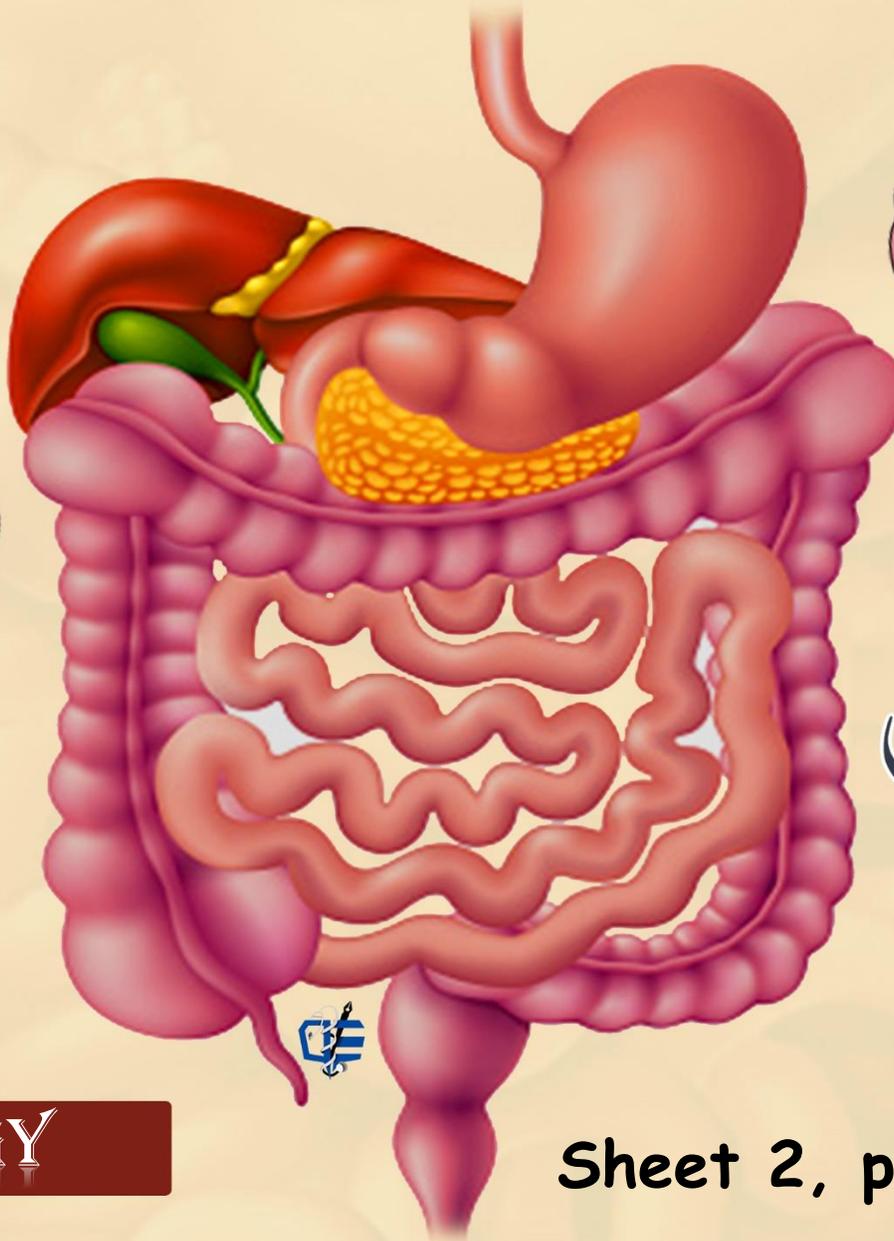


# GastroIntestinal System



**HISTOLOGY**

Sheet 2, part 1

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In this part, we will talk about the histology of the esophagus and stomach.

## Esophagus

Is a muscular tube that extends from the lower border of the sixth cervical vertebra (C6) to the cardia of the stomach. It is divided anatomically into three parts; proximal, middle, and distal.

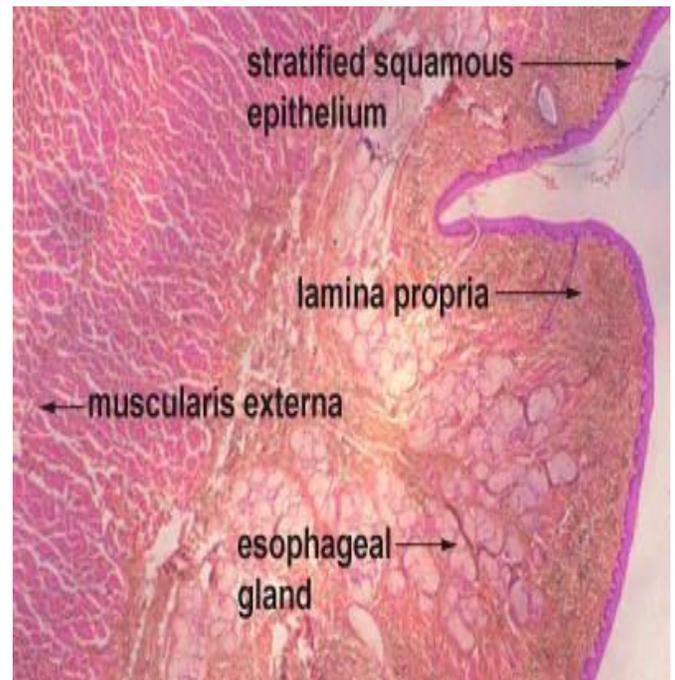
The **function** of the esophagus is to transport foodstuffs from the mouth to the stomach and to prevent the retrograde flow of gastric contents which is achieved by peristaltic contractions and relaxation of the esophageal sphincters (upper and lower), and controlled by reflexes and by the autonomic nervous system.

layers of the esophagus: 4 layers, it has the same layers as the rest of the digestive tract.

### 1. Esophageal Mucosa

is composed of three sublayers:

- **Lining epithelial;** which is stratified squamous nonkeratinized epithelium
- **Lamina propria;** loose connective tissue, contains the **esophageal cardiac glands**, that secrete mucus especially at the distal end of the esophagus (near the stomach)
- **Muscular mucosa;** a layer of smooth muscle, separates the mucosa from the underlying submucosa.



### 2. Submucosa

Dense connective tissue contains lymphatic and blood vessels and also groups of small mucus-secreting glands, the **esophageal glands**, whose secretion facilitates the transport of foodstuffs and protects the mucosa.

### 3. Muscularis Externa

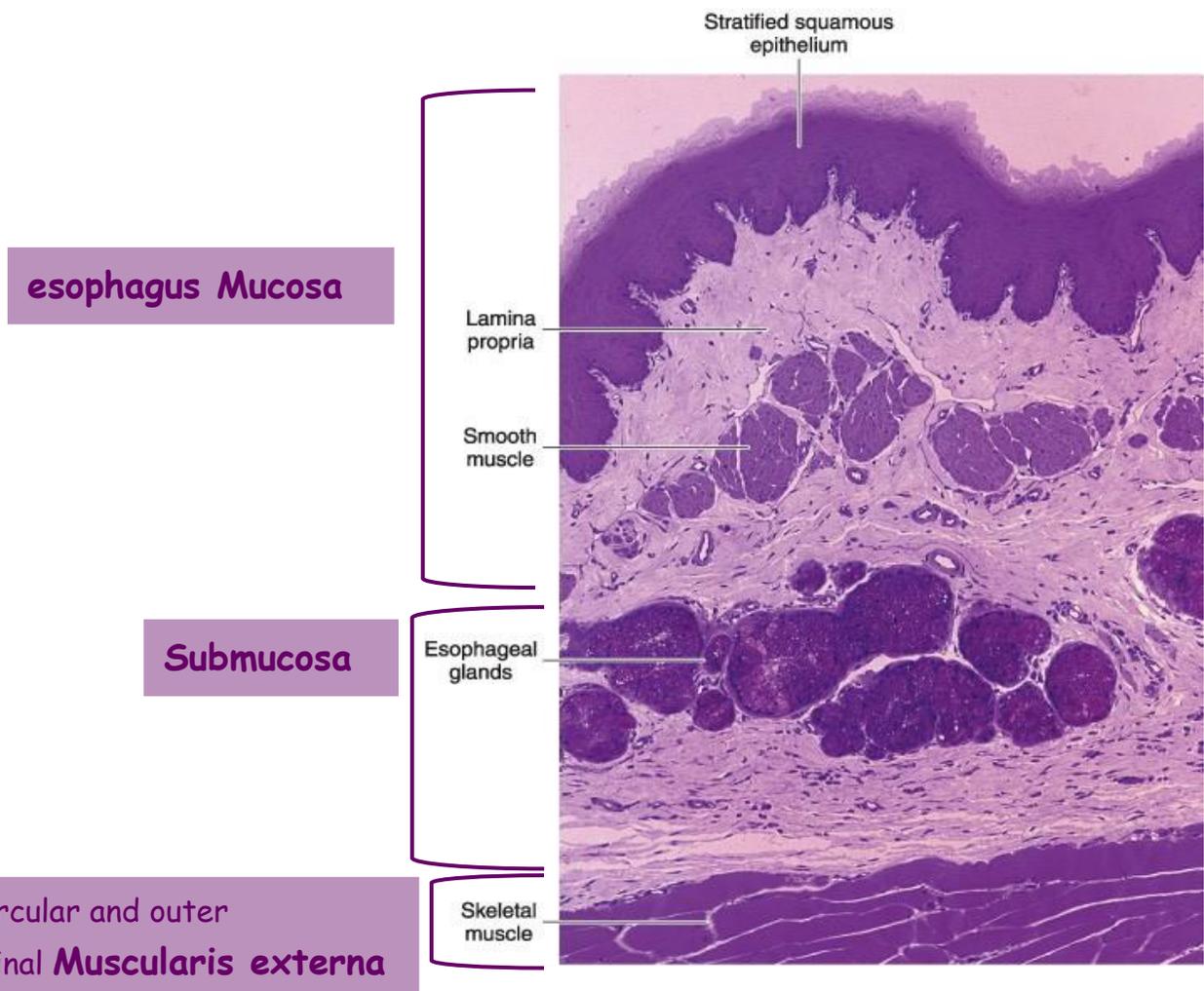
Muscle fibers are oriented in two main directions: **Inner circular and outer longitudinal**. The type of muscles different through the esophagus:

- ✓ Upper third → striated (skeletal) muscles only
- ✓ Middle third → a mixture of striated (skeletal) and smooth muscle cells
- ✓ Lower third → smooth muscles only

### 4. Adventitia OR Serosa

**Adventitia** which is a layer of connective tissue that covers the larger part of the esophagus (neck and thoracic), it blends into the surrounding tissue.

**Serosa** covers only that portion of the esophagus that is in the peritoneal cavity ( below the diaphragm ) 1.3 cm.



# Stomach

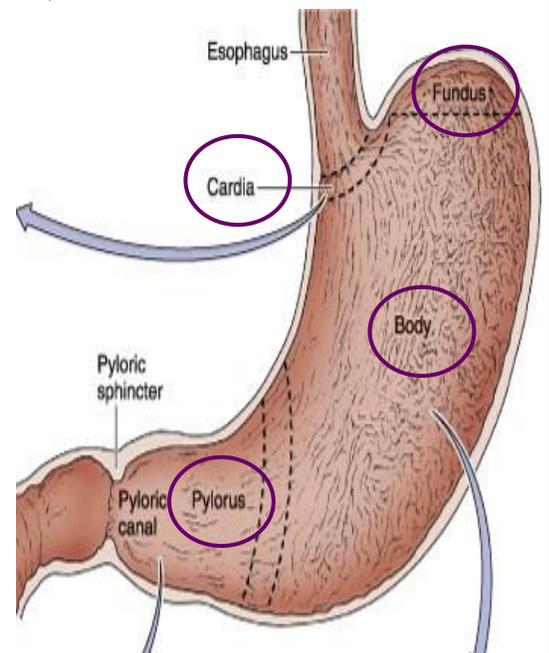
It is a mixed exocrine-endocrine organ that digests food and secretes hormones, lies between the esophagus and the duodenum in the abdominal cavity in the epigastric region.

The main **functions** are:

- continue the digestion of carbohydrates initiated in the mouth
- add an acidic fluid to the ingested food
- transform the ingested food by muscular activity into a viscous mass called **chyme** which will stay in the stomach for 2-4 hours then will be eradicated through the pyloric sphincter into the duodenum.
- promote the initial digestion of proteins with the enzyme **pepsin**.
- produces a gastric lipase that digests triglycerides with the help of lingual lipase.

The Stomach divided **anatomically** into four regions:

1. **Cardia**; a narrow circular band, 1.5-3 cm in width, at the transition between the esophagus and the stomach, contains **the cardiac sphincter** which is a physiological sphincter controlled by the **vagus nerve**.
2. **Fundus**
3. **Body**; the largest portion of the stomach, with the fundus responsible for the digestion. the fundus and body are identical in microscopic structure.
4. **pylorus**; 3 parts:
  - **pyloric antrum**
  - **pyloric canal**



- **pyloric sphincter**, which is an anatomical sphincter formed by the thickening of the inner smooth muscles, controlled by the **autonomic nervous system** (sympathetic and parasympathetic).

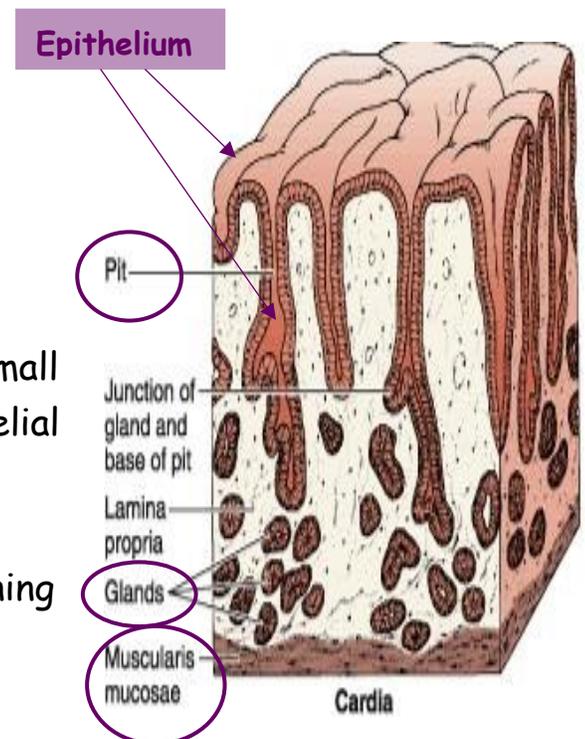
General histology of the stomach:

## 1. Gastric Mucosa

it is composed of three sublayers:

- **Lining epithelium**; simple columnar epithelial **without** goblet cells. Contain **gastric pits**, which are numerous small circular or ovoid invaginations of the epithelial into the lamina propria (can be seen by the magnifying glass). The epithelium covering the surface and lining the pits secrete an **alkaline mucus**.
- **Lamina propria**, composed of **loose connective tissue** interspersed with smooth muscle and lymphoid cells, contains branched, tubular glands (cardiac, gastric, and pyloric) characteristic of each region of the stomach which secretes mucus and **emptying into the gastric pits**. This mucus consists primarily of water (95%), lipids, and glycoproteins, which, in combination, form a **hydrophobic protective gel**.

**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 alkalization.

- **Muscular mucosa**, a layer of smooth muscle, separate the mucosa from the underlying submucosa

## 2. Submucosa

composed of dense connective tissue containing blood and lymph vessels; it is infiltrated by lymphoid cells, macrophages, and mast cells.

Folding of submucosa through the mucosa form **rugae**; When the stomach is filled with food, these folds flatten out to increase the surface area of the mucosa.

In the side of lesser curvature → Longitudinal rugae

Other parts → oblique or horizontal rugae

## 3. Muscularis Externa

composed of smooth muscle fibers oriented in **three main directions**.

→ the external layer is longitudinal

→ the middle layer is circular

→ the internal layer is oblique

- At the pylorus, the middle layer is greatly thickened to form the pyloric sphincter.

## 4. Serosa

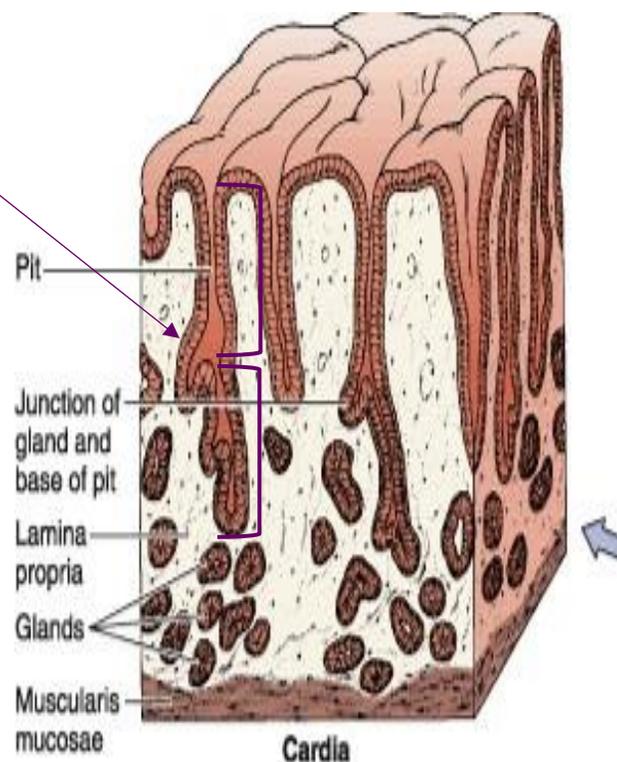
The stomach is covered by a thin serosa.

Now, We will talk about the histological characteristics of the mucosa for each region of the stomach. It is divided **histologically** into three regions:

## 1. Cardia

Its **Mucosa** contains:

- ☑ **Mainly mucus cells, few parietal, stem, and enteroendocrine cells, there are no chief cells.**
- ☑ **simple or branched tubular cardiac glands** which are similar in structure to the cardiac glands of the terminal portion of the esophagus. The terminal portions of these glands are frequently coiled, often with large lumens.
- ☑ Most of the secretory cells produce **mucus** and **lysozyme** (an enzyme that attacks bacterial walls), but a few parietal cells secreting **H<sup>+</sup>** and **Cl<sup>-</sup>** (which will form HCl in the lumen).
- ☑ **Gastric pits are the same length as the gastric gland.**



## 2. 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.
- ☑ The distribution of epithelial cells in gastric glands is not uniform
- ☑ Gastric pits are wide and short, form about  $\frac{2}{5}$  of the thickness of the mucosa
- ☑ Gastric glands are long, form about  $\frac{3}{5}$  of the thickness of mucosa, each gastric gland has three distinct regions:

### 1. **isthmus**; close to the gastric pit, contains:

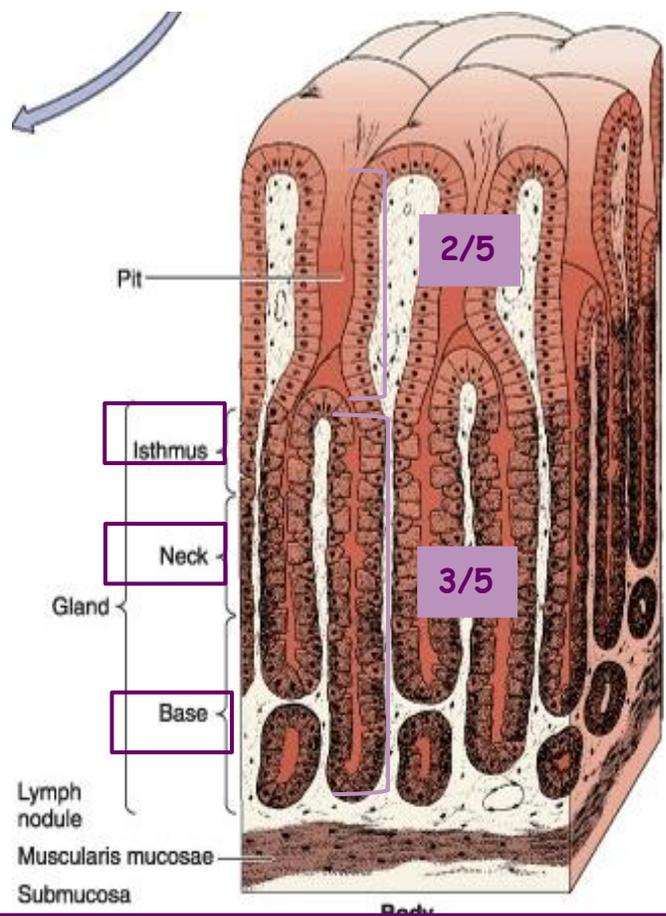
- differentiating mucous cells that will migrate and replace superficial mucous cells
- some undifferentiated stem cells
- some parietal (oxyntic) cells

### 2. **neck**; consists of

- stem cells
- mucous neck cells (different from the mucous cells in the isthmus)
- parietal cells

### 3. **base**; primarily contains

- parietal cells
- chief (zymogenic) cells
- enteroendocrine cells



About the cells of the **Mucosa** layer of the stomach:

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## 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

- ✿ 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.
- ✿ Foamy appearance under the microscope.

## Oxyntic (Parietal) Cells

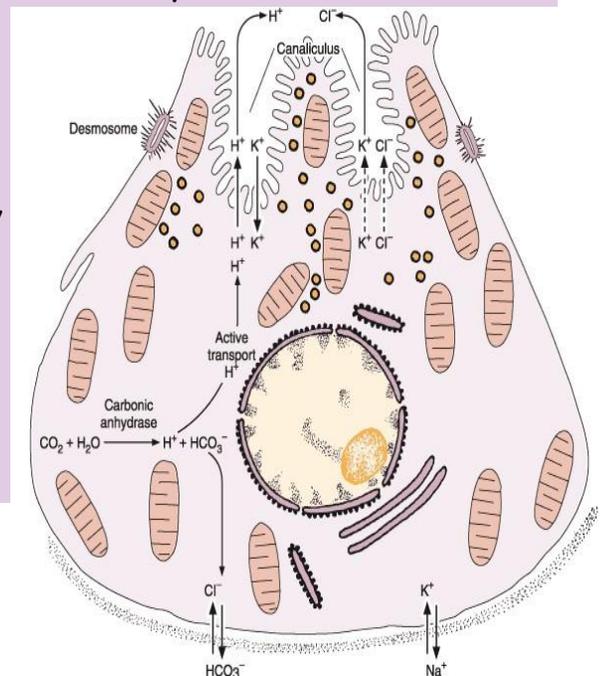
- ✿ present mainly in the upper half of gastric glands; they are scarce in the base
- ✿ They are rounded or pyramidal cells, with one centrally placed spherical nucleus and intensely **eosinophilic** cytoplasm
- ✿ They present in two forms; active and inactive:
  - **Active secreting cells**, in the electron microscope, are an abundance of mitochondria and a deep, circular invagination of the apical plasma membrane, forming the intracellular canaliculus which contains HCL.

- **Inactive cells ( resting cells)**, their cytoplasm contains many tubulovesicular structures that 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( $HCL$ ) and intrinsic hormones.

☑ forming  $HCL$  inside the canaliculi of the active Parietal cells:

(the professor didn't go through the mechanism)

- ✓ The ion  $H^+$  originates from the dissociation of the  $H_2CO_3$  produced by the action of carbonic anhydrase, an enzyme abundant in oxyntic cells
- ✓ Once produced,  $H_2CO_3$  dissociates in the cytoplasm into  $H^+$  and  $HCO_3^-$
- ✓ 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

- ❄ 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 (zymogen granules) contain enzymes:
  - the inactive enzyme **pepsinogen** which rapidly converted into the highly active proteolytic enzyme **pepsin** after being released into the acid environment of the stomach.
  - **enzyme lipase**.
- ❄ There are **seven different pepsins** in the human gastric juice, which are aspartate endoproteinases of relatively broad specificity active at  $\text{pH} < 5$

## Enteroendocrine Cells

- ❄ are found in the neck and bases of gastric glands
- ❄ **G-pylorus** cells are an example of enteroendocrine cells which produce **Gastrin** that leads to the Stimulation of gastric acid secretion and Gastric mucosal growth.
- ❄ In the **fundus** of the stomach, 5-hydroxytryptamine (serotonin) is one of the principal secretory products

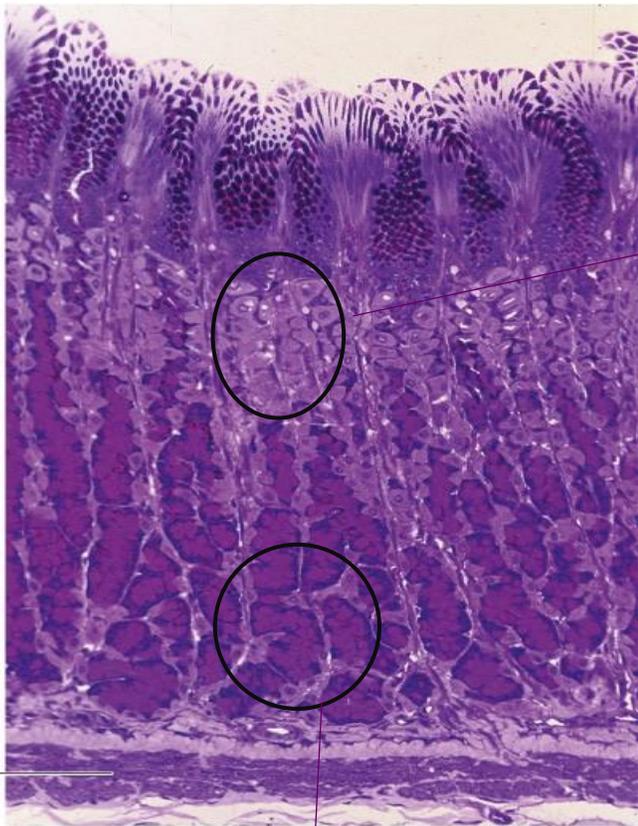


simple columnar epithelial without goblet cells

Short and wide gastric pit

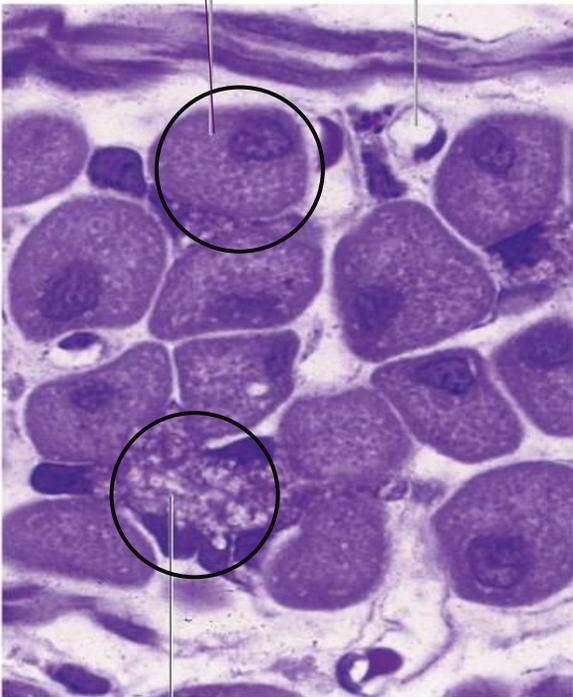
Long Gastric gland, Stem, parietal, mucous cells present in the neck region  
Chief and enteroendocrine cells present in the base

### Fundus & Body



Acidophilic **parietal cell**  
Has central rounded nucleus

Capillary



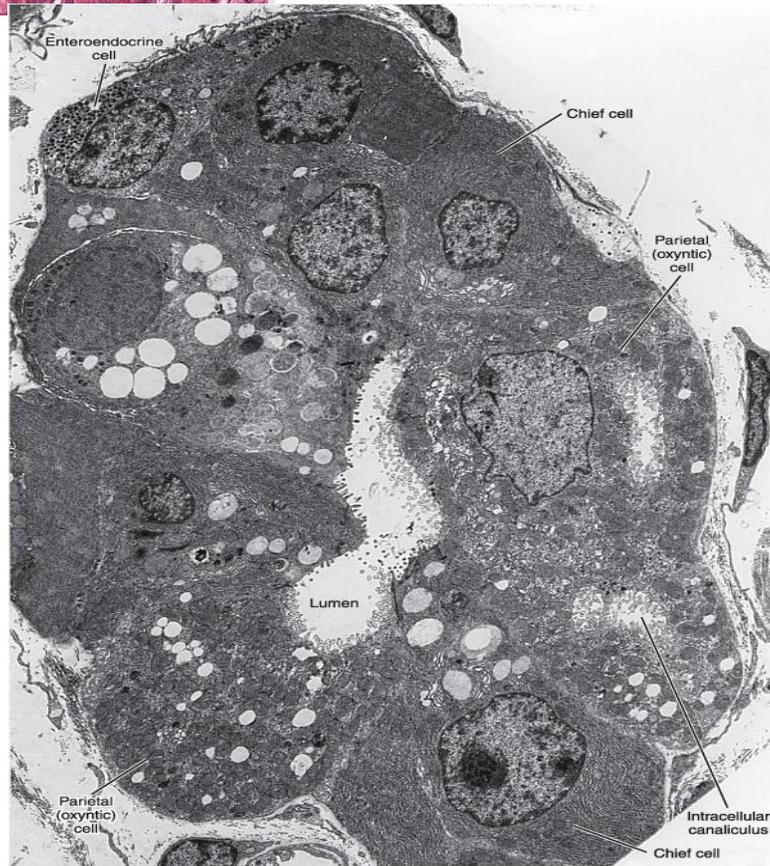
Foamy appearance **Mucous Neck Cells**

basophilic **chief Cells** with granules



**parietal cell**  
 again, it has central rounded nucleus  
 Acidophilic pale in color

**chief cell**  
 basal and basophilic nucleus  
 zymogenic granules in the apex

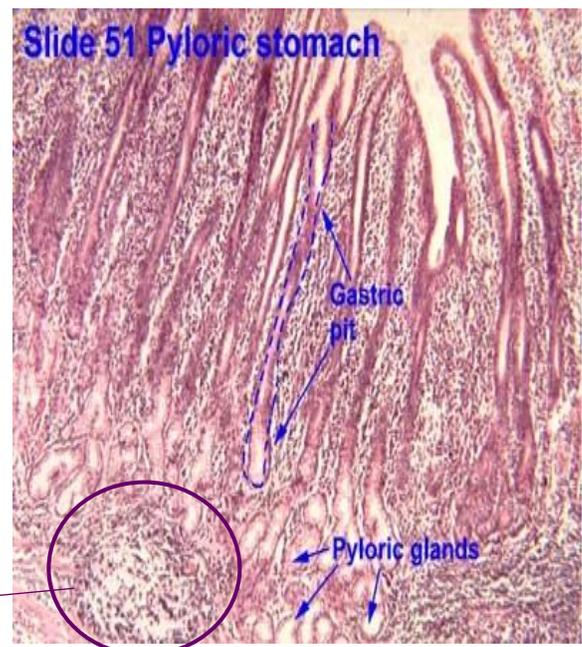
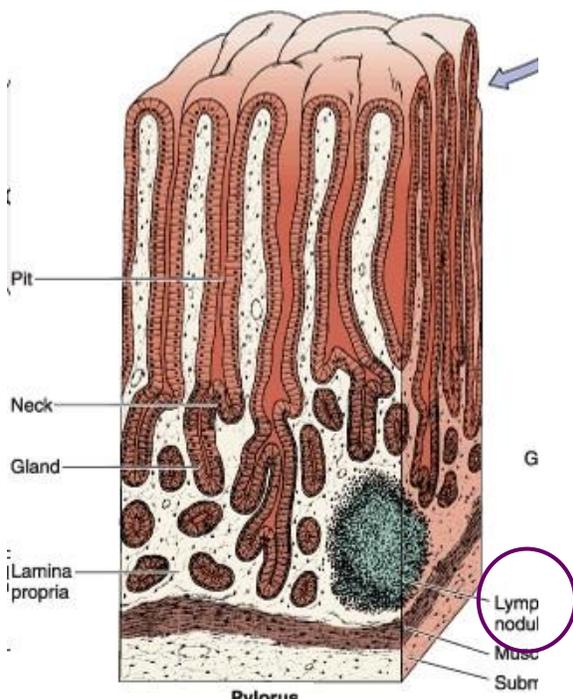


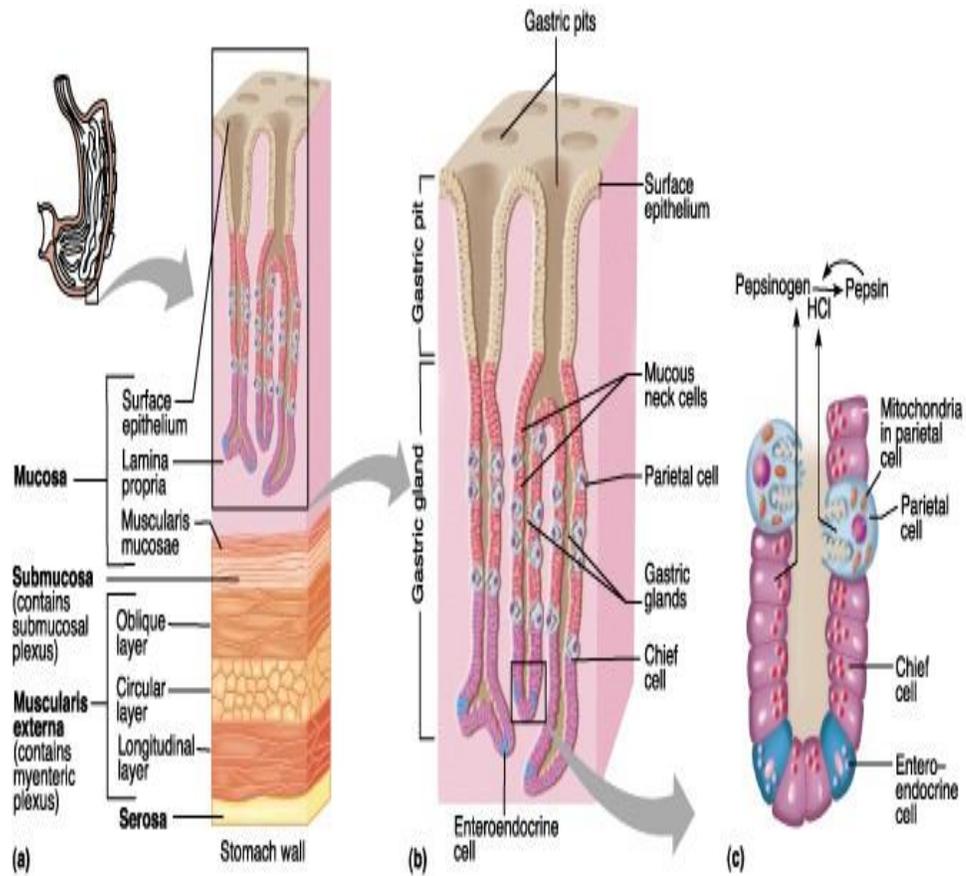
To sum up the cells of the mucosa:

cell	Location in the Gastric gland	Main function	Microscopely appearance
<b>Stem Cells</b>	isthmus and neck	Replace the cells	
<b>Mucous Neck Cells</b>	neck	mucus secretion	<ul style="list-style-type: none"> <li>• Foamy irregular</li> <li>• nucleus at the base of the cell</li> <li>• granules near the apex</li> </ul>
<b>Oxyntic (Parietal) Cells</b>	Isthmus, neck, and base BUT most concentrated in the neck	Secrete <b>HCL</b> & <b>intrinsic hormone</b>	<ul style="list-style-type: none"> <li>• rounded or pyramidal</li> <li>• centrally spherical nucleus</li> <li>• <b>eosinophilic</b> cytoplasm</li> </ul>
<b>Chief (Zymogenic) Cells</b>	base	Secrete <b>pepsinogen</b> and <b>enzyme lipase</b>	<ul style="list-style-type: none"> <li>• <b>basophilic</b></li> <li>• basal nucleus</li> <li>• zymogen granules in the apex</li> </ul>
<b>Enteroendocrine Cells</b>	neck and base	Secrete <b>Gastrin</b> and <b>serotonin</b>	

### 3. Pylorus

- ☑ 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 because this region of the stomach hasn't a role in digestion, rather it secretes mucus to neutralize the acidity of the chyme.
- ☑ These glands secrete mucus as well as appreciable amounts of the enzyme lysozyme (antibacterial enzyme).
- ☑ Gastrin (G) cells (which release gastrin) are enteroendocrine cells intercalated among the mucous cells of pyloric glands.
- ☑ The lamina propria contains lymphatic nodules.
- ☑ Parasympathetic stimulation, the presence of nutrients such as amino acids and amines in the stomach, and distention of the stomach wall directly stimulate the G cell to release gastrin, which in turn activates the parietal cell, increasing acid secretion
- ☑ Other enteroendocrine 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.





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You just finished the first part :)