Chemistry 1506: Allied Health Chemistry 2

Section 10: Enzymes

Biochemical Catalysts

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**Section 10.1 Introduction**

- **Enzymes**
  - Biological Proteinaceous Catalysts
    - Increase rates by $10^{10}$ to $10^{20}$
  - More than 3,000 enzymes in a cell

- **Shapes of Proteins**
  - Most enzymes globular shapes
  - Structural proteins within cells typically rod like shapes
  - Structural proteins within our bodies typically fibrous shapes
6 Major Types of Enzymes

- Oxidoreductases
  - Do Redox Reactions (Oxidation and Reduction)

- Transferases
  - Transfer CH₃, NH₂, etc., groups

- Hydrolases
  - Hydrolysis Reactions (add water while breaking bonds)

- Lyases
  - Double bond addition/elimination reactions

- Isomerases
  - Isomerizations

- Ligases/Synthetases
Join Fragments together
Cofactors

- Non-protein parts of enzymes
- Metal salts
  - e.g., Mg$^{+2}$, Ca$^{+2}$, Fe$^{+2}$ ...
- Organics
  - referred to as coenzymes
  - e.g., heme .....

General Enzyme Structures

- Active Sites
  - Substrate Binding and Reactivity
- Regulatory Sites
  - Activator and Deactivator (Inhibitor) Binding Sites
Section 10.2 Factors Effecting Enzyme Activity

➢ Enzyme Activity (on Conversion of Substrate to Product)

\[ \text{Substrate} \ (+\text{Enzyme}) \rightarrow \text{Product} \]

➢ The effect of the enzyme concentration on the reaction rate

➢ Linear dependence of Rate on [Enzyme]

➢ All enzyme molecules are working at maximum speed and therefore twice as much enzyme will catalyze the reaction twice as fast
➢ The effect of the substrate concentration on the reaction rate

➢ Saturation Curve dependence seen

➢ The maximum rate \( R_{\text{max}} \) is observed where all enzyme molecules are fully occupied which requires a certain substrate concentration
Other Influences on Reaction Rate

Effect of Temperature on Reaction Rate

There is an optimum temperature for each enzyme reaction.

If the temperature gets a little too high the rate reduction is reversible.

If the temperature gets a lot too high the rate reduction is irreversible.
Effect of pH on Reaction Rate

Why

Because enzyme shape changes with the temperature, pH, [Ca^{2+}], etc.

This causes the active site to change which changes the rate
Section 10.3 Mechanism of Enzymes

- **Nature of Enzyme-Substrate Complex**
  - **Lock and Key Model**

- **Induced Fit Model**

- **Reality in Between**

- **Enzyme Binding to Substrate** affected by
  - Both **Reaction site** and “cabbage” on the substrate
  - Both Reaction site and “cabbage” on the active site

- **Active site** usually in hole or cleft in protein
- **Competitive Inhibition**
  - Occurs when there is competition for the active site
  - Inhibitor is almost the same (shape, charge, etc.) as the substrate “key”

- **Non-Competitive Inhibition**
  - No competition at the active site
  - Inhibitor binds somewhere else on the protein
  - Regulatory site
  - This changes the shape of the “lock”

- Graph of inhibitor effects on rate
Section 10.4 Enzyme Regulation

- Typical Metabolic Pathway

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A → E1 → B → E2 → C → E3 → D
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- End Product Inhibition (E1 inhibition by D)
- Starting Materials Activation (E1 activation by A)
- Feedback control
Proenzymes

- Inactive proteins that are cleaved to give active forms when needed
- Very fast way to increase active enzyme concentration
- cf. New synthesis of enzyme

Allosterism

- Binding at non-active site which reversibly speeds/slow reaction
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