



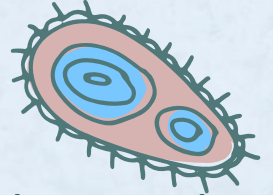
Let's Take Attendance



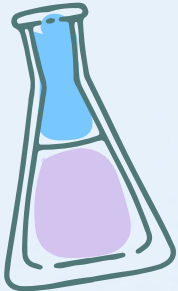
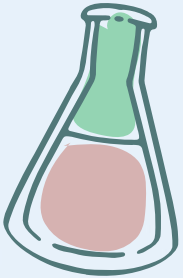
<http://sciovirtual.org/attendance>

Attendance code: bio94

Class Notion



- Join the Class Notion
 - Another place to access class content, class overviews, class homework, updates on course challenges, etc.
 - <https://cyber-sphere-db4.notion.site/ScioCamp-Anatomy-Physiology-6abb13e3037c40d5ba7ad739f00ee243>

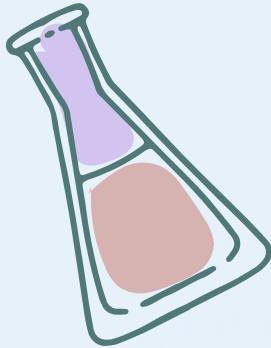


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Lesson 2

Digestive System

ScioCamp 2022: Anatomy & Physiology

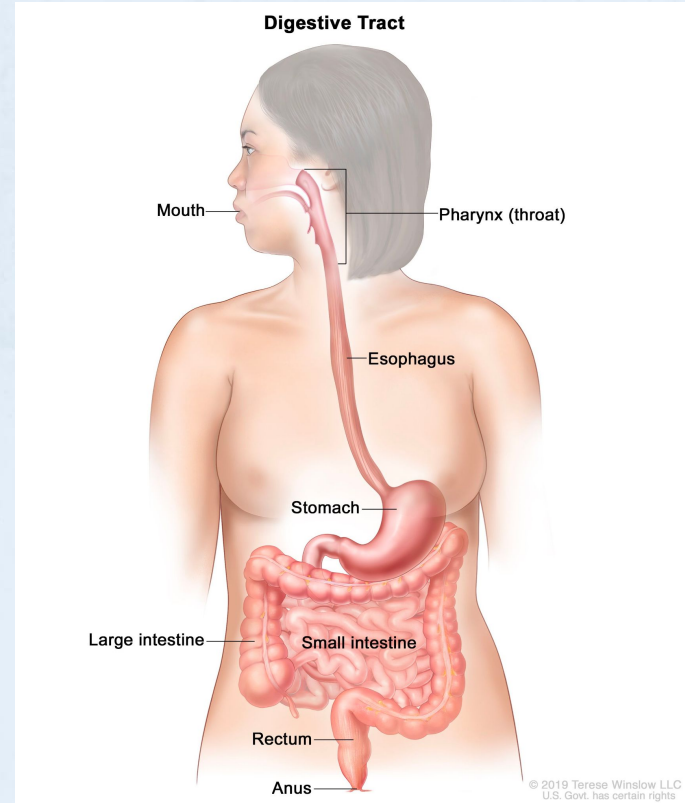


The GI Tract (Gastrointestinal Tract)

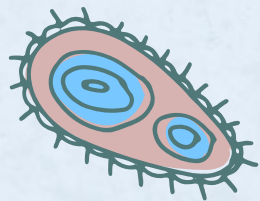
Other names for the GI Tract:

- Alimentary canal
 - Digestive tract
-
- Extends from mouth to anus
 - Includes the mouth, pharynx, esophagus, stomach, small intestine, large intestine, rectum, and anus

Q: Do you still remember each organ's function?



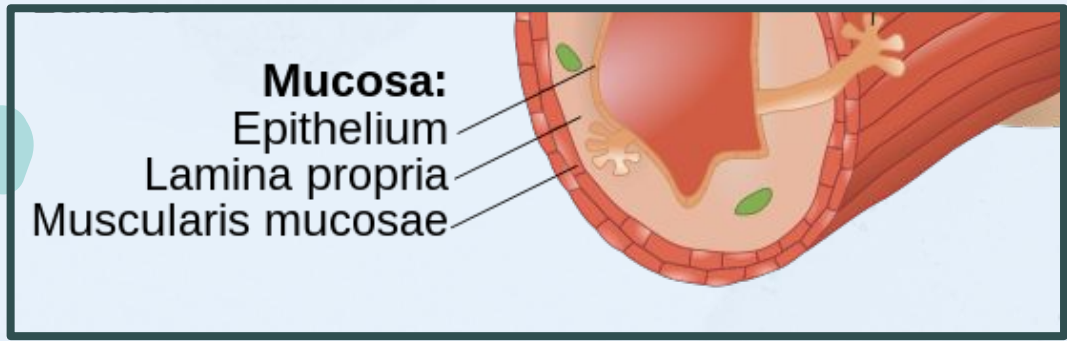
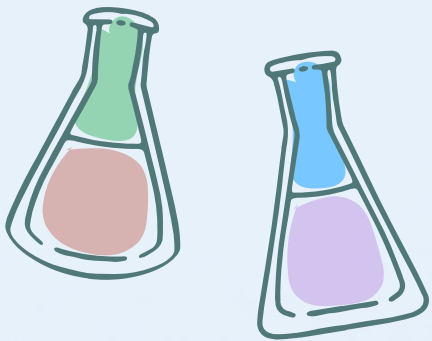
Layers of the GI Tract



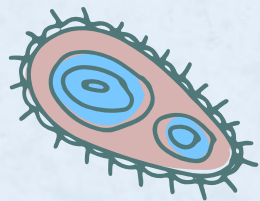
In order of innermost to outermost:

1. Mucosa

- Also called *mucous membrane*, lines the **lumen** of the digestive tract
- Absorptive and major secretory layer
- **Goblet cells** in the mucosa secrete mucus throughout the digestive tract- this mucus helps to **neutralize the stomach acids and protect GI tract**



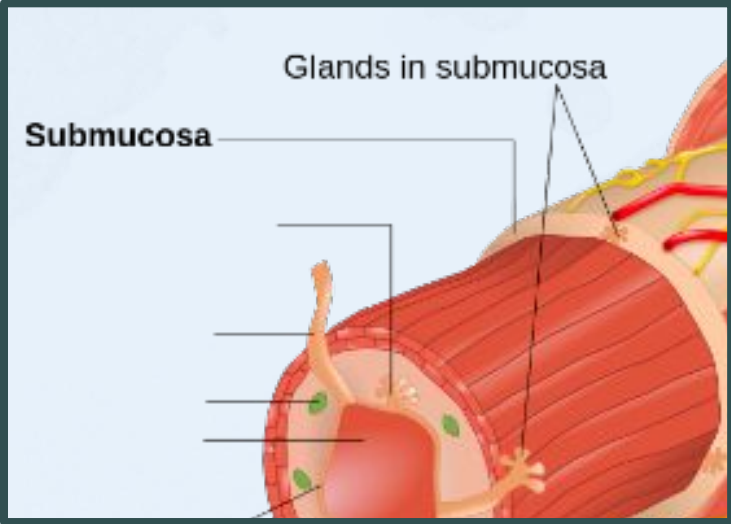
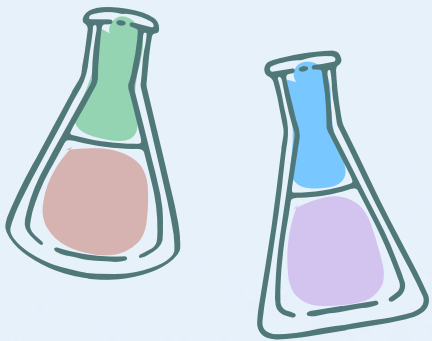
Layers of the GI Tract



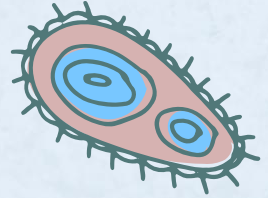
In order of innermost to outermost:

2. Submucosa

- surrounds the mucosa
- contains loose connective tissue as well as glands, blood vessels, lymphatic vessels, and nerves
- provides nutrients to wall of stomach
- **Submucosal (Meissner's) plexus**



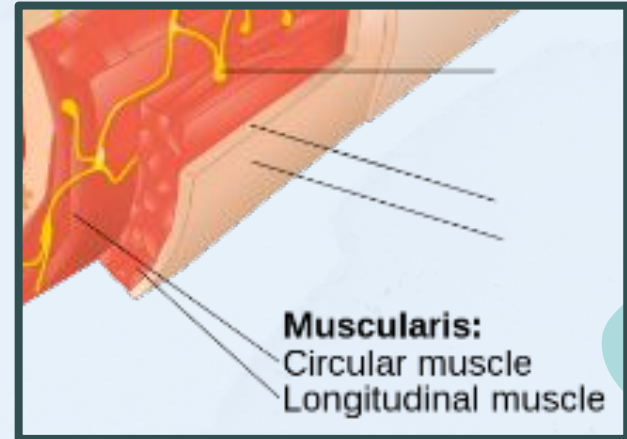
Layers of the GI Tract

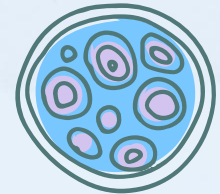
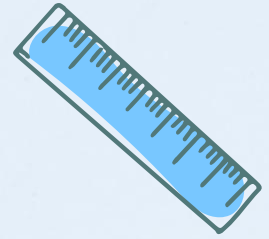
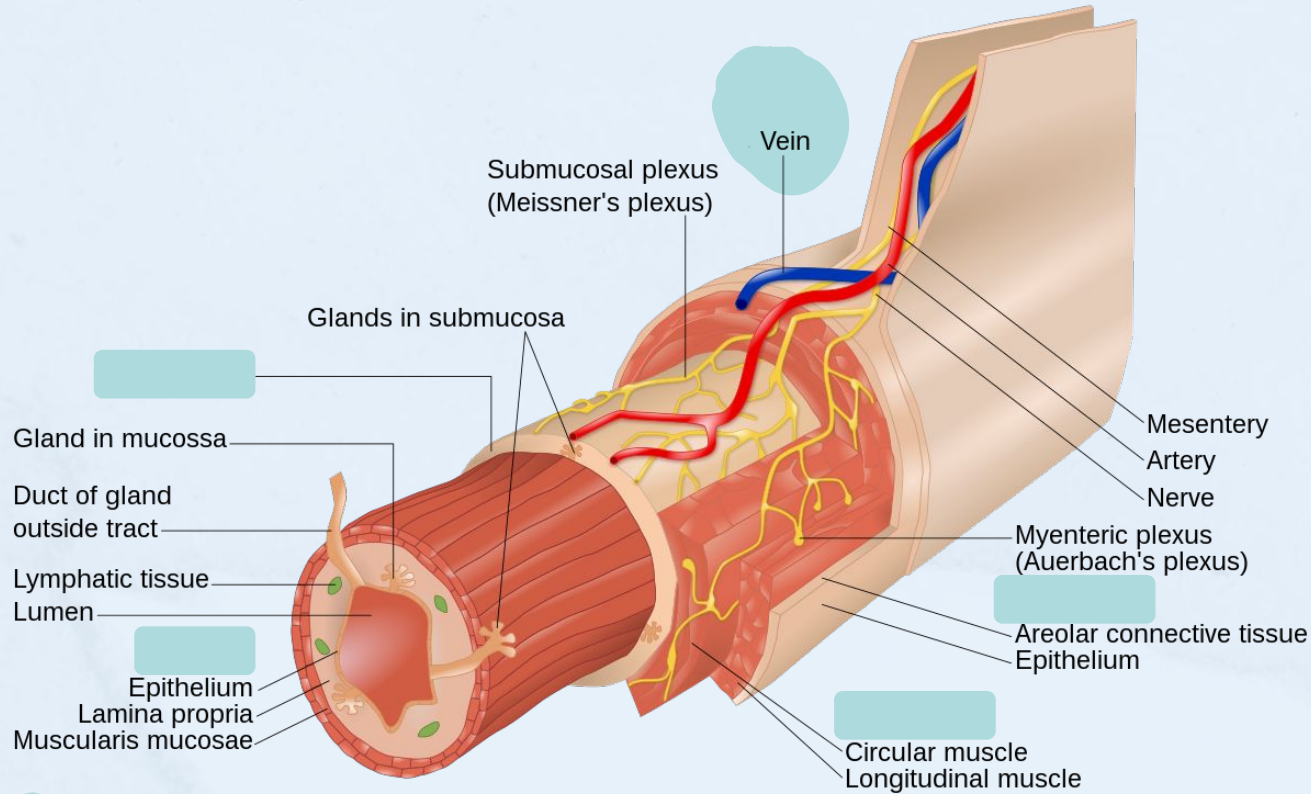


In order of innermost to outermost:

3. Muscularis (*muscularis externa*)

- responsible for segmental contractions and **peristaltic movements** throughout the GI tract
- consists of two layers of smooth muscle
- The layers contract to physically mix food with digestive enzymes, this is called **peristalsis**





Q: Do you know where each of the layers of the GI tract are?

Regulation of Digestion (Extrinsic Effectors)

Extrinsic, or outside, nerves connect the digestive organs to the brain and spinal cord. These nerves release chemicals that cause the muscle layer of the GI tract to either contract or relax, depending on whether food needs digesting.

Parasympathetic effects

The parasympathetic nervous system controls processes in the body such as digestion, repair and relaxation. When the parasympathetic nervous system is dominant in the body it conserves energy, slows heart rate, increases digestion and relaxes sphincter muscles in the digestive tract.

Sympathetic Effects

The sympathetic nervous system is responsible for the 'fight or flight' response experienced in answer to stress, and stimulates blood-flow to the major muscles and brain.



Regulation of Digestion (Intrinsic Effectors)

The intrinsic, or inside, nerves within the GI tract are triggered when food stretches the walls of the hollow organs. The nerves release many different substances that speed up or delay the movement of food and the production of digestive juices.

Enteric Nervous System

- Contains complete reflex circuits that detect the physiological condition of the GI tract, integrate information about the state of the GI tract, and provide outputs to control gut movement, fluid exchange between the gut and its lumen, and local blood flow
- Only part of the peripheral nervous system that contains extensive neural circuits that are capable of local, autonomous function.
- Has extensive, two-way, connections with the central nervous system (CNS), and works in concert with the CNS to control the digestive system in the context of local and whole body physiological demands.



Regulation of Digestion (Intrinsic Effectors)

Paracrine Regulators

- The process whereby a chemical messenger or regulatory peptide is released from a sensing cell, often an EEC, in the intestinal wall that acts on a nearby target cell by diffusion through the interstitial space.
- Paracrine agents exert their actions on several different cell types in the wall of the GI tract, including smooth muscle cells, absorptive enterocytes, secretory cells in glands, and even on other EECs.
- An important paracrine mediator in the gut wall is histamine. In the stomach, histamine is stored and released by ECL cells located in the gastric glands. Histamine diffuses through the interstitial space in the lamina propria to neighboring parietal cells and stimulates the production of acid. **Serotonin** (5-hydroxytryptamine [5-HT]), released from enteric neurons, mucosal mast cells, and specialized EECs called **enterochromaffin cells**, regulates smooth muscle function and water absorption across the intestinal wall.
- There are other paracrine mediators in the gut wall, including prostaglandins, adenosine, and nitric oxide (NO); the functions of these mediators are not well described, but they are capable of producing changes in GI function.



Swallowing (Oral Phase)

- First stage; voluntary process. AKA Buccal phase.
- Involves the contraction of the tongue to push the bolus up against the soft palate and then posteriorly into the oropharynx by both the tongue and the soft palate.
- The pressure that the food bolus places on the posterior oropharynx causes the swallowing center to output signals to initiate and control the next two phases of swallowing, the pharyngeal phase and the esophageal phase.
- During the oral phase, the upper esophageal sphincter is closed, and food will not be able to pass in the esophagus until it is open.



Swallowing (Pharyngeal Phase)

- Involuntary process! (Under autonomic control of the swallowing center located in the lower pons and medulla oblongata of the brainstem)
- Tongue is blocking the oral cavity.
- But then the soft palate is raised, allowing the pharynx to receive the bolus after shortening and widening, at the same time, the larynx will elevate resulting in the epiglottis blocking the trachea.
- Finally, the sphincter relaxes and opens, allowing food to enter the esophagus.
- During this phase, breathing is inhibited, and the epiglottis blocks off the upper airway to prevent the food bolus and liquids from entering the airway and being inhaled.
 - If food does enter the airway, the coughing reflex is triggered.
 - This can happen if someone talks or inhales while swallowing.



Swallowing (Esophageal Phase)

- Food bolus then moves through the esophagus via peristalsis.
- Esophagus pierces the diaphragm at the esophageal hiatus, and continues to join the stomach at the cardiac orifice, which is surrounded by the sphincter.
- As the bolus approaches the stomach, the sphincter will open and allow the food bolus to pass into the stomach.
- Once the bolus has entered, the sphincter will close.

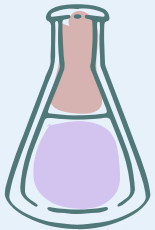
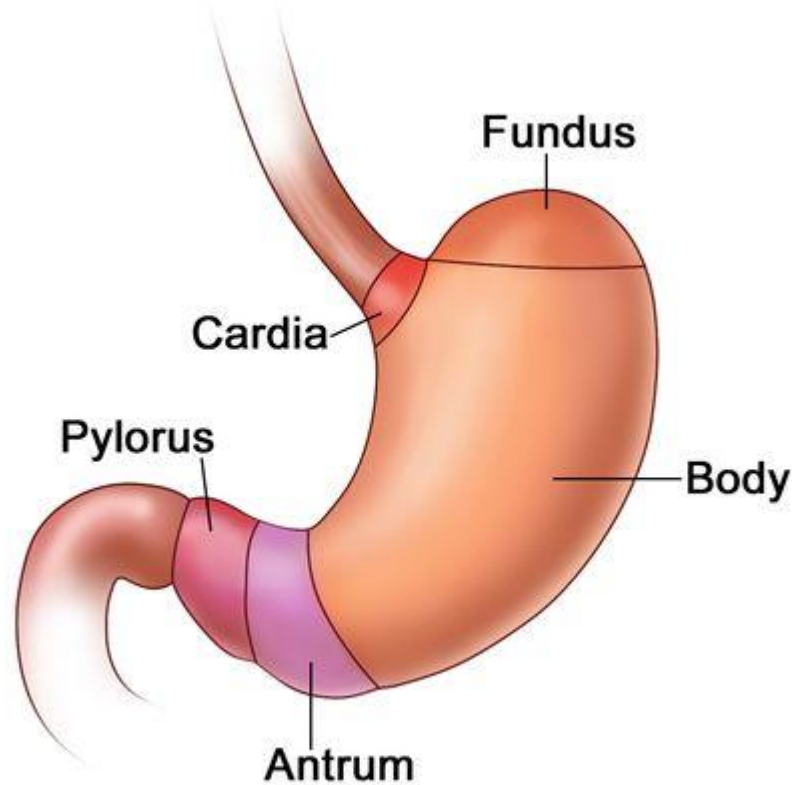


Esophageal Peristalsis

- Smooth muscle contraction and motion required
- Heartburn is caused when the contents of the stomach squeeze up the sphincter into the stomach.
- Since food inside the stomach is only kept there by the force of gravity, so don't lie down after a big meal. Usually, taking an antacid and waiting is all the treatment needed for heartburn in healthy people.



Anatomy and Division of the Stomach



Cardiac Region

- The part of the stomach that is closest to the esophagus.
- Food and liquids pass through the cardia to enter the stomach from the esophagus.
- A valve near the cardia helps keep stomach contents from backing up into the esophagus.



Fundus

- Dome shaped superior dilation of the stomach that projects superiorly to the level of the cardial orifice (which is the opening between the esophagus and the stomach).
- The fundus of stomach lies in contact with the left dome of the diaphragm and allows for the accumulation of gases produced by digestion.



Body and Antrum

Body

- The largest section of your stomach.
- In the body, your stomach contracts and begins to mix food.

Q: Do you still remember what the mixing of food is called?

Antrum

- Lies below the body.
- It holds food until your stomach is ready to send it to your small intestine.



Pyloric Region

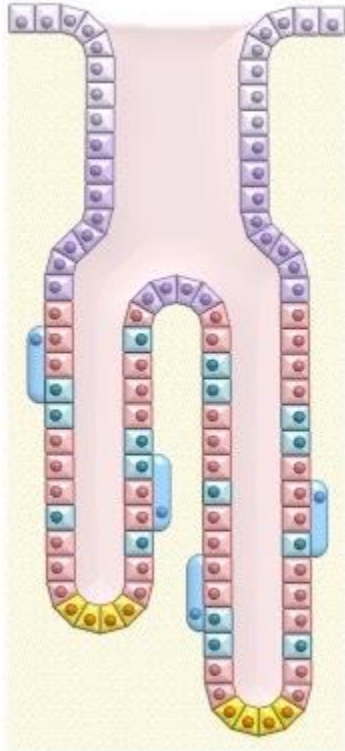
- The part of the stomach that connects to the duodenum

Q: Do you still remember what the duodenum does?

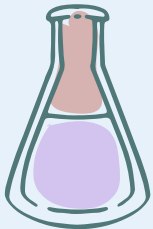
- The pylorus is a valve that opens and closes during digestion.
- This allows partly digested food and other stomach contents to pass from the stomach to the small intestine.

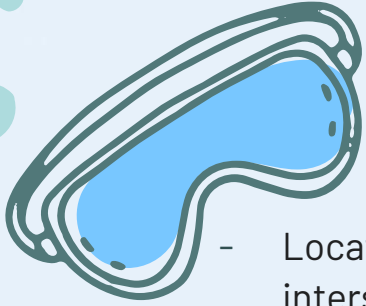


Gastric Glands and Secretions



| Cell Types | Substance Secreted |
|----------------|--|
| Goblet cells | Mucus (protects stomach lining) |
| Parietal cells | Gastric acid (e.g. hydrochloric acid) |
| Chief cells | Pepsinogen (protease precursor) |
| D cells | Somatostatin (inhibits acid secretion) |
| G cells | Gastrin (stimulates acid secretion) |

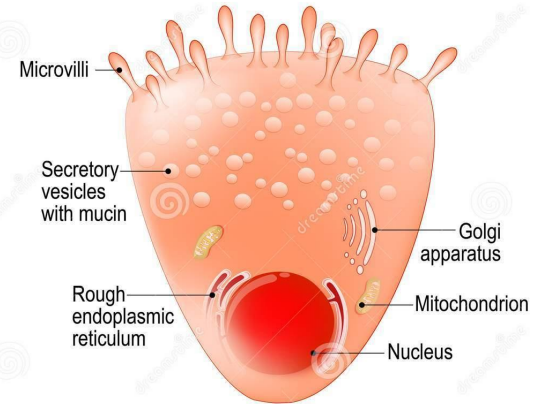




Mucous Neck Cells

- Located within gastric glands, interspersed between parietal cells.
- These are shorter than their surface counterpart and contain lesser quantities of mucin granules in their apical surface.
- Found in the upper parts (isthmus and neck) of the gastric glands.
- They are smaller than surface mucous cells and produce mucins.
- This mucus protects the epithelium from digesting itself.

Mucous neck cell



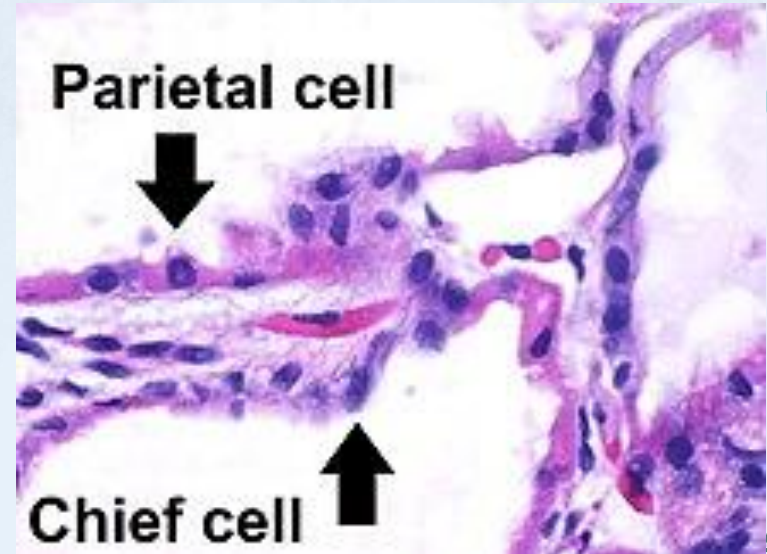
Parietal Cells

- Secrete hydrochloric acid which is responsible for creating a low pH environment in the stomach
- Secrete H^+ ions (via active transport), which combine with Cl^- ions to form hydrochloric acid
- Certain medications and disease conditions can increase the secretion of H^+ ions, lowering the pH in the stomach



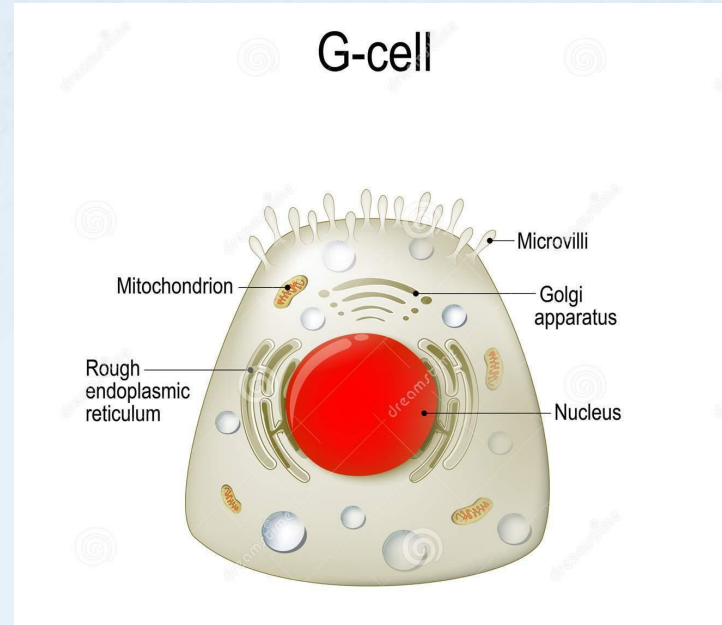
Chief/Zymogenic Cells

- Secrete pepsinogen (inactive protease precursor which is activated by acidity to form active pepsin)
- Located at base of glands throughout the fundus and body of the stomach



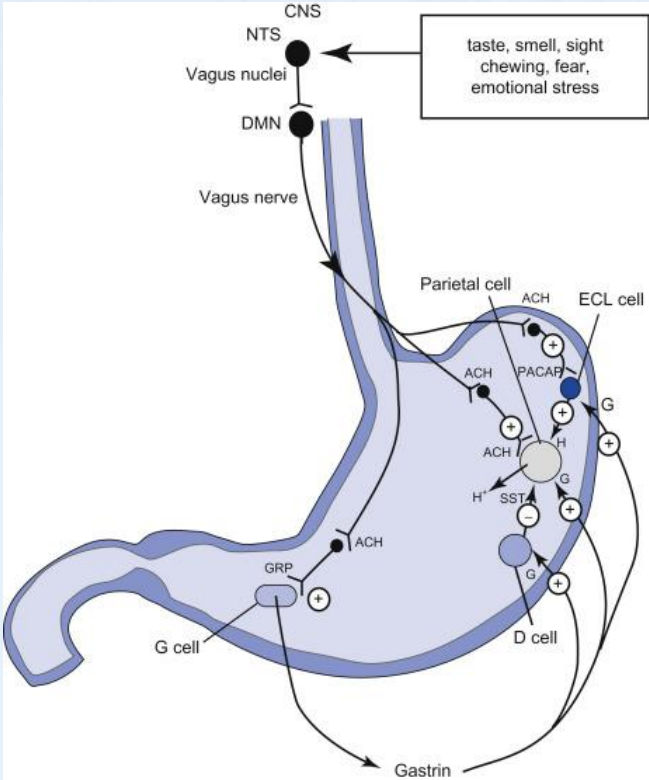
G Cells

- Secrete gastrin (stimulates release of stomach acids to increase stomach acidity)
- Primarily found in pyloric antrum, but can be found in duodenum and pancreas



D Cells

- Secrete somatostatin (inhibits release of stomach acids to reduce stomach acidity)
- Can be found in stomach, intestine and pancreas.



pH in the Stomach

- The pH of your stomach varies, but its natural state is between 1.5 and 3.5.
- This level rises when food enters the stomach; it can reach up to six, but it lowers again throughout digestion as stomach acid is secreted.
- Denaturing ingested proteins and other molecules
- Pepsin most active at low pH (optimum pH)
- Pepsin best activates other pepsinogen at low pH
 - Pepsinogen is secreted by chief cells in the stomach.
 - Once it's activated by low pH, it helps digest proteins.



How does the stomach stay protected against its own acidic secretions?

- Mucus secreted from goblet cells of the mucosa that contain **alkaline bicarbonate ions** help to neutralize the acids as well as slowing diffusion of digestive enzymes
- **Ulcers:** erosions of the mucosa of the stomach or duodenum

Q: What bacteria causes peptic ulcers?

