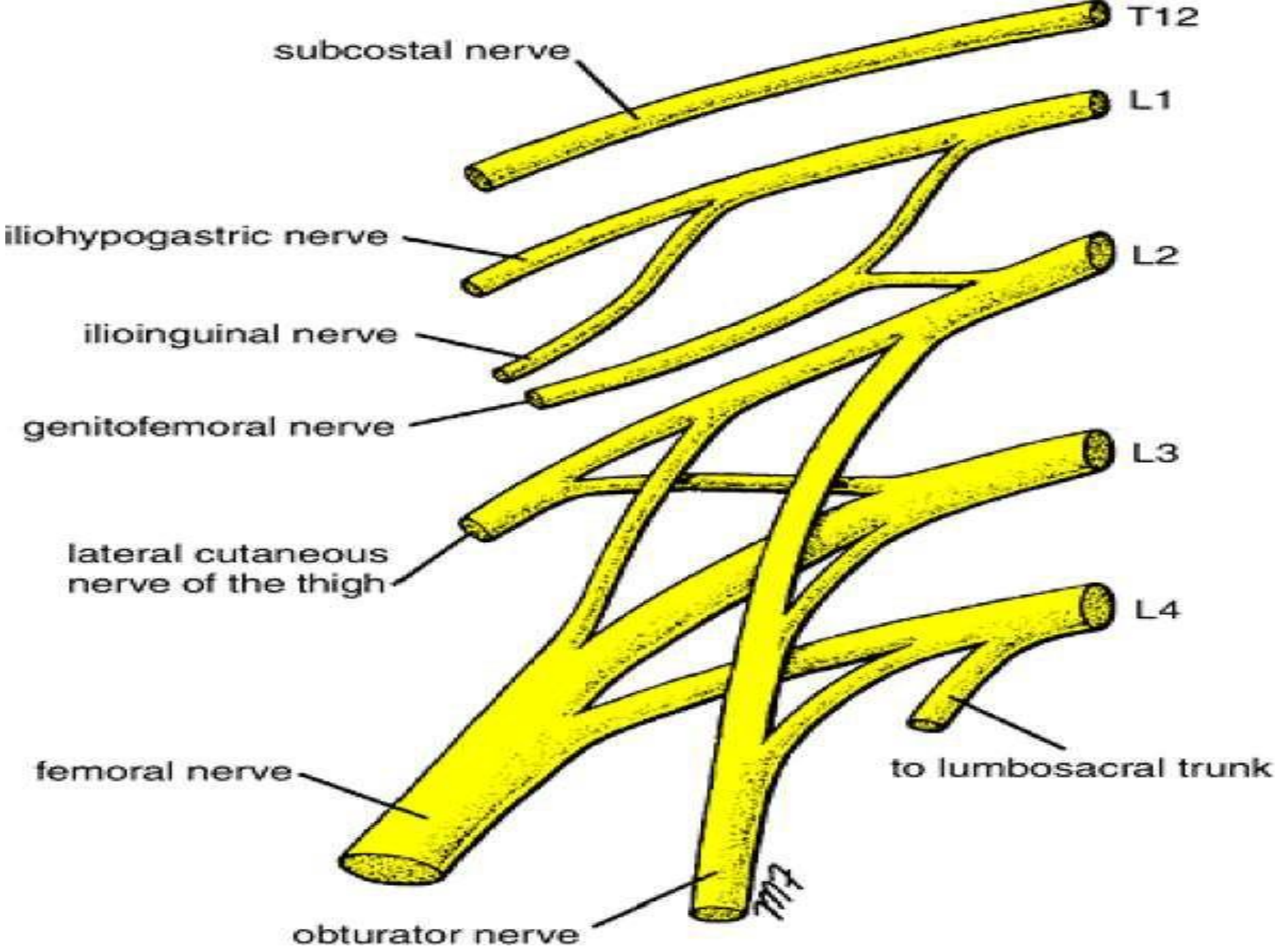
18 – Nerves on the Posterior Abdominal Wall

Nerve relations to the psoas major muscle:

- ✓ laterally to the psoas there is: iliohypogastric, ilioinguinal, lateral cutaneous, and femoral nerve.
- ✓ Medially there is the obturator and the lumbosacral.
- ✓ In contrast, the genitofemoral nerve pierces directly through the muscle (originating from L1 and L2).
- ✓ The femoral and the obturator nerves stem from L2, 3, and L4. Precisely the femoral from posterior division of anterior ramus of L2, 3, and 4. While obturator, from the anterior division of L2, 3, and 4.
- ✓ The femoral nerve goes to the lower limb (anterior surface of the thigh), and the obturator goes to the medial compartment of the thigh.
- ✓ The genitofemoral nerve is divided into genital and femoral branches and it is responsible for the cremasteric reflex, which is when the femoral branch is stimulated on the medial side of the upper thigh, and a signal goes to L1 and L2, promoting the motor activity by the genital branch, leading to a contraction of the cremasteric muscle.



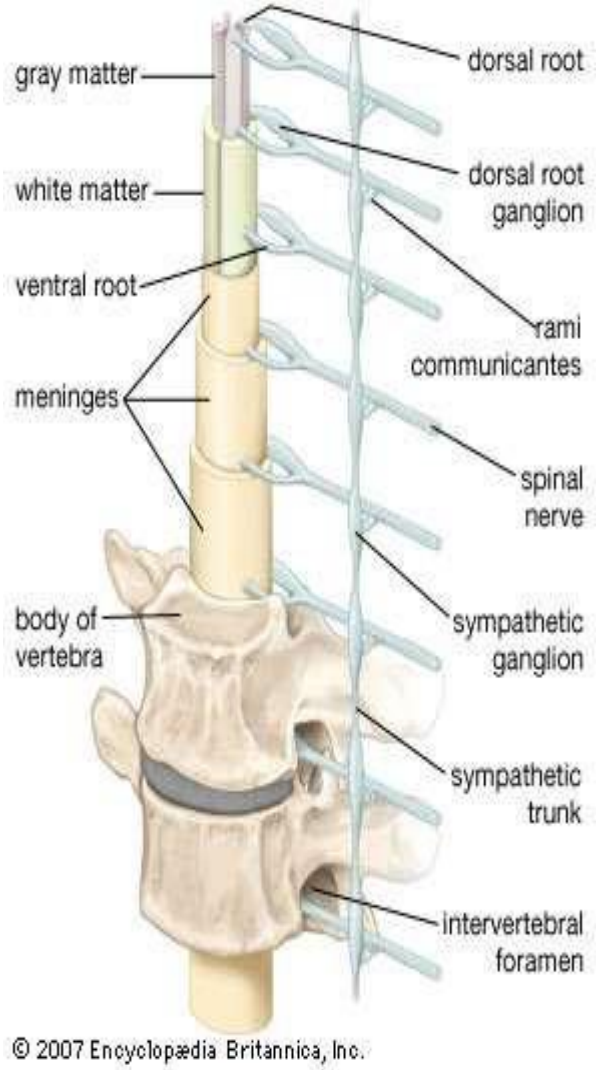



T12
subcostal nerve
L1
iliohypogastric nerve
L2
ilioinguinal nerve
genitofemoral nerve
L3
lateral cutaneous
nerve of the thigh
L4
femoral nerve
to lumbosacral trunk
obturator nerve

19 – The Sympathetic Trunk (Abdominal Part)

The sympathetic chain:

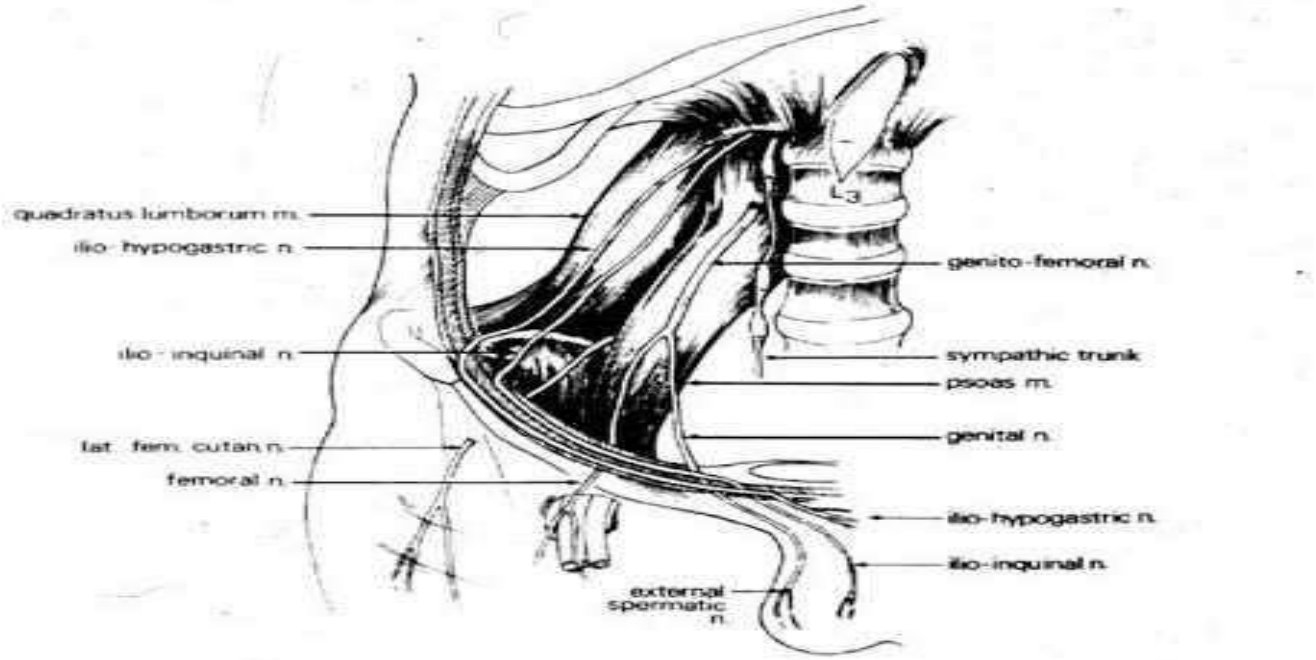
- ✓ Is a series of ganglia connected together by sympathetic fibers.
- ✓ The number of sympathetic ganglia is 4 to 5 in the abdomen, 4 to 5 in the pelvis, 10 to 12 in the thorax, 3 in the cervical region, and 1 in the coccyx bringing the total to ≈ 25.
- ✓ The ganglia starts from the atlas and ends in the coccyx. The origin of the sympathetic chain is from the spinal cord and is called the thoracolumbar segments, as it consists of spinal segments(nuclei) T1 to L2 making a total of 14.
- ✓ The **pre-ganglionic fibers (White rami)**, that start from the spinal cord (from the sympathetic nuclei), end either in the corresponding ganglia, for example, from T5 to ganglia number 5, or it go upwards to the cervical and then make a synapse, it may also travel downward to the lumbar.
- ✓ Another possible route is to the abdomen as a splanchnic nerve, to the prevertebral ganglia (pre-aortic), as the celiac, or the superior mesenteric, or the inferior mesenteric.

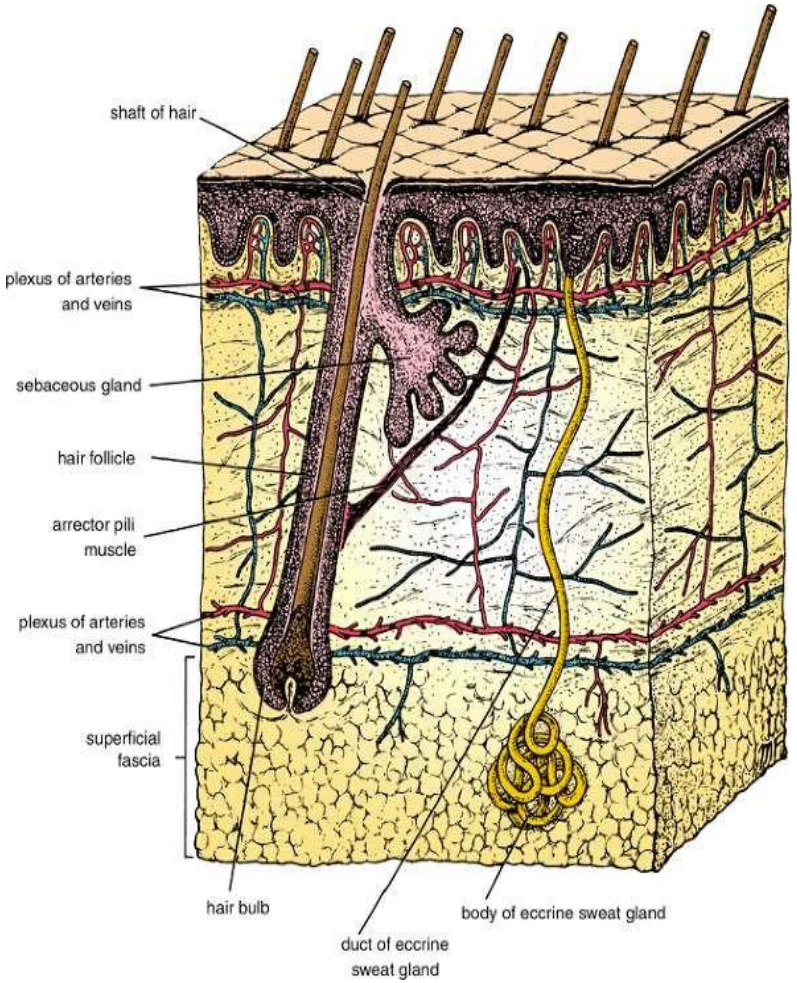


19 – The Sympathetic Trunk (Abdominal Part)

The sympathetic chain:

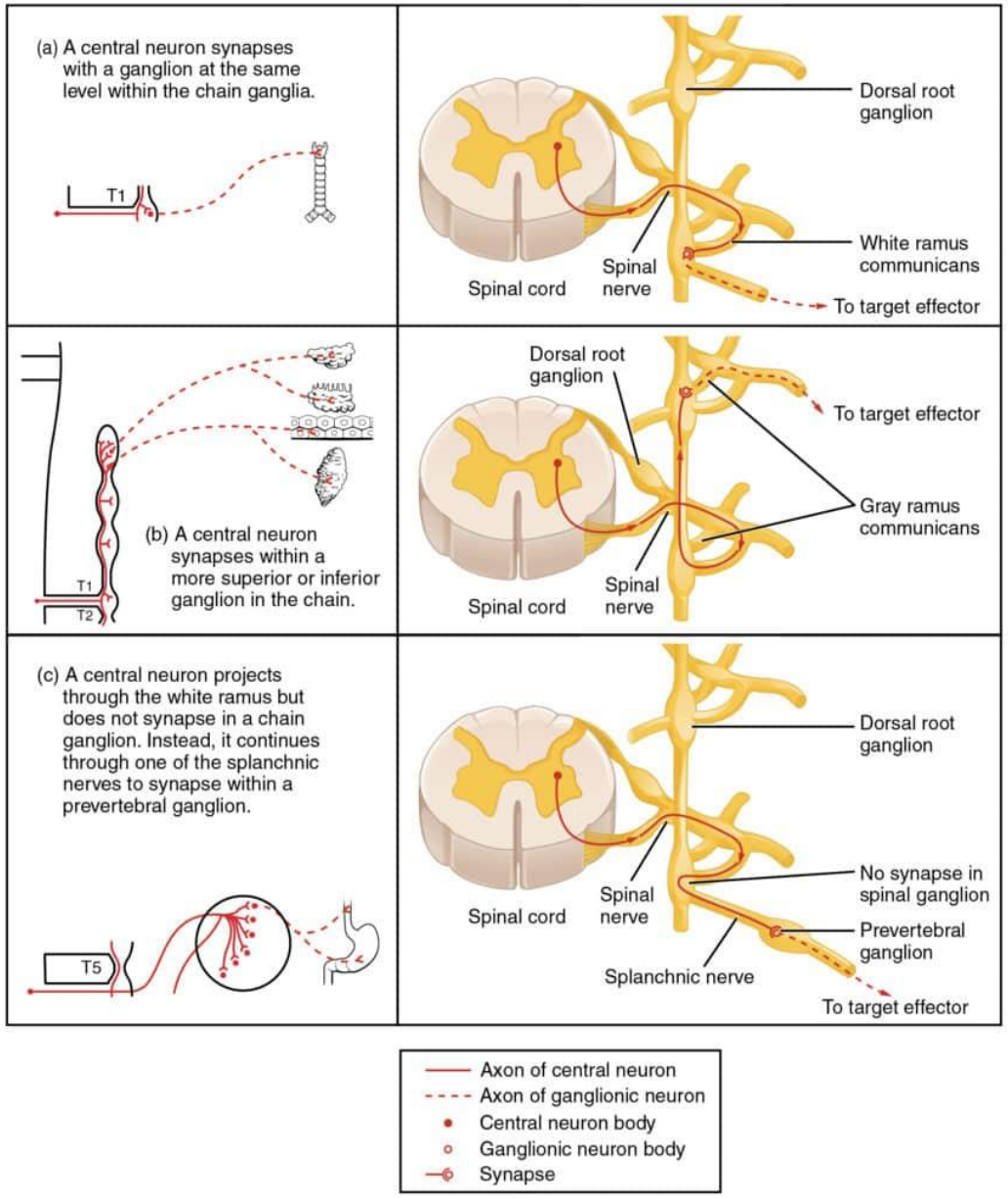
- ✓ As for the **grey rami (the postganglionic fibers)**, it travel back to one of the 31 pairs of spinal nerves.
- ✓ All these pathways enable the sympathetic nerves to innervate blood vessels, glands, and erector pili muscles(presenting in the skin).





20 – Spinal nerves

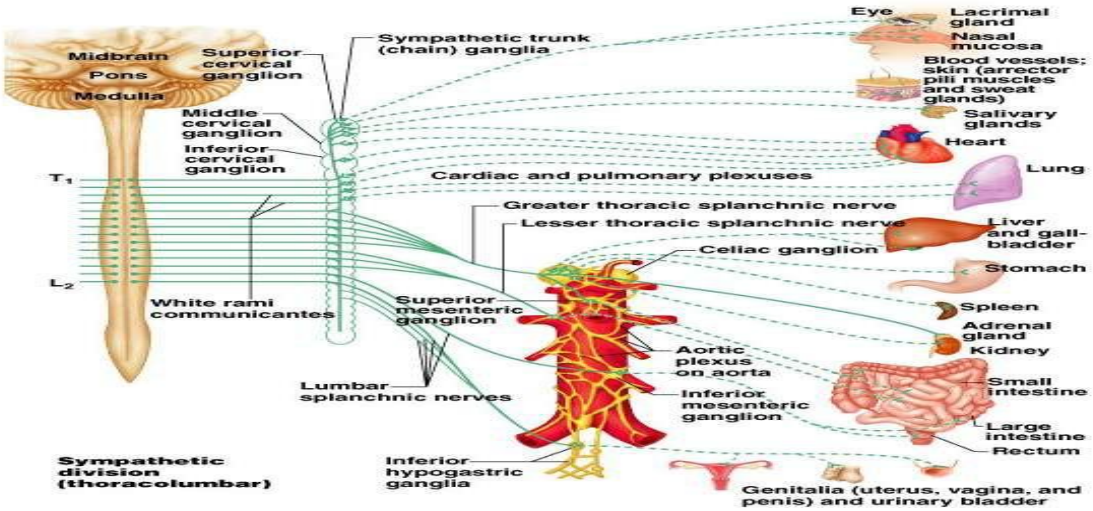
- ✓ The spinal cord sends out a signal from the lateral horn through the ventral root. The synapse occurs at the white ramus, while the post-synaptic signal travels through the gray ramus.
- ✓ From there, the signal returns to the spinal nerve. Every spinal nerve contains a postganglionic fiber.
- ✓ In some cases, the signal travels from the ventral root through the spinal nerve directly to a ganglion without synapsing there, in such cases the synapse occurs in major ganglia like the celiac, superior mesenteric, or inferior mesenteric ganglia. ***(check the third figure).***



Lateral horn → Ventral root → Spinal nerve → White ramus → Sympathetic ganglion (synapse) → Gray ramus → Spinal nerve again → Target tissue. ***(look at the second figure)***

20 – Spinal nerves

- ✓ The gray ramus has 31 pairs — on the right and on the left.
- ✓ The greater splanchnic nerve comes from the thorax. Where originating from the 5th to 9th thoracic segments. It goes down to the abdomen and pierces the right and left crura of the diaphragm, ending in the celiac ganglia.
- ✓ The lesser splanchnic nerve comes from the 9th and 10th thoracic segments. It goes through the ganglia without a synapse. It pierces the diaphragm, synapsing in the superior mesenteric ganglia.



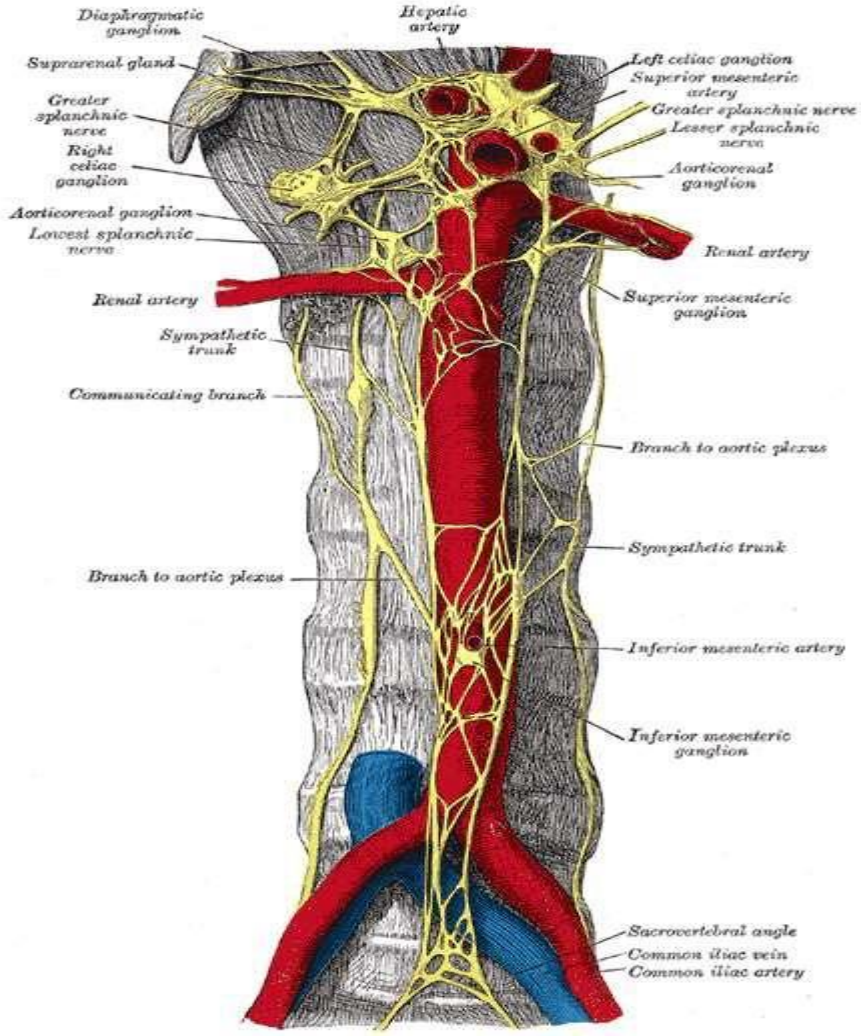
- ✓ The lowest splanchnic nerve comes from the last one or two thoracic ganglia. It penetrates the diaphragm and relay with the renal plexus at the suprarenal gland.
- ✓ As for the lumbar splanchnic, it comes from L1 and L2. It makes a synapse in the inferior mesenteric ganglia, and it goes to the hindgut, through the hypogastric plexus.
- ✓ The hypogastric is sympathetic, arising from the lumbar splanchnic. The parasympathetic is from S2, S3, and S4, this is what is called the pelvic splanchnic.

21 – Aortic Plexus

The aortic plexus:

- ✓ Is around the abdominal aorta and is divided to:
  1) at the origin of the celiac trunk, there is the celiac ganglia.
  2) at the origin of the superior mesenteric, superior mesenteric ganglia.
  3) at the inferior mesenteric, inferior mesenteric ganglia.

- ✓ These ganglia receive preganglionic fibers, which synapse with postganglionic neurons, producing a plexus going along with the blood supply to the organs.
  That is why the abdominal viscera is divided into foregut, midgut, and hindgut.
- ✓ *The* foregut follows the celiac ganglia, so the branches that come out of the celiac trunk carry postganglionic fibers to the viscera in this region.



21 – Aortic Plexus

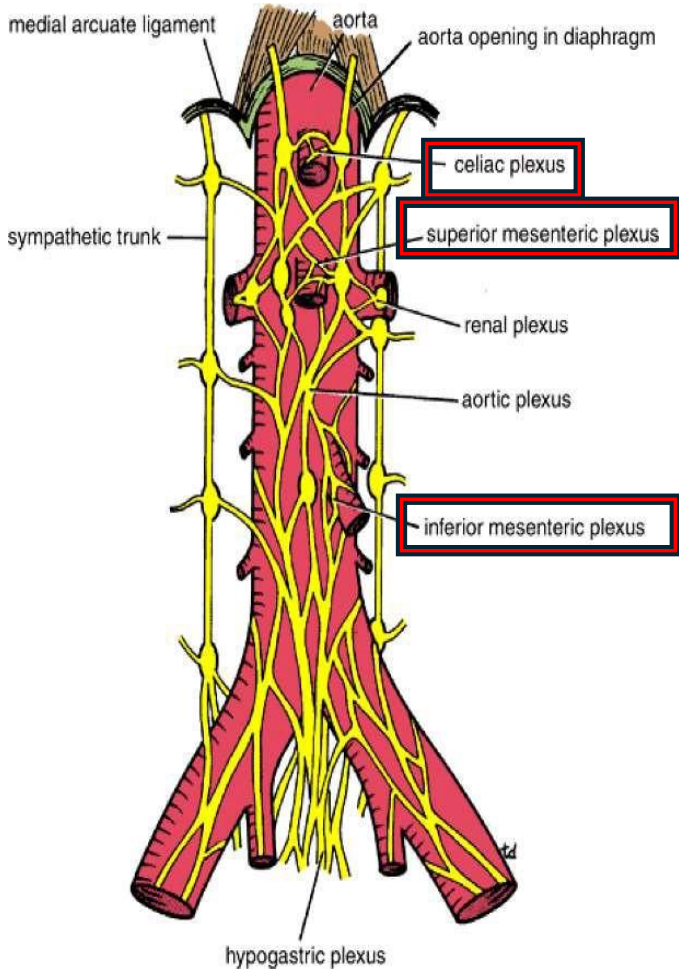
The aortic plexus:

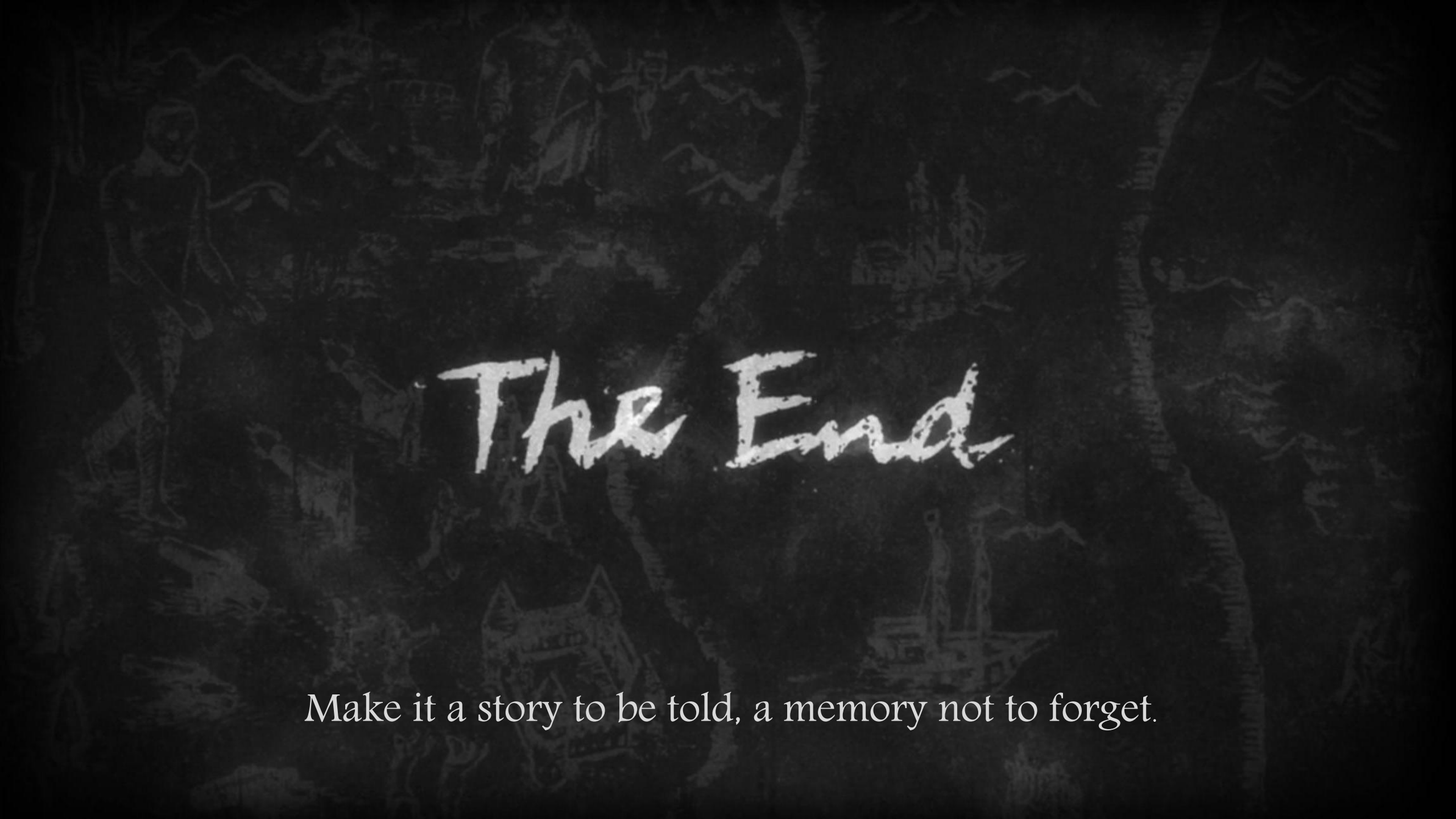
- ✓ The superior mesenteric is for the midgut, and the inferior is for the hindgut, the renal is going to the suprarenal gland, and is coming from the lowest splanchnic nerve.

- ✓ The plexus of nerves has sympathetic and parasympathetic, where the parasympathetic is from the vagus to the celiac and to the superior mesenteric, extending until the lateral third of the transverse colon. As for hindgut, it comes from S2, S3, and S4 parasympathetic, that is also called the pelvic splanchnic nerve.

- ✓ Sympathetic innervation to hindgut consists of the hypogastric plexus (could imply to the superior hypogastric plexus), the inferior hypogastric plexus, and the inferior mesenteric.

- ✓ The sympathetic chain is around the vertebral column.





Make it a story to be told, a memory not to forget.

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

Corrections from previous versions:

Versions	Slide #	Before Correction	After Correction
V0 → V1	13	✓ The difference between the upper (2cm) and lower half (2cm): • The upper half: The epithelium is stratified squamous non keratinized. • And the last cm of lower half is keratinized.	✓ **The upper half (2 cm) of the anal canal resembles the rectum.** ✓ The lower half (2 cm) is different: • The upper cm: stratified squamous non-keratinized. • The lower cm: stratified squamous keratinized. *Clarification to remove ambiguity*
V1 → V2	10	*The information was not fully conveyed.*	The parasympathetic is derived from "pelvic splanchnic nerve".

رسالة من الفريق العلمي:

سُورَةُ النَّجۡمِ

بِسۡمِ ٱللَّهِ ٱلرَّحۡمَٰنِ ٱلرَّحِيمِ

وَأَن لَّيۡسَ لِلۡإِنسَٰنِ إِلَّا مَا سَعَىٰ ٣٩