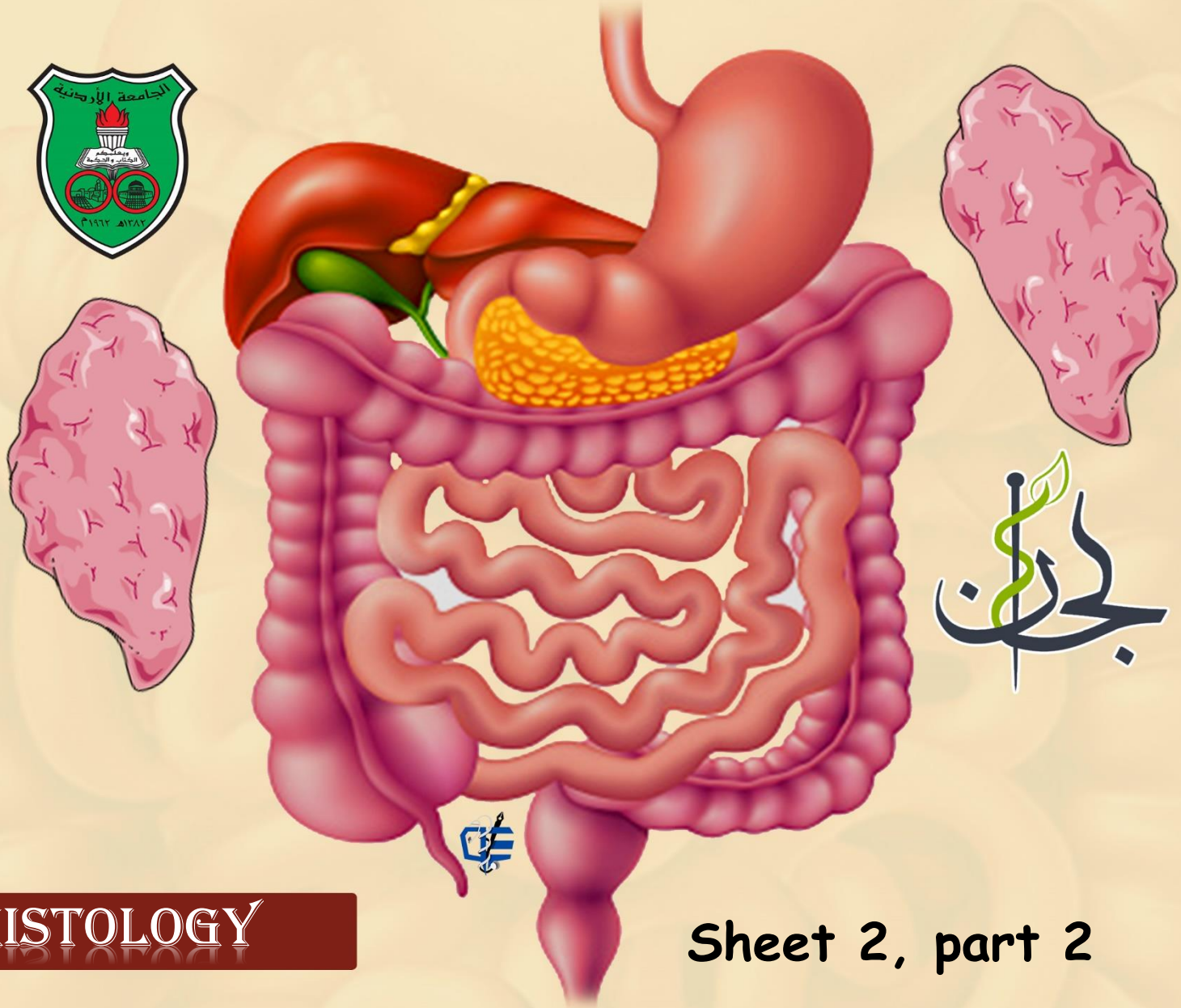
GastroIntestinal System



HISTOLOGY

Sheet 2, part 2

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Small Intestine

The small intestine is the site of terminal food digestion, nutrient absorption, and endocrine secretion.

It is relatively long, approximately 6m and consists of three segments: the duodenum, jejunum, and ileum. Duodenum is retroperitoneal organ while jejunum, and ileum are intraperitoneal organs, they have mesentery.

processes of digestion are completed in the small intestine (mainly in the duodenum), and the nutrients (products of digestion) are absorbed by cells of the epithelial lining (in jejunum, and ileum).

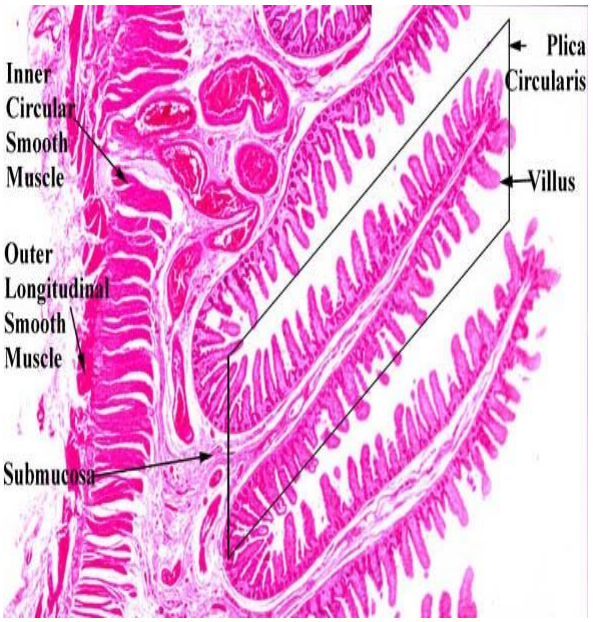
Layers of small intestine:

Similar to the rest of the GI tract, the wall of the small intestine has 4 main layers : **mucosa, submucosa, muscularis externa, and serosa.** We will talk about the prominent structures in each layer:

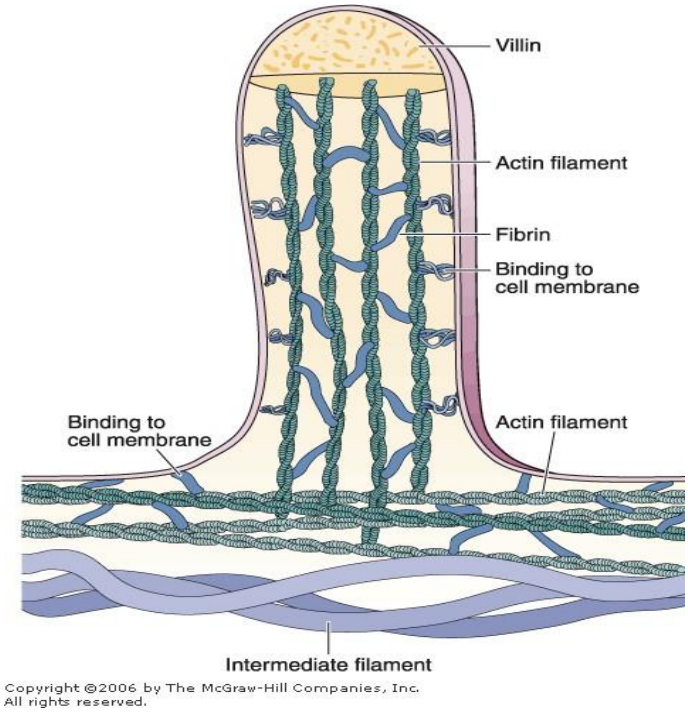
Mucous Membrane

- **Lining epithelium** : simple columnar epithelium with goblet cells.

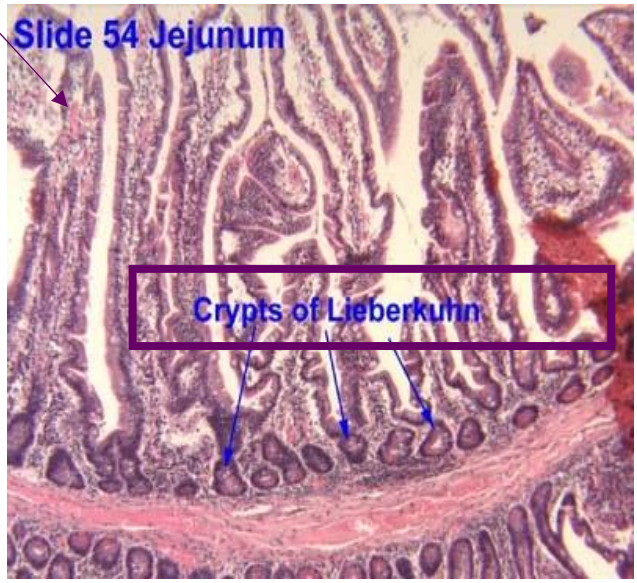
- **Kerckring's valves (plicae circulares)**
  - ☑ series of permanent folds of submucosa through the mucosa, they have a semilunar, circular, or spiral form.
  - ☑ They are most developed in, and consequently a characteristic of, the jejunum.
  - ☑ They do not constitute a significant feature of the duodenum and ileum, although they are frequently present.
  - ☑ They are similar to the **rugae** in the stomach.



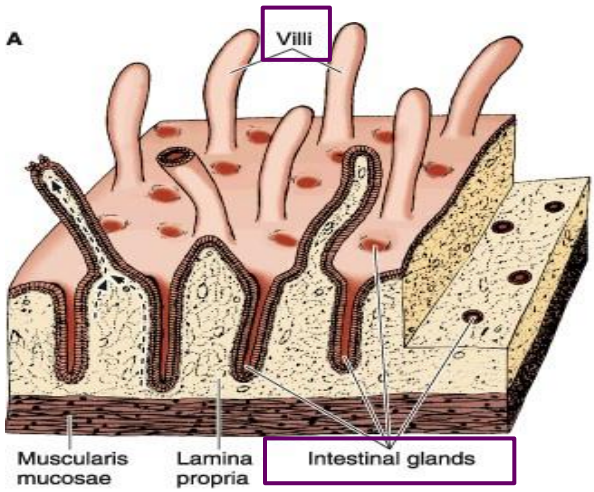
- **Intestinal villi**
  - ☑ They are 0.5- to 1.5-mm-long outgrowths of the mucosa (epithelium plus lamina propria) projecting into the lumen of the small intestine.
  - ☑ In the duodenum they are leaf shaped, gradually assuming fingerlike shapes as they reach the ileum.
  - ☑ **Microvilli** are present on their surfaces.



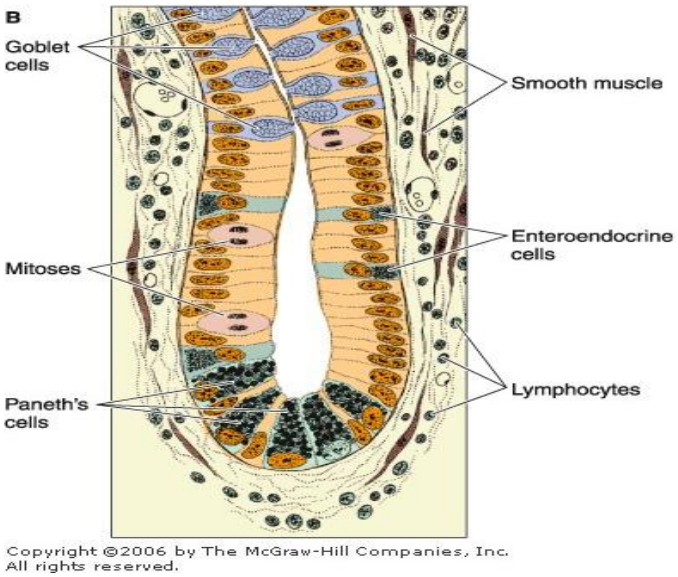
Fingerlike projection villus

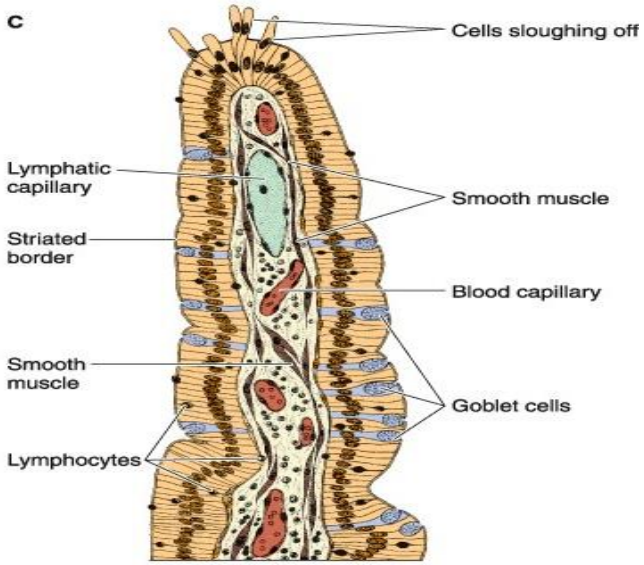


- **intestinal glands (crypts or glands of Lieberkühn)**
  - ☑ they are small openings of simple tubular glands between the villi, the epithelium of the villi is continuous with that of the glands.
  - ☑ They contain stem cells, some absorptive cells, goblet cells, Paneth's cells, and enteroendocrine cells.
  - ☑ They have roles in both secretion and absorption.



The differences between **Intestinal villi** and **intestinal glands** :





Gland:

- ✓ Lining epithelium is simple columnar epithelium with goblet cells
- ✓ Steam cells are present for mitosis
- ✓ Enteroendocrine cells secrete colecistochinina hormone.
- ✓ Paneth's cells in the base secret lysosome and it's important for the normal flora of the small intestine (we will talk about it soon)

Villus:

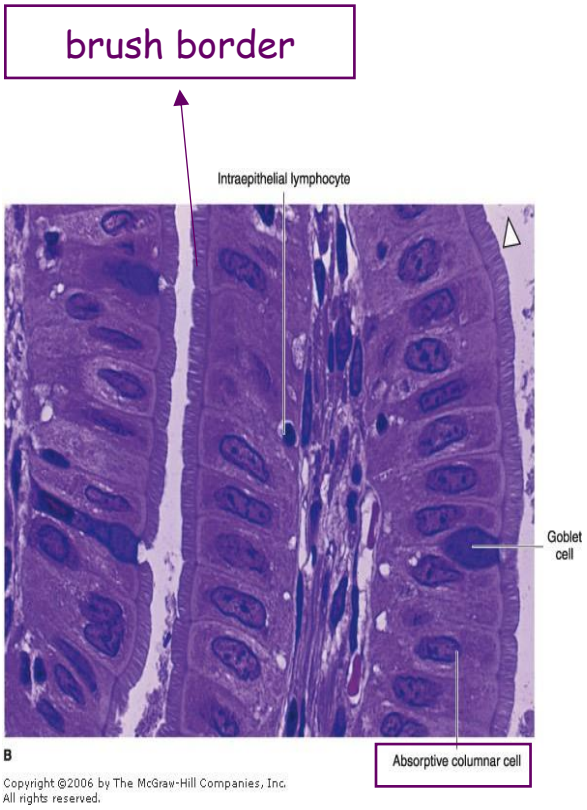
- ✓ Lining epithelium is simple columnar epithelium with goblet cells
- ✓ Microvilli in the surface form a brush border
- ✓ Inside the Villus: lamina propria with loose connective tissue contain capillaries, smooth muscles, fibroblast, lymphocyte, and **lacteal** which is a blind end of lymphatic capillary important in the absorption of fat.

➢ Microvilli

- ☑ present in the surface of villi
- ☑ each microvillus is a cylindrical protrusion of the apical cytoplasm that is approximately 1 m tall by 0.1 m in diameter.
- ☑ consists of the cell membrane enclosing a core of actin microfilaments associated with other cytoskeletal proteins.
- ☑ they have the important physiological function of increasing the area of contact between the intestinal surface and the nutrients.

➢ Absorptive cells or enterocytes

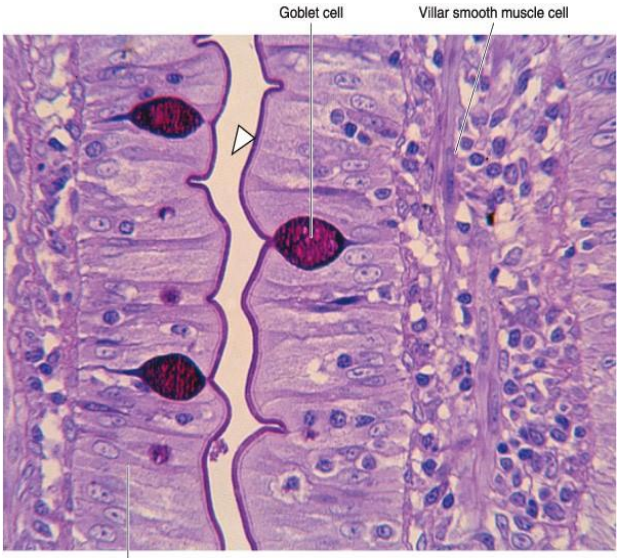
- ☑ They are tall columnar cells, each with an oval nucleus in the basal half of the cell.
- ☑ at the apex of each cell is a homogeneous layer called the striated (brush) border, when viewed with the electron microscope, the striated border is seen to be a layer of densely packed microvilli.
- ☑ each absorptive cell is estimated to have an average of 3000 microvilli, and 1 mm2 of mucosa contains about 200 million of these structures.



The presence of plicae, villi, and microvilli greatly increases the surface of the intestinal lining, It has been calculated that plicae increase the intestinal surface 3-fold, the villi increase it 10-fold, and the microvilli increase it 20- fold. Together, these processes are responsible for a 600-fold increase in the intestinal surface, resulting in a total area of 200 m2

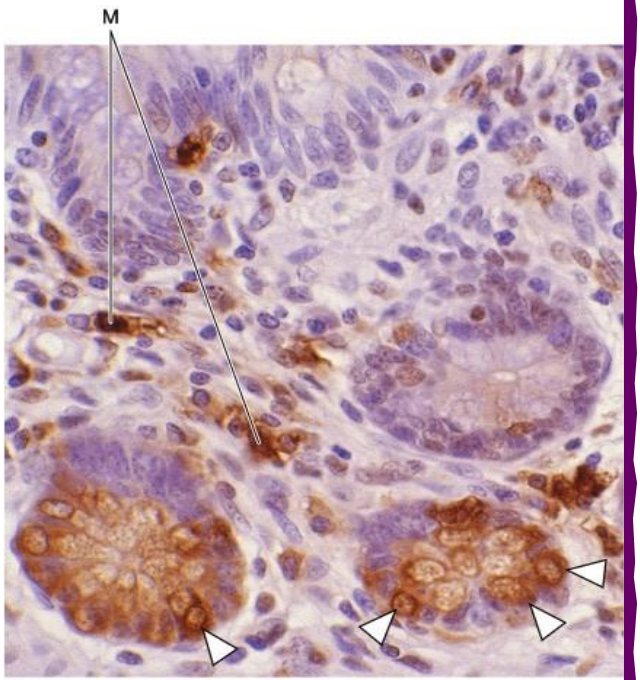
➢ Goblet cells

- ☑ Interspersed between the absorptive cells (epithelial cells).
- ☑ they are less abundant in the duodenum and increase in number as they approach the ileum.
- ☑ they produce acid glycoproteins of the mucin type to form mucus, whose main function is to neutralize the acidity of the stomach thus provide protection especially to the duodenum and to lubricate the lining of the intestine.

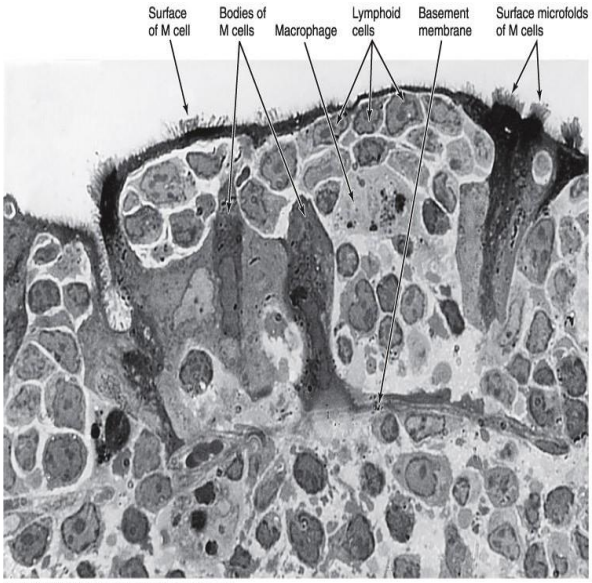


➢ Paneth's cells

- ☑ are exocrine cells present in the basal portion of the intestinal glands with secretory granules in their apical cytoplasm.
- ☑ the large apical eosinophilic secretory granules of these cells secrete lysozyme which is an antibacterial enzyme (digests the cell walls of some bacteria), it may play a role in controlling the intestinal flora.
- ☑ Very common in the jejunum.



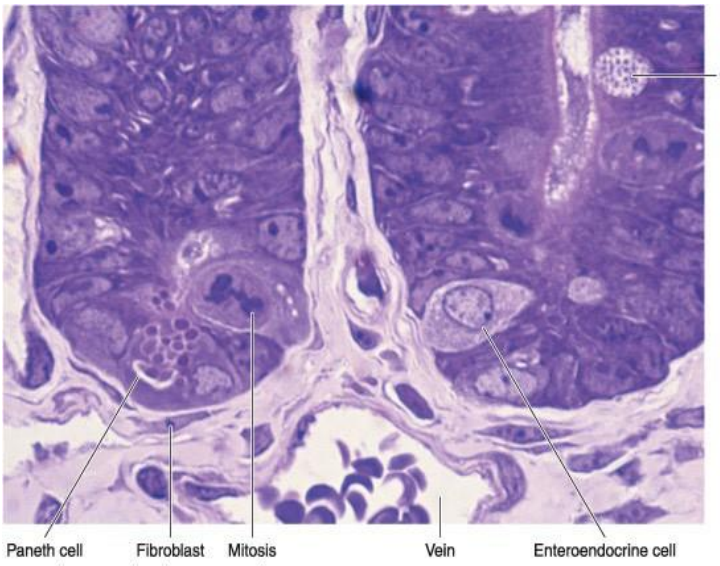
➢ Microfold cells (M cells)

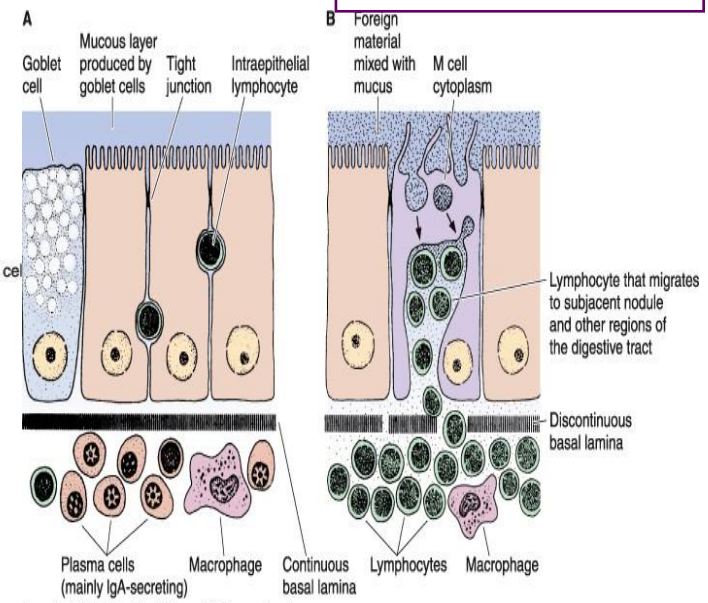


- ☑ are specialized epithelial cells overlying the lymphoid follicles of Peyer's patches so it's very common in the ileum.
- ☑ represent an important link in the intestinal immunological system; the presence of numerous basal membrane invaginations that form pits containing many intraepithelial lymphocytes and antigen presenting cells (macrophages) thus, it can endocytose antigens and transport them to the underlying macrophages and lymphoid cells, which then migrate to other compartments of the lymphoid system (nodes)
- ☑ basement membrane under M cells is discontinuous, facilitating transit between the lamina propria and M cells

M cells engulf the foreign body from the surface of the mucosa

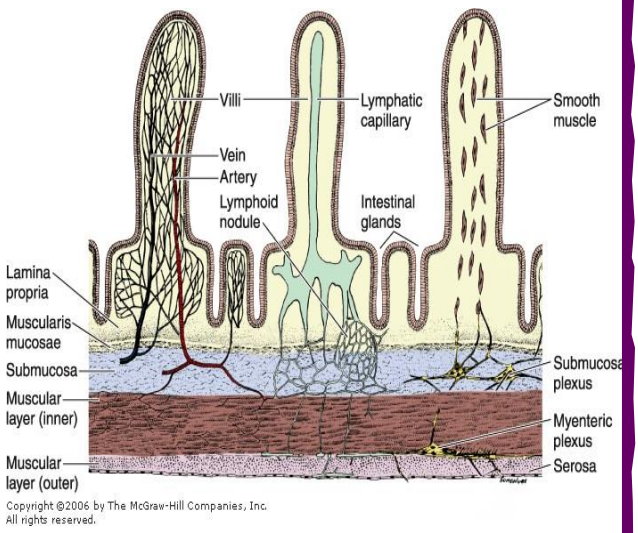
Base of the intestinal villi





Macrophages and lymphocyte enter inside the cytoplasm of M cells from the base

- **lamina propria**
  - ☑ composed of loose connective tissue with blood and lymph vessels, nerve fibers, lymphatic capillaries (**lacteal)** and smooth muscle cells.
  - ☑ penetrates the core of the intestinal villi.
  - ☑ smooth muscle cells are responsible for the rhythmic movements of the villi, which are important for absorption

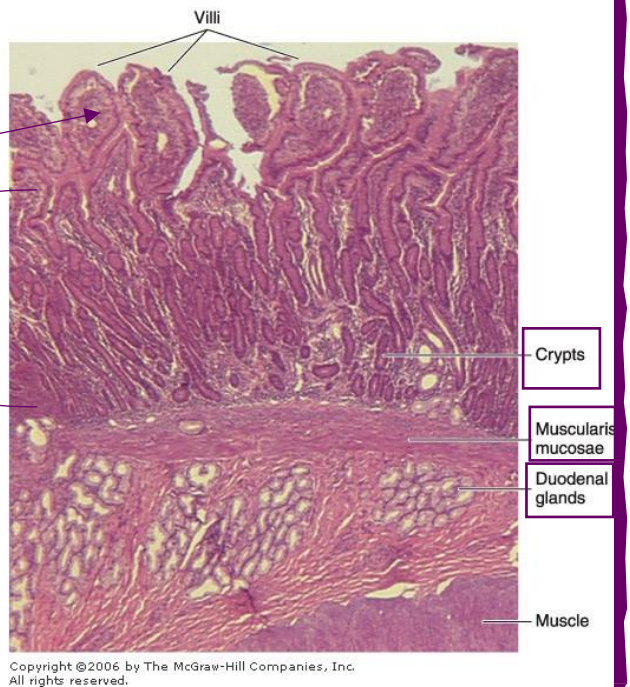


submucosa

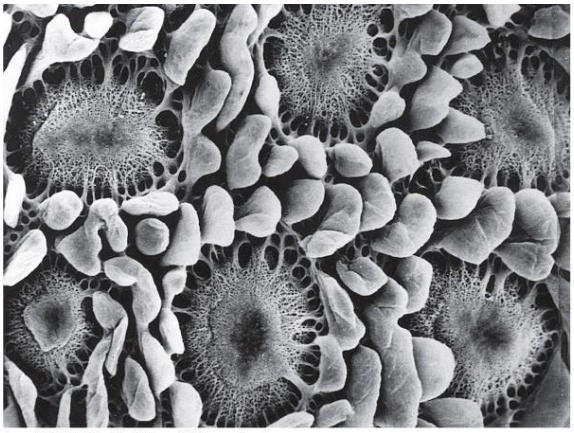
- **duodenal (or Brunner's) glands**
  - ☑ clusters of ramified, coiled tubular glands in the submucosa of the initial portion of the duodenum.
  - ☑ it open into the intestinal glands
  - ☑ The product of secretion of the glands is distinctly alkaline (pH 8.1–9.3), acting to protect the duodenal mucous membrane from the effects of the acid gastric juice and to bring the intestinal contents to the optimum pH for pancreatic enzyme action.

leaf shaped villus

Lamina propria



- **Peyer's patches**
  - ☑ aggregates of lymphoid nodules in lamina propria and the submucosa of the small intestine
  - ☑ it's an important component of the GALT (Gut-associated lymphoid tissue)
  - ☑ Each patch consists of 10–200 nodules and is visible to the naked eye as an oval area on the antimesenteric side of the intestine



  - ☑ There are about 30 patches in humans, most of them in the ileum
  - ☑ each Peyer's patch appears as a dome-shaped area devoid of villi
  - ☑ Instead of absorptive cells, its covering epithelium consists of M cells

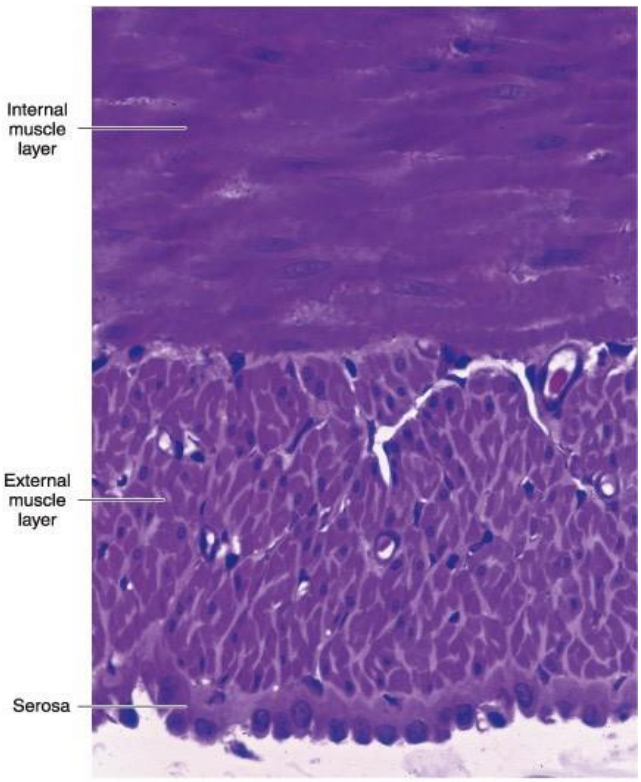
Muscularis Externa

The muscularis is well developed in the intestines, composed of an internal circular layer and an external longitudinal layer (like the esophagus)

myenteric plexus present between the two layers, responsible for the secretion and motility of the small intestine

Serosa

simple squamous epithelium



Gut-associated lymphoid tissue (GALT) immunity of the GI tract

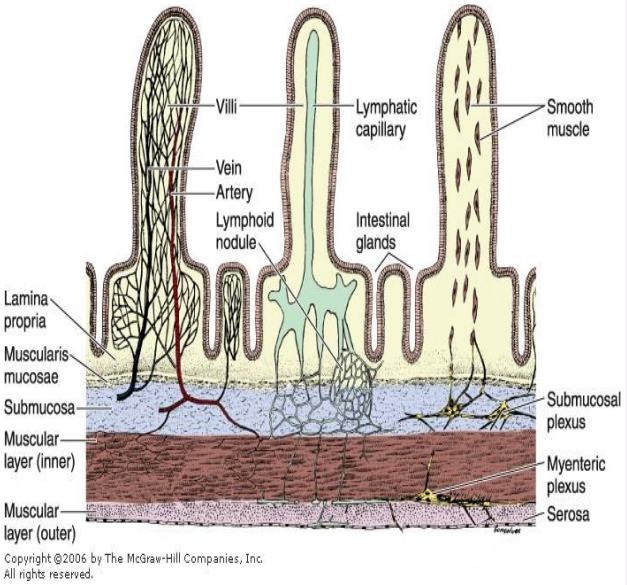
The very large mucosal surface of the gastrointestinal tract is exposed to many potentially invasive microorganisms. There are factors that influence the GI tract immunity:

- ☑ Secretory immunoglobulins of the IgA are the first line of defense
- ☑ Another protective device is the intercellular tight junctions that make the epithelial cells a barrier to the penetration of microorganisms.
- ☑ the GI tract contains antibody-secreting plasma cells, macrophages, and a very large number of lymphocytes located in both the mucosa and the submucosa.
- ☑ Finally, as we mentioned, M cells have a role in the immunity of the GI.

Vessels & Nerves

Blood Vessels

- ☑ The blood vessels that nourish the intestine and remove absorbed products of digestion penetrate the muscularis and form a large plexus in the submucosa
- ☑ branch from the superior mesenteric artery and vein, jejunal and ileal branches which form arcades and vasa recta.
- ☑ From the submucosa, branches extend through the muscularis mucosae and lamina propria and into the villi, each villus receives, according to its size, one or more branches that form a capillary network just below its epithelium .
- ☑ At the tips of the villi, one or more venules arise from these capillaries and run in the opposite direction, reaching the veins of the submucosal plexus.



lacteals

- ☑ lymphatic capillaries, larger than the blood capillaries, are difficult to observe because their walls are so close together that they appear to be collapsed.
- ☑ Lacteals run to the region of lamina propria above the muscularis mucosae, where they form a plexus. From there they are directed to the submucosa, where they surround lymphoid nodules
- ☑ Lacteals anastomose repeatedly and leave the intestine along with the blood vessels.
- ☑ They are especially important for the absorption of lipids, because blood circulation does not easily accept the lipoproteins produced by the absorptive cells during this process
- ☑ important for intestinal function is the rhythmic movement of the villi, this movement is the result of the contraction of smooth muscle cells running vertically between the muscularis mucosae and the tip of the villi, these contractions occur at the rate of several strokes per minute and have a pumping action on the villi that propels the lymph to the mesenteric lymphatics.

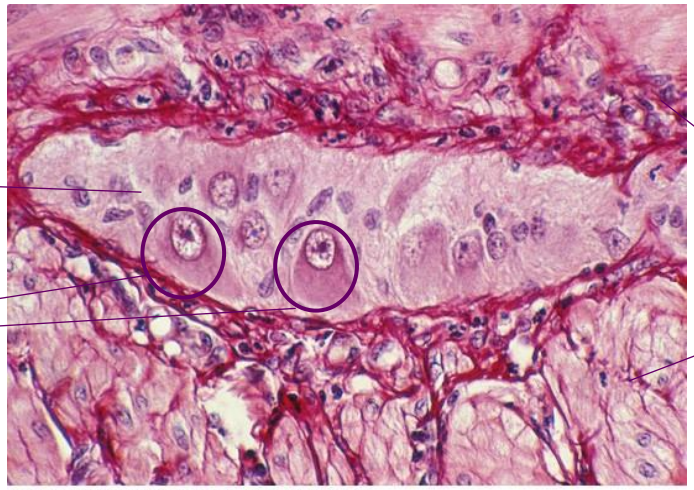
Nerves

- ☑ The innervation of the intestines is formed by both an intrinsic component and an extrinsic component
- ☑ The intrinsic component comprises groups of neurons that form the
  1. **myenteric (Auerbach's) nerve plexus** between the outer longitudinal and inner circular layers of the muscularis
  2. the submucosal (**Meissner's) plexus** in the submucosa
- ☑ The plexuses contain some sensory neurons that receive information from nerve endings near the epithelial layer and in the smooth muscle layer regarding the composition of the intestinal content (chemoreceptors) and the degree of expansion of the intestinal wall (mechanoreceptors)

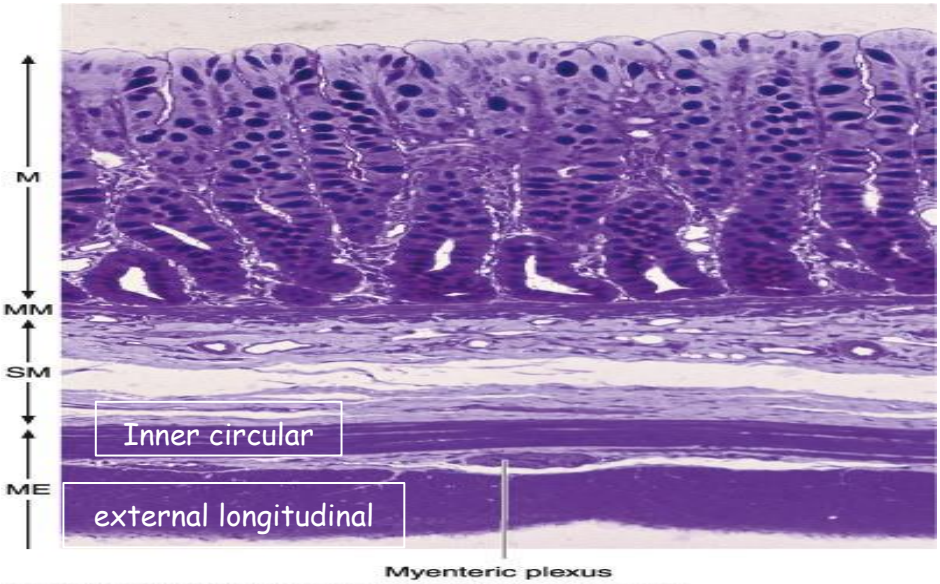
- ☑ The other nerve cells are effectors and innervate the muscle layers and hormone secreting cells
- ☑ The intrinsic innervation formed by these plexuses is responsible for the intestinal contractions that occur in the total absence of the extrinsic innervation.
- ☑ The extrinsic innervation is formed by parasympathetic cholinergic nerve fibers that stimulate the activity of the intestinal smooth muscle and by sympathetic adrenergic nerve fibers that depress intestinal smooth muscle activity.

myenteric plexus

Nerve cells



internal circular and external longitudinal smooth muscles



Thank you so much for bearing!