



🏆 Let's Take Attendance 🏆

<http://sciovirtual.org/attendance>

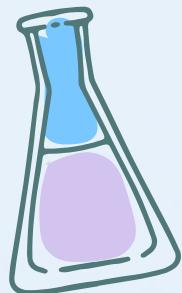
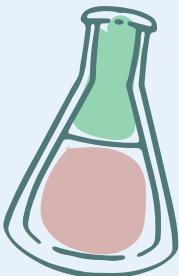
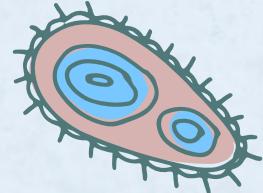
Attendance code: bio94

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>

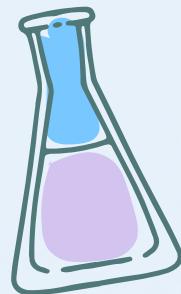
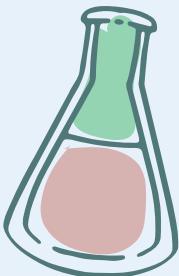
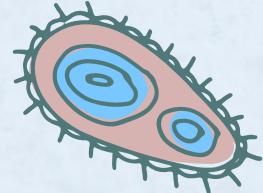
Gartic Phone

- Draw anything you want
- We will all guess what you have drawn
- Upload your drawings at the following google classroom:
 - Code: zioweml

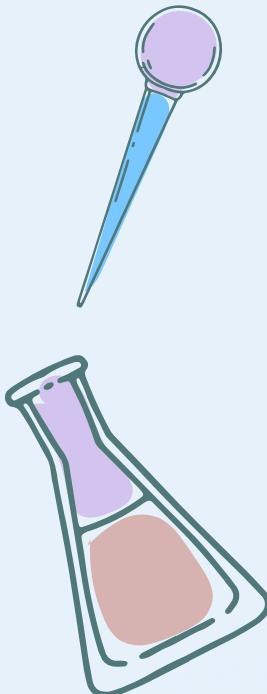


Course Challenge

- Will be attached to the form for homework
- Create a model of the whole digestive tract
 - Use slides for lesson 1 for all parts of digestive tract
 - Label different parts and function
 - Can be hand drawn or online or whatever you like
 - You can work together if you want



$\pi = 3,141592$



Lesson 2

Digestive System

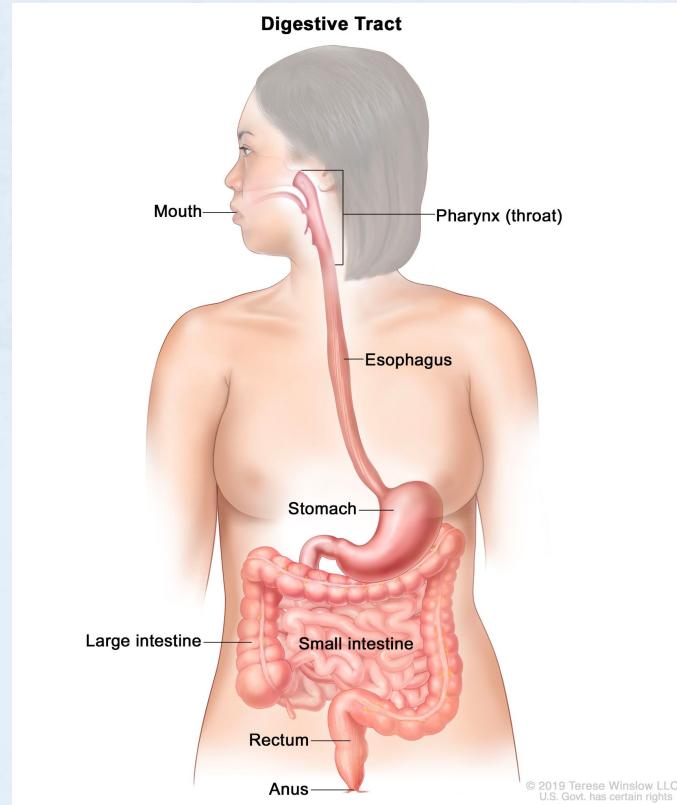
ScioCamp 2022: Anatomy & Physiology

The GI Tract (Gastrointestinal Tract)

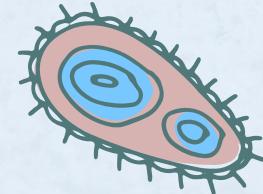
Other names for the GI Tract:

- 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?



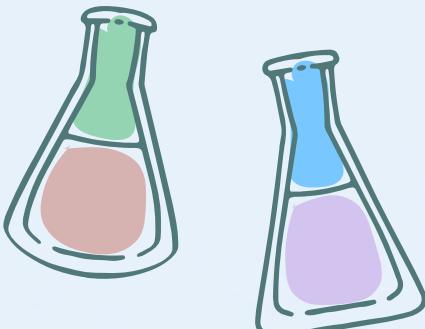
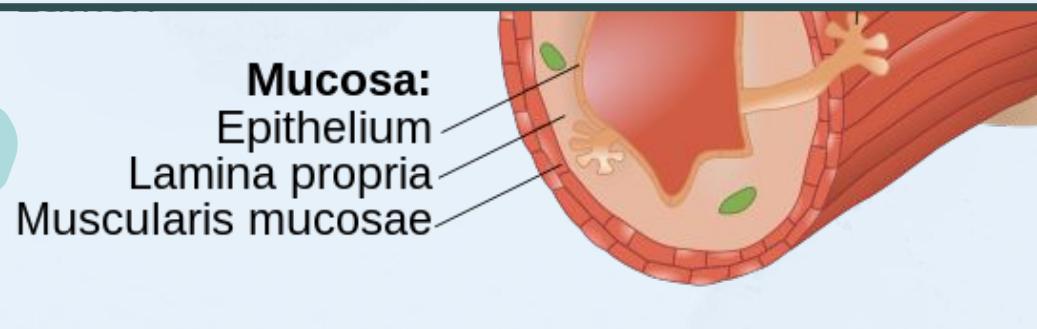
Layers of the GI Tract



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**
- **Lamina propria**(connective tissue with lymph nodules which protect against disease)
- **Muscularis mucosae**(thin layer of smooth muscle)

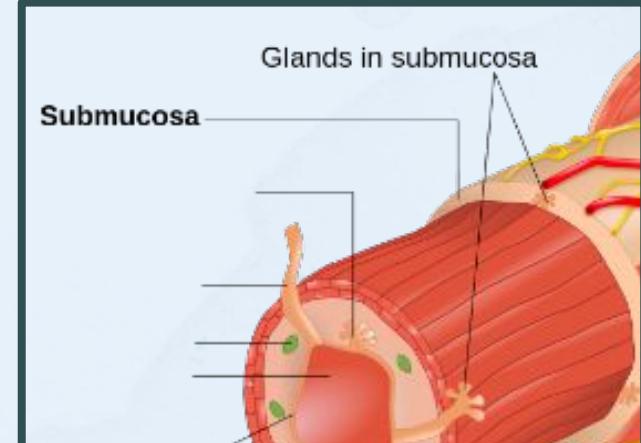


Layers of the GI Tract

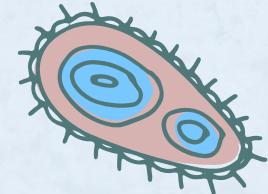
In order of innermost to outermost:

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 - muscularis mucosae of intestines**



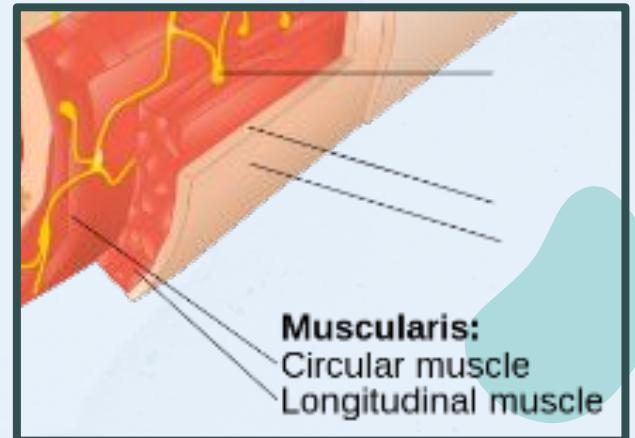
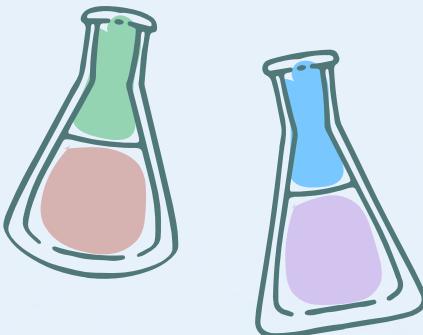
Layers of the GI Tract



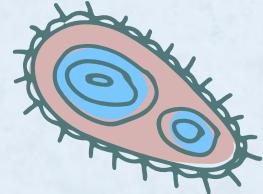
In order of innermost to outermost:

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**
- Myenteric(Auerbach's) plexus - major nerve supply



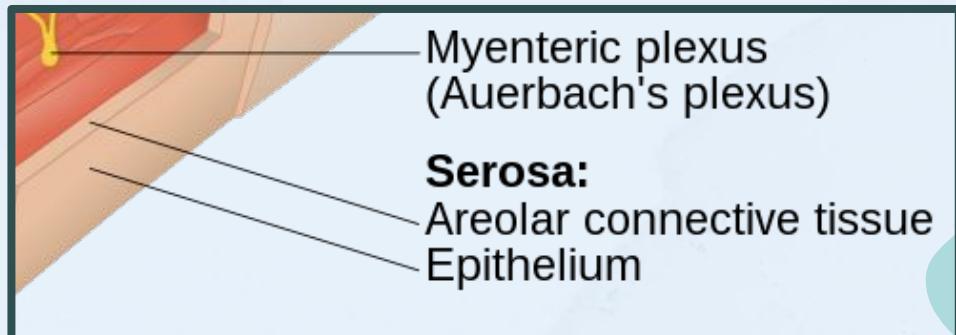
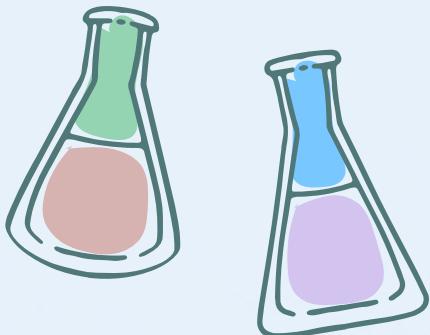
Layers of the GI Tract

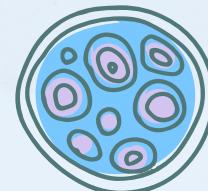
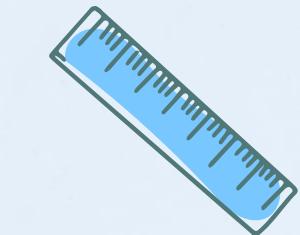
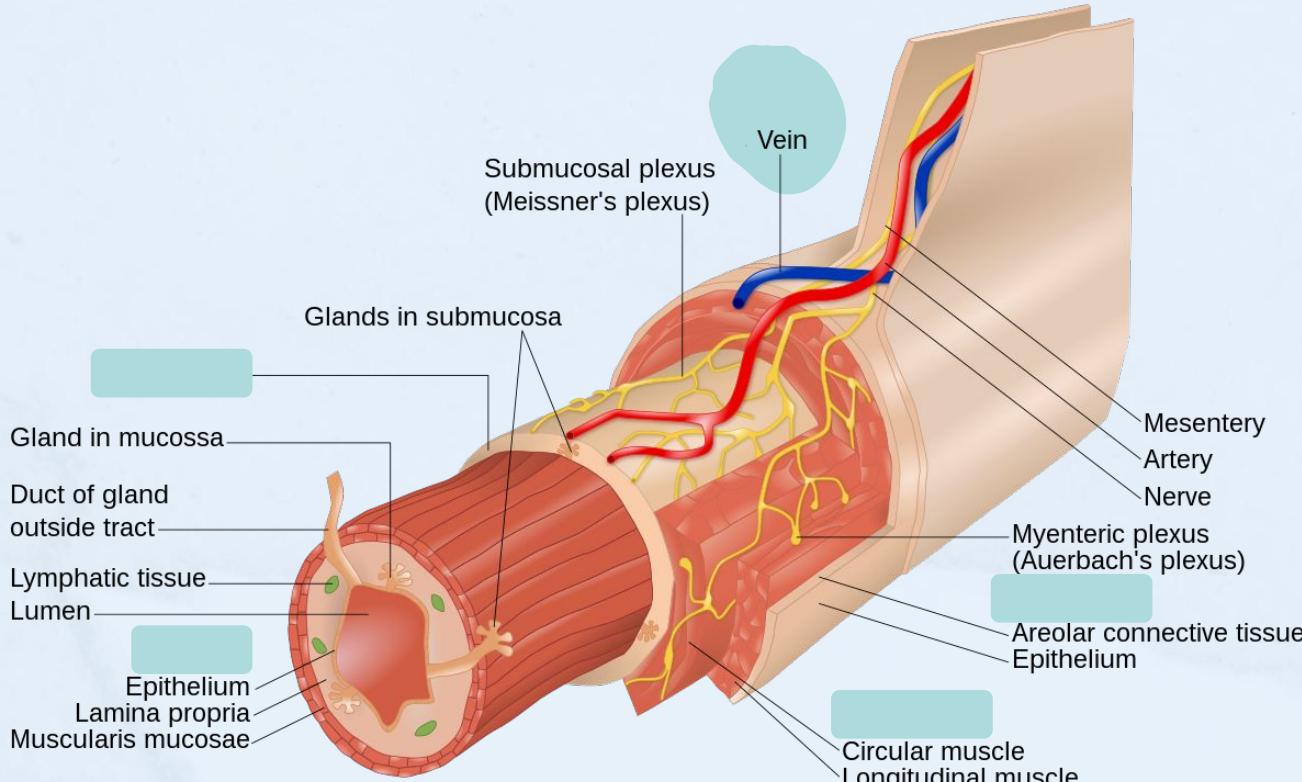


In order of innermost to outermost:

4. Serosa

- completes the wall of the GI tract
- consists of **areolar connective tissue** and is covered with a layer of **simple squamous epithelium**





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 response to stress, and stimulates blood-flow to the major muscles and brain.

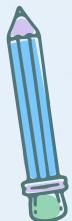


Regulation of Digestion (Intrinsic Effectors)

The intrinsic, or inside, sensory 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

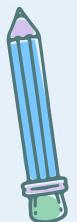
- Contains complete reflex circuits that detect the physiological condition of the GI tract, integrate information about the state of the GI tract, and provide outputs to control gut movement, fluid exchange between the gut and its lumen, and local blood flow
- Only part of the peripheral nervous system 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



Regulation of Digestion (Intrinsic Effectors)

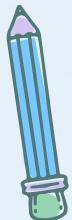
Paracrine Regulators

- The process whereby a chemical messenger or regulatory peptide is released from a cell, often an enteroendocrine cell(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 enterochromaffin-like (ECL) cells located in the gastric glands(stomach). 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 **enterochromaffin cells**, regulates smooth muscle function and salt and water secretion across intestinal wall.
- ECL cells produce motilin, stimulating contractions of duodenum and stomach antrum
-



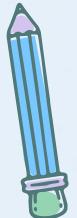
Swallowing (Oral Phase)

- 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 nasopharynx by both the tongue and the soft palate.
- The pressure that the food bolus places on the nasopharynx activates the oropharyngeal sensory receptors of the glossopharyngeal nerve (CN IX), which then send signals to the solitary nucleus in the swallowing center located in the lower pons and medulla oblongata of the brainstem.
- The swallowing center then outputs signals to 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.



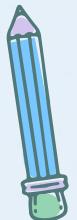
Swallowing (Pharyngeal Phase)

- 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 tip a fold of tissue called the epiglottis down, blocking the trachea.
- Finally, the upper esophageal 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.



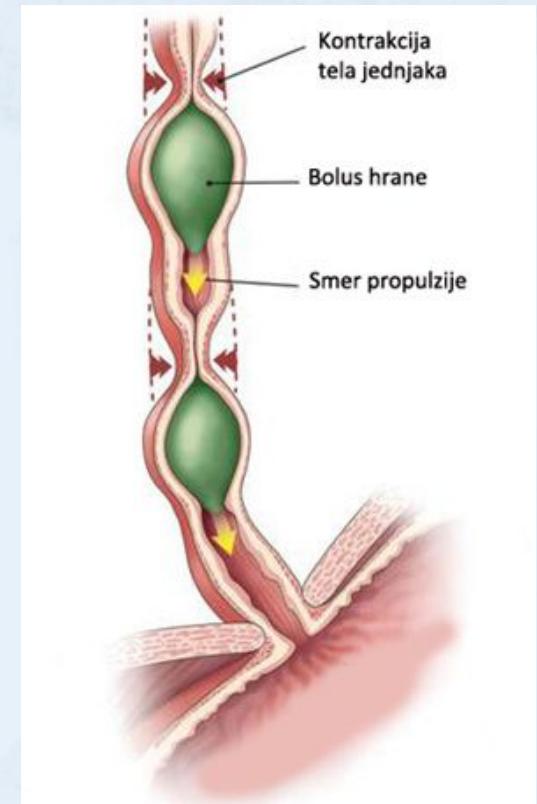
Swallowing (Esophageal Phase)

- 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 gastroesophageal sphincter
 - Space within called cardiac orifice
- 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
 - Important for not allowing acid to go into esophagus

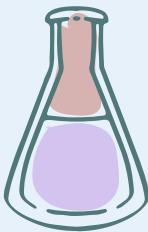
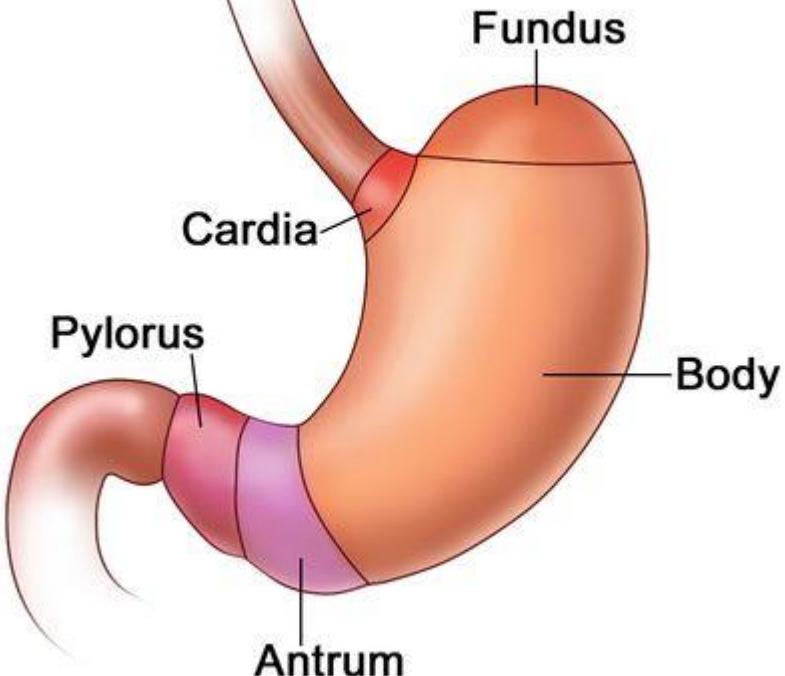


Esophageal Peristalsis

- Smooth muscle contraction and motion required
- Heartburn is caused when the contents of the stomach squeeze up the sphincter into the stomach.
 - Usually, taking an antacid and waiting is all the treatment needed for heartburn in healthy people.
- Contraction behind bolus and relaxation in front of bolus

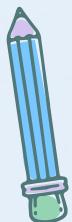


Anatomy and Division of the Stomach



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 sphincter 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 cardiac orifice (which is the opening between the esophagus and the stomach).
- The fundus of stomach allows for the accumulation of gases produced by digestion.



Body and Antrum

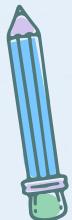
Body

- 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?

Pyloric region(below body)

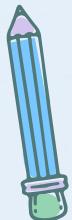
- Antrum
 - Lies below the body.
 - It holds food until your stomach is ready to send it to your small intestine.



Pyloric Region

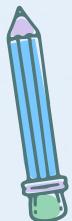
- The part of the stomach that connects to the duodenum

Q: Do you still remember what the duodenum does and what part of the GI tract it is a part of?

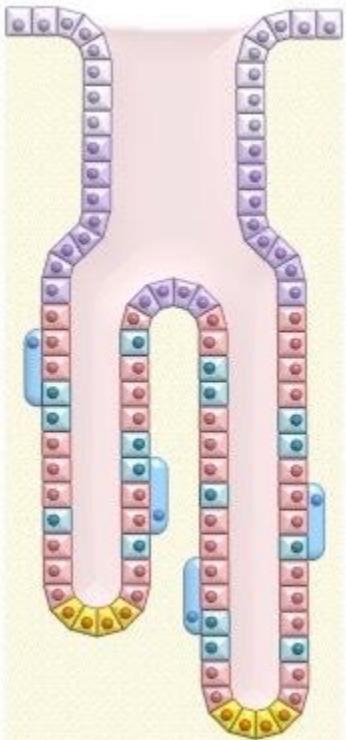


Pyloric Sphincter

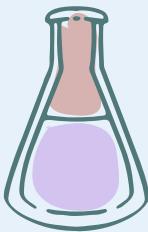
- A ring of smooth muscle that connects the stomach and small intestine.
- It opens and closes to control the passage of partially digested food and stomach juices from the pylorus to the duodenum.
- Sometimes, the pyloric sphincter is weak or doesn't work properly, leading to digestive problems, including:
 - Bile Reflux
 - Bile backs up from small intestine to stomach
 - Gastroparesis
 - Disorder of muscles in stomach where stomach cannot empty itself properly



Gastric Glands and Secretions

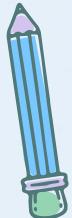
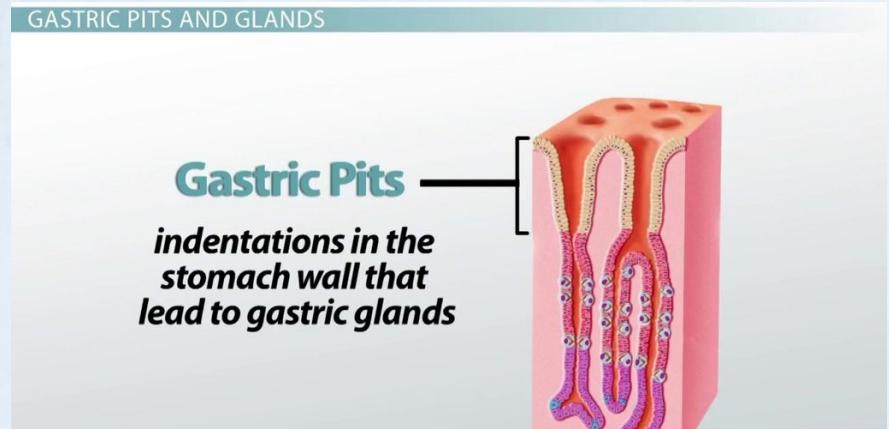


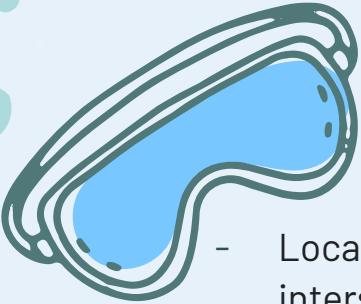
Cell Types	Substance Secreted
Goblet cells	Mucus (protects stomach lining)
Parietal cells	Gastric acid (e.g. hydrochloric acid)
Chief cells	Pepsinogen (protease precursor)
D cells	Somatostatin (inhibits acid secretion)
G cells	Gastrin (stimulates acid secretion)



Gastric rugae

- Inner surface of stomach is folded
- Openings of these folds into stomach lumen are called gastric pits
- Cells lining these folds secrete products into stomach
 - Gastric glands

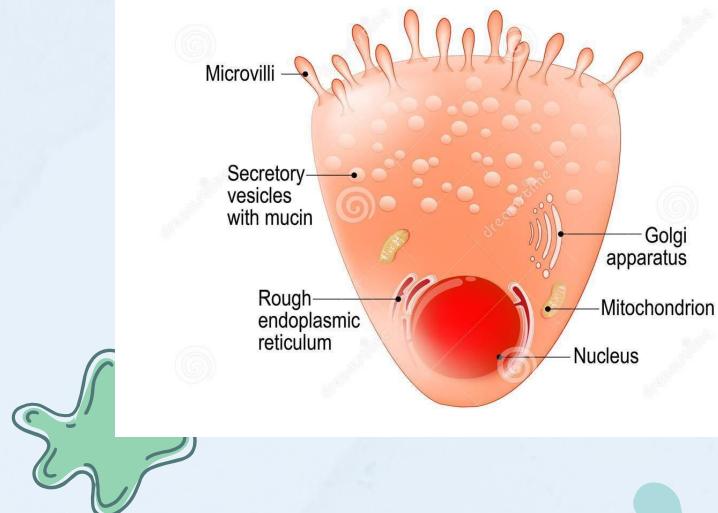




Mucous Neck Cells

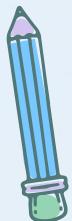
- Located within gastric glands, interspersed between parietal cells.
- These are shorter than their surface counterpart and contain lesser quantities of mucin granules in their apical surface.
- Found in the upper parts (isthmus and neck) of the gastric glands.
- They are smaller than surface mucous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

Mucous neck cell



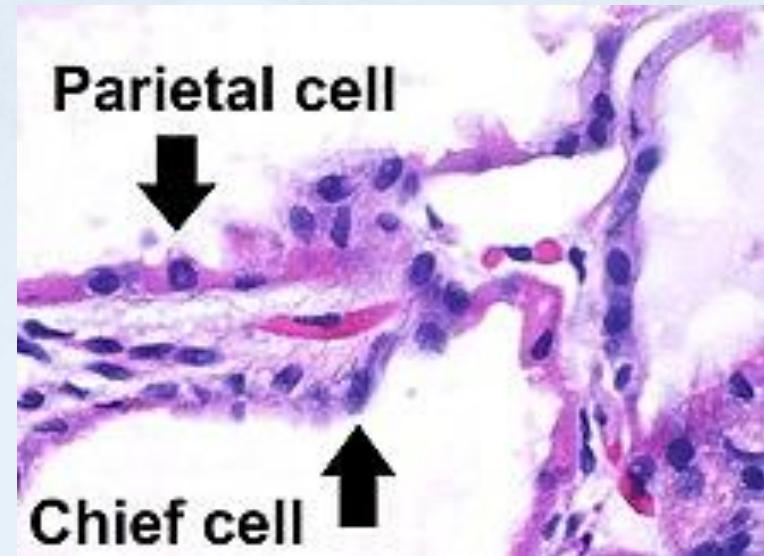
Parietal Cells

- 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



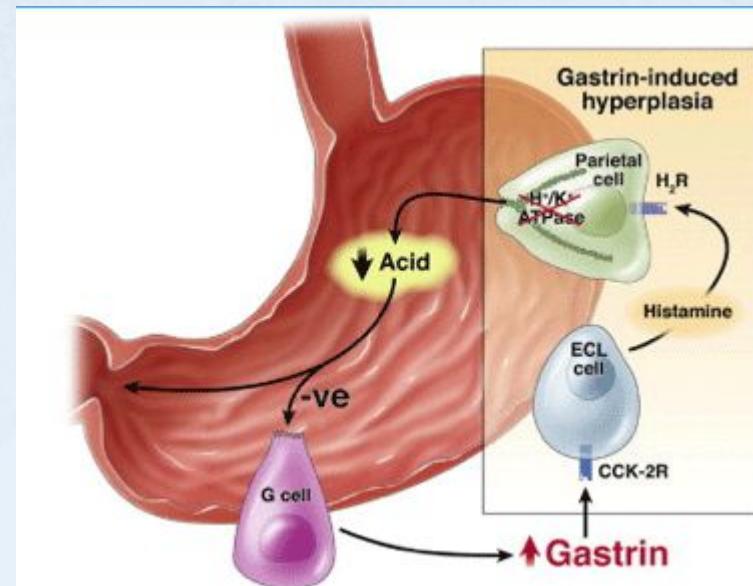
Chief/Zymogenic Cells

- 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



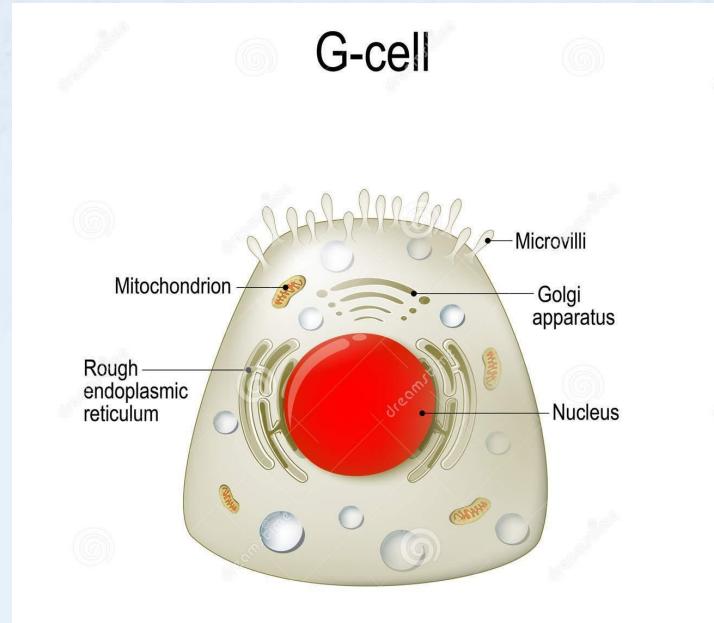
Enterochromaffin-like Cells

- Found in the gastric glands of the gastric mucosa beneath the epithelium, in particular near parietal cells
- Aid in the production of gastric acid via the release of histamine.
- Also considered a type of enteroendocrine cell.



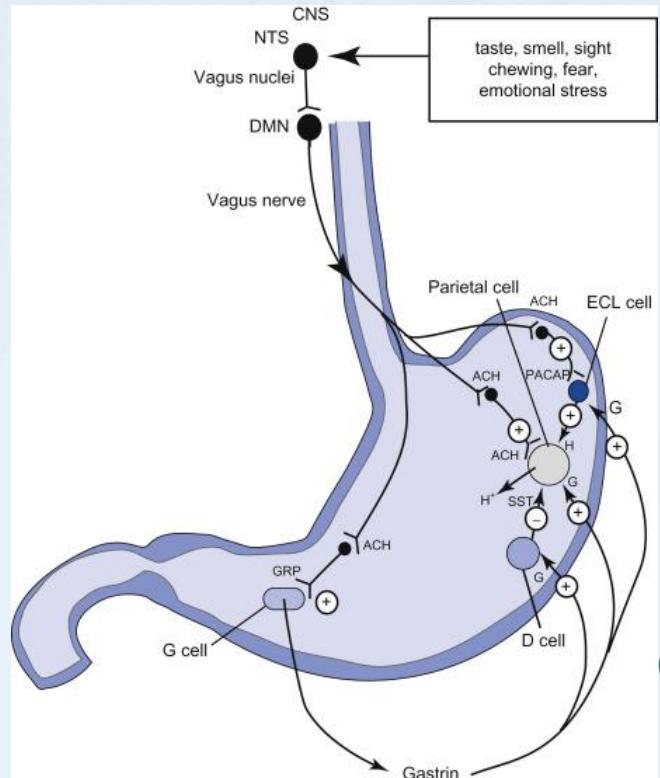
G Cells

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



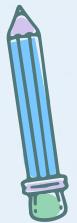
D Cells

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



Goblet cells

- Secrete mucus
 - Protects stomach lining and prevents self-digestion

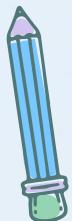


Ghrelin

- A hormone which signals your brain when your stomach is empty and it's time to eat.
- Ghrelin levels increase between mealtimes and decrease when your stomach is full.
- People who have obesity often have low ghrelin levels, while people who significantly restrict their calorie intake have high ghrelin levels.

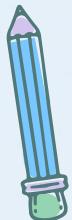
Ghrelin has several key functions. But for digestion, it:

1. Signals part of your brain called the hypothalamus to increase appetite.
2. Promotes fat storage.
3. Stimulates your digestive system to move food from your stomach through your small and large intestines.



pH in the Stomach

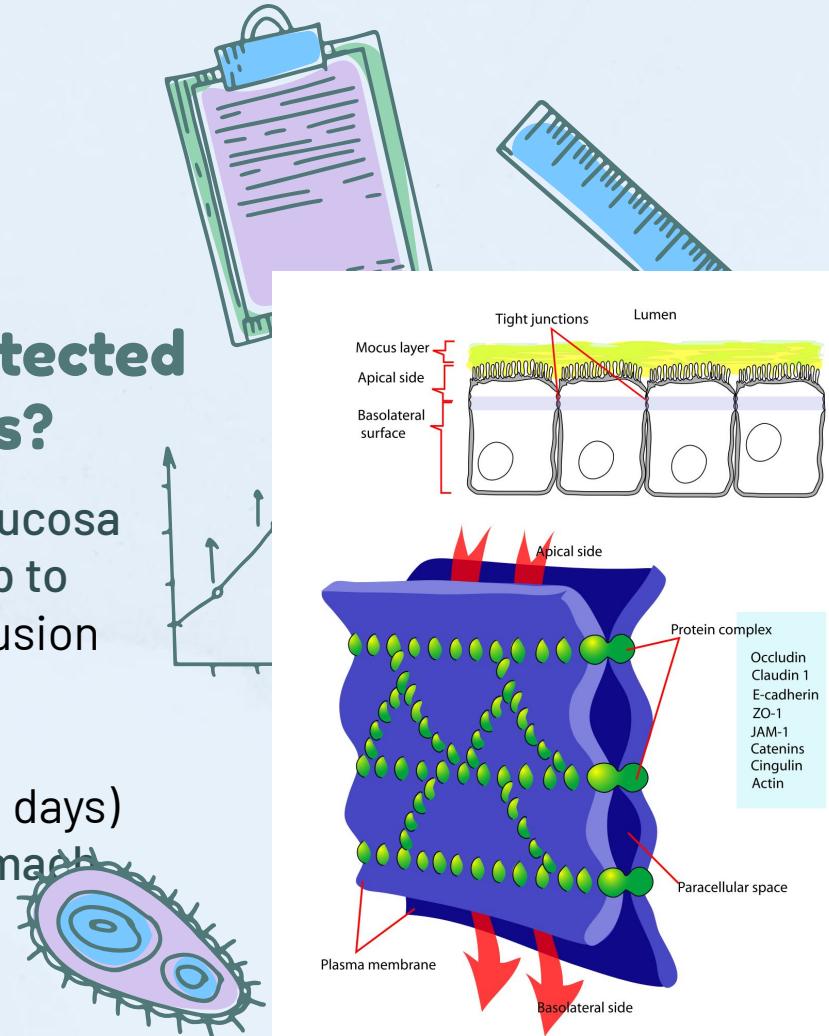
- The pH of your stomach varies, but its natural state is between 1.5 and 3.5.
- This level rises when food enters the stomach; it can reach up to six, but it lowers again throughout digestion as stomach acid is secreted.
- Denaturing ingested proteins and other molecules
- Pepsin most active at low 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?

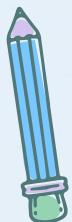
- Mucus secreted from goblet cells of the mucosa that contain **alkaline bicarbonate ions** help to neutralize the acids as well as slowing diffusion of digestive enzymes
- Tight junctions between epithelial cells
- Stomach lining rapidly regenerates(every 3 days)
- **Ulcers:** erosions of the mucosa of the stomach or duodenum

Q: What bacteria causes peptic ulcers?



More information

- Go read Fox Chapter 16(respiration) and 18(digestion):
 - <http://library.lol/main/80F5169D0BC997AD06EB67462C68485F>
- Science Olympiad Digestive Notes:
 - https://sciology.org/wiki/index.php/Anatomy/Digestive_System
- Campbell's Biology Chapter 41(digestive) and part of 42(respiratory):
 - <http://library.lol/main/EEDC6CFC9E0CE4439369C1AB7D3E3B63>



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