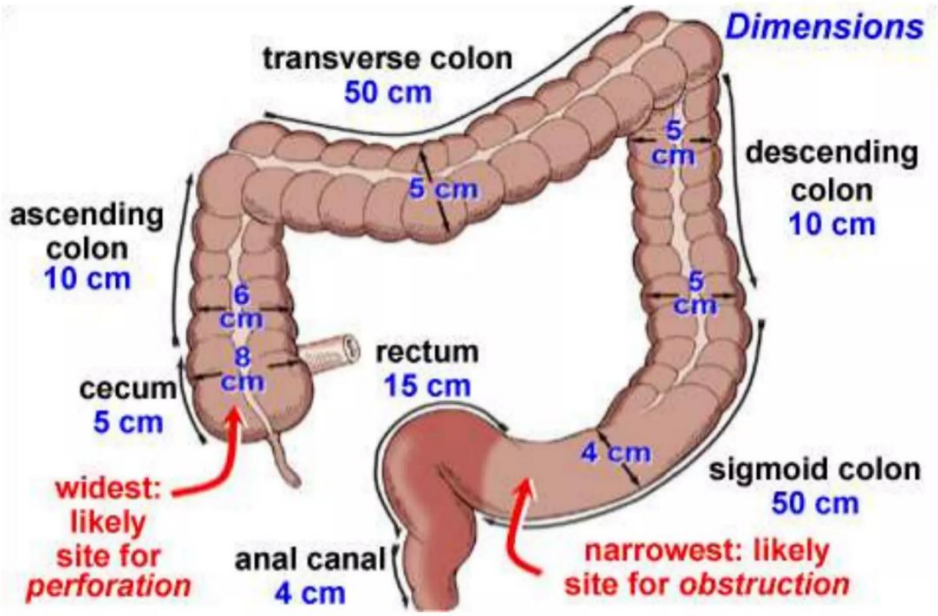
Anatomy of the large bowel

Anatomy of the Colon



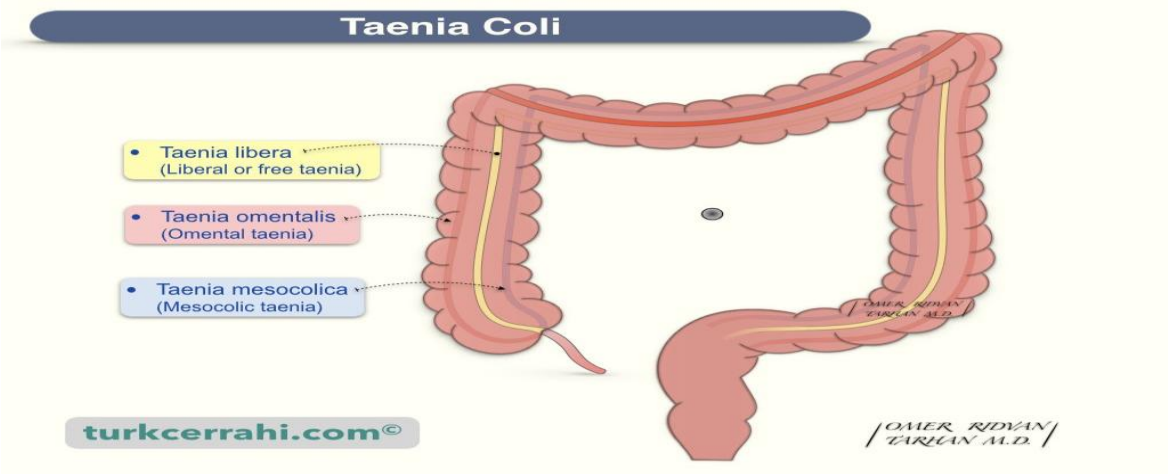
- The diameter of the colon decreases from proximal to distal (cecum about 7 cm and sigmoid colon about 2.5 cm in diameter).

average length approximating 150 cm.

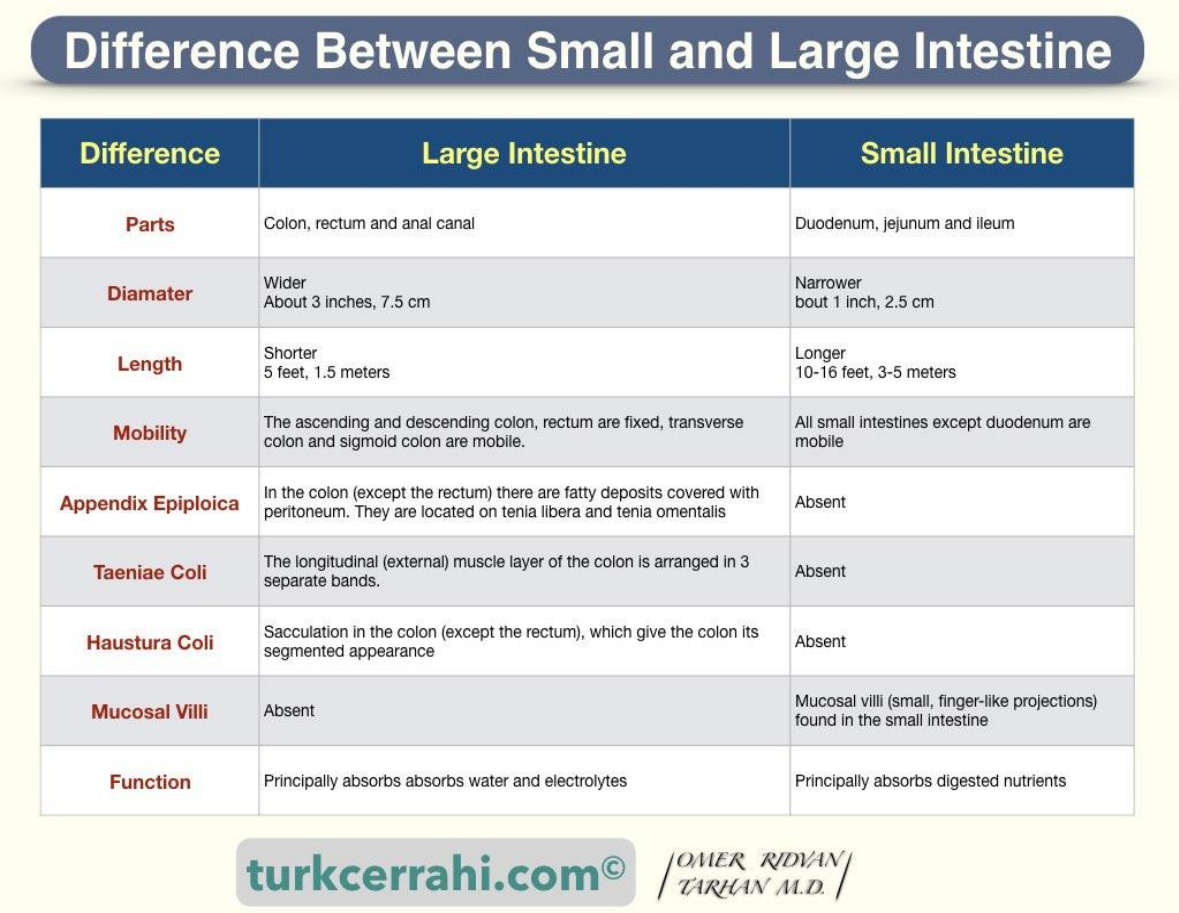
- The right and left sides of the colon are fused to the posterior retroperitoneum (secondarily retroperitonealized), while the transverse colon and sigmoid colon are relatively free within the peritoneum.
- The transverse colon is held in position via its attachments to the right/left colon at the flexures (hepatic and splenic, respectively) and is further fused to the omentum.

- Three classic anatomic points of differentiation between the colon and the small intestine:
  - Appendices epiploicae, the taeniae coli, and the haustra.

- Taenia coli are three thickened bands of outer, longitudinal muscle of the colon. This outer layer of muscle is indeed circumferentially complete but is considerably thicker in three areas represented by the taenia.



- The bands are continuous from their origin at the base of the appendix until the rectosigmoid junction where they converge (marking an anatomically identifiable differentiation between the sigmoid colon and rectum).
- Though they run along the full length of the colon, they are not as long as the bowel wall, so the haustra formed.
- The haustra are further septated by the plicae semilunares.



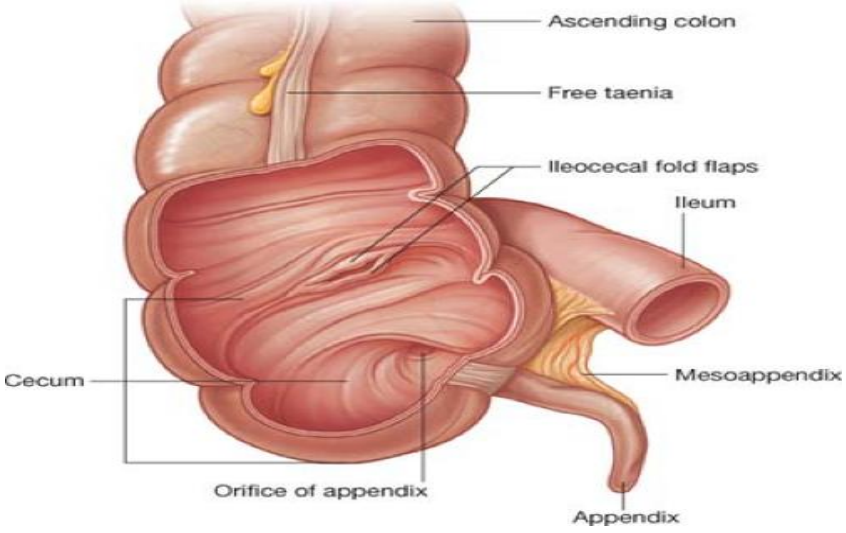
Difference Between Small and Large Intestine

Difference	Large Intestine	Small Intestine
Parts	Colon, rectum and anal canal	Duodenum, jejunum and ileum
Diamater	Wider About 3 inches, 7.5 cm	Narrower bout 1 inch, 2.5 cm
Length	Shorter 5 feet, 1.5 meters	Longer 10-16 feet, 3-5 meters
Mobility	The ascending and descending colon, rectum are fixed, transverse colon and sigmoid colon are mobile.	All small intestines except duodenum are mobile
Appendix Epiploica	In the colon (except the rectum) there are fatty deposits covered with peritoneum. They are located on tenia libera and tenia omentalis	Absent
Taeniae Coli	The longitudinal (external) muscle layer of the colon is arranged in 3 separate bands.	Absent
Haustura Coli	Sacculation in the colon (except the rectum), which give the colon its segmented appearance	Absent
Mucosal Villi	Absent	Mucosal villi (small, finger-like projections) found in the small intestine
Function	Principally absorbs absorbs water and electrolytes	Principally absorbs digested nutrients

Cecum

- The proximal most portion of the colon.
- Saclike segment of the colon below (proximal to) the ileocecal valve.
- Variable in size but generally is about 8 cm in length and 7 cm in diameter.
- The appendix at its base.
- Terminating in the posteromedial area of the cecum is the terminal ileum (ileocecal valve).
- The cecum is generally covered by visceral peritoneum.

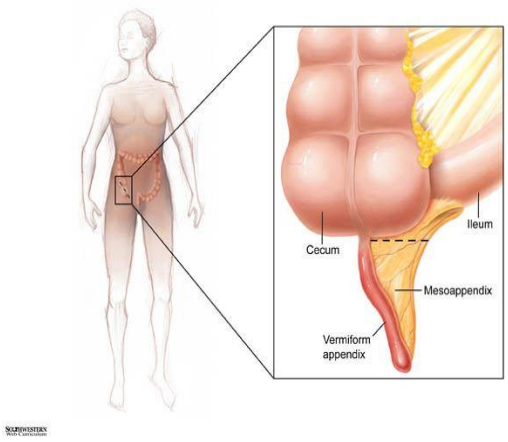
- The ileocecal valve is a circular muscular sphincter (slit-like ("fish-mouth" opening in colonoscopy. The valve is not competent in all patients.
- Regulation of ileal emptying into the colon appears to be the prime task in ileocecal valve function.

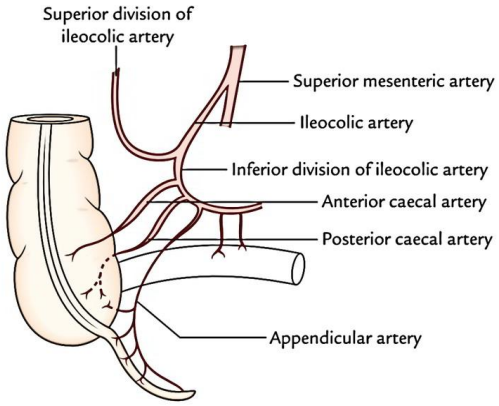


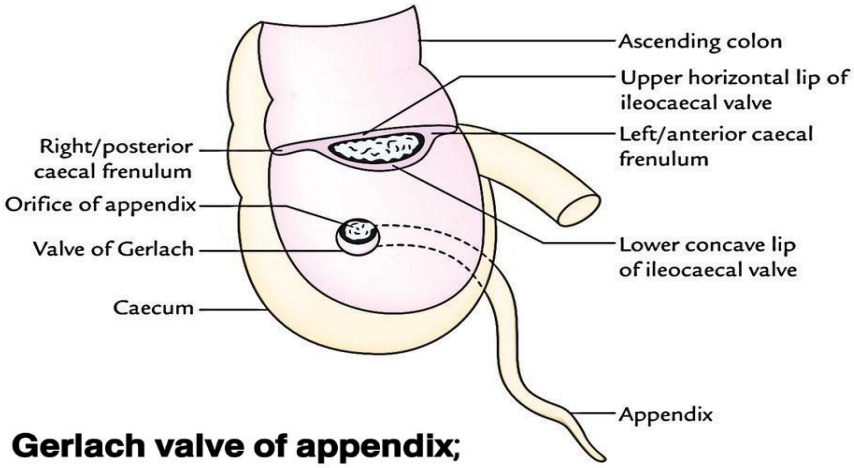
The Appendix

- The appendix is an elongated, true diverticulum arising from the base of the cecum. generally about 3–4 cm from the ileocecal valve, variable length (2–20 cm) and is about 5 mm in diameter in the non-inflamed state.
- Blood is supplied to the appendix via the appendiceal vessels contained within the mesoappendix. This results in the most common location of the appendix base being medially on the cecum toward the ileum, but the appendix tip does have great variability in its location including pelvic, retrocecal, preileal, retroileal, and subcecal.

- The appendix have important role in immune function and/or the colonic microbiome.







Gerlach valve of appendix;

Ascending Colon

- About 15–18 cm.
- The lateral peritoneal reflection can be seen as a thickened line termed the white line of Toldt.
- The right ureter and the right gonadal vessels pass posteriorly to the ascending mesocolon within the retroperitoneum.

Transverse Colon

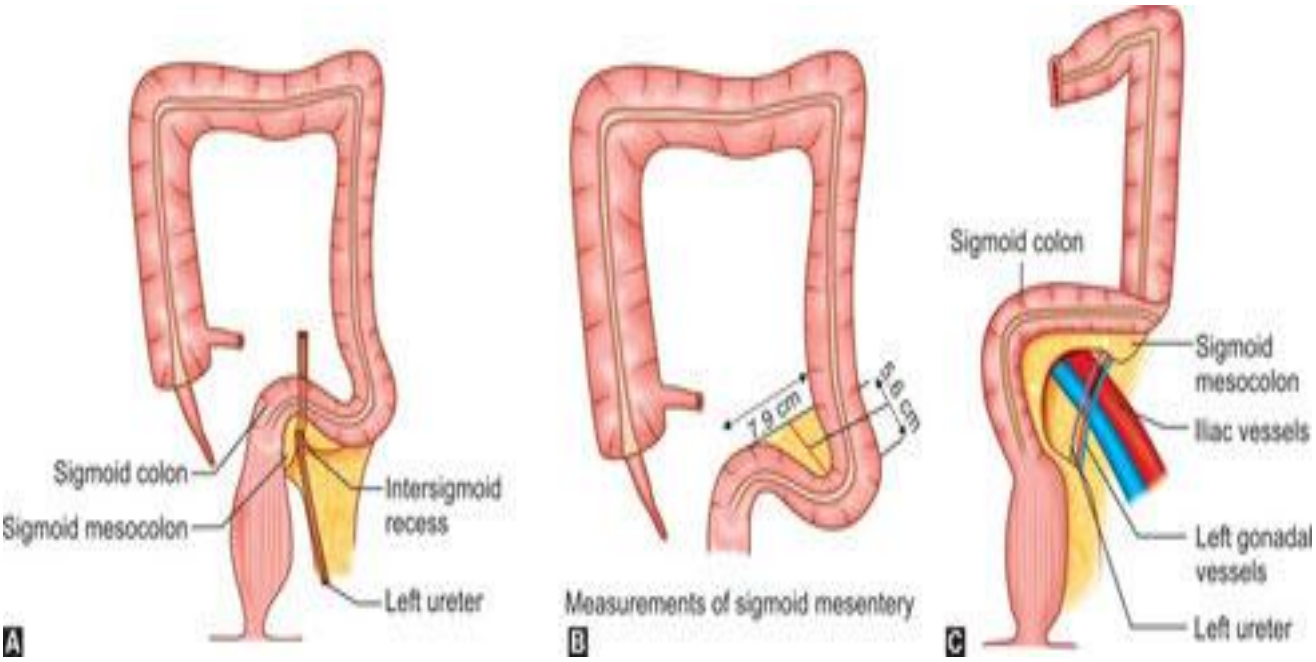
- From the hepatic flexure on the right to the splenic flexure on the left. It is generally the longest section of colon (averaging 45–50 cm).
- The entire transverse colon is covered by visceral peritoneum, but the greater omentum is fused to the anterosuperior surface of the transverse colon.
- Superior to the transverse mesocolon, inferior to the stomach, and posterior to the omentum is the pocket of the peritoneal cavity termed the lesser sac, with the pancreas forming the posterior most aspect.
- It can be adherent to the spleen and to the diaphragm via the phrenicocolic ligament.

Descending Colon

- The descending colon travels inferiorly from the splenic flexure for the course of about 25 cm.
- Its anterior and lateral surfaces are covered with visceral peritoneum, and the lateral peritoneal reflection (white line of Toldt) is again present.

Sigmoid Colon

- most variable part of the colon segments. It is generally 35–45 cm in length.
- Covered by visceral peritoneum, thereby making it mobile.
- Its mesentery is of variable length but is fused to the pelvic walls in an inverted-V shape creating a recess termed the intersigmoid fossa which left ureter, gonadal vessels, and often the left colic vessels travels.



Rectosigmoid Junction

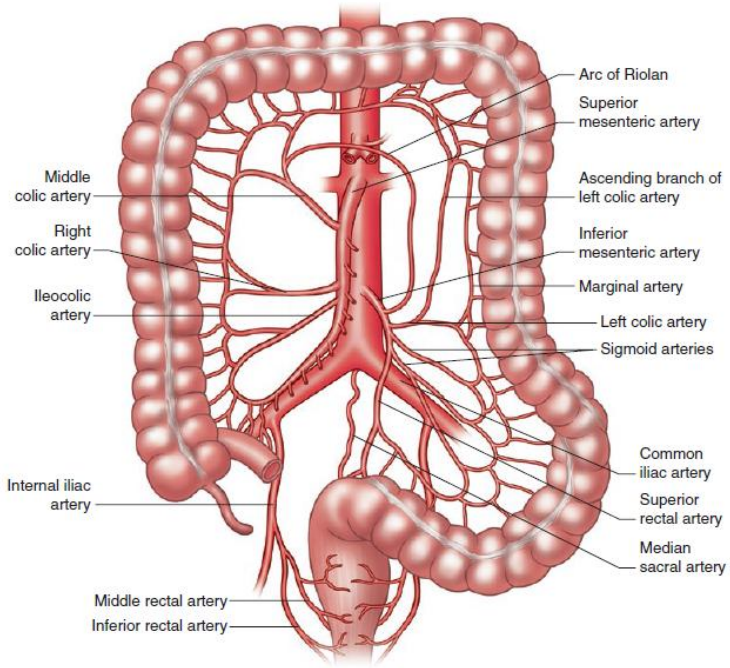
- The end of the sigmoid colon and the beginning of the rectum is termed the rectosigmoid junction.
- It is noted by the confluence of the taeniae coli and the end of epiploicae appendices.
- It is the narrowest portion of the large intestine, measuring 2–2.5 cm in diameter.
- An area of thickened circular muscle within the wall of the rectosigmoid was described and felt to function as a sphincter of sorts.

Blood Supply of the colon

- The colon receives blood supply from two main sources:

1. Branches of the superior mesenteric artery (SMA) (cecum, ascending, and transverse colon).
2. Branches of the inferior mesenteric artery (IMA) (descending and sigmoid co

Fig. 1.9 Arterial anatomy of the colon and rectum



- There is a watershed area between these two main sources located just proximal to the splenic flexure where branches of the **left branch** of the middle colic artery anastomose with **those** of the left colic artery, and represents the border of the embryologic midgut and hindgut.

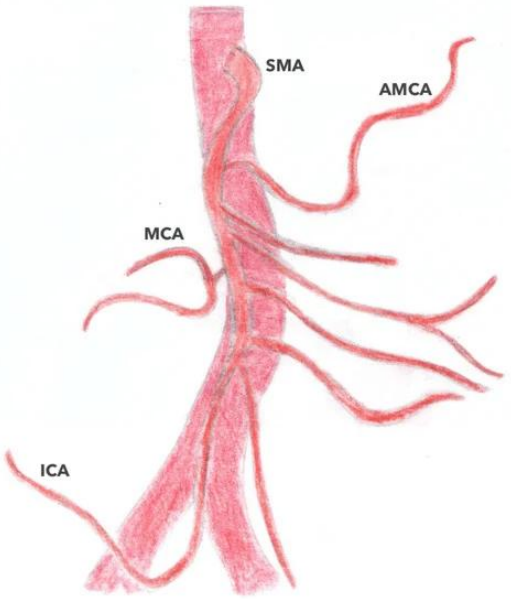
- Though the blood supply to the colon is somewhat variable, there are some general common arteries:

    1. The cecum and right colon are supplied by the terminus of the SMA, the ileocolic artery.
- The right colic artery is less consistent and, when present, can arise directly from the SMA, from the ileocolic, or from other sources.
    2. The transverse colon is supplied via the middle colic artery (originates directly from SMA), which branches early to form right and left branches.
    3. The left colon and sigmoid colon are supplied by branches of the IMA, namely, the left colic and a variable number of sigmoid branches.
    4. After the final branches to the sigmoid colon, the IMA continues inferiorly as the superior hemorrhoidal (rectal) artery.

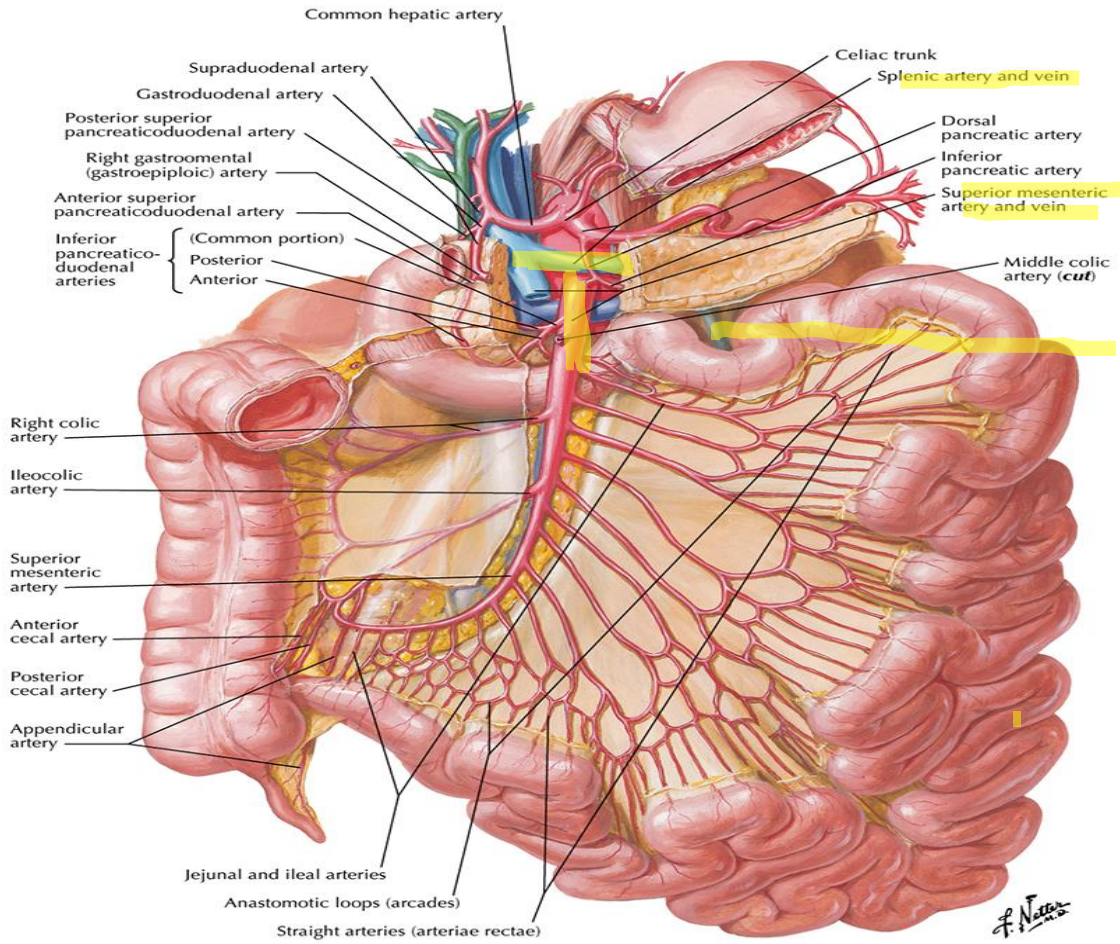
Superior Mesenteric Artery

- The superior mesenteric artery (SMA) is the second, unpaired anterior branch off of the aorta (the first being the celiac trunk).
- It arises posterior to the upper edge of the pancreas (near the L1 vertebrae), courses posterior to the pancreas, and then crosses over the third portion of the duodenum to continue within the base of the mesentery.
    - ❖ **Anterior to the SMA** – pyloric part of the stomach, splenic vein and neck of the pancreas.
    - ❖ **Posterior to the SMA** – left renal vein, uncinate process of the pancreas and inferior part of the duodenum.

- The most constant of the colic branches is the ileocolic vessel which courses through the ascending mesocolon where it divides into a superior (ascending) branch and an inferior (descending) branch.
- A true right colic artery is absent up to **20%** of the time and, when present, typically arises from the SMA. Alternatively, the right colic artery can arise from the ileocolic vessels or from the middle colic vessels
- The middle colic artery arises from the SMA near the **inferior border of the pancreas.** It branches early to give off right (supplies the hepatic flexure and right half of the transverse colon) and left branches (supplies the left half of the transverse colon to the splenic flexure).



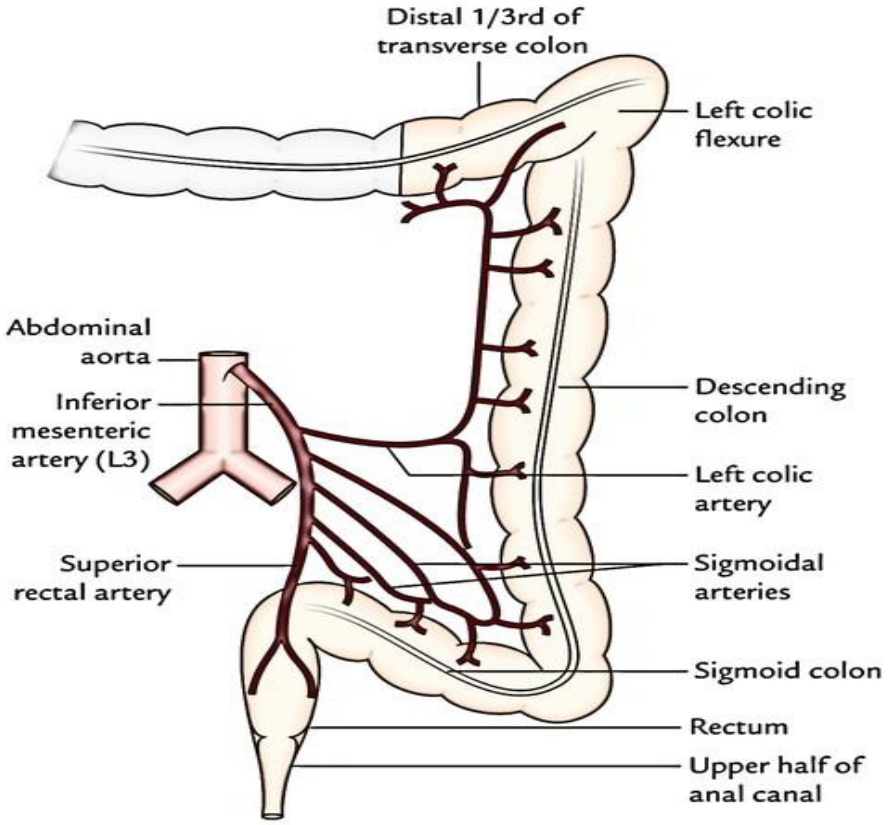
- In up to 33% of patients, the left branch of the middle colic artery can be the sole supplier of the splenic flexure.
- Recent reports describe an accessory middle colic artery (AMCA) in one third of patients and originate from **SMA**.

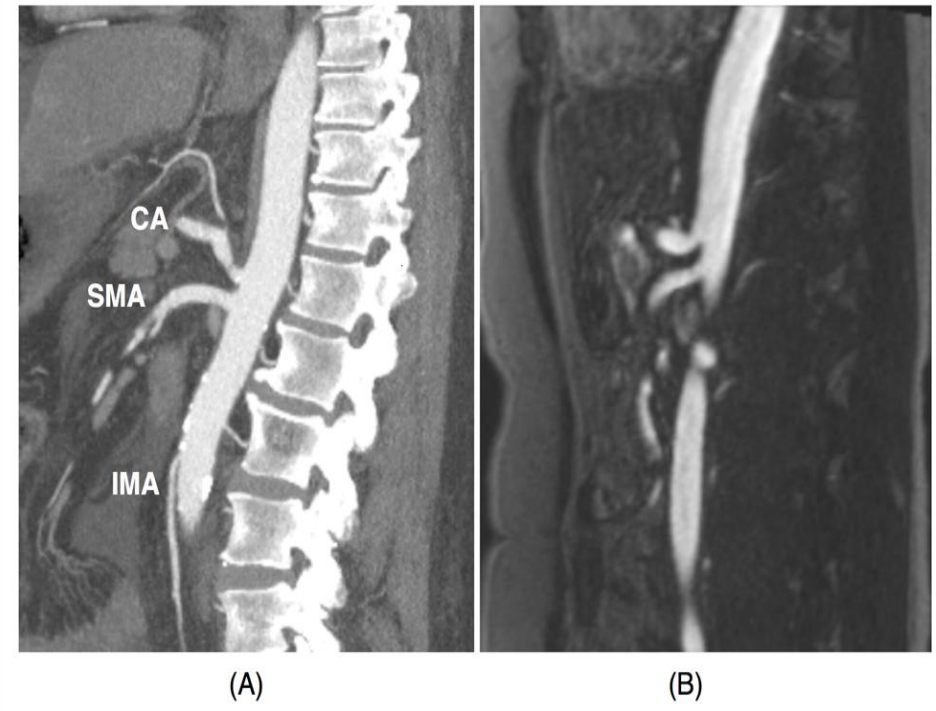


Inferior Mesenteric Artery

- The third unpaired, anterior branch off of the aorta, originating 3–4 cm above the aortic bifurcation at the level of the L2 to L3 vertebrae.
- As the IMA travels inferiorly and to the left, it gives off the left colic artery and several sigmoidal branches.
- The left colic artery divides into an ascending branch (splenic flexure) and a descending branch (the descending colon).
- After these branches, the IMA becomes the superior hemorrhoidal (rectal) artery as it crosses over the left common

iliac artery and carries in mesorectum and bifurcates in 80% of patients .





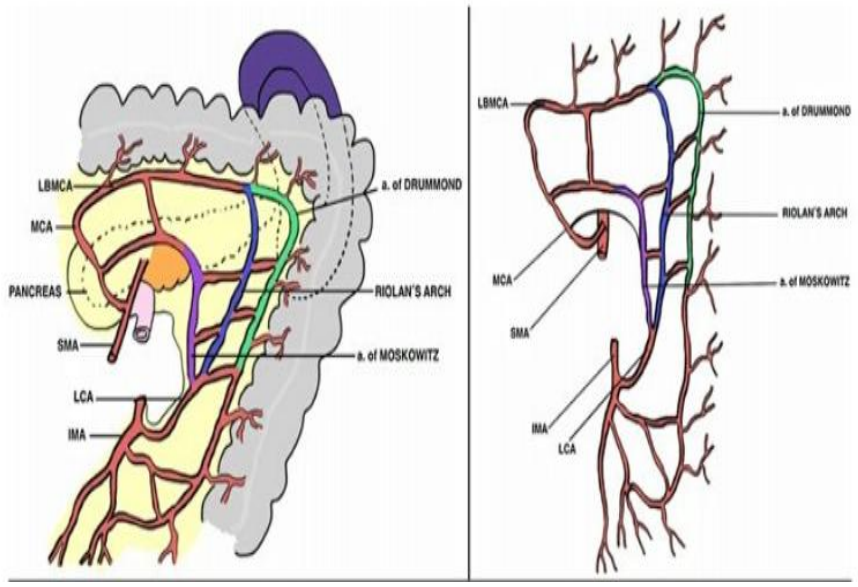
The Marginal Artery and Other Mesenteric Collaterals

- Marginal artery of Drummond is central artery anastomosing all mesenteric branches as described by Haller in 1786 then named as above after Drummond demonstrated its surgical significance in the early twentieth century.
- The marginal artery has been shown to be discontinuous or even absent in some patients, most notably at the splenic flexure (Griffiths' critical point), where it may be absent in up to 50% of patients.
- Inadequacy of the marginal artery likely accounts for this area being most severely affected in cases of colonic ischemia.
- Another potential (though controversial) site of ischemia is at a discontinuous area of marginal artery located at the rectosigmoid junction termed Sudeck's critical point.

Arc of Riolan

- The Arc of Riolan (Riolan's arcade, Arch of Riolan, Haller's anastomosis), also known as the meandering mesenteric artery, is another vascular arcade present in the colonic mesentery that connect the proximal middle colic artery with a branch of the left colic artery. This artery is found low in the mesentery, near the root.

Moskowitz artery is an anastomosis between IMA and SMA which can also be found as direct connection of their trunks or branches, for example between LCA and middle colic artery (MCA), LCA and accessory middle colic artery (AMCA).



Venous Drainage of the colon

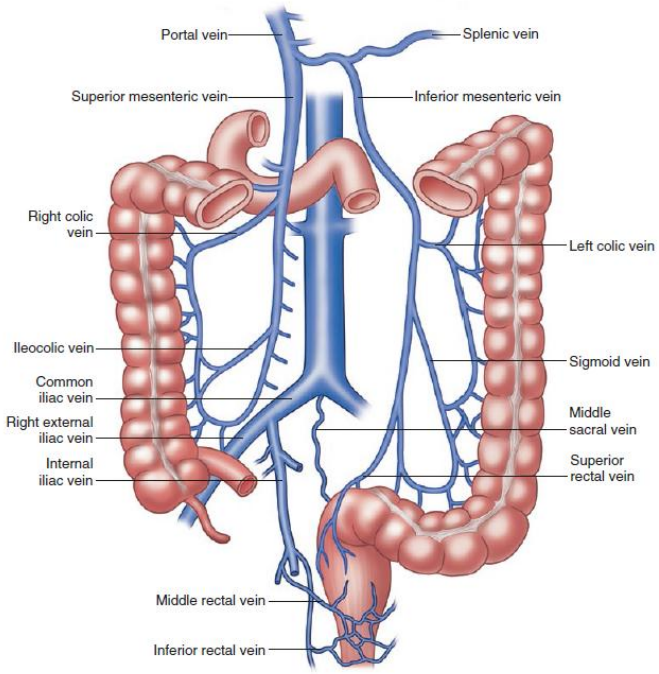
- Venous drainage of the colon largely follows the arterial supply with superior and inferior mesenteric veins draining both the right and left halves of the colon (Fig. 1.10).
- They ultimately meet at the portal vein to reach the intrahepatic system.
- The superior mesenteric vein (SMV) travels parallel and to the right of the artery.
- The inferior mesenteric vein (IMV) does not travel with the artery but rather takes a longer path superiorly to join the splenic vein.

- It separates from the artery within the left colon mesentery and runs along the base of the mesentery where it can be found just

lateral to the ligament of Treitz and the duodenum before joining the splenic vein on the opposite (superior) side of the transverse mesocolon.

- **Dissecting posterior to the IMV** can allow for separation of the mesenteric structures from the retroperitoneal structures during a medial-to-lateral dissection.

Fig. 1.10 Venous anatomy of the colon and rectum



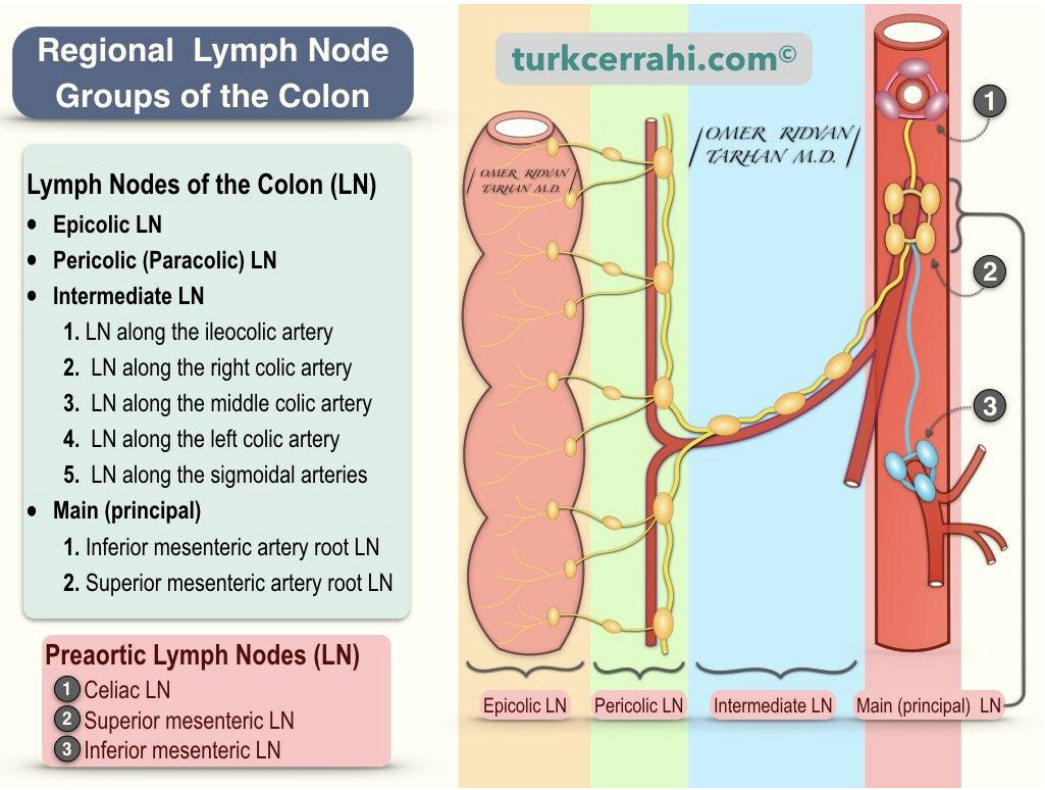
Lymphatic Drainage of the colon

- The colon wall has a dense network of lymphatic plexuses.

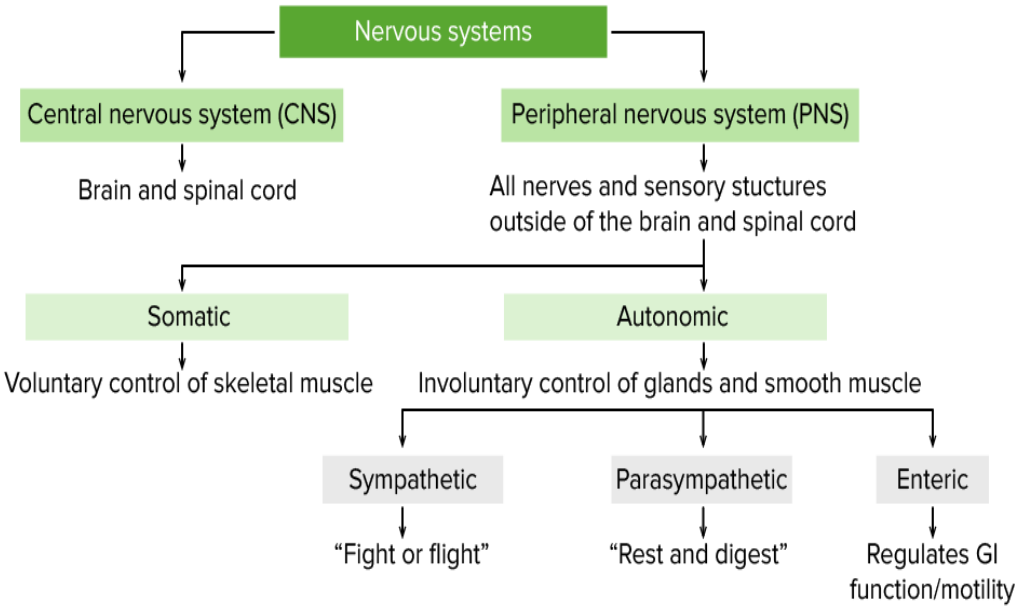
- These lymphatics drain into extramural lymphatic channels which follow the vascular supply of the colon.
- Lymph nodes are plentiful and are typically divided into four main groups.

1. The *epiploic* group lies adjacent to the bowel wall.
2. The *paracolic* nodes (most filtering) are along the marginal artery and the vascular arcades.
3. The *intermediate* nodes are situated on the primary colic vessels.
4. The *main* or *principal* nodes are on the superior and inferior mesenteric vessels.

❖ Once the lymph leaves the main nodes, it drains into the cisterna chili via the para-aortic chain.



Colonic Innervation



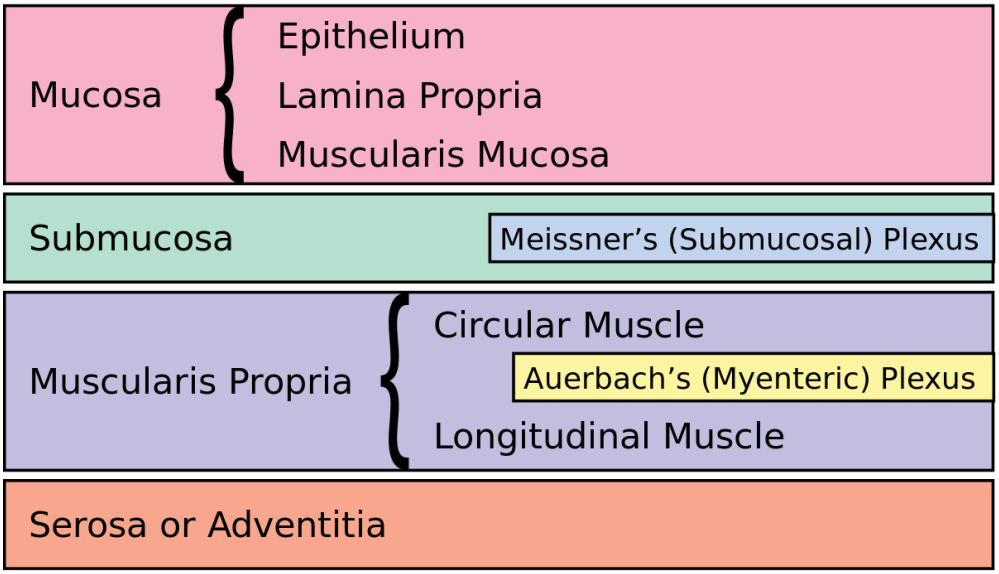
- By both extrinsic and intrinsic pathways.
- The **extrinsic pathways** are derived from the autonomic nervous system. The parasympathetic input is excitatory, while the sympathetic input is inhibitory to colonic motor function.
- The sympathetic innervation of the right half of the colon originates from the **lower six thoracic**, for the left half originates **from L1, L2, and L3.**
- Parasympathetic fibers to the right colon come from the **posterior (right) branch of the vagus** nerve and celiac plexus. On the left side, **from S2, S3, and S4** via splanchnic nerves.

- The **intrinsic innervation** consists of the enteric nervous system.

Two major sets of ganglia are found in the colon.

- The myenteric or **Auerbach's** plexus is located between the longitudinal and circular smooth muscle layers and plays a crucial role in colonic smooth muscle function.
- The **submucosal** or **Meissner's** plexus regulates ion transport.

General Organization of the Gastrointestinal Tract



- The extreme importance of these two plexuses is clear in children with Hirschsprung's disease in which the ganglia of the myenteric and submucosal plexuses are congenitally absent.
- The aganglionic segments do not relax and peristalsis is disturbed resulting in severe constipation.

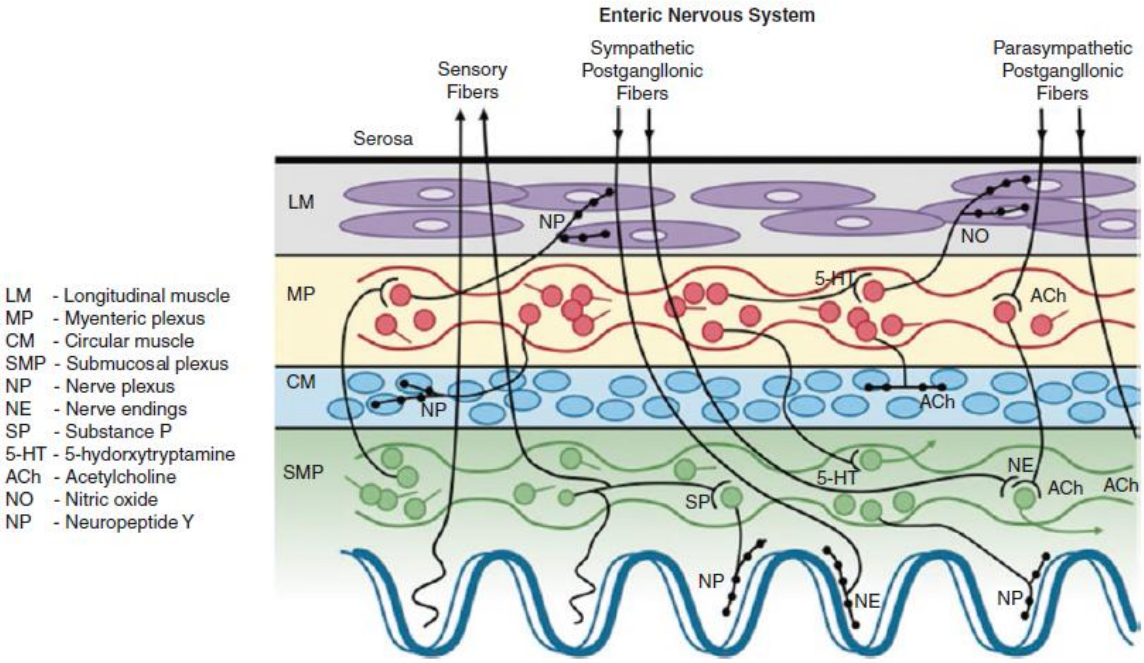


Fig. 2.5 Schematic representation of the components of the enteric nervous system. (*Courtesy of Robin Noel*, used with permission)

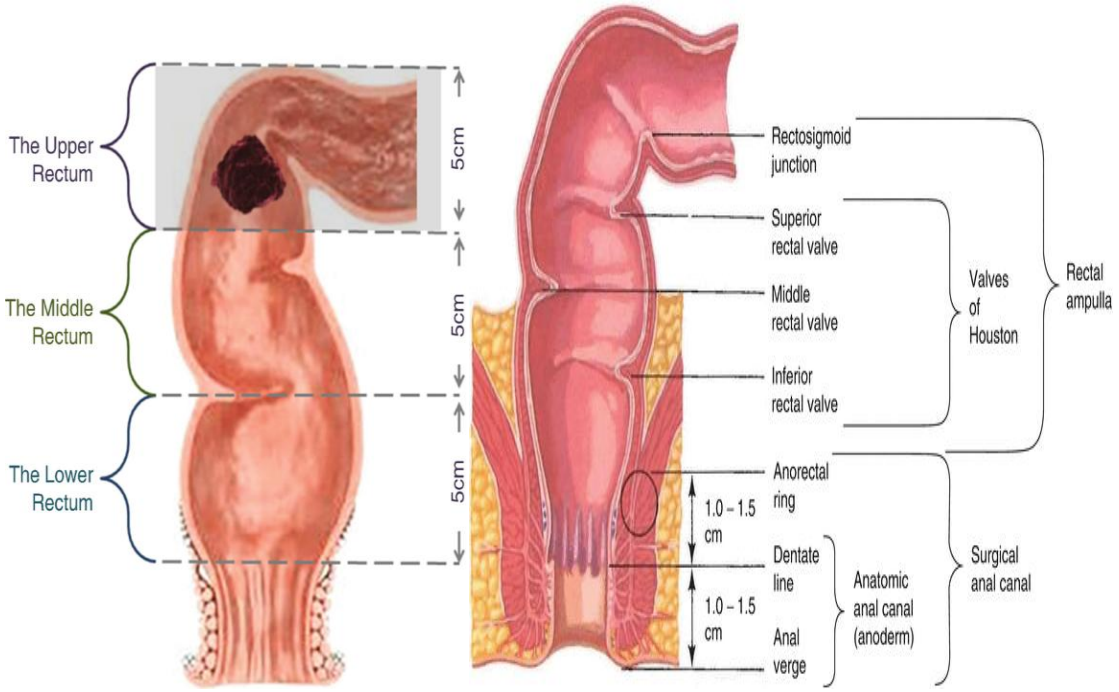
- Excitatory pathways are important for colonic propulsive activity, especially during defecation; damage to these pathways can cause severe constipation.

Rectal anatomy

- Anatomically distinct, the upper, mid, and lower rectal divisions are important when considering surgical treatment of rectal cancer.
- From the anal verge, the lower rectum is 0–7 cm; middle rectum, 7–12 cm; and upper rectum, 12–15 cm.
- The rectum serves as a reservoir for feces, measuring approximately 12–15 cm in length, However, variable in length and may extend beyond 15 cm from the anal verge.
- The rectum, which is identified in the abdomen by the lack of haustra, taeniae, or epiploica, is located along the curve of the

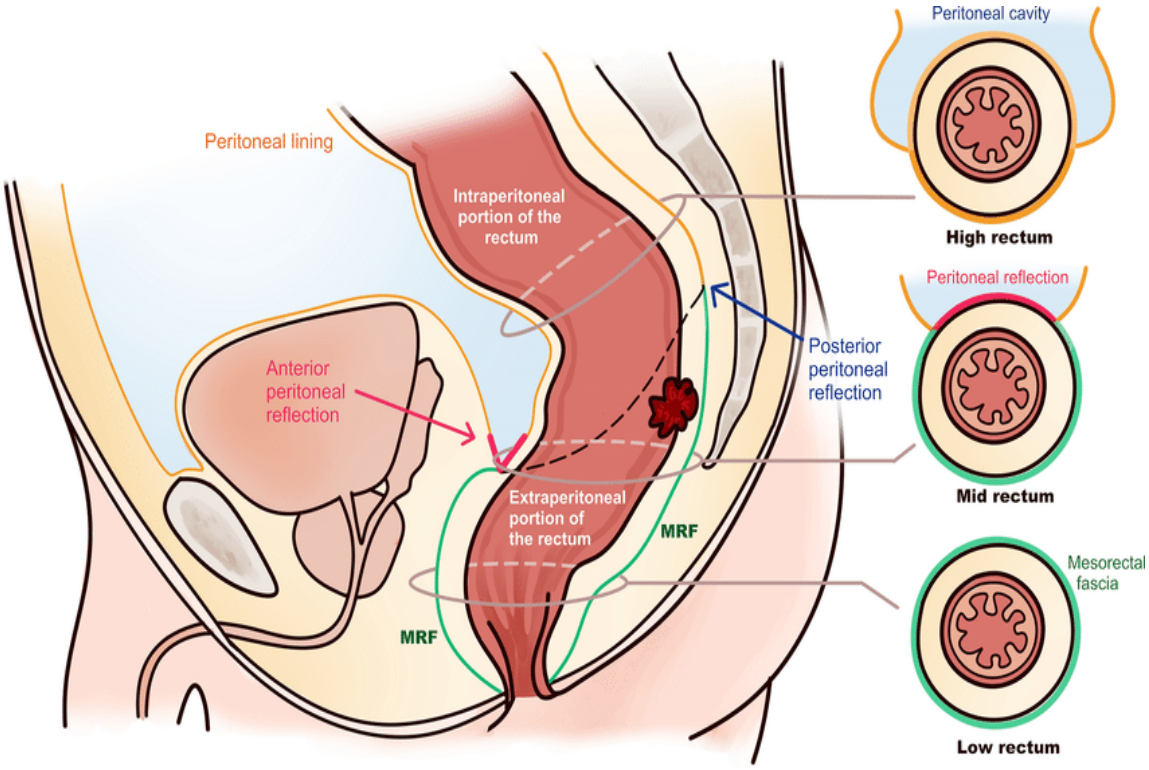
sacrum and coccyx and becomes the anal canal as it passes through the levators.

- The rectal wall contains a layer of longitudinal smooth muscle and a layer of circular smooth muscle that are in continuity with the gastrointestinal tract.



- The majority of the rectum lies outside of the peritoneal cavity, although anteriorly and laterally the upper rectum is covered by a layer of visceral peritoneum down to the peritoneal reflection.

- The location of the anterior peritoneal reflection is highly variable and can be significantly altered by disease such as rectal prolapse.



Rectal Valves: The Spiral Valves of Houston and Kohlrausch's Valve

- Modern anatomy texts usually also describe three rectal valves (Fig. 1.1) with the superior and inferior valves located on the left side of the rectum and the more prominent middle rectal valve on the right; however, Only 45.5% of patients will have the classic three valve rectal anatomy; 32.5% will have only two valves; and 10.25% may have four valves.

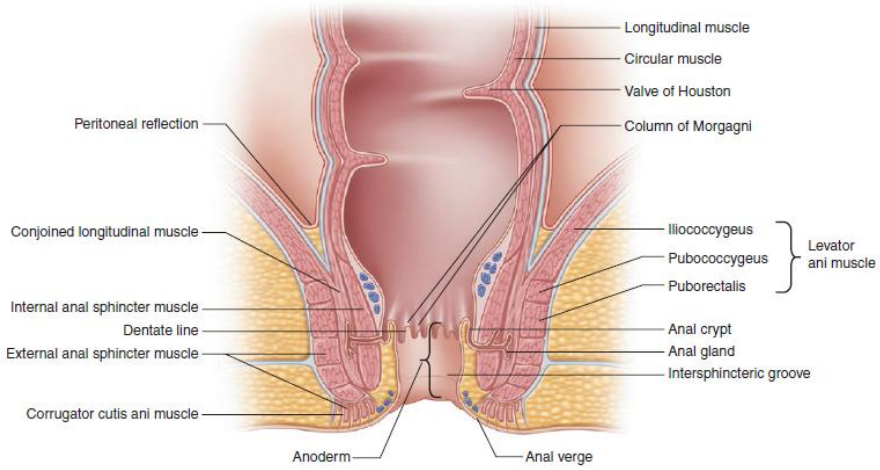
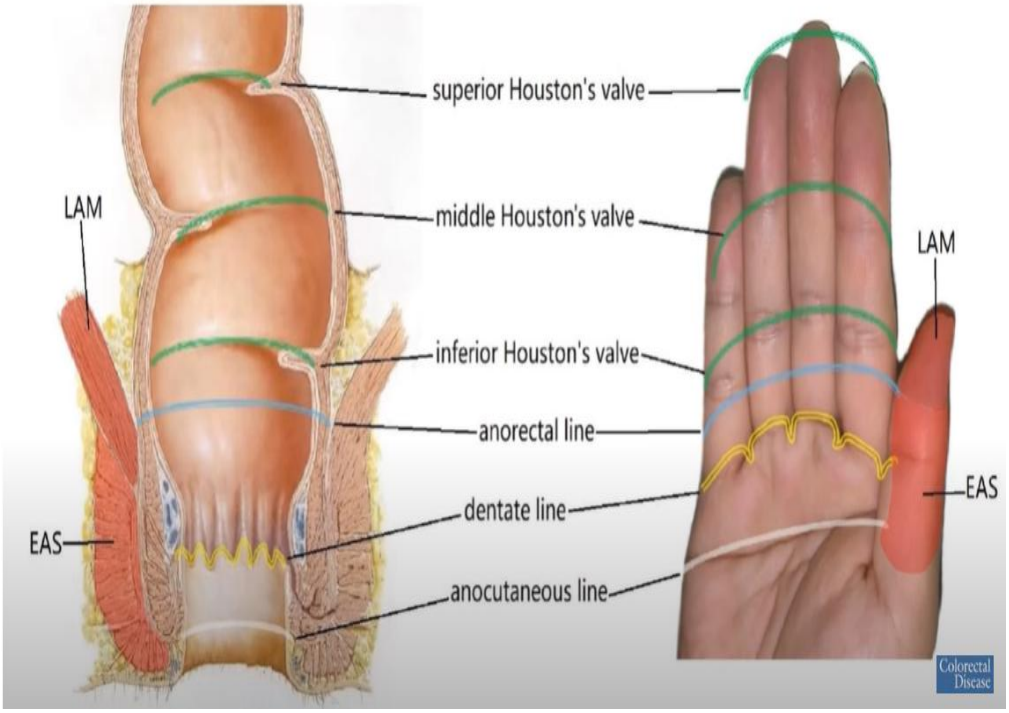


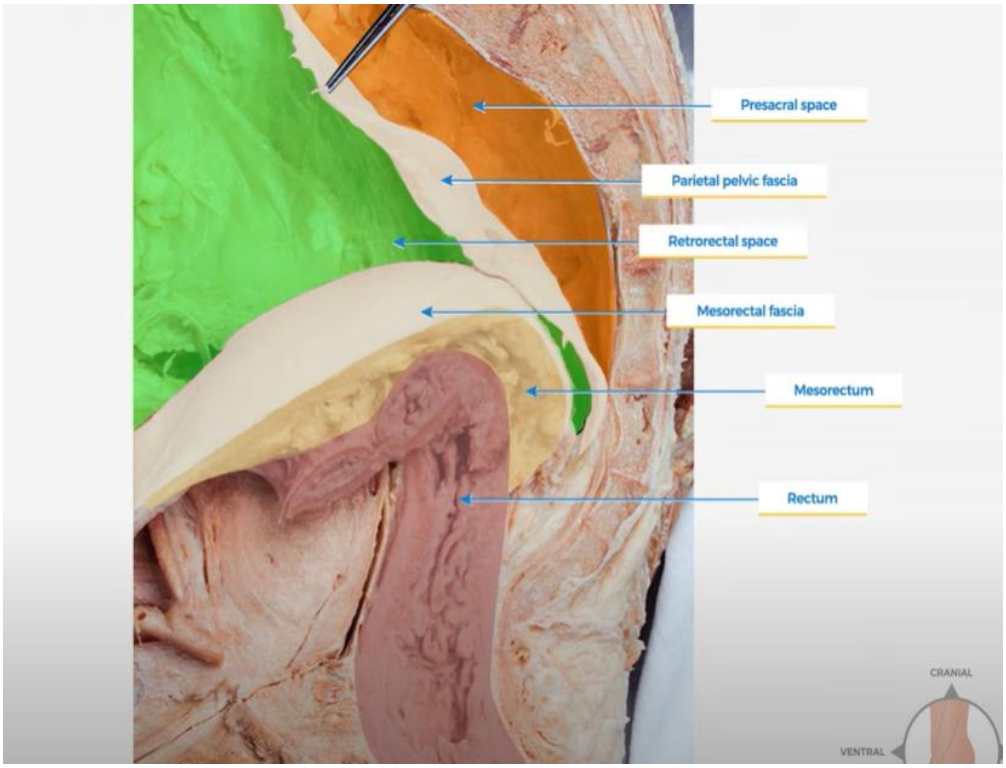
Fig. 1.1 Anal canal

- After Houston's definitive description of rectal valves in 1830, Otto Kohlrausch, a physician and scientist in Germany, described a single mid-rectal valve in 1854.
- This valve is usually the largest, located on the right and approximately 9–11 cm from the anal verge, and some authors have suggested this valve could serve as an intraluminal marker for the area of the anterior peritoneal reflection.



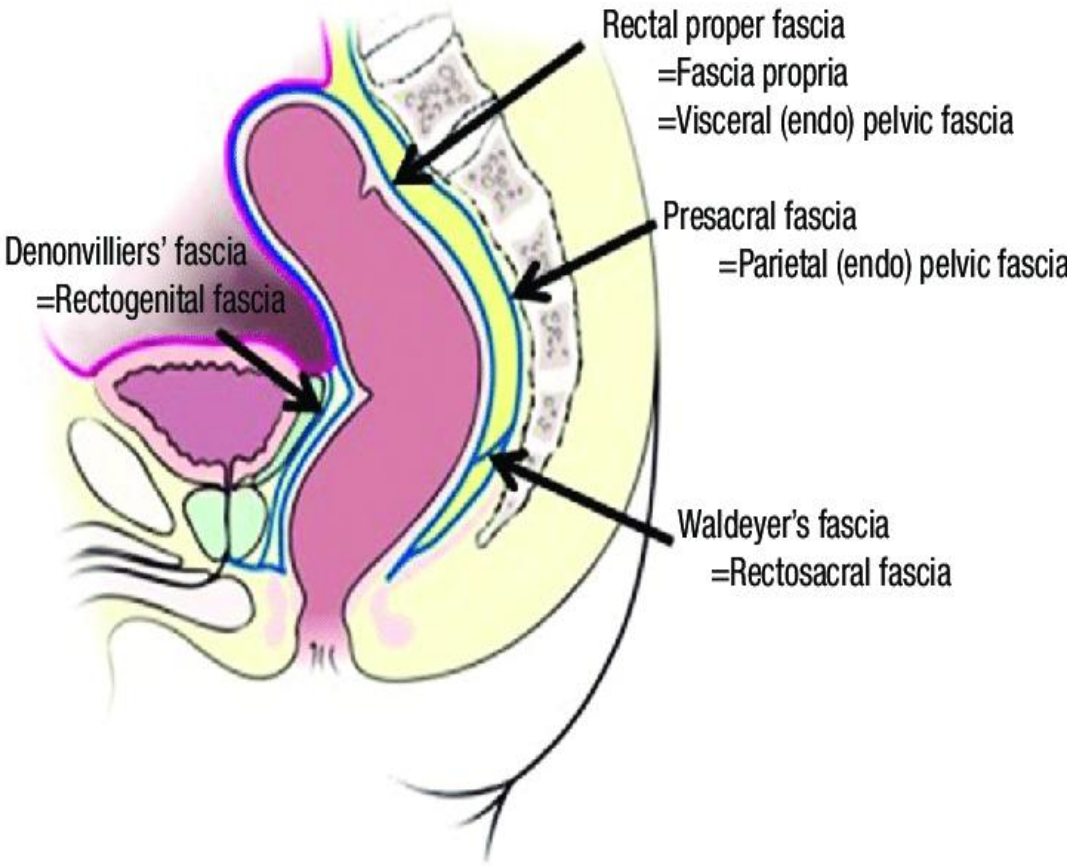
Mesorectum

- The mesorectum is a term employed by surgeons to describe the fascial envelope of the rectum that is excised during surgical treatment of rectal cancer.
- Indeed, failure to completely excise this envelope intact has been associated with an increased incidence of local recurrence of rectal cancer.
- The mesorectum is contained within the **fascia propria**.
- The fascia propria is an upward projection of the parietal endopelvic fascia that lines the walls and floor of the pelvis.
- The fascia propria encloses the perirectal fat, lymphatics, blood vessels, and nerves and is not considered a barrier strong enough to prevent the spread of infection or malignancy.



Presacral Fascia

- The presacral fascia is a thickened portion of the parietal endopelvic fascia overlying the sacrum that covers the **presacral veins and hypogastric nerves**.
- It extends laterally to cover the piriformis and upper coccyx.
- As the presacral fascia extends laterally, it becomes continuous with the fascia propria and contributes to the lateral ligaments of the rectum.



Retrosacral Fascia

- The retrosacral fascia **originates** at the third and fourth portion of the sacrum and extends anteriorly to the posterior layer of the fascia propria 3–5 cm proximal to the anorectal junction.
- This tough fascia layer is surgically relevant as it must be **sharply incised** during total mesorectal excision.
- The space posterior to the retrosacral fascia is referred to as the supralevator or retrorectal space.

Waldeyer's Fascia

There is significant confusion about what Waldeyer's fascia represents as the eponym has been used to describe the presacral fascia, the retrosacral fascia, or all fascia posterior to the rectum.

In Waldeyer's original description of pelvic fascia, there was no particular emphasis on the presacral component.

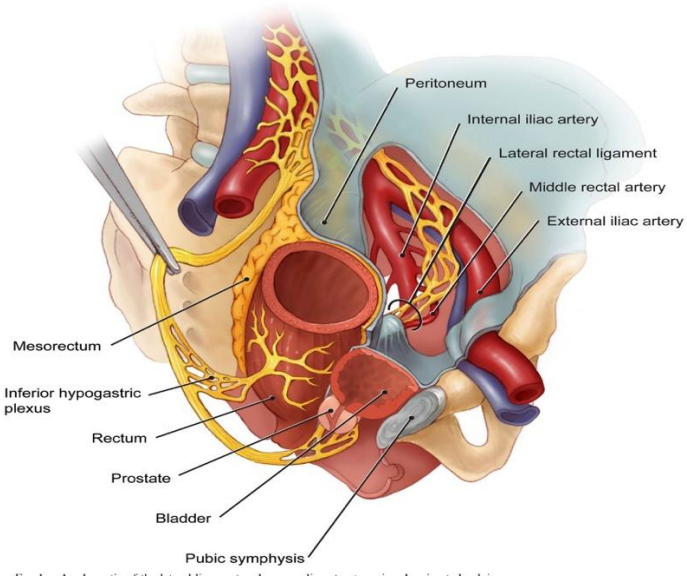
While the debate continues regarding "Waldeyer's fascia," it is important to simply understand that the phrase can have the potential to mean presacral fascia, retrorectal fascia, or both.

Denonvilliers' Fascia

- Denonvilliers' fascia arises from the fusion of the two walls of the embryological peritoneal cul-de-sac and extends from the deepest point of the rectovesical pouch to the pelvic floor.
- Originally described by Denonvilliers in 1836 as a "prostatoperitoneal" membranous layer between the **rectum and seminal vesicles**, Denonvilliers fascia is also present in females as part of the rectovaginal septum and is sometimes referred to **as rectovaginal fascia**.

- It is found immediately beneath the vaginal mucosa and is clearly what most would consider as part of the vaginal wall.
- It merges superiorly with the cardinal/uterosacral complex in females or the rectovesical pouch in males.
- It merges laterally with the endopelvic fascia overlying the levator muscle and distally with the perineal body.
- It contains collagen, some strands of smooth muscle, and heavy elastin fibers. Rectoceles represent a defect in this layer that allows the rectum to bulge anteriorly.

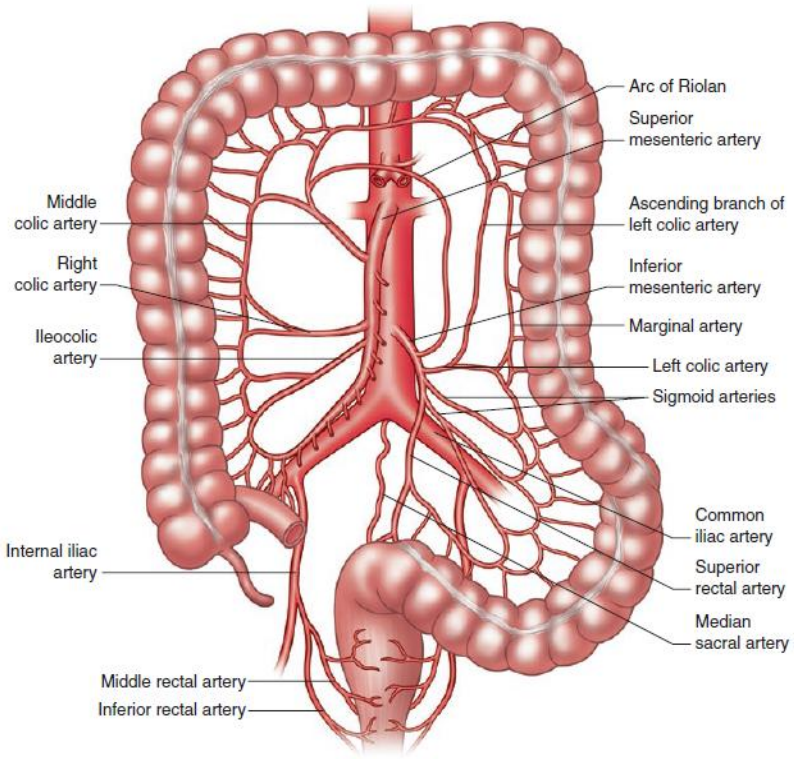
The cavernous nerves run in neurovascular bundles at the anterolateral border of Denonvilliers' fascia.



Rectal Blood Supply

- The rectum is supplied by the superior, middle, and inferior rectal (hemorrhoidal) arteries (Fig. 1.9).
- Both the middle and inferior hemorrhoidal vessels are paired arteries, and the superior rectal artery is not.

Fig. 1.9 Arterial anatomy of the colon and rectum



Superior Rectal Artery

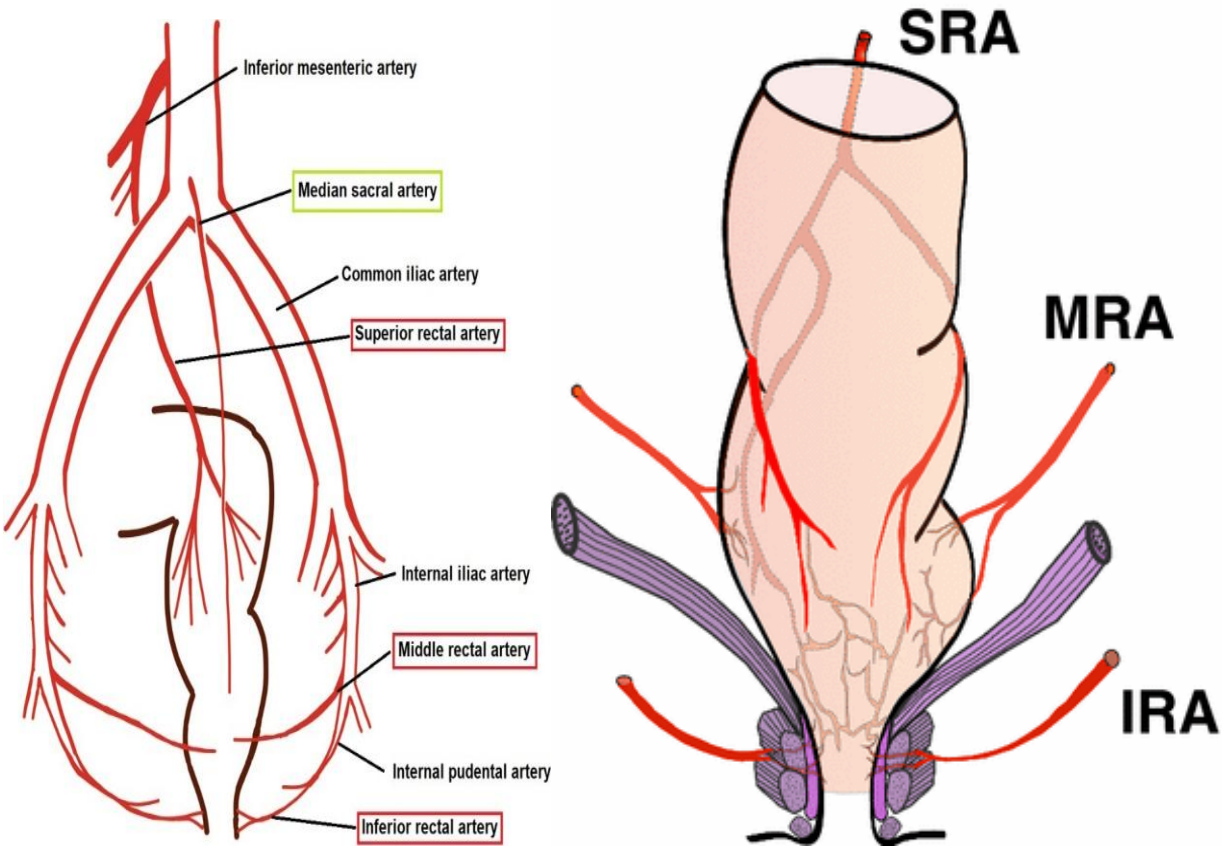
The superior rectal artery (SRA) is the continuation of the inferior mesenteric artery and is so named after the inferior mesenteric artery crosses the **left** iliac vessels. The SRA gives off a rectosigmoid branch,then bifurcates into right and left terminal branches.

Middle Rectal Artery

- The middle rectal artery (MRA) has been variably noted in many studies.
- The MRA originates from the anterior division of the internal iliac or pudendal arteries.

Inferior Rectal Artery

- The inferior rectal arteries (IRA) are paired vessels that originate as branches of the internal pudendal artery which receives its blood supply from the internal iliac artery.
- The artery originates in the pudendal canal and is entirely extra-pelvic (caudal to the levator ani) in its distribution.
- The IRA traverses the obturator fascia and the ischiorectal fossa and pierces the wall of the anal canal in the region of the external anal sphincter.

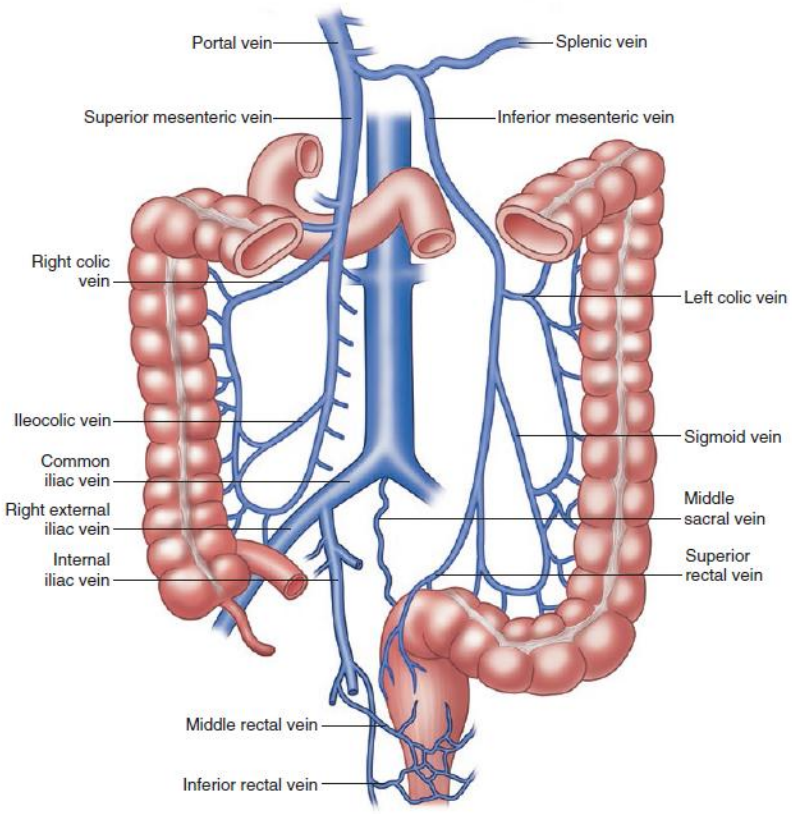


Venous and Lymphatic Drainage of the Rectum and Anus

- **Venous** drainage from the rectum and anus occurs via both the portal and systemic systems.

1. Middle and inferior rectal veins drain to the systemic systems via the internal iliac vein,
2. The superior rectal vein drains the rectum and upper anal canal into the portal system via the inferior mesenteric vein (Fig. 1.10).

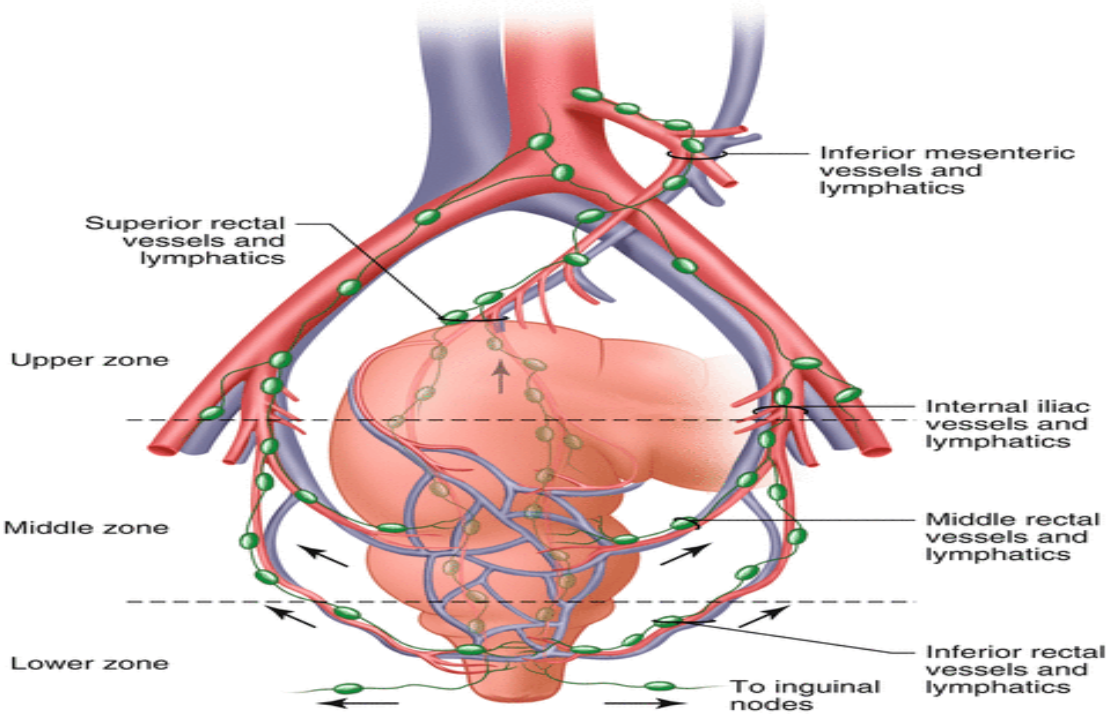
Fig. 1.10 Venous anatomy of the colon and rectum



- **Lymphatics** from the *upper two-thirds* of the rectum drain to the inferior mesenteric lymph nodes and then to the para-aortic lymph nodes.
- Lymphatic drainage from the *lower third* of the rectum occurs superiorly along the superior rectal artery and laterally along the middle rectal artery to the internal iliac lymph nodes.

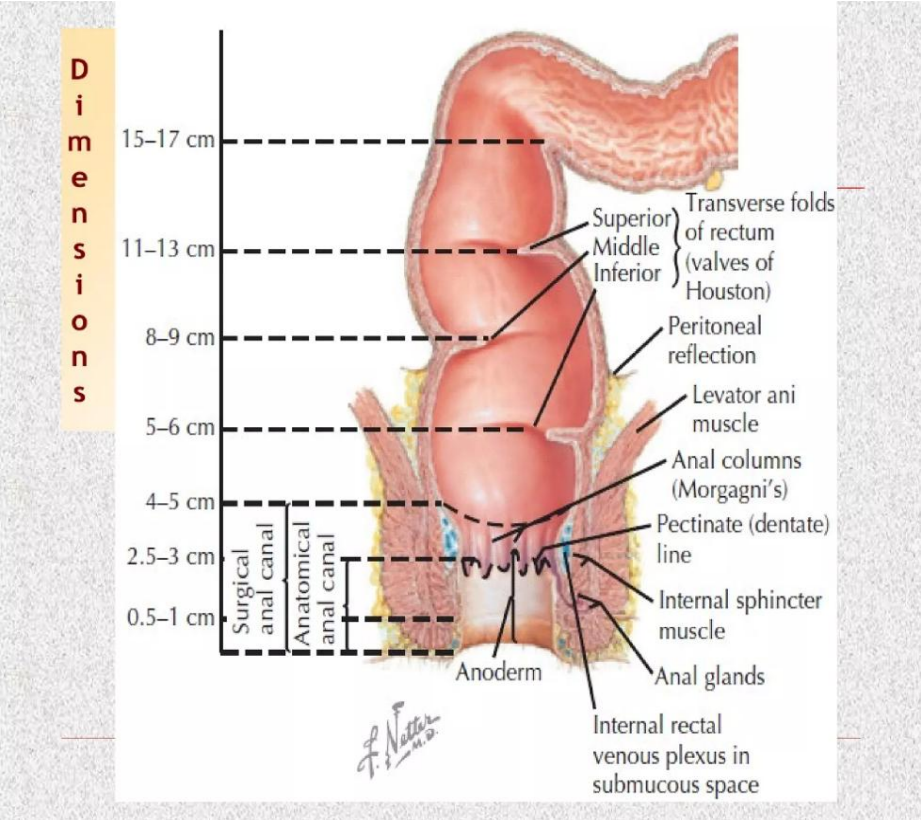
In the **anal canal**, lymphatics above the dentate drain to the inferior mesenteric and internal iliac lymph nodes. Below the dentate line,

lymphatics drain along the inferior rectal lymphatics to the superficial inguinal nodes.



Anatomy of the Anal Canal and Pelvic Floor

- **Anatomic** anal canal defined as beginning at the **dentate (pectinate) line** and extending to the anal verge.
- **Surgical** anal canal as first defined by Milligan and Morgan, extends from the **anorectal ring** to the anal verge.
- On average, the functional or surgical anal canal measures approximately 2.5–5 cm in length and is shorter in females.
- The surgical anal canal is formed by the internal anal sphincter, external anal sphincter, and puborectalis (Fig. 1.1) and is easily identified on digital examination,ultrasound imaging, and magnetic resonance imaging (MRI).



- The anal canal forms proximally where the rectum passes through the pelvic hiatus and joins with the puborectalis muscle.
- Starting at this location, the muscular anal canal can be thought of as a "tube within a tube."

❖ The **inner tube** is the visceral smooth muscle of the internal anal sphincter and longitudinal layer that is innervated by the autonomic nervous system.

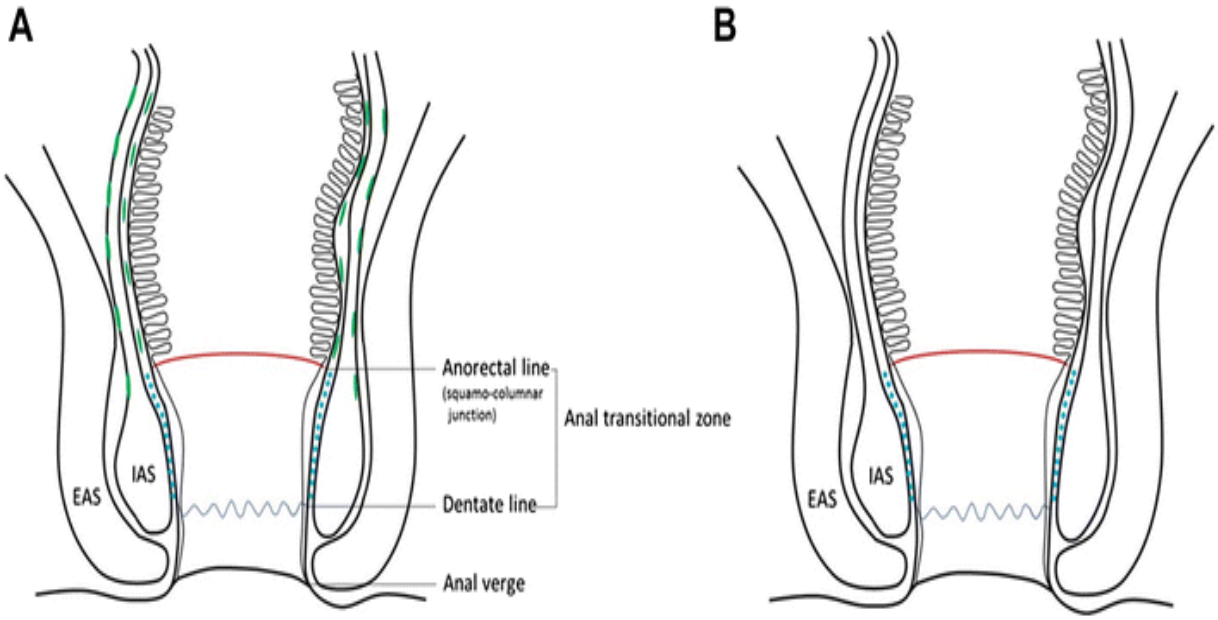
❖ The **outer muscular tube** consists of somatic muscles including the components of the puborectalis and external anal sphincter. It provides conscious control over continence and is strengthened during Kegel exercises.

- The external anal sphincter extends distal to the internal anal sphincter, and the anal canal terminates at the anal verge where

the superficial and subcutaneous portions of the external anal sphincter join the dermis.

Anal Canal Epithelium

- The proximal anal canal has a pink appearance and is lined by the columnar epithelium of the rectal mucosa.
- 6 to 12 mm proximal to the dentate line, the anal transition zone (ATZ) begins(purple in color). It represents an area of gradual transition of columnar epithelium to squamous epithelium.
- In a parallel to cervical anatomy, the ATZ is the area in which the majority of human papillomavirus-related dysplastic lesions are found in the anal canal.
- The columns of Morgagni are noted in this area where redundant columns of tissue are noted with anal crypts at their base.



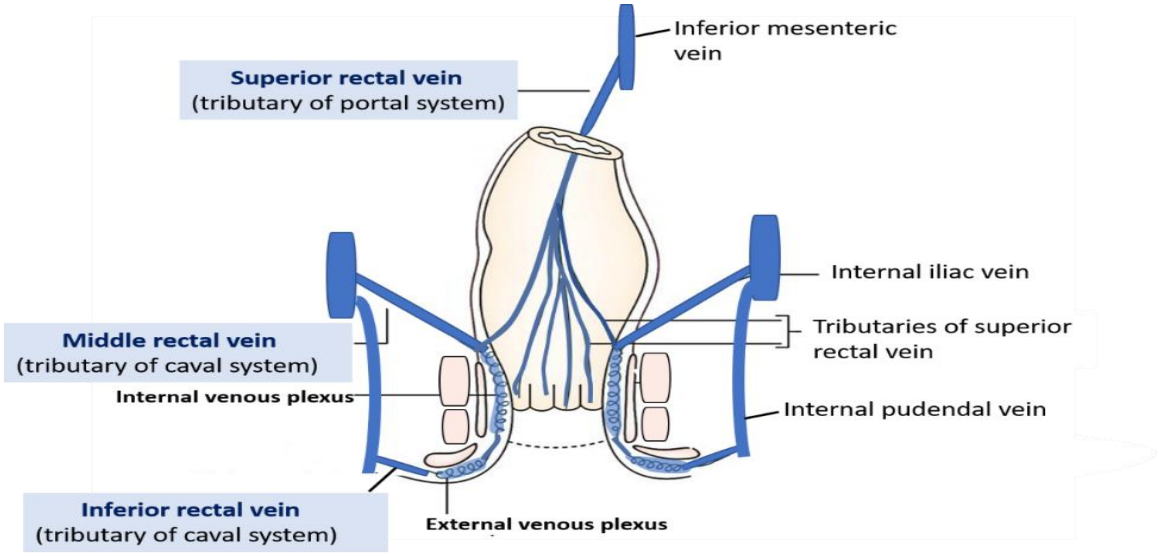
- Anal crypts are connected to underlying anal glands which are the presumed source of sepsis in the majority of anorectal abscesses and fistula.
- On average, there are six anal glands surrounding the anal canal (range, 3–12), and they tend to be more concentrated in the posterior quadrants. More than one gland may open into the same crypt, and some crypts may not be connected to anal glands.
- It is theorized that obstruction of these ducts leads to anal abscess and fistula. Knowledge of the anatomy also explains why the internal opening of a “cryptoglandular” anal fistula should typically be at the dentate line.
- Distal to the dentate line, the anoderm begins and extends for approximately 1.5 cm. anoderm has squamous histology and is devoid of hair, sebaceous glands, and sweat glands.

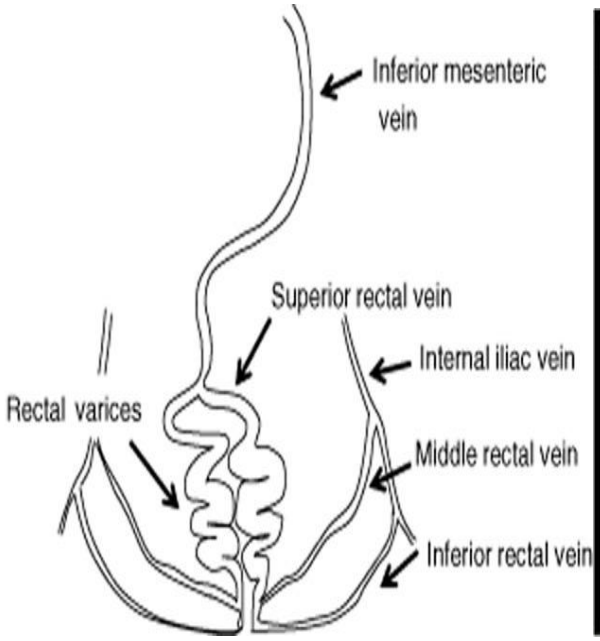
Arterial Supply and Lymphatic Drainage

- **Above the pectinate** line, the anal canal is supplied by terminal branches of the superior rectal artery, a branch of the inferior mesenteric artery. Lymphatic fluid from this region is conveyed to the inferior mesenteric lymph nodes.
- **Below the pectinate line**, the anal canal is served by the middle and inferior rectal arteries. The lymphatic drainage below the pectinate line is primarily to the superficial inguinal lymph nodes.

Venous Drainage

- The venous drainage of the anal canal **superior** to the pectinate line is to the superior rectal veins, which drain into the inferior mesenteric vein.
- The venous drainage of the anal canal **below** the pectinate line is to the internal pudendal veins, which convey their contents to the internal iliac vein.
- In patients with portal hypertension, anorectal varices may be apparent.





Nerves of anal canal

- **Above** the pectinate line, the anal canal receives autonomic innervation from the inferior hypogastric plexus.

❖ The **parasympathetic** innervation inhibits the tone of the internal anal sphincter and evokes a peristaltic contraction to allow defecation.
❖ **Sympathetic** innervation works in opposition to maintain the tone of the internal anal sphincter and preserve continence.

- The **superior** aspect of the anal canal is most sensitive to **stretch** or **distention**.

Below the pectinate line, the anal canal receives somatic innervation derived from branches of the pudendal nerve. As a result, the inferior

aspect of the anal canal is highly sensitive to **pain**, **temperature**, and **touch**.

- The pudendal nerve is the main nerve of the perineum. It is a mixed (motor and sensory) nerve and also conveys sympathetic autonomic fibers. It carries sensation from the external genitalia of both sexes and the skin around the anus and perineum, as well as the motor supply to various pelvic muscles, including the male or female external urethral sphincter and the external anal sphincter.
- If damaged, most commonly by childbirth, loss of sensation or fecal incontinence may result. The nerve may be temporarily anesthetized, called pudendal anesthesia or pudendal block.

The anal sphincter complex

consists of the internal anal sphincter (IAS), the conjoined longitudinal muscle (CLM) and the external anal sphincter (EAS).

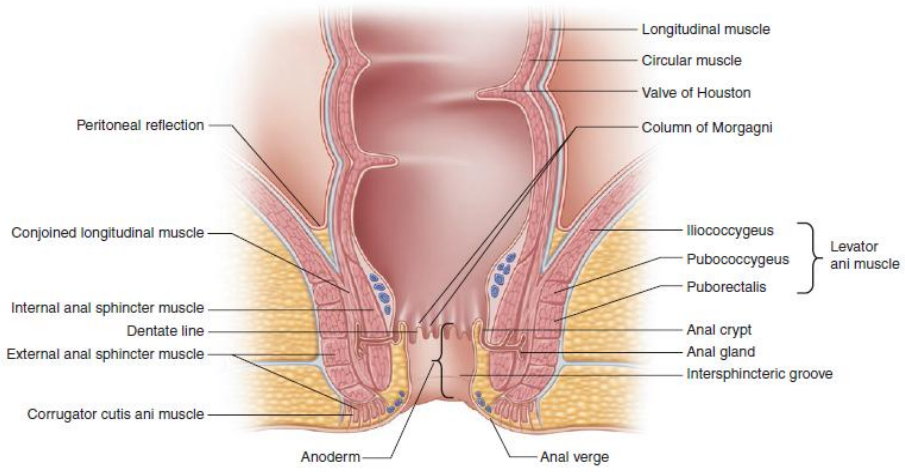


Fig. 1.1 Anal canal

Internal Anal Sphincter

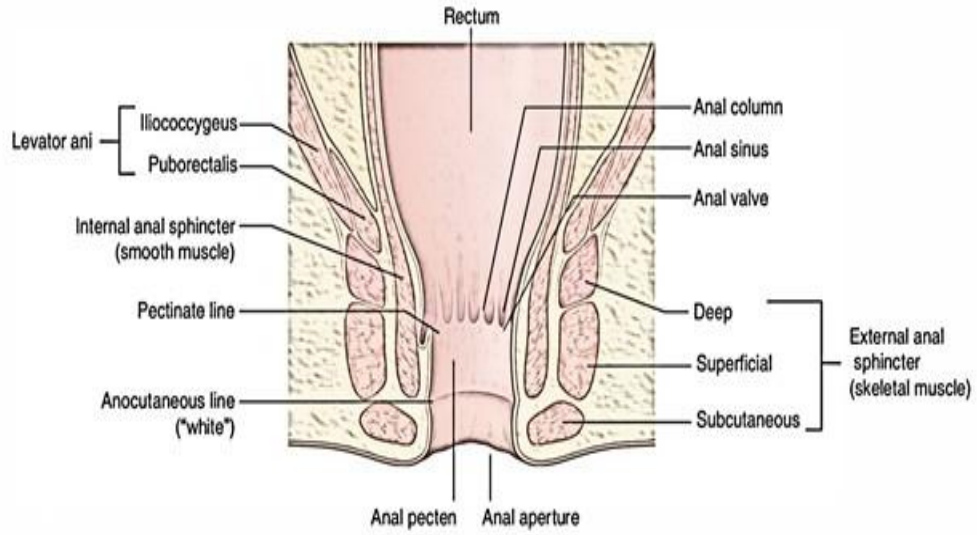
- The internal anal sphincter (IAS) is the downward continuation of the circular smooth muscle of the rectum and terminates with a rounded edge approximately 1 cm proximal to the distal aspect of the external anal sphincter.
- It is always maximally contracted to prevent involuntary loss of stool and flatus.
- The IAS constitutes approximately 50–70% of resting tone or pressure and is maximally contracted at rest, with the hemorrhoid complexes accounting for an additional 15% of resting tone or pressure.

Conjoined Longitudinal Muscle

- Measuring approximately 0.5 mm to 2.0 mm in thickness, the conjoined longitudinal muscle (or conjoined longitudinal coat) lies in between the internal and external anal sphincters.
- It begins at the anorectal ring as an extension of the **longitudinal** rectal muscle fibers and descends caudally joined by fibers of the puborectalis muscle.
- At its most caudal aspect, some of the conjoined longitudinal muscle fibers (referred to as *corrugator cutis ani muscle*) traverse the distal external anal sphincter and insert into the perianal skin, and some enter the fat of the ischiorectal fossa.
- May play a role in minimizing anal incontinence after sphincterotomy.

External Anal Sphincter

- The external anal sphincter (EAS) is composed of striated muscle that forms an elliptical tube around the internal anal sphincter and conjoined longitudinal muscle.
- As it extends beyond the distal most aspect of the internal anal



- While the external anal sphincter does not have three distinct anatomic layers, it is common to see the proximal portion of the EAS referred to as deep EAS, the mid portion as the superficial EAS, and the most distal aspect as the subcutaneous EAS.
- Anteriorly, the proximal EAS forms a portion of the perineal body with the transverse perineal muscle.
- The external anal sphincter is innervated on each side by the inferior rectal branch of the pudendal nerve (S2 and S3) and by the perineal branch of S4.
- The EAS is in constant state of tonic contractile activity, even at rest, and voluntarily contracts during any threat of incontinence.
- The EAS differs from the IAS, however, in its fatiguability,

- Injury to the IAS leads to passive fecal incontinence or leakage, whereas injury to the EAS is associated with urge fecal incontinence.

Hemorrhoids

- Hemorrhoids are a normal feature of human anatomy and have been identified as present in the embryonic stage of development.
- Hemorrhoids are blood-filled cushions that line the anal canal.
- They are present in all humans and function to improve anal continence.
- Hemorrhoids are located above and below the dentate line and have three important components:

1. the lining (**mucosa or anoderm**),
2. the stroma (**blood vessels** surrounded by connective tissue),
3. anchoring **connective tissue** that secures the hemorrhoid to the internal sphincter and conjoined longitudinal muscle.

- Hemorrhoids receive their blood supply from terminal branches of the superior hemorrhoidal artery.

Perineal Body

- The perineal body represents the intersection of the external anal sphincter, superficial transverse perinei, deep transverse perinei, and bulbospongiosus (also referred to as bulbocavernosus) muscles (Fig. 1.2).
- Recent research, based on advanced magnetic resonance imaging and ultrasound, has suggested that the transverse perinei (TP) and bulbospongiosus (BS) muscles contribute significantly to anal incontinence.

- When these muscles are considered as a functional unit, it lends further support to the idea that it is critical to attempt to repair the perineal body during overlapping sphincter reconstructions.

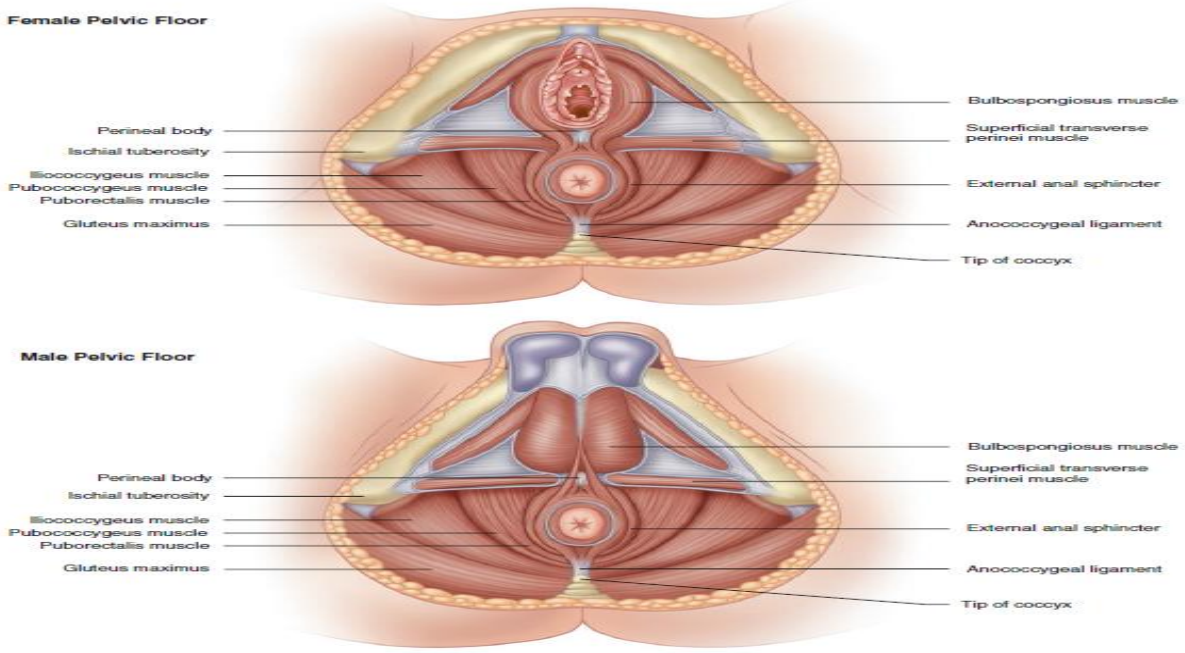


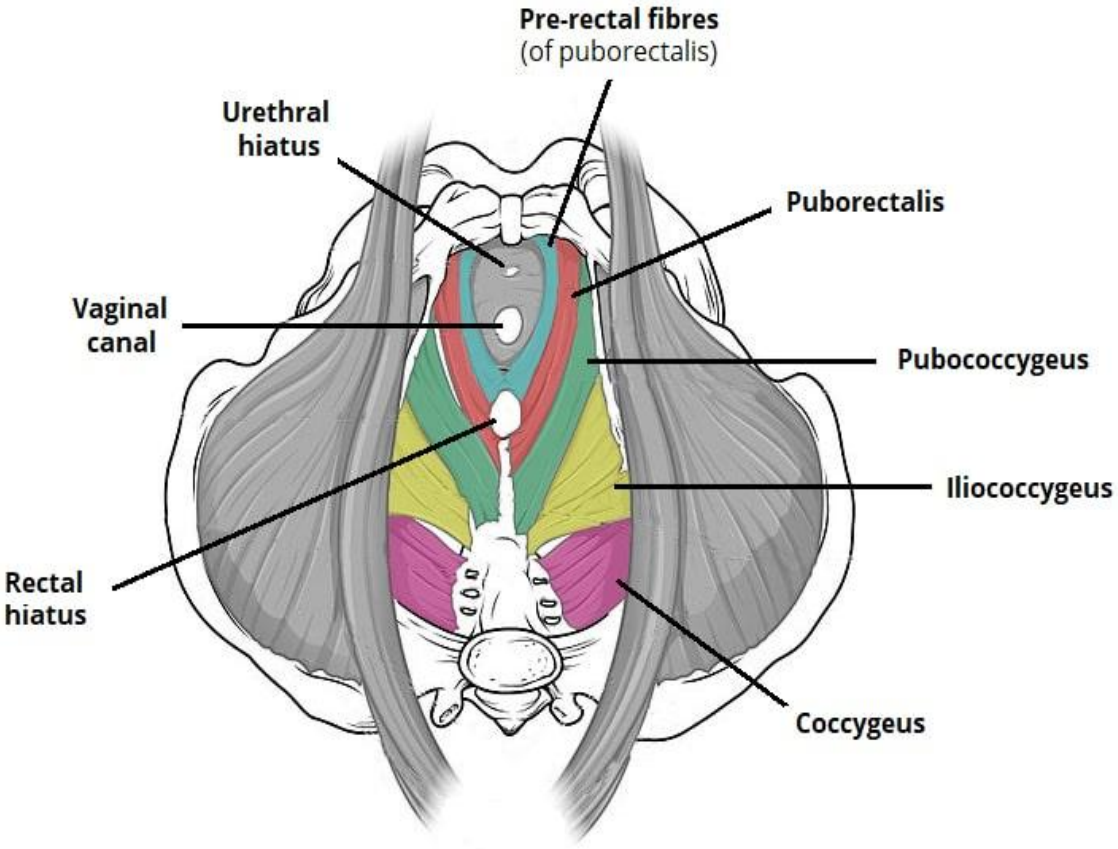
Fig. 1.2 Pelvic floor muscles

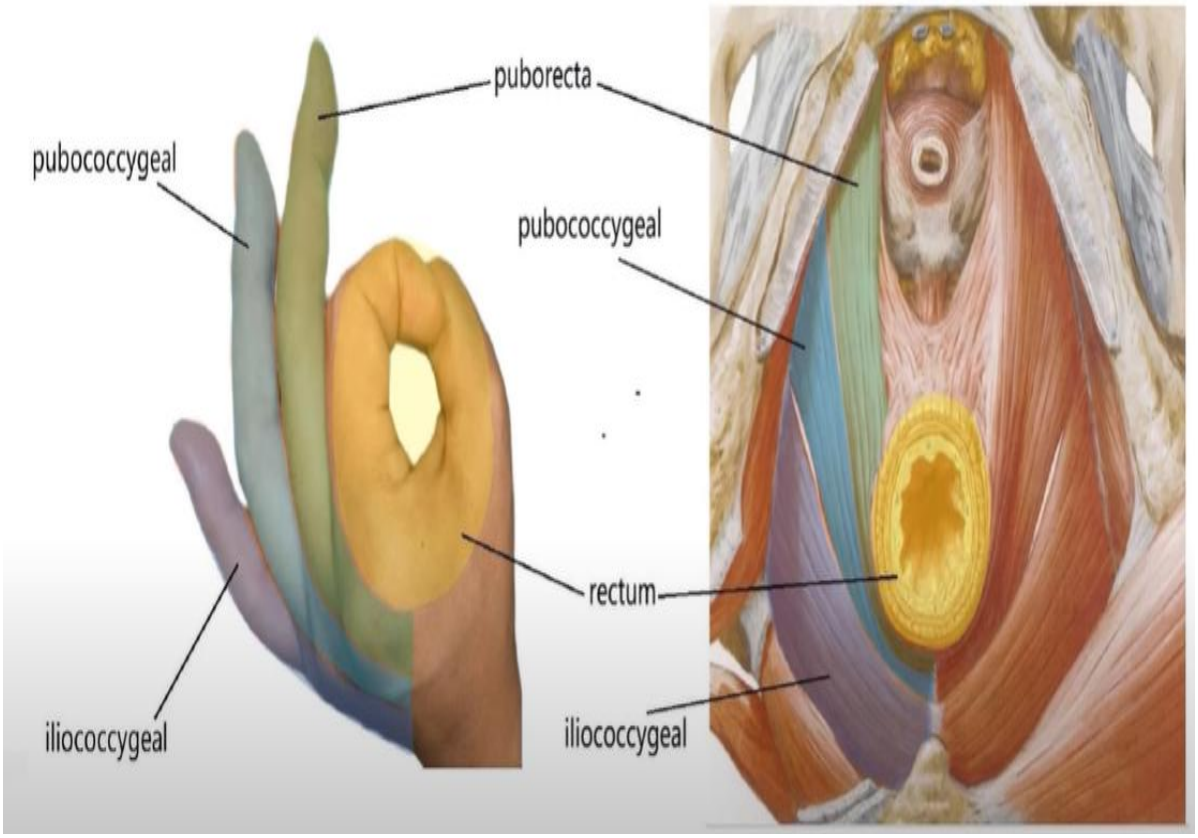
Pelvic Floor Muscles

- In addition to the anal sphincter and perineal body, the levator ani (LA) muscles contribute to pelvic organ support. For example, injury to the LA is seen in 55% of women with pelvic organ prolapse but in only 16% without prolapse.
- The LA has three subdivisions including:

1. pubococcygeus (aka pubovisceral).
2. puborectalis.

3. iliococcygeus.





- LA muscles are innervated by the pudendal nerve branches:

1. Perineal nerve
2. Inferior rectal nerve.
3. Direct sacral nerves S3 and/or S4 (aka levator ani nerve).

- The pubococcygeus muscle and puborectalis muscle are primarily innervated by the pudendal nerve branches, while the iliococcygeus muscle is primarily innervated by the direct sacral nerves S3 and/or S4. (Fig. 1.3).

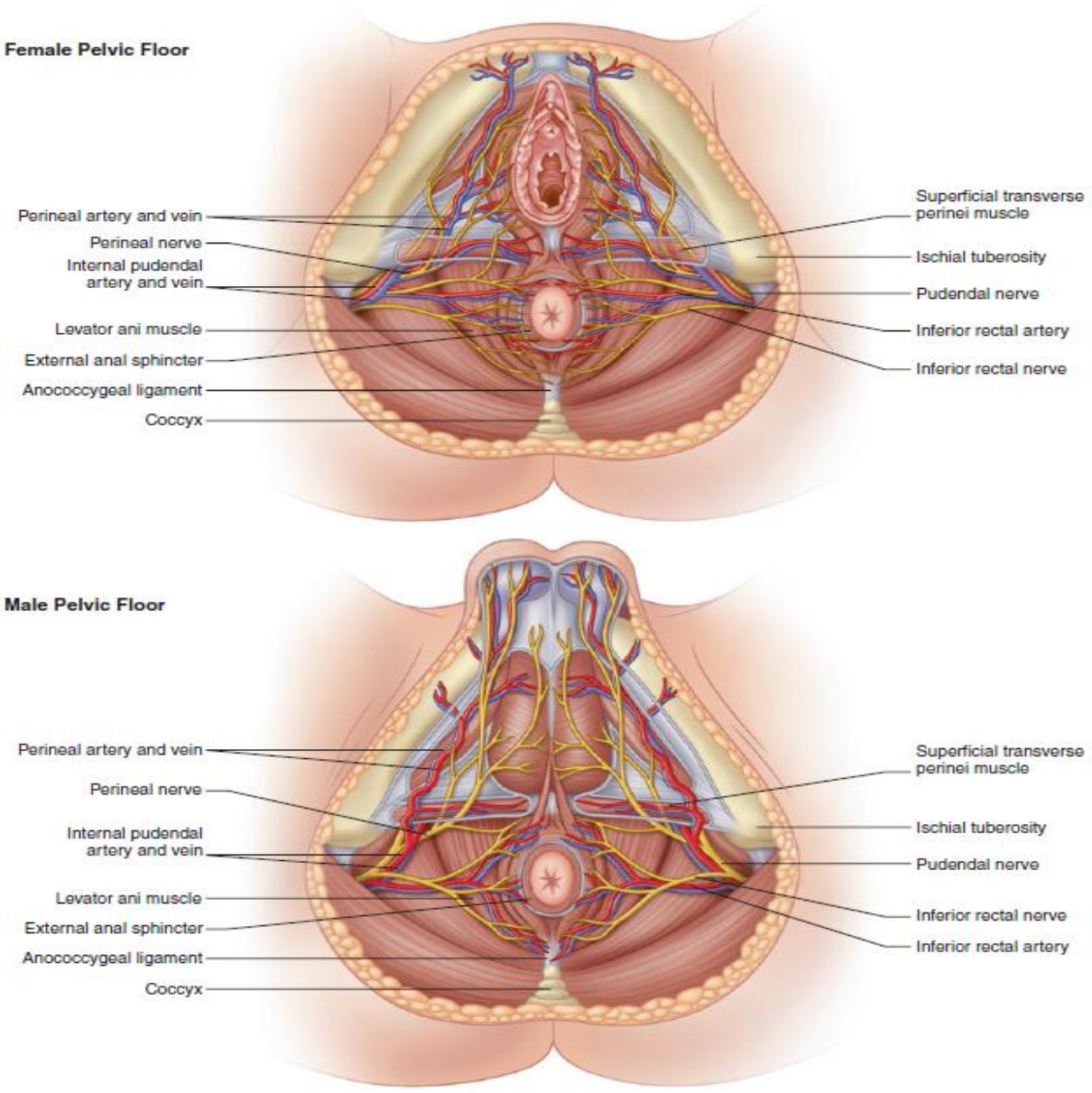
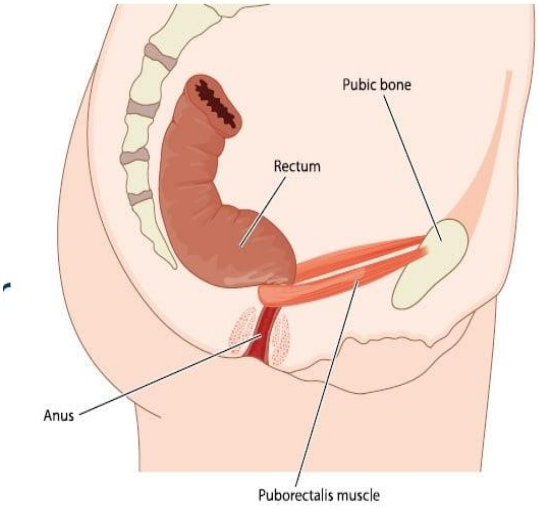


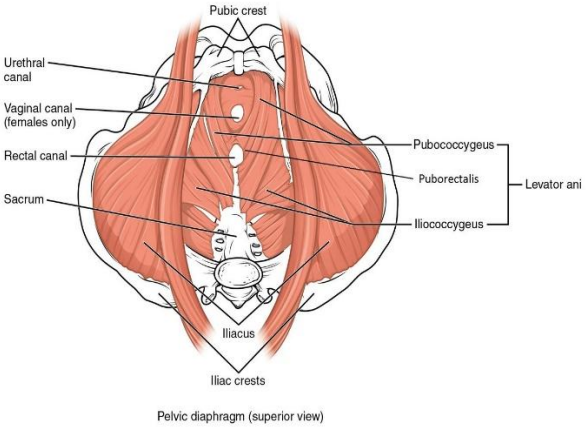
Fig. 1.3 Pelvic floor nerves and blood supply

Puborectalis Muscle

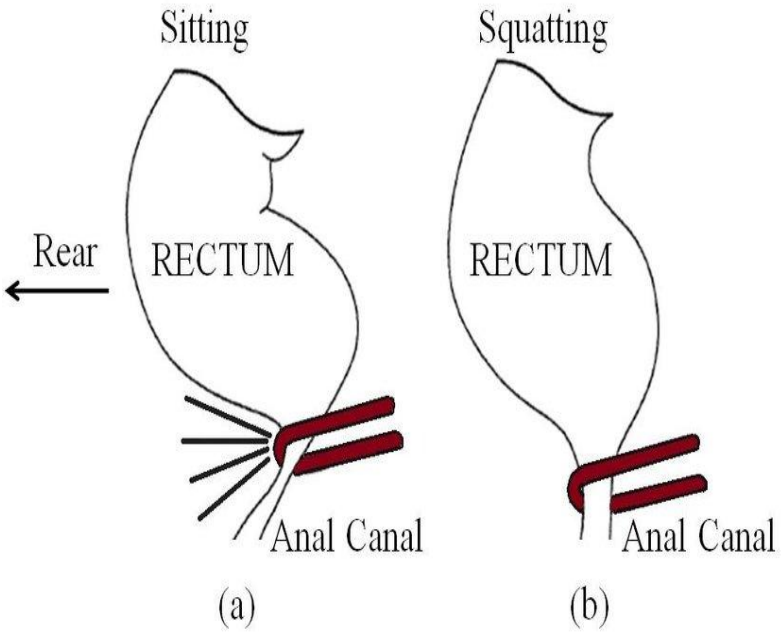
- The puborectalis muscle (PRM) fibers arise from the lower part of the symphysis pubis and from the superior fascia of the urogenital diaphragm and run alongside the anorectal junction.
- Posterior to the rectum, the fibers join forming a sling.

- The “anorectal ring” is composed of the upper borders of the internal anal sphincter and puborectalis muscle.
- As briefly described above, the puborectalis is a striated muscle that acts as a sling located at the anorectal junction, from which a 90- to 100-degree angle is formed at rest.
- Its critical role in continence is believed to be due to this anorectal angle.
- Contraction of the PRM sling causes a horizontal force that closes the pelvic diaphragm and decreases the anorectal angle during squeeze.





Pelvic diaphragm (superior view)



Iliococcygeus Muscle

- Iliococcygeus muscle (ICM) fibers arise from the ischial spines and posterior obturator fascia, pass inferior/posterior and medially, and insert into the distal sacrum, coccyx, and anococcygeal raphe.
- The ICM, along with the pubococcygeus muscle, contributes to “lifting” of the pelvic floor.

Pubococcygeus Muscle

- The pubococcygeus (PCM) muscle lies medial to the PRM.
- PCM fibers arise from the anterior half of the obturator fascia and the high posterior pubis.
- The PCM fibers are directed posterior/inferior and medially, where they intersect with fibers from the opposite side and form the anococcygeal raphe (or anococcygeal ligament).

- PCM muscle fibers insert in the distal sacrum and tip of the coccyx.
- Portions of the PCM contribute to the conjoined longitudinal muscle.
- The PCM forms the “levator hiatus” as it ellipses the lower rectum, urethra, and either the vagina in women or the dorsal vein of the penis in men.
- The levator hiatus is connected to the intrahiatal organs by a fascial condensation called the “hiatal ligament” (Fig. 1.4).
- The hiatal ligament arises circumferentially around the hiatal margin as a continuation of the fascia on the pelvic surface of the levator muscle.
- Enlargement of the levator hiatus has been implicated as a cause of female pelvic organ prolapse.
- The PCM is the portion of the levator ani that is typically injured during traumatic vaginal delivery.

Fig. 1.4 Pelvic floor anatomy, abdominal view

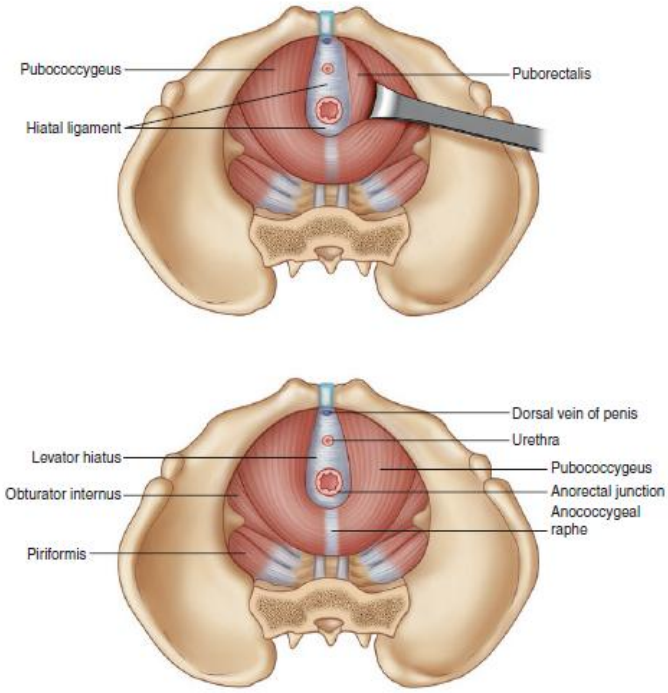
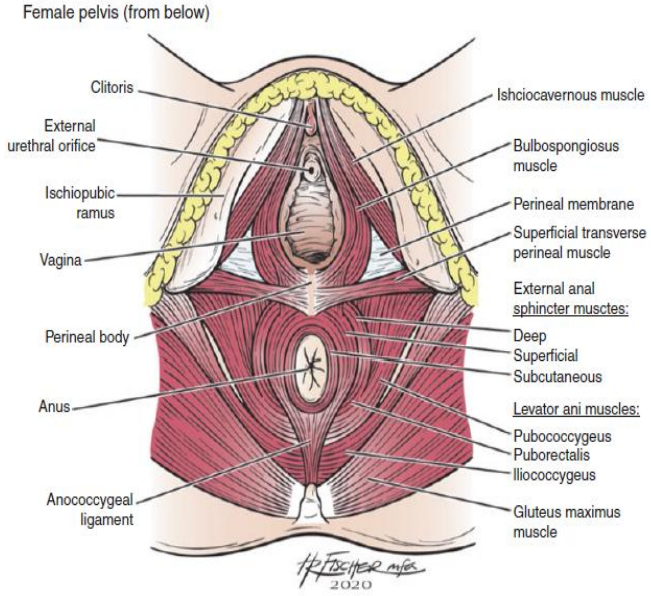


Fig. 3.1 Muscles of the pelvic floor. (Illustration created by H.R. Fischer, MFA)



Anorectal Spaces

Perianal Space

- The perianal space contains external **hemorrhoid** cushions, the subcutaneous **external** anal sphincter and the distal **internal** anal sphincter.
- The perianal space is in communication with the intersphincteric space (Fig. 1.6).
- The perianal space has its cephalad boundary at the dentate line and laterally to the subcutaneous fat of the buttocks or is contained by fibers extending from the conjoined longitudinal muscle often referred to as *corrugator cutis ani* muscle fibers. Otherwise, the perianal space is contained by anoderm.

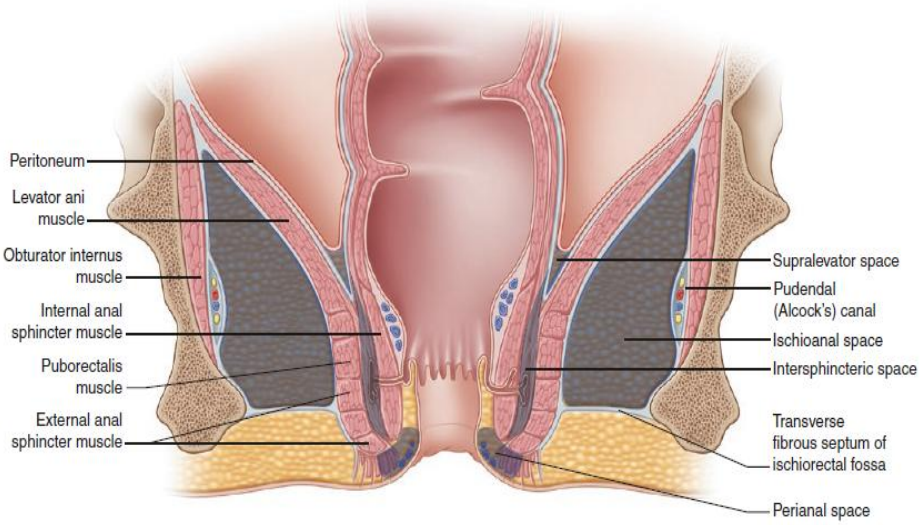


Fig. 1.6 Perianal and perirectal spaces, coronal view

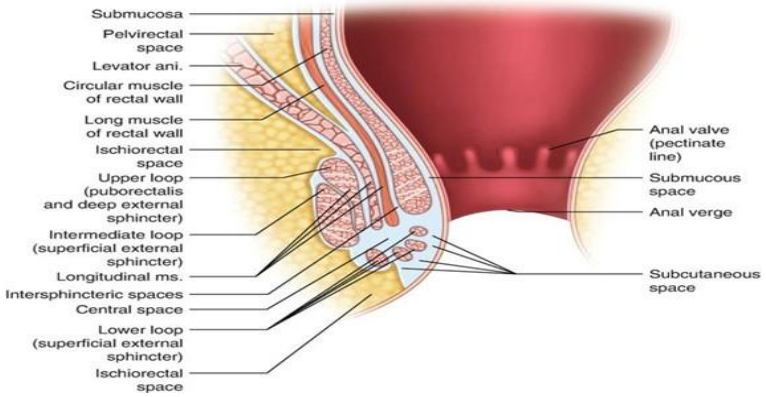
Intersphincteric Space

- The intersphincteric space is the potential space that lies between the internal and external anal sphincter and is continuous with the perianal space.

- It is of clinical importance as cryptoglandular infections tend to begin in this area and expand elsewhere to create anal fistula.

Submucous Space

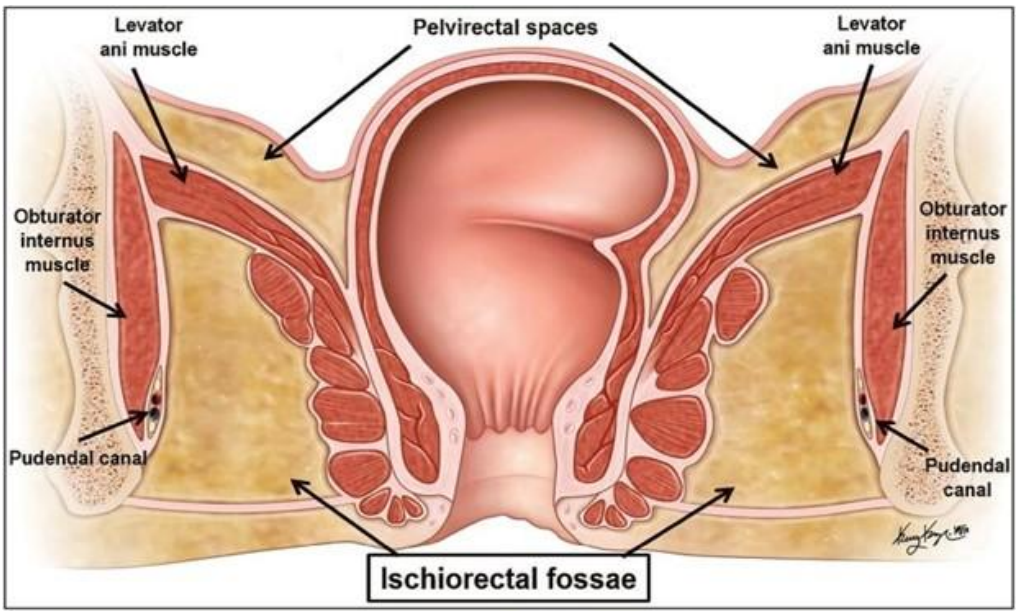
- This space lies between the medial boarder of the internal anal sphincter and the anal mucosa proximal to the dentate line.
- It is continuous with the submucosa of the rectum.
- This area contains **internal hemorrhoid** vascular cushions.



Ischioanal/Ischiorectal Space

- The ischioanal (also referred to as ischiorectal) space is the largest anorectal space.
- It has been described as a pyramid shape with its apex at the levator muscle insertion into the obturator fascia.
- The medial boarder is thus the levator ani muscle and external anal sphincter., while the obturator internus muscle and obturator fascia make up the lateral boarder of the ischioanal space.
- The posterior boundary is formed by the lower border of the gluteus maximus muscle and the sacrotuberous ligament.
- The space has an anterior boundary formed by the superficial and deep transverse perineal muscles.

The caudal boundary is skin of the perineum.



- The ischioanal fossa contains adipose tissue, pudendal nerve branches, and superficial branches of the internal pudendal vessels.
- The right and left ischioanal space communicate posteriorly through the **deep** postanal space between the levator ani muscle and anococcygeal ligament (Fig. 1.7).
- When the ischioanal and perianal spaces are regarded as a single space, it is referred to as the ischioanal **fossa**.

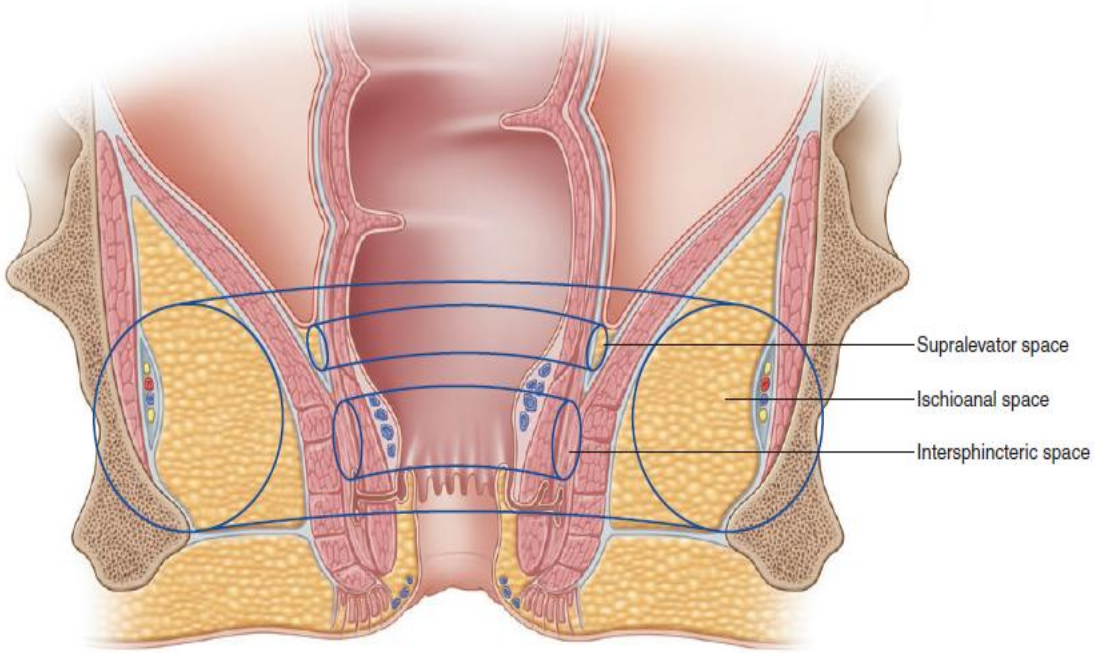
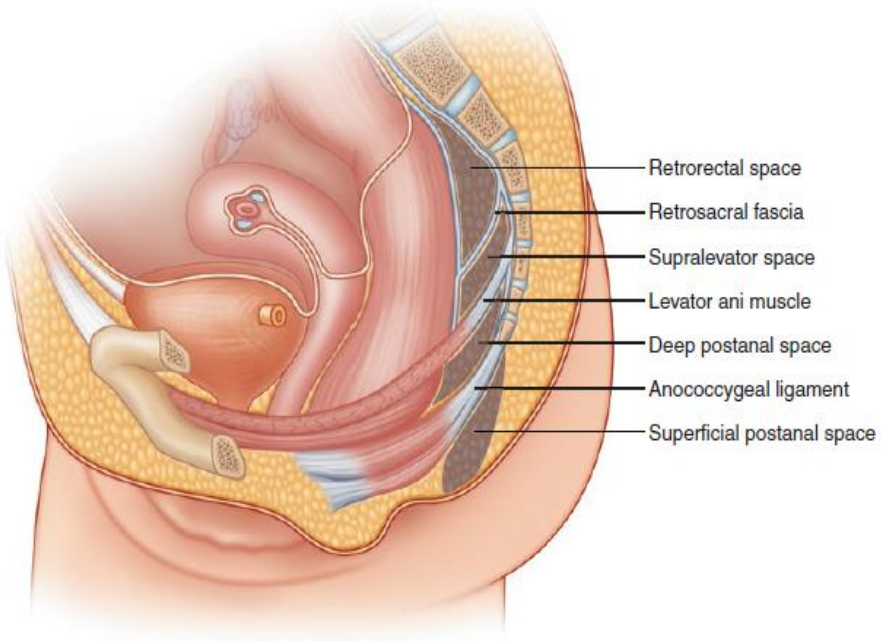


Fig. 1.7 Communication of the anorectal spaces

Supralevator Space

- The upper boundary of the supralevator space is the peritoneum, the lateral boundary is the pelvic wall, the medial boundary is the rectum, and the inferior boarder is the levator ani muscle (Fig. 1.8).

Fig. 1.8 Perianal and perirectal spaces, lateral view

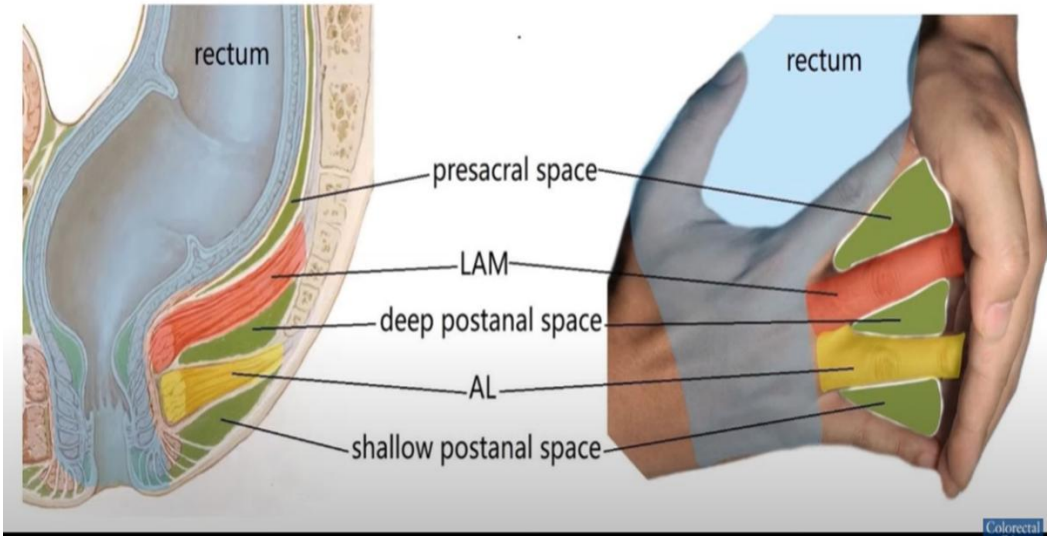


Superficial and Deep Postanal Spaces

- These spaces are located posterior to the anus and inferior to the levator muscle.
- The superficial postanal space is more caudal and is located between the anococcygeal ligament and the skin.
- The superficial postanal space allows communication of perianal space sepsis.
- The deep postanal space (retrosphincteric space of Courtney) is located between the levator ani muscle and the anococcygeal raphe. This space allows ischioanal sepsis to track from one side to the other resulting in the so-called “horseshoe” abscess.

Retrorectal Space

- The retrorectal space is found between the presacral fascia and fascia propria.
- It contains no major blood vessels or nerves.
- It is limited laterally by the lateral ligaments of the piriformis fascia and inferiorly by the retrosacral fascia.
- The fascia propria and presacral fascia come together at the apex of this space.



The end

Sources: **ASCRS, Colorectal disease journal, SlideShare, and Others...**