**How are photosynthesis and cellular respiration related?**

#### Photosynthesis and Cellular Respiration: Metabolism by photosynthesis allows plants and some microorganisms to use the energy of the sun to convert water and carbon dioxide gas into the sugar glucose and atmospheric oxygen. If photosynthetic organisms did not exist, we would not exist because we require oxygen and organic food sources like carbohydrate-rich plant material in order to survive. Our cells metabolize the products of photosynthesis to yield matter for growth and maintenance, and energy through the process of [cellular respiration](http://app.discoveryeducation.com/techbook2:concept/view/guidConceptId/1FB894CA-E429-4995-9477-2203B78FF1FD/guidCourseId/5837B3CD-1013-4178-9C10-264CC91FFD65/citGuid/7805F174-83B8-459A-83B2-BB0F9A5B444F/languageId/eng/readingLevelId/10/includeHeader/true/layout/a9491b1b-acb0-4a53-834a-bed338de09f3).

Photosynthesis only occurs in green plant tissue like leaves and stems, and only during daylight hours when there is sun. However all plant cells need energy and food. Plus the plant still needs energy when it is dark. Therefore, when they need to, plant cells use oxygen plus the energy stored in the organic matter made during daylight hours to get energy at night, by aerobic cellular respiration like we do, to stay alive.

The organic sugars made by photosynthesis have mass which can be incorporated into the growing plant. They also store chemical energy in the bonds of the sugar molecule. Carbohydrates and sugars can be broken down into simpler organic molecules, a process that generates energy. Cellular respiration is the process during which chemical energy stored in the bonds of food substances is used to produce [**adenosine triphosphate**](http://app.discoveryeducation.com/techbook2:concept/view/guidConceptId/1FB894CA-E429-4995-9477-2203B78FF1FD/guidCourseId/5837B3CD-1013-4178-9C10-264CC91FFD65/citGuid/7805F174-83B8-459A-83B2-BB0F9A5B444F/languageId/eng/readingLevelId/10/includeHeader/true/layout/d6706a19-603d-4038-9f69-dbc749b312f8) (ATP) and waste products like carbon dioxide. Cellular respiration that uses oxygen is called **aerobic respiration**. Glucose and oxygen fuel aerobic cellular respiration in a series of stages that convert chemical energy into ATP. Molecules of ATP are the preferred source of energy for the cellular activity of all organisms including growth, reproduction, and maintaining homeostasis.

Photosynthesis requires energy (provided by the sun) and converts, by chemical reduction, six molecules of carbon dioxide plus six molecules of water into one molecule of glucose plus six molecules of oxygen. Aerobic respiration releases energy (yielding a maximum of 36-38 ATP per glucose depending on the organism) and converts, by oxidation, one molecule of glucose plus six molecules of oxygen into six molecules of carbon dioxide plus six molecules of water. Photosynthesis and cellular respiration are therefore two parts of a never-ending cycle. The products of cellular respiration—carbon dioxide and water—are the reactants of photosynthesis, and vice versa. These two processes are important in determining the balance of carbon dioxide and oxygen in the atmosphere.

**Comparing Photosynthesis and Cellular Respiration**Photosynthesis is performed by plants and some microorganisms. Photosynthesis uses the energy of the sun to change water and carbon dioxide gas into the sugar glucose and oxygen. They use six molecules of water, and six molecules of carbon dioxide, to make one molecule of glucose.  If photosynthetic organisms did not exist, we would not exist. We need oxygen and organic food sources obtained from plant carbohydrates to survive. Cells metabolize the products of photosynthesis to make energy by aerobic cellular respiration. Energy and matter derived from photosynthesis are used for growth and maintenance.

**Cellular respiration** is a process used by all cells to produce useful energy from carbohydrates. The form of cellular respiration used in plants and most animals is called aerobic cellular respiration. Aerobic cellular respiration uses oxygen and carbohydrates.  Using a series of chemical reactions aerobic cellular respiration converts the chemical energy in carbohydrates into chemical energy in another substance, adenosine triphosphate (ATP). Molecules of ATP are the preferred source of energy for the cellular activity of all organisms. ATP is needed for growth, reproduction, and maintaining homeostasis. The waste products of cellular respiration are carbon dioxide and water. The aerobic respiration of one glucose molecule produces six water molecules and six carbon dioxide molecules.  
  
**The following table compares photosynthesis with aerobic cellular respiration:**

|  |  |
| --- | --- |
| Photosynthesis | Aerobic Cellular Respiration |
| Uses energy from the sun. | Cellular respiration releases energy. |
| Uses ATP (made in the early steps of photosynthesis) to make carbohydrates. | Uses carbohydrates to make ATP. |
| Converts six molecules of carbon dioxide and six molecules of water into one molecule of glucose. | Converts one molecule of glucose into six molecules of carbon dioxide and six molecules of water. |
| Removes carbon dioxide from the air. | Releases carbon dioxide into the air. |
| Releases oxygen into the air. | Removes oxygen from the air. |
| Overall chemical reaction is:  6 CO2 + 6 H2O + energy → C6H12O6 + 6 O2 | Overall chemical reaction is  C6H12O6 + 6 O2 → 6 CO2 + 6 H2O + energy |

Photosynthesis and cellular respiration are therefore two parts of a never-ending cycle. The products of cellular respiration—carbon dioxide and water—are the reactants of photosynthesis, and vice versa. These two processes determine the amounts of carbon dioxide and oxygen in the air.