Enzymes & the Need for Energy

1: Enzymes

- Catalysts: substances that speed up chemical reactions without being affected by the reactions themselves.
- Enzyme: a **protein** that increases the rate of reactions by lowering the activation energy.
- Activation Energy: the amount of energy needed to start a chemical reaction
- Substrate: molecule on which an enzyme acts
  - An enzyme binds to a substrate and stresses the bonds of that molecule in a way that makes a reaction more likely to occur.
- The key to an enzyme's activity is its shape.
  - Active Site: location on an enzyme where the substrate binds
  - Each substrate can only bind to one enzyme.
- Temperature, pH, substrate concentration, and enzyme concentration affect reaction rates
  - Each enzyme functions within a certain optimal temperature and pH range.
  - The rate of an enzyme-catalyzed reaction is also affected by the concentration of the enzyme and the substrate.

2: The Need for Energy

- Photosynthesis: the process that converts the radiant energy of sunlight into chemical energy
- Respiration: the process that releases chemical energy for use by the cell
- Scientists divide organisms into two groups according to the way in which they get their food.
  - Autotrophs: plants and other organisms that meet their energy needs by building organic molecules from inorganic substances
  - Heterotrophs: organisms that do not make their own food, but depend directly or indirectly on autotrophs for food

Adenosine Triphosphate (ATP)

- Biochemical Pathway: a series of biochemical reactions
  - Usable energy produced by one reaction may be stored and used in a later reaction.
  - In most cases, this energy is stored in a molecule called adenosine triphosphate (ATP).
- Structure- the ATP molecule has three parts:
  1. adenine (a nitrogen-containing molecule)
  2. ribose (a five-carbon sugar)
  3. three phosphate groups
  - The adenine bonds to ribose, forming adenosine.
  - adenosine monophosphate (AMP) = adenosine and one phosphate group
  - adenosine diphosphate (ADP) = adenosine and two phosphate groups
- Function- ATP stores energy in the bonds between the phosphate groups (high-energy bonds)

ATP-ADP Cycle

- The phosphate bonds of ATP must be broken before cells can use the energy stored in them.
  - An enzyme called ATPase breaks the bond between the 2nd and 3rd phosphate groups when energy is needed.
    - ATP → ADP + P + energy
  - When more energy is needed, a similar reaction can occur breaking the bond between the 1st and 2nd phosphate groups.
    - ADP → AMP + P + energy
  - The breakdown of ATP to ADP/AMP may result in:
    1. free phosphate ions + energy. **OR**
    2. ★ the transfer of a phosphate group to another molecule (phosphorylation). The phosphorylated molecule gains both the phosphate group and the energy.
- The formation of ATP is the reverse of its breakdown. ADP is phosphorylated to form ATP.
  - An enzyme called ATP synthase catalyzes the synthesis of ATP.
    - ADP + P + energy → ATP
- Photosynthesis, respiration, and the ATP-ADP cycle form a fundamental biological cycle:
  - plants store energy in glucose molecules during photosynthesis → animals and plants release that energy during respiration → the energy is stored in ATP → until it is needed to fuel cell activities