SRI VENKATESWARA COLLEGE OF ENGINEERING

COURSE DELIVERY PLAN - THEORY

Department of Biotechnology	LP: BT 18404 Rev. No: 02 Date: 01.02.2023
~~B.E~~/B.Tech/~~M.E/M.Tech~~ : Biotechnology Regulation:2018 PG Specialisation : NA Sub. Code / Sub. Name : **BT 18404/ Enzyme Technology and Biotransformation** Unit : I	

UNIT I INTRODUCTION TO ENZYMES 9

Classification of enzymes - Oxidoreductases, Transferases, Hydrolases, Lyases, Isomerases, Ligases, Nomenclature of enzyme, Mechanisms of enzyme action – Specificity, Factors affecting enzyme activity, Concept of active site, Enzyme substrate complex formation, Lock and Key Hypothesis - Induced Fit Hypothesis, Non Productive Hypothesis, Substrate strained Hypothesis, Collision theory and Transition state theory.

OBJECTIVE: To introduce basics of enzymes, classification, mechanisms and basic hypothesis behind enzymatic reactions.

Session No *	Topics to be covered	Ref	Teaching Aids
1	Classification of enzymes, Nomenclature of enzyme	T1 (5-7); T2 (35-37) R1 (1-5); AR3; AR4	LCD, BB & Edpuzzle
2	Mechanisms of enzyme action – Specificity, Factors affecting enzyme activity	T2 (41-51); T1 (19-31)	LCD & BB
3	Concept of active site	R1 (4-5, 13-14, 22-23)	LCD & BB
4	Enzyme substrate complex formation	R1 (4-5, 13-14, 22-23)	LCD & BB
5	Lock and Key Hypothesis	AR1 (70)	LCD & BB
6	Non Productive Hypothesis	AR 1 (70-72)	LCD & BB
7	Substrate strained Hypothesis	AR1 (72-75, 193, 200, 220)	LCD & BB
8	Collision theory	AR1 (89, 91)	LCD/BB
9	Transition state theory	AR1 (72-73, 89-93)	LCD/BB
Content beyond syllabus covered (if any): Brenda. KEEG enzyme database - web interface demo			

* Session duration: 50 minutes

Sub. Code / Sub. Name : **BT 18404/ Enzyme Technology and Biotransformation**
Unit : II

UNIT II KINETICS OF ENZYME ACTION 13

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 – Integral form of Michelis-Menten Equation, 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, pH and Temperature effect on enzymes.

OBJECTIVE: To impart knowledge on kinetics enzymes, enzymes structure and their mechanism.

Session No *	Topics to be covered	Ref	Teaching Aids
10	Kinetics of single substrate reactions	T1 (38-58); T3(109-132)	LCD & BB
11	Briggs- Haldmann Equation	R1 (9-10)	LCD & BB
12	Estimation of Michelis-Menten parameters	R1 (11-15)	LCD & BB
13	Reciprocal plot, Eadie-Hofstee plot	AR1 (111-113, 226, 233, 234, 237)	LCD & BB (MS EXCEL)
14	Hans Wolf Plot, Eisenthal Carnish Bowdan Plot	AR1 (112-114)	LCD & BB (GRAPH)
15	Multi-substrate reactions	T1 (38-58) R2 (116-119)	LCD & BB
16	Turnover number	R1(39-45)	LCD & BB
17	Types of inhibition	T3(268-290) R1 (39-45)	LCD, BB & Edpuzzle
18	Numerical Problems on enzyme kinetics	R1 (9-15), AR1 (111-113, 226, 233, 234, 237)	LCD & BB
19	Models for substrate and product inhibition	R1(39-45)	LCD & BB
20	Allosteric regulation of enzyme	T3(373-378); R1(67-75) R3(83-91); AR5	LCD & BB
21	Monod Changeux Wyman model	R1(70-73)	LCD & BB
22	pH and Temperature effect on enzymes	R1(76-85) R2 (130-134)	LCD & BB (Animation-Simulator)
Content beyond syllabus covered (if any): Presteady-State Kinetics			

* Session duration: 50 minutes

Sub. Code / Sub. Name : **BT 18404/ Enzyme Technology and Biotransformation**
Unit : III

UNIT III ENZYME IMMOBILIZATION AND BIOSENSORS 7

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 impart knowledge on enzymes immobilization methods and their application in industry.

Session No *	Topics to be covered	Ref	Teaching Aids
23	Enzyme immobilization – Introduction	T1 (549 – 567) T2 (313-318)	LCD & BB
24	Physical techniques for enzyme immobilization	T1 (549 – 567) T2 (330-334)	LCD & BB
25	Chemical techniques for enzyme immobilization	T1 (549 – 567) R3(113-117)	LCD & BB
26	Advantages and disadvantages of Enzyme immobilization	T1 (549 – 567)	LCD & BB
27	Design of Enzyme Electrodes	T1 (549 – 567)	LCD & BB
28	Application of enzymes as Biosensors in Industry	T1 (549 – 567)	LCD & BB
29	Enzymes in Healthcare and Environment	T1 (549 – 567)	LCD & BB
Content beyond syllabus covered (if any): -			

* Session duration: 50 minutes

Sub. Code / Sub. Name : **BT 18404/ Enzyme Technology and Biotransformation**
Unit : IV

UNIT IV **PURIFICATION AND CHARACTERIZATION OF ENZYMES FROM NATURAL SOURCES** **8**

Methods of Enzyme Production, Extraction and Purification of Enzymes, Methods of characterization of enzymes, Development of enzymatic assays – Enzyme units, Enzyme activity, Specific activity, Rate of a reaction, Percentage of purity, Continuous and Discontinuous assay, Factors to control in assay.

OBJECTIVE: To impart knowledge on production of enzymes from various natural sources and different purification and biochemical characterization methods.

Session No *	Topics to be covered	Ref	Teaching Aids
30	Methods of Enzyme Production	T1 (515-530); T2 (227-237); AR2 (284-310)	LCD & BB
31	Extraction and Purification of Enzymes	T1 (515-530) T2 (245-258); AR2 (284-310)	LCD & BB
32	Methods of characterization of enzymes	T1 (515-530) R5 (284-310)	LCD & BB
33	Development of enzymatic assays	T1 (515-530) R5 (284-310)	LCD & BB
34	Enzyme activity, Specific activity	T1 (515-530) R5 (284-310)	LCD & BB
35	Rate of a reaction, Percentage of purity	T1 (515-530) R5 (284-310)	LCD & BB
36	Continuous and Discontinuous assay	T1 (515-530) R5 (284-310)	LCD & BB
37	Factors to control in assay	T1 (515-530) R5 (284-310)	LCD & BB
Content beyond syllabus covered (if any): Large scale production and cost analysis for enzyme production/purification			

* Session duration: 50 minutes

Sub. Code / Sub. Name : **BT 18404/ Enzyme Technology and Biotransformation**
Unit : V

UNIT V **BIOTRANSFORMATION** **8**

Hydrolytic- Ester bond, Amide, Epoxides, Nitriles, Reduction reactions – Aldehydes, Ketones, C=C, Oxidation reactions – Alkanes, Aromatic, Baeyer-Villiger – Enzymes in organic synthesis – esters, amide, peptide – Modified and Artificial Enzymes – Catalytic antibodies.

OBJECTIVE: To discuss in detail about the enzymatic biotransformation, biocatalytic mechanisms and applications of enzymes.

Session No *	Topics to be covered	Ref	Teaching Aids
38	Biotransformation applications of enzymes - Introduction	T2 (141-144) AR2 (1-27)	LCD & BB
39	Hydrolytic- Ester bond, Amide, Epoxides, Nitriles	T2 (178-181) R4(363-365, 533-536) AR2 (31-130)	LCD & BB
40	Reduction reactions – Aldehydes, Ketones, C=C	T2 (157-158) R4(171-172) AR2 (139-166)	LCD & BB
41	Oxidation reactions – Alkanes, Aromatic, Baeyer- Villiger	R4(168-171) AR2 (173- 204)	LCD & BB
42	Enzymes in organic synthesis	AR2 (315- 354)	LCD & BB
43	Synthesis of esters, amide, peptide	R4(251-256) AR2 (315- 354)	LCD & BB
44	Modified and Artificial Enzymes	AR2 (367- 377)	LCD & BB
45	Catalytic antibodies	R4(1735-153) AR2 (367- 377)	LCD & BB
Content beyond syllabus covered (if any): Biotransformation for synthesis of biologics/therapeutic compounds			

* Session duration: 50 minutes

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TEXT BOOKS:

1. Pandey A, Webb C, Soccol C. R and Larroche C, "Enzyme Technology", Springer, 2006.
2. Buchholz K, Kasche, V and Bornscheuer, U, "Biocatalysts and Enzyme Technology", Wiley-VCH, 2005.
3. Copeland, R. A, "Enzymes, A Practical Introduction to Structure, Mechanism and data analysis" 2nd Edition, Wiley-VCH, 2012.

REFERENCES:

1. Blanch, H.W and Clark D.S, "Biochemical Engineering", 2nd Edition, Marcel Dekker, 1996.
2. Bailey J.E. and Ollis D.F, "Biochemical Engineering Fundamentals", 2nd Edition, McGraw Hill, 1986.
3. Wiseman A, "Hand book of Enzyme Biotechnology", 3rd Edition, Ellis Harwood, 1995.
4. Drauz K, Gröger H and May O, "Enzyme Catalysis in Organic Synthesis: A Comprehensive Handbook", Wiley VCH Verlag & Co, 2012.
5. James M L, "Biochemical Engineering", 2nd Edition, PHI USA, 2007.

ADDITIONAL REFERENCES:

1. Palmer, T., and Bonner, P. L. "Enzymes: biochemistry, biotechnology, clinical chemistry", 2nd Edition, Elsevier, 2008.
2. Faber K and Faber K, "Biotransformations in Organic Chemistry", 6th ed. 2011
3. BRENDA Enzyme Database: https://www.brenda-enzymes.org/
4. KEEG Enzyme Database: https://www.genome.jp/kegg/annotation/enzyme.html
5. Allosteric Enzyme Database: http://mdl.shsmu.edu.cn/ASD

	Prepared by	Approved by
Signature		
Name	Dr. K. Divakar	Dr. E. Nakkeeran
Designation	Associate Professor	HOD
Date	01.02.2023	01.02.2023
Remarks *: The Same lesson plan will be followed in the subsequent year		
Remarks *:		

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