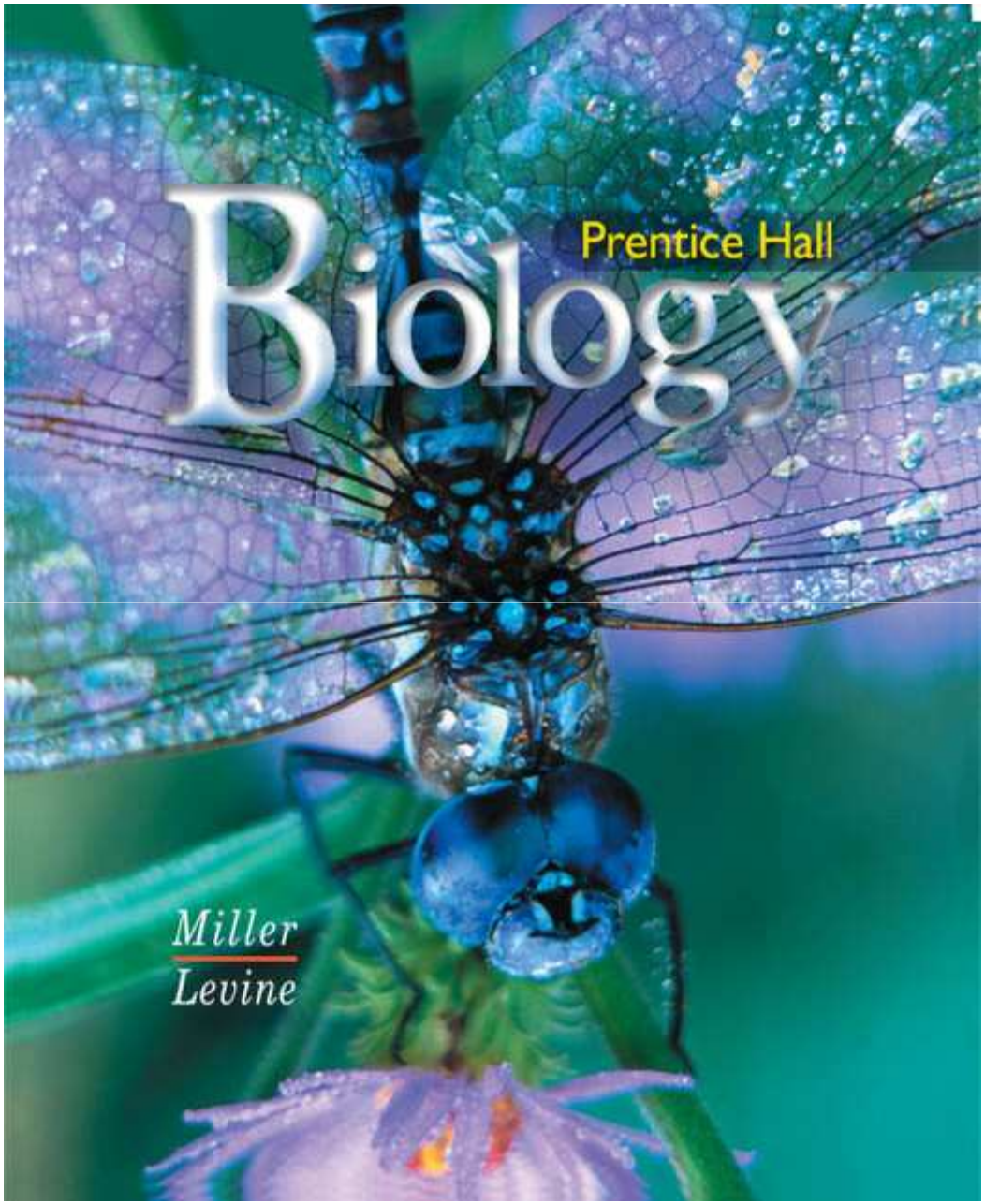

2–4 Chemical Reactions and Enzymes

Chemical Reactions

A **chemical reaction** is a process that changes one set of chemicals into another set of chemicals.

Some chemical reactions occur slowly, such as the combination of iron and oxygen to form an iron oxide called rust.

Other reactions occur quickly. For example, when hydrogen gas is ignited in the presence of oxygen, the reaction is rapid and explosive.

The elements or compounds that enter into a chemical reaction are known as **reactants**.

The elements or compounds produced by a chemical reaction are known as **products**.

What happens to chemical bonds during chemical reactions?

Chemical reactions always involve changes in the chemical bonds that join atoms in compounds.

Energy in Reactions

Energy is released or absorbed whenever chemical bonds form or are broken.

Because chemical reactions involve breaking and forming bonds, they involve changes in energy.

How do energy changes affect whether a chemical reaction will occur?

Energy Changes

Chemical reactions that release energy often occur spontaneously. Chemical reactions that absorb energy will not occur without a source of energy.

When hydrogen gas reacts with oxygen to produce water vapor, it is an energy-releasing reaction in which energy is given off as heat.

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

Reversing this reaction would require the addition of large amounts of energy.

In order to stay alive, organisms need to carry out reactions that require energy.

Because matter and energy are conserved in chemical reactions, every organism must have a source of energy to carry out chemical reactions.

Plants get their energy from the sun.

Animals get their energy from eating plants or other animals.

Activation Energy

Chemical reactions that release energy do not always occur spontaneously.

Chemists call the energy that is needed to get a reaction started the **activation energy**.

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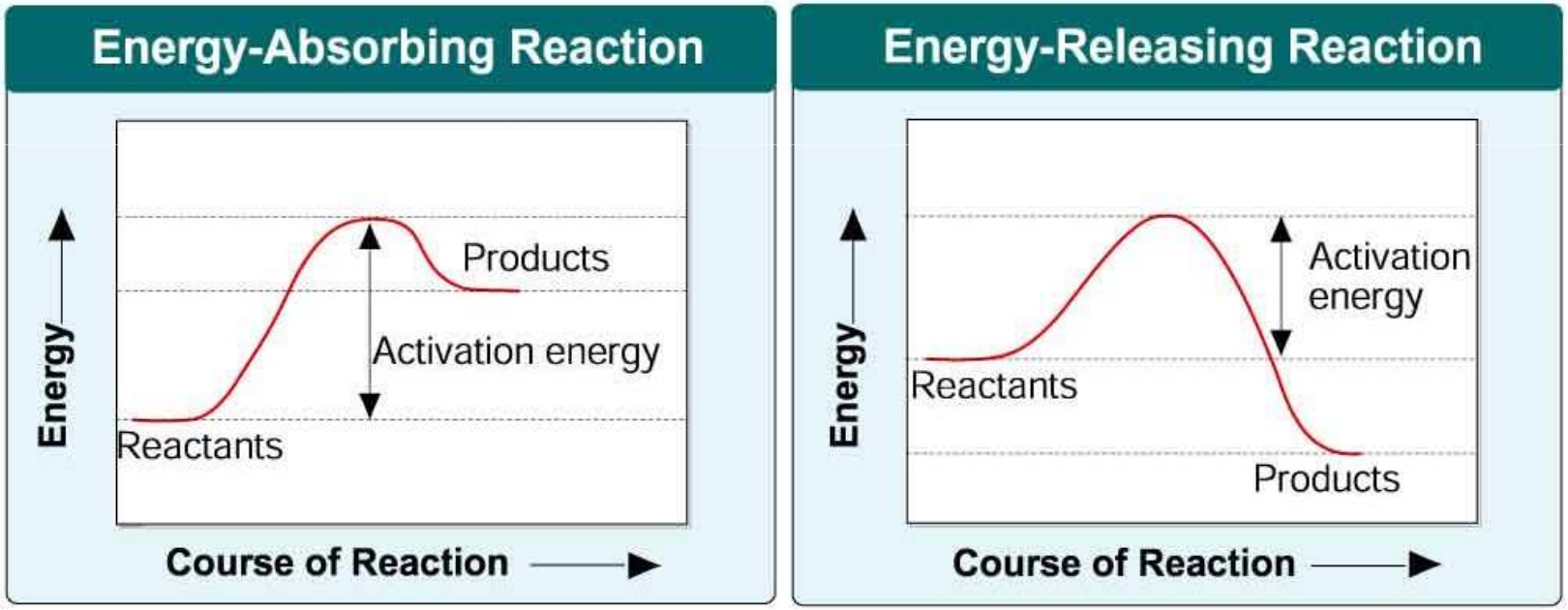
Activation energy is a factor in whether the overall chemical reaction releases energy or absorbs energy.



Enzymes

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

These chemical reactions are made possible by catalysts.

A **catalyst** is a substance that speeds up the rate of a chemical reaction.

Catalysts work by lowering a reaction's activation energy.

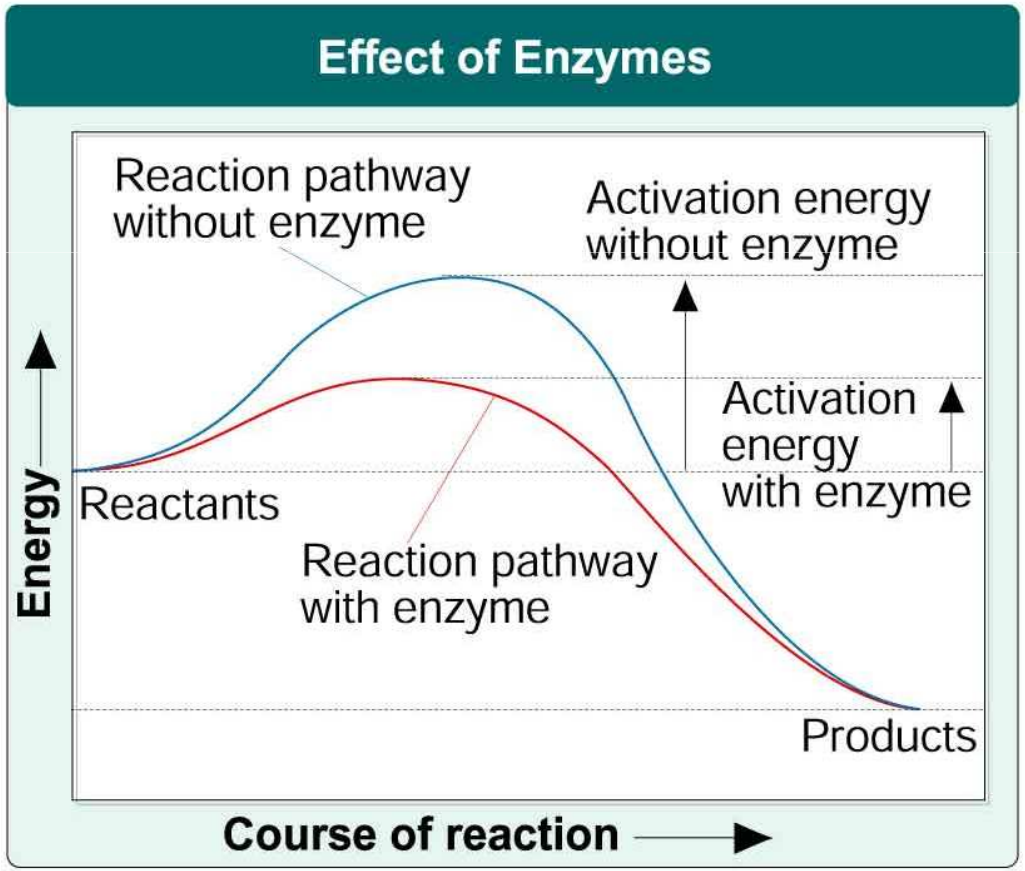
Why are enzymes important to living things?

Enzymes are proteins that act as biological catalysts.

Enzymes speed up chemical reactions that take place in cells.

Enzymes act by lowering the activation energy.

Lowering the activation energy has a dramatic effect on how quickly the reaction is completed.



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

For this reason, part of an enzyme's name is usually derived from the reaction it catalyzes.

Enzyme Action

For a chemical reaction to take place, the reactants must collide with enough energy so that existing bonds will be broken and new bonds will be formed.

If reactants do not have enough energy, no reaction will take place.

The Enzyme-Substrate Complex

Enzymes provide a site where reactants can be brought together to react, reducing the energy needed for reaction.

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

The substrates glucose and ATP bind to the active site on the enzyme, hexokinase, forming an enzyme-substrate complex.

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

The enzyme and substrates remain bound together until the reaction is done and the substrates are converted to products.

The products of the reaction are released and the enzyme is free to start the process again.

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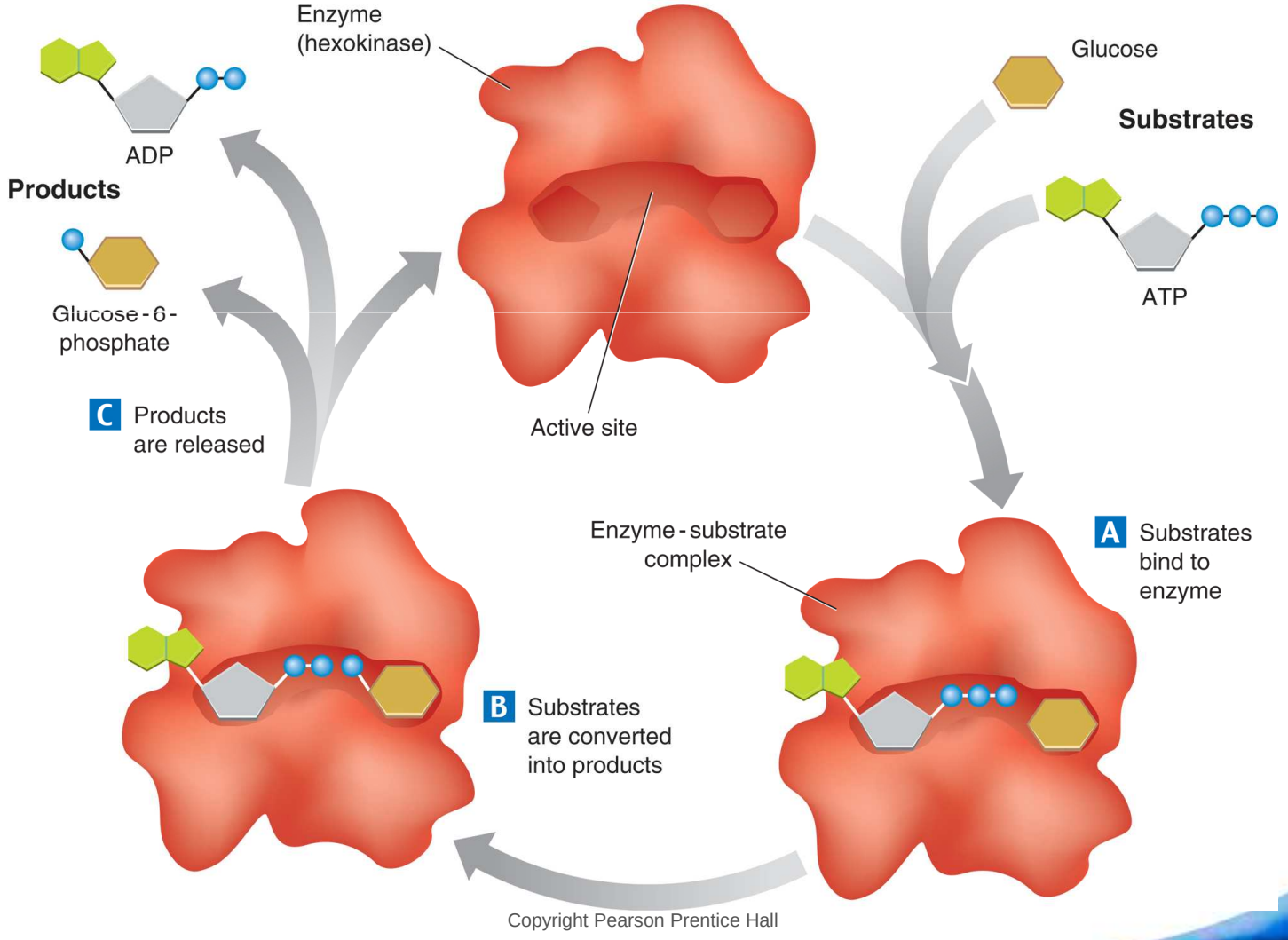
An Enzyme-Catalyzed Reaction



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Regulation of Enzyme Activity

Enzymes can be affected by any variable that influences a chemical reaction.

Enzymes work best at certain pH values.

Many enzymes are affected by changes in temperature.

Cells can regulate the activities of enzymes.

Most cells contain proteins that help to turn key enzymes “on” and “off” at critical stages in the life of the cell.

Enzymes play essential roles in:

- regulating chemical pathways.
- making material that cells need.
- releasing energy.
- transferring information.

2–4 Section QUIZ

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2–4 Section QUIZ

1 The elements or compounds produced by a chemical reaction are known as

a. reactants.

b. enzymes.

A c. products.

d. waste.

2–4 Section QUIZ

2 Chemical reactions always involve

A a. changes in energy.

b. enzymes.

c. catalysts.

d. changes in the atomic number of the reactants.

2–4 Section QUIZ

3 The factor that prevents many energy-releasing reactions from occurring at relatively low temperatures is called

a. catalytic energy.

b. chemical bond energy.

c. enzyme energy.

A d. activation energy.

2–4 Section QUIZ

4 Which of the following statements is true?

a. All proteins are enzymes.

b. All catalysts are enzymes.

A c. All enzymes are catalysts.

d. All catalysts are proteins.

2–4 Section QUIZ

5 What happens to an enzyme after the reaction it catalyzes has taken place?

a. The enzyme is destroyed, and the cell must make another.

b. The enzyme holds on to the product until another enzyme removes it.

A c. The enzyme is unchanged and ready to accept substrate molecules.

d. The enzyme changes shape so it can accept a different kind of substrate.

END OF SECTION