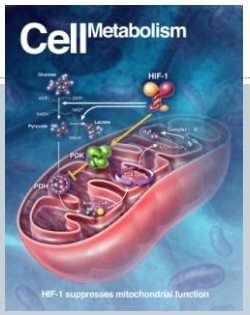


Section 2.4 Chemical Reactions

MRS. MICHAELSEN
BIOLOGY

THINK ABOUT IT

A. Living things are made up of chemical compounds, but chemistry isn't just what life is made of—chemistry is also what life does.

B. Everything that happens in an organism—its growth, its interaction with the environment, its reproduction, and even its movement—is based on chemical reactions.

Chemical Reactions

A. A **chemical reaction** is a process that changes, or transforms, one set of chemicals into another by changing the chemical bonds that join atoms in compounds.

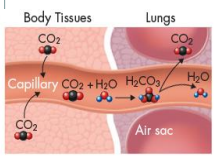
B. Mass and energy are conserved.

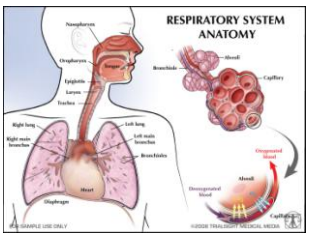
C. Elements or compounds that enter into a chemical reaction: **Reactants.**

D. Elements or compounds produced by a chemical reaction: **Products.**

Chemical Reactions

E. E.g. Carbon dioxide has to be removed from the body.



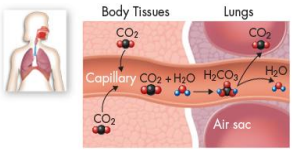


Chemical Reactions

F. As carbon dioxide (CO_2) enters the blood, it reacts with water to produce carbonic acid (H_2CO_3), which is highly soluble.

G. This chemical reaction enables the blood to carry carbon dioxide to the lungs.

H. In the lungs, the reaction is reversed and produces carbon dioxide gas, which you exhale.



Energy Changes

A. Energy is released or absorbed whenever chemical bonds are formed or broken during chemical reactions.

B. Chemical reactions that *release* energy often occur on their own, or *spontaneously*.

C. Chemical reactions that *absorb* energy will not occur without a *source* of energy.

Energy Changes

D. An example of an energy-releasing reaction is the burning of hydrogen gas, in which hydrogen reacts with oxygen to produce water vapor.

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

Energy Changes

E. The reverse reaction absorbs so much energy that it generally doesn't occur by itself.

$$2H_2O + \text{energy} \rightarrow 2H_2 + O_2$$

F. Electric current must be passed through to decompose water into gases.

G. In one direction the reaction produces energy, and in the other direction the reaction requires energy.

Energy Sources

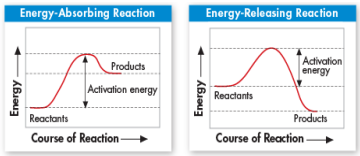
A. Every organism must have a source of energy to carry out the chemical reactions it needs to stay alive.
   1. Plants get their energy by trapping and storing the energy from sunlight in energy-rich compounds.
   2. Animals get their energy when they consume plants or other animals.

B. When a reaction doesn't occur spontaneously, the energy that is needed to get a reaction started is called the **activation energy.**

Activation Energy

A. The peak of each graph represents the energy needed for the reaction to go forward.

B. The difference between the required energy and the energy of the reactants is the activation energy.



Enzymes

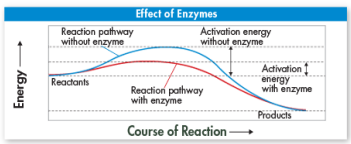
A. Some chemical reactions are too slow or have activation energies that are too high to make them practical for living tissue.

B. These chemical reactions are made possible by catalysts.
   1. A **catalyst** is a substance that speeds up the rate of a chemical reaction.
   2. Catalysts work by lowering a reaction's activation energy.

Nature's Catalysts

A. **Enzymes** are proteins that act as biological catalysts. They speed up chemical reactions that take place in cells.

B. Enzymes are a catalyst and act by lowering the activation energies.



Nature's Catalysts

C. For example, the reaction in which carbon dioxide combines with water to produce carbonic acid is so slow that carbon dioxide might build up in the body faster than the bloodstream could remove it.

$$CO_2 + H_2O \longrightarrow H_2CO_3$$

D. Enzyme called carbonic anhydrase speeds up the reaction by a factor of 10 million.

Nature's Catalysts

E. Enzymes are very specific, generally catalyzing only one chemical reaction.

F. Part of an enzyme's name is usually derived from the reaction it catalyzes.

1. E.g. carbonic anhydrase.

The Enzyme-Substrate Complex

A. For a chemical reaction to take place, new bonds must be formed.

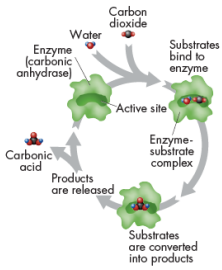
B. If the reactants do not have enough energy, they will be unchanged after the collision.

C. Enzymes provide a site where reactants can be brought together to react. Such a site reduces the energy needed for reaction.

The Enzyme-Substrate Complex

D. The reactants of enzyme-catalyzed reactions are known as **substrates.**

E. For example, the enzyme carbonic anhydrase converts the substrates carbon dioxide and water into carbonic acid (H_2CO_3).

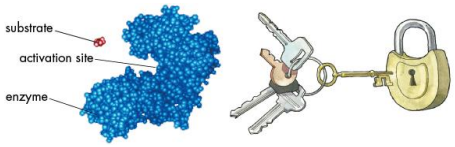


The Enzyme-Substrate Complex

F. The substrates bind to a site on the enzyme called the active site.

G. The active site and the substrates have complementary shapes.

H. The fit is so precise that the active site and substrates are often compared to a lock and key.



Regulation of Enzyme Activity

A. Temperature, pH, and regulatory molecules are all factors that can affect the activity of enzymes.

B. Produced by human cells generally work best at temperatures close to 37 C.

C. Work best at certain pH values. For example, the stomach enzyme pepsin, which begins protein digestion, works best under acidic conditions.

D. Regulated by molecules that carry chemical signals within cells, switching enzymes “on” or “off” as needed.