# Chemistry 1506: Allied Health Chemistry 2

## Section 10: Enzymes

## Biochemical Catalysts

.

## Outline

## 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 $CH_3$, $NH_2$, 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…..

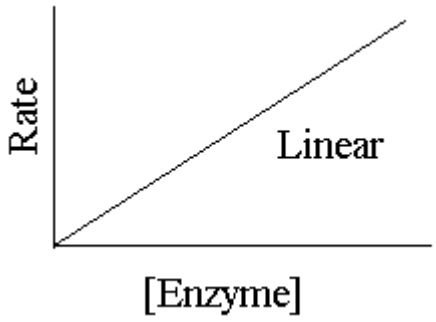
- General Enzyme Structures
  - Active Sites
    - Substrate Binding and Reactivity
  - Regulatory Sites
    - Activator and Deactivator (Inhibitor) Binding Sites

## Section 10.2 Factors Effecting Enzyme Activity

- Enzyme Activity (on Conversion of Substrate to Product)

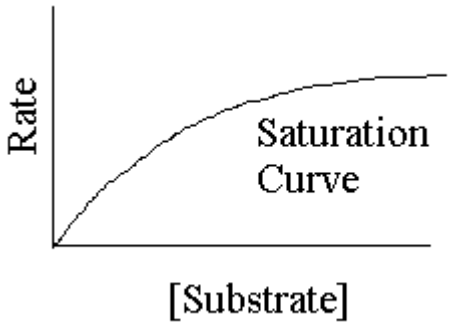
Substrate (+Enzyme) → Product

- The effect of the enzyme concentration on the reaction rate
  - Linear dependence of Rate on [Enzyme]



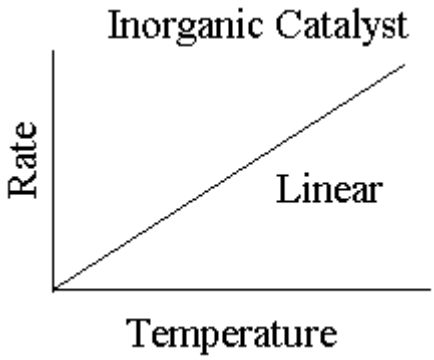

- All enzyme molecules are working at maximum speed and therefore twice as much enzyme will catalyze the reaction twice as fast

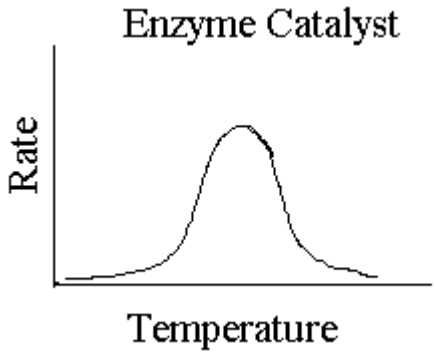
- The effect of the substrate concentration on the reaction rate
  - Saturation Curve dependence seen




- The maximum rate ($R_{max}$) is observed where all enzyme molecules are fully occupied which requires a certain substrate concentration

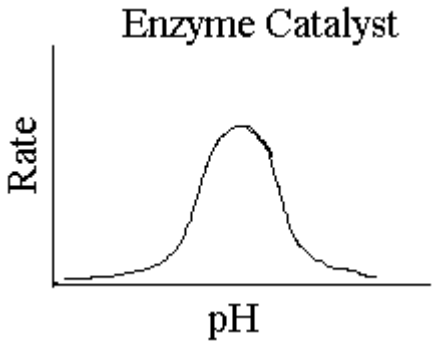
- Other Influences on Reaction Rate
  - Effect of Temperature on Reaction Rate




- 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

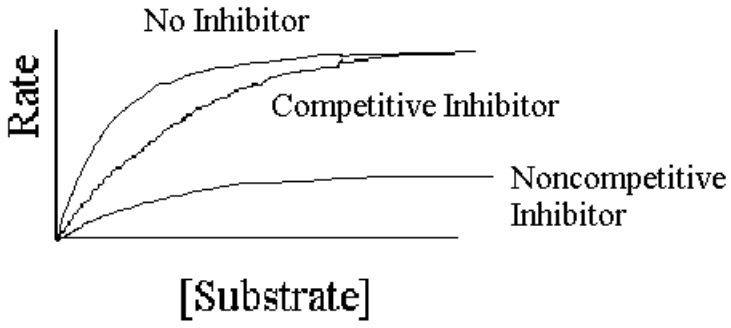
## Section 10.3 Mechanism of Enzymes

- Nature of Enzyme-Substrate Complex
  - Lock and Key Model
  - Induced Fit Model
  - Reality in Between
- Enzyme Binding to Substrate effected 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"

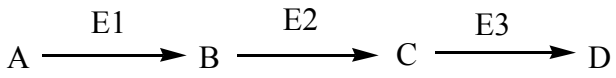
- Non-Competitive Inhibition
  - No competition at the active site
  - Inhibitor binds somewhere else on the protein
  - Regulatory site
  - This changes the shape of the "lock"

- Graph of inhibitor effects on rate



## Section 10.4 Enzyme Regulation

- Typical Metabolic Pathway




- 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/slows reaction

# Index of Topics and Vocabulary