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8-1 Energy and Life WORKSHEET

Energy is the ability to do work. Nearly every activity in modern society depends on one kind of energy or another. When a car runs out of fuel - more precisely, out of the chemical energy in gasoline - it comes to a sputtering halt. Without electrical energy, lights, appliances, and computers stop working.

Living things depend on energy too. Sometimes, the need for energy is easy to see. It is obvious that energy is needed to play soccer or other sports. However, there are times when that need is less obvious. For example, when you are sleeping, your cells are busy using energy to build new proteins and amino acids. Clearly, without the ability to obtain and use energy, life would cease to exist.

Autotrophs and Heterotrophs

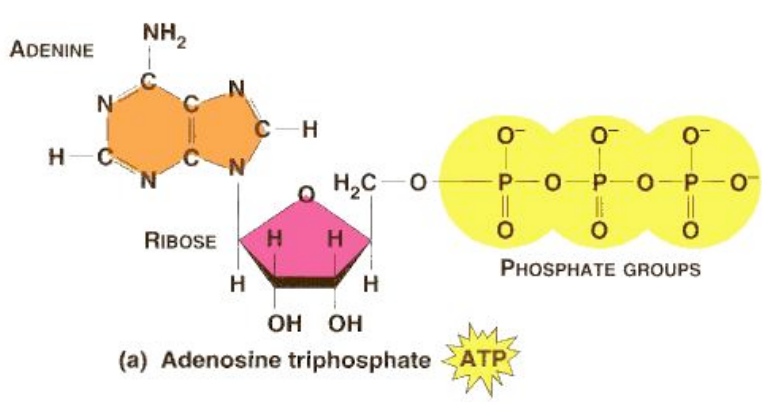
Where does the energy that living things need come from? The simple answer is that it comes from food. Originally, though, the energy in most food comes from the sun. **Plants and some other types of organisms are able to use light energy from the sun to produce food.** Organisms such as plants, which make their own food, are called **autotrophs**.

Other organisms, such as animals, cannot use the sun's energy directly. These organisms, known as **heterotrophs**, obtain energy from the food they consume. Impalas, for example, eat grasses, which are autotrophs. Other heterotrophs, such as a leopard, obtain the energy stored in autotrophs indirectly by feeding on animals that eat autotrophs. Still other heterotrophs - mushrooms, for example - obtain food by decomposing other organisms. To live, all organisms, including plants, must release the energy in sugars and other compounds.

Chemical Energy and ATP

Energy comes in many forms, including light, heat, and electricity. Energy can be stored in chemical compounds, too. For example, when you light a candle, the wax melts, soaks into the wick, and is burned, releasing energy in the form of light and heat. As the candle burns, high-energy chemical bonds between carbon and hydrogen atoms in the wax are broken. The high-energy bonds are replaced by low-energy bonds between these atoms and oxygen. The energy of a candle flame is released from electrons. When the electrons in those bonds are shifted from higher energy levels to lower energy levels, the extra energy is released as heat and light.

Living things use chemical fuels as well. One of the principal chemical compounds that cells use to store and release energy is **adenosine triphosphate (ATP)**. ATP consists of adenine, a 5-carbon sugar called ribose, and three phosphate groups. Those three phosphate groups are the key to ATP's ability to store and release energy.



(a) Adenosine triphosphate

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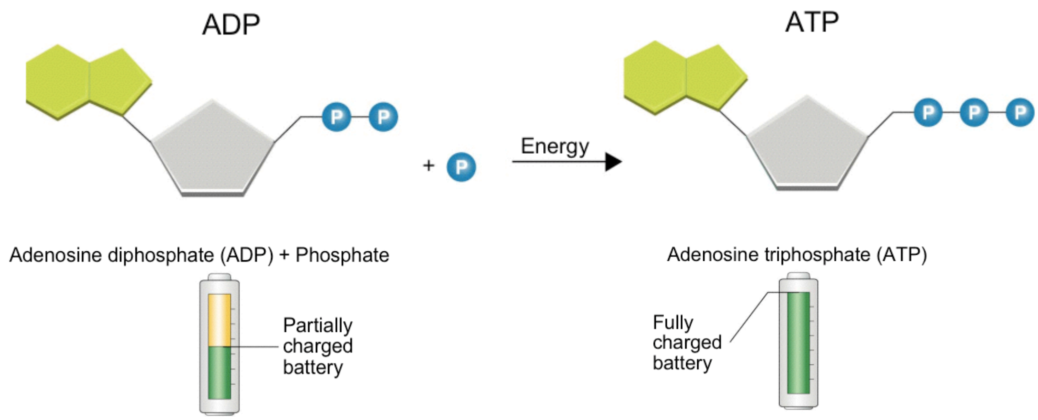
Adenosine diphosphate (ADP) is a compound that looks almost like ATP, except that it has two phosphate groups instead of thee. This difference is the key to the way in which living things store energy. When a cell has energy available, it can store small amounts of it by adding a phosphate group to ADP molecules, producing ATP. In a way, ATP is like a fully charged battery, ready to power the machinery of the cell.



How is the energy that is stored in ATP released? Simply by breaking the chemical bond between the second and third phosphates, energy is released. Because a cell can subtract that third phosphate group, it can release energy as needed. ATP has enough energy to power a variety of cellular activities, including active transport across cell membranes, protein synthesis, and muscle contraction. **The characteristics of ATP make it exceptionally useful as the basic energy source of all cells.**

Using Biochemical Energy

One way cells use the energy provided by ATP is to carry out active transport. Many cell membranes contain a sodium-potassium pump, a membrane protein that pumps sodium ions (Na^+) out of the cell and potassium ions (K^+) into it. ATP provides the energy that keeps this pump working, maintaining a carefully regulated balance of ions on both sides of the cell membrane. ATP produces movement, too, providing the energy for motor proteins that move organelles through the cell.

Energy from ATP powers other important events in the cell, including the synthesis of proteins and nucleic acids and responses to chemical signals at the cell surface. The energy from ATP can even be used to produce light. In fact, the blink of a firefly on a summer night comes from an enzyme powered by ATP!

ATP is such a useful source of energy that you might think the cells would be packed with ATP to get them through the day, but this is not the case. In fact, most cells have only a small amount of ATP, enough to last them for a few seconds of activity. Why? Even though ATP is a great molecule for transferring energy, it is not a good one for storing large amounts of energy over the long term. A single molecule of the sugar glucose stores more than 90 times the chemical energy of a molecule of ATP. Therefore, it is more efficient for cells to keep only a small supply of ATP on hand. Cells can regenerate ATP from ADP as needed by using the energy in foods like glucose. As you will see, that's exactly what they do.

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8-1 Energy and Life Worksheet - QUESTIONS

1. Where does the energy of food originally come from? ___________________________

2. What type of organism makes its own food? ____________________________________

3. What type of organism obtains its energy from the food they eat?

____

4. How is ATP different from ADP? ____

____

5. When is the energy stored in ATP released? _____________________________________

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6. What are two ways in which cells use the energy provided by ATP?

____

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7. A single glucose molecule stores _______ times the chemical energy of an ATP molecule.

8. Where do cells get the energy to regenerate ATP? _______________________________