

# Anatomy of Rectum & Anal canal

## A Radiation Oncology Perspective

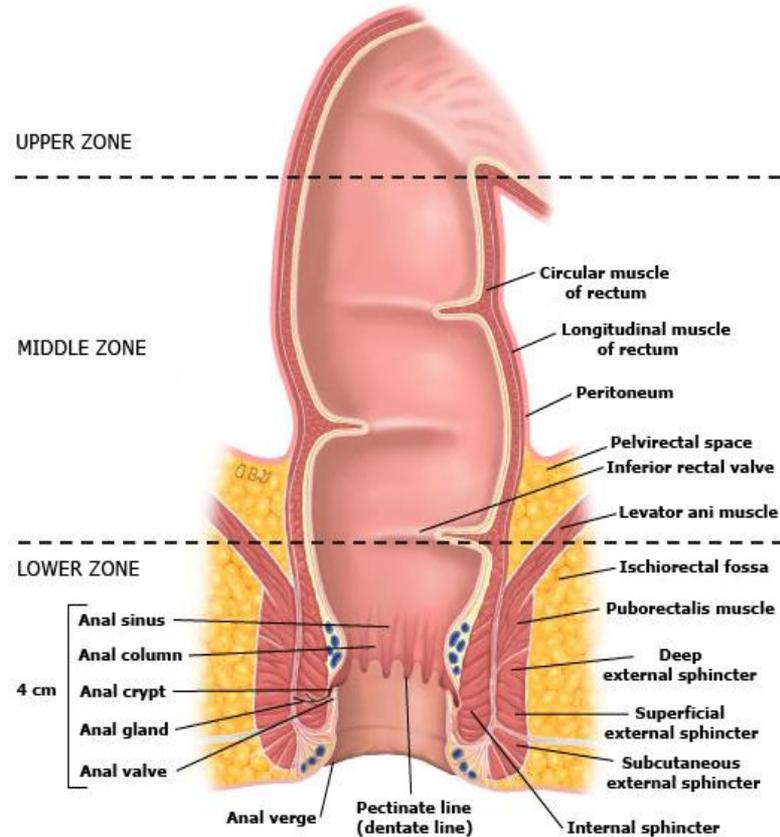
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# Why anatomy important

- Anatomically close structures, BUT distinct entities with
  - Different histologic features
  - Different risk factors
  - Different routes of spread
  - Different staging systems
  - Different treatment pathways
- Imaging is the core of initial staging
  - MRI – local regional staging
  - CT- metastatic disease

# objectives

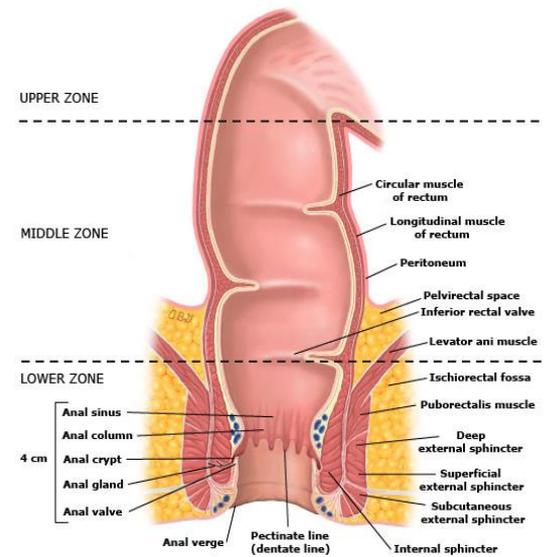
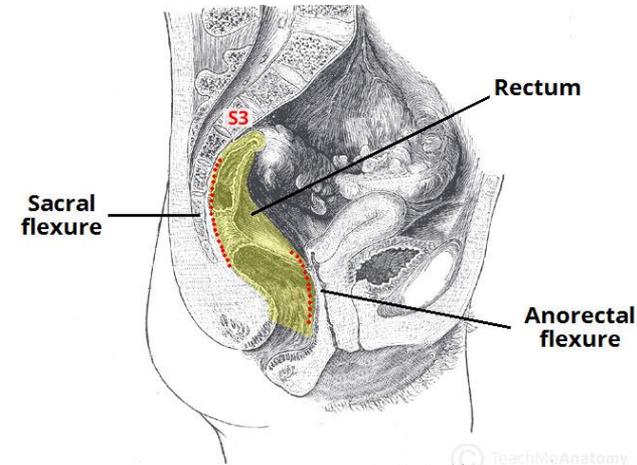
- Introduction
- Course
- Measurements
- Curvatures
- Relations
- Structure
- Blood supply
- Nerve supply
- Applied



Rectum: anatomy and our perspective

# Rectum

- Rectum= ?straight
  - Straight in quadrupeds
  - Not straight in man
  - Curved in A-P and side to side
- It's the lower dilated part of large gut and continuation of sigmoid colon at S3 vertebral level.
- It lies in pelvis (12-15cm) b/w sigmoid colon and anal canal and ends at 2-3 cm in front and little below tip of coccyx.
- DEVOID of taenia coli, sacculations, epiploic appendices and mesentery
- Anteriorly, **Denonvilliers' fascia** separates the rectum from the prostate and seminal vesicles in male and from the vagina in female.



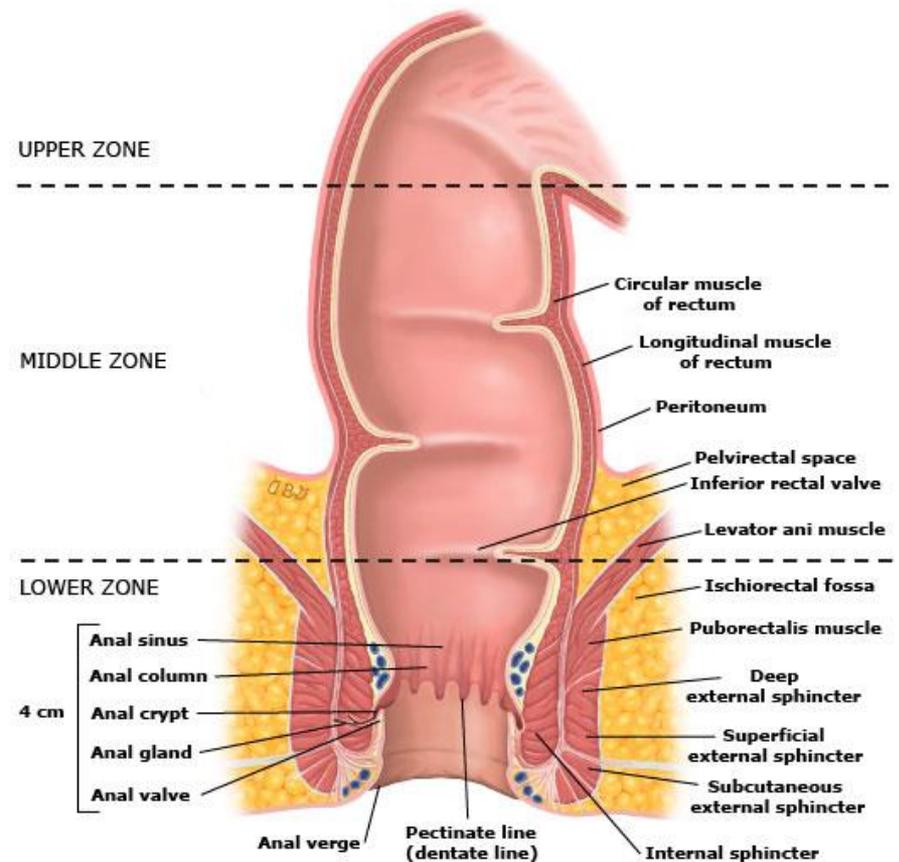
# Rectum

- **Surgically:** upper limit of rectum is defined as where the taeniae coli of sigmoid colon splay and becomes indistinct.
- **Radiographically:** the sacral promontory is regarded as the upper limit of the rectum
- **Endoscopically:** the upper limit is defined as 15cm from the anal verge on rigid proctoscopic examination.
- **Generally:** we accept upper limit of rectum at rectosigmoid junction and lower limit at the dentate line, located in the middle of anorectal ring.
- The **dentate line** is the point where columnar mucosa of rectum transitions to the squamous mucosa of the anus.

# Rectum

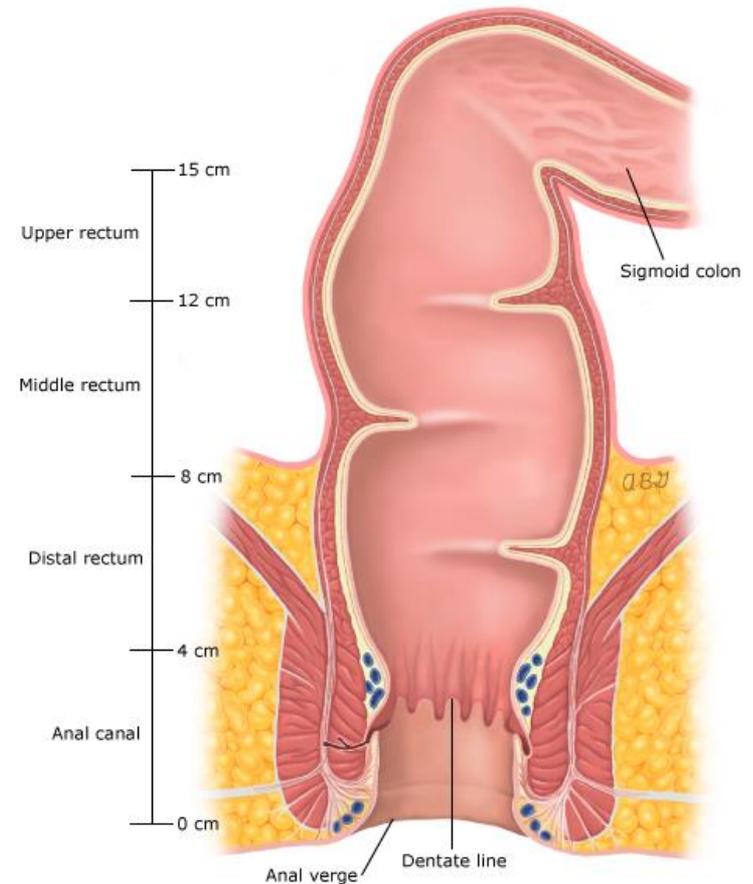
- The rectum has three lateral curves corresponding to the valves (folds) of Houston.
  - The upper and lower curves are convex to the right,
  - And the middle is convex to the left.

Once the rectum is mobilized, these valves are no longer present and are responsible for the increase in length gained during the surgical dissection.



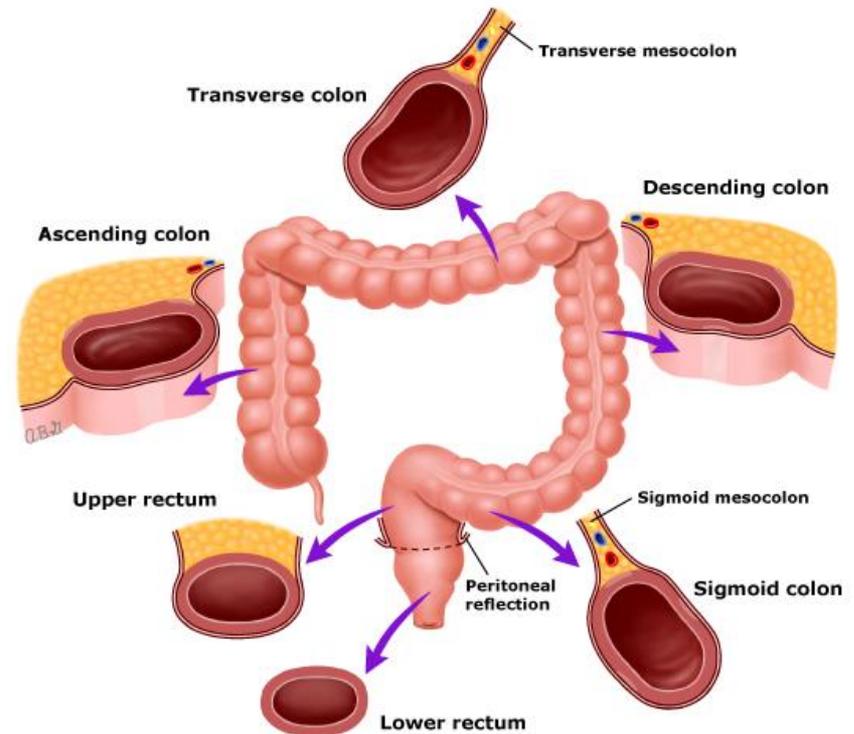
# Rectum

- The location of a rectal cancer is identified by its distance from the anal verge rather than the dentate line.
  - Low (distal) rectal cancers are located 4 to 8 cm from the anal verge,
  - Middle rectal cancers 8 to 12 cm,
  - Upper (proximal) rectal cancers 12 to 15 cm.
- The anal canal is 0 to 4 cm from the anal verge
- However, **surgical decision making for sphincter preservation** is dependent mostly upon the distance from the lower border of the tumor to the top of the anorectal ring rather than the anal verge



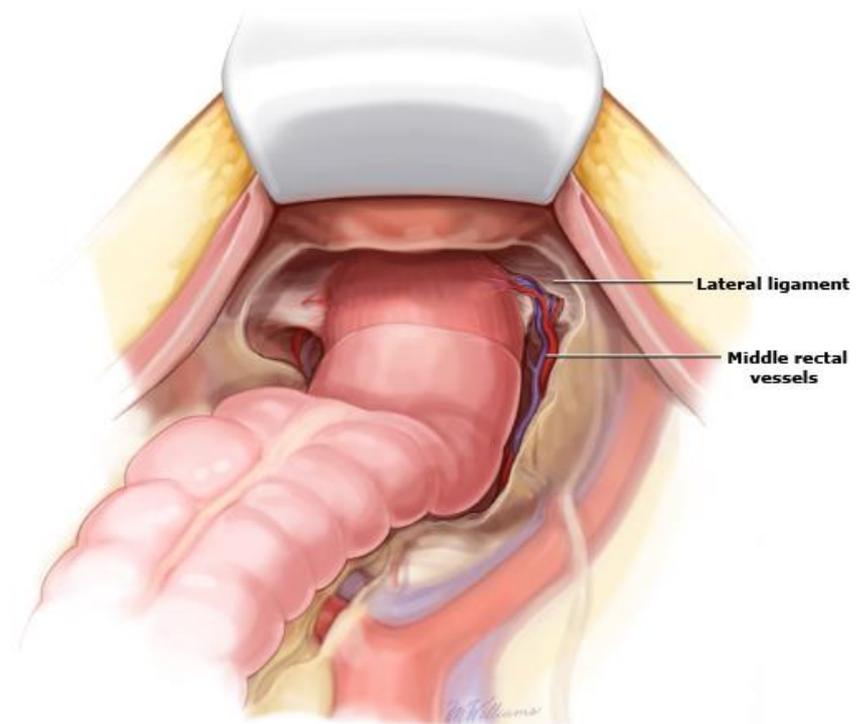
# Rectum

- The rectum is typically located below the peritoneal reflexion.
- The posterior rectal wall, which is close to the sacral hollow, is entirely extra-peritoneal.
- The upper rectum is invested by peritoneum anteriorly and laterally.
- The middle rectum is invested by peritoneum only anteriorly.



# Fascia Propria and Lateral Ligament

- The fascia propria is an extension of the pelvic fascia and encloses the rectum, adipose tissue, blood, and lymphatic vessels.
- It is more pronounced laterally and posteriorly and forms the lateral ligaments of the rectum.
- In 25 percent of patients, the lateral ligaments contain branches of the middle rectal artery and venous plexus



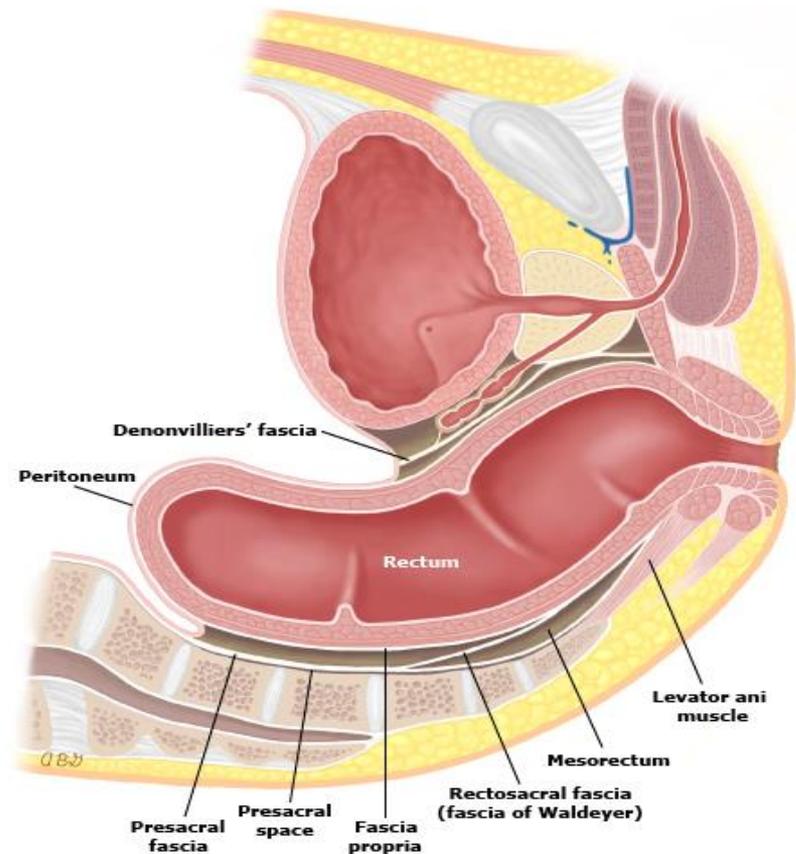
lateral ligament of the rectum, which is comprised of the fascia propria.

Typically, this is an avascular structure, but it can contain small arterial and venous vessels.

# Mesorectum

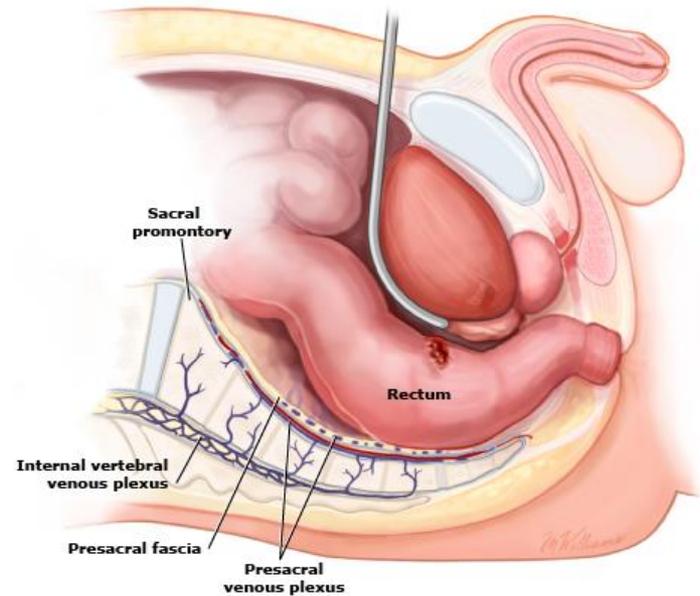
- The rectum is not suspended by a true mesentery (ie, two layers of peritoneum that suspend an organ).
- The "mesorectum" is perirectal areolar tissue that is thicker posteriorly and contains the terminal branches of the inferior mesenteric artery.

The mesorectum is not a true mesentery



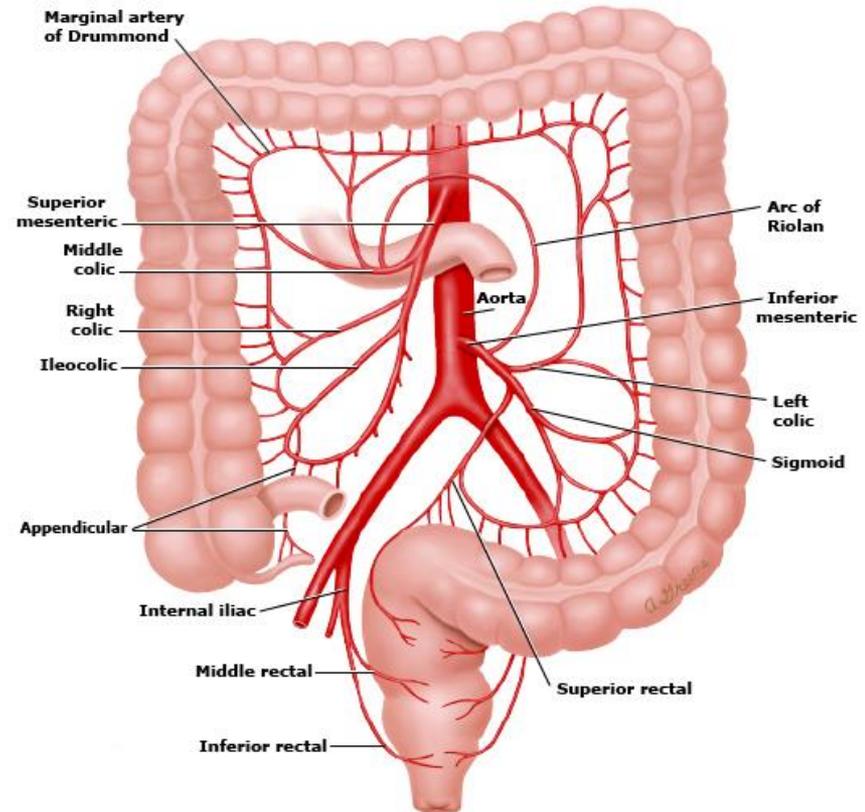
# Pre-sacral fascia

- The rectum occupies the sacral concavity and ends 2 to 3 cm proximal to the tip of the coccyx.
- The presacral fascia covers the concavity of the sacrum and coccyx, presacral nerves, the middle sacral artery, and presacral veins.
- This plane should not be violated during the pelvic dissection, as life-threatening hemorrhage from the presacral venous plexus can occur.



# Rectum: blood supply

- The blood supply enters the rectum posteriorly.
- The upper rectum is supplied by the superior rectal artery (SRA), a branch of the inferior mesenteric artery (IMA).
- The middle and lower rectum are supplied by the middle rectal artery and inferior rectal artery, respectively, which branch from the anterior division of the internal iliac artery and/or the pudendal artery



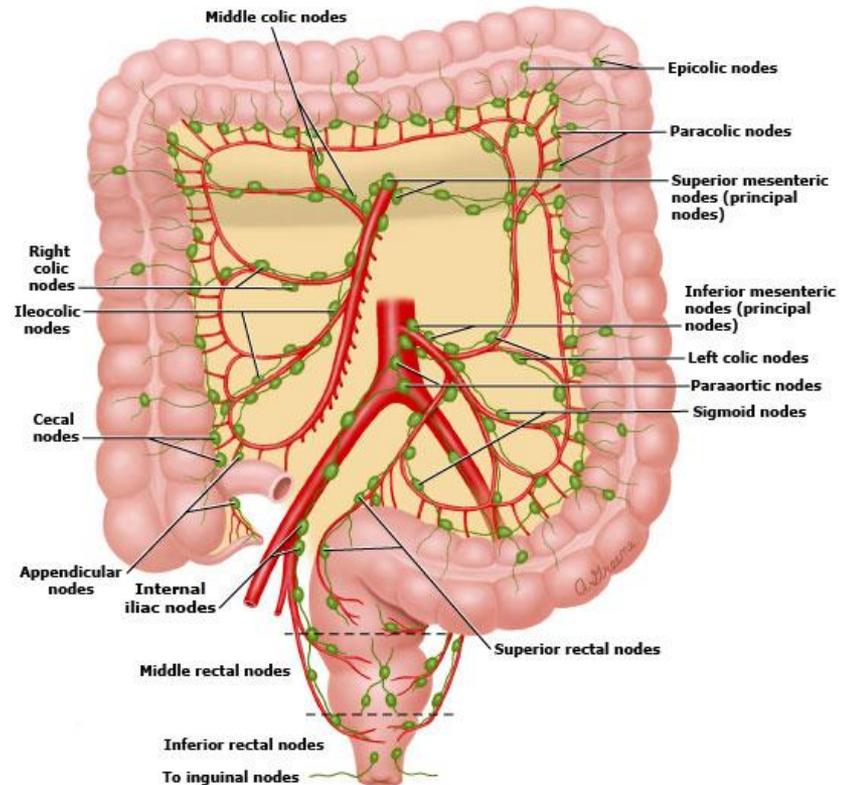
The IMA arises approximately 6 to 7 cm below the SMA. The IMA gives rise to the left colic artery and sigmoid arteries continuing as the superior rectal (hemorrhoidal) artery.

# Rectum: Venous Drainage

- The superior rectal vein drains into the portal system via the inferior mesenteric vein.
- The middle rectal vein drains into the internal iliac vein.
- The inferior rectal vein drains into the internal pudendal vein, and subsequently into the internal iliac vein.
- A submucosal plexus deep to the columns of Morgagni forms the hemorrhoidal plexus and drains into all three veins

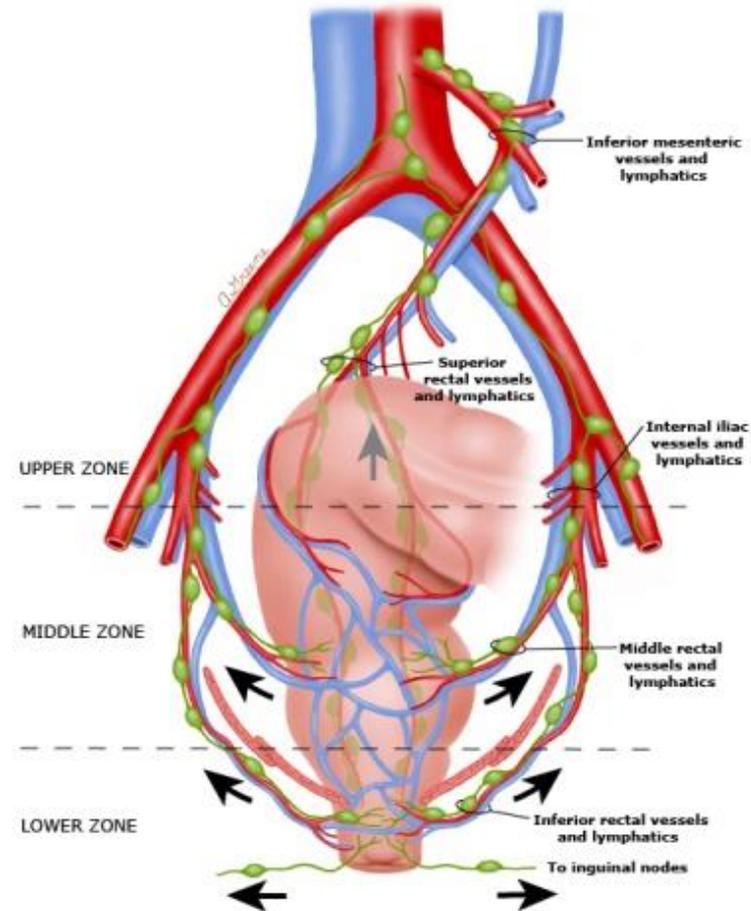
# Rectum: Lymphatic Drainage

- The pathways for the lymphatic and venous drainage of the rectum are cephalad and lateral.
- The lymphatic drainage of the upper two-thirds of the rectum is along the pathway of the superior hemorrhoidal vein
  - cephalad to the inferior mesenteric nodes, and the paraaortic nodes.
- The lymphatic drainage of the lower third of the rectum is
  - cephalad as well as lateral
  - along the middle hemorrhoidal vessels to the internal iliac nodes.



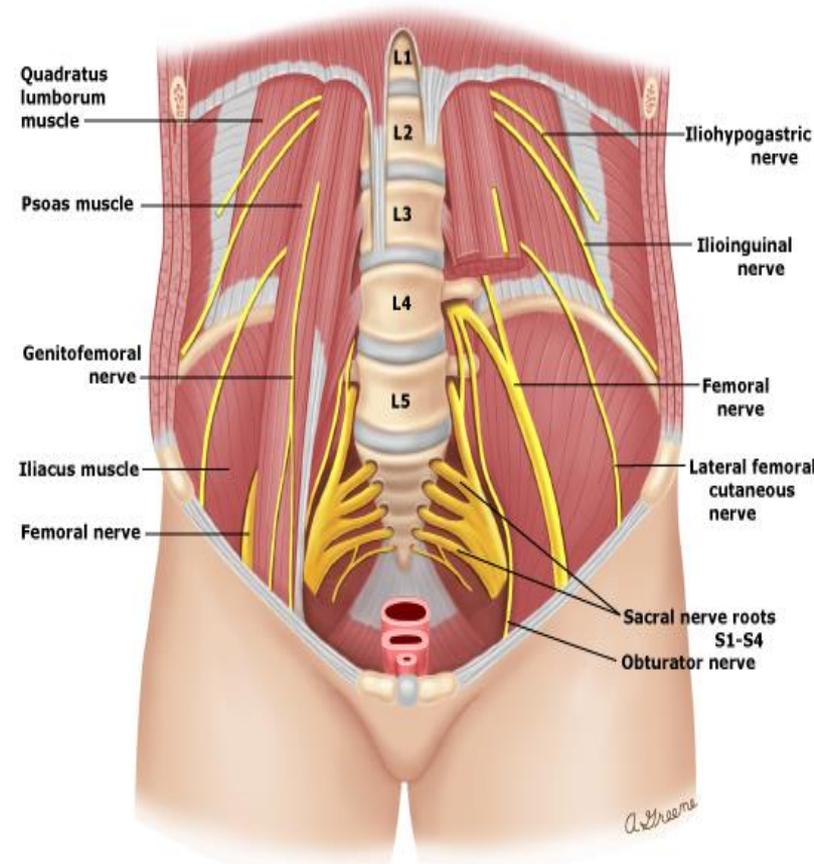
# Rectum: Lymphatic Drainage

- There are no communications between the inferior mesenteric and internal iliac lymphatics.
- In women, lymphatic drainage above the dentate line also includes the posterior wall of the vagina and reproductive organs.
- Below the dentate line, the drainage is along the inferior rectal lymphatics to the superior inguinal nodes and along the pathway of the inferior rectal artery
- Rectal metastasis travel **along the portal drainage to liver via superior rectal vein.**
- Rectal metastasis travel **along the systemic drainage to lung via middle inferior rectal veins.**



# Rectum: Nerve Supply

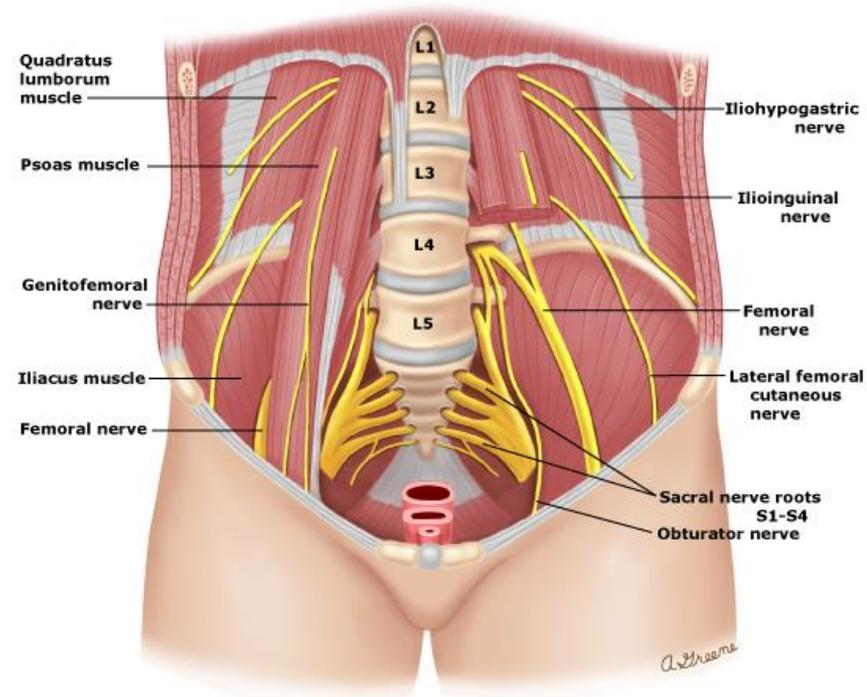
- All pelvic nerves lie in the plane between the peritoneum and the endopelvic fascia, and can be injured or transected during a rectal dissection.
- The preganglionic fibers via the sympathetic nerves follow the branches of the IMA and the SRA to the left colon and upper rectum.
- The presacral nerves, which are a fusion of the aortic plexus and lumbar splanchnic plexus, innervate the lower rectum.



When considering the metastases of cancer cells, tumors in the superior part are painless, while in the inferior part are painful

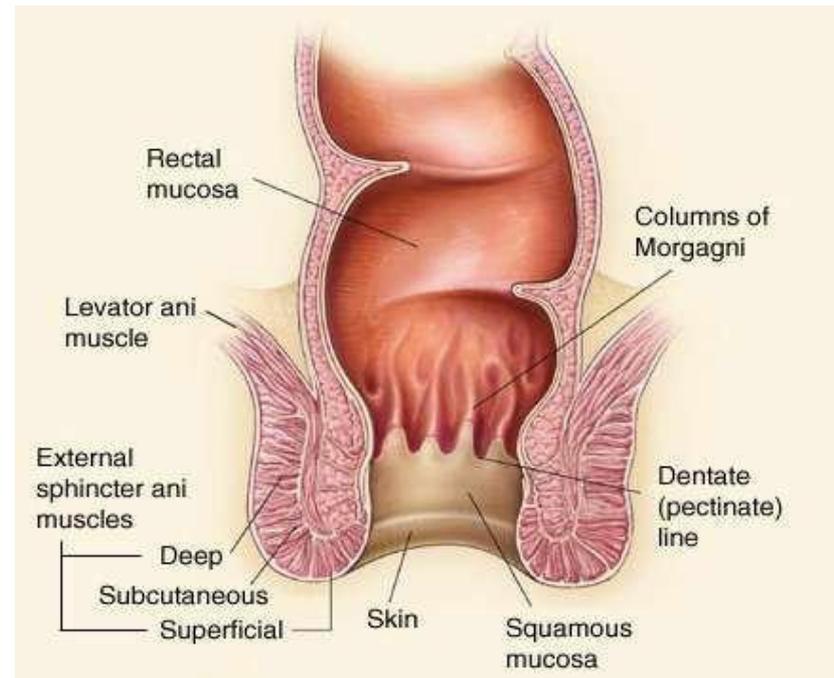
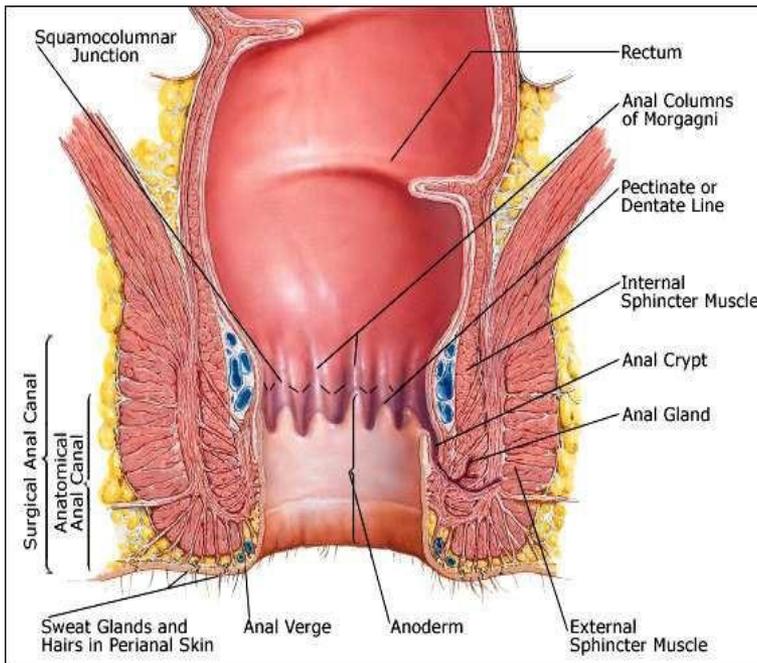
# Rectum: Nerve Supply

- Just below the sacral promontory, the presacral nerves form the hypogastric plexus.
- The main hypogastric nerves enter the rectum laterally and carry sympathetic innervation from the hypogastric to the pelvic plexus, located on the lateral side of the pelvis adjacent to the lateral stalks, at the level of the lower rectum.
- The parasympathetic plexus emerges through the sacral foramen and joins the sympathetic hypogastric nerves at the pelvic plexus.
- Postganglionic parasympathetic and sympathetic fibers are distributed to the left colon and upper rectum via the inferior mesenteric plexus and directly to the lower rectum and upper anal canal.



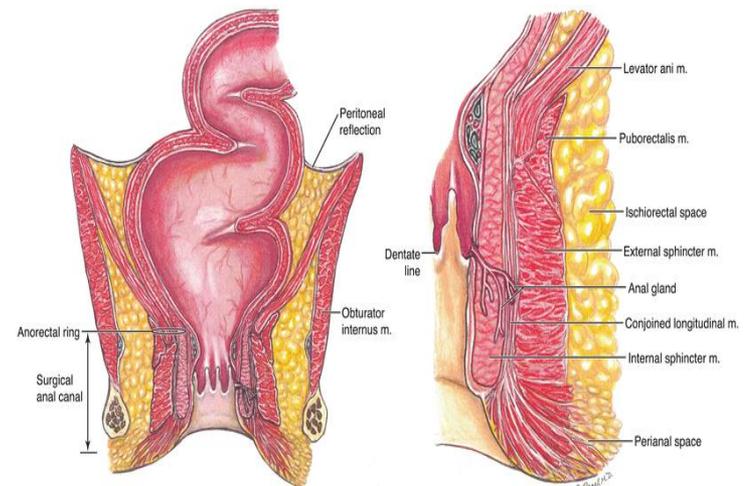
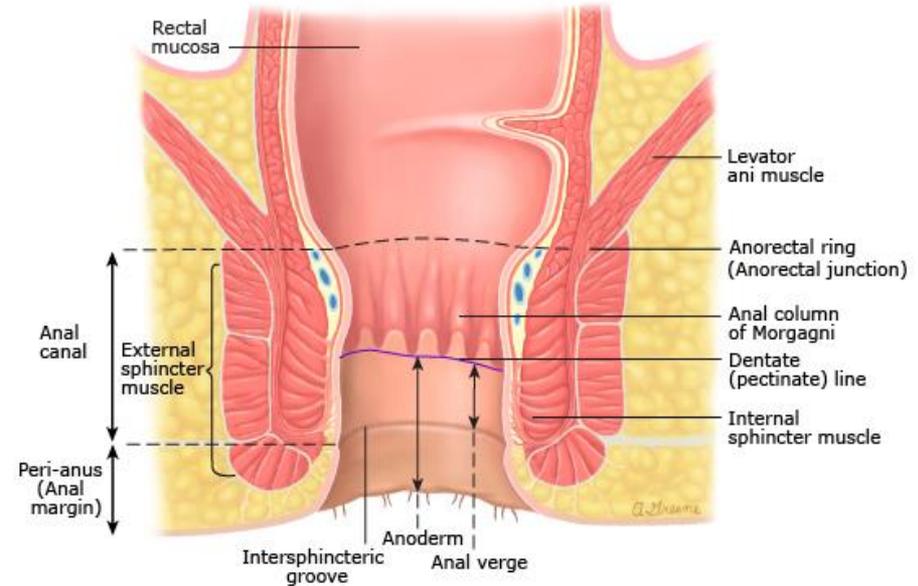
# Anal canal

## Anatomy and our perspective

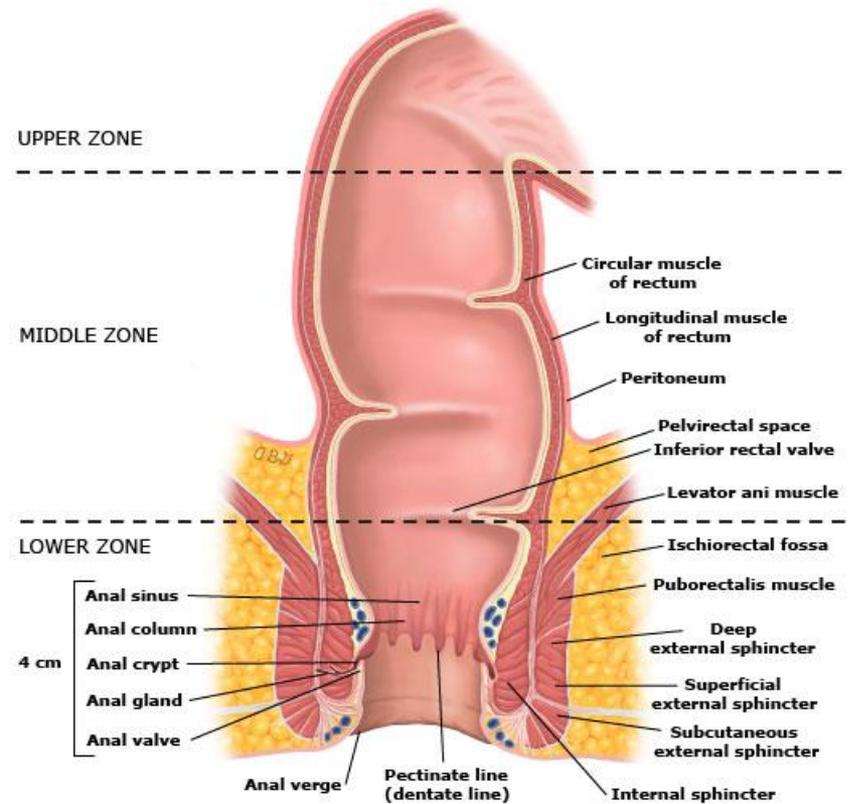
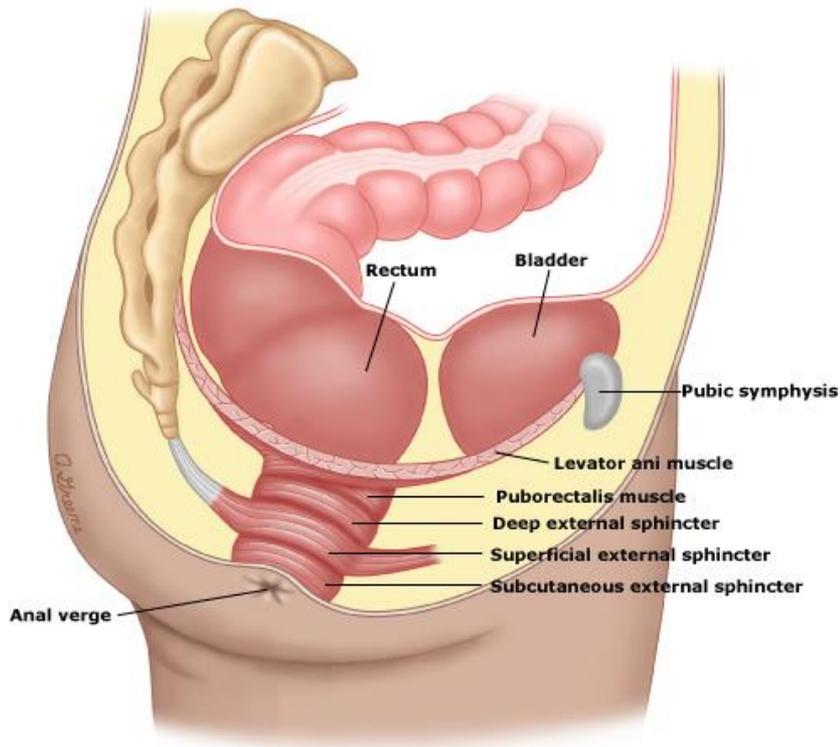


# Anal Canal

- The anal canal is 2.5 to 3.5 cm long
- Begins superiorly where the rectal ampulla is narrowed by the puborectalis sling (the levator ani muscle, which is palpable as the anorectal ring).
- It ends at the intersphincteric groove.
- The anal verge is demarcated at the site where the squamous epithelium lining of the lower anal canal becomes continuous with the skin of the perineum.

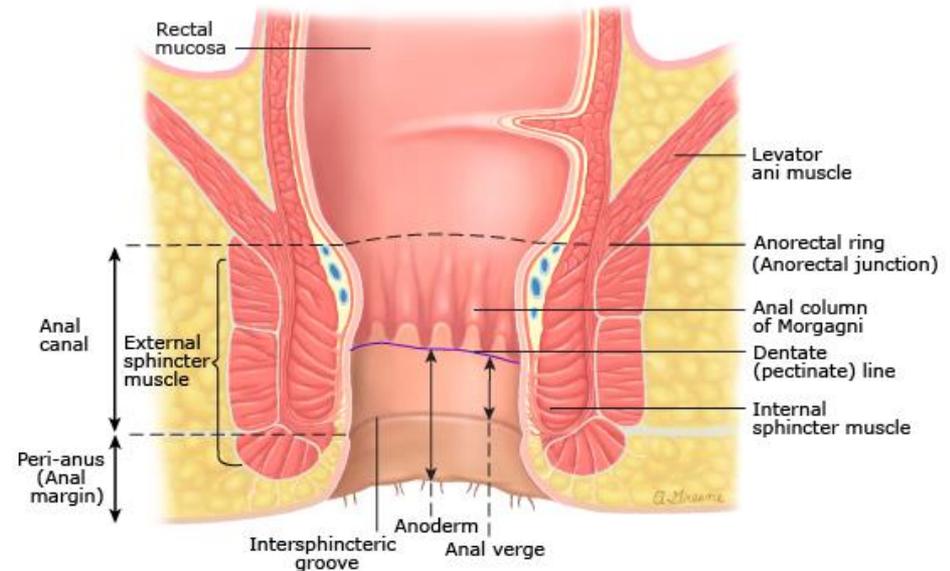


# Anal Canal



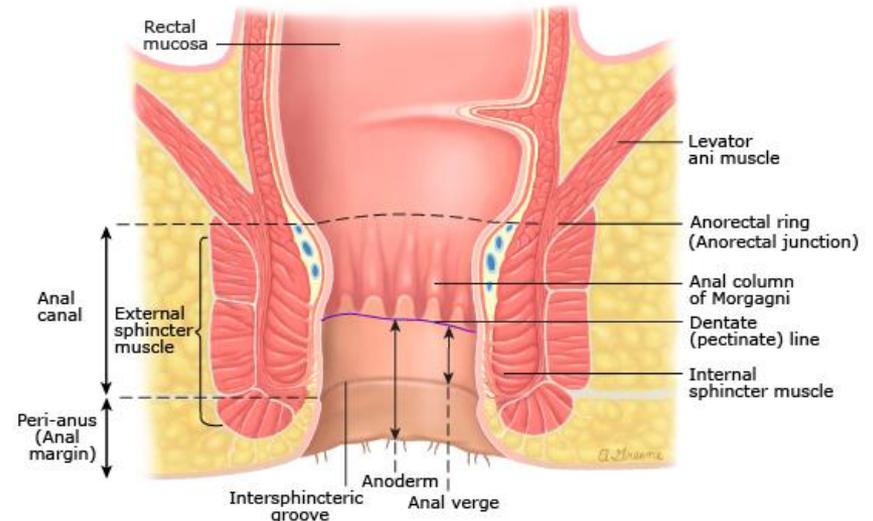
# Anal Canal

- Externally, the anal canal is surrounded by the internal and external anal sphincter muscles.
- The superior half of the anal canal contains a series of longitudinal ridges called the anal columns (of Morgagni), which extend from the anorectal junction superiorly to the anal valves inferiorly.
- The anal valves form an irregular line called the dentate (or pectinate) line (colored purple in the diagram), which is an important anatomical landmark.



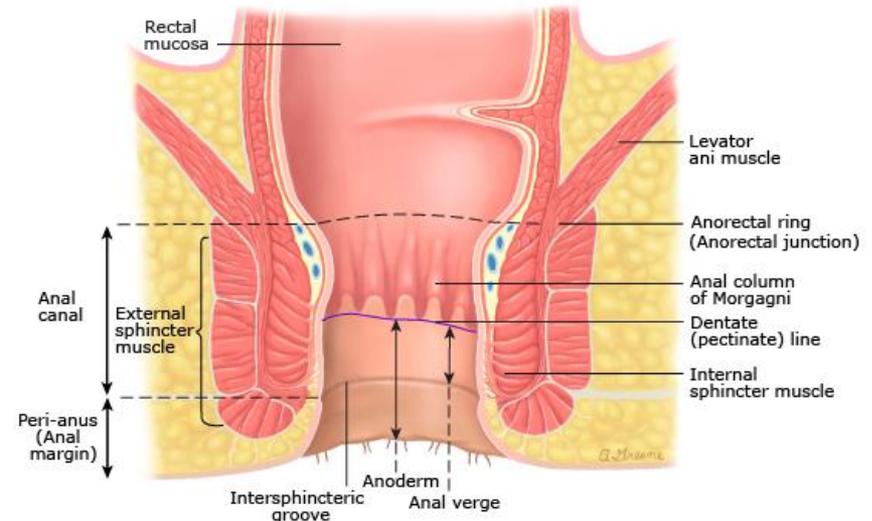
# Dentate (Pectinate) Line

- This line represents the change in epithelium as well as lymphatic drainage, blood supply, and venous drainage.
- The pectinate line is palpated or visualized approximately 2 cm above the anal opening.
- The portions of the anal canal superior and inferior to it have different origins of arterial supply, nerve innervation, venous/lymphatic drainage, and epithelial lining.
- The anal canal is internally lined with mucus membrane above the dentate line and anoderm below it.
- The upper portion of the anoderm (anal verge) consists of smooth, hairless skin;
- The lower portion of the anoderm (perianal skin) contains pigmented skin containing hair follicles and glands.



# Dentate (Pectinate) Line

- The dentate or pectinate line marks the transition point between columnar rectal mucosa and squamous anoderm.
- The 1 to 2 cm of mucosa just proximal to the dentate line shares histologic characteristics of columnar, cuboidal, and squamous epithelium and is referred to as the anal transition zone.
- The dentate line is surrounded by longitudinal mucosal folds, known as the columns of Morgagni, into which the anal crypts empty. These crypts are the source of cryptoglandular abscesses



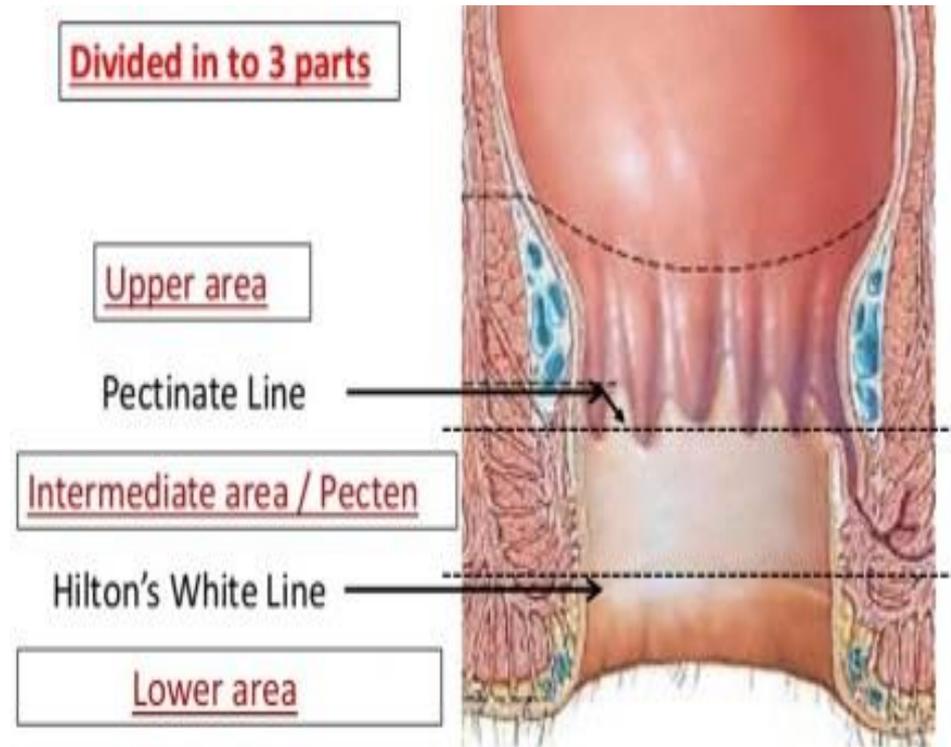
# Pectinate & Hilton Line

## PECTINATE LINE:

- True Muco-cutaneous junction of anal canal.
- Corresponds with position of anal valves.
- Situated at the middle of internal sphincter.
- 1 to 1.5 cms above the anal verge.

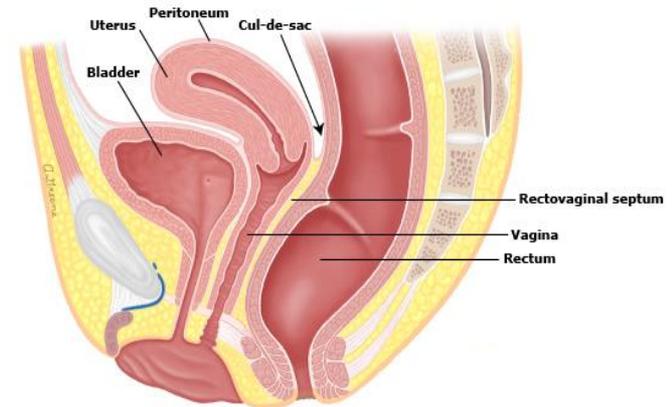
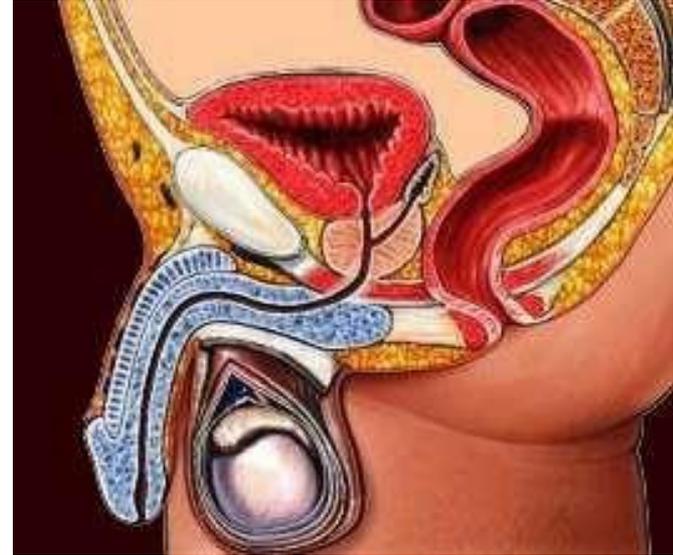
## HILTON'S LINE:

- Color contrast bluish pink area above and the black skin below.
- Indicates lower end of internal sphincter.
- Ishiorectal abscess when the communicates with anal canal usually opens at or below the Hilton's line.



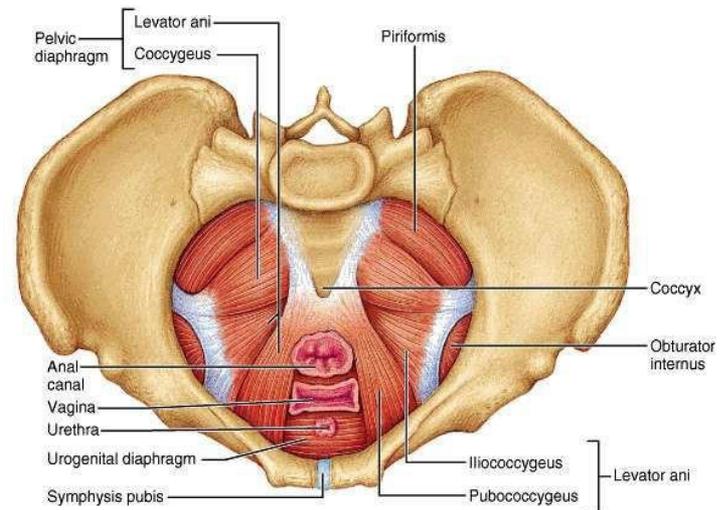
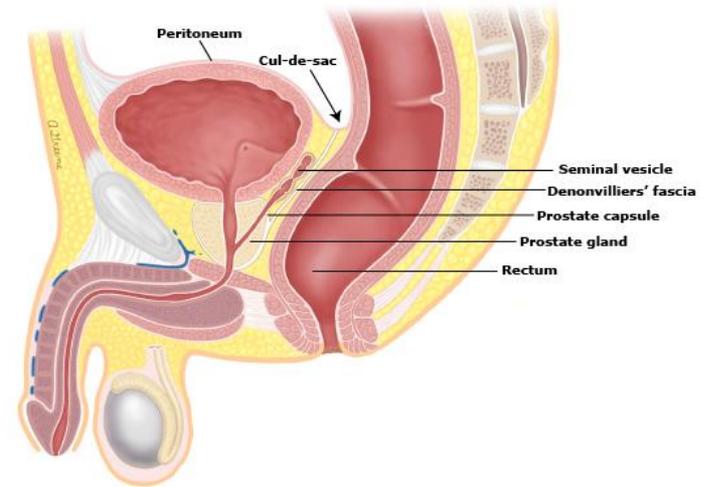
# Anal Canal (Relations)

- Anteriorly, the middle third of the anal canal is attached by dense connective tissue to the perineal body,
  - which separates it from the membranous urethra and penile bulb in males
  - from the lower vagina in females.



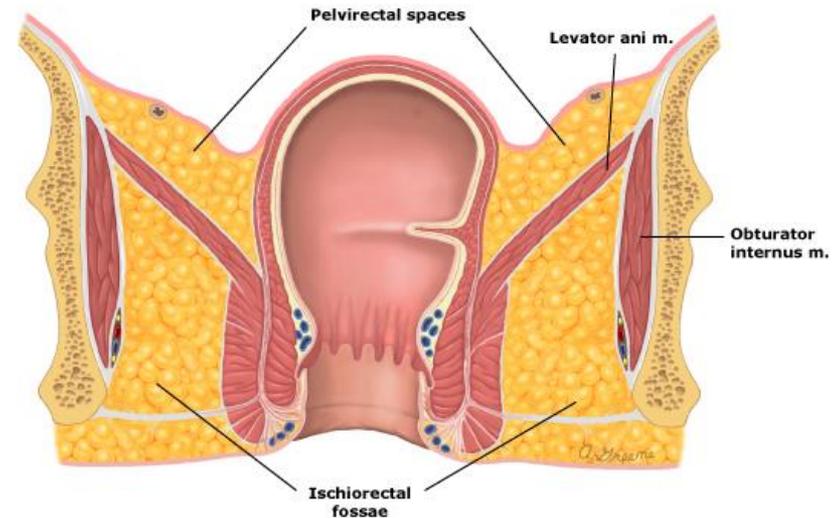
# Anal Canal (Relations)

- Laterally and posteriorly, the anal canal is surrounded by loose adipose tissue within the ischiorectal fossas.
- Posteriorly, the anal canal is attached to the coccyx by the anococcygeal ligament, a midline fibroelastic structure that may possess some skeletal muscle elements and that runs between the posterior aspect of the middle portion of the external sphincter and the coccyx.
- Just above this is the raphe of the levator ani muscle, the fusion of the two halves of iliococcygeus, which merges anteriorly with the puborectalis muscle



# Ischiorectal Fossa

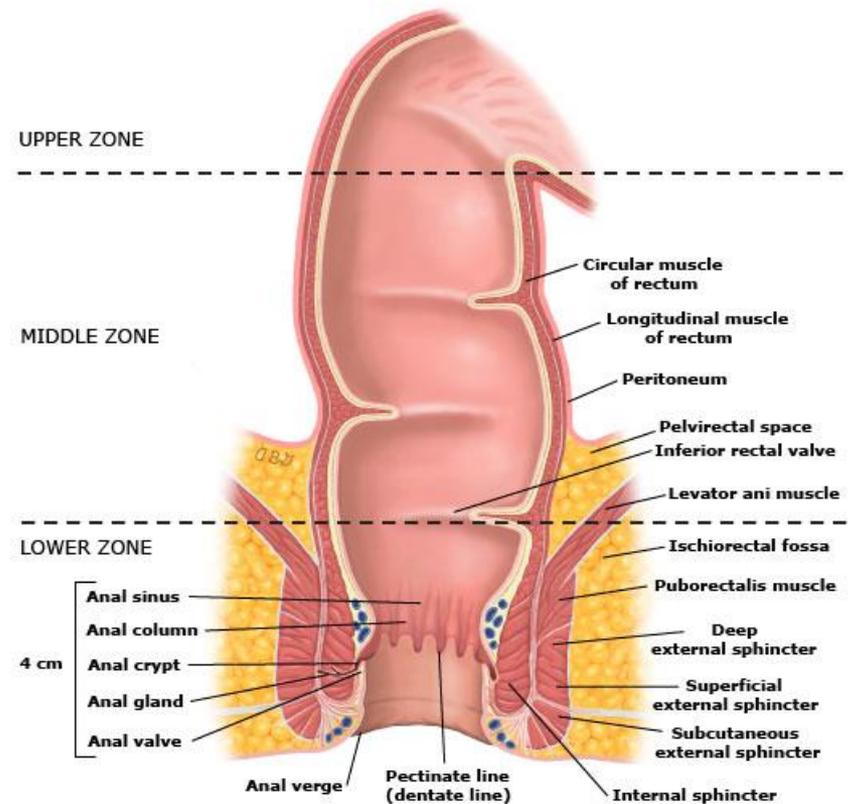
- Triangular in shape
- bounded by the skin inferiorly, the obturator internus muscle laterally, and the inferior surface of the levator ani as its anterior and medial border.
- Posteriorly, the ischiorectal space is continuous to the sacrotuberous ligament and the gluteus maximus muscle with the potential space in the buttock deep to the muscle.
- Superiorly, the ischiorectal fossa is sealed off by the origin of the levator ani from the inner surface of the obturator internus and the continuity of the inferior fascia of the pelvic diaphragm with the obturator fascia.
- Anteriorly, the ischiorectal fossa is separated from the superficial perineal space by the attachment of the perineal fascia to the posterior border of the urogenital diaphragm.



The ischiorectal fossa continues forward for a short distance above the urogenital diaphragm and the lower border of the pelvic diaphragm until these two diaphragms join. The left and right ischiorectal fossas communicate posteriorly, above a portion of the external anal sphincter that extends posteriorly to attach to the coccyx

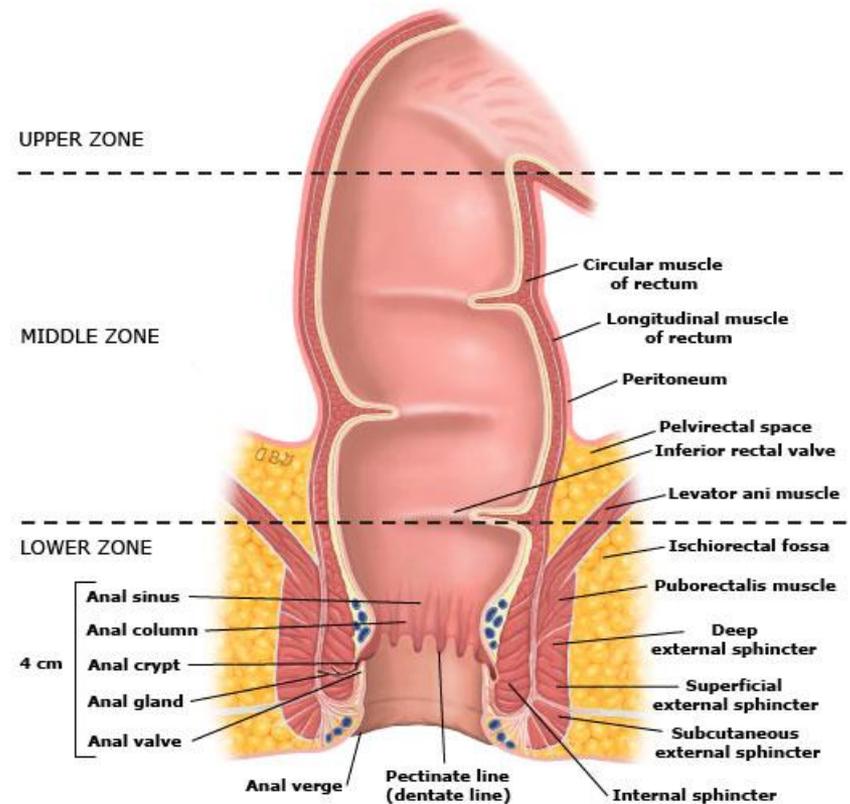
# Anal Sphincter

- The internal anal sphincter is a well-defined ring of obliquely orientated smooth muscle fibers
  - continuous with the circular muscle of the rectum and
  - terminates at the junction of the superficial and subcutaneous components of the external sphincter.
  - The lower portion of the sphincter is crossed by fibers from the conjoint longitudinal tendon that pass into the submucosa of the lower canal



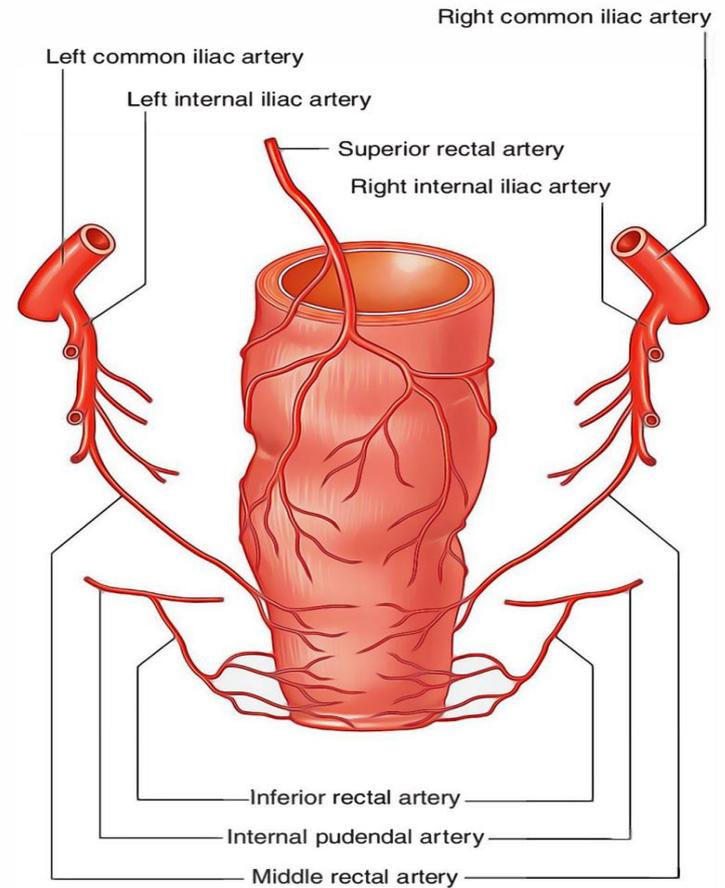
# Anal Mucosal Lining

- The upper part of the anal canal is lined by mucosa similar to the rectum, while the lower portion is lined by stratified epithelium similar to the skin of the perianal region.
- At the junction of these two types of lining are the anal columns, longitudinal and wider at the distal end, while fading at the proximal end of the canal.
- They are united distally by thin membranes called anal valves. Between the bases of the longitudinal columns and the anal valves are anal sinuses, rudimentary anal glands (also called crypts or ducts), which open into the anal sinuses.



# ARTERIAL SUPPLY

- The arterial supply of the anus is derived from branches from the superior rectal artery, the inferior rectal branch of the pudendal artery and branches of the median sacral artery.

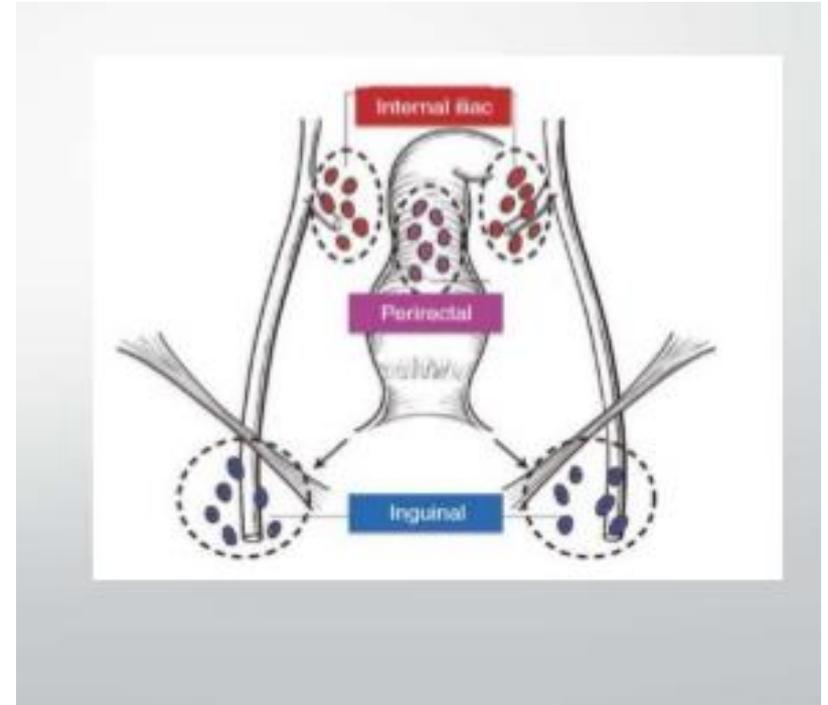


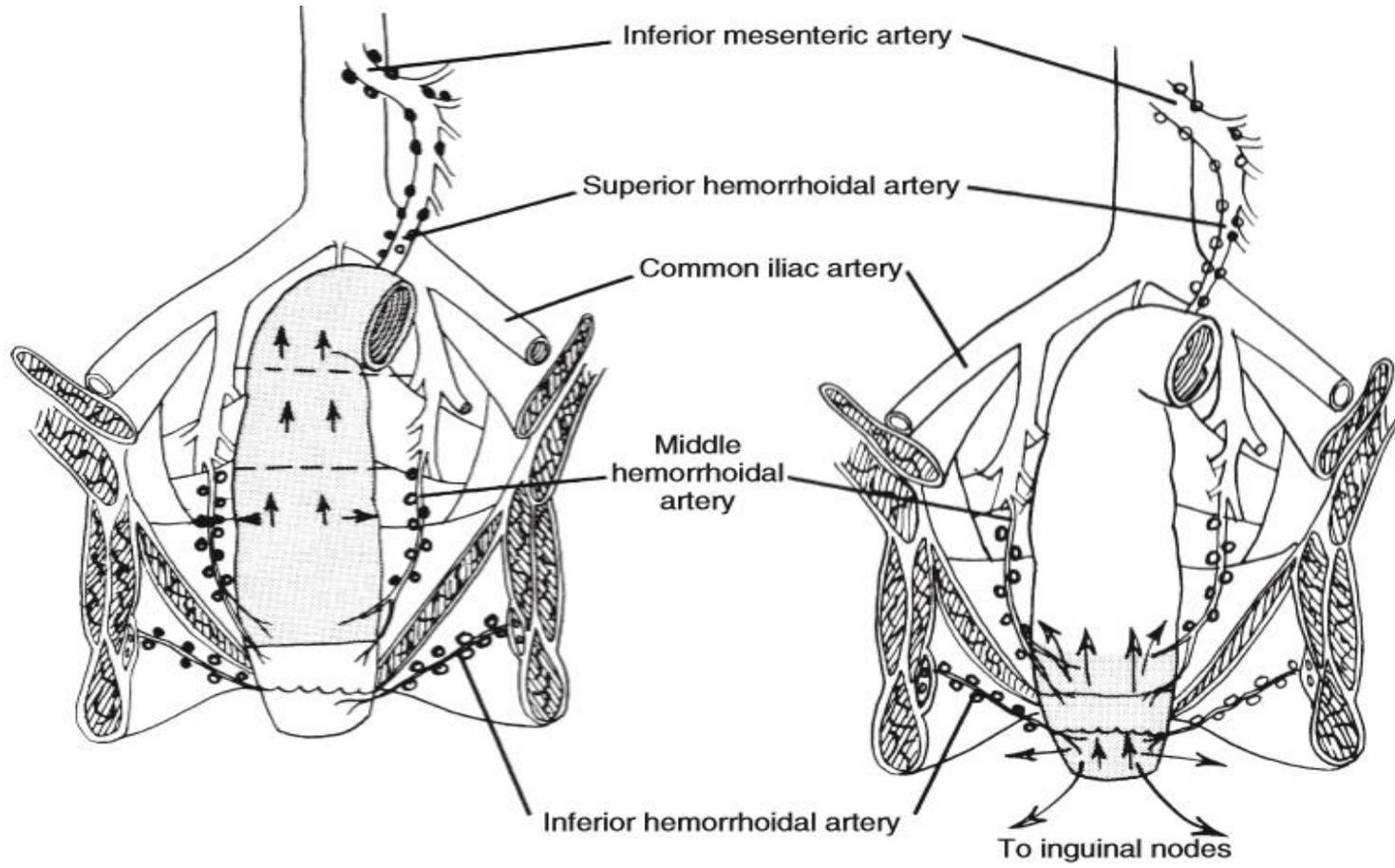
# VENOUS SUPPLY

- The venous drainage of the anal canal is divided into two patterns based on the dentate line.
- The upper anal canal and internal anal sphincter drains via the terminal branches of the superior rectal vein into the inferior mesenteric vein and portal system.
- The lower anal canal and external anal sphincter drain via the inferior rectal vein into the pudendal vein passing to the internal iliac vein.

# LYMPHATIC DRAINAGE

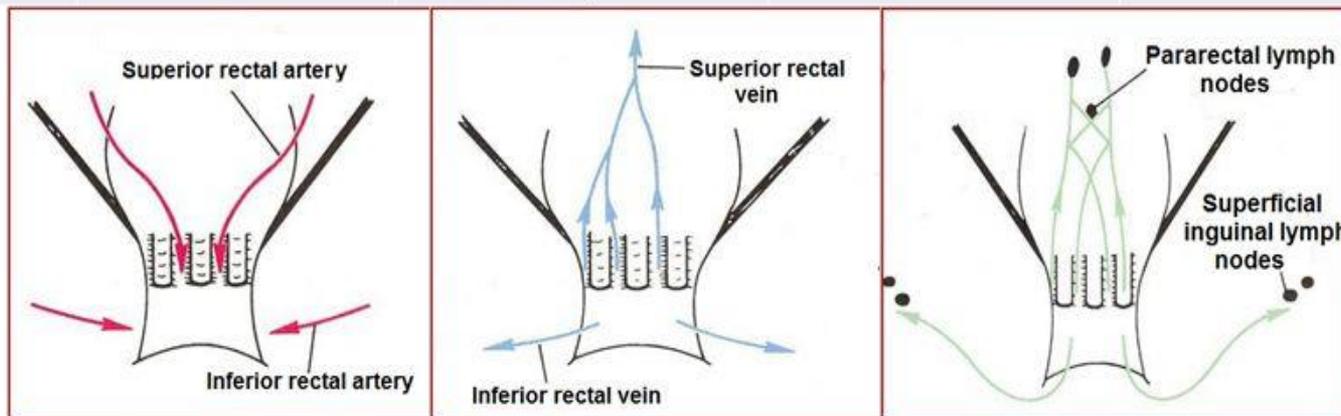
- Lymphatic drainage and the nodal involvement of anal canal depend on the location of the primary tumor.
- Tumors above the dentate line drains:  
**Locoregional LN i.e.**
  1. Peri-rectal
  2. Ano-rectal
  3. Lateral sacral
- Tumors below the dentate line drains:  
**Superficial inguinal LN.**





Distinction	Above Pectinate line	Below Pectinate line
Destination of lymph drainage	Internal iliac lymph nodes (pararectal lymph nodes)	Superficial inguinal lymph nodes (Below Hilton's line)
Epithelium	Columnar epithelium (as is most of the digestive tract – the line represents the end of the part derived from the hind gut)	Stratified squamous epithelium , non keratinized (until Hilton's white line, where the anal verge becomes continuous with the perianal skin containing keratinized epithelium)
Embryological origin	Endoderm	Ecotoderm
Artery	Superior rectal artery	Middle & inferior rectal arteries
Vein	Superior rectal vein	Middle & inferior rectal veins
Hemorrhoids classification	Internal hemorrhoids (not painful)	External hemorrhoids (painful)
Nerves	Inferior hypogastric plexus Symp L1,L2 & parasymp S2,S3,S4	Inferior rectal nerves

Anal canal	Arterial supply	Venous drainage	Lymphatic drainage	Nerves
Upper half	Superior rectal artery (continuation of the inferior mesenteric artery)	Superior rectal vein drained into the inferior mesenteric vein (portal circulation)	Para-rectal nodes drained into inferior mesenteric lymph nodes	Visceral motor (sympathetic & parasympathetic) & sensory nerves
Lower half	Inferior rectal a. (branch of internal pudendal artery)	Inferior rectal vein drained into the internal pudendal vein (Systemic circulation) (site of portal-systemic anastomosis)	Superficial inguinal lymph nodes	Somatic motor & sensory nerves



**THANK YOU**