Cell Structure and Function

Cells and Energy

**Key Concepts**
- How does a cell obtain energy?
- How do some cells make food molecules?

**Before You Read**

**What do you think?** Read the two statements below and decide whether you agree or disagree with them. Place an A in the Before column if you agree with the statement or a D if you disagree. After you’ve read this lesson, reread the statements to see if you have changed your mind.

<table>
<thead>
<tr>
<th>Before</th>
<th>Statement</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.</td>
<td>ATP is the only form of energy found in cells.</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Cellular respiration occurs only in lung cells.</td>
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</table>

**Read to Learn**

**Cellular Respiration**

All living organisms need energy to survive. Cells use energy from food and make an energy-storing compound, ATP. **Cellular respiration** is a series of chemical reactions that convert the energy in food into a usable form of energy called ATP. Cellular respiration takes place in the cytoplasm and in the mitochondria of a cell.

**Reactions in the Cytoplasm**

The first step of cellular respiration is called glycolysis. It takes place in the cytoplasm of all cells. **Glycolysis** is a process by which a sugar called glucose is broken down into smaller molecules. Glycolysis produces some ATP molecules. It also uses energy from other ATP molecules. More ATP is made during the second step of cellular respiration than during glycolysis.

**Visual Check**

1. **Locate** Circle where sugar breaks down in the cell during glycolysis.
Reactions in the Mitochondria

The second step in cellular respiration, shown below, takes place in the mitochondria of eukaryotic cells. This step uses oxygen. The smaller molecules made during glycolysis are broken down. Many ATP molecules are made. Cells use ATP molecules to power all cellular processes. Two waste products, water and carbon dioxide (CO₂), are given off during this step of cellular respiration. The CO₂ released by cells as a waste product is used by plants and some unicellular organisms in a process called photosynthesis.

Fermentation

Sometimes, as you exercise, there is not enough oxygen in your cells to make ATP molecules through cellular respiration. When this happens, cells use a process called fermentation to obtain chemical energy. Fermentation is a reaction that eukaryotic and prokaryotic cells use to obtain energy from food when oxygen levels are low. Because no oxygen is used, fermentation makes less ATP than cellular respiration does. Fermentation takes place in a cell’s cytoplasm, not in mitochondria.

Types of Fermentation

There are several types of fermentation. One type occurs when glucose is changed into ATP and a waste product called lactic acid.

Lactic-Acid Fermentation Some bacteria and fungi help produce cheese, yogurt, and sour cream using lactic-acid fermentation. The muscle cells in animals, including humans, can release energy during exercise using lactic-acid fermentation.

Visual Check
2. Compare the reactions in mitochondria with glycolysis.

Key Concept Check
3. Explain how a cell obtains energy.
Reading Check

4. **Compare** lactic-acid fermentation and alcohol fermentation.

Visual Check

5. **Identify** the products of both lactic-acid fermentation and alcohol fermentation.

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**Lactic-Acid Fermentation**

Muscle cells

Glucose \((C_6H_{12}O_6)\) → ATP + Lactic acid

(Energy)

**Alcohol Fermentation**

Yeast cells

Glucose \((C_6H_{12}O_6)\) → ATP + Carbon dioxide + Alcohol

\((CO_2)\)

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**Photosynthesis**

Plants and some unicellular organisms obtain energy from light. They use photosynthesis. Photosynthesis is a series of chemical reactions that convert light energy, water, and carbon dioxide into the food-energy molecule glucose and the waste product oxygen.

**Light and Pigments**

Photosynthesis uses light energy. In plants, pigments such as chlorophyll absorb light energy. As chlorophyll absorbs light, it absorbs all the colors in it except green.

The green light is reflected as the green color that you see in leaves and stems. Plants might also contain pigments that reflect other colors, such as red, yellow, or orange light.

**Reactions in Chloroplasts**

The chlorophyll that absorbs light energy for photosynthesis is in chloroplasts. Chloroplasts are organelles in plant cells that convert light energy to chemical energy in food. During photosynthesis, light energy, water, and carbon dioxide combine and make sugars. Photosynthesis also produces oxygen, which is released into the atmosphere.
**Importance of Photosynthesis**

Photosynthesis uses light energy and carbon dioxide to make food energy. Oxygen is released during this process. This food energy is stored as glucose. When an organism eats plant material, such as fruit, it takes in food energy. The cells of the organism will then go through cellular respiration. They will use the oxygen released during photosynthesis and convert the food energy into ATP. These organisms then release carbon dioxide into the atmosphere. The relationship between cellular respiration and photosynthesis is shown in the diagram below.

**Word Origin**

*photosynthesis*

from Greek *photo*, means “light,” and *synthesis*, means “composition’

**Visual Check**

7. Explain the relationship between cellular respiration and photosynthesis.

\[
\text{Cellular respiration: } \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O} + \text{ATP (Energy)}
\]

\[
\text{Photosynthesis: } 6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2
\]
Mini Glossary

cellular respiration: a series of chemical reactions that convert the energy in food molecules into a usable form of energy called ATP

fermentation: a reaction that eukaryotic and prokaryotic cells use to obtain energy from food when oxygen levels are low

glycolysis: a process by which glucose, a sugar, is broken down into smaller molecules

photosynthesis: a series of chemical reactions that converts light energy, water, and carbon dioxide into the food-energy molecule glucose and gives off oxygen

1. Review the terms and their definitions in the Mini Glossary. Explain, using complete sentences, how photosynthesis and cellular respiration are related.

2. Fill in the table below to identify what is needed by each chemical reaction and what is produced by each chemical reaction.

<table>
<thead>
<tr>
<th></th>
<th>Photosynthesis</th>
<th>Cellular Respiration</th>
<th>Fermentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is needed?</td>
<td>1.</td>
<td>1.</td>
<td>1. glucose molecules</td>
</tr>
<tr>
<td></td>
<td>2.</td>
<td>2.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.</td>
<td>3.</td>
<td></td>
</tr>
<tr>
<td>What is produced?</td>
<td>1.</td>
<td>1.</td>
<td>1. glucose molecules</td>
</tr>
<tr>
<td></td>
<td>2.</td>
<td>2.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.</td>
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</tbody>
</table>

3. As chlorophyll in plants absorbs light, it absorbs all the colors except one color. Which color is that?