Cells At Work—Photosynthesis and Respiration

Obtaining and Using Energy

When someone asks, "Where do you get your energy?", the simplest answer is "from the food I eat." Life is filled with many cycles. Two types of organelles, chloroplasts and mitochondria, are involved in a cycle that is necessary for the lives of plants and animals. Through the processes of photosynthesis and respiration, chemical reactions occur in cells that change the energy stored into forms needed to perform all the activities necessary for life. This allows plants and animals to get the materials they need from one another. The sum total of all your chemical reactions is called metabolism. All chemical reactions need enzymes. An enzyme is a substance that speeds up the chemical changes by the breaking down and joining of molecules. Without the right enzymes, chemical reactions in cells cannot take place. Because of photosynthesis (foh th oh SIN thuh sies) and respiration, the sun's energy is used. Photosynthesis is the food-making process in plant cells. Cellular respiration is the energy-releasing process in cells. So now you are ready to put it all together to understand this sugar-making to sugar-burning process.

Photosynthesis: Sugar-Making

Photosynthesis is the reason plants do not have to eat. They use their leaves as food factories. Photosynthesis is a food-making process that uses sunlight. The food made by the plant is a sugar called glucose. Plants can change glucose into nutrients (starch, fats, and proteins) to be stored and used later.

During photosynthesis, water and carbon dioxide, in the presence of sunlight, are used to make sugar. The water and carbon dioxide are the raw materials used to produce the food, or glucose. Roots absorb the water from the soil, and veins carry the water up and into the leaves. Carbon dioxide enters the leaf through tiny openings called stomata. Sunlight then provides the plant with the energy needed to change the raw materials into glucose, a product the plant needs and uses. The extra molecules produce oxygen and water, which is then given off by the plant as a waste product. Simply stated, plants capture the energy in sunlight and use it to convert carbon dioxide and water into a sugar that is used for the plant's life processes. The "extra" glucose is stored in the parts of plants we eat—fruits and vegetables.

The process cannot occur without chlorophyll (KLOH uh fil). Chlorophyll is a green chemical pigment found in the cell's chloroplasts. Chloroplasts are mostly found in the plant's leaves, which is why the leaves are often called food factories. Photosynthesis can only occur in plant cells that contain chlorophyll. Photosynthesis releases more oxygen than the plant needs for cellular respiration, so the "extra" oxygen is released into the air. You use the oxygen to breathe for your own cellular respiration.

Respiration: Sugar-Burning

Many students believe that plants do not need oxygen. All plants respire just as we do. There are two types of respiration. One is our method of respiration; the plant takes in the oxygen through its leaves and releases carbon dioxide. The other, cellular respiration, occurs inside the cell's mitochondria. Cellular respiration is the process of breaking down nutrients to create energy for cell processes. This breakdown occurs in all cells in all organs. When cells break down nutrients, wastes, such as carbon dioxide, are produced. You inhale oxygen
and exhale carbon dioxide. Have you ever breathed on a mirror before? Did you see a fog on the glass? The fog is actually water vapor you exhaled along with the carbon dioxide. During respiration, chemical reactions (changes) occur that break down food molecules into simpler substances and release stored energy. Just as with photosynthesis, enzymes are needed for the chemical reactions to take place.

What happens when you run—do you begin to breathe faster and feel hot? Why does this happen? It's because your muscle cells use a lot of energy when you run. To get the needed energy, your muscle cells break down food. Your muscles use some of the energy created from the breakdown of your food as you move. Some of the energy becomes thermal energy, which is why you feel hot. Most cells need oxygen in order to break down the food; this is why you breathe so fast. Your muscle cells need and use the oxygen for the process of respiration. In respiration, chemical reactions occur that break down food molecules into a simpler substance and release stored energy. Review the chemical equation for photosynthesis and respiration. Then make a comparison of the two equations.

**PHOTOSYNTHESIS**

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6\text{CO}_2 + 6\text{H}_2\text{O} + \text{Sunlight} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2
\]

**RESPIRATION**

\[
\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O} + \text{Energy}
\]

**The Chemistry Behind It All**

Compounds are represented by a chemical formula. Formulas show how many and what type of atoms are found in one molecule of the compound. The small numbers, subscripts, show how many atoms of each element it takes to make the compound. For example, there are 24 atoms in one molecule of sugar. It takes 6 carbon, 12 hydrogen, and 6 oxygen atoms to make one molecule of sugar. The large numbers in front of the compound formula, coefficients, indicate how many molecules of each compound are needed.