

Digestive System III:

Small Intestine and Large Intestine

Department of Anatomy

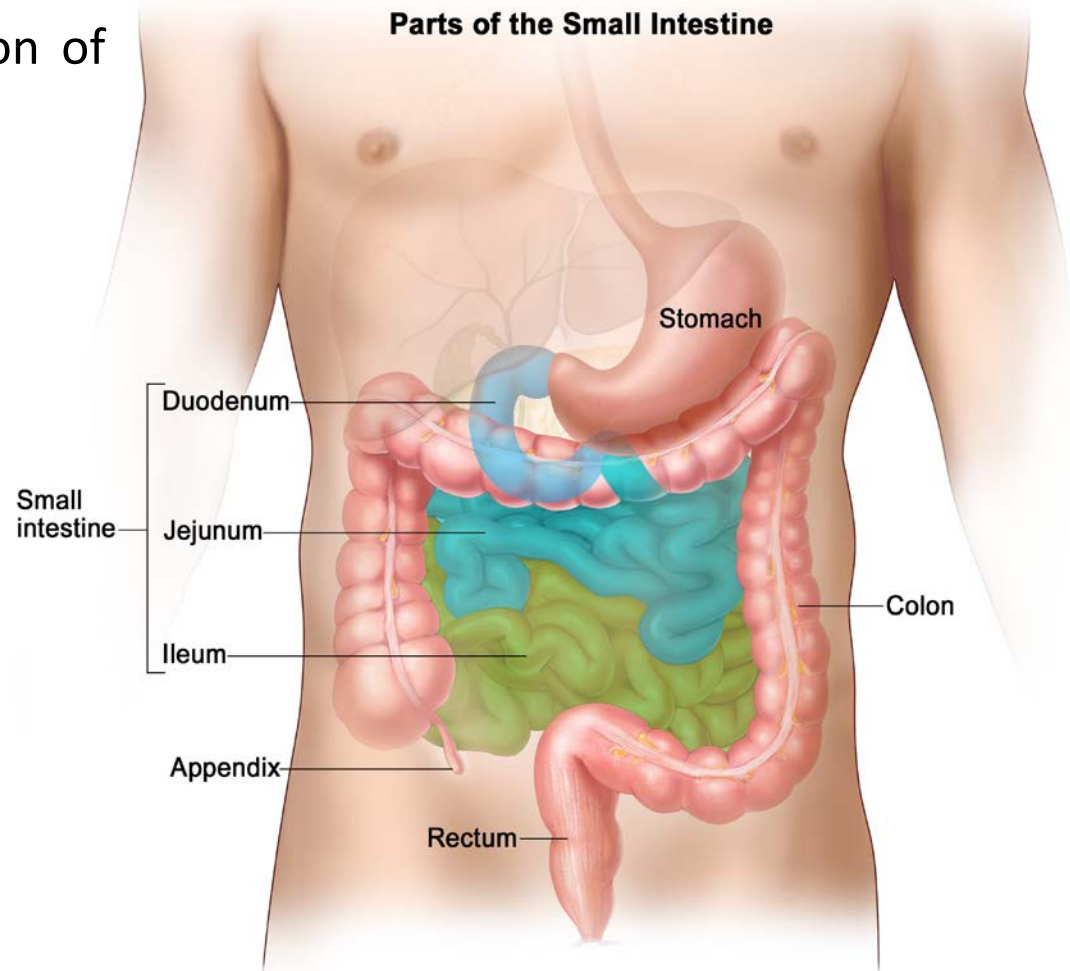
Stefan Trifonov MD, PhD

23.03.2020 II stream (group 11-20)

25.03.2020 I stream (group 1-10)

Small Intestine

- **Small intestine, Lat. *intestinum tenue*** is a hollow, convoluted tube.
- It extends from the pylorus to the ileocecal valve.
- It is the longest component of the digestive tract – 6 to 8 m length, diameter is between 3 and 4 cm, and it has a capacity of about 4 l.
- It is the principal site for the digestion of food and for absorption of nutrients.
- The small intestine consists of:
 - ✓ **Duodenum** – 25 to 30 cm long.
 - ✓ **Jejunum** – 2.5 m long.
 - ✓ **Ileum** – 3.5 m long.



Duodenum

Relations of duodenum

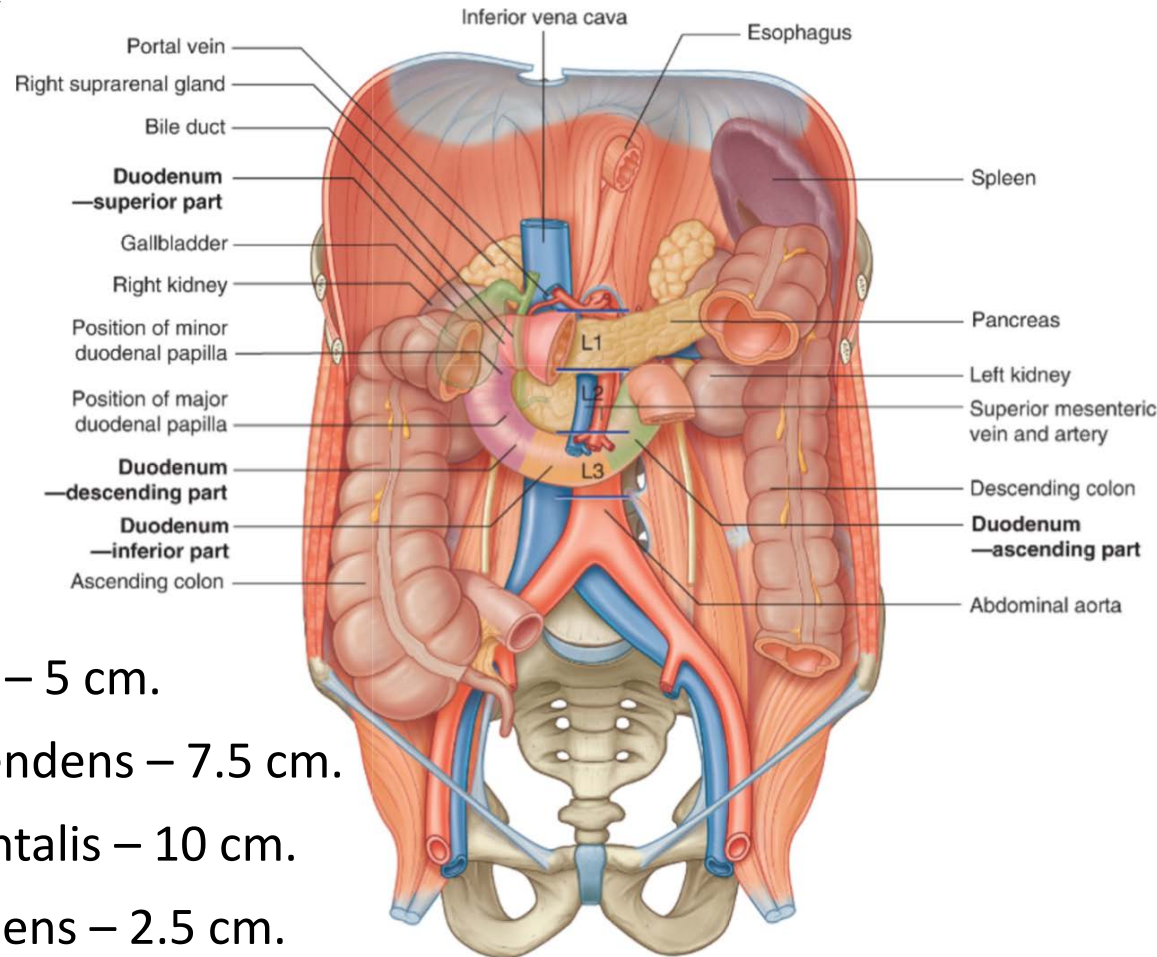
➤ C-shaped (horseshoe-shaped) structure, adjacent to the head of the pancreas and is above the level of the umbilicus.

➤ Projects into the:

- ✓ Epigastric region.
- ✓ Umbilical region.

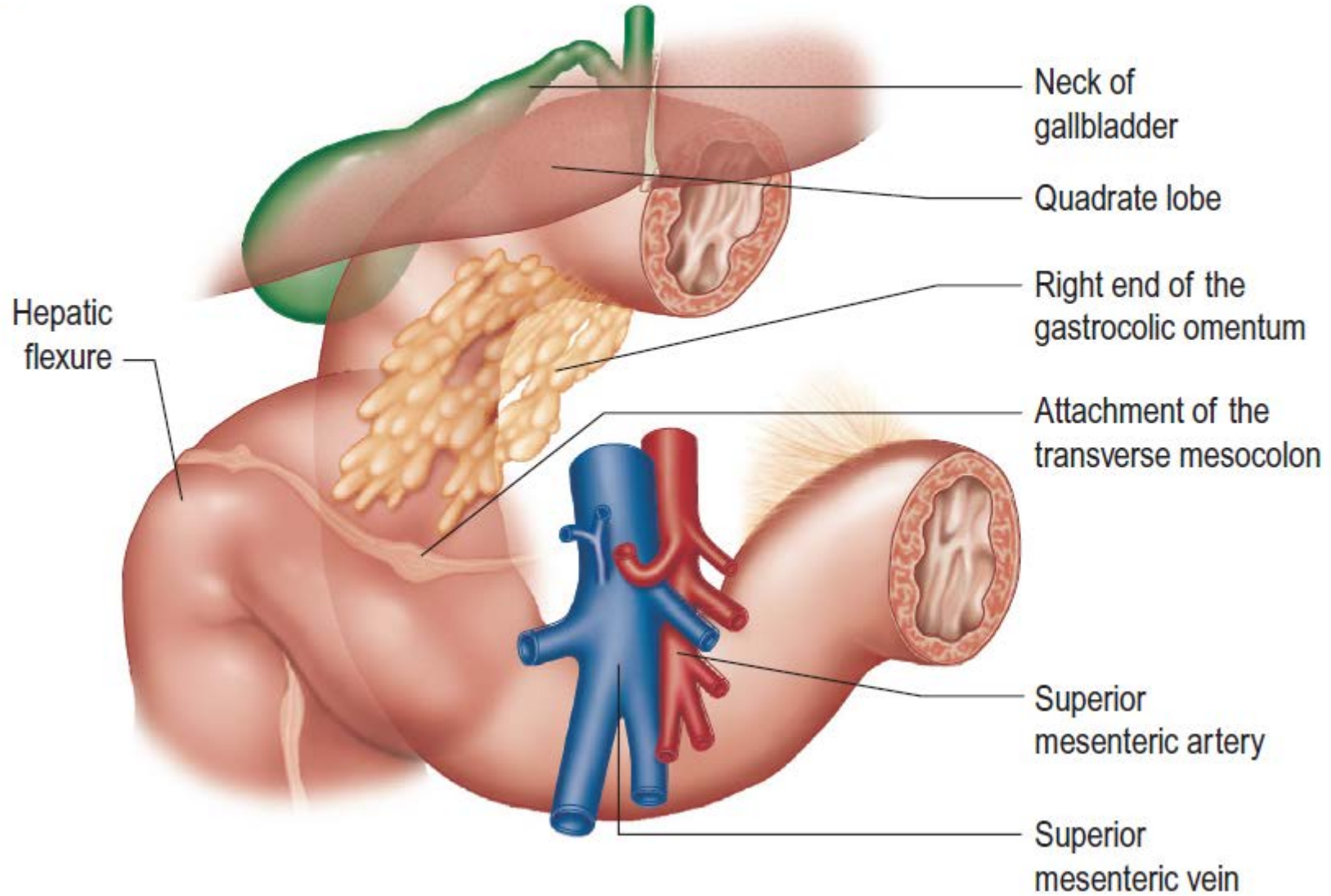
➤ It has four anatomical parts:

- ✓ **Superior part**, Lat. pars superior – 5 cm.
- ✓ **Descending part**, Lat. pars descendens – 7.5 cm.
- ✓ **Horizontal part**, Lat. pars horizontalis – 10 cm.
- ✓ **Ascending part**, Lat. pars ascendens – 2.5 cm.



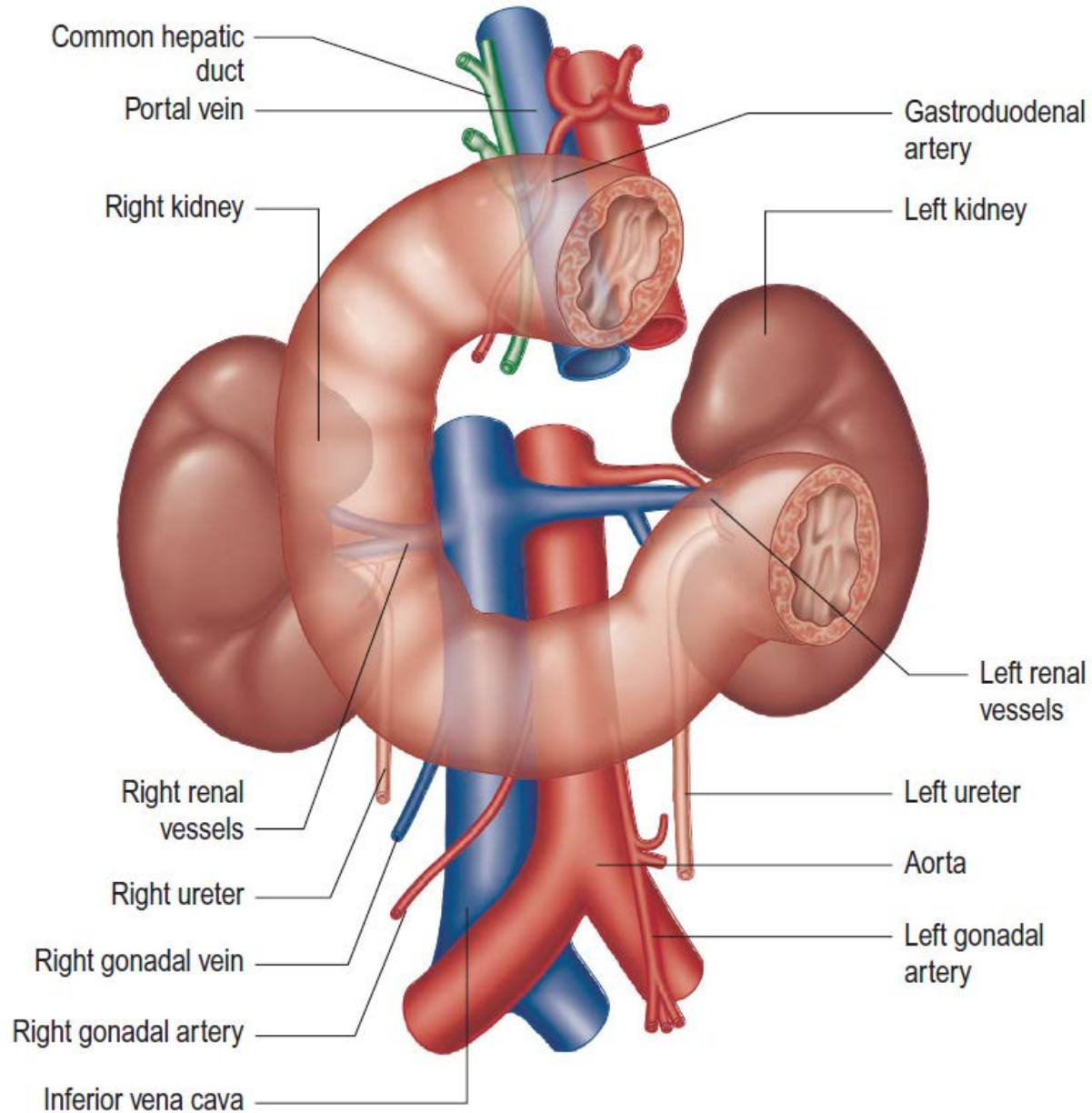
Duodenum

Anterior relations of duodenum



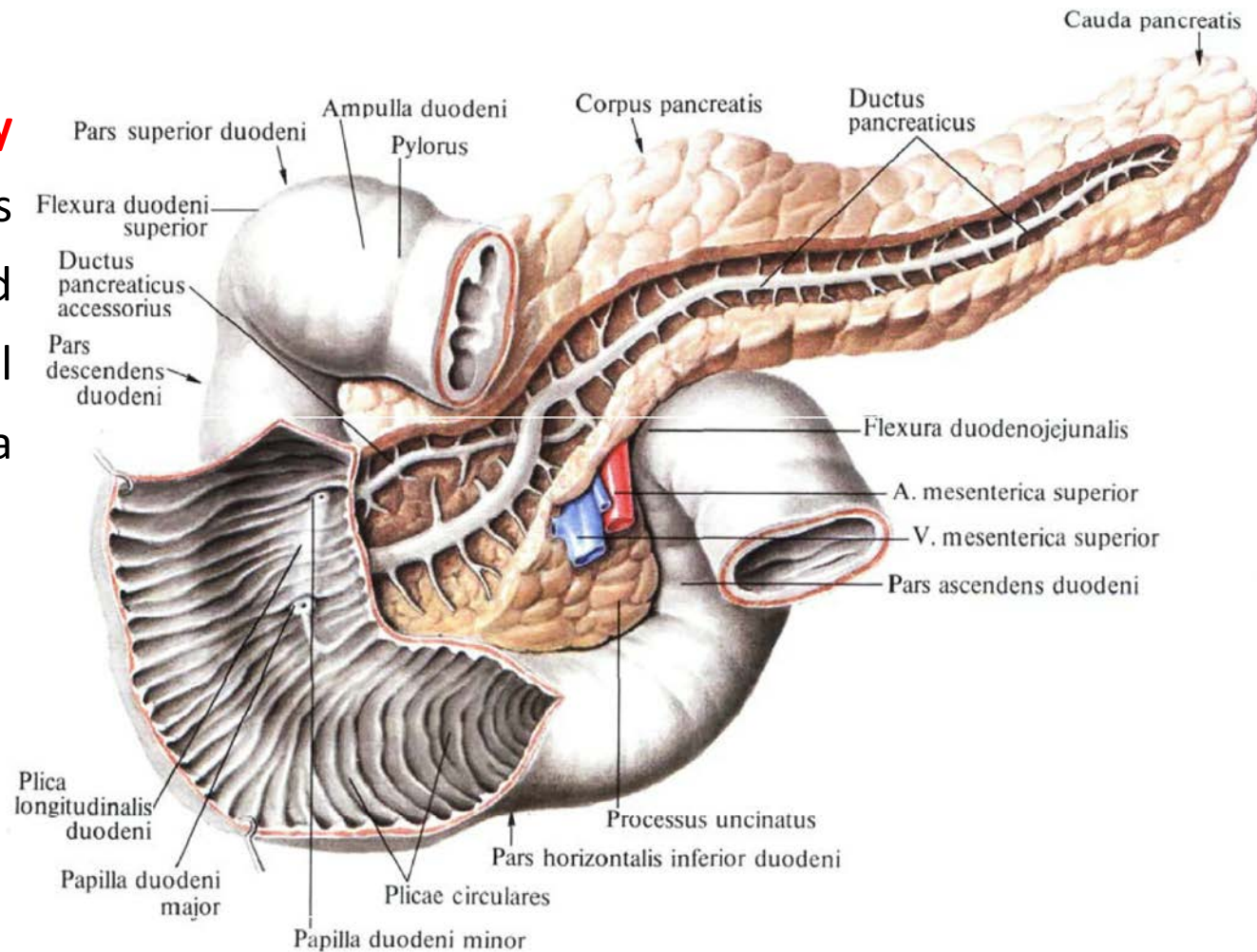
Duodenum

Posterior relations of duodenum



Duodenum

- The **common bile duct** and **pancreatic duct** enter the medial wall of the descending part, where they usually unite to form a common channel.
- The narrow distal end of this channel opens on the **major duodenal papilla** 8-10 cm distal to the pylorus.
- A second, **accessory pancreatic duct** is sometimes present and opens about 2 cm proximal to the major papilla on a **minor duodenal papilla**.



Mesenteric Small Intestine

➤ **Mesenteric small intestine:**

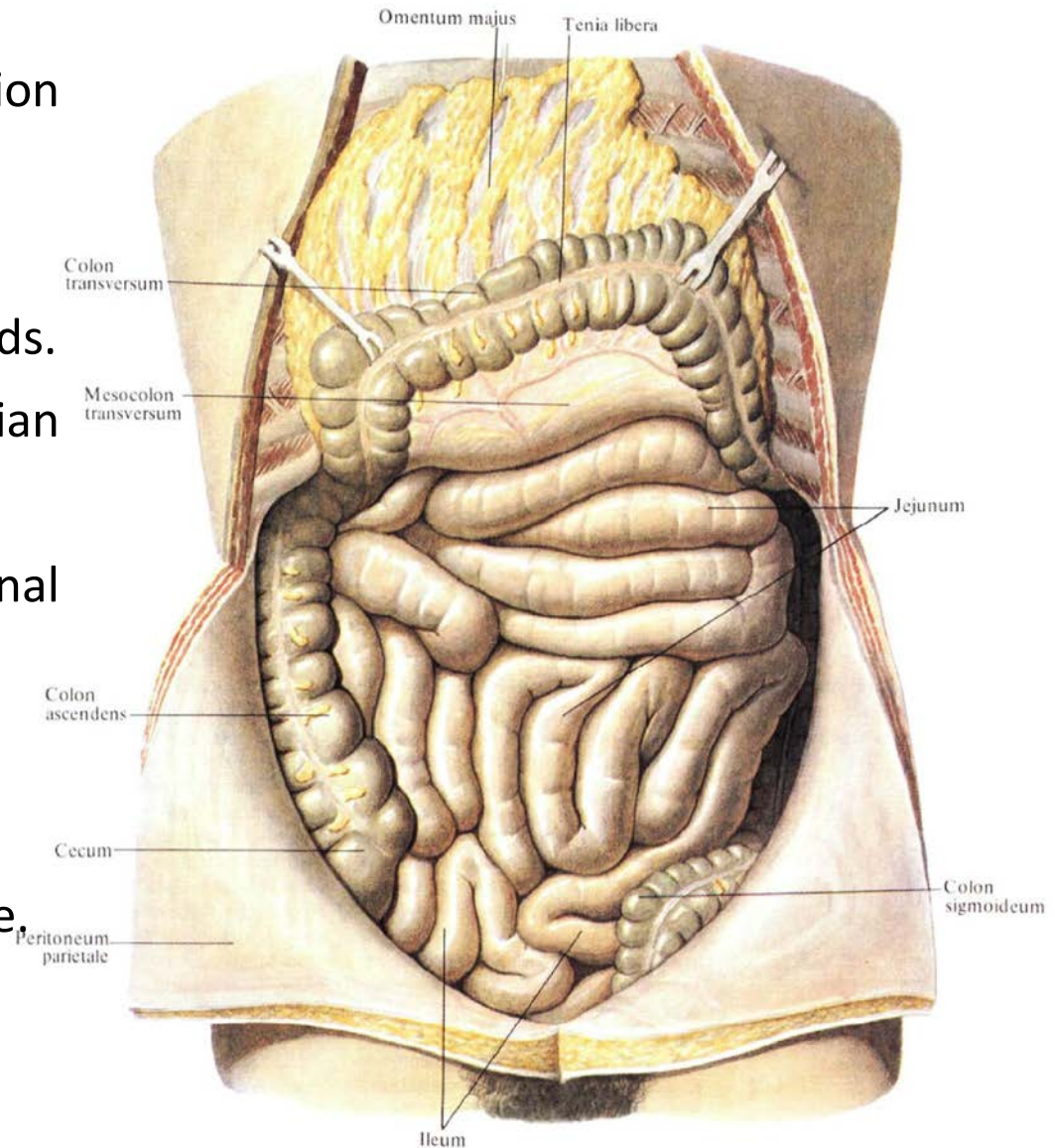
- ✓ Is located intraperitoneally.
- ✓ Projects into the mesogastric region and hypogastric region.

➤ **The jejunum**, Lat. jejunum:

- ✓ Has mostly horizontally oriented folds.
- ✓ They are located to the left of median plane.
- ✓ It begins at the duodenojejunal flexure (L₂).

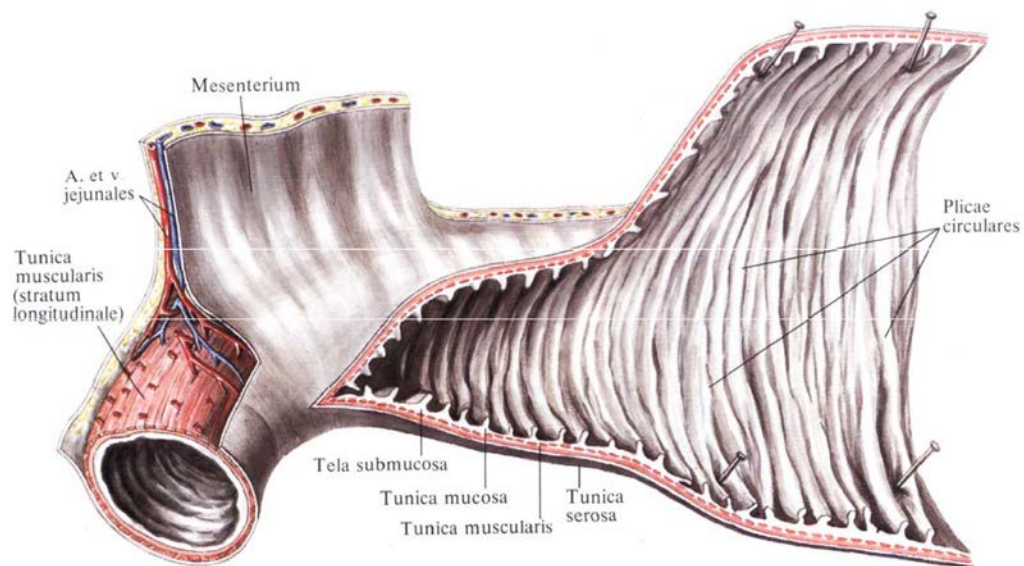
➤ **The ileum**, Lat. ileum:

- ✓ Has vertically oriented folds.
- ✓ Located to the right of median plane.
- ✓ Ends at the ileocecal valve (L₄).

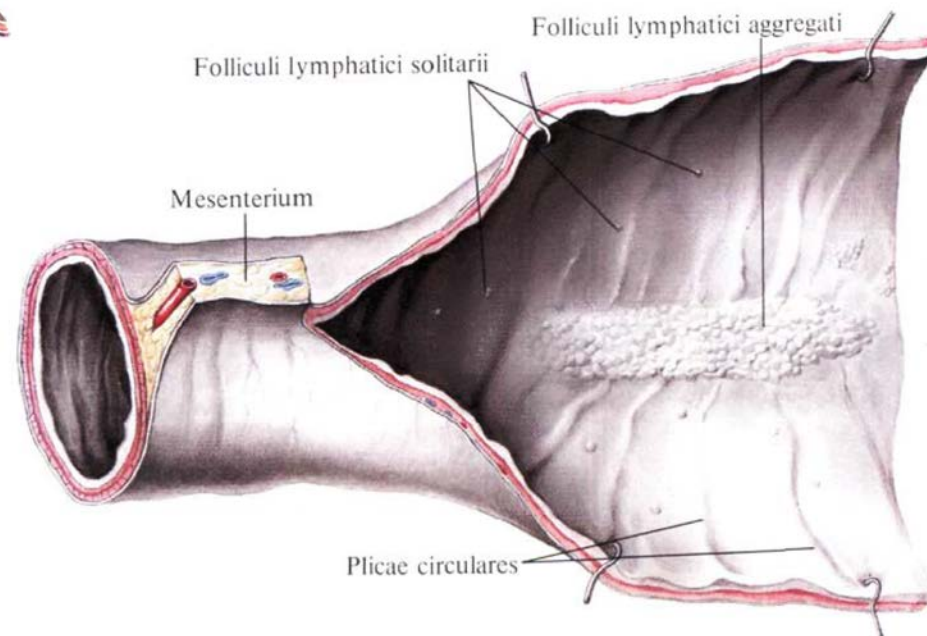


Mesenteric Small Intestine

➤ **Jejunum**, Lat. jejunum.

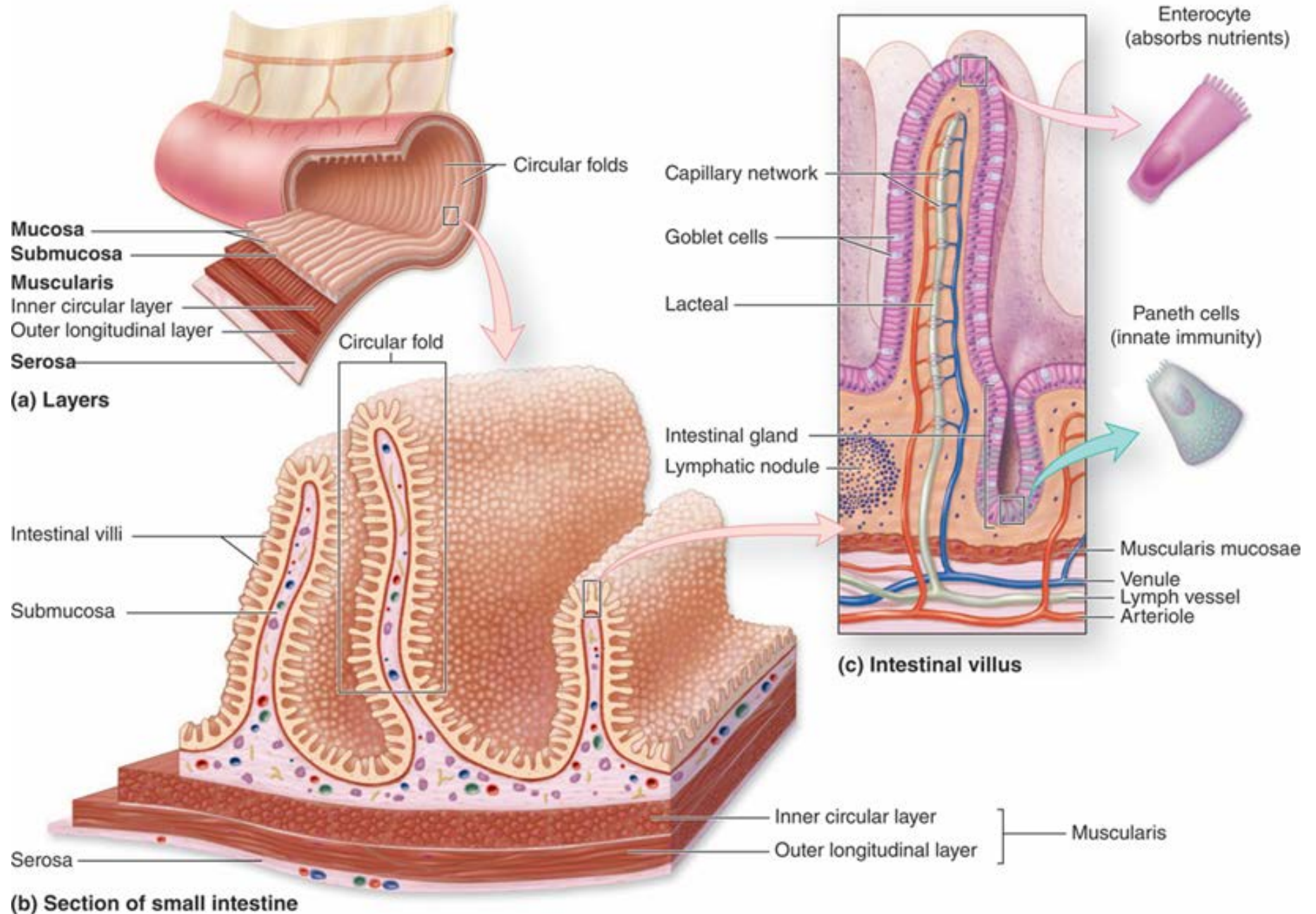


➤ **Ileum**, Lat. ileum.



Histological structure

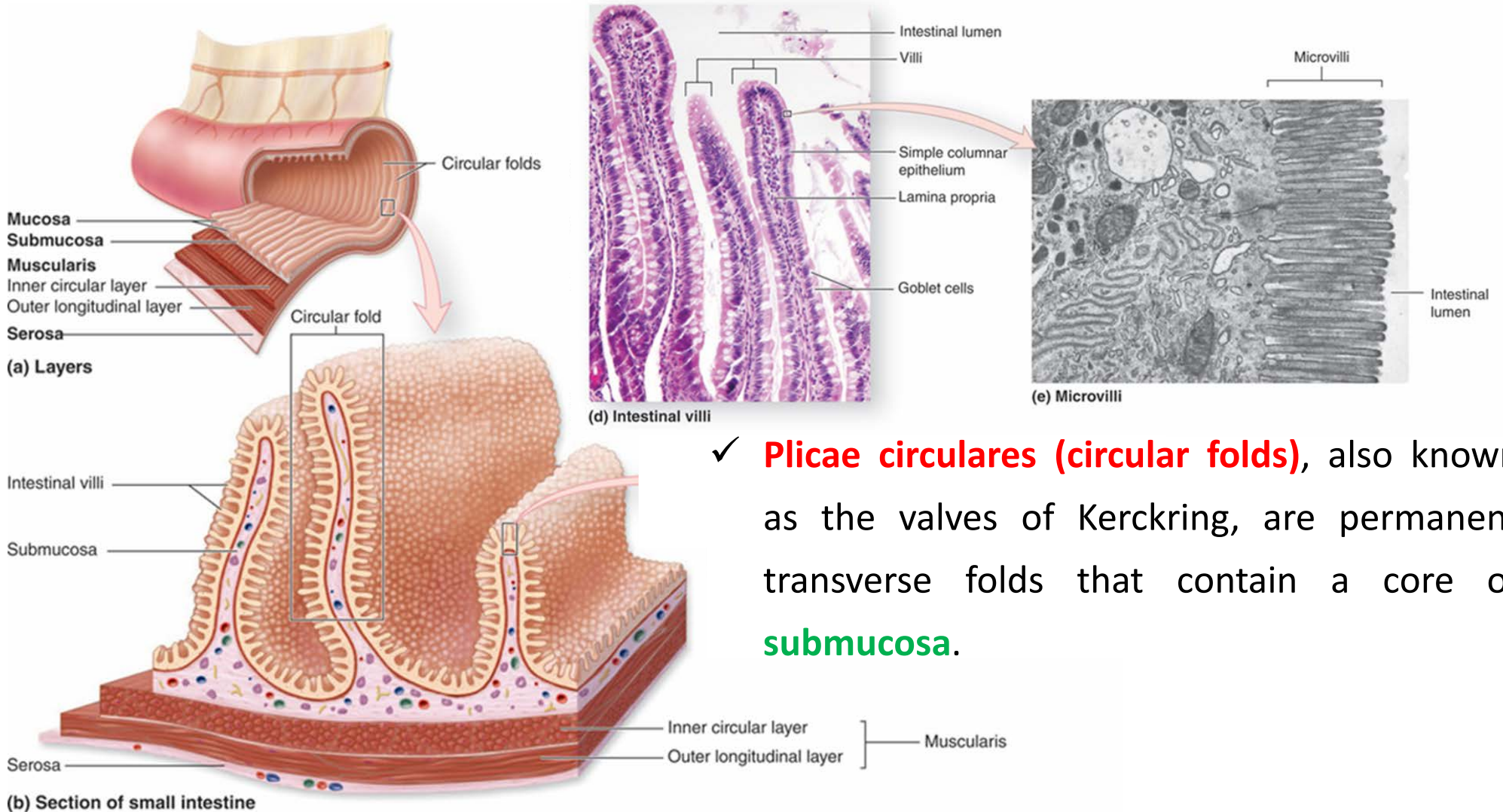
Small Intestine



Small Intestine

Histological structure

- The absorptive surface area of the small intestine is amplified by tissue and cell specializations of the submucosa and mucosa.

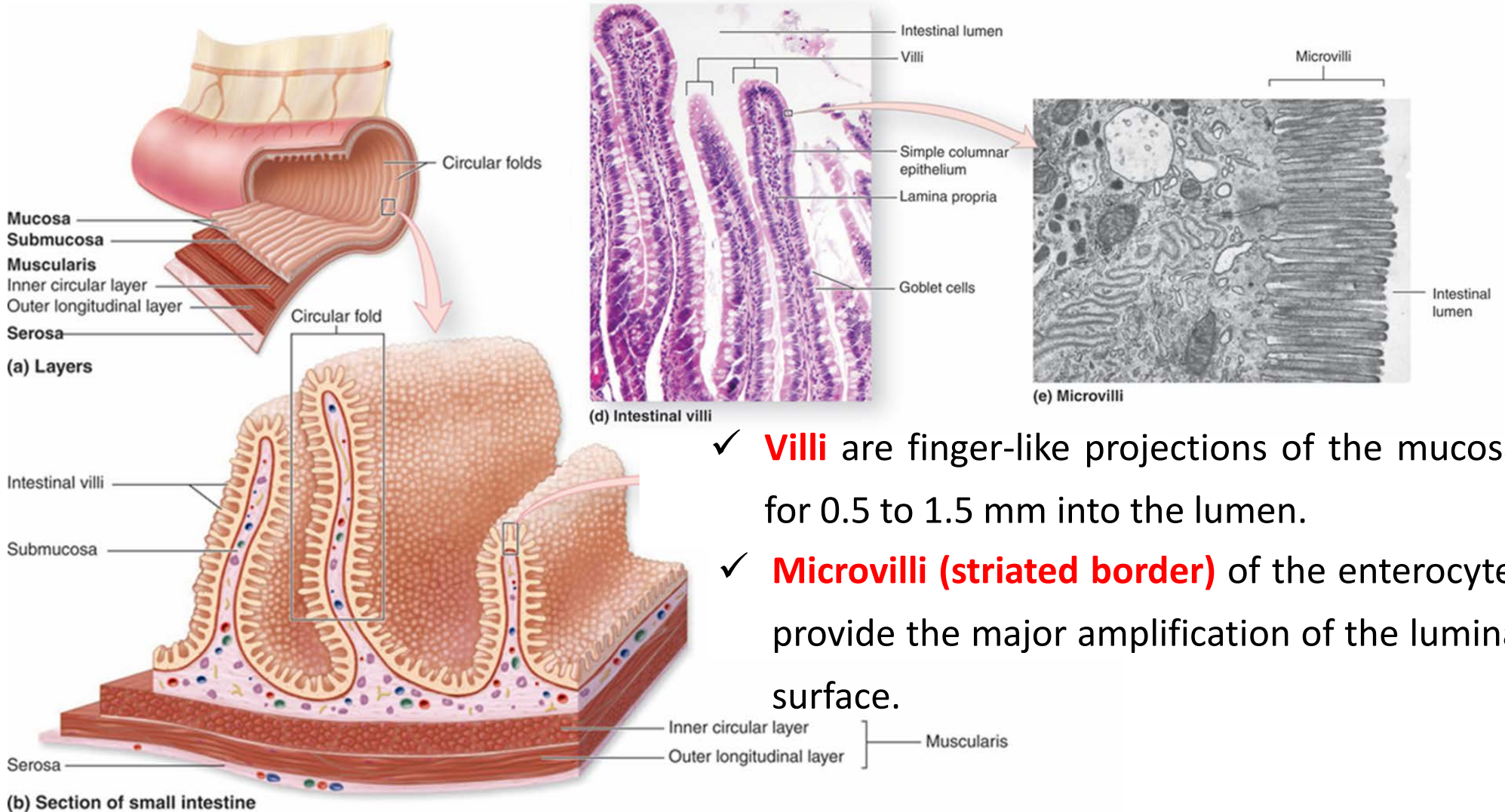


- ✓ **Plicae circulares (circular folds)**, also known as the valves of Kerckring, are permanent transverse folds that contain a core of **submucosa**.

Small Intestine

Histological structure

- The absorptive surface area of the small intestine is amplified by tissue and cell specializations of the submucosa and mucosa.



- ✓ **Villi** are finger-like projections of the mucosa for 0.5 to 1.5 mm into the lumen.
- ✓ **Microvilli (striated border)** of the enterocytes provide the major amplification of the luminal surface.

Small Intestine

Histological structure

I. Mucosa

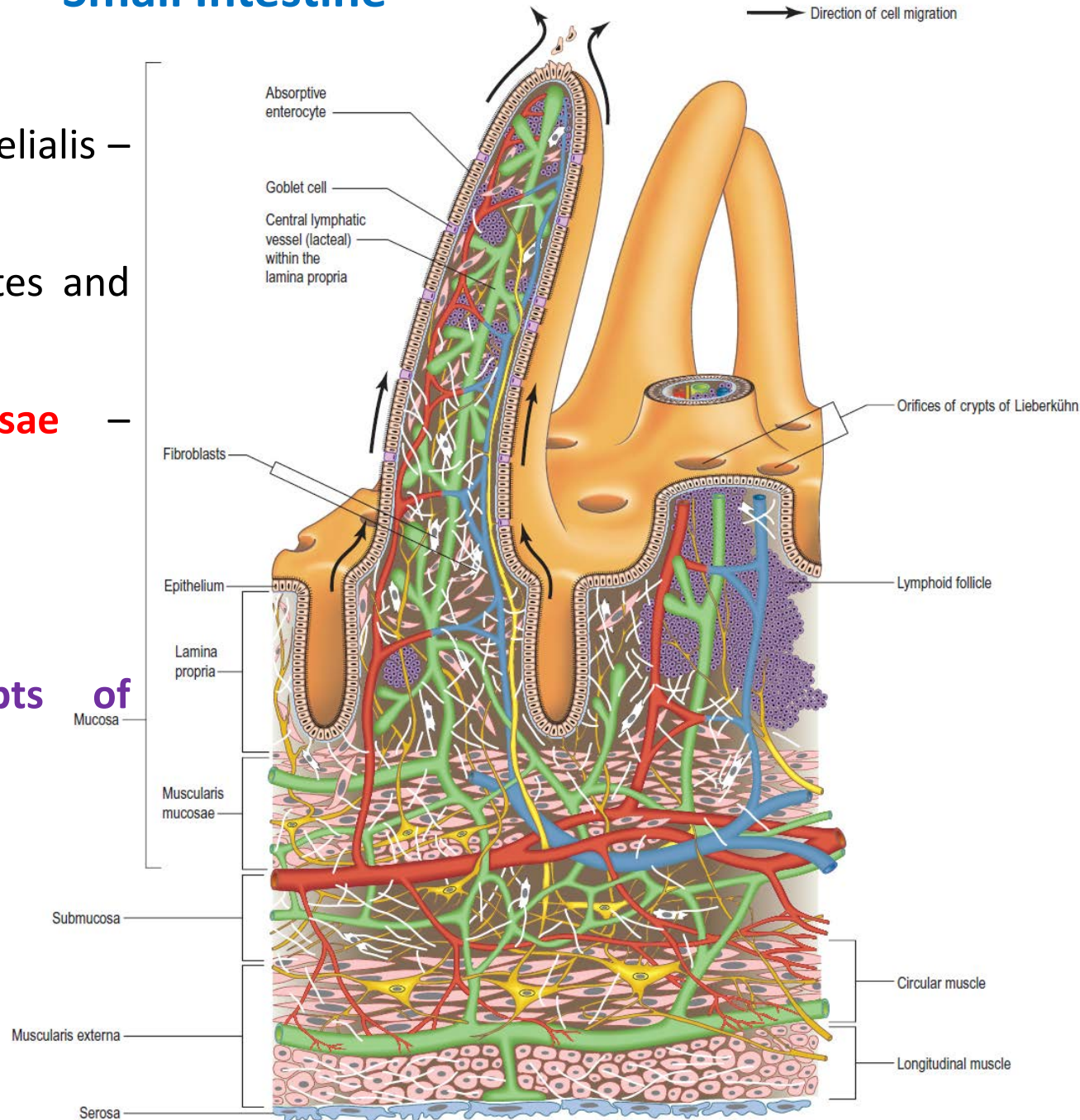
1. **Epithelium**, Lat. lamina epithelialis – **simple columnar epithelium**.

2. **Lamina propria** – lymphocytes and lymphatic nodules (GALT).

3. **Lamina muscularis mucosae** – smooth muscle fibers.

➤ **Intestinal villi.**

➤ **Intestinal glands (crypts of Lieberkühn).**

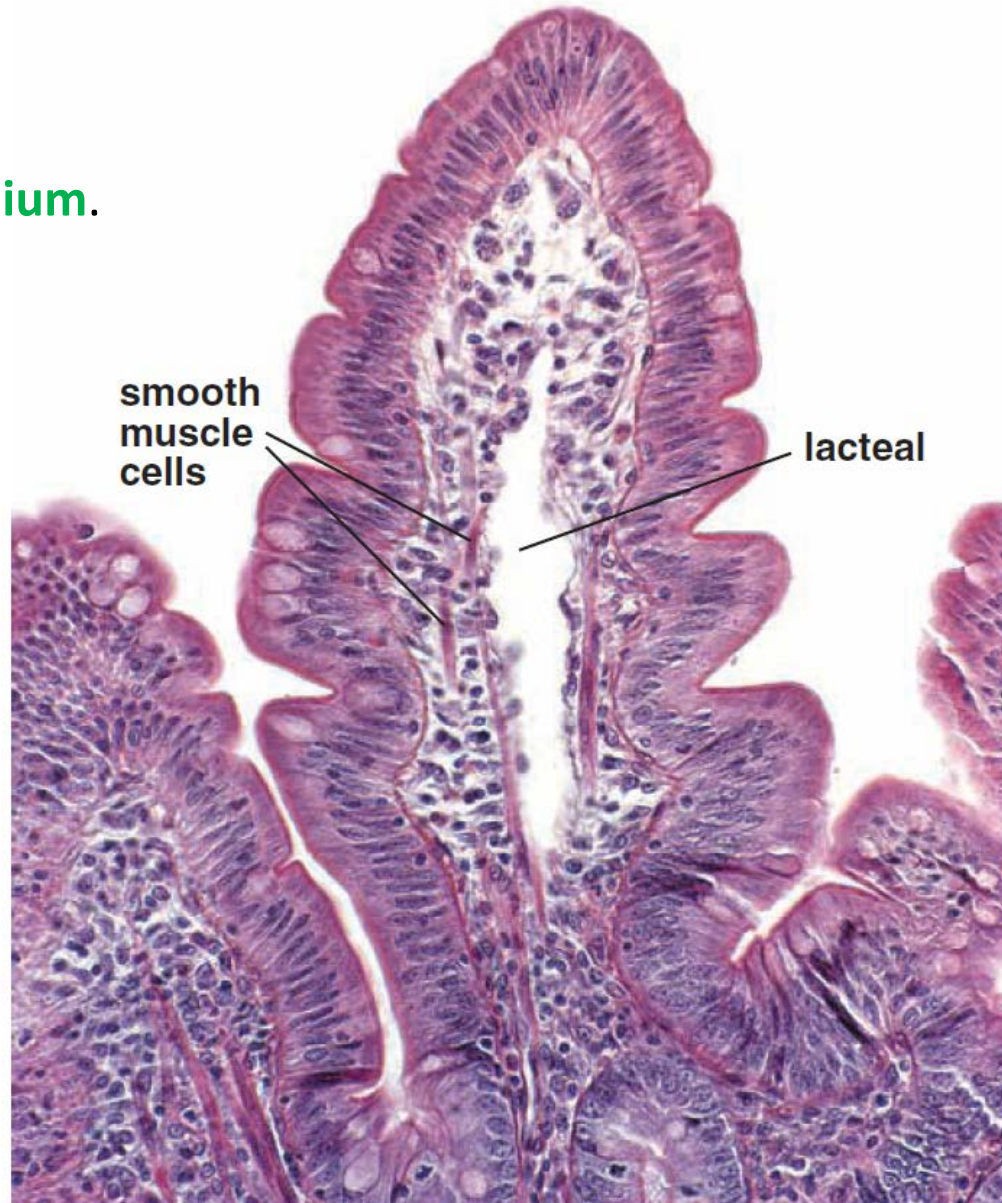


Small Intestine

Histological structure

➤ Intestinal villi.

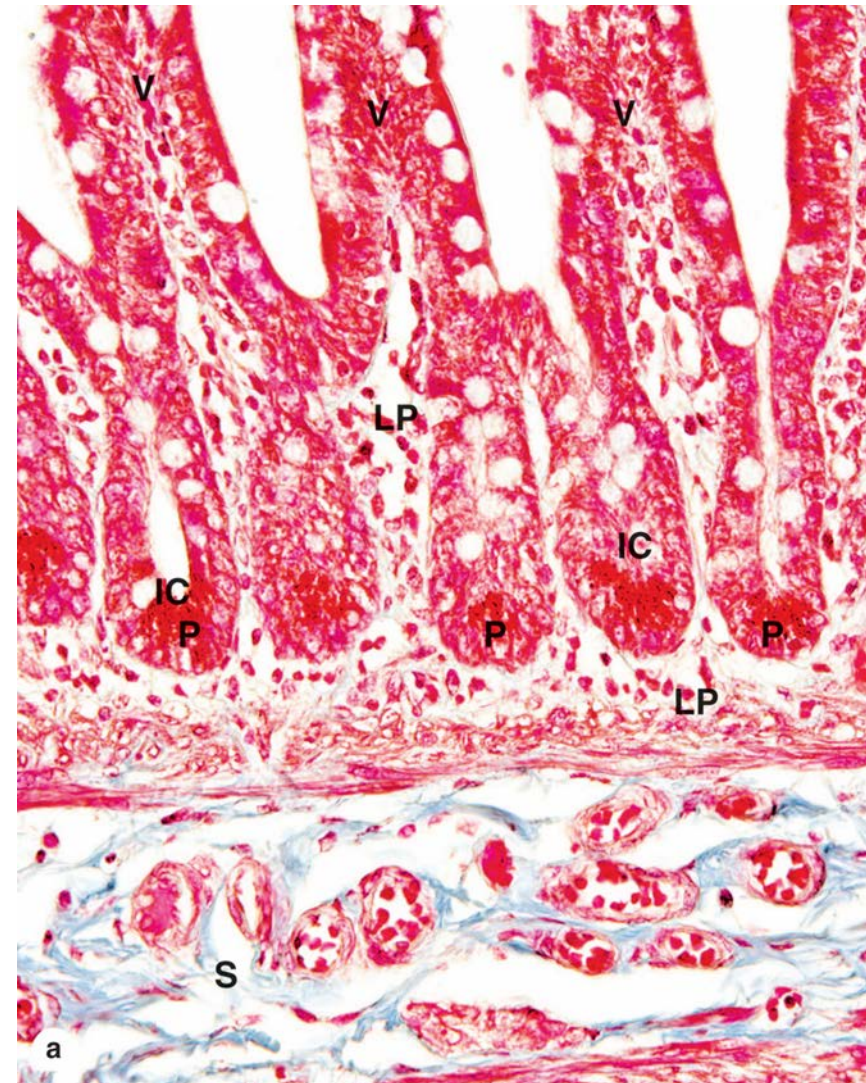
- ✓ Covered by a **simple columnar epithelium**.
- ✓ Core of the villus is an extension of the **lamina propria**.
 - Contains a central, blind-ending **lymphatic capillary** (lacteal).



Small Intestine

Histological structure

- **Intestinal glands.**
 - ✓ **Simple tubular glands**, partially branched.
 - ✓ Composed of a **simple columnar epithelium** that is continuous with the epithelium of the villi.
 - ✓ Secretion of **intestinal juice**.
 - ✓ Located in **lamina propria**.



Small Intestine

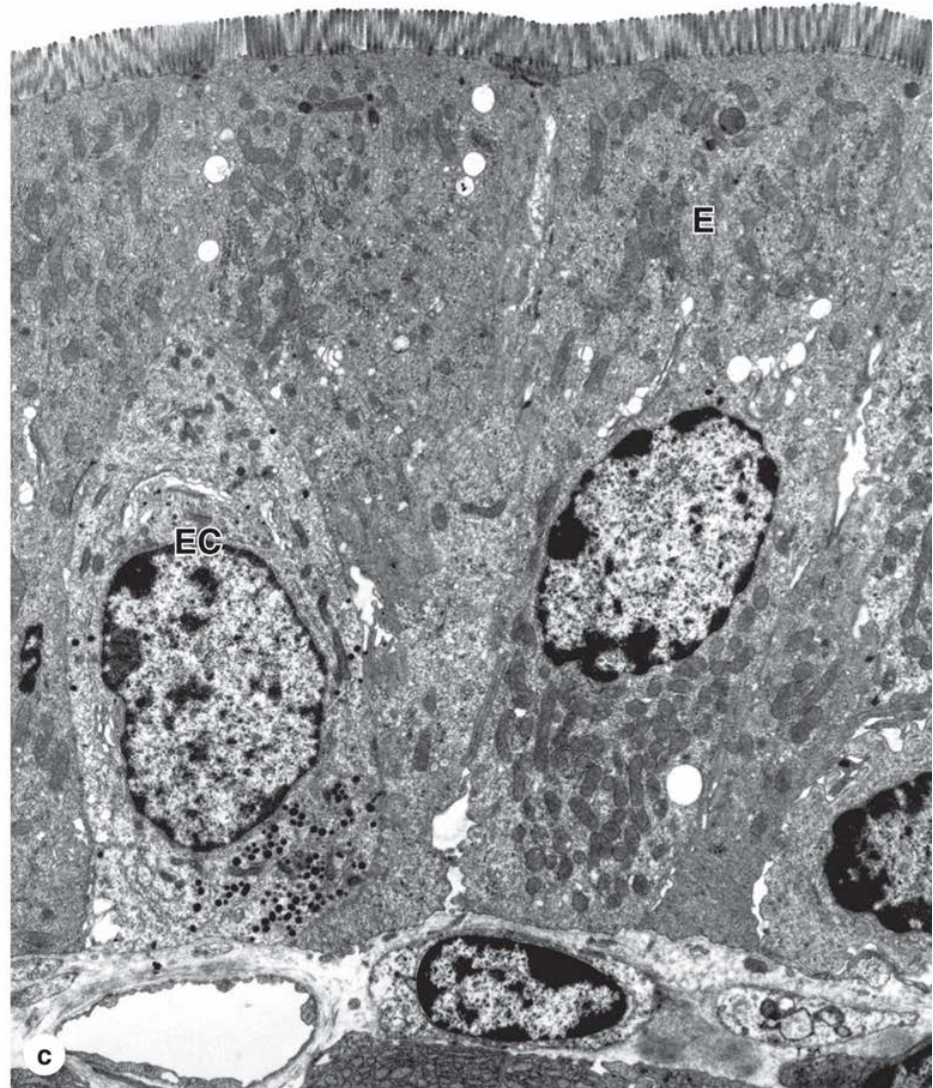
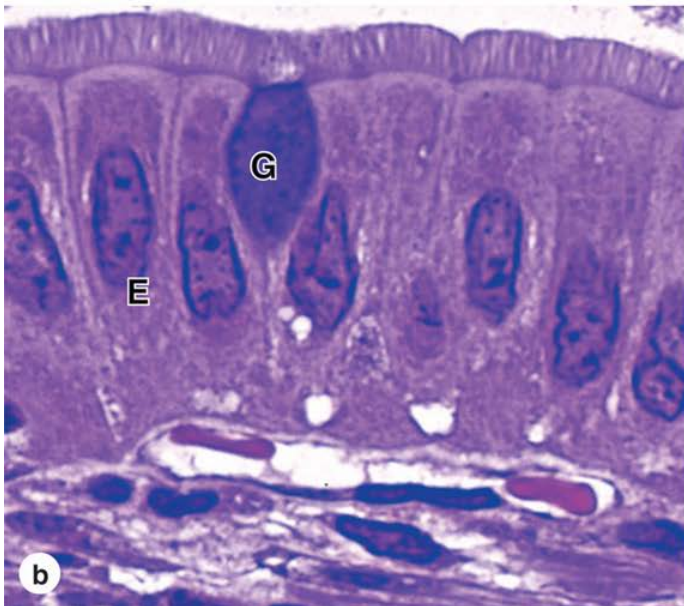
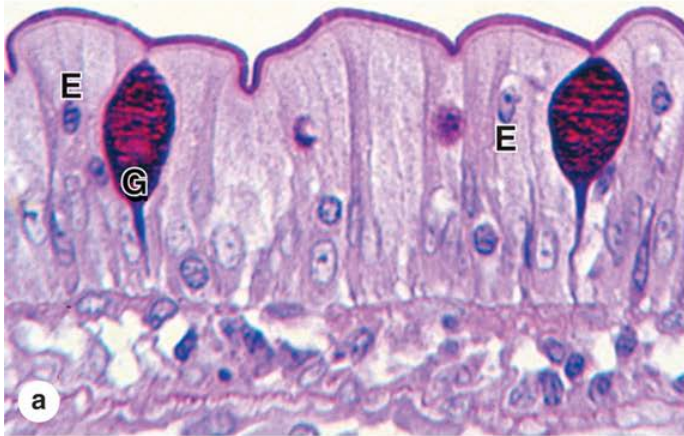
Histological structure

- Five types of cells are found both in the intestinal glands and on the surface of the villi.
 - ✓ **Enterocytes**, whose primary function is absorption.
 - ✓ **Goblet cells**, unicellular mucin-secreting glands.
 - ✓ **Paneth cells located at the bottom of the glands**, whose primary function is to maintain mucosal innate immunity by secreting antimicrobial substances.
 - ✓ **Enteroendocrine cells**, which produce various paracrine and endocrine hormones.
 - ✓ **M cells (microfold cells)**, specialized cells **located in the epithelium** that covers lymphatic nodules in the lamina propria.

Small Intestine

Histological structure

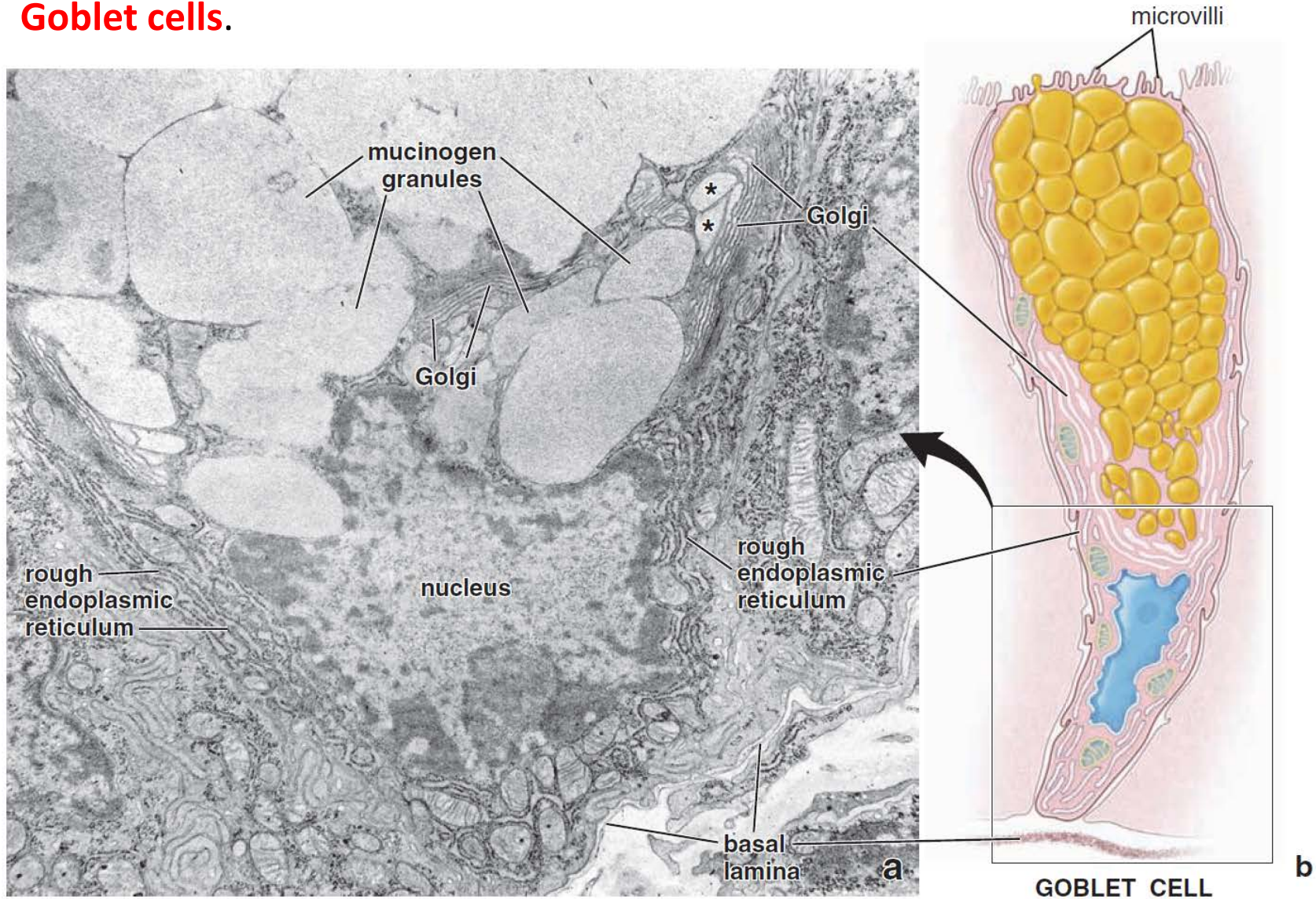
✓ **Enterocytes.**



Small Intestine

Histological structure

✓ Goblet cells.

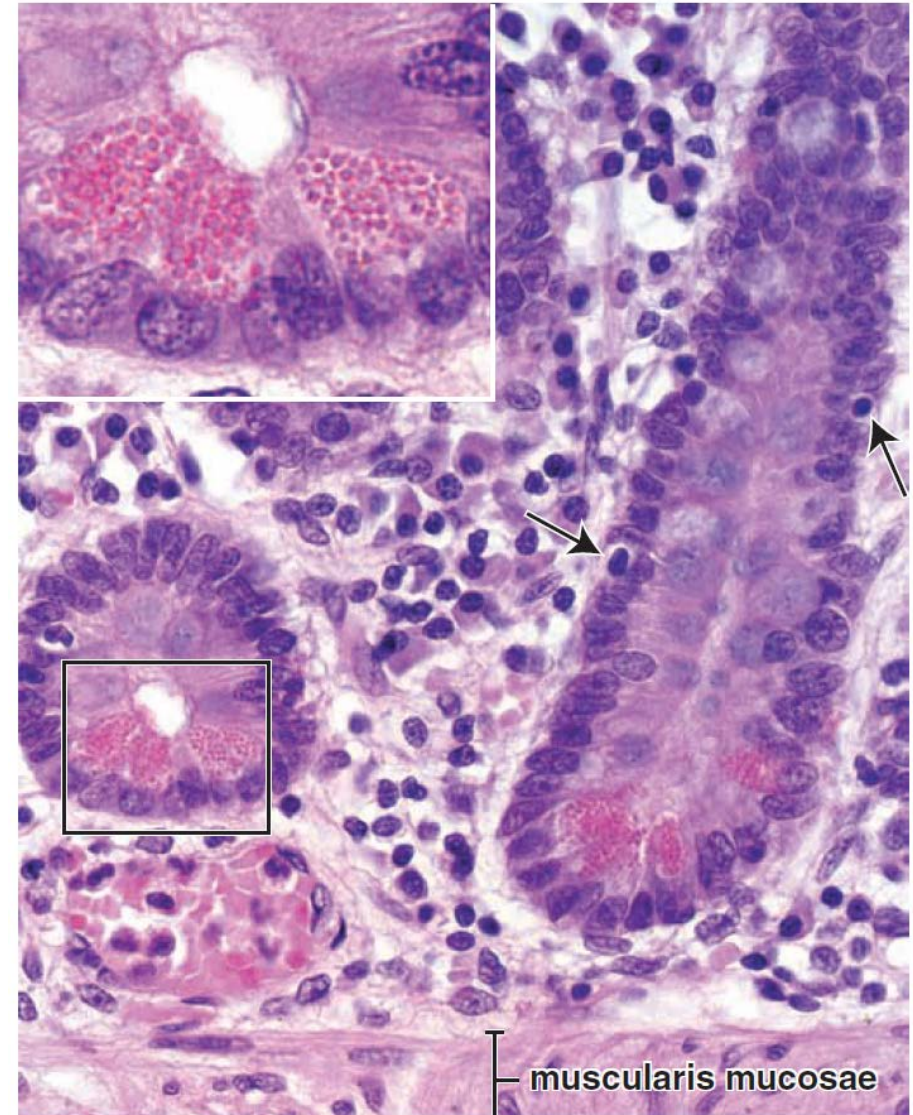


Small Intestine

Histological structure

✓ Paneth cells:

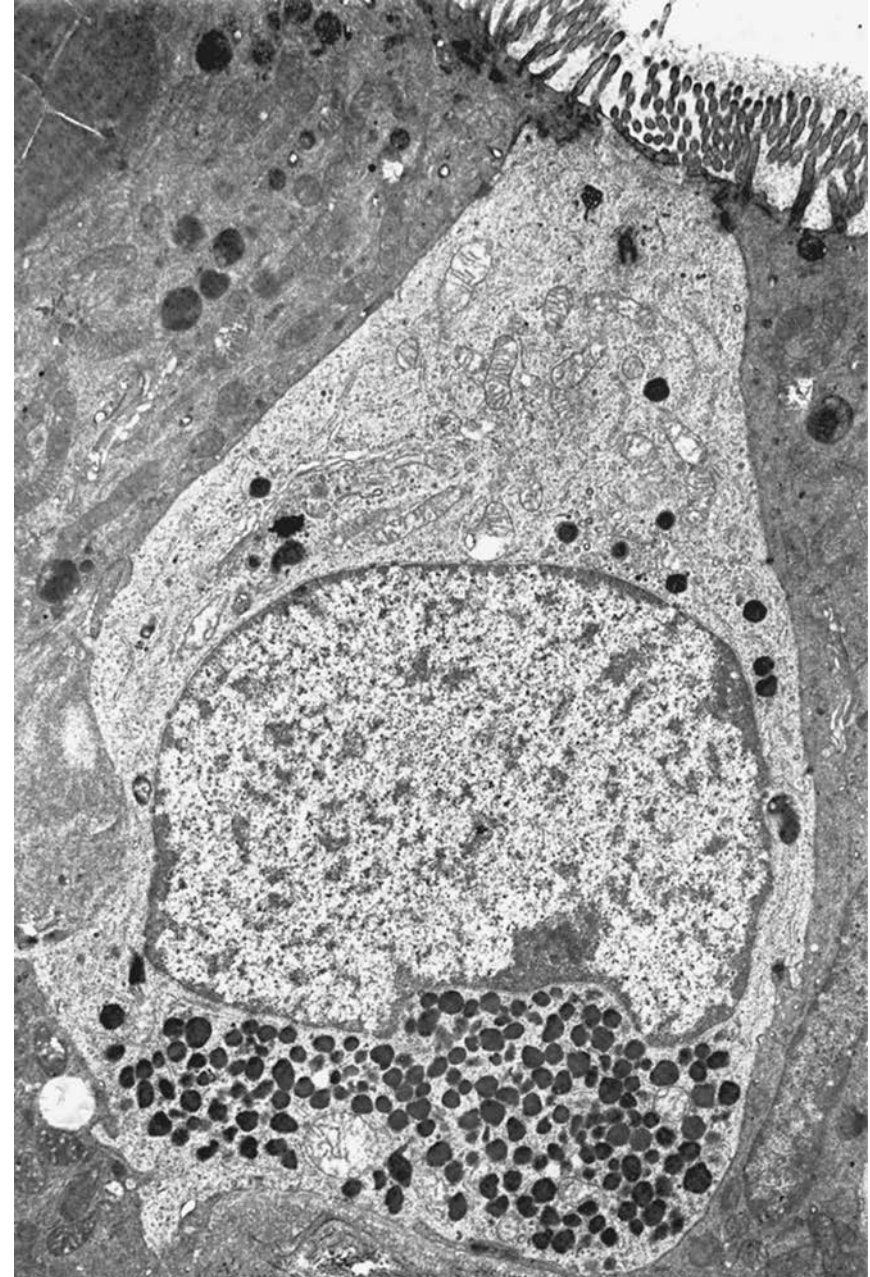
- Located in the basal portion of the intestinal crypts.
- They are exocrine cells with large, eosinophilic secretory granules in their apical cytoplasm.
- Paneth cell granules release **lysozyme**, **phospholipase A2**, and hydrophobic peptides called **defensins**.



Small Intestine

Histological structure

- ✓ **Enteroendocrine cells** produce various paracrine and endocrine **hormones** (**gastrin, somatostatin, cholecystinin, GIP, motilin, secretin**).

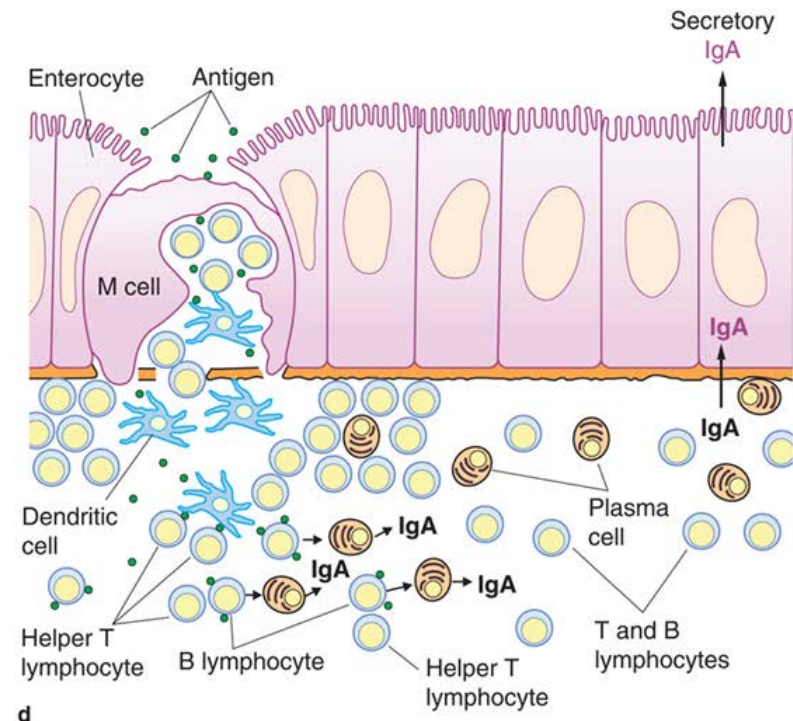
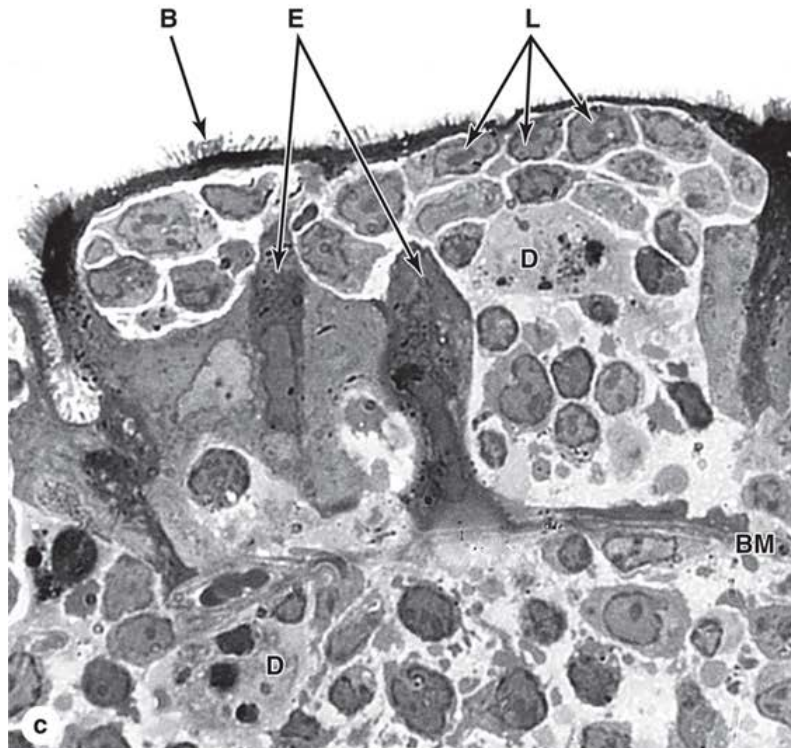


Small Intestine

Histological structure

➤ M cells (microfold cells):

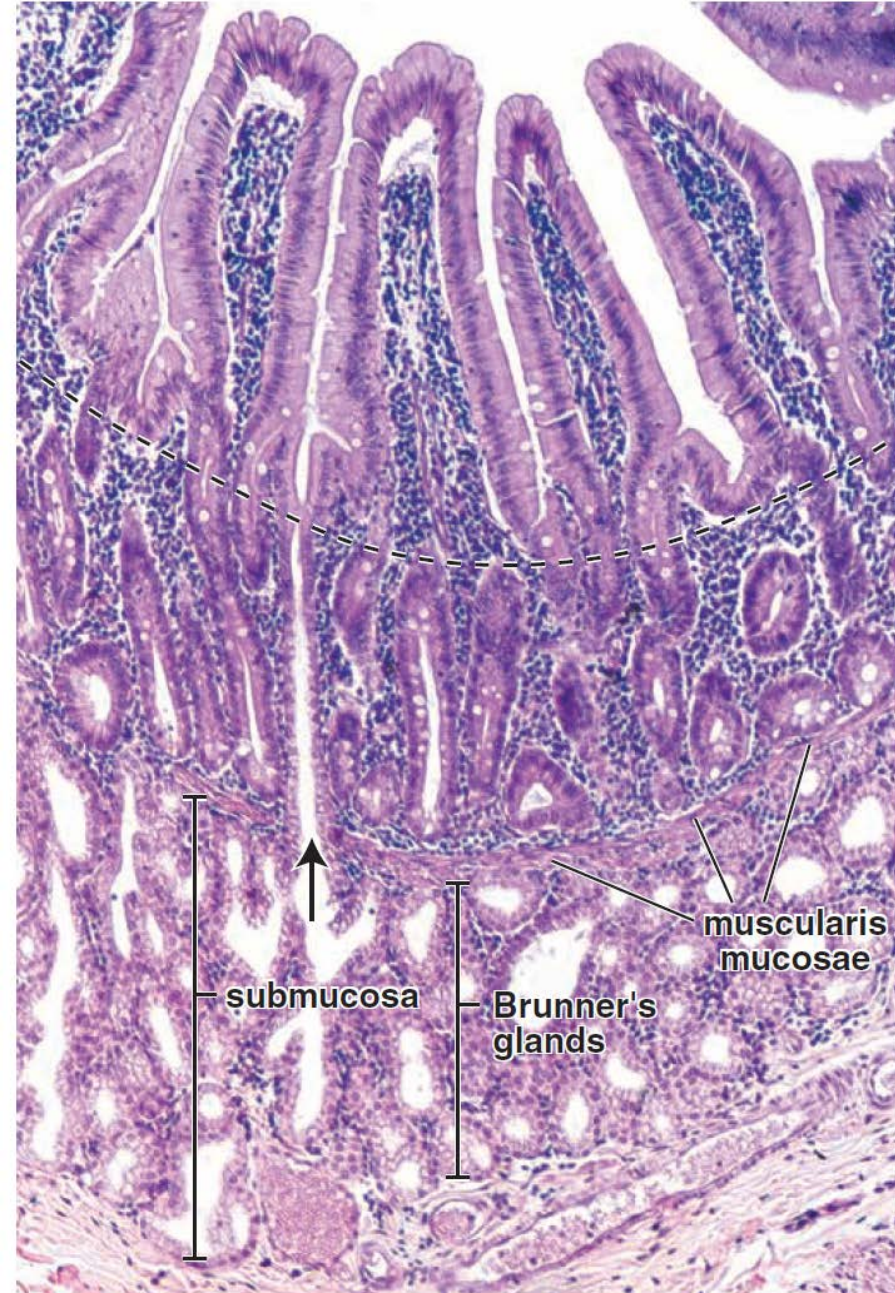
- Specialized cells located in the epithelium that covers **lymphatic nodules** in the lamina propria.
- Characterized by the presence of pockets containing many intraepithelial **lymphocytes** and **antigen-presenting cells**.



Duodenal Glands

Histological structure

- The branched, tubular glands of the duodenum (**Brunner's glands**) are located in the **submucosa**.
- They have secretory cells with characteristics of both **zymogen-secreting** and **mucus-secreting cells**.
- The secretion of these glands has a **pH of 8.1 to 9.3** and contains neutral and alkaline glycoproteins and bicarbonate ions.

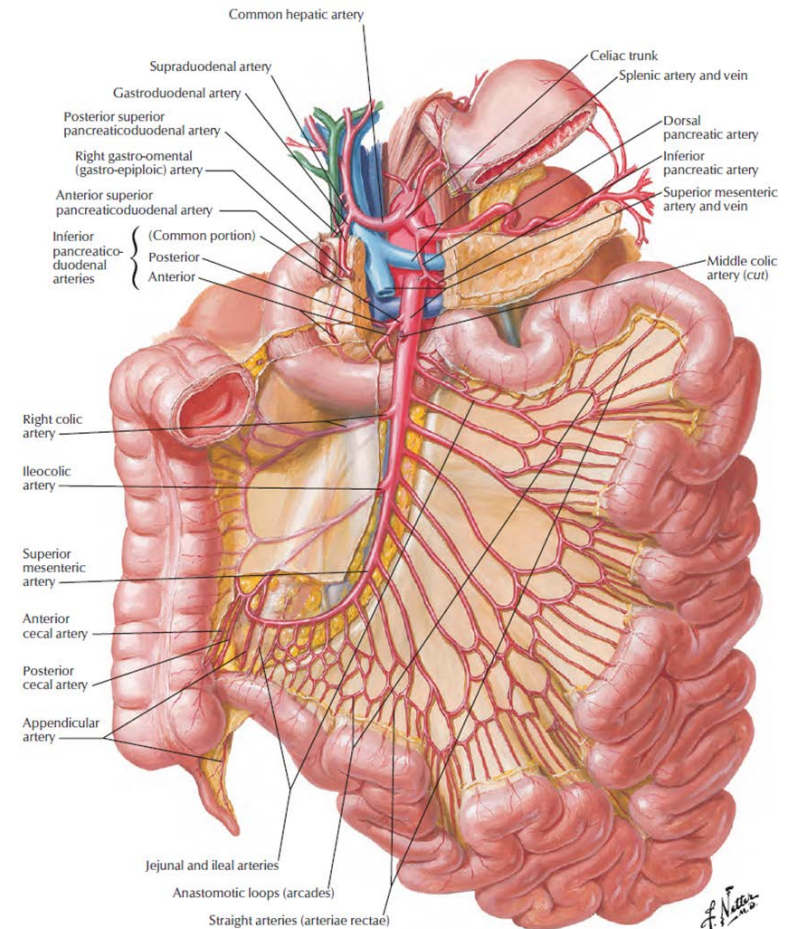
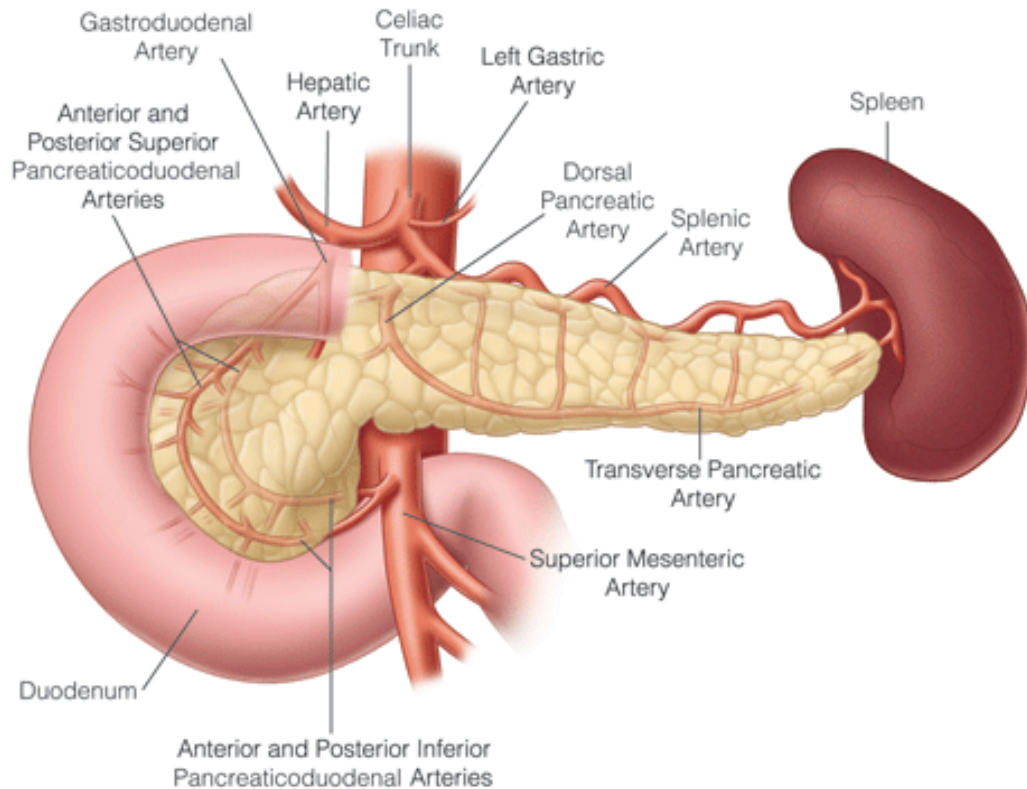


Small Intestine

Arterial supply

➤ Mesenteric small intestine.

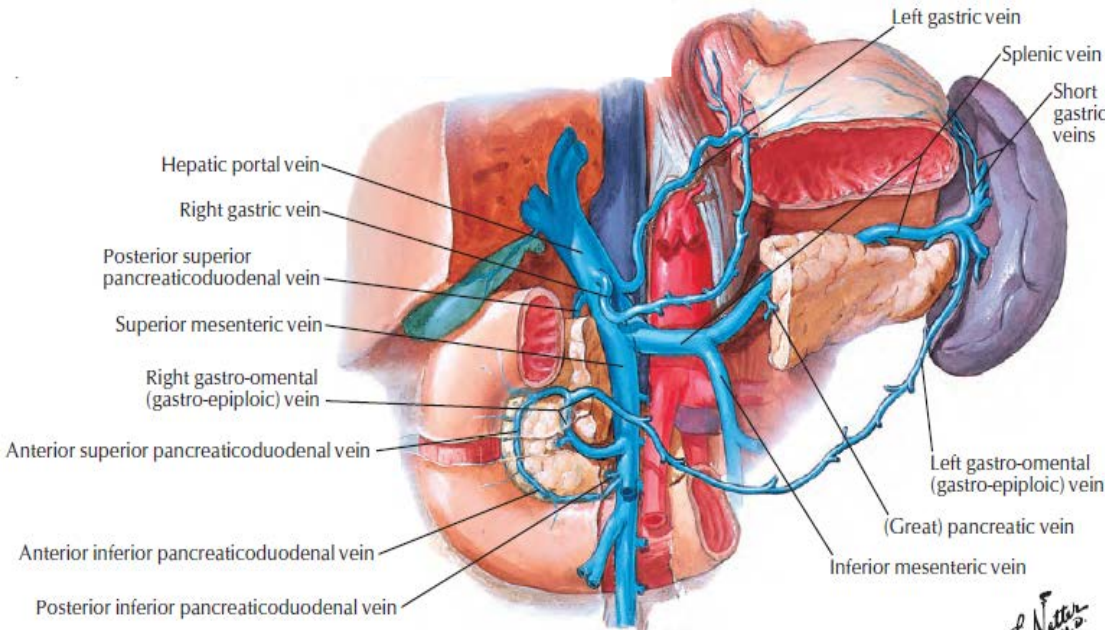
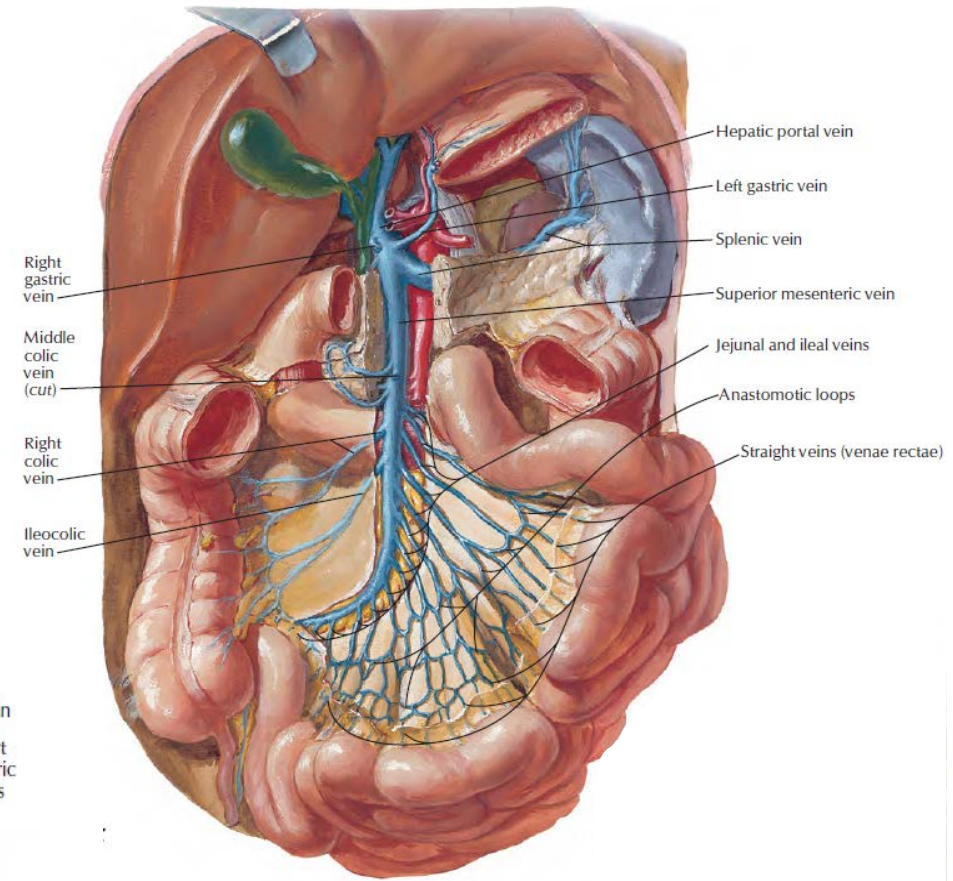
- ✓ **Superior mesenteric artery** → anterior and posterior inferior pancreaticoduodenal arteries.
- ✓ **Superior mesenteric artery** → anterior and posterior inferior pancreaticoduodenal arteries.



Venous drainage

- Duodenum.
 - ✓ Pancreaticoduodenal veins → portal vein.
- Mesenteric small intestine.
 - ✓ Jejunal and ileal veins → superior mesenteric vein → portal vein.

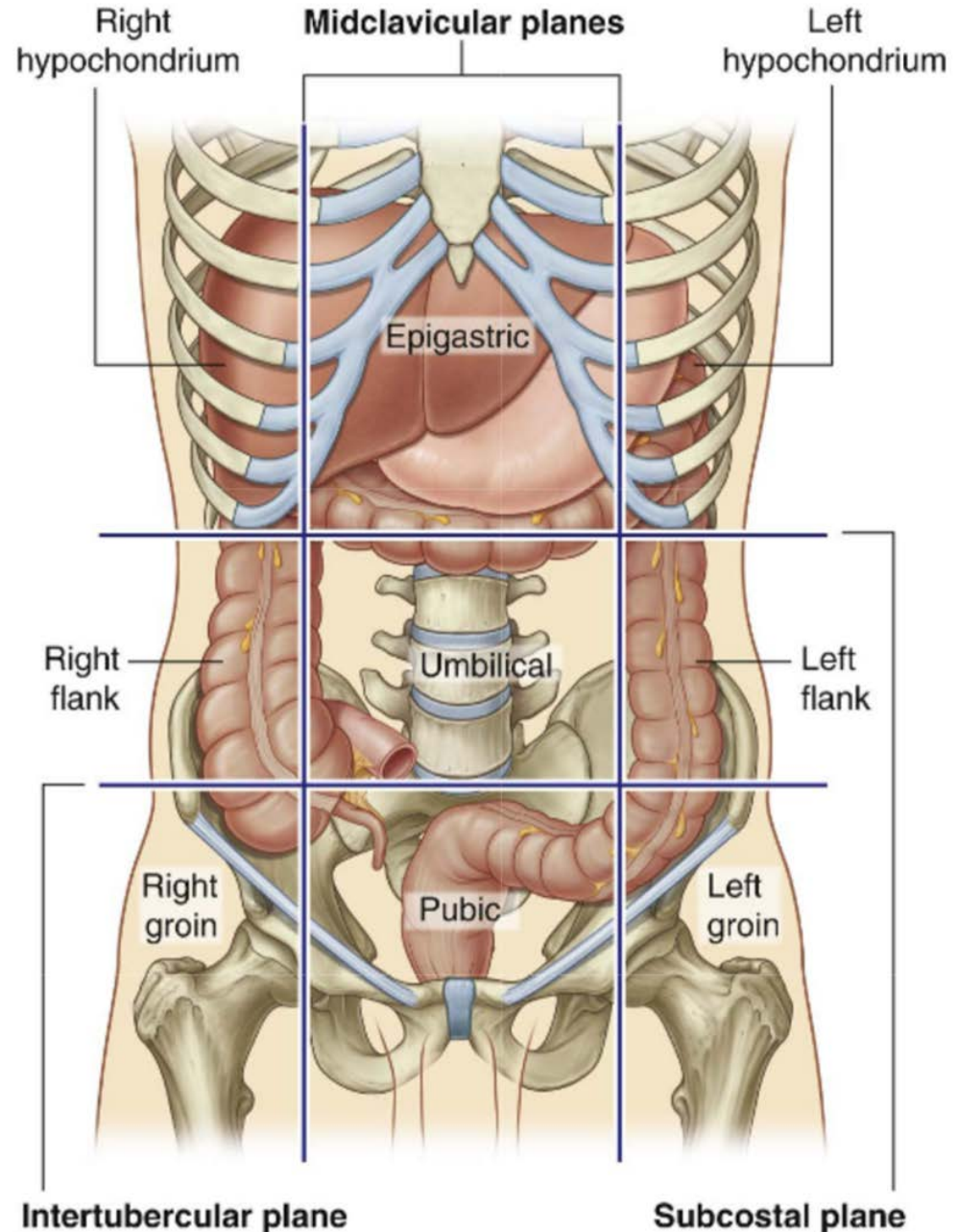
Small Intestine



F. Netter M.D.

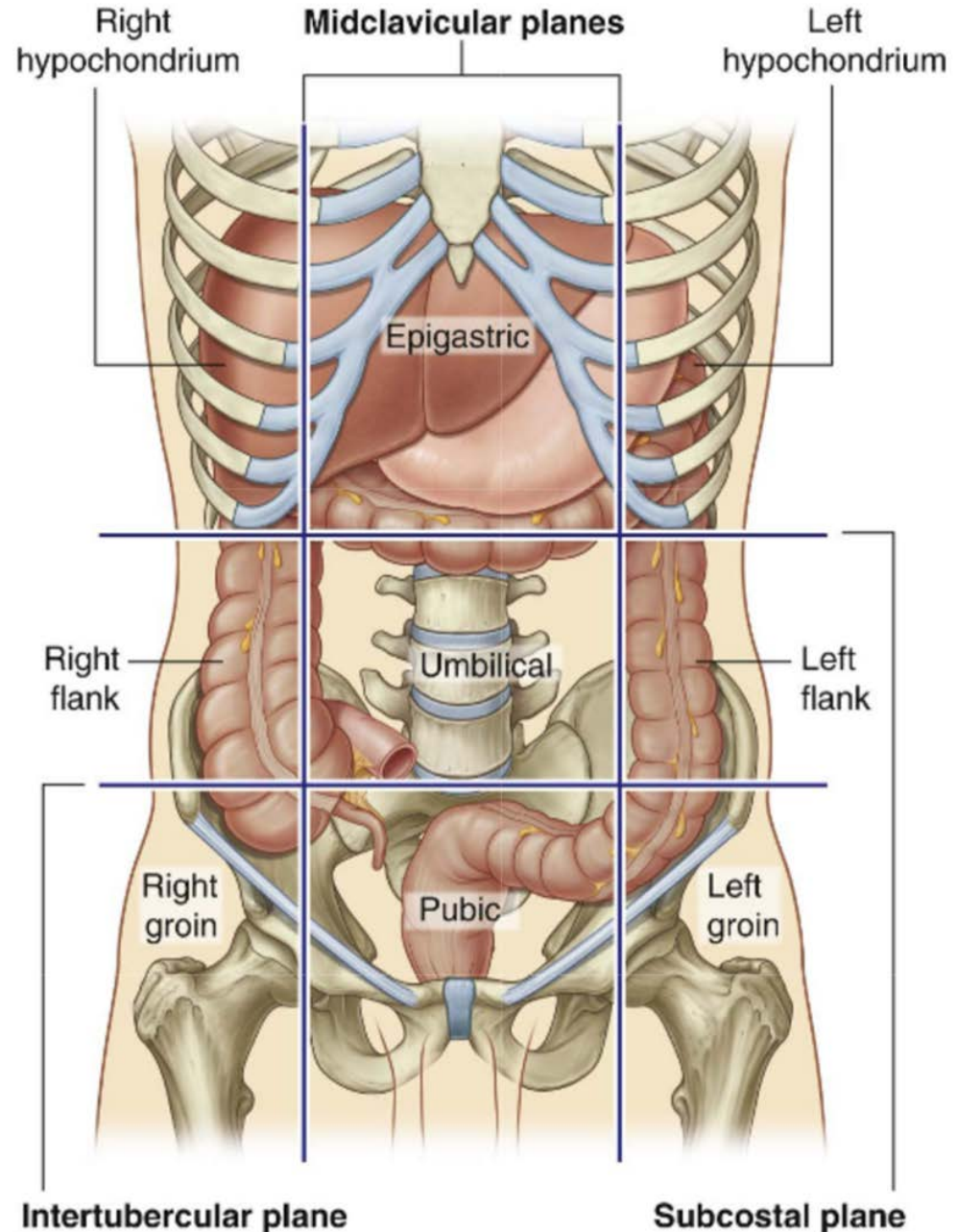
Large Intestine

- The large intestine extends from the **ileocaecal junction** to the **anus**.
- In the adult, the large intestine is approximately 1 to 1.5 m long in vivo.
- Its total capacity is 2 to 3 l.
- **Main functions:**
 - ✓ Stool formation and defecation.
 - ✓ Absorption of fluids and electrolytes.
 - ✓ Breakdown of cellulose and mucus.



Large Intestine

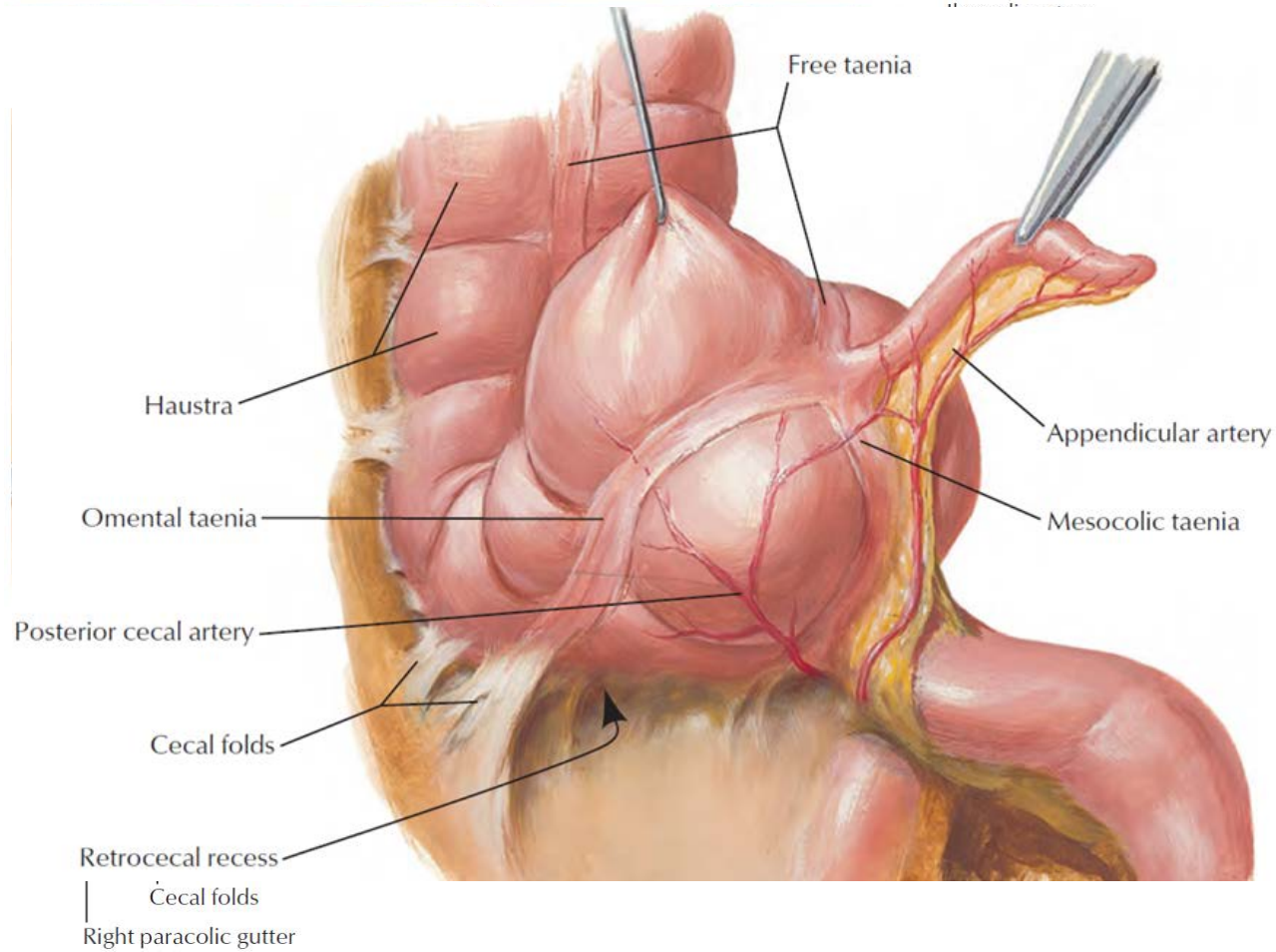
- Large intestine has **three** anatomical parts:
- ✓ **Cecum** (Lat. caecum) with **appendix** (Lat. appendix vermiformis).
 - ✓ **Colon.**
 - **Ascending colon.**
 - **Transverse colon.**
 - **Descending colon.**
 - **Sigmoid colon.**
 - ✓ **Rectum** and **anal canal.**



Caecum

External features and relations

- Blind pouch, measuring approximately 6 cm in length.
- Lies below the level of the **ileocolic junction**.
- Usually lies adjacent to the anterior abdominal wall.
- **Intraperitoneal position** – completely covered by peritoneum (**does not have mesentery**).
- It is continuous with the **ascending colon** at the entrance of the ileum.
- The **appendix** is attached to it posteromedially, just inferior to the end of the ileum.

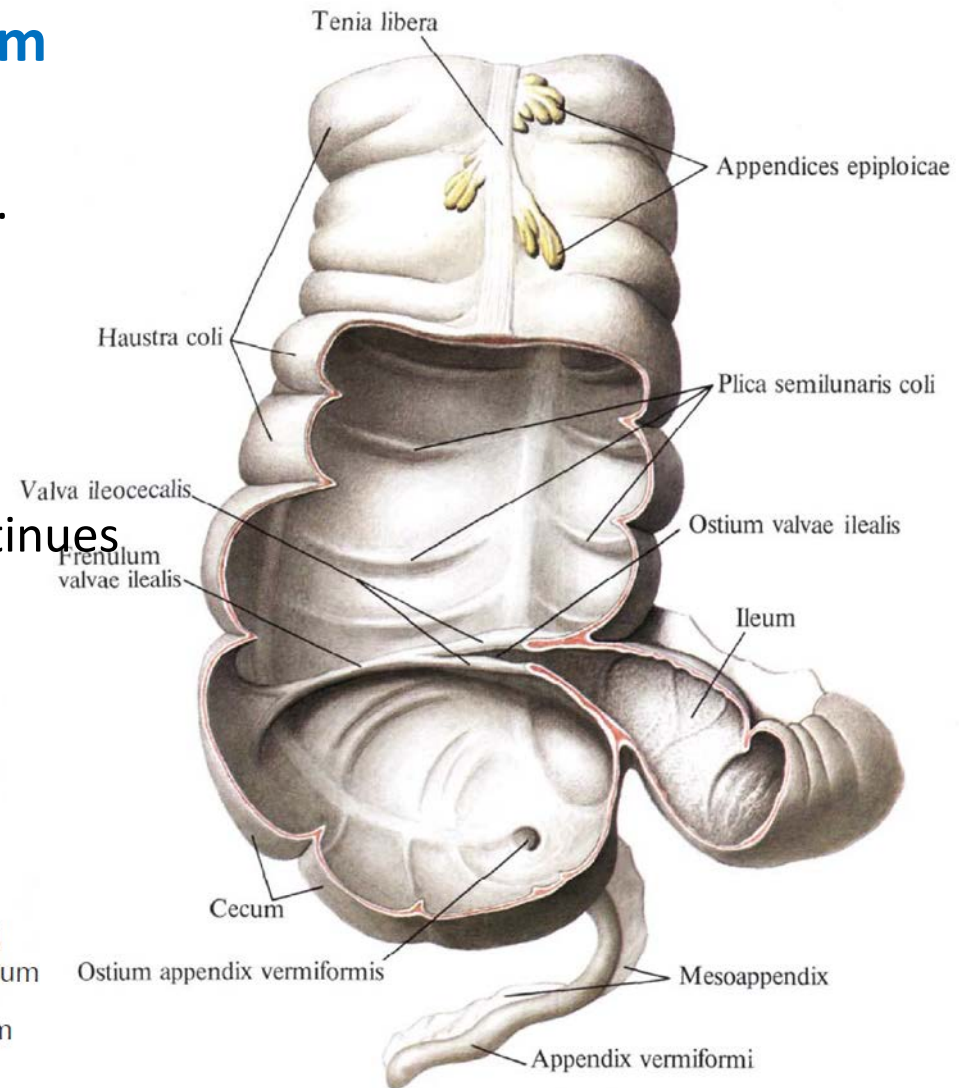
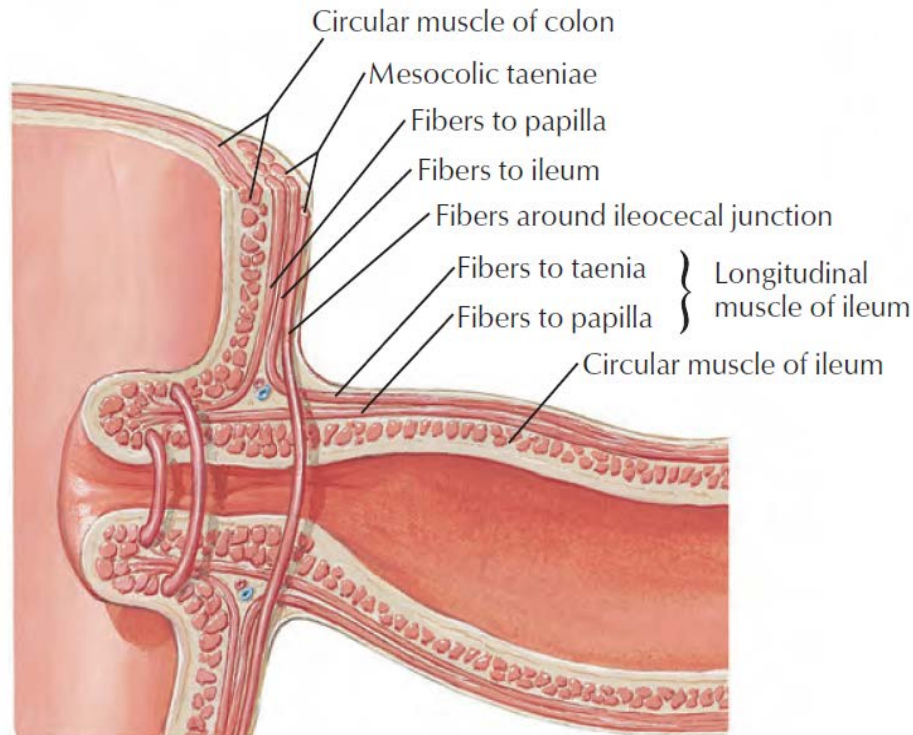


Caecum

➤ **Ileocecal fold** (Bauchin or Tulp valve):

✓ **Ileocecal orifice** – papillary or labial type.

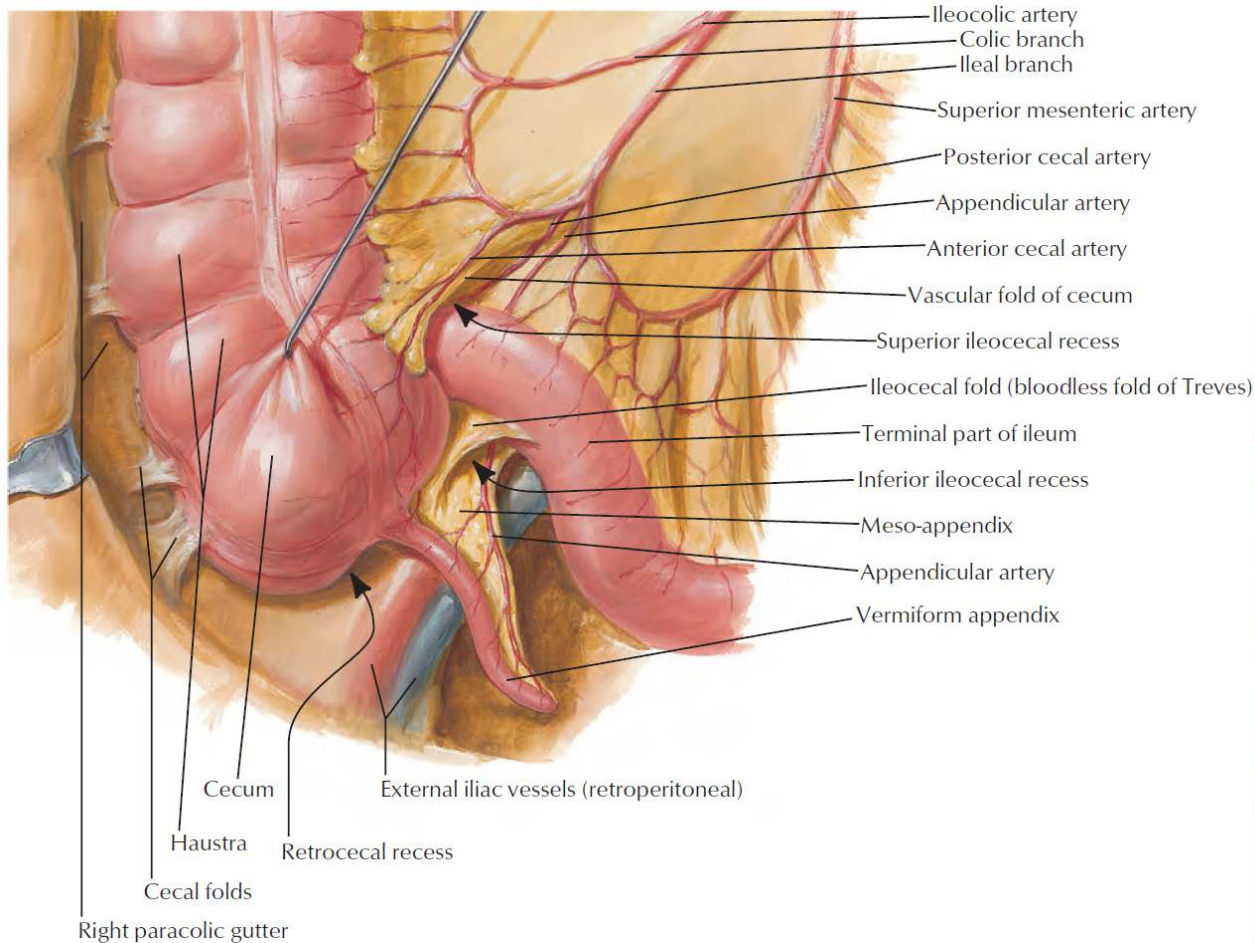
- **Superior labial fold.**
- **Inferior labial fold.**
- **Frenulum** of the ileocecal orifice.
- Musculature from the ileum continues into each flap, forming a sphincter.



Appendix

The **appendix**, Lat. appendix vermiformis:

- The vermiform (worm-like) appendix is a narrow, blind-ending tube.
- Usually between 6 and 10 cm long in the adult with diameter of 6 to 7 mm.
- It is 2-4 cm below the ileocecal valve, **where the three taeniae coli merge**.
- Intraperitoneal organ (**mesoappendix**).



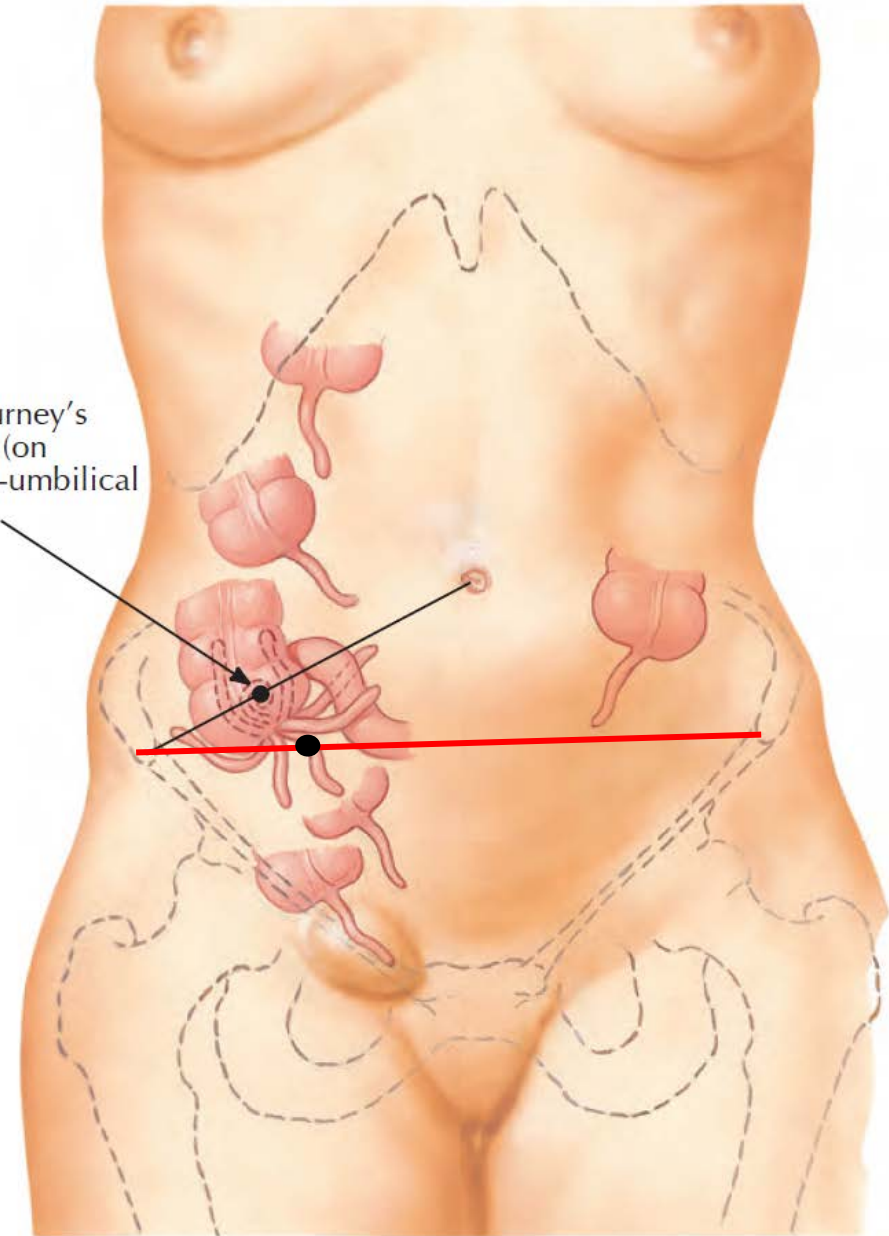
Appendix

Positions of appendix

- Pelvic position.
- Subcecal location
- Lateral ascending.
- Medial (preileal position or postileal position).
- Posterior ascending (retrocecal or retrocolic position).

Surface projections

- The surface projection of the base of the appendix is at the junction of the lateral and middle one-third of a line from the anterior superior iliac spine to the umbilicus (**McBurney's point**).
- **Lanz point**.

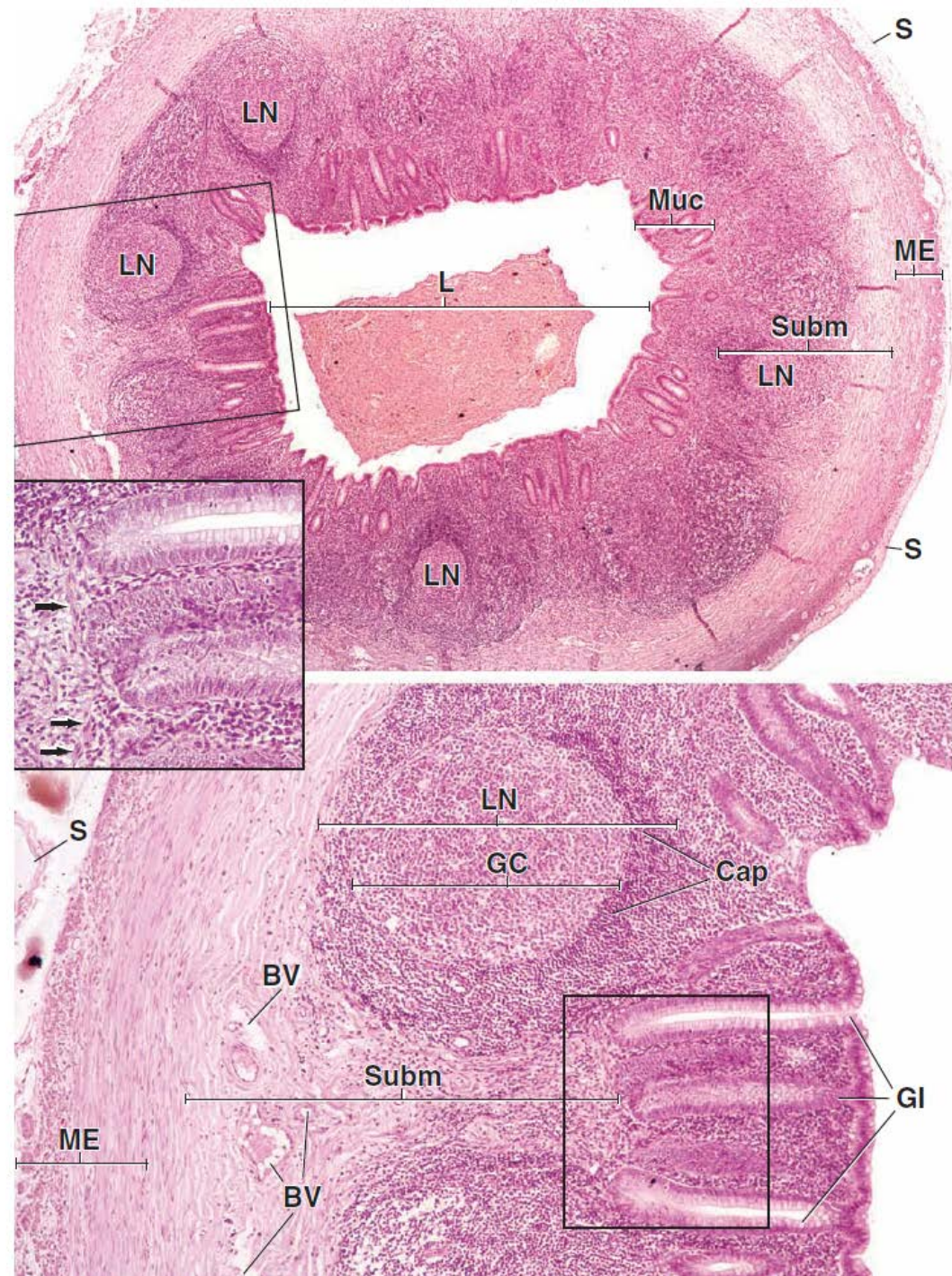


Variations in position of appendix

Appendix

Histological structure

- I. **Mucosa**, Lat. tunica mucosa.
 1. Epithelium – **simple columnar epithelium**.
 2. Lamina propria – **intestinal glands** and 150 to 200 **lymph follicles** (intestinal tonsil, Lat. tonsilla intestinalis).
 3. Muscularis mucosa.
- II. **Submucosa**, Lat. tela submucosa.
- III. **Muscularis externa**, Lat. tunica muscularis – **inner circular** and **outer longitudinal layers**.
- IV. **Serosa**, Lat. tunica serosa.



Caecum and Appendix

Blood supply

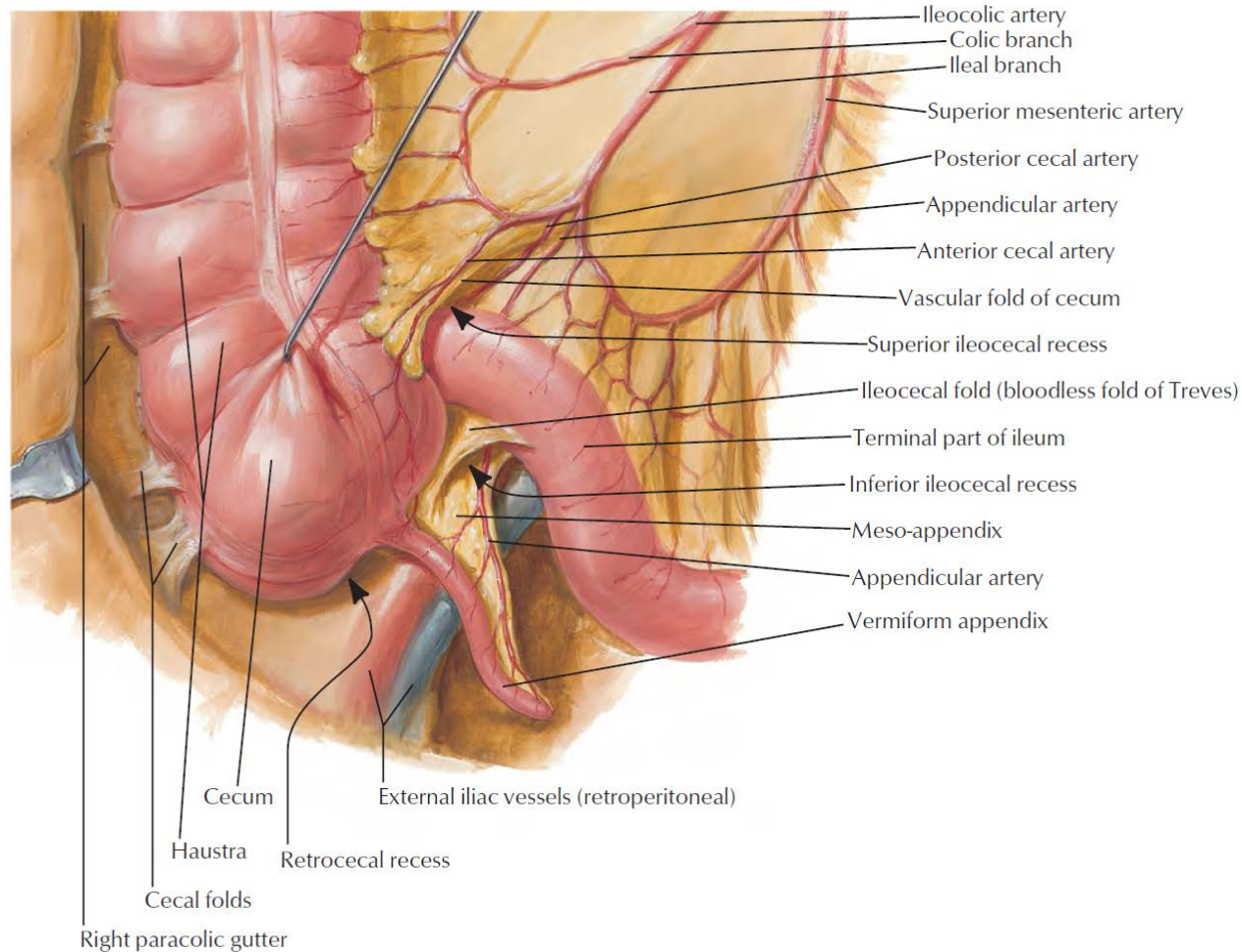
➤ Caecum – **ileocolic artery** (a. ileocolica) from **superior mesenteric artery**:

✓ **Anterior cecal artery** (a. ceacalis anterior).

✓ **Posterior cecal artery** (a. ceacalis posterior)

➤ Appendix:

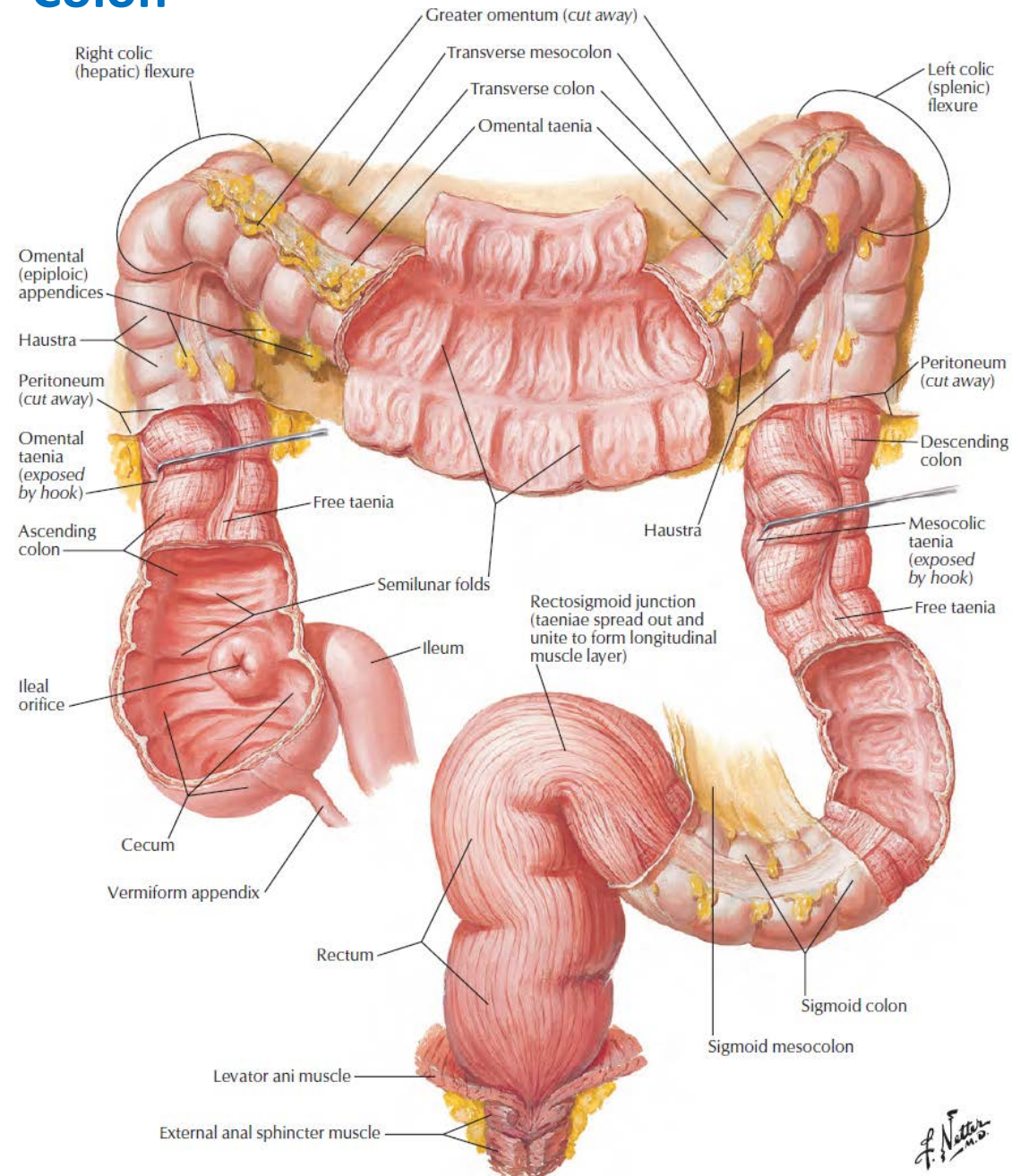
✓ **Appendicular artery** (a. appendicularis).



Colon

➤ The colon extends superiorly from the cecum and consists of:

- ✓ **Ascending colon**, Lat. colon ascendens.
- ✓ **Transverse colon**, Lat. colon transversum.
- ✓ **Descending colon**, Lat. colon descendens.
- ✓ **Sigmoid colon**, Lat. colon sigmoideum.

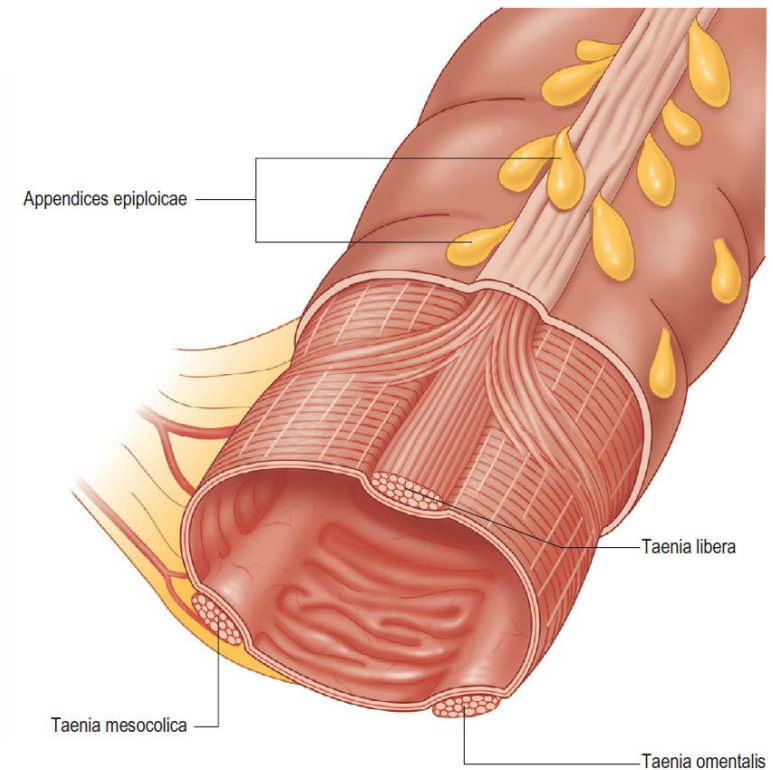
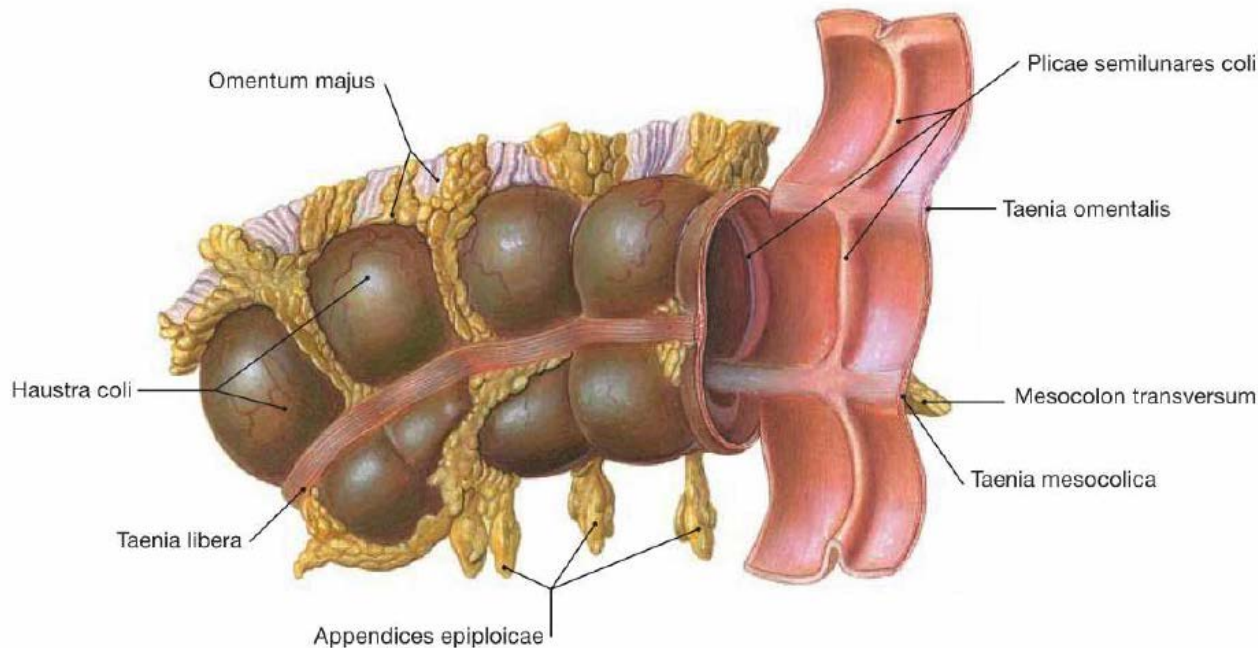


Colon

Distinct external features

- Three longitudinal equally spaced bands, Lat. **taeniae coli**:
 - ✓ **Free taenia**, Lat. taenia libera.
 - ✓ **Omental taenia**, Lat. taenia omentalis.
 - ✓ **Mesocolic taenia**, Lat. taenia mesocolica.

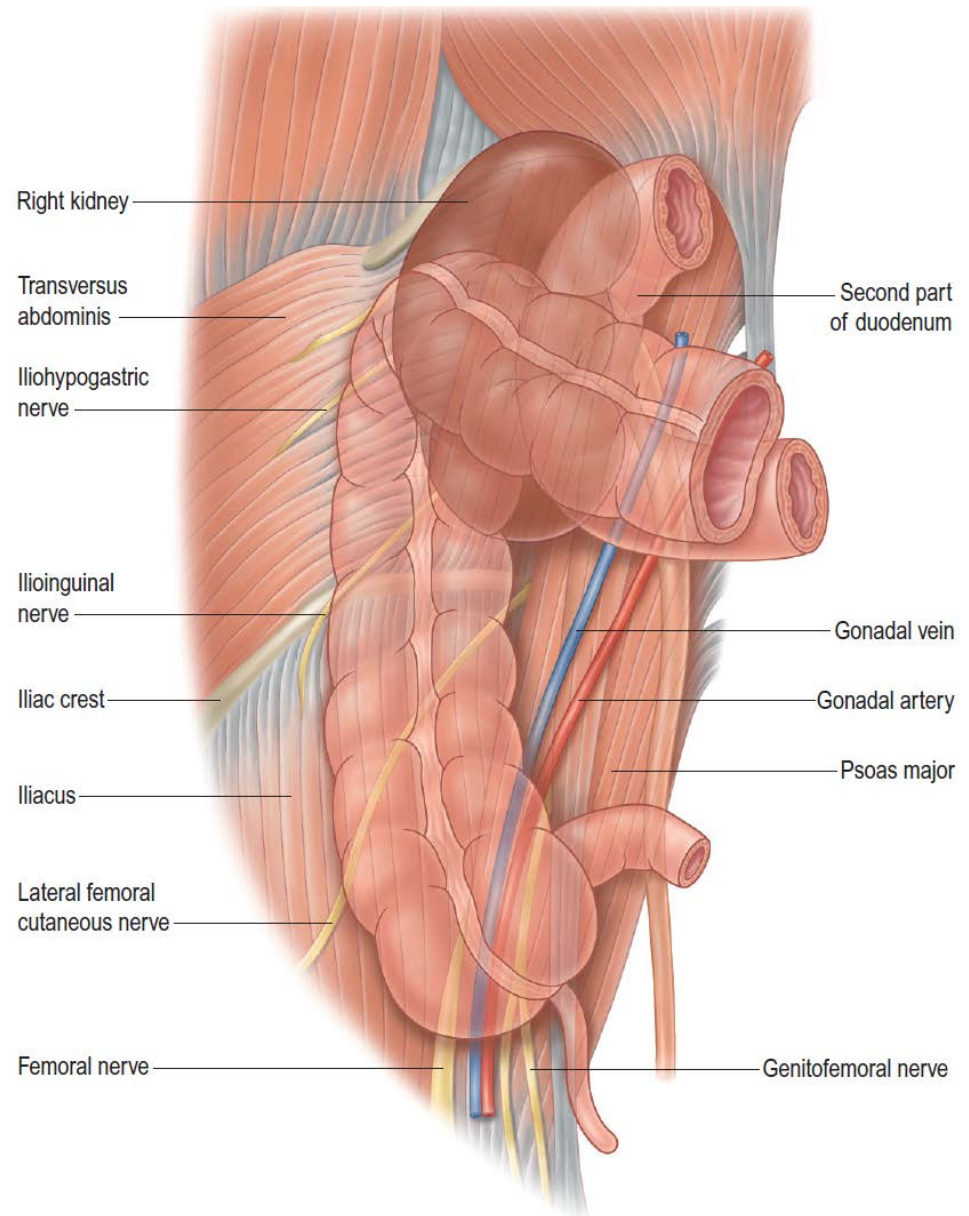
- Sacculations (haustrations), Lat. **haustreae**.
- **Omental appendices**, Lat. appendices epiploicae (omentales).
- **Semilunar folds**, Lat. plicae semilunares coli.



Ascending Colon

Anatomical relations

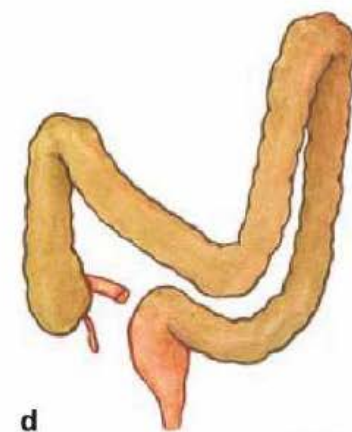
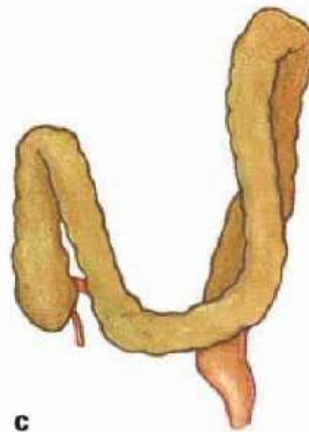
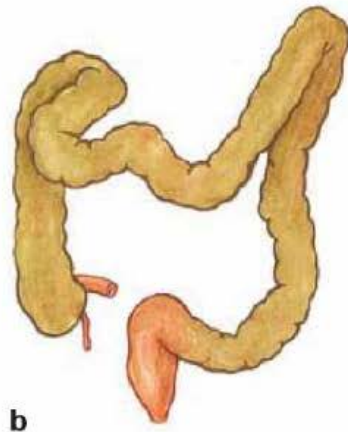
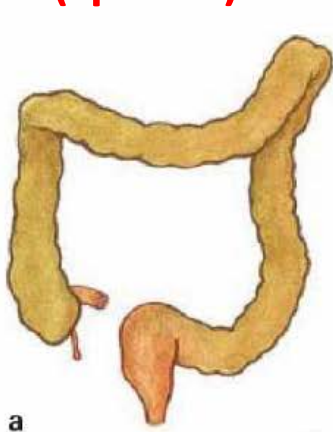
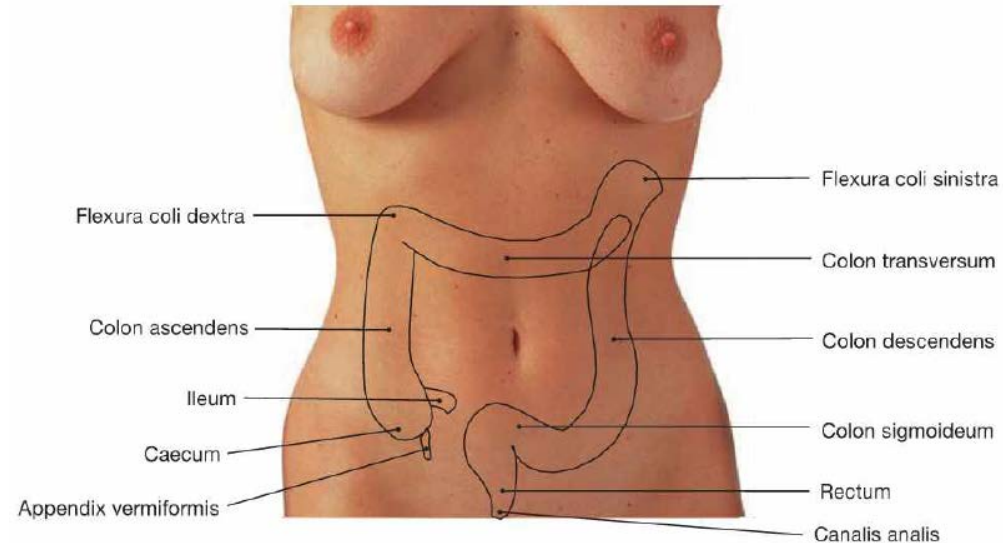
- The ascending colon is 15–20 cm long.
- Passes upwards from the **ileocolic junction** to the **right colic (hepatic) flexure**.
- **Mesoperitoneal position**.
- Immediately lateral to the ascending colon is the **right paracolic gutter** (Lat. canalis lateralis dexter).
- The **hepatic flexure** is at the junction between the ascending and transverse colon.



Transverse Colon

Anatomical relations

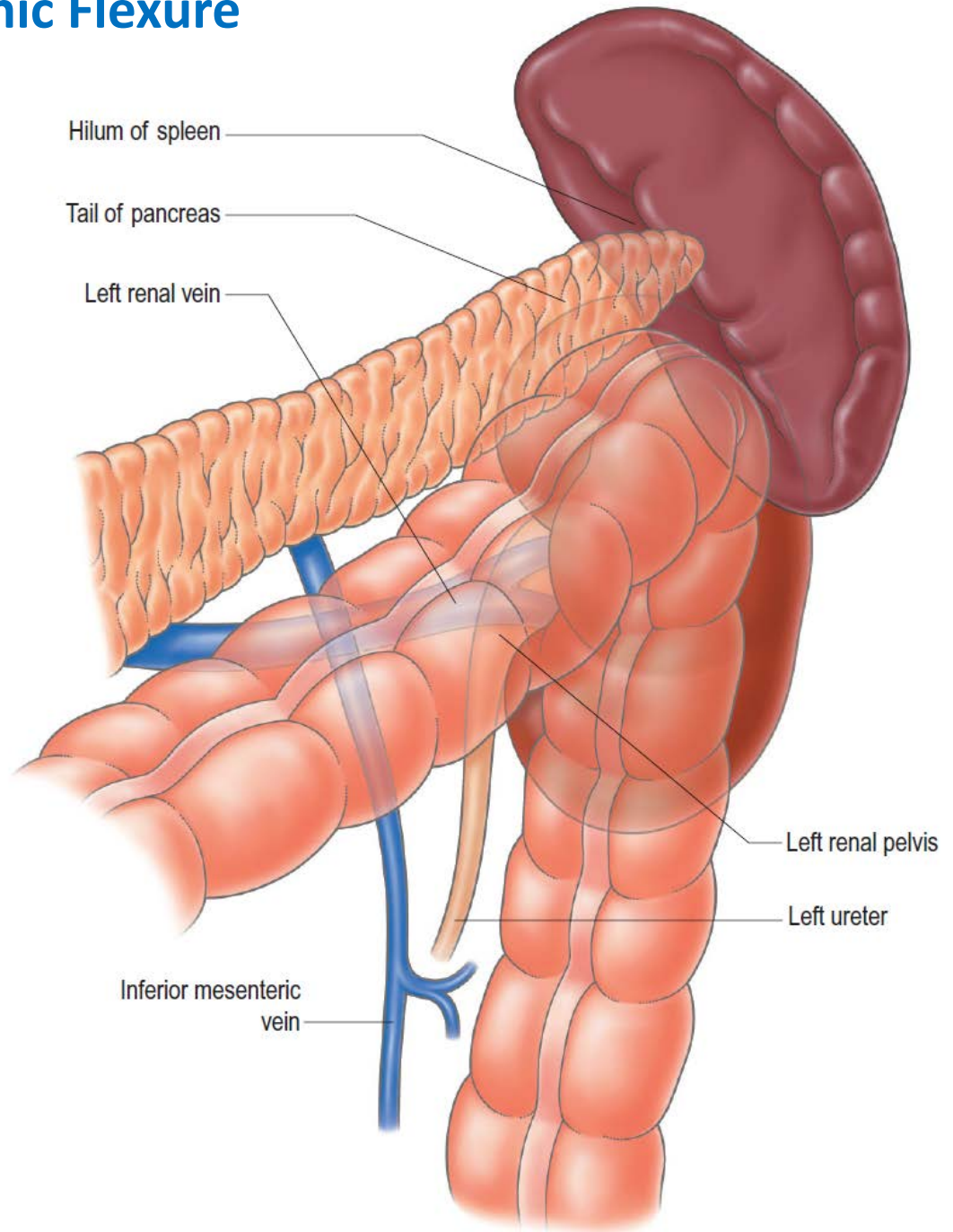
- The transverse colon is **intraperitoneal** (**transverse mesocolon**, Lat. mesocolon transversum).
- It is highly **variable** both in length (approximately 50 cm long on average) and the extent to which it hangs down anterior to the small bowel between sites of attachment at the **right (hepatic)** and **left (splenic) colic flexures**.



Splenic Flexure

Anatomical relations

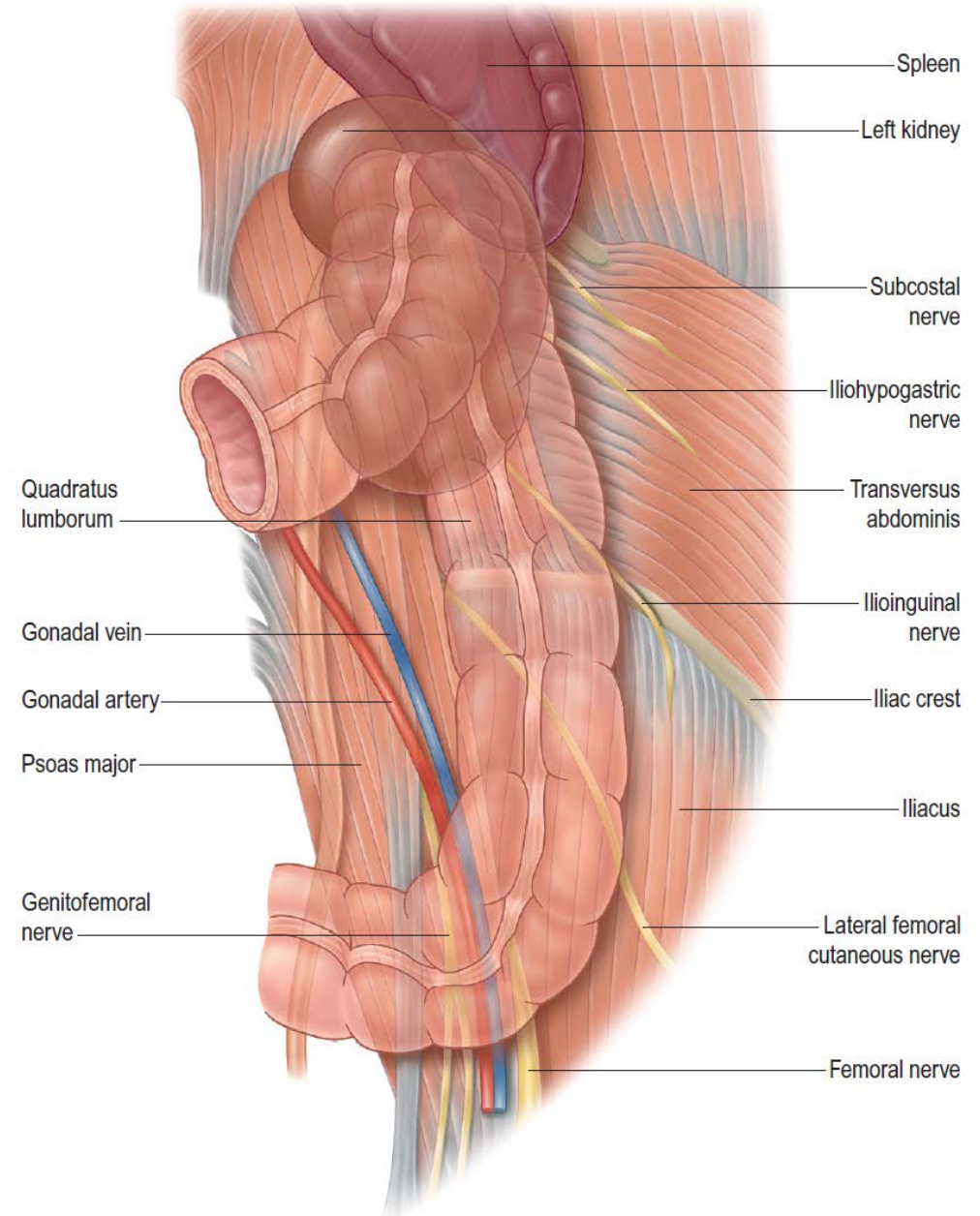
- The **splenic flexure** marks the junction between the transverse and descending colon.
- Lies in the **left hypochondrium**, anterior to the tail of the pancreas and the left kidney.
- It is often attached to the splenic capsule by a peritoneal ligament.
- The **phrenicocolic ligament** attaches the flexure to the diaphragm below the inferior pole of the spleen at about the level of the tenth rib.



Descending Colon

Anatomical relations

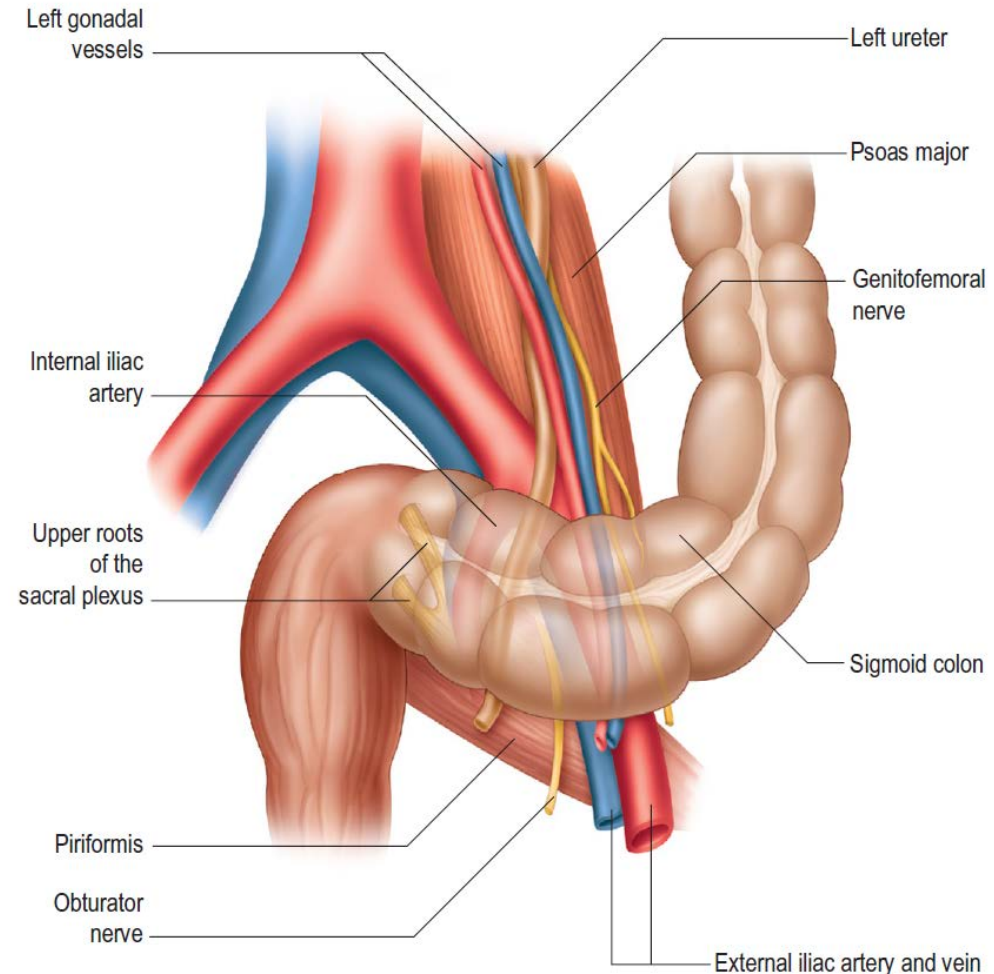
- It is 25–30 cm long.
- Descends from the **splenic flexure** to the level of the **iliac crest**, where it becomes the sigmoid colon.
- **Mesoperitoneal position.**
- Immediately lateral to the descending colon is the **left paracolic gutter** (Lat. canalis lateralis sinister).
- It is smaller in caliber and more deeply placed than the ascending colon.
- **Appendices epiploicae** are more common.



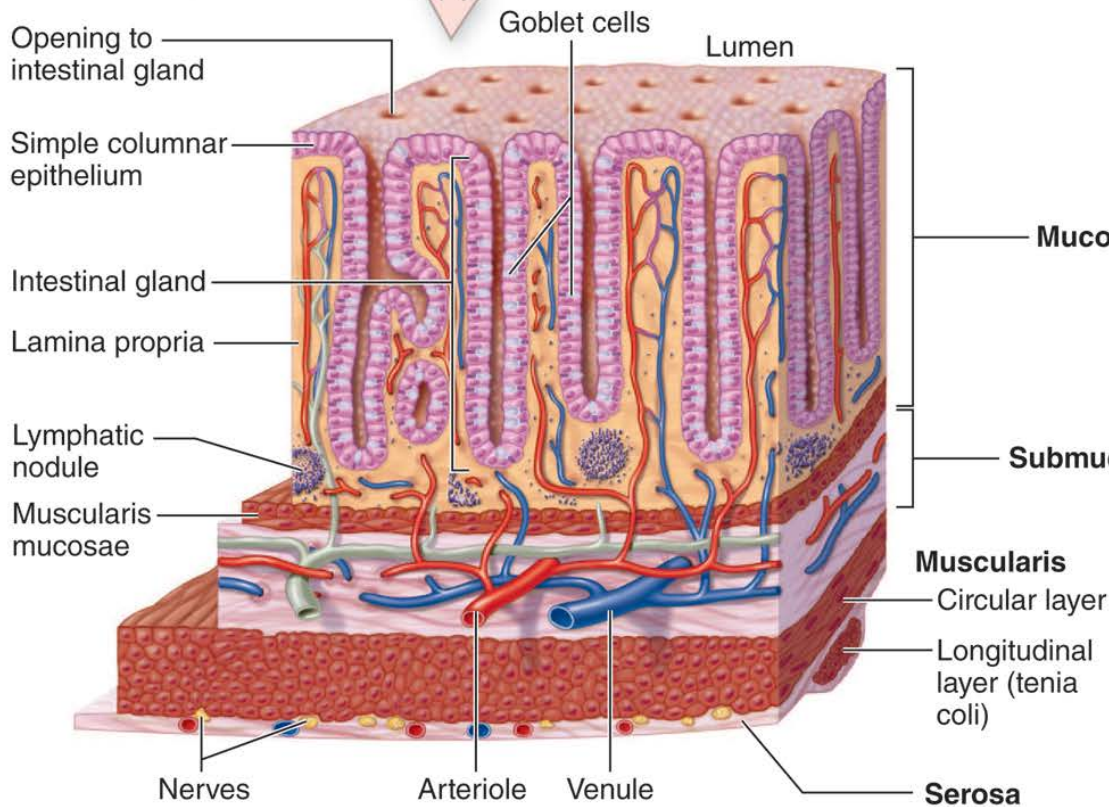
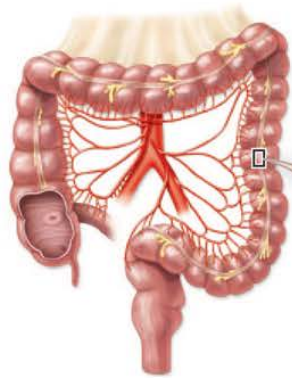
Sigmoid Colon

Anatomical relations

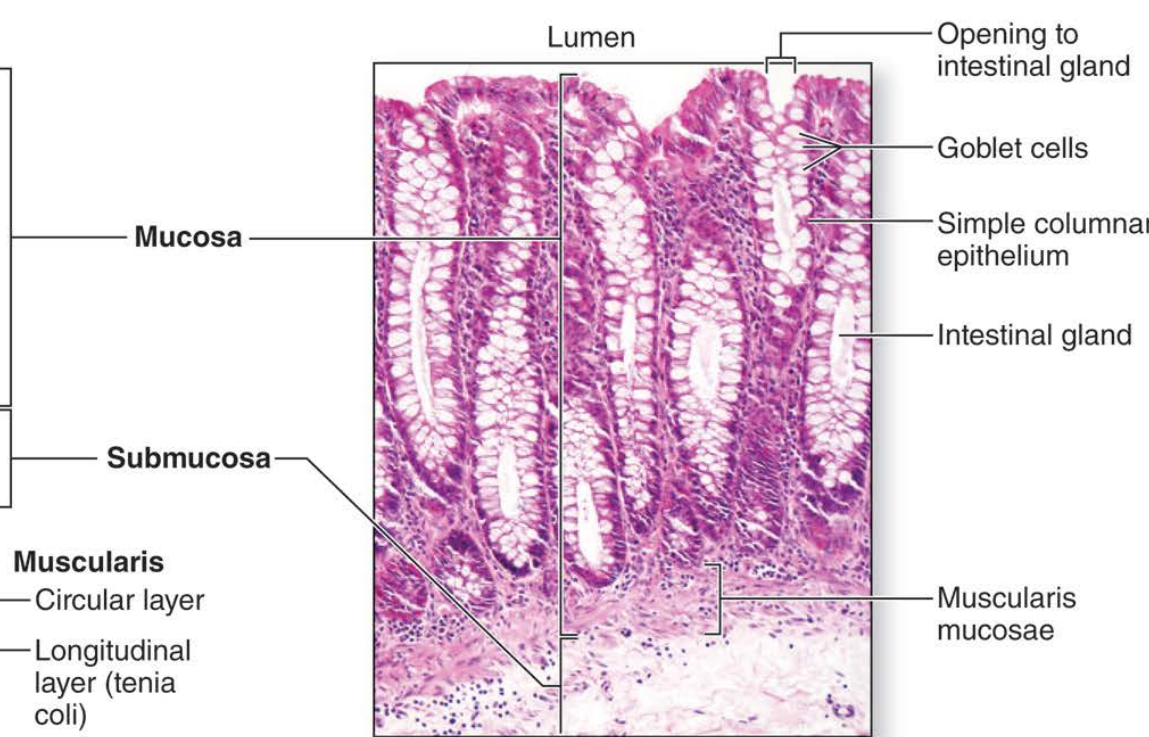
- Runs from the **iliac crest** to the beginning of the rectum at the level of the **S3** (promontorium, art. sacroiliaca).
- S-shaped and quite mobile structure.
- **Intraperitoneal position** – **sigmoid mesocolon** (Lat. mesocolon sigmoideum).
- The **taeniae coli** of the sigmoid colon are wider and coalesce at its distal end to form a complete circumferential longitudinal muscle layer.
- **Appendices epiploicae** are particularly prominent in the sigmoid colon.



Microstructure of Colonic Wall

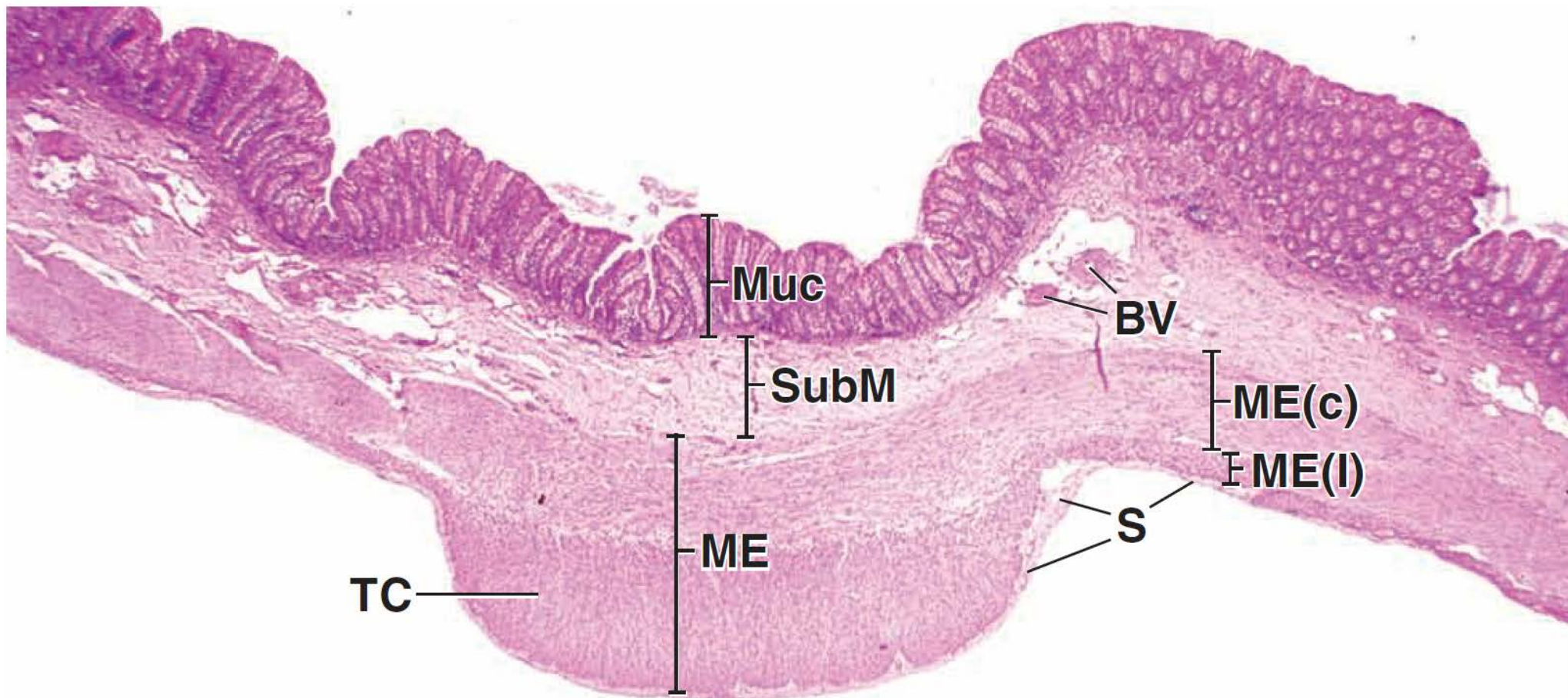


(a) Large intestine tunics

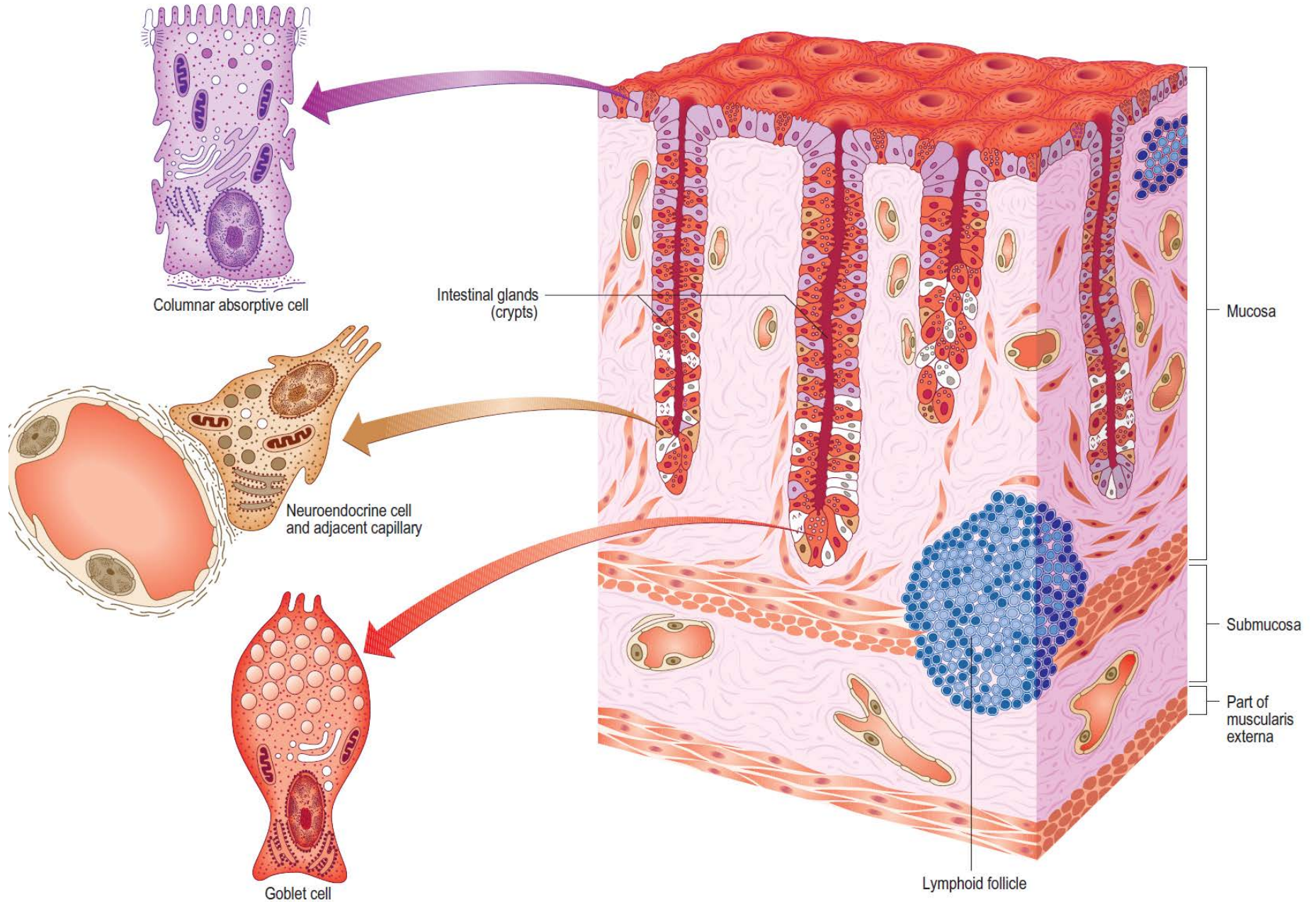


(b) Large intestine mucosa and submucosa

Microstructure of Colonic Wall

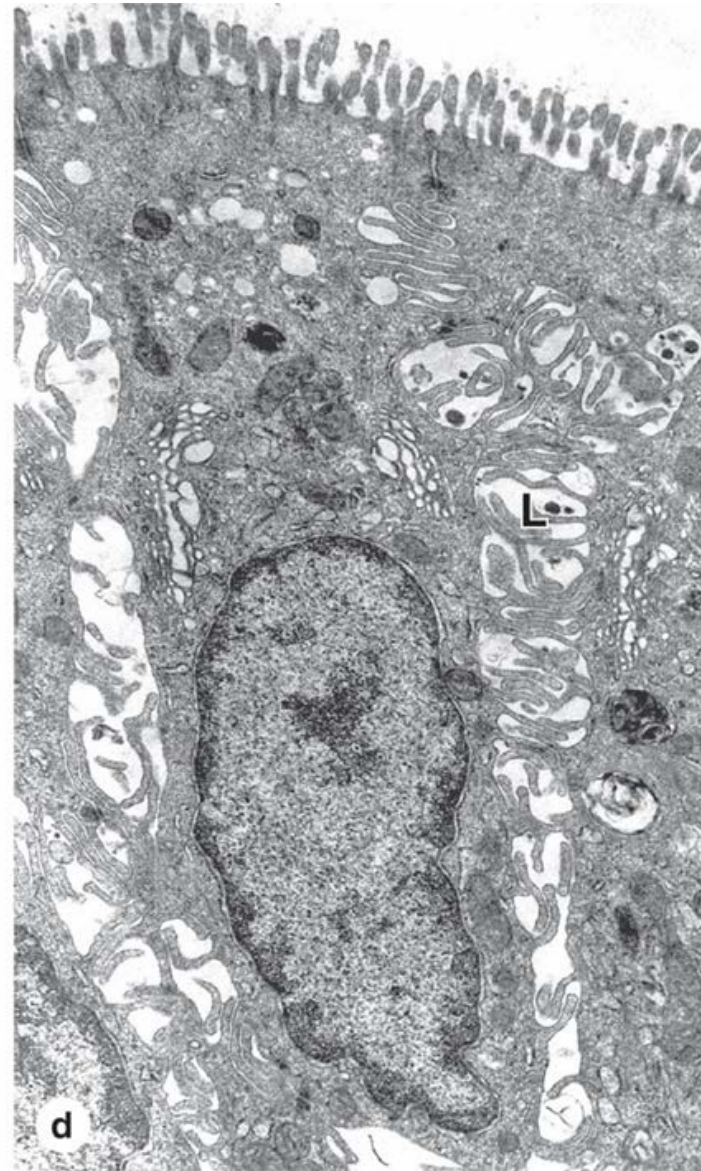
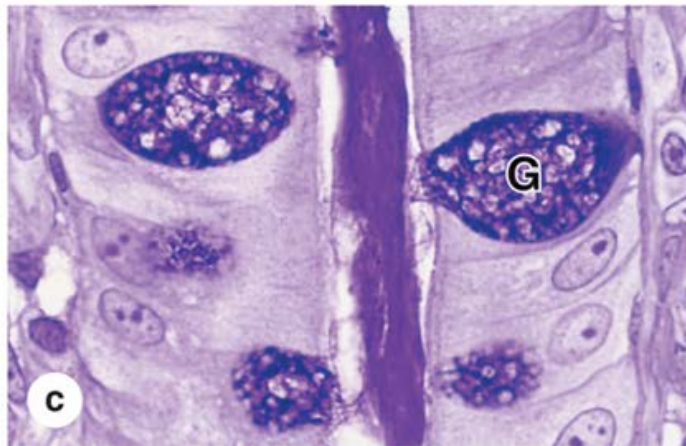
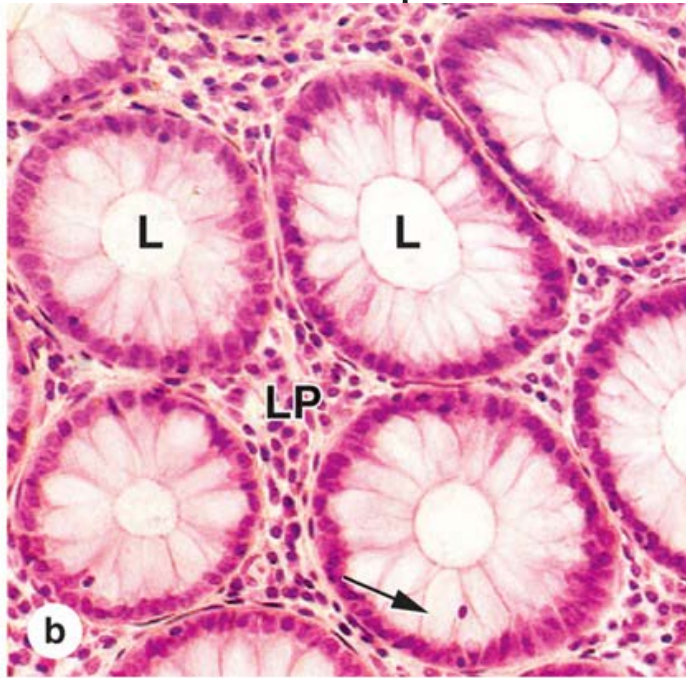
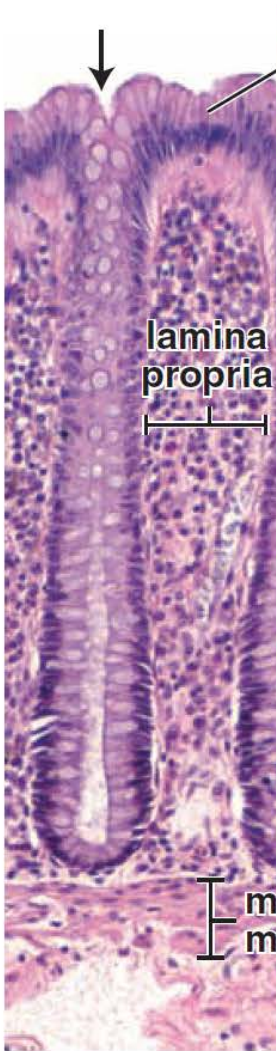


Microstructure of Colonic Wall

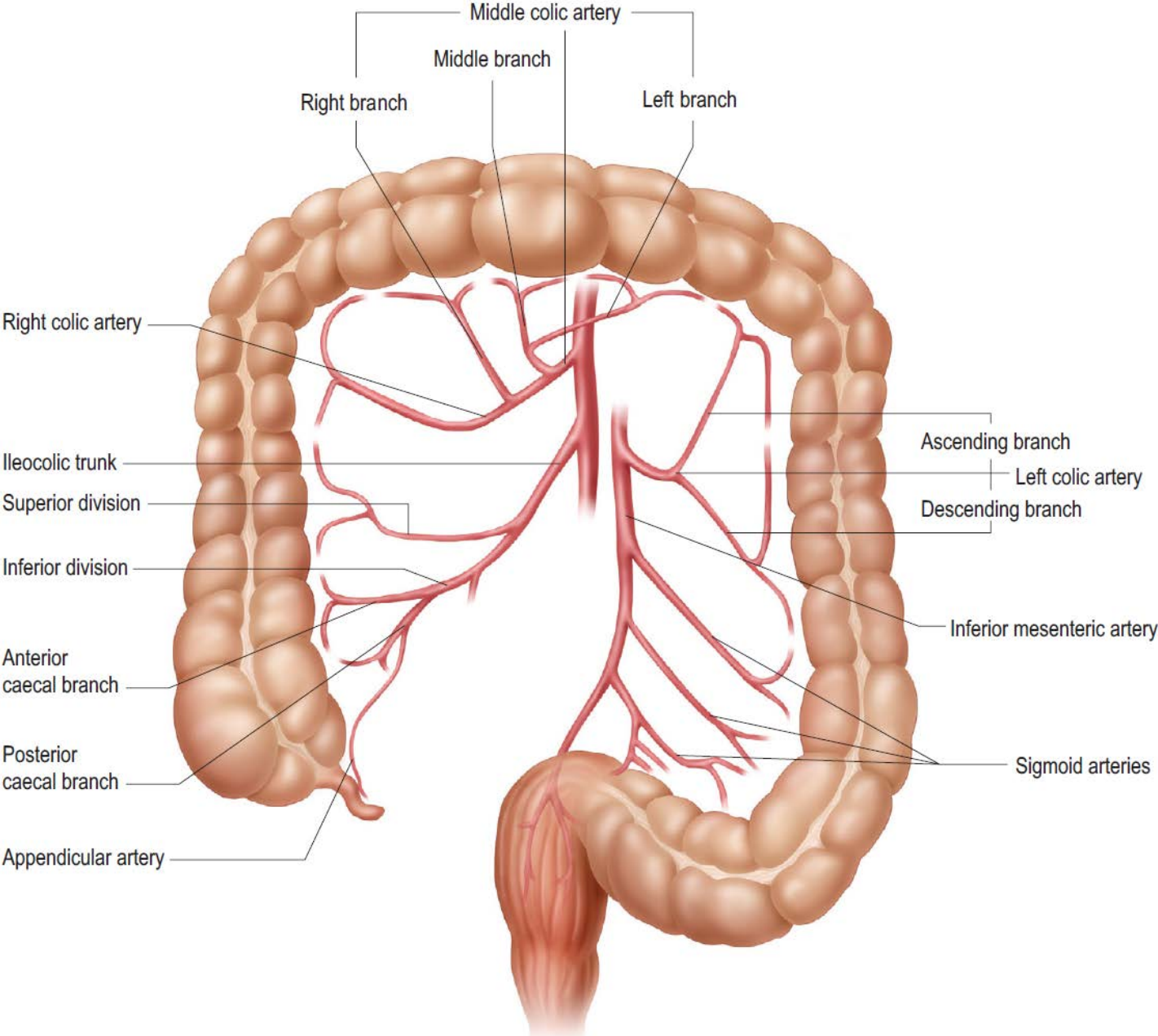


Microstructure of Colonic Wall

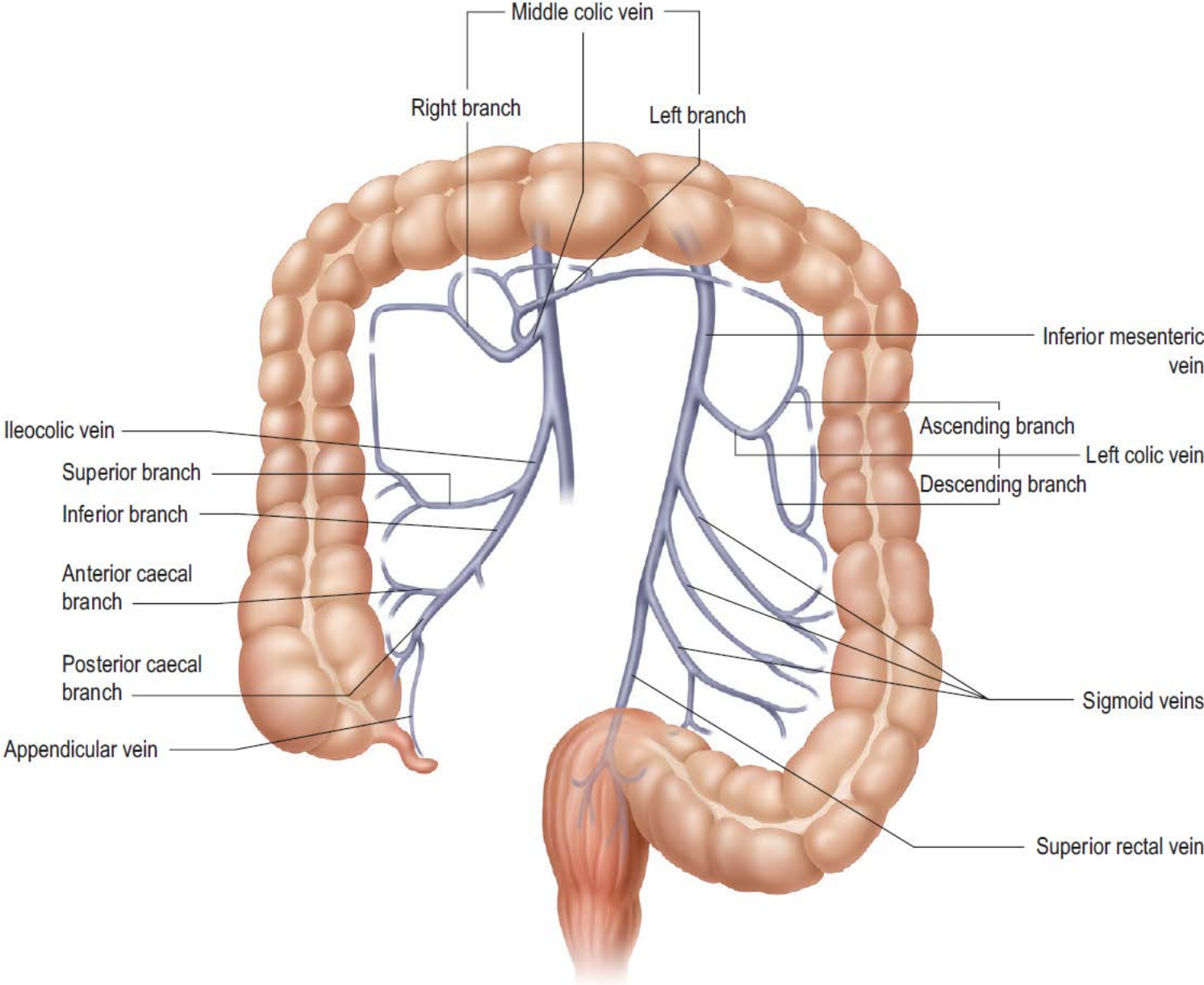
I. **Mucosa**, Lat. tunica mucosa



Blood Supply of the Colon

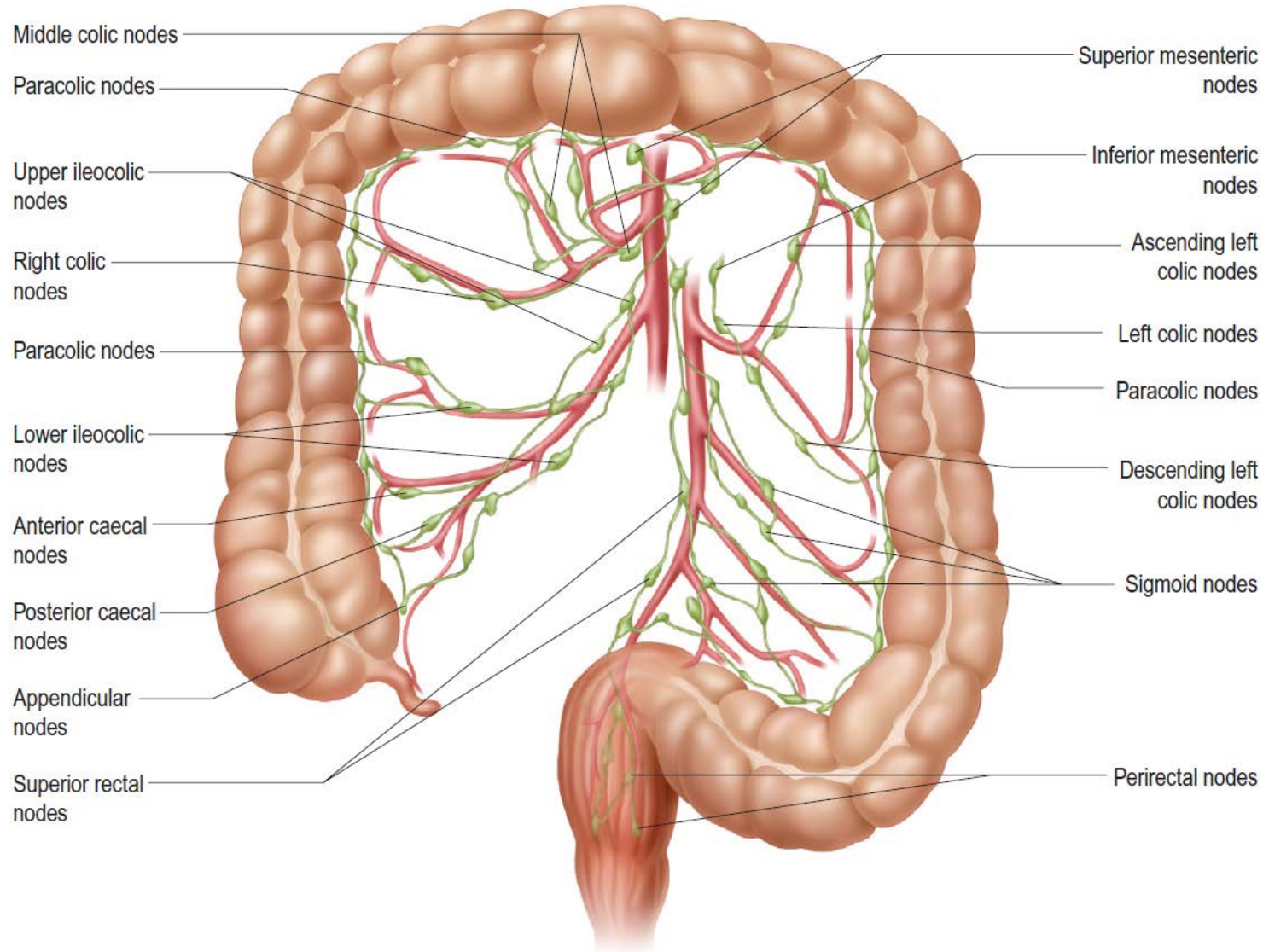


Blood Supply of the Colon



Lymphatic Drainage

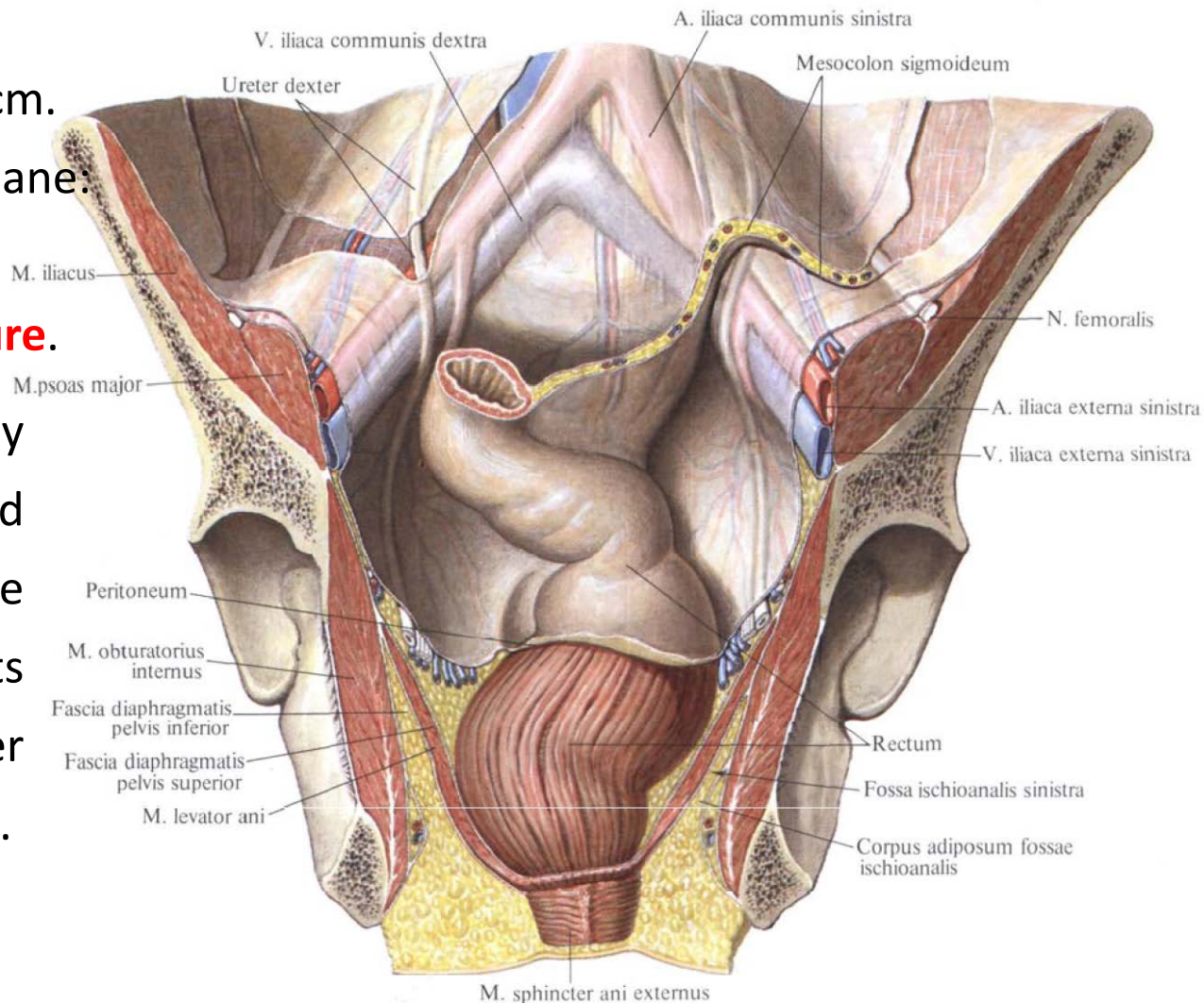
➤ Lymph nodes related to the colon form four groups – **epicolic**, **paracolic**, **intermediate colic** and **preterminal colic nodes**.



Rectum

External features and relations

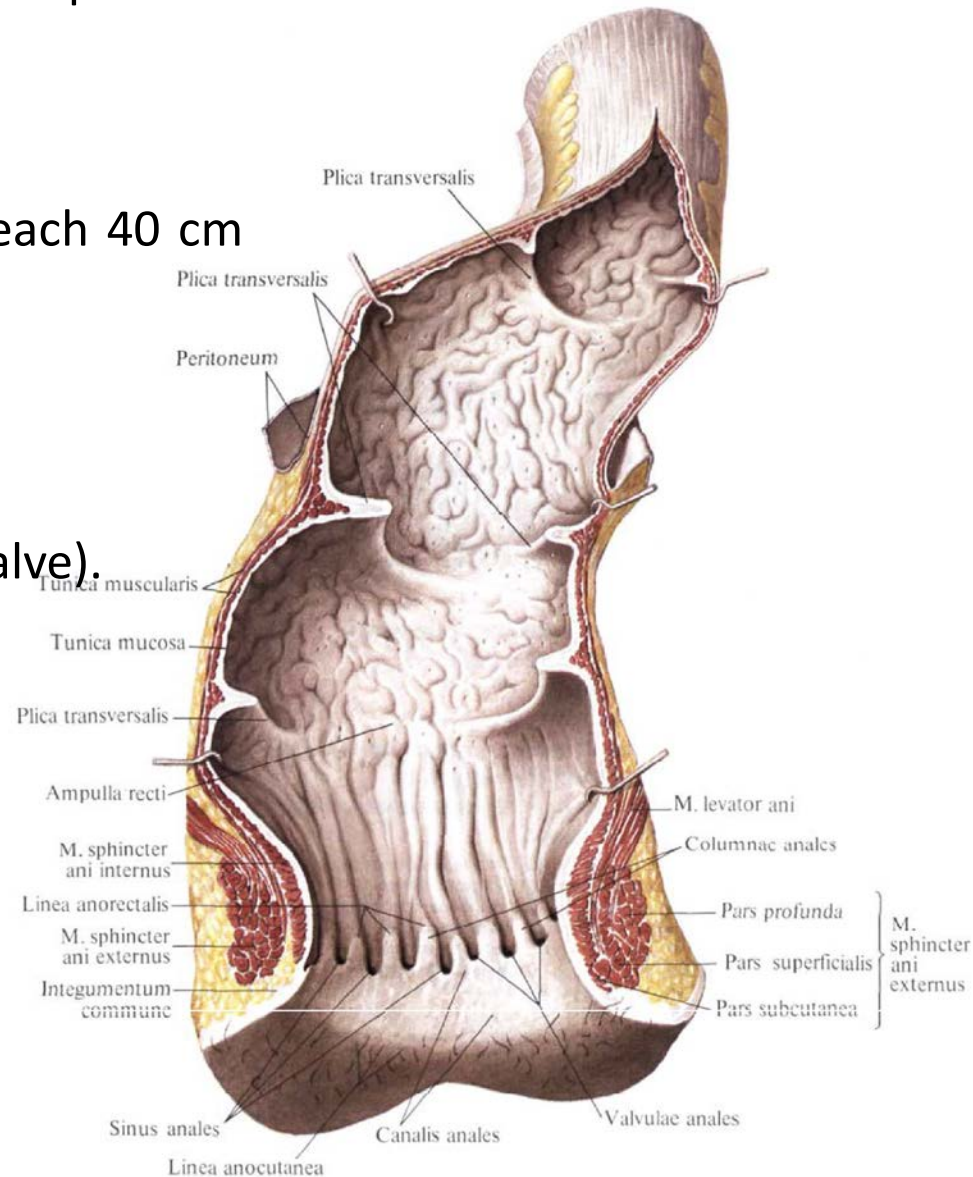
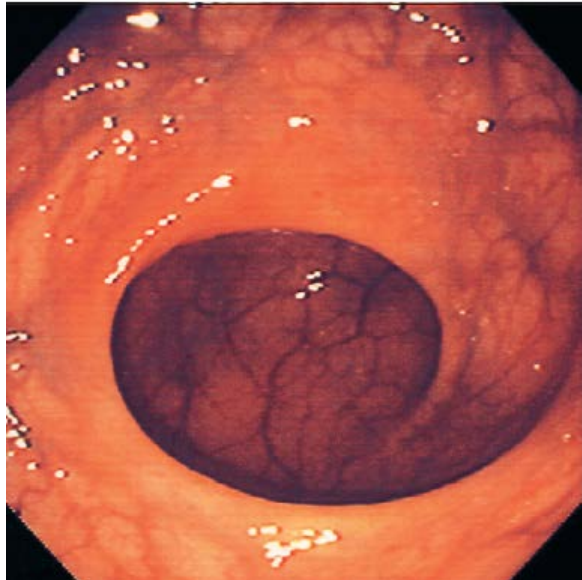
- **Rectum** (Gr. proctos) is the dilated distal portion of the large intestine from **S3** to the **anal canal**.
- Its average length is 12 to 15 cm.
- It is S-shaped in the coronal plane:
 - ✓ **Sacral flexure.**
 - ✓ **Perineal (anorectal) flexure.**
- The upper third is covered by peritoneum on its anterior and lateral aspects, and the middle third by peritoneum on its anterior aspect only. The lower third is below the peritoneum.



Rectum

Anatomical parts of rectum

- **Supraampullar part** – intraperitoneal position (mesorectum).
- **Rectal ampulla**, Lat. ampulla recti.
 - ✓ It has a diameter of 8 to 16 cm (can reach 40 cm when distended).
 - ✓ Its length is 10 to 13 cm.
 - ✓ It is meso- and retroperitoneal.
 - ✓ Transverse folds of rectum (Houston's valve).

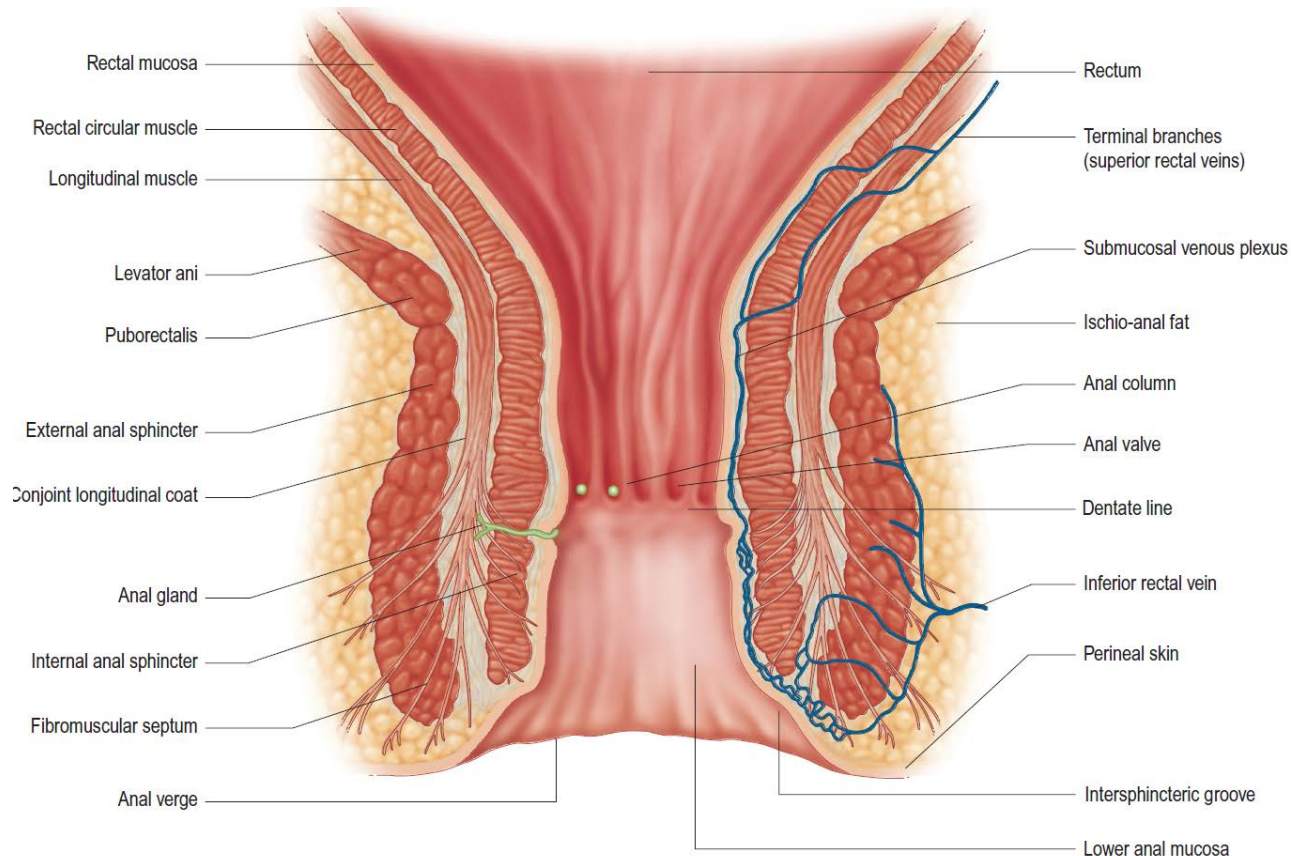


Rectum

Anatomical parts of rectum

- **Anal canal**, Lat. canalis analis.
 - ✓ Its length is between 2.5 and 3 cm.
 - ✓ It is located extraperitoneally.
 - ✓ It is surrounded by the external anal sphincter and the levator ani muscle.

- ✓ **Anal columns** (of Morgagni).
- ✓ **Anal sinus**.
- ✓ **Anal valves**.
- ✓ **Anal transitional zone** (zona hemorrhoidalis)



Microstructure of the Rectum

➤ The mucosa of the **rectal ampulla** is similar to that of the rest of the distal colon, having simple columnar epithelium and straight, tubular intestinal glands with many goblet cells.

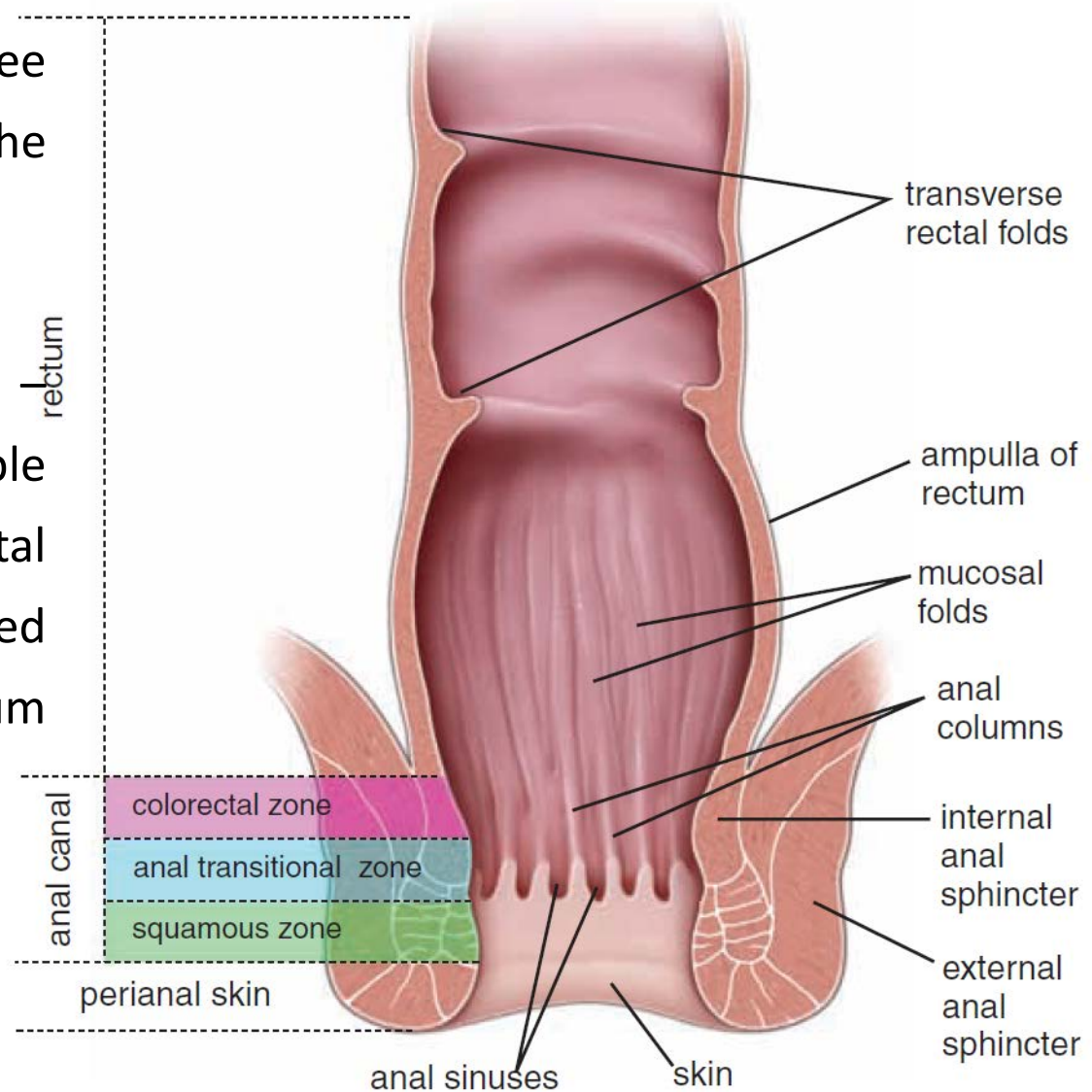
➤ The **anal canal** is divided into three zones according to the character of the epithelial lining:

✓ **Colorectal zone.**

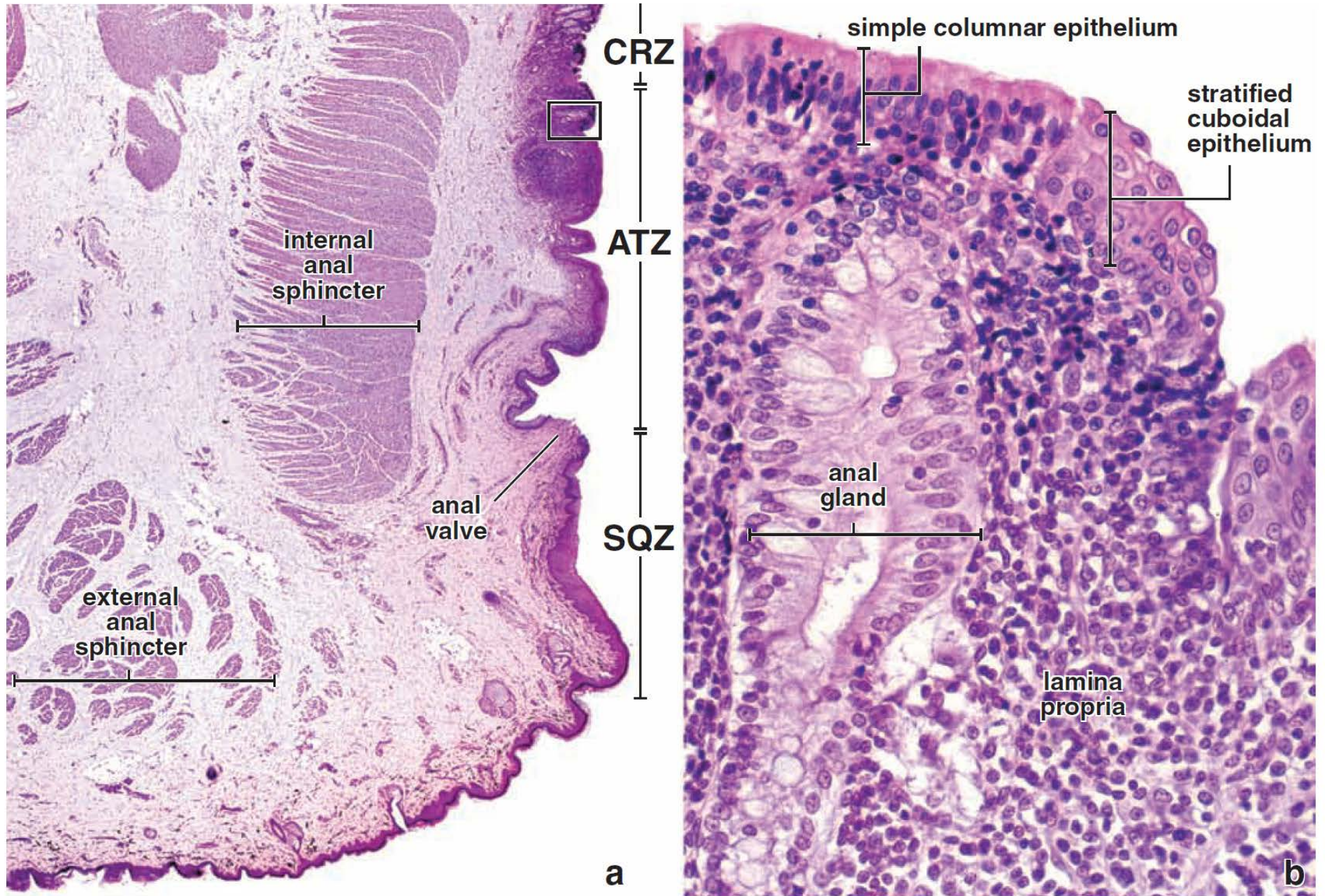
✓ **Anal transitional zone**

transition between the simple columnar epithelium of the rectal mucosa and the stratified squamous keratinized epithelium of the perianal skin.

✓ **Squamous zone.**



Microstructure of the Rectum



Vessels of the Rectum

Arterial blood supply

- **Superior rectal artery** (a. mesenterica inf.).
- **Middle rectal artery** (a. iliaca interna).
- **Inferior rectal artery** (a. pudenda interna)

Venous drainage – rectal venous plexus:

- Inferior mesenteric vein → **portal vein**.
- Inferior and middle rectal veins → iliac internal vein → **inferior vena cava**.
- Portocaval anastomosis → **hemorrhoids**.

Lymphatic drainage

- Internal iliac nodes.
- Inferior mesenteric lymph nodes.
- Along the median sacral artery to presacral nodes.

