

Section 4: Energy and Metabolism

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Bellringer

Write down as many different kinds of energy that you can think of and give an example of each.

Key Ideas

- Where do living things get energy?
- How do chemical reactions occur?
- Why are enzymes important to living things?

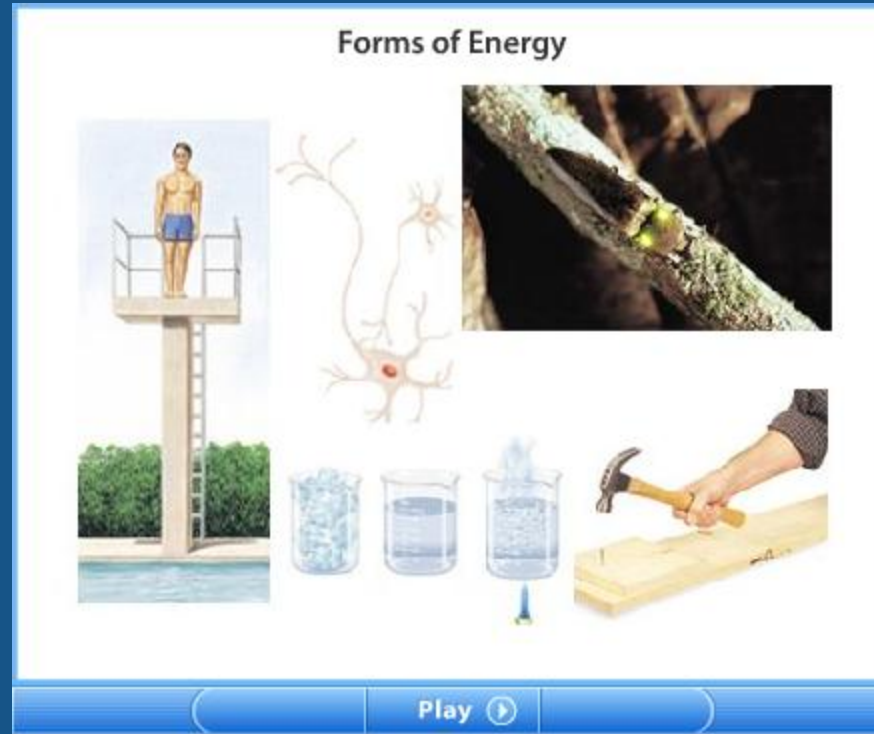
Changing Matter

- Living things are made of matter, which consists of a substance with a form.
- Changes constantly occur in living things.
- A physical change occurs when only the form or shape of the matter changes.
- A chemical change occurs when a substance changes into a different substance.

Changing Matter, continued

- Matter is neither created nor destroyed in any change. This observation is called the *law of conservation of mass*.
- The ability to move or change matter is called **energy**.
- Energy exists in many forms and can be converted from one form to another.
- Every change in matter requires a change in energy.

Visual Concept: Energy



Changing Matter, *continued*

- Energy may change from one form to another, but the total amount of energy does not change. This observation is called the *law of conservation of energy*.
- The total amount of usable energy decreases because some energy is given off to the surroundings as heat.
- Living things use different chemical reactions to get the energy needed for life processes.

Chemical Reactions

- Changing a substance requires a chemical reaction. During this process, bonds between atoms are broken, and new ones are formed.
- A **reactant** is a substance that is changed in a chemical reaction
- A **product** is a new substance that is formed.
- Sometimes products can reform reactants.

Chemical Reactions, *continued*

Activation Energy

- Chemical reactions can only occur under the right conditions.
- To form new bonds, the particles must collide fast enough to overcome the repulsion between their negatively charged electron clouds.
- The **activation energy** of a reaction is the minimum kinetic energy required to start a chemical reaction.

Visual Concept: Activation Energy and Chemical Reactions



Chemical Reactions, *continued*

Alignment

- Even if enough energy is available, the product still may not form.
- When the reactant particles, the correct atoms must be brought close together in the proper orientation.
- Chemical reactions can only occur when the activation energy is available and the correct atoms are aligned.

Reaction Conditions


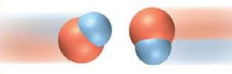

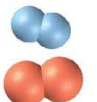
Reaction Conditions			
Reactants	Conditions	Result	Products
	not enough energy	no reaction	none
	enough energy; wrong orientation	no reaction	none
	enough energy; proper orientation	reaction	

Figure 15 Chemical reactions can occur only under the right conditions. The correct atoms of reactants must be aligned, and they must collide with enough energy.

➤ What term describes the minimum amount of energy needed for a reaction to occur?

Biological Reactions

- In living things, chemical reactions occur between large, complex biomolecules.
- Many of these reactions require large activation energies.
- Many of these reactions would not occur quickly enough to sustain life without the help of enzymes.

Biological Reactions, *continued*

Enzymes

- An **enzyme** is a molecule that increases the speed of biochemical reactions.
- Enzymes hold molecules close together and in the correct orientation. An enzyme lowers the activation energy of a reaction.
- By assisting in necessary biochemical reactions, enzymes help organisms maintain homeostasis.

Effect of Enzyme on Activation Energy

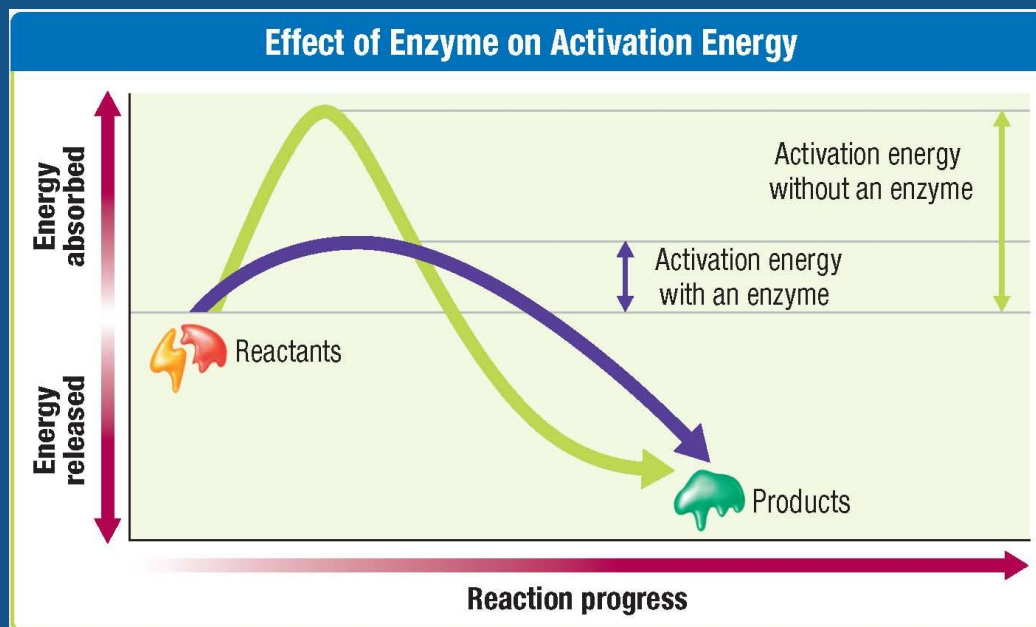


Figure 16 Enzymes decrease the amount of energy needed to start a chemical reaction without changing the amount of energy contained in either the reactants or the products.

Biological Reactions, *continued*

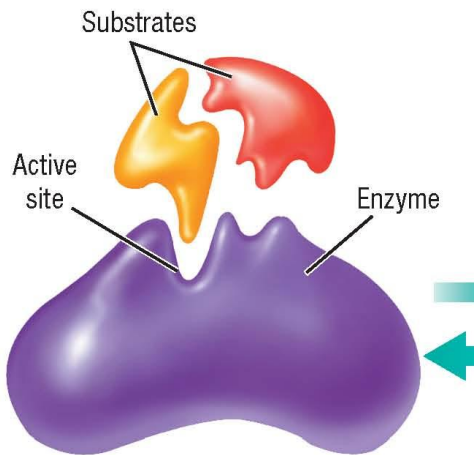
Enzymes

- Each enzyme has an **active site**, the region where the reaction takes place.
- The shape of the active site determines which reactants, or **substrates**, will bind to it. Each different enzyme acts only on specific substrates.
- Binding of the substrates causes the enzyme's shape to change. This change causes some bonds in the substrates to break and new bonds to form.

Enzyme Action

Click to animate the image.

- 1 The substrates bind to the enzyme's active site.



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Preview 

Main 

Biological Reactions, *continued*

Enzymes

- Many enzymes are proteins. Changes in temperature and pH can change a protein's shape.
- If an enzyme changes shape, it won't work well.
- Most enzymes need a certain range of temperatures and pH.

Biological Reactions, *continued*

Metabolism

- Cells get most of the energy needed for metabolism by breaking down food molecules.
- The release of energy from food molecules occurs in a series of reactions using many enzymes to capture energy in the form of ATP molecules.
- The enzymes reduce the activation energy so much that only a little energy is needed to start the reactions. In this process, very little energy is lost as heat.

Summary

- Living things use different chemical reactions to get the energy needed for life processes.
- An activation energy is needed to start a chemical reaction. The reactants must also be aligned to form the product.
- By assisting in necessary biochemical reactions, enzymes help organisms maintain homeostasis.