

Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Student Exploration: Digestive System

**Vocabulary:** absorption, amino acid, carbohydrate, chemical digestion, chyme, complex carbohydrate, digestion, digestive system, elimination, enzyme, fat, fatty acid, fiber, food calorie, mechanical digestion, monoglyceride, nutrient, peristalsis, protein, starch, sugar, villus

**Prior Knowledge Questions** (Do these BEFORE using the Gizmo.)

1. Why do we need to eat food? \_\_\_\_\_

\_\_\_\_\_

2. How do you think our bodies break food down into useful **nutrients**? \_\_\_\_\_

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### Gizmo Warm-up

The **digestive system** is a group of organs that does three things:

- First, the digestive system breaks food down into useful nutrients, a process called **digestion**.
- Next, the nutrients move into the bloodstream, a process called **absorption**.
- Finally, the leftover waste is removed from the body, a process called **elimination**.

#### Mouth/pharynx

The mouth contains teeth, which cut and grind to push food back into the throat, or pharynx.




With the *Digestive System Gizmo™*, you can arrange the organs of the digestive system any way you like. To begin, look at the organs on the **Large Organs** tab. Place your cursor over each organ to learn more about it.

1. Which organs allow nutrients to be absorbed? \_\_\_\_\_

2. Which organ stores and compacts waste before it is eliminated? \_\_\_\_\_

3. Which *two* organs help to break food down mechanically? \_\_\_\_\_

<b>Activity A:</b> <b>Build a digestive system</b>	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> <li>If necessary, click <b>Clear screen</b>.</li> </ul>	
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**Goal: Design your own digestive system.**

1. Explore: Read the descriptions of the large organs, as well as those of the **Small Organs** on the next tab. Fill in the names of the organs that serve the functions listed below:

- \_\_\_\_\_ This organ absorbs water and vitamin K from digested food.
- \_\_\_\_\_ This organ produces **enzymes** that break down nutrients.
- \_\_\_\_\_ These tiny blood vessels transport absorbed nutrients.
- \_\_\_\_\_ These cells produce hydrochloric acid (HCl).
- \_\_\_\_\_ These cells produce *pepsin*, which breaks down proteins.

2. Build: Now it is time to design and build your own digestive system! Start with the **Large Organs** tab to build a basic system, starting with the **Mouth/pharynx**. Next, attach organs from the **Small organs** tab to the large organs to complete your system. Draw a picture of your system below. (If you like, you can click the **Screen shot** icon to take a snapshot, and then paste the image into a blank document to hand in with this worksheet.)

3. Predict: How well do you think your system will digest food? Explain your reasoning.

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**(Activity A continued on next page)**

**Activity A (continued from previous page)**

4. Prepare: Select the **Food** tab. The energy we get from food is measured in **food calories** (Calories). Each Calorie is equal to 4,184 joules of energy. Calories are found in the three main nutrients in food: **carbohydrates** (**sugars** and **starches**), **proteins**, and **fats**.

Drag the **Cheeseburger** above the mouth in your digestive system. How many Calories in the cheeseburger come from carbohydrates, proteins, and fats?

Carbohydrate Calories: \_\_\_\_\_ Protein Calories: \_\_\_\_\_ Fat Calories: \_\_\_\_\_

5. Run the Gizmo: Click **Play** (▶), and observe the food moving through the digestive system. The muscular contractions that push food through the system are called **peristalsis**. When food has finished passing through the system, you will see a message.

- A. What percentage of Calories were absorbed by your system? \_\_\_\_\_
- B. What percentage of water was absorbed? \_\_\_\_\_
- C. Based on these results, how well do you think this digestive system worked? Explain.

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6. Revise: Click **Reset** (↶). Rearrange the organs of your system to try to improve your results. Describe how you changed your system below.

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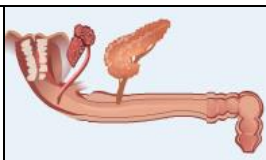
7. Test: Click **Play**. List the results below. Did the system improve? \_\_\_\_\_

Percentage of Calories absorbed: \_\_\_\_\_ Percentage of water absorbed: \_\_\_\_\_

8. Explain: If your system improved, why do you think this was so? \_\_\_\_\_

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<b>Activity B:</b>  <b>Mechanical and chemical digestion</b>	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> <li>• Click <b>Reset</b> and <b>Clear screen</b>.</li> <li>• Build a system with a <b>Mouth, Salivary gland, Esophagus, Pancreas, and Rectum</b>.</li> </ul>	
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**Introduction:** Before nutrients are absorbed, they must be broken down to their simplest components. Teeth and muscular contractions in the stomach break food down into smaller particles, a process called **mechanical digestion**. In the meantime, powerful chemicals break down food in a process called **chemical digestion**.

**Question: How are nutrients broken down in your digestive system?**

1. Set up the Gizmo: Check that the current digestive system has a mouth, salivary gland, esophagus, pancreas, and rectum, as shown above. From the **Food** tab, drag the **Baked potato** to the mouth. A potato mostly consists of **complex carbohydrates**, such as starch.
  - A. Select the **Analysis** tab. What is the initial value of complex carbohydrates? \_\_\_\_\_
  - B. Click **Play**. What is the ending value of complex carbohydrates? \_\_\_\_\_
  - C. How many Calories of complex carbohydrates were converted to sugars? \_\_\_\_\_

Explain how you know: \_\_\_\_\_

The pancreas produces three digestive enzymes: *Amylase* breaks down complex carbohydrates into simple carbohydrates (sugars), *trypsin* breaks down proteins into **amino acids**, and *lipase* breaks down fats into **fatty acids** and **monoglycerides**.

2. Experiment: Click **Reset**. Move the **Rectum, Esophagus, and Pancreas** to the right and insert the **Stomach** so that the system looks like the image at right. Click **Play**.



- A. After digestion is complete, what is the value of complex carbohydrates? \_\_\_\_\_
- B. How many Calories of complex carbohydrates were converted to sugars? \_\_\_\_\_
- C. Why do you think the results were different? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

The muscular walls of the stomach churn food, transforming food chunks into a thick liquid called **chyme**. The nutrients in chyme break down more easily because they are exposed to digestive enzymes rather than hidden in food chunks.

**(Activity B continued on next page)**

**Activity B (continued from previous page)**

3. Observe: Click **Reset**. Drag the **Steamed tofu** above the mouth. The Calories in tofu mostly come from proteins and fat. We will look at fat digestion first.

A. What is the initial number of fat Calories? \_\_\_\_\_

B. Click **Play**. How many fat Calories were converted to fatty acids? \_\_\_\_\_

4. Experiment: Click **Reset**. Move the **Pancreas** one space to the right (still attached to the esophagus). Place the **Gallbladder** on the esophagus to the left of the pancreas. Click **Play**.

A. How many fat Calories were converted to fatty acids in this situation? \_\_\_\_\_

B. How did adding the gallbladder affect fat digestion? \_\_\_\_\_

Fat molecules can be difficult to break down because large fat droplets do not mix well with water-based enzymes such as lipase. For lipase to work, it helps if the fat is *emulsified* into tiny droplets. This is done with the help of *bile*, which is stored in the gallbladder.

5. Observe: Now look at the results for proteins. (Do not press **Reset** yet.) Proteins are complex molecules formed from long chains of amino acids.

How many of the original 72 protein Calories were converted to amino acids? \_\_\_\_\_

6. Experiment: Click **Reset**. The process of protein digestion is helped by the enzyme *pepsin*.

A. Look at the remaining small organs. Which ones produce pepsin? \_\_\_\_\_

Add these cells to the stomach.

B. Click **Play**. How much protein is converted to amino acids now? \_\_\_\_\_

C. Click **Reset**. Pepsin works best in an acidic environment. Which of the remaining small organs produces an acid? \_\_\_\_\_ Add these to the stomach.

D. Click **Play**. How much protein is converted to amino acids now? \_\_\_\_\_

7. Explain: How do mechanical and chemical digestion work together to break down food?

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<b>Activity C:</b> <b>Absorption</b>	<u>Get the Gizmo ready:</u>	<b>Nutrient:</b> Complex ca
	<ul style="list-style-type: none"> <li>Click <b>Reset</b> and <b>Clear screen</b>.</li> </ul>	Initial: 184 Current: 175.4 Absorbed:

**Introduction:** Digesting nutrients into simple carbohydrates, amino acids, and fatty acids is important, but it doesn't matter unless the nutrients get into the bloodstream to feed body cells. This process is called absorption.

**Question: How are nutrients absorbed?**

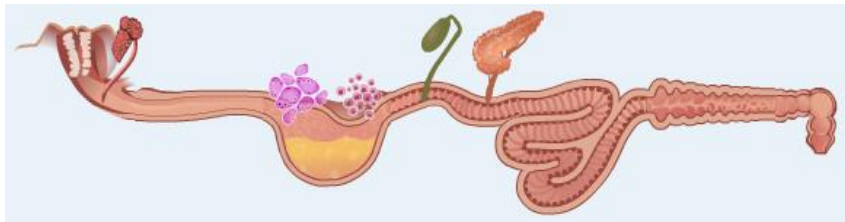
- Observe: Look through the descriptions of the large and small organs.
  - Which of the large organs allow nutrients and water to pass through their walls?

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- Which of the small organs transport absorbed nutrients to the bloodstream?

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- Set up the Gizmo: Create the digestive system shown. The small intestine has three parts: the *duodenum* (attached to the stomach), the *jejunum* (the middle portion), and the *ilium* (attached to the large intestine). Drag the **Pecan pie** to the mouth.



Test each of the scenarios below. For each setup, record the nutrients that are *absorbed* by the system. (Be sure to look at the "Absorbed" row of the **Analysis** table.)

Scenario	Sugars	Amino acids	Fatty acids	Water
Capillaries attached to the small intestine segments only				
Capillaries attached to the large intestine only				
Lymphatic vessels attached to the small intestine segments only (no capillaries)				
Lymphatic vessels attached to the large intestine only (no capillaries)				

**(Activity C continued on next page)**

**Activity C (continued from previous page)**

3. Analyze: Examine the results of your four experiments.

A. Which nutrients were absorbed by capillaries in the small intestine? \_\_\_\_\_  
\_\_\_\_\_

B. Which nutrients were absorbed by capillaries in the large intestine? \_\_\_\_\_  
\_\_\_\_\_

Bacteria in the large intestine break down some types of **fiber**—a difficult to digest complex carbohydrate—into sugars and other nutrients.

C. Which nutrient was absorbed by small intestine lymphatic vessels? \_\_\_\_\_

D. Did lymphatic vessels absorb anything from the large intestine? \_\_\_\_\_

4. Draw conclusions: Based on your experiments, where should the capillaries and lymphatic vessels be placed to maximize the absorption of nutrients from food?

Capillaries: \_\_\_\_\_

Lymphatic vessels: \_\_\_\_\_

5. Investigate: Click **Reset**. From the **Food** tab, drag the **Apple** to the work area to view its

**Nutritional Facts**. What nutrient makes up most of an apple's Calories? \_\_\_\_\_


6. Challenge: Using a total of only *five* organs, design a digestive system that can absorb the maximum number of Calories from the apple. Describe your system below.

\_\_\_\_\_  
\_\_\_\_\_

7. Test: Click **Play**. What percentage of Calories did your system absorb? \_\_\_\_\_

8. Explore: Use the Gizmo to determine how absorption of water affects the texture of the stool (poop) that is produced by the digestive system. What do you conclude?

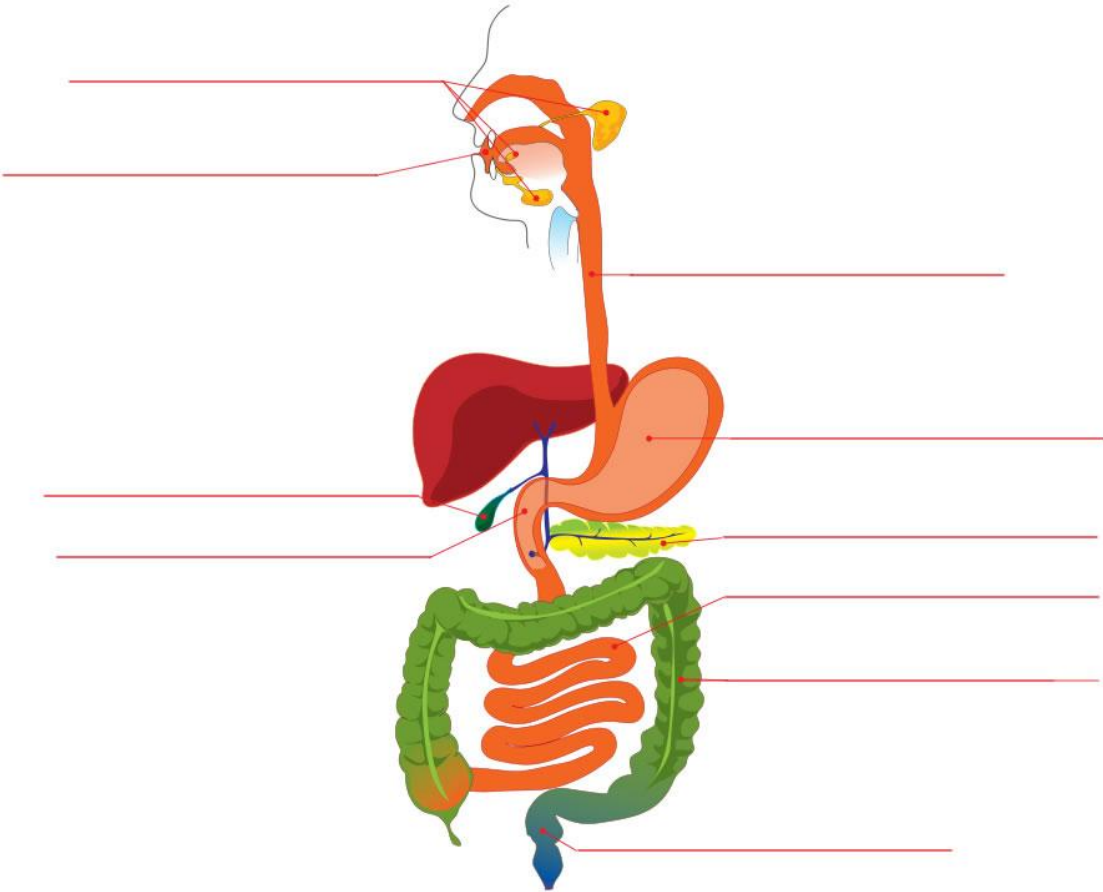
\_\_\_\_\_  
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<b>Activity D:</b> <b>Human digestion</b>	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> <li>• Click <b>Reset</b> and <b>Clear screen</b>.</li> </ul>	
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**Introduction:** Now that you have explored a model of human digestion, it is time to apply what you have learned to the real human digestive system.

**Goal: Describe the human digestive system.**

1. Label: Based on what you have learned, identify the organs of the human digestive system.



2. Think and discuss: Why is it important that the mouth and stomach are near the start of the digestive system? \_\_\_\_\_  
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**(Activity D continued on next page)**



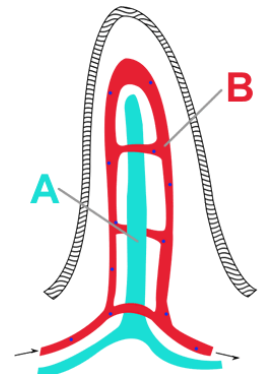
**Activity D (continued from previous page)**

3. **Match:** Match each structure, chemical, or process to its function.

- |       |                  |  |
|-------|------------------|--|
| _____ | Amylase          | A. Upper section of the small intestine                              |
| _____ | Peristalsis      | B. Muscular tube connecting the throat and stomach                   |
| _____ | Duodenum         | C. Organ that produces a variety of digestive enzymes                |
| _____ | Lymphatic vessel | D. Chemical that breaks up large fat droplets                        |
| _____ | Anus             | E. Muscular contractions that push food through the digestive system |
| _____ | Large intestine  | F. Enzyme that starts to digest proteins in the stomach              |
| _____ | Esophagus        | G. Opening through which wastes are eliminated                       |
| _____ | Pepsin           | H. Produces hydrochloric acid in the stomach                         |
| _____ | Pancreas         | I. Transports absorbed fatty acids to the bloodstream                |
| _____ | Parietal cell    | J. Organ that absorbs water and vitamin K                            |
| _____ | Bile             | K. Enzyme that breaks down starches into simple carbohydrates        |

4. **Infer:** The diagram at right shows part of a **villus**. A villus is a tiny, fingerlike projection in the wall of the small intestine. The small intestine contains millions of villi.

- A. What are the names of the vessels labeled A and B in the diagram? \_\_\_\_\_
- B. What do you think is the function of a villus? \_\_\_\_\_
- \_\_\_\_\_



5. **Evaluate:** In humans, the small intestine can be over 8 meters (26 feet) long. Why do you think this organ is so long? \_\_\_\_\_

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