STATION CARDS
EXPLORE 1 LESSON 3

Food and Agriculture Center for Science Education

Station 1: The Mouth/Esophagus

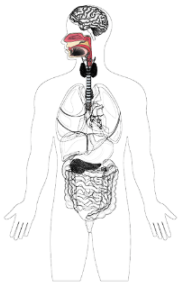
The mouth is where food enters the digestive system. The mouth includes the tongue, teeth, cheeks, and salivary glands. In the mouth, food is chewed and mixed with saliva. The chewing action from the lips, tongue, cheeks, teeth, and jaws breaks food down mechanically into small pieces, forming a bolus that can be swallowed. When food is chewed, the teeth break, crush, and grind food into increasingly smaller pieces.

While chewing, saliva is released by three salivary glands: the parotid (in the check), the sublingual (under the tongue), and the submandibular (under the lower jaw). These salivary glands release saliva to aid in the breakdown of food. The tongue helps to mix the food with saliva and helps food to be swallowed. Saliva contains water, mucus, and enzymes that can contribute to the chemical digestion of some nutrients. Cells called acinar cells line the surface of the salivary glands. These cells are involved in the production and release of saliva into the mouth.

The food passes from the mouth into the esophagus. The esophagus is a long, narrow tube that carries food from the pharynx to the stomach. It has no other digestive functions. It remains in a closed form when not engaged in swallowing. Peristalsis, or the muscular contractions that help move food through the body, start at the top of the esophagus when food is swallowed and continue down the esophagus in a single wave.

At the Mouth/Esophagus station, you will complete an investigation to determine if a common digestive enzyme in the mouth, amylase, has a role in the digestion of milk in the mouth.

Mouth/Esophagus



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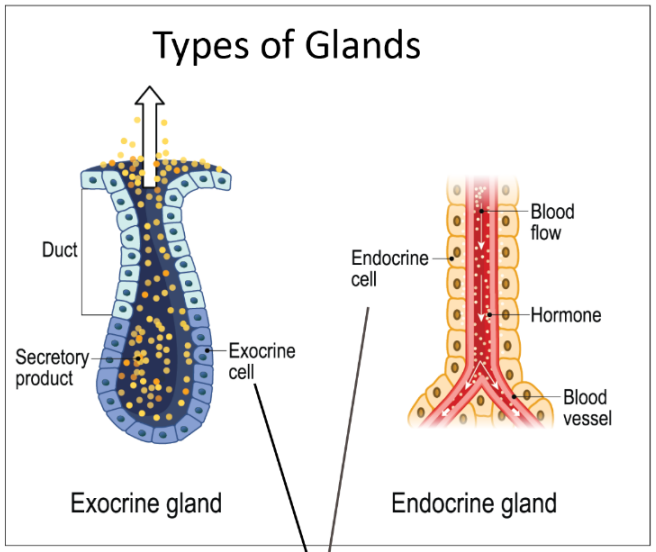

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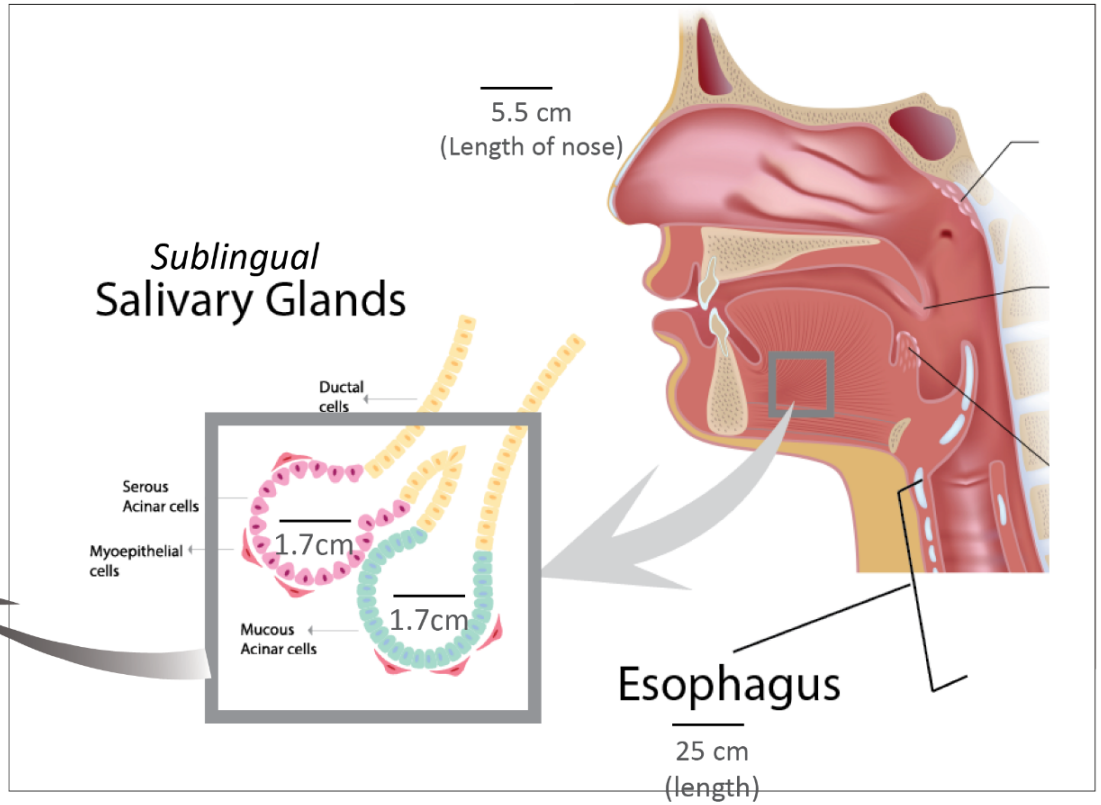


Digestion Station - Mouth/Esophagus

Part 1: Planning for the Experiment

1. What digestive enzyme is found in the in this organ?

2. According to the ***Testing for Digestion Appendix***, what type of nutrient/molecule does this enzyme act on?

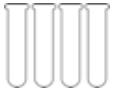
The ***Testing for Digestion Appendix*** lists reagents that can be used to test for the digestion of each type of nutrient. Refer to the appendix to answer the following questions.

3. Which reagent should be selected to test for digestion that occurs in the mouth?

4. Based on your answer, add the needed reagent(s) any additional items noted in the appendix to the **Materials**

Materials List

Milk
Digestive enzyme:
Testing reagent:
Other (if needed):
37 Degree Celsius Water Bath
Thermometer
4 labeled test tubes
Test tube rack
5 pipettes (m - 5ml)
Standard lab safety gear

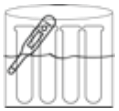


1. Label each test tube (C = control, E = experimental milk).
2. Add 5ml of the appropriate milk to each test tube.
3. Note the contents added to each test tube (including amount) on in the corresponding boxes below.
    - Add the indicator to all test tubes. Note the amount.
    - Add the appropriate enzyme to test tubes 1 and 2. Note the amount.
    - If called for, add any extra materials to all test tubes.

C: Milk -- Control
- 5ml milk
- Other (if called for):
- Reagent:

E: Milk -- Experimental
- 5ml milk
- Enzyme:
- Other (if called for):
- Reagent:

Digestion Station - Mouth/Esophagus (continued)



Part 3: Water Bath

1. Check that the water bath is approximately 37 degrees C/98 degrees F
2. Note the temperature of the water bath (note any fluctuations throughout)
3. Add test tubes to water bath for 10 minutes (assuming milk is already at body temp). If cold, reaction may require 12 - 15 minutes.
4. Remove test tubes from water bath.

Part 4: Notes/Observations

Use the space below to capture your observations throughout and after the investigation.

Part 5: Interpreting Results

Use the ***Interpreting Results*** of the Testing for Digestion Appendix and the Digestion of Nutrients Appendix for each solution (control milk and experimental milk):

- What nutrient(s) are digested in this organ?

- For each test tube, were the results of your tests positive or negative for digestion?

Station 2 - The Stomach

The stomach is one of the gastrointestinal organs responsible for the digestion of food. It's shaped like the letter J and sits in the upper left quadrant of the abdomen. Food enters through a round opening between the lowest part of the esophagus and the top of the stomach. Surrounding the stomach opening is a sphincter muscle known as the esophageal sphincter, which acts as a valve. It relaxes to open and allows food to pass into the stomach, and it constricts to close and prevents the passage of stomach acid and food back into the esophagus.

The stomach wall is made of three layers of smooth muscle: a layer running side-to-side, another top to bottom, and a third that encircles the stomach. The layers allow the stomach to contract from multiple angles. The contraction and relaxation of the muscle fibers aid the stomach in physically churning food to help break it down mechanically and emptying the stomach.

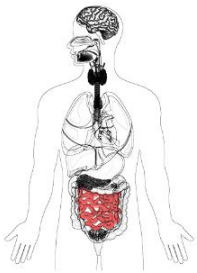
Epithelial tissue makes up the inner lining of the stomach. Epithelial tissue is a type of tissue found on many surfaces and linings throughout the body. It is a thin, protective layer of tightly packed cells. The epithelial tissue along the innermost layer of the stomach contains millions of tiny glands. The glands of the stomach are lined with four different types of cells.

- G-cells secrete the hormone gastrin directly into the bloodstream. The gastrin in the bloodstream triggers the other three types of cells to produce secretions.
- Parietal cells produce stomach acid (hydrochloric acid), which creates an acid (low pH) environment to kill pathogens, aids in the chemical breakdown of food, and activates digestive enzymes.
- Mucous neck cells produce mucus that forms a protective layer to keep the stomach cells from being harmed by stomach acid.
- Chief cells produce the digestive enzyme pepsin.

The combination of mechanical digestion via the churning of the stomach muscle and the chemical digestion via the enzymes present in gastric juice eventually transforms the food that initially arrived in the stomach into a thick, semi-digested fluid mixture called chyme. Chyme is then passed out of the stomach through another sphincter muscle, known as the Pyloric sphincter or valve. The pyloric sphincter relaxes when ready, and the chyme passes into the small intestine. Then, it closes to prevent stomach acid and other contents from passing to the small intestine.

At the Stomach station, you will do an investigation to determine the role of pepsin in the digestion of milk in the stomach.

Stomach



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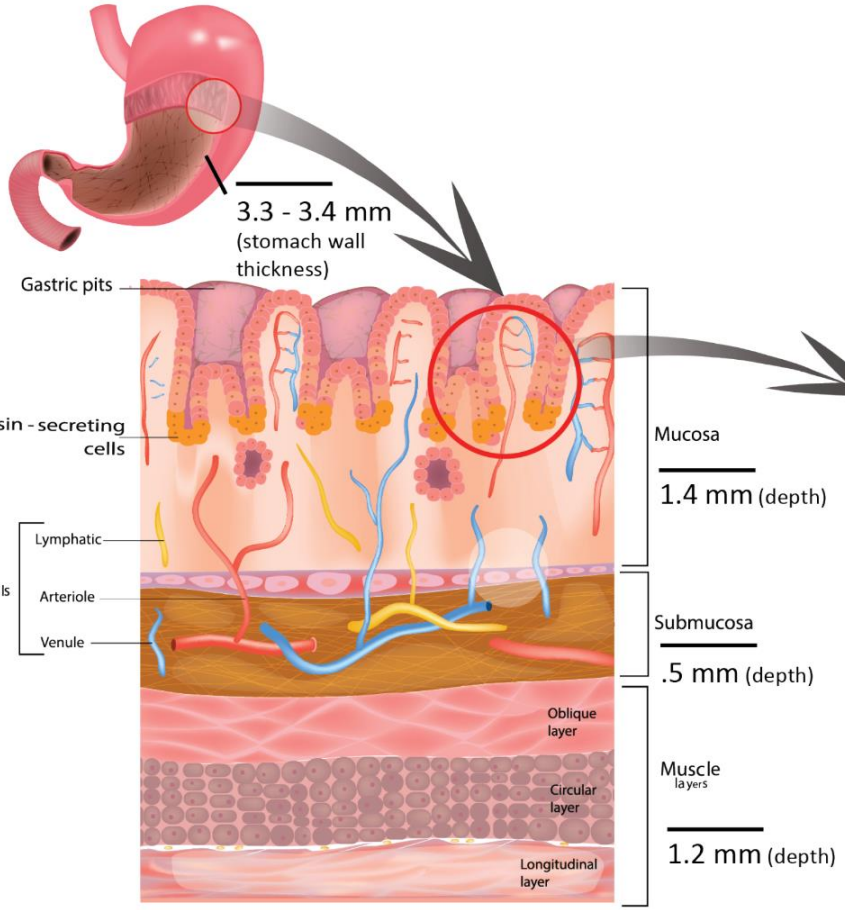
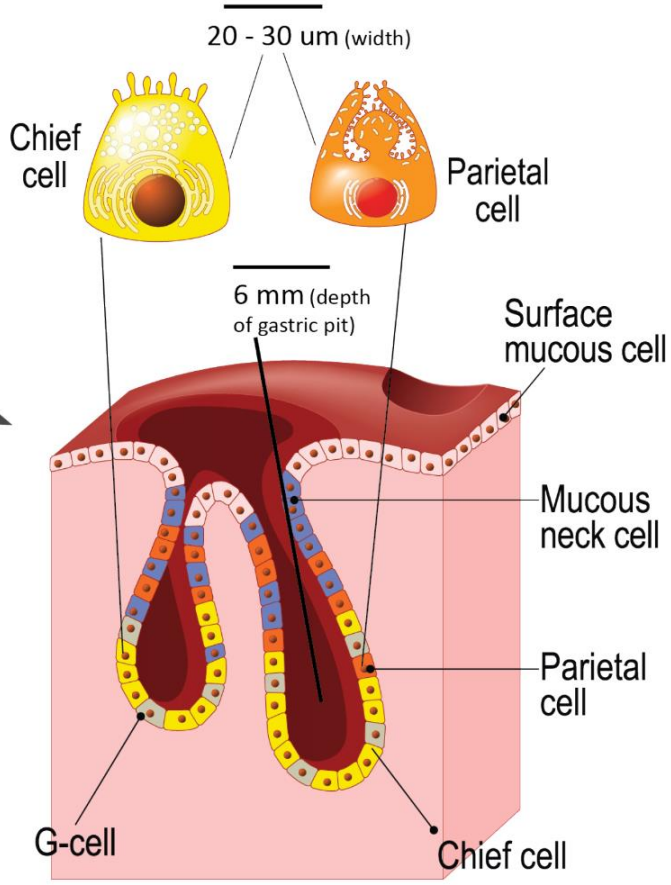




Digestion Station - Stomach

Part 1: Planning for the Experiment

1. What digestive enzyme is found in the in this organ?

2. According to the ***Testing for Digestion Appendix***, what type of nutrient/molecule does this enzyme act on?

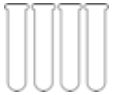
The ***Testing for Digestion Appendix*** lists reagents that can be used to test for the digestion of each type of nutrient. Refer to the appendix to answer the following questions.

3. Which reagent should be selected to test for digestion that occurs in this organ?

4. Based on your answer, add the needed reagent(s) any additional items noted in the appendix to the **Materials List** below.

Materials List

Milk
Digestive enzyme:
Testing reagent:
Other (if needed):
37 Degree Celsius Water Bath
Thermometer
2 labeled test tubes
Test tube rack
4 pipettes (m - 5ml)
Standard lab safety gear



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2. Add 5ml of the appropriate milk to each test tube.
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    - Add the appropriate enzyme to test tubes 1 and 2. Note the amount.
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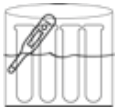
C: Milk -- Control
- 5ml milk
- Other (if called for):
- Reagent:

E: Milk -- Experimental
- 5ml milk
- Enzyme:
- Other (if called for):
- Reagent:

Digestion Station - Stomach (continued)



Part 3: Water Bath

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4. Remove test tubes from water bath.

Part 4: Notes/Observations

Use the space below to capture your observations throughout and after the investigation.

Part 5: Interpreting Results

Use the ***Interpreting Results*** of the Testing for Digestion Appendix and the Digestion of Nutrients Appendix for each solution (control milk and experimental milk):

- What nutrient(s) are digested in this organ?

- For each test tube, were the results of your tests positive or negative for digestion?

Station 3 - The Small Intestine

The small intestine is located below the stomach in the abdomen. It receives the partially digested food and digestive juices that enter from the lower sphincter of the stomach. It also receives a substance called bile from the liver and a lipase enzyme made in the pancreas. The small intestine is responsible for the digestion of some nutrients and the absorption of all nutrients. To fit inside the body, the small intestine is folded up. Fully stretched, the average small intestine is approximately 500 cm in length. The diameter of the small intestine is about 2.5 cm.

Within the wall of the small intestine are two layers of smooth muscle: a layer with fibers that run along the length from top to bottom and a second layer that encircles the diameter. These layers allow the small intestine to contract and expand to help mix and move the contents of the intestine. The muscle contractions also help mix the bile from the liver with large fat globules from food to break the fat globules down into smaller droplets.

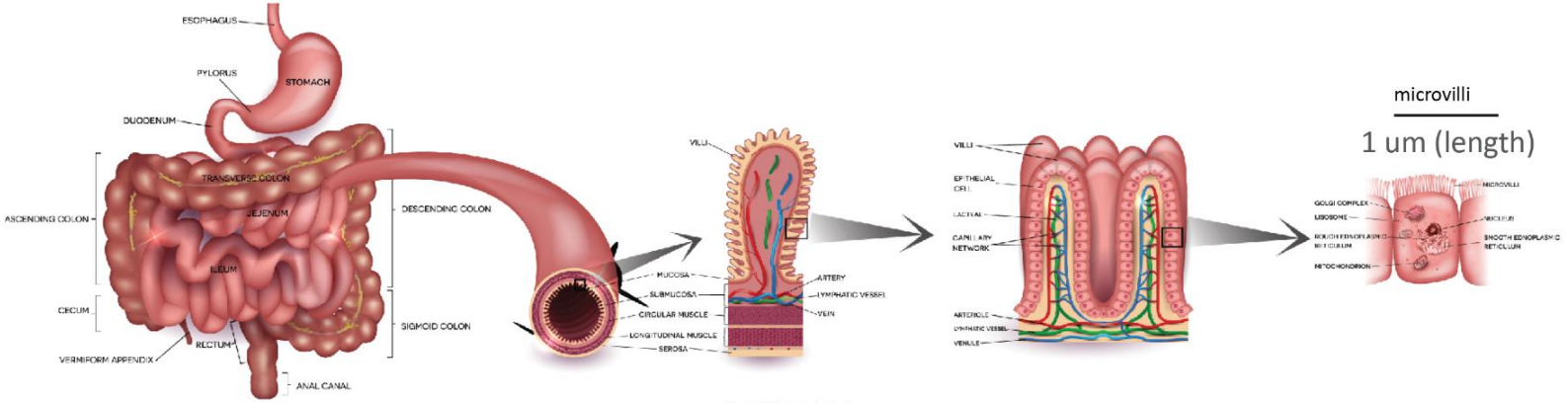
The tissues that line the small intestine are covered in smaller folds. On the surface of these folds, along the outermost surface of the small intestine, are finger-like villi. The villi are lined with epithelial tissue. Epithelial tissue is a type of tissue found on many surfaces and linings throughout the body. It is a thin, protective layer of tightly packed cells.

The epithelial tissue in the small intestine is made up of a single layer of epithelial cells. Different types of epithelial cells are found along the villi. Chief cells are epithelial cells that are specialized to produce specific enzymes, including lipase (in addition to the lipase from the pancreas), sucrase, proteases, and lactase. The vast majority of epithelial cells in the small intestine are enterocytes. In the small intestine, enterocytes (Fig 5) are designed to absorb nutrients. They have tiny microvilli to help increase the surface area so more nutrients can come in contact with them.

At the Small Intestine station, you will complete two investigations to determine the roles of lipase and lactase in the digestion of milk.

Small Intestine: Epithelial Cells

1.7 m



GASTROINTESTINAL TRACT

3 - 5 m (length)

SMALL INTESTINE

1 - 3 cm (width)

A FOLD OF THE INTESTINAL LINING

2 - 4 mm (fold thickness)

VILLI

.5 - 1 mm (length)

EPITHELIAL CELL WITH MICROVILLI

microvilli

1 um (length)

10 - 20 um (thick)

Digestion Station – Small Intestine (A)

Part 1: Planning for the Experiment

1. What digestive enzyme is found in the in this organ?

2. According to the ***Testing for Digestion Appendix***, what type of nutrient/molecule does this enzyme act on?

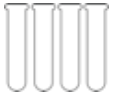
The ***Testing for Digestion Appendix*** lists reagents that can be used to test for the digestion of each type of nutrient. Refer to the appendix to answer the following questions.

3. Which reagent should be selected to test for digestion that occurs in this organ?

4. Based on your answer, add the needed reagent(s) any additional items noted in the appendix to the **Materials List** below.

Materials List

Milk
Digestive enzyme:
6 Glucose testing strips:
37 Degree Celsius Water Bath
Thermometer
2 labeled test tubes
Test tube rack
2 pipettes (m - 5ml)
Standard lab safety gear



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- Other (if called for):
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- Enzyme:
- Other (if called for):
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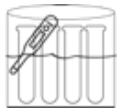
Digestion Station – Small Intestine (A) (continued)



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Part 4: Notes/Observations

Use the space below to capture your observations throughout and after the investigation.

Part 5: Interpreting Results

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Digestion Station – Small Intestine (B)

Part 1: Planning for the Experiment

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2. According to the ***Testing for Digestion Appendix***, what type of nutrient/molecule does this enzyme act on?

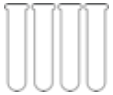
The ***Testing for Digestion Appendix*** lists reagents that can be used to test for the digestion of each type of nutrient. Refer to the appendix to answer the following questions.

3. Which reagent should be selected to test for digestion that occurs in this organ?

4. Based on your answer, add the needed reagent(s) any additional items noted in the appendix to the **Materials List** below.

Materials List

Milk
Digestive enzyme:
Testing reagent:
Other (if needed)
37 Degree Celsius Water Bath
Thermometer
2 labeled test tubes
Test tube rack
2 pipettes (m - 5ml)
Standard lab safety gear



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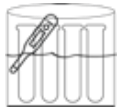
    - Add the indicator to all test tubes. Note the amount.
    - Add the appropriate enzyme to test tubes 1 and 2. Note the amount.
    - If called for, add any extra materials to all test tubes.

C: Milk – Control
- 5ml milk
- Other (if called for):
- Reagent:

E: Milk -- Experimental
- 5ml milk
- Enzyme:
- Other (if called for):
- Reagent:

Digestion Station – Small Intestine (B) (continued)



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- What nutrient(s) are digested in this organ?

- For each test tube, were the results of your tests positive or negative for digestion?

Station 4 - The Large Intestine

The large intestine is often referred to as the colon. It is wider and shorter in length than the small intestine. Overall, it is shaped similarly to a question mark, with the top of the question mark being about even with the waistline and a descending section that moves from the waist to the rectum and anus.

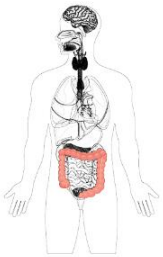
The layers of the large intestine are designed to help the large intestine carry out its main functions: movement of the waste and reabsorption of water and salts from the waste. Three layers of smooth muscle, each running in different directions, are able to contract and relax to mix and move waste. The outside of the large intestine is surrounded by a protective layer called the serosa. Inside the serosa are three layers of smooth muscles, each running in a different direction, which help the intestine contract.

The innermost layers of the large intestine lining are made of epithelial tissue that forms glands. Enterocyte cells are plentiful along the lining of the glands. They interact with bacteria found in the large intestine to ferment and digest fibers from foods that do not get broken down in prior stages of digestion. The other common types of cells found lining the glands are goblet cells that secrete mucus to protect the lining of the large intestine.

Enzymes have been responsible for chemical digestion in organs prior to the large intestine, however, enzymes are not present in the large intestine. The chemical digestion in the large intestine occurs due to the bacteria found in the large intestine, which digest things that humans cannot digest, including fiber and indigestible sugars. One of the by-products created by the bacteria during digestion is gas.

The remaining waste that is not digested by bacteria is formed into stool, which is stored in the rectum until excreted.

Large Intestine



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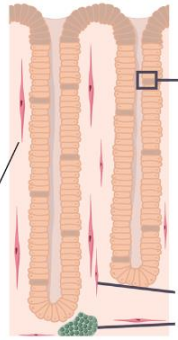
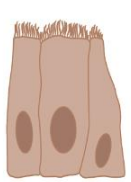
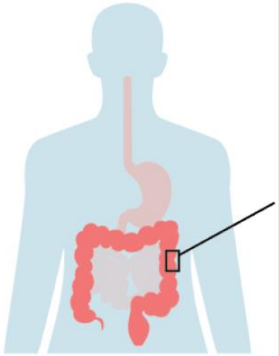
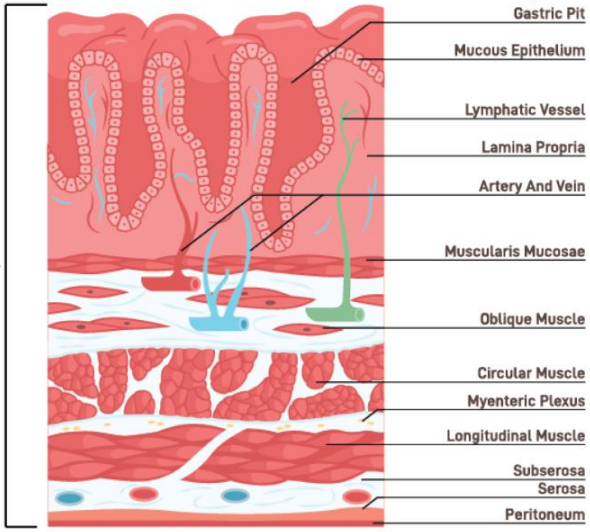


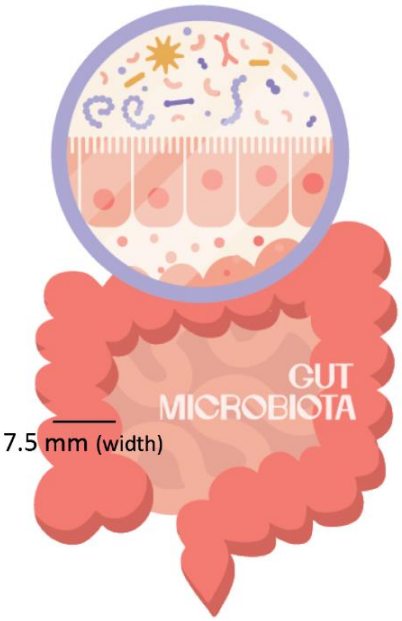


9 - 17 um
(height)



1.5 - 2.5 m
(length of lg intestine)





7.5 mm (width)

Appendix: Testing for Digestion

Digestive Enzyme	Nutrient	Reagent used to test for digestion	Extra Materials Needed	Interpreting Results
Amylase (5 drops)	Starched-based Carbohydrates	Potassium Iodine Solution (3 - 4 drops)		When a solution containing potassium iodine is added to a solution containing starch, it will turn a deep blue color. If there is no starch present, present, the solution will remain the brownish color of the potassium iodine solution. If starch is not present, or has been digested into simpler sugars, the potassium iodine will not display blue because there is no starch present to react with.
Lactase (2 - 3 drops)	Carbohydrates (Lactose)	Glucose Test Strips		Glucose test strips contain a chemical that reacts in the presence of glucose. Note that it will not react with other types of sugars such as, fructose, sucrose, galactose, including lactose. When lactose is digested by its corresponding enzyme, it breaks apart into two simple sugars, one of those being glucose. Results Yellow = negative Shades of Green = positive (the darker the green, the more glucose present)
Lipase (15 drops)	Lipids	Phenol-phthalein plus .1M (15 drops)	Sodium Hydroxide .1M (15 drops)	Phenolphthalein is used as a pH indicator. When it is added to an environment with a pH > 8 (an alkaline/basic environment), it turns bright pink. The lipid molecules in milk are called triglycerides. They have three chains of fatty acids bonded to a glycerol backbone. As the fatty acids break apart (are digested), the “acids” lower the pH of a solution. To test for the digestion of lipids, we first used sodium hydroxide (a base) to raise the pH of our solution so that the phenolphthalein will turn bright pink. As the lipids are digested and the chains of fatty acids break apart from the glycerol backbone, the pH of solution lowers/gets more acidic). As this happens, the phenolphthalein indicator turns lighter pink and eventually colorless.
Pepsin (2 ml)	Proteins	Biuret Reagent (40 drops)	Hydrochloric acid (50 drops) (stimulates the acidic environment in the stomach) and is needed to activate the pepsin enzyme)	In the presence of lots of peptide bonds, Biuret reagent turns violet. Peptide bonds are the bonds between amino acids in proteins. As proteins are digested, peptide bonds are broken. After protein has been digested, Biuret reagent shows up as a lavender/pinkinsh color.