Biochemical Reactions

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This marathon runner has just finished running a 26.2-mile race! Running that far nonstop takes a lot of energy—you can tell how drained she is from her face. But you don’t have to run a marathon to use energy. All living things need energy all the time just to stay alive. Whether it’s running a marathon or simply taking a breath, energy is required. Where does all that energy come from? The answer is chemical reactions.

**Chemical Reactions in Living Things**

Chemical reactions that take place inside living things are called **biochemical reactions** (*bio-* means “life”). It’s not just for energy that living things depend on biochemical reactions. Every function and structure of a living organism depends on thousands of biochemical reactions taking place in each cell. The sum of all these biochemical reactions is called metabolism.

**Catabolic and Anabolic Reactions**

Biochemical reactions of metabolism can be divided into two general categories: catabolic reactions and anabolic reactions.

- Catabolic reactions involve breaking bonds. Larger molecules are broken down to smaller ones. For example, complex carbohydrates are broken down to simple sugars. Catabolic reactions release energy, so they are exothermic.
• Anabolic reactions involve forming bonds. Smaller molecules are combined to form larger ones. For example, simple sugars are combined to form complex carbohydrates. Anabolic reactions require energy, so they are endothermic.

Q: Imagine! Each of the trillions of cells in your body is continuously performing thousands of catabolic and anabolic reactions. That’s an amazing number of biochemical reactions—far more than the number of reactions that might take place in a lab or factory. How can so many biochemical reactions take place simultaneously in our cells?
A: So many reactions can occur because biochemical reactions are amazingly fast.

Q: In a lab or factory, reactants can be heated to very high temperatures or placed under great pressure so they will react very quickly. These ways of speeding up chemical reactions can’t occur inside the delicate cells of living things. So how do cells speed up biochemical reactions?
A: The answer is enzymes.

The Importance of Enzymes

Enzymes are proteins that increase the rate of chemical reactions by reducing the amount of activation energy needed for reactants to start reacting. Enzymes are synthesized in the cells that need them, based on instructions encoded in the cell’s DNA. Enzymes aren’t changed or used up in the reactions they catalyze, so they can be used to speed up the same reaction over and over again. Enzymes are highly specific for certain chemical reactions, so they are very effective. A reaction that would take years to occur without its enzyme might occur in a split second with the enzyme. Enzymes are also very efficient, so waste products rarely form.

Photosynthesis and Cellular Respiration

Some of the most important biochemical reactions are the reactions involved in photosynthesis and cellular respiration. Together, these two processes provide energy to almost all of Earth’s organisms. The two processes are closely related, as you can see in the Figure 1.1. In photosynthesis, light energy from the sun is converted to stored chemical energy in glucose. In cellular respiration, stored energy is released from glucose and stored in smaller amounts that cells can use.
Q: What are the reactants and products in photosynthesis and cellular respiration?

A: In photosynthesis, carbon dioxide (CO$_2$) and water (H$_2$O) are the reactants. They combine using energy from light to produce oxygen (O$_2$) and glucose (C$_6$H$_{12}$O$_6$). Oxygen and glucose, in turn, are the reactants in cellular respiration. They combine to produce carbon dioxide, water, and energy.

Summary

• Biochemical reactions are chemical reactions that take place inside living things. Thousands of biochemical reactions continuously take place inside each cell. The sum of all these biochemical reactions is called metabolism.
• Biochemical reactions of metabolism can be divided into two general categories: catabolic reactions, which break bonds and release energy, and anabolic reactions, which form bonds and absorb energy.
• Enzymes are proteins that greatly increase the rate of biochemical reactions, allowing thousands of reactions to occur simultaneously in living cells.
• The chemical reactions of photosynthesis and cellular respiration together provide energy to virtually all living things on Earth.

Review

1. What is a biochemical reaction?
2. Compare and contrast catabolic and anabolic reactions.
3. Why are enzymes needed for biochemical reactions?
4. How are photosynthesis and cellular respiration related?

Explore More

Watch the video about metabolism and then answer the questions below.

1. How is metabolism defined in the video?
2. Fill in the blanks in the following sentences with the terms that follow.
   a. The harvesting of energy is __________.
   b. The using of energy is __________.
   c. Organisms who get energy themselves are __________.
   d. Organisms who get energy from other sources are __________.
   e. Using sunlight to make organic matter is __________.
   f. Using inorganic molecules to make organic matter is __________.

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<th>Table 1.1: Choices for Practice Question 2</th>
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<tr>
<td>anabolism</td>
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