Activity   continued from previous page)

        3.

Name: _____   Date: _____

Student Exploration: Digestive System

Vocabulary: absorption, chemical digestion, digestion, digestive system, elimination, enzyme, fat, fiber, food calorie, mechanical digestion, nutrient, protein, starch, sugar

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**?
    _____
    _____

Gizmo Warm-up

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

Mouth/pharynx
The mouth contains teeth, which start mechanical digestic
small pieces. The tongue helps to push food back into the

- First, it 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**.
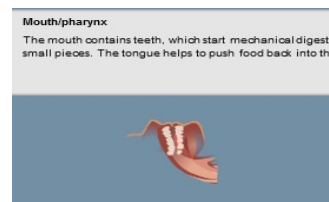
With the *Digestive System* Gizmo™, you can arrange the organs of the digestive system any way you like. To begin, look at the organs on the LARGE ORGANS tab. Place your cursor over each organ to learn.
1. Which organs allow nutrients to be absorbed?
    _____
2. Which organ stores and compacts waste before it is eliminated? _____
3. Which *two* organs help to break food down mechanically? _____ _____

Activity A: Build a digestive system	**Get the Gizmo ready:** ☐ **If necessary, click Clear screen.**	

Goal: Design your own digestive system.
1. <u>Explore</u>: 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. <u>Build</u>: 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.
3. <u>Predict</u>: How well do you think your system will digest food? Explain your reasoning.
    _____
    _____
4. <u>Prepare</u>: 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. 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.

_____

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

_____

7. Test: Click **Play** or **Fastplay** (⏭). 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? _____

Activity B: **Mechanical and chemical digestion**	Get the Gizmo ready: Click **Reset** and **Clear screen**. Build a system with a **Mouth**, **Salivary gland**, **Esophagus**, **Pancreas**, and **Rectum**.	

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**. Powerful chemicals break down food in a process called **chemical digestion**.

Question: How are nutrients broken down in your digestive system?
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. View the ANALYSIS tab. What is the initial value of complex carbohydrates? _____
B. Click **Play** or **Fastplay**. What is the final 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**.

1. 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**/**Fastplay**.
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? _____

_____

Activity   continued from previous page)

3.
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.

2. 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? _____

3. 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.This is done with the help of *bile*, which is stored in the gallbladder.

4. 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? _____

5. 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? _____

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

Activity C:	Get the Gizmo ready:	Complexca
	☐ **Click Reset and Clear screen.**	178
Absorption		175.4

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?**
1. Observe: Look through the descriptions of the large and small organs.
A. Which of the large organs allow nutrients and water to pass through their walls?
_____B.
Which of the small organs transport absorbed nutrients to the bloodstream?
_____ 2.
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)				

2. 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 that are absorbed in the large intestine.
   a. Which nutrient was absorbed by small intestine lymphatic vessels? _____
   b. Did lymphatic vessels absorb anything from the large intestine? _____

3. 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: _____

4. 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? _____

5. 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.
   _____
   _____

6. Test: Click **Play**. What percentage of Calories did your system absorb? _____

7. 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?
   _____
   _____