PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I. To provide students with solid fundamentals and strong foundation in statistical, scientific and engineering subjects required to create and innovate in the field of biotechnology.

II. To train students with good scientific and technical knowledge so as to comprehend, analyze, design, and create novel products and solutions for developing novel therapeutics and enzymes.

III. To prepare students to excel and succeed in Biotechnology research or industry through the latest state-of-art post graduate education.

IV. To sensitize students about scientific temper and the necessity of bioethics, social responsibility and awareness of the environment.

V. This course enables the student to develop good communication and leadership skills, respect for authority, loyalty and the life-long learning needed for a successful scientific and professional career.

PROGRAMME OUTCOMES (POs):

On successful completion of the Masters in Biotechnology graduates will be able to

1. Acquire in depth knowledge of Biological science and Bioengineering for gaining ability to develop and evaluate new ideas

2. Demonstrate Scientific and technological skills to design and perform research through modern techniques for the development of high throughput process and products.

3. Analyze Biotechnological problems and formulate intellectual and innovative vistas for research and development

4. Provide potential solutions for solving technological problems in various domains of Biotechnology considering the societal, public health, cultural environmental factors.

5. Examine the outcomes of Biotechnological issues critically and gain knowledge for composing suitable corrective measures.

6. Create and apply modern engineering tools for the prediction and modeling of complex bioengineering activities

7. Posses self management and team work skills towards collaborative, multidisciplinary scientific endeavors in order to achieve common goals

8. Develop entrepreneurial and managerial skills for the implementation of multidisciplinary projects

9. Demonstrate adherence to accepted standards of professional bioethics and social responsibilities

10. Posses the attitude necessary for lifelong and acquire communication skills relevant to professional positions
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The table represents the course selections for different semesters. Each course is listed with its respective semester and whether it is compulsory ( ✔️ ) or not (   ).
# ANNA UNIVERSITY:: CHENNAI 600 025
## AFFILIATED INSTITUTIONS
### M. TECH. BIOTECHNOLOGY
#### REGULATIONS – 2017
#### CHOICE BASED CREDIT SYSTEM
#### I TO IV SEMESTERS CURRICULUM AND SYLLABUS

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## SEMESTER I, PROFESSIONAL ELECTIVES II

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**EMPLOYABILITY ENHANCEMENT COURSES (EEC)**

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OBJECTIVES:

- This course is designed to provide a solid foundation on topics in statistics that can be useful for the biotechnologists to conduct research on different types of data arising in public health and clinical studies. It is framed to address the issues in biotechnology using the concepts on probability, regression, sampling, estimation theory, testing of hypothesis and design an analysis of experiments.

UNIT I RANDOM VARIABLE AND PROBABILITY DISTRIBUTION 12

UNIT II SAMPLING DISTRIBUTION AND ESTIMATION THEORY 12
Random sampling – Sample mean and variance – Standard error – Simple problems – Estimator : Unbiasedness – Maximum likelihood estimation – Method of moments – Curve fitting by the method of least squares : Fitting curves of the form \( y = ax + b, y = ax^2 + bx + c, y = ab^x \) and \( y = ax^b \) - Multiple regression lines.

UNIT III TESTING OF HYPOTHESIS 12
Sampling distributions – Type I and Type II errors – Tests based on Normal, t, \( \chi^2 \) and F distributions for testing of mean, difference between two means, proportion, difference between two proportions, variance, ratio of two variances – Independence of attributes (r x c contingency table) - Goodness of fit.

UNIT IV NON-PARAMETRIC STATISTICS 12

UNIT V DESIGN OF EXPERIMENTS 12
Completely random design–Randomized complete block design – Analysis of variance : One - way and Two - way classifications – Latin square design - \( 2^2 \) factorial design.

TOTAL : 60 PERIODS

OUTCOMES :

After completing this course, students should demonstrate competency in the following topics:

- Basic probability axioms and rules and the moments of discrete and continuous random variables.
- Distributions and their properties.
- Least squares, correlation, regression, consistency, efficiency and unbiasedness of estimators, method of maximum likelihood estimation and Central Limit Theorem.
- Sampling and use statistical tests in testing hypotheses on data.
• List the guidelines for designing experiments, recognize the key historical figures in Design of Experiments, conduct statistical tests and analyze the results.
• Analyze the experiments by applying suitable non-parametric tests

The students should have the ability to use the appropriate and relevant, fundamental and applied mathematical and statistical knowledge, methodologies and modern computational tools.

REFERENCES:

BY5101 ADVANCED GENETIC ENGINEERING L T P C
3 0 0 3

OBJECTIVES:
• To understand the gene cloning methods and the tools and techniques involved in gene cloning and genome analysis and genomics.
• To explain the heterologous expression of cloned genes in different hosts, production of recombinant proteins and PCR techniques.
• To understand comparative genomics and proteomics.

UNIT I CLONING WITH SPECIALIST-PURPOSE VECTORS
M13 based vectors, production of RNA probes and interfering RNA - controllable promoters for maximal expression of cloned gene – λPⅠ, trc, T7 and pBAD - factors affecting the expression of cloned genes - purification tags for purification of cloned gene product – vectors for solubilization of expressed proteins - gateway system of transferring DNA fragments to vectors

UNIT II cDNA LIBRARY CONSTRUCTION

UNIT III MUTAGENESIS AND ALTERED PROTEIN SYNTHESIS
Random mutagenesis - Error-prone PCR, Rolling circle error-prone PCR, use of mutator strains, temporary mutator strains, Insertion mutagenesis, ethyl methanesulfonate, DNA Shuffling, signature tagged mutagenesis and transposon mutagenesis. Incorporation of unnatural amino acids into proteins – Phage and cell-surface display for selection of mutant peptides.
UNIT IV GENOME ENGINEERING 9
DNA damage – sources and types - DNA double stranded break repair mechanisms - Engineered nucleases in genome engineering - meganucleases, ZFNs, TALEN and CRISPR-Cas system – Mechanisms and applications – Benefits of genome engineering – targeted gene mutation, creating chromosome rearrangement, studying gene function with stem cells, transgenic animals, endogenous gene labelling and targeted transgene addition – genome engineering -prospects and limitations.

UNIT V GENETIC MANIPULATION OF CELLS AND ANIMALS 9
Overview - principle of gene transfer - methods of gene transfer to animal cell culture - selectable markers for animal cells - Isolation and manipulation of mammalian embryonic stem cells - Using gene transfer to study gene expression and function - creating disease models using gene transfer and gene targeting technology - potential of animal for modelling human disease

TOTAL: 45 PERIODS

OUTCOMES:
- The students after completing this course would be aware of clone methods of commercially important genes.
- The students would be aware of producing the commercially important recombinant proteins.
- The students would be aware of gene and genome sequencing techniques.
- The students would be aware of microarrays, Analysis of Gene expression and proteomics.

REFERENCES

BY5102 ENZYME TECHNOLOGY AND FERMENTATION TECHNOLOGY

OBJECTIVES:
To enable the students
- To learn enzyme reactions and its characteristics along with the production and purification process
- To give the student a basic knowledge concerning biotransformation reactions with the usage of enzymes
- To understand the production process of Primary and Secondary metabolites
UNIT I  FUNDAMENTALS OF FERMENTATION  

UNIT II  INDUSTRIAL FERMENTATION PROCESSES  
Aerobic and anaerobic fermentations –Batch culture, continuous culture, fed batch culture – Comparison of batch and continuous culture – Submerged and solid state fermentation for the production of enzymes – Immobilization of enzymes and techniques for enzyme immobilization – Biocatalysis in organic media using enzymes – Biotransformation with crude enzymes and whole cells.

UNIT III  PRODUCTION OF ENZYMES AND METABOLITES  
Production of Proteases, Cellulas, Lipase, Amylase, Glucose isomerase, Pectinase, Peroxidase
Production of primary metabolites– organic acids (Citric acid, Lactic acid), amino acids (Glutamic acid, Lysine), alcohols (ethanol, butanol). Production of secondary metabolites – aminoacids (Glutamic acid, Lysine), antibiotics (Penicillin, streptomycin), Vitamins (Vitamin B12, Riboflavin)

UNIT IV  ENZYME KINETICS  

UNIT V  APPLICATIONS OF ENZYMES  
Enzymes in organic synthesis – Enzymes as biosensors – Enzymes for food, pharmaceutical, tannery, textile, paper and pulp industries – Enzyme for environmental applications- Enzymes for analytical and diagnostic applications – Enzymes for molecular biology research.

OUTCOMES:
- The knowledge on enzyme and enzyme reactions will be the key step in to proceed towards various concepts in biotechnology.
- The theoretical and practical aspects of kinetics will provide the importance and utility of enzyme kinetics towards research.
- The process of immobilization has been increased steadily in food, pharmaceutical and chemical industries and thus this study will provide simple and easy method of implementation.
- Ideas on Processing, Production and Purification of enzymes and metabolites at an industrial scale will be helpful to work technologically.

TOTAL: 45 PERIODS

REFERENCES
OBJECTIVES:
- To improve the programming skills of the student in the field of Biological research
- To let the students know the recent evolution in biological databank usage

UNIT I LINUX OS AND PERL

UNIT II BIOLOGICAL SEQUENCES AND DATABANKS
Introduction to Biological sequences and methods of sequencing, Biological databases: Primary, Secondary and Composite databanks - Scoring matrices: PAM, BLOSUM - Data lifecycle

UNIT III SEQUENCE ANALYSIS

UNIT IV DATA ANALYSIS AND VISUALIZATION

UNIT V STRUCTURAL ANALYSIS
Protein structure visualization and prediction: Pymol, Rasmol, ab initio folding, Threading, Homology modelling - RNA structure prediction, Mfold - Molecular dynamics: Rosetta - protein-ligand docking – QSAR-Protein-protein interaction

OUTCOMES:
Upon completion of this course, students will be able to
- Develop bioinformatics tools with programming skills.
- Apply computational based solutions for biological perspectives.

REFERENCES

BY5111 PREPARATIVE AND ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY L T P C 0 0 6 3

OBJECTIVES
- To learn and understand the principles behind the qualitative and quantitative estimation of bio molecules and laboratory analysis of the same in the body fluids
- To have a practical hands on experience on Absorption Spectroscopic methods and to validate spectrometric and microscopic techniques
- To acquire experience in the purification by performing chromatography
- To design processes for the recovery and subsequent purification of target biological products.

EXPERIMENTS
1. Estimation of amino acids by Ninhydrin method
2. Estimation of total sugars by Phenol sulphuric acid method
3. Estimations of carbohydrates – reducing vs non-reducing, polymeric vs oligomeric, hexose vs pentose.
4. Estimation of protein concentration using Lowrys’ and Bradford method
5. DNA determination by UV-visible spectrophotometer – hyperchromic effect.
6. Separation of amino acids and lipids by TLC.
7. Enzyme kinetics: Determination of Km, Vmax and Kcat, Kcat/ Km.
8. Restriction enzyme – Enrichment and unit calculation.
10. Gel filtration – Size based separation of proteins.
12. Extraction and characterization of photochemical using UV-visible spectrophotometer.
13. Separation of compounds using Column chromatography.

TOTAL: 90 PERIODS

OUTCOMES
Upon success completion of this lab course, the students will be able to
- Quantify Bio molecules using spectroscopy methods
- Purify enzymes and metabolites using Chromatography techniques
- Solve problems related Enzyme involved reactions and kinetics

REFERENCES
OBJECTIVES:
To enable the students to
- Understand the methods to obtain pure proteins, enzymes and in general about product development R & D
- Have depth knowledge and hands on experience on Downstream processes to commercial therapeutically important proteins.

UNIT I  DOWNSTREAM PROCESSING IN BIOTECHNOLOGY  9
Role and importance of downstream processing in biotechnological processes – Problems and requirements of bio product purification – Economics of downstream processing in Biotechnology, cost-cutting strategies – Separation characteristics of proteins and enzymes – size, stability, properties – Flocculation and conditioning of broth – Process design criteria for various classes of bio products (high volume, low value products and low volume, high value products) – Upstream production methods affect downstream purification strategies.

UNIT II  PHYSICO-CHEMICAL BASIS OF BIO-SEPARATION PROCESSES  9

UNIT III  MEMBRANE SEPARATIONS AND ENRICHMENT OPERATIONS  9

UNIT IV  MECHANISM AND MODES OF CHROMATOGRAPHIC SEPARATION  9
Chromatography – Classification of chromatographic techniques – General description of column chromatography – Chromatographic terms and parameters – Practice of chromatography – Partition, normal-phase, displacement, reversed-phase, size exclusion, ion exchange, hydrophobic, affinity chromatography – Scale-up of chromatography – Process considerations in Preparative liquid chromatography and HPLC.

UNIT V  FINISHING OPERATIONS AND FORMULATIONS  9

TOTAL: 45 PERIODS

OUTCOMES:
Upon success completion of this course, the students will be able to:
- Define advanced downstream processing methods for product recovery.
• Describe the components of downstream equipment and to understand the requirements for successful operations.
• To enhance problem solving techniques required in multi-factorial manufacturing environment in a structured and logical fashion.

REFERENCES

BY5202 BIOPROCESS ENGINEERING  L T P C
3 2 0 4

OBJECTIVES:
• To impart knowledge on design and operation of fermentation processes with all its prerequisites.
• To endow the students with the basics of microbial kinetics, metabolic stoichiometry and energetics.
• To develop bioengineering skills for the production of biochemical product using integrated biochemical processes.

UNIT I METABOLIC STOICHIOMETRY AND ENERGETICS

UNIT II MICROBIAL GROWTH, KINETICS, MAINTENANCE AND PRODUCT FORMATION

UNIT III STRUCTURED MODELS
Structured models for growth and product formation – Compartmental and metabolic models – Mechanistic models - Product formation kinetics – Gaden’s and Deindoerfer’s classifications – Chemically and genetically structured models – Kinetics models of heterogenous bioprocesses – Biofilm kinetics, Unstructured models of pellet growth – Considerations for the production of r-DNA products.
UNIT IV  MASS TRANSFER IN BIOLOGICAL SYSTEMS  
Interphase Gas-Liquid mass transfer – General oxygen balances for Gas-Liquid transfer – Models for oxygen transfer in large scale bioreactors – Case studies for large scale bioreactors – Model for oxygen gradients in a bubble column bioreactor, air lift bioreactor – Model for a multiple impeller fermenter – Gas-liquid mass transfer of components other than oxygen.

UNIT V  DIFFUSION AND BIOLOGICAL REACTION IN IMMobilized BIOCATALYST  

TOTAL: 45+30 PERIODS

OUTCOMES:  
Upon completion of the course in Bioprocess Principles graduates will be able to  
• Apply engineering principles to systems containing biological catalysts to meet the needs of the society.  
• Interpret the kinetics of living cells and to develop a strategy to solve the issues emerging during fermentation processes.

REFERENCES  

BY5203  BIOREACTOR DESIGN AND ANALYSIS  
OBJECTIVES:  
• To provide the students with the design and scaleup of bioreactors.  
• To develop bioengineering skills for the production of biochemical product using integrated biochemical processes.

UNIT I  BASIC BIOREACTOR CONCEPTS  
Bioreactor Operation – Batch operation, semi-continuous and fed-batch operation, Continuous Operation – Chemostat, turbidostat – Microbiological reactors, enzyme reactors – Tank-type, Column-type biological reactors – Case studies – Continuous Fermentation with Biomass Recycle, Tanks-in-series, Tubular plug flow bioreactors.

UNIT II  AERATION AND AGITATION IN BIOPROCESS SYSTEMS  
Mass transfer in agitated tanks – Effect of agitation on dissolved oxygen - Correlations with k_%a in Newtonian and non Newtonian liquid – Power number, Power requirement for mixing in aerated
and non aerated tanks for Newtonian and non Newtonian liquids – Agitation rate studies - Mixing time in agitated reactor, residence time distribution – Shear damage, bubble damage, Methods of minimizing cell damage – Laminar and Turbulent flow in stirred tank bioreactors.

UNIT III SELECTION AND DESIGN OF BIOPROCESS EQUIPMENT 12
Materials of construction for bioprocess plants – Design considerations for maintaining sterility of process streams processing equipments, selection, specification – Design of heat and mass transfer equipment used in bioprocess industries – Requirements, design and operation of bioreactor for microbial, plant cell and animal cell.

UNIT IV SCALE UP AND SCALE DOWN ISSUES 12
Effect of scale on oxygenation, mixing, sterilization, pH, temperature, inoculum development, nutrient availability and supply – Bioreactor scale-up based on constant power consumption per volume, mixing time, impeller tip speed (shear), mass transfer co-efficients – Scale up of downstream processes – Adsorption (LUB method), Chromatography (constant resolution etc.), Filtration (constant resistance etc.), Centrifugation (equivalent times etc.), Extractors (geometry based rules) – Scale-down related aspects.

UNIT V BIOREACTOR INSTRUMENTATION AND CONTROL 12

TOTAL: 60 PERIODS

OUTCOMES:
Upon completion of Bioprocess Engineering course graduates will be able to

- Select appropriate bioreactor configurations and operation modes based upon the nature of bio products and cell lines and other process criteria.
- Apply modelling and simulation of bioprocesses so as to reduce costs and to enhance the quality of products and systems.
- Integrate research lab and Industry; identify problems and seek practical solutions for large scale implementation of Biotechnology.

REFERENCES
OBJECTIVES:
- To understand the structure, functions and integration of immune system.
- To explain the antigen-antibody interactions that offers defence mechanism.
- To explain various techniques of therapeutically significant monoclonal and engineered antibodies production.

UNIT I IMMUNE SYSTEM AND ITS RESPONSE

UNIT II ANTIGEN AND ANTIBODY

UNIT III CELLULAR IMMUNOLOGICAL TECHNIQUES
PBMC separation from the blood – Ficoll-hypaque method – Identification of lymphocytes based on CD markers – FACS – Lymphoproliferation assay – Cr5I release assay – Macrophage cultures detection assays – Rosette assay – Cytokine bioassays: IL2, IFNγ, TNFα – Mixed lymphocyte reaction – HLA typing.

UNIT IV VACCINE TECHNOLOGY

UNIT V IMMUNOTHERAPEUTICS

OUTCOMES:
- The students after completing the course would be aware of immune system structure and functions, immunity to various pathogens.
- To produce the therapeutic and diagnostic molecules and to aware of tumour, allergy and hypersensitivity reactions.

REFERENCES
BY5205 ADVANCED GENOMICS AND PROTEOMICS

OBJECTIVES:
- To understand the gene cloning methods, tools and techniques involved in genome analysis and genomics.
- To explain the heterologous expression of cloned genes in different hosts, production of recombinant proteins and PCR techniques.
- To identify the importance of protein bio molecules and the structure-function relationships in proteins.
- To explain comparative genomics and proteomics.

UNIT I GENE AND GENOME ANALYSIS
Gene prediction in prokaryotes and eukaryotes - Genome-wide association (GWA) analysis - Massively parallel Signature sequencing (MPSS), Whole genome Shotgun sequencing, Next Generation Sequencing (NGS) - Cytogenetic and physical mapping - GDB, NCBI, OMIM, NGI/MGD - Structural annotation - Functional annotation - Limitation of genomics

UNIT II GENOME INFORMATICS
Functional genomics: Developmental biology and Differential gene expression, Microarray analysis - Epigenomics: Histone modification assays-ChIP-Chip and ChIP-Seq, DNA Methylation assays-DNA hybridization technique - Metagenomics: de novo transcriptome assembly

UNIT III GENOMIC DIVERSITY
Study systems: Cyanobacteria, Plasmodium, Yeast, Virus, Arabidopsis thaliana, Homo sapiens, Worm, Zebra fish - Comparative databases: COG, KEGG, MBGD, PEDANT, Organism Specific databases

UNIT IV PROTEOME INFORMATICS
2D Electrophoresis - Spot visualization and picking - Database for 2D gel - Tryptic digestion of protein - Peptide fingerprinting - Data analysis: Mass spectrometry; ion source (MALDI, spray sources); analyzer (ToF, quadrupole, quadrupole ion trap) and detectors - Ramachandran plot - Post-translational modifications of proteins - Limitation of proteomics

UNIT V APPLICATIONS OF GENOMICS AND PROTEOMICS
Genomic medicine - Synthetic biology and bioengineering - Conservation genomics - Interaction proteomics - Protein networks - Expression proteomics – Biomarkers - Proteogenomics

TOTAL: 60 PERIODS
OUTCOMES:
- The students after completing this course would be aware of how to clone commercially important genes and recombinant proteins.
- The students would be aware of gene and genome sequencing techniques.
- The students would be aware of microarrays, Analysis of Gene expression and proteomics.
- To analyze the various interactions in protein makeup and different levels of protein structure.
- To practice the latest application of protein science in their research.

REFERENCES

BY5211 IMMUNOTECHNOLOGY LABORATORY L T P C
0 0 6 3

OBJECTIVES:
- To give practical exposure in the clinical diagnosis.
- To give laboratory training in different immunotechnological techniques.

1. Preparation of antigen and Routes of immunization (Intra-peritonial, Sub-cutaneous, Intramuscular, Intra- nasal, Oral)
2. Methods of bleeding (Eg. Tail bleeding, Intravenous, intraorbital)
3. Collection of serum, storage and purification of total IgG (salt precipitation).
4. Evaluation of Antibody titre by direct ELISA
5. Evaluation of Antigen by Sandwich ELISA
6. Characterization of antigens by native and SDS-PAGE
7. Characterizations of antigens by Western blot analysis – Wet and semidry transfer
8. Conjugation of Immunoglobins (Streptavidin, colloidal gold)
9. Methods for prototype development of Immunodiagnostics (ICT card)
10. Blood smear identification of leucocytes by Giemsa stain
11. Separation of mononuclear cells by Ficoll-Hypaque
12. Separation of spleenocytes and proliferation against mitogens

Required Equipments:
- Microscopes, restainer (mouse, rat, rabbit), purification columns, microplate reader, UV spectrometer, PAGE apparatus, Western blot apparatus (dry/semi-dry/wet), centrifuge, Haemocytometer, required strains & consumables

TOTAL : 90 PERIODS
OUTCOMES:
- The students would be aware of immune system cells and tissues.
- The students would have knowledge on immunological/clinical tests.

REFERENCES

BY5311 ADVANCED GENETIC ENGINEERING LABORATORY L T P C
0 0 6 3

OBJECTIVES:
- Provide hands-on experience in performing basic recombinant DNA techniques.
- To understand the principle behind each techniques and applications of each methodology in applied biological research.

1. Isolation of DNA
2. Electroporation to Yeast
3. Isolation of RNA
4. cDNA synthesis
5. Primer designing
6. Real-time PCR
7. Plasmid isolation and confirming recombinant by PCR and RE digestion.
8. Confirmation of the presence of insert by colony PCR
9. Induction and expression of recombinant protein
10. Western blot with ECL detection
11. Site directed mutagenesis
12. Southern blot (Non-radioactive)
13. RFLP analysis of the recombinant DNA

Required Equipments:
- Microscopes, PCR, purification columns, microplate reader, UV spectrometer, PAGE apparatus, Western blot apparatus (dry/semi-dry/wet), Southern blot apparatus, centrifuge, Haemocytometer, required stains, chemicals, enzymes & consumables

OUTCOMES:
By the end of this course, students should be able to:
- Describe the main principles, methods for preparation and cloning of DNA in various organisms.
- Express clearly about the gene amplification and methods for analysis of DNA, such as hybridization, restriction analysis and gene expressions.
- Use genetic and biotechnological techniques to manipulate genetic materials and develops new and improved living organisms.

TOTAL : 90 PERIODS
REFERENCES

BY5312 BIOPROCESS AND DOWNSTREAM PROCESSING LABORATORY L T P C 0 0 6 3

OBJECTIVES:
- The course applies earlier learned knowledge about mass transfer in bio reactors and sterilization kinetics.
- To provide hands on training in Downstream processing through simple experimentations in the laboratory.
- To understand the nature of the end product, its concentration, stability and degree of purification required for targeted biological products.
- Skills and knowledge gained is useful by analogy when solving problems typical for the bio industry or for research.

1. Enzyme immobilization studies – Gel entrapment, adsorption and cross linking immobilisation.
2. Batch cultivation – E.coli – growth rate, substrate utilization kinetics, product analysis after induction, metabolite analysis by HPLC.
3. Fed batch cultivation - E.coli - growth rate, substrate utilization kinetics, product analysis after induction, metabolite analysis by HPLC.
5. Optimization techniques – Plackett Burman, Response surface methodology.
7. Cell separation methods-Centrifugation and microfiltration
9. Aqueous two phase extraction of biologicals.
10. Protein precipitation by salting –out method (ammonium sulphate).
11. Protein purification method- Column chromatography.

Required Equipments:
Centrifuge, Column for purification, Ultrasonicator, Homogeniser, Microfiltration capsule, Hot air oven, Incubator, Laminar air flow chamber, HPLC, required chemicals & stains.

TOTAL : 90 PERIODS

OUTCOMES:
At the end of this course,
- Graduates gain ability to investigate, design and conduct experiments, analyze and interpret data, and apply the laboratory skills to solve complex bioprocess engineering problems.
- Acquired knowledge for the separation of whole cells and other insoluble ingredients from the culture broth.
- Learned the basic principles and techniques of chromatography to purify the biological products and formulate the products for different end uses.
REFERENCES
2. Pauline Doran, Bioprocess Engineering Calculation, Blackwell Scientific Publications

BY5001 MOLECULAR CONCEPTS IN BIOTECHNOLOGY L T P C
(FOR ENGINEERING STREAM) 3 0 0 3

OBJECTIVES:
- Familiarize students with the cell and molecular biology of both Prokaryotes and Eukaryotes.
- By doing this course students will acquire basic fundamental knowledge and explore skills in molecular biology and become aware of the complexity of the cells.
- This course will emphasize the molecular mechanism of DNA replication, repair, transcription, protein synthesis and gene regulation in various organisms.

UNIT I DNA, RNA AND PROTEIN SYNTHESIS 9
Structure of DNA – DNA replication, Decoding genetic information – Transcription and translation. Regulation of transcription in bacteria and eukaryotes – Non-coding RNAs.

UNIT II MANIPULATION OF GENE EXPRESSION IN PROKARYOTE 9

UNIT III DIRECTED MUTAGENESIS AND PROTEIN ENGINEERING 9
Directed mutagenesis – Oligonucleotide-directed mutagenesis with M13 virus and plasmid DNA – PCR amplified oligonucleotide directed mutagenesis – Protein thermo stability – Addition of disulfide bonds, reduction in free sulfhydryl residues – Protein stability – Modifying the substrate binding specificity, modifying metal cofactor requirements – Restriction modification enzymes – Zinc finger proteins.

UNIT IV TRANSGENIC ANIMALS 9
Transgenic animals – Gene transfer methods – Retroviral vector method, DNA microinjection, engineered embryonic stem cell, nuclear transfer, YAC – Applications of transgenic animals – Transgenic livestock – Production of donor organs, pharmaceuticals, disease resistant livestock – Improving milk quality and animal production traits.

UNIT V HUMAN MOLECULAR GENETICS 9
Genetic linkage and gene mapping – Genetic polymorphism, RFLP, SNP, STRP – Physical mapping of the human genome – Sequence tagged site (STS) for constructing physical maps from YAC, BAC or PAC – Genomic libraries – Transcriptional mapping – Cloning human disease genes and methods.

TOTAL: 45 PERIODS
OUTCOMES:
By the end of this course, students should be able to:

- Describe the basic structure and biochemistry of nucleic acids and proteins and discriminate between them;
- Identify the principles of DNA replication, transcription and translation and explain how they relate to each other.
- Discuss clearly about gene organization and mechanisms of control the gene expression in various organisms.
- Articulate applications of molecular biology in the modern world.

REFERENCES

BY5002 PRINCIPLES OF CHEMICAL ENGINEERING (FOR SCIENCE STREAM) L T P C 3 0 0 3

OBJECTIVES:
The course aims to develop skills of the students in the area of Chemical Engineering with emphasis in process calculations and fluid mechanics. The objectives are to enable the students

- To perform calculations pertaining to processes and operations.
- To apply fluid mechanics principles to applied problems

UNIT I FUNDAMENTALS OF CHEMICAL ENGINEERING 9
Concepts of unit operation and unit process with examples – Units and dimensions, conversion factors, dimensional analysis – Presentation and analysis of data – Mole, density, Specific gravity – Mass fraction, Mole fraction – Analysis of multicomponent system – Concentration.

UNIT II MATERIAL AND ENERGY BALANCES 9

UNIT III FLUID MECHANICS 9
Laminar and turbulent flow – Basic equations of fluid flow, continuity equations and Bernoulli’s equation – Shear – Stress relationships – Non-Newtonian fluids, friction factor and its calculation in
laminar and turbulent flow – Operational principles of different types of pumps, compressors and valves – Measurement of fluid flow using venturimeters, orifice meters – Rotameters, pivot tube.

UNIT IV HEAT TRANSFER 9

UNIT V MASS TRANSFER 9
Fick's law of diffusion – Analogy with momentum and heat transfer, diffusivities of gases and liquids, diffusion in binary mixtures, Interphase mass transfer – Film theory of mass transfer, determination of volumetric mass transfer coefficient – Overview of separation operations with examples, ideal stage concept – Mass transfer equipment – Distillation, liquid extraction, gas absorption, drying.

OUTCOMES:
Upon success completion of this course, the students will be able to:
- Solve problems related to units and conversions and fit the given data using the methodologies
- Solve problems related to material and energy balance concepts and design reactors for biochemical processes
- Apply their knowledge in the field of biochemical engineering from the principles of thermodynamics.

REFERENCES

BY5003 METABOLIC PROCESS AND ENGINEERING (FOR BIOTECHNOLOGY STREAM) 3 0 0 3

OBJECTIVES:
- To provide a quantitative basis, enzyme kinetics, for the understanding of metabolic networks in single cells and at the organ level
- To enable the students to use organisms to produce valuable substances on an industrial scale in cost effective manner
UNIT I  CELLULAR METABOLISM

UNIT II  REGULATION, MANIPULATION AND SYNTHESIS OF METABOLIC PATHWAY

UNIT III  ANALYSIS AND METHODS FOR THE METABOLIC FLUX
Metabolic flux map – Fluxes through the catabolic pathways in microbes– Metabolic flux analysis for determined, over-determined and under-determined systems –Sensitivity analysis – Direct flux determination from fractional label enrichment – Applications involving complete enumeration of metabolite isotopomers – Carbon metabolite balances.

UNIT IV  APPLICATION OF METABOLIC FLUX ANALYSIS
Amino acid production – Biochemistry and regulation– Metabolic flux analysis of lysine biosynthetic network and specific deletion mutants – Metabolic fluxes in mammalian cell cultures – Intracellular fluxes, validation of flux estimates by $^{13}$C labeling studies – Design of cell culture media.

UNIT V  ANALYSIS OF METABOLIC CONTROL AND INDUSTRIAL CASE STUDIES
Fundamental of Metabolic Control Analysis (MCA), MFA, and MPA and their application, relating system variables to enzyme kinetics, Multi-substrate enzyme kinetics, Metabolic engineering examples for bio-fuel, bio-plastic and green chemical synthesis and industrial case studies..

TOTAL: 45 PERIODS

OUTCOMES:
After completion of metabolic engineering, students will be able
- To learn stoichiometry and energetics of metabolism.
- To apply practical applications of metabolic engineering in chemical, energy, medical and environmental fields.
- To integrate modern biology with engineering process to meet desired needs

REFERENCES
OBJECTIVES:
- To provide the fundamentals of animal cell culture, diseases and therapy
- To offer the knowledge about the micromanipulation and transgenic animals

UNIT I  CELL CULTURE
Culturing of cells– Primary and secondary cell lines – Genetics of cultured cells – Scaling up in suspension –Monolayer culture – Bio-reactors used for animal cell culture –Roller bottle culture– Bioreactor process control –Stirred animal cell culture –Air-lift fermentor, Chemostat/Turbidostat– Cell lines and their applications.

UNIT II  GENE CLONING VECTORS AND IMMUNOLOGY

UNIT III  STEM CELL AND CLONING

UNIT IV  GENETIC ENGINEERING

UNIT V  APPLICATIONS
Rumen manipulation– Probiotics embryo transfer technology – Invitro fertilization, transgenesis–Methods of transferring genes into animal oocytes, eggs, embryos and specific tissues by physical, chemical and biological methods–Biopharming– Transgenic animal technology, application to production and therapeutics (mice, sheep, cattle) – Artificial insemination and embryo transfer – Transgenic growth hormone genes.

OUTCOMES:
Upon completion of this subject the student will be able to
- Understand the animal cell culture, animal diseases and its diagnosis
- Gain the knowledge for therapy of animal infections
- Know the concepts of micromanipulation technology and transgenic animal technology

TOTAL : 45 PERIODS
• Use the knowledge gained in this section to apply in the field of clinical research

REFERENCES

BY5005  COMPUTER AIDED LEARNING OF STRUCTURE AND FUNCTION OF PROTEINS  L T P C  2  2  0  3

OBJECTIVES:
To enable the students
• To identify the importance of protein bio molecules.
• To realize the structure-function relationships in proteins

UNIT I  AMINO ACIDS AND 3D STRUTURE  9
Amino acids – Acid-base properties – Stereo chemical representations – Chemical and Physical properties – Primary structure – Secondary structure and motifs – Tertiary structures and domains – Quaternary structures – Classifications – CATH, SCOP – Protein Data Base analysis.

UNIT II  FIBROUS AND MEMBRANE PROTEINS  9

UNIT III  FUNCTION AND CONTROL OF FUNCTION  9

UNIT IV  BIOSYNTHESIS AND DEGRADATION  9

UNIT V  DETERMINATION AND PREDICTION OF 3D STRUCTURE  9

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of this course, students will be able:
To analyze the various interactions in protein makeup.
To be familiar with different levels of protein structure.
To know the role of functional proteins in various field of study.
To practice the latest application of protein science in their research.

REFERENCES

BY5006 ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:
To enable the students
- To have a fundamental knowledge about the Light spectrum, Absoprtion, Fluorescence, NMR, Mass spectroscopy
- To acquire knowledge on the different chromatographic methods for separation of biological products.
- Understand the methods to obtain pure proteins, enzymes and in general about product development R & D

UNIT I PROTEIN CRYSTALLOGRAPHY

UNIT II PROTEIN AND PEPTIDE PURIFICATION
- Chromatographic methods for protein and peptide purification – Multidimensional chromatography – High throughput screening of soluble recombinant proteins – Immunoprecipitation – Affinity chromatography for antibody purification – Role of reverse phase HPLC in proteomic research.

UNIT III ELECTROPHORETIC TECHNIQUES

UNIT IV MICROSCOPY
UNIT V  SPECTROSCOPY

TOTAL: 45 PERIODS

OUTCOMES:
• On completion of the course, students will have a better understanding of spectroscopy and the separation techniques used for biological products.
• Apply principles of various unit operations used in downstream processing and enhance problem solving techniques

REFERENCES

BY5007  BIO THERMODYNAMICS  L T P C
OBJECTIVE:
• To enable the students to learn about basic concepts of classical and statistical thermodynamics
• To demonstrate the capability to analyze the energy conversion performance in a variety of modern applications in biological systems.

UNIT I  CONCEPTS AND LAWS OF THERMODYNAMICS

UNIT II  ENERGY TRANSFORMATION AND BIOENERGETICS
Distribution of energy – Carbon, energy and life – Molecular level energy storage – Biothermodynamics of energy use by plant and animals – Methods for measuring the thermodynamic stability of membrane proteins – Protein folding – Modeling the native state ensemble of proteins using statistical thermodynamics – Energetic profiles of proteins derived from thermodynamics of the native state ensemble – Principle of components analysis of energetic profile space – Energetic profiles are conserved between homologous proteins.
UNIT III  GIBB’S FREE ENERGY AND ITS APPLICATIONS 9

UNIT IV  STATISCAL THERMODYNAMICS AND BINDING EQUILIBRIA 9

UNIT V  REACTION KINETICS TO BIOLOGICAL SYSTEM 9
Free energy analysis of chemical reactions – Chemical coupling to drive reactions in biological systems – First order and second order reactions – Collision theory – Transition state theory – Free energy of activation – Arrhenius rate constant equation – Applications – Temperature and concentration effects on enzyme kinetics – Reaction mechanism of lysozyme – Kinetic identification of reaction intermediates – Sequential enzyme reactions in metabolism and analysis.

TOTAL: 45 PERIODS

OUTCOMES:
At the end of this course, the student would have the ability
- To explain the theoretical concepts of thermodynamics and how it applies to energy
- conversion in technological applications and biological systems.
- To design and carry out bioprocess engineering experiments, and analyze and
- interpret fundamental data to do the design and operation of bioprocesses.
- To describe the criteria when two phases coexist in equilibrium and the vapour liquid
- equilibrium calculations microbial growth and product formation.

REFERENCES

BY5008  PLANT BIOTECHNOLOGY  LT P C 3 0 0 3

OBJECTIVES:
- To give the details of plant cells and its functions
- To provide the basics of agro bacterium and applications of plant biotechnology
UNIT I PLANT TISSUE CULTURE
Concept of cellular totipotency – Cytodifferentiation – Organogenic differentiation – Nutritional requirements – Seed culture, embryo culture, Protoplast culture, Micropropagation, Cell suspension – In vitro production of haploids – Somaclonal variation – Germplasm storage and cryopreservation.

UNIT II CHLOROPLAST AND MITOCHONDRIA
Structure, function – Light and dark reaction and genetic material – Rubisco synthesis and assembly, coordination, regulation and transport of proteins – Mitochondria: Genome – Cytoplasmic male sterility and import of proteins – Comparison and differences between mitochondrial and chloroplast genome – Chloroplast transformation

UNIT III PLANT METABOLISM AND METABOLIC ENGINEERING

UNIT IV GENE TRANSFER IN PLANTS

UNIT V TRANSGENICS IN CROP IMPROVEMENT

TOTAL : 45 PERIODS

OUTCOMES:
Upon completion of the course, the student would be able

- To understand the fundamentals of plant cells, structure and functions
- To learn the nitrogen fixation mechanism and significance of viral vectors
- To gain the knowledge about the plant tissue culture and transgenic plants
- To use of the gained knowledge for the development of therapeutic products

REFERENCES
OBJECTIVES:
The proposed course is designed
  • To understand the scientific and engineering principles of microbiological treatment technologies to clean up contaminated environments
  • To replace of conventional treatment methodologies by molecular biology and genetic engineering strategies
  • To seek the way for the alternate sources of energy to avoid environmental issues

UNIT I  BIODEGRADATION AND BIOREMEDIATION  9
Aerobic and Anaerobic degradation of aliphatic and aromatic compounds – Biodegradation of herbicides and pesticides. Bioremediation technologies – Biostimulation, Bioaugmentation, Bioventing, biosparging and Phytoremediation – Bioleaching, bioprecipitation, bioaccumulation and biosorption of heavy metals.

UNIT II  MICROBIAL METABOLISM IN WASTEWATER TREATMENT  9

UNIT III  BIOLOGICAL TREATMENT OF WASTEWATER  9

UNIT IV  BIOTECHNOLOGY FOR AIR POLLUTION AND WASTE MANAGEMENT  9
Air pollution control and treatment strategies – Biotechnology for treating air pollutants – Biofilters and Bioscrubbers – Biotechnology for the management of agricultural, plastic, dairy, paper and pulp, textile, leather, hospital and pharmaceutical industrial wastes.

UNIT V  BIOPRODUCTS FROM RENEWABLE SOURCES  9
Overview of renewable sources – Production of biocompost and vermicompost – Production of biofertilizers and biopesticides – Production of biomethane, bioethanol, biohydrogen, biodiesel – Production of bioplastics and biopolymers – Bioelectricity generation and value added products from renewable sources.

TOTAL: 45 PERIODS

OUTCOMES:
Upon successful completion of the course
  • Environmental Pollution or problems can be solved
  • Scientific solutions and participation can be served for the environmental Protection
  • improvement for the alternate sources of energy to avoid environmental disasters

REFERENCES

BY5010 CANCER BIOLOGY

OBJECTIVES:
To enable the students to understand
- Basic biology of cancer
- Impact of antibodies against cancer in the human body leading to more effective treatments
- Enhanced immunology based detection methods and imaging techniques
- Development of cell based and cytokine based immunotherapy against cancer

UNIT I PRINCIPLES OF CANCER BIOLOGY  9

UNIT II PRINCIPLES OF CARCINOGENESIS  9

UNIT III MOLECULAR BIOLOGY OF CANCER  9

UNIT IV CANCER METASTASIS  9

UNIT V CANCER THERAPY  9
Therapy forms – Surgery, chemotherapy, radiation therapy - Detection of cancers – Prediction of aggressiveness of cancer – Advances in cancer detection – Tumor markers; New approaches of cancer therapy – mAbs, vaccines, gene therapy, stem cell therapy.

TOTAL: 45 PERIODS
OUTCOMES:
The course would facilitate the students
- To appreciate the role of immune system in cancer
- To understand the cancer microenvironment and its influence on immune cells
- To medical applications of cytokines and immune cells against cancer.

REFERENCES

BY5011 TECHNOLOGY MANAGEMENT  L T P C  3 0 0 3

OBJECTIVE:
- To impart the knowledge of various aspects of Creativity, Innovation and New Product Development

UNIT I TECHNOLOGY MANAGEMENT  9

UNIT II TECHNOLOGICAL FORECASTING & ASSESSMENT  9

UNIT III TECHNOLOGY STRATEGY  9

UNIT IV TECHNOLOGY TRANSFER MANAGEMENT  9
UNIT V TECHNOLOGY TRANSFER AND ACQUISITION


OUTCOME:

- On completion of the course, students will have gained knowledge on various issues related to Patents, Quality, Creativity, Innovation, New Product Development, Planning and Evaluation.

REFERENCES


BY5012 COMPUTATIONAL METHODS IN FLUID DYNAMICS

OBJECTIVES:
The course aims to develop skills of the students in the area of Chemical Engineering with emphasis in process calculations and fluid mechanics. The objectives are to enable the students

- To perform calculations pertaining to processes and operations.
- To apply fluid mechanics principles to applied problems

UNIT I GOVERNING EQUATIONS


UNIT II NUMERICAL ANALYSIS


UNIT III COMPRESSIBLE FLOW COMPUTATION

UNIT IV  TURBULENT FLOW COMPUTATION  9

UNIT V  FINITE ELEMENT METHOD  9

OUTCOMES:
Upon success completion of this course, the students will be able to:
- Solve problems related to units and conversions and fit the given data using the methodologies
- Solve problems related to material and energy balance concepts and design reactors for biochemical processes
- Apply their knowledge in the field of biochemical engineering from the principles of thermodynamics.
- Acquire knowledge related to fluid statics and dynamics, agitators and applications of various pumps.

REFERENCES

BY5013  BIOTECHNOLOGY IN FOOD PROCESSING  L T P C  3 0 0 3

OBJECTIVES:
To enable the students
- To know about the constituents and additives present in the food.
- To gain knowledge about the microorganisms, food spoilage diseases.
- To know different techniques used for the preservation of foods.

UNIT I  FOOD PROCESSING  9
Heat Processing using steam or water (Blanching, Pasteurization) – Heat sterilization (Evaporation and distillation) – Heat processing using hot air (Dehydration, baking and roasting) – Heat processing using hot oils – Processing by the removal of heat (chilling , Freezing) – High pressure processing of foods – Pulsed electric field processing of liquids and beverages – Non-thermal processing by radiofrequency electric fields.
UNIT II FOOD FERMENTATION


UNIT III FERMENTED FOODS


UNIT IV FOOD PRESERVATION TECHNIQUES

Spoilage of food - Microbiology of water, meat, milk, vegetables – Food poisoning – Cold preservation – Heat conservation – Ionizing radiation – High pressure – Electric field – Chemical food preservation – Combination of techniques for food preservation – Natural antioxidants – Antimicrobial enzymes – Edible coatings – Control of pH and water activity.

UNIT V FOOD QUALITY AND CONTROL

Analysis of food – Major ingredients present in different product – Food additives, vitamins – Analysis of heavy metal, fungal toxins, pesticide and herbicide contamination in food – Microbial safety of food products – Chemical safety of food products – Good manufacturing practice

TOTAL: 45 PERIODS

OUTCOMES:
Through this subject the student can understand about
- Different constituents present in food and microorganism involved in processing of food.
- Principles and different preservations techniques of food can also be known.
- Unit operations in modern food processing and impact of the process on food quality

REFERENCES
OBJECTIVES:
To enable the students
- To learn about basis of nanomaterial science, preparation method, types and application

UNIT I  NANOSCALE PROCESSES AND NANOMATERIALS  9

UNIT II  STRUCTURAL AND FUNCTIONAL PRINCIPLES OF BIONANOTECHNOLOGY  9

UNIT III  PROTEIN-BASED NANOTECHNOLOGY  9

UNIT IV  DNA-BASED NANOTECHNOLOGY  9

UNIT V  NANOMEDICINE AND NANONSENSING  9

TOTAL: 45 PERIODS

OUTCOMES:
Upon completing this course, the students
- Will familiarize about the science of nanomaterials
- Will demonstrate the preparation of nanomaterials
- Awareness about the properties and broad applications of biomaterials

REFERENCES

BY5015

PHYTOCHEMISTRY

OBJECTIVES:
- To give the details of plant derived value added compounds and its functions
- To provide knowledge on biotech based production of agro medicines

UNIT I HERBAL DRUGS
Phytochemicals and their classification—Phytochemical screening —Physiochemical tests —Macrosopic and microscopic techniques —Traditional plant and Herbal remedies — Herbal drugs WHO guidelines—Standardization of Herbal Drugs Derivatives with Special Reference to Brazilian Regulations

UNIT II PHYTOCOMPOUNDS
Plant extract used to Bacterial, Fungal and Parasitic infection – Biological and Toxicology Properties of plant extract –Anti-MRSA and Anti-VRE activities of Phytoalexins and Phytoncides– Anti microbial and targeted screening of Plant extract – Plant derived compound against drug resistant microorganisms –Antioxidant and antitumor Plant metabolites (fruits and vegetables)– Bioactive compounds as food

UNIT III PHYTOMEDICINE
Medicinal Plants for Development of Phytomedicine and Use in Primary Health Care– Immunostimulants and adaptogen from Plants –Polyphenols for Atherosclerosis and Ischemic Heart disease –Cancer Chemopreventive agents –Lipidoxidation nitrogen Radicals– Phytochemicals in oilseeds – Flavonoids in Cardiovascular disease – Bioengineering and Breeding approaches in improving phytochemical content of plants.

UNIT IV SEPARATION TECHNIQUES AND STRUCTURE ELUCIDATION

UNIT V SECONDARY METABOLITE

OUTCOMES:
Upon completion of the course, the student would be able
- To understand the fundamentals of phytochemicals and its functions

TOTAL: 45 PERIODS
• To learn the separation techniques of herbal agromedicines and its analysis
• To gain the knowledge about the plant tissue culture based secondary metabolite
• To use of the gained knowledge for the development of therapeutic products

REFERENCES

BY5016 ADVANCES IN MOLECULAR PATHOGENESIS L T P C
3 0 0 3

OBJECTIVES:
To enable the students
• To understand about the microbial toxins and modern molecular pathogenesis
• To know about the host pathogen interaction and identifying virulence factors
• To control pathogens by modern approaches.

UNIT I VIRAL PATHOGENESIS
Various pathogen types and modes of entry – Viral dissemination in the host – Viral virulence – Injury induced by virus – Host susceptibility of viral disease – Pattern of infection - Acute infection – Persistent infection – Latent infection – Slow infection – Methods for the study of pathogenesis – Foot and mouth disease virus, Pestiviruses, Arteriviruses, Blue tongue virus and Animal herpesviruses

UNIT II FUNGAL PATHOGENESIS

UNIT III BACTERIAL PATHOGENESIS

UNIT IV MANIPULATION OF HOST CELLS AND IMMUNE FUNCTION BY VIRAL PROTEINS
Clinical importance of understanding host defence – Interference with cytokine and Chemokine function – impairment of host mediated killing of infected cells – inhibition of apoptosis –
Immunological structure of proteins – Class I and II MHC mediated antigen – Evasion from natural killer cells.

UNIT V  MOLECULAR APPROACHES TO CONTROL
Classical approaches based on serotyping – Modern diagnosis based on highly conserved virulence factors, immune and DNA based techniques – New therapeutic strategies based on recent findings on molecular pathogenesis – Viral Vaccines – Immune modulators – New vaccine technology.

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of this course, the student will be able to understand the

• Host pathogen interactions at the level of cellular and molecular networks.
• Diagnosis of diseases through the examination of molecules.
• Modern therapeutic strategies on various pathogens.

REFERENCES

BY5017  SPECTROSCOPY FOR BIOTECHNOLOGISTS  L T P C
3 0 0 3

OBJECTIVES:
To enable the students

• To have a fundamental knowledge about the Light spectrum, Absorption, Fluorescence NMR, Mass spectroscopy
• To deliver the knowledge of spectroscopic techniques and its functions
• To provide the technical information of spectroscopy for biological applications

UNIT I  ELECTRONIC SPECTRA
Overview of electronic spectra – Absorption spectra – Ultraviolet spectra of proteins – Nucleic acid spectra – Prosthetic groups – Difference spectroscopy – X-ray absorption spectroscopy – Fluorescence and phosphorescence – Helicase activity monitored by fluorescence – Fluorescence energy transfer – Molecular ruler-application of energy transfer to biological systems.

UNIT II  CIRCULAR DICHRIOISM, OPTICAL ROTARY DISPERSION AND FLUORESCENCE POLARIZATION
UNIT III IR AND RAMAN SPECTROSCOPY

UNIT IV NUCLEAR MAGNETIC RESONANCE AND ELECTRON SPIN RESONANCE

UNIT V MASS SPECTROMETRY

OUTCOMES:
Upon completion of this course, the student would be able understand
- Basics of optical rotary dispersion methods and nuclear magnetic resonance
- Principles and applications of mass spectrometry and X-ray diffraction
- The spectroscopic techniques and its applications for various biological applications

REFERENCES

BY5018 IPR AND BIOSAFETY L T P C 3 0 0 3

OBJECTIVES:
- To create awareness about IPR and engineering ethics
- To follow professional ethics and practices in their careers
- To create awareness and responsibilities about the environment and society

UNIT I AGREEMENTS, TREATIES AND CONCEPT OF PRIOR ACT
UNIT II  IPR  9

UNIT III  PATENT FILING PROCEDURES  9

UNIT IV  BIOSAFETY  9

UNIT V  GENETICALLY MODIFIED ORGANISMS  9
Definition of GMOs & LMOs – Roles of Institutional Biosafety Committee – RCGM – GEAC etc. for GMO applications in food and agriculture – Environmental release of GMOs – Risk Analysis – Risk Assessment – Risk management and communication – Overview of National Regulations and relevant International Agreements including Cartegana Protocol.

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of this course, the student would be able
- To understand the ethics and responsibility for safety
- To create awareness for the professional responsibilities and rights

REFERENCES

BY5019  BIOPHARMACEUTICALS AND BIOSIMILARS  L T P C
3 0 0 3

OBJECTIVES:
The aim of the course is to give strong foundation and advanced information on
- Core responsibilities for the development and monitoring of the drug and the preparation of medicines according to the norms.
To gain knowledge in physicochemical properties, pharmacology and the formulation of commonly used biopharmaceuticals.

UNIT I  INTRODUCTION

UNIT II  DOSAGE FORMS

UNIT III  ADVANCED DRUG DELIVERY SYSTEMS

UNIT IV  BIOSIMILARS

UNIT V  CASE STUDIES ON BIOPHARMACEUTICALS

OUTCOMES:
The knowledge gained in this course would be used to understand and evaluate different
- Pharmaceutical parameters for the current and future biotechnology related products on the market.
- To acquire knowledge on novel biotechnological and pharmaceutical products, current medicines and their applications in therapeutic and diagnostic fields.
- To demonstrate knowledge and understanding of current topical and newly emerging aspects of pharmaceutical biotechnology.
- Understand the legal steps involved in progressing a new drug to market. Grasping the current regulatory acts and safety norms of the modern pharmaceutical industries.

TOTAL: 45 PERIODS

REFERENCES

BY5020 BIOPROCESS MODELING AND SIMULATION L T P C 3 0 0 3

OBJECTIVES:
- To make the students aware of the overall industrial bioprocess so as to help them to manipulate the process to the requirement of the industrial needs.
- To impart knowledge on design and operation of fermentation processes with all its prerequisites.
- Provide the students with the basics of bioreactor engineering.
- To develop bioengineering skills for the production of biochemical product using integrated biochemical processes.

UNIT I CONCEPTS AND PRINCIPLES 9
Introduction to modelling – Systematic approach to model building – Material and energy balance – Classification of models – General form of dynamic models dimensionless models – General form of linear systems of equations nonlinear function – Conservation principles thermodynamic principles of process systems

UNIT II MODELS 9
Structured kinetic models – Compartmental models (two and three) – Product formation Unstructured models – Genetically structured models – Stochastic model for thermal sterilization of the medium – Modelling for activated sludge process – Model for anaerobic digestion – Models for lactic fermentation and antibiotic production

UNIT III MODELLING OF BIOREACTORS 9
Modelling of non-ideal behaviour in Bioreactors – Tanks-in-series and Dispersion models – Modelling of PFR and other first order processes – Analysis of packed bed and membrane bioreactors Recombinant Cell Culture Processes – Plasmid stability in recombinant Cell Culture limits to over-expression

UNIT IV MONITORING OF BIOPROCESSES 9
On-line data analysis for measurement of important physico-chemical and biochemical parameters – State and parameter estimation techniques for biochemical processes – Biochemical reactors-model equations – Steady-state function – Dynamic behaviour – Linearization – Phase plane analysis – Multiple steady state – Bifurcation behaviour

UNIT V SOLUTION STRATEGIES 9

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of Bioprocess Engineering course graduates will be able to
- Select appropriate bioreactor configurations and operation modes based upon the nature of bio products and cell lines and other process criteria.
• Apply modelling and simulation of bioprocesses so as to reduce costs and to enhance the quality of products and systems.
• Plan a research career or to work in the biotechnology industry with strong foundation about bioreactor design and scale-up.
• Integrate research lab and Industry; identify problems and seek practical solutions for large scale implementation of Biotechnology.

REFERENCES

BY5021 TISSUE ENGINEERING L T P C 3 0 0 3

OBJECTIVES:
To enable the students
• To learn the fundamentals of tissue engineering and tissue repairing
• To acquire knowledge on clinical applications of tissue engineering
• To understand the basic concept behind tissue engineering focusing on the stem cells, biomaterials and its applications

UNIT I FUNDAMENTAL OF TISSUE ENGINEERING

UNIT II BIOMATERIALS FOR TISSUE ENGINEERING

UNIT III DELIVERY OF MOLECULAR AGENTS AND CELL INTERACTIONS WITH POLYMERS
Molecular agents in tissue engineering – Controlled released of agents – Methods, in time and space – Future applications of controlled delivery – Microfluidic systems – Microfluidics and microfluidic devices – Cell interactions – Factors influencing cell interactions – Cell interactions with polymer surfaces and suspension – Cell interactions with three-dimensional polymer.
UNIT IV  POLYMERS AND CONTROLLED DRUG DELIVERY  9

UNIT V  BIOPOLYMER- BASED BIOMATERIALS AS SCAFFOLDS AND STEM CELLS  9
Natural polymers – Structural and chemical properties, scaffold processing, mechanical properties and biodegradability – Biocompatibility and host response – Application of scaffolds in tissue engineering. Use of stem cells in tissue engineering – Embryonic stem cells, mesenchymal stem cells (MSC), adult stem cells, markers for detection of stem cells – Risks with the use of stem cells.

OUTCOMES:
Upon completion of this course, the students would get
- Ability to understand the components of the tissue architecture
- Opportunity to get familiarized with the stem cell characteristics and their relevance in medicine
- Awareness about the properties and broad applications of biomaterials
- Overall exposure to the role of tissue engineering and stem cell therapy in organogenesis

REFERENCES

BY5022  RESEARCH METHODOLOGY IN BIOTECHNOLOGY  L T P C
3 0 0 3

OBJECTIVES:
- To impart the knowledge of various methods of research strategy
- To understand Biotech research constraints and its analysis
- To emphasise the Creativity, Innovation and New Product Development

UNIT I  RESEARCH AND ITS METHODOLOGIES  9
Motivation – Objective and significance of research – Research process – Observation – Axiom – Theory – Experimentation – Types of research (basic, applied, qualitative, quantitative, analytical etc). Features of translational research – Concept of laboratory to market (bench to public) – Industrial R&D.

UNIT II  RESEARCH IN BIOTECHNOLOGY  9
Laboratory policy and procedure of academic research – Types of expertise and facilities required. Technology and product transfer research – Grant funding – Sources of literature – Interdisciplinary nature – Collaboration based research.
UNIT III  EXPERIMENTAL RESEARCH  9

UNIT IV  RESULTS AND ANALYSIS  9
Scientific methodology in recording results – Importance of negative results – Ways of recording – Industrial requirement – Artifacts versus true results – Types of analysis (analytical, objective, subjective) and cross verification – Correlation with published results – Discussion – Hypothesis – Concept – Theory and model.

UNIT V  PUBLISHING SCIENTIFIC AND TECHNICAL PAPERS  9

OUTCOMES:
On completion of the course, students will have gained knowledge on
- Biotechnology research planning and execution and result analysis
- Innovation and New product development
- Issues related to Patents, Quality, Evaluation

REFERENCES

BY5023  BIOFUELS AND PLATFORM CHEMICALS  L T P C
3 0 0 3

OBJECTIVES:
- To impart the knowledge Bioconversion of renewable lignocelluloses biomass to bio fuel and value added products
- To demonstrate a drive towards products benign to natural environment increasing the importance of renewable materials
- To emphasise the development of Biomass an inexpensive feedstock considered sustainable and renewable to replace a wide diversity of fossil based products

UNIT I  INTRODUCTION  9

UNIT II  ETHANOL  9
Ethanol as transportation fuel and additive; bioethanol production from carbohydrates; engineering strains for ethanol production from variety of carbon sources to improved productivity.
UNIT III  BIODIESEL  9
Chemistry and Production Processes; Vegetable oils and chemically processed biofuels; Biodiesel composition and production processes; Biodiesel economics; Energetics of biodiesel production and effects on greenhouse gas emissions; Issues of ecotoxicity and sustainability with; expanding biodiesel production

UNIT IV  OTHER BIOFUELS  9
Biodiesel from microalgae and microbes; biohydrogen production; biorefinery concepts

UNIT V  PLATFORM CHEMICALS  9
Case studies on production of C3 to C6 chemicals such as Hydroxy propionic acid, 1,3 propanediol, propionic acid, succinic acid, glucaric acid, cis-cis muconic acid.

TOTAL: 45 PERIODS

OUTCOMES:
On completion of the course, students will have gained knowledge on
- The use of Biomass an inexpensive feedstock as sustainable and renewable energy
- To replace fossil based products with Biodiesel
- To source other alternate energy such as bio hydrogen and bio refinery

REFERENCE