



Department of Biotechnology		LP: BT 22501 Rev. No: 00 Date: 01.07.2024
B.E/B.Tech/M.E/M.Tech : Biotechnology	Regulation:2022	
PG Specialisation : NA		
Sub. Code / Sub. Name : BT 22501/ Introduction to Enzyme Technology and Biotransformation		
Unit : I		

**UNIT I INTRODUCTION TO ENZYMES AND ENZYMATIC REACTIONS 5**

Classification of enzymes, Factors affecting enzyme activity - pH and Temperature effect on enzyme. Free Energy Changes, Evaluation of activation energy, Specificity of Enzyme-Catalyzed Reactions, Enzyme units, Enzyme activity, Specific activity, Unit activity, Coenzymes and Cofactors- Prosthetic group, coenzymes involved in different metabolic pathways, Single substrate, bi substrate, multi substrate reaction.

OBJECTIVE: To impart knowledge on the fundamentals of enzyme properties, characteristics and mechanisms.

Session No *	Topics to be covered	Ref	Teaching Aids
1	Classification of enzymes	TB 1 (Ch:1, 1.3) TB 2 (Ch:2, 2.2, pg. 35) AR1 & AR1	LCD, BB, Blended Learning - Video 1
2	Factors affecting enzyme activity - pH and Temperature effect on enzyme	TB 2 (Ch:2, 2.7, Pg. 69-71) RB 1 (Ch:1, Pg. 13)	LCD, BB & Edpuzzle
3	Free Energy Changes, Evaluation of activation energy, Specificity of Enzyme-Catalyzed Reactions.	TB 2 (Ch:2, 2.5, 2.6, Pg. 52-54)	LCD & BB
4	Enzyme units, Enzyme activity, Specific activity, Unit activity	TB 1 (Ch:4, 4.1)	LCD & BB
5	Coenzymes and Cofactors- Prosthetic group, coenzymes involved in different metabolic pathways, Single substrate, bi substrate, multi substrate reaction.	TB 2 (Ch:2, 2.3, Pg. 37-40) TB 3 (Ch: 11, Pg. 350-362) AR3	LCD & BB
<b>Content beyond syllabus covered (if any): -</b>			

\* Session duration: 50 minutes



Sub. Code / Sub. Name : **BT 22501/ Introduction to Enzyme Technology and Biotransformation**  
Unit : II

**UNIT II ENZYME KINETICS AND INHIBITION**

8

Significance and Kinetics of single substrate reactions- Michelis-Menten Equation, Briggs- Haldmann Equation, Estimation of Michelis-Menten parameters, Reciprocal plot, Eadie-Hofstee plot, Hans Wolf Plot, Eisenthal Carnish Bowdan Plot, Multi-substrate reactions - Mechanisms and kinetics, Turnover number, Types of inhibition – Reversible and Irreversible Inhibitors, Competitive, Uncompetitive and Non Competitive Inhibitions, Models for substrate and product inhibition, Allosteric regulation of enzyme, Monod Changeux Wyman model.

OBJECTIVE: To illustrate theoretical and practical aspects of enzyme kinetics and perform enzyme kinetics experiment.

Session No *	Topics to be covered	Ref	Teaching Aids
6	Significance and Kinetics of single substrate reactions, Michelis-Menten Equation	TB 1 (Ch:6, 6.4, 6.5, 6.6) TB 2 (Ch:2, 2.7, Pg. 58, 68) TB 3 (Ch: 5, Pg. 109-111)	LCD, Digital Writing Pad
7	Estimation of Michelis-Menten parameters, Briggs- Haldmann Equation	TB 1 (Ch:7, 7.1, 7.2) TB 2 (Ch:2, 2.7, Pg. 59, 2.9 pg. 83-89) TB 3 (Ch: 5, Pg. 113-124)	BB, (MS EXCEL), Blended Learning - Video 2.
8	Reciprocal plot, Eadie-Hofstee plot, Hans Wolf Plot, Eisenthal Carnish Bowdan Plot, Turnover number	TB 2 (Ch:2, 2.7, Pg. 59) TB 4 (Ch 9, Pg 322-378)	LCD & BB (MS EXCEL)
9	Multi-substrate reactions - Mechanisms and kinetics	TB 1 (Ch:9, 9.1, 9.2) TB 3 (Ch: 8, Pg. 350-362)	LCD & BB
10	Types of inhibition – Reversible and Irreversible Inhibitors	TB 1 (Ch:8, 8.1, 8.2, Pg. 139-140) TB 3 (Ch: 8, Pg. 268-270)	LCD & BB
11	Competitive, Uncompetitive and Non Competitive Inhibitions	TB 1 (Ch:8, 8.2, Pg. 146-159) TB 3 (Ch: 8, Pg. 270-273)	LCD & BB (GRAPH)
12	Models for substrate and product inhibition	TB 3 (Ch: 12, Pg. 367-380)	LCD & BB
13	Allosteric regulation of enzyme, Monod Changeux Wyman model.	TB 1 (Ch:13, 13.2) TB 1 (Ch:14, 14.1, 14.2)	LCD & BB
Content beyond syllabus covered (if any): -			

\* Session duration: 50 minutes





Sub. Code / Sub. Name : **BT 22501/ Introduction to Enzyme Technology and Biotransformation**  
Unit : III

**UNIT III****PROTEIN AND ENZYME ENGINEERING****6**

Overview of protein structure and function, Protein structure levels: primary, secondary, tertiary, and quaternary, Applications of rational protein engineering in drug development, enzyme design, and biocatalysis, Designing enzymes for enhanced catalytic activity and substrate specificity.

**OBJECTIVE:** To impart knowledge on various protein engineering techniques involved in modification of enzymes.

Session No *	Topics to be covered	Ref	Teaching Aids
14	Overview of protein structure and function	TB 1 (Ch:2, 2.1, 2.2)	LCD & BB
15	Protein structure levels: primary, secondary, tertiary, and quaternary	TB 1 (Ch:2, 2.3)	LCD & BB
16	Applications of rational protein engineering in drug development	RB 2 (Pg. 169-218)	LCD, BB & Edpuzzle
17	Enzyme engineering design, and biocatalysis	TB 2 (Ch:3, 3.1, 3.2, Pg. 111-129)	LCD & BB
18	Designing enzymes for enhanced catalytic activity and substrate specificity	TB 2 (Ch:3, 3.3, Pg. 131)	LCD & BB
19	Case studies on Enzyme engineering and improving biocatalytic efficiency	TB 2 (Ch:12, Pg. 493-507) RB 2 (Pg. 125-144) RB 3 (Ch:4, Pg. 90-96)	LCD & BB

**Content beyond syllabus covered (if any): -**

\* Session duration: 50 minutes



Sub. Code / Sub. Name : **BT 22501/ Introduction to Enzyme Technology and Biotransformation**  
Unit : **IV**

**UNIT IV****ENZYMATIC ASSAYS AND IMMOBILIZATION OF ENZYMES****5**

Methods of Characterization of Enzymes, Development of enzymatic assays, Continuous and Discontinuous assay, Factors to control and monitor assay, Physical and chemical techniques for enzyme immobilization - Adsorption, Matrix entrapment, Encapsulation, Cross-Linking, Covalent binding and Suitable examples, Advantages and disadvantages, Design of enzyme electrodes and their application as Biosensors in industry, Healthcare and environment.

**OBJECTIVE:** To illustrate about various enzyme assay methods used for assessing enzyme activity and immobilization methods used for improving enzyme activity.

Session No *	Topics to be covered	Ref	Teaching Aids
20	Methods of Characterization of Enzymes, Development of enzymatic assays,	TB 1 (Ch:15, 15.1, 15.2) RB 5 (Pg. 122-157)	LCD & BB
21	Continuous and Discontinuous assay, Factors to control and monitor assay	TB 3 (Ch: 7, Pg. 204-257) TB 4 (Ch 6, Pg. 128-136)	LCD & BB
22	Physical and chemical techniques for enzyme immobilization - Adsorption, Matrix entrapment - Advantages and Disadvantages	TB 2 (Ch:8, 8.1, 8.2, Pg. 313-330)	LCD & BB
23	Enzyme immobilization by Encapsulation, Cross-Linking, Covalent binding - Advantages and Disadvantages	TB 2 (Ch:8, 8.3, Pg. 330-335)	LCD, BB & Edpuzzle
24	Design of enzyme electrodes and their application as Biosensors in industry, Healthcare and environment.	RB 3 (Ch:6, Pg. 298-327)	LCD & BB
<b>Content beyond syllabus covered (if any):</b>			

\* Session duration: 50 minutes





Sub. Code / Sub. Name : **BT 22501/ Introduction to Enzyme Technology and Biotransformation**  
Unit : V

**UNIT V****BIOTRANSFORMATION****6**

Kinetic resolution or asymmetric synthesis using enzymes, Hydrolytic- Ester bond, Amide, Epoxides, Nitriles, Oxidoreductase enzymes for biotransformation, Baeyer-Villiger – Enzymes in organic synthesis – esters, amide, peptide – Modified and artificial Enzymes.

**OBJECTIVE:** To train students for developing an enzymatic biocatalytic process and applying enzyme technology for the commercialization purpose of biotechnological products.

Session No *	Topics to be covered	Ref	Teaching Aids
25	Kinetic resolution or asymmetric synthesis using enzymes	TB 1 (Ch:11, 11.1) RB 1 (Ch:6, Pg. 46-48)	LCD & BB
26	Enzyme catalyzing - Hydrolytic- Ester bond, Amide, Epoxides, Nitriles	TB 2 (Ch:4, 4.1, 4.2, Pg. 141-193) RB 1 (Ch:5, 5.8 Pg. 161, Ch8: 251-276, Ch:9, 363-371)	LCD & BB
27	Oxidoreductase enzymes for biotransformation	RB 1 (Ch:5, 5.8 Pg. 170)	LCD & BB
28	Baeyer-Villiger – Enzymes in organic synthesis	RB 1 (Ch:5, 5.8 Pg. 168)	LCD & BB
29	Enzyme involved in esters, amide, peptide bond synthesis and hydrolysis	TB 2 (Ch:4, 4.1, 4.2, Pg. 141-193) RB 1 (Ch:5, 5.8 Pg. 172-173, Ch:15, Pg. 561-575, Ch:19, Pg. 779-790)	LCD, BB & Plickers
30	Modified and artificial Enzymes	TB 2 (Ch:5, Pg. 209-220)	LCD & BB
<b>Content beyond syllabus covered (if any):</b>			

\* Session duration: 50 minutes



Sub Code / Sub Name: **BT 22501/ Introduction to Enzyme Technology and Biotransformation**

**TEXT BOOKS (TB):**

1. Palmer T, Philip B "ENZYMES: Biochemistry, Biotechnology, Clinical Chemistry", 2<sup>nd</sup> Edition, Woodhead Publishing, 2011.
2. Buchholz K, Volker K, and Bornscheuer UT, "Biocatalysts and enzyme technology", 1<sup>st</sup> Edition, John Wiley & Sons, 2012.
3. Copeland, RA, "Enzymes, A Practical Introduction to Structure, Mechanism and data analysis" 2<sup>nd</sup> Edition, Wiley-VCH, 2012.
4. Nicholas P and Lewis S, "Fundamentals of Enzymology", 3<sup>rd</sup> Edition, Oxford University Press, 1999.

**REFERENCE BOOKS (RB):**

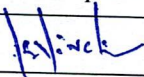

1. Drauz K, Gröger H and May O, "Enzyme Catalysis in Organic Synthesis: A Comprehensive Handbook", Wiley VCH Verlag & Co, 2012.
2. Faber, K. Biotransformations in Organic Chemistry, Springer International Publishing, 2018
3. Wolfgang, A. "Enzymes in Industry: Production and Applications", 3<sup>rd</sup> Edition, Wiley-VCH, 2007
4. Richard JS, "Purifying Proteins for Proteomics: A Laboratory Manual", 1<sup>st</sup> Edition, Cold Spring Harbor Laboratory Press, U.S. 2003
5. Thomas EC and Jack K, "Experiments in the Purification and Characterization of Enzymes: A Laboratory Manual", 1<sup>st</sup> Edition, Academic Press, 2014

**ADDITIONAL REFERENCES (AR):**

1. BRENDA Enzyme Database: <https://www.brenda-enzymes.org/>
2. KEEG Enzyme Database: <https://www.genome.jp/kegg/annotation/enzyme.html>
3. Allosteric Enzyme Database: <http://mdl.shsmu.edu.cn/ASD>

**BLENDED LEARNING VIDEO LINKS (BL):**

1. BRENDA Enzyme Database Enzyme Classification : [Video Link](#)
2. Estimation of MM parameters: Plotting using MS excel : [Video Link](#)

	Prepared by	Approved by
Signature		
Name	Dr. K. Divakar	Dr. E. Nakkeeran
Designation	Associate Professor	HOD
Date	01.07.2024	2.07.2024
Remarks *:	Nil	
Remarks *:	Nil	

\* If the same lesson plan is followed in the subsequent semester/year it should be mentioned and signed by the Faculty and the HOD