SECTION

2.4 Chemical Reactions

KEY CONCEPT Life depends on chemical reactions.

FLORIDA STANDARDS
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Bonds break and form during chemical reactions.

Plant and animal cells break down sugars to make energy. All cells build protein molecules by bonding amino acids together. These processes are examples of chemical reactions. **Chemical reactions** change substances into different substances by breaking and forming chemical bonds.

Reactants and Products

The oxygen molecules (O_2) that you breathe in are part of a series of chemical reactions. These chemical reactions use oxygen and glucose ($C_6H_{12}O_6$), and produce carbon dioxide (CO_2), water (H_2O), and energy that your body can use. This process is called cellular respiration.

$$6O_2 + C_6H_{12}O_6 \longrightarrow 6CO_2 + 6H_2O$$

Reactants — Direction — Products

- **Reactants** are the substances that are changed during a chemical reaction. Oxygen and glucose are the reactants in the reaction shown above.
- **Products** are the substances made by a chemical reaction. Carbon dioxide and water are the products of the above reaction.

The breakdown of glucose provides chemical energy for all activities, including running.

Bond Energy

In order for reactants to change into products, the bonds of the reactants must break, and new bonds must form in the products. Breaking a bond requires energy. **Bond energy** is the amount of energy that it takes to break a bond between two atoms. Bonds between different types of atoms have different bond energies. A certain amount of energy is needed to break the bond between two oxygen atoms. A different amount of energy is needed to break the bond between carbon and hydrogen. Energy is released when bonds form.

Chemical Equilibrium

Some chemical reactions only go one way, from reactants to products, until all the reactants are used up. However, many reactions in living things are reversible. These reactions can move in both directions at the same time. One reaction that goes both directions allows your blood to carry carbon dioxide. Carbon dioxide reacts with water in your blood to form a compound called carbonic acid (H_2CO_3).

$$CO_2 + H_2O \rightleftharpoons H_2CO_3$$

The arrows in this equation show that the reaction goes in both directions. Usually, the direction depends on the amounts of each compound. If there is a high concentration of carbon dioxide—like around your cells—the reaction moves toward the right and carbonic acid forms. If there is a low concentration of carbon dioxide—like in your lungs—the reaction goes toward the left and carbonic acid breaks down.

When a reaction takes place at an equal rate in both directions, the concentration, or amounts, of the reactants and products stays the same. **Equilibrium** (EE-kwuh-LIHB-ree-uhm) is when both the reactants and products are made at the same rate.

STANDARDS CHECK

In which part of a chemical reaction do bonds break? In which part do they form?

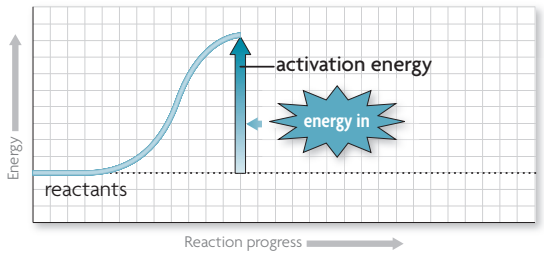
Chemical reactions release or absorb energy.

Energy is both absorbed* and released during a chemical reaction. Some chemical reactions give off more energy than they take in. Other chemical reactions take in more energy than they give off. **Activation energy** is the amount of energy that needs to be absorbed for a chemical reaction to start.

VOCABULARY

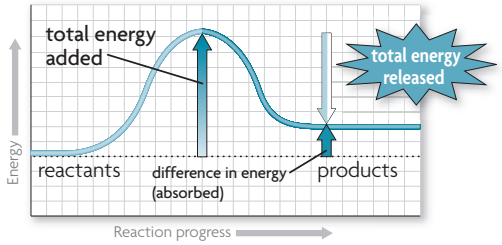
The prefix *exo-* means "out," and the prefix *endo-* means "in." Energy "moves out of" an exothermic reaction, and energy "moves into" an endothermic reaction

ACTIVATION ENERGY



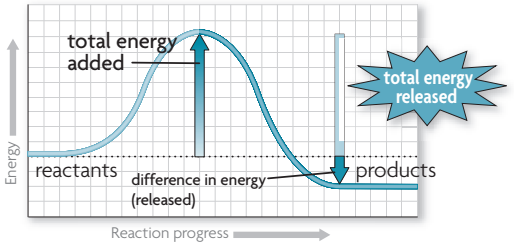
Activation energy is the amount of energy that needs to be absorbed for a chemical reaction to start. When enough activation energy is added to the reactants, bonds in the reactants break and the reaction begins.

ENDOTHERMIC REACTION Energy Absorbed



An **endothermic** chemical reaction absorbs more energy than it releases. The products have a higher bond energy than the reactants, and the difference in bond energy is absorbed from the surroundings. Photosynthesis is an endothermic reaction.

EXOTHERMIC REACTION Energy Released



An **exothermic** chemical reaction releases more energy than it absorbs. The products have a lower bond energy than the reactants, and the difference in bond energy is released to the surroundings. Cellular respiration is an exothermic reaction.

* ACADEMIC VOCABULARY

absorb to take in or use

Both **exothermic** and **endothermic** reactions take place in organisms. For example, cellular respiration—the process that uses glucose and oxygen to provide usable energy—is exothermic. It also provides heat that keeps your body warm. Photosynthesis, on the other hand, is endothermic. It absorbs more energy from sunlight than it releases.

INSTANT REPLAY

What is the difference between an exothermic reaction and an endothermic reaction? _____

_____

2.4 Vocabulary Check

chemical reaction	equilibrium
reactant	activation energy
product	exothermic
bond energy	endothermic

Mark It Up

Go back and highlight each sentence that has a vocabulary word in **bold.**

Use the words above to fill in the blanks in the section summary below.

Making and breaking chemical bonds are examples of **1.** _____. Bonds are broken in the **2.** _____, the chemicals that are changed during the process. Bonds are made in the **3.** _____, the chemicals that result from the process. If a reaction takes place at an equal rate in both directions, it is in **4.** _____. The amount of energy needed to break a bond is called the **5.** _____.

The **6.** _____ is the amount of energy needed to start a reaction. If a reaction absorbs more energy than it releases it is called an **7.** _____ reaction. If a reaction releases more energy than it absorbs it is called an **8.** _____ reaction.

2.4 The Big Picture

9. Look at the chemical reaction below. Draw a circle around the reactant(s). Underline the product(s).

hydrogen peroxide		water		oxygen
H_2O_2	$\longrightarrow$	H_2O	+	O_2

10. Imagine a seesaw, like on a children's playground. Which of the following drawings of a seesaw best represents equilibrium? Explain.