Modeling Photosynthesis and Cellular Respiration

Teacher Information

science take·out just add students™

Summary

Students use simple snap beads to model the reactants and products of photosynthesis and cellular respiration. Optional review cards are provided to help students distinguish between photosynthesis and cellular respiration.

Core Concepts

- Photosynthesis, which occurs in chloroplasts, uses light energy to combine carbon dioxide and water into energy-rich organic molecules (such as glucose) and releases oxygen into the environment.
- Cellular respiration, which occurs in mitochondria, uses energy-rich organic molecules (such as glucose) and oxygen. It converts the energy from organic compounds into heat and the energy stored in ATP molecules. Carbon dioxide and water are released as waste products of cellular respiration.
- The energy stored in ATP is used to power an organism's life activities such as circulation, excretion, movement and synthesis.
- Carbon dioxide and water molecules used in photosynthesis are returned to the environment by the process of cellular respiration.
- Glucose and oxygen used in cellular respiration are produced by the process of photosynthesis.

Time Required

Two 40-minute class periods

Kit contains

- 18 red beads to represent oxygen atoms
- 12 white beads to represent hydrogen atoms
- 6 black beads to represent carbon atoms
- "Photosynthesis and Cellular Respiration" sheet
- "Energy" diagram
- Sheet of review cards (these need to be cut)
- Plastic plate for holding beads

Teacher Provides

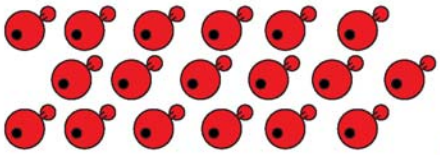
- Scissors

Warning: Choking Hazard This Science Take-Out kit contains small parts. Do not allow children under the age of seven to have access to any kit components.

Reusing *Modeling Photosynthesis and Cellular Respiration* kits

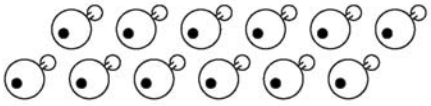
Kits may be reused. If you plan on reusing this kit, consider laminating the printed parts of the kits that will be reused ("Photosynthesis and Cellular Respiration" sheet, review cards and "Energy" diagram).

Kit Contents Quick Guide

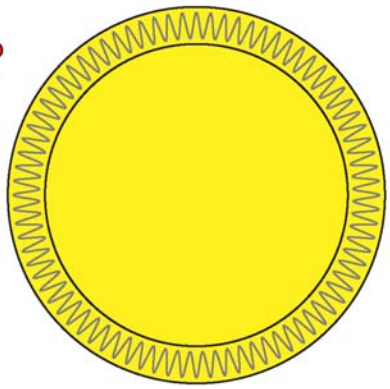


"Oxygen Atoms"

"Carbon Atoms"

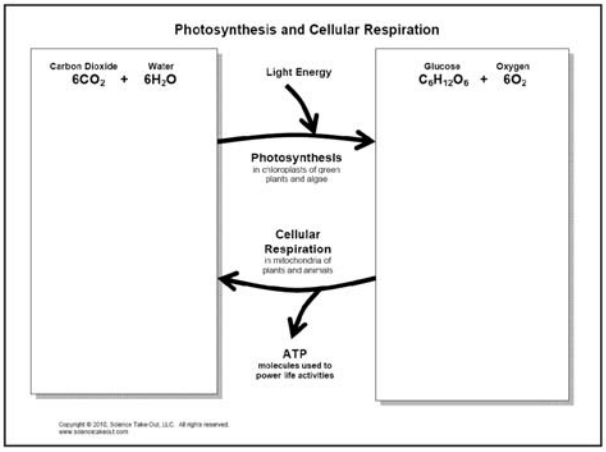


"Hydrogen Atoms"

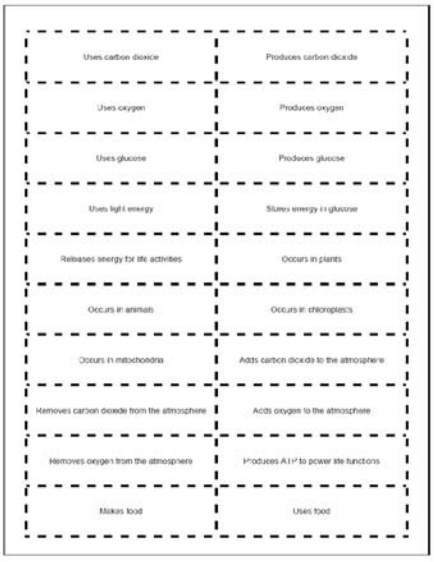


Plate

Energy Diagram



Photosynthesis and Cellular Respiration Sheet



Review Cards

Modeling Photosynthesis and Cellular Respiration:

Introduction

In this activity, you will create simple snap bead models to illustrate the reactants and products of photosynthesis and cellular respiration. You will also use review cards to help you distinguish between the processes of photosynthesis and cellular respiration.

Part 1: Modeling Molecules

A **molecule** is a group of atoms held together by chemical bonds. In this activity you will use snap beads to represent atoms and to make models of different molecules.

Your kit contains:

- 6 BLACK beads representing carbon atoms
- 12 WHITE beads representing hydrogen atoms
- 18 RED beads representing oxygen atoms

1. A single oxygen molecule (O_2) is made of two oxygen atoms bonded together.

Oxygen Molecule (O_2)

O = O

- Make a model of one oxygen molecule (O_2). How many oxygen atoms do you need to make one oxygen molecule? ____
- Sketch your model of one oxygen molecule in the box on the right.

2. A single water molecule (H_2O) is made of two hydrogen atoms bonded to one oxygen atom.

Water Molecule (H_2O)

H − O − H

- Make a model of one water molecule (H_2O). You need _ _ hydrogen atoms and _ _ oxygen atom.
- Sketch your model of one water molecule in the box on the right.

Black = carbon	White = hydrogen	Red = oxygen

3. A single carbon dioxide molecule (CO_2) is made of one carbon atom and two oxygen atoms.

Carbon Dioxide Molecule (CO_2)

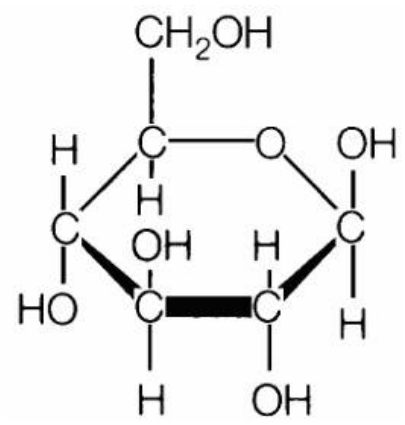
O = C = O

- Make a model of one carbon dioxide molecule (CO_2). To make this model you need _____ carbon atom and _____ oxygen atoms.
- Sketch your model of one carbon dioxide molecule in the box on the right.

4. A single glucose molecule ($C_6H_{12}O_6$) is made of six carbon atoms, twelve hydrogen atoms, and six oxygen atoms.

- Make a model of one glucose molecule ($C_6H_{12}O_6$). How many atoms (beads) do you need? _____ carbon atoms, _____ hydrogen atoms, and _____ oxygen atoms.
- Because glucose is a complex molecule, you won't be able to put the beads (atoms) together accurately to reflect the shape of the glucose molecule. Instead, simply make a collection of the correct number of beads in any order that you like.
- Sketch the glucose molecule you made in the box below. It is important to remember that the beads you draw do not accurately show the shape of a glucose molecule. It only shows how many of each type of atom are needed to make a glucose molecule.

Glucose Molecule ($C_6H_{12}O_6$)



Glucose

Black = carbon	White = hydrogen	Red = oxygen

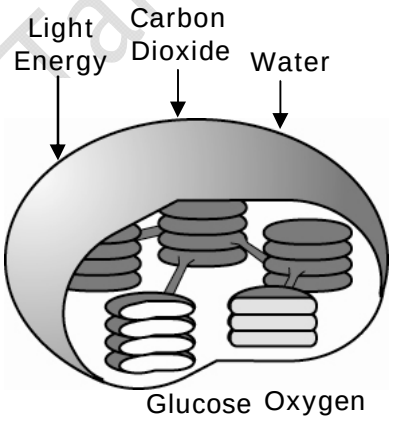
Part 2: Modeling Photosynthesis

Photosynthesis

The process of **photosynthesis** uses light energy, carbon dioxide and water and produces glucose and oxygen. During the process of photosynthesis, light energy is converted into energy stored in the chemical bonds of glucose molecules. Chloroplasts, found in the cells of green plants and algae, are the sites for photosynthesis. Here is the chemical equation for the photosynthesis process.

$$\text{Light Energy} + 6\,CO_2 + 6\,H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$$

1. The diagram on the right shows the organelle where photosynthesis occurs.
   - What is the name of this organelle?
   - What types of organisms have cells that contain these organelles?



2. What are the **reactants** (substances used) in photosynthesis?

3. Model the **reactants** in the photosynthesis process by arranging beads in the box on the left side of the *Photosynthesis and Cellular Respiration* sheet.

4. Complete Column 1 in the Photosynthesis table below by indicating the number of beads needed to make models of the **reactants** in the photosynthesis process.

Photosynthesis Table

		Column 1	Column 2
Color of beads	**Beads represent**	**Number of beads needed to model the reactants**	**Number of beads needed to model the products**
Black	Carbon atoms		
White	Hydrogen atoms		
Red	Oxygen atoms		

Black = carbon	White = hydrogen	Red = oxygen

5. Photosynthesis converts light energy into energy stored in glucose molecules. Your kit contains a colored "Energy" diagram. Where on the *Photosynthesis and Cellular Respiration* sheet should you put the "Energy" diagram to show the source of energy used for photosynthesis?

6. What are the **products** (substances made) in photosynthesis?

7. Model the **products** of photosynthesis process by arranging beads in the box on the right side of the *Photosynthesis and Cellular Respiration* sheet.

8. Complete Column 2 in the Photosynthesis table on the previous page by indicating the number of beads needed to make models of the **products** of the photosynthesis process.

9. "During photosynthesis, the light energy is converted into the energy stored in glucose molecules." To represent this statement, put the "Energy" diagram on top of the glucose molecule.

10. Which **product** of photosynthesis remains in the green plant for use as a building material or as a source of energy?

11. Which **product** of photosynthesis is released as a gas into the atmosphere by green plants?

Black = carbon	White = hydrogen	Red = oxygen

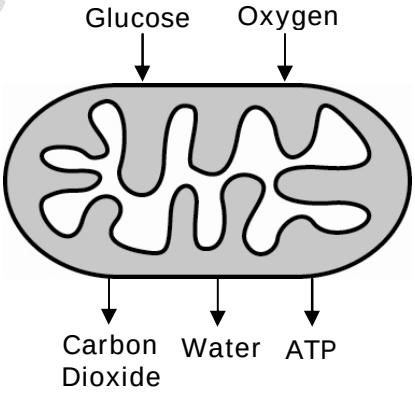
Part 3: Modeling Cellular Respiration

Cellular Respiration

Both plants and animals carry out **cellular respiration.** Cells in both plants and animals contain organelles called mitochondria that are the sites for the cellular respiration process. Cellular respiration uses glucose and oxygen and produces carbon dioxide, water, and energy stored in ATP molecules. The energy stored in ATP is used to power and organism's life activities such as circulation, excretion, movement, and synthesis. Here is the chemical equation for the cell respiration.

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6\,CO_2 + 6\,H_2O + ATP$$

1. The diagram on the right shows the organelle where cellular respiration occurs.
   - What is the name of this organelle?
   - What types of organisms have cells that contain these organelles?



2. Model the **reactants** (substances used) in cellular respiration by arranging beads in the box on the right side of the *Photosynthesis and Cellular Respiration* sheet.

3. Complete Column 1 in the Cellular Respiration table below by indicating the number of beads needed to make models of the **reactants** in the cellular respiration process.

Cellular Respiration Table

		Column 1	Column 2
Color of beads	**Beads represent**	**Number of beads needed to model the reactants**	**Number of beads needed to model the products**
Black	Carbon atoms		
White	Hydrogen atoms		

Red	Ox		

Black = carbon White = hydrogen Red = oxygen

4. Which **reactant** is the source of energy for the process of cellular respiration?

5. What are the **products** (substances made) during cellular respiration?

6. Model the **products** (substances made) in cellular respiration by rearranging the beads in the box on the left side of the *Photosynthesis and Cellular Respiration* sheet.

7. Complete Column 2 in the Cellular Respiration table on the previous page by indicating the number of beads needed to make models of the **products** of cellular respiration.

8. "The energy released by cellular respiration is captured by ATP molecules." To model this, place the "Energy" diagram on top of the ATP molecule.

9. The energy in ATP molecules is used to power life activities such as circulation, excretion, reproduction, regulation, synthesis, and movement. Model the use of energy in ATP to power life activities by tearing the "Energy" diagram into small pieces. Tearing the ATP diagram represents the fact that energy cannot be recycled.

10. List three examples of life activities that are powered by the ATP molecules produced by cellular respiration.

11. Which waste products of cellular respiration are released into the environment and could be used in the process of photosynthesis?

Respiration may be defined as:

1. the act of breathing (inhaling and exhaling) air in order to obtain oxygen and excrete carbon dioxide.
2. the cellular metabolic process by which cells use oxygen and food to produce ATP energy that powers life activities.

12. Based on the two definitions for respiration shown in the box above, what is the relationship between **breathing** and **cellular respiration**?

Part 4: Comparing Photosynthesis and Cellular Respiration

1. When would green plants carry out photosynthesis—only during the day, only at night, continuously, or never?

2. When would green plants carry out cellular respiration—only during the day, only at night, continuously, or never?

3. Are the **atoms** used in photosynthesis and cellular respiration recycled? Explain how the models you made illustrate your answer.

4. During photosynthesis, light energy is converted into energy stored in _____ molecules.

5. During cellular respiration, the energy stored in these molecules is transferred to ___ ___ molecules. The energy in these molecules is then used to power ___ ___ such as movement and chemical reactions.

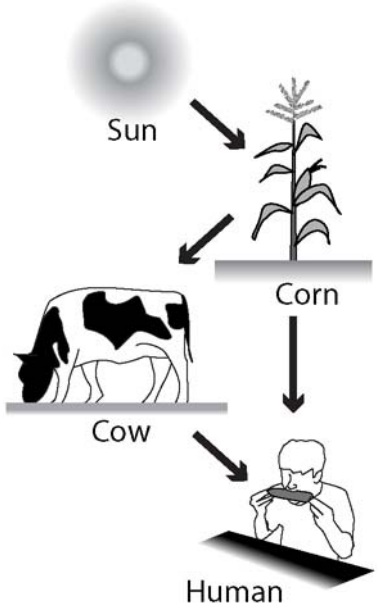
6. Is the **energy** used in photosynthesis and cellular respiration recycled? Explain how the models illustrate your answer.

7. The number of carbon, hydrogen, and oxygen atoms on Earth remains constant. Explain how this is possible.

8. You don't carry out photosynthesis.

   - How do you get the **atoms** that you need to make your body? *Hint: Look at the Food Web shown in the diagram on the right.*

   - How do you get the **energy** you need for your life activities?



Food Web

9. The number of carbon, hydrogen, and oxygen atoms on Earth remains constant. Explain how this is possible.

Part 5: Reviewing Photosynthesis and Cellular Respiration

Because photosynthesis and cellular respiration are opposites in many ways, it's easy to get these two processes confused. Your lab kit contains a set of cards designed to help you practice so that you don't get the two processes confused.

1. Cut the cards along the dotted lines.

2. Organize the cards so that the side with large bold print is facing upward.

3. Read the statements on the bold print side of the cards and sort the cards into two piles – a "Photosynthesis" pile and a "Cellular Respiration" pile.

4. There is one card that belongs in both the "Photosynthesis" pile and the "Cellular Respiration" pile. What is written on that card?

5. Once you have sorted all of the cards, turn the cards in the two piles over and check the small print on the back. If you have done this correctly, all cards in the "Photosynthesis" pile will have the word "photosynthesis" and all cards in the "Cellular Respiration" pile will have the word "cellular respiration."

6. Shuffle the cards and repeat the sorting process until it is easy for you to sort all cards into the correct piles.