Chemical Reactions and Enzymes
Chemical Reactions

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- During chemical reactions, both mass and energy are conserved.
Chemical Reactions

- The elements or compounds that enter into a chemical reaction are known as reactants
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- The elements or compounds produced by a chemical reaction are known as products.
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- The elements or compounds produced by a chemical reaction are known as products.
- Example…

\[ \text{2 Na} + \text{2 HCl} \rightleftharpoons \text{2 NaCl} + \text{H}_2 \]

REACTANTS \hspace{1cm} PRODUCTS
Chemical Reactions

A chemical reaction in the bloodstream…

- As it enters the blood, carbon dioxide reacts with water to produce carbonic acid ($\text{H}_2\text{CO}_3$), which is highly soluble
Chemical Reactions

A chemical reaction in the bloodstream…

- This reaction enables the blood to carry carbon dioxide to the lungs
Chemical Reactions

A chemical reaction in the bloodstream…

- In the lungs, the reaction is reversed and produces carbon dioxide gas, which you exhale
Energy in Reactions

Chemical reactions involve changes in energy
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- Some chemical reactions, called exothermic reactions, release energy.
Energy in Reactions

Chemical reactions involve changes in energy

- Some chemical reactions, called *exothermic* reactions, release energy
- Other reactions, called *endothermic* reactions, absorb energy
Energy in Reactions

The energy needed to get a reaction started is called activation energy.
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- Activation energy is the difference between the required energy and the energy of the reactants.
Energy in Reactions

Energy-releasing (exothermic) reactions have more energy in the reactants than in the products.
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Energy-absorbing (endothermic) reactions have less energy in the reactants than in the products.
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Energy in Reactions

An example in living things…

- An example of an energy-releasing reaction is the breakdown of ATP to form ADP and a phosphate group.
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An example in living things…

- An example of an energy-releasing reaction is the **breakdown** of ATP to form ADP and a phosphate group.

- An example of an energy-absorbing reaction is the **synthesis** of ATP from ADP and a phosphate group.
Enzymes

A catalyst is a substance that speeds up the rate of a chemical reaction.
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- Catalysts work by lowering the activation energy.

Catalysts are important because some reactions that make life possible are too slow or have activation energies that are too high.
Enzymes

Enzymes are proteins that act as biological catalysts.
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- Enzymes speed up chemical reactions that take place in cells by lowering the activation energy of the reaction.
Enzymes

Enzymes provide a site where reactants can be brought together to react.

Such a site reduces the energy needed for reaction.
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Such a site reduces the energy needed for reaction.

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

An enzyme-catalyzed reaction…

- The substrates bind to the enzyme on the **active site**
Enzymes

An enzyme-catalyzed reaction…

- The substrates bind to the enzyme on the **active site**
- The substrates are converted into products
Enzymes

An enzyme-catalyzed reaction...

- The substrates bind to the enzyme on the **active site**
- The substrates are **converted** into products
- The products are **released**
Enzymes

An enzyme-catalyzed reaction...

- The substrates bind to the enzyme on the **active site**
- The substrates are **converted** into products
- The products are **released**
- The enzyme is ready for another **reaction**
Enzymes

The active site and the substrates have complementary shapes.

The fit is very precise, much like a lock that can only be opened by one key.
Enzymes

Because enzymes are catalysts for chemical reactions, they can be affected by any variable that influences a chemical reaction.
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- Many enzymes are affected by changes in temperature.

Enzymes work best at certain temperatures.

Enzymes produced by human cells generally work best at temperatures close to 37 degrees Celsius, the normal temperature of the human body.
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- Enzymes work best at certain pH values.

For example, the stomach enzyme pepsin, which begins protein digestion, works best under acidic conditions.
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- The activities of most enzymes are regulated by molecules that carry chemical signals within cells, switching enzymes “on” or “off” as needed.