

Modeling Activity for Photosynthesis and Cellular Respiration

Time required: two 50-minute periods

Introduction

Photosynthesis is the process by which green plants capture energy from sunlight and use it to make food molecules like glucose. Cellular respiration is the process used by plants and most animals, to convert the energy stored in food molecules into energy of adenosine triphosphate, (ATP). ATP has high-energy bonds that store energy in a form that is directly useable by plants and animals for conducting life processes such as growth, maintenance, and reproduction.

Photosynthesis and cellular respiration are the fundamental processes in the flow of energy and the cycling of matter. Energy cannot be recycled because it is used. Matter, in the forms of carbon, oxygen, and hydrogen, is continually recycled.

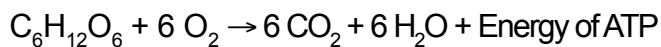
Photosynthesis

Photosynthesis is the process by which plants convert carbon dioxide into their food, by using the energy derived from the Sun. The essential materials for this process are sunlight, water, carbon dioxide, and chlorophyll. The leaves and stem of a plant have microscopic holes, known as stomata, through which the carbon dioxide enters the plant. Water enters the plant through its roots. After being absorbed by the roots, water travels all the way through the stem to reach the leaves where photosynthesis takes place. Water is combined with carbon dioxide and used by the plant to produce oxygen and the energy-rich molecule, glucose. Oxygen is released into the atmosphere through the stomata. The chemical reaction for photosynthesis is:



Cellular Respiration

Energy is defined as the ability to do work. The cells of both plants and animals require a continuous supply of energy for the performance of their life activities. Carbohydrates, especially glucose, generally provide this energy through the process of cellular respiration. The chemical reaction for cellular respiration is:



In this activity, you will;

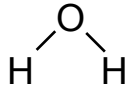
1. learn to interpret the molecular and structural formulas of water, carbon dioxide, glucose and oxygen.
2. construct molecular models to illustrate the processes of photosynthesis and cellular respiration.

Materials

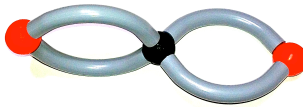
The Molecular Model Set for Photosynthesis and Cellular Respiration

Part I Modeling Molecules

A molecule is a group of atoms held together with chemical bonds. The atoms important for photosynthesis and cellular respiration are carbon, hydrogen, and oxygen. Using the molecular models, build a single molecule of water. You will need one oxygen atom, two hydrogen atoms, and two 25 mm bonds. The molecular formula for water is H_2O . The structural formula for water is



Build a single molecule of carbon dioxide, CO_2 . You will need one carbon atom, two oxygen atoms, and four 51 mm tubes to build the double bonds.



Part II Modeling Photosynthesis

The process of photosynthesis uses light energy, water, and carbon dioxide to produce 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.

1. Look at the card with the picture of the chloroplast. What is the function of the chloroplast?
2. Assemble and place 6 water molecules and 6 carbon dioxide molecules on the chloroplast. What types of organisms have cells that contain chloroplasts?

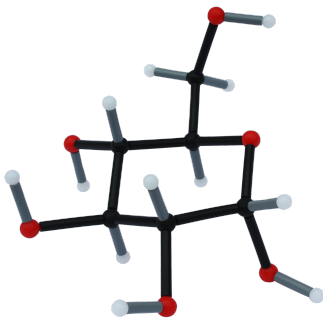
- Without the beginning materials (reactants) for photosynthesis, plants could not survive. What are the beginning materials (reactants) needed by plants for photosynthesis?
- Count and record the number of atom models for the reactants for photosynthesis.

Table 1

Atoms	Number of atoms in the reactants	Number of atoms in the products
Black carbon atoms		
White hydrogen atoms		
Red oxygen atoms		

In photosynthesis light energy is converted into chemical energy during a series of reactions that produce glucose and oxygen molecules. Using only the atoms in carbon dioxide and water, rearrange the atoms to make one glucose molecule.

Glucose



Hint: In constructing a molecule of glucose, it is best to first connect the oxygen atom and the 5 carbon atoms to form the central ring of the molecule.

- To build 1 molecule of glucose, you need:
 _____ carbon atoms, _____ hydrogen atoms, and _____ oxygen atoms.
- An oxygen molecule, O_2 , is made of two oxygen atoms bonded together with a double bond. The structural formula for the oxygen molecule is $O = O$. How many oxygen molecules can you build?
- Complete Table 1 above by counting the number of atom models for the products of photosynthesis.

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

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

Part III Modeling Cellular Respiration

Both plant and animal cells contain organelles called mitochondria that are the principle site for cellular respiration. In cellular respiration 1 glucose molecule combines with 6 oxygen molecules to produce 6 water molecules, 6 carbon dioxide molecules, and energy stored in ATP molecules.

10. Look at the card with the picture of the mitochondrion. What types of organisms have cells with this organelle?

11. Place the glucose molecule and 6 oxygen molecules that you made during Part II, Modeling Photosynthesis, on the diagram of the mitochondria. Without the beginning materials (reactants) for cellular respiration, plants and animals cells could not convert the energy stored in food molecules into energy of ATP and they would die. What reactants are required for cellular respiration?

In cellular respiration, food molecules like glucose are converted through a series of chemical reactions into carbon dioxide, water, and chemical energy that is stored in ATP. Using only the atoms in glucose and oxygen rearrange the atoms to make carbon dioxide and water molecules

12. Which reactant contains the energy released during the process of cellular respiration?

13. How many carbon dioxide molecules can you make?

14. How many water molecules can you make?

15. The energy released during cellular respiration is stored in the high-energy bonds of ATP. The energy stored in ATP is used to power the plant or animal's activities such as growth, repair, digestion, excretion, and movement. Name two activities that you do which required energy stored in ATP.
16. Which products of cellular respiration could be released into the atmosphere and used as the reactants of photosynthesis.
17. Are the atoms used in photosynthesis and cellular respiration recycled?
Explain how the models illustrate your answer.
18. Is the energy obtained from sunlight during photosynthesis recycled?
Explain your answer.