Category V Life Science Examples

Guiding student interpretation and reasoning

Food, Energy, and Growth
Questions are provided to guide student interpretation and reasoning about investigations and readings. A particularly nice example follows an investigation on the digestion (by enzymes in meat tenderizer) of a protein (gelatin) (p. **23s**). These questions are scaffolded to help students make connections between their own ideas and the phenomena. Questions at the end of another activity (in which students investigate where digestion begins) help students consider alternative explanations for their observation that a chewed oatmeal cracker tests positive for glucose (p. **21s**). And questions following a simulation in which students model the idea that small—but not large—particles can get through a screen help students relate their model to the scientific idea of digestion and absorption of food (p. **33s**).

D. Use one square of gelatin as the control (what does that mean?) Then sprinkle both sides of the other piece of gelatin with one-quarter teaspoon of meat tenderizer.

E. After 2 minutes, poke the gelatin *gently* with a stirring rod to check its consistency. You may notice that water also comes out of the gelatin, but in this activity, you are mainly concerned with the consistency of the gelatin. Record your observations. Repeat this test at 5-minute intervals for at least four observations, more if time permits. Keep recording.

Think, write, and discuss

1. At the end of this experiment, how is the control gelatin different from the gelatin treated with meat tenderizer?

2. **Draw a conclusion from your observations:** In which case was the gelatin actually broken down or "digested"—the control or the one treated with meat tenderizer?

3. Look at the label on the meat tenderizer and decide which ingredient is responsible for this reaction. The chemical substance which actually breaks up the gelatin is—can you guess?—an enzyme.

4. Now think about real meat and how meat tenderizer works.
   a) Meat tenderizer reacts with which nutrient in meat?
   b) What does it do to that component?
   c) How do you think meat tenderizer works?

5. a) Explain, in your own words, using a couple of sentences, what happens to proteins in your body after you eat them. Talk about where the foods containing protein travel, what happens to them along the way, and what chemical substance is necessary for this to happen.

   b) Add to your drawing and explanation from Lesson 4, or start a new drawing, to show what you're learning that's new. Save your drawings for later use.

6. **Speculate:** Where in your body do you think the chemical substance—the enzyme—that breaks down protein could come from?

Step E requires students to check on the consistency of their gelatin every 5 minutes over a period of 20 minutes or so. During this time, you may want to have them write in their journals first a prediction about what they might see, and then their own speculation about what is happening. That is, their "observations" might include more than just a note about the appearance of the gelatin—they may also include some analysis of what might be happening. They should especially come to see the difference between any water that leaves the gelatin, and the product of the chemical reaction, which might look "watery." You may want to ask students to clarify their notes if they suggest that the gelatin is turning watery. Do they mean that it's turning into water, or simply changing to the *consistency* of water?

1. The control stayed very hard and firm while the one with the meat tenderizer got very soft and liquid-like.

2. The treated one.

3. Usually papain, a derivative of the papaya plant.

4. a) Protein.
   b) It helps digest the protein and make it soft and not so tough.
   c) It is an enzyme that chemically changes the protein so it can be used by cells.

5. The **key points** are:

- the protein enters your mouth (where it is crushed and ground as it is chewed).
- it goes through the esophagus to the stomach where the protein is mixed with enzymes that begin to chemically change it into simpler substances.
- it then leaves the stomach and goes into the small intestine where it is mixed with more enzymes that continue the process of chemically changing it into

6. Students' answers vary. It may be interesting to ask them why they think what they do. It comes from the walls of the stomach and small intestine and from the pancreas.

Lesson 6

I. One explanation is that the grinding of the oatmeal by your teeth produced the sugar. Do you agree? How could you test this?

II. Another possible explanation is that something in your mouth chemically reacted with the oatmeal to change it into a new substance. If this is true, what could there be in your mouth that could do that?

III. A third possible explanation is that the saliva in your mouth contains sugar, and it mixed in with the oatmeal as you chewed. What do you think about this? **How could you test this?**

1. Think over the three possible explanations above. Write in your journal *your* explanation for why sugar is produced when oatmeal is chewed.
2. Try any tests you can think of to prove or disprove any of the three possible explanations.
3. Do you think digestion starts in the mouth? If you said yes, what evidence do you have? If you said no, why?
4. Discuss your explanation with your group partners. After your discussion, make any changes that will make your explanation better.

I. You could test this by grinding up oatmeal outside of the mouth, in a mortar and pestle, and then testing it.

III. You could test for sugar already in your mouth by testing saliva. (It tests negative for sugar.)

1. Answers will vary, but most students will probably choose one of the three possibilities stated at top of page.

2. If students test chewed oatmeal for sugar, they should also test saliva to determine if it has any sugar itself (it doesn't.). This would allow them to decide on whether they believe the 3rd possible explanation (III). (It is often helpful to chew on a clean rubber band or paraffin to produce saliva. Students should not test their saliva after eating.)

3. Digestion is the *chemical* breakdown of foods. It begins in the mouth when saliva chemically reacts with starches to form sugars (simple and smaller molecules.)

4. If students chose I or III, they may change to II after testing saliva and discussing the test results with their group partners.

Lesson 5

Let's review what we've talked about so far:

Think, write, and discuss

1. Create a table in your journal that tells what substance each component of the food you eat changes into when it is digested.

2. What has to happen to food so that it can make the trip out of the small intestine and into the cells?

3. a) Was all of the food able to get out of the small intestine? Why or why not?

   b) What happens to the particles that don't get out?

4. **Speculate:** Why must new materials be assembled inside of the cells rather than being assembled and then transported?

5. a) The picture you have assembled shows only one specific cell of the organism. How many other kinds of cells can you imagine there must be in your body?

   b) Name at least ten kinds of cells that need to get food.

Brick by Brick: Digestion is like taking a building apart, brick by brick, so you can use the bricks to build (and power) a new building. During the process of digestion, the large molecules of the food we eat, like the building, are torn down and chemically changed into simpler molecules—the bricks. These bricks are then carried to another location, where they are used to build a different building.

The bloodstream (the bus) is what carries the simpler molecules to all the cells of your body. The cells then use the "building block" molecules to make the exact proteins or fats they need to grow, to repair damaged parts, or to store energy for later use. And they use the glucose molecules for the fuel needed by the cell for powering everything that cells do.

Exactly what goes on in cells with the digested food—how cells extract the energy stored in glucose, and how they use amino acids to grow and repair themselves—is discussed in Cluster 3!

What's feces? Indigestible food (like fiber), bacteria, mucus, dead cells, and food that just didn't get digested; and 75% water. It's the bacteria that produce the odor; as they feed on leftover and indigestible food, they produce gas. Some foods (notably beans and cabbage) are for a large part not digested, leaving lots for bacteria to eat, and producing lots of gas.

1. Proteins change into amino acids, carbohydrates into glucose, and fats into fatty acids.

2. It has to be chemically changed (digested) into new molecules that can pass through the small intestine wall.

3. a) No, some of the food molecules were too big to get through the openings, like the fiber molecules. If students say "there weren't enough enzymes," make sure they know what the function of the enzymes is—to break down the parts of the food that are digestible—and that they aren't just parroting back a key word without understanding what enzymes do.

   b) They move from the small intestine to the large intestine and out of the body as feces.

4. We begin to answer this question on the bottom of this page ("Brick by Brick"); a more-complete answer is developed in Cluster 3. It is interesting to listen to students' speculations, though, and you should encourage this. We are referring to amino acids as "building blocks" because they are re-assembled into different proteins in the cells, depending on the individual cell's need. Each cell is responsible for synthesizing its own proteins (following directions in its DNA). The purpose (function) of digestion, then, is to take apart the food we eat, (which has been built up in other organisms into their "body parts") into the amino acids, fatty acids, and glucose we need for making new body parts and storing and releasing energy.

5. a) Answers will vary.
   b) Additional cells mentioned might include skin, blood (red and white), brain, nerve, liver, muscle, egg, sperm, etc.

Lesson 8