SYLLABUS

Post Graduate Diploma in Applied Microbiology - Bioprocess Technology

(Semester I-II)

Choice Based Credit System (CBCS)

Effective from June 2016

Accredited **Grade A** by NAAC

(CGPA 3.05)

Department of Biochemistry

Saurashtra University

Rajkot

POSTGRADUATE DIPLOMA IN APPLIED MICROBIOLOGY - BIOPROCESS TECHNOLOGY

Name of Program	Sem.	Course Group	Credits	Hours / Week	Internal marks	External Marks	Practical/ Viva Marks	Total Marks	16 digit Number
		Core							
PG Diploma in Applied Microbiology –Bioprocess Technology	1	CBPT 101: Advances In Biomolecules	04	04	30	70		100	1603120105010100
		CBPT 102: Molecular Methods And Techniques	04	04	30	70		100	1603120105010200
		CBPT 103: Bioprocessing Technology And Application	04	04	30	70		100	1603120105010300
		Interdisciplinary							
		IBPT 101: Downstream Processing	04	04	30	70		100	1603120205010100
		Seminar							
		CBPT 104: Class Presentation	02	02	-	50		50	1603120305010100
		Practical							
		CBPT 105: Practicals	06	12	-	-	150	150	1603120405010100
	2	**Elective** (Any one)	04	04	30	70		100	
		EBPT 101: Fermentation Technology							1603120505020100
		EBPT 102: Biosafety and IPR							1603120505020200
		Project Work							
		CBPT 106: Dissertation Thesis Work / Project Work	12	26	-	300		300	1603120605020100

Examination Marks Distribution

Subject	External Marks		Internal Marks		Total Marks	
	Max	**Min**	**Max**	**Min**	**Max**	**Min**
All Theory Papers (Core, Interdisciplinary & Elective)	070	028	030	012	100	040
Practicals	150	060	-	-	150	060
Seminar	050	020	-	-	050	020
Dissertation	300	120	-	-	300	120

SEMESTER-I

PAPER-I

CBPT -101: ADVANCES IN BIOMOLECULES

Unit-1: Amino Acids, Peptides and Proteins

pH, Buffers, Henderson- Hasselbalch equation. Amino Acids: Classification, structure, stereochemistry, chemical reactions of amino acids due to carbonyl and amino groups. Titration curve of glycine and pK values. Essential and non-essential amino acids, non-protein amino acids. Peptide bond - nature and conformation. Naturally occurring peptides – glutathione, enkephalin. Proteins: Classification based on solubility, shape and function. Determination of amino acid composition of proteins. General properties of proteins, denaturation and renaturation of proteins. Structural organization of proteins- primary, secondary, tertiary and quaternary structures (Eg. Hemoglobin and Myoglobin), forces stabilizing the structure of protein. Outlines of protein sequencing.

Unit-2: Enzymes

Introduction to biocatalysis, differences between chemical and biological catalysis. Classification of enzymes. Enzyme specificity. Active site. Principles of energy of activation, transition state. Interaction between enzyme and substrate- lock and key, induced fit models. Definition of holo-enzyme, apo-enzyme , coenzyme, cofactor. Fundamentals of enzyme assay, enzyme units. Factors affecting the catalysis- substrate concentration, pH, temperature. Michaelis - Menten equation for uni-substrate reaction (derivation not necessary), significance of KM and Vmax. Enzyme inhibition- irreversible and reversible, types of reversible inhibitions- competitive and non-competitive. Outline of mechanism of enzyme action- acid-base catalysis, covalent catalysis, electrostatic catalysis, and metal ion catalysis. Regulation of enzyme activity- allosterism and cooperatitvity, ATCase as an allosteric enzyme, covalent modulation- covalent phosphorylation of phosphorylase, zymogen activation- activation of trypsinogen and chymotrypsinogen. Isoenzymes (LDH). Multienzyme complxes (PDH). Ribozyme. Restriction enzymes.

Unit-3: Nucleic Acids and Porphyrins

Nature of nucleic acids. Structure of purines and pyrimidines, nucleosides, nucleotides. Stability and formation of phosphodiester linkages. Effect of acids, alkali and nucleases on DNA and RNA. Structure of Nucleic acids- Watson-Crick DNA double helix structure, introduction to circular DNA, super coiling, helix to random coil transition, denaturation of nucleic acids- hyperchromic effect, Tm-values and their significance. Reassociation kinetics, cot curves and their significance. Types of RNA and DNA . Prophyrins: Structure, properties and functions of heme, chlorophylls and cytochromes.

CBPT -101: ADVANCES IN BIOMOLECULES

Objectives:

The objective of this paper is to provide students with a basic understanding of…

- The physical and chemical properties of the components of living things
- Structural, chemical biology and three-dimensional construction of amino acids, proteins and nucleic acids
- Functional properties and importance of amino acids, proteins and nucleic acids.
- Classification and basic structural properties of enzyme
- Mechanical and kinetics properties of enzyme including various models of kinetics and various types of inhibition
- Mechanism of enzyme action, regulation and allostery in enzyme

Outcome:

Students will be prepared for theoretically & practically to understanding of aspects of physical and chemical properties of aqueous solutions, molecular machinery of living cells, principles that govern the structures of macromolecules and their participation in living system, classification and structural properties of amino acids, proteins, enzymes and nucleic acids; this paper also help students to prepare their mind for interdisciplinary functional properties of protein and vast range of application of industrially valuable enzymes.

PAPER-II

CBPT -102: MOLECULAR METHODS AND TECHNIQUES

Unit-1: Molecular dogma

DNA replication, repair and recombination: Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms. RNA synthesis and processing: Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, splicing, polyadenylation, structure and function of different types of RNA, RNA transport. Protein synthesis and processing: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, translational proof-reading, translational inhibitors, post- translational modification of proteins. Control of gene expression at transcription and translation level: Regulation of phages, viruses, prokaryotic and eukaryotic gene expression, role of chromatin in regulating gene expression and gene silencing.

Unit-2: Methods in Molecular biology

Cloning, Cloning vectors, Properties and applications of plasmids, phagemids, phage vectors, cosmids, YAC, BAC, etc; Selection and expression of suitable vectors, cDNA libraries and Genomic libraries, DNA sequencing, Site directied mutagenesis, Hybridization techniques, Molecular markers, Transgenic animals and Plants, Applications of recombinant technology

Unit 3: Characterization of Nucleic acid

Mapping and DNA fingerprinting: Methodology and applications of Restriction mapping; RFLP; RAPD; AFLP; SSR; REMAP and SCAR analysis. DNA sequencing: Principles and methods for DNA sequencing. Polymerase Chain Reaction: Principle and basic types of PCR; Reverse Transcription and Real Time PCRs; Factors affecting PCR; Applications and precautions.

CBPT -102: MOLECULAR METHODS AND TECHNIQUES.

Objectives:

- Detailed understanding of prokaryotic and eukaryotic replication, types of DNA polymerases and inhibitors of DNA replication
- To gain detail on prokaryotic and eukaryotic transcription, translation and gene expression regulation
- In depth study of various types of vectors, hybridization technique and its application
- To develop an understating of advanced technologies like RFLP, Sequencing, SSR, REMAP, SCAR and various types of PCR

Outcome:

Students will choose appropriate experimental strategy for research in basic and molecular biology. To perform laboratory techniques in basic biology, molecular biology, and advanced techniques. Explanation and integration of biological principles, as applied to basic and molecular biology. Development of strong diversified background in modern biology, appropriate to the individual student goals. Develop critical-thinking, and problem based learning skills. This paper will open an understanding of current trends in molecular and genetic research, and critically appraise published work. Students will be prepared to demonstrate an ability to design, undertake, and interpret, a research project, presented in the form of a dissertation.

PAPER-III

CBPT -103: BIOPROCESSING TECHNOLOGY AND APPLICATION

Unit-1: General Microbiology

Introduction to Microbiology, Microbial diversity with representative examples, structure and organization of microbial cells, Microbiology of environment, water and sewage, air, environmental pollution and biodegradation. Microbial physiology and biochemistry, Aerobic and anaerobic growth, microbial nutrition, growth kinetics, microbiological methodology with reference to special metabolic pathways and emphasis on industrial applications, Medical microbiology, Microbiology in human disease, Basic immunological techniques, Immunodiagnostic methods with examples of applications, Monoclonal antibodies.

Unit-2: Basics of Bioprocessing

Raw materials for bioprocessing, comparison of chemical and biochemical processing based on energetics and environmental issues. Development of inocula, kinetics of enzymatic and microbial processes, optimisation studies, sterilization of media, air and equipment, modes of cell cultivation, general principles of bioreactor design and their operation. Media formulation, sterilization of equipments, gas compressor types and principles of compression, air filtration, solid and liquid handling. Industrially fermented broth (filtration and ultrafiltration), centrifugation, solvent extraction, chromatographic separation, liquid extraction of biopolymers and antibiotics ion exchange recovery of antibiotics and proteins.

Unit-3: Upstream processing

Production of antibiotics vitamins definition, classification of antibiotics and biochemistry, penicillin, streptomycin, tetracycline's, geriosofulvin, cephalosporin, ampicillin, piocyanase, vitamins-A, Riboflavin, cephalosporin, valinomycin, carotenoids, Solvents, biopolymers and microbial insecticides solvents, ethylalcohol, glycerol, acetone, butanol, 2, 3 butandiol, Biopolymers – expolysacharides, alaganides xanthan, dextran, curdlan polyhydroxybutrate

CBPT -103: BIOPROCESSING TECHNOLOGY AND APPLICATION

Objectives

- To learn the microbial diversity and structural organization of microbial cells
- To learn microbial physiology, biochemistry, environmental and nutritional factors for microbial growth
- To develop concept regarding basics of bioprocessing; principle and design of bioreactors, media formulation, separation of bioprocessed product from mixture
- To understand the classification of different antibiotics, their biochemistry and production

Outcomes

Upon completion of this course students will be able to understand the fine mechanism of role of microbiology in human disease, apply modeling and simulation of bioprocesses so as to reduce costs and to enhance the quality of products and systems, understand the modes of cell cultivation, general principles of bioreactor design and their operation and operate the fermentor to produce the different bioprocessed products.

PAPER-IV

IBPT -101: DOWNSTREAM PROCESSING

Unit 1. Basics of downstream processing

Microbial biomass, single cell proteins and its nutritional values, bakers yeast brewers yeast, food and fodder yeast, carbohydrates – whey molasses starch cellulose / wood waste, sulfite liquor, SCP production technology bacterial protein ICI process yeast protein actionomyceatous protein, mycoproteins, algal proteins (spirulina cultivations)

Unit 2. Downstream processing, application and properties

Downstream processing, separation and purification techniques, quality assurance testing, representative examples of microbial products, vaccines and vaccine development, immobilization of cells and enzymes : principles, methodology and applications, disintegration of cells, separation of solid and liquid phases, isolation and purification techniques for proteins and other products based on different physico-chemical properties, eg., precipitation, adsorption, chromatographic separations, bio-affinity based methods, Principles of bioprocess control, bioprocess automation and application of computers in bioprocessing, recombinant products with representative examples

Unit 3. Softwares and application

Computer control of fermentation process, hardware and software application in fermentation technology, fermentation economics, fermentation biofertilizer production, fuel alcohol production, biogas production technology, silage production, aspartame

IBPT -101: DOWNSTREAM PROCESSING

Objectives

- Understand the methods to obtain pure proteins, enzymes and in general about product development R & D
- Have depth knowledge and hands on experience with on downstream processes
- To understand the nature of the end product, its concentration, stability and degree of purification required
- To design processes for the recovery and subsequent purification of target biological products.
- To learn the usefulness of softwares and their application

Outcomes

Upon success completion of this course, the students will be able to define the fundamentals of downstream processing for product recovery, acquired knowledge for the separation of whole cells and other insoluble ingredients from the culture broth, understand the requirements for successful operations of downstream processing, describe the components of downstream equipment and explain the purpose of each, apply principles of various unit operations used in downstream processing and enhance problem solving techniques required in multi-factorial manufacturing environment in a structured and logical fashion.

SEMESTER-II

PAPER-V

EBPT -101: FERMENTATION TECHNOLOGY

Unit 1. Bioreactor and fermentation

Introduction to Bioreactor & fermentation, scope, concept & range of Fermentation technology, Tabulation of important fermentation processes

Unit 2. Fermenter Design & types

Fermenter Design, Design of a typical aerobic fermenter, A study of the parameters to be considered in designing a typical fermentor, Examples of fermenters, i. Mechanical – Typical fermentor, Waldoff fermenter, ii. Hydrodynamic- deep-jet fermenter, iii. Pneumatic - air-lift fermenter, bubble-cap fermenter. Modes of fermentation operation, Aerobic & Anaerobic, Surface & Submerged, Batch & Continuous

Unit 3. Fermentation process

Overview of a fermentation process, Development of Industrial Process, Screening of industrially useful microbes – ideal characteristics, primary & secondary screening, Stock cultures – primary & working stock cultures, preservation & inoculum preparation & scaleup of culture for a fermentation process, Fermentation media, Upstream Processing of a typical aerobic, submerged batch fermentation – requirements & scale–up

EBPT -101: FERMENTATION TECHNOLOGY

Objectives

- To learn basics of bioreactors and fermentation
- To impart knowledge on design and operation of fermentation processes with all its prerequisites
- To select appropriate bioreactor configurations and operation modes based upon the
- nature of bioproducts and other process criteria
- To study the overview of fermentation operation, fermentation media and upstream processing

Outcomes

Upon completion of the course in students will be able to describe the most common equipment, materials and methods related to fermentation processes, different parameters considered in designing of typical fermentor, what is aerobic and anaerobic, surface and submerged, batch and continuous fermentation? How fermentation process is industrially scale-up for development of product.

PAPER-VI

EBPT -102: BIOSAFETY AND IPR

Unit 1. Bioethics and Biosafety

Introduction to Bioethics. Social and ethical issues in Pharma and Biotech industrial research, public education of the process of biotechnology involved in generating new forms of life for informed decision making, biosafety regulation and national and international guidelines, r-DNA guidelines, experimental protocol approvals, levels of containment, regulatory bodies in biotechnology, biosafety committee. biosafety and environmental monitoring of GEMs. Definition of Biosafety. Biosafety for human health and environment. Social and ethical issues. Use of genetically modified organisms and their release in to the environment.

Unit 2. IPR & Trade Marks

Introduction to patents, Intellectual property rights, WTO, TRIPS, International conventions, patents and copy rights, patent claims, methods of applications of patents. Ethical issues, moral values on experimental animals, ethical implications of biotechnological products and techniques. Regulatory requirements for drugs and Biologics. GLP. GMP, Trade Secrets copyrights, Trade Marks, legal implications, farmers rights, plant breeder's rights. International and National conventions on biotechnology and related areas.

Unit 3. Application

WTO guidelines, Legal implications, biodiversity and farmers right. Beneficial application and development of research focus to the need of the poor, identification of directions for yield effect in pharmaceutical & biotechnological industry, agriculture, aquaculture etc.

EBPT -102: BIOSAFETY AND IPR

Objectives

- To create awareness about social and ethical issues in Pharma and Biotech industries
- To create awareness and responsibilities about the environment and society
- To study biosafety regulation, national and international guidelines for Bioethics
- To create awareness about IPR and trade marks

Outcomes

Upon completion of this course, the student would be able to understand the ethics and responsibility for safety, create awareness for the professional responsibilities and rights, offer the importance of intellectual property rights for the technologies, apply the guidelines at different ethical and safety issues of industry.

CBPT -106: DISSERTATION THESIS WORK / RESEARCH PROJECT

Dissertation research work is offered to students of Semester II to carry out research according to the provision of objectives and teacher guide. Students are eligible to apply in other national and international level research institutes, Universities and industries of high repute to pursue six month dissertation research project for the partial fulfillment of PG Diploma.

REFERENCE BOOKS

1. Biochemical calculation by Segel
2. Laboratory Manual in Biochemistry by Jayraman
3. Biochemistry and Molecular Biology of Antimicrobial Drug Action by Franklin, T. J. & Snow, J. A.
4. Biochemistry by Champe
5. Biochemistry by Todd, W. B., Mason, M., Bruggen, R. V. & Macmillan.
6. Biochemistry by Voet & Voet
7. Lehninger Principles of Biochemistry by Nelson, D. L. & Cox, M. M.
8. Biochemistry by Mathews
9. Biochemistry by Satyanarayana, U.
10. Biochemistry: The Chemical Reactions of Living Cells by Metzler, D. E.
11. Biochemistry with Clinical Correlation by Devlin, T. M.
12. Biochemistry by Zubay, J.
13. Biochemistry by Stryer
14. Dynamics of Proteins and Nucleic Acids by Mccammon, J. A. & Harvey, S. C.
15. Enzymes : Biochemistry Biotechnology And Clinical Chemistry by Palmer, T.
16. Fundamentals of Enzymology by Price & Stevens
17. Enzyme kinetics - A modern approach by Marangoni, A. G.
18. Enzyme Kinetics Principles and Methods by Bisswanger, H.
19. Introduction to Molecular Biology by Paolella, P.
20. Introduction to Protein Architecture: The structural biology of proteins by Lesk, A. M.
21. Introductory Biostatistics by Chap T. Le
22. Molecular biology of the gene by Watson.
23. Genes IX by Lewin, B.
24. Essential Molecular Biology by T. A. Brown
25. Principles Of Gene Manipulation And Genomics by Primarose
26. Molecular Cloning by Russell Sambrook
27. Culture of Animal Cells by Freshney R. I.
28. Animal Cell Culture by Masters
29. Microbiology by Pelczar, M. J.
30. Microbiology Ecology Fundamental and Application by Ronald M. Atlas

31. Pharmacology by Rang and Dele
32. Fundamentals of Biostatistics by Bernard Rosner 5th Ed.
33. Principles of Fermentation Technology by Stanbury PF
34. Fermentation Technology Part-A & B by Modi HA
35. Fermentation Technologies: Industrial Applications by PAK-LAM YU
36. Downstream Processing of Proteins: Methods And Protocols by Mohamed A. Desai
37. Downstream Processing Techniques in Biotechnology by Anuj Kumar Rana
38. Bioseparation Downstream Processing For Biotechnology by Belter
39. Bioprocess Technology: Kinetics and Reactors by Anton Moser
40. Modern Technology of Bioprocessing by EIRI
41. Bioprocess Engineering Basic Concept by Micheal L. Shuler
42. Bioprocess Technology by PT Kalaichelvan
43. IPR handbook for pharmastudents by Parikshit bansal
44. Intellectual Property Law by Lionel Bently
45. Intellectual Property in the Food Technology Industry by O' Donnell