

# Chapter 3 – Energy, Catalysis, Biosynthesis

## The Use of Energy by Cells

- Enzymes reduce the amount of activation energy needed to start a reaction.
- Some enzymes need to be activated with a molecule in the enzyme substrate complex
- Biological order is made possible by the release of heat energy from cells.
  - o As spontaneous reactions occur, order within the cell will begin to decrease.
  - o The cell and its processes can put in effort and cause the organization to return to normal over time.
  - o As the cell begins to have more increased order, the area outside the cell will have more disorder.
- Cells can convert energy from one form to another
  - o Photosynthesis: Light energy  $\rightarrow$  usable chemical energy
  - o Cellular respiration: Sugars (Unusable chemical energy)  $\rightarrow$  ATP (usable chemical energy)
- Photosynthetic organisms use sunlight to synthesize organic molecules.
  - o Sunlight  $\rightarrow$  capturing of sunlight and replenishing activated carriers  $\rightarrow$  manufacturing of sugars.
- Cells obtain energy by the oxidation of organic molecules.
  - o Photosynthesis requires water to be oxidized and the addition of  $\text{CO}_2$  to make sugar molecules.
  - o Those sugar molecules are then broken down in the rest of the cells to be able to make ATP molecules.
- Oxidation and Reduction involve electron transfer.
  - o Oxidation – loss of H atoms, gain of oxygen atoms.
  - o Reduction – Gain of H atoms, loss of Oxygen atoms
  - o Both reactions are usually coupled and happen interchangeably of one another
  - o Oxidation is typically considered the “favorable” reaction because it releases heat, whereas reduction is the unfavorable reaction.

## Free Energy and Catalysis

- Chemical Reactions proceed in the direction that causes a loss of free energy.
  - o  $\Delta G = \Delta H - T\Delta S$ 
    - $\Delta G$  – Free energy
    - $\Delta H$  – Enthalpy – Total heat content of a system
    - $T$  – Temperature
    - $\Delta S$  – Entropy (Spontaneity)
  - o In order to get  $\Delta G$  negative (what is favorable), you want a reaction that will release heat to the surroundings.
  - o When  $\Delta G$  is negative, the reaction is considered to be spontaneous

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