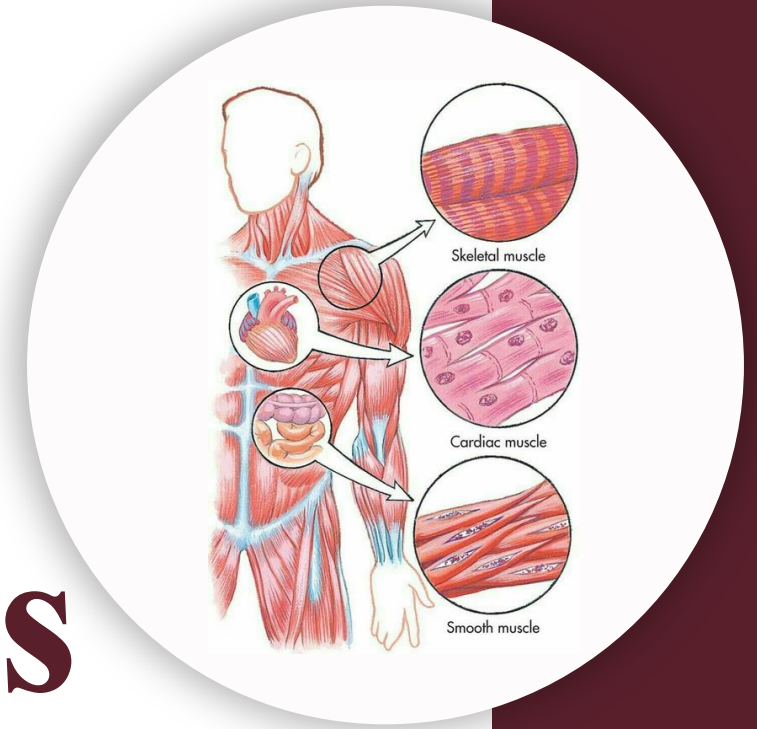
بسم الله الرحمـٰن الرحيم

(وَفَوْقَ كُلِّ ذِي عِلْمٍ عَلِيمٌ)

Histology | Final 1-V1

Small and Large intestines



Written by : Tala Alali
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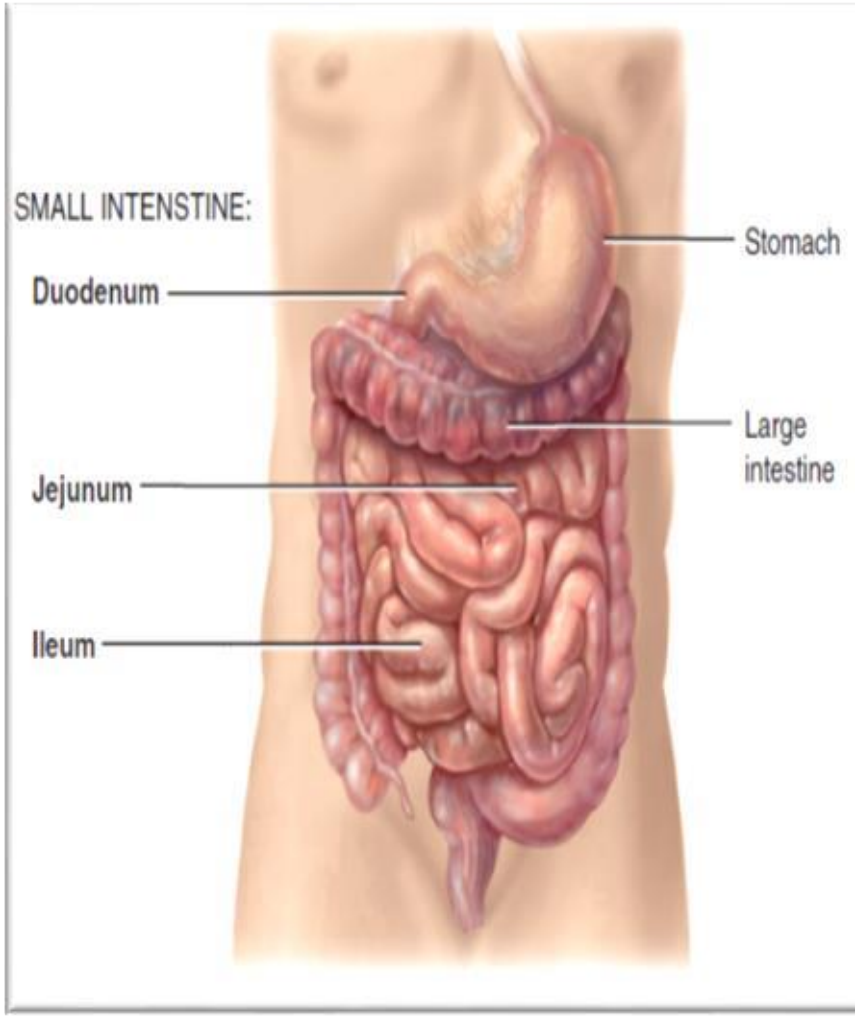
Gastrointestinal Tract (GIT)

Small Intestine

- Most digestion and absorption of nutrients occur in **small intestine**.
- Its length alone provides a large surface area.
- Surface area is further increased by circular folds, villi, and microvilli.
- Begins at the pyloric sphincter of the stomach, opens into the large intestine.
- It is 2.5 cm in diameter and 3 m long.

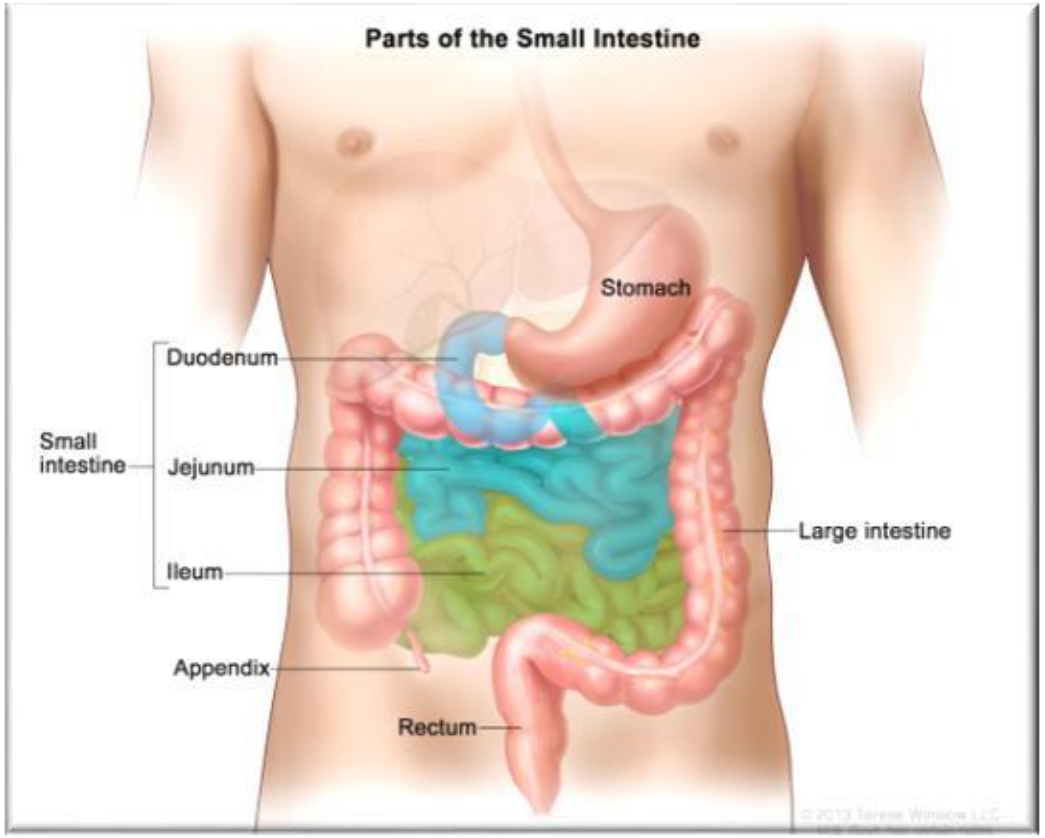


Anatomy Of The Small Intestine

READ ONLY

Divided into three regions:

- The first part is the **duodenum.**
- The shortest region.
- Retroperitoneal.
- Starts at the pyloric sphincter of the stomach.
- C-shaped tube that extends about 25 cm.



- The **jejunum:** 1 m long and extends to the ileum.
- The **ileum:** about 2 m, joins the large intestine at a smooth muscle sphincter called the **ileocecal sphincter.**

- The small intestine upgrade the absorption at 3 different levels :

1) Plicae circulares (circular folds): Permanent folds formed by all mucosa and submucosal core ,best placed to develop in jejunum. Usually they run at the same direction of small intestine.

Increase the absorptive surface area and slow the movement of chyme.

2) Villi : Finger-like projections of the mucosa extending into the lumen lined by simple columnar epithelium called enterocytes and some goblet cells, their core consists of lamina propria.

3) Microvilli: Tiny projections present on the apical surface of the absorptive epithelial cells covering the villi. They are densely packed together to form the brush border, increasing the surface area for absorption, the number of microvilli decreases in the larger intestine.

- The small intestine is composed of three parts: duodenum, jejunum, and ileum. Each part has characteristic features.
- **ileum > jejunum > duodenum** in length.
- The duodenum is characterized by abundant submucosal (Brunner's) glands located in the submucosa(not in the lamina propria). The connective tissue in the submucosa of duodenum is loaded with glands.
- Beneath it directly there's muscularis which contains a small amount of connective tissue.
- As we proceed caudally from the stomach toward the ileum, the amount of MALT (mucosa-associated lymphoid tissue) and lymphocytes progressively **increases**.
- These lymphoid cells may extend from the lamina propria into the submucosa, forming lymphoid nodules. Aggregates of lymphocytes form lymphoid nodules that contains a light-staining core center surrounded by a darker peripheral zone.
- The muscularis of the intestine consists of two smooth muscle layers: (inner:circular ,outer: longitudinal)

- Absorption is maximal in the proximal part of the small intestine, especially in the duodenum and jejunum, and gradually decreases distally toward the ileum.
- Therefore, the structures that maximize the absorptive surface area – including the plicae circulares (circular folds), villi, and microvilli – are most prominent in the proximal small intestine and progressively decrease in number and size toward the distal ileum.

- In the large intestine:

The epithelium has lower plicae circulares and villi because of the lower capacity of absorption.

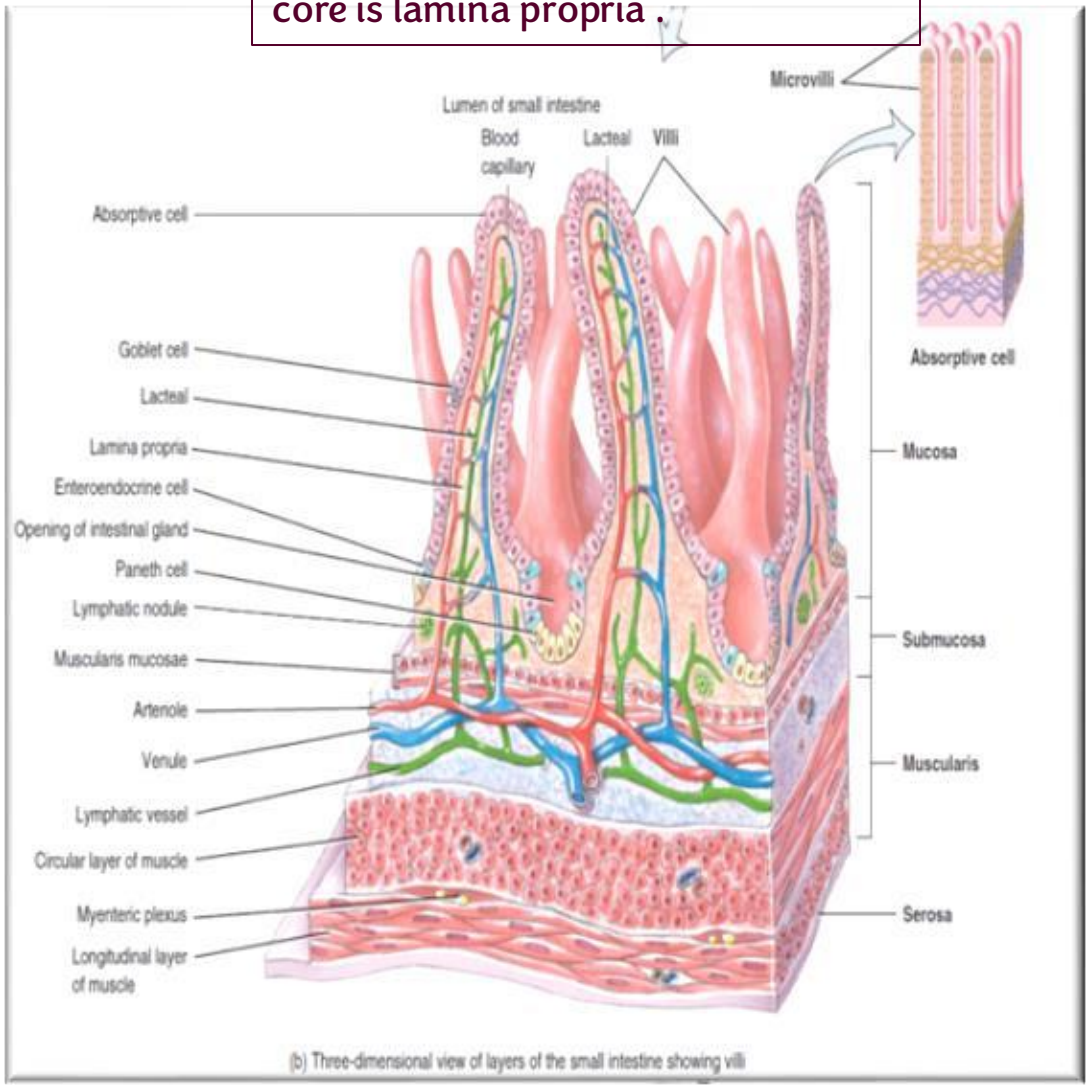
The muscularis still has two layers, but the outer longitudinal layer is condensed into three thick bands called the taeniae coli, producing sacculations known as haustra.

Histology Of The Small Intestine

The covering here is mucosa and the core is lamina propria .

The small intestine is composed of: mucosa, submucosa, muscularis, and serosa.

- The **mucosa:** epithelium, lamina propria, and muscularis mucosae.
- The epithelial layer: simple columnar epithelium---- many types of cells (Goblet cells) .
- Shows permanent circular or semilunar folds (plicae circulares)---consisting of mucosa and submucosa--- **best developed in the jejunum.** Seen in longitudinal section



Histology Of The Small Intestine

- Villi: short (0.5-1.5 mm) mucosal outgrowths that project into the lumen through the entire length---covered by simple columnar epithelium of absorptive cells called **enterocytes**, with many interspersed **goblet** cells.

Typical loose CT contains arterial and venous blood supply

- Each villus has a core of loose CT (lamina propria) and contains fibroblasts, smooth muscle, lymphocytes and plasma cells, fenestrated capillaries, and a central lymphatic called a **lacteal.**

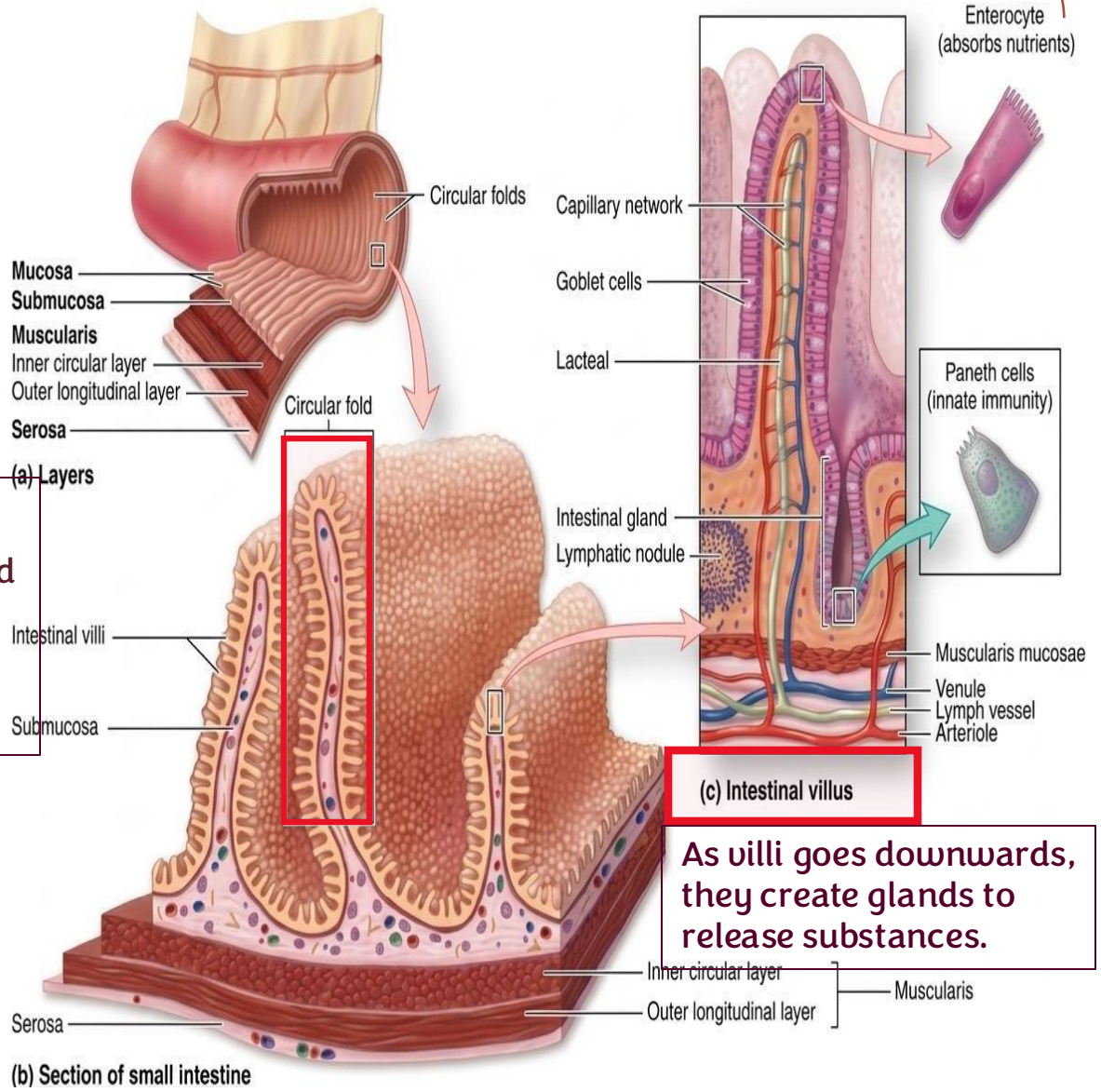
Lacteal: a specialized lymphatic capillary found in the intestinal villi.

It has a distinctive appearance because of active absorption in the intestine and the need to maximize the transport of absorbed substances, especially lipids, back into the circulation.

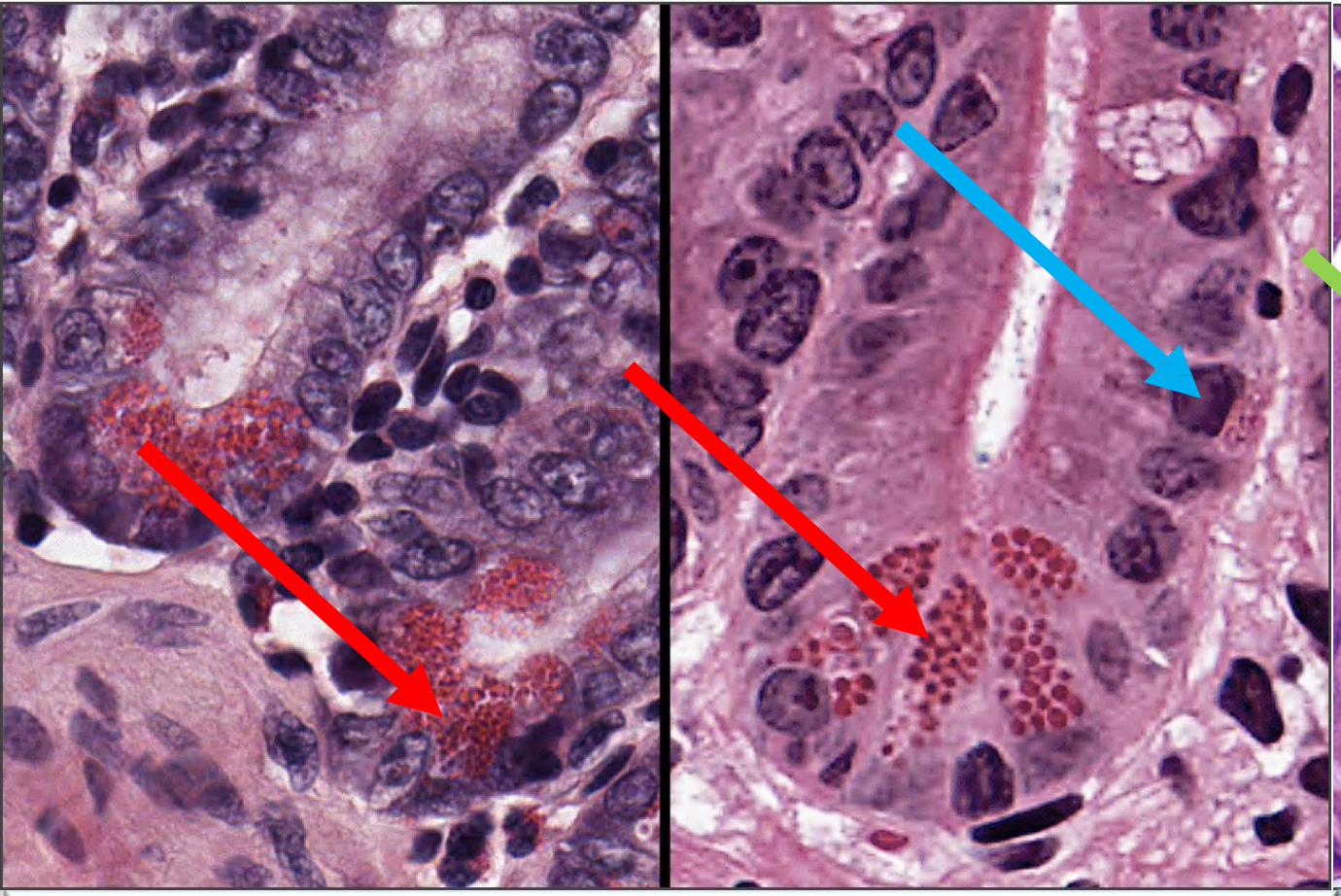
You should expect to see a good amount of MALT.

- Between the villi are the openings of short tubular glands called intestinal glands or crypts (or crypts of lieberkühn) and the epithelium of each villus is continuous with that of the intervening glands

Enterocytes are cells with abundant amount of cytoplasm and basal located nucleus and apical surface rich with microvilli



As villi goes downwards, they create glands to release substances.



1. **Enterocytes (absorptive cells):** tall columnar cells-–apical end called brush border---densely packed microvilli covered by glycocalyx.
2. **Goblet cells:** secrete mucins---mucous.
3. **Paneth cells:** contains eosinophilic granules. Secrete lysozyme (bactericidal enzyme), defensins phospholipase A---break down membranes and cell walls and. Regulating the microbial population in the small intestine.

4. **Enteroendocrine** cells: mentioned earlier.

5. **M (microfold) cells** are specialized epithelial cells in the mucosa of the ileum overlying the lymphoid follicles of Peyer patches, selectively endocytose antigens and transport them to the underlying lymphocytes and dendritic cells.

- **Paneth cells:** are immune-related cells found at the deep basal part of the intestinal crypts between the villi and the short tubular glands.
- They are part of the epithelium and help defend against the microbiome and harmful microbes that we ingest, preventing them from reaching the underlying connective tissue.
- These cells are abundant in number.
- These cells contain eosinophilic granules that release antimicrobial substances such as:

1) lysozyme

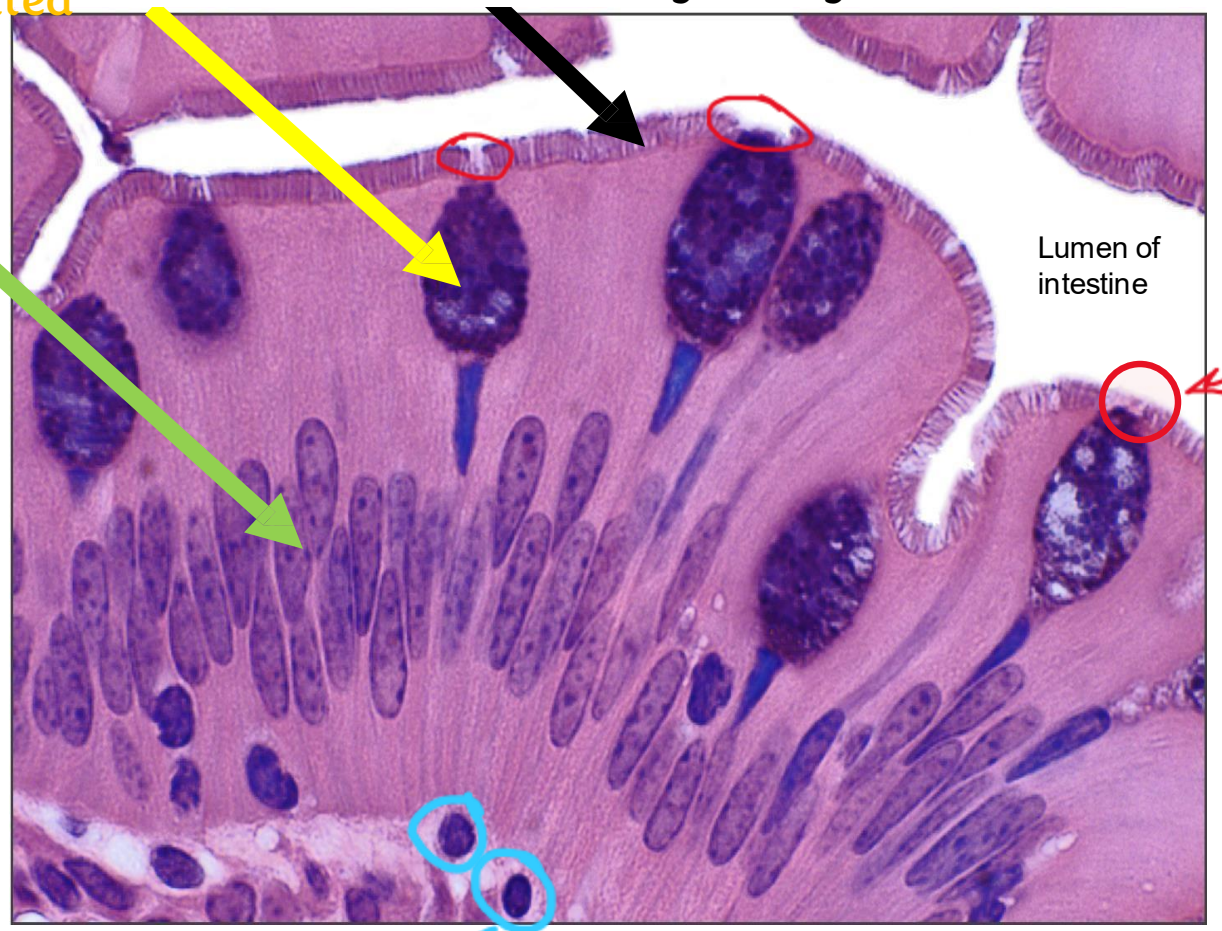
2) phospholipase A2

3) defensins

- Their main role is protection, innate immunity, and maintaining a healthy environment inside the intestinal crypts.

Goblet cells :-
-The apical part is filled with basophilic structure (special stain;PAS Stain)
- slander nucleus basally located

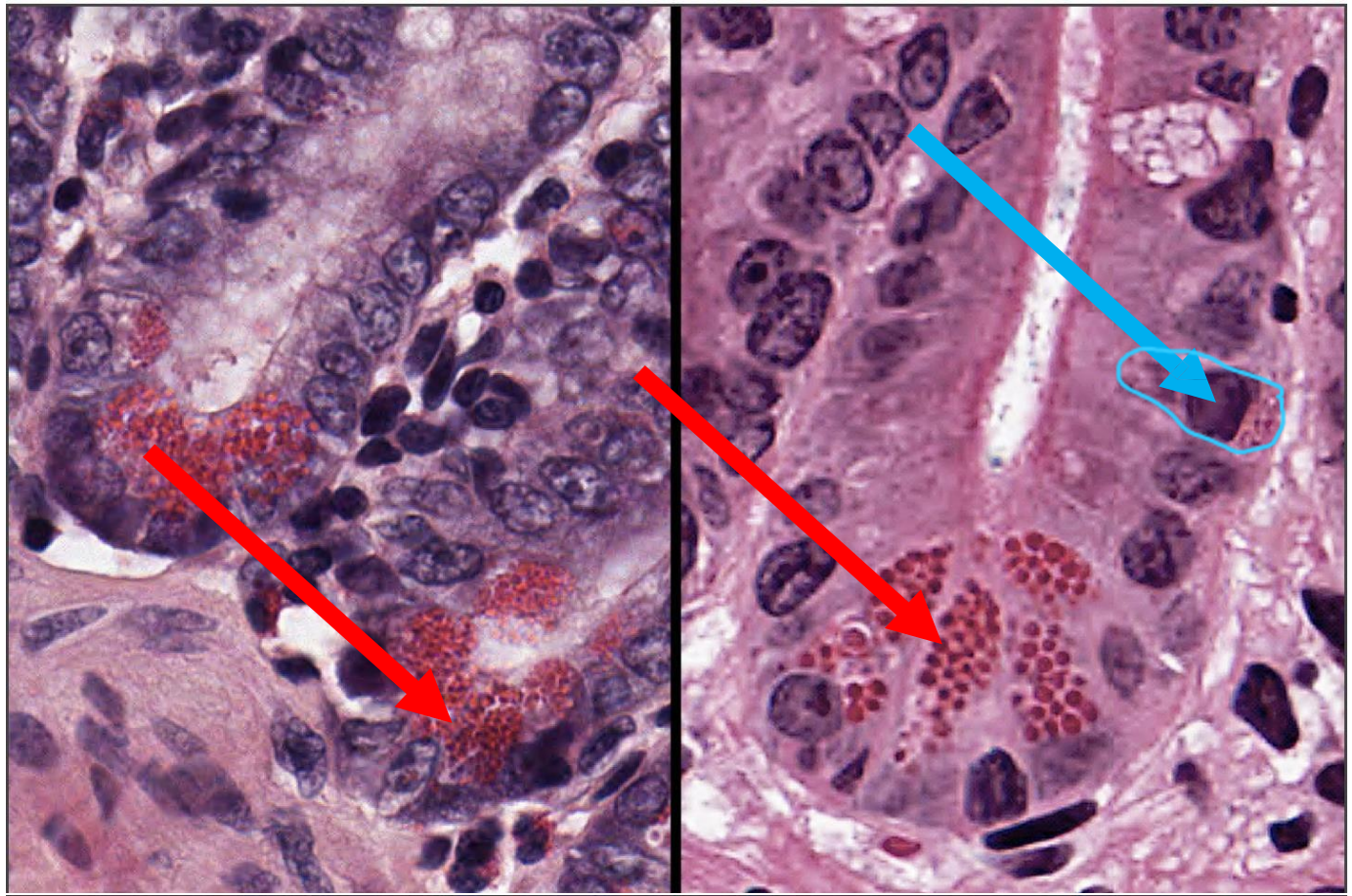
Microvilli directly facing the lumen



Enterocytes:-
Basally located nucleus and apical cytoplasm (the absorbative cells)

There is no villi on top of goblet cells because its function is secretion not absorption

Lymphocytes: Diffuse throughout the lamina propria and they make the lymphatic nodules



Blue arrow:-
Enteroendocrine cells

- located basally to face the BV and drain into the blood instead of lumen
- Their effect is paracrine

Red arrow : Paneth cells

- It is Immune cells that have granules filled with(lysozyme ,phospholipase A2, defensins)
- To breakdown any invasive microorganisms or antigens
- If the Paneth cells couldn't get rid of them the submucosal immune cells will do.

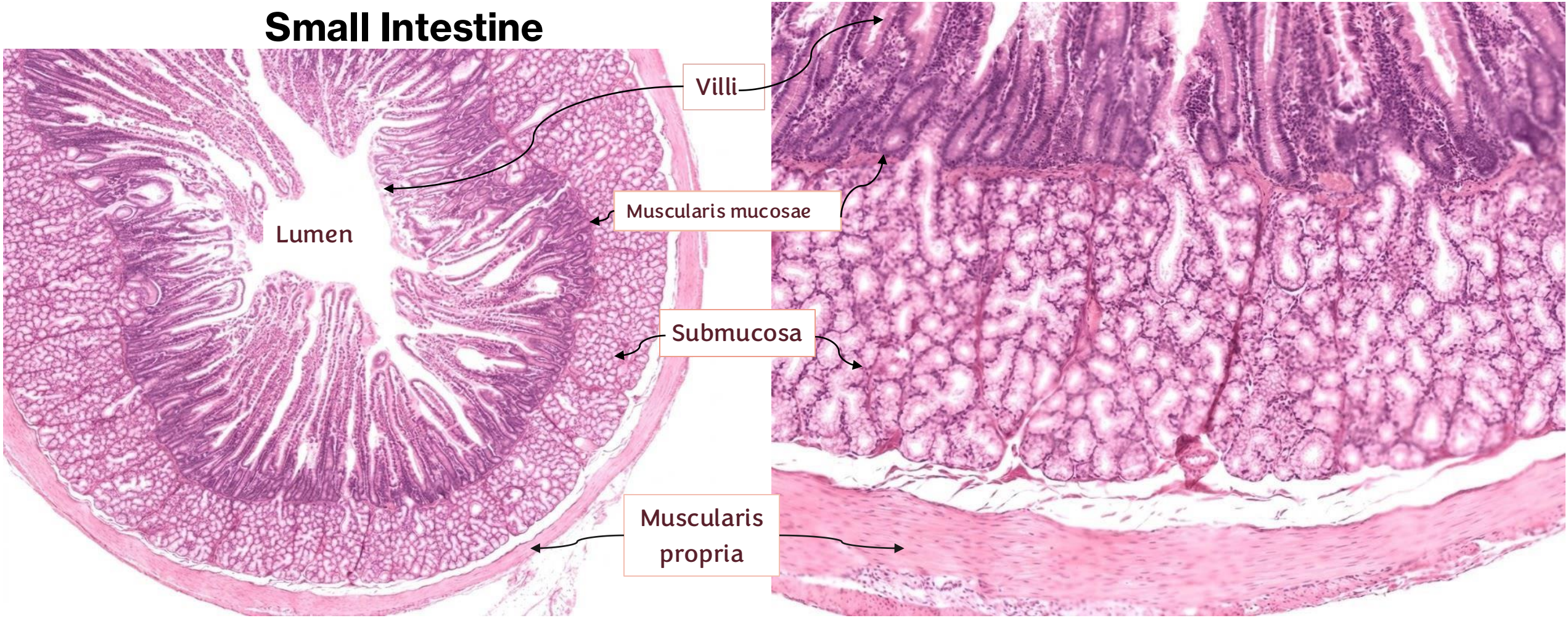
- **M cells or Microfolds:** are specialized epithelial cells in the mucosa (Peyer's patches) of the ilium, and it's part of innate immunity.

- Their function is to sample antigens and microorganisms from the intestinal lumen by endocytosis and transport them to underlying immune cells such as lymphocytes and dendritic cells, helping the immune system detect microorganisms that enter the intestinal environment and optimize immune defense at that site.

- All epithelial cells have the same genetic material, but they differ in which gene is upregulated , which leads to different functions depending on their location. This allows the tissue to perform multiple functions without needing many different types of cells in the same tissue.

- For example, Merkel cells in the skin and M cells in the intestine both originate from epithelial cells, yet each performs a different specialized function.
- Another examples: Paneth functions as immune, Merkel works as neuro.

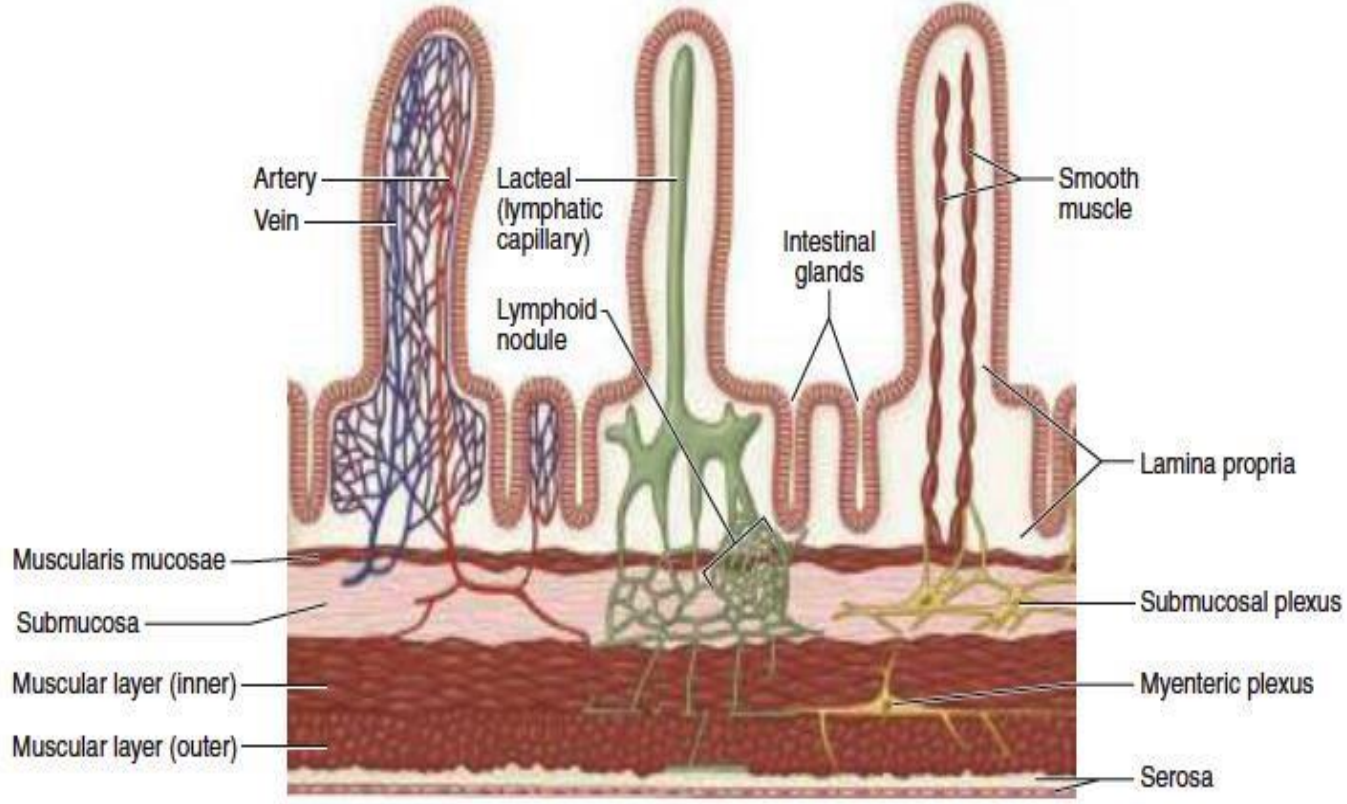
Small Intestine



- The lamina propria: abundance of mucosa-associated lymphoid tissue (MALT).
- **Submucosa:** of the duodenum contains **duodenal glands** **(*brunner's glands*)**.. Alkaline mucus---neutralize gastric acid---pancreatic enzymes.
- Ilium: MALT (Peyers patches) present in LP and submucosa.
- **Muscularis**: well-developed with myenteric (Auerbach) nerve plexus---peristaltic movement.
- Covered by **serosa**.

- The amount of muscles in intestine is lesser than in the stomach and esophagus because the intestinal contents (bolus) are smaller and softer, so less force is needed for propulsion.
- In addition, movement occurs mainly through peristalsis and the movement of the contents themselves.

FIGURE 15–28 Microvasculature, lymphatics, and muscle in villi.



MEDICAL APPLICATION

Celiac disease (celiac sprue) is a disorder of the small intestine mucosa that causes **malabsorption** and can lead to damage or destruction of the villi. The cause of celiac disease is an immune reaction against gluten or other proteins in wheat and certain other types of grain. The resulting inflammation affects the enterocytes, leading to reduced nutrient absorption.

MEDICAL APPLICATION

Crohn disease is a chronic inflammatory bowel disease that occurs most commonly in the ileum or colon, resulting from a poorly understood combination of immune, environmental, and genetic factors. Excessive lymphocytic activity and inflammation occur in any or all layers of the tract wall, producing pain, localized bleeding, malabsorption, and diarrhea.

The pinkish color: Glycocalyx (mucus on the surface of glands and a part of it bound to enzymes)

Yellow arrow: Submucosa

Green arrow: Lumen

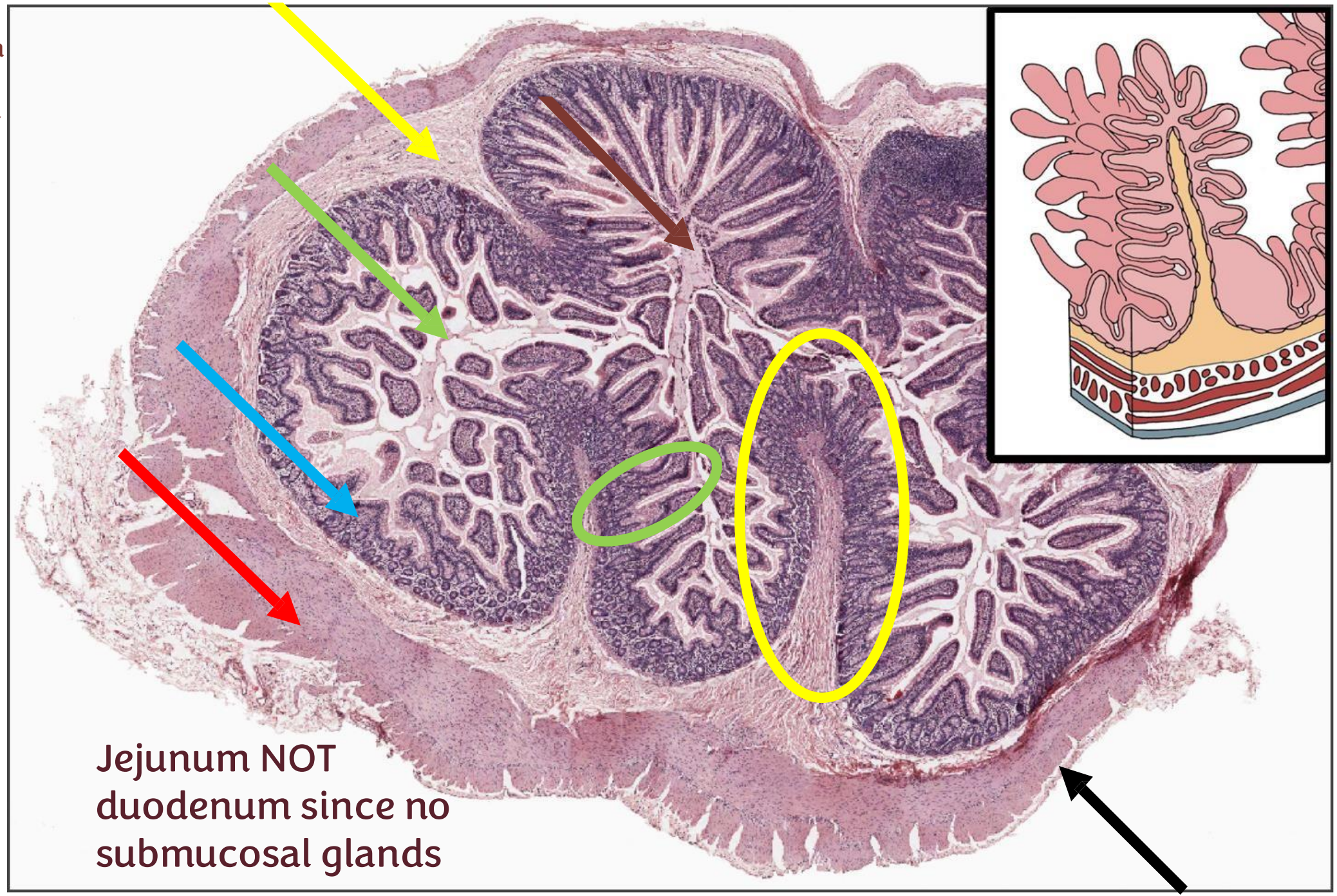
Blue arrow: Lamina propria

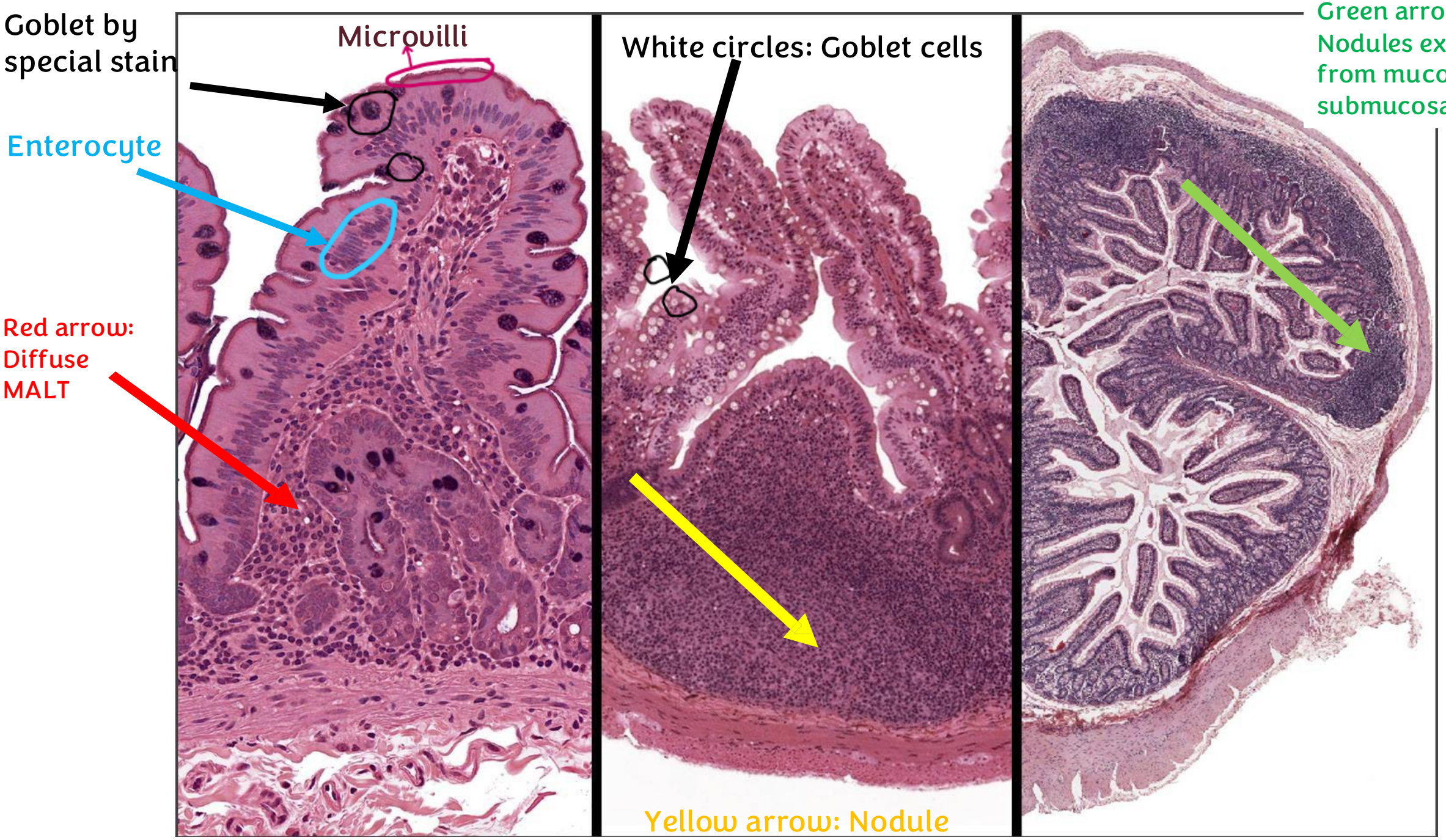
Red arrow: Muscularis (inner is circular, outer is longitudinal)

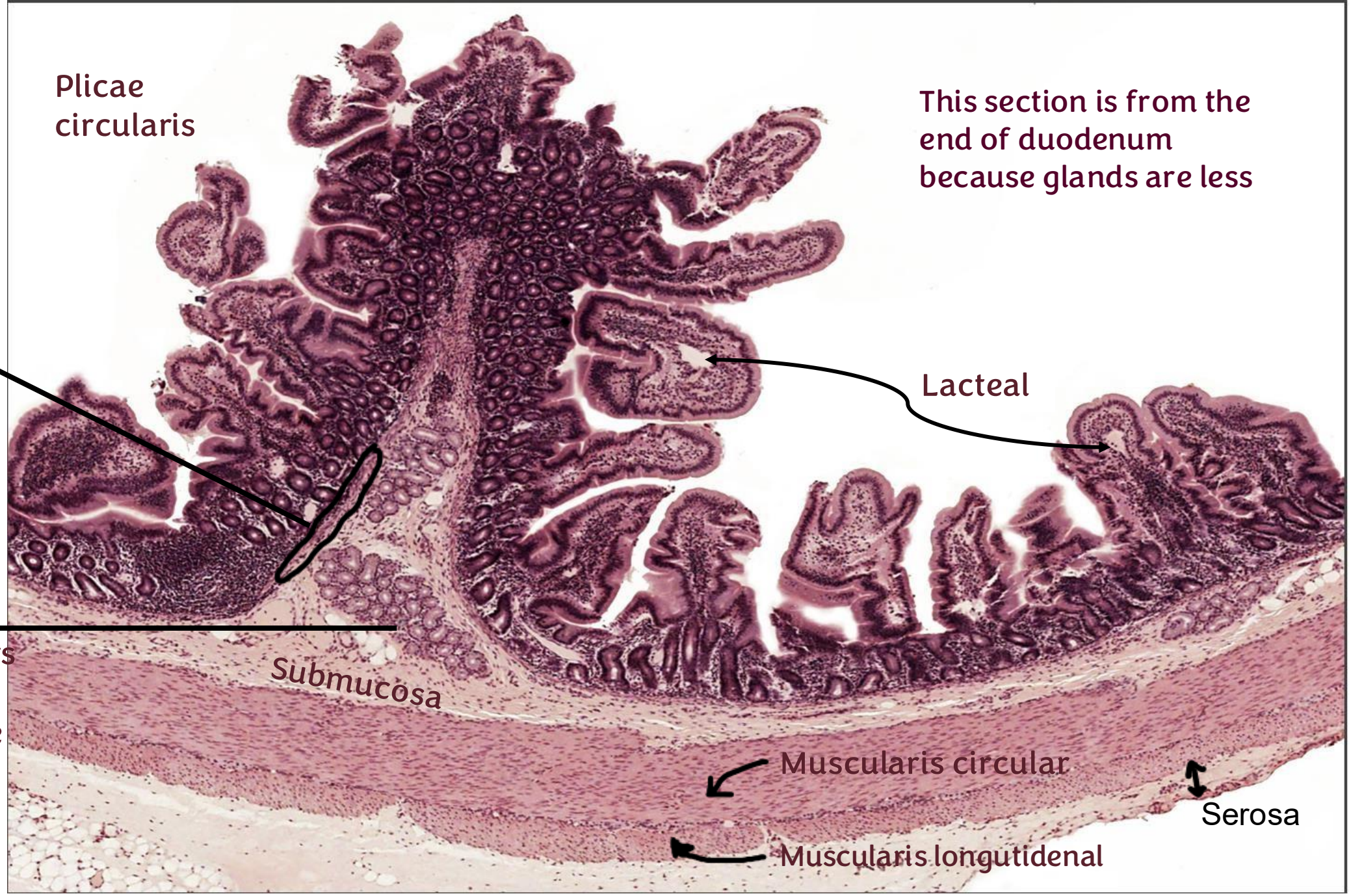
Black arrow: Serosa

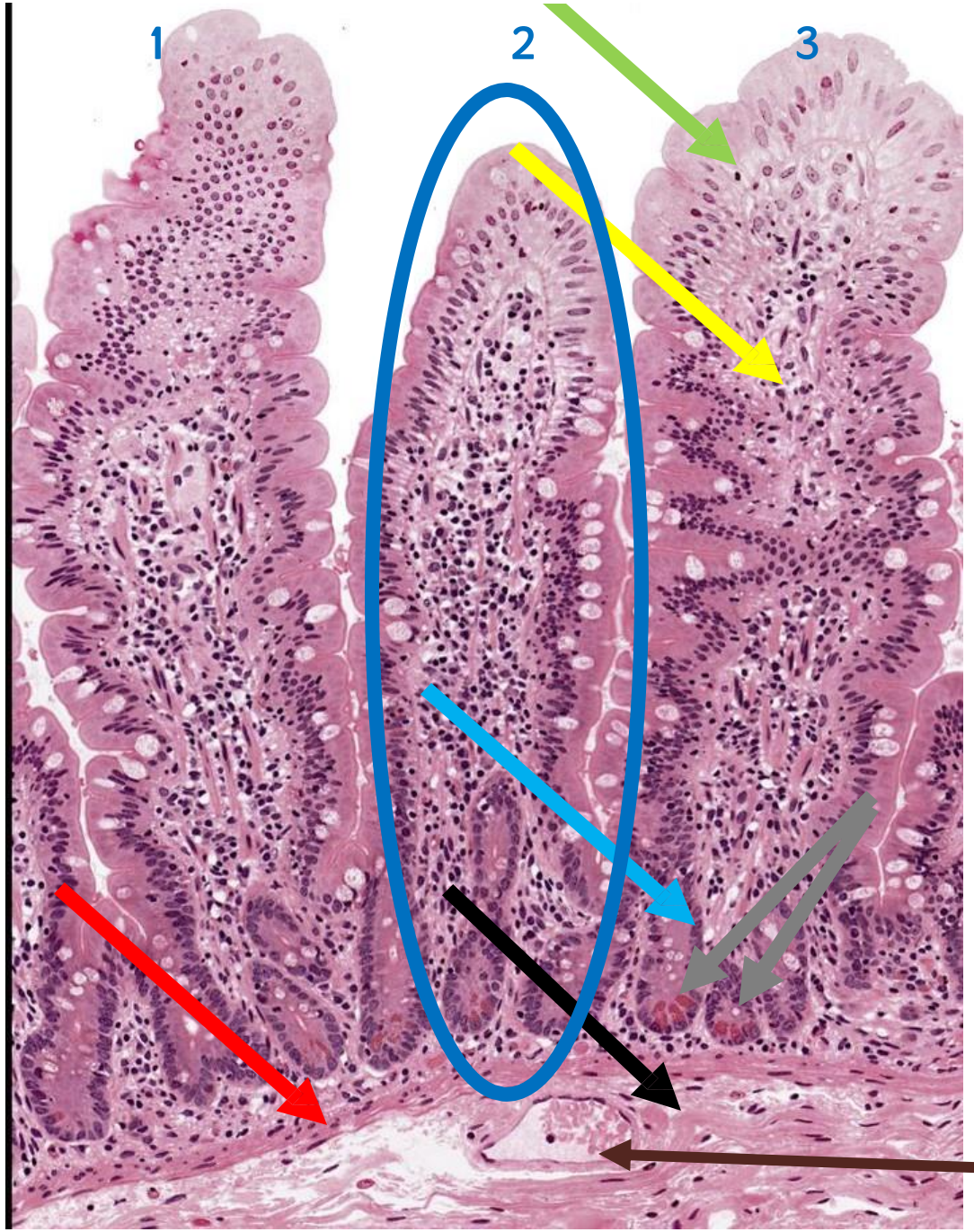
Green circle: villi

Yellow circle: Plicae circularis with submucosal core




Goblet by special stain
Microvilli
Enterocyte
Red arrow: Diffuse MALT
White circles: Goblet cells
Yellow arrow: Nodule
Green arrow: Nodules extend from mucosa into submucosa


Plicae circularis
This section is from the end of duodenum because glands are less
Muscularis mucosa
Lacteal
Few glands NOT brenners because it's not filled like brenners
Submucosa
Muscularis circular
Serosa
Muscularis longutidenal



Green arrow:
Enterocyte

Yellow arrow:
Lamina propria

Blue circle:
Villi (3 villus)

Blue arrow:
Glands

Gray arrows:
Paneth cells

Black arrow:
submucosa

Blood vessel

Red arrow:
Muscularis mucose

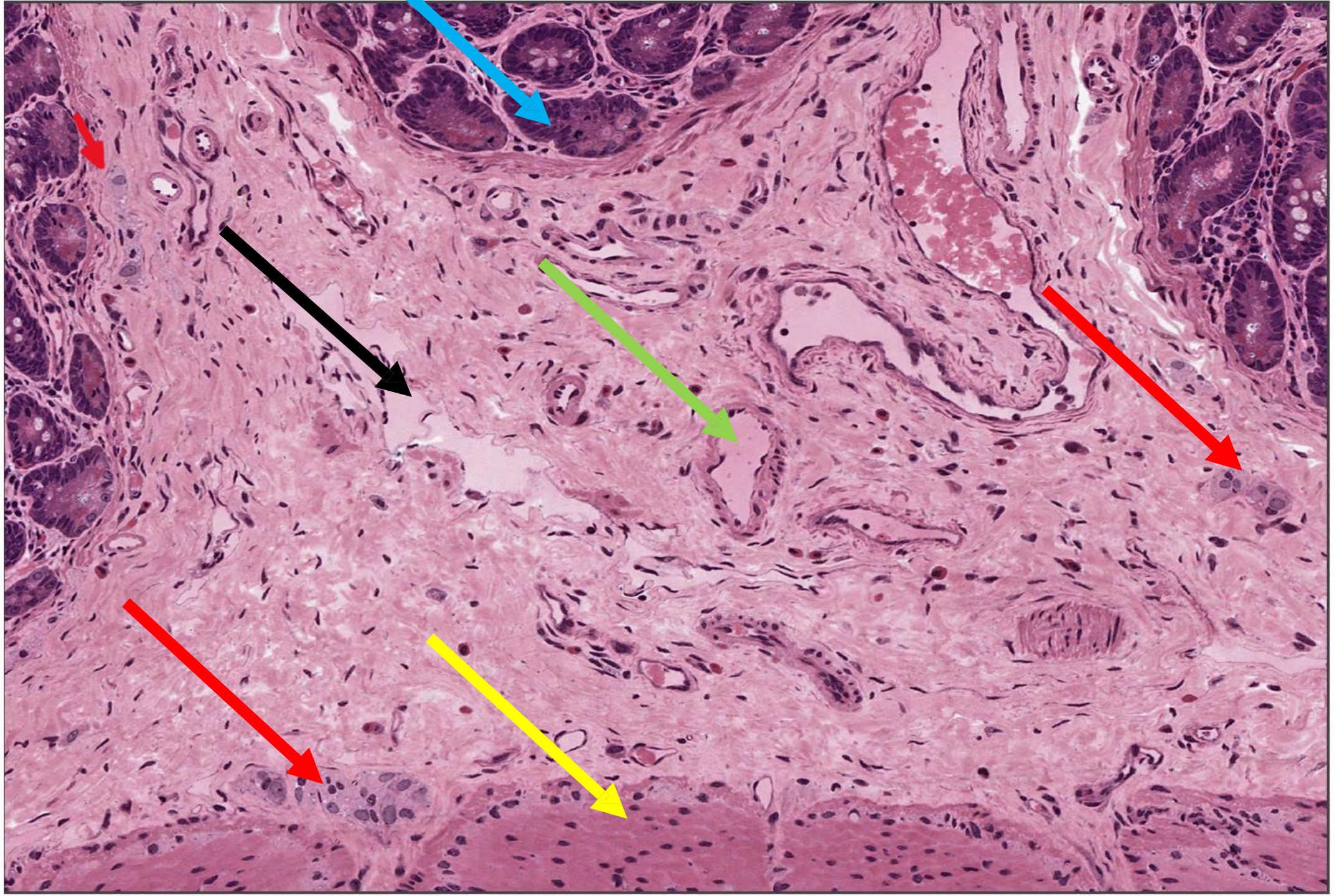
Red arrows: Meissner Plexus

Green arrow: Blood vessel (thicker wall- smooth muscle)

Black arrow: lymphatic (flattened endothelium)

Yellow arrow: muscularis

Blue arrow: Glands

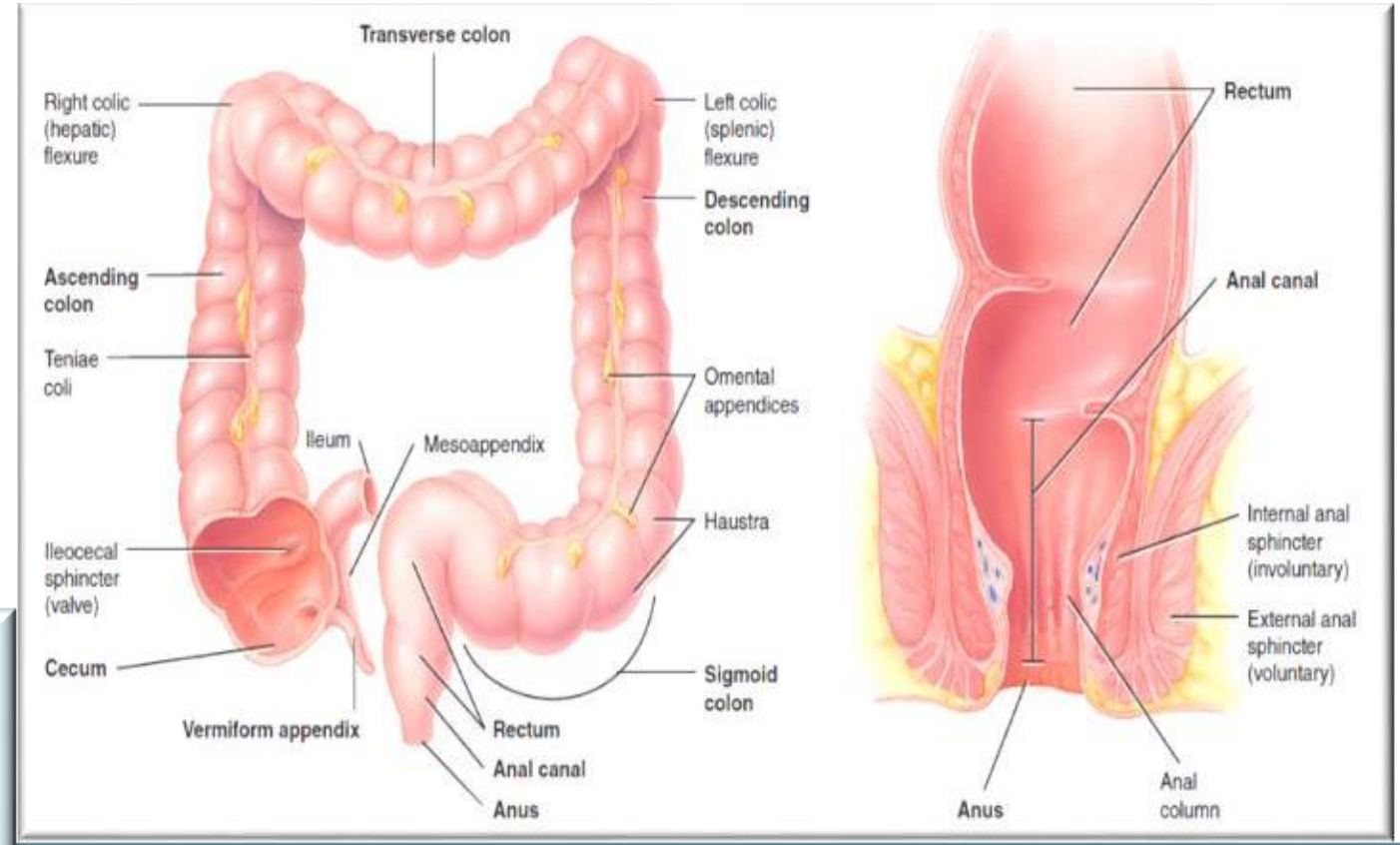


The Large Intestine

- 1.5 m long and 6.5 cm in diameter.
- Extends from the ileum to the anus.
- Attached to the posterior abdominal wall by its mesocolon (double layer of peritoneum)
- Four major regions: cecum, colon, rectum, and anal canal.

- The ileocecal sphincter (fold of mucous membrane called): the opening from the ileum into the large intestine.
- **Cecum:** hangs inferior to the ileocecal valve.
- **Appendix:** attached to the cecum. Is a twisted, coiled tube, measuring about 8 cm.

- Colon: is divided into ascending, transverse, descending, and sigmoid portions.
- Ascending and descending colon are retroperitoneal; the transverse and sigmoid colon are not.
- The **rectum** is about 15 cm in length and lies anterior to the sacrum and coccyx.



- **Anal canal** : terminal part of the large intestine, is 2–3 cm long.
- The mucous membrane of the anal canal is arranged in longitudinal folds called **anal columns** that contain a network of arteries and veins.
- **Anus:** opening of the anal canal to the exterior, guarded by an **internal anal sphincter** (involuntary) and an **external anal sphincter** (voluntary).

Histology Of The Large Intestine

- The wall contains the typical four layers: mucosa, submucosa, muscularis, and serosa:

➢ **The mucosa:** simple columnar epithelium, lamina propria, and muscularis mucosae.

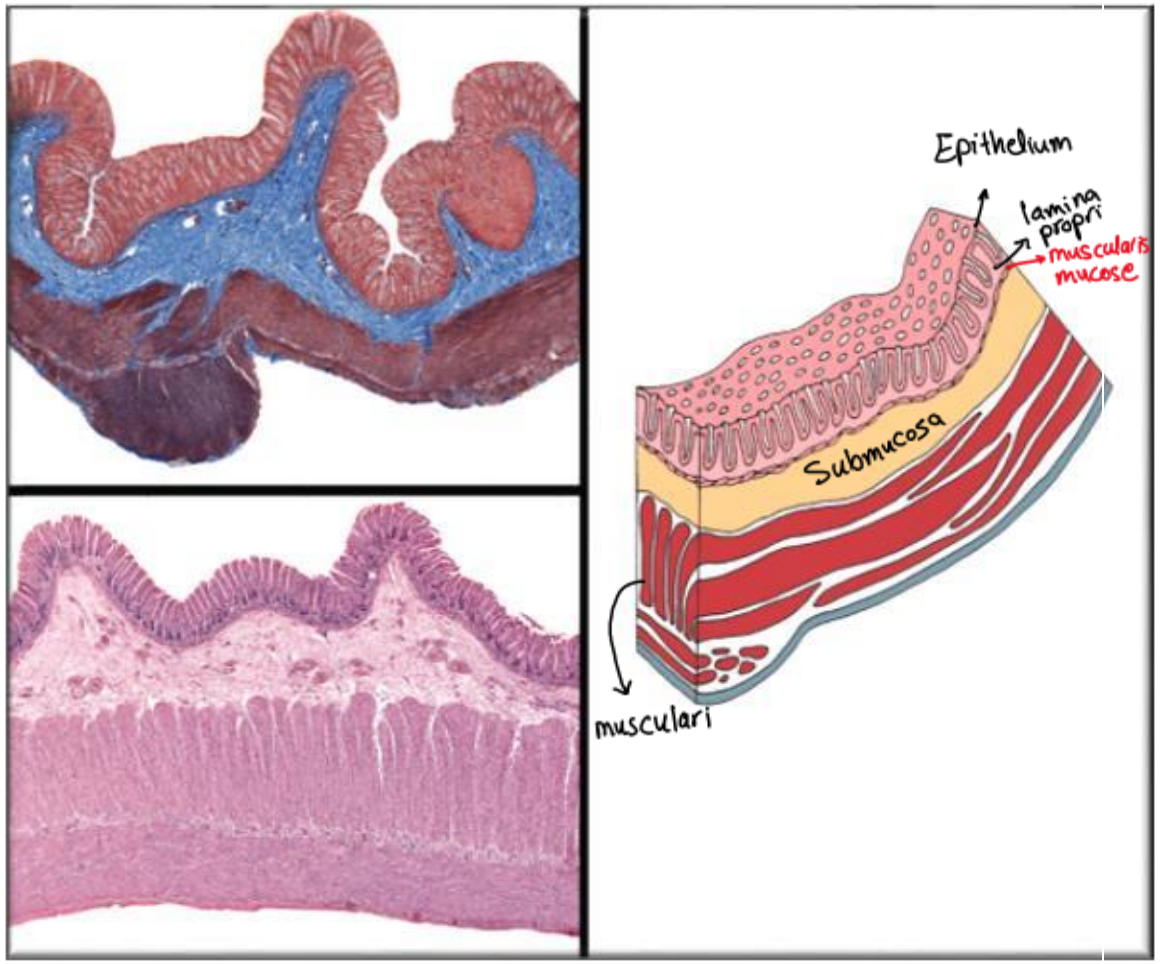
✓ The epithelium contains mostly absorptive (**colonocytes**) and **goblet** cells.

✓ Much more absorption occurs in the small intestine than in the large intestine.

✓ Tubular intestinal glands.

✓ Small number of **enteroendocrine** cells

✓ LP is rich with **MALT–**---due to large bacterial population

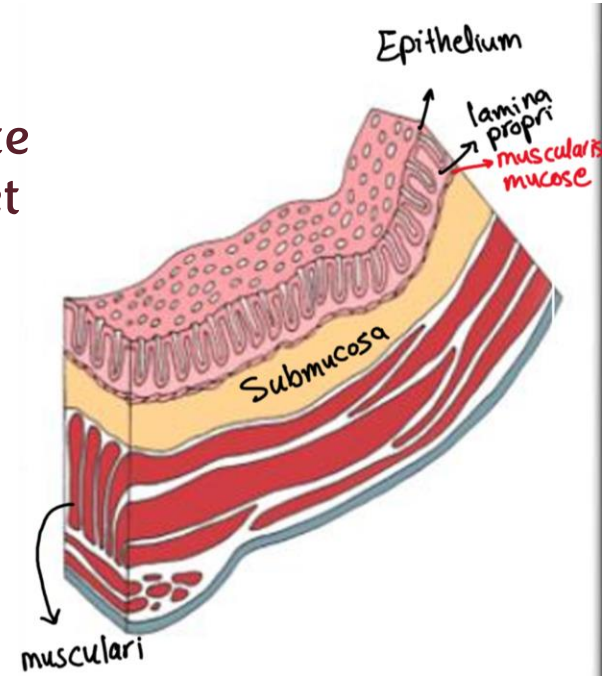


- Mucosa of the large intestine does not have as many structural adaptations that increase surface area (*except in the rectum has no major folds*

The large intestine vs. The small intestine:

- Most of the absorption has already been processed in the small intestine, and whatever is left (undigested, unabsorbed material and the remaining of water + electrolytes) will be dried up by the large intestine to form solid waste.
- So, you shall not expect the absorption mechanisms (the plicae circulares, the villi) while (microvilli) are still present but they are less in numbers, density and scattered, and as we proceed distally these structures will start to disappear.

- In the large intestine, the epithelium invaginate into the lamina propria to create tubular glands, essentially acting as mucus-secreting factories filled with goblet cells. You will also notice as you proceed distally the MALT becomes more prominent, forming large, distinct nodules within the tissue.
- Another feature is the condensation of the outer longitudinal muscularis into the “teniae coli” which extends on the external surface of colon, and because these bands are shorter than the intestinal wall itself, they cause the colon to form into “haustra”.



*Teniae coli are three distinct, longitudinal ribbon-like bands of smooth muscle running along the outer surface of the large intestine, extending from the cecum to the sigmoid colon.

*Haustra (singular: haustrum) are the small, segmented pouches or sacculation that give the colon its segmented appearance.

Large Intestine

- **The submucosa** of the large intestine consists of connective tissue.
- **The muscularis**: external longitudinal (gathered into teniae coli) and internal circular layers.
- **The serosa** is part of the visceral peritoneum.

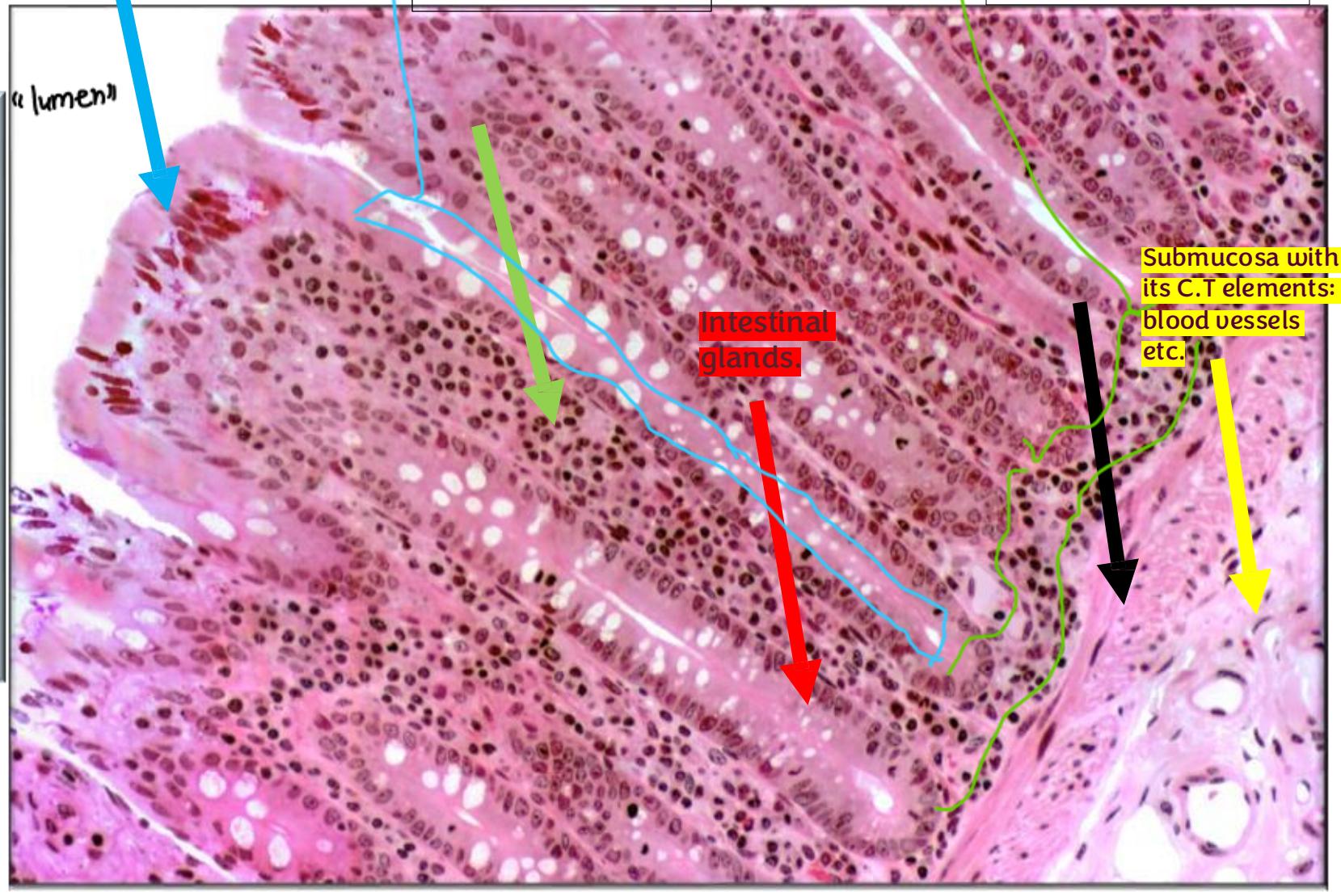
The blue arrow:
The colonocytes at the lining epithelium.
+ small amount of diffuse neuroendocine cells.

Simple tubular glands result from the invagination of epithelium into the lamina propria.

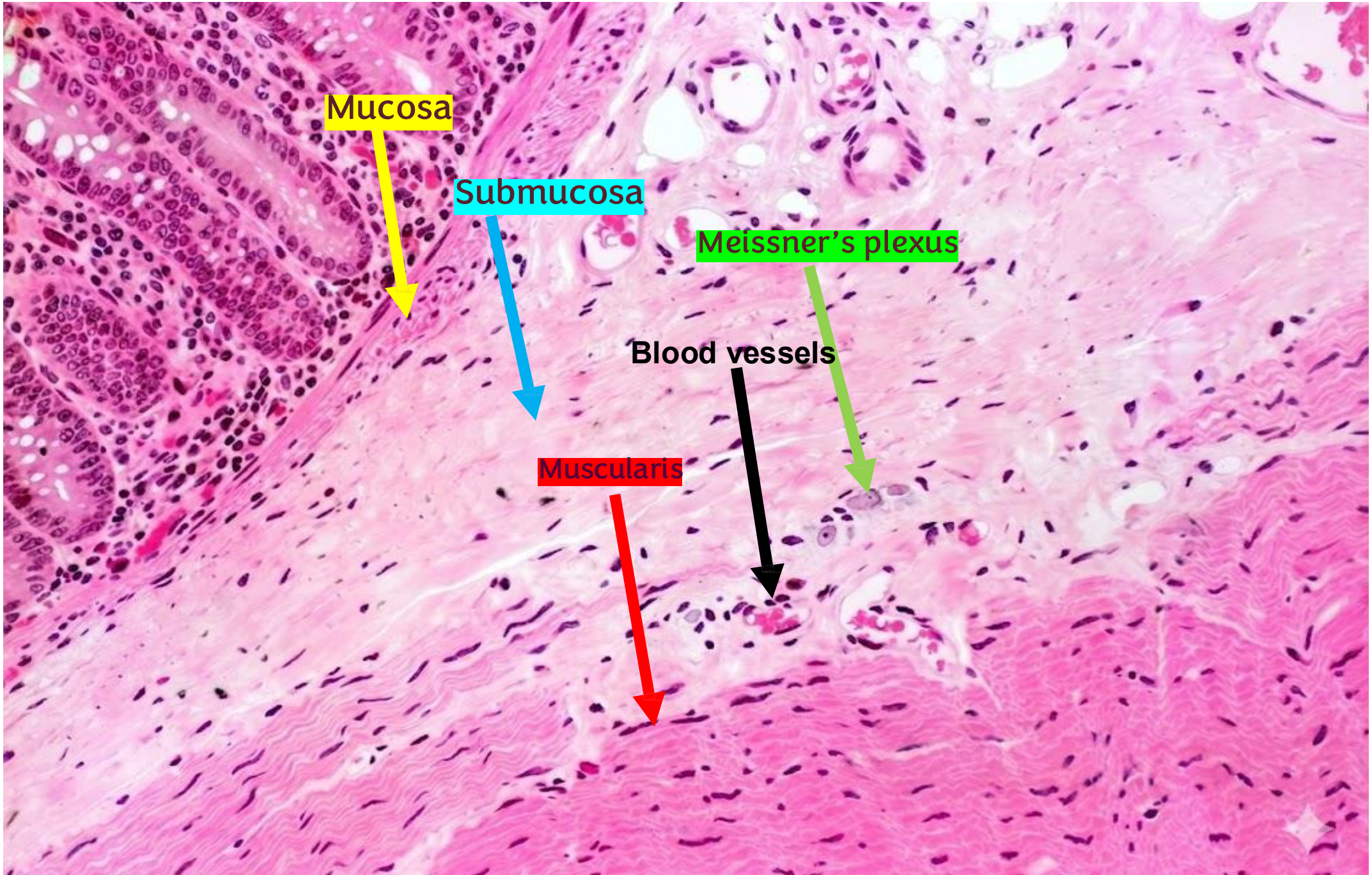
The dark nuclei of the "lymphocytes" at what's left of the lamina propria.

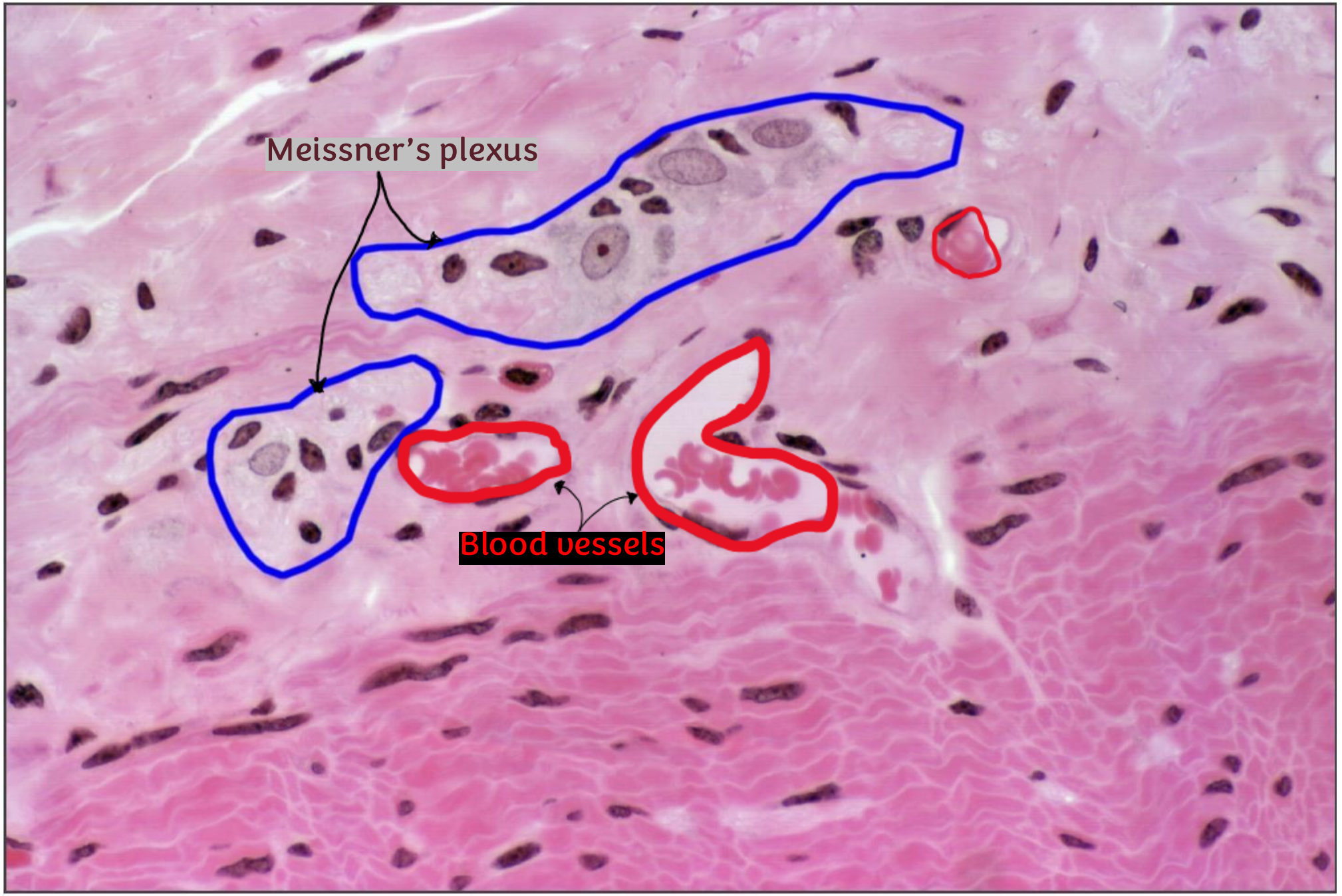
Green arrow:
Lamina propria.

Black arrow:
Muscularis mucosa.



Here you can see 3 layers of the large intestine :

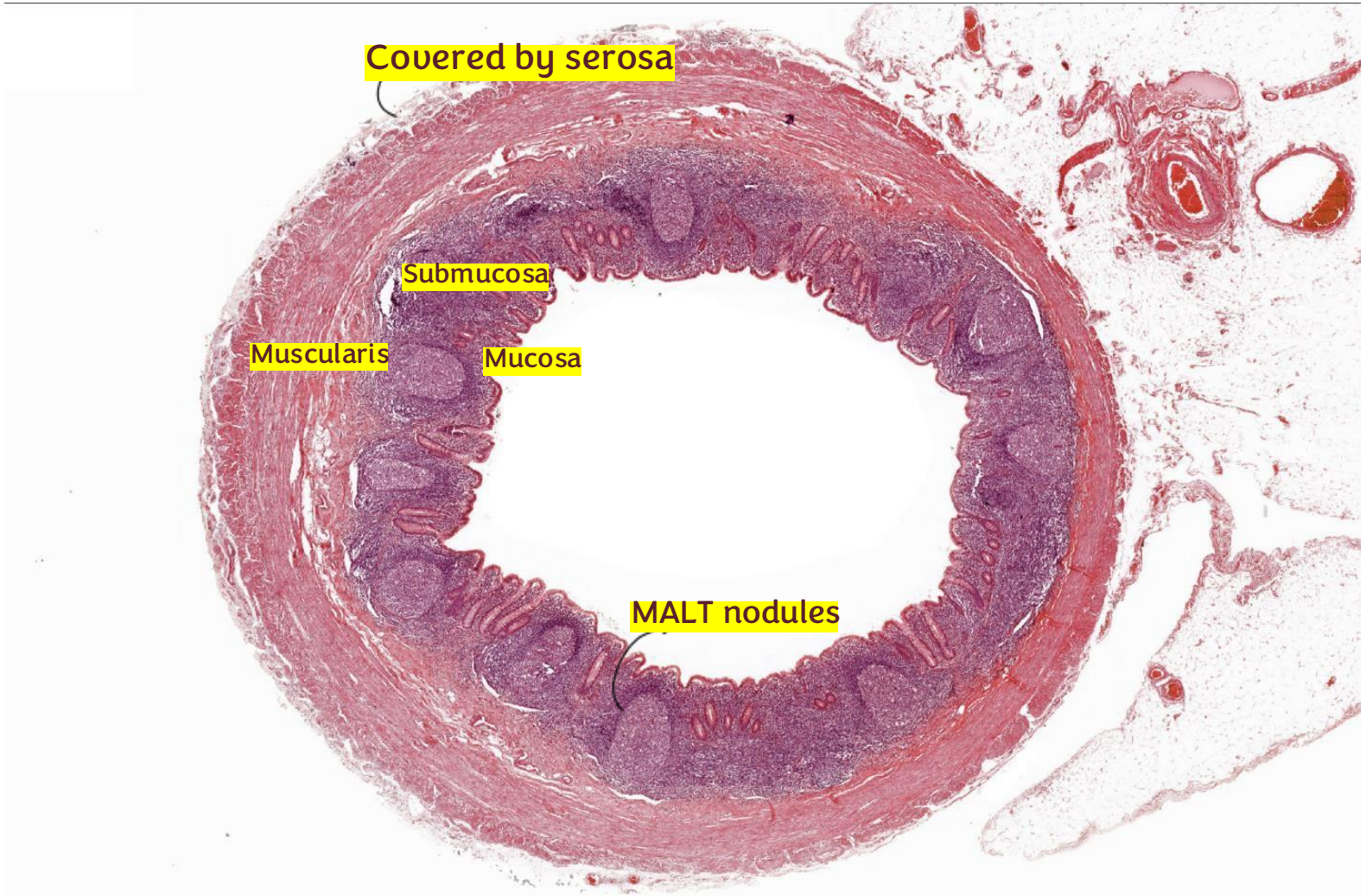



Meissner's plexus
Blood vessels

Appendix

- Has little or no absorptive function but is a significant component of MALT

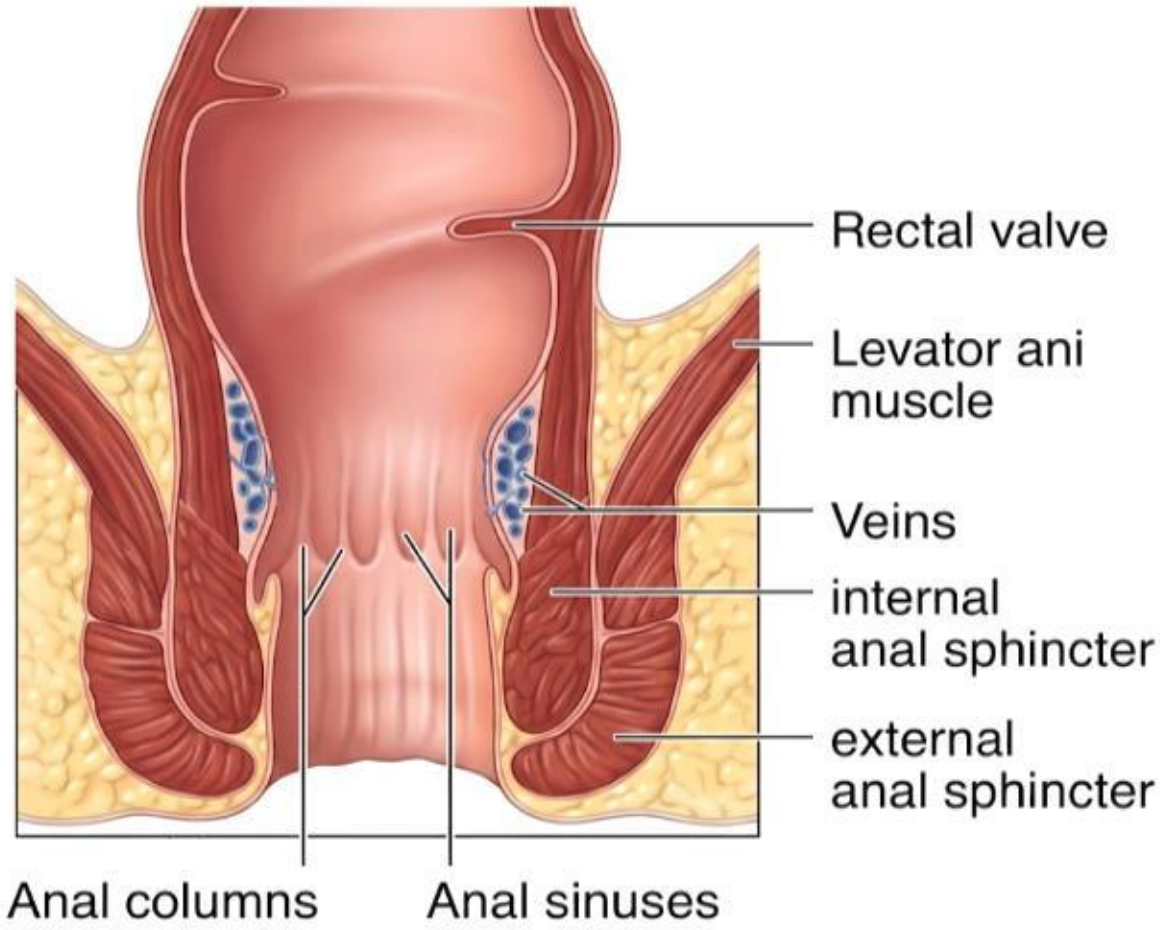
In these secondary MALT nodules, the inner portion is visibly lighter than the outer section.



Has the exact same layers

Anal Canal

- The anal canal 3-4 cm long, Is a short structure,
- It is the last end of the GIT, where the feces are pushed to move outside of the body.
- At the rectoanal junction the simple columnar mucosal is lining of the rectum it is replaced by a protective stratified squamous epithelium (non-keratinized).
- The mucosa and submucosa form several longitudinal folds---anal columns; lamina propria and submucosa include sinuses of the rectal venous plexus.

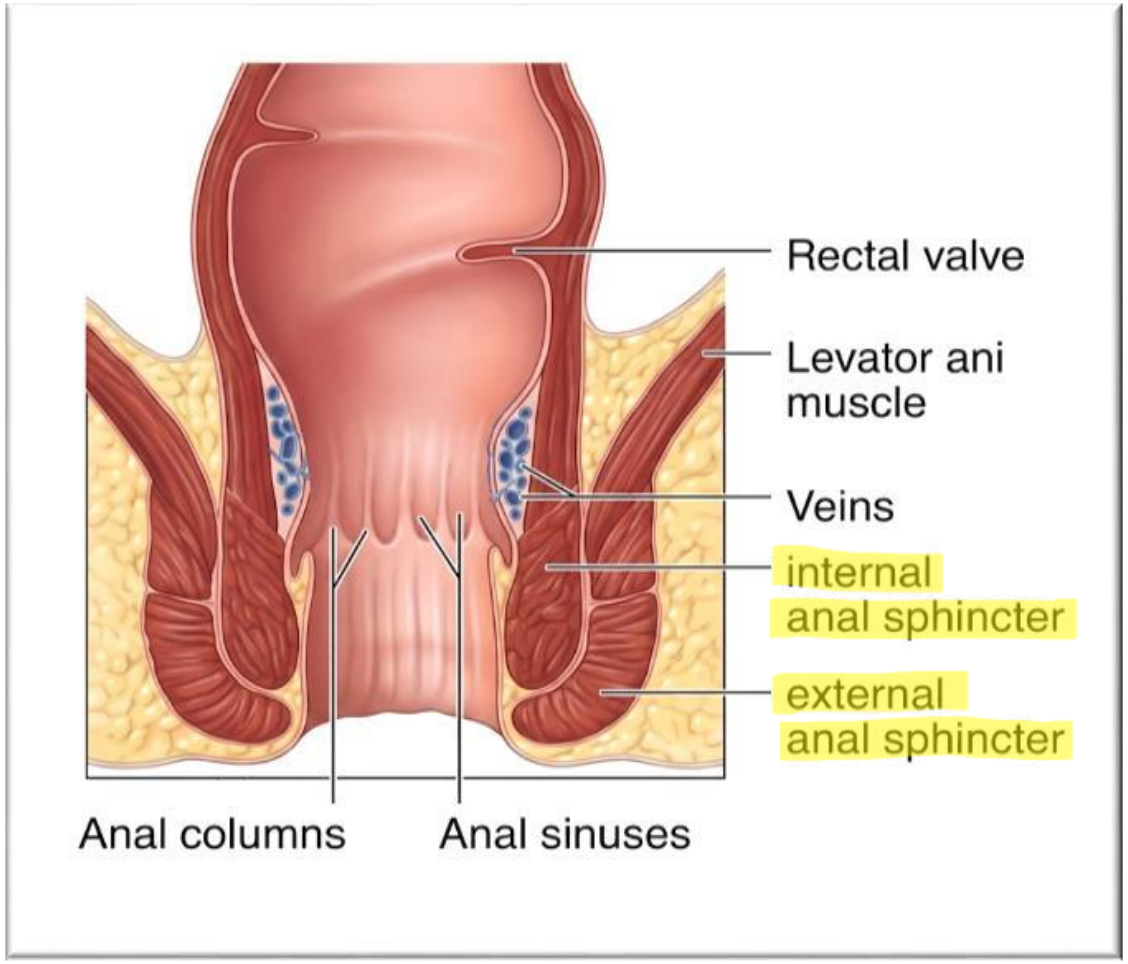


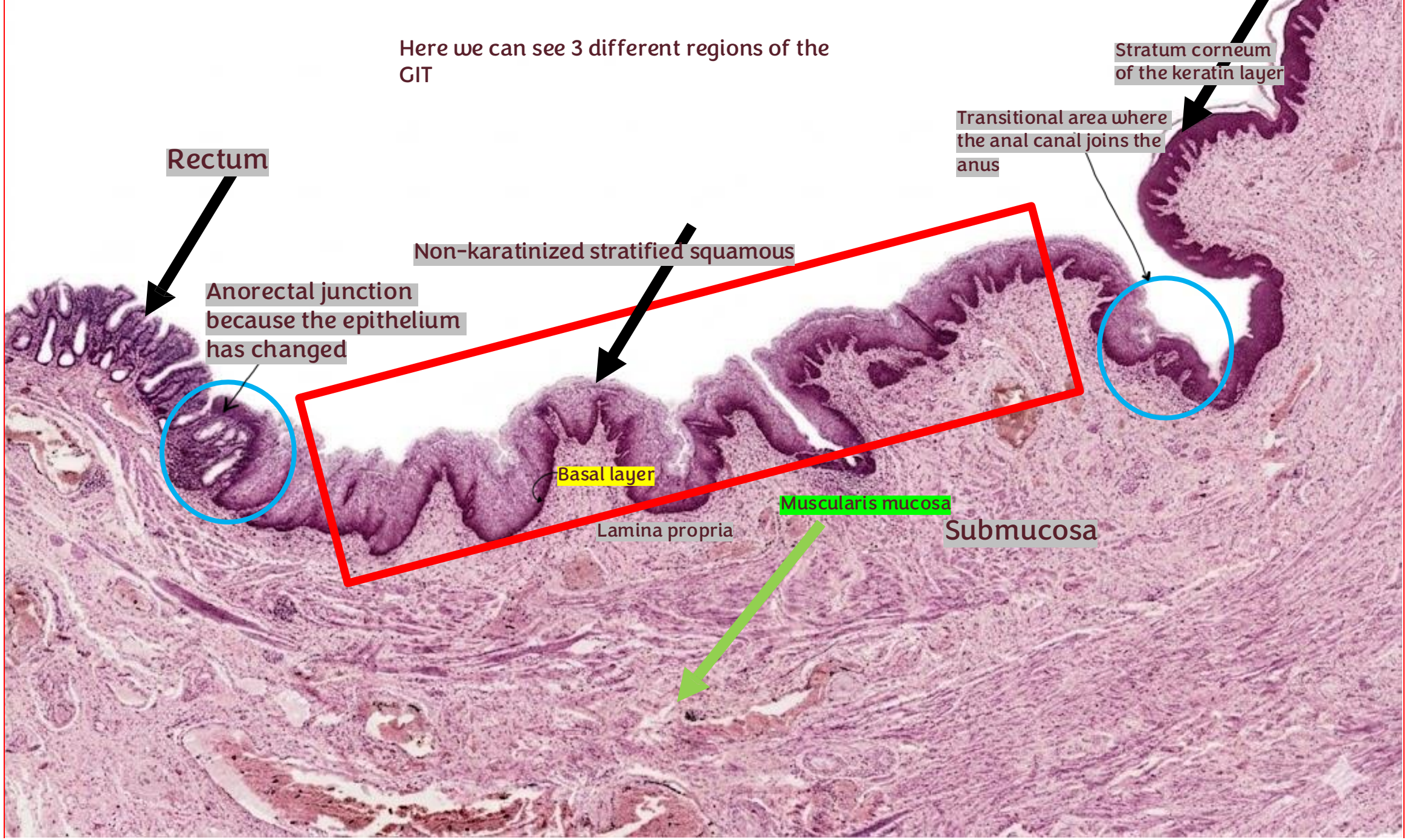
- Near the anus the circular layer of the rectum's muscularis forms the internal anal sphincter.
- Defecation involves the action of voluntary muscle comprising the external anal sphincter

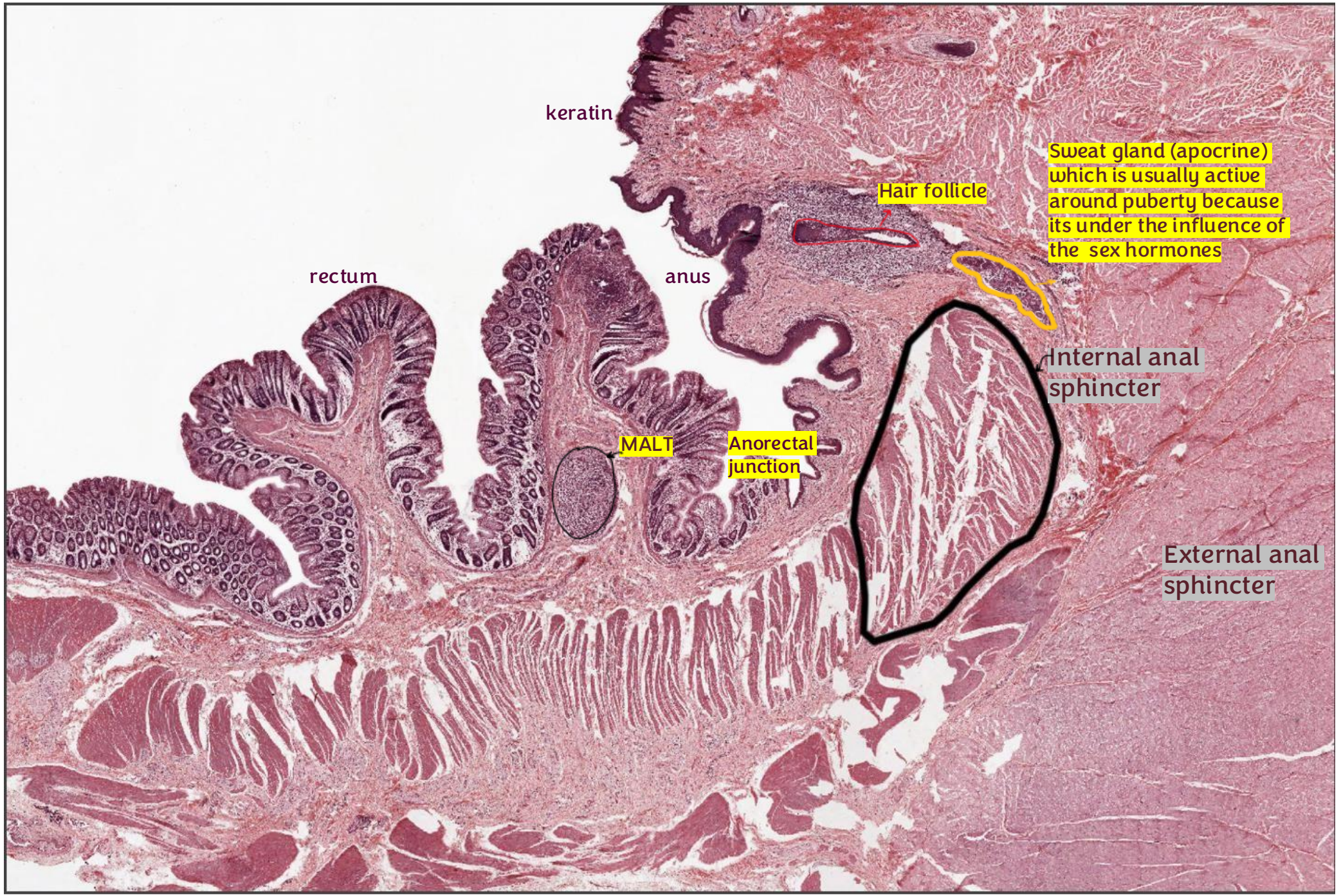
Anal Canal

The anal canal features mucosal and submucosal elevations known as anal columns, which facilitate the passage of feces. These columns contain the rectal venous plexus where hemorrhoids can develop; consequently, a fiber-rich diet is advised to ensure soft stools that pass easily without excessive pressure.

Following the anal canal distally, the internal anal sphincter (the inner smooth layer) provides involuntary control, while the external anal sphincter(the thicker outer layer) is made of skeletal muscle allowing of vouluntry control.




Here we can see 3 different regions of the GIT
Stratum corneum of the keratin layer
Transitional area where the anal canal joins the anus
Rectum
Non-karatinized stratified squamous
Anorectal junction because the epithelium has changed
Basal layer
Muscularis mucosa
Lamina propria
Submucosa


keratin
Hair follicle
Sweat gland (apocrine) which is usually active around puberty because its under the influence of the sex hormones
rectum
anus
Internal anal sphincter
MALT
Anorectal junction
External anal sphincter

Summarize table

Region and Subdivisions	Mucosa (Epithelium, Lamina Propria, Muscularis Mucosae)	Submucosa (With Submucosal Plexuses)	Muscularis (Inner Circular and Outer Longitudinal Layers, With Myenteric Plexuses Between Them)	Adventitia/Serosa
Esophagus(upper, middle, lower)	Nonkeratinized **stratified squamous epithelium**; **cardiac glands** at lower end	Small **esophageal glands** (mainly mucous)	Both layers **striated muscle**in upper region; both layers **smooth muscle** in lower region; **smooth and striated muscle** mingled in middle region	Adventitia, except at lower end with serosa
Stomach(cardia, fundus, body, pylorus)	**Surface mucous cells** and **gastric pits** leading to **gastric glands** with **parietal and chief cells**, (in the fundus and body) or to mucous **cardiac glands** and **pyloric glands**	No distinguishing features	**Three indistinct layers** of smooth muscle (inner oblique, middle circular, and outer longitudinal)	Serosa
Small intestine(duodenum, jejunum, ileum)	**Plicae circulares; villi**, with **enterocytes** and **goblet cells**, and **crypts/glands** with **Paneth Cells** and **stem cells; Peyer patches** in ileum	**Duodenal (Brunner) glands**(entirely mucous); possible extensions of Peyer patches in ileum	No distinguishing features	Mainly serosa
Large intestine(cecum, colon, rectum)	**Intestinal glands** with **goblet cells** and **absorptive cells**	No distinguishing features	Outer longitudinal layer separated into three bands, the **teniae coli**	Mainly serosa, with adventitia at rectum
Anal canal	**Stratified squamous epithelium**; longitudinal **anal columns**	Venous sinuses	Inner circular layer thickened as **internal sphincter**	Adventitia

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Corrections from previous versions:

Versions	Slide # and Place of Error	Before Correction	After Correction
V0 → V1	Slide 8	The covering here is mucosa and the core is submucosa.	The covering here is mucosa and the core is lamina propria .
V1 → V2			