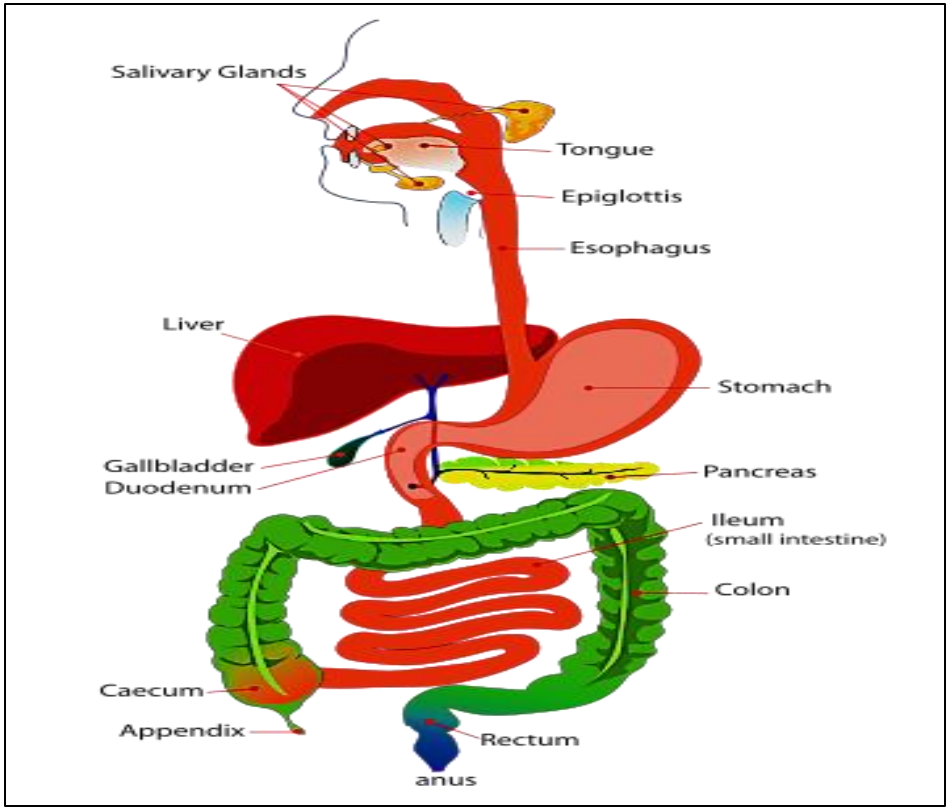
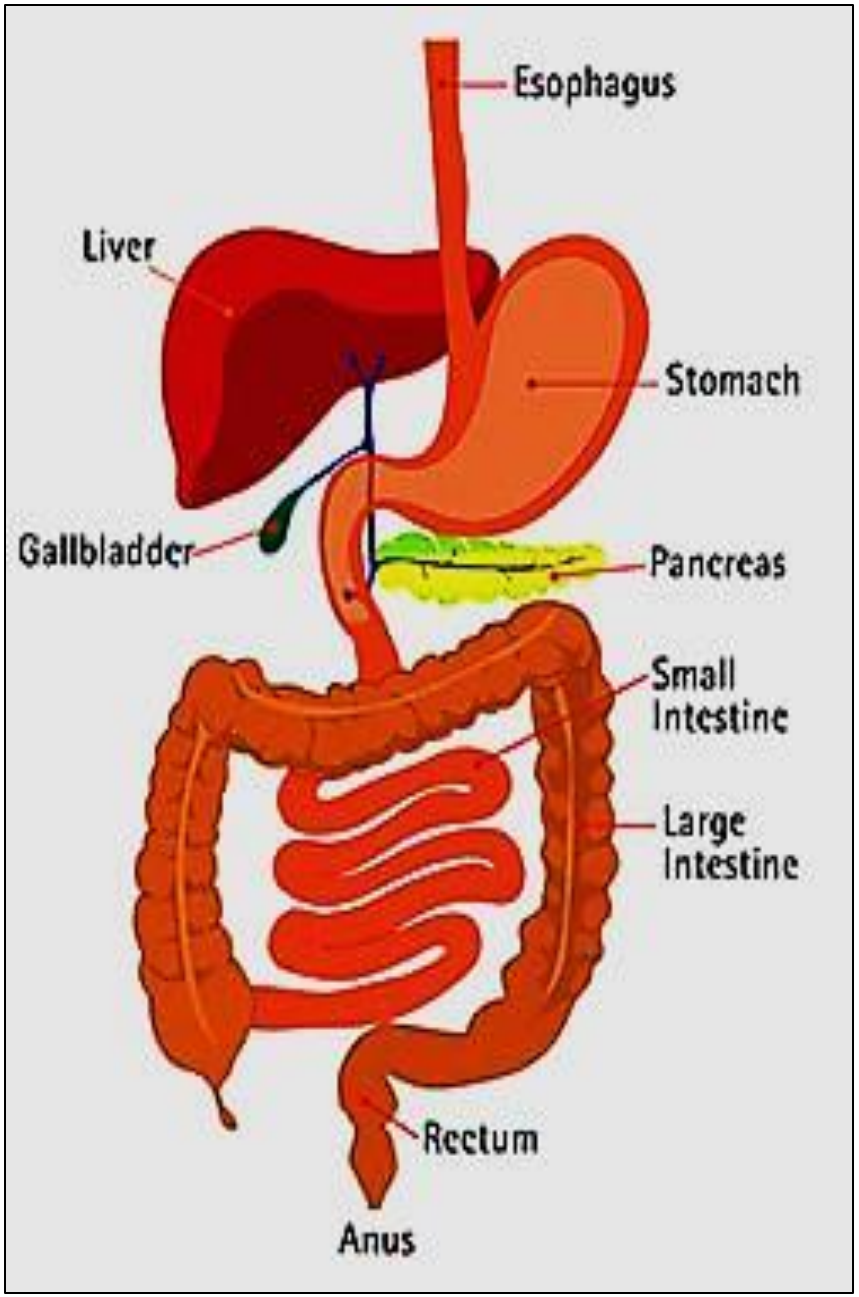
The digestive system II



The gastro- intestinal tract:

Composed of:

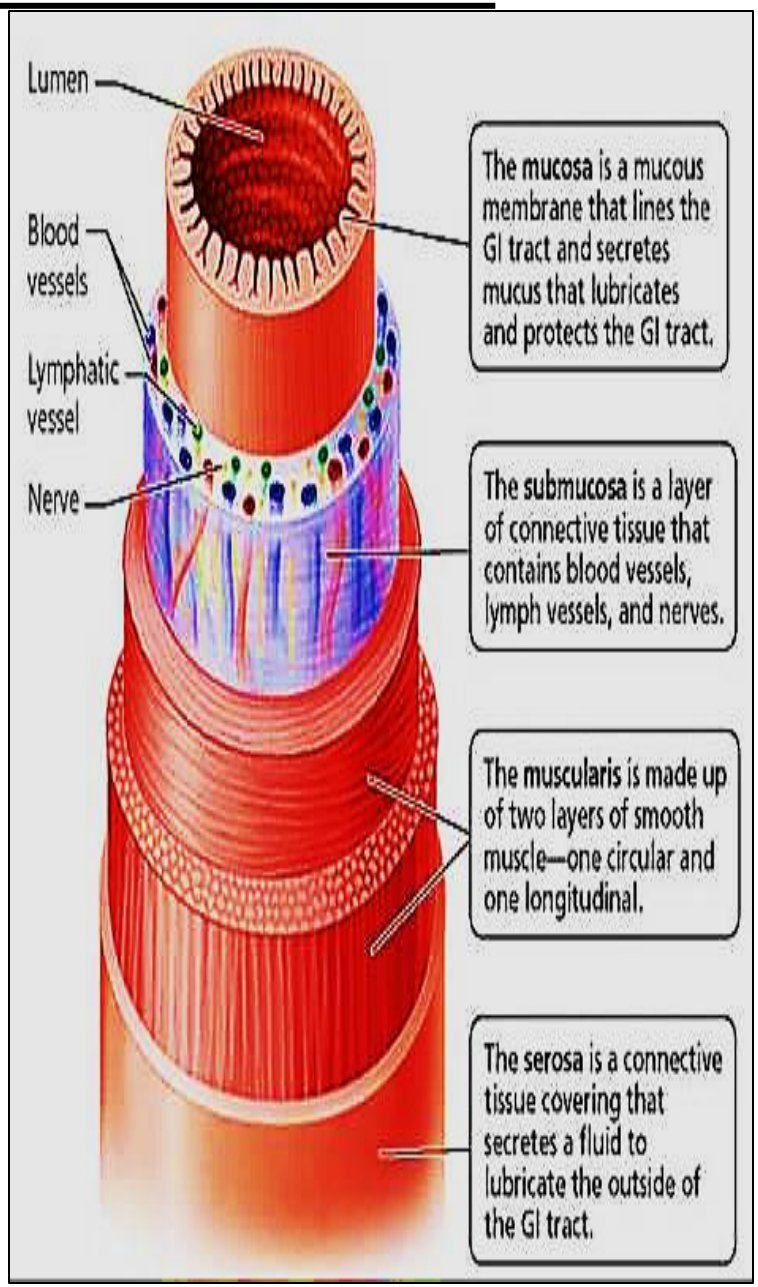
- Esophagus
- Stomach
- Small intestine
- Large intestine
- Anal canal



General features of the wall of the GIT

its wall is composed of **4 layers**:

- Mucosa:
  - Epithelium
  - CT (Lamina propria, corium)
  - Muscularis mucosa (s. ms.)
- Submucosa: C.T.
- Musculosa : 2 layers of smooth muscles (IC & OL)
- Adventitia or serosa



Adventitia vs. serosa

Serosa: double layer membrane made of epithelium

One layer is attached to the organ called visceral layer , the other layer will be close to the body cavity & called partial layer. In between these two epithelial layer is fluid called serous for lubrication (reduce friction)

Serosa will wrap organs that set in a body cavity i.e abdominal cavity like GIT organs within the peritoneum i.e intraperitoneal organs (liver, stomach, spleen, 1st part pf duodenum, ileum, jejunum, transverse & sigmoid colon)

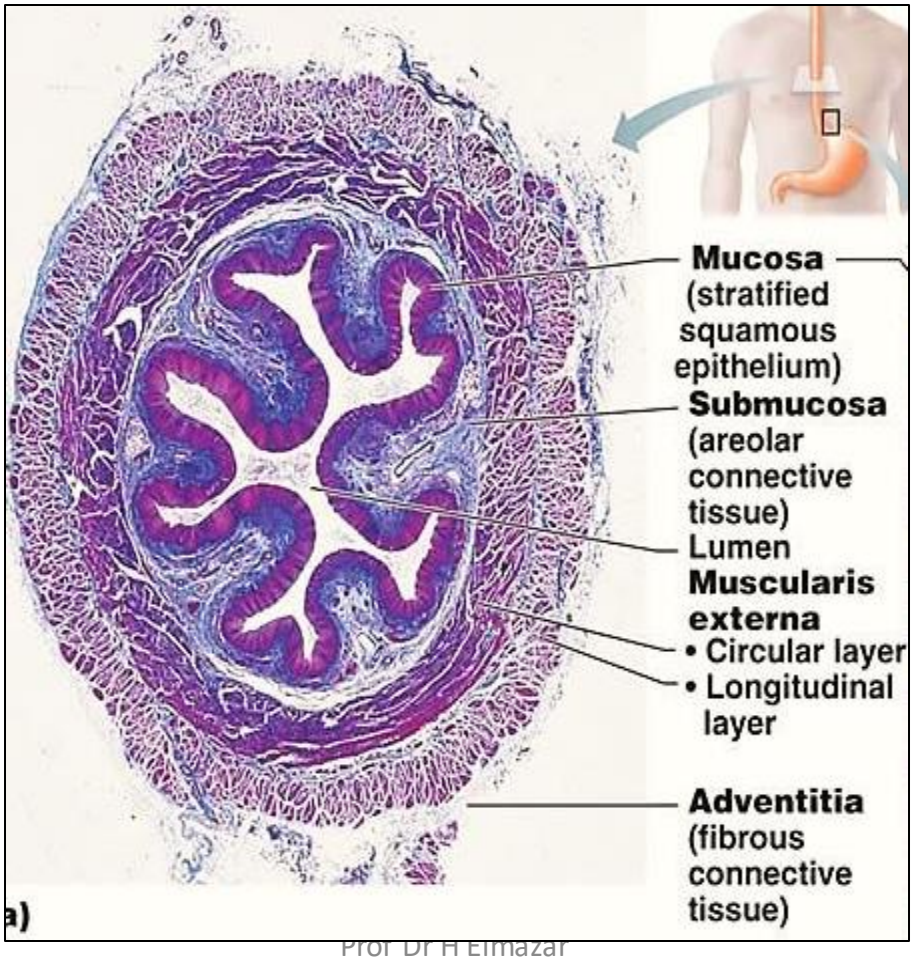
Adventitia: is not epithelial is loose CT that wraps organs that set outside the peritoneal cavity i.e. retroperitoneal and attach them to the abdominal cavity

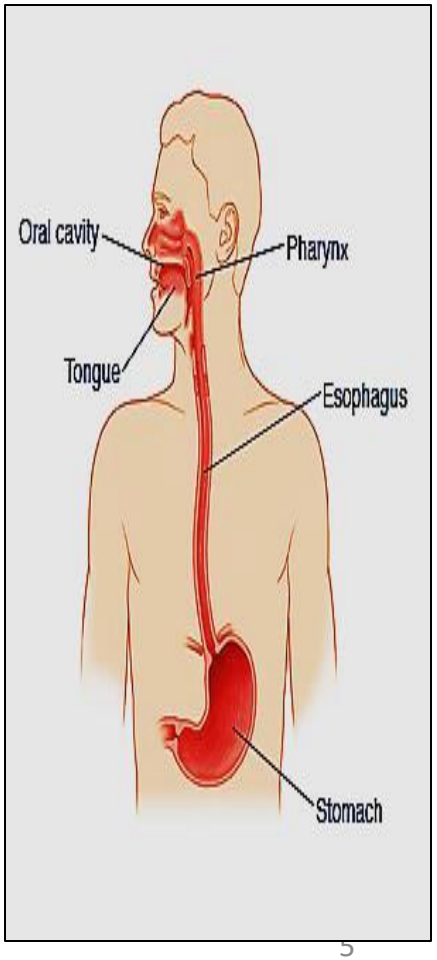
pancreas, rest of duodenum, cecum, ascending & descending Colcon

The esophagus

- Muscular tube connects the pharynx with stomach, transport food
- Its wall consists of 4 layers:

- Mucosa
- Submucosa:
- Musculosa
- Adventitia





- **Mucosa**

  Epithelium: Non-keratinized stratified squamous epith.

  Lamina propria: B.V., nerves, lymphatics (!Cardiac orifice)

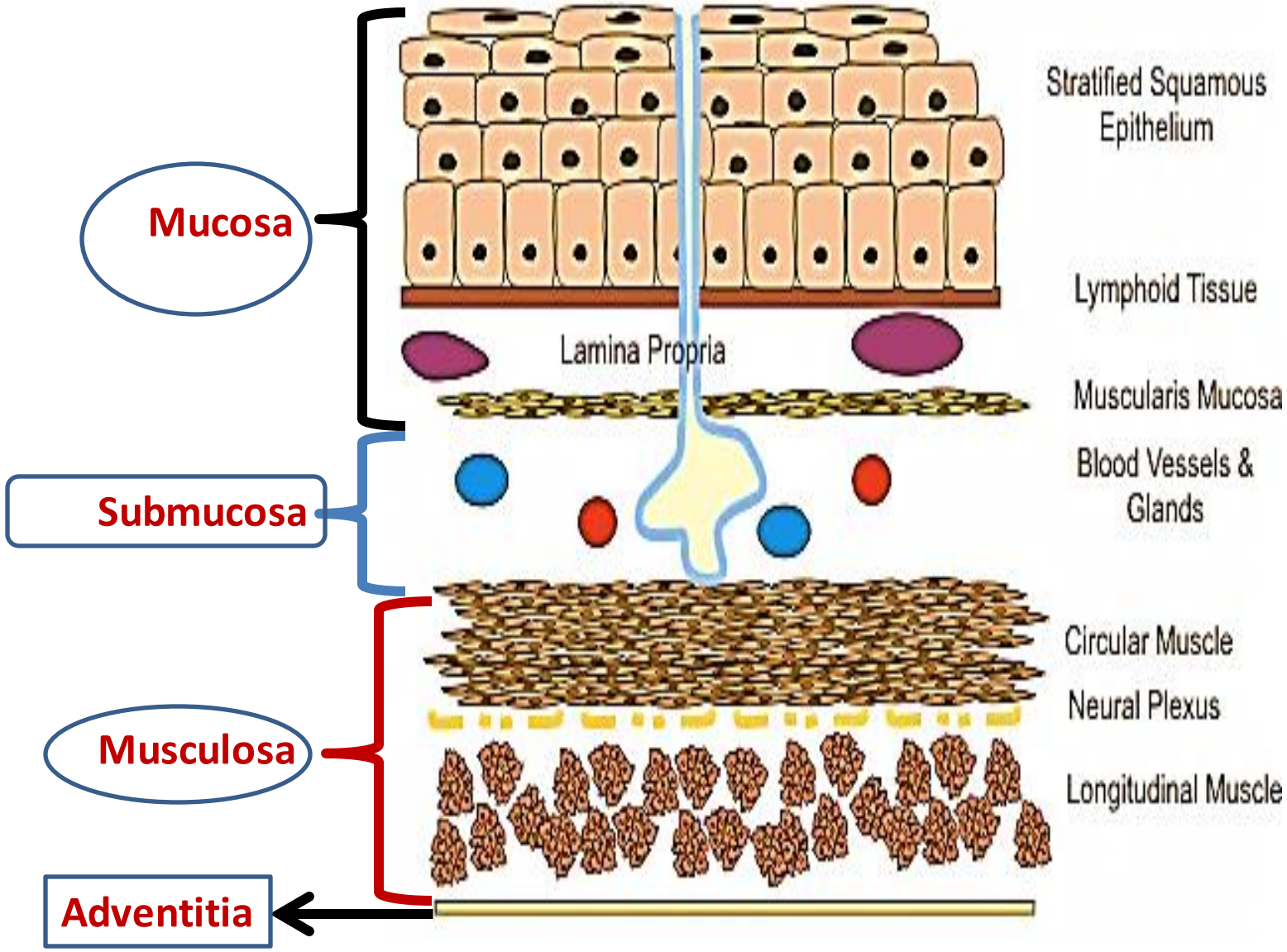
  Muscularis mucosa: smooth ms.

- **Submucosa**: loose C.T. contains BV, lymphatics, Meissner's plexus of nerves & esophageal mucous glands

- **Musculosa**: IC &OL (**OL**: upper 1/3 Striated *, middle 1/3 mixed & lower 1/3 smooth ms.) NB: swallowing start with controllable motion but finishes with involuntary peristalsis

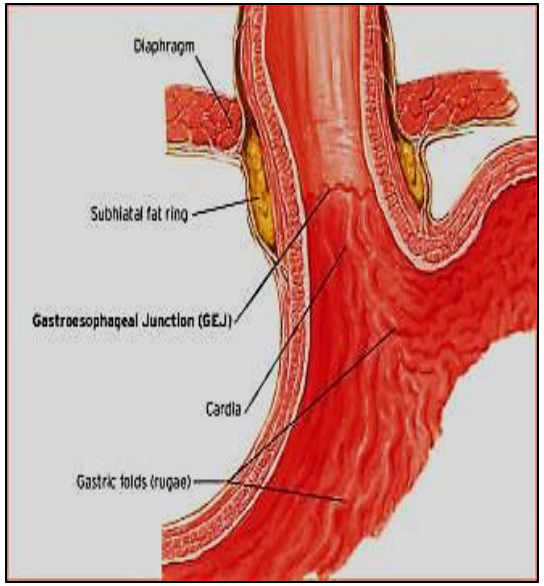
- **Adventitia**: covers most of the esophagus except the most distal portion which is located in the abdominal cavity is covered by serosa

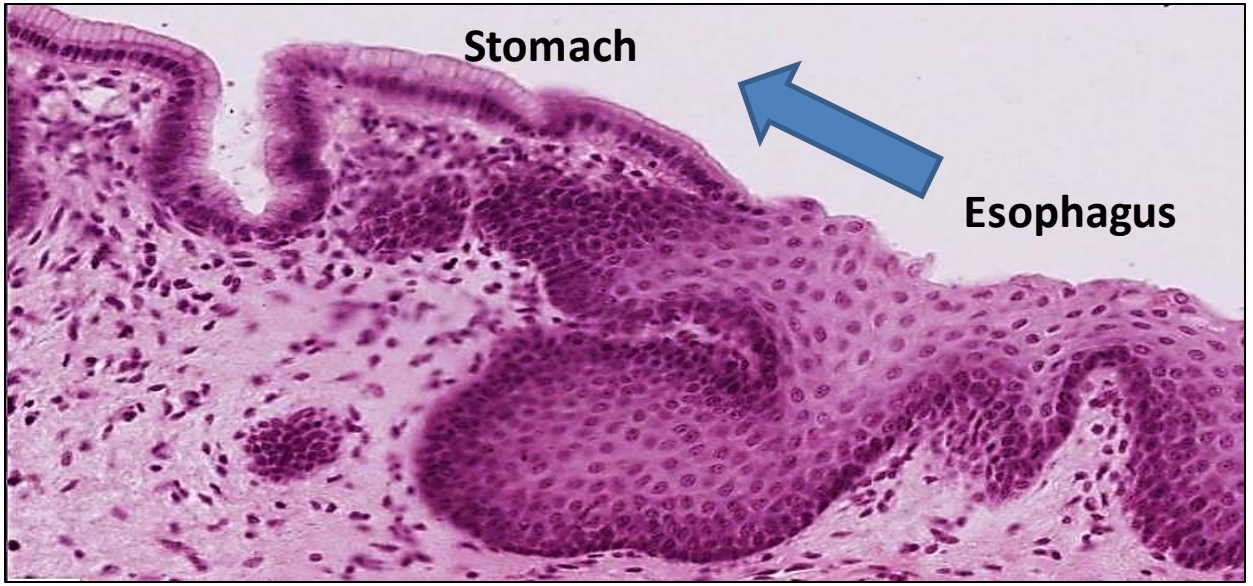
Layers of the wall of the esophagus



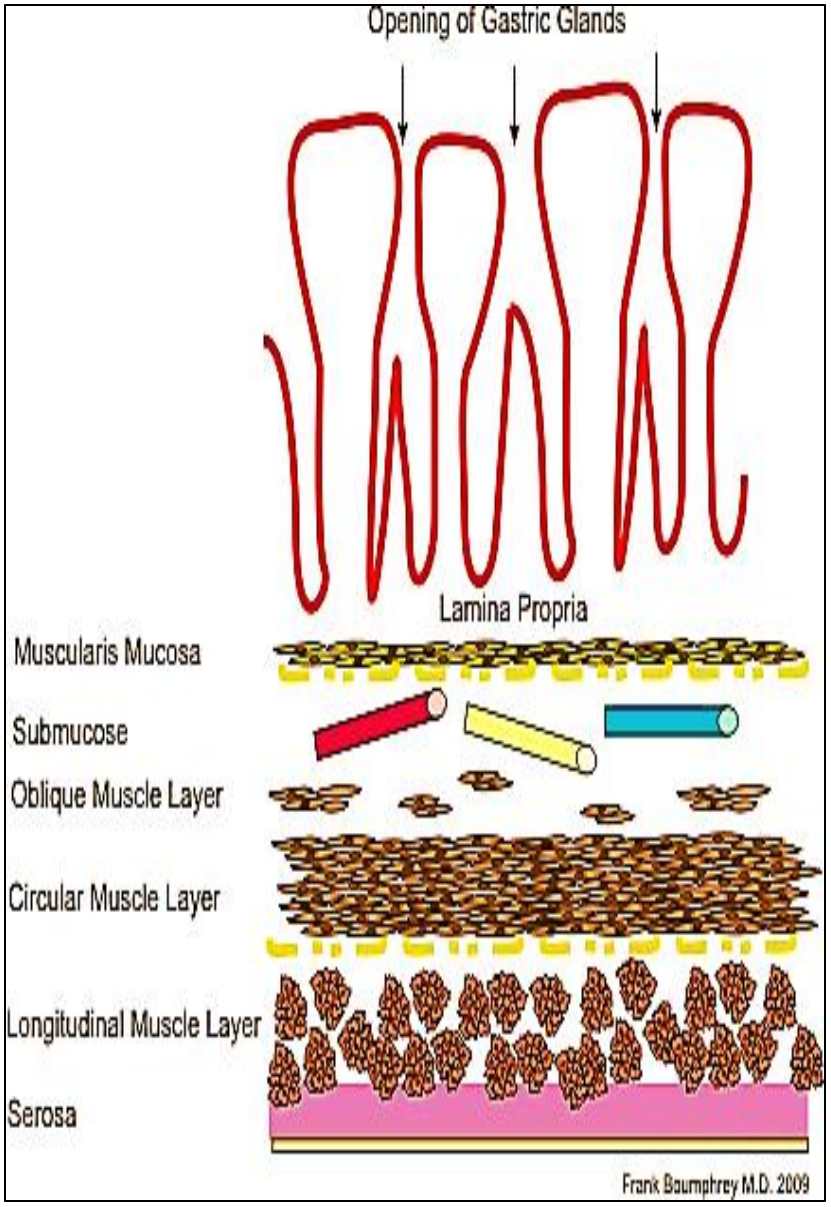
Changes at gastro- esophageal junction

1. The stratified Squamous → simple columnar epithelium
2. The lamina propria of stomach is wide & contains gastric glands (branched tubular)
3. The esophageal glands in the submucosa of esophagus stops in that of stomach
4. The musculosa becomes more thick in stomach due to the appearance of inner oblique layer

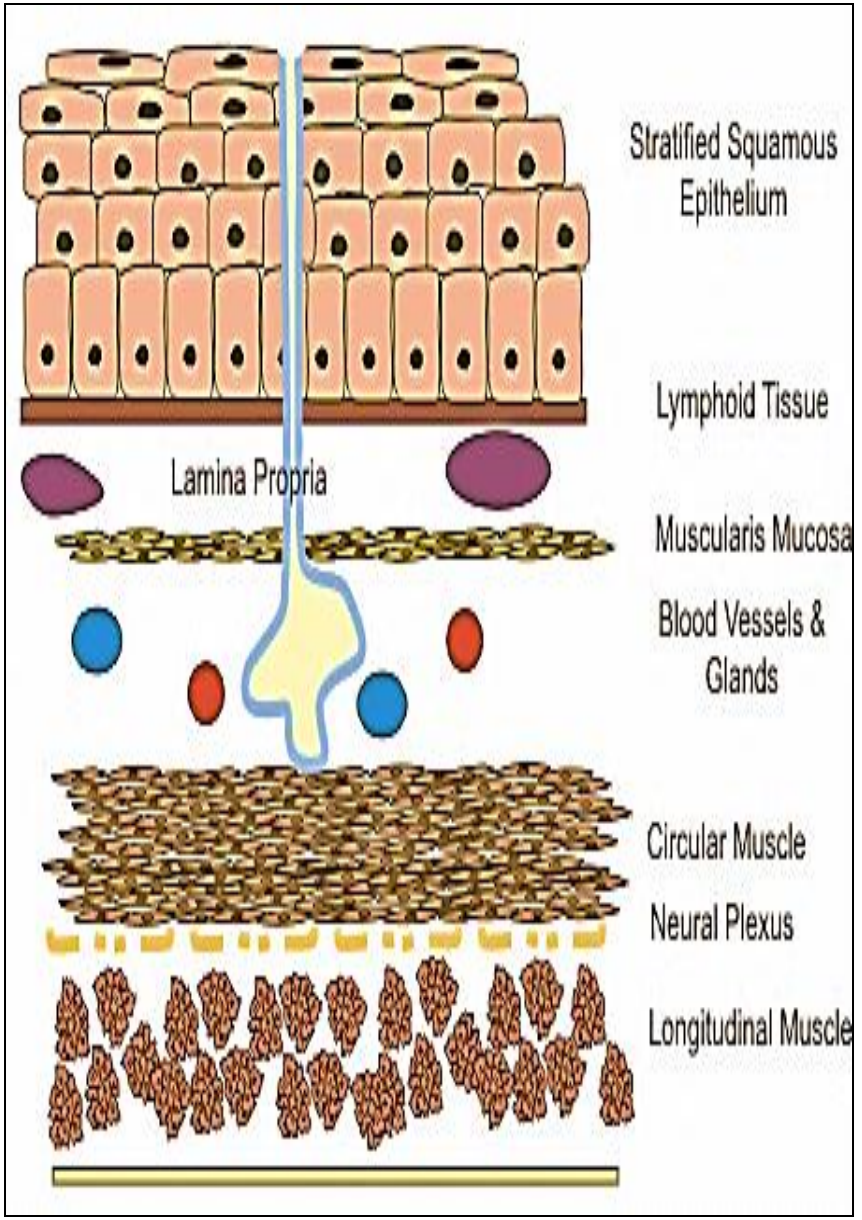




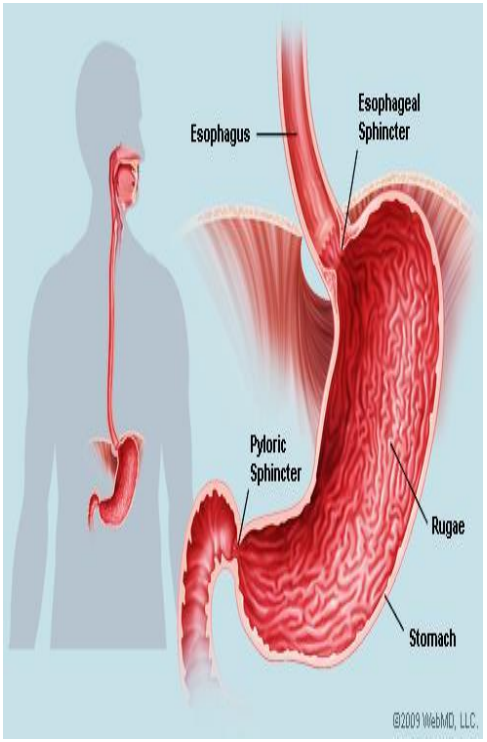
Layers of wall of stomach



Layers of wall of esophagus



The stomach

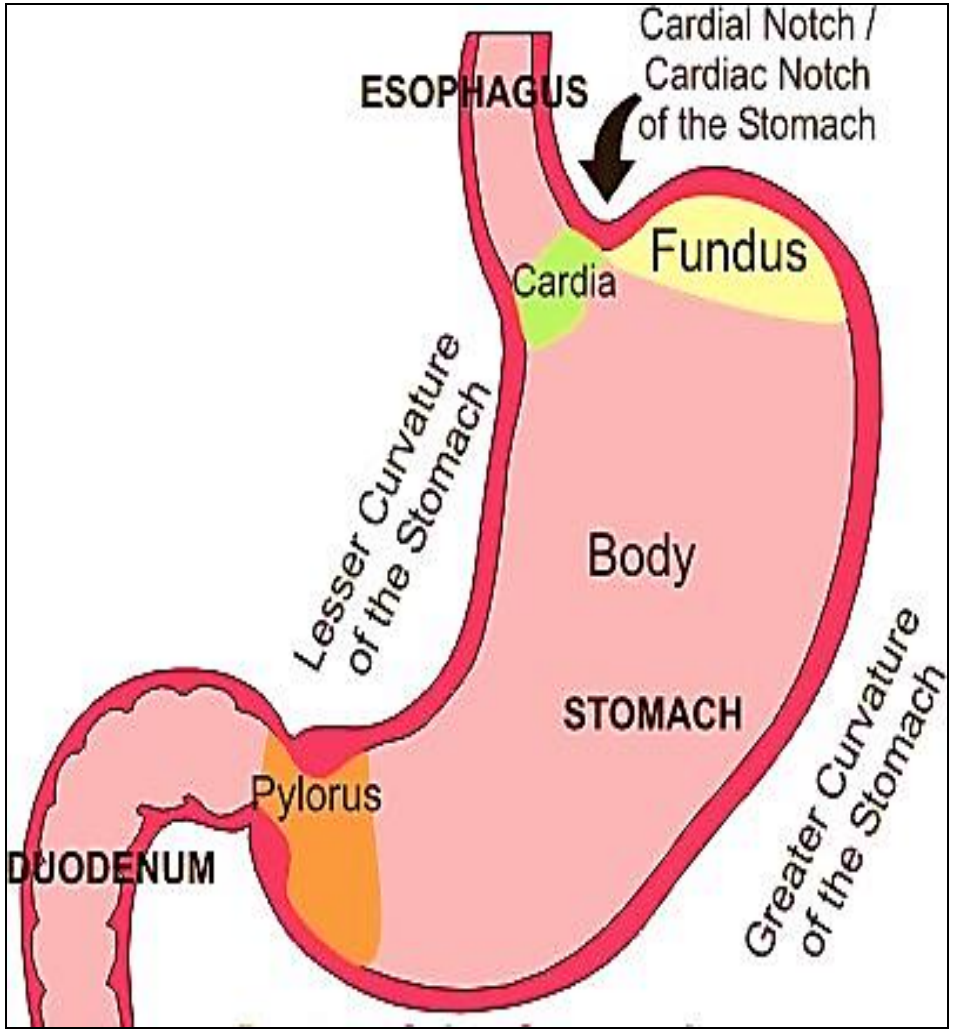


- The most dilated part of the GIT
- The mucosa in empty stomach forms longitudinal folds called gastric rugae
- It acidifies & converts the food → **chyme**
- The mucosa of stomach contains gastric glands (cardiac, fundic , pyloric)
- These glands secrete gastric juice which contains:
  - Acid: HCl
  - Mucus
  - enzymes: pepsinogen, lipase

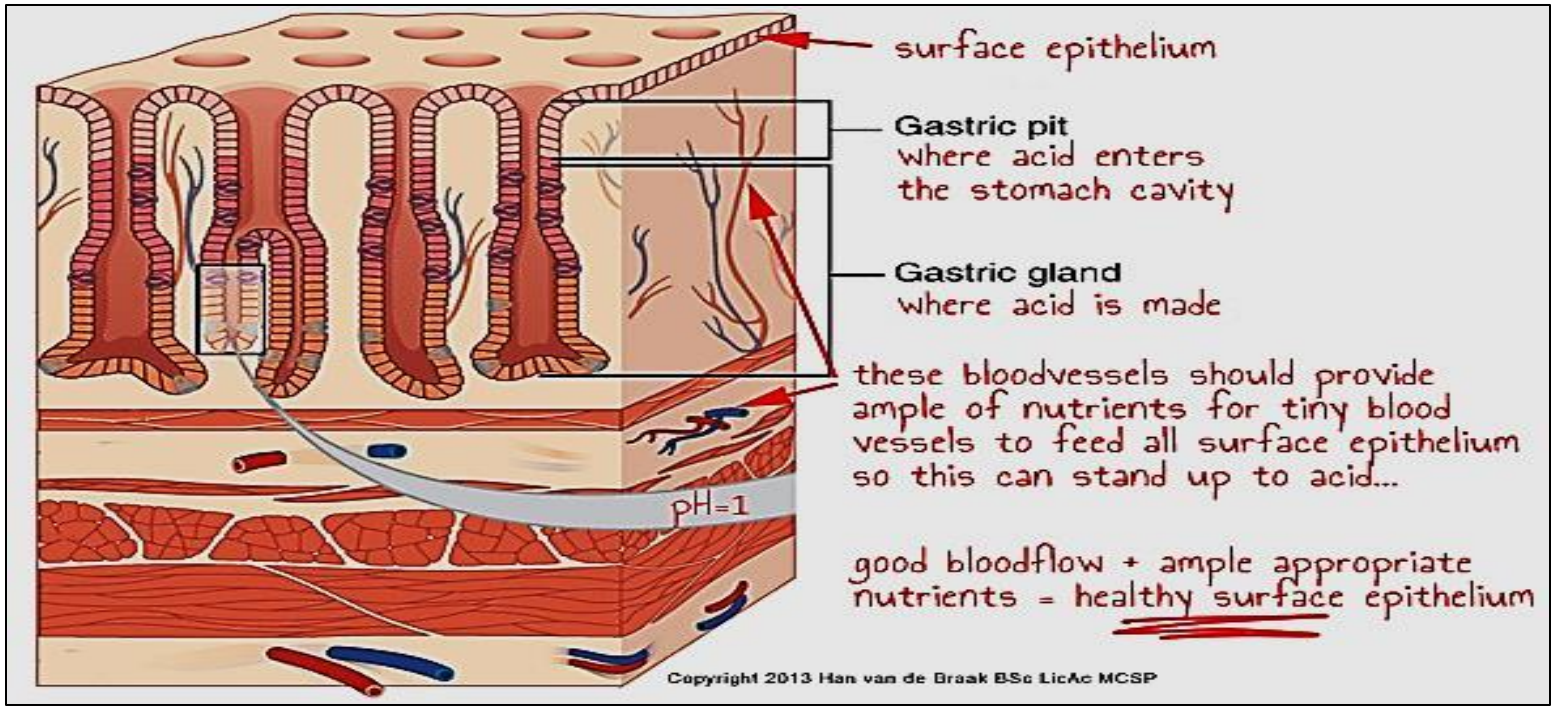
The stomach

The stomach is subdivided into 4 regions:

1. The cardiac region
2. The fundus
3. The body
4. The pyloric region



The fundus & body of the stomach

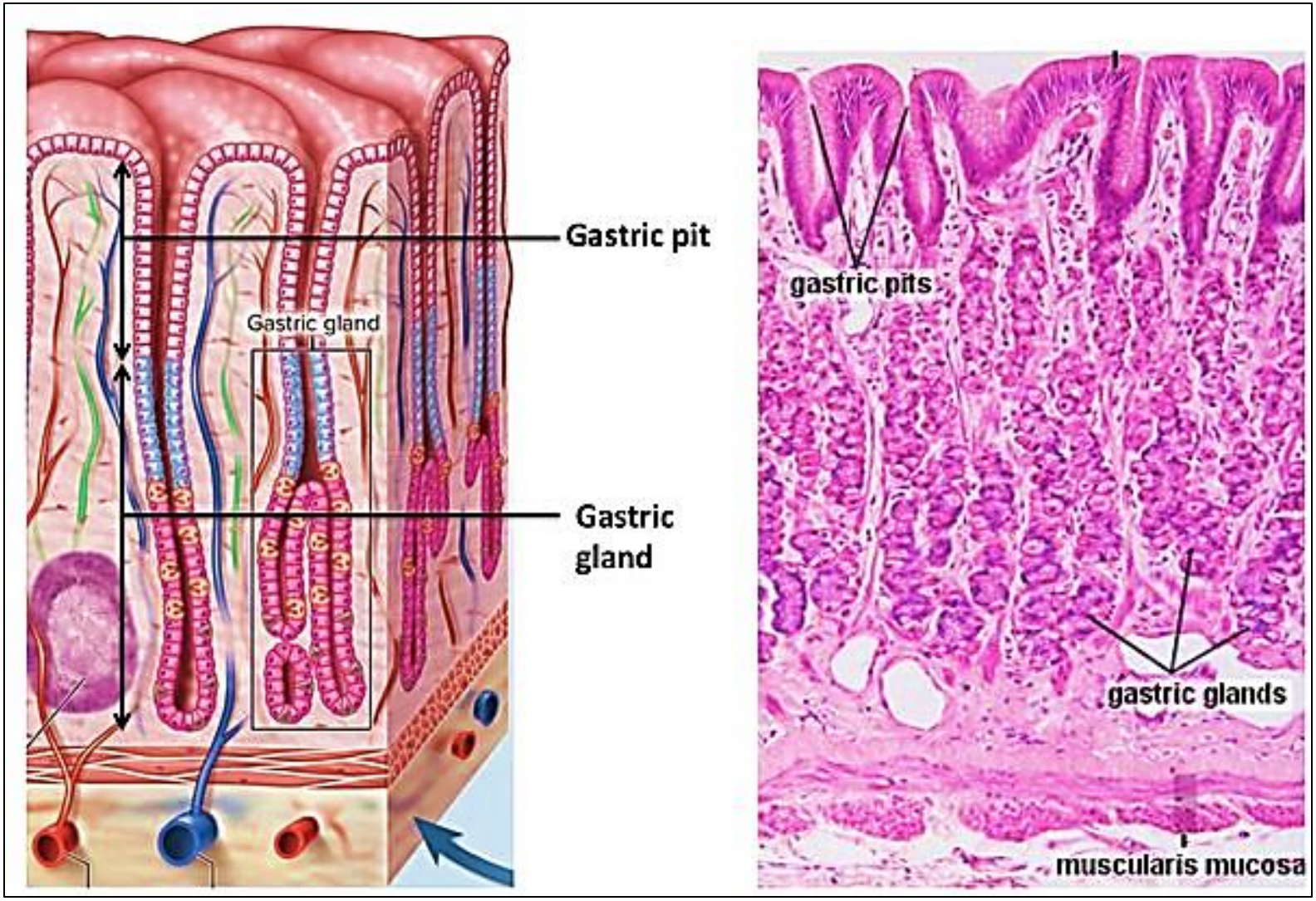


1- The mucosa:

- **epithelium**: ***simple columnar cells***, **these cells secrete neutral mucus for lubrication & protection***

- **lamina propria**: **contains *gastric glands* & C.T. fills the spaces between the glands . It also contains B.V., lymphatics, nerves**

The gastric (fundic) glands

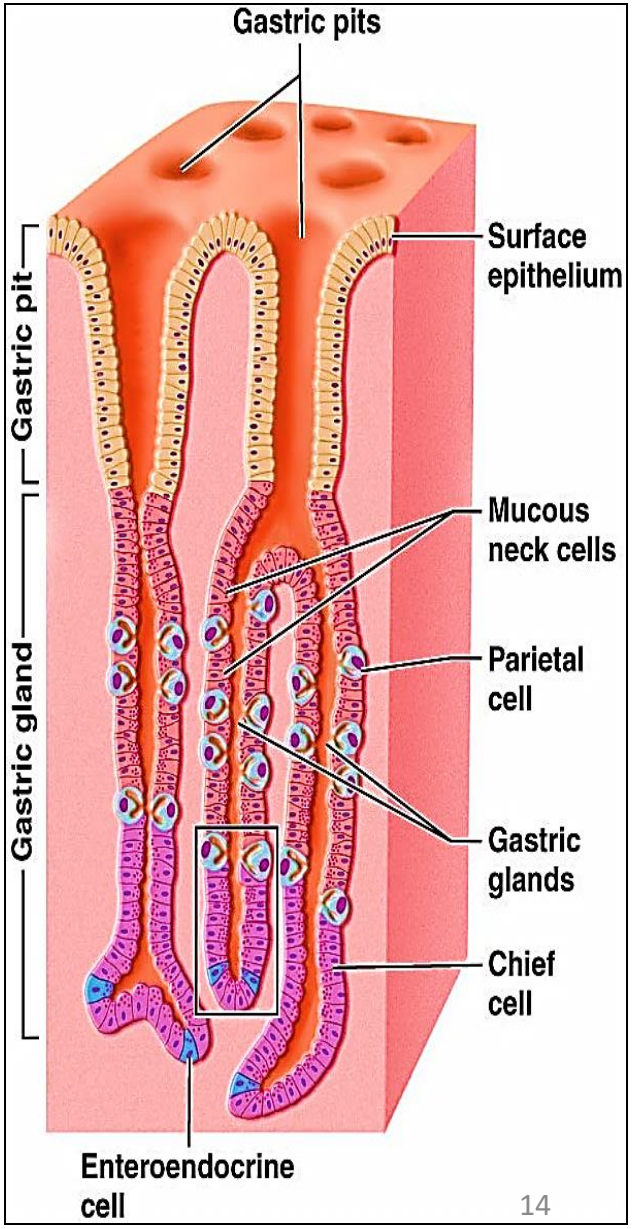


- **Muscularis mucosa: layer of smooth muscles arranged as (IC & OL) inner circular & outer longitudinal**

Gastric glands (fundus)

- simple branched tubular.
- occupy the entire thickness of the mucosa .
- They open onto the surface epithelium through gastric pits.

- through the pits the mucus, HCl & gastric enzymes reach the lumen of the stomach

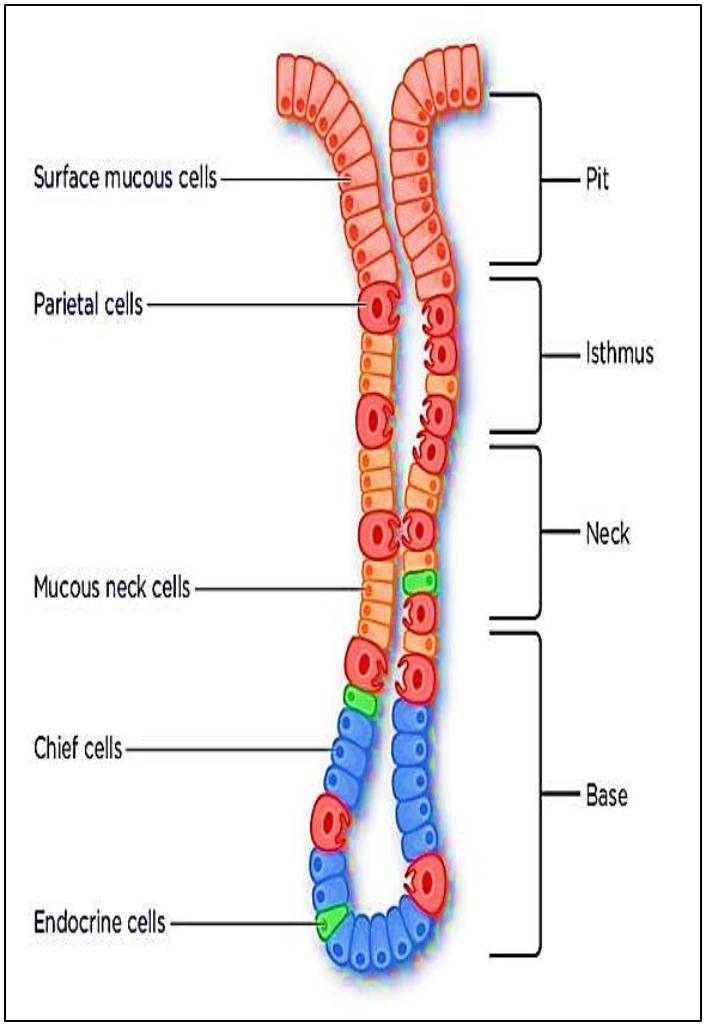


- **Each gland is formed of 3 parts: isthmus, neck & base**

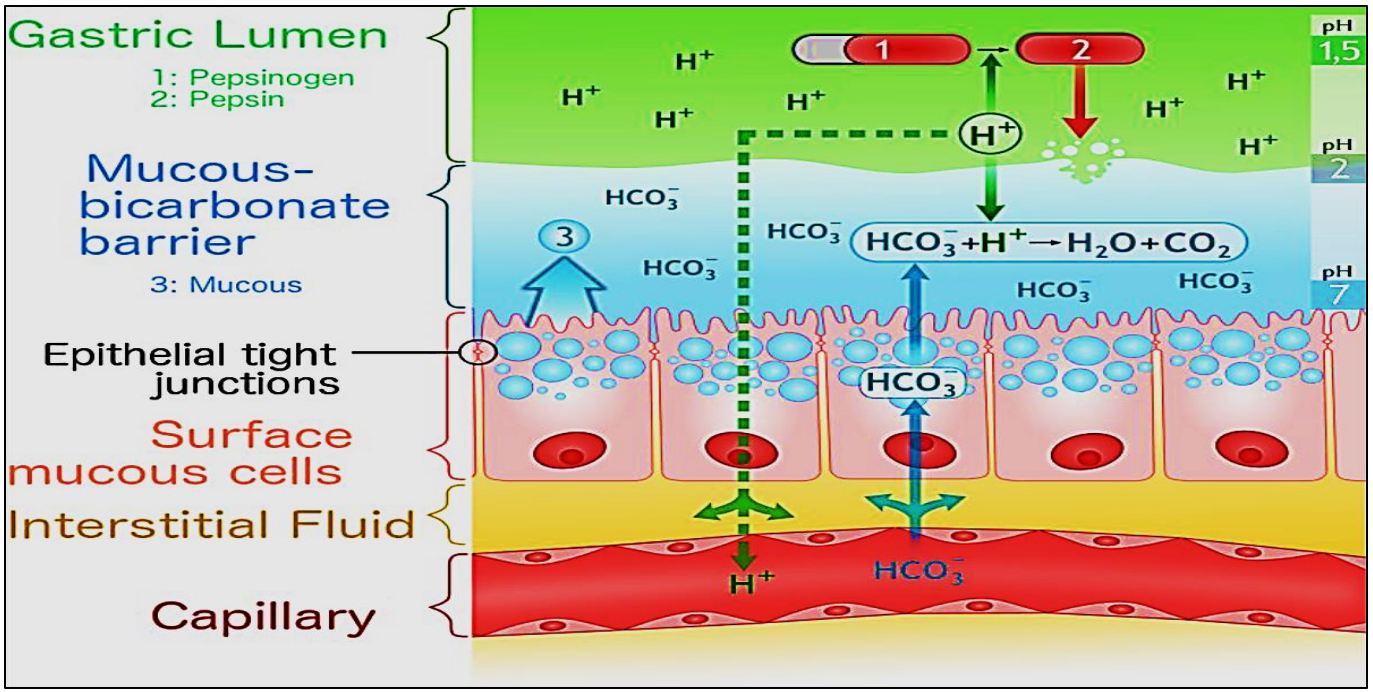
- **6 types of cells line the fundic glands:**

1- Surface mucous cells (Foveolar cells):
cover the surface & line the gastric pits & isthmus. Their apical cytoplasm contains mucin granules.
They sec. *neutral mucus* for protection (Gastric mucosal barrier)

2- Mucous neck cell: present in neck of gastric glands,
low columnar cells e foamy cytoplasm.
They secrete *acidic mucus*



Gastric mucosal barrier

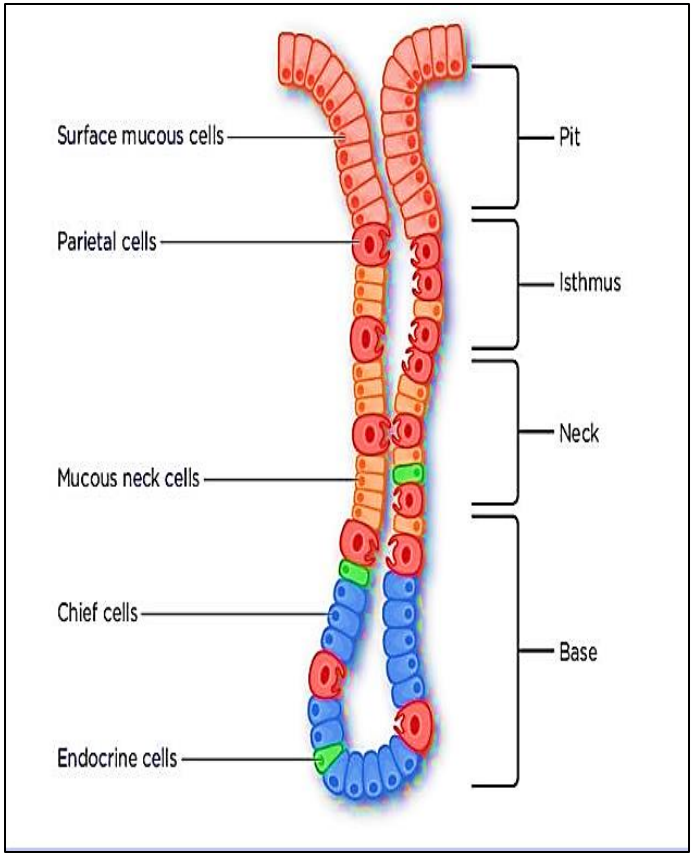


1- epithelial cell lining. Cells in the epithelium of the stomach are bound by tight junctions

2- A special mucus covering, secreted by surface epithelial cells. This insoluble mucus forms a protective gel-like coating over the entire surface of the gastric mucosa.

3- Bicarbonate ions, secreted by the surface epithelial cells. The bicarbonate ions act to neutralize harsh acids that find access to cells

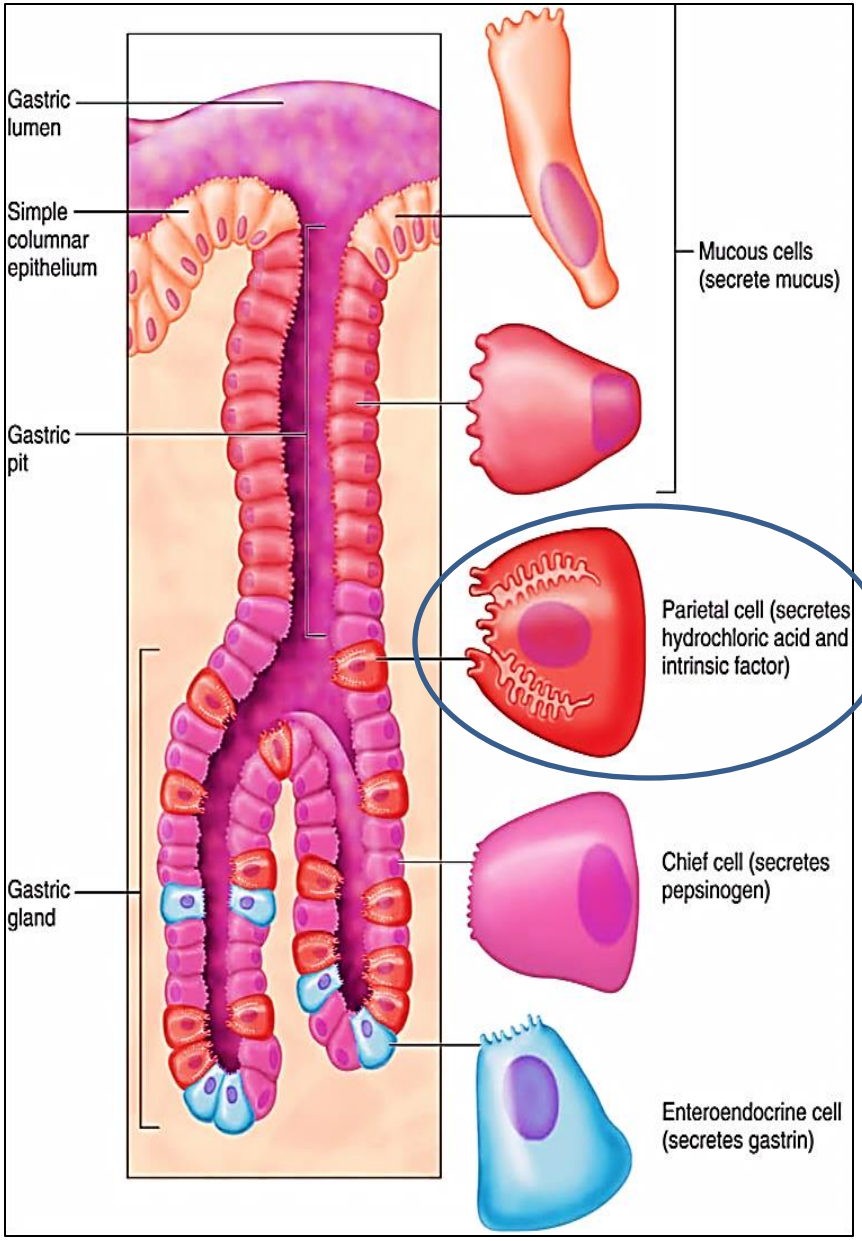
3- stem cells: present in neck region, low columnar. They differentiate to other gastric cells

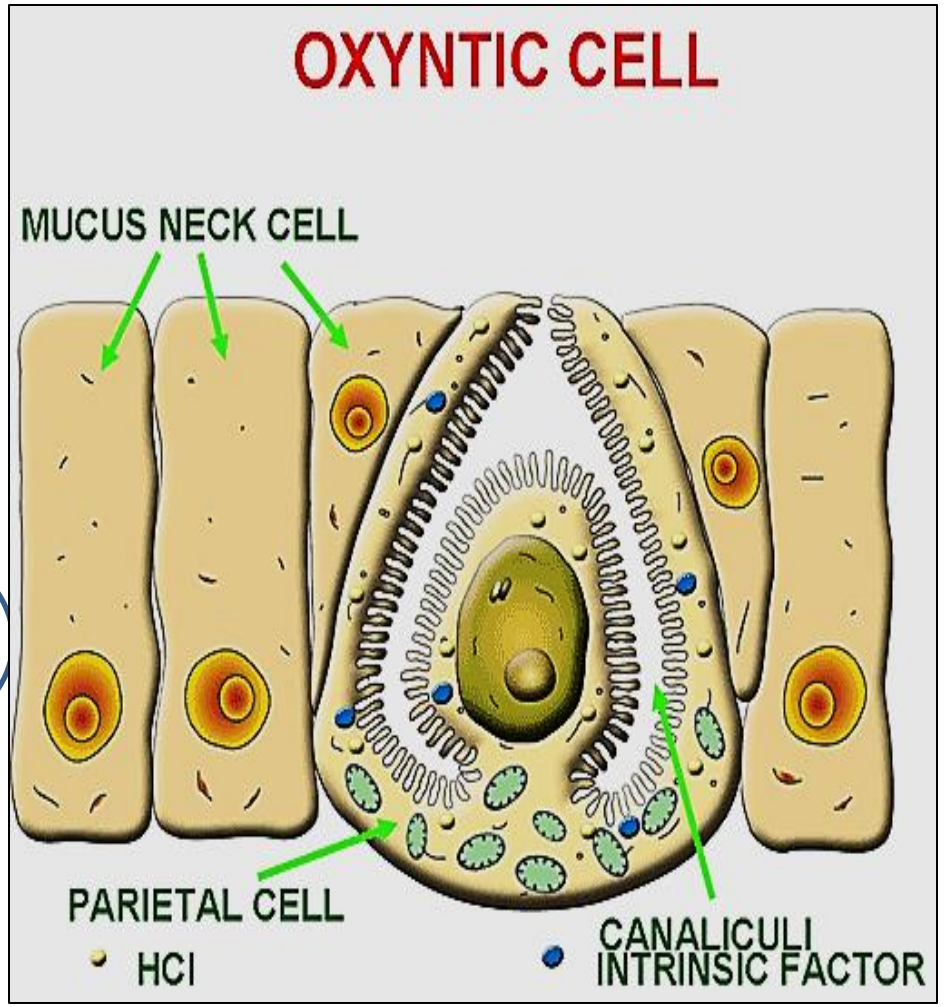


4- Parietal (oxyntic) cells :

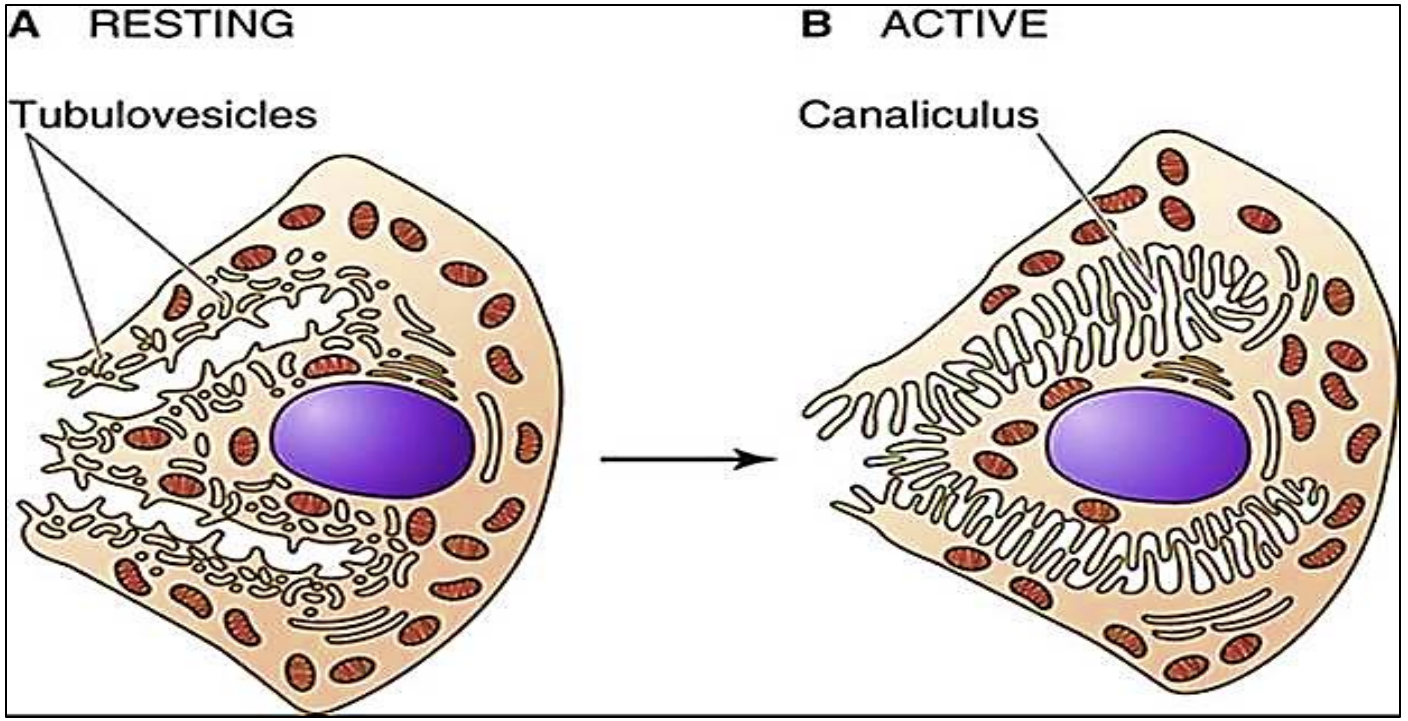
- ***triangular* in shape e *acidophilic cytoplasm* & *rounded central nucleus*.**
  present mainly in the upper half of the glands – fewer in the base

- **E/M : their apical surfaces show branching Intracellular canaliculi that open at the apex.**
- **↑ mitochondria, ↑SER, NO sec. granules**
- **They secret HCl & intrinsic factor(glycoprotein) needed for vit. B12 absorption**





Oxyntic cell secretes HCl & intrinsic factor showing intracellular canaliculi system(enfolding channels)



Tubulovesicular system of parietal cells

- **System of tubules and vesicles. The system is totally consumed during maximal gastric acid secretion due to its role in increasing the surface area of the canaliculi surface membrane.**
- **Reciprocal endocytosis of the canaliculi (reforming the tubule-vesicles) decrease the surface area (during resting)**
- **The number of canaliculi rise and fall according to the secretory need**

Pernicious Anemia

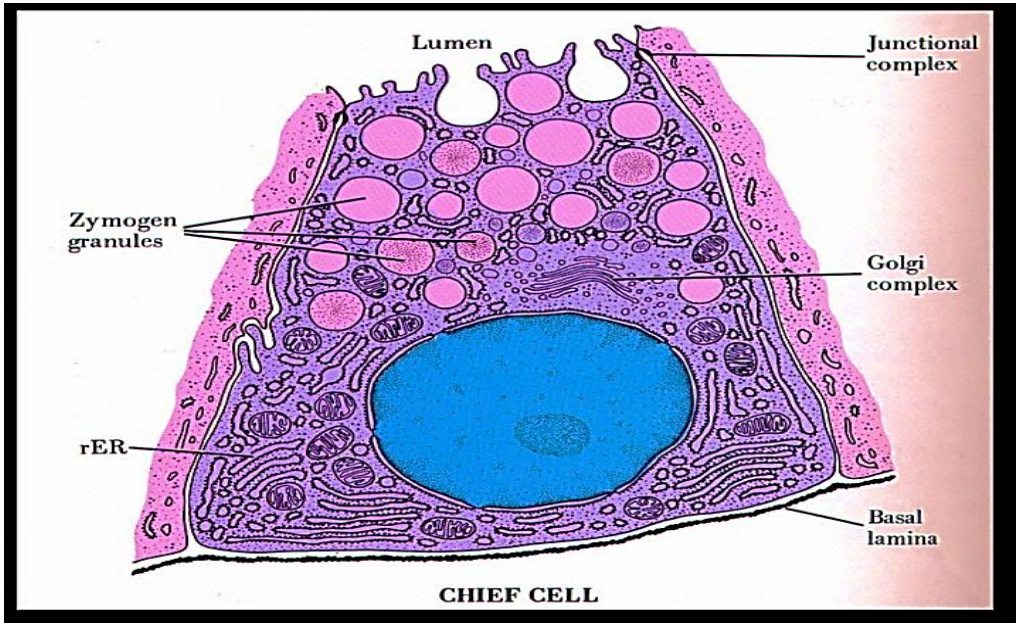
- Pernicious anemia is caused by a lack of intrinsic factor
- Intrinsic factor is a protein made in the stomach. It helps your body absorb vitamin B12, necessary for normal RBC production; RBCs are larger

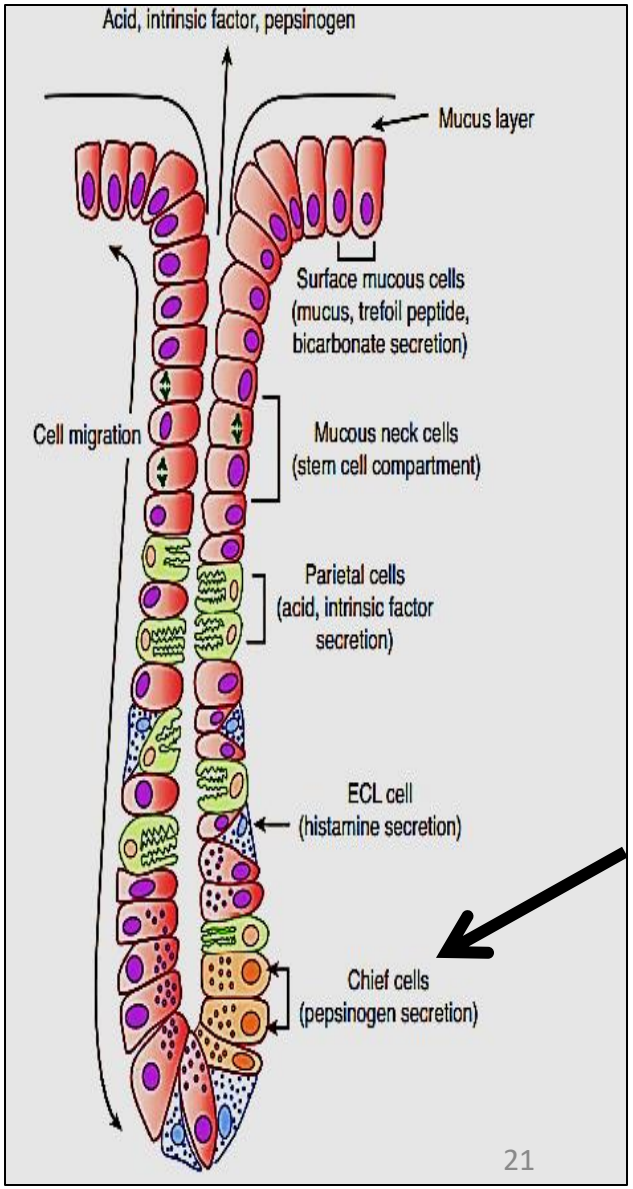
One of the signs of pernicious anemia is red tongue with smooth surface (Beefy tongue)

5-Peptic (Chief, Zymogenic) cells: mainly at the base of gastric glands. columnar cells e basal rounded nuclei.

- **The basal cytoplasm is basophilic due to ↑rER, while the apical part contains ↑↑ zymogen granules**

- **E/M : protein secreting cells**
- **These cells secrete pepsinogen & G. lipase**





6- Entero-endocrine cells :

- present in the base of the glands.
- Hormone secreting cells
- (diffuse neuroendocrine system)

- Their secretions accumulates in the basal part to be released to the B.V.

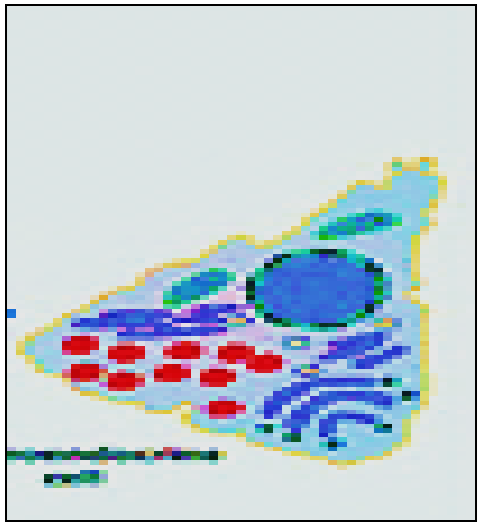
- They secrete:

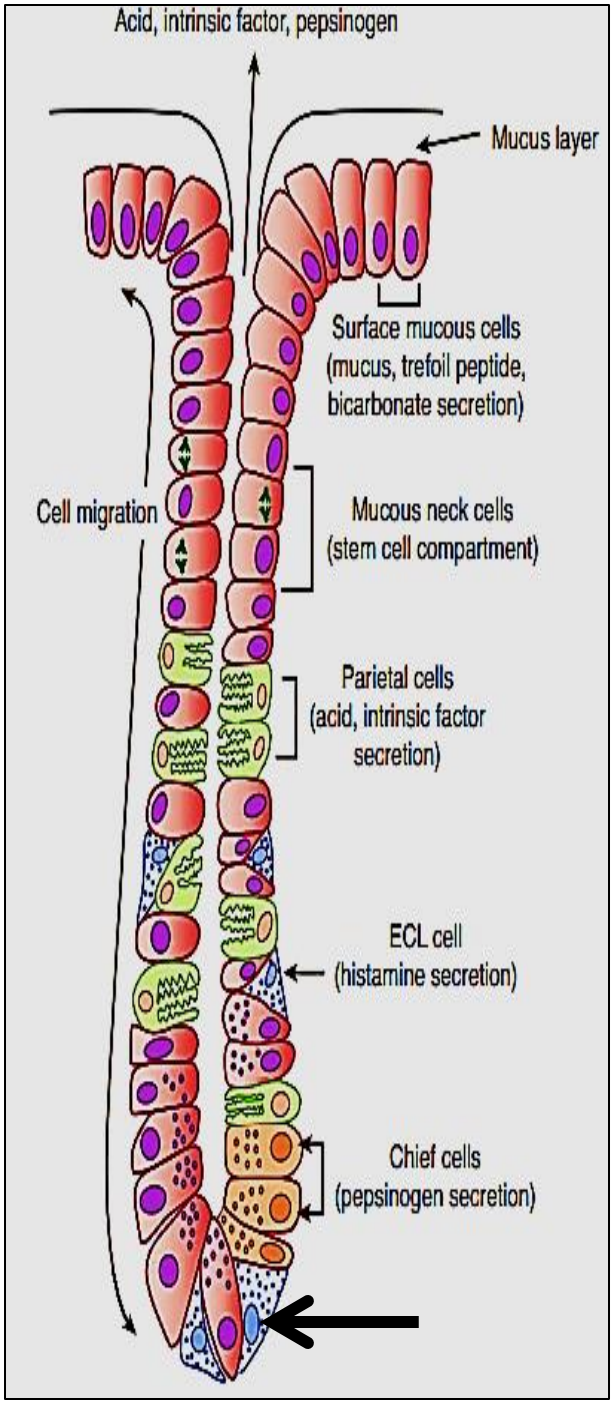
✓ Gastrin

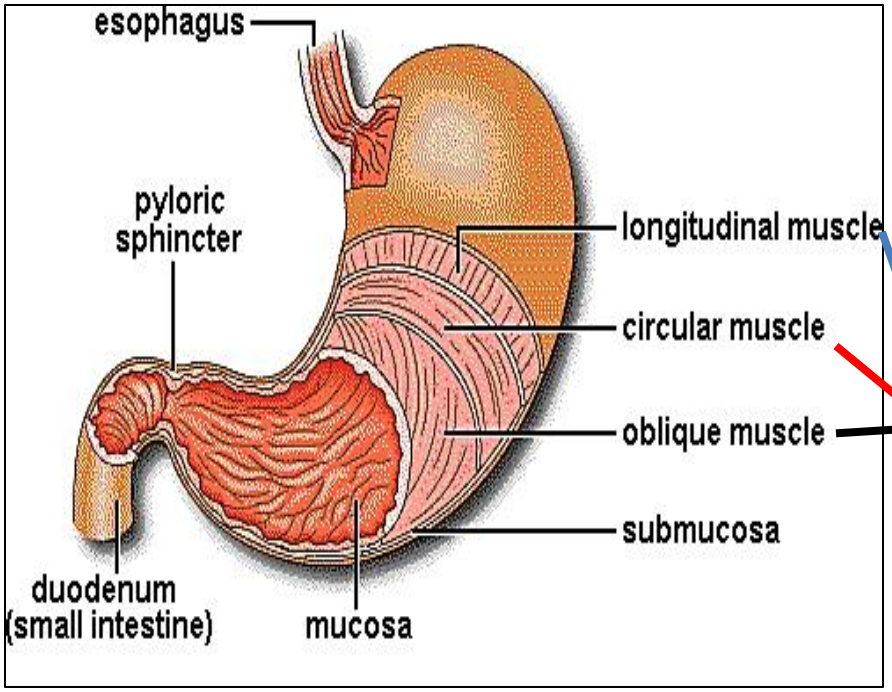
✓ Enteroglucagon

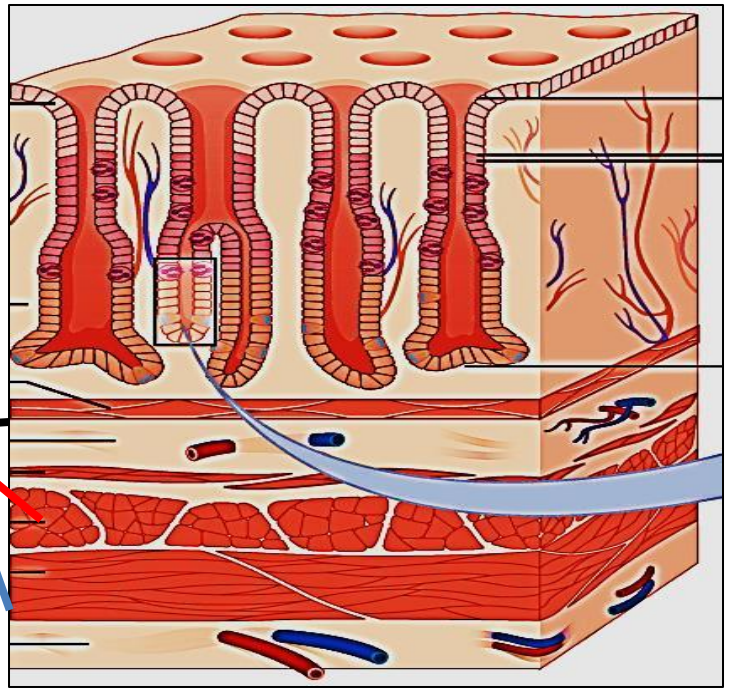
✓ Serotonine

✓ Somatostatin(D cells)









2- The submucosa: **loose C.T. with B.V., lymphatics, meissner's plexus of nerves**

3- The musculosa: formed of 3 layers of smooth ms.

Inner oblique - middle circular - outer longitudinal.

Auerbach's plexus is present between middle & outer layers

4- The Serosa: is the peritoneal covering, is formed simple squamous mesothelium & loose C.T. It contains B.V., lymphatics, & nerves

The difference between fundus & pylorus

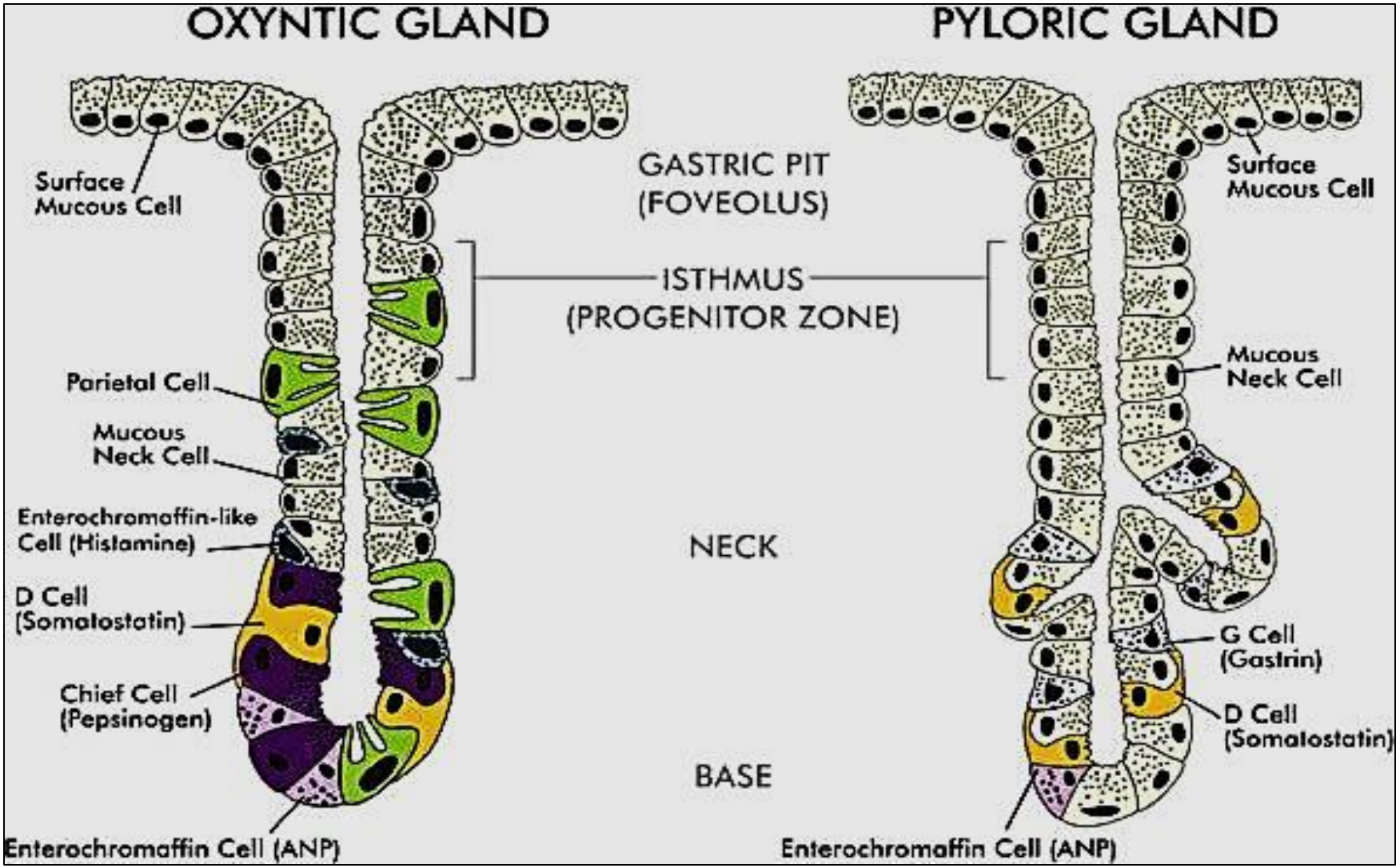
Fundus

- Thick mucosa
- Pits are narrow & short
- F. Glands are simple branched tubular & long
- occupy most of mucosal thickness
- Lined e 6 types of cells
- Musculosa: thinner formed of 3 layers of ms. (IO, MC,OL)

Pylorus

- Thin mucosa
- Pits are wide & long
- P. Glands are coiled branched tubular & short
- Occupy ½ of mucosal thickness
- Lined e all cell types Except No oxyntic, No peptic cells
- Thicker , formed of 2 layers of muscles. Thick IC to form the p. sphincter & OL

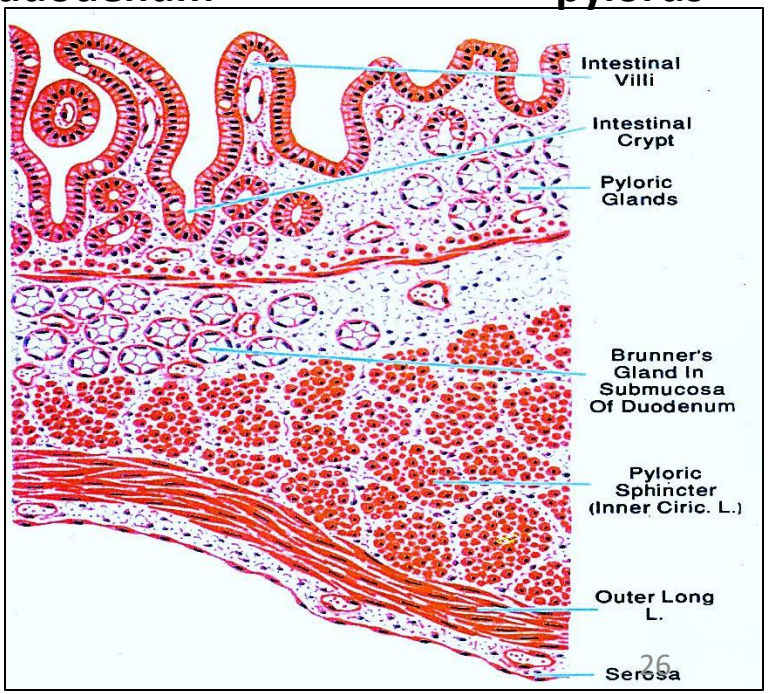
Difference between fundic & pyloric glands

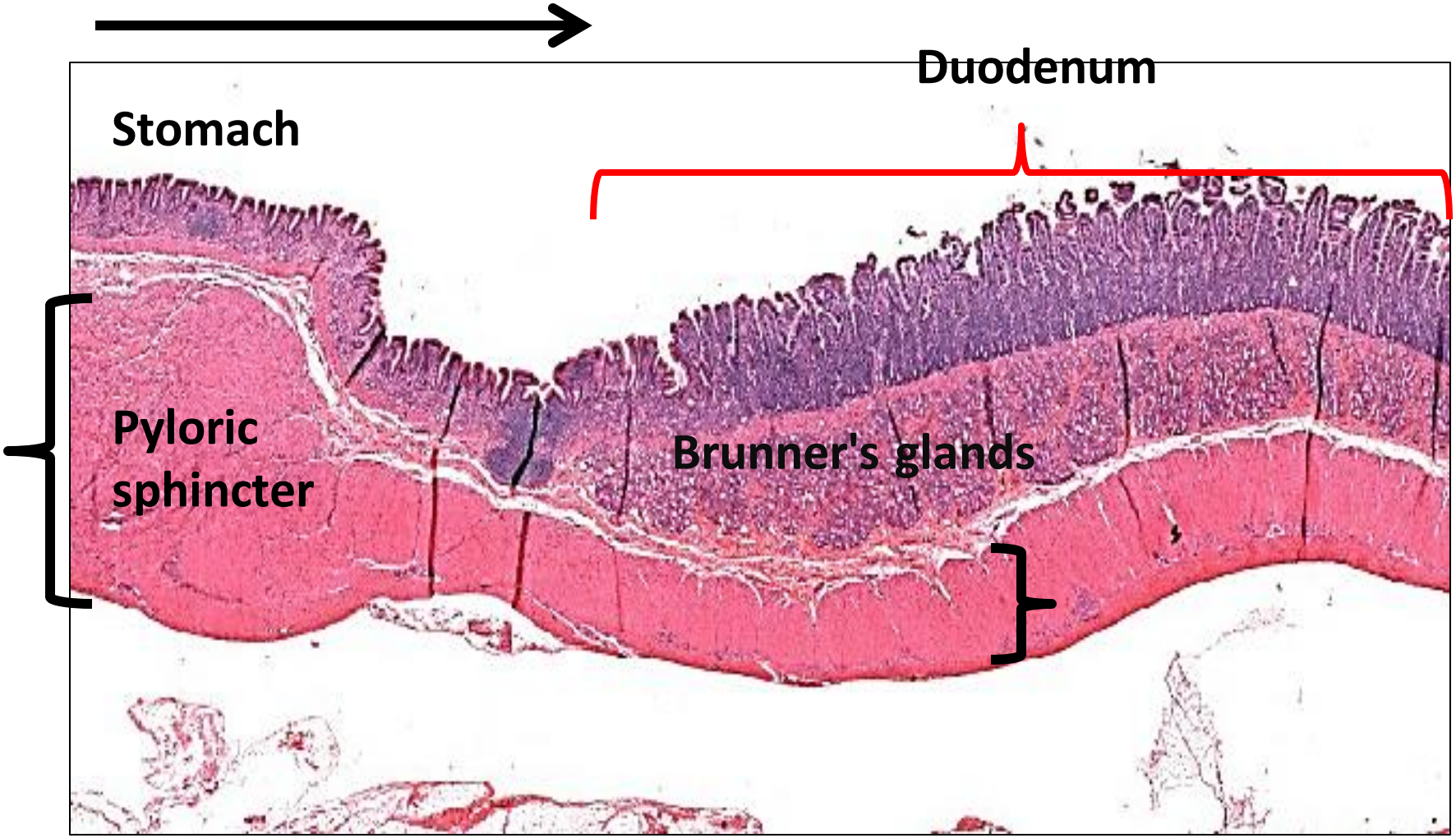


Changes at gastro duodenal junction

- intestinal villi start to project from mucosa
- Intestinal crypts replace pyloric glands in the corium of duodenum
- Surface columnar cells with brush border. Goblet cells appear between cells
- Muscularis mucosa: pass unchanged
- Brunner's glands appear in duodenal submucosa
- Musculosa is thinner in the duodenum
- Serosa pass unchanged

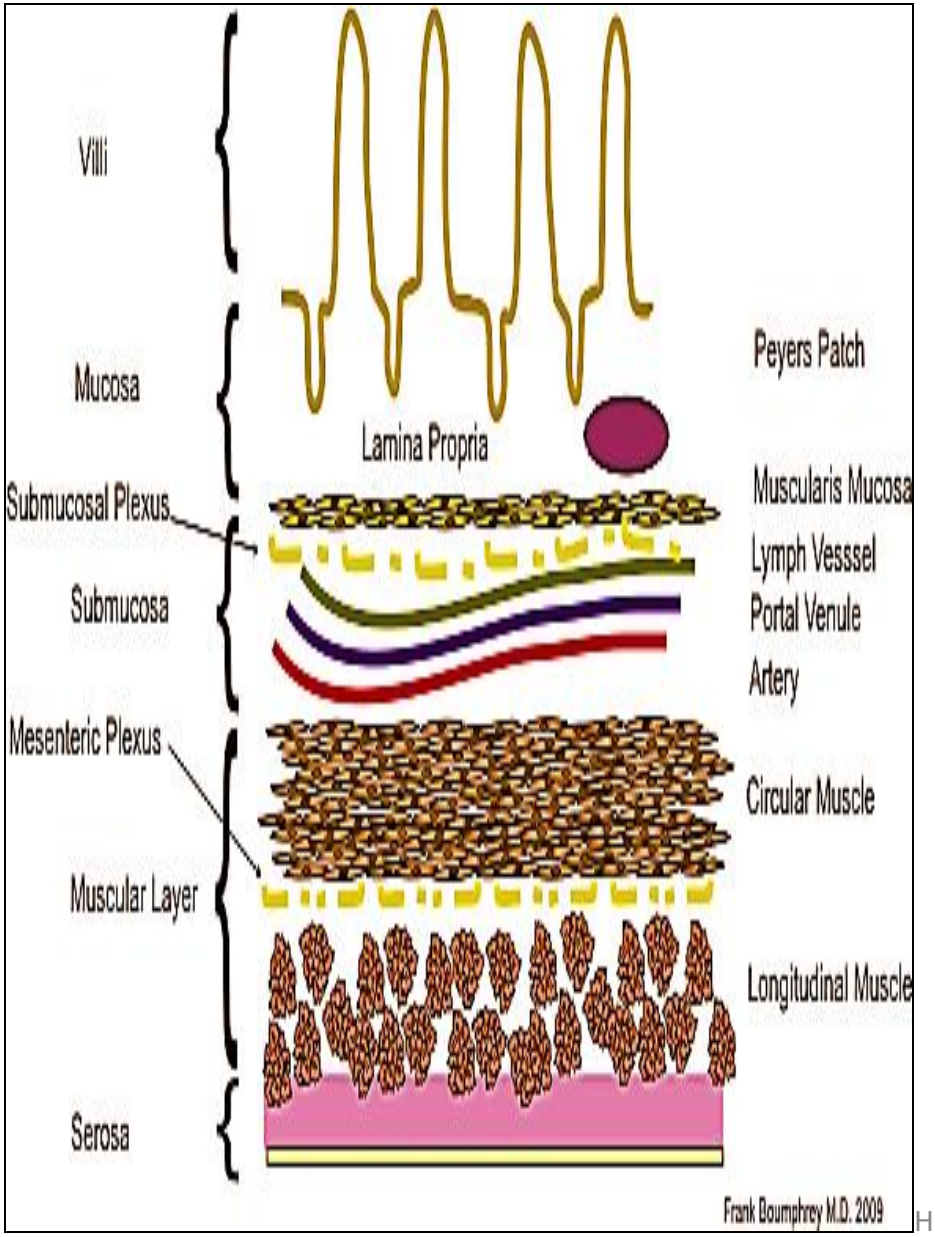
duodenum ← pylorus



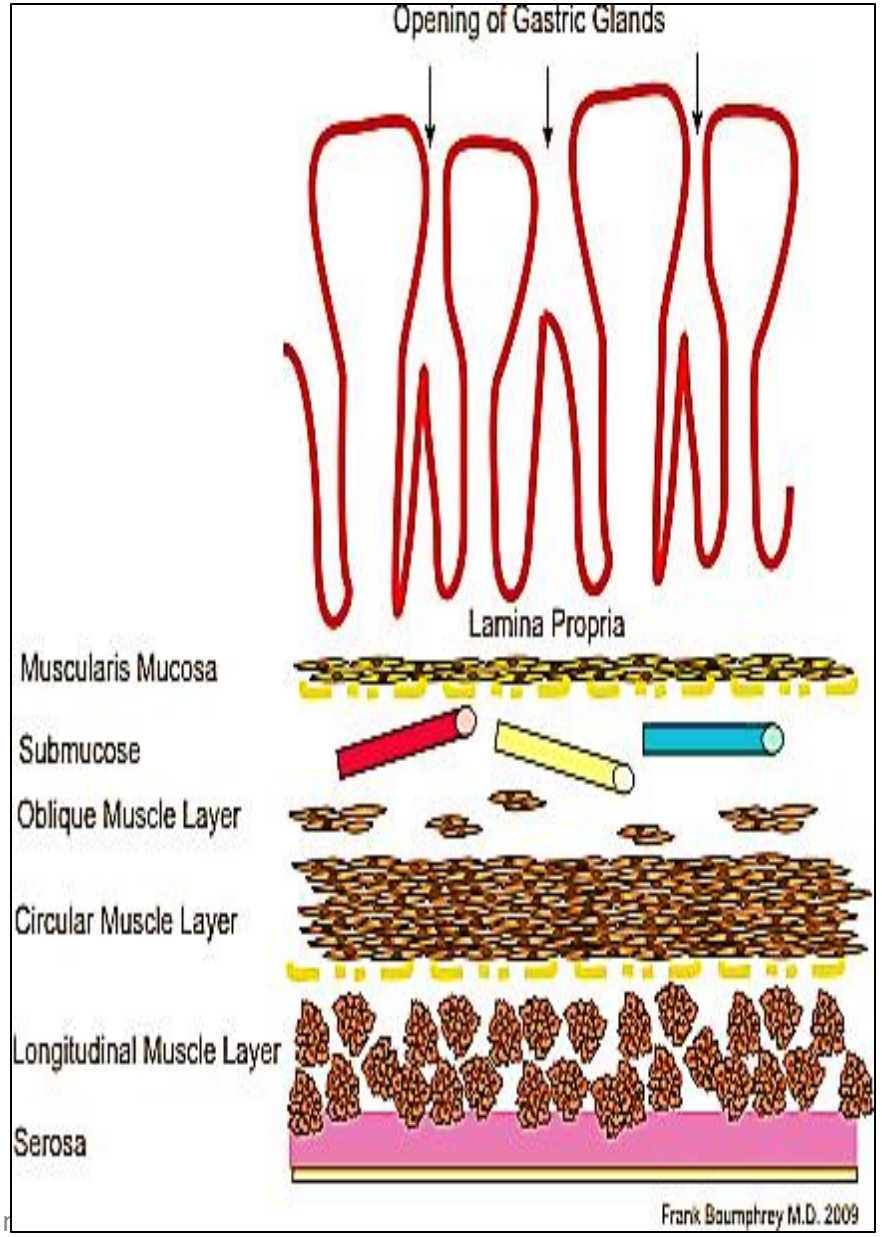


Gastro duodenal junction

Wall of intestine



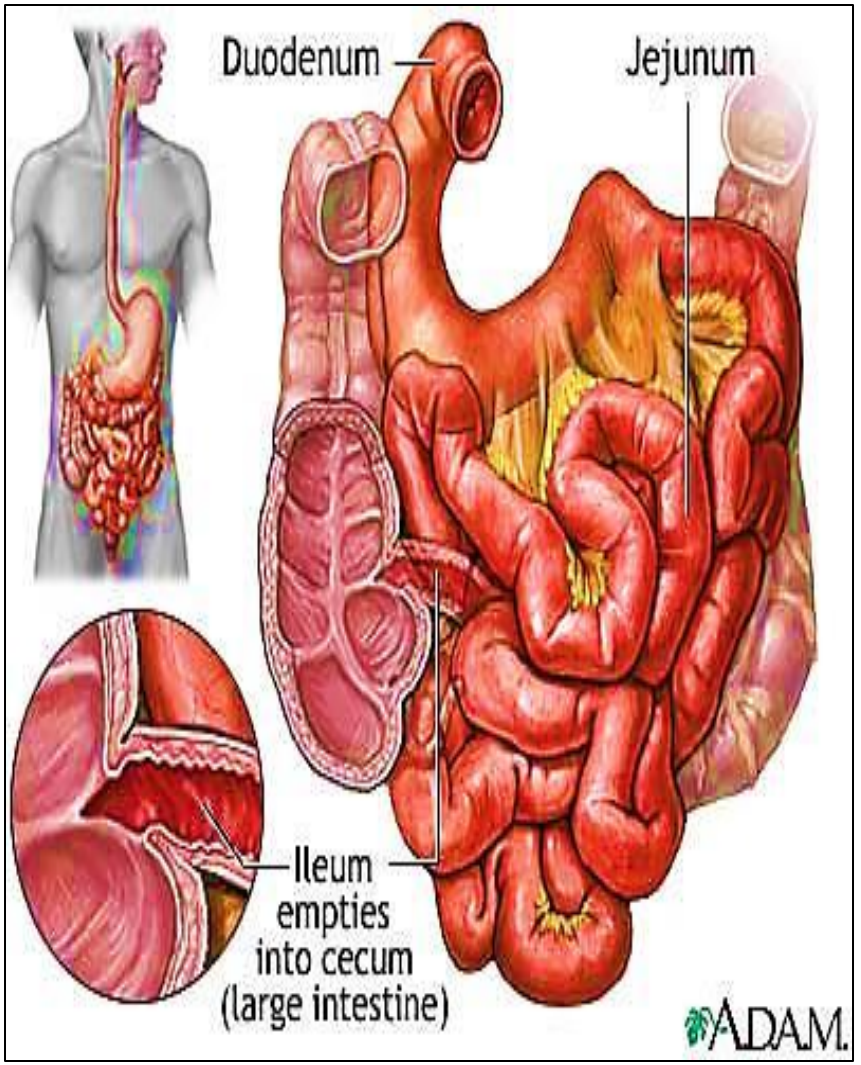
Wall of stomach

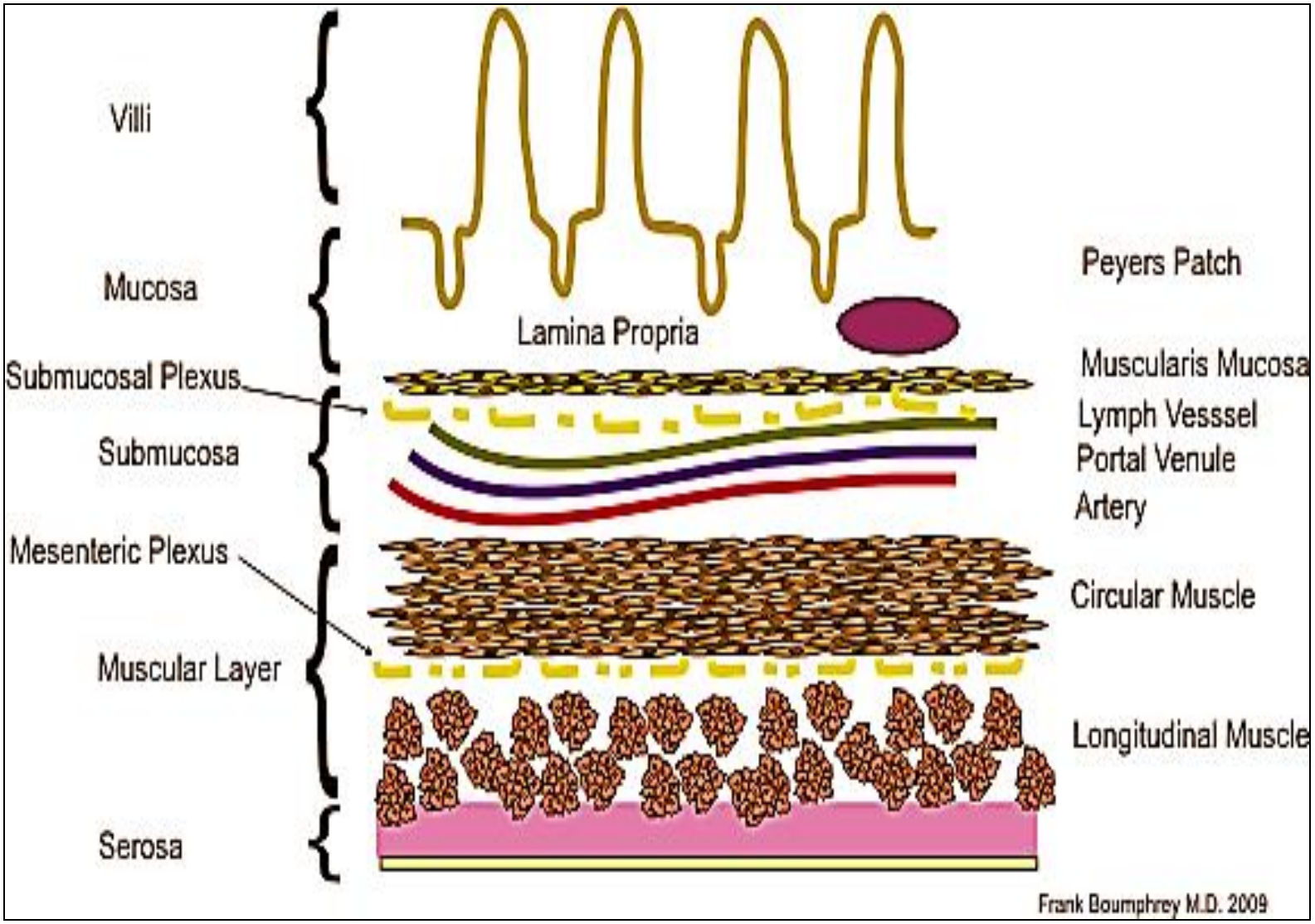


Small intestine

- **Parts of small intestine:**
- Duodenum
- Jejunum
- Ileum

- **Function:**
- Digestion
- Absorption
- Endocrine secretion





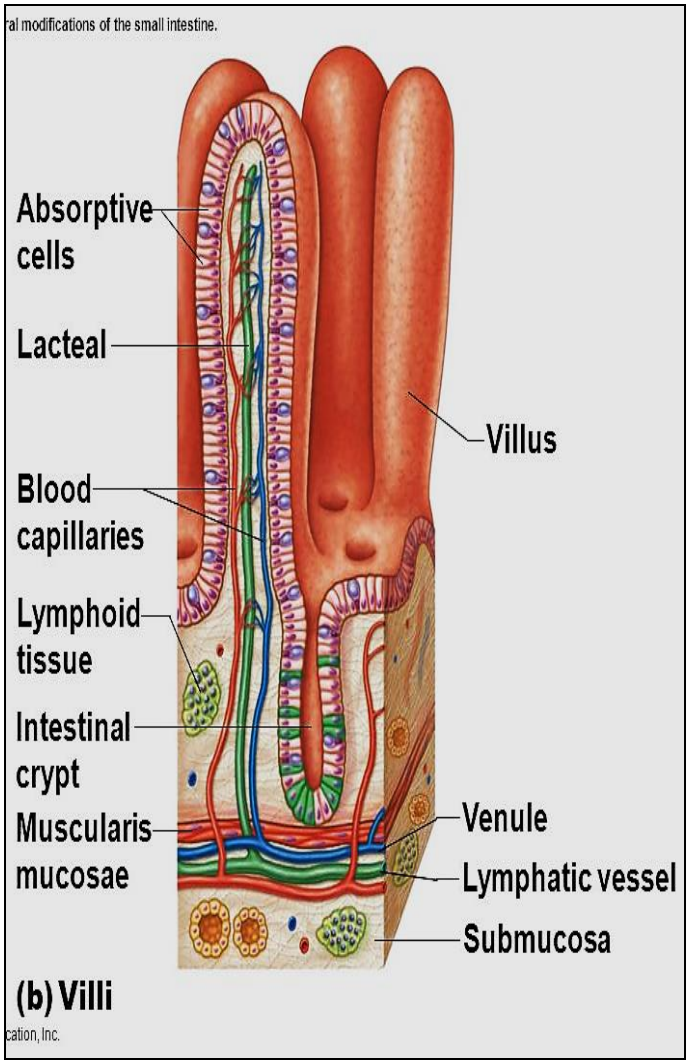
General structure of the small intestine

I- The mucosa

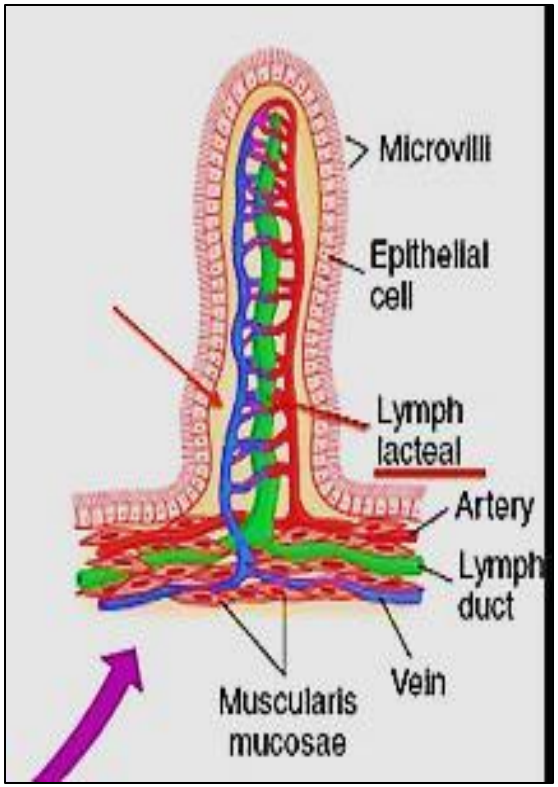
Contains : villi & crypts,

- The villi are finger like projections, extend into lumen of SI. They have central core of C.T. (lamina propria)

- The crypts of Lieberkuhn (intestinal glands) : simple tubular glands in the C.T. of lamina propria



The intestinal villi



- Each villus is formed of:

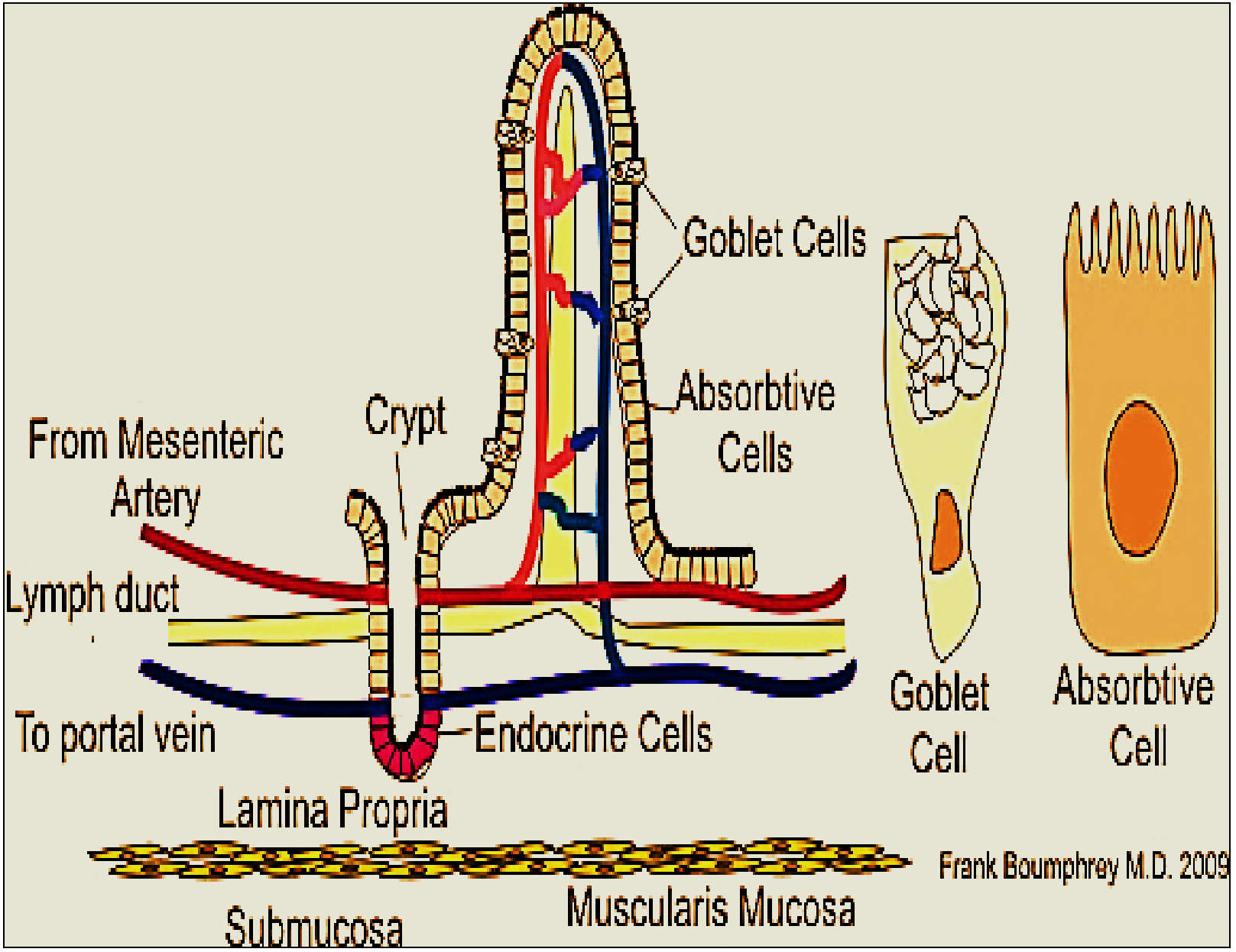
a) Epithelium: showing only 3 types of cells : columnar absorbing cells (90%), goblet cells (9.5%), endocrine cells (0.5%)

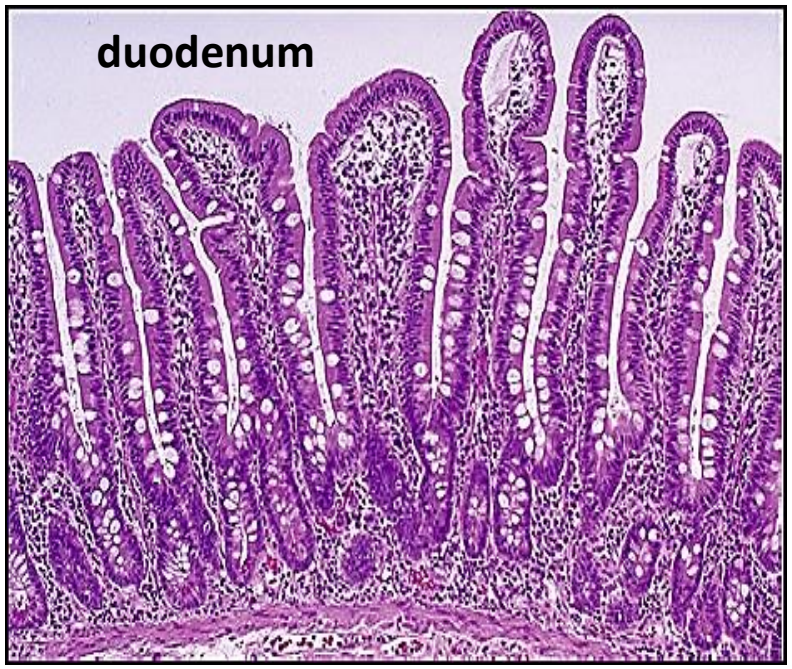
b) Central CT core (lamina propria) contains:

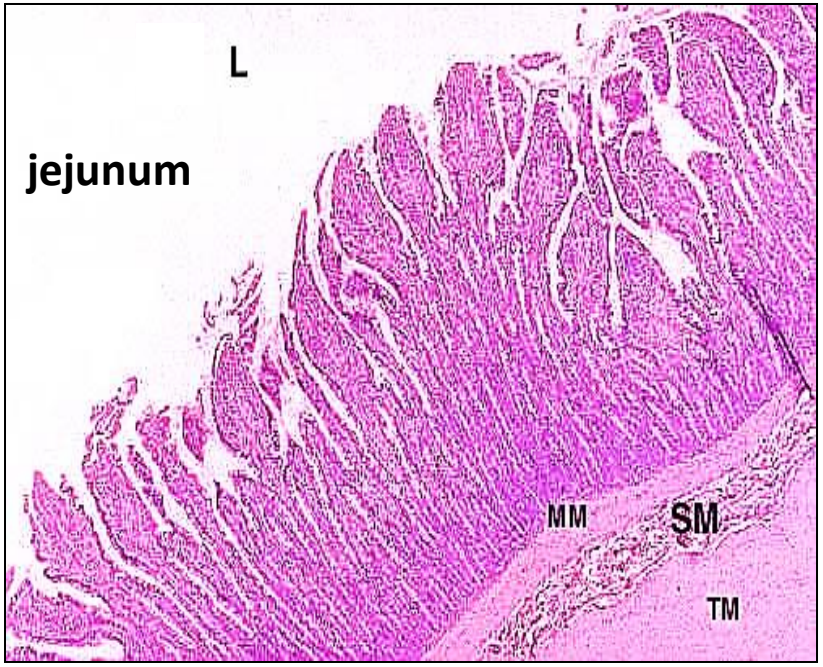
1- Network of fenestrated capillaries

2- Central blind end lymphatic (lacteal) needed for the absorption of fat . The fat is absorbed in the form of chylomicron (large molecules)to end in the thoracic duct

3- smooth muscle fibers . Its contraction aid in the flow of lymph in the lymphatic capillaries. Since lymphatic capillaries wall is devoid of smooth muscle fibers

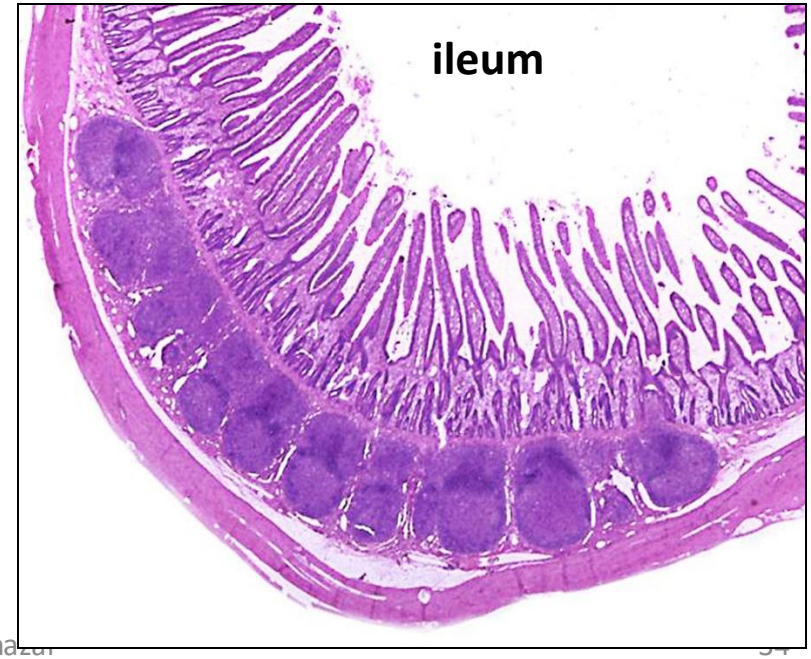

Goblet Cells
Absorbtive Cells
Crypt
From Mesenteric Artery
Lymph duct
To portal vein
Endocrine Cells
Lamina Propria
Submucosa
Muscularis Mucosa
Goblet Cell
Absorbtive Cell
Frank Boumphrey M.D. 2009





Villi vary in shape throughout the different segments of Small Intestine:

- **Duodenum: broad, leaf- like**
- **Jejunum : long & slender**
- **Ileum: short, absent over Peyer's patches**

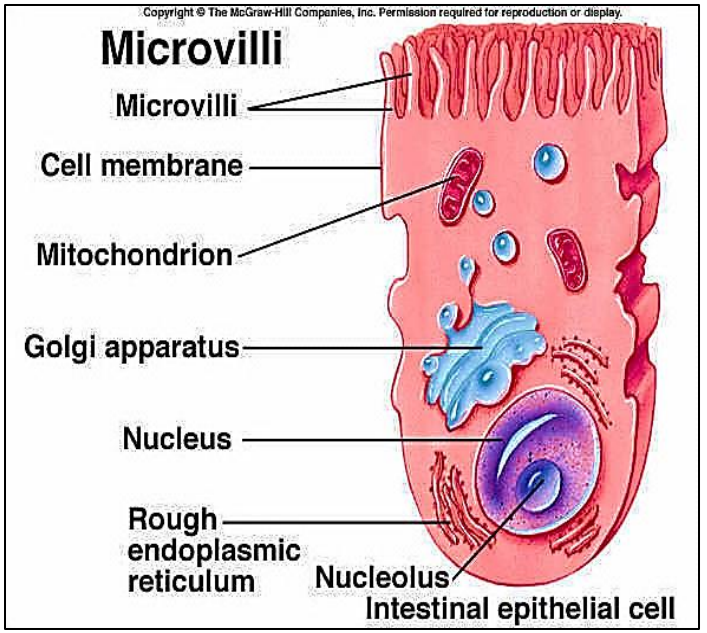


Type of cells on villi

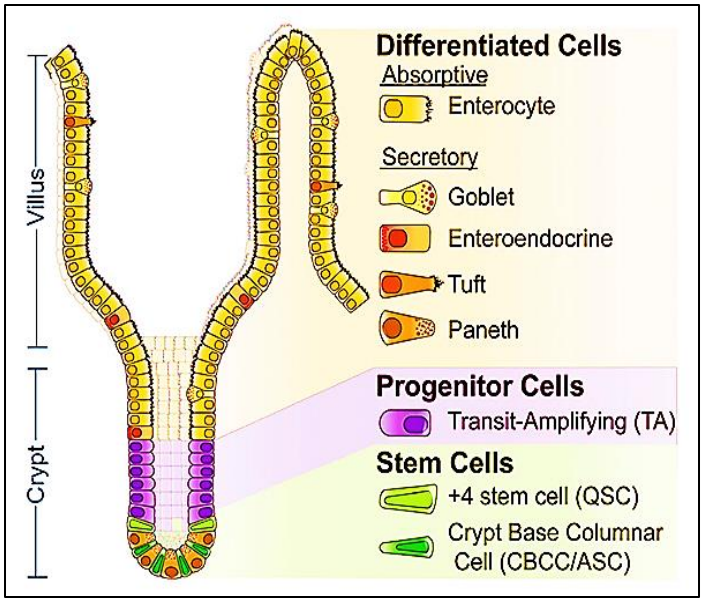
1- Enterocytes:

- Absorptive cells

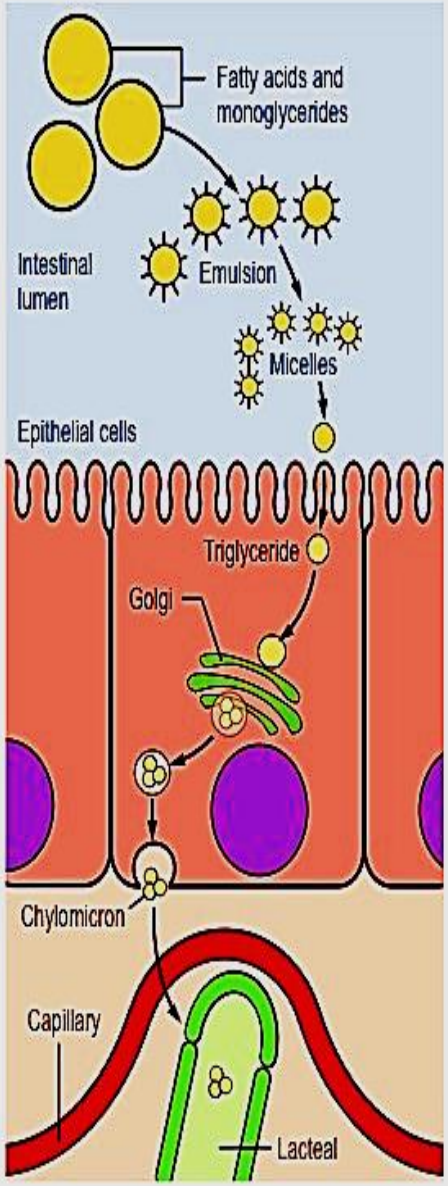
- Tall columnar cells e basal oval nuclei & brush border of microvilli to increase The absorptive surface area (10 folds) covered with cell coat



- E/M: ↑sER (form chylomicron), Golgi, ↑ mitochondria, their lateral borders show tight junctions (Leaky Gut syndrome)



- Their function is : Terminal digestion & absorption of carbohydrates , proteins & Fat

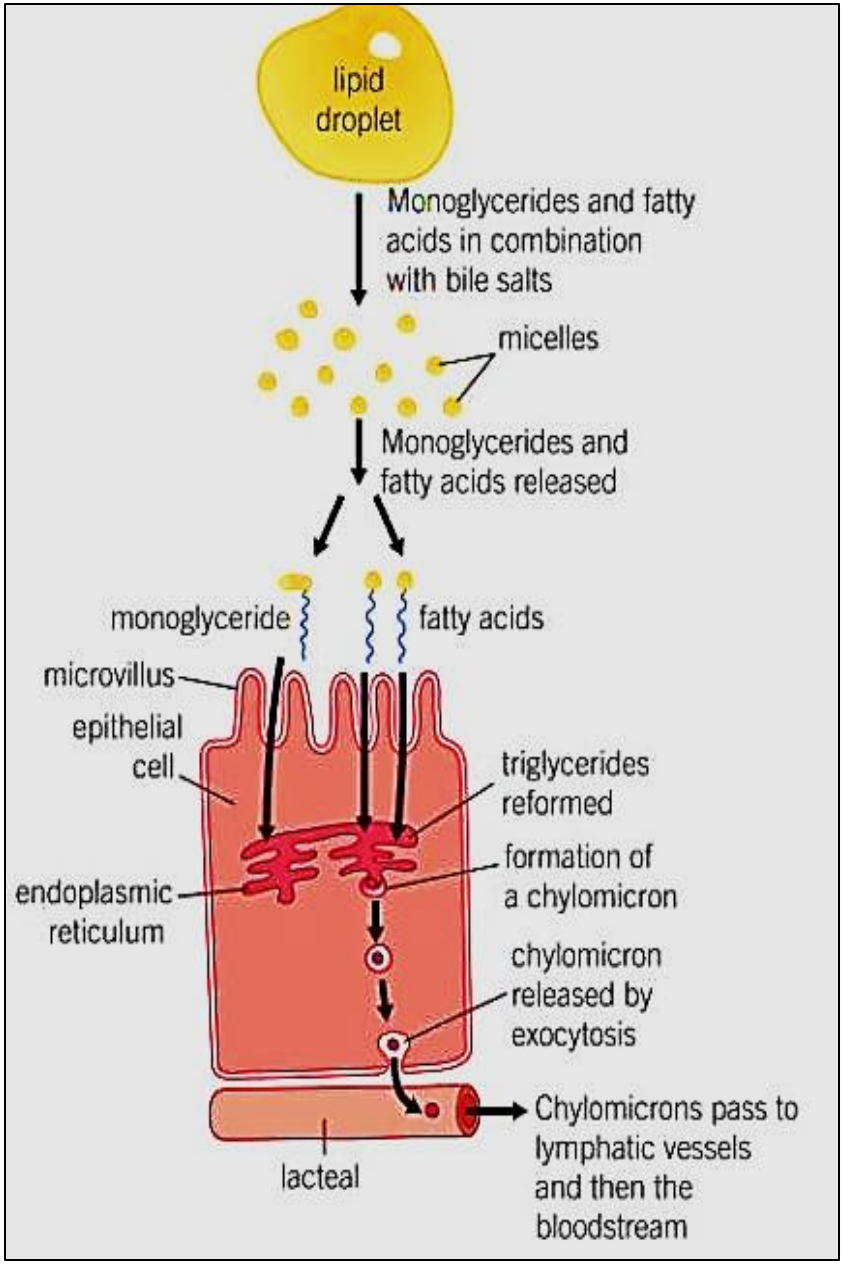


Fatty acids and monoglycerides are emulsified by bile salts to form micelles

Fatty acids enter the epithelial cells and link to form triglycerides

Triglycerides combine with proteins inside the Golgi body to form chylomicrons

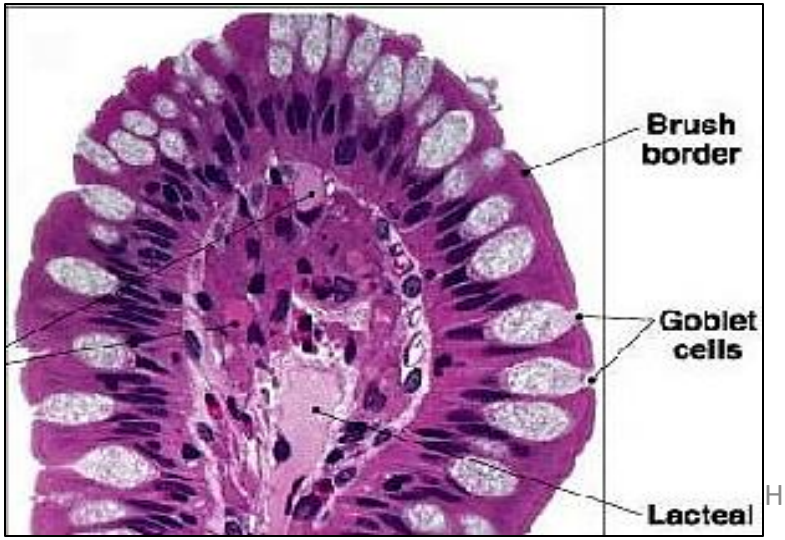
Chylomicrons enter the lacteal and are transported away from the intestine

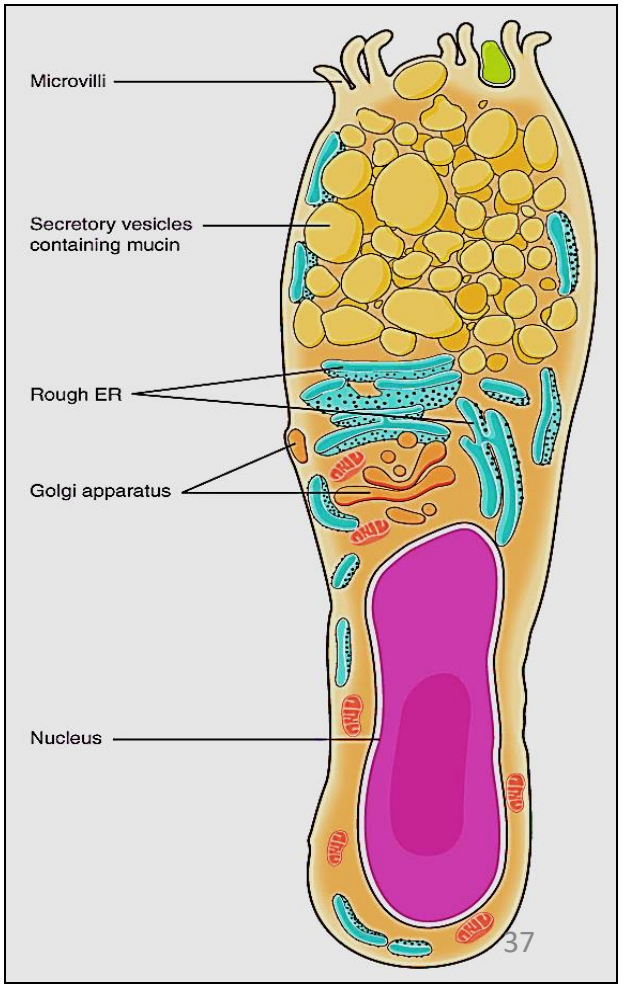


Absorption of fat & formation of chylomicron in enterocytes

2- Goblet cells:

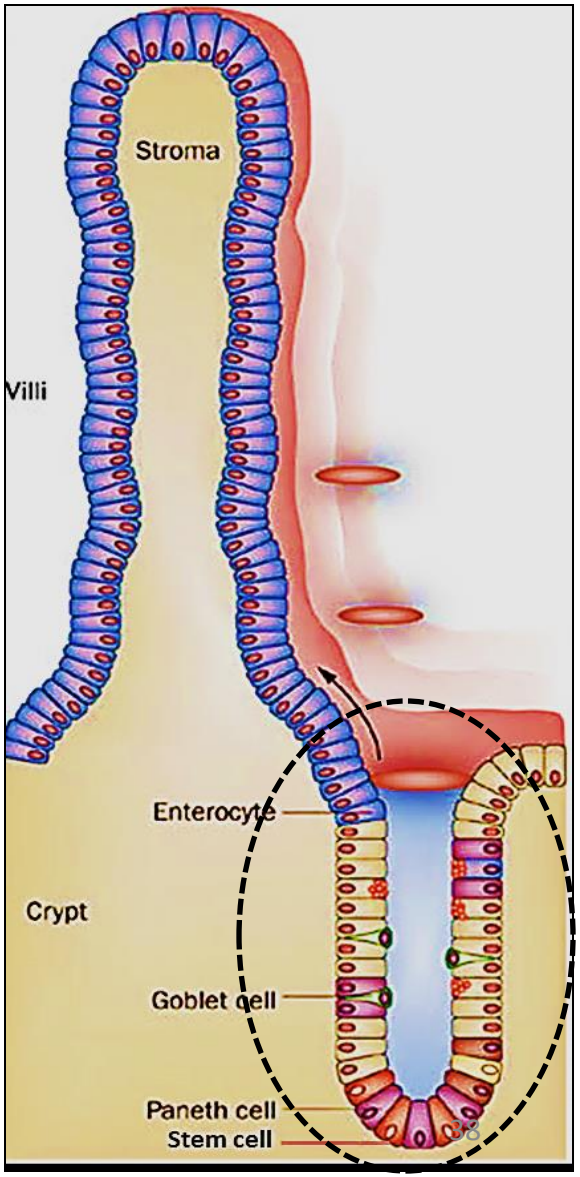
- Present between the enterocytes on the villi & in the crypts
- Unicellular mucous secreting gland
- Each cell has expanded apical part full of mucin granules & basal cylindrical part contain the deeply nucleus
- Secrets mucus at intervals for lubrication





Crypts of Leiberkuhn

- They are simple tubular glands occupy the thickness of the corium till the muscularis mucosa



- 6 types of cells line the crypts:

1- Enterocytes

2- Goblet cells

3- **Paneth cells**

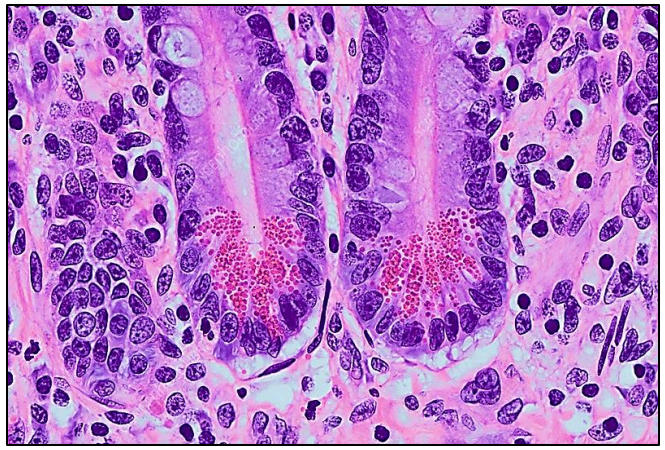
4- endocrine cells

5- stem cells

6- **M cells** (Microfold, macrophage)

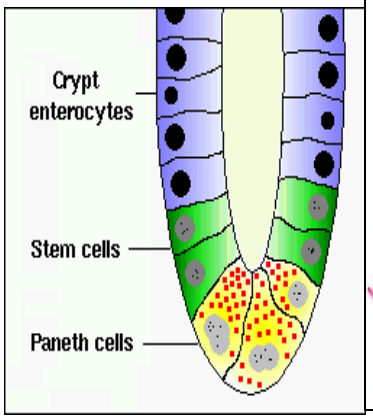
3- Paneth cells:

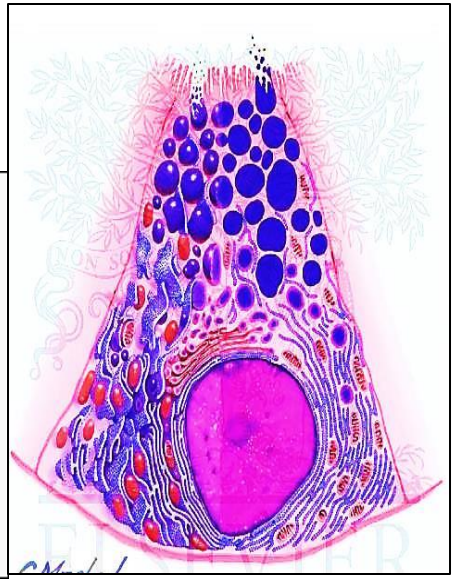
- Present in groups at **bottoms of crypts** only



- Pyramidal cells e basal oval nuclei & narrow apical part

- Basal cytoplasm is basophilic due to↑ rER , apical part has acidophilic zymogen granules



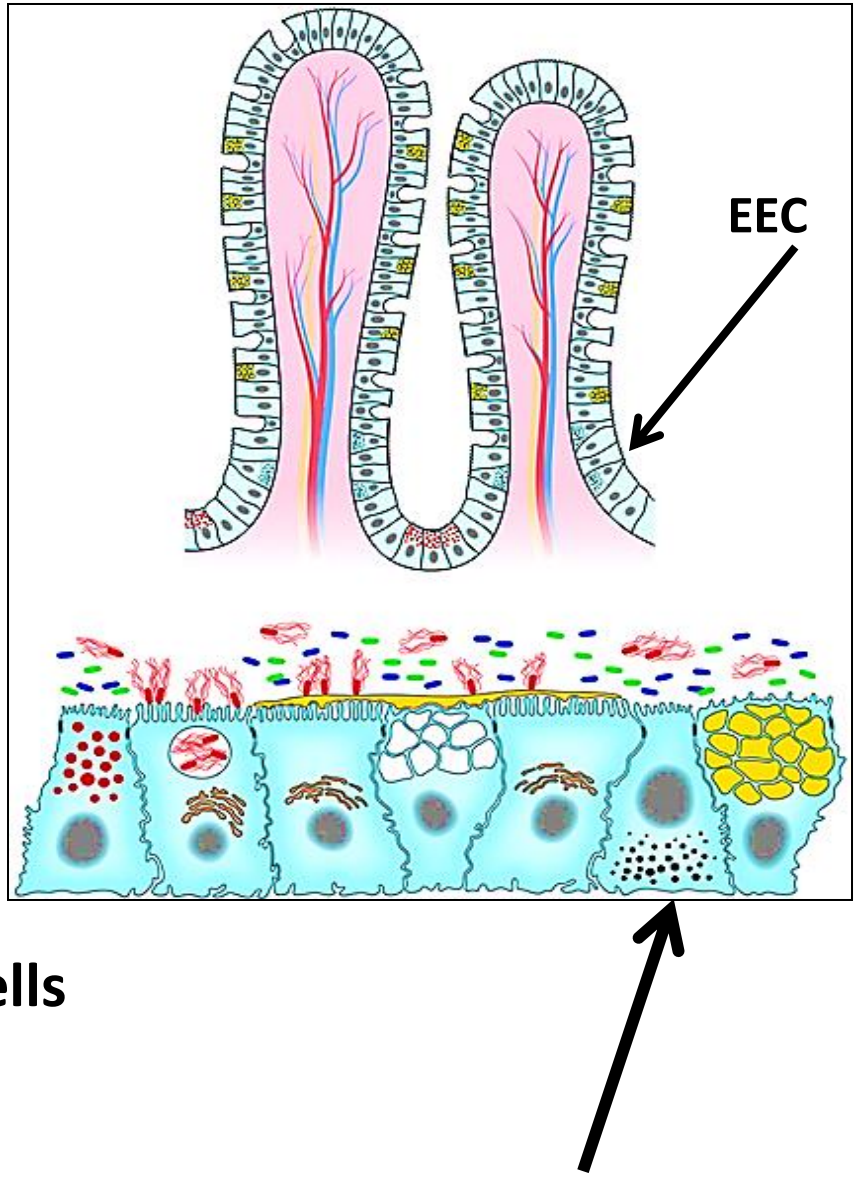


- They secrete intestinal lysozyme which has bactericidal effect

4- Enteroendocrine cells:

- Secrets intestinal hormones
- Present mainly in base of crypts,
- Their secretions released to blood
- Their secretions control peristalsis,

sense of being satisfied after eating

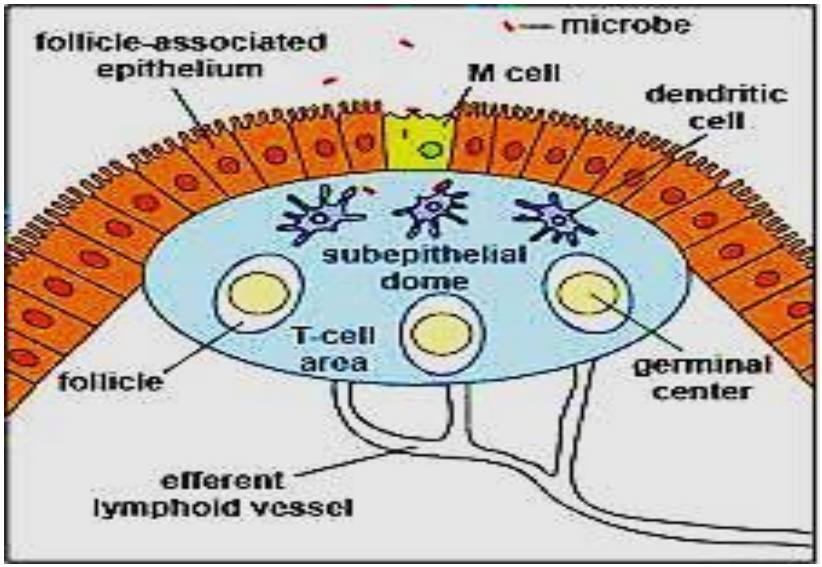


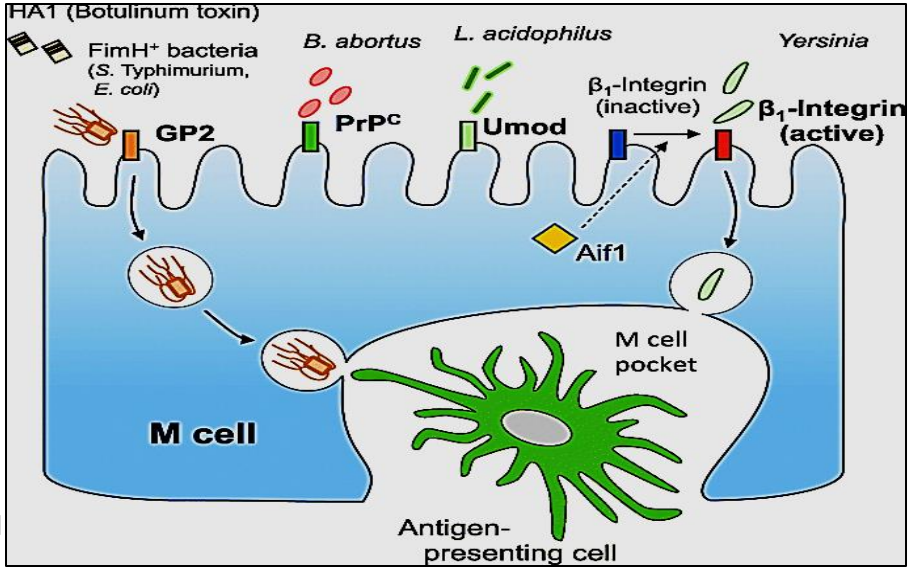
5- Stem cells:

- Short columnar cells ,present at base of crypts in between Paneth cells
- Differentiate to replace other cells

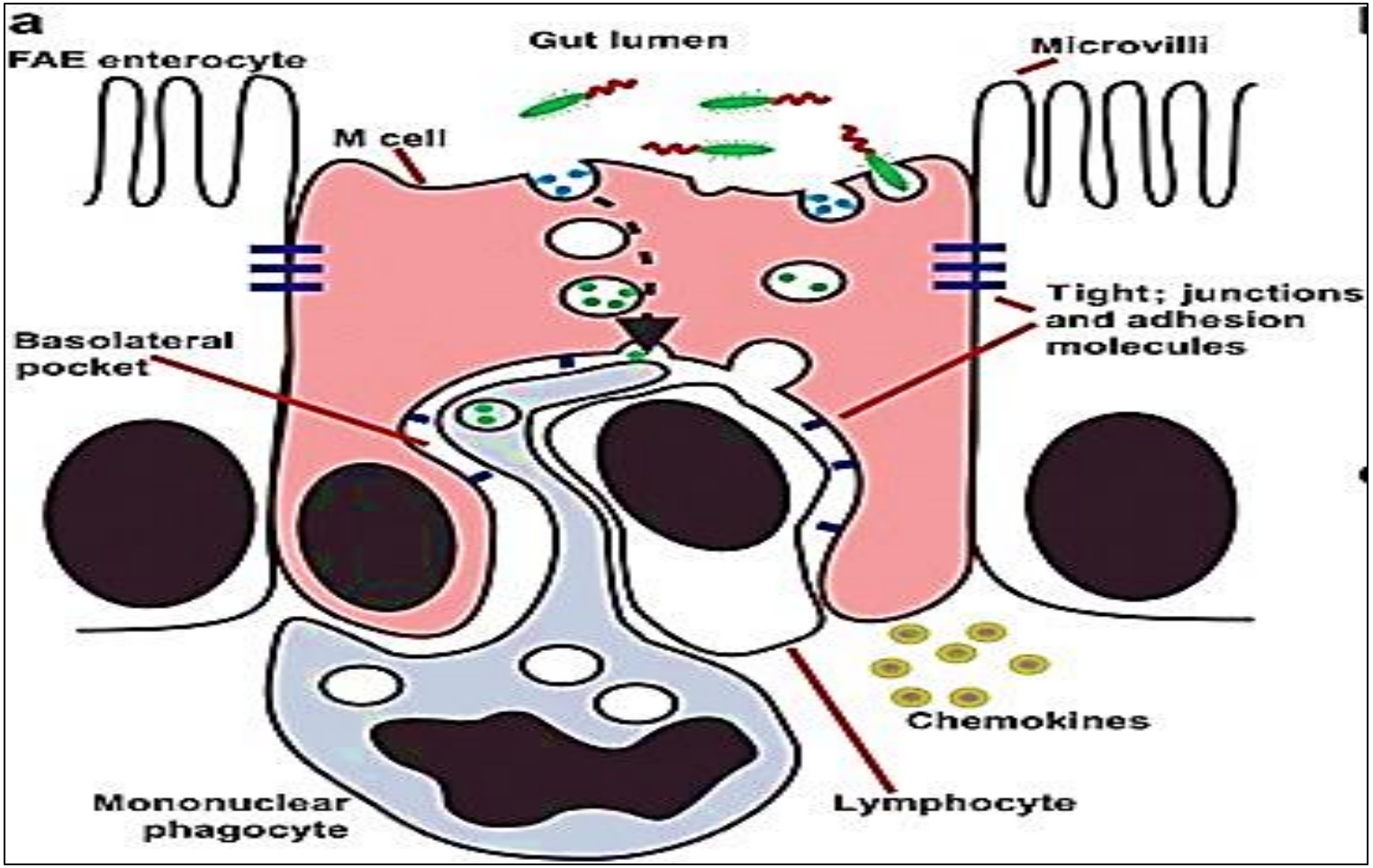
6- M (microfold) cells:

- Squamous - like cells present in between enterocytes of ileum in association with **lymphoid nodules of Peyer's patches.** Play a role in intestinal mucosal immunity
- Have microfolds on their apical surface & basal membrane invaginations forming pockets.
- Phagocytosis & transport antigens from intestinal lumen to the underlying macrophages & lymphocytes





M- cells



M cells function as guards against intestinal toxins and/or pathogens, transporting them (trans-epithelial) to awaiting immune cells. M cells specialize in transcytosis (i.e., trans-epithelial transport)

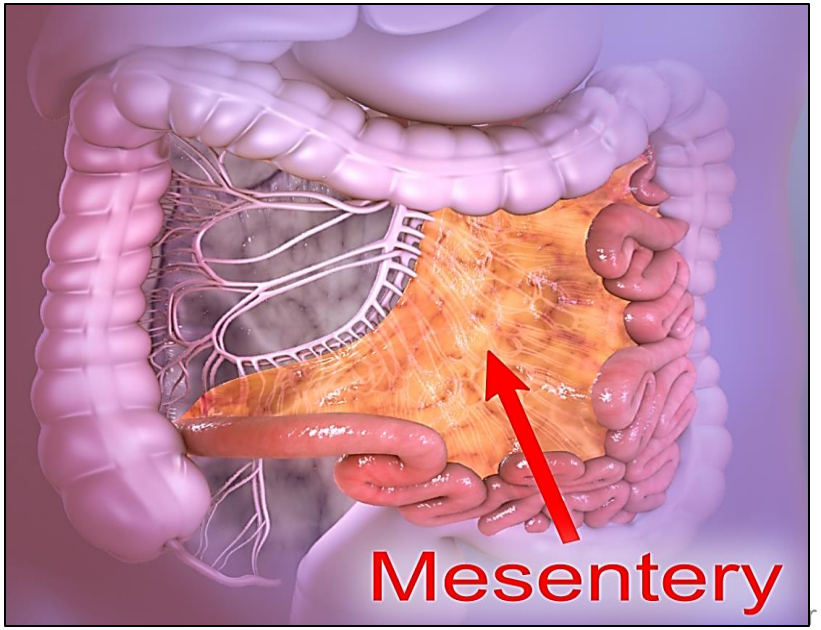
Peyer's patches (ileum)

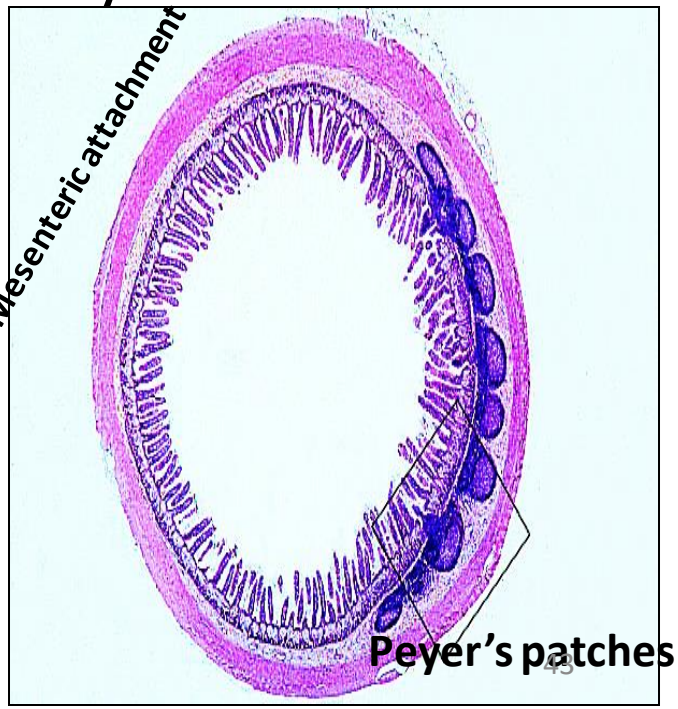
a) present mainly in the ileum. In both lamina propria of mucosa & submucosa (MALT)

b) They are aggregations of lymph follicles, lies in the side opposite to the mesenteric attachment.

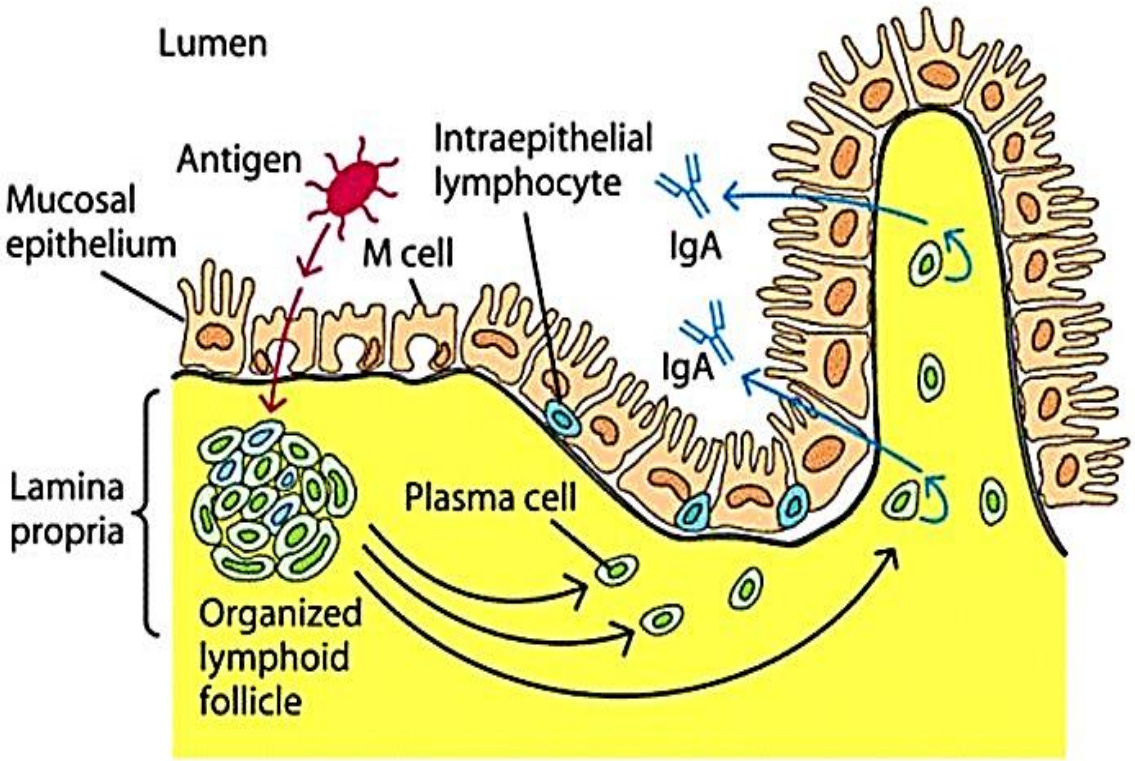
c) the intestinal villi absent over Peyer's patches

d) They are important for mucosal immunity





Mucosal Associated Lymphoid Tissue



Antigen transported across the epithelial layer by M cells at an inductive site activates B cells in the underlying lymphoid follicles. The activated B cells differentiate into IgA-producing plasma cells, which migrate along the submucosa. The outer mucosal epithelial layer contains intraepithelial lymphocytes, of which are T cells.

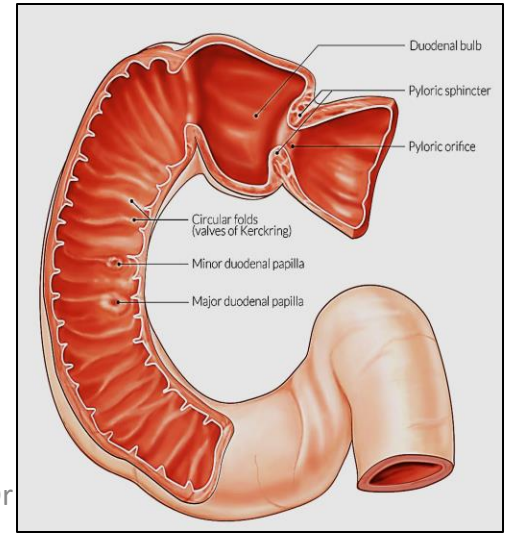
Adaption of Small intestine to its function

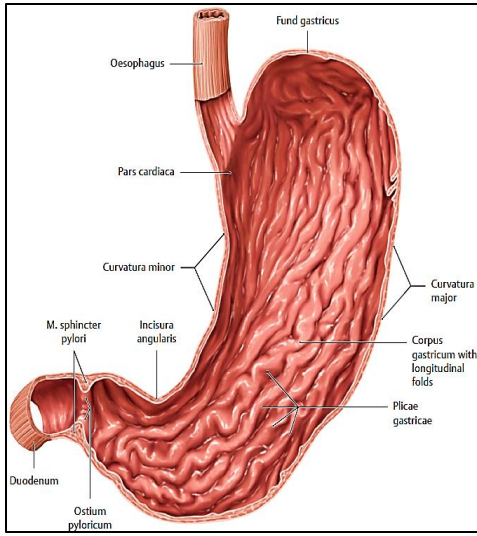
- The small intestine is the longest segment (7.5m) of the GIT which provide long contact between food & digestive enzymes

- The presence of Plicae circulares (valves of Kerckirng) which is more prominent in the lower part of duodenum jejunum because maximum absorption occurs there

- The presence of villi

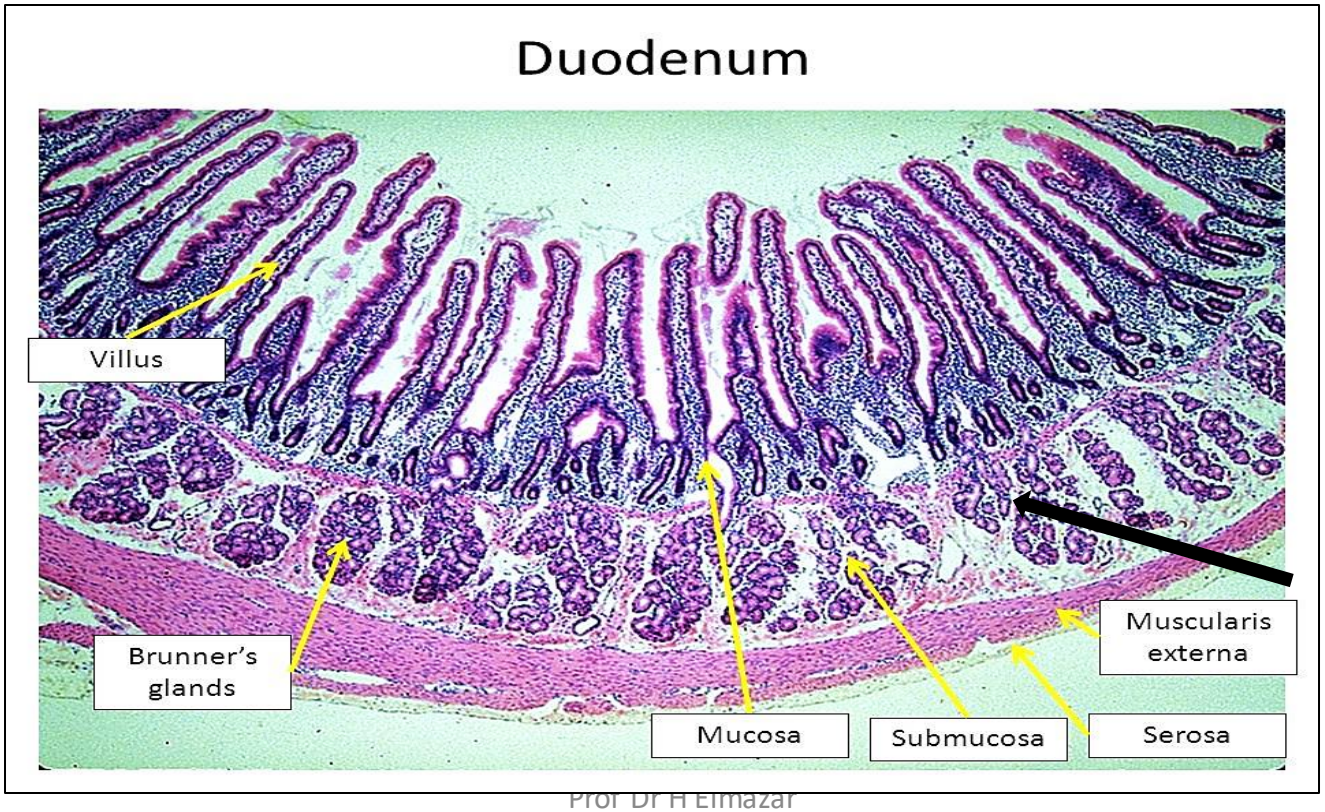
- The presence of microvilli





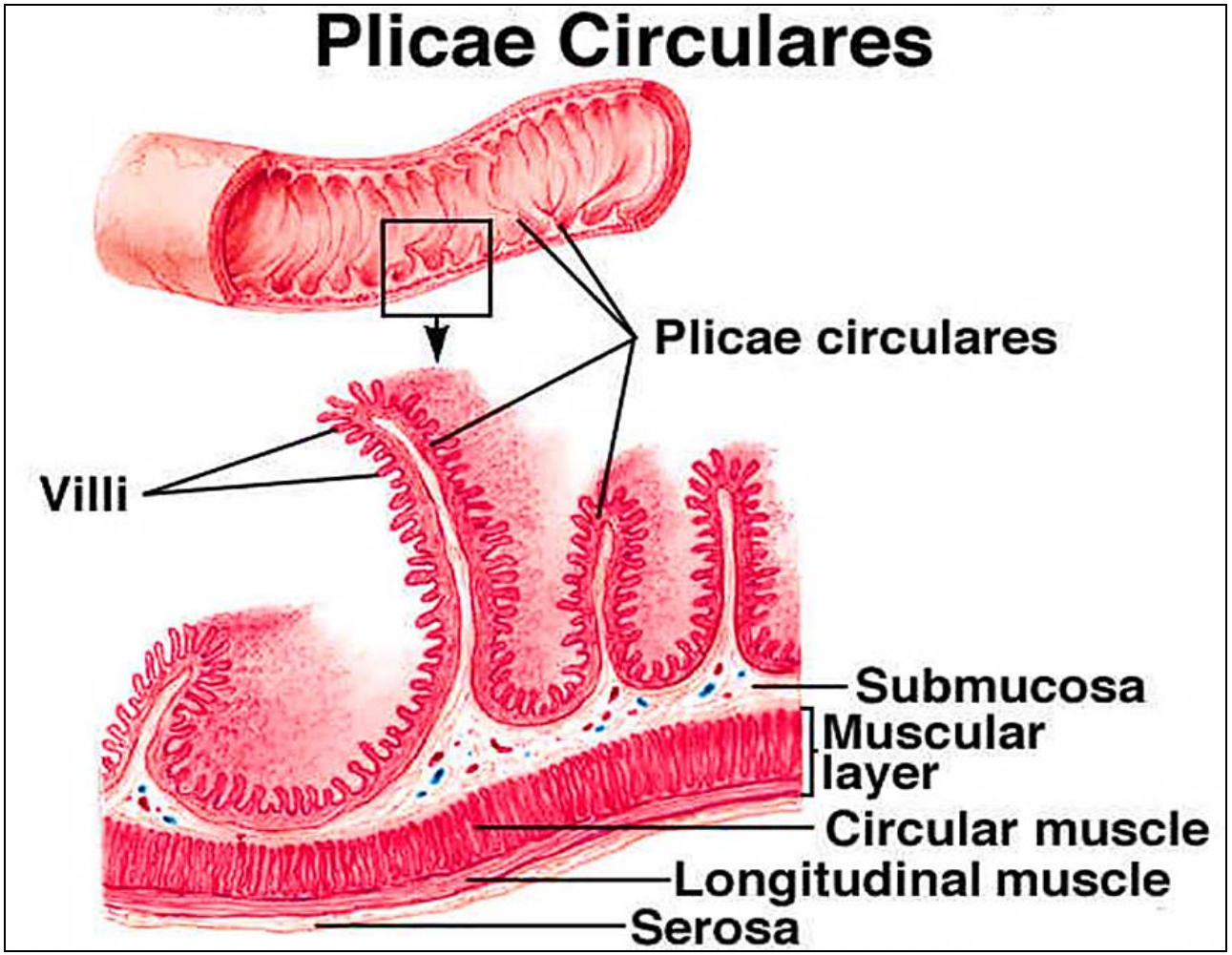
Brunner's glands

- Found in the **submucosa** of the duodenum
- Their ducts open into the bases of intestinal crypts
- They secrete alkaline mucous



Brunner's glands

Plicae circularis: circular folds of mucosa & submucosa projecting into the lumen of small intestine



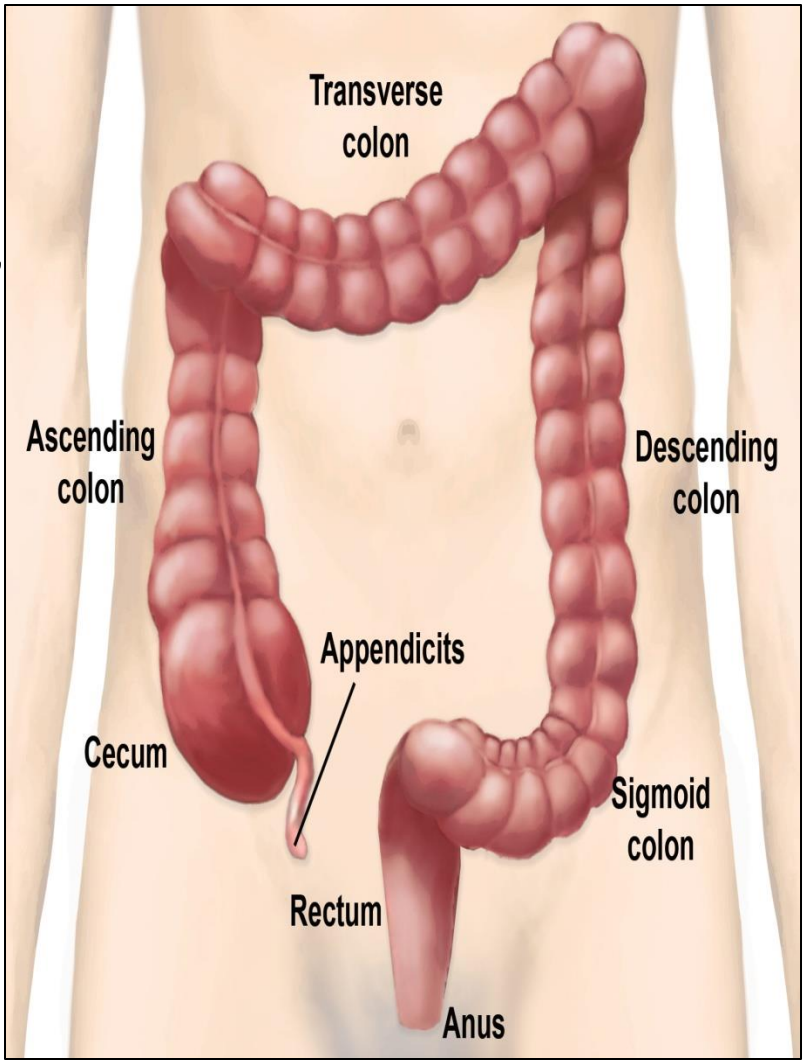
Large intestine

Composed of:

- Cecum
- Colon (ascending, transverse, descending, sigmoid)
- Rectum
- Anal canal

Function:

- Absorption of water & ions
- Production of mucus
- Formation of fecal mass



The large intestine

1- the mucosa: thick, smooth contains No villi only crypts (deep & wide)

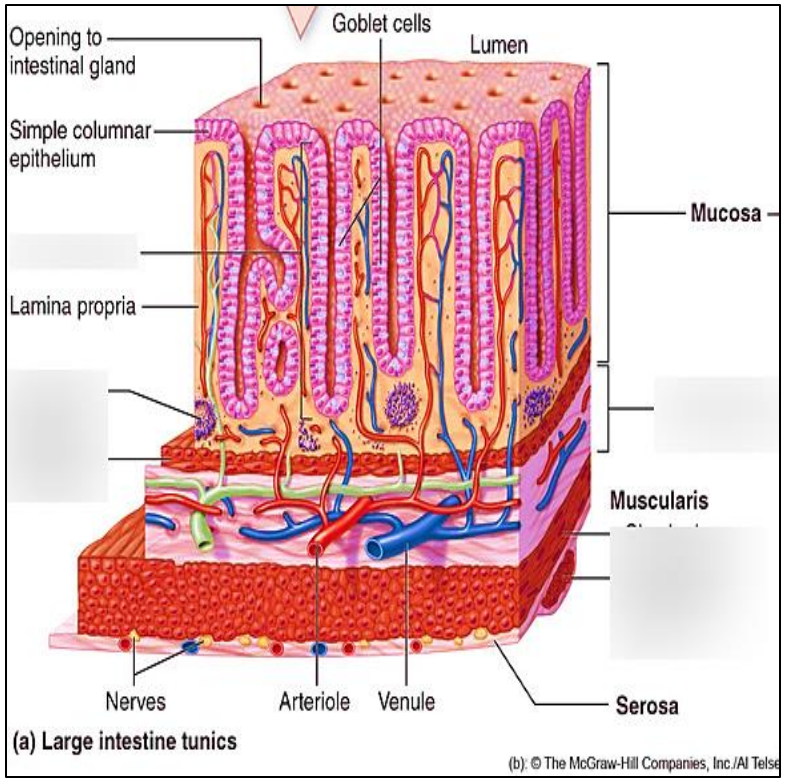
a) The epithelium: Enterocytes, MANY goblet cells, stem cells and endocrine cells

b) The lamina propria :

contains the crypts, lymphoid follicles

c) the muscularis mucosa:

well developed layer



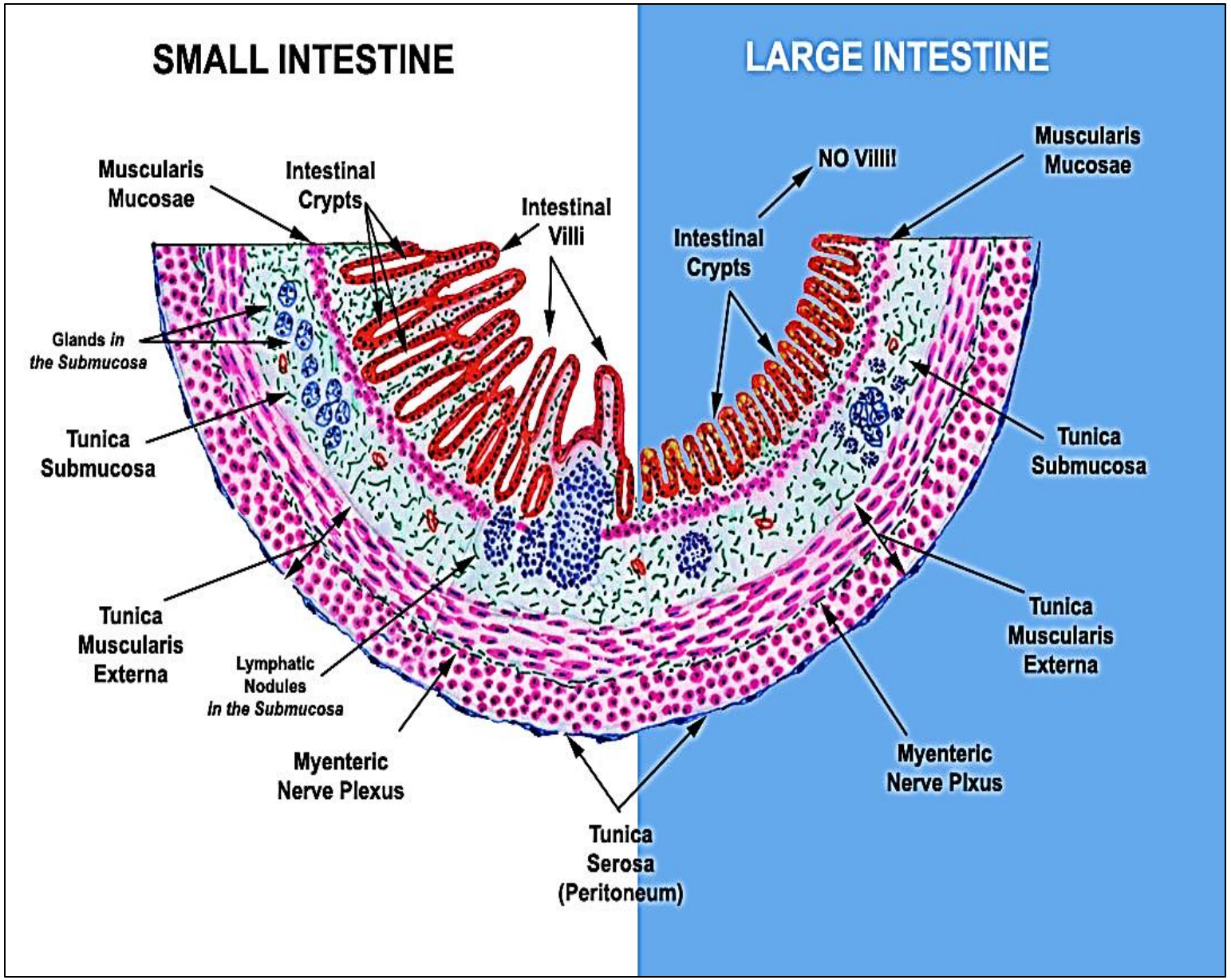
cells lining The crypts of large intestine

1- Simple columnar cells e brush border for absorption of water

2- Goblet cells: very numerous to secrete mucus

3- endocrine cells

4- stem cells: at the base of the crypts


SMALL INTESTINE
LARGE INTESTINE
Muscularis Mucosae
Intestinal Crypts
Intestinal Villi
Glands in the Submucosa
Tunica Submucosa
Tunica Muscularis Externa
Lymphatic Nodules in the Submucosa
Myenteric Nerve Plexus
Tunica Serosa (Peritoneum)
NO Villi!
Intestinal Crypts
Muscularis Mucosae
Tunica Submucosa
Tunica Muscularis Externa
Myenteric Nerve Plxus

cells lining The crypts of large intestine

1- Simple columnar cells e brush border (short & few in #) for absorption of water

2- Goblet cells: very numerous to secrete mucus

3- Endocrine cells: secrets Serotonin

(Although is best known as a neurotransmitter critical for central nervous system (CNS) development and function. **95% of the body's serotonin, however, is produced in the intestine** … (irritable bowel syndrome)

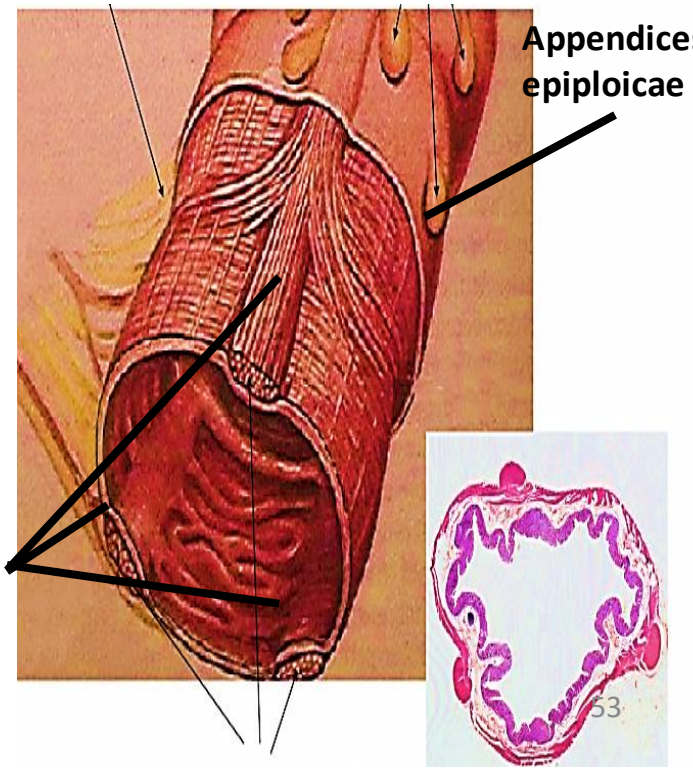
4- stem cells: at the base of the crypts

Taenia coli

- **The musculosa** of the large intestine 2 layers (IC & OL).
- **IC** is continuous but the **OL** breaks up into 3 longitudinal bands to forms the taenia coli
- Responsible for haustra (segmentation) of colon. Haustra helps to push contents of colon through under peristalsis

appendices Epiploicae

The serosa: shows small pouches of peritoneum contains fat

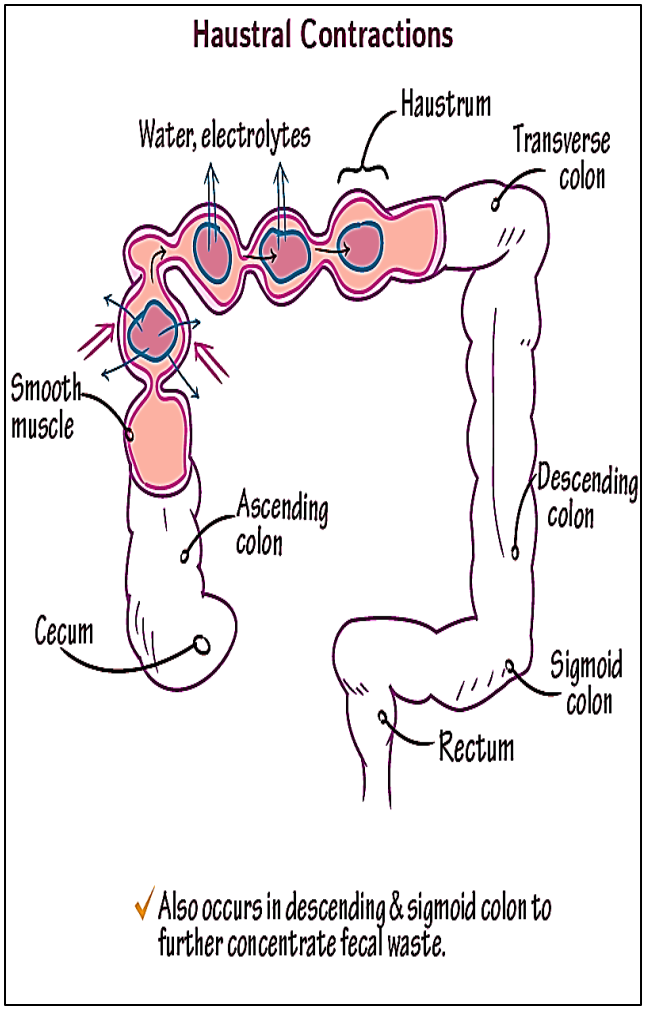


Importance of taenia coli

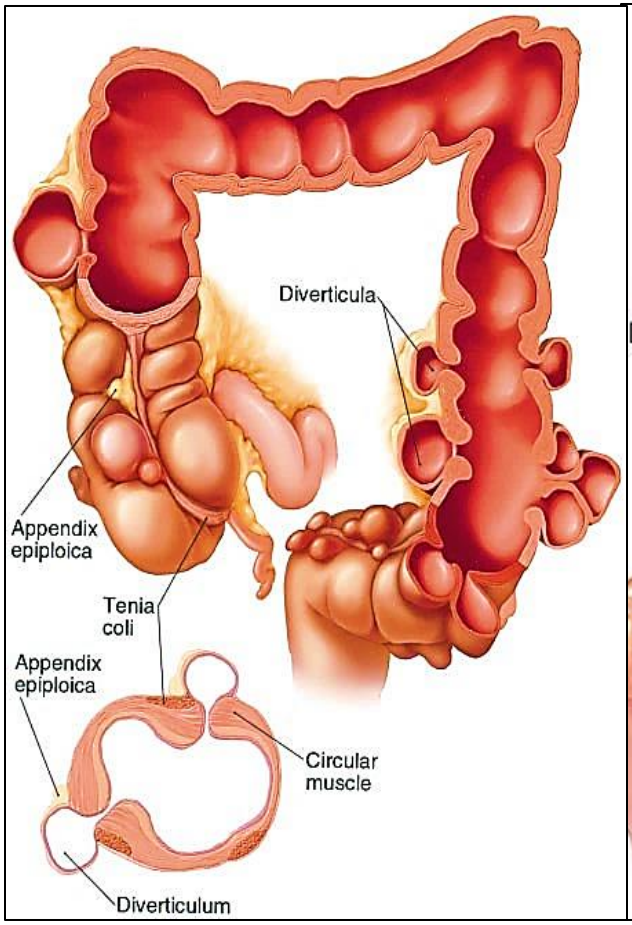
There are 2 types of ms. contractions in the large intestine Haustral & peristaltic contractions

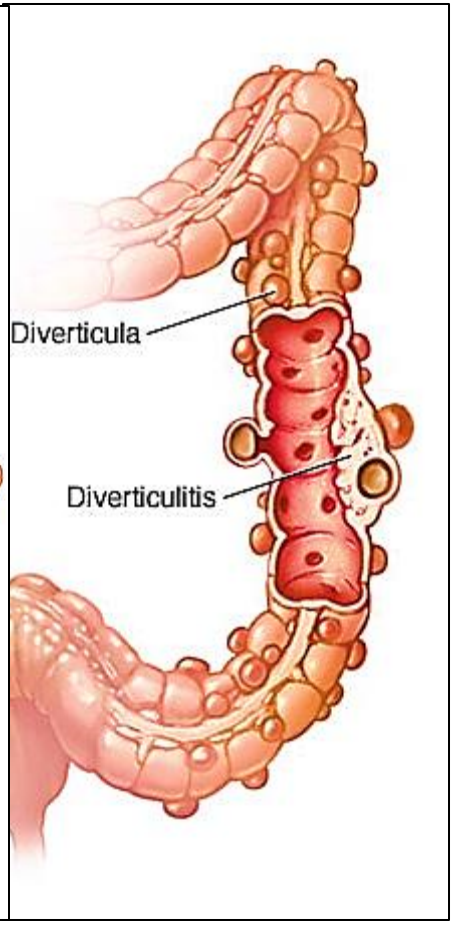
Haustral movement : localized slow movement. The distension of one haustrum initiate contraction T Coli which pushes the waste product to the next Haustrum → slow to allow time for water absorption

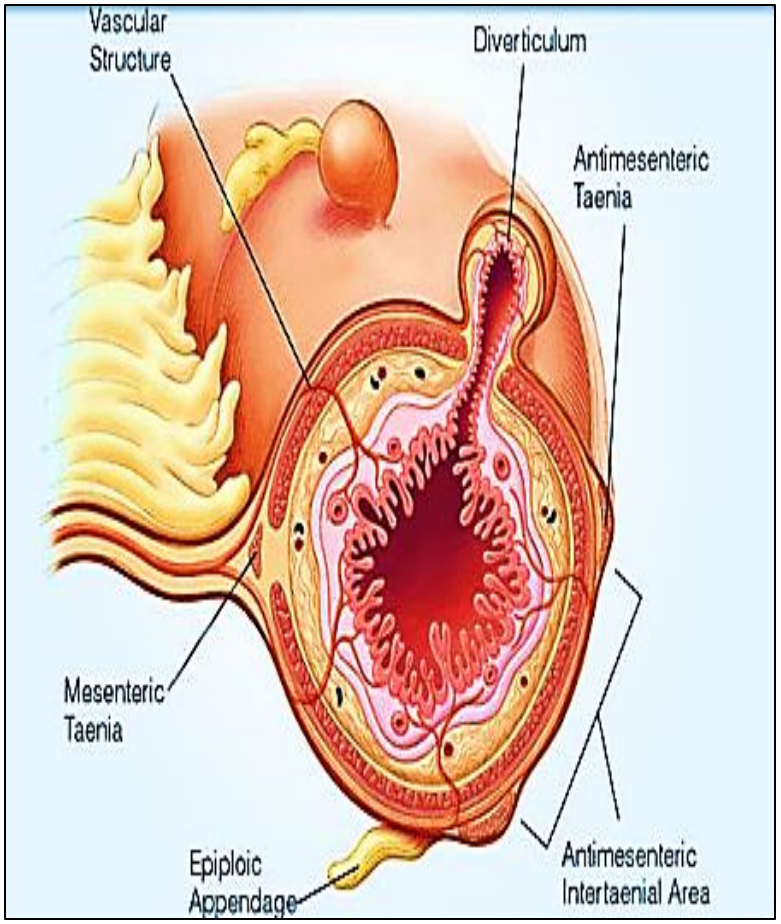
Peristaltic movement involve both IC & OL ms → distal mass movement of colonic content from part to another (once/day)



Diverticulosis



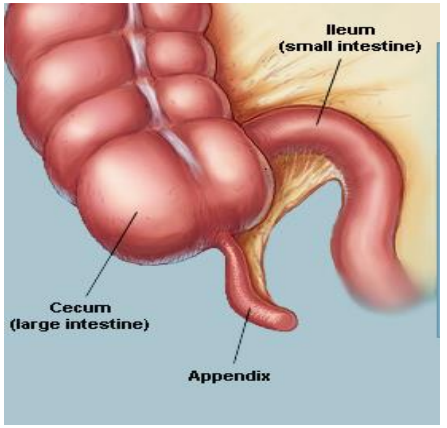




Diverticulosis is caused by small outward bulges in the large intestine (diverticula) wall in areas lack Taenia coli which can be blocked with food residue . If any of the diverticula become infected, this leads to symptoms of diverticulitis. The exact reason why diverticula develop is not known, but they are associated with not eating enough fiber

The appendix

It is a projection from the cecum, 8 cm

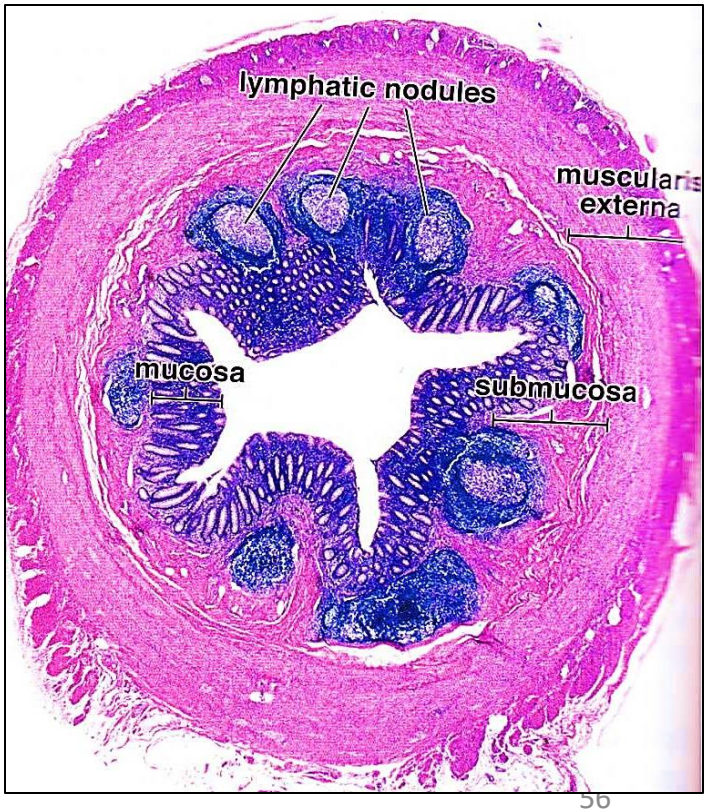


- The mucosa: crypts short & few in number

a) Epithelium: simple columnar + goblet cells + endocrine cells

b) The corium & submucosa: rich in **lymphoid follicles**

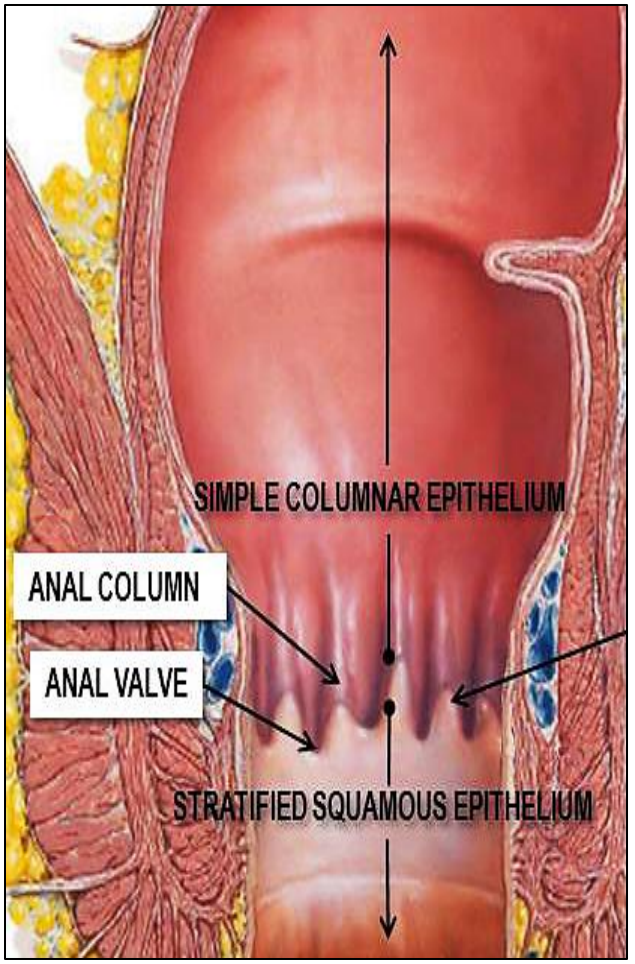
c) No muscularis mucosa, NO taenia coli No appendices epiploicae



The anal canal

The mucosa of the anal canal shows permanent vertical folds called **columns of Morgagni**

The ends of Morgagni columns connected together with transverse mucosal folds called **anal valves which mark the pectinate line**



The columns mark the recto-anal junction

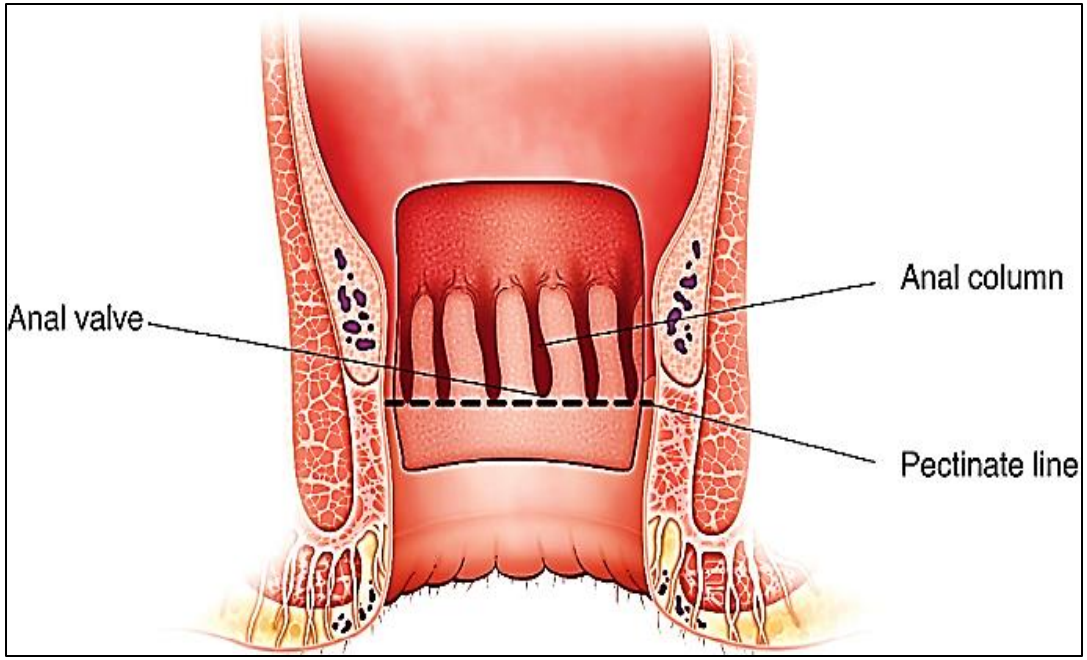
The epithelium is stratified columnar on columns of Morgagni

Importance of the pectinate line

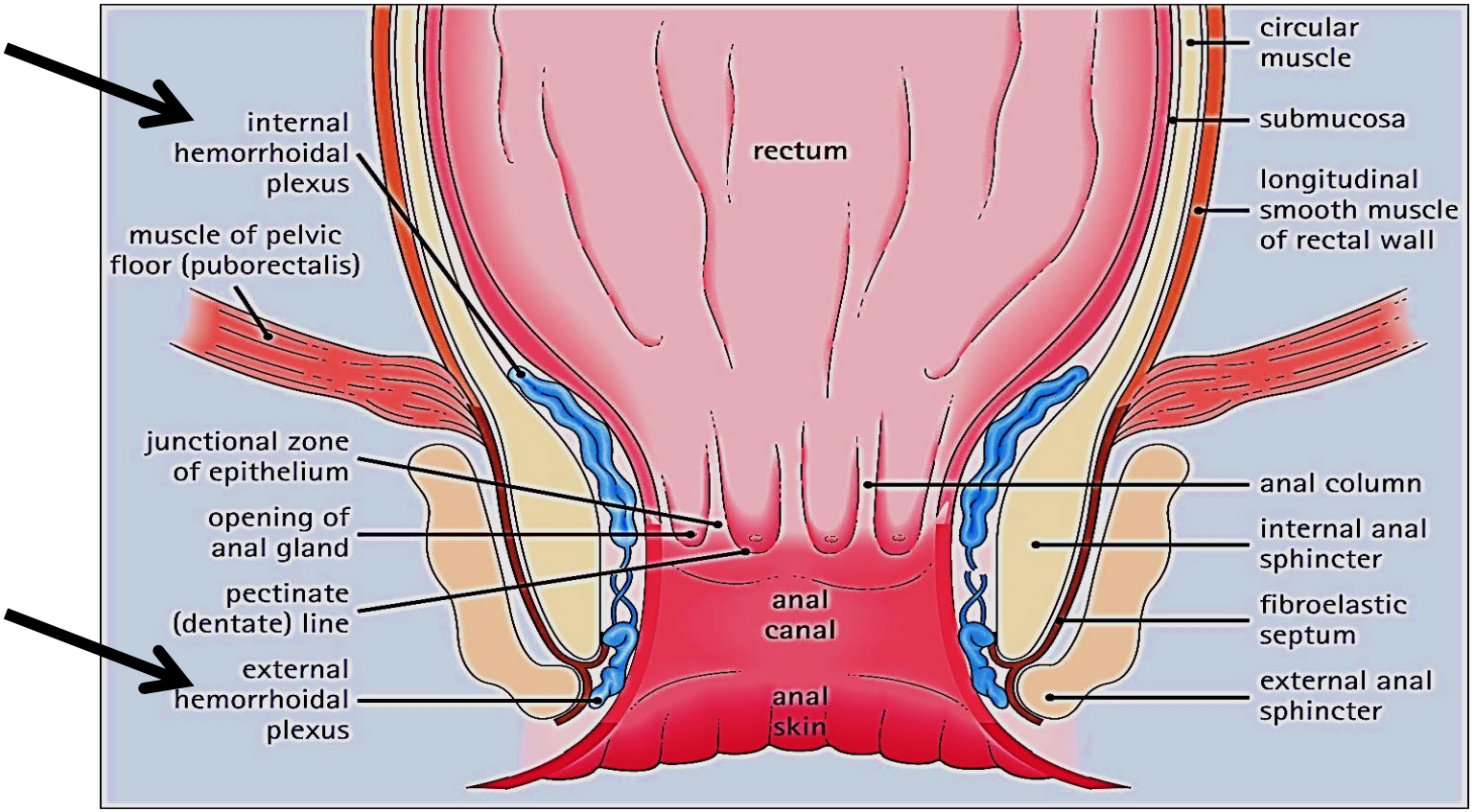
The pectinate line demarcates the upper two-thirds of the anal canal from the lower one-third.

It also serves as an embryologic landmark that explains the different arterial supply, venous drainage, lymphatic drainage, and nervous supply of the segments of the anal canal

Even tumors arise in the upper 2/3 different from tumors arise in the lower 1/3

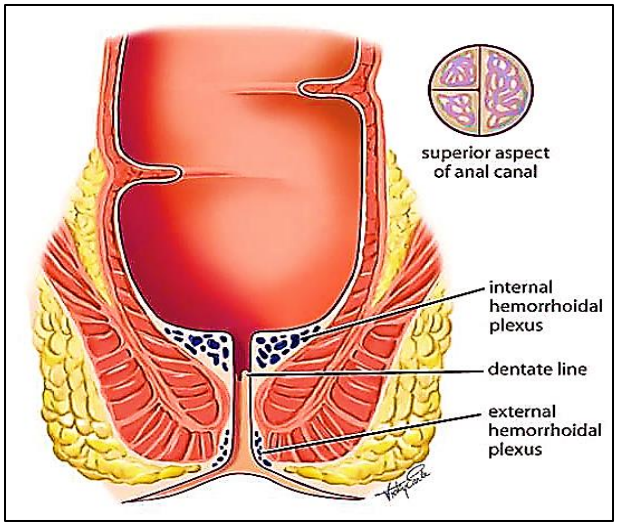


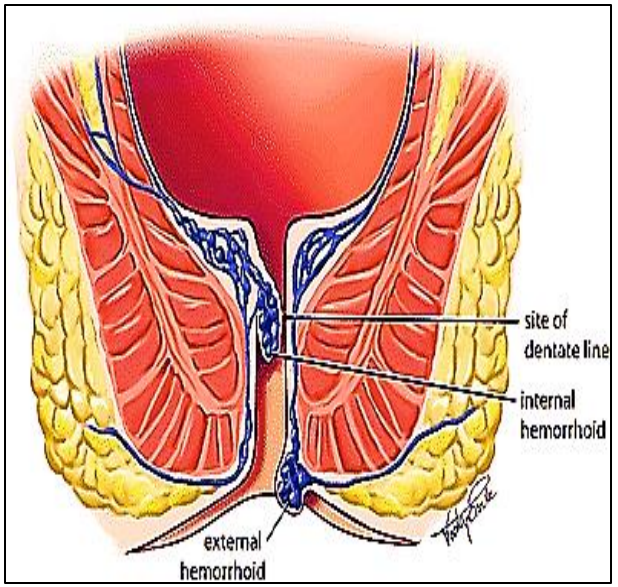
- C.T. under the level of the valves is rich e convoluted veins → the internal piles (plexus of veins)
- At the anus another group of veins under the skin forms the external piles



Hemorrhoids also called piles, are swollen veins of the anus and lower rectum, similar to varicose

Internal hemorrhoids are usually painless, but tend to bleed. External hemorrhoids may cause pain

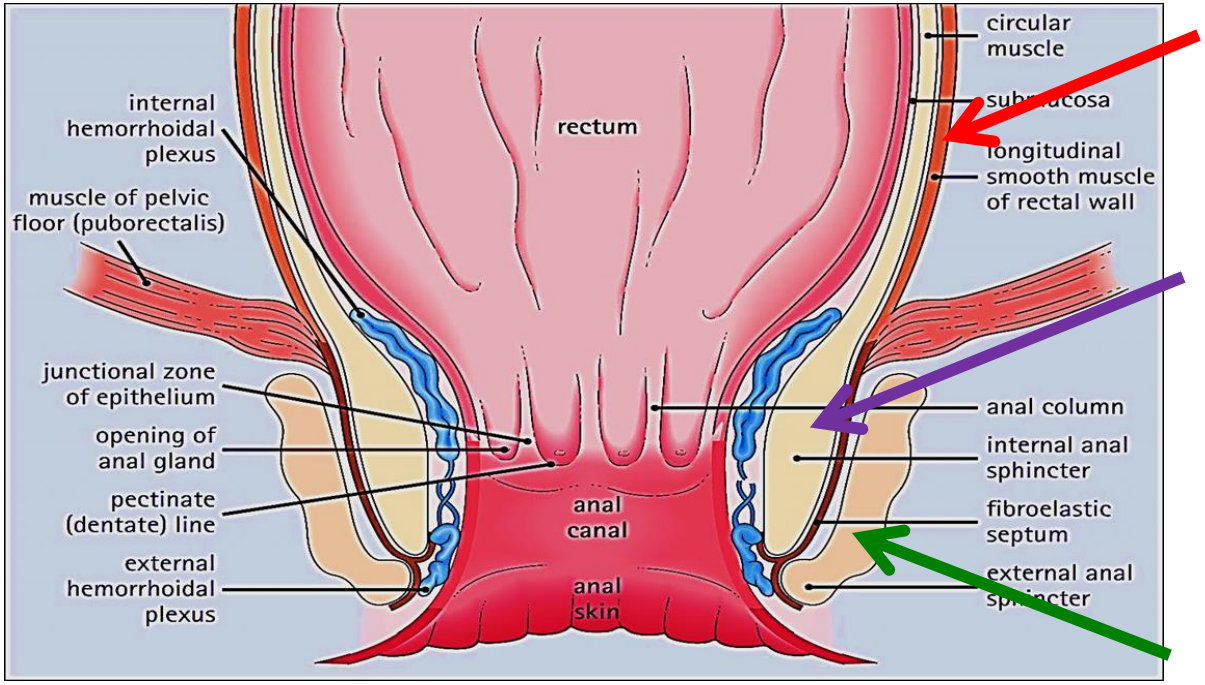




- The inner circular becomes thick to form internal anal sphincter (Involuntary)

- The outer longitudinal layer of rectum pass unchanged the between internal & external sphincters of the anal canal

- The skeletal ms of pelvic floor form the external sphincter (voluntary)



Thank you