بسم الله الرحمن الرحيم

HISTOLOGY

MID | Lecture 2

Histology of lower GI

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﴿ وَإِن تَتَوَلَّوْا يَسْتَبْدِلْ قَوْمًا غَيْرَكُمْ ثُمَّ لَا يَكُونُوا أَمْثَالَكُم ﴾

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GI Histology 2

A quiz on the previous lecture

Esophagus

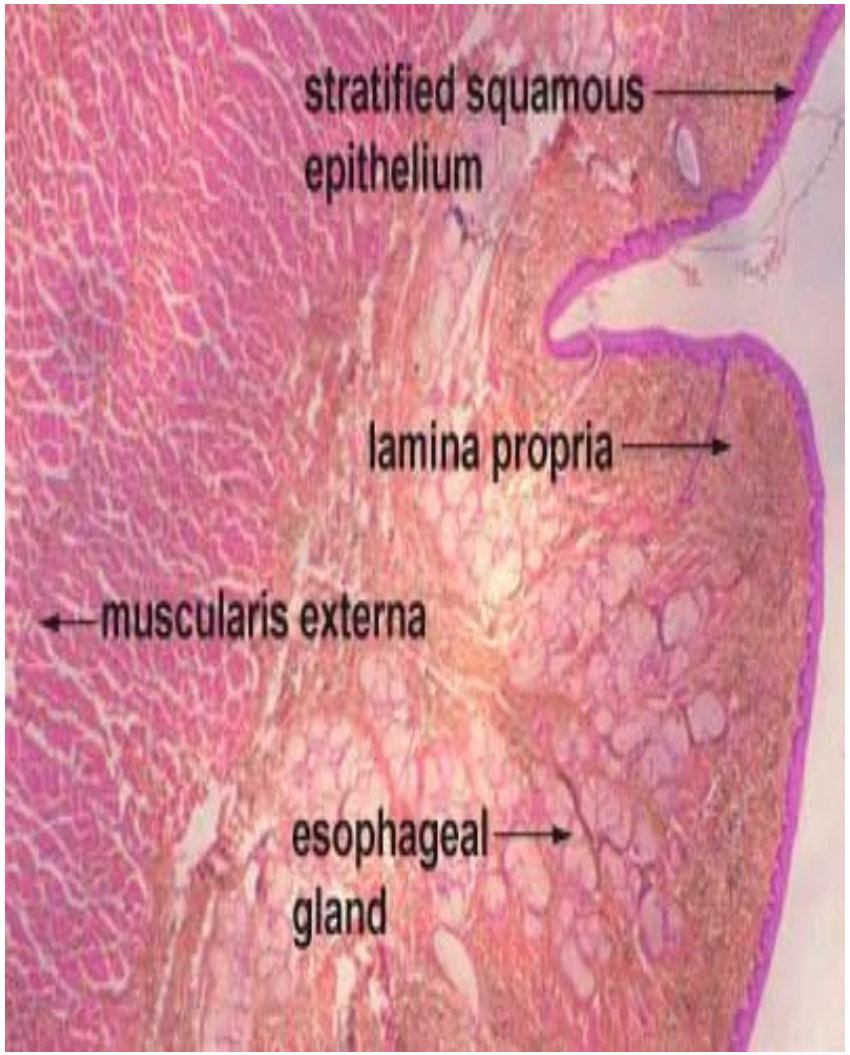
- is a muscular tube whose function is to transport foodstuffs from the mouth to the stomach and to prevent the retrograde flow of gastric contents

- It begins at the level of the sixth cervical vertebra as a continuation of the pharynx and ends at the cardia of the stomach. Its total length is 25 cm, and the distance from the incisors is 45 cm

- Transport is achieved by peristaltic contractions and Relaxation of the esophageal sphincters (upper and lower)

- Usually controlled by reflexes and by the autonomic nervous system.
- In humans the esophagus is covered by nonkeratinized stratified squamous epithelium similar to that found in the oral cavity, pharynx, and anal canal. This type of epithelium is characterized by active mitosis due to frequent exposure to injury, allowing for rapid regeneration and healing.

- it has the same layers as the rest of the digestive tract.



- In the submucosa are groups of small mucus- secreting glands, the **esophageal glands**, whose secretion facilitates the transport of foodstuffs and protects the mucosa.

- It also contains Meissner's plexus of nerves.

-(note: only the esophagus and duodenum have glands in the submucosa).

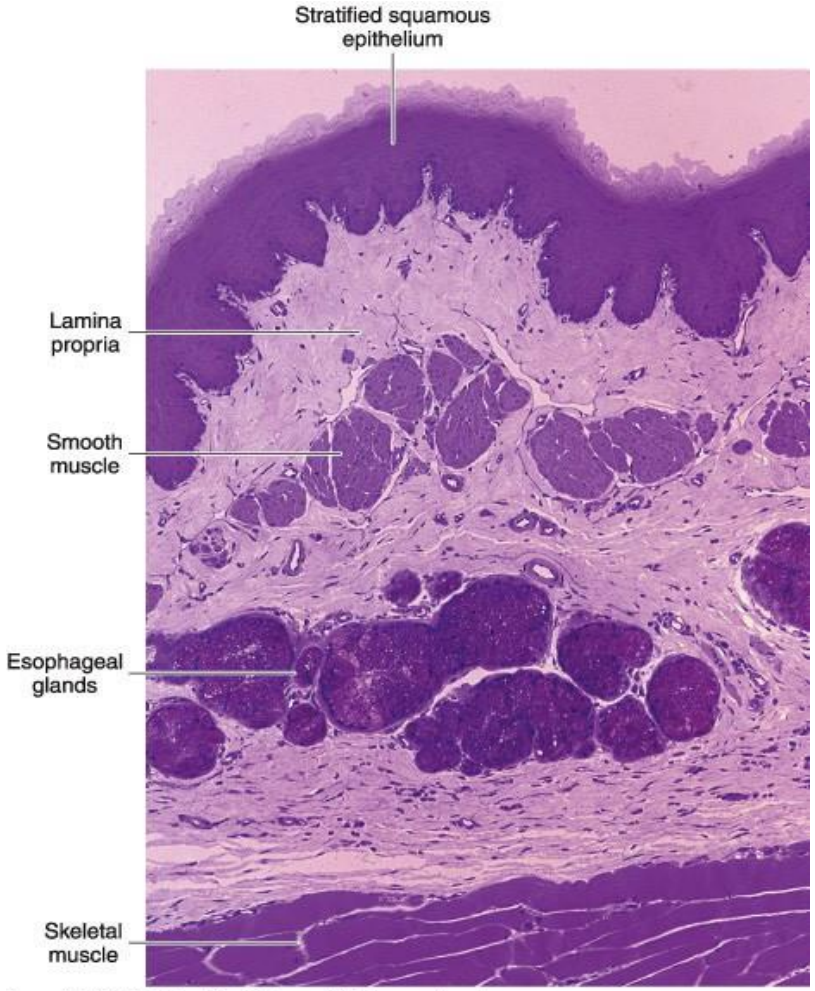
- In the lamina propria of the region near the stomach are groups of glands, the **esophageal cardiac glands**, that also secrete mucus .These glands become prominent in the lower part of the esophagus

- At the distal end of the esophagus, the muscular layer consists of only smooth muscle cells that, close to the stomach, form the lower esophageal sphincter

- in the mid portion, a mixture of striated and smooth muscle cells; and at the proximal end, only striated muscle cells.

- Only that portion of the esophagus that is in the peritoneal cavity is covered by serosa.

- The rest is covered by a layer of connective tissue, the adventitia, that blends into the surrounding tissue.



An Overview of the Esophageal Wall Layers

1. Mucosa

a.Epithelium: Stratified squamous non-keratinized (for protection and regeneration)

b.Lamina propria: Loose connective tissue with blood vessels, lymphatics, and cardiac glands (more prominent near the stomach)

c.Muscularis mucosa: Thin layer of smooth muscle (inner circular and outer longitudinal)

2. Submucosa

-Dense connective tissue

-Contains esophageal glands proper .

-Contains Meissner's plexus.

3. Muscularis externa

-Consists of inner circular and outer longitudinal muscle layers.

-Myenteric (Auerbach's) plexus between the two layers

-Muscle type changes along the esophagus:

- a.Upper third: Skeletal muscle (somatic control)
- b.Middle third: Mixed skeletal and smooth muscle
- c.Lower third: Smooth muscle (autonomic control)

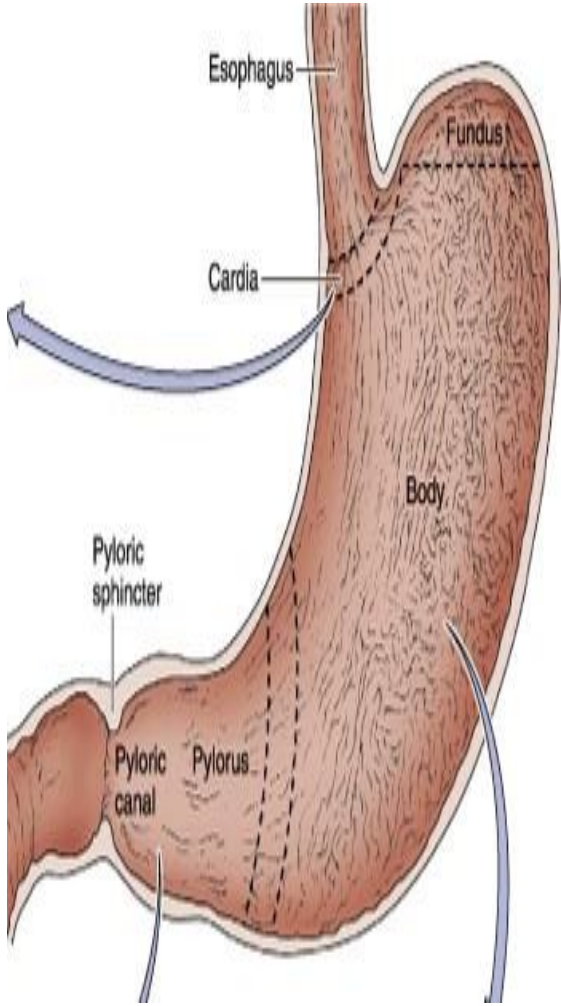
4. Adventitia or Serosa

Adventitia: Covers the esophagus in the neck and thorax

Serosa: Covers the short abdominal segment below the diaphragm (about 1.3 cm)

Stomach

- The stomach, like the small intestine, is a mixed exocrine–endocrine organ that digests food and secretes hormones.
- main functions are to continue the digestion of carbohydrates initiated in the mouth, add an acidic fluid to the ingested food, transform it by muscular activity into a viscous mass / semi-fluid mass **(chyme)**
- The chyme remains in the stomach for about 2 to 4 hours before being gradually released into the intestine through the pyloric sphincter.
- and promote the initial digestion of proteins with the enzyme **pepsin**
- It also produces a gastric lipase that digests triglycerides with the help of lingual lipase.
- Gross inspection reveals four regions: The stomach begins with a physiological sphincter called the **cardia,** followed by the **fundus, body, pylorus** and the **incisura angularis,** which serves as a boundary between the body and the pylorus.
- the fundus and body are identical in microscopic structure
- The mucosa and submucosa of the undistended stomach lie in longitudinally directed folds known as **rugae**. When the stomach is filled with food, these folds flatten out.



An Overview of the Structural Layers of the Stomach Wall

1-Mucosa:

a.Lining epithelium: simple columnar epithelium without goblet cells.

b.lamina propria: loose connective tissue containing gastric glands.

c. Muscularis Mucosa: This is a thin layer of smooth muscle located beneath the lamina propria.

2. Submucosa: The submucosa is made of dense connective tissue and contains blood vessels, lymphatic vessels, and the Meissner's nerve plexus (a part of the enteric nervous system).

3. Muscularis Externa:

- The muscularis externa of the stomach is composed of three layers of smooth muscle:

a. Outer **longitudinal** layer

b. Middle **circular** layer

c. Innermost **oblique** layer: This third layer is unique to the stomach and is present throughout the gastric wall except in the pyloric canal and pyloric sphincter, where it is absent. In these regions, the inner circular smooth muscle is responsible for forming the pyloric sphincter.

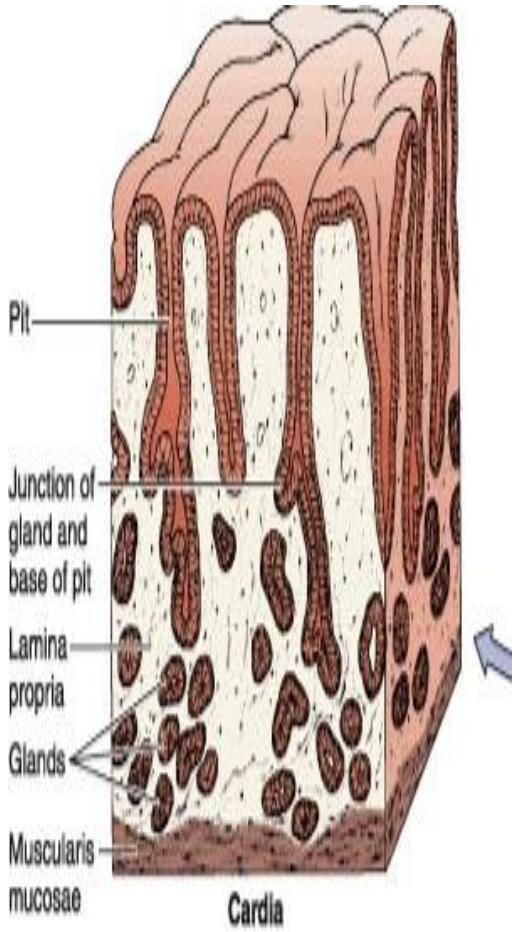
- The sympathetic nervous system stimulates contraction of the sphincter.

When the sympathetic influence is inhibited, the parasympathetic system becomes dominant, leading to increased peristaltic activity and facilitation of chyme drainage from the stomach into the duodenum.

4. Serosa

Mucosa

- The gastric mucosa consists of a **surface epithelium** that invaginates to various extents into the lamina propria, forming **gastric pits (can be seen by the magnifying glass).**
- Emptying into the gastric pits are branched, tubular glands (cardiac, gastric, and pyloric) characteristic of each region of the stomach.
- The **lamina propria** of the stomach is composed of loose connective tissue interspersed with smooth muscle and lymphoid cells.
- Separating the mucosa from the underlying submucosa is a layer of smooth muscle, the **muscularis mucosae.**
- numerous small circular or ovoid invaginations of the epithelial lining are observed. These are the openings of the gastric pits
- Depending on the plane of histological section, gastric glands can appear circular, oblique, or coiled. Sometimes the glandular duct is visible and referred to as a **gastric pit.**
- The epithelium covering the surface and lining the pits is a simple columnar epithelium without goblet cells, and all the cells secrete an alkaline mucus (the lining epithelium is the major source of this secretion)



- This mucus consists primarily of water (95%), lipids, and glycoproteins, which, in combination, form a hydrophobic protective gel

- The structure of this mucosal layer reflects its protective function. In contrast, the structure of the small intestine is adapted for absorption, which explains the differences in epithelial features between the stomach and small intestine.

- Bicarbonate, secreted by the surface epithelial cells into the mucous gel, forms a pH gradient ranging from 1 at the gastric luminal surface to 7 along the epithelial cell surface

- Surface epithelial cells also form an important line of defense due to their function in mucus production, intracellular tight junctions, and the ionic transporters that maintain intracellular pH and bicarbonate production, important for gel alkalinization.

Variation across stomach regions:

• The cardia, body, and pylorus of the stomach each show distinct gland-to-pit ratios:

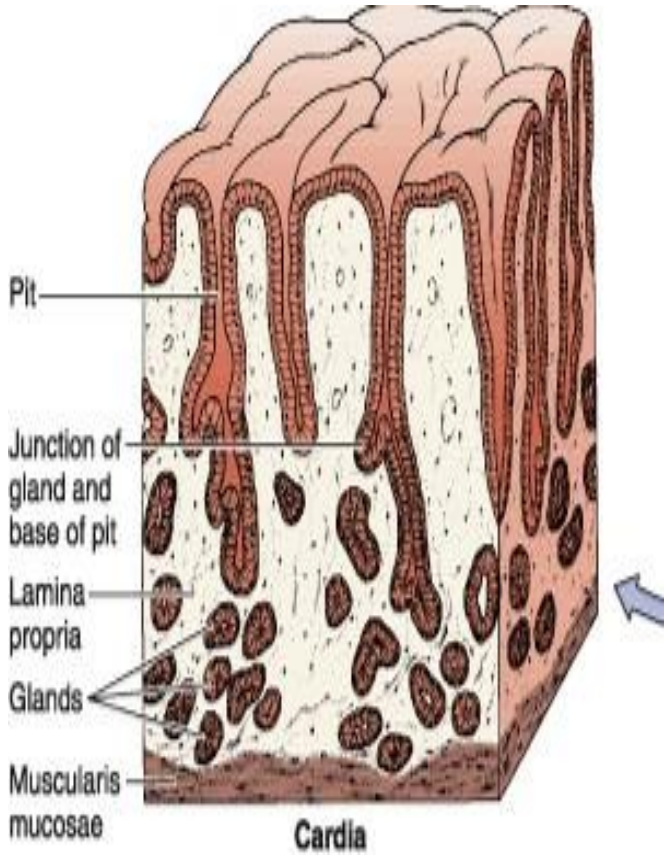
1-In the cardia, the thickness of the glands and pits is nearly equal.

2-In the body, the glands occupy about 3/5 of the mucosal thickness, while the pits make up 2/5. The pits appear wide and short, reflecting the body's primary role in digestion, which requires abundant glandular secretion.

3-In contrast, **the pylorus** does not play a major role in digestion like the body. Therefore, the glandular portion is shorter, and the pits are long and narrow.

Cardia

- The cardia is a narrow circular band, 1.5–3 cm in width, at the transition between the esophagus and the stomach
- Its mucosa contains simple or branched tubular cardiac glands
- The terminal portions of these glands are frequently coiled, often with large lumens.
- The thickness of the gastric pit and gland are equal
- Most of the secretory cells produce mucus and lysozyme (an enzyme that attacks bacterial walls), but a few parietal cells secreting H+ and Cl– (which will form HCl in the lumen) can be found
- These glands are similar in structure to the cardiac glands of the terminal portion of the esophagus.
- The glandular epithelium is simple columnar without goblet cells, similar to the surface epithelial lining.



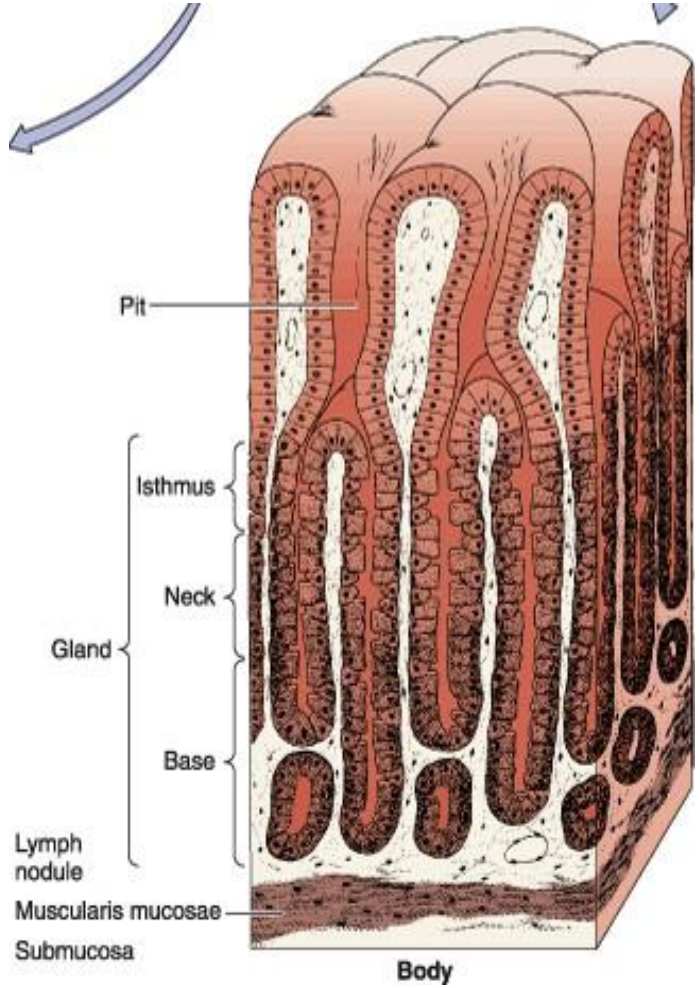
The following cell types are found in the cardia:

- **Mucous** glands and mucous cells
- **Enteroendocrine cells**: secrete gastrin
- **Parietal cells** : secrete HCl
- **Chief cells** : secrete pepsinogen
- **Stem cells** :precursors for other cells, responsible for mitosis

- All cell types are present in the cardia, but parietal and chief cells are fewer compared to their abundance in the body of the stomach.

Fundus & Body

- The lamina propria of the fundus and body is filled with branched, tubular **gastric (fundic) glands**, three to seven of which open into the bottom of each gastric pit
- Each gastric gland has three distinct regions: the isthmus, neck, and base
- The distribution of epithelial cells in gastric glands is not uniform (see the next slide then continue reading)
- The isthmus, close to the gastric pit, contains differentiating mucous cells that will migrate and replace superficial mucous cells, undifferentiated **stem cells**, and **oxyntic (parietal) cells**
- the **neck** of the glands consists of stem, mucous neck (different from the mucous cells in the isthmus,Also, they are present throughout the gland but most numerous in the neck), and parietal cells
- the **base** of the glands primarily contains parietal and chief (zymogenic) cells
- Enteroendocrine cells are dispersed in the neck and base of the glands.



Fundus & Body

- The distribution of epithelial cells in gastric glands is not uniform

- **Distribution of cells within the gland:**

-Mucous cells:

Present throughout the gland but most numerous in the neck.

-Chief cells and enteroendocrine cells:

Located in the base.

-Parietal cells:

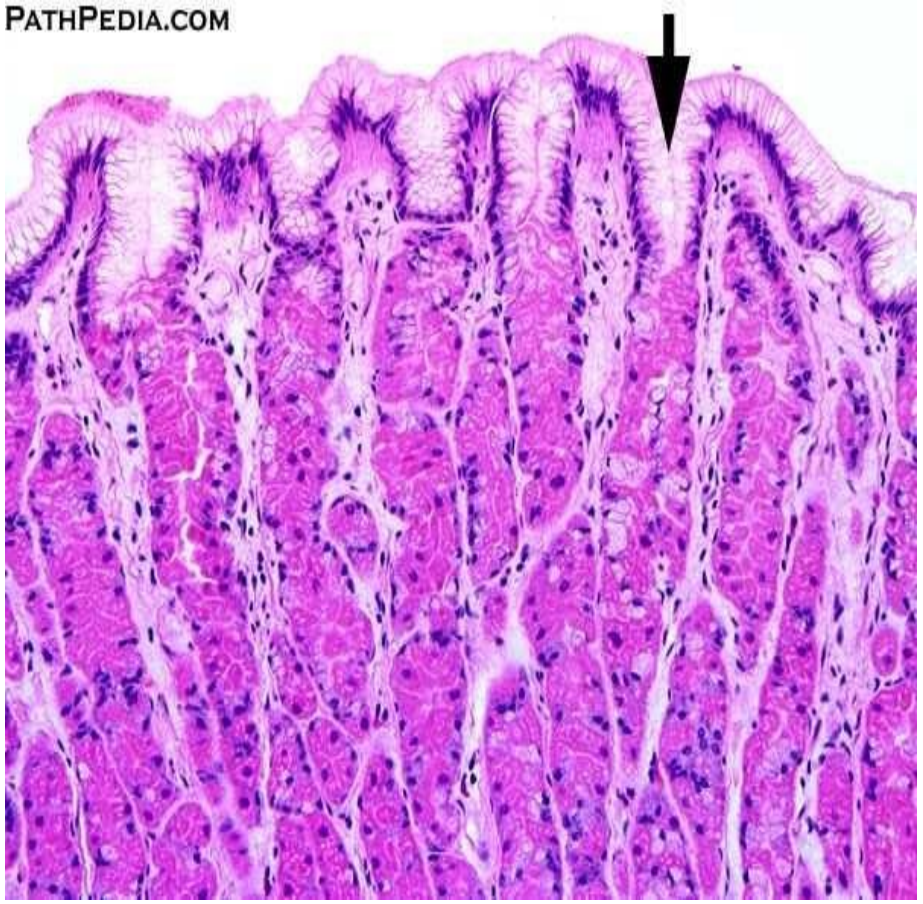
Concentrated in the neck and upper part of the body.

- Stem cells:

Located in the middle, so that when mitosis occurs, the new cells can migrate upward or downward to replace damaged cells.

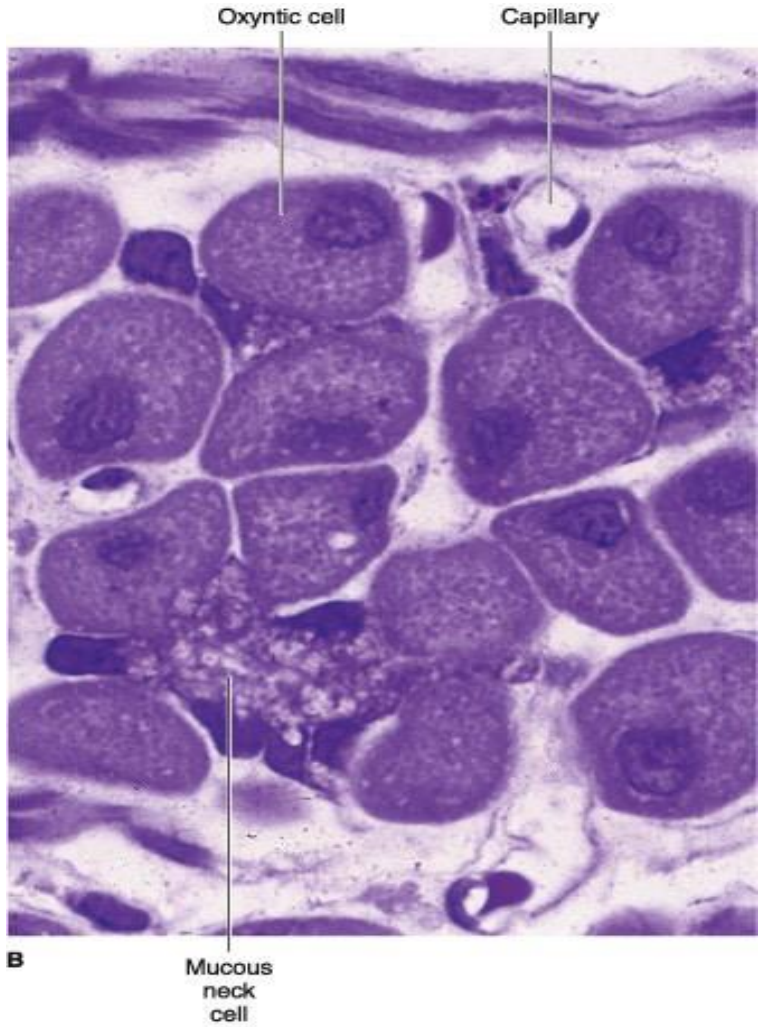
Stem Cells

- Found in the isthmus and neck regions but few in number, stem cells are low columnar cells with oval nuclei near the bases of the cells
- These cells have a high rate of mitosis; some of them move upward to replace the pit and surface mucous cells, which have a turnover time of 4–7 days
- Other daughter cells migrate more deeply into the glands and differentiate into mucous neck cells and parietal, chief, and enteroendocrine cells



Mucous Neck Cells

- Mucous neck cells are present in clusters or as single cells between parietal cells in the necks of gastric glands
- Their mucus secretion is quite different from that of the surface epithelial mucous cells
- They are irregular in shape, with the nucleus at the base of the cell and the secretory granules near the apical surface.
- Have a foamy appearance due to mucous dissolution during slide preparation.



Oxyntic (Parietal) Cells

- Parietal cells are present mainly in the upper half of gastric glands; they are scarce in the base

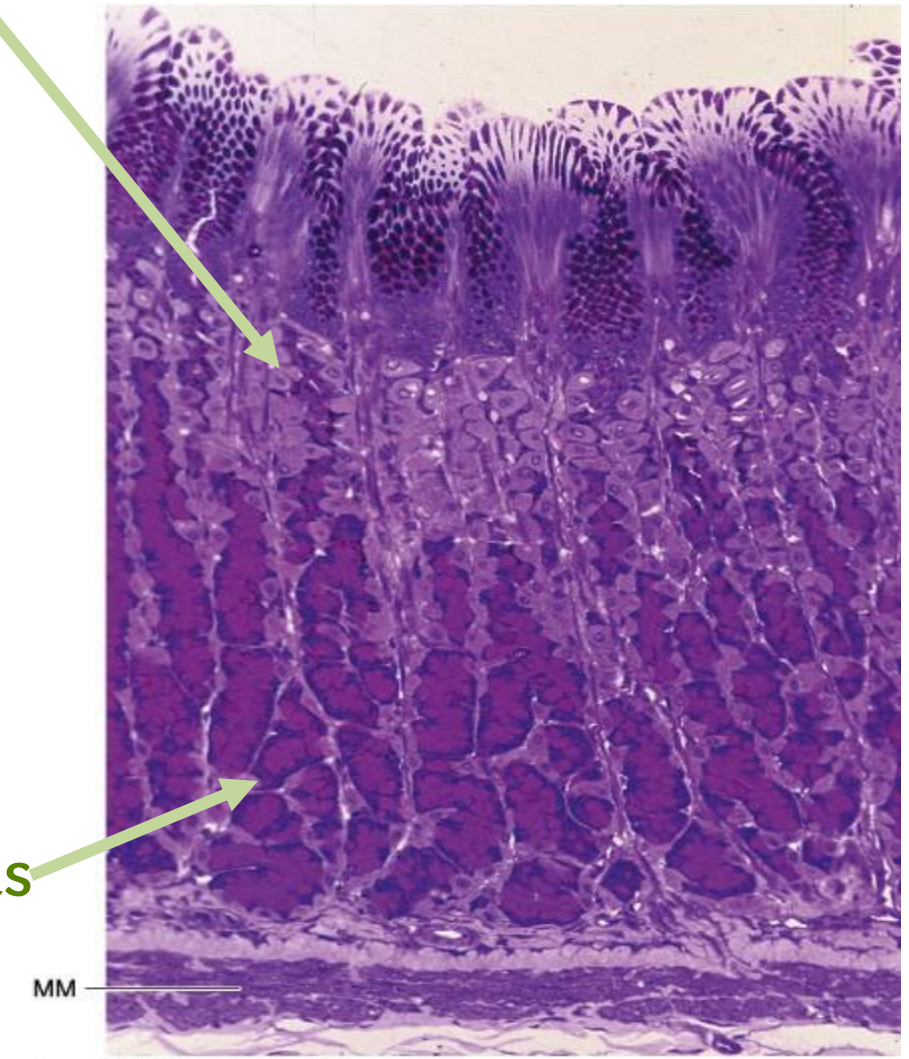
- They are rounded or pyramidal cells, with one centrally placed spherical nucleus and intensely **eosinophilic cytoplasm**

Or it could even binucleated

- The most striking features of the active secreting cell seen in the electron microscope are an abundance of mitochondria and a deep, circular invagination of the apical plasma membrane, forming the **intracellular canaliculus**

- In the resting cell, a number of tubulovesicular structures can be seen in the apical region just below the plasmalemma , At this stage, the cell has few microvilli

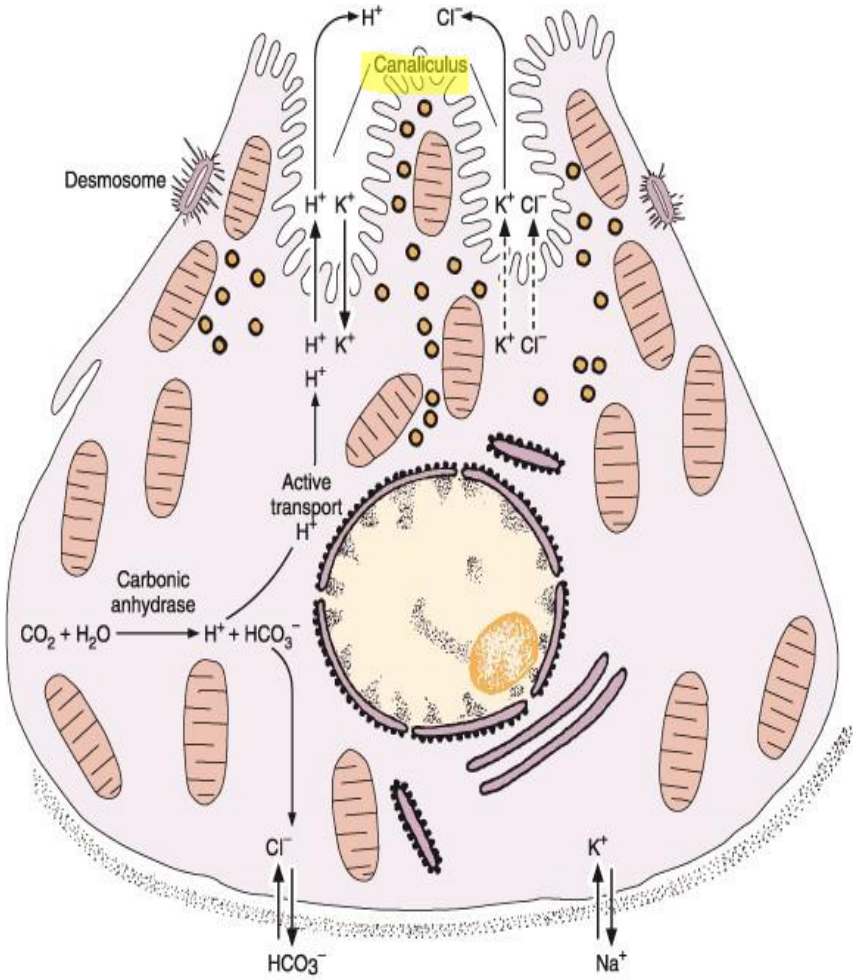
- When stimulated to produce H+ and Cl−, tubulovesicles fuse with the cell membrane to form the canaliculus and more microvilli, thus providing a generous increase in the surface of the cell membrane



- Parietal cells secrete hydrochloric acid

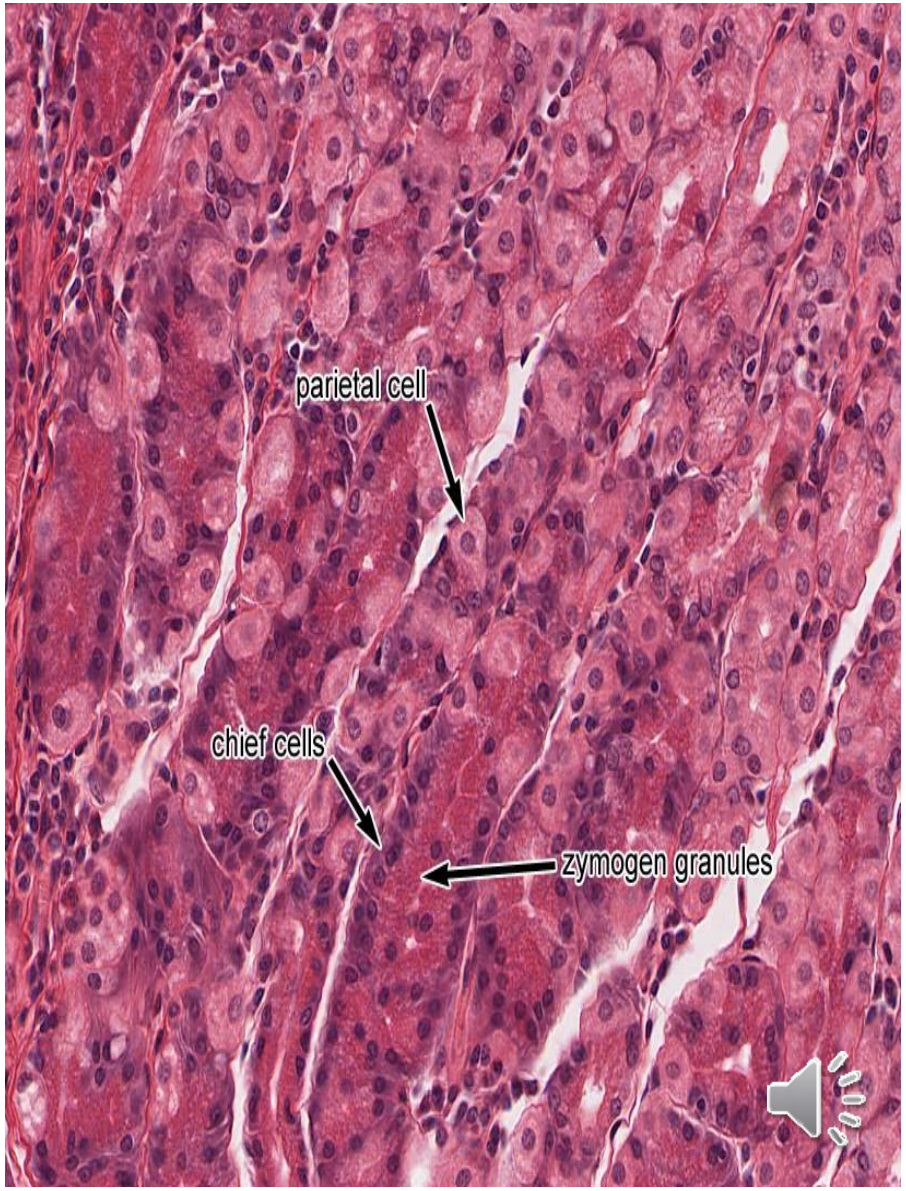
This is the biochemistry of HCl formation
The canaliculi indicate the active stage, during which the formation of HCl occurs

- The ion H+ originates from the dissociation of the H2CO3 produced by the action of carbonic anhydrase, an enzyme abundant in oxyntic cells
- Once produced, H2CO3 dissociates in the cytoplasm into H+ and HCO32
- The active cell also secretes K+ and Cl− in the canaliculus; the K+ is exchanged for H+ by the action of the H+/K+ pump, while the Cl− forms HCl.
- The presence of abundant mitochondria in the parietal cells indicates that their metabolic processes, particularly the pumping of H+/K+, are highly energy consuming
- The secretory activity of parietal cells is initiated by various mechanisms. One mechanism is through the cholinergic nerve endings (parasympathetic stimulation).
- Histamine and a polypeptide called gastrin, both secreted in the gastric mucosa, act strongly to stimulate the production of hydrochloric acid
- Gastrin also has a trophic effect on the gastric mucosa stimulating growth



Chief (Zymogenic) Cells

- Chief cells predominate in the lower region of the tubular glands
- characteristics of protein-synthesizing and - exporting cells
- Their basophilia is due to the abundant rough endoplasmic reticulum. The granules in their cytoplasm contain the inactive enzyme **pepsinogen**
- The precursor pepsinogen is rapidly converted into the highly active proteolytic enzyme **pepsin** after being released into the acid environment of the stomach
- There are seven different pepsins in the human gastric juice, which are aspartate endoproteinases of relatively broad specificity active at pH <5
- In humans, chief cells also produce the enzyme **lipase**.



Parietal (Oxyntic) Cells vs. Chief Cells:

Histological appearance:

- Parietal cells are **acidophilic**, appearing faint under the microscope.
- Chief cells are **basophilic**, appearing dark.

Parietal cells:

- Have a central nucleus, and may sometimes be binucleated.
- Function: Secrete hydrochloric acid (HCl).
- Exist in two stages:

1. Active stage:

-Involved in the formation of HCl.

-Characterized by the presence of intracellular canaliculi indicates active secretion.

2. Resting stage:

Contains tubulovesicular structures (clear vesicles).

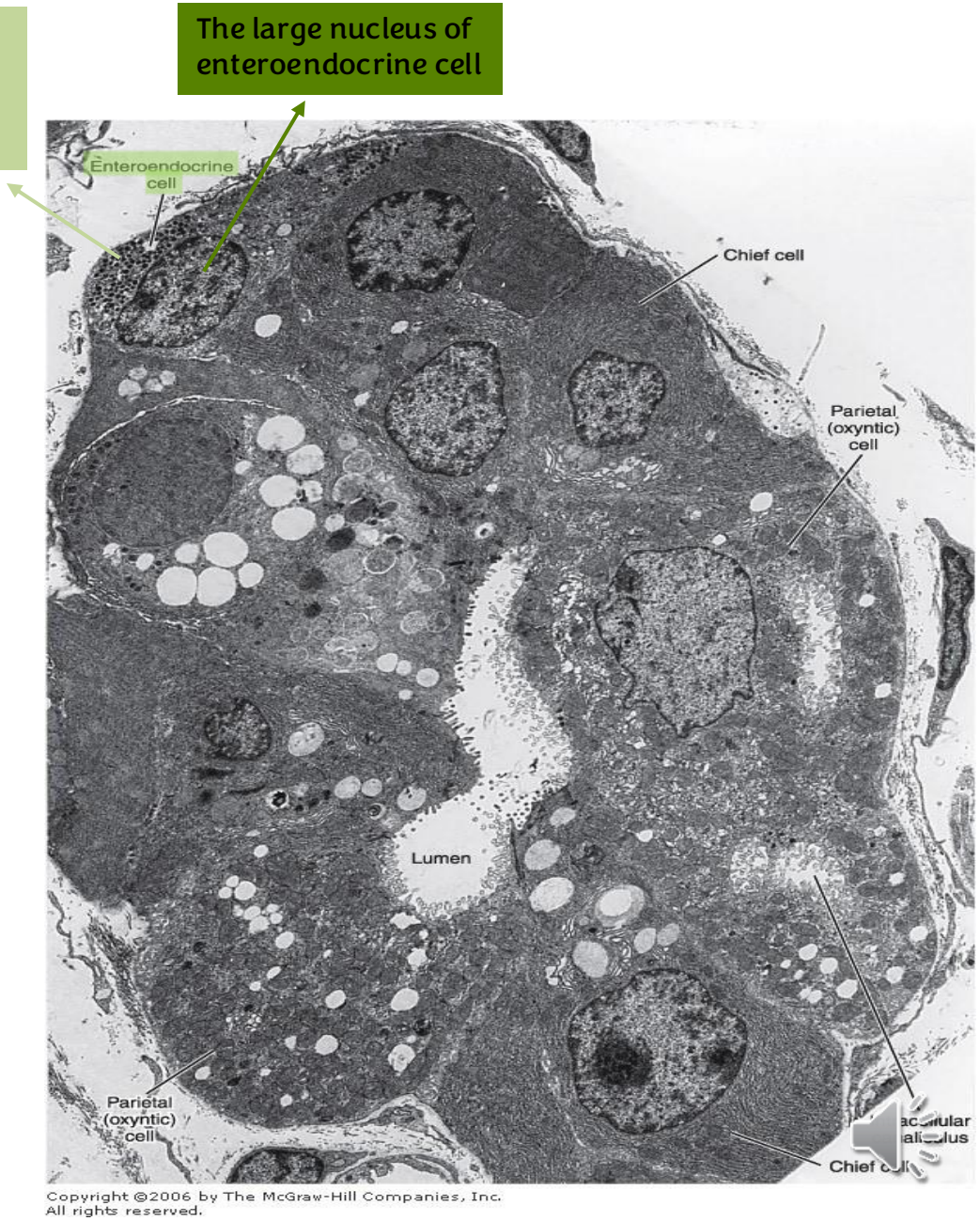
These vesicles are usually found in the apical region.

Chief cells:

- Located in the basal part of the gland.
- Dark in color.
- Function: Secrete pepsinogen.

Enteroendocrine Cells

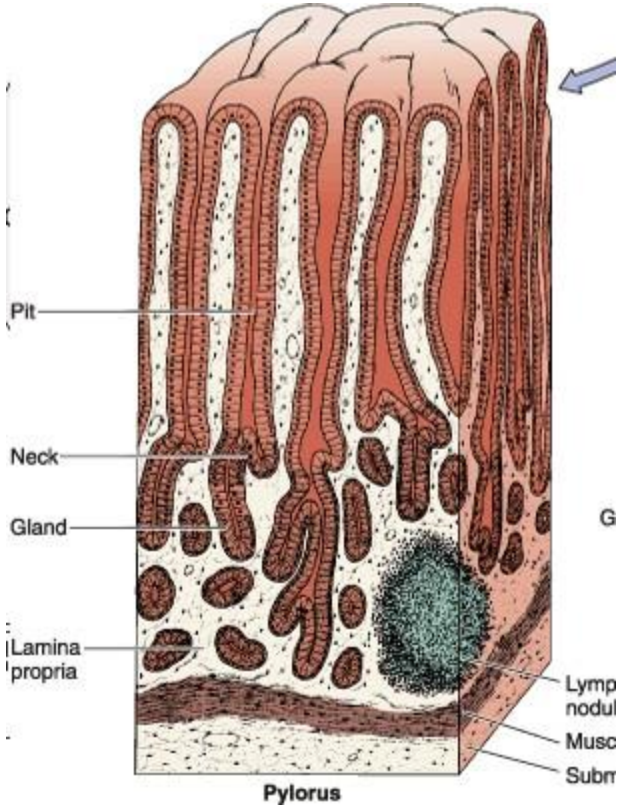
- are found in the neck and bases of gastric glands
- In the fundus of the stomach, **5-hydroxytryptamine (serotonin) is one of the principal secretory products**
- In the stomach the G—pylorus cells produces **Gastrin hormone** that lead to the Stimulation of gastric acid secretion and Gastric mucosal growth



Pylorus

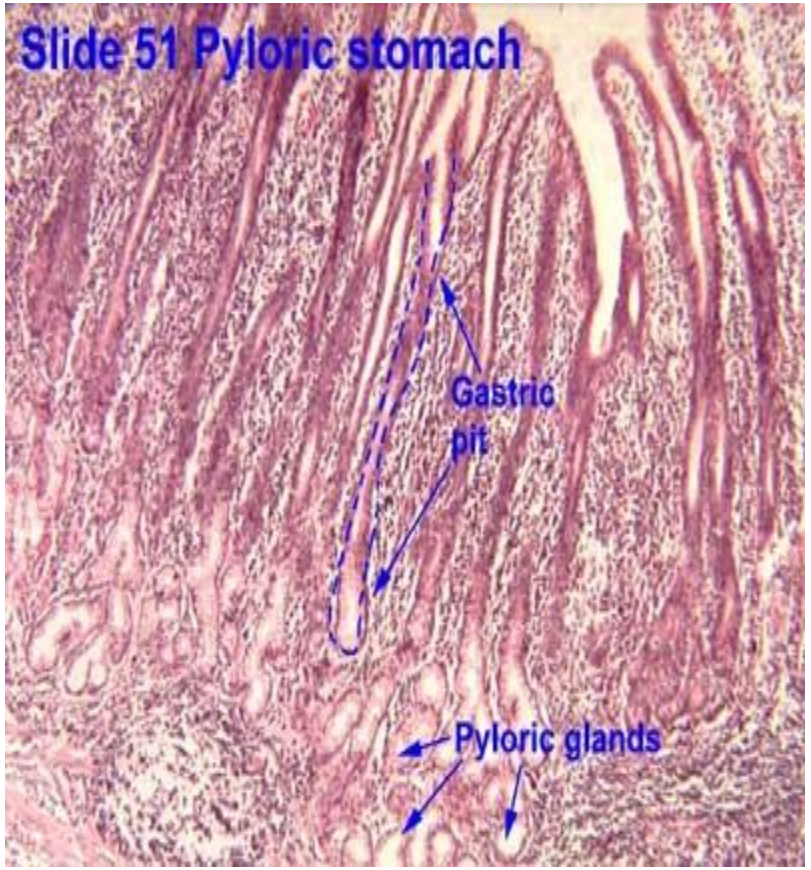
While lymphocytes are normally scattered diffusely throughout the gastrointestinal tract (GIT), they aggregate into distinct *lymphatic nodules* in the pyloric region, specifically within the lamina propria.

- Pylorus: includes antrum, pyloric canal, and pyloric sphincter.
- has deep gastric pits into which the branched, tubular **pyloric glands** open.
- Compared with the glands in the cardiac region, pyloric glands have longer pits and shorter coiled secretory portions
- At these glands, there are no chief cells and no parietal cells , most of cells are mucus cells; which is important in neutralisation of the acidity of chyme, before it goes to the duodenum.
- These glands secrete mucus as well as appreciable amounts of the enzyme lysozyme
- **Gastrin (G) cells** (which release **gastrin**) are enteroendocrine cells intercalated among the mucous cells of pyloric glands



- Parasympathetic stimulation, the presence of nutrients such as amino acids and amines in the stomach, and distention of the stomach wall directly stimulates the G cell to release gastrin,
- Which in turn activates the parietal cell, increasing acid secretion
- Other enters endocrine cells (**D cells**) secrete **somatostatin**, which inhibits the release of some other hormones, including gastrin
- Secretion of somatostatin is stimulated by HCl counterbalancing the acid secretion

Innervations:- **Myenteric plexus & Meissner's plexus** supplying glands and smooth muscles



Gastric pit => very long
Gland => short, seen in lamina propria

Other layers

Cells of gastric glands :- (from top to base)

1. Mucus Neck Cells
Location: Neck region (upper part of gland).

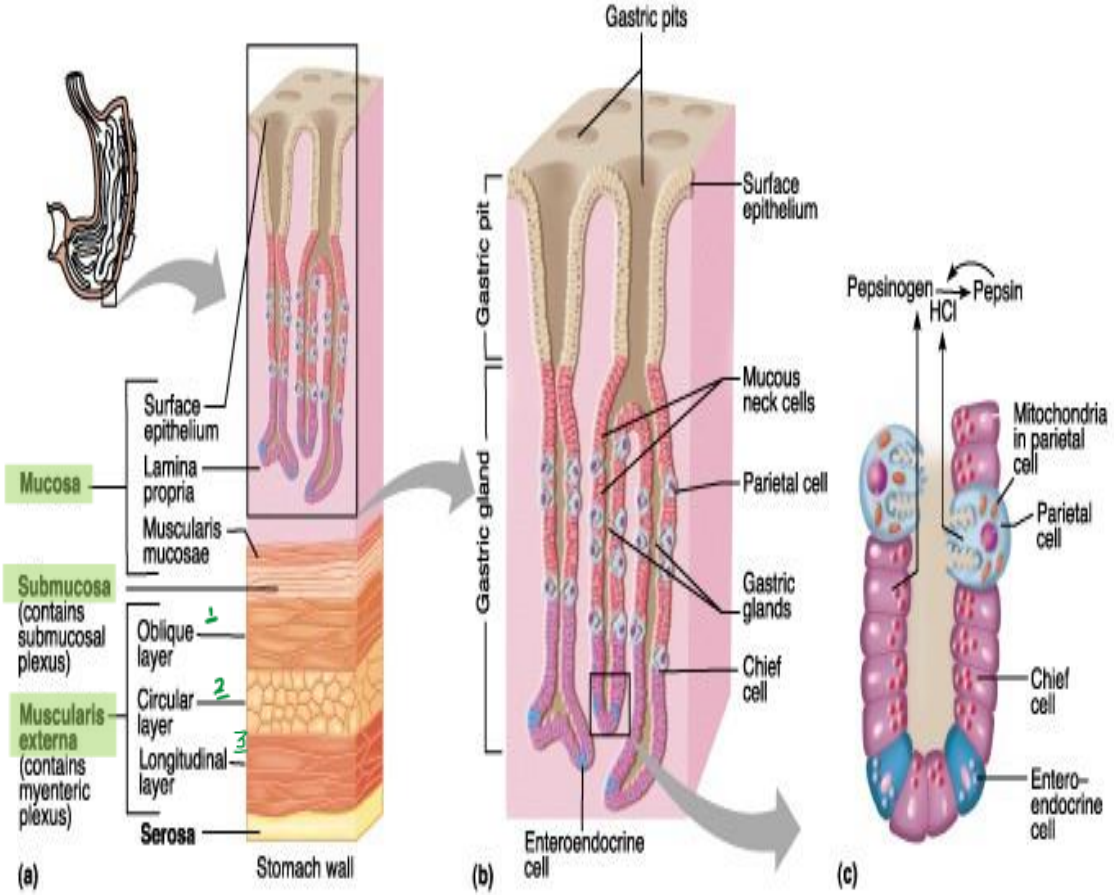
2. Parietal (Oxyntic) Cells
Location: Neck + body

3. Chief (Zymogenic) Cells
Location: Base of the gland.

4. Enteroendocrine Cells
Location: Mostly in the base.

5. Stem Cells
Location: Middle region (progenitor zone).
Replace all other cells (upward → surface mucus cells; downward → gland cells).

- The **submucosa** is composed of dense connective tissue containing blood and lymph vessels; it is infiltrated by lymphoid cells, macrophages, and mast cells.
- The **muscularis** is composed of smooth muscle fibers oriented in three main directions.
- The external layer is longitudinal, the middle layer is circular, and the internal layer is oblique
- At the pylorus, the middle layer is greatly thickened to form the **pyloric sphincter.**
- The stomach is covered by a thin **serosa**.



Small Intestine

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

- processes of digestion are completed in the small intestine, where the nutrients (products of digestion) are absorbed by cells of the epithelial lining

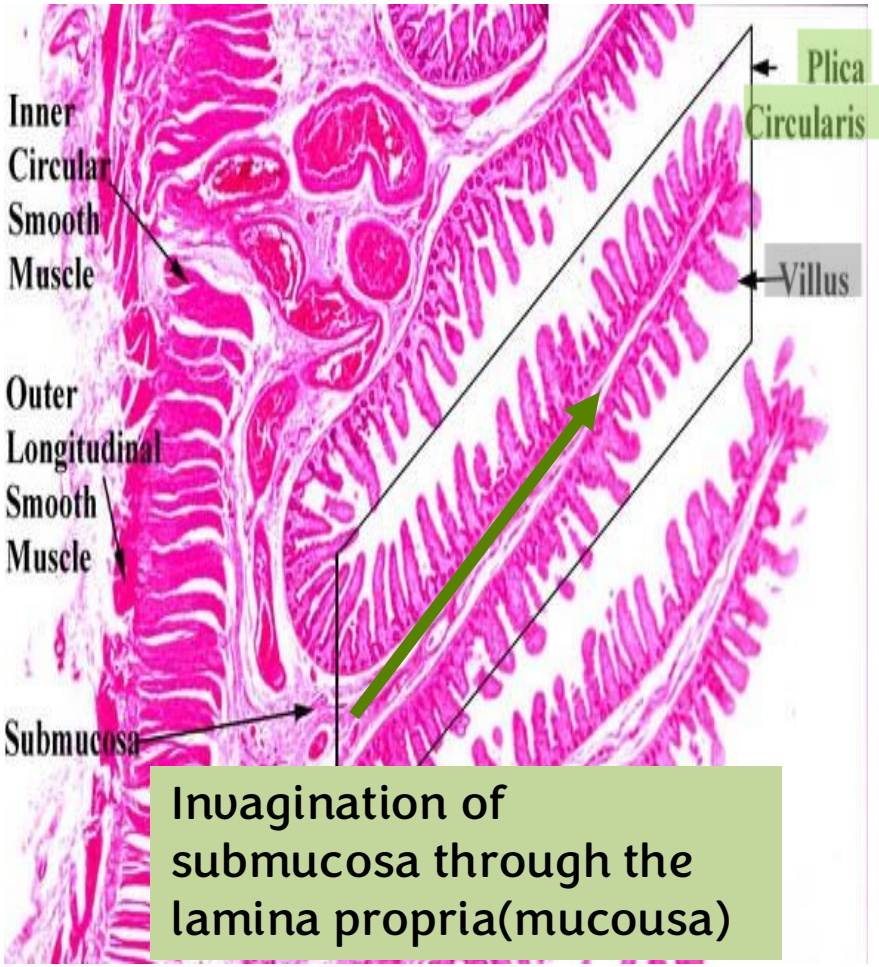
- The small intestine is relatively long—approximately 5 m—and consists of three segments: the **duodenum, jejunum,** and **ileum.**

Generally, in small intestine the lining epithelium is simple columnar epithelium with goblet cells
Once we go distally, # of goblet cells increases

Mucous Membrane

- the lining of the small intestine shows a series of permanent folds, **plicae circulares (Kerckring's valves),**
- consisting of mucosa and submucosa and having a semilunar, circular, or spiral form
- The plicae 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.
- **Intestinal villi** 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

Finger-like projections, on the lateral side of plica circularis



Structural Features of the Small Intestine

1. Intestinal Villi

- **General Structure**: Finger-like projections that **increase absorptive surface area**.
- **Regional Variations**:
  - **Duodenum**: Broad, **leaf-like villi**(projection).
  - **Jejunum & Ileum**: **finger-like villi** .

2. Microvilli (Brush Border)

- absorptive cells
- **Most prominent in duodenum** (maximal absorption).
- Also present in **jejunum and ileum**, but gradually decrease in density.

3. Jejunum-Specific Feature: Plicae Circulares

- **Structure**: Permanent **folds** of **submucosa + mucosa** (not muscularis mucosae).
- **Function**: Further increase surface area (like gastric rugae but more pronounced).

4. Ileum-Specific Feature: Peyer's Patches

- **Structure**: **Aggregated lymphoid nodules** in the **lamina propria**

- Between the villi are small openings of simple tubular glands called **intestinal glands** (also called **crypts**), or **glands of Lieberkühn**

- The type of epithelium is simple columnar with goblet cells

- The epithelium of the villi is continuous with that of the glands
- The intestinal glands contain stem cells, some absorptive cells, goblet cells, Paneth's cells, enteroendocrine cells and mucus cells.

- There are no parietal and chief cells here

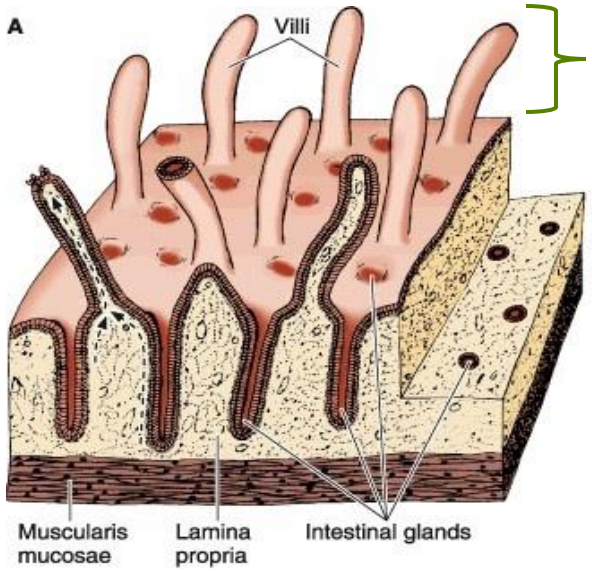
- At the base, there's a type of cells called Paneth's cells, which are found in intestinal crypts , but not found on stomach

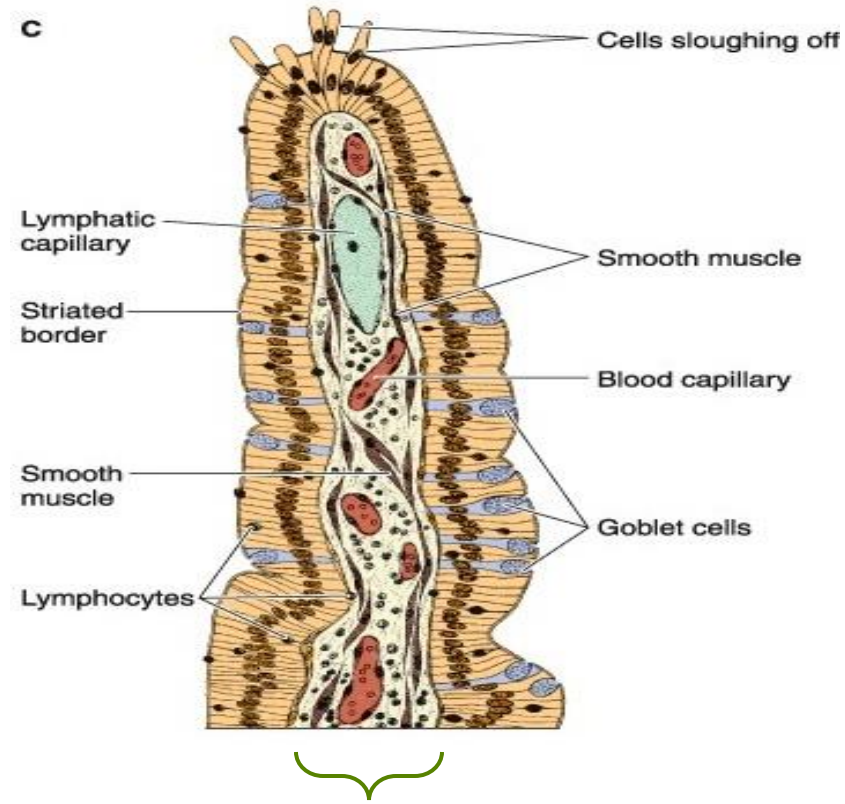
Mucus cells are totally different from those found in stomach
- In stomach => the main function is protection
- in intestines => they help in absorption

The upper half of the mucosa of small intestine

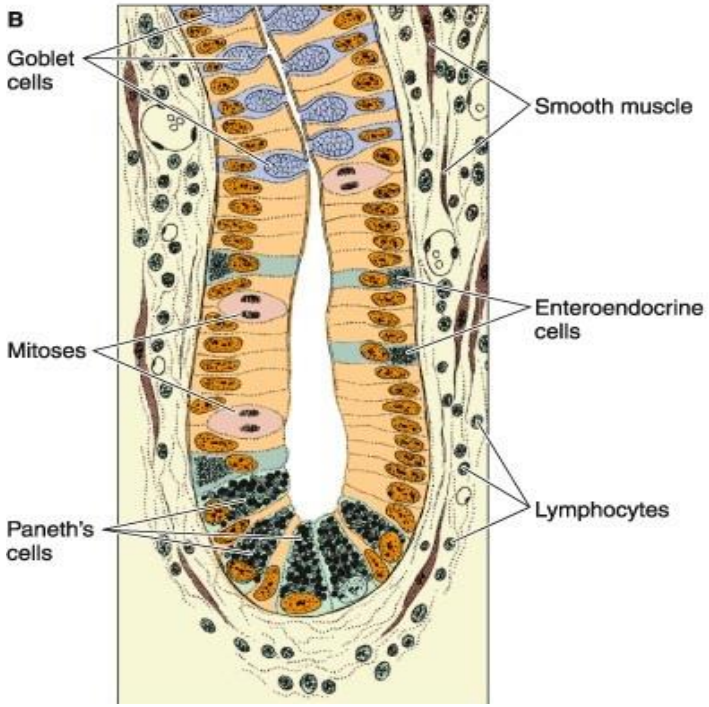
The upper half of the mucosa of small intestine => Villus:- finger-like projection
The lining epithelium is simple columnar with goblet cells

The lower half of the of small intestine





The lower half of the mucosa of small intestine
=> The gland

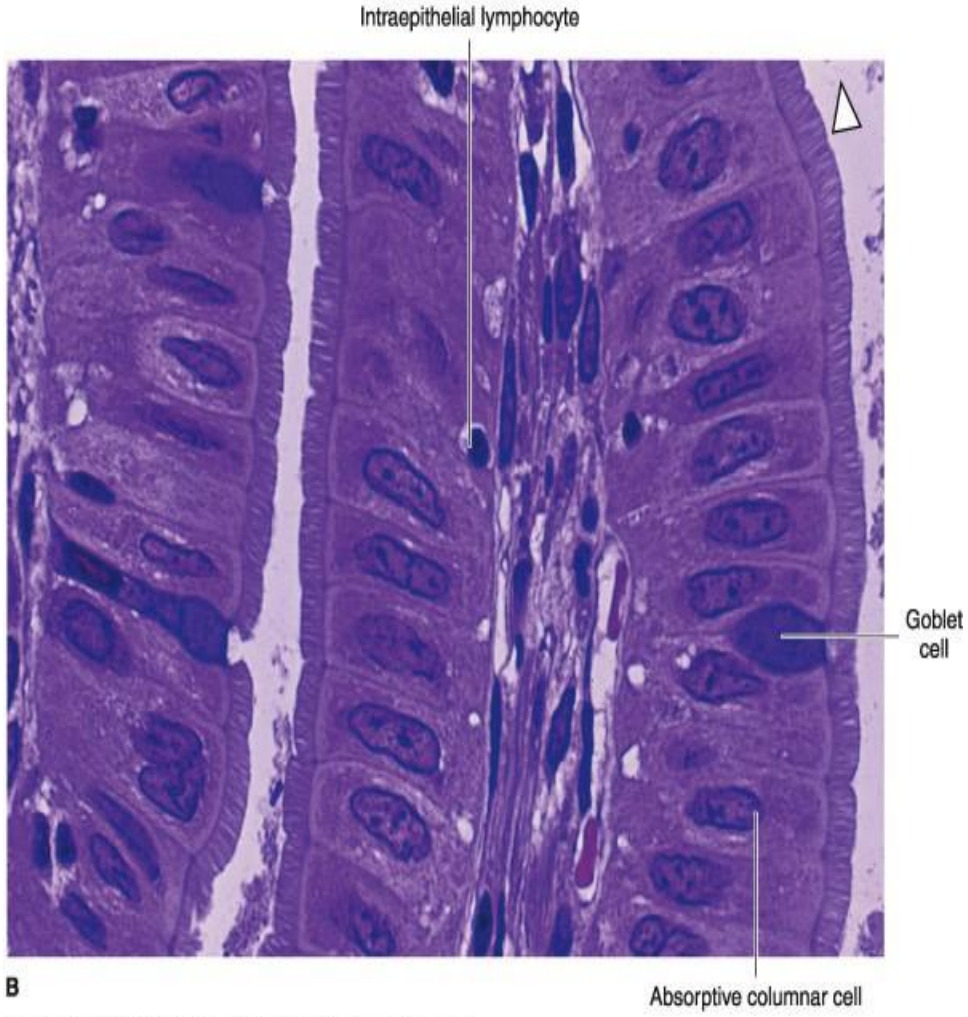


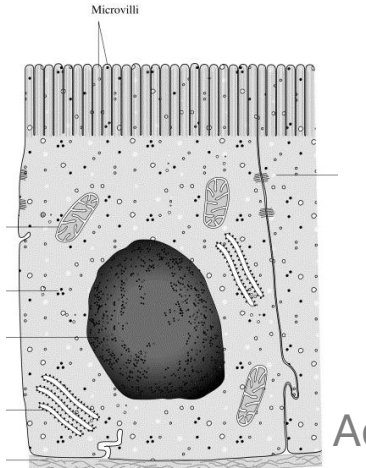
What do we see in glands?
- Smooth muscle in the wall
- Goblet cells(as the lining of it is simple columnar epithelium with goblet cells)
- Paneth's cells at the base, which secrete lysozyme enzymes {which is antibacterial}

Those paneth's cells are prominent jejenum
- Stem cells doing mitosis
- Enteroendocrine cells secreting gastric hormone

Lamina propria contains:- smooth muscle, capillaries (veins & arteries) and lacteal [a blind lymphatic vessel, important in absorption of fat]
Also, because lamina propria is a loose connective tissue, we could see fibroblasts , fibrocytes, immune cells (such as macrophages, plasma cells, lymphocytes and mast cells)

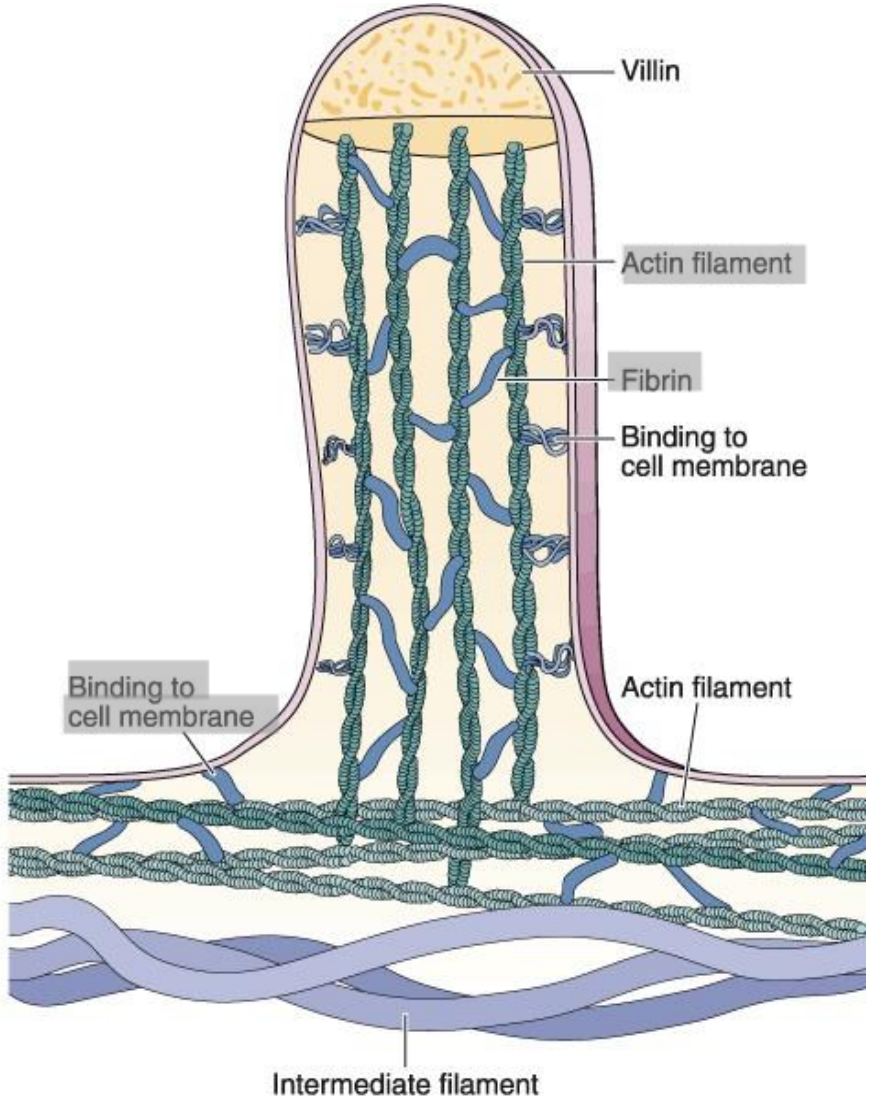
- **Absorptive cells** or **enterocytes** are tall columnar cells, each with an oval nucleus in the basal half of the cell
- At the apex of each cell is a homogeneous layer called the **striated (brush) border**
- When viewed with the electron microscope, the striated border is seen to be a layer of 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



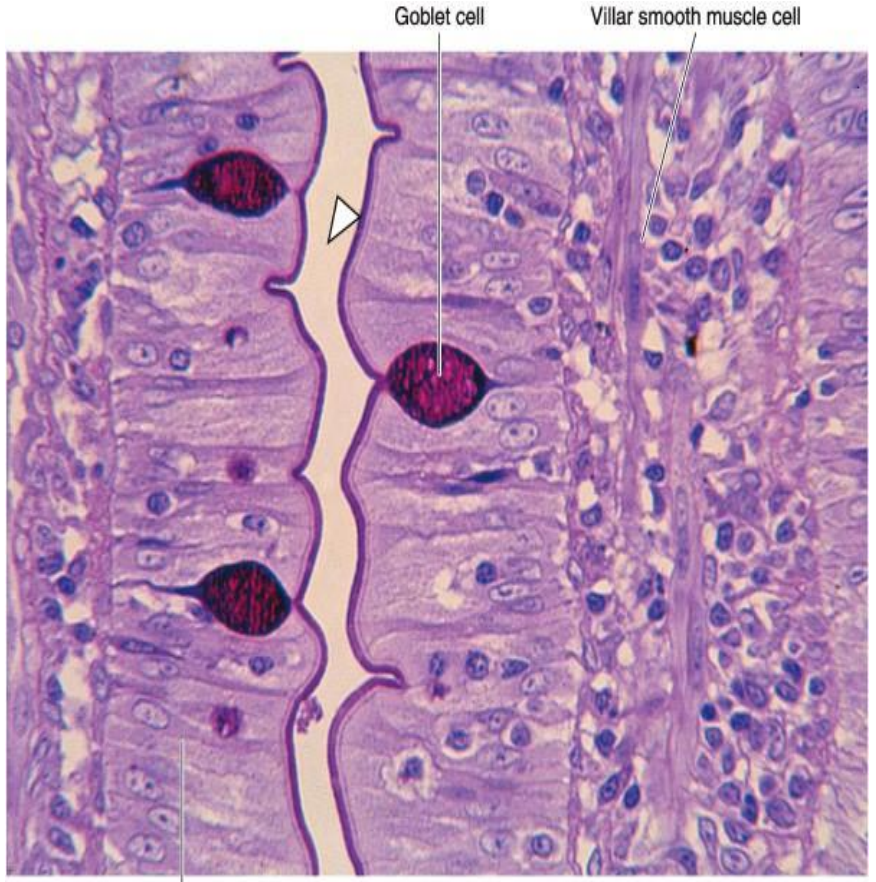


Additional figure

- 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
- Microvilli have the important physiological function of increasing the area of contact between the intestinal surface and the nutrients.
- The presence of plicae **circularis** , 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 (the absorption area)

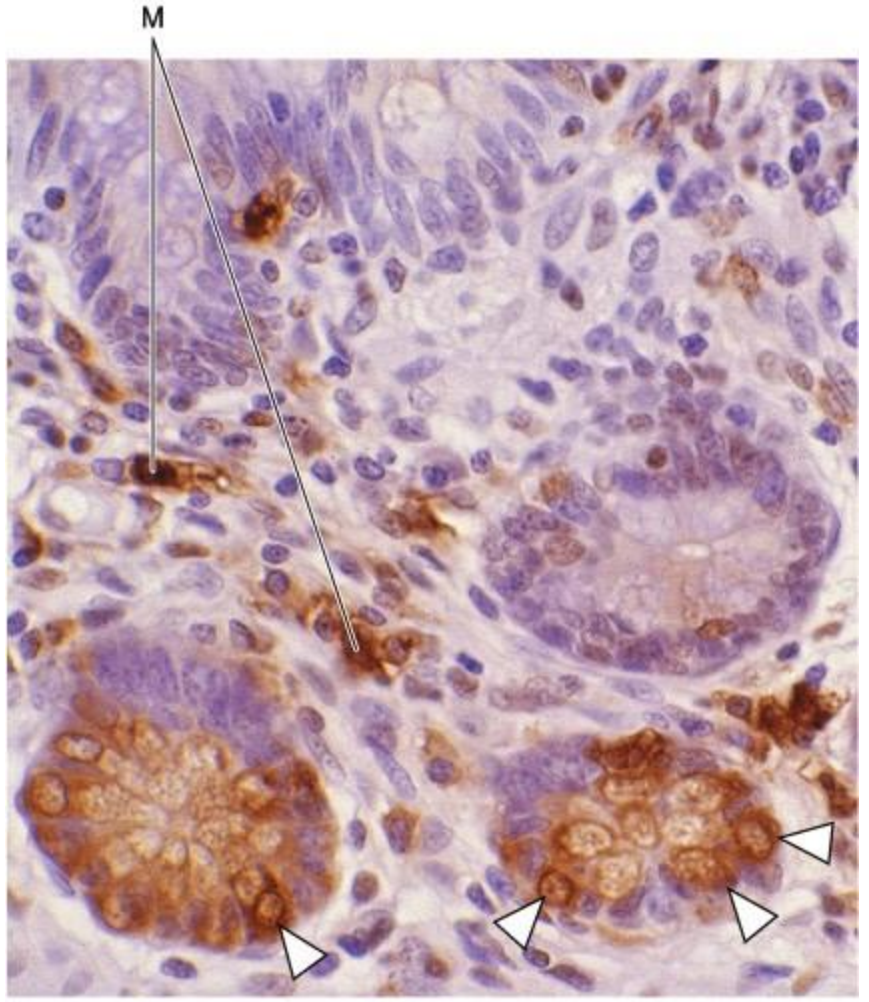


- **Goblet cells** are interspersed between the absorptive cells
- They are less abundant in the duodenum and increase in number as they approach the ileum
- These cells produce acid glycoproteins of the mucin type to form mucus,those secretions whose main function is to protect,lubricate the lining of the intestine (mucosa) and helps in absorption in the small intestine



Paneth's cells

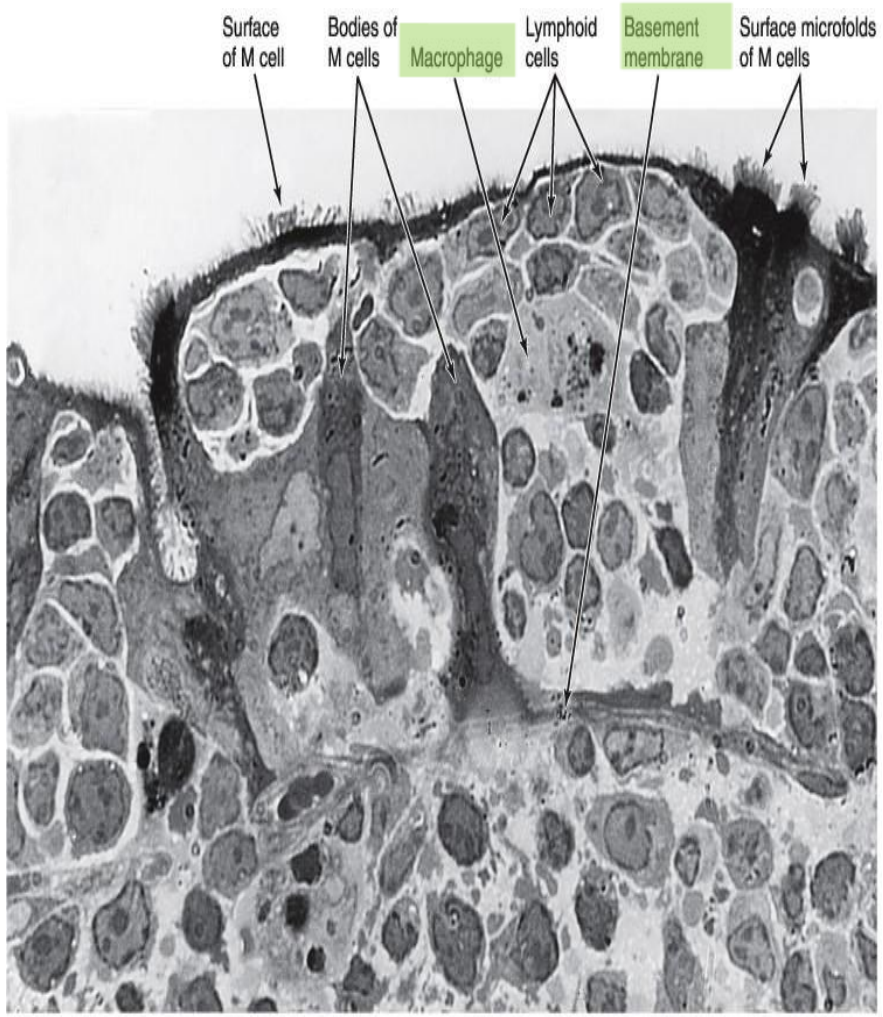
- Paneth's cells are acidophilic cells
- in the basal portion of the intestinal glands are exocrine cells with secretory granules in their apical cytoplasm.
- lysozyme—an enzyme that digests the cell walls of some bacteria— was detected in the large eosinophilic secretory granules of these cells
- Lysozyme has antibacterial activity and may play a role in controlling the intestinal flora.

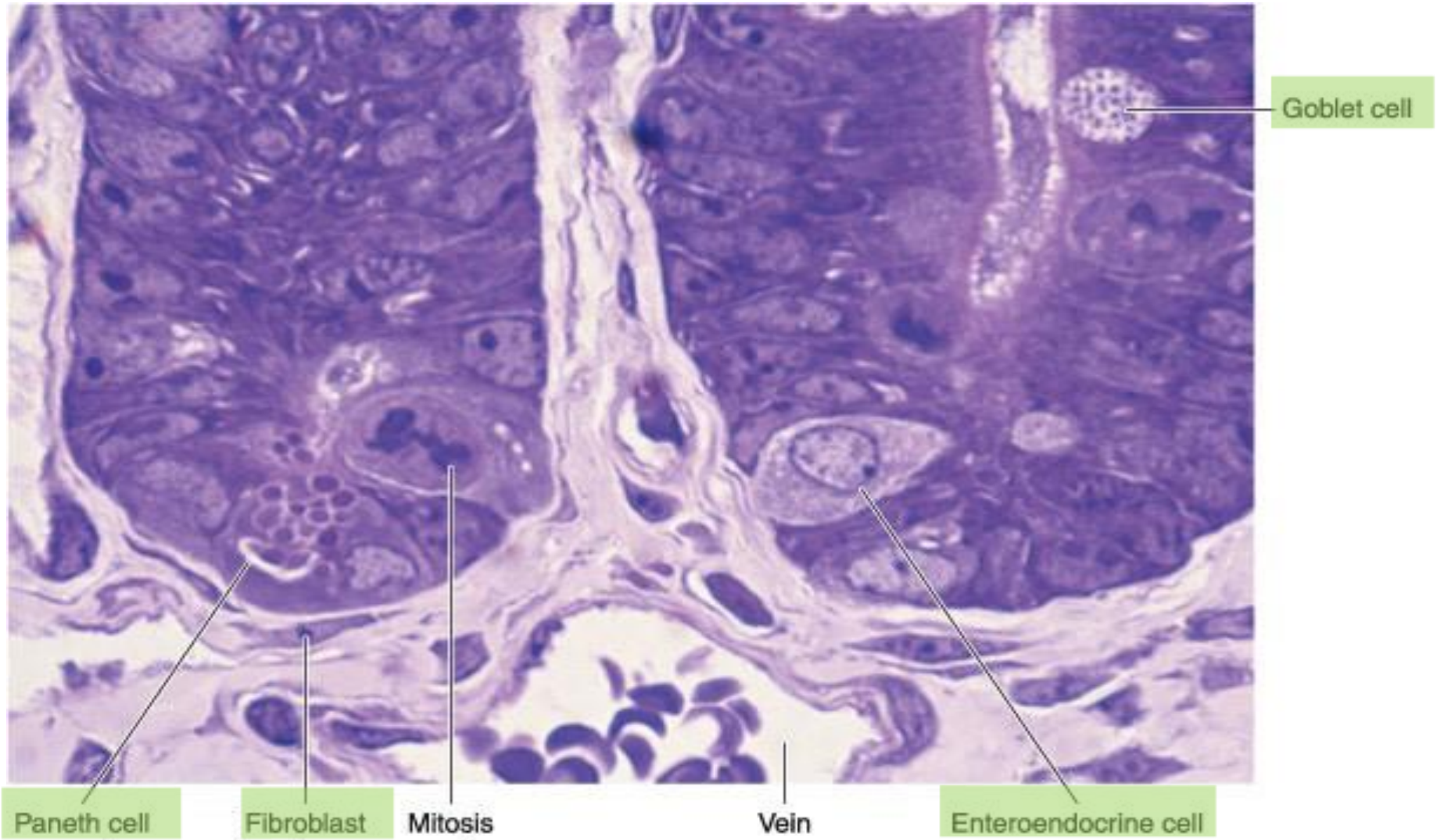


Macrophages enter the cytoplasm of M cells because M cells transport bacteria and foreign particles from the gut lumen to immune cells. Once at the surface, macrophages engulf these microbes, digest them, and present small fragments (antigens) on their surface. These antigens are then shown to lymphocytes, which triggers the immune response and leads to the production of antibodies.

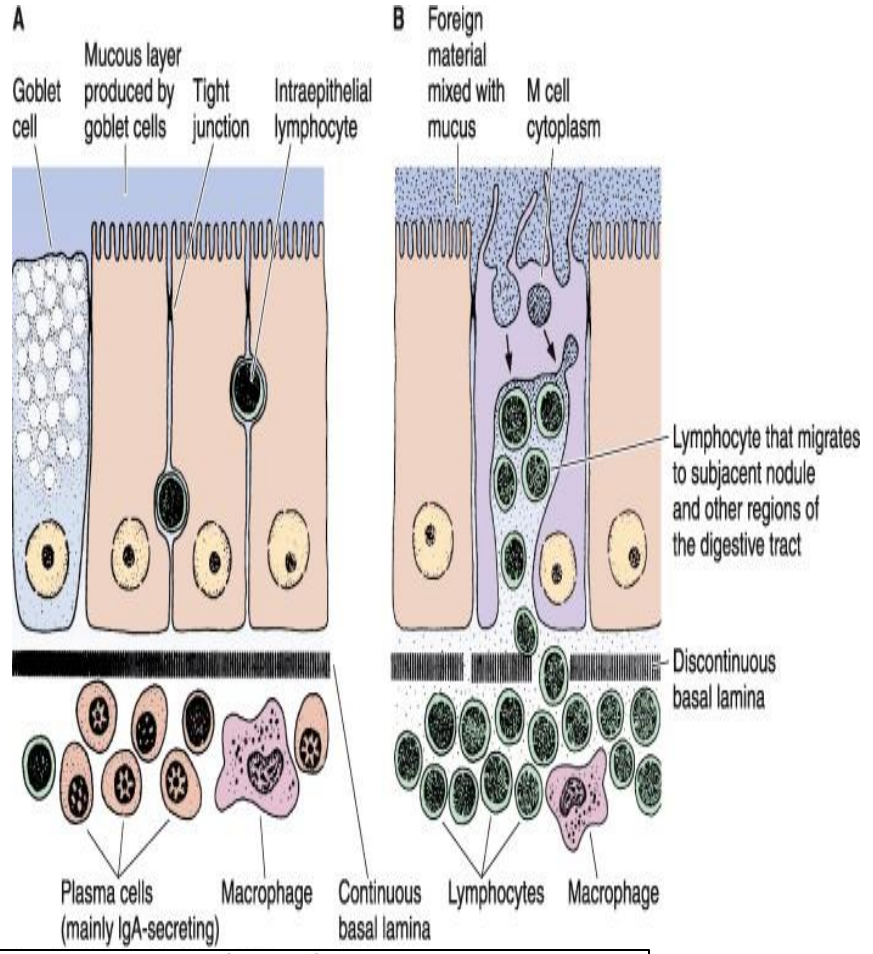
M (microfold) cells

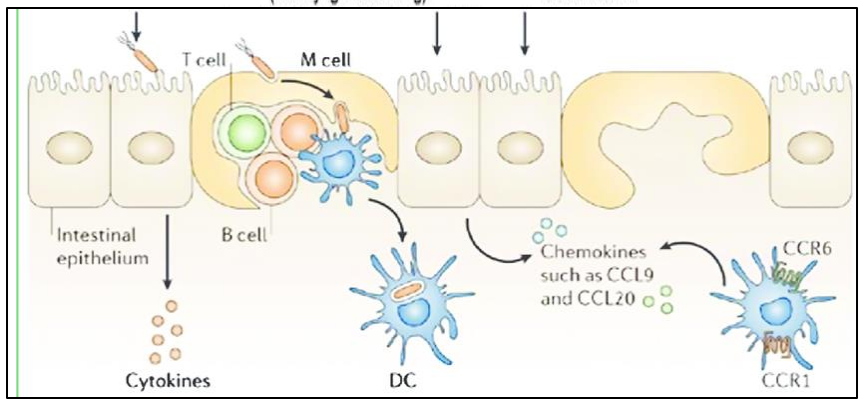
- Those cells are more Prominent in ileum
- are specialized **epithelial cells** overlying the lymphoid follicles of Peyer's patches
- the presence of numerous basal membrane invaginations that form pits containing many intraepithelial lymphocytes and antigen- presenting cells (macrophages).
- M cells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





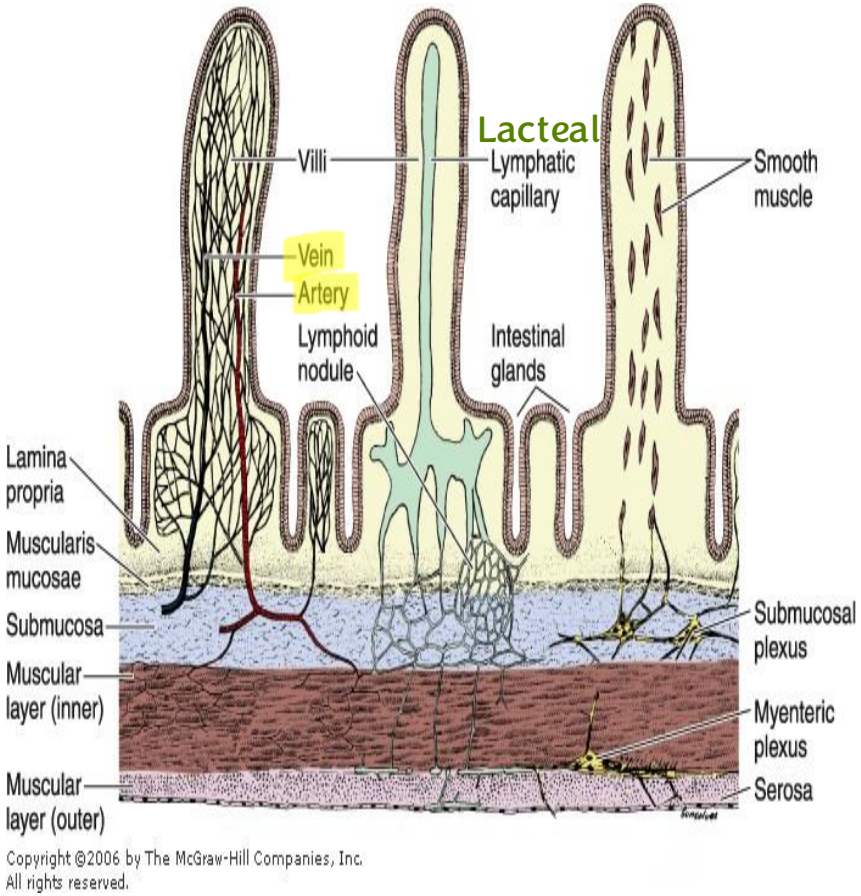
- The very large mucosal surface of the gastrointestinal tract is exposed to many potentially invasive microorganisms
- Secretory immunoglobulins of the IgA are the first line of defense
- Another protective device is the intercellular tight junctions that make the epithelial cells a barrier to the penetration of microorganisms.
- In addition the gastrointestinal tract contains antibody-secreting plasma cells, macrophages, and a very large number of lymphocytes
- located in both the mucosa and the submucosa. Together, these cells are called the gut-associated lymphoid tissue (GALT).





Additional figure

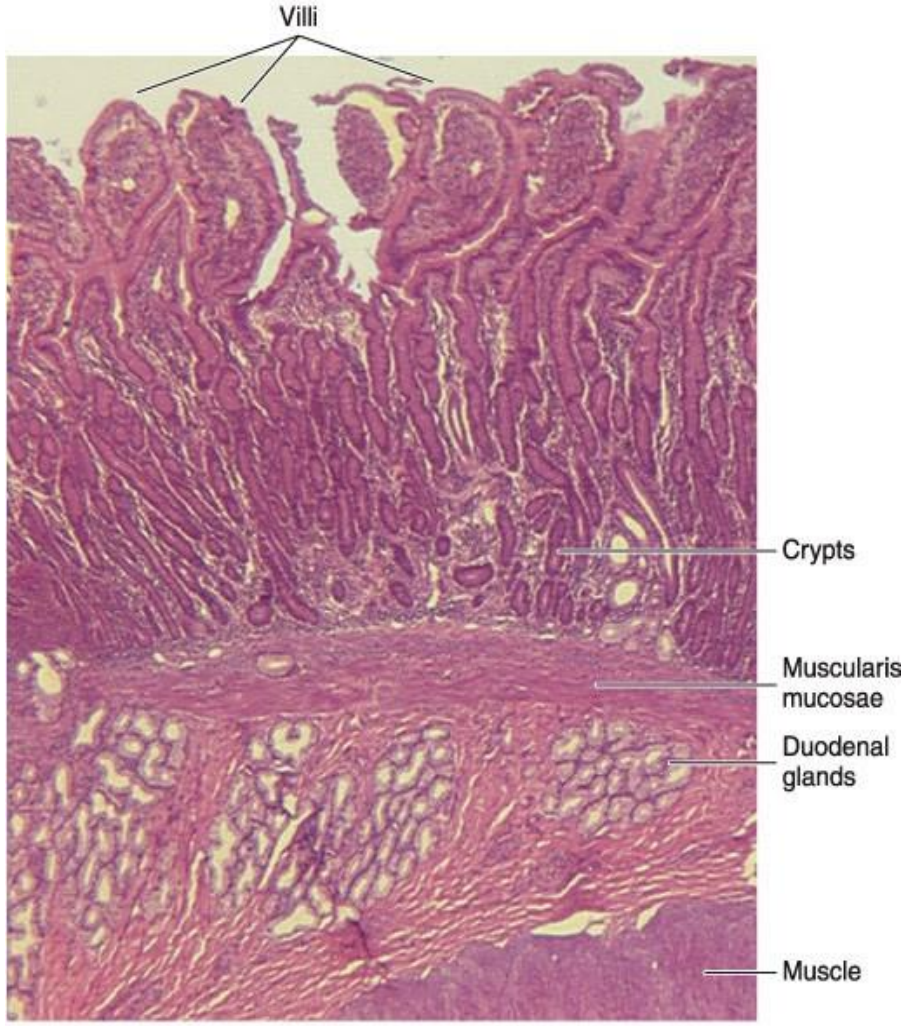
- The lamina propria of the small intestine is composed of loose connective tissue with blood and lymph vessels, nerve fibers, and smooth muscle cells.
- The lamina propria penetrates the core of the intestinal villi
- smooth muscle cells are responsible for the rhythmic movements of the villi, which are important for absorption
- The main function of Villi is increasing the gut's surface area to absorb more nutrients and contain tiny blood vessels and lymphatics to carry those nutrients



- In the initial portion of the duodenum the **submucosa** contains clusters of ramified, coiled tubular glands that open into the intestinal glands. These are the **duodenal** (or **Brunner's**) **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.



See next slide

Notes regarding previous slide

1. Duodenal Villi
Structure: Leaf-like projections (unlike finger-like villi in jejunum/ileum).
Function: Increase surface area for nutrient absorption.

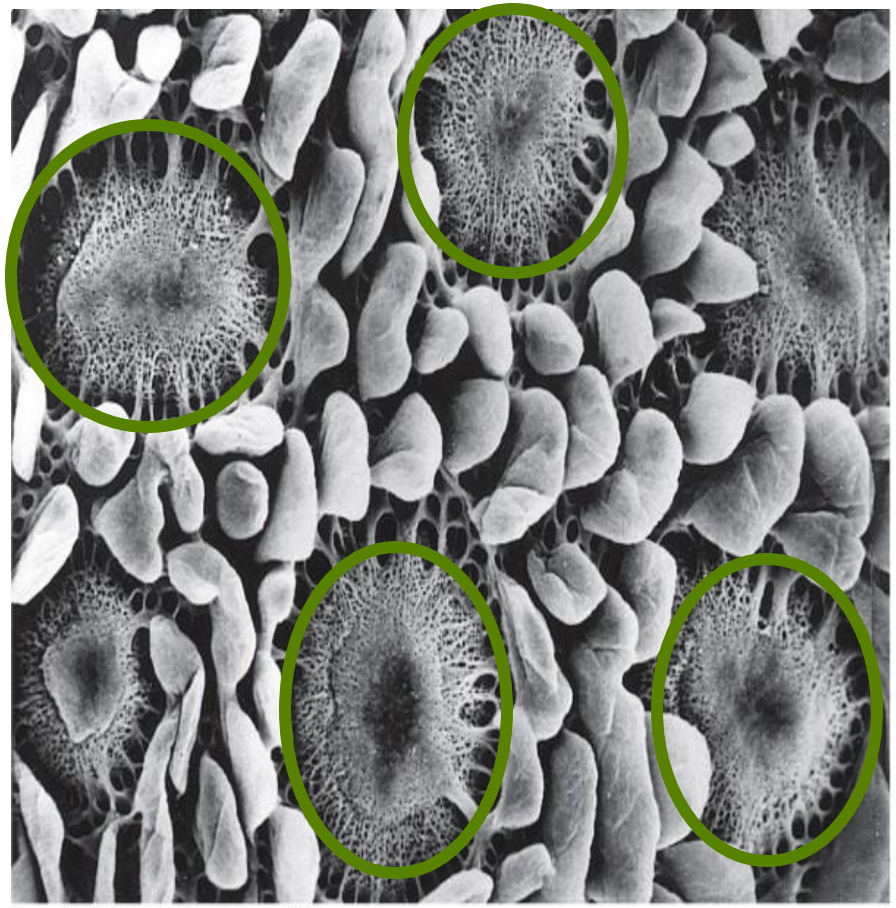
2. Crypts of Lieberkühn
Location: Embedded in the **lamina propria** (below villi).
Function: Produce:

- **Enterocytes** (absorb nutrients).
- **Goblet cells** (secrete mucus).
- **Paneth cells** (antibacterial peptides).

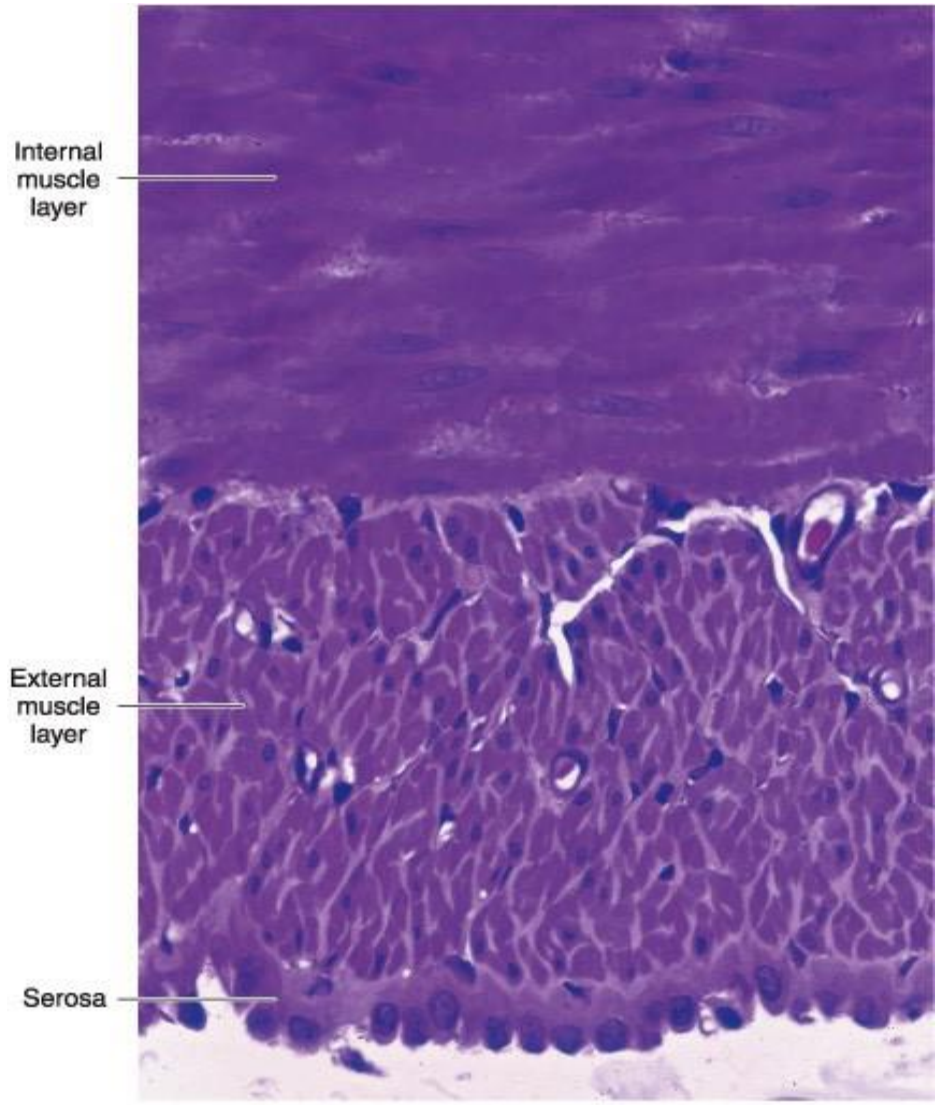
3. Muscularis Mucosae
Thin muscle layer beneath the lamina propria.

Unique Feature: Duodenum is the **only GI organ after the esophagus** with submucosal glands (Brunner's glands).
Why?
When Acidic chyme from the stomach enters the duodenum.
Brunner's glands secrete: **Alkaline mucus** (rich in bicarbonate) to **neutralize acid**, to avoid peptic ulcers
Pylorus' Role: While the pylorus releases mucus, its neutralization is limited—Brunner's glands handle the bulk of pH adjustment.

- The lamina propria and the submucosa of the small intestine contain aggregates of lymphoid nodules known as **Peyer's patches,** an important component of the GALT
- *Peyer's patches are clearly evident in the ileum as part of gut immunity.*
- 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**

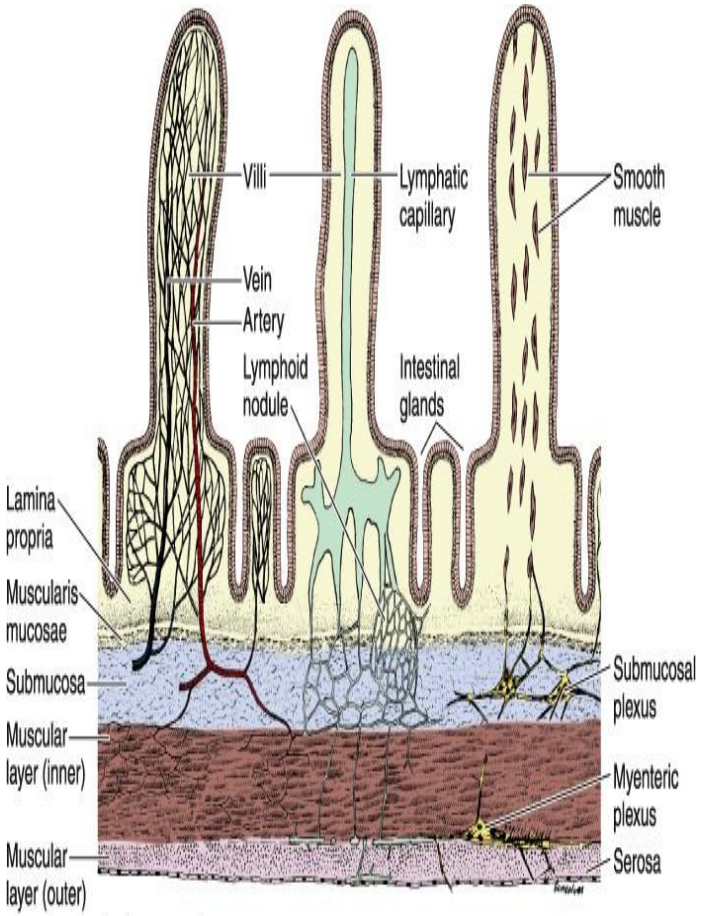


- The muscularis is well developed in the intestines, composed of an internal circular layer and an external longitudinal layer **with myenteric plexus between them**



Vessels & Nerves

- The blood vessels that nourish the intestine and remove absorbed products of digestion penetrate the muscularis and form a large plexus in the submucosa
- 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
- These capillaries (**lacteals**), although 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.

- The innervation of the intestines is formed by both an **intrinsic component** and an **extrinsic component**

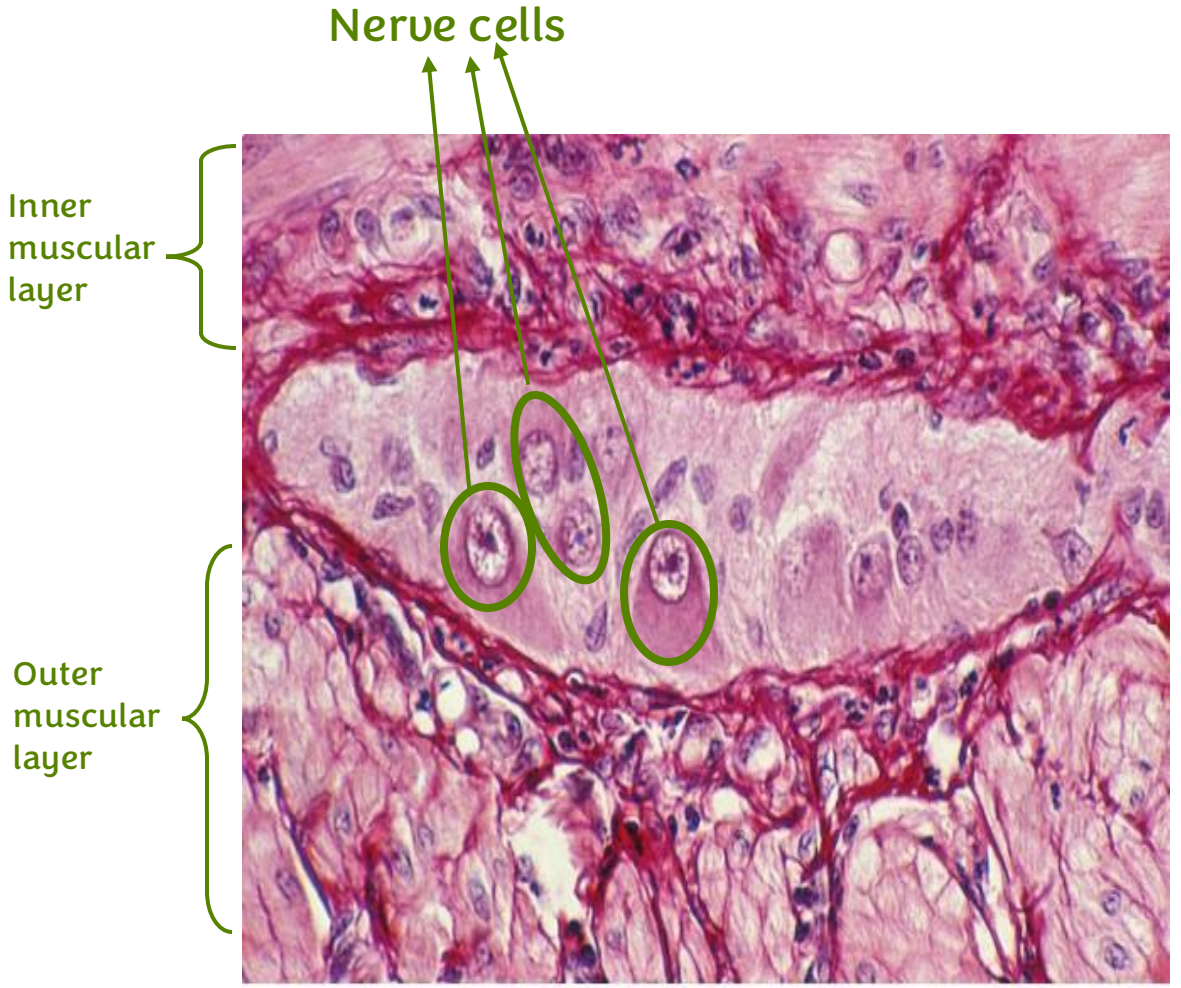
- The intrinsic component comprises groups of neurons that form the **myenteric (Auerbach's) nerve plexus** between the outer longitudinal and inner circular layers of the muscularis

- and 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 gastrointestinal (GI) tract is regulated by:

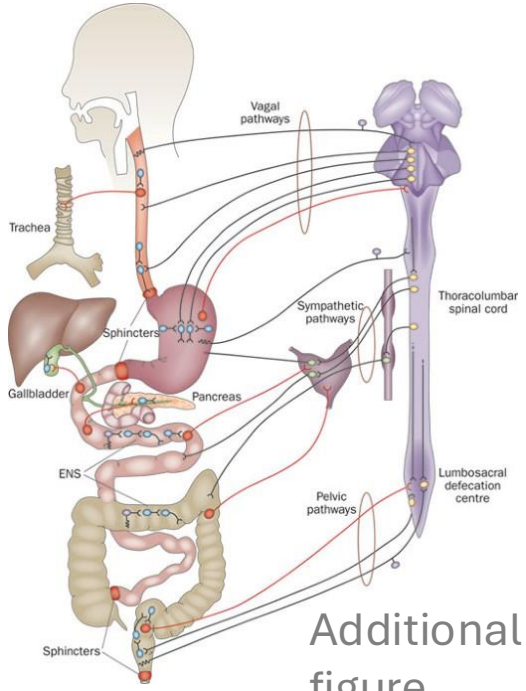
⇒ **Enteric Nervous System (ENS)**: An independent neural network embedded in the gut wall .
Enteric plexus = Myenteric (Auerbach's) + Submucosal (Meissner's) plexuses.

⇒ **Autonomic Nervous System (ANS)**: Modulates the ENS via:
Parasympathetic (stimulates digestion).
Sympathetic (inhibits digestion).

Where the Nerves Reside?
In the GI wall (e.g., duodenum), between the **inner circular** and **outer longitudinal muscle layers**, you find:
Myenteric (Auerbach's) Plexus:
Contains **axons**, **Schwann cells** (supporting glia), and **neuronal cell bodies**.
It's Part of the **ENS** (intrinsic control).

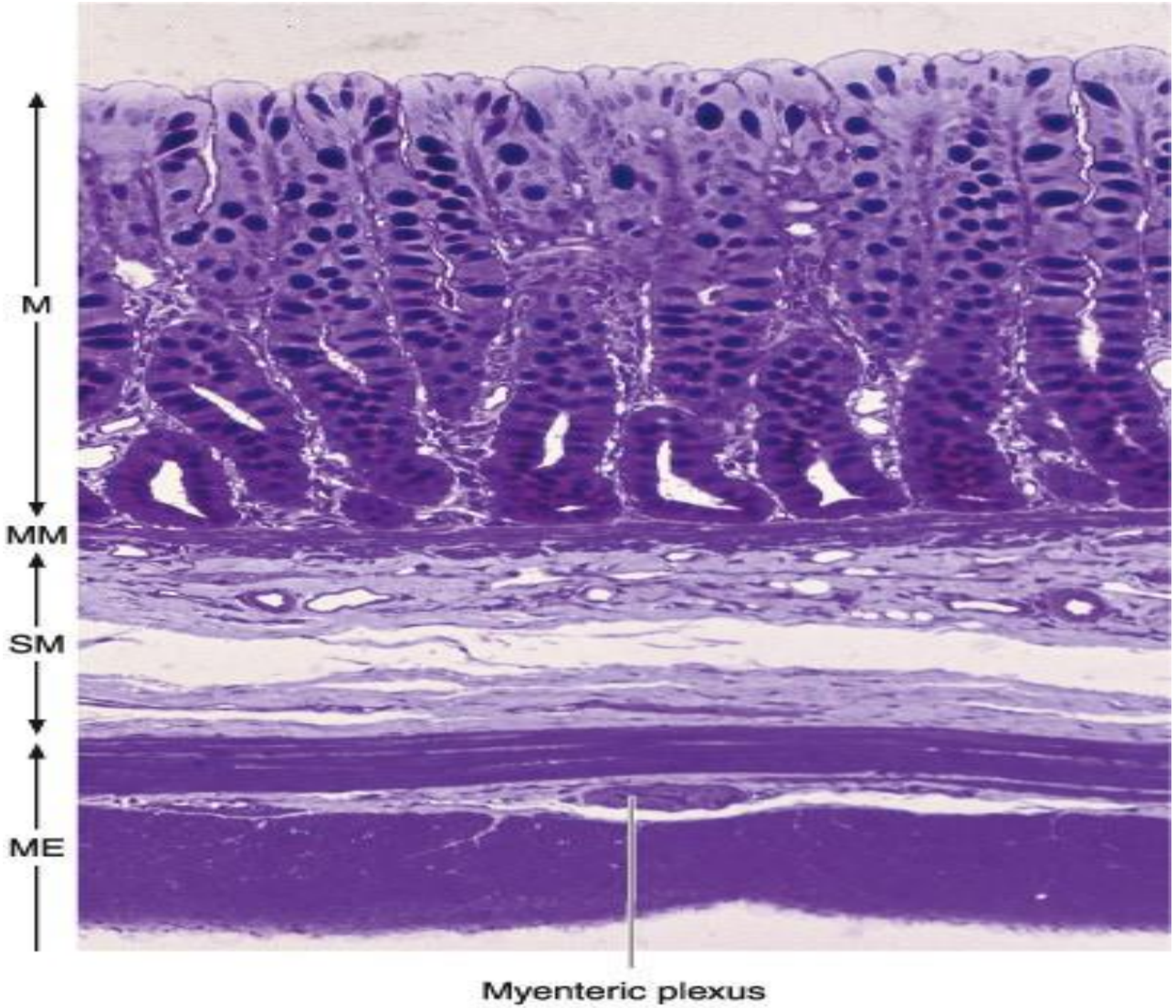
Parasympathetic Pathway (Vagus Nerve)
Preganglionic fibers:
Travel via the **vagus nerve** .
Synapse **directly** onto neurons in the myenteric plexus.
Postganglionic fibers:
Very short (since synapse already happened in the plexus).
Target: **Smooth muscle** and **glands**

Sympathetic Pathway (Stress Response)
Preganglionic fibers:
Originate in spinal cord (T5–T12).
Synapse in **prevertebral ganglia** (e.g., celiac, superior mesenteric ganglia).
Postganglionic fibers:
Long



Additional figure

M= Mucosa
MM = Muscularis mucosa
SM = submucosa
ME = Musculais externa



- 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.

Parasympathetic = direct to gut wall

Sympathetic = first synapse in a ganglion, then travel along vessels

Past paper questions

1) all the following statements are correct EXCEPT:
- *A. Chief cells are basophilic and predominant in the base of tubular gastric gland.*
- *B. The gastric pits in the body are long and narrow.*
- *C. The predominant cells in the pyloric region are the mucous cells.*
- *D. Parietal cells show intracellular canaliculi during activity.*
- *E. The parietal cells are located in the neck aspect of the fundic gland.*

Ans:- B

2) Which of the following is NOT predominant in the pyloric region of the stomach?
A. Mucus-secreting cells
B. G cells (gastrin-secreting cells)
C. Basophilic chief cells
ans: C

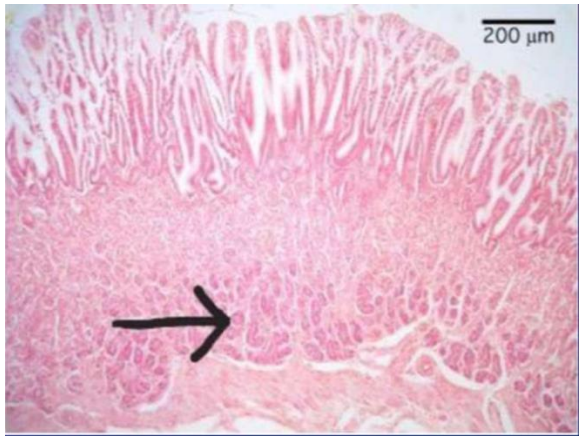
3) Intestinal glands (crypts of Lieberkühn) contain all of the following EXCEPT:
A. Paneth cells
B. Goblet cells
C. Enteroendocrine cells
D. Lacteal
ans: D

4) The intestinal Villi contain all the followings EXCEPT:
- A. Smooth muscle.
- B. Striated borders.
- C. Paneth cells.
- D. Lacteals.
- E. Simple columnar epithelium and goblet cells.
- Answer: C

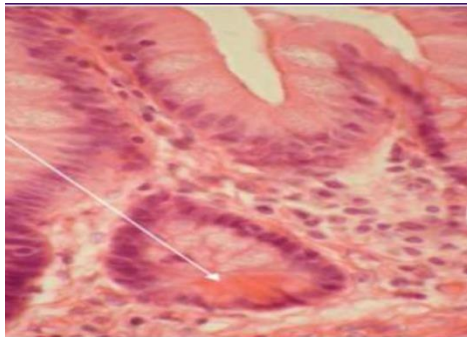
5) All the following statements concerning the jejunum are correct EXCEPT:
- *A. The mucosa has prominent plicea circularis.*
- *B. The mesentery contains simple arcades and long vasa recta.*
- *C. The submucosa contains brunners gland.*
- *D. The villi contains blood capillaries and lacteals.*
- *E. It is suspended from the posterior abdominal wall by mesentery.*
- *Answer: C*

Past paper questions

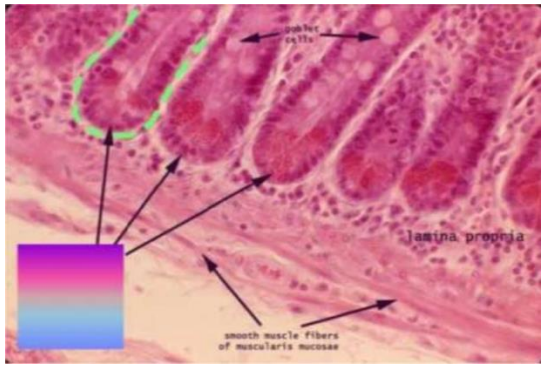
6) Identify the pointed cells in this section:
- A. Chief cells.
- B. Parietal cells.
- C. Mucouscells.
- D. Paneth cell.
- E. Lymphocytes.
- Answer: A



7) The pointed cells are:
- Answer: panet's cells



8) Identify the pointed structures in this section:
- A. Intestinal gland
- B. Brunner's gland
- C. Gastric gland
- D. Von Ebner's gland
- E. Esophageal gland
- Answer: A



For any feedback, scan the code or click on it.

Corrections from previous versions:

Versions	Slide # and Place of Error	Before Correction	After Correction
V0 → V1			
V1 → V2			

Additional Resources:

رسالة من الفريق العلمي:

Extra References for the Reader to Use:

1. Esophagus histology by Osmosis
2. Stomach histology by Osmosis
3. ...