

Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Student Exploration: Cell Energy Cycle

**Vocabulary:** aerobic respiration, anaerobic respiration, ATP, cellular respiration, chemical energy, chlorophyll, chloroplast, cytoplasm, glucose, glycolysis, mitochondria, photosynthesis, radiant energy

**Prior Knowledge Questions** (Do these BEFORE using the Gizmo.)

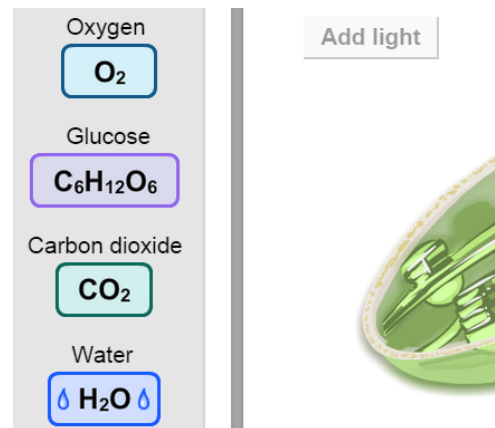
1. What does a plant need to survive and grow? \_\_\_\_\_  
\_\_\_\_\_
2. What does an animal need to survive and grow? \_\_\_\_\_  
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3. How do animals and plants depend on each other? \_\_\_\_\_  
\_\_\_\_\_

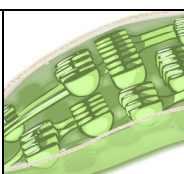
### Gizmo Warm-up

The *Cell Energy Cycle* Gizmo™ illustrates two processes that are essential to life: **photosynthesis** and **cellular respiration**.

Although both of these reactions involve a series of complex steps, the basic reactants and products in each process are four relatively simple molecules.

1. What is the chemical formula of oxygen? \_\_\_\_\_
2. **Glucose** is a simple sugar. What is the chemical formula of glucose? \_\_\_\_\_
3. What is the chemical formula of carbon dioxide? \_\_\_\_\_
4. What is the chemical formula of water? \_\_\_\_\_



<b>Activity A:</b> <b>Photosynthesis</b>	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> <li>• If necessary, click <b>Reset</b>.</li> <li>• Check that the PHOTOSYNTHESIS tab is selected. Check that <b>Description</b> is turned on.</li> </ul>	
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**Introduction:** Photosynthesis occurs in the **chloroplast**, an organelle found in plant and algae cells. Within the chloroplast, a green pigment called **chlorophyll** converts the **radiant energy** of sunlight into **chemical energy** that the plant can use.

**Question: What are the reactants and products of photosynthesis?**

1. Predict: Of the molecules shown on the CHEMICALS pane, which do you think are reactants (ingredients) in photosynthesis? Which do you think are products?

Reactants: \_\_\_\_\_ Products: \_\_\_\_\_

2. Explore: Drag each molecule from the CHEMICALS pane to the chloroplast on the PHOTOSYNTHESIS pane. If a molecule is a reactant, it will stay in the chloroplast.

Which molecules are reactants in photosynthesis? \_\_\_\_\_

3. Observe: Click **Add light** and look at the **Output**. What are the products of photosynthesis?

\_\_\_\_\_

4. Summarize: A chemical equation shows reactants on the left side of an arrow, and products on the right, like this: *reactant + reactant* → *product + product*.

Based on your observations, what is the chemical equation for photosynthesis?

\_\_\_\_\_

Turn on **Show chemical equation** to check. Were you correct? \_\_\_\_\_


5. Challenge: A chemical equation is balanced when each side of the equation includes the same number of each type of atom.

A. Is the equation balanced as written? Why or why not? \_\_\_\_\_

\_\_\_\_\_

B. If you are familiar with balancing equations, balance the photosynthesis equation. Write the balanced equation below, and then check your work by clicking **Balance**.

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<b>Activity B:</b>  <b>Cellular respiration</b>	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> <li>• Click <b>Reset</b>.</li> <li>• Select the RESPIRATION tab.</li> </ul>	
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**Introduction:** Cellular respiration occurs in the **cytoplasm** of the cell and in **mitochondria**, organelles found in all complex cells. (Bacteria and other simple organisms do not contain mitochondria.) The Gizmo shows a green mitochondrion surrounded by blue cytoplasm.

**Question: What are the reactants and products of cellular respiration?**

1. Predict: Of the molecules shown on the CHEMICALS pane, which do you think are reactants (ingredients) in cellular respiration? Which do you think are products?

Reactants: \_\_\_\_\_ Products: \_\_\_\_\_

2. Explore: Drag each molecule from the CHEMICALS pane to the RESPIRATION pane.

Which molecules are reactants in cellular respiration? \_\_\_\_\_

3. Observe: Click **Next**. What happens in the cytoplasm? \_\_\_\_\_

\_\_\_\_\_

This process is called **glycolysis**. The word **Pyruvic** is short for pyruvic acid, a product of glycolysis. Glycolysis produces energy, which is stored in the form of **ATP** (adenosine triphosphate) molecules. Glycolysis results in a net production of two ATP molecules.

4. Observe: Click **Next**. What happens now? \_\_\_\_\_

5. Observe: Click **Next**. What happens in the mitochondrion? \_\_\_\_\_

\_\_\_\_\_

Energy from the mitochondrion is also stored in the form of ATP. Thirty ATP molecules are produced for every two molecules of pyruvic acid.

6. Analyze: Cellular respiration involves two phases. **Anaerobic respiration** does not involve oxygen, while **aerobic respiration** does. Where does each phase take place?

Anaerobic respiration: \_\_\_\_\_

Aerobic respiration: \_\_\_\_\_

**(Activity B continued on next page)**

**Activity B (continued from previous page)**

7. Summarize: Based on what you have seen, what is the overall chemical equation for cellular respiration? \_\_\_\_\_

Turn on **Show formula of chemical equation** to check. Were you correct? \_\_\_\_\_

8. Challenge: A chemical equation is balanced when each side of the equation includes the same number of each type of atom.

A. Is the equation balanced as written? Why or why not? \_\_\_\_\_

\_\_\_\_\_

B. If you are familiar with balancing equations, balance the cellular respiration equation. Write the balanced equation below, and then check your work by clicking **Balance**.

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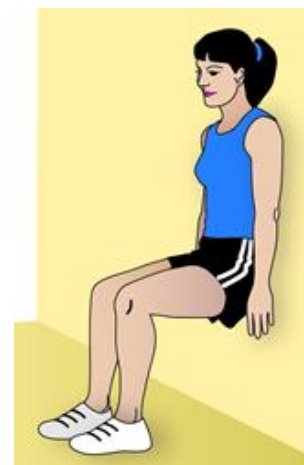
9. Extend your thinking: When you think of the word “respiration,” you might think about the process of breathing, which is actually called *ventilation*. (The respiratory system consists of the windpipe, lungs, etc.)

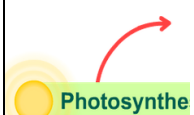
How is breathing related to cellular respiration? (Hint: Think about both the reactants and the products of cellular respiration.)

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\_\_\_\_\_  
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10. On your own: If no oxygen is present, pyruvic acid breaks down to form lactic acid. You can feel the effects of lactic acid if you exercise very hard. One way to produce lactic acid is to do a “wall sit,” supporting yourself against a wall in a sitting position. Try doing this for a few minutes. What do you feel in your thigh muscles?

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<b>Activity C:</b> <b>The carbon-oxygen cycle</b>	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> <li>• Click <b>Reset</b>.</li> <li>• Select the <b>CYCLE</b> tab.</li> </ul>	
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**Question: How is photosynthesis related to cellular respiration?**

1. Form a hypothesis: How do you think photosynthesis is related to cellular respiration?

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2. Predict: Look at the red arrows, and think about the photosynthesis and respiration reactions. Each red arrow connects a set of reactants to the products of the reaction.

A. Which chemicals would you expect to find at the top of the diagram? Explain.

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B. Which chemicals would you expect to find at the bottom of the diagram? Explain.

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3. Observe: Drag the **Oxygen**, **Glucose**, **Carbon dioxide**, and **Water** into the CYCLE pane.

A. Which substances are reactants in photosynthesis? \_\_\_\_\_

B. Which substances are products of photosynthesis? \_\_\_\_\_

C. Which substances are reactants in respiration? \_\_\_\_\_

D. Which substances are products of respiration? \_\_\_\_\_

4. Compare: How are the reactants and products of photosynthesis and respiration related to one another?

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**(Activity C continued on next page)**



**Activity C (continued from previous page)**

5. Review: In photosynthesis and respiration, energy is converted from one form to another. Light is a form of radiant energy. Glucose and ATP molecules store chemical energy.

A. In the photosynthesis chemical equation, does the radiant energy of the Sun act as a reactant or a product? Explain your answer. \_\_\_\_\_

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B. In photosynthesis, what form of energy is sunlight converted to, and how is this energy stored? \_\_\_\_\_

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C. In the respiration equation, does energy act as a reactant or a product? Explain.

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D. How is the energy produced by respiration stored? \_\_\_\_\_

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6. Summarize: How are respiration and photosynthesis related to each other? \_\_\_\_\_

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7. Think and discuss: In what ways are plants and animals dependent on each other?

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