Photosynthesis: Making Energy

**Chloroplasts**

Photosynthesis is a process in which sunlight energy is used to make glucose. The site of photosynthesis is in the **chloroplast** – an organelle found in the leaves of green plants. The main functions of chloroplasts are to produce food (glucose) during **photosynthesis**, and to store food energy. Chloroplasts contain the pigment, chlorophyll. Chlorophyll absorbs most of the colors in the color spectrum, and reflects only green and yellow wavelengths of light. This is why we see leaves as green or yellow – because these colors are reflected into our eyes.

1. What is photosynthesis? A process in which sunlight is converted into glucose.
2. Where does photosynthesis occur? Photosynthesis occurs in the chloroplast.
3. What are chloroplasts and where are they found? An organelle found in the leaves of green plants.
4. What are the two main functions of chloroplasts? The two functions of a chloroplast are to produce glucose and store food energy.
5. Why do most leaves appear green? The pigment chlorophyll absorbs red and blue wavelengths of light and reflects back green and yellow wavelengths of light.
6. What is the primary pigment found in the chloroplast? Chlorophyll is the primary pigment found in chloroplasts.

**Photosynthesis**

Glucose is another name for sugar. The molecular formula for glucose is $\text{C}_6\text{H}_{12}\text{O}_6$. Plants make sugar by using the energy from sunlight to transform $\text{CO}_2$ from the air with water from the ground into glucose. This process, called photosynthesis occurs in the chloroplast of the plant cell. During this process, oxygen ($\text{O}_2$) is created as a waste product and is released into the air for us to breathe. The formula for photosynthesis is:

\[
\text{CO}_2 + \text{H}_2\text{O} + \text{sunlight} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2
\]

This formula says that carbon dioxide + water molecules are combined with the energy from sunlight to produce sugar and oxygen. The reactants in photosynthesis (what is used) are $\text{CO}_2$, water and sun. The plant gets water from the ground through its roots. The plant collects carbon dioxide from the air. Much of the carbon dioxide comes from living organisms that exhale (breath it out) it, but some also comes from factory smokestacks and car fumes.

7. What is the formula for photosynthesis? $\text{CO}_2 + \text{H}_2\text{O} + \text{sunlight} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2$
8. What three things are used to make glucose in photosynthesis? Carbon Dioxide, water and sunlight are three things that are used to make glucose in photosynthesis.
9. Where does the water come from? The water comes from in the ground.
10. Where does the water enter the plant? The water enters the plants through the roots.
11. Name 3 some sources of CO₂. Three sources of Carbon Dioxide are: exhalations from living organisms, pollution from factory smokestacks and car fumes.
12. What type of energy does the plant use to convert CO₂ and H₂O into sugar? Energy from sunlight is used to convert Carbon Dioxide and water into sugar.

The products are glucose and oxygen. The glucose produced is used by the plant for energy and growth. We also use this glucose by eating plants. The oxygen produced is released into the air for us to breathe.

Photosynthesis is essential for all life on earth, because it provides food and oxygen. Plants are considered autotrophs because unlike us humans, they can make their own food using this process.

13. What is produced in photosynthesis? Glucose and oxygen are the products of photosynthesis.
14. What is the glucose used for? The glucose is used by the plant for energy and growth. Animals use the glucose for the same reason but get it by eating plants.
15. What is the oxygen used for? The oxygen produced is released into the air for use by animals to breathe.
16. Here are three different ways to visualize the photosynthesis reaction: Is it easier for you to understand the reaction by using pictures, words, or symbols (see above)? Why?

<table>
<thead>
<tr>
<th>Photosynthesis in pictures</th>
<th>Photosynthesis in words</th>
<th>Photosynthesis in symbols</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Photosynthesis Diagram" /></td>
<td>Carbon dioxide and water combine with sunlight to create oxygen and glucose.</td>
<td>light CO₂ + H₂O → C₆H₁₂O₆ + O₂</td>
</tr>
</tbody>
</table>

**Essential Question:** Describe, using scientific terms, how plants turn sunlight into energy? Make sure to refer to the chemical equation to photosynthesis and discuss the reactants and products. Plants take in sunlight, carbon dioxide and water to create glucose. They do this in the chloroplasts that are located in the leaves of plants. Oxygen is also a product of photosynthesis and gets released back into the atmosphere for animals to breathe in.
Cellular Respiration: Breaking down Energy

**Mitochondria** are known as the powerhouses of the cell. They are **organelles** that act like a digestive system that takes in nutrients, breaks them down, and creates energy for the cell. The process of creating cell energy is known as **cellular respiration**. Most of the chemical reactions involved in cellular respiration happen in the mitochondria. A mitochondrion is shaped perfectly to maximize its efforts.

1. What process happens in the mitochondria? **Cellular Respiration happens in the mitochondria.**

2. What is the purpose of the process in #1 (what does it create)? **The purpose of Cellular Respiration is to take nutrients and break them down for energy for the cell.**

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**Introduction to Cellular Respiration**

Organisms, such as plants and algae, can trap the energy in sunlight through photosynthesis and store it in the chemical bonds of carbohydrate molecules. The principal carbohydrate formed through photosynthesis is **glucose**. Other types of organisms, such as animals, fungi, protozoa, and a large portion of the bacteria, are unable to perform this process. Therefore, these organisms must rely on the carbohydrates formed in plants to obtain the energy necessary for their metabolic processes. This means they must eat plants and other animals in order to gain energy.

3. Some organisms perform photosynthesis to produce energy. Other organisms cannot do photosynthesis. What can they do in order to generate energy? **Organisms that cannot perform photosynthesis must eat the carbohydrates produced by plants and algae.**

4. Animals and other organisms obtain the energy available in carbohydrates through the process of **cellular respiration**. What is the purpose of cellular respiration? **The purpose of Cellular Respiration is to take nutrients and break them down for energy for the cell.**

Cells take the carbohydrates into their cytoplasm, and through a complex series of metabolic processes, they break down the carbohydrates and release the energy. The energy is generally not needed immediately; rather it is used to combine adenosine diphosphate (ADP) with another phosphate to form adenosine triphosphate (ATP) molecules. The **ATP** can then be used for processes in the cells that require energy, much as a battery powers a mechanical device. During the process of cellular respiration, carbon dioxide is given off. Plant cells can use this carbon dioxide during photosynthesis to form new carbohydrates.

5. What happens to carbohydrates during cellular respiration? **Carbohydrates are broken down into stored energy in ATP.**

6. What is the chemical energy in the cell called? **The chemical energy in the cell is called ATP.**

7. What does ATP stand for? **ATP stands for Adenosine Triphosphate.**

8. What is one product of cellular respiration? **Carbon Dioxide is one product of cellular respiration.**
9. How do animals get rid of the carbon dioxide? Animals get rid of Carbon Dioxide by exhaling it into the atmosphere. What body system is involved with removing this waste? The respiratory and circulatory systems are involved with removing the Carbon Dioxide.

Also in the process of cellular respiration, oxygen gas is required to serve as an acceptor of electrons. This oxygen is identical to the oxygen gas given off during photosynthesis.

10. (Circle one) Oxygen is a PRODUCT OR REACTANT of respiration? (In other words, is it needed or released?)

<table>
<thead>
<tr>
<th>Energy-producing process</th>
<th>Reaction</th>
<th>Location in cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photosynthesis</td>
<td>[11. \text{CO}_2 + \text{H}_2\text{O} + \text{sunlight} \rightarrow \text{C}_6\text{H}_12\text{O}_6 + \text{O}_2]</td>
<td>Chloroplast</td>
</tr>
<tr>
<td>Cellular respiration</td>
<td>[\text{C}_6\text{H}_12\text{O}_6 + 6 \text{O}_2 \rightarrow 6 \text{H}_2\text{O} + 6\text{CO}_2 + \text{energy}]</td>
<td>12. Mitochondria</td>
</tr>
</tbody>
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13. Reflection Question: Explain the relationship between photosynthesis and cellular respiration. Be sure to include the main purpose of both and where they occur inside the cell.

The products of one process are the reactants of another process. For example: water, carbon dioxide, and sunlight are converted to glucose and oxygen in the chloroplasts during photosynthesis. Water, carbon dioxide and energy are the reactants in photosynthesis. Glucose and oxygen are the products in photosynthesis. In cellular respiration, glucose and oxygen are converted into energy, water and carbon dioxide. Glucose and oxygen are the reactants in cellular respiration and energy, water and carbon dioxide are the products in cellular respiration.