chapter 6 Chemistry in Biology

section 2 Chemical Reactions

Before You Read

On the lines below, explain why you think rust forms on metal. Then read the section to learn the role of chemical reactions in living things.

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MAIN Idea

Chemical reactions allow living things to grow, develop, reproduce, and adapt.

What You'll Learn

- the parts of a chemical reaction
- how energy changes relate to chemical reactions
- the importance of enzymes in organisms

Read to Learn

Reactants and Products

Chemical reactions occur inside your body all the time. You digest food. Your muscles grow. Your cuts heal. These functions and many others result from chemical reactions.

A **chemical reaction** is the process by which atoms or groups of atoms in substances are reorganized into different substances. Chemical bonds are broken and formed during chemical reactions. For example, rust is a compound called iron oxide. It forms when oxygen in the air reacts with iron.

What was once silver and shiny becomes dull and orange-brown. Other clues that a chemical reaction has taken place include the production of heat or light, and formation of gas, liquid, or solid.

How are chemical equations written?

Scientists express chemical reactions as equations. On the left side of the equation are the starting substances, or **reactants**. On the right side of the equation are the substances formed during the reaction, or the **products**. An arrow is between these two parts of the equation. You can read the arrow as "yield" or "react to form." The general form of a chemical equation is shown below.

$$\text{Reactants} \longrightarrow \text{Products}$$

Study Coach

Create a Quiz After you read this section, create a five-question quiz from what you have learned. Then, exchange quizzes with another student. After taking the quizzes, review your answers together.

Picture This

1. **Describe** how this general chemical equation would be expressed in words.

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Why must chemical equations balance?

The following chemical equation describes the reaction between hydrogen (H) and oxygen (O) to form water (H_2O).

$$2H_2 + O_2 \longrightarrow 2H_2O$$

Picture This

2. Label the subscripts and the coefficients in this equation after you read the discussion on this page.

Matter cannot be created or destroyed in chemical reactions. This is the principle of conservation of mass. Therefore, mass must balance in all chemical equations. This means that the number of atoms of each element on the reactant side must equal the number of atoms of the same element on the product side. In our example, the number of H atoms on the left side must equal the number of H atoms on the right side. The same must be true of O atoms.

The larger 2 to the left of the element H is called a coefficient. Coefficients are used to balance chemical equations. If no coefficient or subscript appears with an element, both are assumed to be 1.

To see that the above equation is balanced, multiply the coefficient by the subscript for each element. Then add up the total number of atoms of each element. Follow along in the equation above as you read the analysis below.

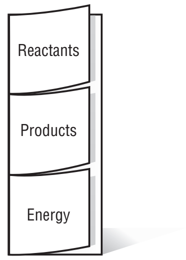
Reactant side:
2 (coefficient of H) × 2 (subscript of H) = 4 H atoms
1 (coefficient of O) × 2 (subscript of O) = 2 O atoms

Product side:
2 (coefficient of H) × 2 (subscript of H) = 4 H atoms
2 (coefficient of O) × 1 (subscript of O) = 2 O atoms

The equation has the same number of H atoms on both sides. It also has the same number of O atoms on both sides. No mass has been gained or lost. The equation balances.

FOLDABLES™

Take Notes Make a three-tab Foldable from a sheet of notebook paper. As you read, record what you learn about reactants, products, and the energy required to start a chemical reaction.



Energy of Reactions

Energy is required to start a chemical reaction. The minimum amount of energy needed for reactants to form products in a chemical reaction is called the **activation energy**. For example, a candle will not burn until you light the wick. The flame from a match provides the activation energy for the candle wick to react with oxygen in the air. Some reactions need higher activation energy than others.

How does energy change in chemical reactions?

Chemical reactions can be exothermic or endothermic. In exothermic reactions, energy is released in the form of heat or light. As a result, the energy of the product is lower than the energy of the reactants. In endothermic reactions, energy is absorbed. As a result, the energy of the product is higher than the energy of the reactants.

Reading Check

3. Explain why the energy of the product might be lower than the energy of the reactants.

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Enzymes

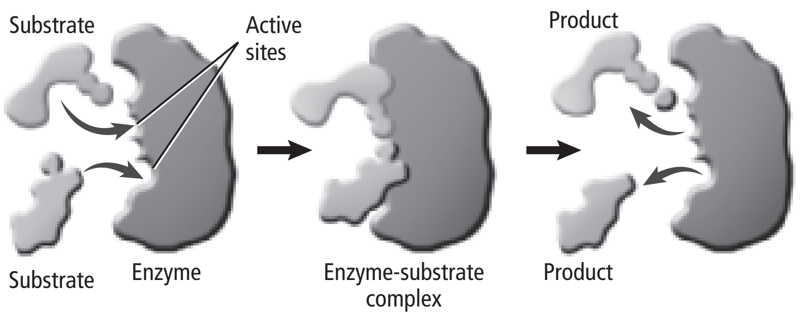
Some chemical reactions occur slowly in a laboratory because the activation energy is high. To speed up the chemical reaction, scientists use catalysts. A **catalyst** is a substance that lowers the activation energy needed to start a chemical reaction. A catalyst does not increase how much product is made, and it does not get used up in the reaction.

In living things, special proteins called **enzymes** are biological catalysts. Enzymes speed up the rate of chemical reactions in the body. Like all catalysts, enzymes are not used up by the chemical reaction. They can be used again. Also, most enzymes act in just one type of reaction. For example, the enzyme amylase is found in saliva. Amylase helps begin the process of food digestion in the mouth.

The figure below shows how an enzyme works. The reactants that bind to the enzyme are called **substrates**. The specific location where a substrate binds on an enzyme is called the **active site**. The substrate and active site are shaped to fit together exactly. Only substrates shaped to fit the active site will bind to the enzyme.

The bond between the enzyme and substrates creates the enzyme-substrate complex. This complex helps to break bonds in the reactants and form new bonds, changing the substrates into products. The enzyme then releases the products.

Enzymes are the chemical workers in cells. The actions of enzymes enable cell processes that supply energy. Factors such as pH and temperature affect enzyme activity.



Picture This

4. Label each of the three parts of this process with a brief description of what the part shows.