



# THE SMALL INTESTINE

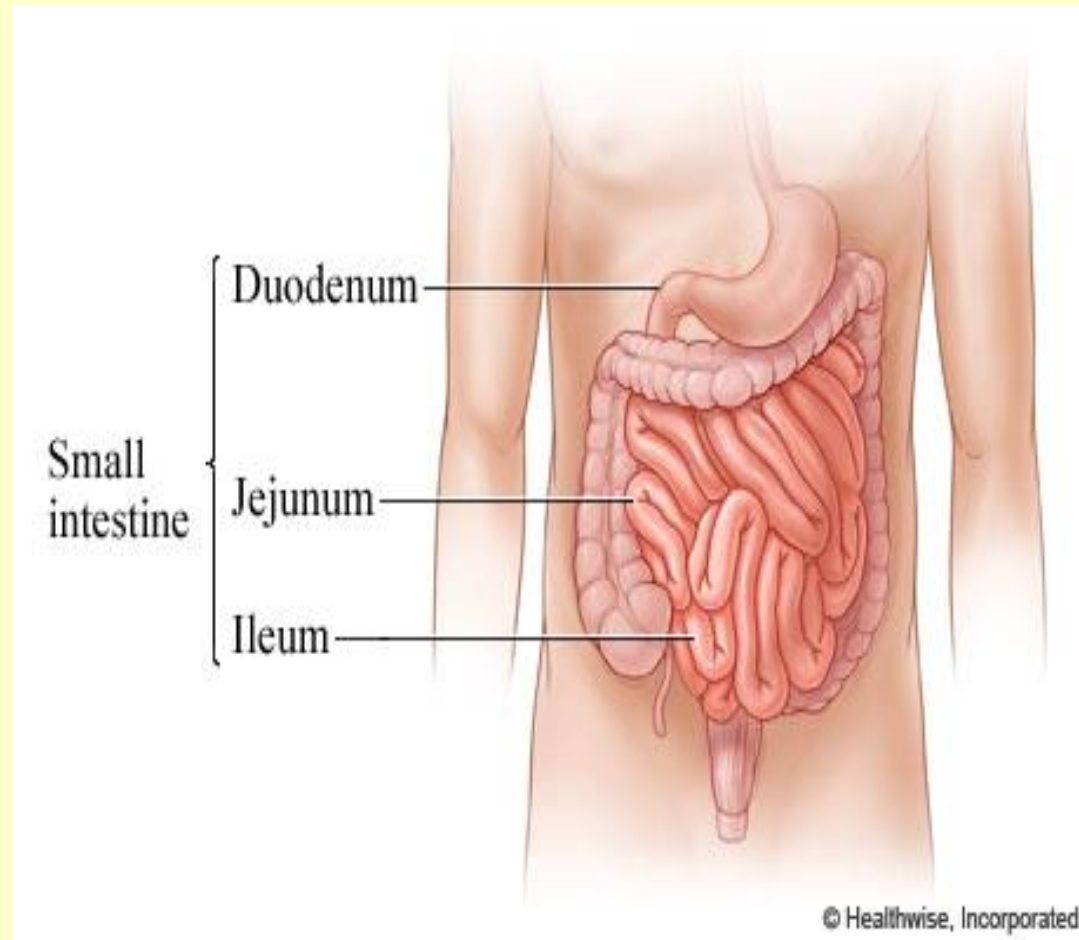
# THE LARGE INTESTINE

Lecture no. 8  
Assoc.Prof. Şişu Alina, MD, PhD

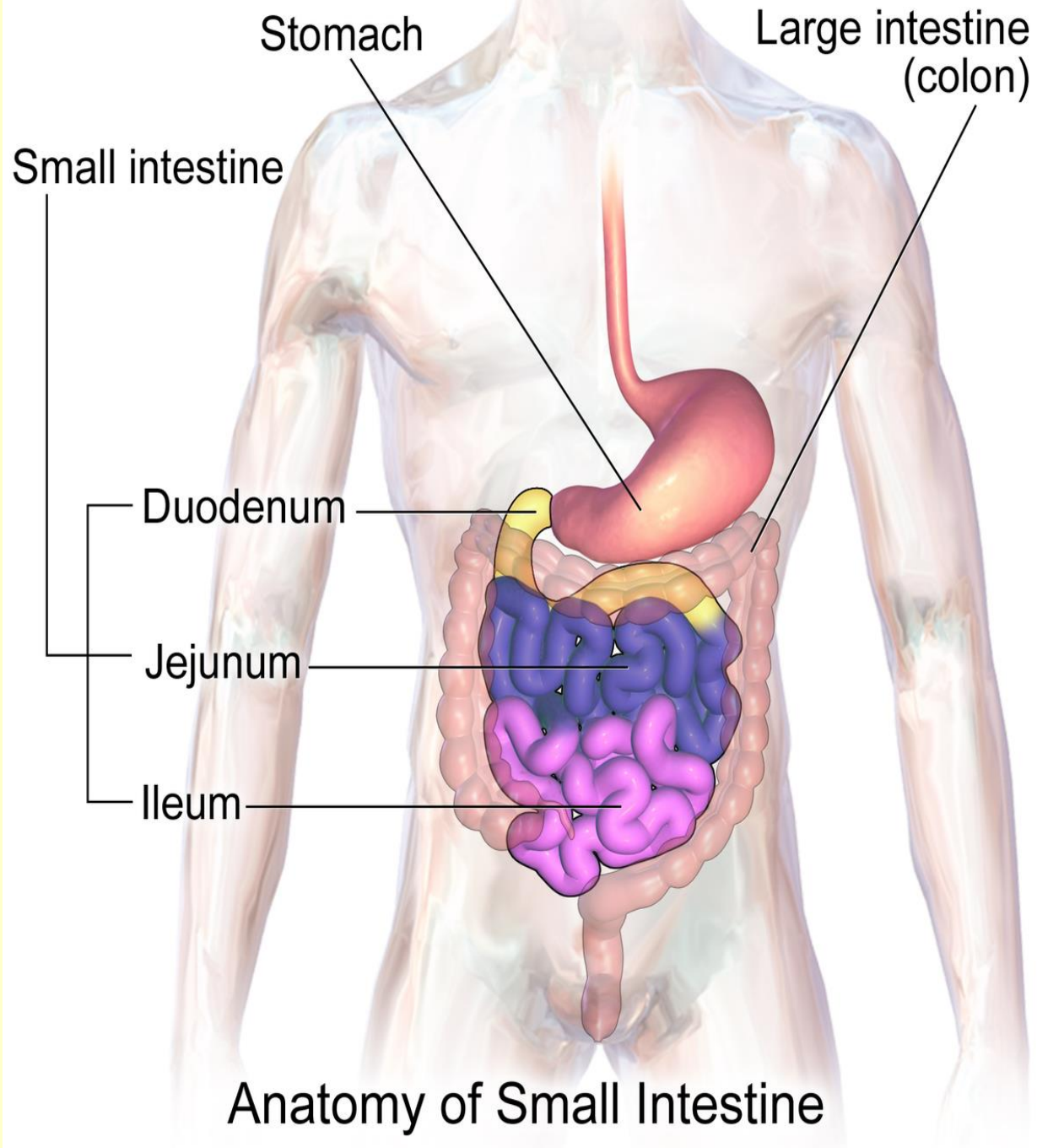
# **The Small Intestine** ***(Intestinum Tenue)***

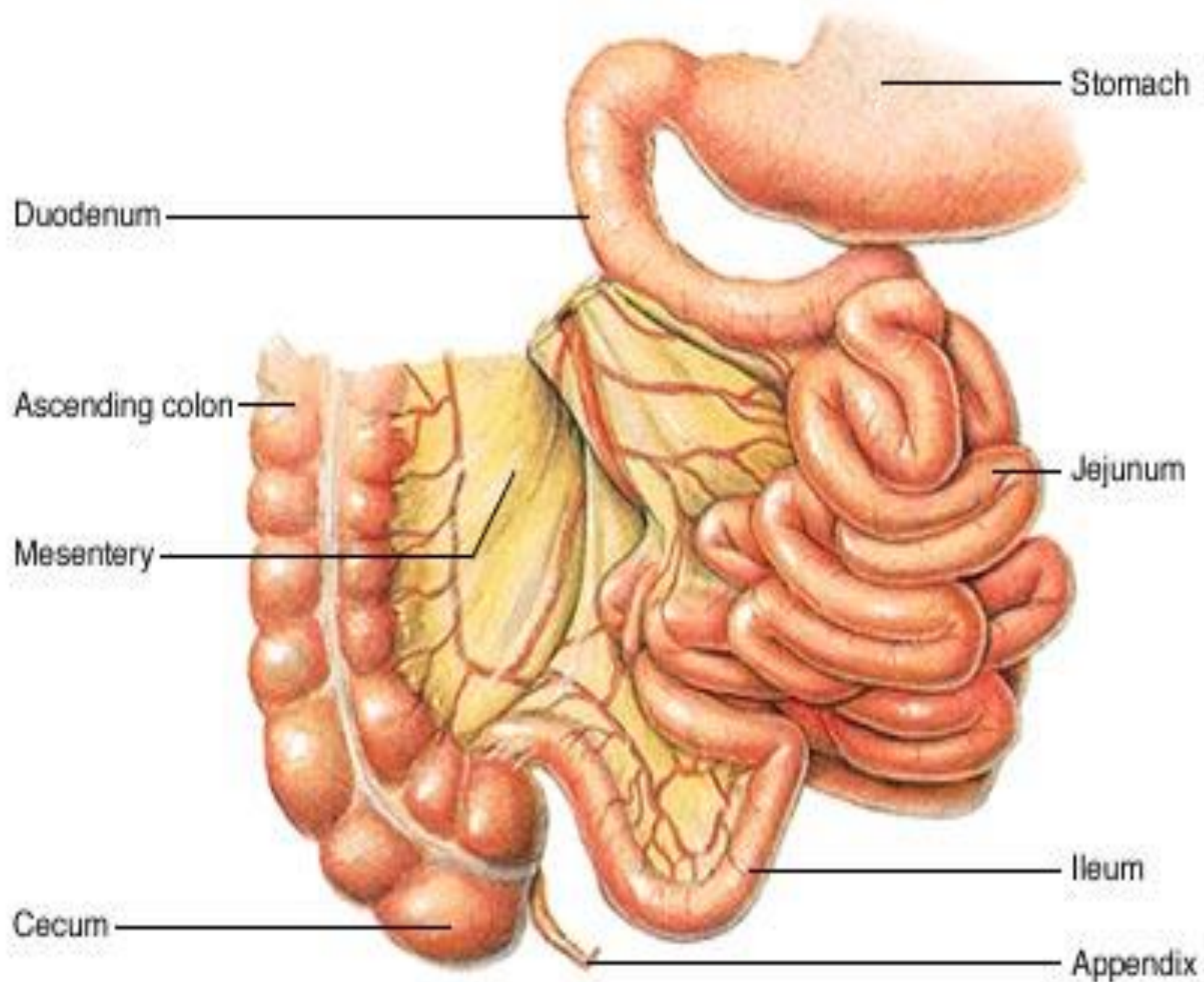
- The small intestine is a convoluted tube, extending from the pylorus to the colic valve, where it ends in the large intestine.
- It is about 7 meters long, and gradually diminishes in size from its commencement to its termination.
- It is contained in the central and lower part of the abdominal cavity, and is surrounded above and at the sides by the large intestine;
- A portion of it extends below the superior aperture of the pelvis and lies in front of the rectum.
- It is in relation, in front, with the greater omentum and abdominal walls, and is connected to the vertebral column by a fold of peritoneum, the mesentery.
- The small intestine is divisible into three portions: the duodenum, the jejunum, and the ileum.

- The remainder from the end of the duodenum is named jejunum and ileum; the of the small intestine former term being given to the upper two-fifths and the latter to the lower three-fifths.
- There is no morphological line of distinction between the two, and the division is arbitrary; but at the same time the character of the intestine gradually undergoes a change from the commencement of the jejunum to the end of the ileum, so that a portion of the bowel taken from these two situations would present characteristic and marked differences.



- **The Jejunum (*intestinum jejunum*)** is wider, its diameter being about 4 cm., and is thicker, more vascular, and of a deeper color than the ileum, so that a given length weighs more.
- The circular folds (*valvulæ conniventes*) of its mucous membrane are large and thickly set, and its *villi* are larger than in the ileum.
- The aggregated lymph nodules are almost absent in the upper part of the jejunum, and in the lower part are less frequently found than in the ileum, and are smaller and tend to assume a circular form.
- By grasping the jejunum between the finger and thumb the circular folds can be felt through the walls of the gut.
- These being absent in the lower part of the ileum, it is possible in this way to distinguish the upper from the lower part of the small intestine.



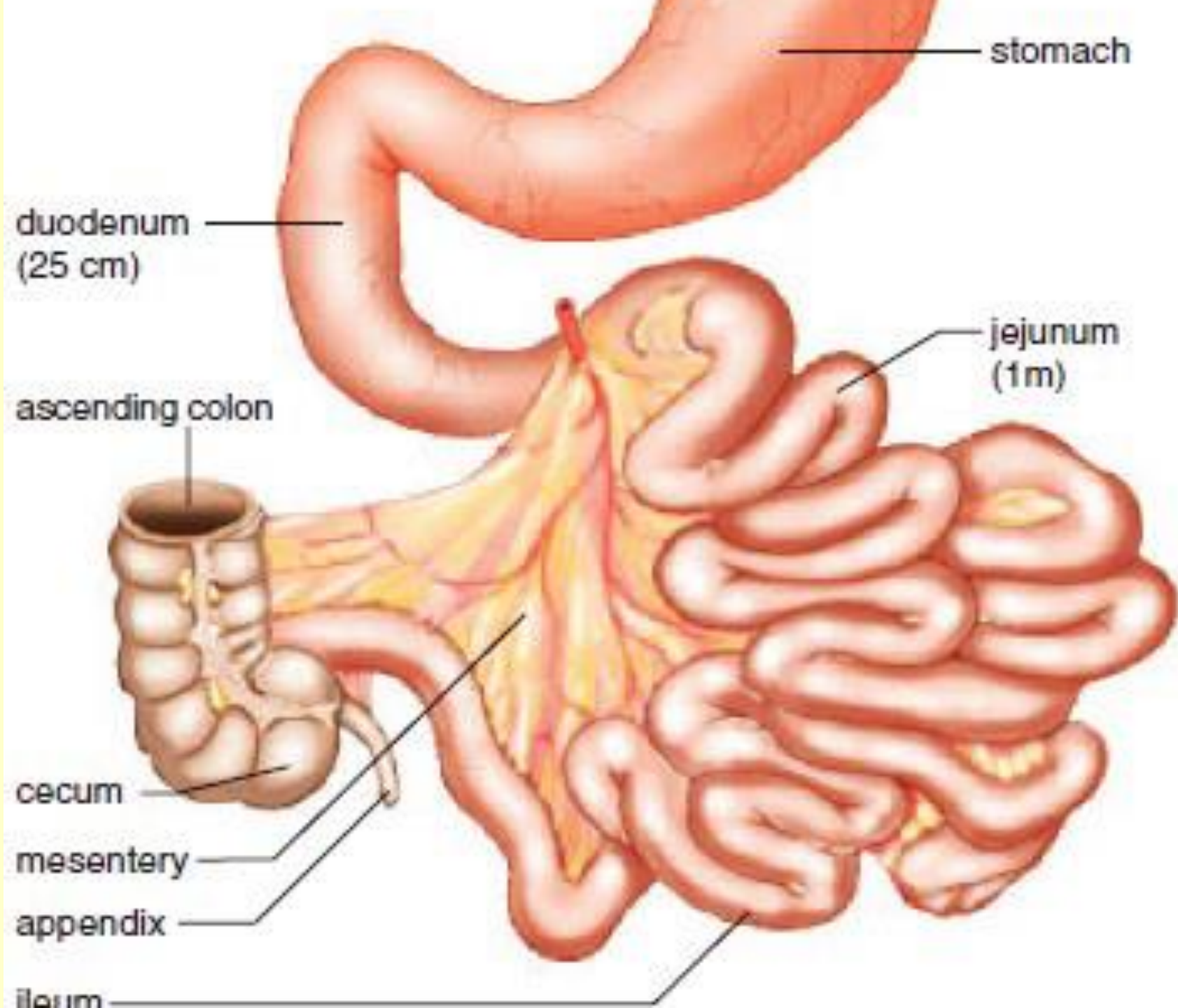




- **The Ileum (*intestinum ileum*)** is narrow, its diameter being 3.75 cm., and its coats thinner and less vascular than those of the jejunum.
- It possesses few circular folds, and they are small and disappear entirely toward its lower end, but aggregated lymph nodules (**Peyer's patches**) are larger and more numerous.
- The jejunum for the most part occupies the umbilical and left iliac regions, while the ileum occupies chiefly the umbilical, hypogastric, right iliac, and pelvic regions.
- The terminal part of the ileum usually lies in the pelvis, from which it ascends over the right Psoas and right iliac vessels; it ends in the right iliac fossa by opening into the medial side of the commencement of the large intestine.



- The *jejunum and ileum* are attached to the posterior abdominal wall by an extensive fold of peritoneum, **the mesentery**, which allows the freest motion, so that each coil can accommodate itself to changes in form and position.
- The mesentery is fan-shaped; its posterior border or root, about 15 cm. long, is attached to the posterior abdominal wall from the left side of the body of the second lumbar vertebra to the right sacroiliac articulation, crossing successively the horizontal part of the duodenum, the aorta, the inferior vena cava, the ureter, and right Psoas muscle .
- Between the two layers of which it is composed are contained bloodvessels, nerves, lacteals ( lymphatic capillary that absorbs fats in the villi of the small intestine), and lymph glands, together with a variable amount of fat.



# Structure

- The wall of the small intestine is composed of four coats: **serous, muscular, areolar, and mucous.**
- **The serous coat (*tunica serosa*)** is derived from the peritoneum.
- The superior portion of the duodenum is almost completely surrounded by this membrane near its pyloric end, but is only covered in front at the other extremity.
- the descending portion is covered by it in front, except where it is carried off by the transverse colon;
- and the inferior portion lies behind the peritoneum which passes over it without being closely incorporated with the other coats of this part of the intestine, and is separated from it in and near the middle line by the superior mesenteric vessels.
- The rest of the small intestine is surrounded by the peritoneum, excepting along its attached or mesenteric border; here a space is left for the vessels and nerves to pass to the gut.

- **The muscular coat (*tunica muscularis*)** consists of two layers of unstriated fibers: an external, longitudinal, and an internal, circular layer.
- The longitudinal fibers are thinly scattered over the surface of the intestine, and are more distinct along its free border.
- The circular fibers form a thick, uniform layer, and are composed of plain muscle cells of considerable length.
- The muscular coat is thicker at the upper than at the lower part of the small intestine.
- **The areolar or submucous coat (*tela submucosa*)** connects together the mucous and muscular layers.
- It consists of loose, filamentous areolar tissue containing bloodvessels, lymphatics, and nerves.
- It is the strongest layer of the intestine.

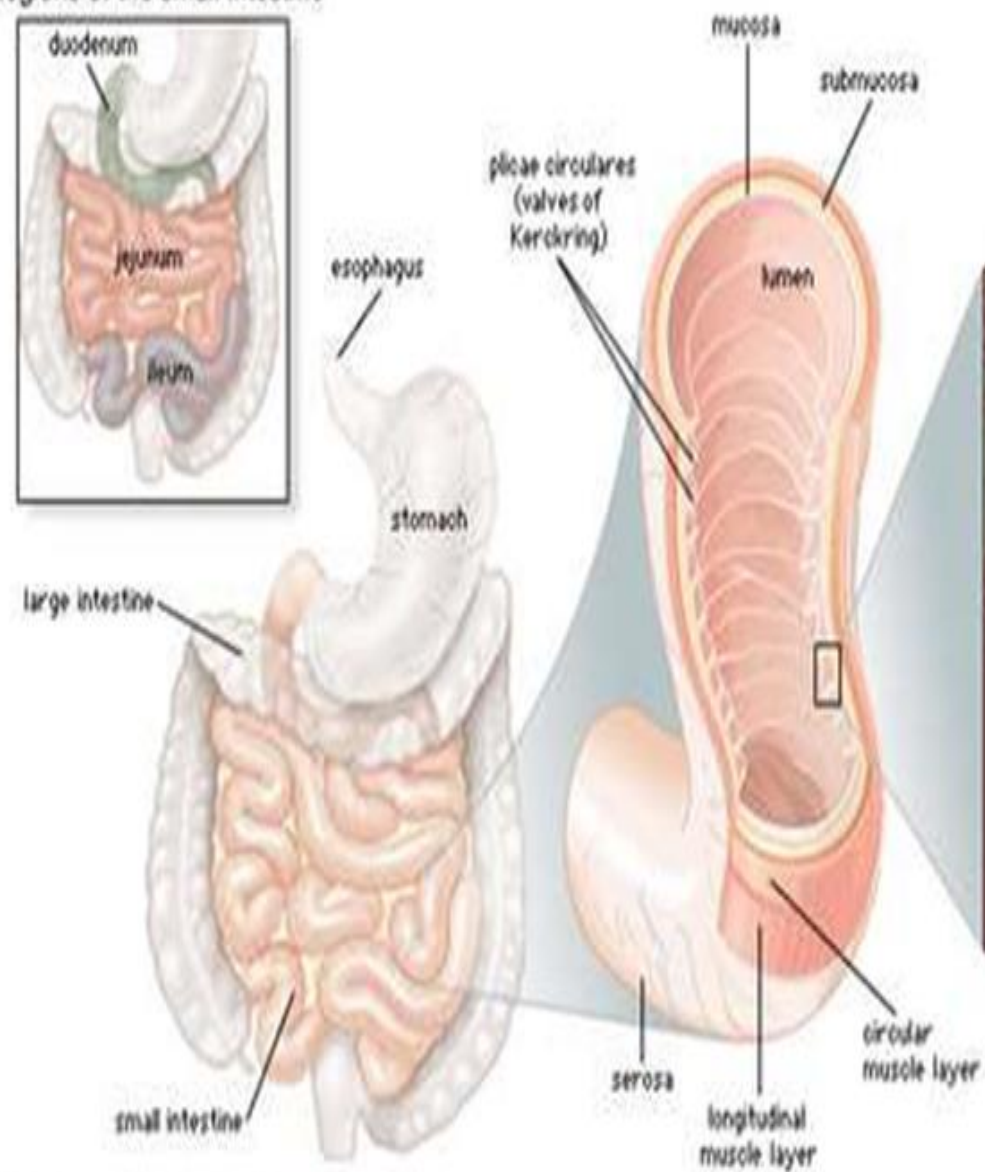
- **The mucous membrane (*tunica mucosa*)** is thick and highly vascular at the upper part of the small intestine, but somewhat paler and thinner below.
- It consists of the following structures: next the areolar or submucous coat is a double layer of unstriated muscular fibers, outer longitudinal and inner circular, ***the muscularis mucosæ*** internal to this is a quantity of retiform tissue, enclosing in its meshes lymph corpuscles, and in this the bloodvessels and nerves ramify; lastly, a basement membrane, supporting a single layer of epithelial cells, which throughout the intestine are columnar in character.
- The cells are granular in appearance, and each possesses a clear oval nucleus.
- At their superficial or unattached ends they present a distinct layer of highly refracting material, marked by vertical striæ, the striated border.
-

- **The mucous membrane presents for examination the following structures, contained within it or belonging to it:**
- **Circular folds.**
- ***Villi.***
- **Solitary lymphatic nodules.**
- **Intestinal glands.**
- **Aggregated lymphatic nodules.**

- **The circular folds (*plicæ circulares* [Kerkringi]; *valvulae conniventes*; valves of Kerkring) are large valvular flaps projecting into the lumen of the bowel.**
- **They are composed of reduplications of the mucous membrane, the two layers of the fold being bound together by submucous tissue;**
- **unlike the folds in the stomach, they are permanent, and are not obliterated when the intestine is distended.**
- **The majority extend transversely around the cylinder of the intestine for about one-half or two-thirds of its circumference, but some form complete circles, and others have a spiral direction; the latter usually extend a little more than once around the bowel, but occasionally two or three times.**
- **The larger folds are about 8 mm. in depth at their broadest part; but the greater number are of smaller size.**
- **The larger and smaller folds alternate with each other.**



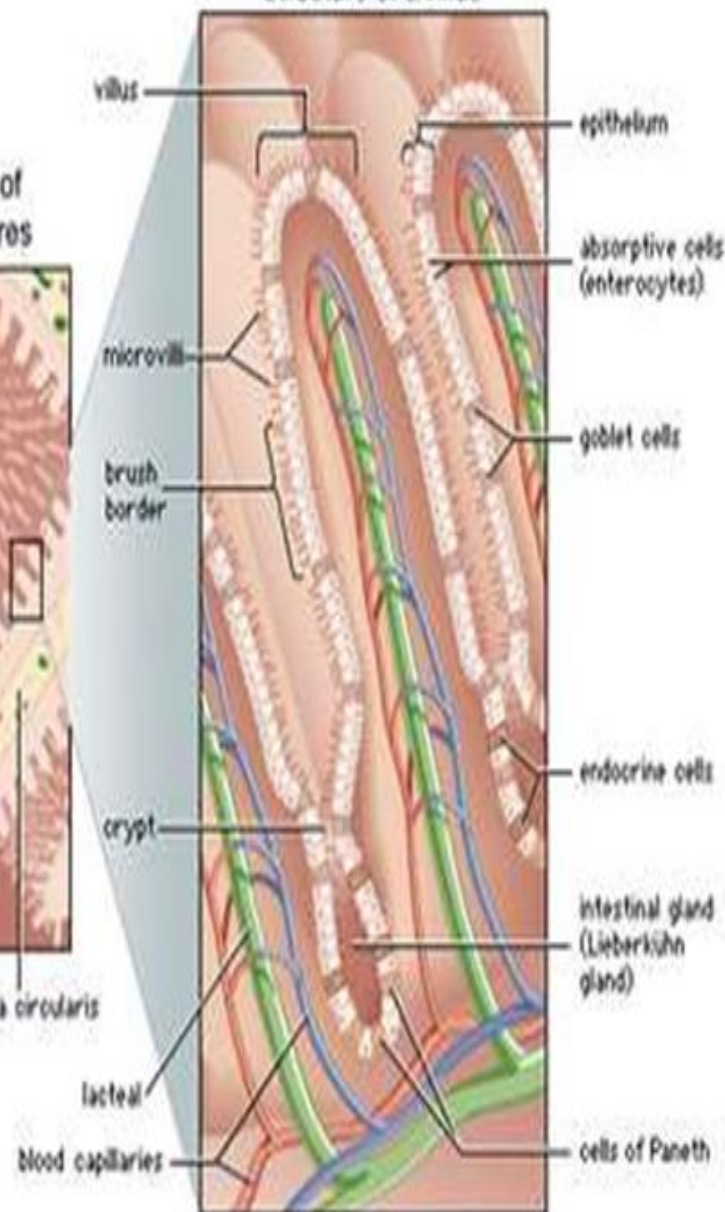
## Regions of the small intestine



## Enlargement of plicae circulares



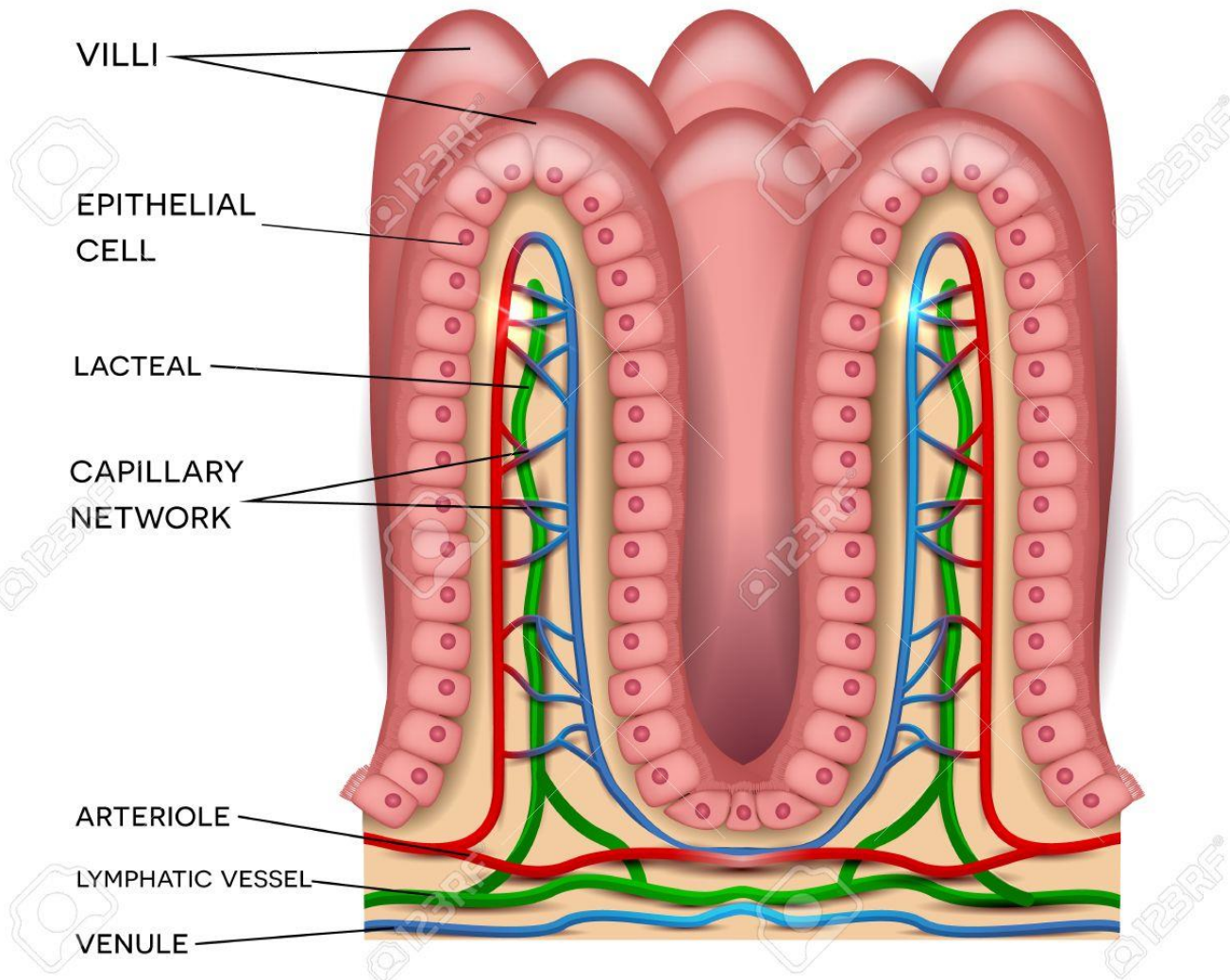
## Structure of a villus



- They are not found at the commencement of the duodenum, but begin to appear about 2.5 or 5 cm. beyond the pylorus.
- In the lower part of the descending portion, below the point where the bile and pancreatic ducts enter the intestine, they are very large and closely approximated.
- In the horizontal and ascending portions of the duodenum and upper half of the jejunum they are large and numerous, but from this point, down to the middle of the ileum, they diminish considerably in size.
- In the lower part of the ileum they almost entirely disappear; hence the comparative thinness of this portion of the intestine, as compared with the duodenum and jejunum.
- The circular folds retard the passage of the food along the intestines, and afford an increased surface for absorption.

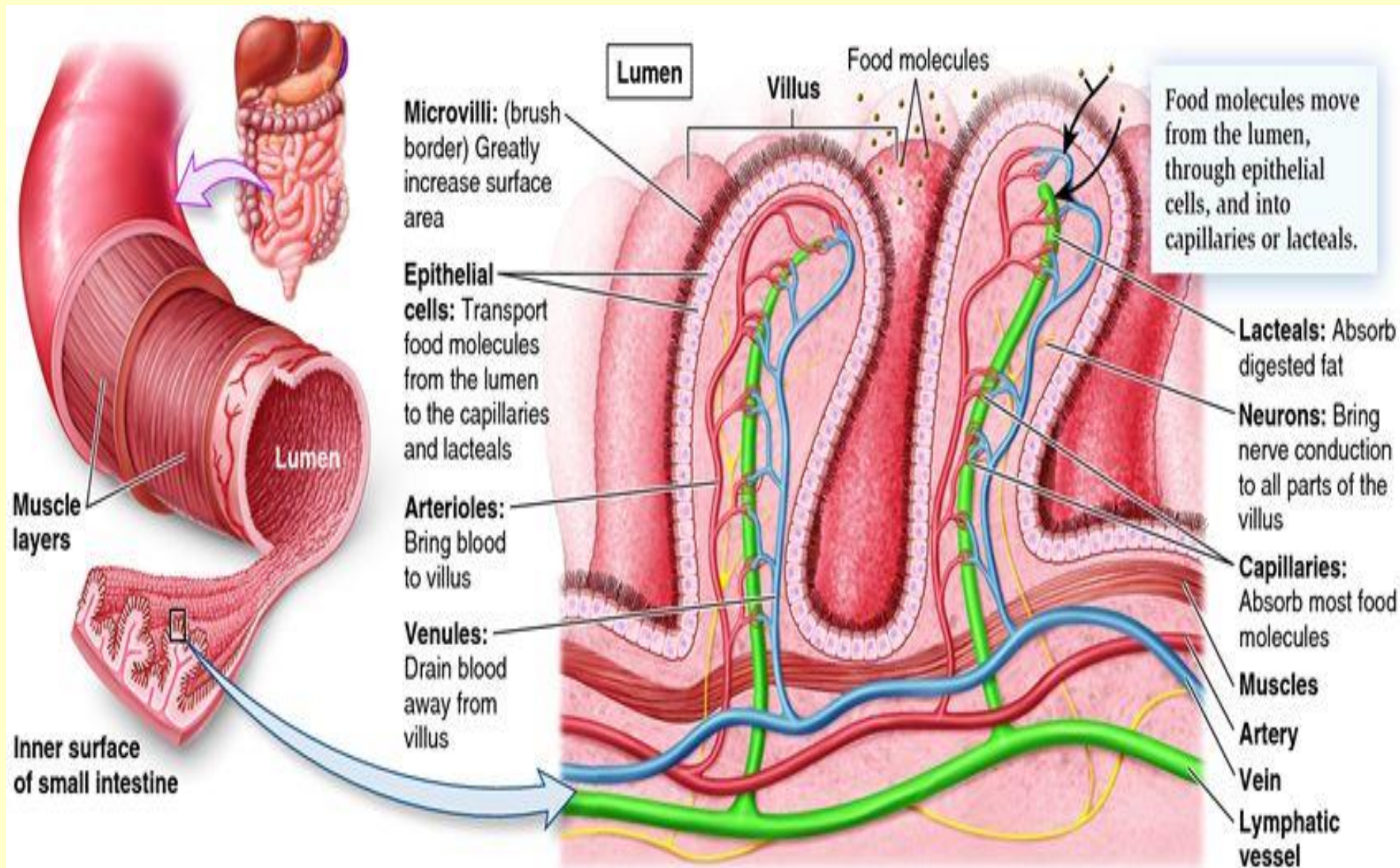
- **The intestinal villi (*villi intestinales*)** are highly vascular processes, projecting from the mucous membrane of the small intestine throughout its whole extent, and giving to its surface a velvety appearance.
- They are largest and most numerous in the duodenum and jejunum, and become fewer and smaller in the ileum.

# INTESTINAL VILLI



- **Structure of the villi**
- The essential parts of a *villus* are: the lacteal vessel, the bloodvessels, the epithelium, the basement membrane, and the muscular tissue of the mucosa, all being supported and held together by retiform lymphoid tissue.
- The lacteals are in some cases double, and in some animals multiple, but usually there is a single vessel.
- Situated in the axis of the villus, each commences by dilated caecal extremities near to, but not quite at, the summit of the villus.
- The walls are composed of a single layer of endothelial cells.
- The muscular fibers are derived from the *muscularis mucosæ*, and are arranged in longitudinal bundles around the lacteal vessel, extending from the base to the summit of the *villus*, and giving off, laterally, individual muscle cells, which are enclosed by the reticulum, and by it are attached to the basement-membrane and to the lacteal.
- The bloodvessels form a plexus under the basement membrane, and are enclosed in the reticular tissue.
- These structures are surrounded by the basement membrane, which is made up of a stratum of endothelial cells, and upon this is placed a layer of columnar epithelium.
- The retiform tissue forms a network in the meshes of which a number of leucocytes are found.





- **The intestinal glands (*glandulæ intestinales* [Lieberkühni]; crypts of Lieberkühn) are found in considerable numbers over every part of the mucous membrane of the small intestine.**
- **They consist of minute tubular depressions of the mucous membrane, arranged perpendicularly to the surface, upon which they open by small circular apertures.**
- **They may be seen with the aid of a lens, their orifices appearing as minute dots scattered between the villi.**
- **Their walls are thin, consisting of a basement membrane lined by columnar epithelium, and covered on their exterior by capillary vessels.**



- **The solitary lymphatic nodules (*noduli lymphatici solitarii*; solitary glands)** are found scattered throughout the mucous membrane of the small intestine, but are most numerous in the lower part of the ileum.
- Their free surfaces are covered with rudimentary villi, except at the summits, and each gland is surrounded by the openings of the intestinal glands.
- Each consists of a dense interlacing retiform tissue closely packed with lymph-corpuscles, and permeated with an abundant capillary network.
- The interspaces of the retiform tissue are continuous with larger lymph spaces which surround the gland, through which they communicate with the lacteal system.
- They are situated partly in the submucous tissue, partly in the mucous membrane, where they form slight projections of its epithelial layer .

- The aggregated lymphatic nodules (*noduli lymphatici aggregati*; Peyer's patches; Peyer's glands; agminated follicles; *tonsillæ intestinales*) form circular or oval patches, from twenty to thirty in number, and varying in length from 2 to 10 cm.
- They are largest and most numerous in the ileum.
- In the lower part of the jejunum they are small, circular, and few in number.
- They are occasionally seen in the duodenum.
- They are placed lengthwise in the intestine, and are situated in the portion of the tube most distant from the attachment of the mesentery.
- Each patch is formed of a group of solitary lymphatic nodules covered with mucous membrane, but the patches do not, as a rule, possess *villi* on their free surfaces.
- They are best marked in the young subject, become indistinct in middle age, and sometimes disappear altogether in advanced life.
- They are freely supplied with bloodvessels, which form an abundant plexus around each follicle and give off fine branches permeating the lymphoid tissue in the interior of the follicle.
- The lymphatic plexuses are especially abundant around these patches.

- **Vessels and Nerves**

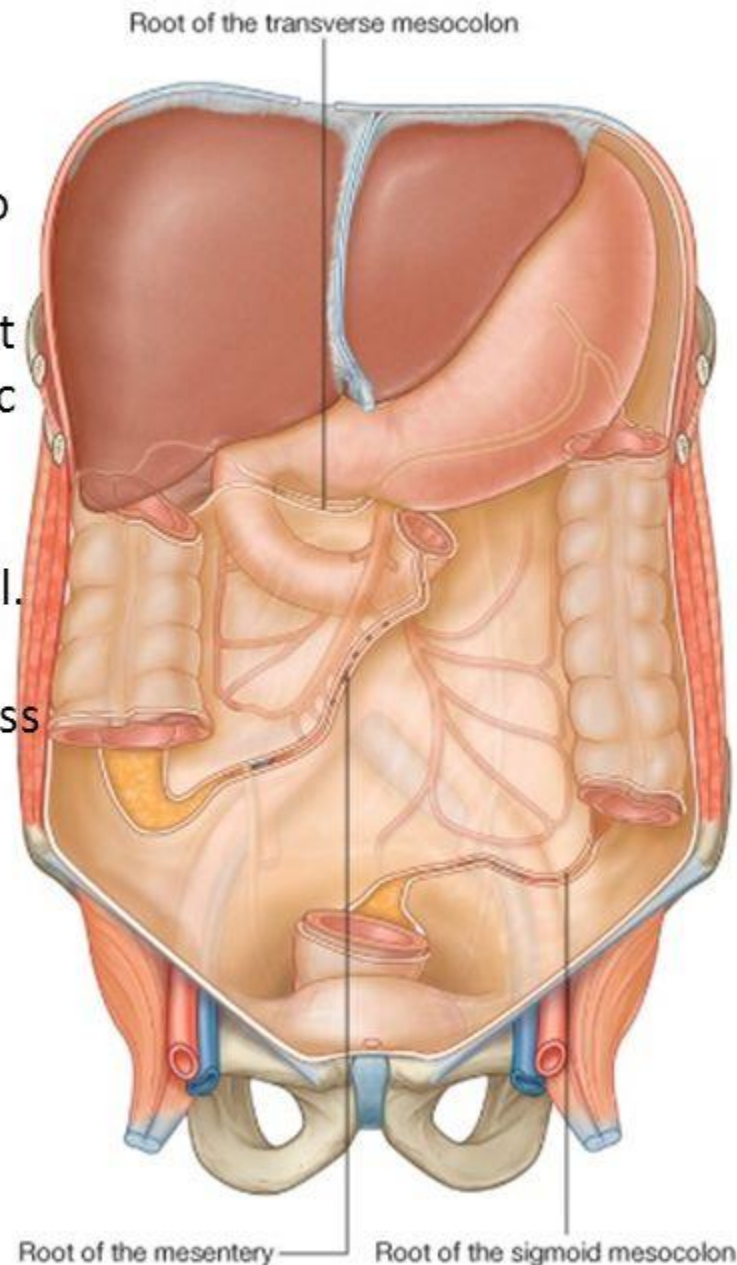
- The jejunum and ileum are supplied by **the superior mesenteric artery**, the intestinal branches of which, having reached the attached border of the bowel, run between the serous and muscular coats, with frequent inosculations to the free border, where they also anastomose with other branches running around the opposite surface of the gut.
- From these vessels numerous branches are given off, which pierce the muscular coat, supplying it and forming an intricate plexus in the submucous tissue.
- From this plexus minute vessels pass to the glands and villi of the mucous membrane.

# Mesenteries

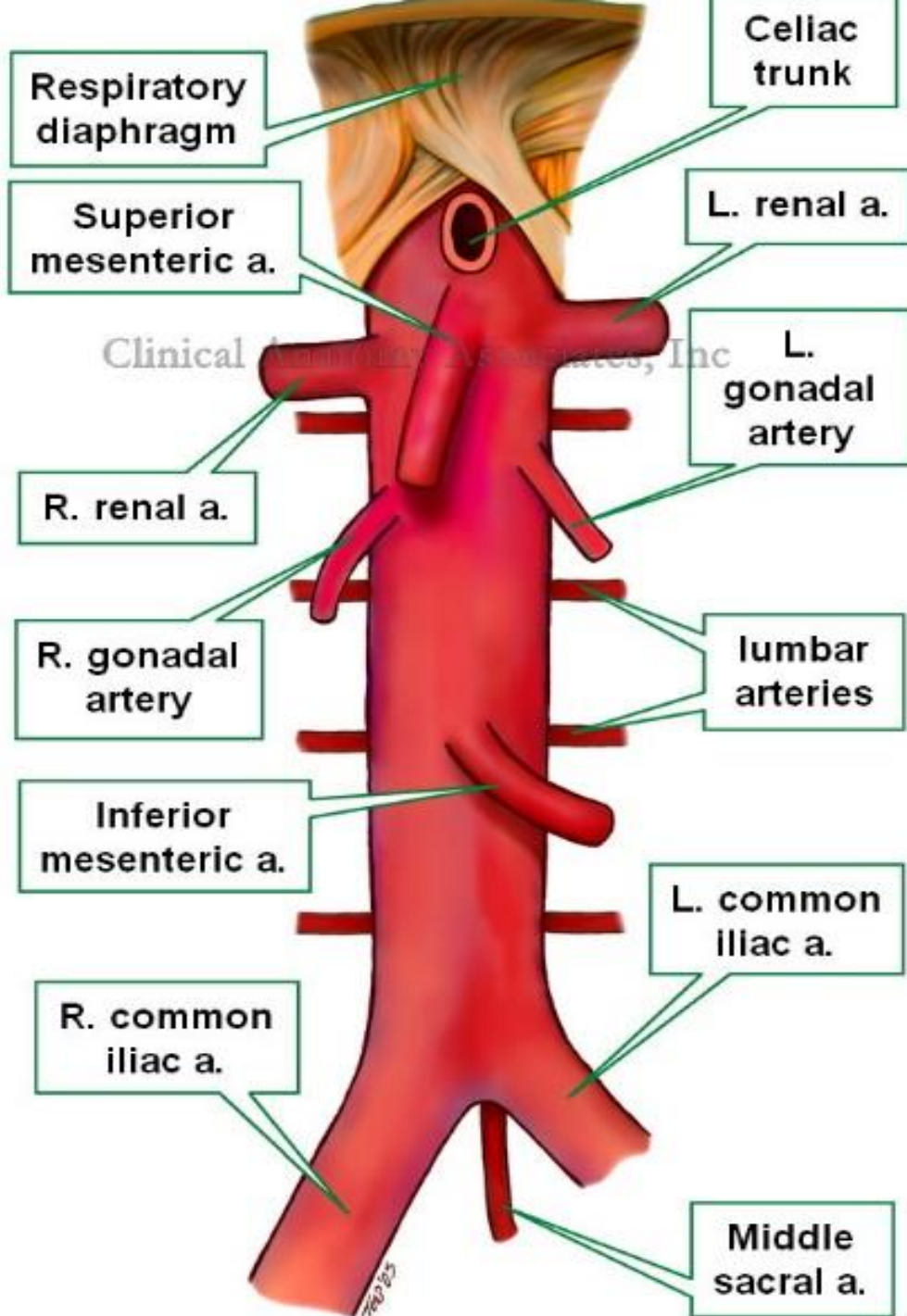
**Mesentery of small intestine:** is a large, fan-shaped, double-layered fold of peritoneum that connects jejunum and ileum to posterior abdominal wall. Its superior attachment is at **duodenojejunal** junction (to the left of upper lumbar part of vertebral column). It passes obliquely downward and to the right, ending at **ileocecal** junction near upper border of right sacroiliac joint. It contains aa, vv, nn & lymph.vv.

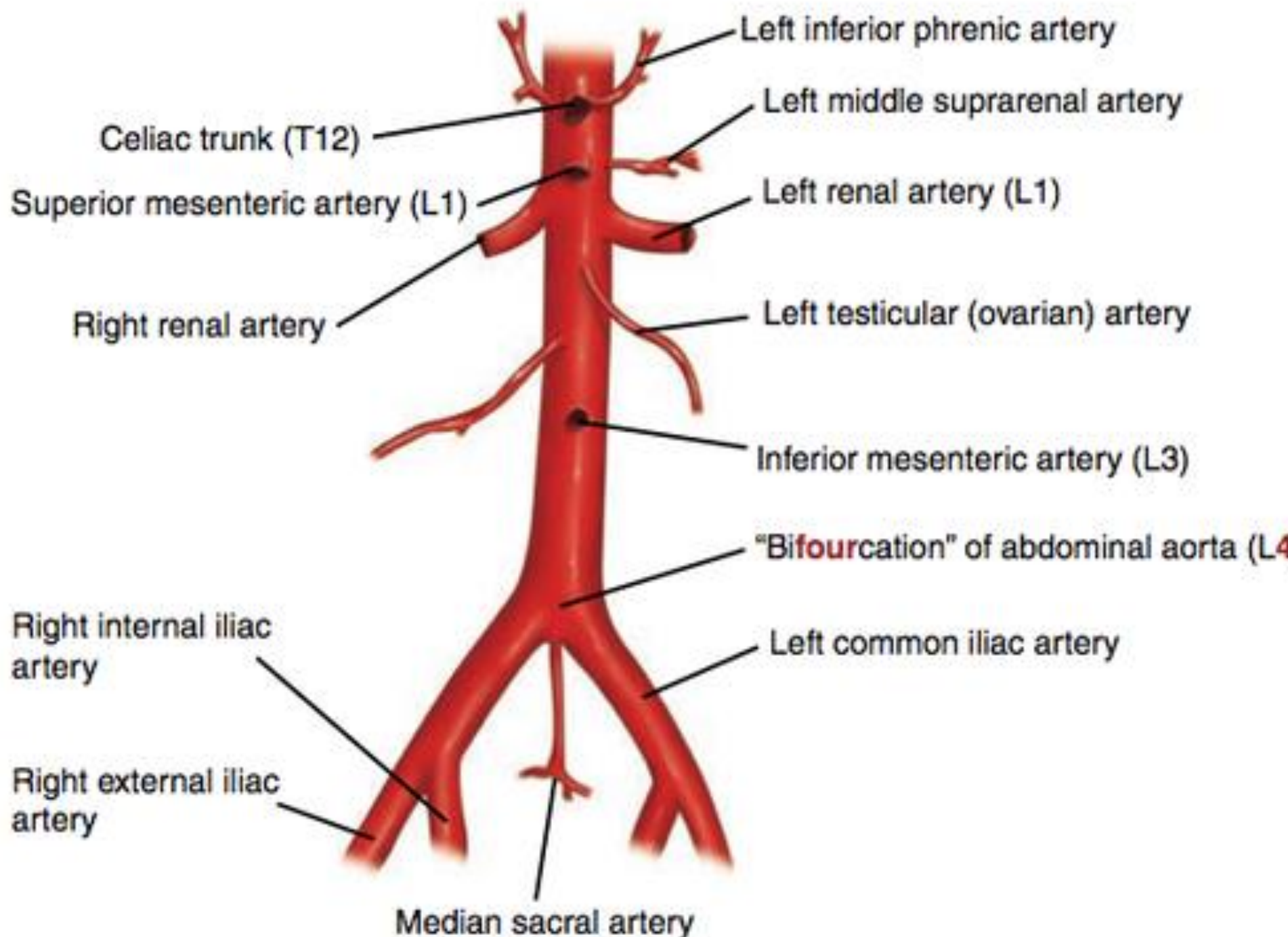
**Transverse mesocolon:** is a fold of peritoneum that connects transverse colon to posterior abdominal wall. It is originated from posterior abdominal wall across anterior surface of head and body of pancreas and passes outward to surround transverse colon.

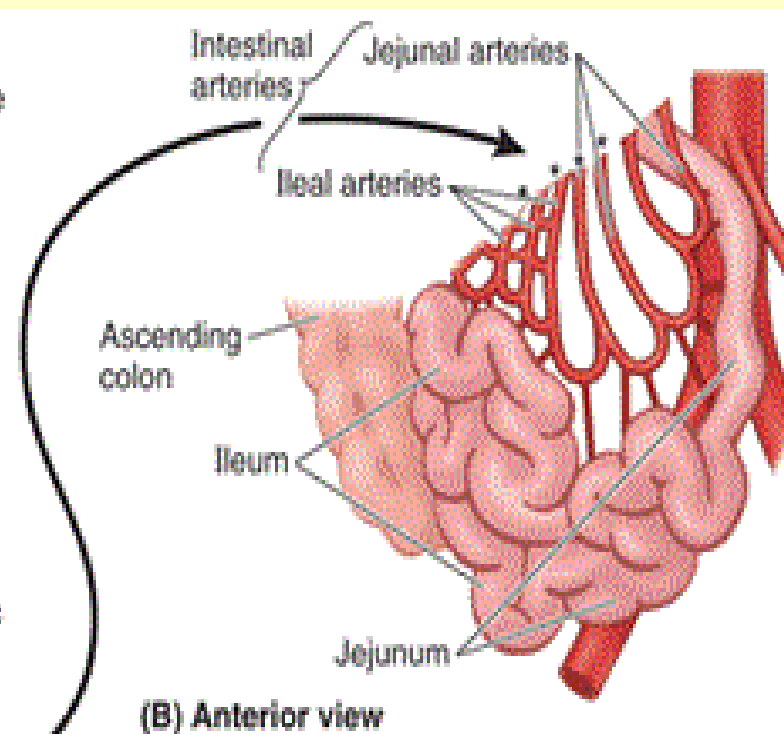
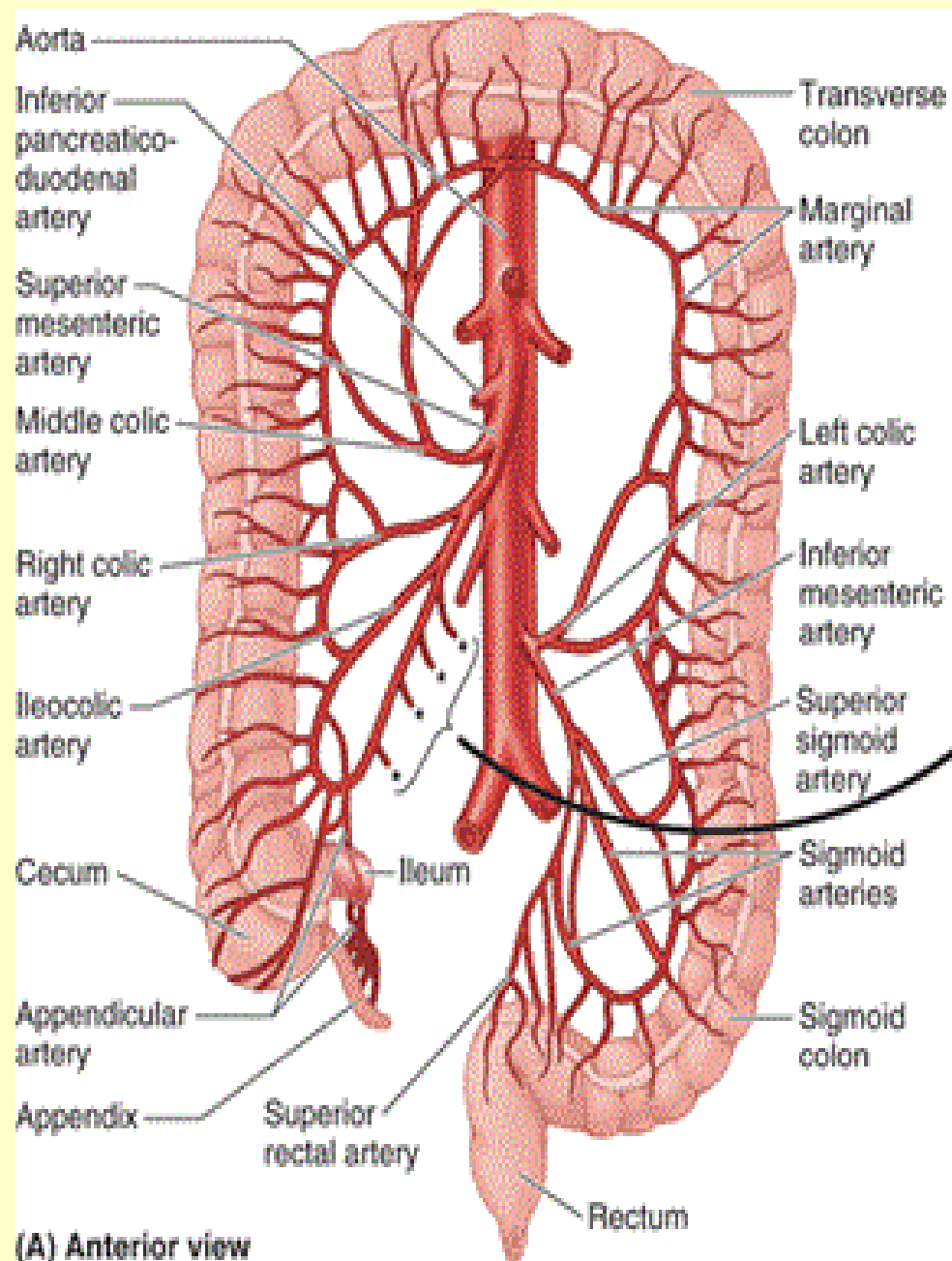
**Sigmoid mesocolon:** is an inverted, V-shaped peritoneal fold that attaches sigmoid colon to abdominal wall. Apex of the 'V' is near the division of left common iliac artery into its internal & external branches. Sigmoid and superior rectal vessels, along with the nerves and lymphatics associated with the sigmoid colon, pass through this peritoneal fold.





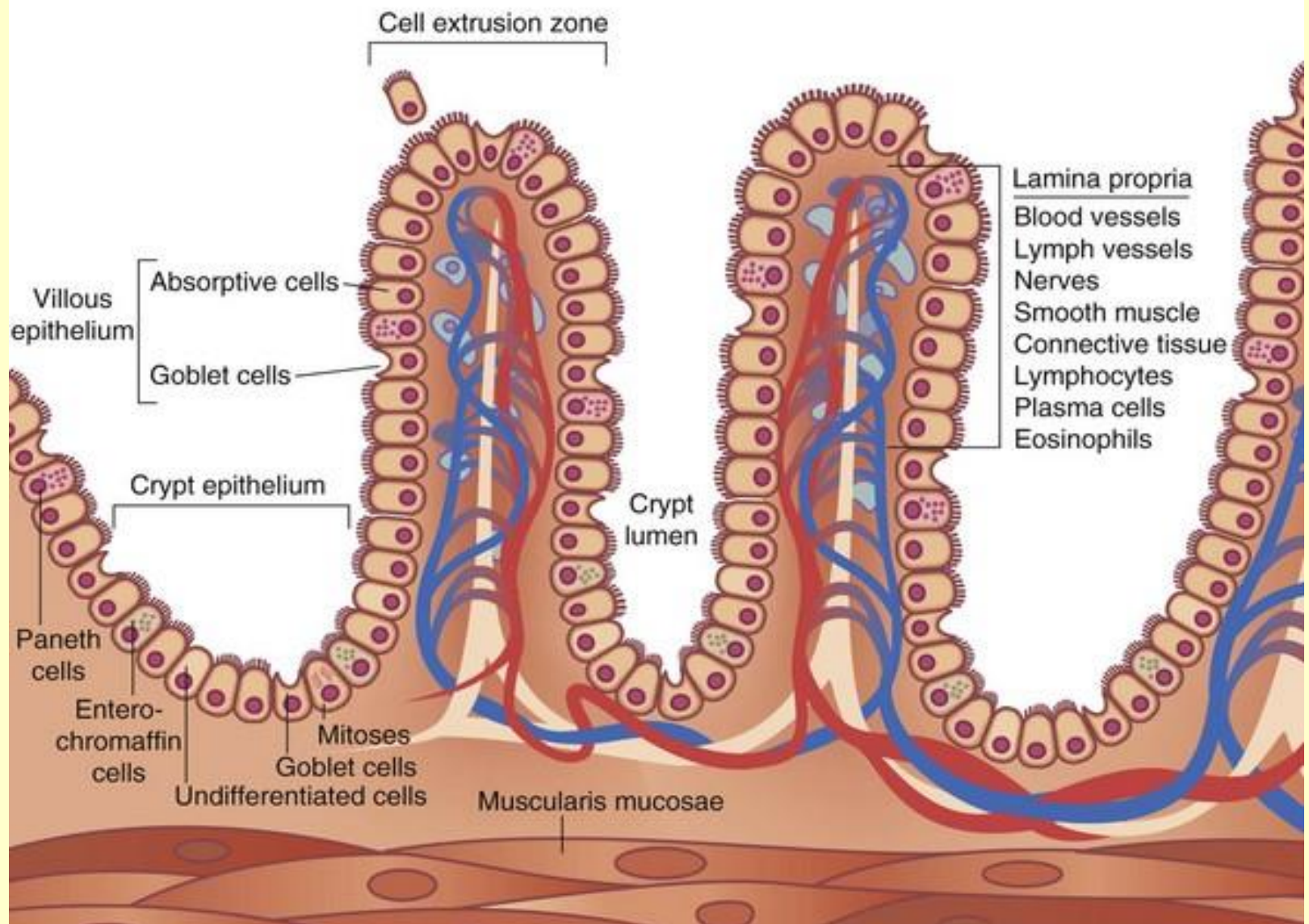






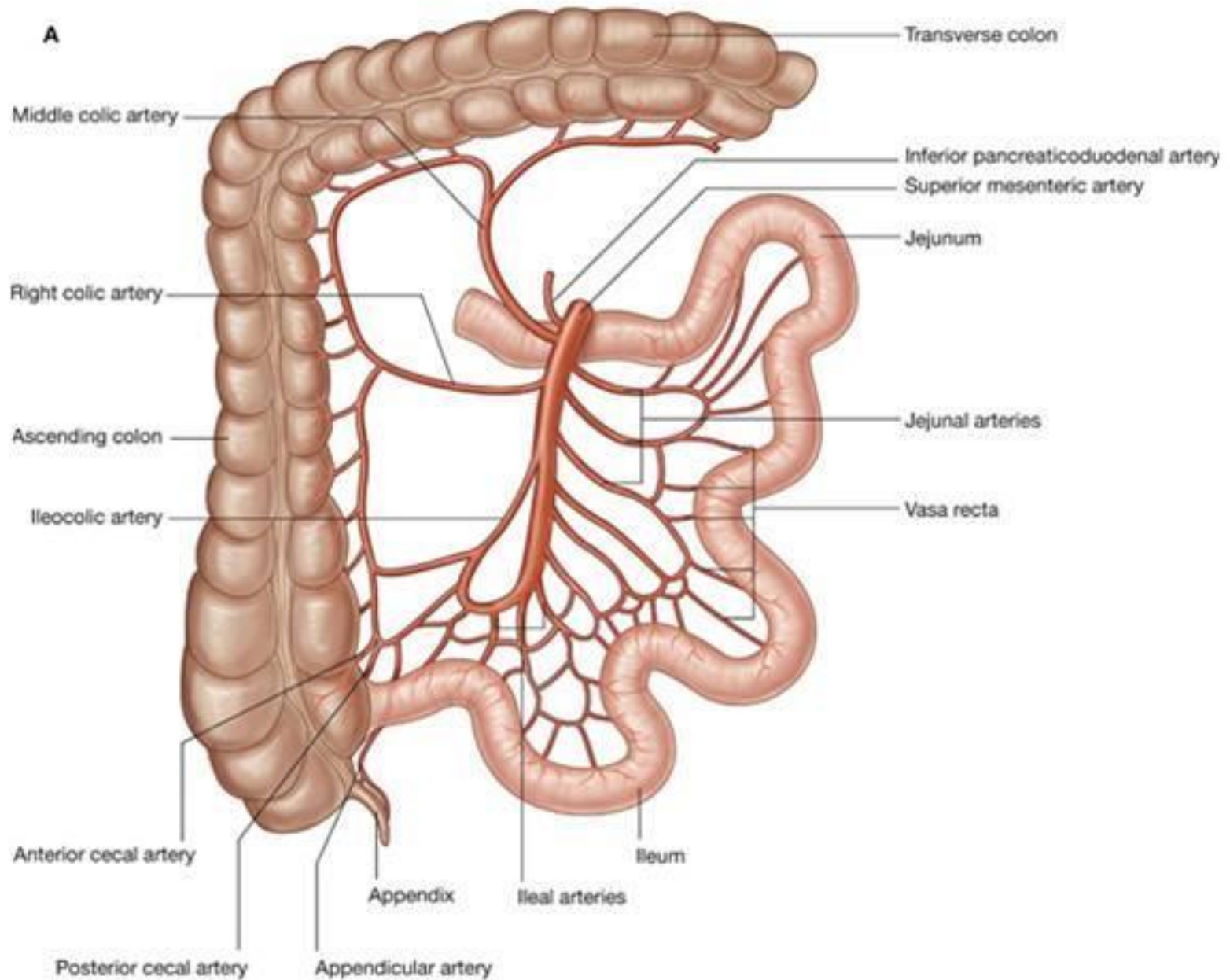


- **The veins have a similar course and arrangement to the arteries.**
- **The lymphatics of the small intestine (lacteals) are arranged in two sets, those of the mucous membrane and those of the muscular coat.**
- **The lymphatics of the villi commence in these structures in the manner described above.**
- **They form an intricate plexus in the mucous and submucous tissue, being joined by the lymphatics from the lymph spaces at the bases of the solitary nodules, and from this pass to larger vessels at the mesenteric border of the gut.**
- **The lymphatics of the muscular coat are situated to a great extent between the two layers of muscular fibers, where they form a close plexus; throughout their course they communicate freely with the lymphatics from the mucous membrane, and empty themselves in the same manner as these into the origins of the lacteal vessels at the attached border of the gut.**



- The nerves of the small intestines are derived from the plexuses of sympathetic nerves around the superior mesenteric artery.
- From this source they run to **the myenteric plexus (Auerbach's plexus)** of nerves and ganglia situated between the circular and longitudinal muscular fibers from which the nervous branches are distributed to the muscular coats of the intestine. From this a secondary plexus, **the plexus of the submucosa (Meissner's plexus)** is derived, and is formed by branches which have perforated the circular muscular fibers.
- This plexus lies in the submucous coat of the intestine; it also contains ganglia from which nerve fibers pass to the *muscularis mucosæ* and to the mucous membrane.
- The nerve bundles of the submucous plexus are finer than those of the myenteric plexus.

**A**



# The Large Intestine (*Intestinum Crassum*)

The large intestine extends from the end of the ileum to the anus.

It is about 1.5 meters long, being one-fifth of the whole extent of the intestinal canal.

Its caliber is largest at its commencement at the caecum, and gradually diminishes as far as the rectum, where there is a dilatation of considerable size just above the anal canal.

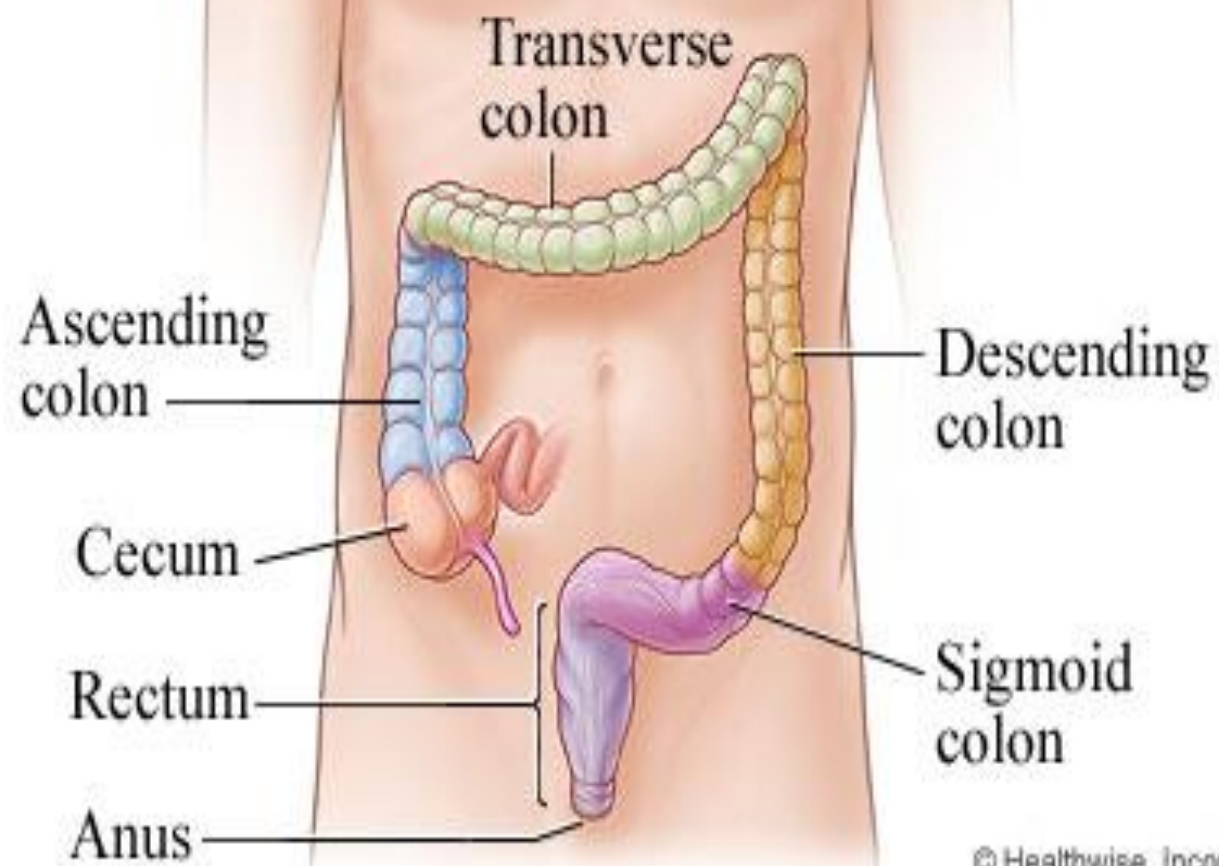
It differs from the small intestine in its greater caliber, its more fixed position, its sacculated form, and in possessing certain appendages to its external coat, *the appendices epiploicæ*.

Further, its longitudinal muscular fibers do not form a continuous layer around the gut, but are arranged in three longitudinal bands or *tæniæ*.

The large intestine, in its course, describes an arch which surrounds the convolutions of the small intestine.

It commences in the right iliac region, in a dilated part, the caecum.





- It ascends through the right lumbar and hypochondriac regions to the under surface of the liver; it here takes a bend, the right colic flexure, to the left and passes transversely across the abdomen on the confines of the epigastric and umbilical regions, to the left hypochondriac region;
- it then bends again, the left colic flexure, and descends through the left lumbar and iliac regions to the pelvis, where it forms a bend called the sigmoid flexure;
- from this it is continued along the posterior wall of the pelvis to the anus.
- The large intestine is divided into the caecum, colon, rectum, and anal canal.



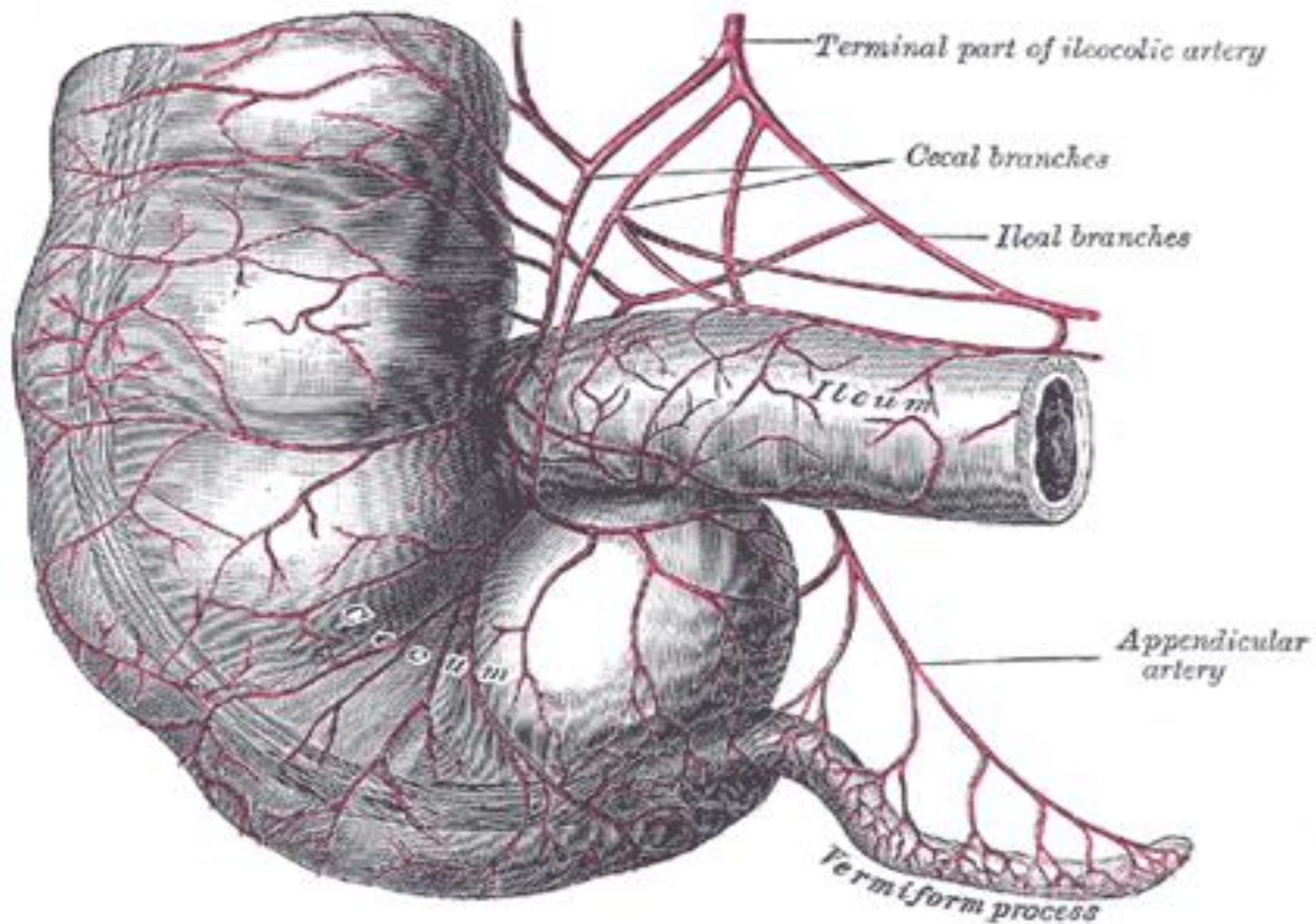
# **The Cecum (*intestinum cæcum*)**

**Is the commencement of the large intestine, is the large blind pouch situated below the colic valve.**

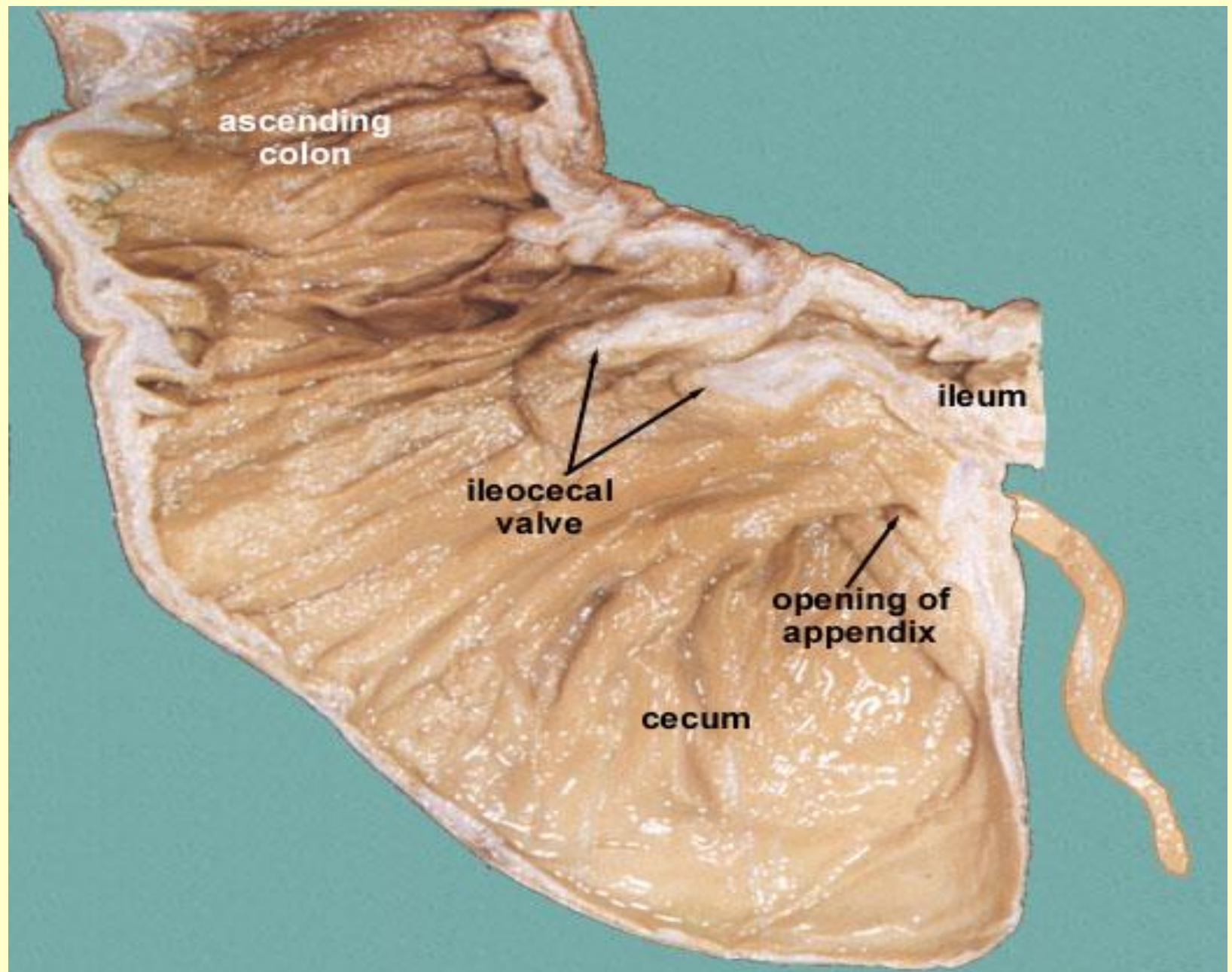
**Its blind end is directed downward, and its open end upward, communicating directly with the colon, of which this blind pouch appears to be the beginning or head, and hence the old name of *caput cæcum coli* was applied to it.**

**Its size is variously estimated by different authors, but on an average it may be said to be 6.25 cm. in length and 7.5 in breadth.**

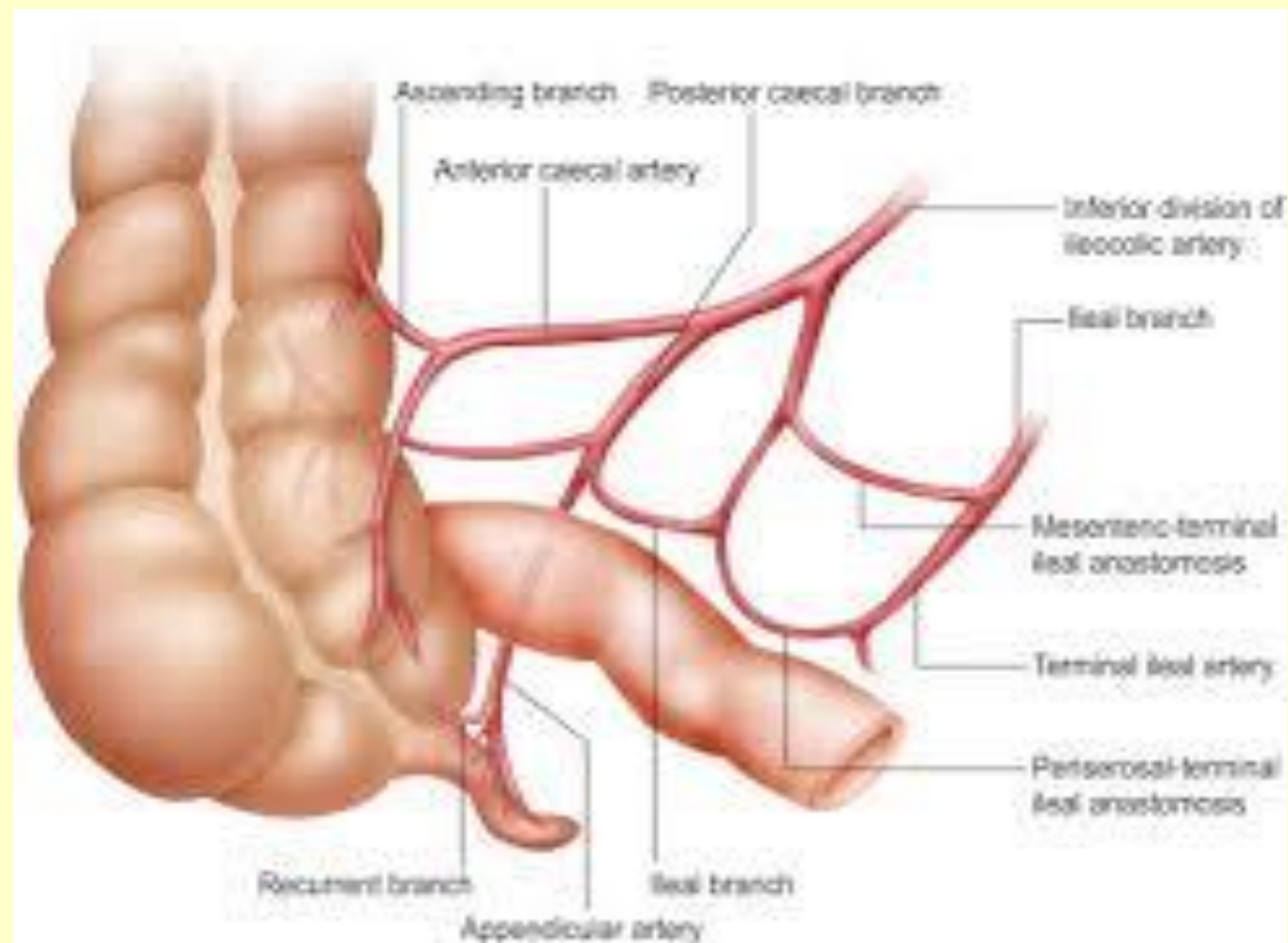
**It is situated in the right iliac fossa, above the lateral half of the inguinal ligament: it rests on the *Iliacus* and *Psoas major*, and usually lies in contact with the anterior abdominal wall, but the greater omentum and, if the caecum be empty, some coils of small intestine may lie in front of it.**



- **As a rule, it is entirely enveloped by peritoneum.**
- **The caecum lies quite free in the abdominal cavity and enjoys a considerable amount of movement, so that it may become herniated down the right inguinal canal.**
- **The caecum varies in shape.**







- **The Vermiform Process or Appendix (*processus vermiformis*)** is a long, narrow, worm-shaped tube, which starts from what was originally the apex of the caecum, and may pass in one of several directions: upward behind the caecum; to the left behind the ileum and mesentery; or downward into the lesser pelvis.
- It varies from 2 to 20 cm. in length, its average being about 8.3 cm.
- It is retained in position by a fold of peritoneum (mesenteriole), derived from the left leaf of the mesentery.
- This fold, in the majority of cases, is more or less triangular in shape, and as a rule extends along the entire length of the tube.
- Between its two layers and close to its free margin lies the appendicular artery.
- The canal of the vermiform process is small, extends throughout the whole length of the tube, and communicates with the caecum by an orifice which is placed below and behind the ileocecal opening.
- It is sometimes guarded by a semilunar valve formed by a fold of mucous membrane, but this is by no means constant.
- **Structure**
- The coats of the vermiform process are the same as those of the intestine: serous, muscular, submucous, and mucous.



**B**

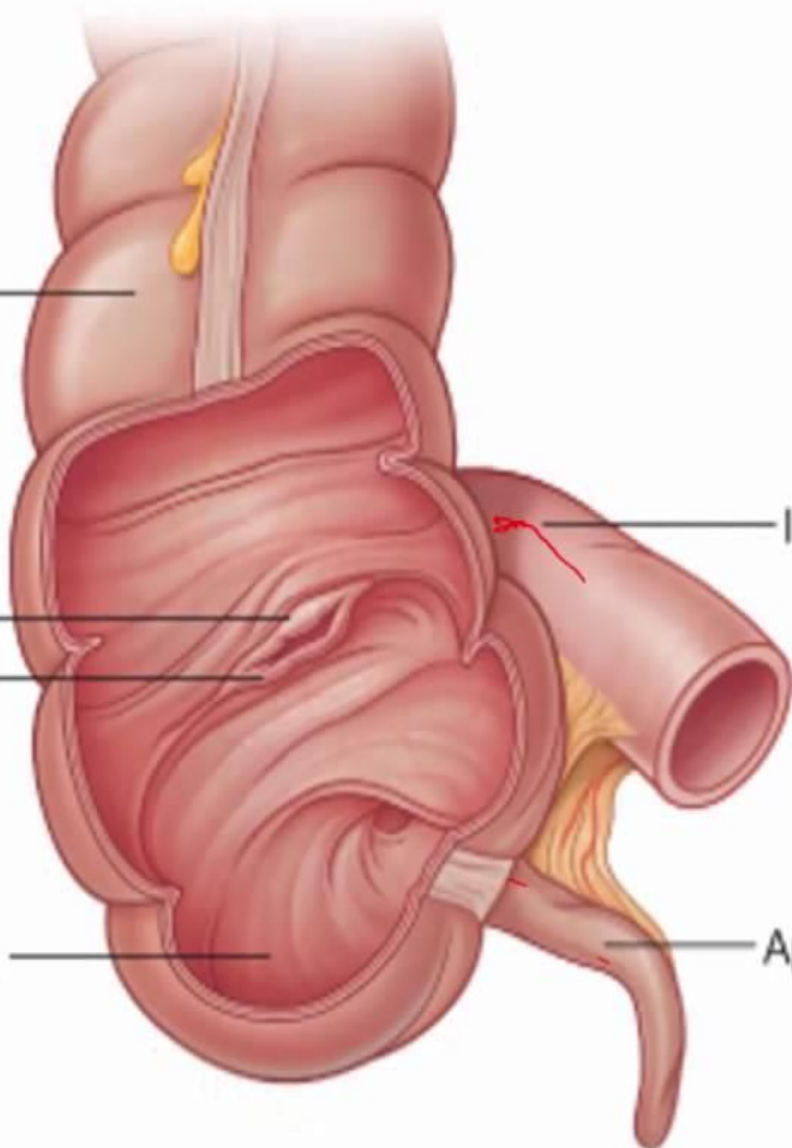
Ascending  
colon

Ileocecal  
fold flaps

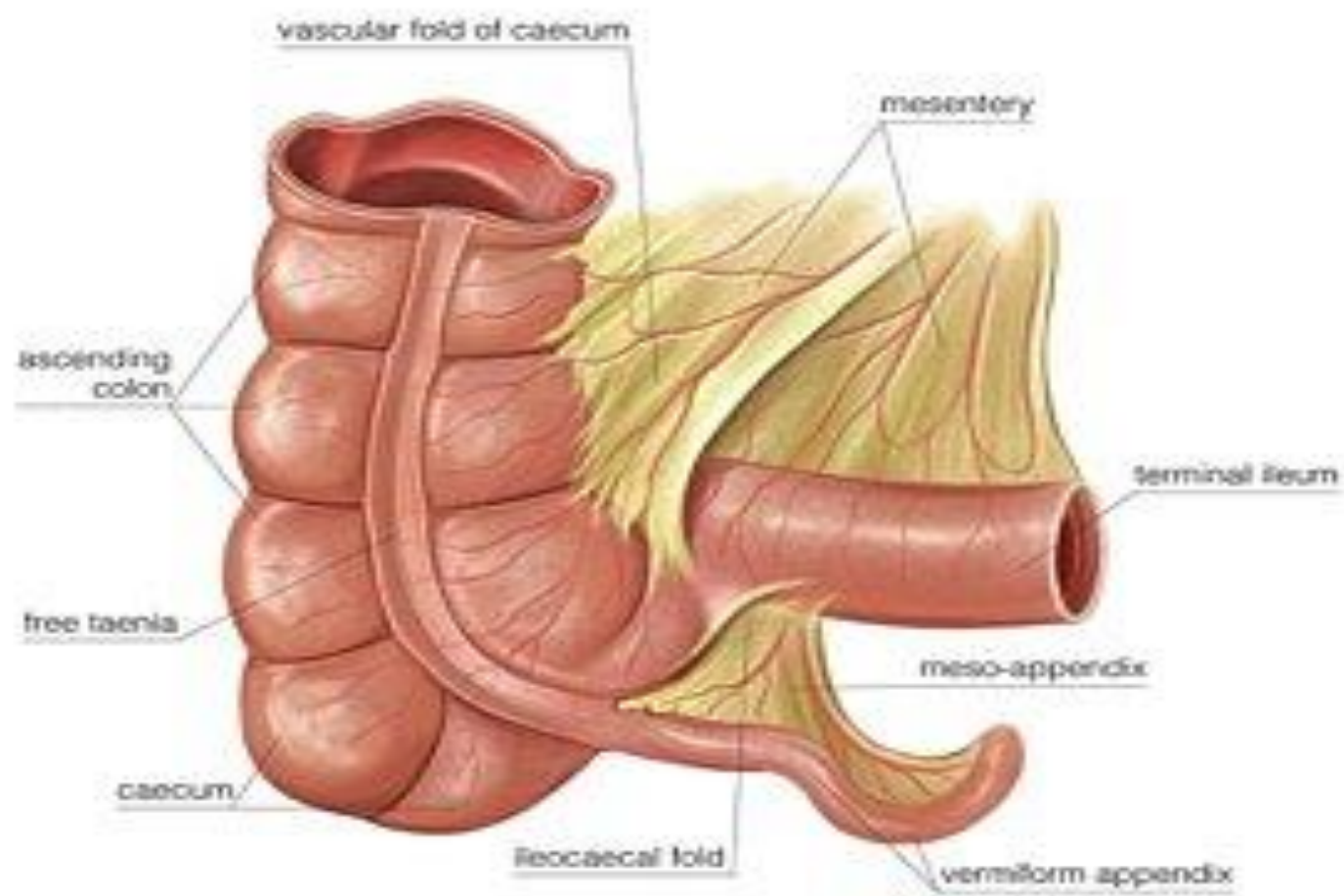
Cecum

Ileum

Appendix



- **The Colic Valve (*valvula coli*; ileocecal valve)**
- The lower end of the ileum ends by opening into the medial and back part of the large intestine, at the point of junction of the caecum with the colon.
- The opening is guarded by a valve, consisting of two segments or lips, which project into the lumen of the large intestine.
- If the intestine has been inflated and dried, the lips are of a semilunar shape.
- The upper one, nearly horizontal in direction, is attached by its convex border to the line of junction of the ileum with the colon;
- the lower lip, which is longer and more concave, is attached to the line of junction of the ileum with the caecum.
- At the ends of the aperture the two segments of the valve coalesce, and are continued as narrow membranous ridges around the canal for a short distance, forming the *frenula* of the valve.
- The left or anterior end of the aperture is rounded; the right or posterior is narrow and pointed.
- In the fresh condition, or in specimens which have been hardened in situ, the lips project as thick cushion-like folds into the lumen of the large gut, while the opening between them may present the appearance of a slit or may be somewhat oval in shape.



- Each lip of the valve is formed by a reduplication of the mucous membrane and of the circular muscular fibers of the intestine, the longitudinal fibers and peritoneum being continued uninterruptedly from the small to the large intestine.
- The surfaces of the valve directed toward the ileum are covered with villi, and present the characteristic structure of the mucous membrane of the small intestine; while those turned toward the large intestine are destitute of villi, and marked with the orifices of the numerous tubular glands peculiar to the mucous membrane of the large intestine.
- These differences in structure continue as far as the free margins of the valve.
- It is generally maintained that this valve prevents reflux from the caecum into the ileum, but in all probability it acts as a sphincter around the end of the ileum and prevents the contents of the ileum from passing too quickly into the caecum.

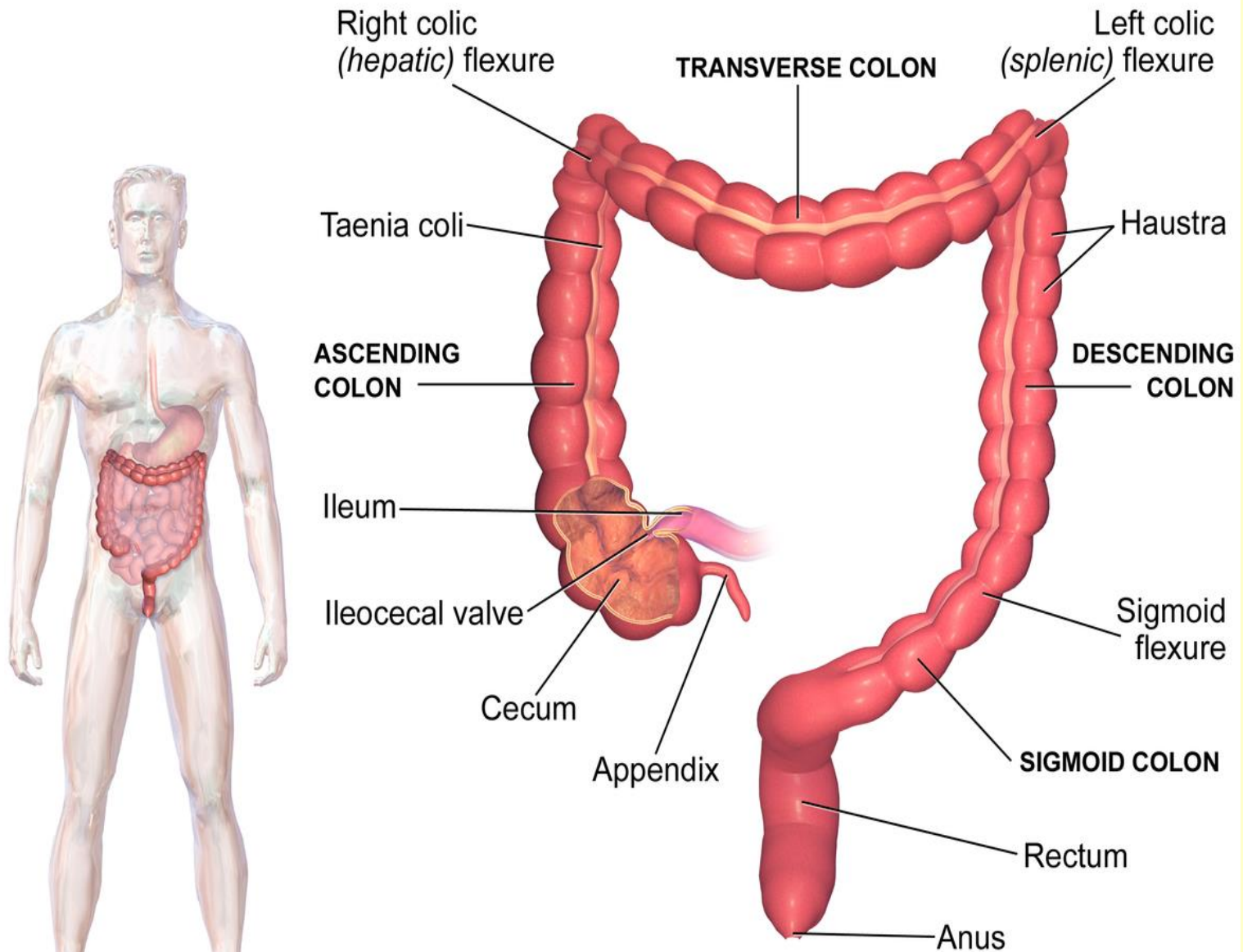
- **The Colon** is divided into four parts:  
the ascending,
- transverse,
- descending,
- and sigmoid.





# **The Ascending Colon (*colon ascendens*)**

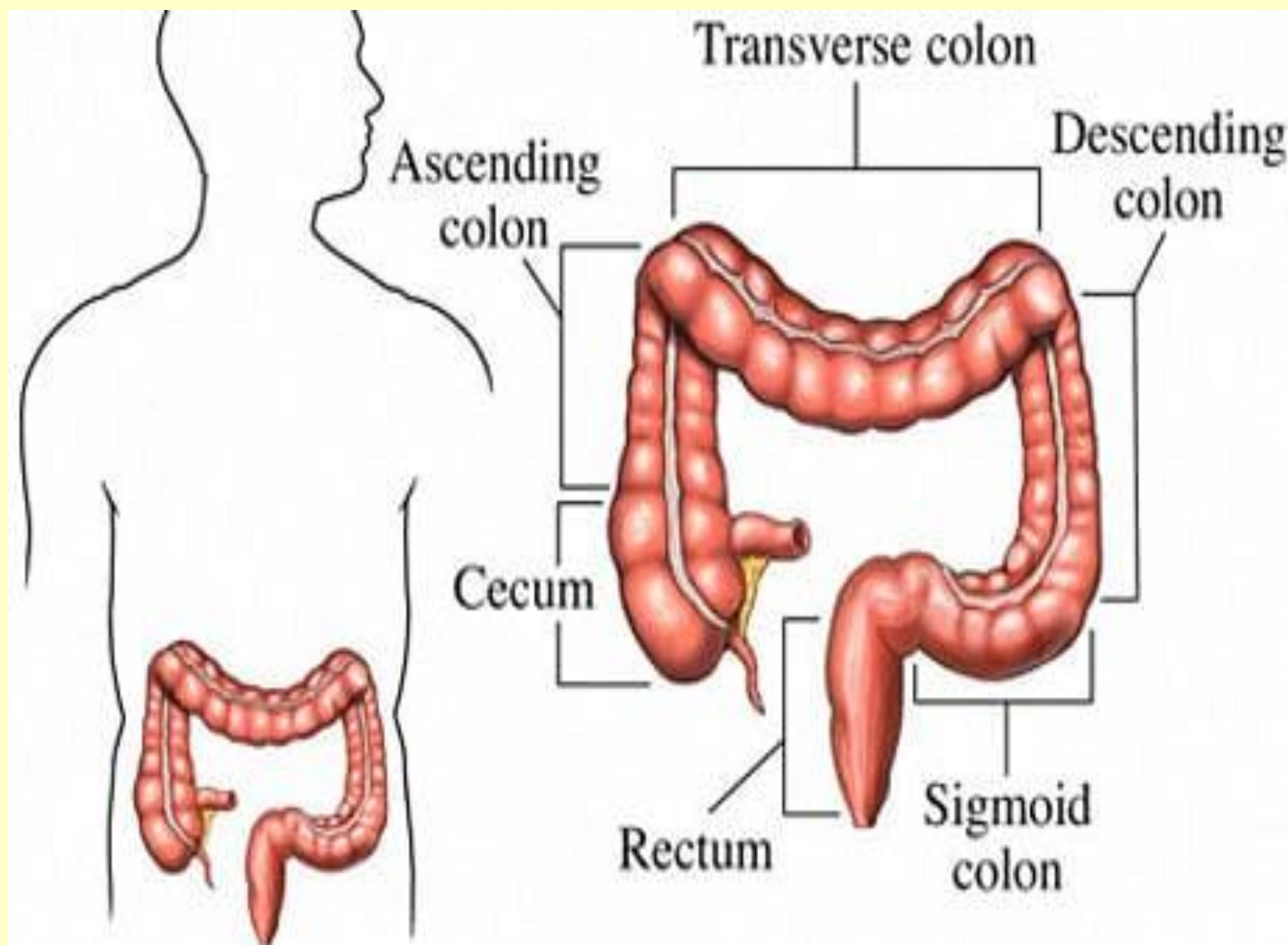
- is smaller in caliber than the caecum, with which it is continuous.
- It passes upward, from its commencement at the caecum, opposite the colic valve, to the under surface of the right lobe of the liver, on the right of the gall-bladder, where it is lodged in a shallow depression, the colic impression; here it bends abruptly forward and to the left, forming **the right colic (hepatic) flexure** .
- It is retained in contact with the posterior wall of the abdomen by the peritoneum, which covers its anterior surface and sides, its posterior surface being connected by loose areolar tissue with the *Iliacus*, *Quadratus lumborum*, aponeurotic origin of *Transversus abdominis*, and with the front of the lower and lateral part of the right kidney.
- It is in relation, in front, with the convolutions of the ileum and the abdominal walls.



**The Large Intestine**

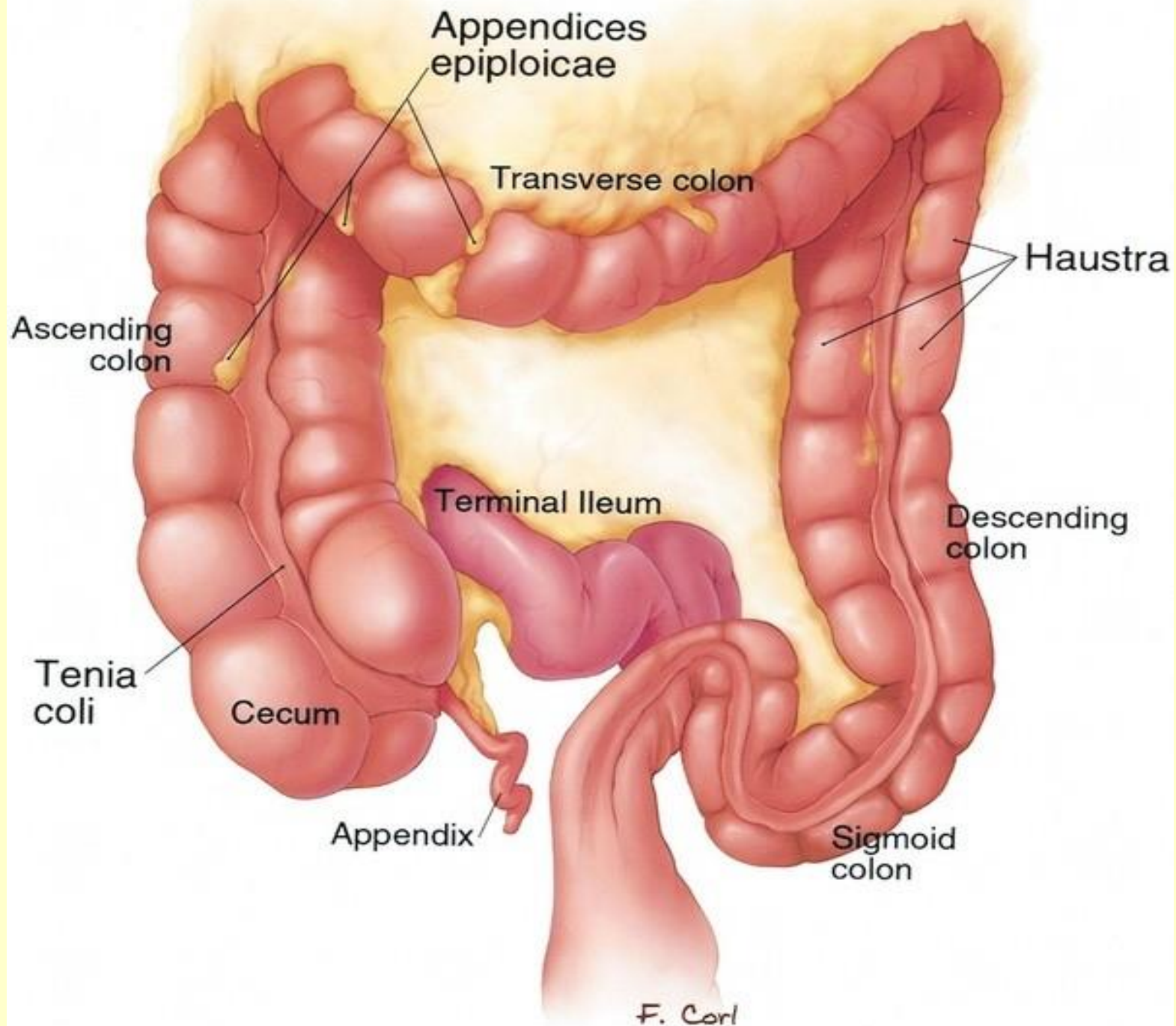
# The Transverse Colon (*colon transversum*)

- the longest and most movable part of the colon, passes with a downward convexity from the right hypochondriac region across the abdomen, opposite the confines of the epigastric and umbilical zones, into the left hypochondriac region, where it curves sharply on itself beneath the lower end of the spleen, forming **the left colic (splenic) flexure**.
- In its course it describes an arch, the concavity of which is directed backward and a little upward; toward its splenic end there is often an abrupt U-shaped curve which may descend lower than the main curve.
- It is almost completely invested by peritoneum, and is connected to the inferior border of the pancreas by a large and wide duplicature of that membrane, **the transverse mesocolon**.
- It is in relation, by its upper surface, with the liver and gall-bladder, the greater curvature of the stomach, and the lower end of the spleen; by its under surface, with the small intestine; by its anterior surface, with the anterior layers of the greater omentum and the abdominal wall; its posterior surface is in relation from right to left with the descending portion of the duodenum, the head of the pancreas, and some of the convolutions of the jejunum and ileum.





- **The left colic or splenic flexure** is situated at the junction of the transverse and descending parts of the colon, and is in relation with the lower end of the spleen and the tail of the pancreas;
- the flexure is so acute that the end of the transverse colon usually lies in contact with the front of the descending colon.
- It lies at a higher level than, and on a plane posterior to, the right colic flexure, and is attached to the diaphragm, opposite the tenth and eleventh ribs, by a peritoneal fold, named the **phrenicocolic ligament**, which assists in supporting the lower end of the spleen.



# The Descending Colon (*colon descendens*)

- passes downward through the left hypochondriac and lumbar regions along the lateral border of the left kidney.
- At the lower end of the kidney it turns medialward toward the lateral border of *the Psoas*, and then descends, in the angle between *Psoas and Quadratus lumborum*, to the crest of the ilium, where it ends in **the iliac colon**.
- The peritoneum covers its anterior surface and sides, while its posterior surface is connected by areolar tissue with the lower and lateral part of the left kidney, the aponeurotic origin of the *Transversus abdominis*, and the *Quadratus lumborum* .
- It is smaller in caliber and more deeply placed than the ascending colon, and is more frequently covered with peritoneum on its posterior surface than the ascending colon .
- In front of it are some coils of small intestine.

# The Iliac Colon

- is situated in the left iliac fossa, and is about 12 to 15 cm. long.
- It begins at the level of the iliac crest, where it is continuous with the descending colon, and ends in the sigmoid colon at the superior aperture of the lesser pelvis.
- It curves downward and medialward in front of *the Iliacus and Psoas*, and, as a rule, is covered by peritoneum on its sides and anterior surface only.

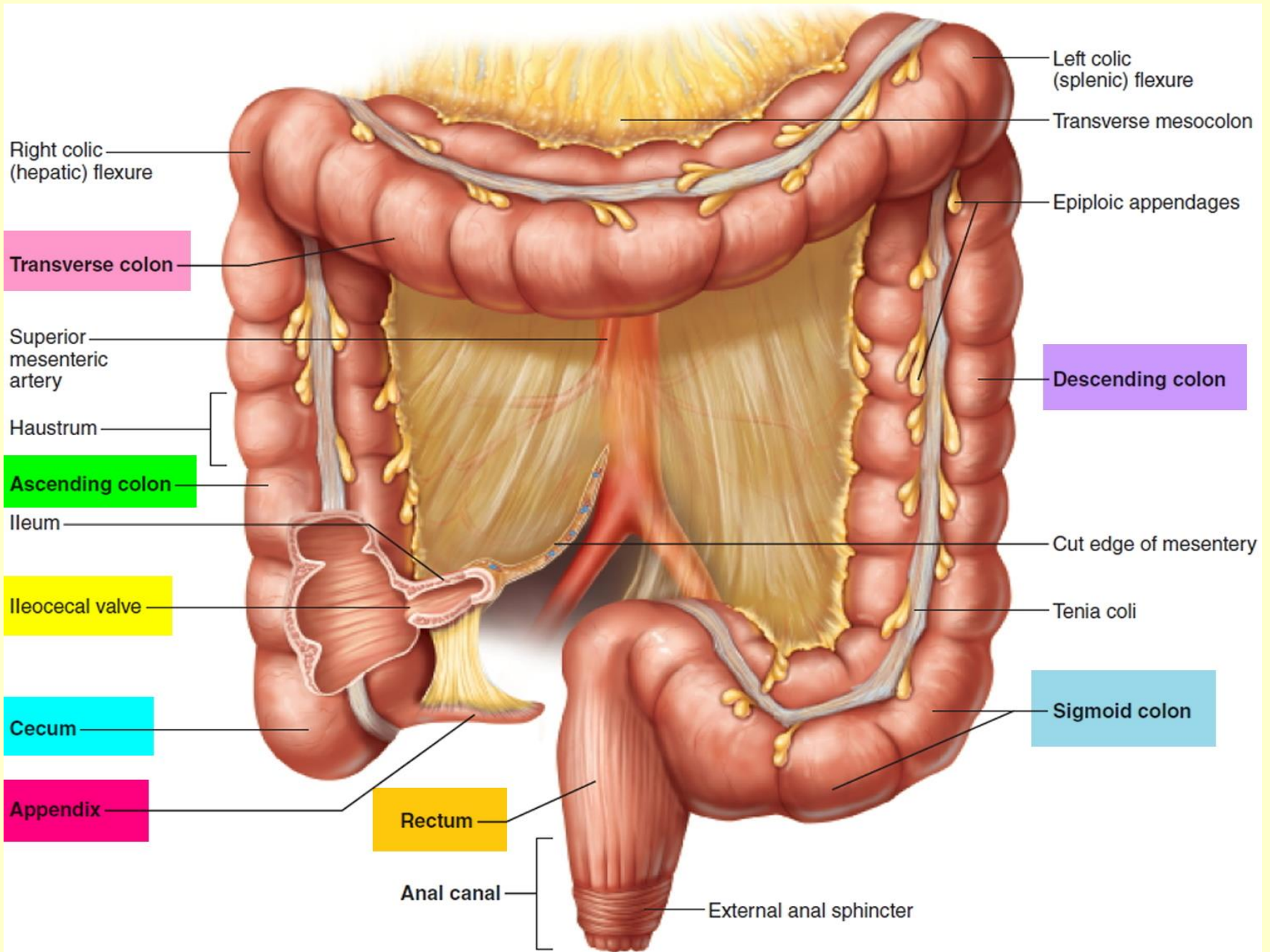
# **The Sigmoid Colon (*colon sigmoideum*; pelvic colon; sigmoid flexure)**

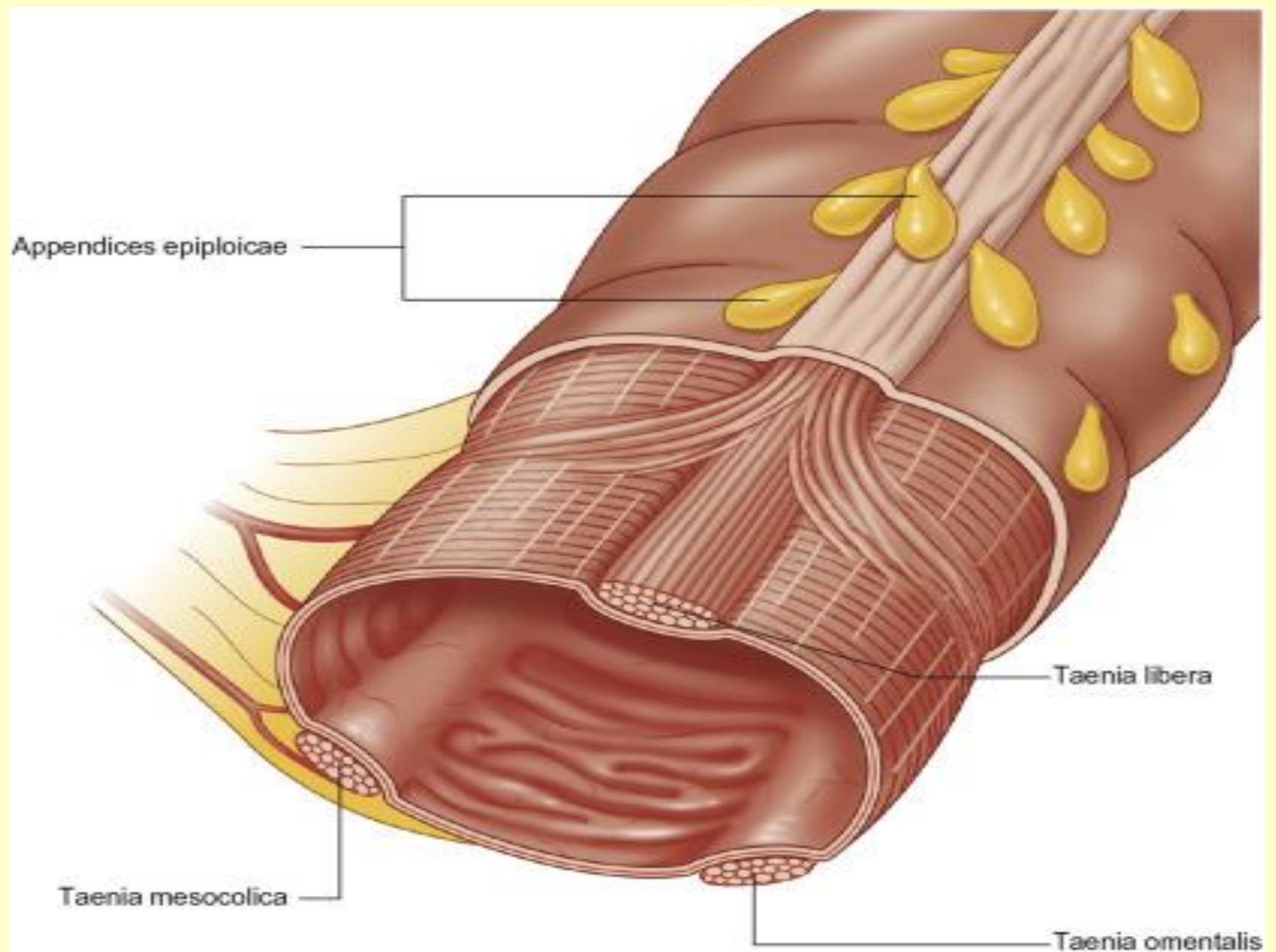
- 
- forms a loop which averages about 40 cm. in length, and normally lies within the pelvis.
- It begins at the superior aperture of the lesser pelvis, where it is continuous with the iliac colon, and passes transversely across the front of the sacrum to the right side of the pelvis; it then curves on itself and turns toward the left to reach the middle line at the level of the third piece of the sacrum, where it bends downward and ends in **the rectum**.
- It is completely surrounded by peritoneum, which forms a mesentery (**sigmoid mesocolon**), which diminishes in length from the center toward the ends of the loop, where it disappears, so that the loop is fixed at its junctions with the iliac colon and rectum, but enjoys a considerable range of movement in its central portion.
- Behind the sigmoid colon are the external iliac vessels, the left *Piriformis*, and left sacral plexus of nerves;
- in front, it is separated from the urinary bladder in the male, and the uterus in the female, by some coils of the small intestine.



# Structure of the Colon

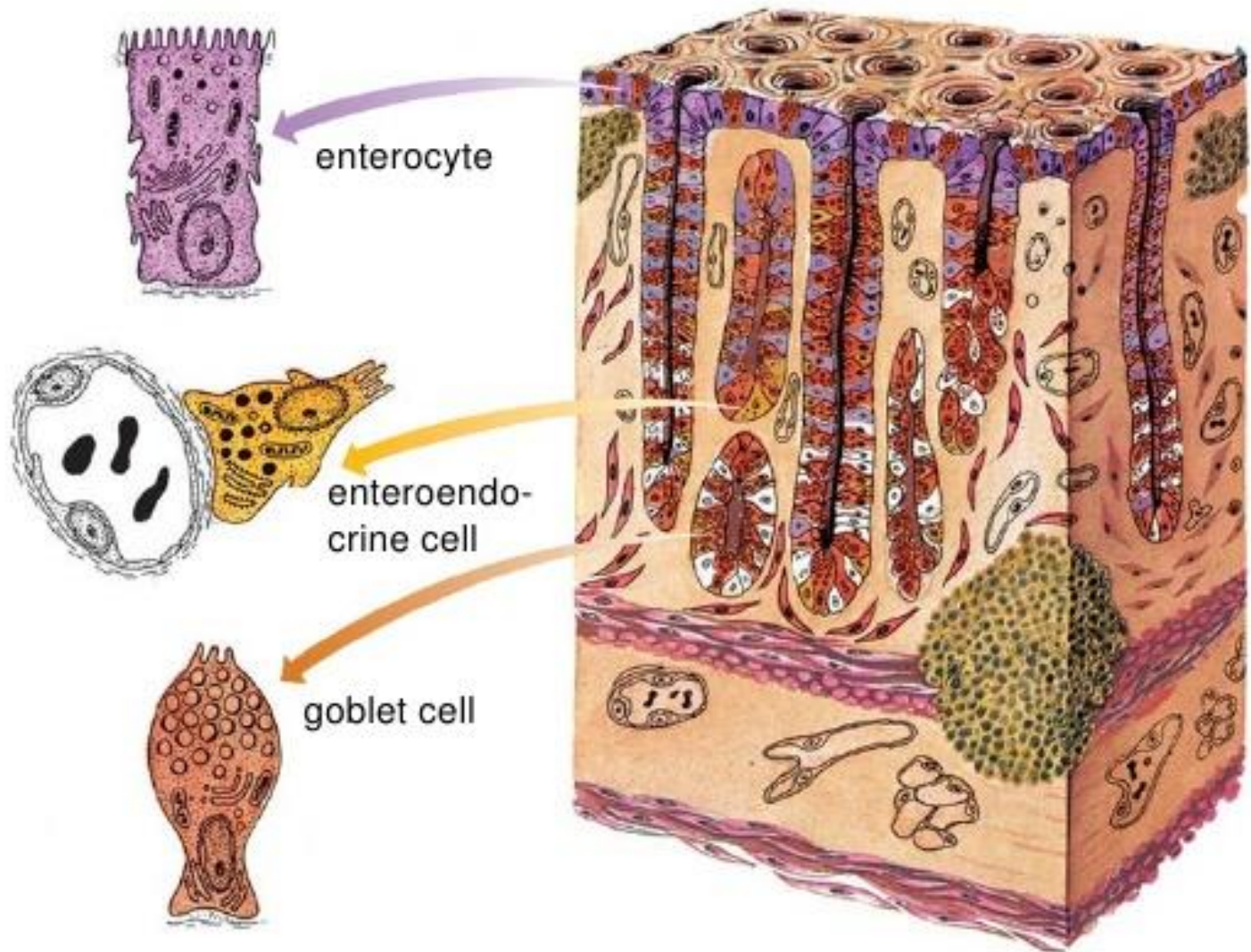
- The large intestine has four coats: serous, muscular, areolar, and mucous.
- **The serous coat (*tunica serosa*)** is derived from the peritoneum, and invests the different portions of the large intestine to a variable extent.
- The caecum is completely covered by the serous membrane, except in about 5 per cent. of cases where the upper part of the posterior surface is uncovered.
- The ascending, descending, and iliac parts of the colon are usually covered only in front and at the sides; a variable amount of the posterior surface is uncovered.
- The transverse colon is almost completely invested, the parts corresponding to the attachment of the greater omentum and transverse mesocolon being alone excepted.
- The sigmoid colon is entirely surrounded.
- The rectum is covered above on its anterior surface and sides; below, on its anterior aspect only;
- the anal canal is entirely devoid of any serous covering.
- In the course of the colon the peritoneal coat is thrown into a number of small pouches filled with fat, called ***appendices epiploicæ***.
- They are most numerous on the transverse colon.

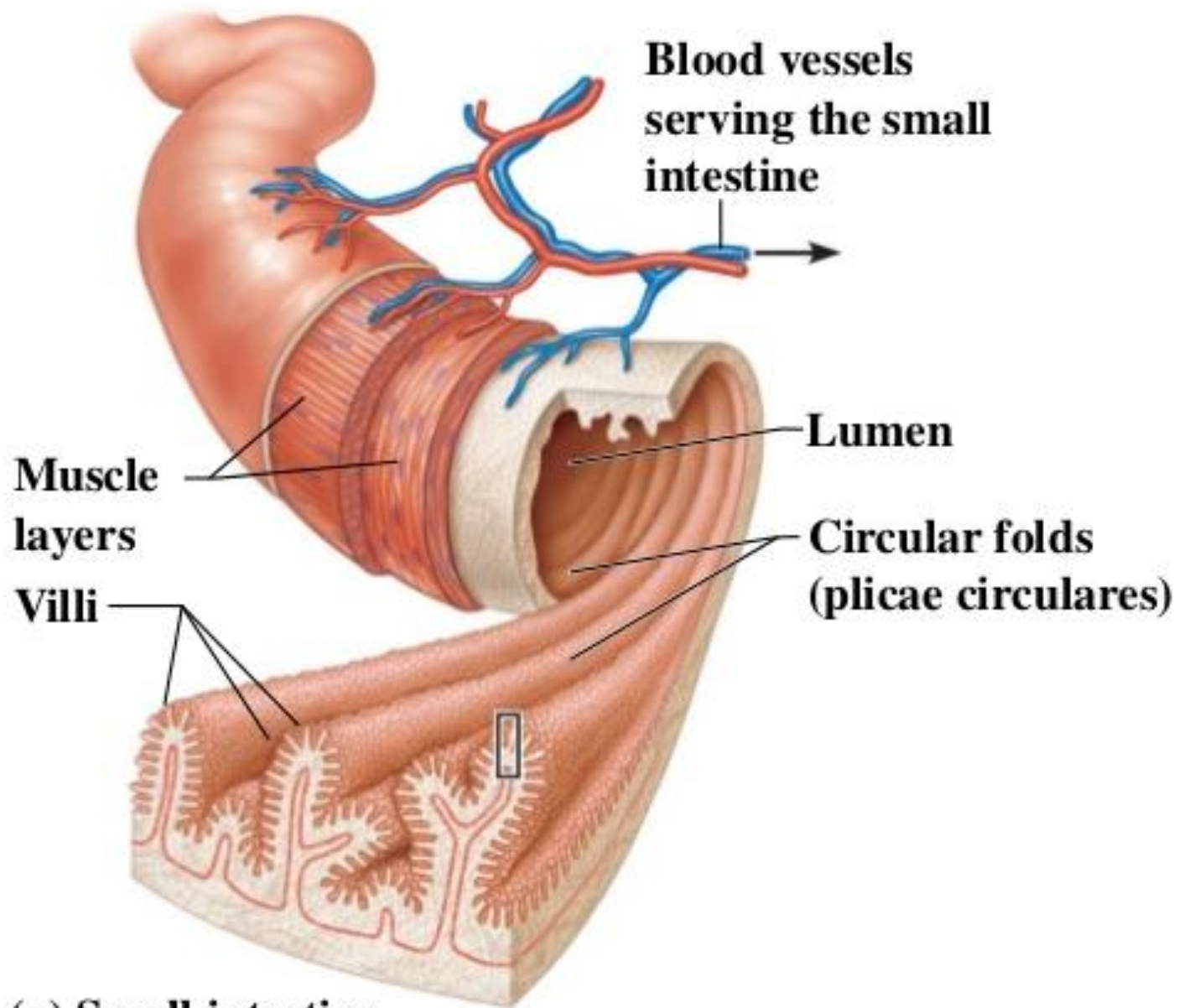






# Histology of large intestine





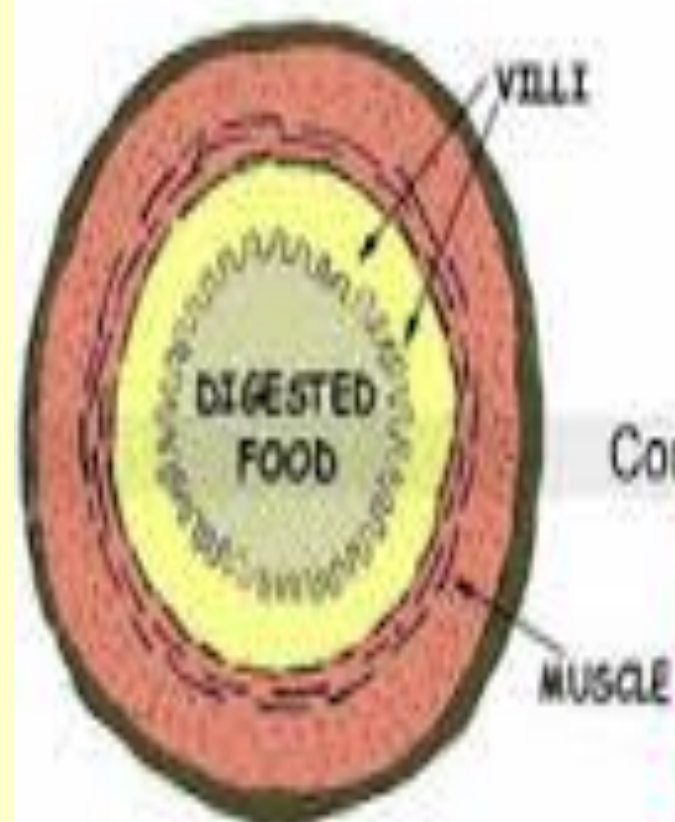


# The muscular coat (*tunica muscularis*)

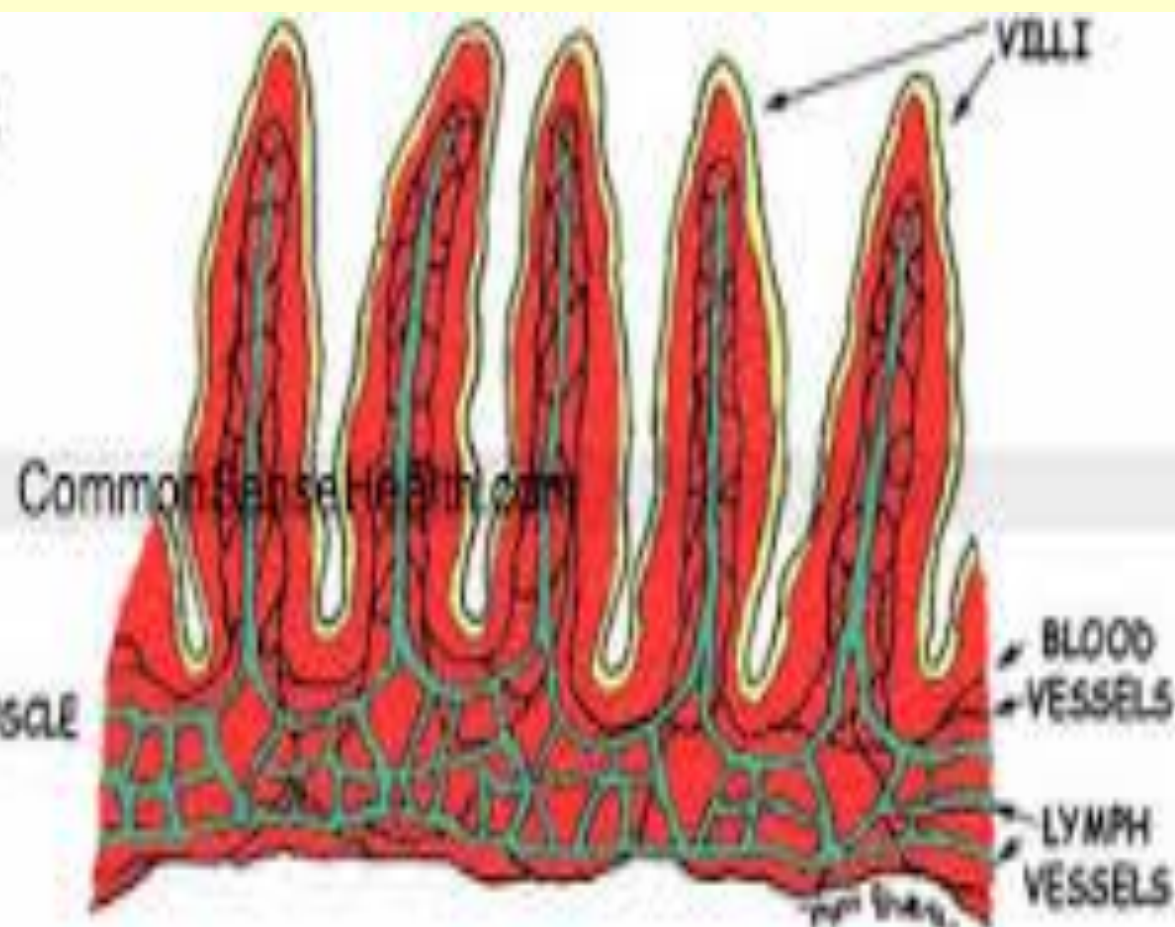
- consists of an external longitudinal, and an internal circular, layer of non-stripped muscular fibers:
- **The longitudinal fibers** do not form a continuous layer over the whole surface of the large intestine.
- In the caecum and colon they are especially collected into three flat longitudinal bands (*tænæi coli*), each of about 12 mm. in width;
- one, **the posterior**, is placed along the attached border of the intestine;
- **the anterior**, the largest, corresponds along the arch of the colon to the attachment of the greater omentum, but is in front in the ascending, descending, and iliac parts of the colon, and in the sigmoid colon;
- the third, **or lateral** band, is found on the medial side of the ascending and descending parts of the colon, and on the under aspect of the transverse colon.
- These bands are shorter than the other coats of the intestine, and serve to produce the **sacculi** which are characteristic of the caecum and colon.
- In the sigmoid colon the longitudinal fibers become more scattered; and around the rectum they spread out and form a layer, which completely encircles this portion of the gut, but is thicker on the anterior and posterior surfaces, where it forms two bands, than on the lateral surfaces.
- In addition, two bands of plain muscular tissue arise from the second and third coccygeal vertebræ, and pass downward and forward to blend with the longitudinal muscular fibers on the posterior wall of the anal canal. These are known as the Rectococcygeal muscles.
- **The circular fibers** form a thin layer over the caecum and colon, being especially accumulated in the intervals between the *sacculi*; in the rectum they form a thick layer, and in the anal canal they become numerous, and constitute the *Sphincter ani internus*.

# The areolar coat (*tela submucosa*; submucous coat)

- connects the muscular and mucous layers closely together.
- **The mucous membrane (*tunica mucosa*)** in the caecum and colon, is pale, smooth, destitute of villi, and raised into numerous crescentic folds which correspond to the intervals between the sacculi.
- In the rectum it is thicker, of a darker color, more vascular, and connected loosely to the muscular coat, as in the oesophagus.
- As in the small intestine, the mucous membrane consists of a muscular layer, the *muscularis mucosæ*; a quantity of retiform tissue in which the vessels ramify; a basement membrane and epithelium which is of the columnar variety, and resembles the epithelium found in the small intestine.
- The mucous membrane of the large intestine presents for examination glands and solitary lymphatic nodules.

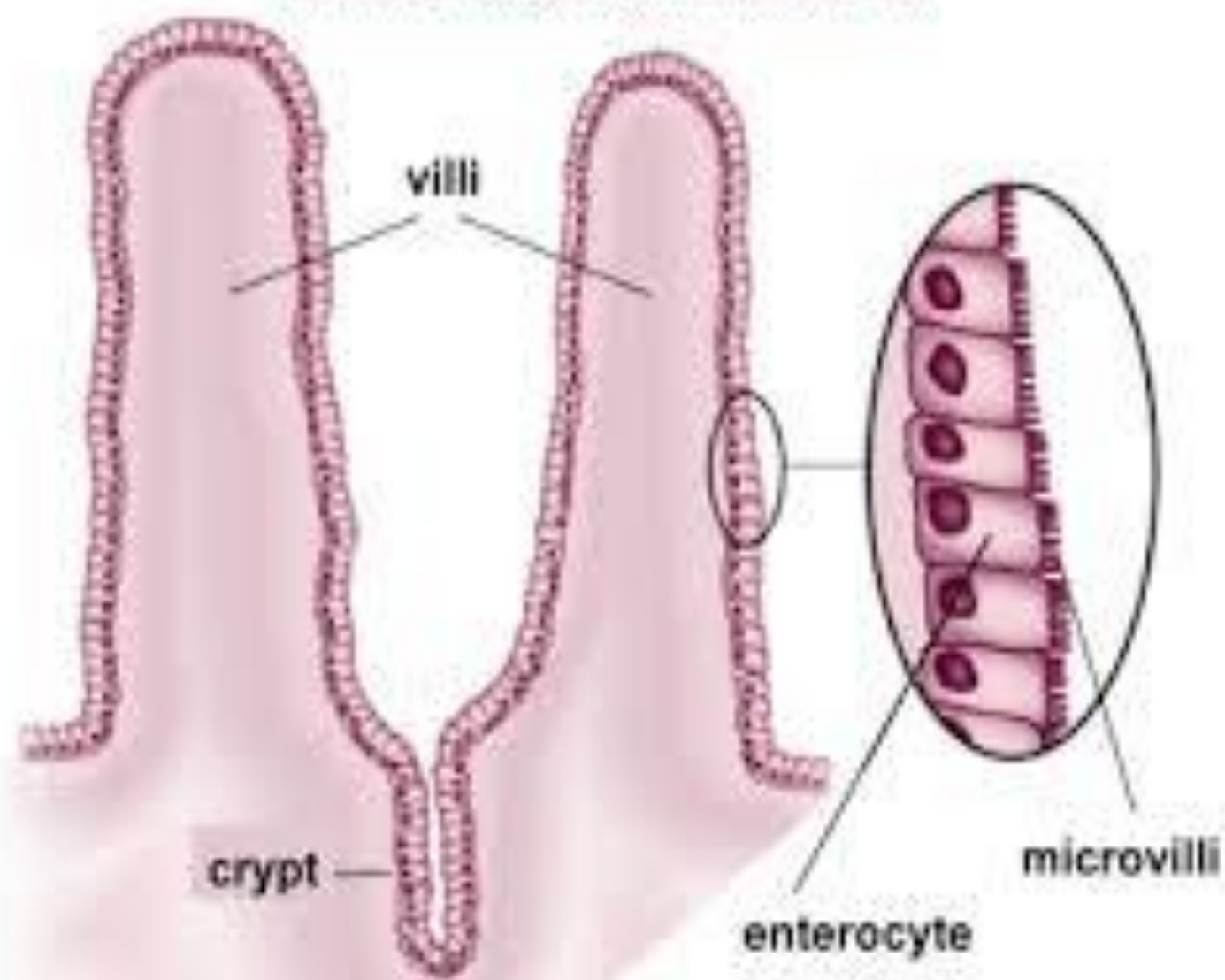


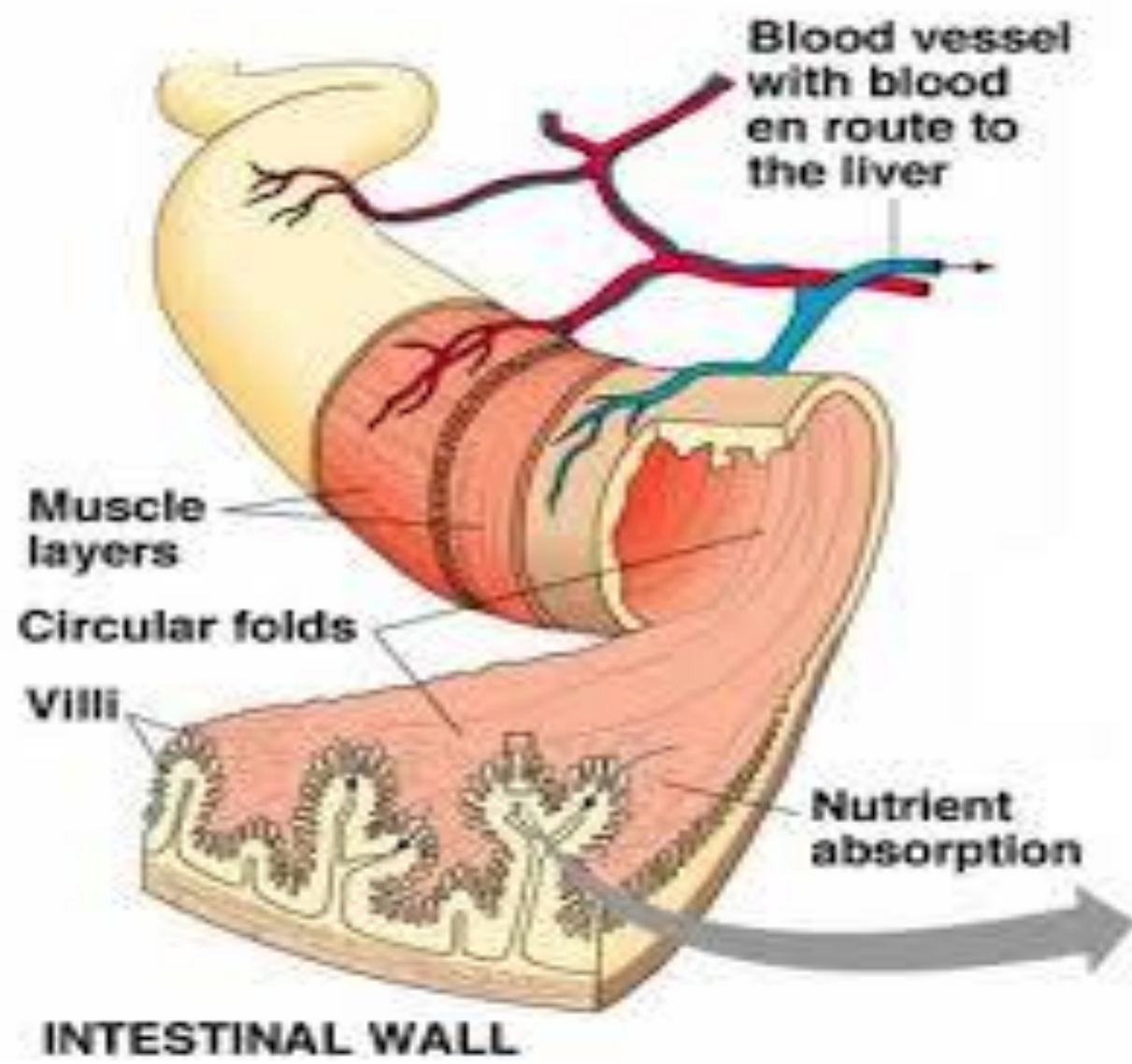
CROSS SECTION  
SMALL INTESTINE



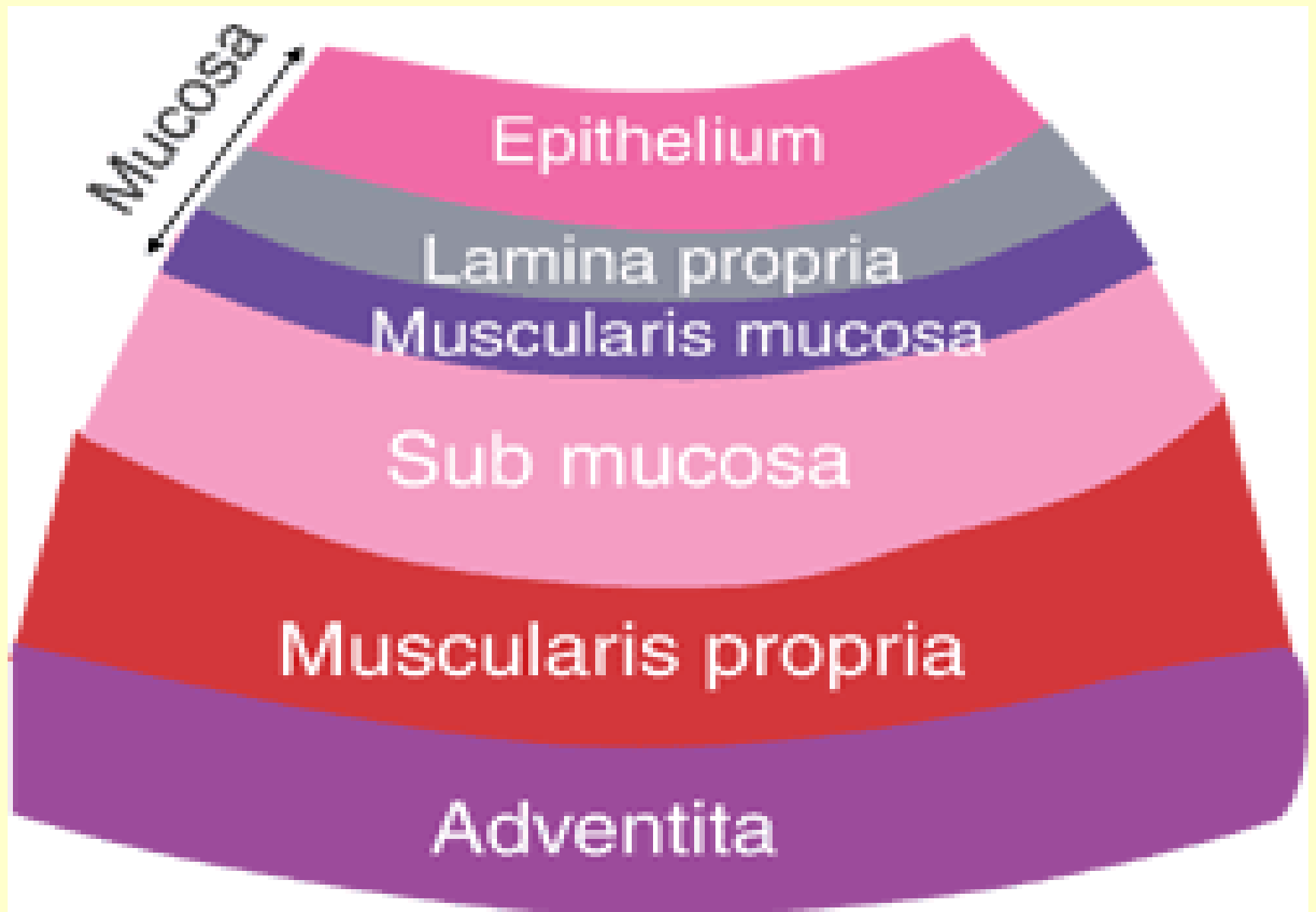
VILLI CROSS SECTION

lumen of small intestine

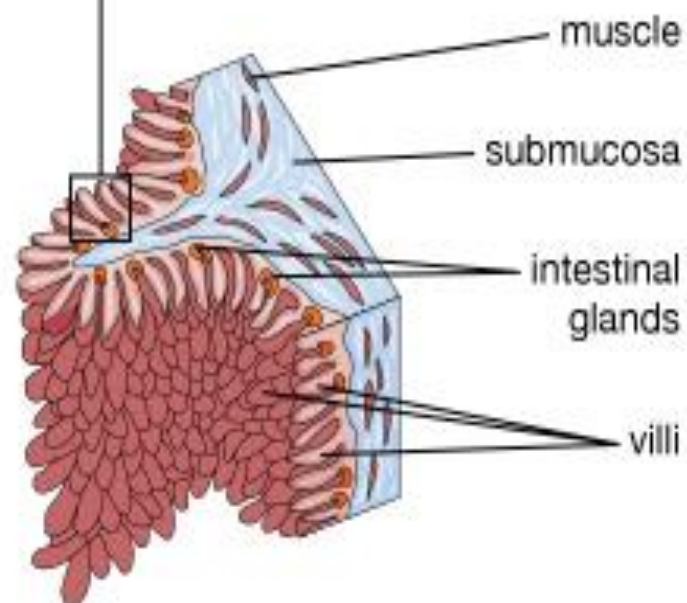
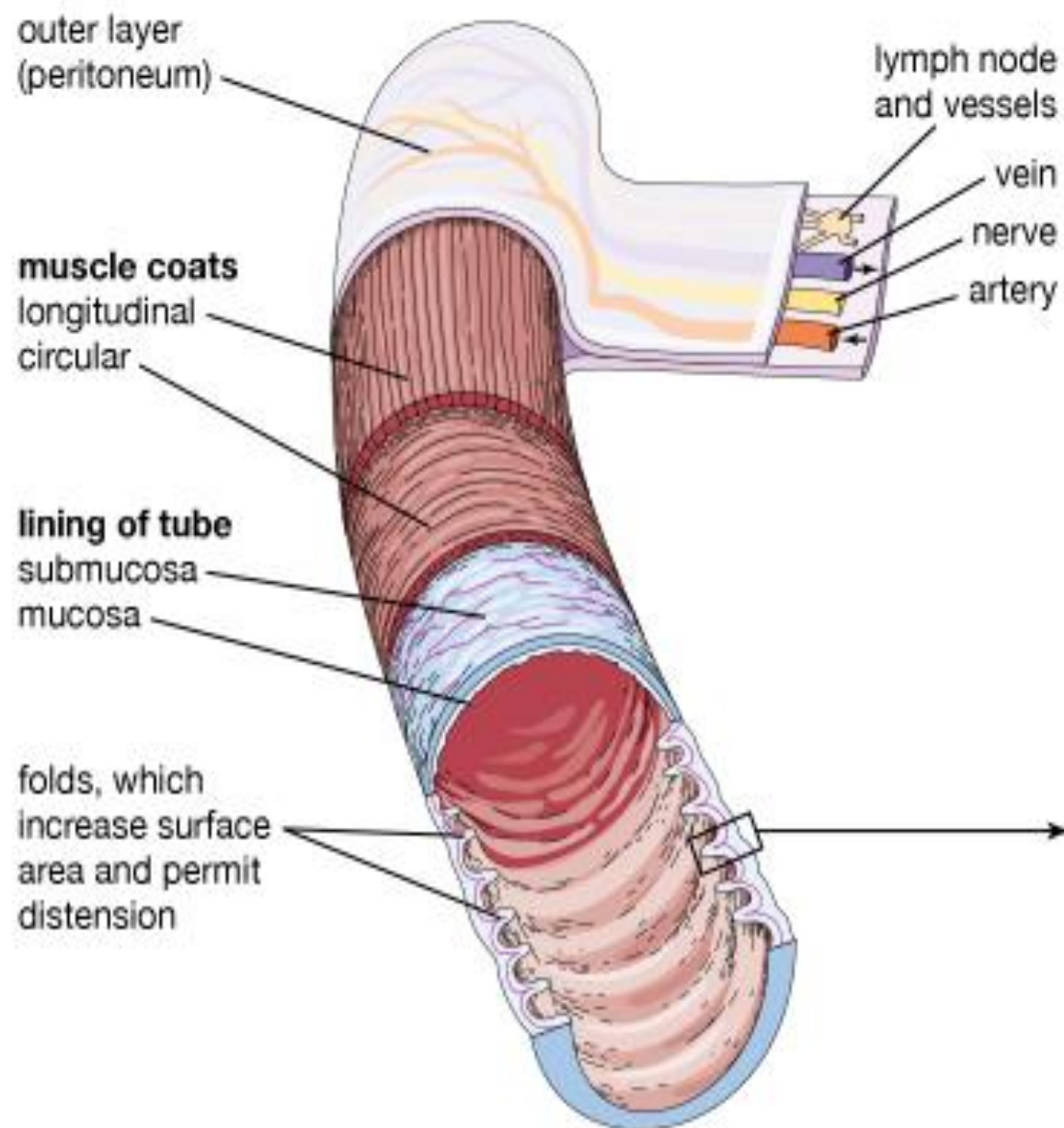


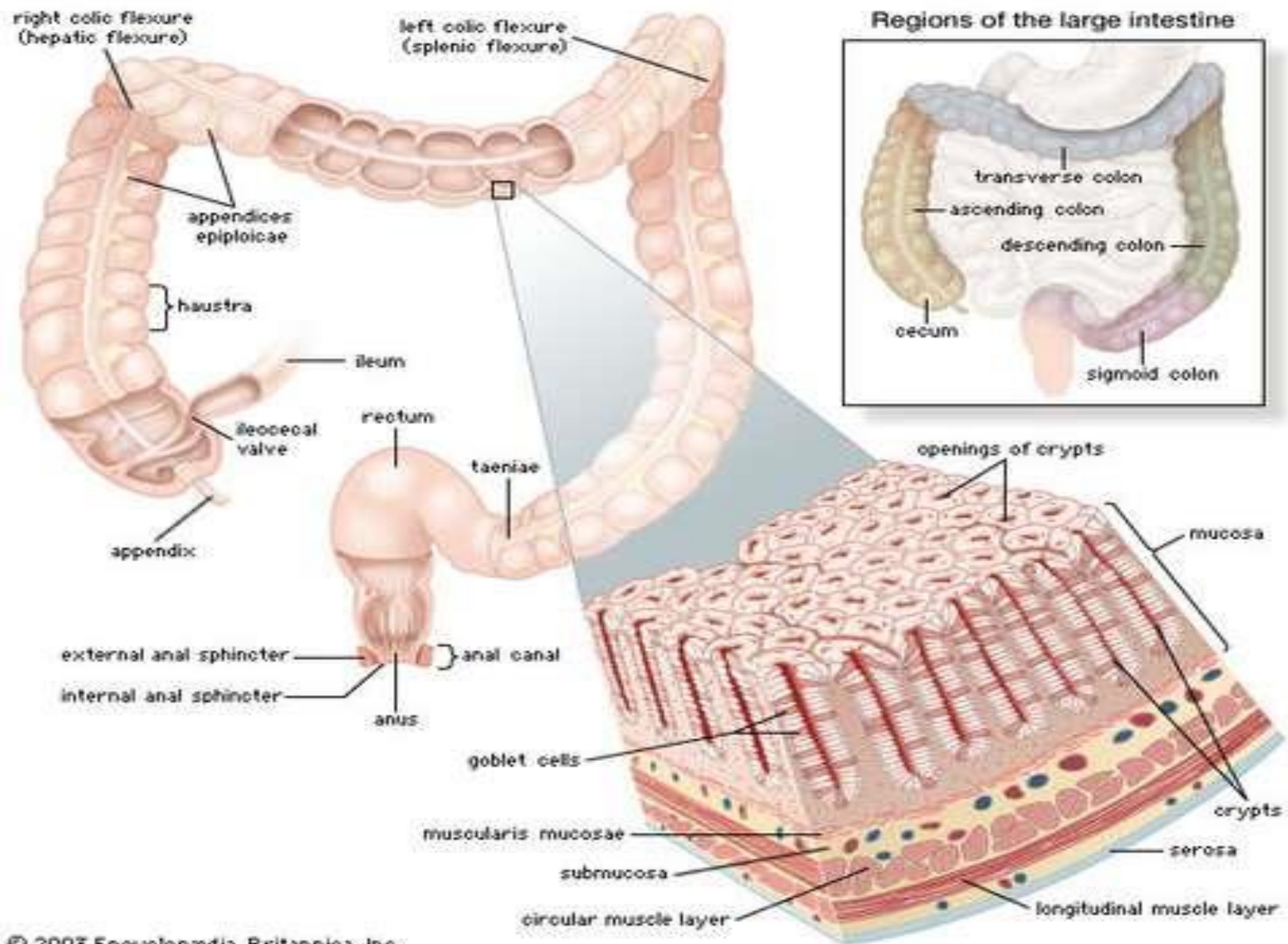




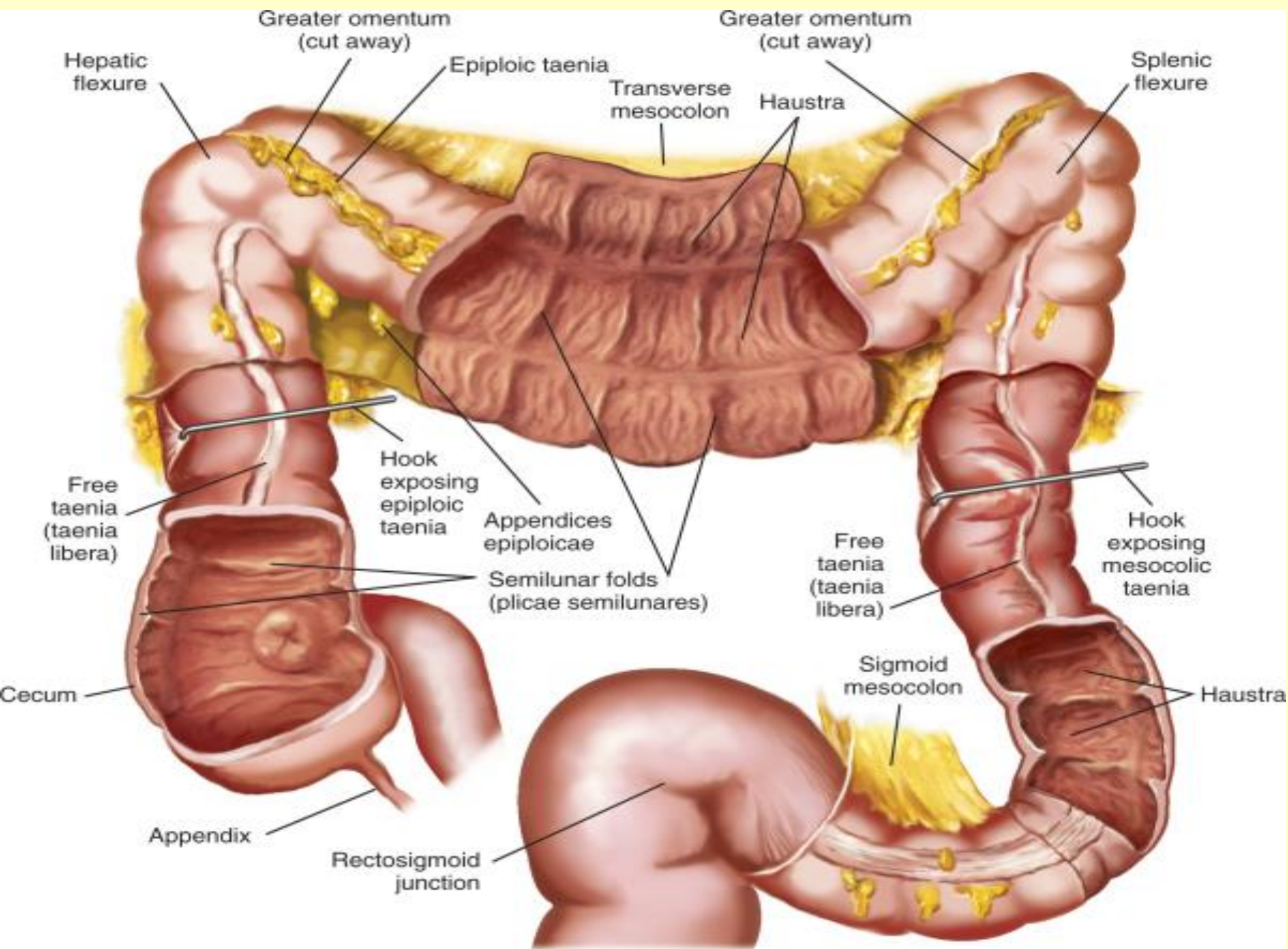


# Structure of the digestive tube



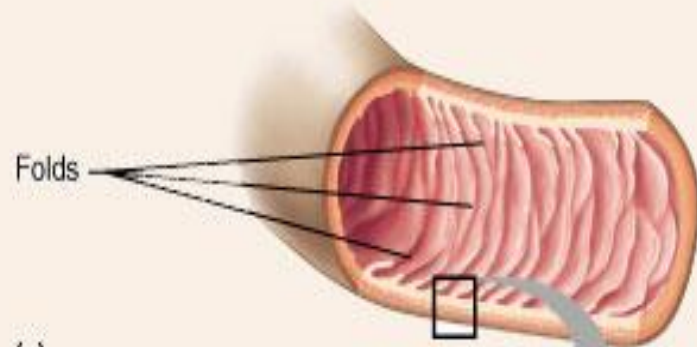




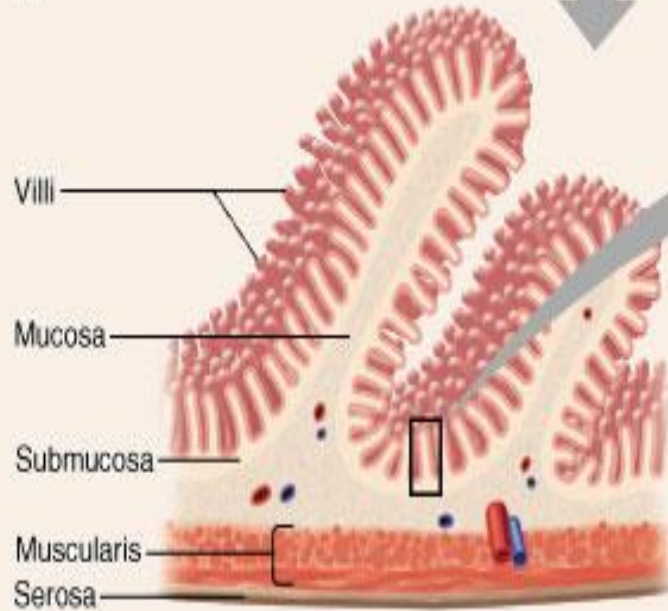


- The glands of the large intestine are minute tubular prolongations of the mucous membrane arranged perpendicularly, side by side, over its entire surface; they are longer, more numerous, and placed in much closer apposition than those of the small intestine; and they open by minute rounded orifices upon the surface, giving it a cribriform appearance.
- Each gland is lined by short columnar epithelium and contains numerous goblet cells.
- The solitary lymphatic nodules (*noduli lymphatic solitarii*) of the large intestine are most abundant in the caecum and vermiform process, but are irregularly scattered also over the rest of the intestine.
- They are similar to those of the small intestine.

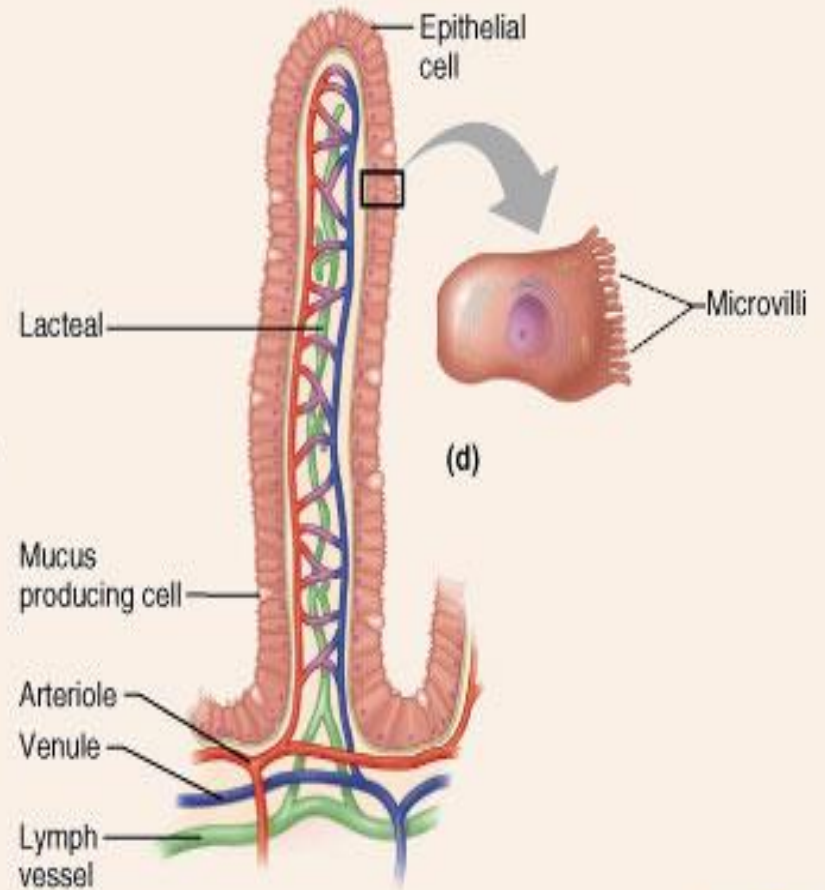




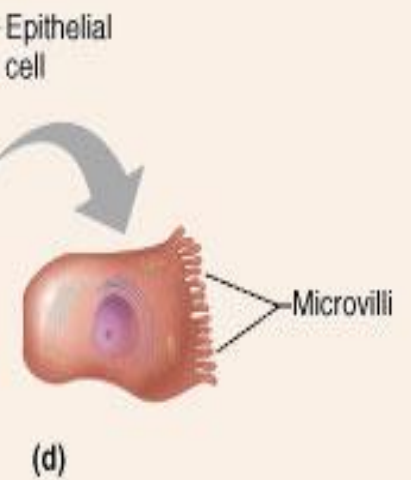
(a)



(b)

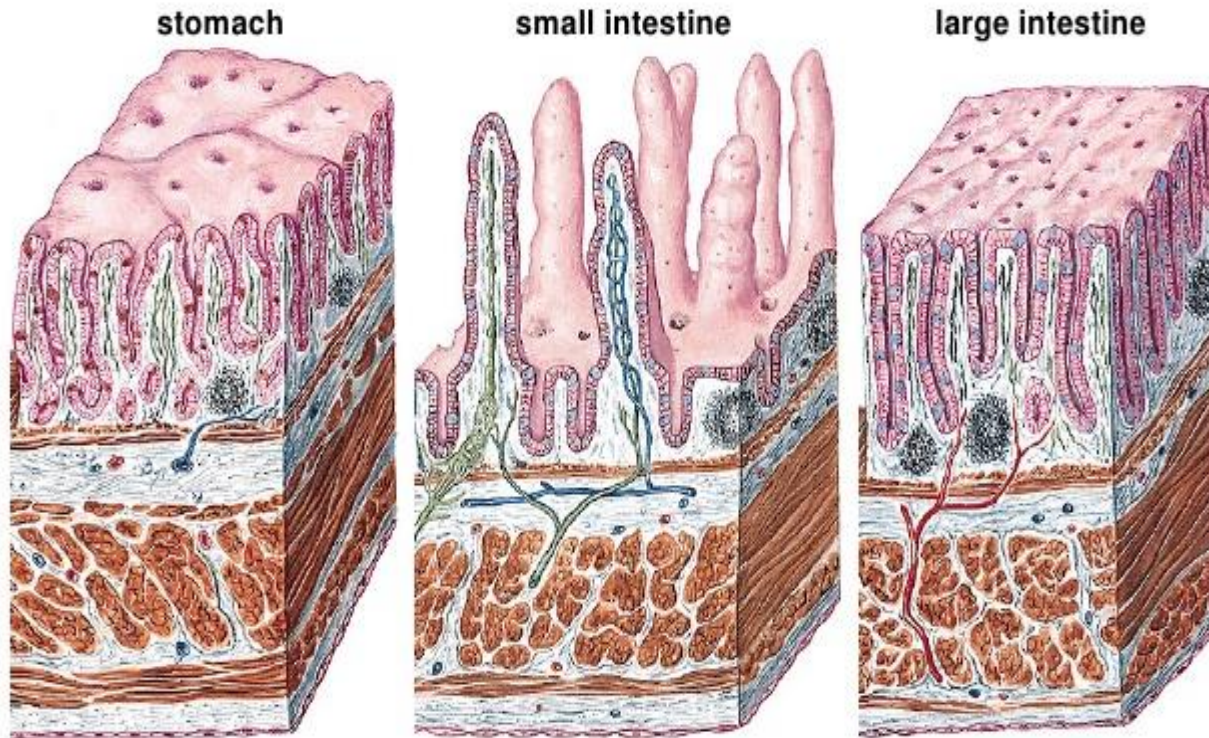


(c)

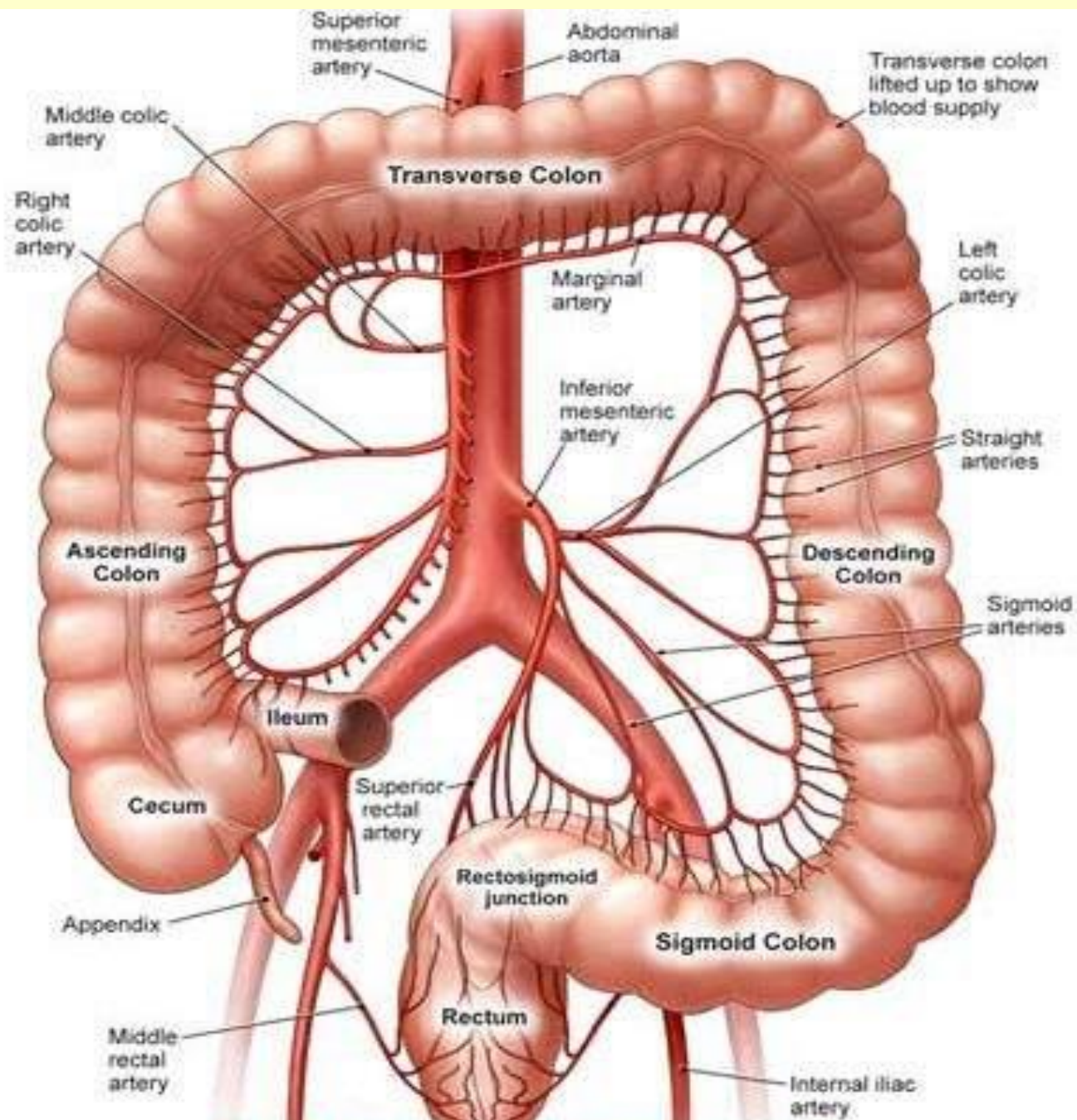


(d)

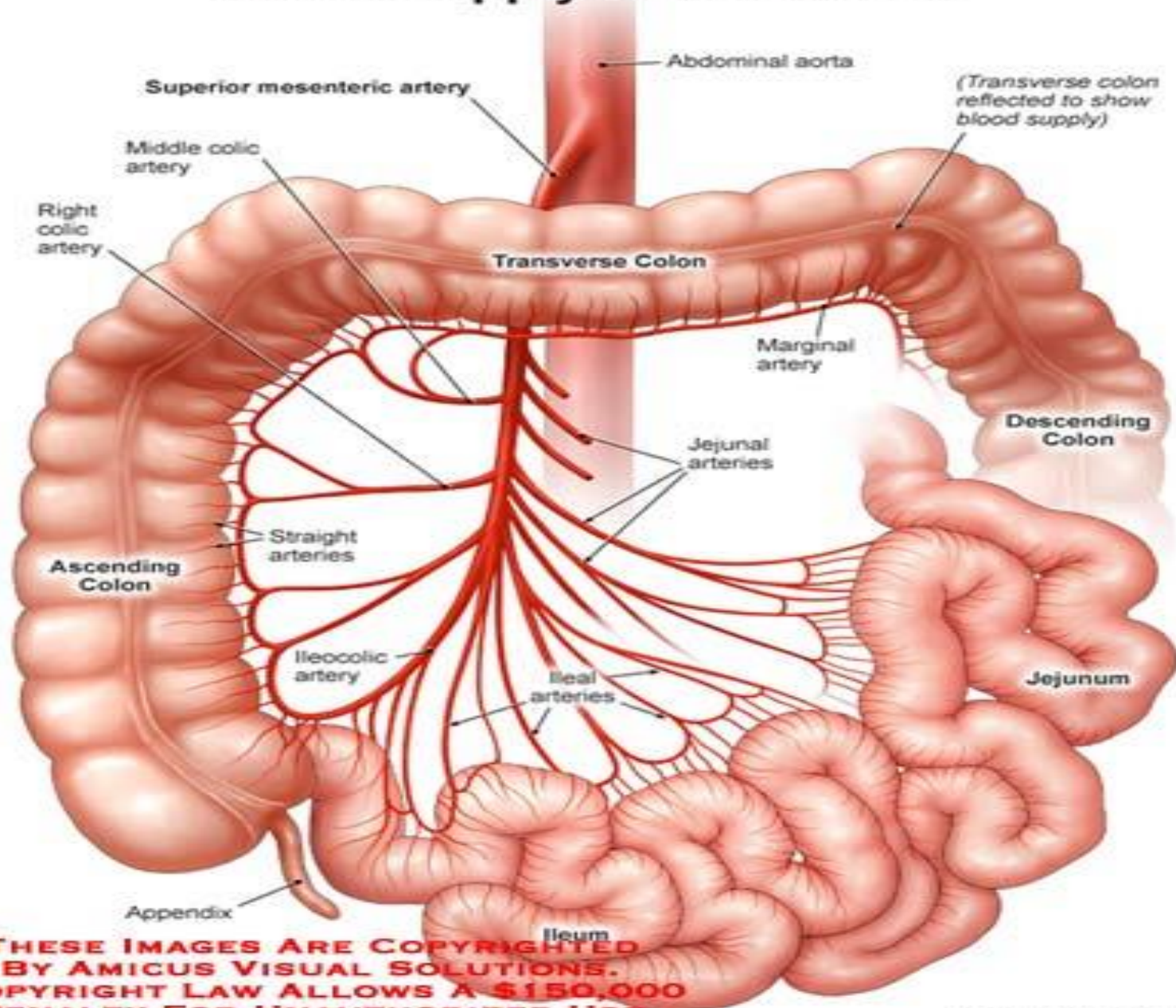
# Comparison of histology of stomach, small- and large intestines





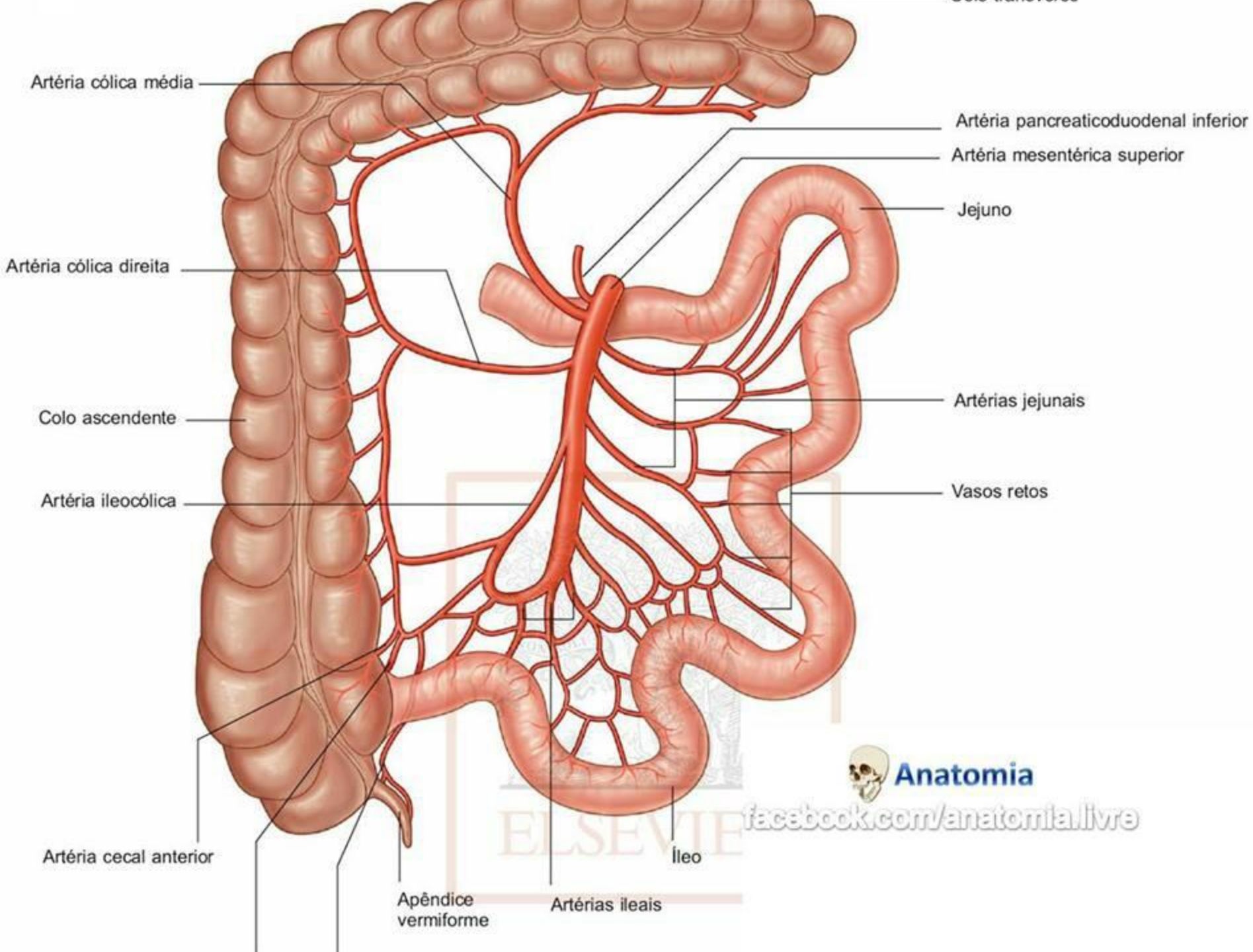


# Blood Supply to the Bowels

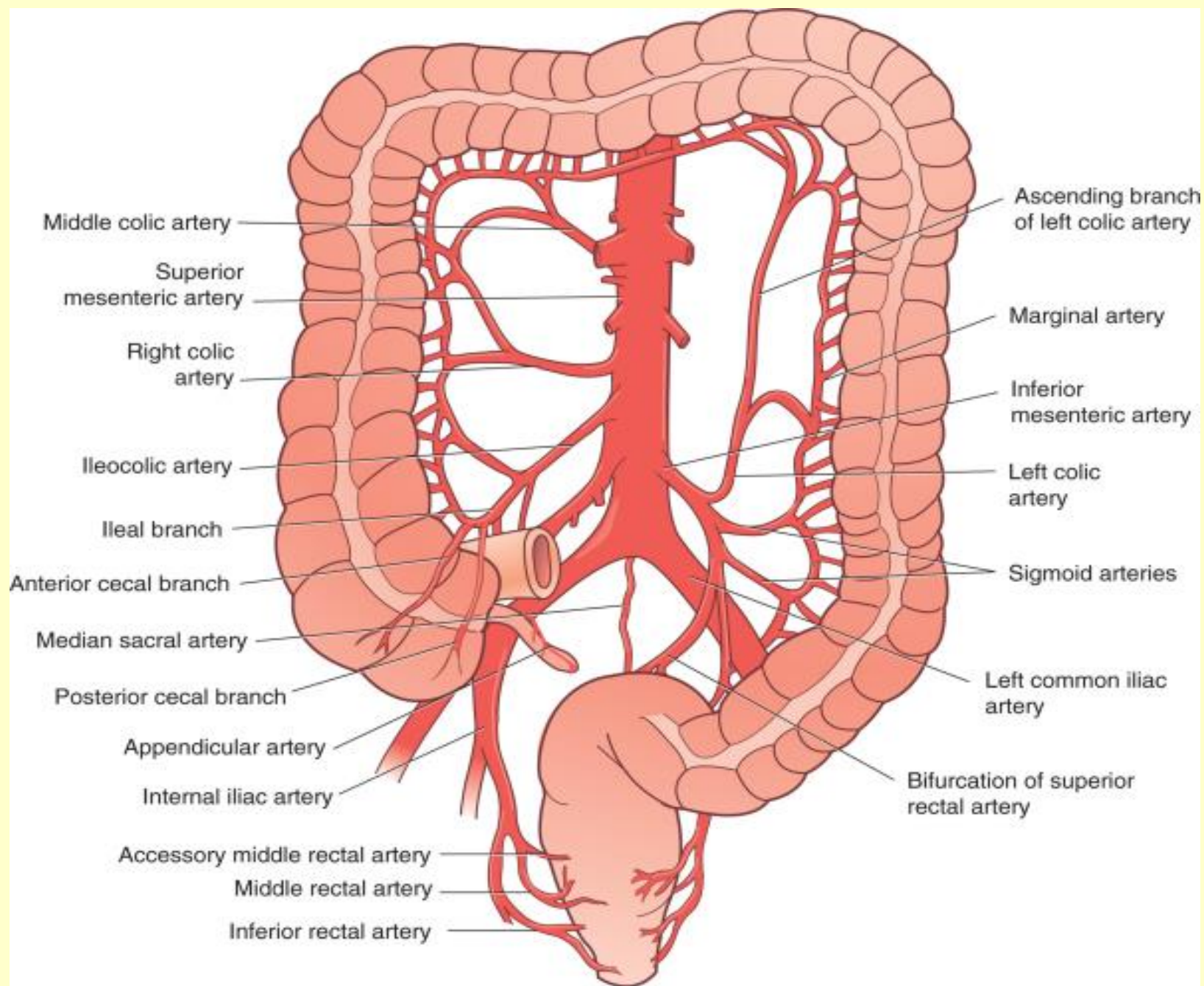


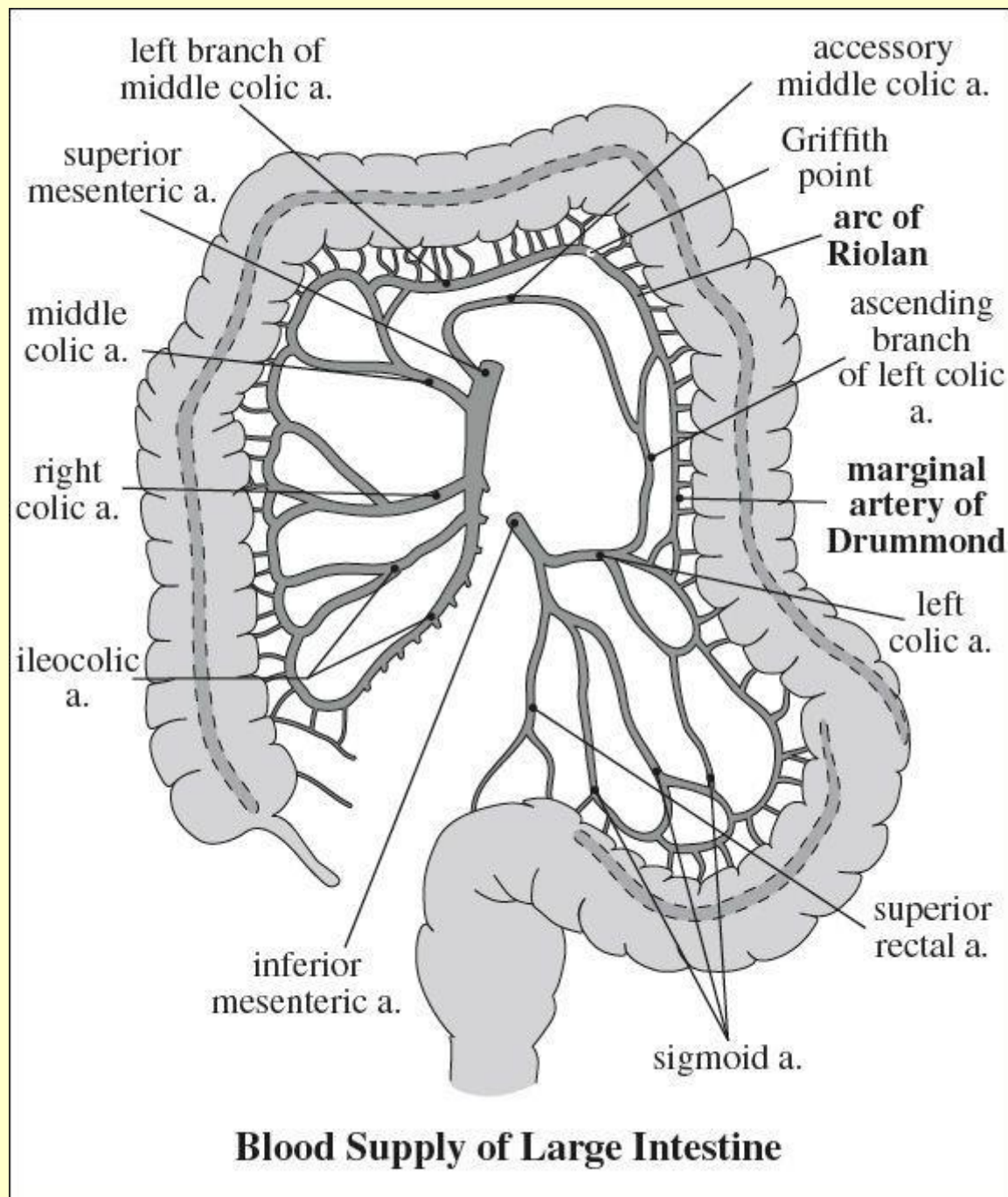
THESE IMAGES ARE COPYRIGHTED  
BY AMICUS VISUAL SOLUTIONS.  
COPYRIGHT LAW ALLOWS A \$150,000  
PENALTY FOR UNAUTHORIZED USE.  
CALL 1-877-303-1952 FOR LICENSE.













Branches of SMA:

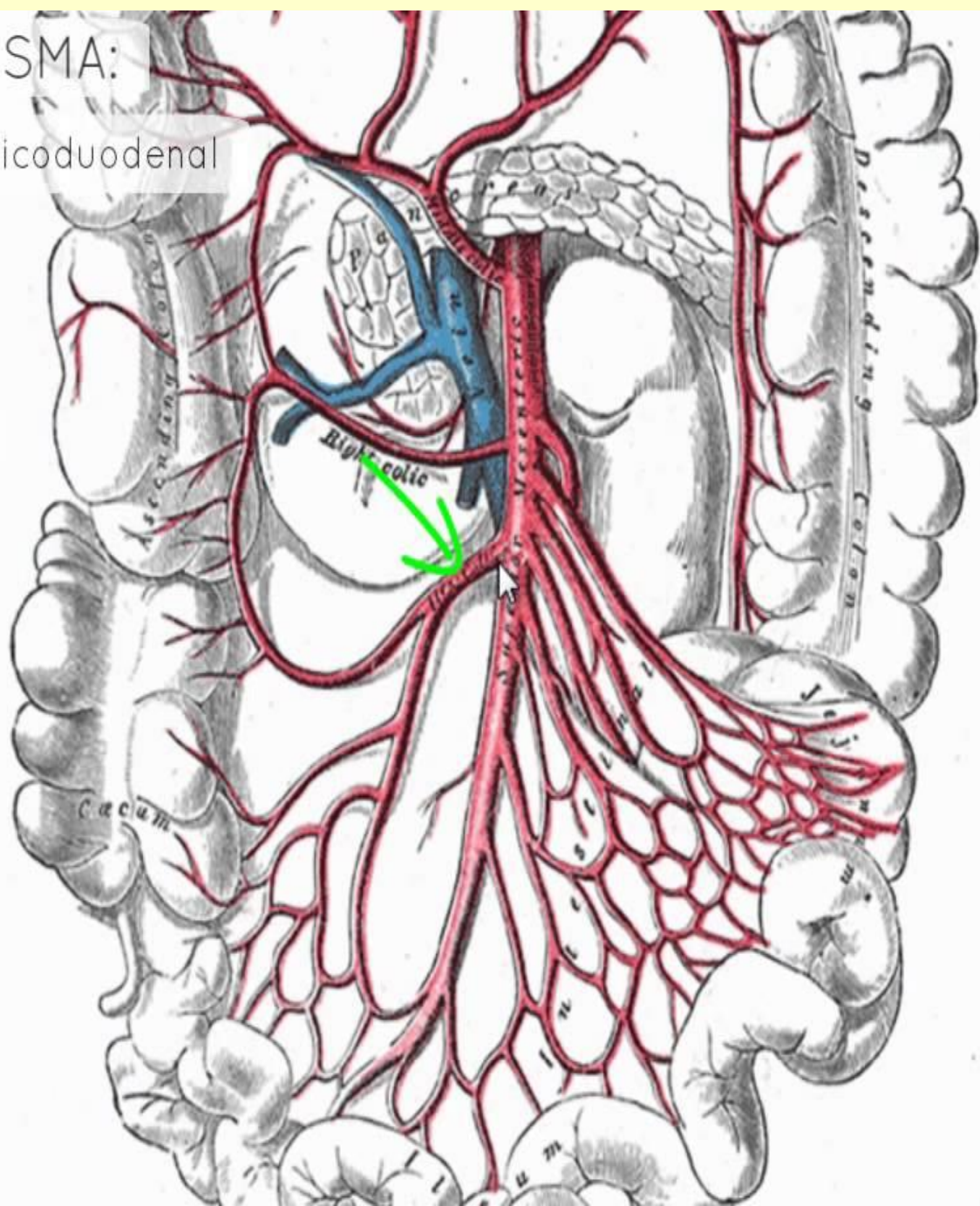
inferior pancreaticoduodenal

left side:

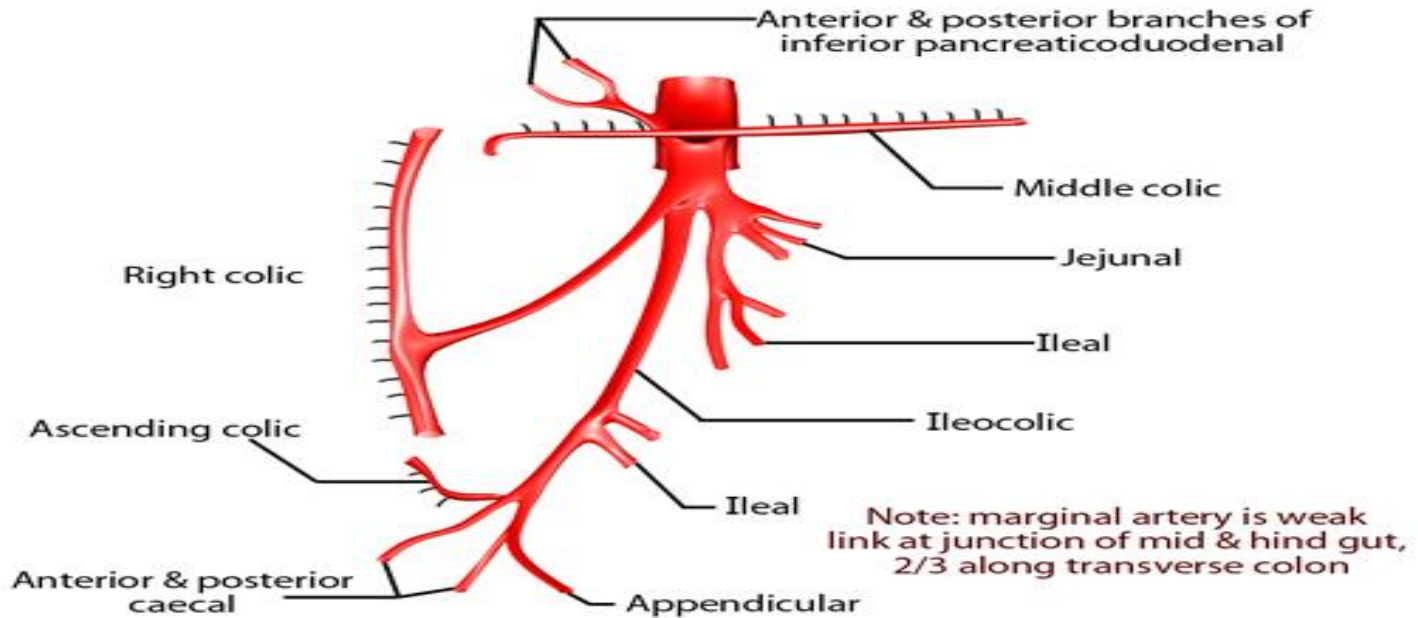
jejunal  
ileal

right side:

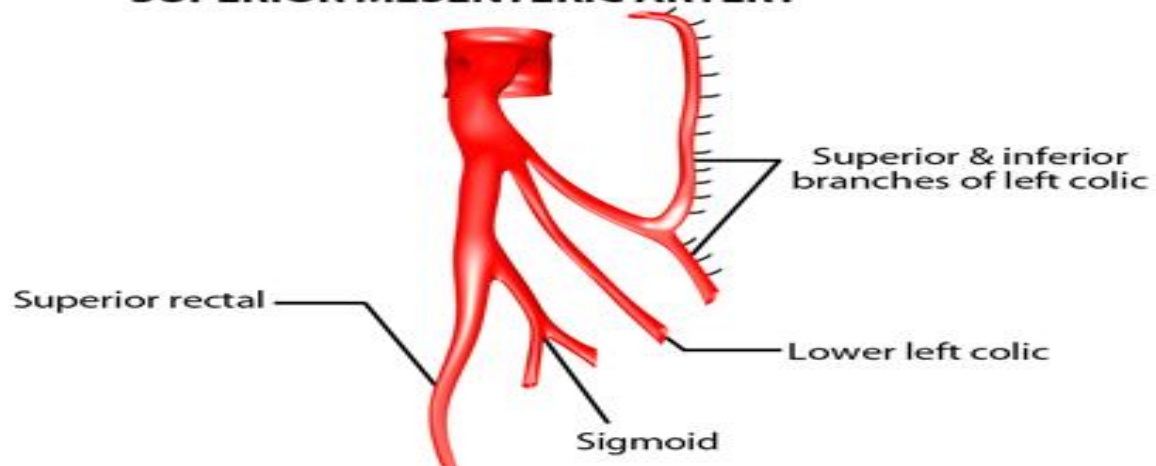
ileocolic



## SUPERIOR & INFERIOR MESENTERIC ARTERIES

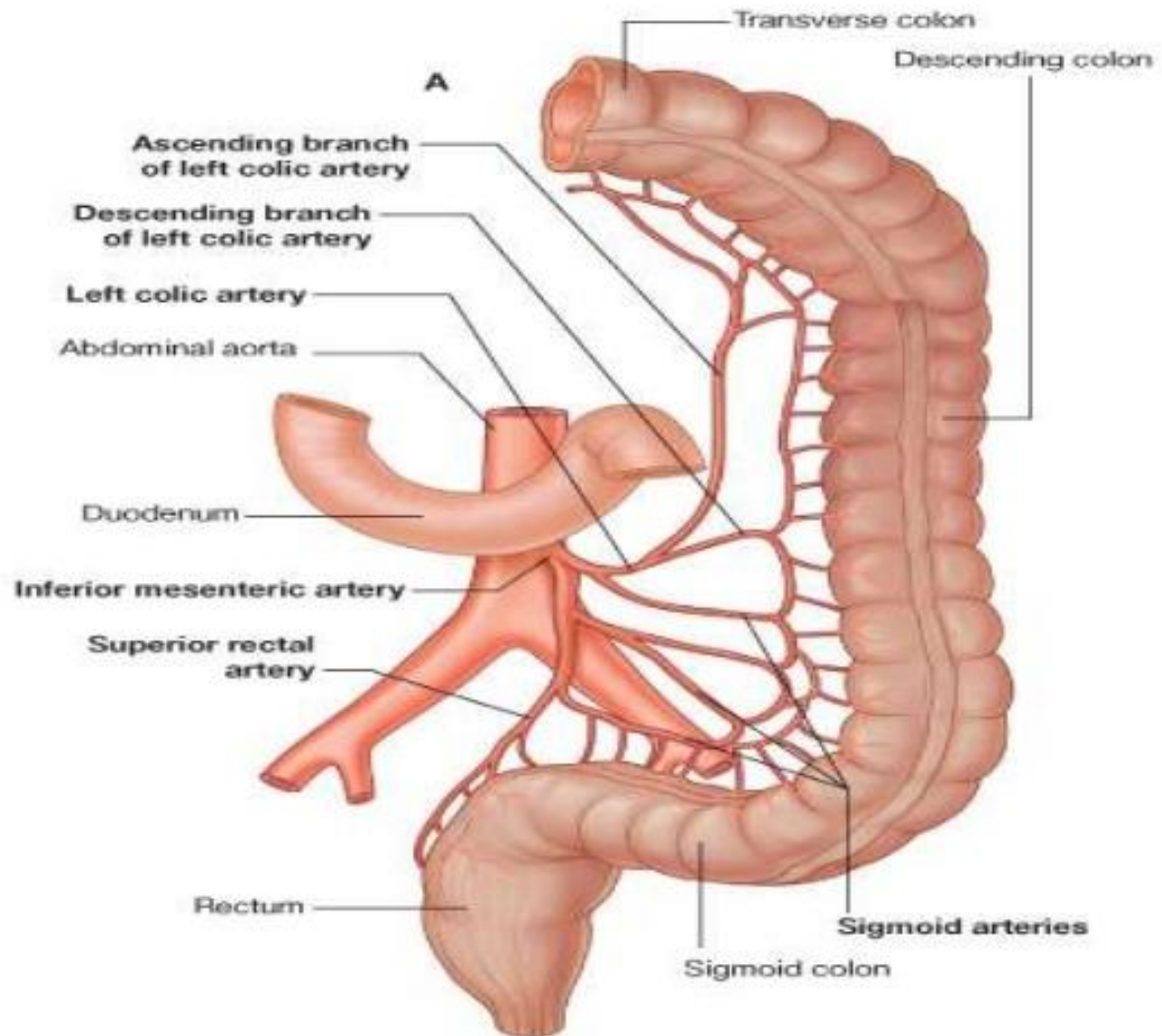


## SUPERIOR MESENTERIC ARTERY



## INFERIOR MESENTERIC ARTERY

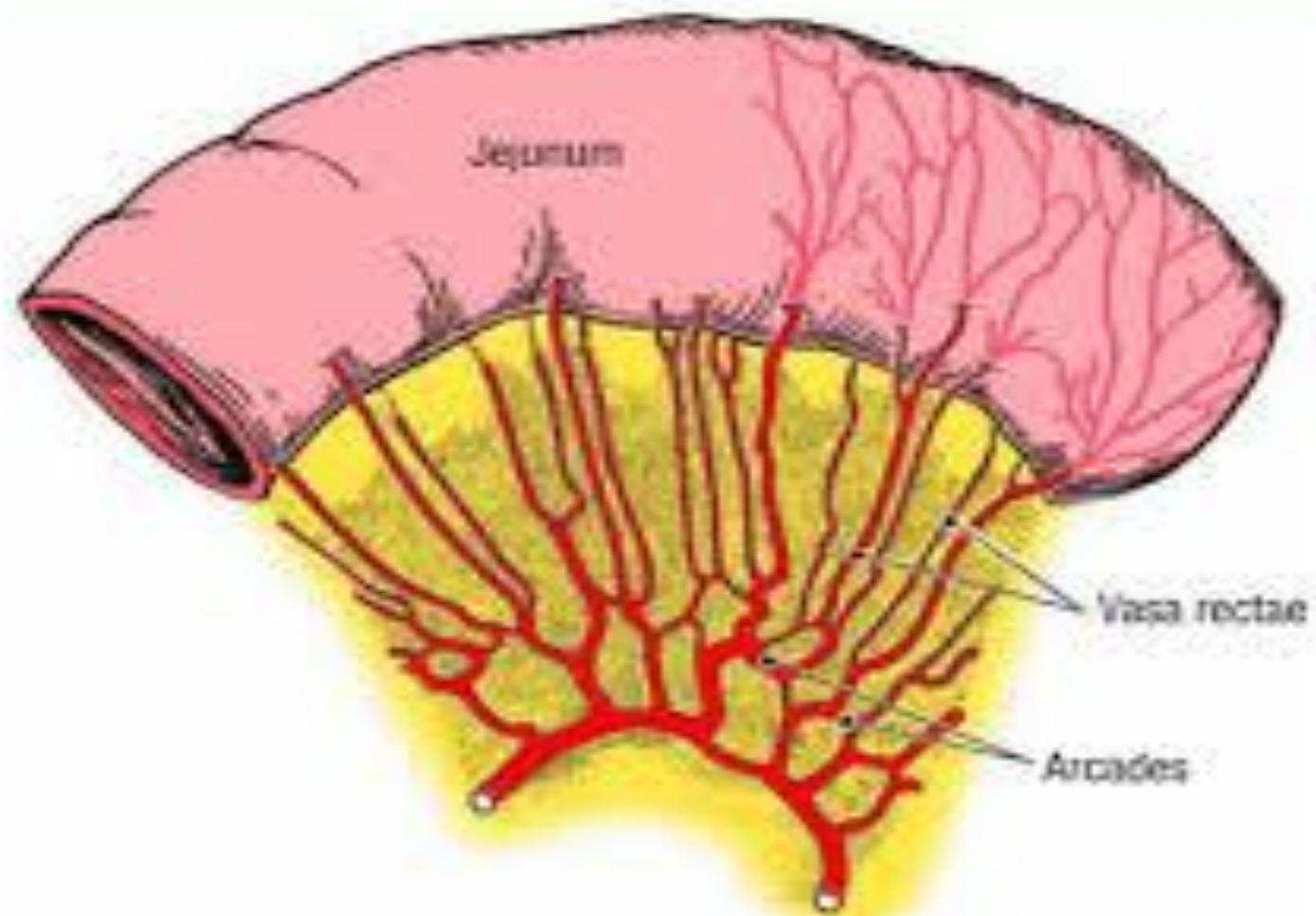
Copyright© www.gastrotraining.com. All rights reserved.

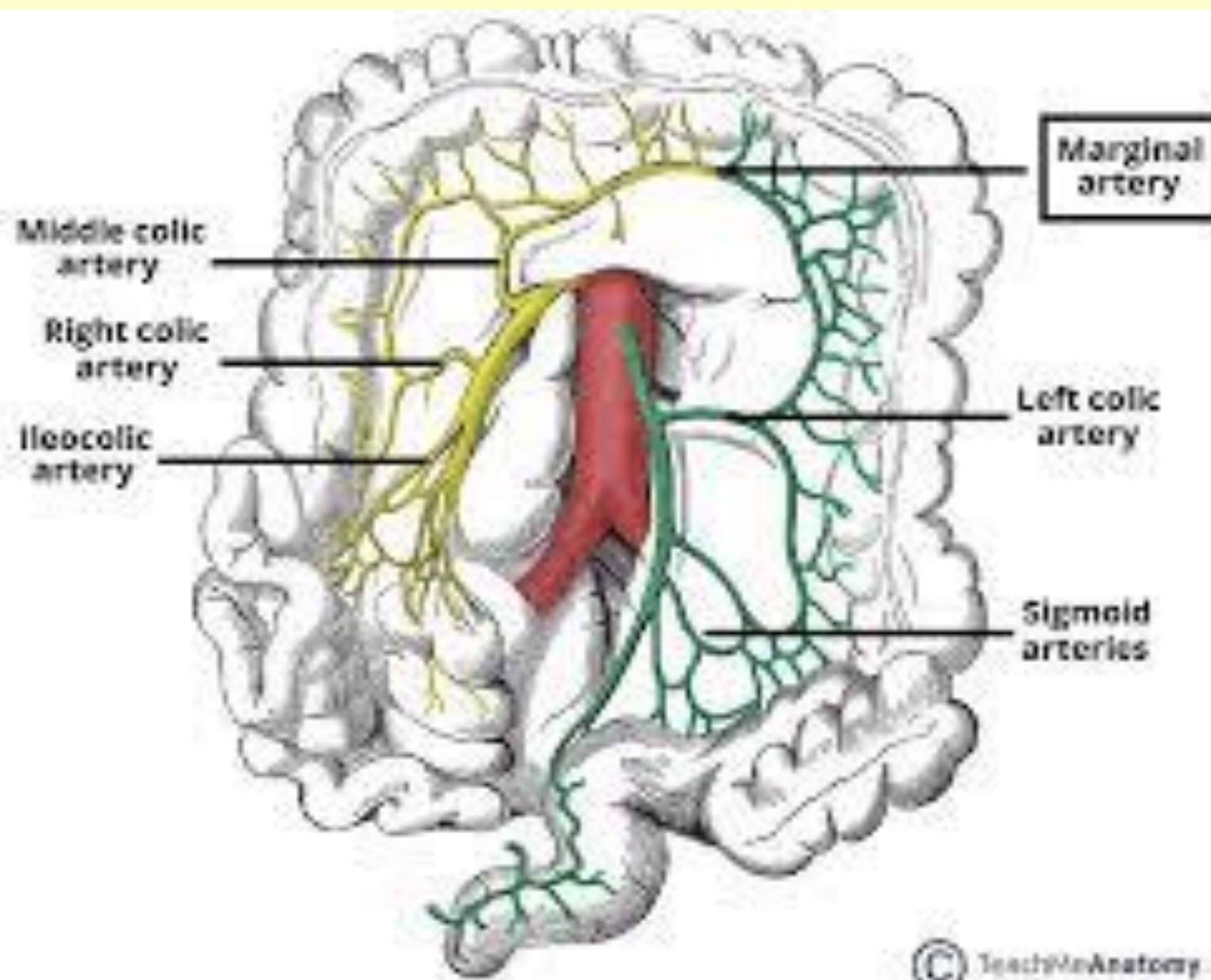


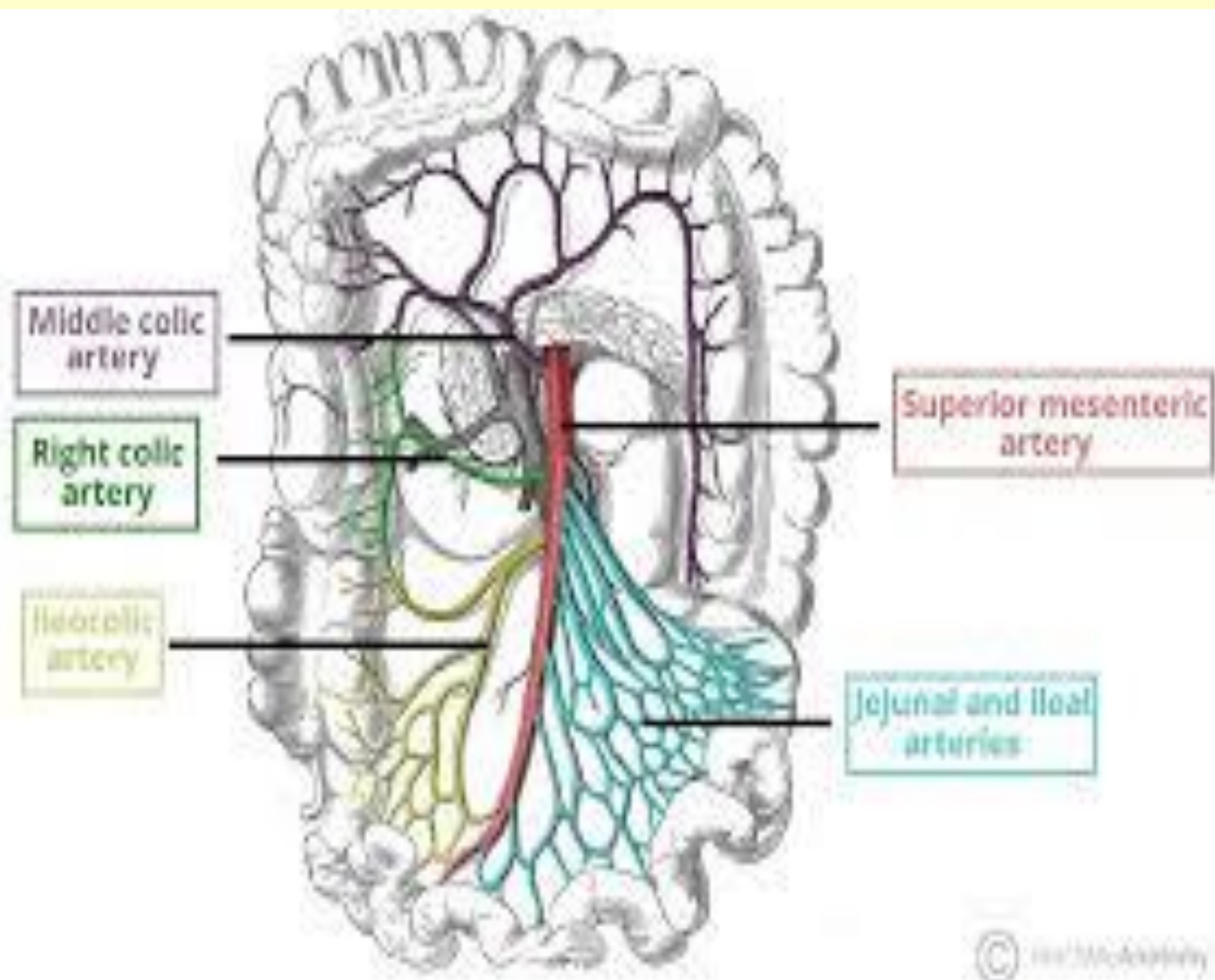


# Vessels and Nerves

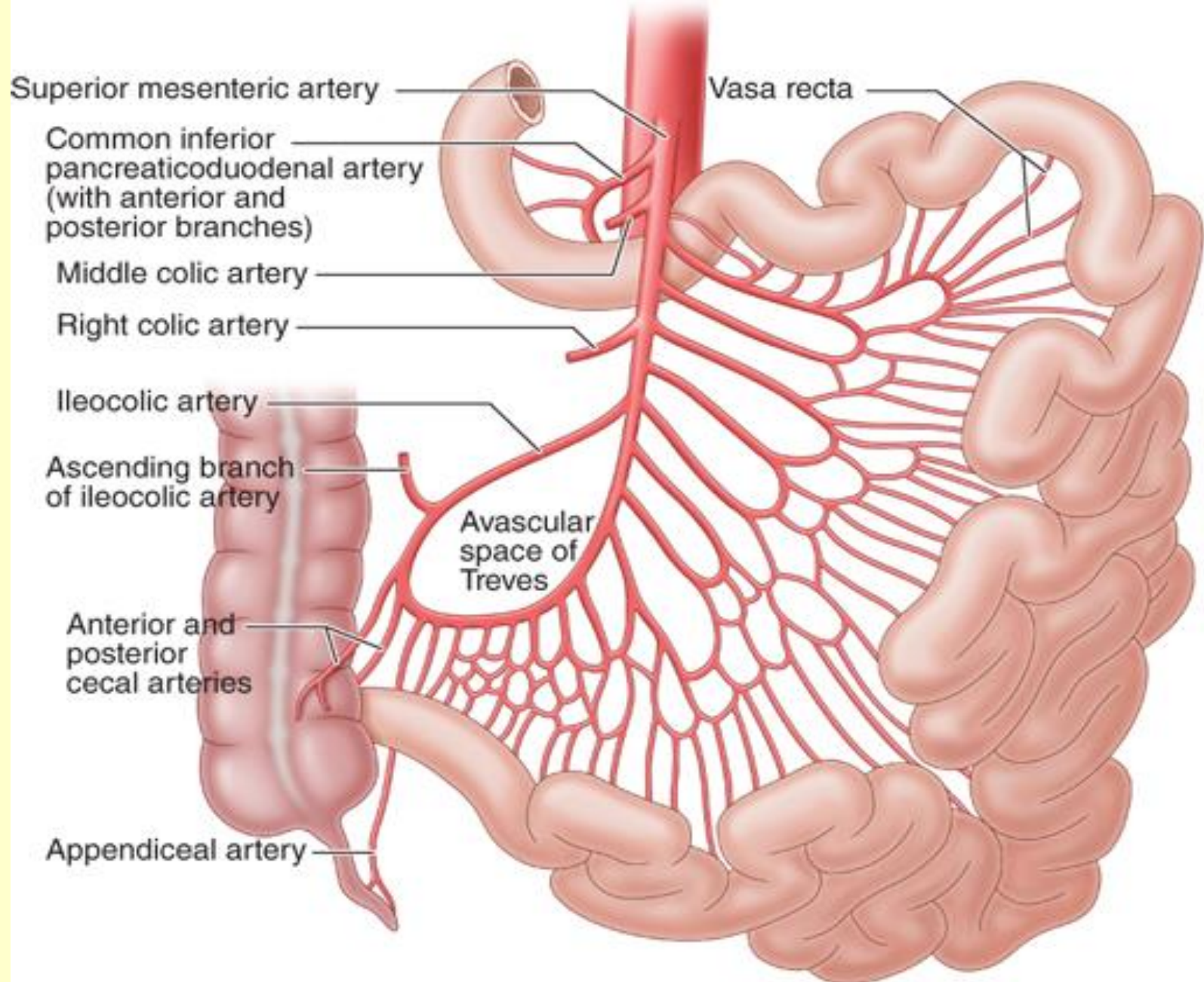
- The arteries supplying the colon are derived from the colic and sigmoid branches of the mesenteric arteries.
- They give off large branches, which ramify between and supply the muscular coats, and after dividing into small vessels in the submucous tissue, pass to the mucous membrane.
- The rectum is supplied by the superior hemorrhoidal branch of the inferior mesenteric, and the anal canal by the middle hemorrhoidal from the hypogastric, and the inferior hemorrhoidal from the internal pudendal artery.
- The superior hemorrhoidal, the continuation of the inferior mesenteric, divides into two branches, which run down either side of the rectum to within about 12.5 cm. of the anus; they here split up into about six branches which pierce the muscular coat and descend between it and the mucous membrane in a longitudinal direction, parallel with each other as far as the *Sphincter ani internus*, where they anastomose with the other hemorrhoidal arteries and form a series of loops around the anus.







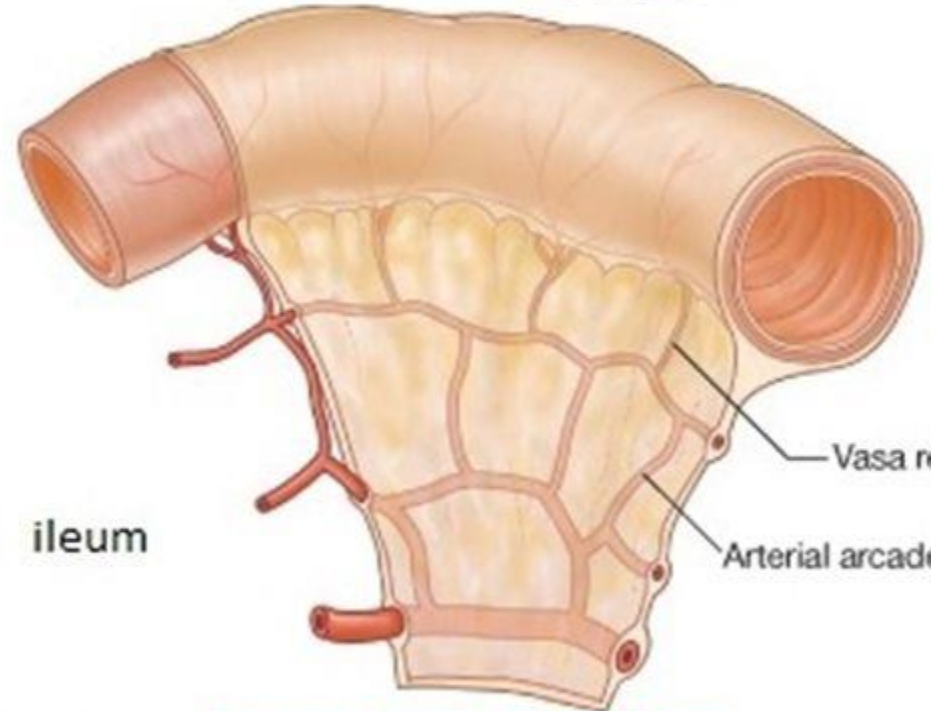
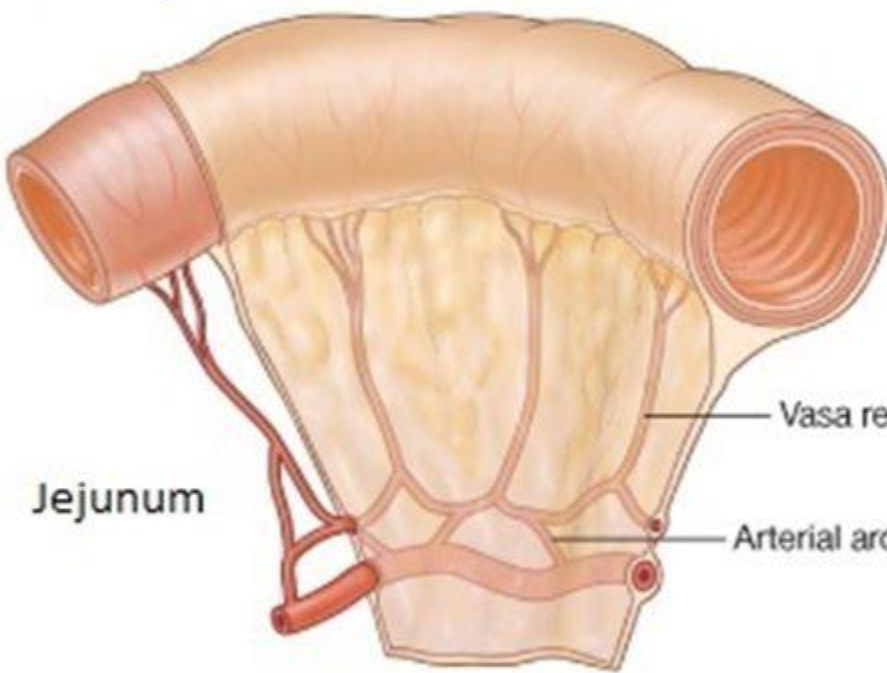






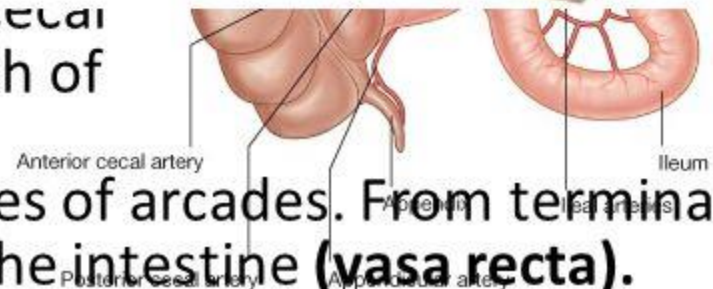
## B. Superior Mesenteric Artery

It supplies distal part of duodenum, jejunum, ileum, cecum, appendix, ascending colon, and right 2/3 transverse colon. It runs downward & to the right behind neck of pancreas and in front of 3<sup>rd</sup> part of duodenum. It continues downward between layers of mesentery of small intestine.

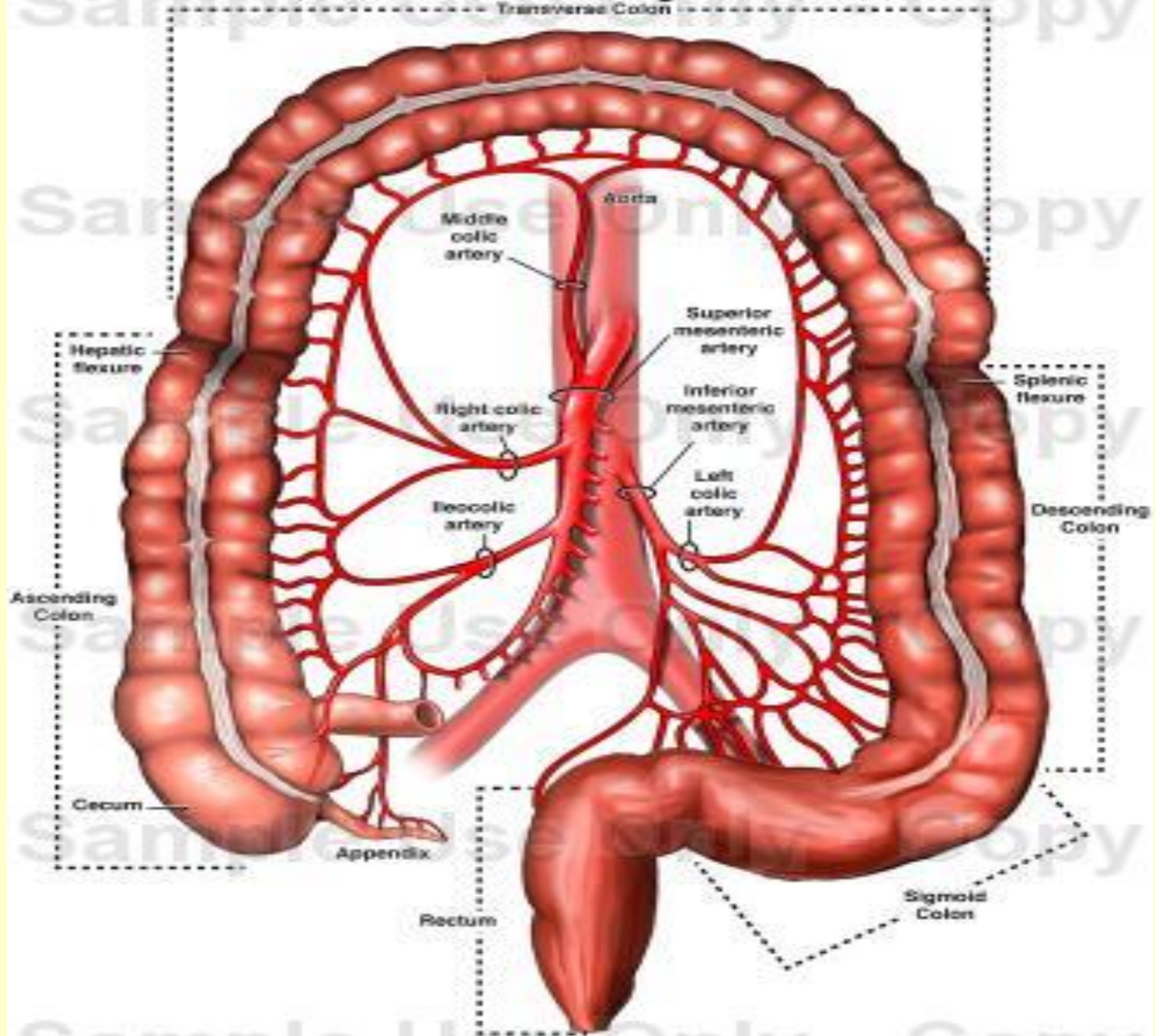


that gives rise to anterior & posterior cecal arteries; appendicular artery is a branch of posterior cecal artery.

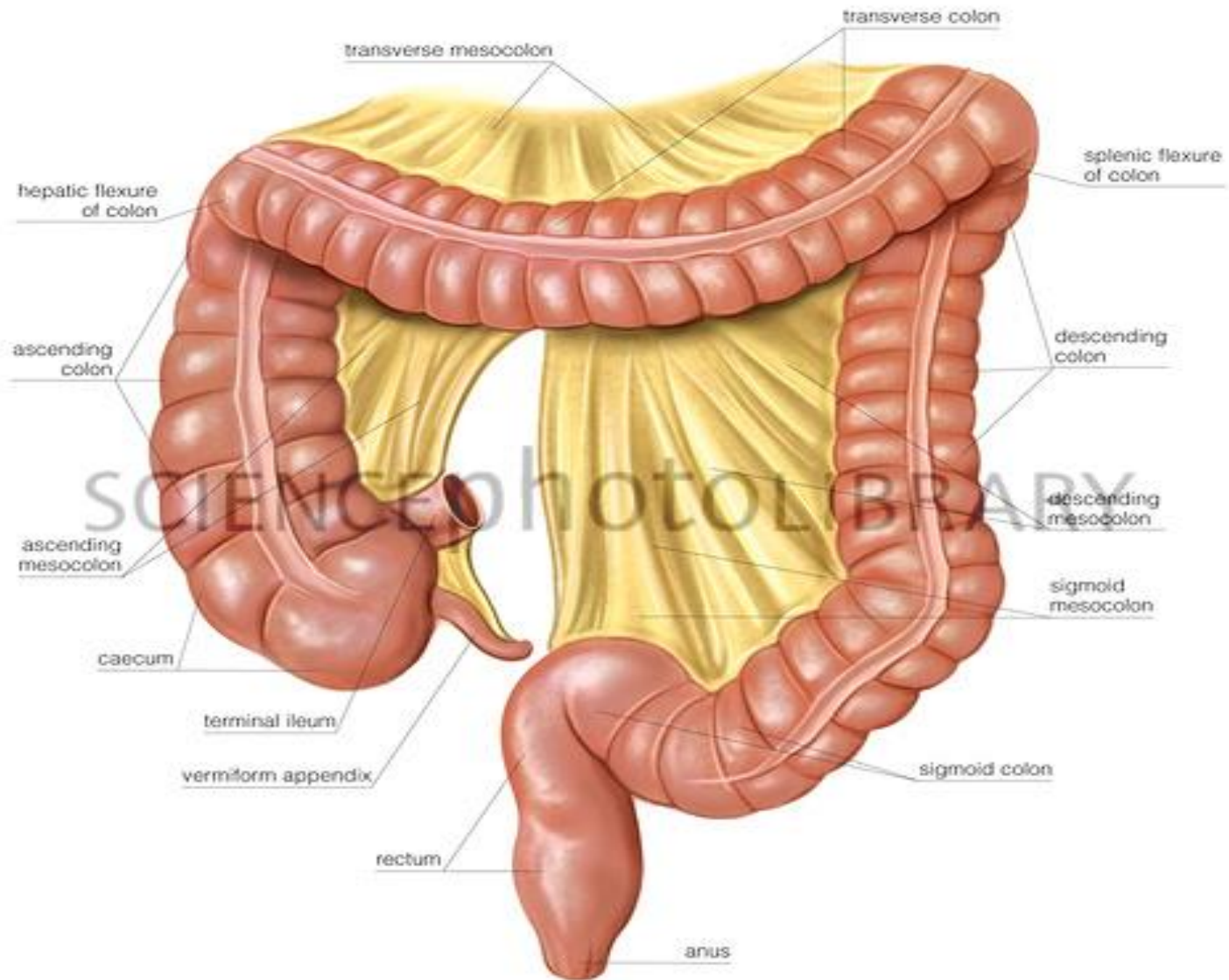
**Jejunal and ileal branches:** form a series of arcades. From terminal arcades, small straight vessels supply the intestine (**vasa recta**).

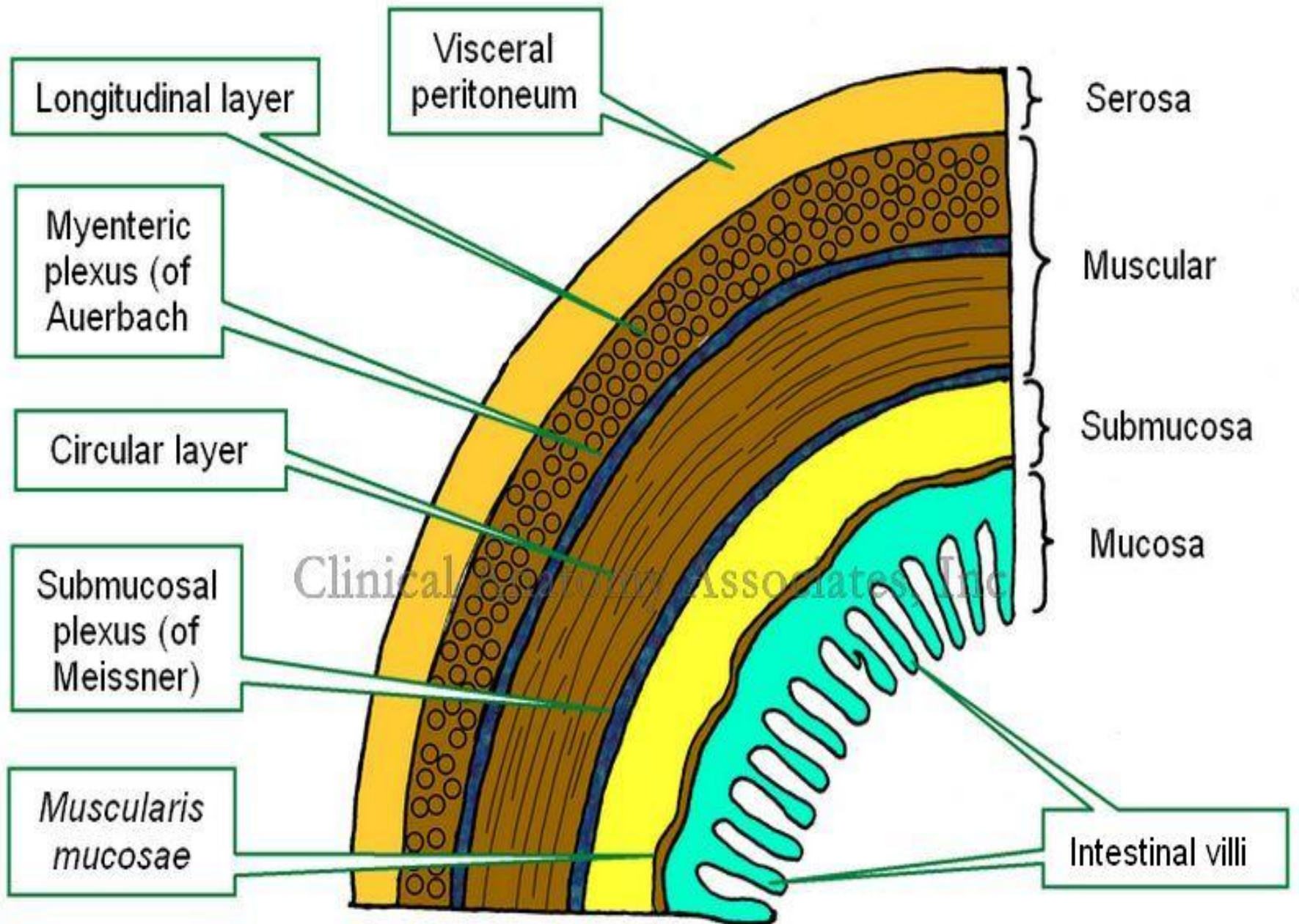


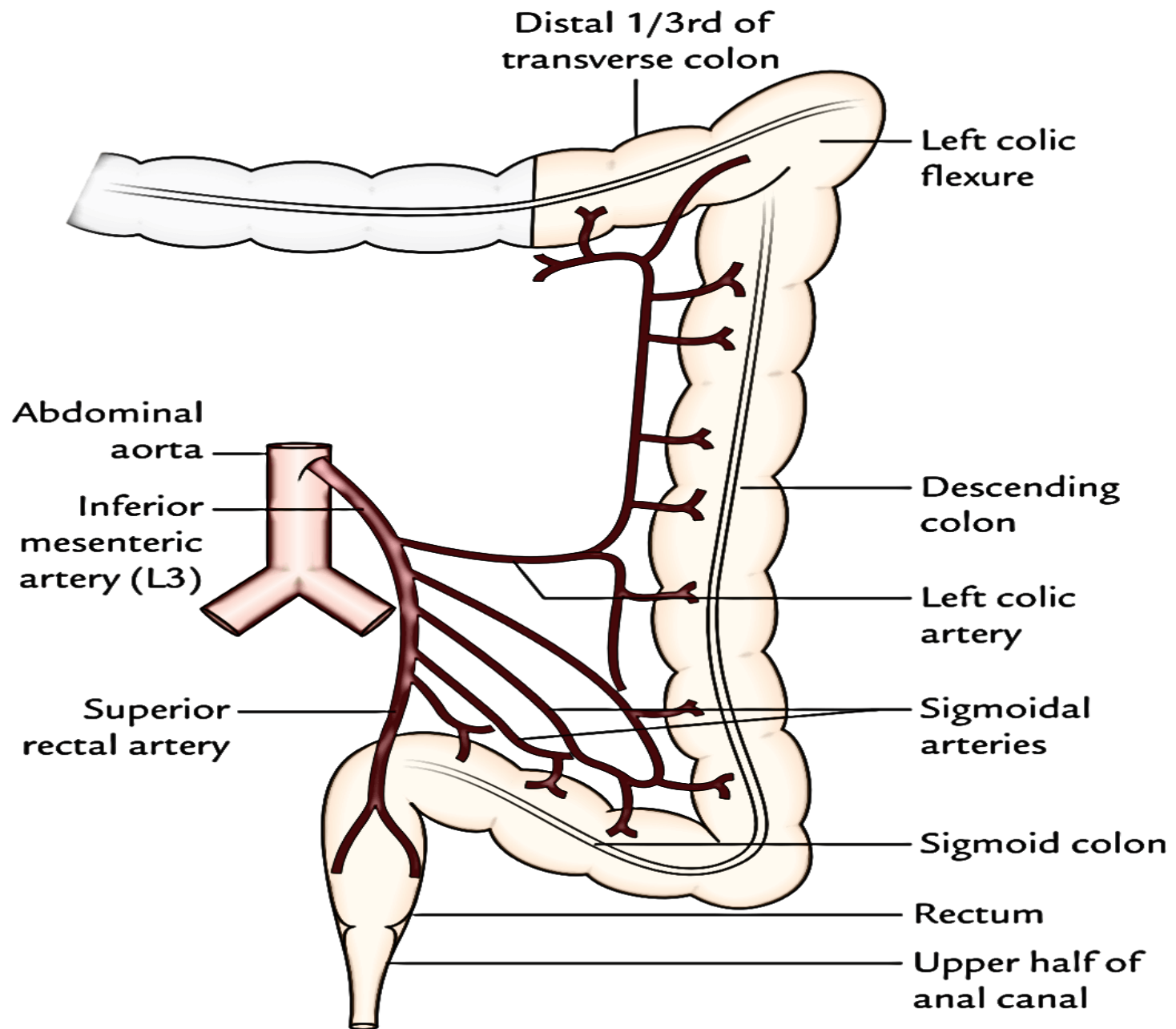
## Vasculature of Large Intestine



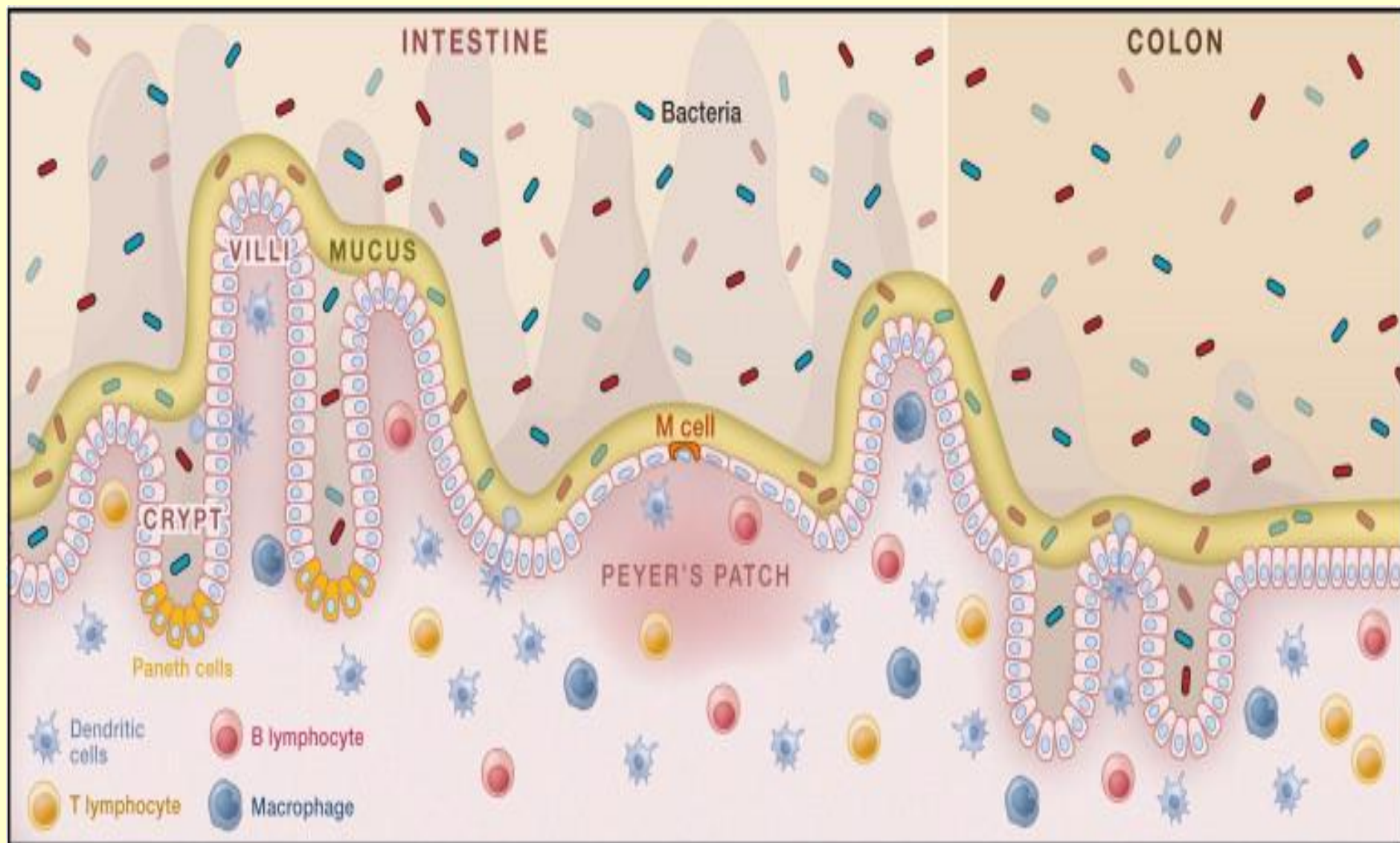


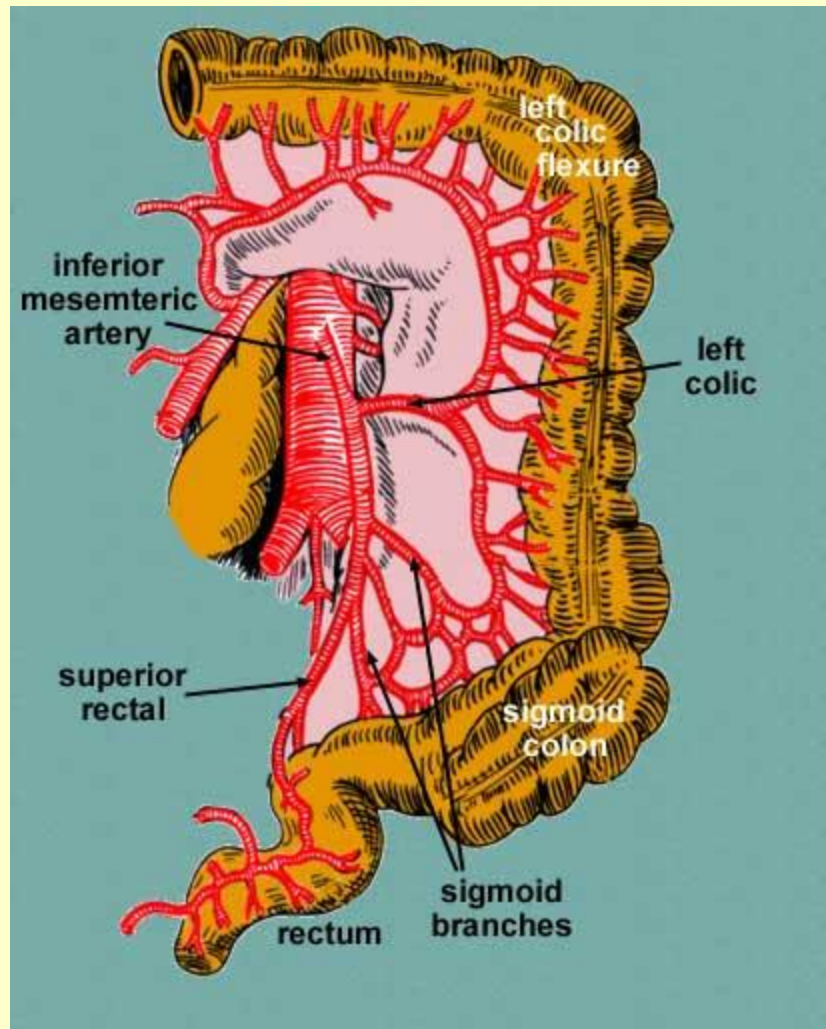


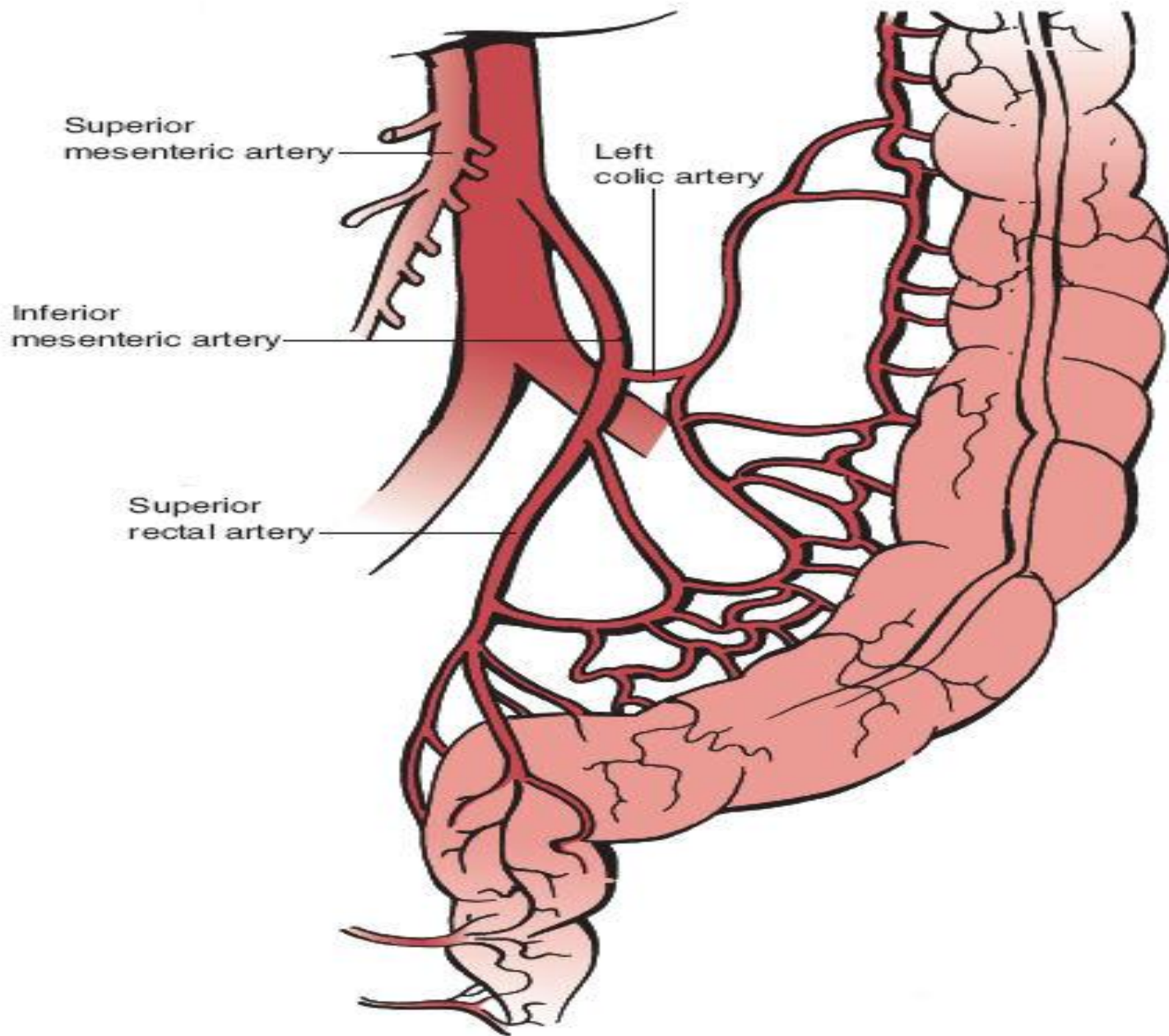






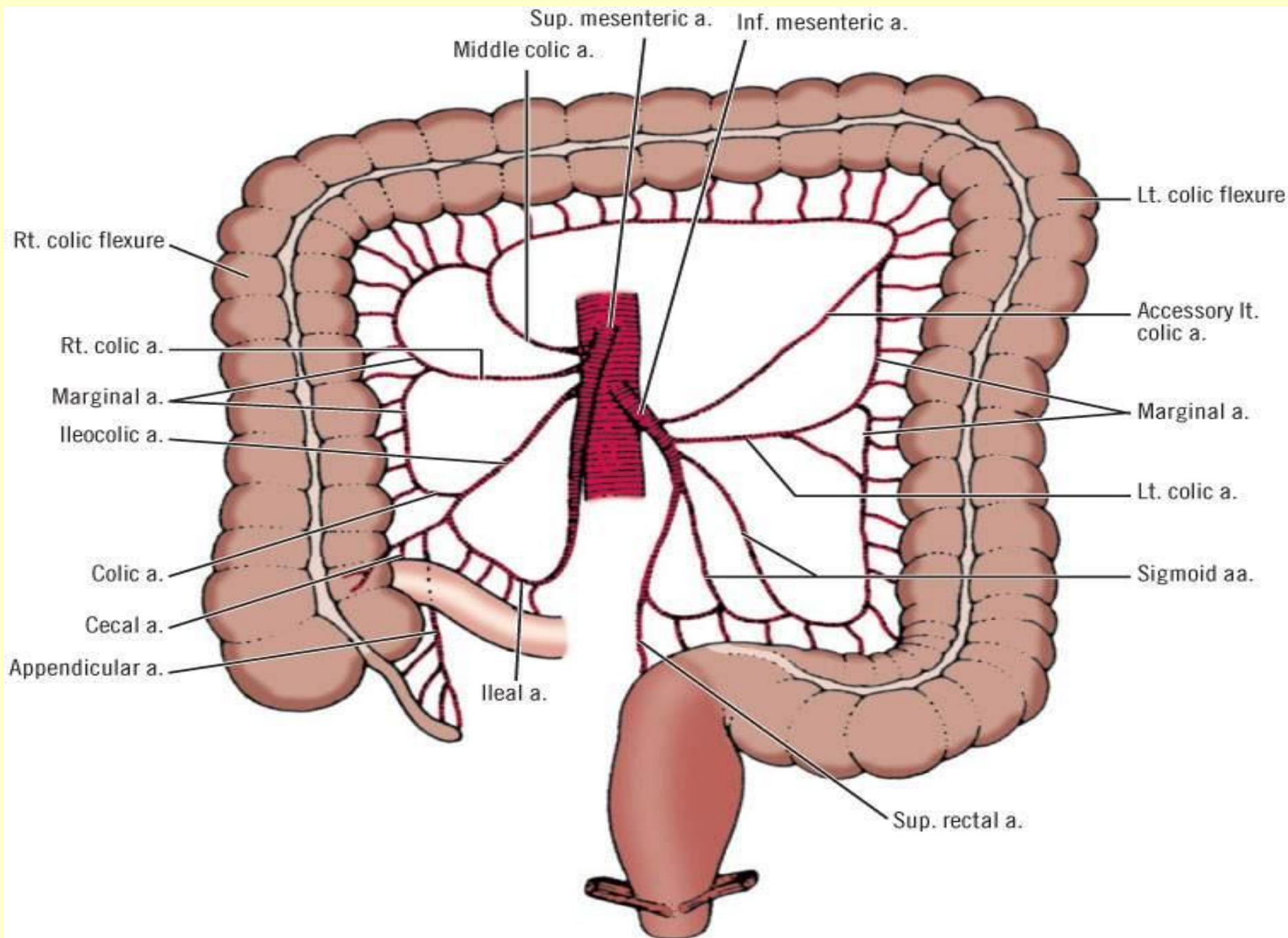


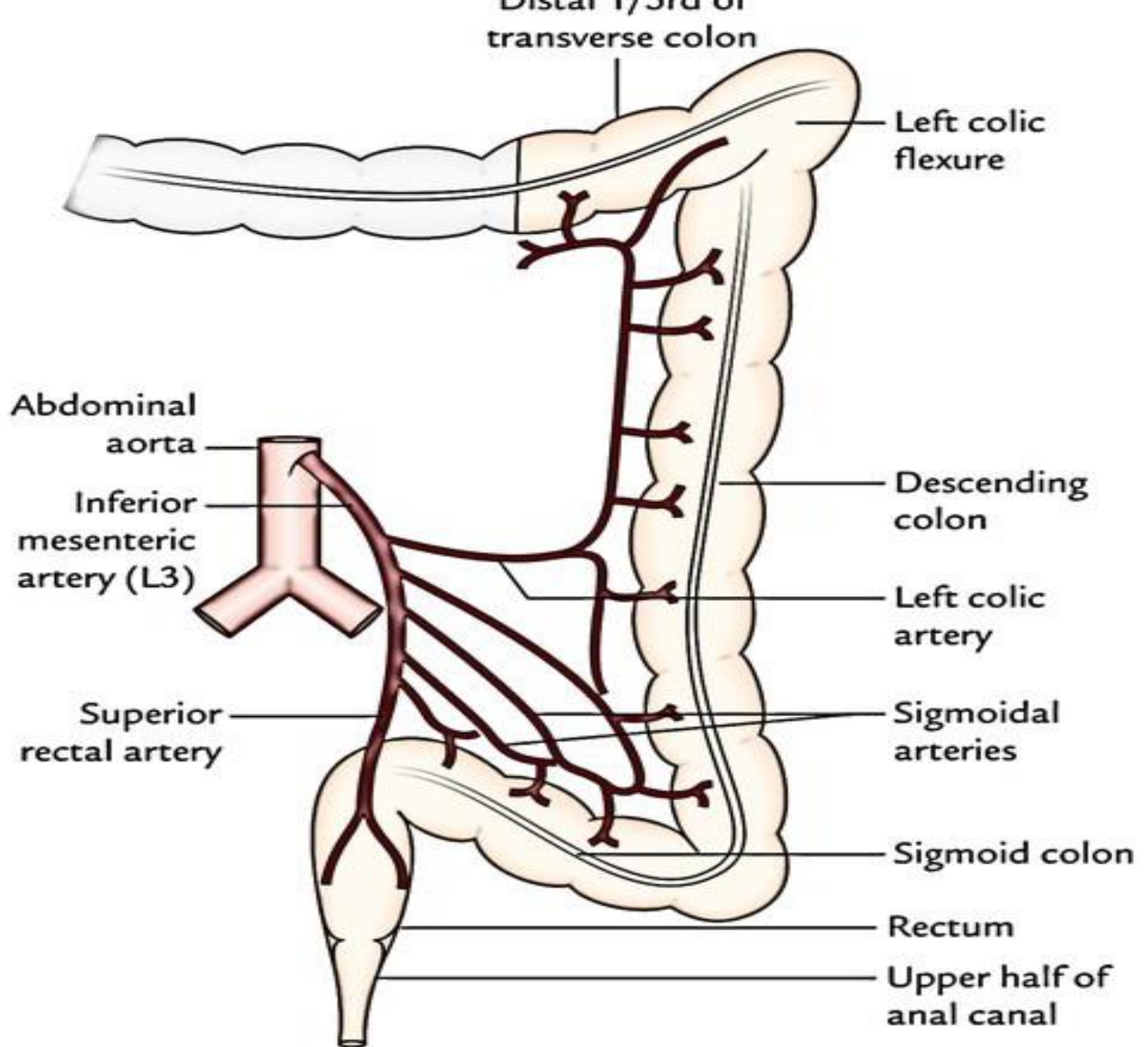




- **The veins of the rectum commence in a plexus of vessels which surrounds the anal canal.**
- **In the vessels forming this plexus are smaller saccular dilatations just within the margin of the anus; from the plexus about six vessels of considerable size are given off.**
- **These ascend between the muscular and mucous coats for about 12.5 cm., running parallel to each other; they then pierce the muscular coat, and, by their union, form a single trunk, the superior hemorrhoidal vein.**
- **This arrangement is termed the hemorrhoidal plexus; it communicates with the tributaries of the middle and inferior haemorrhoidal veins, at its commencement, and thus a communication is established between the systemic and portal circulations.**
- **The nerves are derived from the sympathetic plexuses around the branches of the superior and inferior mesenteric arteries. They are distributed in a similar way to those found in the small intestine.**









**Arterial supply:**

**Marginal artery (of Drummond)** →

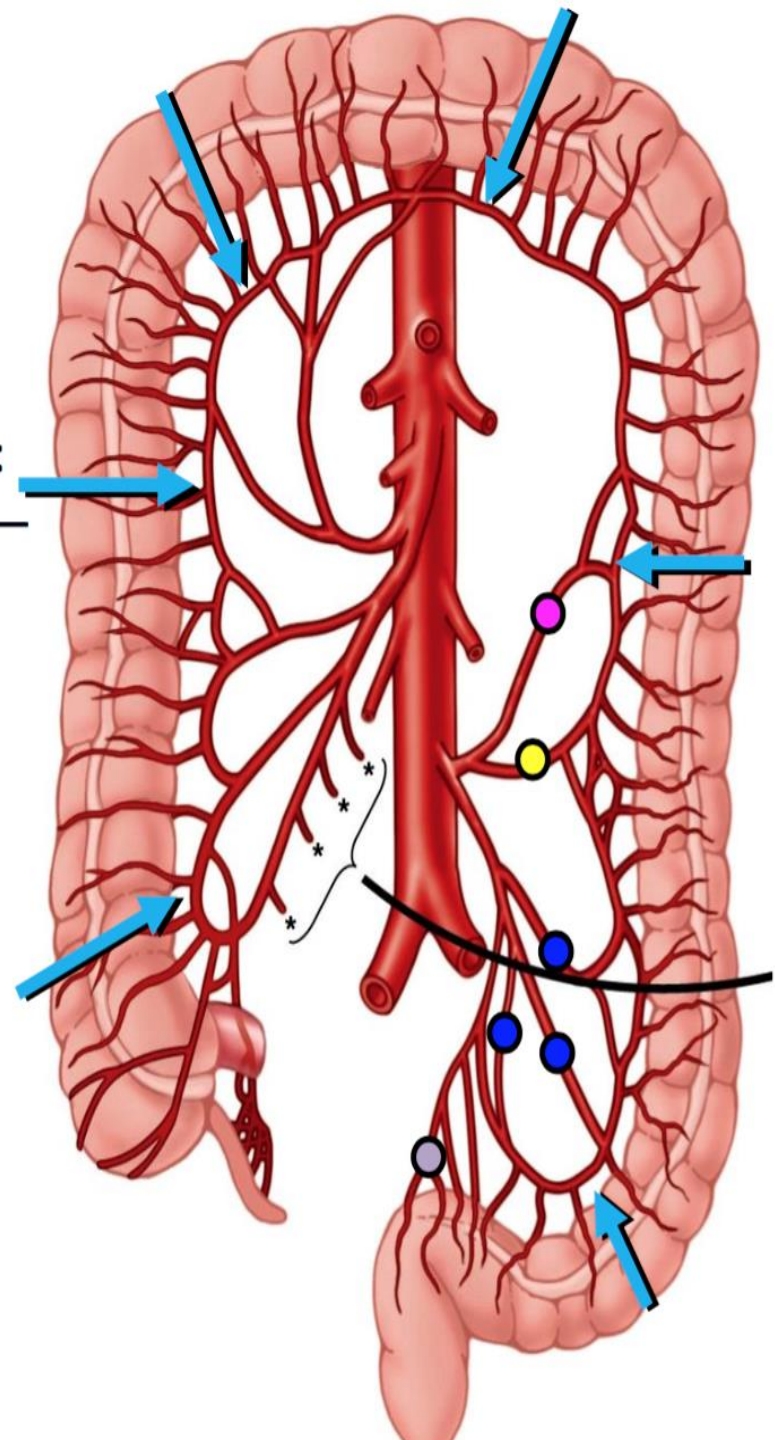
Parallels the internal border of the colon  
Formed by a series of anastomotic loops

Inferior mesenteric artery branches to colon (HINDGUT):

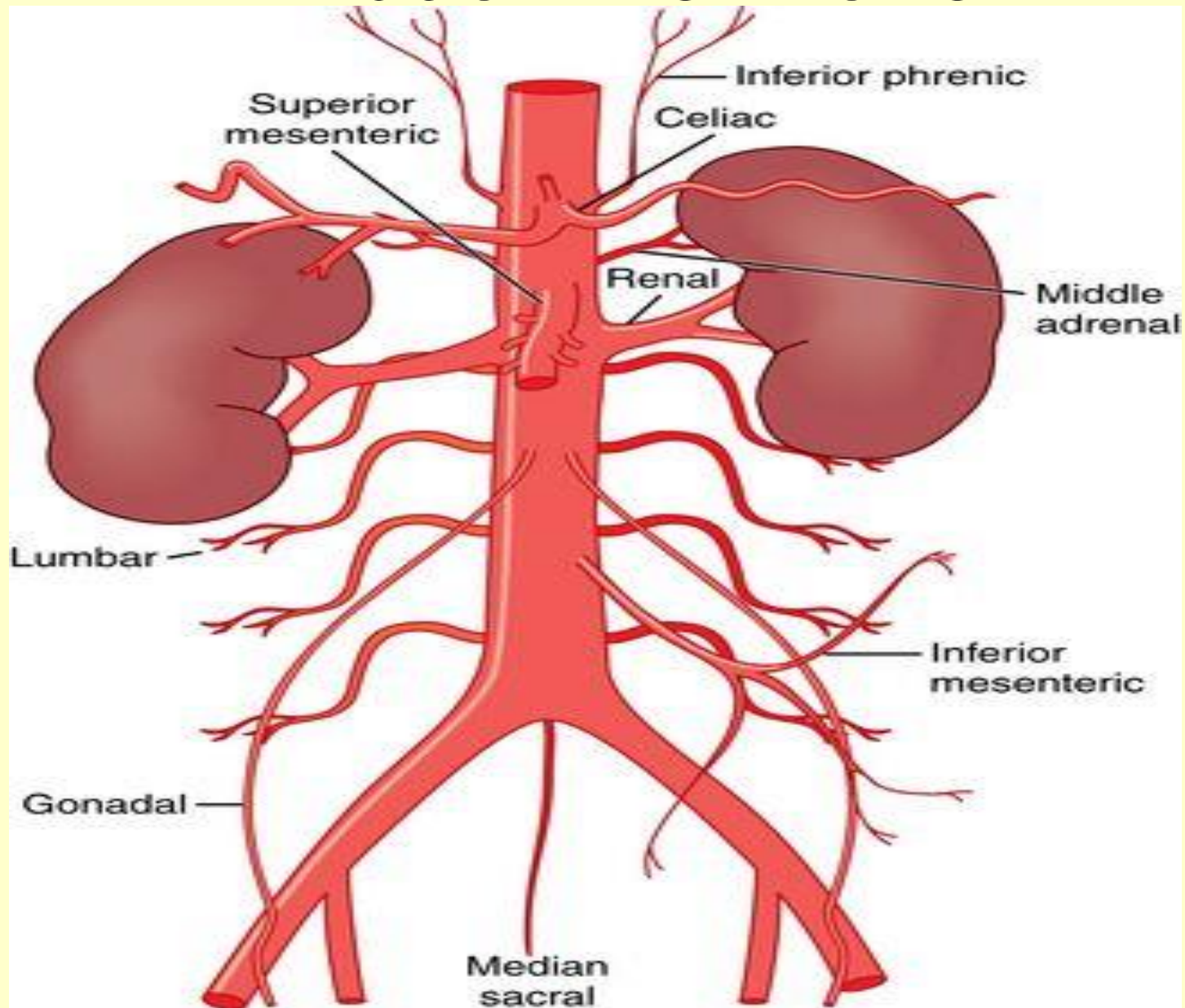
**Left colic artery** ● w/ **ascending branch** ● —  
to distal transverse colon, descending  
colon

**Sigmoidal arteries** ● (3–5) —to sigmoid  
colon via sigmoid mesocolon

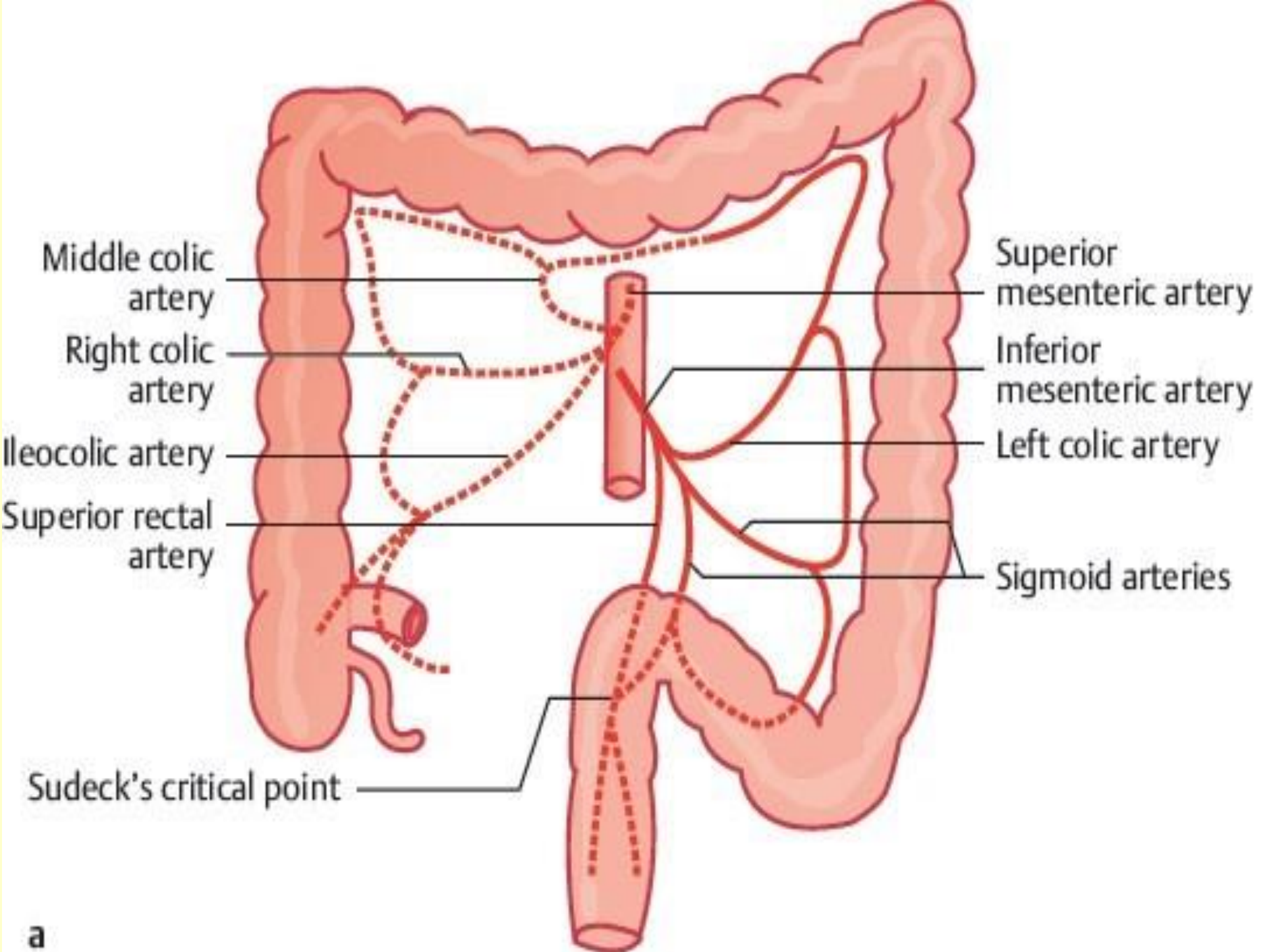
**Superior rectal artery** ● —to superior  
rectum



# Abdominal Aorta







# Branches of abdominal aorta

## 1- visceral

### a. Unpaired

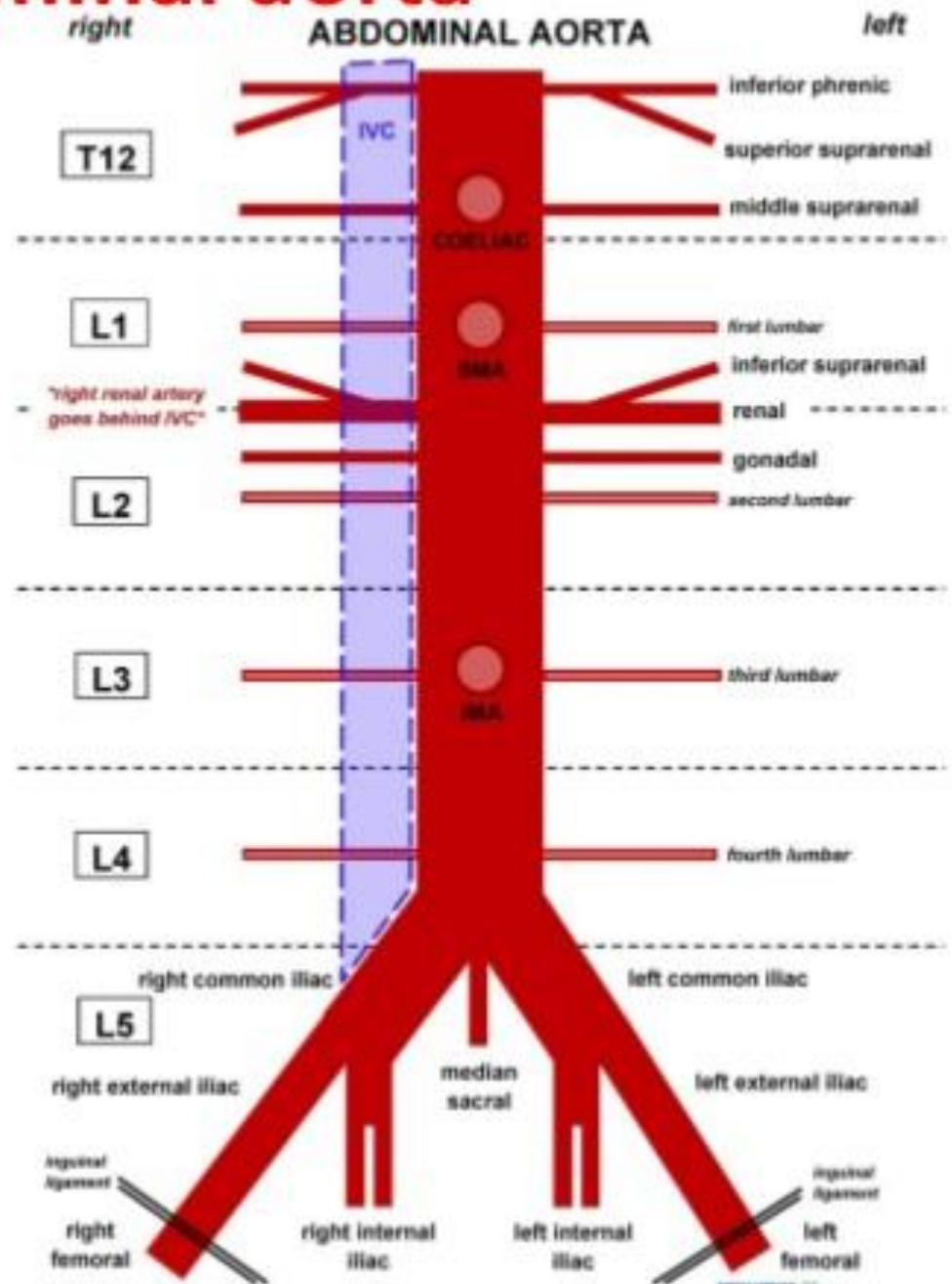
- Celiac trunk
- SMA
- IMA

### b. Paired

- Middle suprarenal a.
- Renal a.
- Testicular or ovarian a.

## 2- posterior branches

- Inferior phrenic artery
- Lumbar arteries
- Median sacral a.

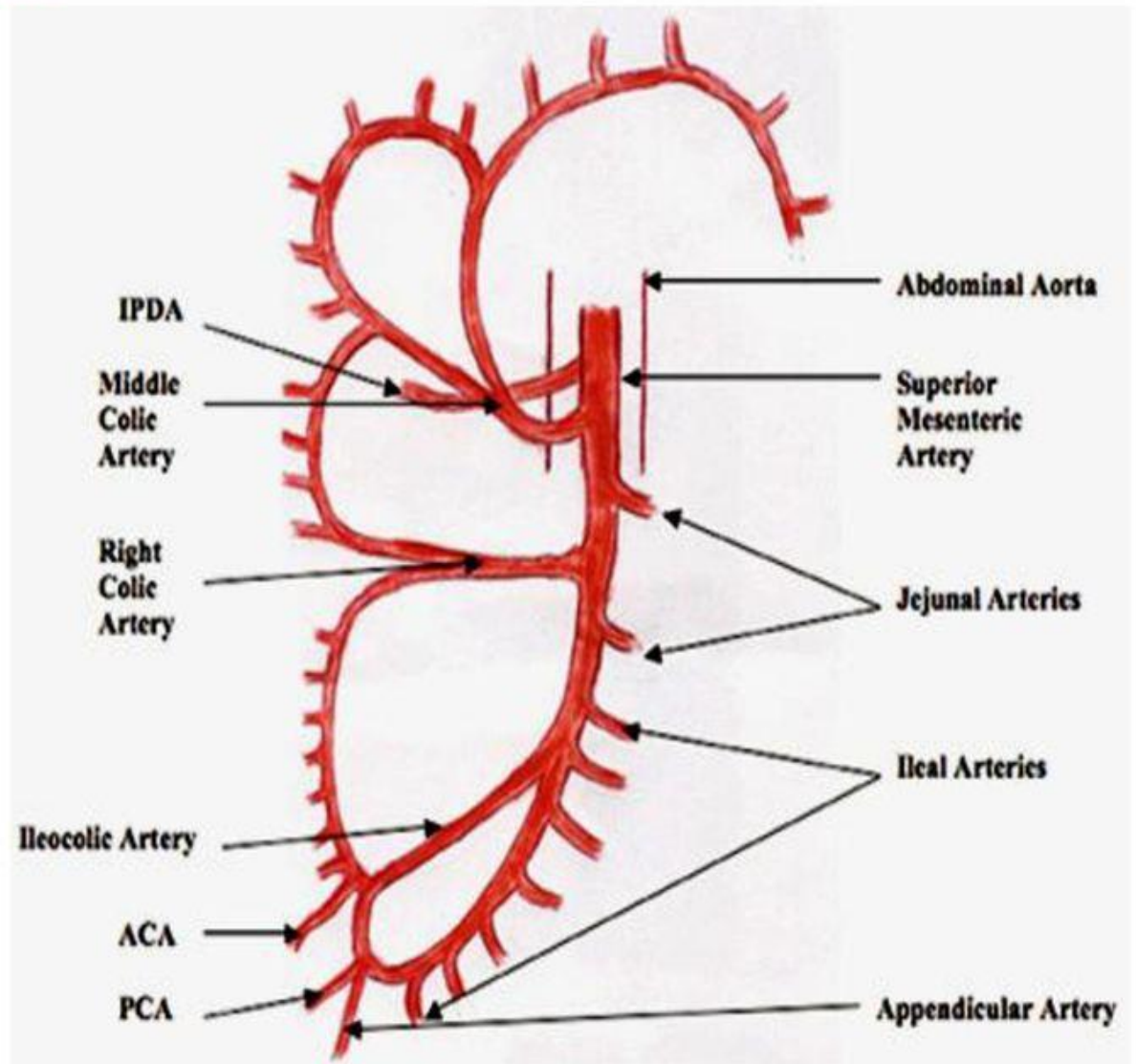


# Branches of the Superior Mesenteric Artery

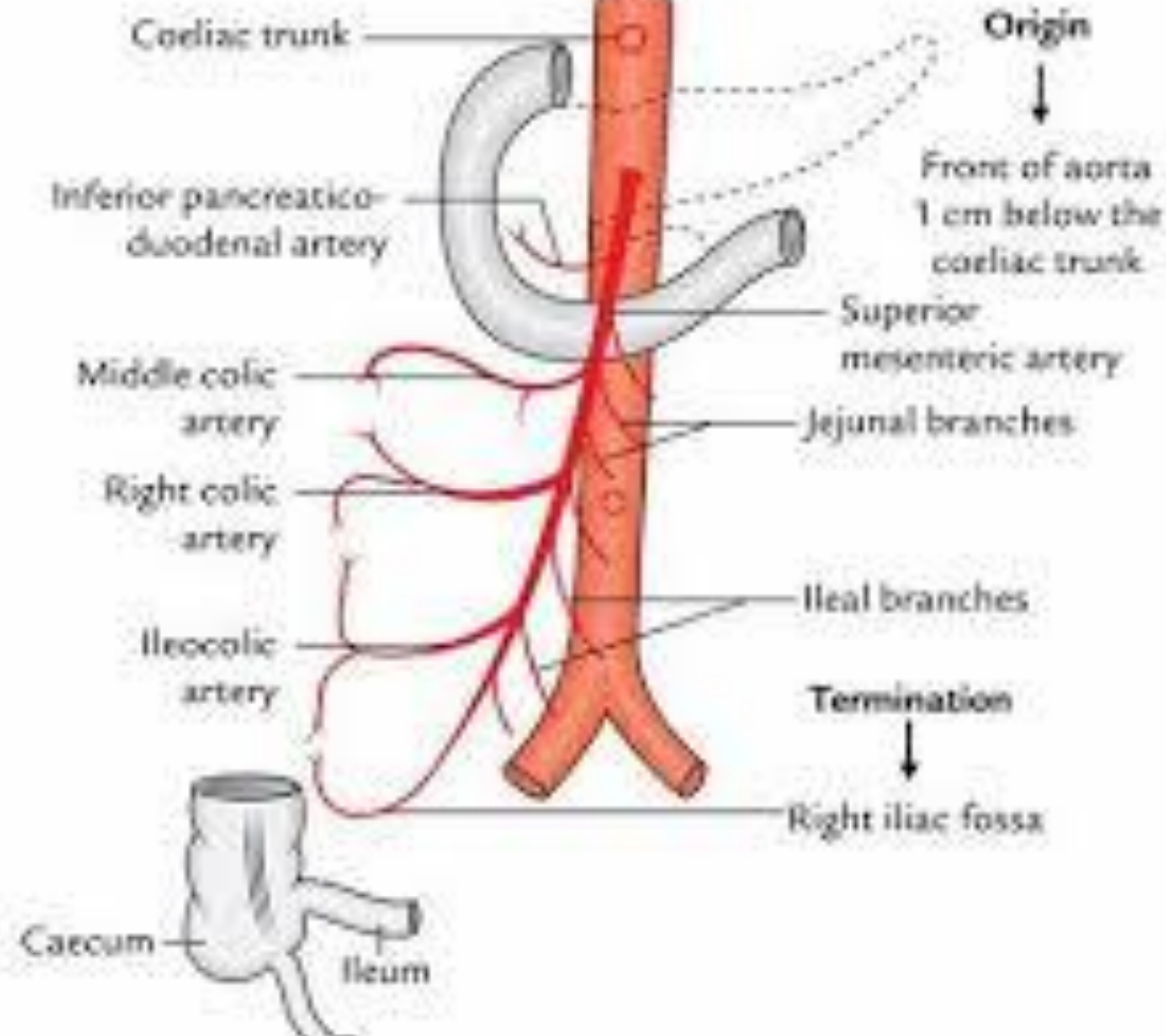
1. Inferior pancreaticoduodenal artery
2. Jejunal arteries
3. Ileal arteries
4. Middle colic artery
5. Right colic artery
6. Ileocolic artery

- **Inferior pancreaticoduodenal artery**
- **Jejunal and ileal arteries**
- **Middle colic artery**
- **Right colic artery**
- **Ileocolic artery**

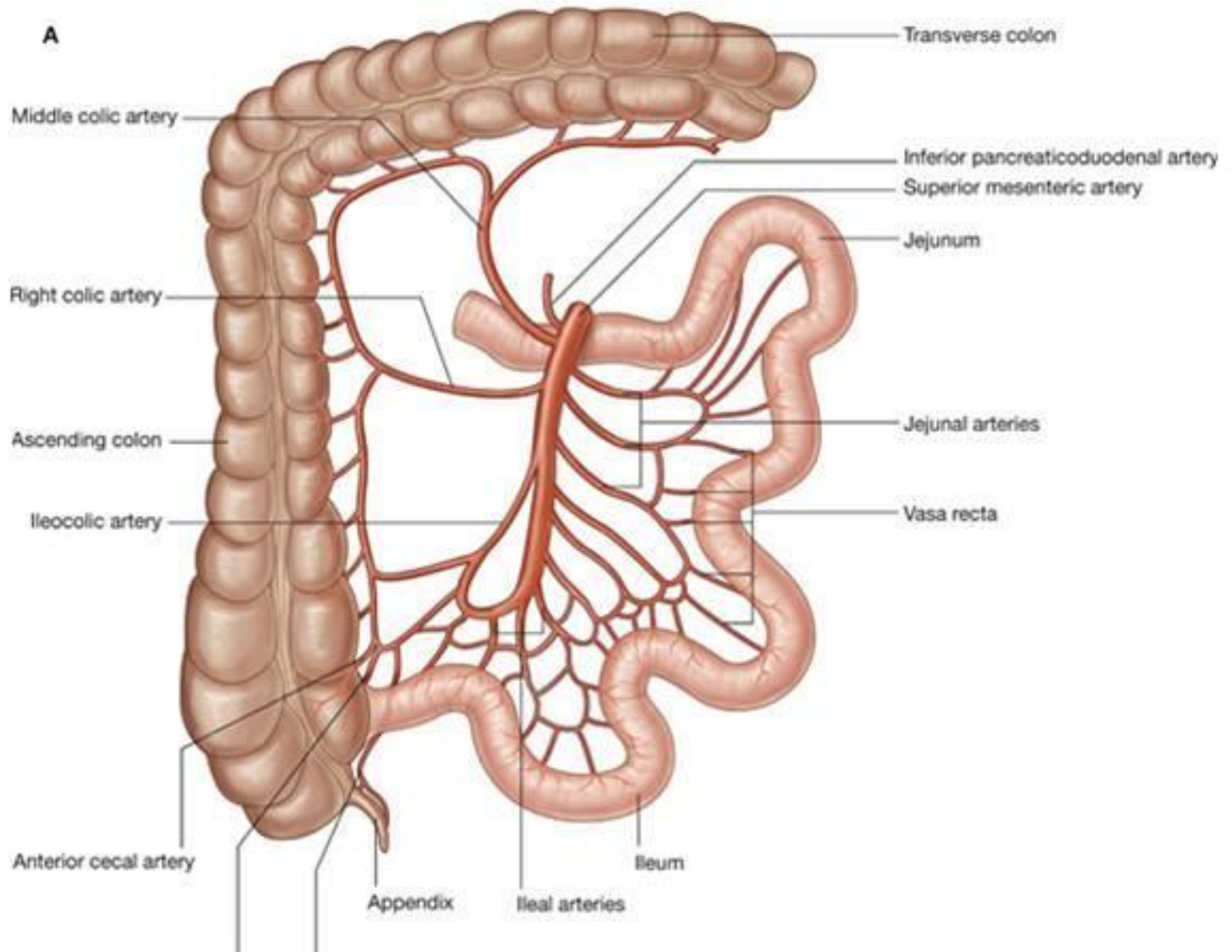
## **Branches of Superior Mesenteric Artery**







A



Right 2/3rd of  
transverse colon

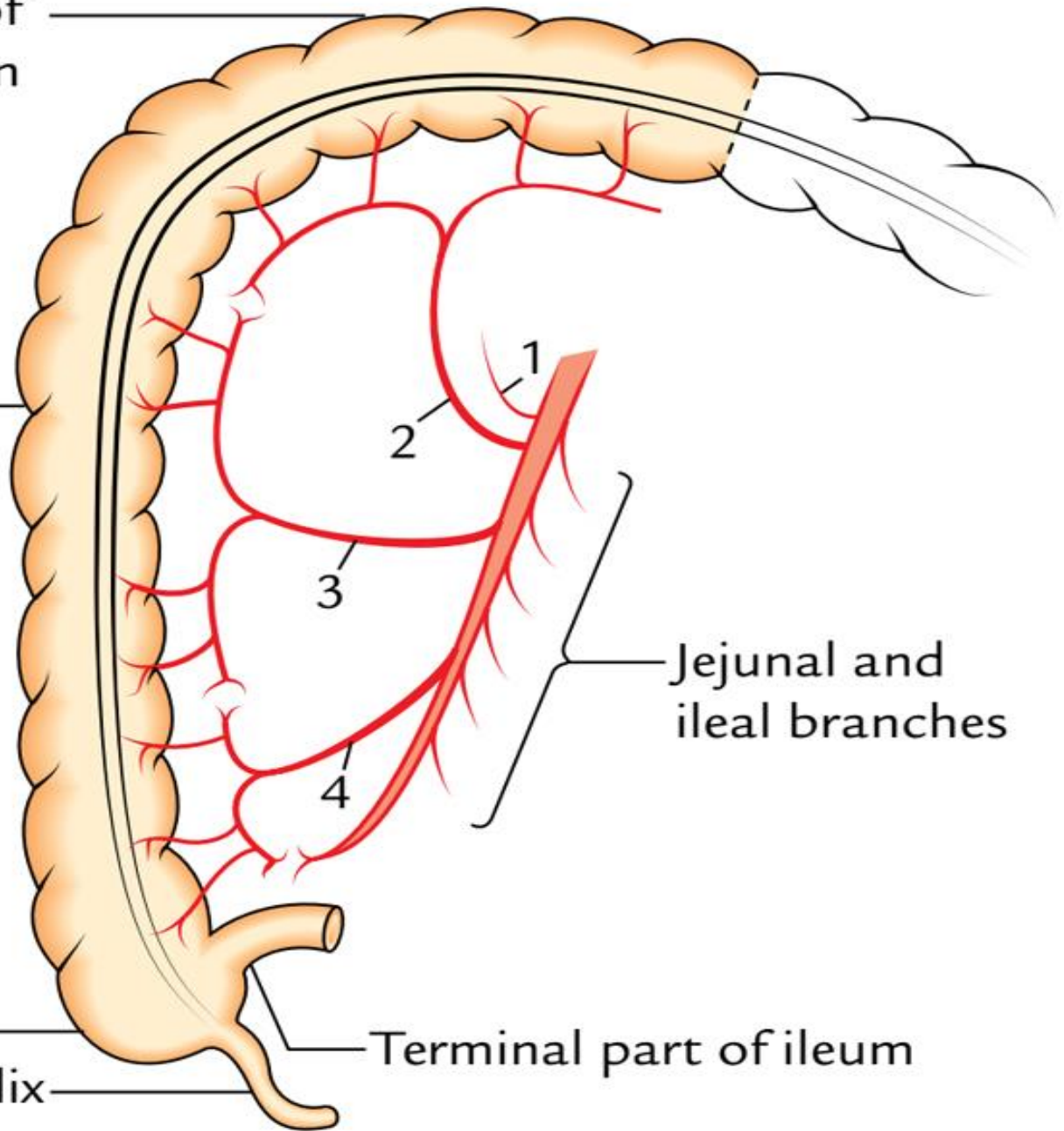
Ascending  
colon

Caecum

Appendix

Terminal part of ileum

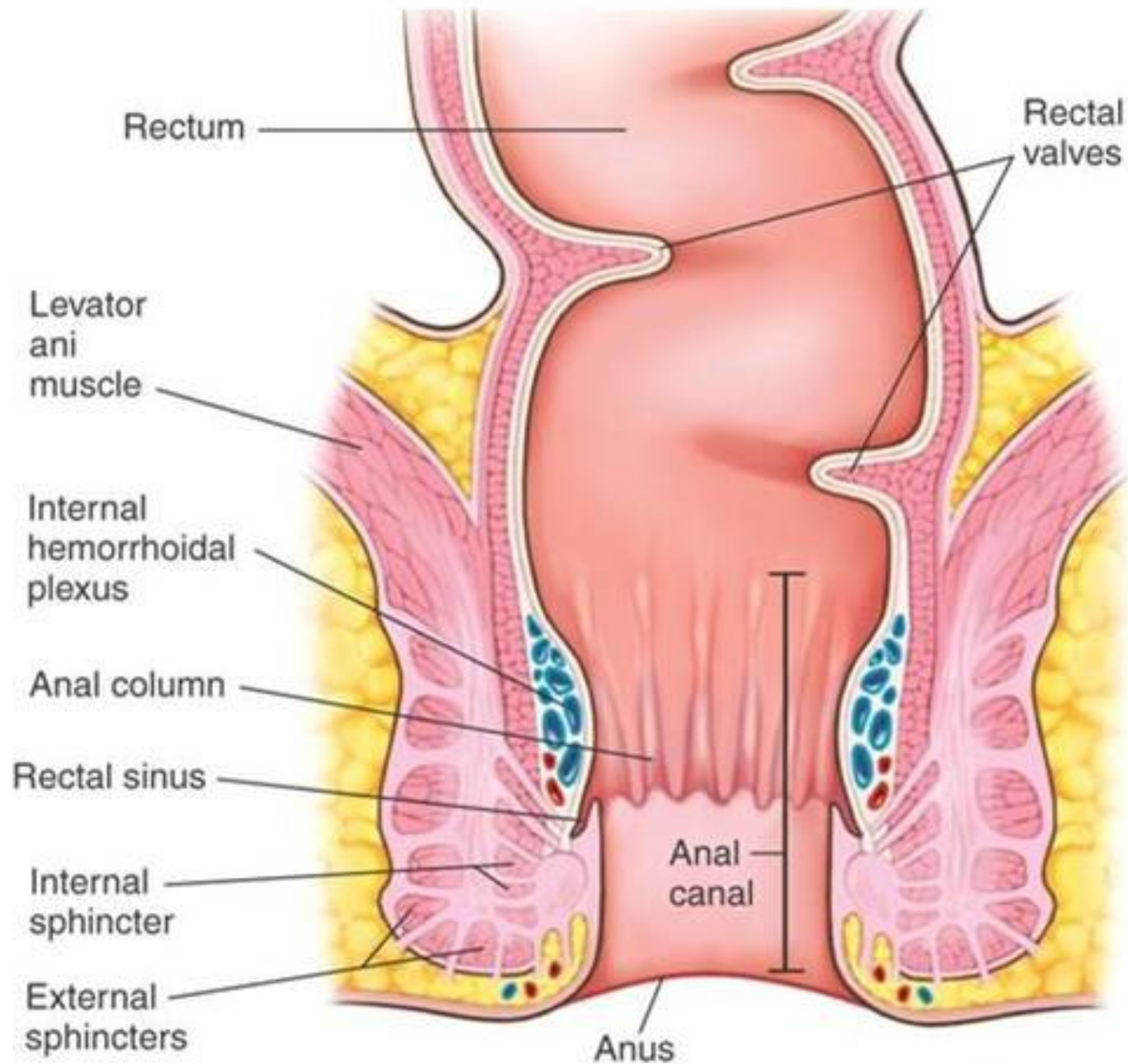
Jejunal and  
ileal branches

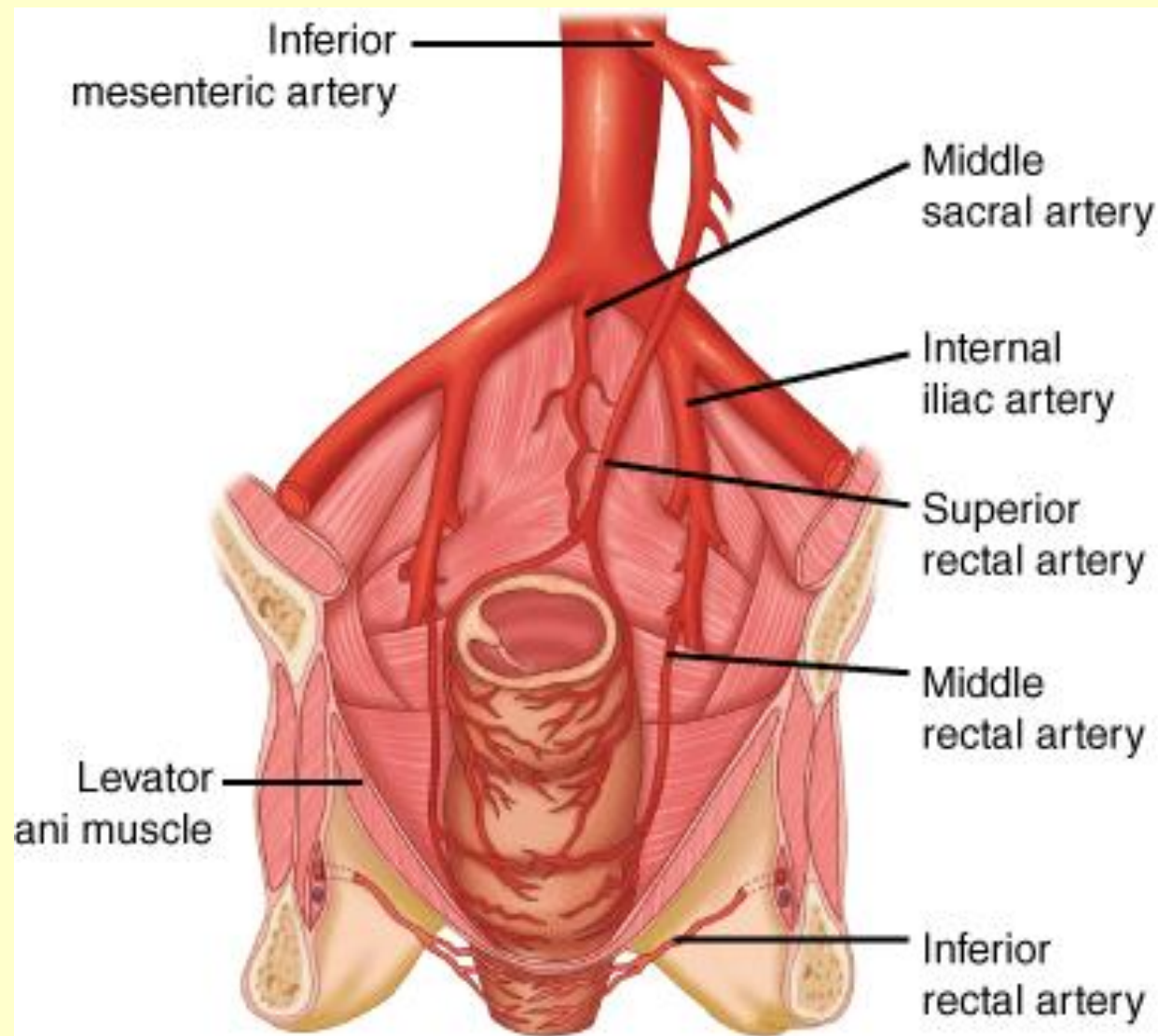


# The Rectum (*intestinum rectum*)

- is continuous above with the sigmoid colon, while below it ends in **the anal canal**.
- From its origin at the level of the third sacral vertebra it passes downward, lying in the sacrococcygeal curve, and extends for about 2.5 cm. in front of, and a little below, the tip of the coccyx, as far as the apex of the prostate.
- It then bends sharply backward into the anal canal.
- It therefore presents two antero-posterior curves: an upper, with its convexity backward, and a lower, with its convexity forward.
- Two lateral curves are also described, one to the right opposite the junction of the third and fourth sacral vertebræ, and the other to the left, opposite the left sacrococcygeal articulation; they are, however, of little importance.
- The rectum is about 12 cm. long, and at its commencement its caliber is similar to that of the sigmoid colon, but near its termination it is dilated to form **the rectal ampulla**.







Source: Brunicaudi FC, Andersen DK, Billiar TR, Dunn DL, Hunter JG, Matthews JB, Pollock RE: *Schwartz's Principles of Surgery*, 9th Edition: <http://www.accessmedicine.com>

Copyright © The McGraw-Hill Companies, Inc. All rights reserved.

- The rectum has no sacculations comparable to those of the colon, but when the lower part of the rectum is contracted, its mucous membrane is thrown into a number of folds, which are longitudinal in direction and are effaced by the distension of the gut.
- Besides these there are certain permanent transverse folds, of a semilunar shape, known as Houston's valves .
- They are usually three in number; sometimes a fourth is found, and occasionally only two are present.
- One is situated near the commencement of the rectum, on the right side; a second extends inward from the left side of the tube, opposite the middle of the sacrum; a third, the largest and most constant, projects backward from the forepart of the rectum, opposite the fundus of the urinary bladder.
- These folds are about 12 mm. in width, and contain some of the circular fibers of the gut. In the empty state of the intestine they overlap each other, as Houston remarks, so effectually as to require considerable maneuvering to conduct a bougie or the finger along the canal.
- Their use seems to be, "to support the weight of fecal matter, and prevent its urging toward the anus, where its presence always excites a sensation demanding its discharge.

- The peritoneum is related to the upper two-thirds of the rectum, covering at first its front and sides, but lower down its front only; from the latter it is reflected on to the seminal vesicles in the male and the posterior vaginal wall in the female.
- The level at which the peritoneum leaves the anterior wall of the rectum to be reflected on to the viscus in front of it is of considerable importance from a surgical point of view, in connection with the removal of the lower part of the rectum.
- It is higher in the male than in the female.
- In the former the height of the rectovesical excavation is about 7.5 cm., i. e., the height to which an ordinary index finger can reach from the anus. In the female the height of the rectouterine excavation is about 5.5 cm. from the anal orifice.
- The rectum is surrounded by a dense tube of fascia derived from the fascia endopelvina, but fused behind with the fascia covering the sacrum and coccyx.
- The facial tube is loosely attached to the rectal wall by areolar tissue in order to allow of distension of the viscus.

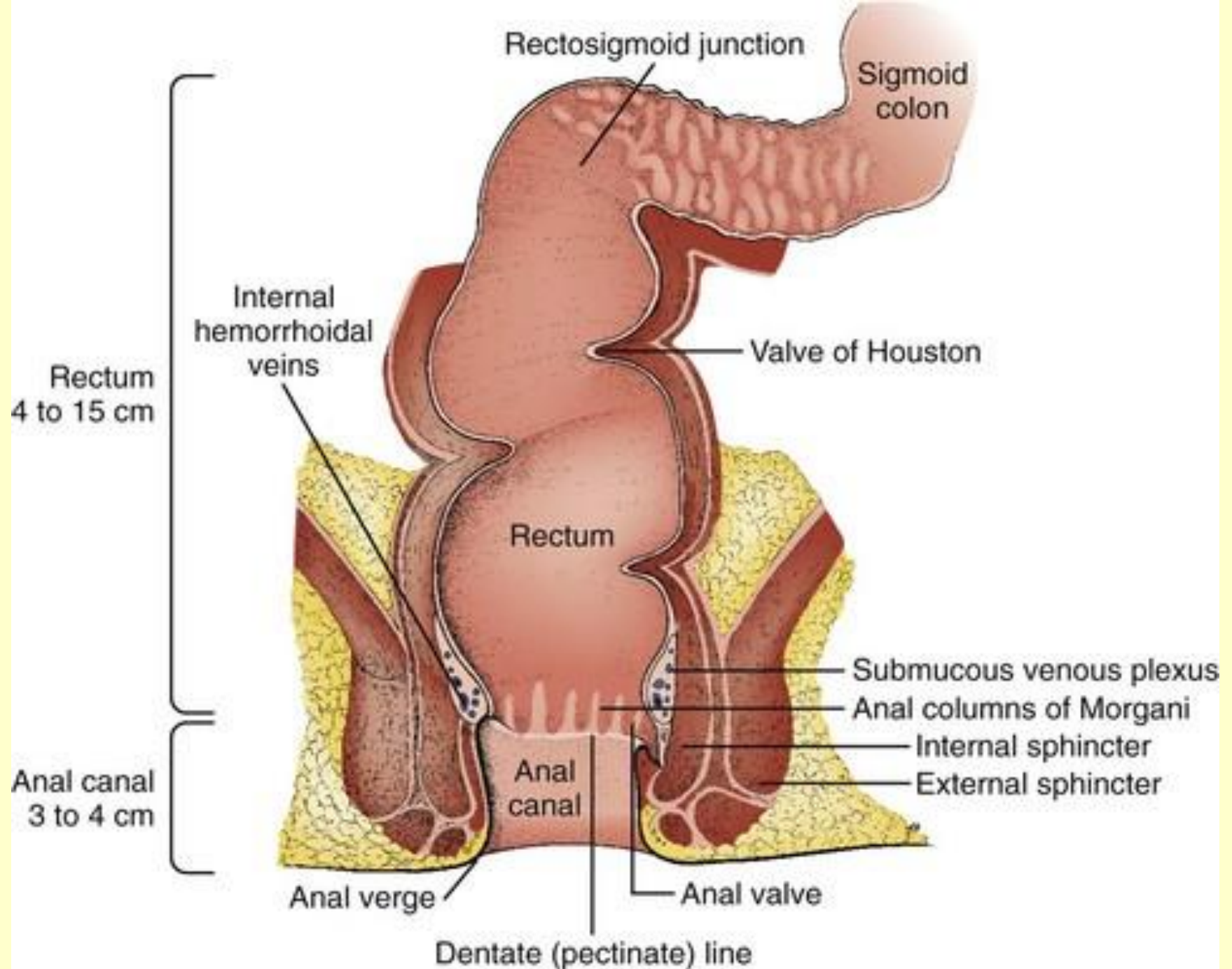


- **Relations of the Rectum**

- The upper part of the rectum is in relation, behind, with the superior hemorrhoidal vessels, the left Piriformis, and left sacral plexus of nerves, which separate it from the pelvic surfaces of the sacral vertebræ;
- in its lower part it lies directly on the sacrum, coccyx, and Levatores ani, a dense fascia alone intervening;
- in front, it is separated above, in the male, from the fundus of the bladder;
- in the female, from the intestinal surface of the uterus and its appendages, by some convolutions of the small intestine, and frequently by the sigmoid colon;
- below, it is in relation in the male with the triangular portion of the fundus of the bladder, the vesiculæ seminales, and ductus deferentes, and more anteriorly with the posterior surface of the prostate;
- in the female, with the posterior wall of the vagina.

# The Anal Canal (*pars analis recti*)

- , or terminal portion of the large intestine, begins at the level of the apex of the prostate, is directed downward and backward, and ends at the anus.
- It forms an angle with the lower part of the rectum, and measures from 2.5 to 4 cm. in length.
- It has no peritoneal covering, but is invested by the *Sphincter ani internus*, supported by *the Levatores ani*, and surrounded at its termination by the *Sphincter ani externus*.
- In the empty condition it presents the appearance of an antero-posterior longitudinal slit.
- Behind it is a mass of muscular and fibrous tissue, the anococcygeal body; in front of it, in the male, but separated by connective tissue from it, are the membranous portion and bulb of the urethra, and the fascia of the urogenital diaphragm; and in the female it is separated from the lower end of the vagina by a mass of muscular and fibrous tissue, named the perineal body.
- 
- The lumen of the anal canal presents, in its upper half, a number of vertical folds, produced by an infolding of the mucous membrane and some of the muscular tissue.
- They are known as **the rectal columns [Morgagni]** , and are separated from one another by furrows (rectal sinuses), which end below in small valve-like folds, termed anal valves, which join together the lower ends of the rectal columns.

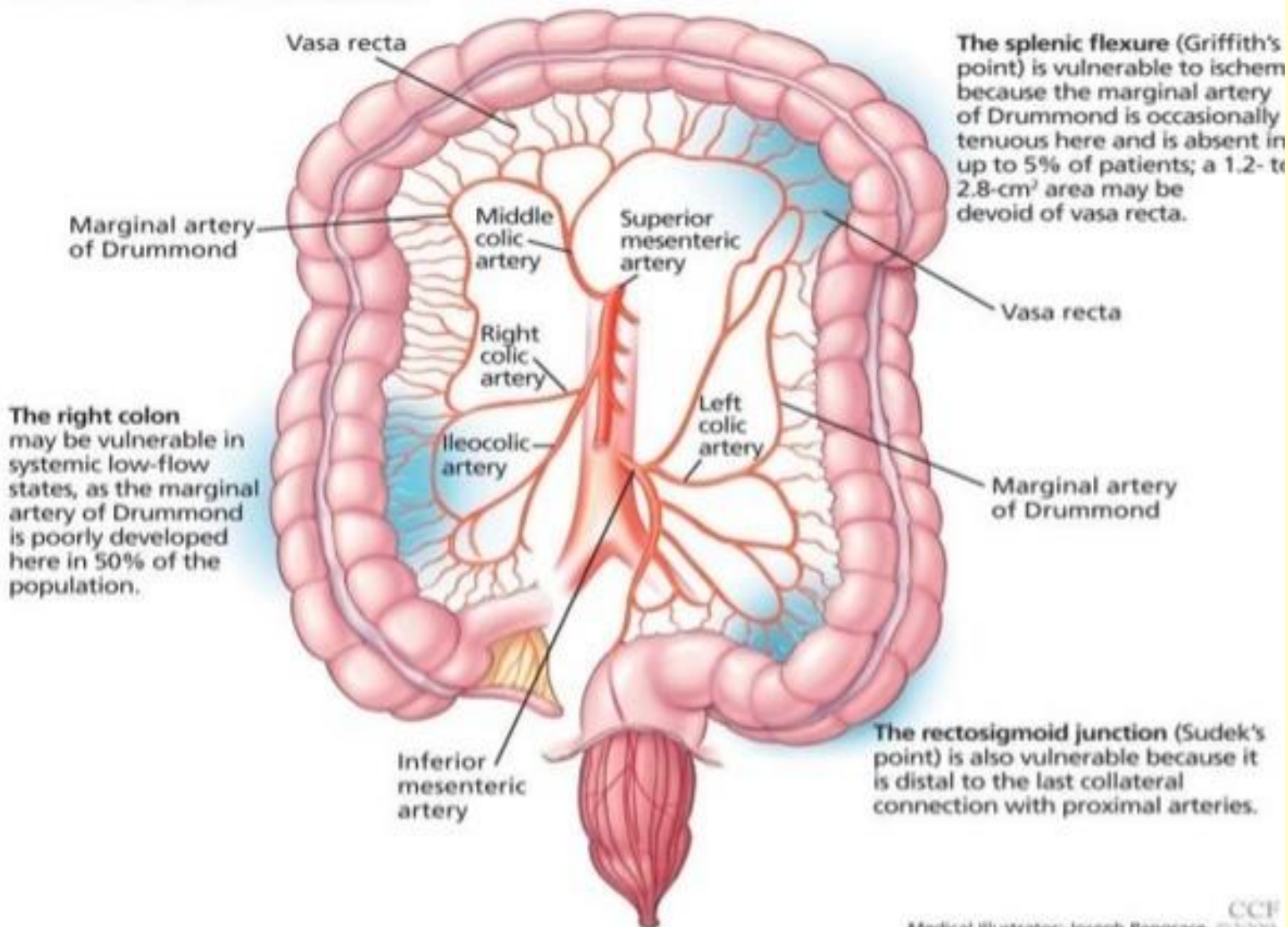


- **Watershed area** is the medical term referring to regions of the body that receive dual blood supply from the most distal branches of two large arteries, such as the splenic flexure of the large intestine.
- During times of blockage of one of the arteries that supply the watershed area, such as in atherosclerosis, these regions are spared from ischemia by virtue of their dual supply.
- However, during times of systemic hypoperfusion, such as in disseminated intravascular coagulation or heart failure, these regions are particularly vulnerable to ischemia by virtue of the fact that they are supplied by the most distal branches of their arteries, and thus the least likely to receive sufficient blood.
- Watershed areas are found in the brain, where areas are perfused by both the anterior and middle cerebral arteries, and in the intestines, where areas are perfused by both the superior and inferior mesenteric arteries ( splenic flexure).
- Additionally, the sigmoid colon and rectum form a watershed zone with blood supply from inferior mesenteric, pudendal and iliac circulations.
- Hypoperfusion in watershed areas can lead to mural and mucosal infarction in the case of ischemic bowel disease.



## ■ Why some areas of the colon are prone to ischemia

The colon is protected from ischemia by a collateral blood supply via the marginal artery of Drummond, a system of arcades connecting the major arteries. The anatomy is highly variable, however, and certain areas are more vulnerable in some people.



## Ischemic Colitis

Arterial blood supply to the large bowel showing the potential site of ischemia.

