

Chemistry 506: Allied Health Chemistry 2

Chapter 19: Enzymes

Biochemical Catalysts

Introduction to General, Organic & Biochemistry, 5th Edition by
Bettelheim and March: Chapter 19, Pages 623-640

Outline Notes by Dr. Allen D. Hunter, YSU Department of
Chemistry, ©2000.

Outline

1A SECTION(S) 19.1/2/3 INTRODUCTION	2
1B SECTION(S) 19.4 FACTORS EFFECTING ENZYME ACTIVITY.....	5
1C SECTION(S) 19.5 MECHANISM OF ENZYMES	9
1D SECTION(S) 19.6 ENZYME REGULATION.....	11

1A Section(s) 19.1/2/3 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

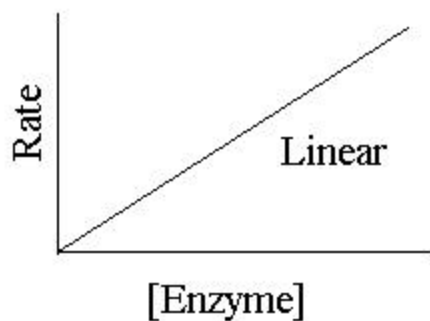
1B Section(s) 19.4 Factors Effecting Enzyme Activity

➤ Enzyme Activity (on Conversion of Substrate to Product)



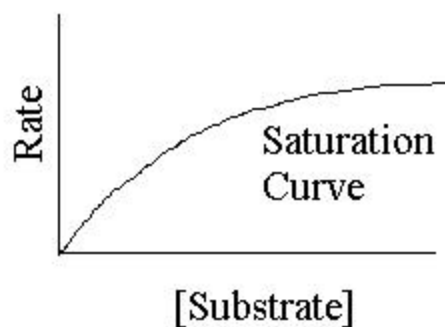
➤ The effect of the enzyme concentration on the reaction rate

➤ 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

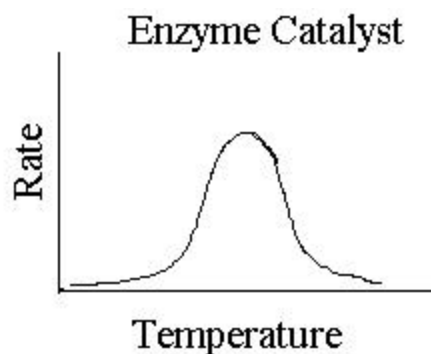
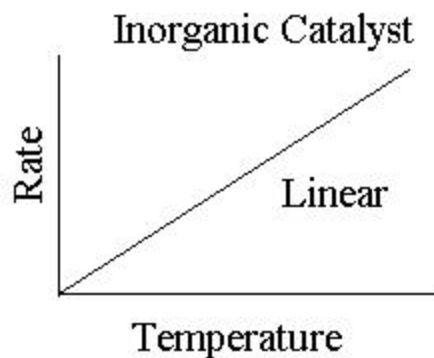
- The effect of the **substrate concentration on the reaction rate**
- **Saturation Curve dependence** seen



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

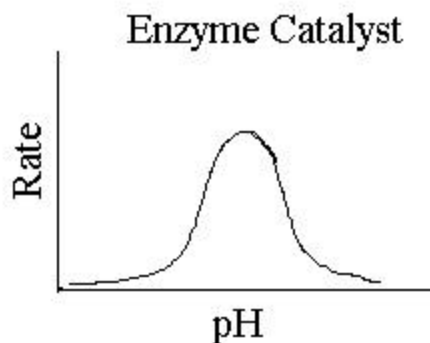
➤ Other Influences on Reaction Rate

➤ 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

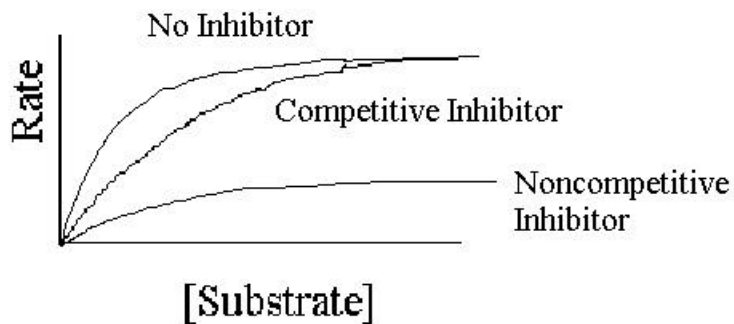
- Because **enzyme shape changes** with the temperature, pH, $[Ca^{+2}]$, etc.
- This causes the **active site** to change which changes the rate

➤ **Competitive Inhibition**

- Occurs when there is competition for the active site
- **Inhibitor** is almost the same (shape, charge, etc.) as the substrate “key”

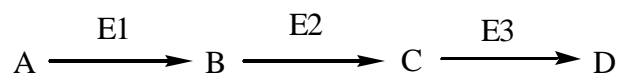
➤ **Non-Competitive Inhibition**

- 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**



1D Section(s) 19.6 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

Skip: Section 19.7

Problems: 19.1 to 19.27

Index of Topics and Vocabulary

A	Isomerizations..... 3
Activator..... 4	J
active site..... 8	Join Fragments together..... 3
Active site..... 9	L
Active Sites..... 4	Ligases..... 3
Allosterism..... 12	Linear dependence of Rate on [Enzyme]..... 5
B	Lock and Key Model..... 9
Binding Sites..... 4	Lyases..... 3
C	M
Ca ⁺² 4	maximum rate..... 6
cabbage..... 9	maximum speed..... 5
Catalysts..... 2	Mechanism of Enzymes..... 9
coenzymes..... 4	Metabolic Pathway..... 11
Cofactors..... 4	Metal salts..... 4
Competitive Inhibition..... 10	Mg ⁺² 4
Conversion of Substrate to Product..... 5	N
D	Non-Competitive Inhibition..... 10
Deactivator..... 4	O
Double bond addition/elimination reactions..... 3	Oxidation..... 3
E	Oxidoreductases..... 3
End Product Inhibition..... 11	P
Enzyme Activity..... 5	pH on Reaction Rate..... 8
Enzyme Binding to Substrate..... 9	Problems..... 12
enzyme concentration..... 5	Product..... 5
Enzyme Regulation..... 11	Proenzymes..... 12
enzyme shape changes..... 8	Proteinaceous..... 2
Enzyme Structures..... 4	R
Enzymes..... 2	Reaction site..... 9
enzymes in a cell..... 2	Redox Reactions..... 3
Enzyme-Substrate Complex..... 9	Reduction..... 3
F	Regulatory site..... 10
Factors Effecting Enzyme Activity..... 5	Regulatory Sites..... 4
Fe ⁺² 4	R _{max} 6
Feedback control..... 11	rod like shapes..... 2
fibrous shapes..... 2	S
G	Saturation Curve dependence..... 6
globular shapes..... 2	Shapes of Proteins..... 2
H	Skip..... 12
heme..... 4	Starting Materials Activation..... 11
Hydrolases..... 3	Substrate..... 5
Hydrolysis Reactions..... 3	Substrate Binding and Reactivity..... 4
I	substrate concentration..... 6
Inactive proteins..... 12	substrate concentration on the reaction rate..... 6
Increase rates by 10 ¹⁰ to 10 ²⁰ 2	synthesis of enzyme..... 12
Induced Fit Model..... 9	Synthetases..... 3
Inhibitor..... 4, 10	T
inhibitor effects on rate..... 10	Temperature on Reaction Rate..... 7
Introduction..... 2	Transfer CH ₃ , NH ₂ , etc., groups..... 3
irreversible..... 7	Transferases..... 3
Isomerases..... 3	Types of Enzymes..... 3

