Cells

1.2.4 Cell Energy

Introduction

Have the class brainstorm to create a list of energy sources. Mention that food is a fuel that is burned by the body of an organism to produce energy. Discuss that most energy in the biosphere originates from the sun. Review that metabolism is the sum of the activities taking place inside a living cell or organism. Show the container of gelatin and ask what has caused it to break down and become watery. (**heat, time, or both**) Explain that the gelatin softens because the protein bonds in the gelatin broke apart.

Discussion

- Challenge students to list ways God designed the human body to thrive. Emphasize that He gave humans and other organisms certain enzymes to speed up reactions that would otherwise be too slow to support life. Without enzymes, most cellular reactions that sustain energy levels within cells would not occur. God made enzymes to ensure that the living things in His creation flourish.

- Use the following metaphor to reinforce the concept of an enzyme: *The entire class is asked to climb over a high stone wall. Some students can rock climb up the face, and a few others can boost each other up over the wall, but the rate of students making it over the wall is very slow. A set of stairs is placed in front of the wall, and another set of stairs is placed on the other side. With two sets of stairs in place, the rate of students climbing over the wall increases dramatically.* Emphasize that in cellular activities, enzymes act like the stairs by greatly speeding up reactions.

- Ask the following questions:
  1. Do cells create energy? (**No. Cells change energy from one form to another.**) Explain that energy cannot be created or destroyed.
  2. Why are there are so many different types of enzymes? (**Each particular chemical reaction must have its own enzyme to speed it up.**)
  3. Why does a cell go through the process of respiration? (**Cellular respiration is the breaking down of food molecules by cells into usable energy. Cells use this energy to carry on life functions such as cell growth, reproduction, and the manufacturing of organic substances.**)

Activities

Lab 1.2.4A The Enzyme Effect

- marking pencils, 1 per group
- beakers, 6 per group
- fresh pineapple chunks, 4 per group
- kiwi chunks, 4 per group
- canned pineapple chunks, 4 per group
- apple chunks, 4 per group
- orange slices—cut in half, 4 per group
- gelatin, 1 package per group
- large bowl, 1 per group
- measuring cup, 1 per group
- boiling water
- spoons, 1 per group
- cold water
- refrigerator

This activity can be done as a demonstration. Point out that fresh pineapple and kiwi have enzymes that act on gelatin, which is a protein derived from the skin, bones, and connective tissue of animals. The enzymes break up the protein polymer and prevent it from gelling. These enzymes are destroyed in the canning process, which is why the gelatin with canned pineapple did solidify. Explain the terms *dependent variable* and *independent variable* to students.

A. Divide the class into small groups. Direct each group to make a list of functions that are part of a cell's life processes and to identify the cell organelles involved in each function. Functions should include the following:
   1. Nuclear DNA provides instructions for protein production.
   2. Ribosomes produce protein for the cell.
   3. Proteins are used for repair and growth of the cell.

OBJECTIVES

Students will be able to
- explain the relationship between energy, ATP, and cellular respiration.
- describe the purpose of enzymes.

VOCABULARY

- cellular respiration the breaking down of food molecules by cells into usable energy

MATERIALS

- Flavored gelatin (*Introduction*)

PREPARATION

- Prepare a container of flavored gelatin several days in advance and keep it in the refrigerator. When it begins to break down, bring it to class. (*Introduction*)
- Obtain materials for *Lab 1.2.4A The Enzyme Effect*.

4. The Golgi apparatus adds sugar molecules in short chains to proteins.
5. Mitochondria convert food to energy.
6. Lysosomes recycle worn-out cell organelles and digest food particles.
7. Carbohydrates are assembled from simple sugars.

B. Assign each student to research an enzyme used by the human body and to determine what reaction that enzyme accelerates.

NOTES

Lesson Review

1. What is cellular respiration? (**the breaking down of food molecules by cells into usable energy**)
2. What is a metabolic pathway? (**A metabolic pathway is a series of chemical reactions that break down or make materials that the cell needs.**)
3. Would you expect to find more mitochondria in liver cells, which are very active, in or teeth cells, which are less active? Why? (**More mitochondria would be found in liver cells because they are more active and need more energy. Mitochondria produce energy so the cell can perform its functions.**)
4. What is the relationship between energy, ATP, and cellular respiration? (**Cells use cellular respiration to convert energy into a form they can use. During cellular respiration, glucose is metabolized and the energy from the glucose is released. Some of the energy is stored in a molecule called ATP, which carries energy for the cell's activities.**)
5. What is the purpose of enzymes? (**Enzymes speed up the chemical reactions that happen in cells. They speed up the metabolic pathways so a cell can live.**)

1.2.4 Cell Energy

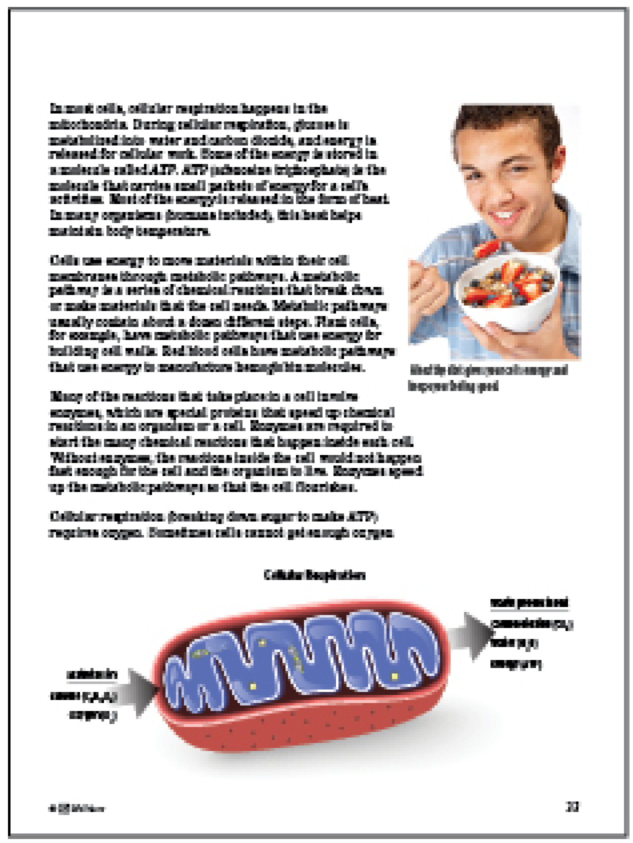
OBJECTIVES

VOCABULARY

It is not hard to tell when you have run out of energy—you feel tired and hungry. Your body uses these feelings to tell you that your cells need energy to carry out the chemical activities needed to live, reproduce, and grow. Energy is the ability to do work. It is the ability to make things happen and to cause processes to occur. A cell is the smallest living unit that uses energy for life.

God designed the sun as the source of energy for life on Earth. Plants capture light energy and change it into food through photosynthesis. In this process plants use energy to change carbon dioxide and water into glucose. Plants then use some of the glucose as food and store some of it as starch. Photosynthesis also produces oxygen.

Cells must be able to convert energy into a form that they can use. The conversion of energy generally happens through **cellular respiration**—the breaking down of food molecules by cells into usable energy. Cellular respiration is not breathing respiration, which is the way your body takes in oxygen and expels carbon dioxide. The two processes are related, however, because breathing supplies an organism's cells with the oxygen needed for cellular respiration.



In most cells, cellular respiration happens in the mitochondria. During cellular respiration, glucose is metabolized into water and carbon dioxide, and energy is released for cellular work. Some of the energy is stored in a molecule called *ATP*. ATP (adenosine triphosphate) is the molecule that carries small packets of energy for a cell's activities. Most of the energy is released in the form of heat. In many organisms (humans included), this heat helps maintain body temperature.

Cells use energy to move materials within their cell membranes through metabolic pathways. A metabolic pathway is a series of chemical reactions that break down or make materials that the cell needs. Metabolic pathways usually contain about a dozen different steps. Plant cells, for example, have metabolic pathways that use energy for building cell walls. Red blood cells have metabolic pathways that use energy to manufacture hemoglobin molecules.

Many of the reactions that take place in a cell involve enzymes, which are special proteins that speed up chemical reactions in an organism or a cell. Enzymes are required to start the many chemical reactions that happen inside each cell. Without enzymes, the reactions inside the cell would not happen fast enough for the cell and the organism to live. Enzymes speed up the metabolic pathways so that the cell flourishes.

Cellular respiration (breaking down sugar to make ATP) requires oxygen. Sometimes cells cannot get enough oxygen.

Cellular Respiration

FYI

Glucose

[illegible]

[illegible]

needed for sufficient cellular respiration to occur. This lack of oxygen causes the production of ATP to diminish. When this happens, cells use fermentation. Fermentation produces a small amount of ATP and other products by partially breaking down glucose without using oxygen. In muscles, fermentation produces lactic acid, which contributes to muscle fatigue. The burning sensation that sometimes occurs after exercise is caused by lactic acid. Some bacteria and yeast also use fermentation for energy. However, alcohol, not lactic acid, is a product of yeast fermentation.

LESSON REVIEW

1. What is cellular respiration?
2. What is a metabolic pathway?
3. Would you expect to find more mitochondria in liver cells, which are very active, or in tooth cells, which are less active? Why?
4. What is the relationship between energy, ATP, and cellular respiration?
5. What is the purpose of enzymes?

Name: ________________ Date: ________

Lab 1.2.4A The Enzyme Effect

QUESTION: How do enzymes affect reactions?

HYPOTHESIS: Answers will vary.

EXPERIMENT:

You will need:
- marking pencil
- 6 beakers
- 1 package of gelatin
- bowl
- measuring cup
- boiling water
- spoon
- cold water
- 4 fresh pineapple chunks
- 4 canned pineapple chunks
- 4 apple chunks
- 4 kiwi chunks
- 4 orange slices (cut in half)
- refrigerator

Steps:
1. Thoroughly clean and dry all the beakers. With the marking pencil, label the beakers *Gelatin*, *Fresh Pineapple*, *Canned Pineapple*, *Apple*, *Kiwi*, and *Orange*.
2. Prepare the gelatin in the bowl according to the directions on the package. (Gelatin is a protein that solidifies as it absorbs water.)
3. Fill each beaker half full of the liquid gelatin. Use the measuring cup to remove the gelatin from the bowl and pour it into the beakers.
4. Use your fingers to add four chunks of each fruit to the corresponding marked beakers. Leave the control beaker without any fruit. Wipe your hands off before handling each fruit. Be careful not to allow the juice of any fruit into another beaker or your results may be inaccurate. Do not stir the contents.
5. Refrigerate the beakers overnight.
6. The next day check to see which contents solidified. Record your observations.

Beaker Contents	Observations
Gelatin	Gelatin solidified.
Fresh Pineapple and Gelatin	Gelatin did not solidify.
Canned Pineapple and Gelatin	Gelatin solidified.
Apple and Gelatin	Gelatin solidified.
Kiwi and Gelatin	Gelatin did not solidify.
Orange and Gelatin	Gelatin solidified.

Lab 1.2.4A The Enzyme Effect

ANALYZE AND CONCLUDE:

1. What was the independent variable in this experiment? the different fruits
2. What was the dependent variable? the gelatin
3. In which conditions did the gelatin set? the control, canned pineapple, apple, and orange
4. In which conditions did the gelatin remain a liquid? fresh pineapple and kiwi
5. Why did these particular fruits keep the gelatin from solidifying? Pineapple and kiwi had a certain enzyme that stopped the protein from solidifying.
6. All living cells produce enzymes of some type. Since gelatin is a protein, which fruit contains enzymes that break down proteins? fresh pineapple and kiwi
7. Which fruit does not contain the enzymes that break down proteins? canned pineapple, apple, and orange
8. Compare your hypothesis to the results. Answers will vary.

Research to find the answers to the following questions:

9. What type of enzyme breaks down protein? protease enzymes
10. Why did the canned pineapple allow the gelatin to solidify when the fresh pineapple did not? The canning process inactivates the protease enzyme.
11. What can you do to the fresh pineapple that would allow the gelatin to solidify? Adding heat (boiling or steaming) the fruit will inactivate the protease enzyme.
12. If you wanted to make a marinade that would help tenderize meat, would you use fresh pineapple or canned pineapple? Why? I would use fresh pineapple because bromelain (a type of protease enzyme) would break down the protein.
13. What other fruits would not be good to put in gelatin? mango, papaya, guava
14. What other fruits would work well with making gelatin? blueberries, strawberries
15. Does freezing the fruit inactivate the protease enzyme? No.