### SEMESTER – I

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## LIST OF ELECTIVES

### M. TECH. BIOTECHNOLOGY

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UNIT I  BLACK BOX MODEL  9
Yield coefficients, black box stoichiometries, elemental balances, heat balance, degrees of reduction balances, systematic analysis of black box stoichiometries, identification of gross measurement errors.

UNIT II  MODELING OF VARIOUS FERMENTATION PROCESSES  9
Principles of model building for biotechnological processes, unstructured models on the population level, structured models on the cellular level, morphologically structured model, genetically structured models, cytemetic model, modeling of recombinant systems.

UNIT III  DESIGN OF FERMENTATION PROCESSES  9
Kinetics of substrate utilization, biomass growth and product formation, inhibition on cell growth and product formation. Design and operation of continuous cultures, chemostat in series, batch and fed batch cultures, total cell retention cultivation.

UNIT IV  BIOREACTOR DESIGN & CONSTRUCTION  9
Basic design and construction of CSTR, bioreactor design of agitator/agitator motor, power consumption in aerated bioreactor, design of sparger, mixing time estimation, oxygen mass transfer capability in bioreactor, Removal of Heat in bioreactor, Main parameters to be monitored and controlled in fermentation processes.

UNIT V  CASE STUDIES IN FERMENTATION DERIVED PRODUCTS  9
Case studies on Production of green chemicals, algal biofuels, recombinant Insulin. Case studies should deal with medium design, reactor design & process optimization etc.

TEXTS BOOKS

REFERENCES

UNIT I  INTRODUCTION TO COMPUTATIONAL BIOLOGY AND SEQUENCE ANALYSIS  9
Molecular sequences, Genome sequencing: pipeline and data, Next generation sequencing data, Biological databases: Protein and Nucleotide databases, Sequence Alignment, Dynamic Programming for computing edit distance and string similarity, Local and Global Alignment, Needleman Wunsch Algorithm, Smith Waterman Algorithm, BLAST family of programs, FASTA algorithm, Functional Annotation, Progressive and Iterative Methods for Multiple sequence alignment, Applications.
UNIT II  PHYLOGENETICS  7
Introduction to Phylogenetics, Distance and Character based methods for phylogenetic tree construction: UPGMA, Neighbour joining, Ultrametric and Min ultrametric trees, Parsimonous trees, Additive trees, Bootstrapping.

UNIT III  PROTEIN STRUCTURE, MODELLING AND SIMULATIONS  9

UNIT IV  MACHINE LEARNING, SYSTEMS BIOLOGY AND OTHER ADVANCED TOPICS  11

UNIT V  PERL FOR BIOINFORMATICS  9
Variables, Data types, control flow constructs, Pattern Matching, String manipulation, arrays, lists and hashes, File handling, Programs to handle biological data and parse output files for interpretation Laboratory Demonstrations for Biological Databases, Sequence alignment: BLAST family of programs, FASTA, ClustalW for multiple sequence alignment, Phylogenetics software, Homology Modeling and Model evaluation, AutoDock, GROMACS, Prokaryotic and Eukaryotic Gene finding software, Programs in PERL.

TOTAL: 45 PERIODS

TEXT BOOKS
4. Tisdall, James, Beginning PERL for Bioinformatics, O’Reilley Publications, 2001.

REFERENCES

BT8151  APPLIED STATISTICS FOR BIOTECHNOLOGISTS  L T P C  3 1 0 4

OBJECTIVES
This subject will facilitate the students to understand the fundamentals of statistics for biologists.

OUTCOME
On the completion of the course the students are expected to have learnt, Understanding and applying Statistical methods of analysis for Biological applications
UNIT I
Random variable-sample spaces-Events-Axiomatic approach to probability- conditional probability-additional theorem, Multiplication theorem - Baye’s theorem problems-continuous and discrete random variables, Distribution function-Expectation with properties-Moments, mean, Variance problems-for continuous and discrete distributions.

UNIT II
Bivariate distribution-conditional and marginal distribution-Discrete distribution-Binomial, Poisson, geometric distribution-Continuous distribution, Normal, exponential and negative exponential, gamma distributions-simple problems-properties

UNIT III
Correlation coefficient, properties-problems-Rank correlation-Regression equations-problems-curve fitting by the method of least squares-fitting curves of the form ax+b,ax^2+bx+c,ab^ and ax^n- Bivariate correlation application to biological problems

UNIT IV
Concept of sampling-Methods of sampling-sampling distributions and Standard Error-Small samples and large samples-Test of hypothesis-Type I, Type II Errors-Critical region-Large sample tests for proportion, mean-Exact test based on normal , t, f and chi-square distribution-problems-Test of goodness of fit.

UNIT V
Basic principles of experimentation-Analysis of variance-one-way, Two-way classifications-Randomised block design, Latin square design-problems.

TOTAL : 60 PERIODS

TEXT BOOKS
1. Kapoor, V. C. “Elements of Mathematical statistics”.

REFERENCES
2. Arora, P. N. Smeet Arora, and Arora, S. “Comprehensive Statistical Methods”. S. Chand & Co,

BT8152 ENTREPRENEURSHIP, IPR AND BIOSAFETY L T P C 3 0 0 3

UNIT I ENTREPRENEURSHIP
Definition, functions and kinds of entrepreneurs, intrapreneur-entrepreneurship and economic development, entrepreneurial competencies-traits, developing competencies, project identification, selection and financing, Project report- content and significance, Planning Commission’s guidelines for formulating project reports-methods of project appraisals.
UNIT II  INTRODUCTION TO INTELLECTUAL PROPERTY  10
Types of Intellectual property (IP): Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs IP as a factor in R&D; IPs of relevance to Biotechnology Agreements and Treaties
History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments
Case Studies

UNIT III  BASICS OF PATENTS AND CONCEPT OF PRIOR ART  8
Introduction to Patents; Types of patent applications; Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; Forms and fees
Invention in context of “prior art”; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, esp@cenet (EPO), PATENTScope (WIPO), IPO, etc.)

UNIT IV  PATENTING PROCEDURES  7
National & PCT filing procedure; Time frame and cost; Status of the patent applications filed;
Precautions while patenting – disclosure/non-disclosure; Financial assistance for patenting - introduction to existing schemes Patent licensing and agreement Patent infringement-meaning, scope, litigation, case studies

UNIT V  BIOSAFETY  10
Introduction; Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; 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 Cartagena Protocol.

TOTAL : 45 PERIODS

TEXTS/REFERENCES

BT8111  PREPARATIVE AND ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY  L T P C 0 0 6 3
1. Preparation of Acetate, Tris and Phosphate Buffer systems and validation of Henderson-Hasselbach equation.
2. Reactions of amino acids – Ninhydrin, Pthaldehyde, Dansyl chloride – measurement using colorimetric and fluorimetric methods.
3. Differential estimations of carbohydrates – reducing vs non-reducing, polymeric vs oligomeric, hexose vs pentose
4. Estimation of protein concentration using Lowry’s method, Dye-binding method
5. DNA determination by UV-Vis Spectrophotometer – hyperchromic effect Separation of lipids by TLC.
6. Enzyme Kinetics: Direct and indirect assays – determination of $K_m$, $V_{max}$ and $K_{cat}$, $K_{cat}/K_m$
7. Restriction enzyme – Enrichment and unit calculation
8. Ion-exchange Chromatography – Purification of IgG and Albumin
9. Gel filtration – Size based separation of proteins
10. Affinity chromatography – IMAC purification of His-tagged recombinant protein
11. Assessing purity by SDS-PAGE Gel Electrophoresis
12. Chemical modification of proteins – PITC modification of IgG and Protein immobilization

TOTAL : 90 PERIODS

REFERENCES
UNIT I  INTRODUCTION TO BIOSEPARATION  
Characterization of biomolecules and fermentation broth. Guidelines to recombinant protein purification.

UNIT II  SOLID-LIQUID SEPARATION AND CELL DISRUPTION  

UNIT III  CONCENTRATION AND PURIFICATION  
Liquid- liquid extraction – theory and practice with emphasis on Aqueous two phase extraction. Solid liquid extraction. Precipitation techniques using salt and solvent. Separation by ultrafiltration, Dialysis, Electrophoresis.

UNIT IV  CHROMATOGRAPHY  
Theory, practice and selection of media for – Gelfiltration chromatography, Ion exchange chromatography, Hydrophobic interaction chromatography, reverse phase chromatography, Affinity chromatography – Metal affinity chromatography, dye affinity chromatography, immunosorbert affinity chromatography & Expanded bed chromatography. Scaleup criteria for chromatography, calculation of no of theoretical plates and design

UNIT V  FINAL POLISHING AND CASE STUDIES  
Freeze drying, spray drying and crystallization. Purification of cephalosporin, aspartic acid, Recombinant Streptokinase, Monoclonal antibodies, Tissue plasminogen activator, Taq polymerase, Insulin.

TOTAL : 45 PERIODS

REFERENCES
UNIT IV  VACCINE TECHNOLOGY  6
Basic principles of vaccine development; protein based vaccines; DNA vaccines; Plant based vaccines; recombinant antigens as vaccines; reverse vaccinology

UNIT V  DEVELOPMENT OF IMMUNOTHERAPEUTICS  5
Engineered antibodies; catalytic antibodies; idiotypic antibodies; combinatorial libraries for antibody isolation.

TOTAL : 45 PERIODS

REFERENCES

BT8251  ADVANCED GENETIC ENGINEERING  L T P C
                                                   3 0 0 3

OBJECTIVE
This subject provides conceptual knowledge in the Cloning & Expression of genes; Construction of DNA libraries & Sequencing; PCR & mutagenesis; Gene transfer & Gene therapy to students.

OUTCOME
Students will learn advanced molecular methods to help them design and execute complex molecular Biology experiments.

UNIT I  CLONING AND EXPRESSION OF GENES  10

UNIT II  CONSTRUCTION OF DNA LIBRARIES  10

UNIT III  DNA SEQUENCING  8
DNA sequencing – Importance, Chemical & Enzymatic methods, Pyrosequencing, Automated sequence, Genome sequencing methods – top down approach, bottom up approach.

UNIT IV  PCR AND MUTAGENESIS  9
UNIT V  GENE TRANSFER & GENE THERAPY


TOTAL : 45 PERIODS

TEXTS/REFERENCES

BT8211  MICROBIAL AND IMMUNO TECHNOLOGY LAB  L T P C
0 0 6 3

PART I  MICROBIAL TECHNOLOGY
1. Disinfection, safety instructions; Preparation of media and Sterilization
2. Identification and staining of microbes (gram staining, Giemsa etc)
3. Enumeration of microorganisms by serial dilution
4. Growth curve, measure of bacterial population by turbidometry

PART II  IMMUNO TECHNOLOGY
1. Ethics, selection and handling of animals for immunological experiments (Eg. Mice, Rats, Rabbits)
2. Preparation of antigen and Routes of immunisation (Intra-peritonial, Sub-cutaneous, Intra-muscular, Intra-nasal, Oral)
3. Methods of bleeding (Eg. Tail bleeding, Intravenous, intraorbital)
4. Collection of serum, storage and purification of total IgG (salt precipitation).
5. Evaluation of Antibody titre by direct ELISA
6. Evaluation of Antigen by Sandwich ELISA
7. Characterisation of antigens by native, SDS-PAGE
8. Characterisation of antigens by Immunoblotting
9. Conjugation of Immunoglobins (Streptavidin, colloidal gold)
10. Methods for prototype development of Immunodiagnostics (ICT card)
11. Blood smear identification of leucocytes by Giemsa stain
12. Separation of mononuclear cells by Ficoll-Hypaque
13. Separation of spleenocytes and proliferation against mitogens

TOTAL : 90 PERIODS

REFERENCES
Enzyme kinetics, inhibition, factors affecting reaction pH, temp.
Enzyme immobilization studies – Gel entrapment, adsorption and ion exchange immobilisation.
Optimization techniques – Plackett burman, Response surface methodology.
Batch cultivation – recombinant E.coli – growth rate, substrate utilization kinetics, plasmid stability, product analysis after induction, Metabolite analysis by HPLC
Fed batch cultivation E.coli, Pichia pastoris
Continuous cultivation – x - d construction, kinetic parameter evaluation, gas analysis, carbon balancing, Pulse and shift techniques.
Bioreactor studies: Sterilisation kinetics, k_{La} determination, residence time distribution
Animal cell culture production: T-flask, spinner flask, bioreactor
Cell separation methods: Centrifugation and microfiltration
Cell disruption methods: Chemical lysis and Physical methods
Product concentration: Precipitation, ATPS, Ultrafiltration
High resolution purification: Ion exchange, affinity and Gel filtration
Freeze drying

TOTAL : 90 PERIODS

Preparation of Genomic DNA
PCR amplification of gene from the genomic DNA
Preparation of plasmid DNA
Restriction Digestion of the vector and Insert
Ligation and Transformation to E.coli
Lysate PCR confirmation.
Restriction & gel elution of DNA fragments
Electroporation to Yeast
Induction experiments in E.coli using IPTG, salt etc
SDS-PAGE analysis of expression
Western blot confirmation of expressed protein (anti his)
ELISA (anti his) – Quantification of expressed protein.
RNA Isolation
cDNA preparation from RNA
Site directed mutagenesis
Southern hybridization experiment

TOTAL : 90 PERIODS
UNIT I  MICRO ARRAY SINGENOMICS  
Designing and producing microarrays; types of microarrays; cDNA microarray technology; oligonucleotide arrays; Sample preparation, labeling, hybridization, generation of microarray data. Gene Expression analysis by cDNA and oligonucleotide arrays; ChiP-on-Chip; Bioinformatic analysis of large-scale microarray data for comparative transcriptomics.

UNIT II  NEXT GENERATION SEQUENCING TECHNOLOGIES  
Introduction to Next Generation Sequencing (NGS) technologies; Principles of NGS by Roche/454, Illumina, Life Technologies, Pacific Biosciences, Ion Torrent technologies; Applications of NGS to disease diagnosis and personalized medicine.

UNIT III  PROTEIN MICRO ARRAYS  
Types of protein arrays; Protein microarray fabrication; Experimental analysis of proteins arrays. Data acquisition and processing; Applications of protein microarray types.

UNIT IV  TWO-DIMENSIONAL GELELECTRO PHORESIS OF PROTEINS  
Sample preparation, First-dimension IEF with IPG; Second dimensional separation of proteins; Image analysis of 2-DE gels; Protein expression profiling and comparative proteomics of complex proteomes using 2-DE.

UNIT V  MASS-SPECTROMETRY  
Basics of Mass-spectrometry (MS) and bimolecular analysis; Common ionization methods for peptide/protein analysis (MALDI and ESI); Principles of Time of Flight (TOF), Ion Trap (IT), Quadrupole (Q), Fourier Transform-Ion cyclotron Resonance (FT-ICR), and Orbitrap mass analyzers; Collision-Induced Dissociation (CID) of peptides; Analysis of complex protein mixtures using Nano-liquid chromatography (Nano-LC) coupled to Mass-spectrometry analysis; Analysis of metabolites using Gas-chromatography coupled to Mass-spectrometry; Mass-spectrometry analysis of Post-Translational Modifications of proteins (Phosphorylation and glycosylation). Accurate quantitation of peptides and small molecules using SRM/MRM approach.

REFERENCES

UNIT I  CALCULUS  
Calculus (Quick review of concepts): Review of limits, continuity, differentiability; Mean value theorem, Taylor’s Theorem, Maxima and Minima; Fundamental theorem of Calculus; Improper integrals; Applications to area, volume; Convergence of sequences and series; Power series; Partial Derivatives; Gradient and Directional derivatives; Chain rule; Maxima and Minima.
UNIT II DIFFERENTIAL EQUATION AND PARTIAL DIFFERENTIAL EQUATIONS

12

Introduction- Differential Equation and solution-First order, linear differential equation, partial differential equations solution-Various types of partial different equation of the form f(p,q)=0, f(x, p, q)=0, f(x, y, q)=0. Clairaut’s form z=px+qy+f(p,q), Lagrange’s equation Pp+Qq=R. Total differentiation Pdx+Qdy+Rdz=0. Simple Problem application to biology

UNIT III SECOND AND HIGHER ORDER DIFFERENTIAL EQUATIONS

12

Linear ODE's with constant coefficients: the characteristic equations; Cauchy-Euler equations; Linear dependence and Wronskians; Method of undetermined coefficients; Method of variation of parameters; Laplace transforms: Inverse theorem, shifting theorems, partial fractions.

UNIT IV LINEAR ALGEBRA

12

Basics: Vectors, matrices, determinants; Matrix addition and multiplication; Systems of equations: Gauss elimination, Matrix rank, Linear independence, Cramer’s rule; Inverse of a matrix: Gauss-Jordan elimination; Eigenvalues and Eigenvectors: characteristic polynomials, eigenvalues of special matrices(orthogonal, unitary, hermitian, symmetric, skewsymmetric, normal)

UNIT V NUMERICAL METHODS

12

Solution of equations by iteration; Interpolation by polynomials; Piecewise linear and cubic splines; Numeric integration and differentiation; Linear systems: Gauss elimination, Gauss-Siedel, matrix inversion; LU factorization; Matrix eigenvalues; Numerical solution of ODEs: Euler and Runge-Kutta methods, Predictor-Corrector methods; Exposure to software packages like Matlab or Scilab.

TOTAL : 60 PERIODS

TEXTS/REFERENCES


BT8003 BIOFUELS AND PLATFORM CHEMICALS L T P C 3 0 0 3

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 emissionsIssues of ecotoxicity and sustainability with ; expanding biodiesel production

13
UNIT IV OTHER BIOFUELS
Biodiesel from microalgae and microbes; biohydrogen production; biorefinery concepts

UNIT V PLATFORM CHEMICALS
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

REFERENCE

BT8004 BIOPROCESS MODELING AND SIMULATION

OBJECTIVE
To introduce the fundamental aspects of modeling of various biological systems. To address the various modeling paradigms, based on the level of detail, the extent of data available as well as the question the model must address. To outline the applications of such modeling techniques

UNIT I MODELING OF BIOLOGICAL SYSTEMS
Modeling Principles, model development from first principles. Modeling approaches for Biological systems – structured and unstructured systems; Compartment models; Deterministic and stochastic approaches for modeling structured systems.

UNIT II MODELLING OF DIFFUSION SYSTEMS (BIOFILM AND IMMOBILIZED ENZYME SYSTEMS)
External mass transfer, Internal diffusion and reaction within biocatalysts, derivation of finite model for diffusion-reaction systems, dimensionless parameters from diffusion-reaction models, the effectiveness factor concept, case studies; oxygen diffusion effects in a biofilm, biofilm nitrification

UNIT III MODELING BIOREACTOR
Bioreactor modelling: Ideal and non-ideal bioreactors; Stirred tank models; characterization of mass and energy transfer distributions in stirred tanks, Tower Reactor Model; Flow modeling, bubble column flow models, mass transfer modeling, structured models for mass transfer in tower reactors, process models in tower reactors, airlift models,

UNIT IV LINEAR SYSTEM ANALYSIS
Study of linear systems, linearization of non-linear systems; Simulation of linear models using MATLAB; Parameter estimation and sensitivity analysis; Steady state and unsteady state systems; stability analysis; Case study of recombinant protein production.

UNIT V HYBRID AND OTHER MODELING TECHNIQUES
Advanced modeling techniques such as fuzzy logic, neural network, hybrid systems and fuzzy logic systems; case studies.

TOTAL: 45 PERIODS

TEXT BOOKS
REFERENCES

BT8005 BIOREACTOR ENGINEERING L T P C
3 0 0 3

UNIT I TRANSPORT PROCESS IN BIOREACTOR 9
Gas-liquid mass transfer in cellular systems, determination of oxygen transfer rates, mass transfer for freely rising or falling bodies, forced convection mass transfer, Overall kLa estimation and power requirements for sparged and agitated vessels, mass transfer across free surfaces, other factors affecting kLa, non Newtonian fluids, Heat transfer correlations, thermal death kinetics of microorganisms, batch and continuous heat, sterilisation of liquid media, filter sterilisation of liquid media, Air. Design of sterilisation equipment batch and continuous.

UNIT II MONITORING OF BIOPROCESSES 6
On-line data analysis for measurement of important physico-chemical and biochemical parameters; Methods of on-line and off-line biomass estimation; microbial calorimetry; Flow injection analysis for measurement of substrates, product and other metabolites; State and parameter estimation techniques for biochemical processes. Case studies on applications of FIA and Microbial calorimetry.

UNIT III MODERN BIOTECHNOLOGICAL PROCESSES 14
Recombinant cell culture processes, guidelines for choosing host-vector systems, plasmid stability in recombinant cell culture, limits to over expression, Modelling of recombinant bacterial cultures; Bioreactor strategies for maximising product formation; Case studies on high cell density cultivation and plasmid stabilization methods. Bioprocess design considerations for plant and animal cell cultures. Analysis of multiple interacting microbial populations – competition:survival of the fittest, predation and parasitism: Lotka Volterra model.

UNIT IV DESIGN AND ANALYSIS OF BIOLOGICAL REACTORS 11
Ideal bioreactors-batch, fed batch, continuous, cell recycle, plug flow reactor, two stage reactors, enzyme catalyzed reactions. Reactor dynamics and stability. Reactors with non ideal mixing. Other types of reactors- fluidized bed reactors, packed bed reactors, bubble column reactors, trickle bed reactors.

UNIT V SCALEUP OF REACTORS 5
Scaleup by geometry similitude, oxygen transfer, power correlations, mixing time

TOTAL : 45 PERIODS

REFERENCES
3. Lee, James M. Biochemical Engineering, PHI, USA.
UNIT I  FLUID DYNAMICS

UNIT II  BASIC NUMERICS
Mathematical behavior of hyperbolic, parabolic and elliptic equations. Well posedness. Discretization by finite differences. Analysis of discretized equations; order of accuracy, convergence, and stability (von Neumann analysis). Numerical methods for model equations related to different levels of approximation of Navier Stokes equation: linear wave equation, Burgers equation, convection-diffusion equation. First and second order numerical methods such as upwind, Lax-Friedrichs, Lax-Wendroff, MacCormack, etc. Modified equation - dissipation and dispersion.

UNIT III  COMPRESSIBLE FLOW

UNIT IV  FINITE VOLUME AND FINITE DIFFERENCE METHODS

UNIT V  FINITE ELEMENTS

TOTAL : 45 PERIODS

REFERENCES
2. K.A. Hoffman and S. Chiang, Computational fluid dynamics for scientists and engineers, engineering education system.
UNIT I  
Computation and Error Analysis. Linear Systems and Equations: Matrix representation; Cramer's rule; Gauss Elimination; Matrix Inversion; LU Decomposition; Iterative Methods; Relaxation Methods; Eigen Values.

UNIT II  
Bracketing methods: Bisection, Reguli-Falsi; Open methods: Secant, Fixed point iteration, Newton-Raphson; Multivariate Newton’s method. Regression and Curve Fitting, Linear regression; Least squares; Total Least Squares; Interpolation; Newton’s Difference Formulae; Cubic Splines.

UNIT III  
Numerical Differentiation, higher order formulae. Integration and Integral Equations, Trapezoidal rules; Simpson's rules; Quadrature.

UNIT IV  
ODEs: Initial Value Problems - Euler's methods; Runge-Kutta methods; Predictor-corrector methods; Adaptive step size; Stiff ODEs.

UNIT V  

Note: In practical MATLAB will be used and applications of these computational techniques in bioprocess starting from simple enzyme kinetics to parameter estimation in bioprocess modelling will be given as examples.

TOTAL : 45 PERIODS

BT8008  COMPUTER AIDED LEARNING OF STRUCTURE AND FUNCTION OF PROTEINS  L T P C  3 0 0 3

UNIT I COMPONENTS OF PROTEIN STRUCTURE  
Introduction to Proteins, structure and properties of amino acids, the building blocks of Proteins, Molecular Interactions and their roles in protein structure and function, Primary Structure – methods to determine and synthesis.

UNIT II PROTEIN BIOINFORMATICS  
Protein sequence and structural databases, Multiple sequence alignment, Secondary, Tertiary and Quaternary Structure of Proteins; Sequence and Structural Motifs; Protein folding.

UNIT III OVERVIEW OF STRUCTURAL AND FUNCTIONAL PROTEINS  

UNIT IV PROTEIN STRUCTURAL CLASSIFICATION DATABASES  
SCOP and CATH. Evolutionary relationships and Phylogenetic Studies.
UNIT IV  PROTEIN MODIFICATIONS
Post translational modifications, Engineering of proteins, Site directed mutagenesis, Fusion Proteins, Chemical derivatization.

TOTAL : 45 PERIODS

REFERENCES

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OBJECTIVE
The proposed course is designed to teach students the scientific and engineering principles of microbiological treatment technologies to clean up contaminated environments and to generate valuable resources for the human society. Conventional treatment methodologies can be replaced with the advancements in biotechnological field such as molecular biology and genetic engineering strategies will be taught to the students. Also this study paves the way for the alternate sources of energy to avoid environmental issues.

UNIT I
Microbial flora of soil, Ecological adaptations, Interactions among soil microorganisms, biogeochemical role of soil microorganisms. Biodegradation, Microbiology of degradation and its mechanism, Bioaugmentation, Biosorption, Bioleaching, Bioremediation- Types of Bioremediation, Bioreactors for Bioremediation, Metabolic pathways for Biodegradation for specific organic pollutants.

UNIT II
Pollution- Sources of pollutants for Air, Water (ground water, marine), Noise, Land and its characteristics- Pollution control and management- Environmental monitoring & sampling, Physical, chemical and biological methods and analysis- Air pollution- control and treatment strategies. Modes of Biological treatment methods for wastewater- aerobic digestion, anaerobic digestion, Anoxic digestion, the activated sludge process, Design and modeling of activated sludge processes, Aerobic digestion, Design of a trickling biological filter, Design of anaerobic digester.

UNIT III

UNIT IV
Molecular biology tools for Environmental management, rDNA technology in waste treatment, Genetically modified organisms in Waste management, Genetic Sensors, Metagenomics, Bioprospecting, Nanoscience in Environmental management, Phytoremediation for heavy metal pollution, Biosensors development to monitor pollution.

Attested

[Signature]
DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025
UNIT V
Alternate Source of Energy, Biomass as a source of energy, Biocomposting, Vermiculture, Biofertilizers, Organic farming, Biofuels, Biominalization, Bioethanol and Biohydrogen, Bio-electricity through microbial fuel cell, energy management and safety.

TOTAL : 45 PERIODS

TEXT BOOKS
5. Environmental Biotechnology by Alan Scragg (1999); Longman.

REFERENCES

BT8010 FOOD PROCESSING AND BIOTECHNOLOGY L T P C 3 0 0 3

UNIT I FOOD CHEMISTRY
Constituent of food – contribution to texture, flavour and organoleptic properties of food; food additives – intentional and non-intentional and their functions; enzymes in food processing.

UNIT II FOOD MICROBIOLOGY
Sources and activity of microorganisms associated with food; food fermentation; food chemicals; food borne diseases – infections and intoxications, food spoilage – causes.

UNIT III FOOD PROCESSING
Raw material characteristics; cleaning, sorting and grading of foods; physical conversion operations – mixing, emulsification, extraction, filtration, centrifugation, membrane separation, crystallization, heat processing.
UNIT IV FOOD PRESERVATION 9
Use of high temperatures – sterilization, pasteurization, blanching, asceptic canning; frozen storage – freezing curve characteristics. Factors affecting quality of frozen foods; irradiation preservation of foods

UNIT V MANUFACTURE OF FOOD PRODUCTS 9
Bread and baked goods, dairy products – milk processing, cheese, butter, ice-cream, vegetable and fruit products; edible oils and fats; meat, poultry and fish products; confectionery, beverages.

REFERENCES
2. Sivasankar B. Food processing and preservation, Prentice Hall of India Pvt.Ltd., New Delhi, 2002

BT8011 PHARMACEUTICAL BIOTECHNOLOGY L T P C 3 0 0 3
UNIT I INTRODUCTION 8
History of pharmaceutical industry, Drugs discovery and Development phases; Drugs and Cosmetics ACT and regulatory aspects; Definition: Generics and its advantages; Biogenerics and Biosimilars; The role of patents in the drug industry; Protein-based biopharmaceuticals; International Non-proprietary Names (INN) nomenclature system biosimilars regulation

UNIT II DOSAGE FORM: SCIENCE, PHARMACOKINETICS AND PHARMACODYNAMICS 10
Definition of Dosage forms, Classification of dosage forms (solid unit dosages – Tablets, capsules; liquids – solutions, lotions, suspension etc; semi-solid – ointments, creams, gel, suppositories, etc; Parenterals, Aerosols etc), Introduction to pharmacokinetics and pharmacodynamic principles (factors affecting the ADME process); bioavailability, bioequivalence.

UNIT III DRUG DELIVERY AND CHARACTERISATION OF BIOGENERIC RECOMBINANTS 9
Advanced drug delivery systems – controlled release, transdermals, liposomes and drug targeting. Approaches to the characterization of biosimilars; Problems in characterizing biologics (Types of biologic, Peptides, Non-glycosylated proteins, Glycosylated proteins, Monoclonal antibodies); Equivalence issues; Post-translational modifications; Effect of microheterogeneity.

UNIT IV PHARMACOLOGY PRINCIPLES, CLASSIFICATION OF DRUGS AND MECHANISM 10
Understanding principles of pharmacology, pharmacodynamics Study of a few classes of therapeutics like laxatives, antacids and drugs used in peptic ulcers, drugs used in coughs and colds, analgesics, contraceptives, antibiotics (folate inhibitors, protein synthesis inhibitors, DNA inhibitors), hormonal agonists and antagonists.
UNIT V CASE STUDIES ON BIOPHARMACEUTICAL PRODUCT DEVELOPMENT

Erythropoietin, Insulin, Somatotropin, Interleukin-2, Interferon Granulocyte- macrophage-CSF, Factor VIIa, Factor IX, Factor VIII, Tissue plasminogen activator, Monoclonal antibodies and engineered Mabs

TOTAL : 45 PERIODS

REFERENCES

BT8013 PLANT DESIGN AND PRACTICE

UNIT I PLANT DESIGN 12
Fermenter design, vessels for Biotechnology, piping and valves for biotechnology, Pressure relief system. Materials of construction and properties. Utilities for plant and their design introduction

UNIT II PROCESS ECONOMICS 8
General fermentation process economics, materials usage and cost, capital investment estimate, production cost estimate. Two case studies – one traditional product and one recombinant product.

UNIT III PHARMACEUTICAL WATER SYSTEM 7
Grades of water, sanitary design, water treatment system, Water distribution system, validation

UNIT IV VALIDATION OF BIOPHARMACEUTICAL FACILITIES 8
Introduction, why validation, when does validation occur, validation structure, resources for validation, validation of systems and processes including SIP and CIP

UNIT V GOOD MANUFACTURING PRACTICES 10
Structure – quality management, personnel, premises and equipment, documentation, production, quality control, contract manufacturing and analysis, complaints and product recall, self inspection. GLP and its principles.

TOTAL: 45 PERIODS

REFERENCES

BT8014 SENSORS AND INSTRUMENTATION FOR BIOAPPLICATIONS

UNIT I 9
Basic concepts in molecular interactions – types of forces involved (electrostatic, H-bonding, hydrophilic and hydrophobic), characterization of molecular recognition – affinity, avidity, binding and dissociation constants; basic design and characterization of sensor instrumentation - precision, sensitivity, resolution and specificity, errors and standard deviation, linear regression analysis.
UNIT II
Basic concepts in instrumentation: Basic concepts of circuit elements (resistors, capacitors, conductors, diodes and transistors), Integrated Circuits; Measurement devices: AC, DC Voltmeter, Ammeter, LCR Bridge, Oscilloscope.

UNIT III
Working principles of commonly used instrumentation in bioanalysis – gravimetric, optical - microscopic, spectrophotometric, spectrofluorimetric, luminometric; electrochemical; high-throughput devices: microplate readers, biochemical autoanalyzers, thermocyclers, microarray readers.

UNIT IV

TOTAL : 45 PERIODS

REFERENCES

BT8015 UNIX OPERATING SYSTEM AND PROGRAMMING LANGUAGE C++

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UNIT I UNIX Operating System
Introduction to Operating Systems, Basic Commands in Unix, vi editor, filters, input/output redirection, piping, transfer of data between devices, shell scripts.

UNIT II INTRODUCTION TO C++
Programming methodologies- Introduction to Object Oriented Programming - Comparison of Procedural and Object Oriented languages - Basics of C++ environment, Data types, Control Flow Constructs, Library functions, Arrays

UNIT III CLASSES
Definition-Data members-Function members-Access specifiers-Constructors-Default constructors-Copy constructors-Destructors-Static members- This pointer- Constant members- Free store operators- Control statements

UNIT IV INHERITANCE AND POLYMORPHISM
Overloading operators- Functions- Friends- Class derivation-Virtual functions-Abstract base classes-Multiple inheritance.

UNIT V TEMPLATES AND FILE HANDLING
Class templates-Function templates-Exception handling- File Handling

Lab: Exercises for all the topics.

TOTAL : 45 PERIODS
REFERENCES

BT8072 BIOCATALYSTS AND ENZYME TECHNOLOGY L T P C 3 0 0 3

OBJECTIVES
The course intends to give advanced knowledge about Biocatalysts, Enzyme kinetics, immobilization and enzymatic biotransformation of drugs.

OUTCOME
The students will acquire knowledge in all aspect of Biocatalysis, enzyme kinetics and immobilization. The enzymatic transformation will give theoretical idea about drug biotransformation.

UNIT I BASICS OF ENZYMES AS BIOCATALYSIS
Introduction to enzymes, Classification, Sources, Mechanism of enzyme action. Strategies of purification of enzymes, criteria of purity, molecular weight determination and characterization of enzymes, Enzymes of biological importance - Acetylcholinesterase, angiotensin converting enzyme (ACE), ACE Inhibitors, HMG Co A reductase inhibitors, pseudocholinesterase, 5'-nucleotidase (5NT), glucose-6-phosphate dehydrogenase (GPD), CKisoforms, immunoreactive trypsinogen (IRT) and chymotrypsin; amylase isoenzymes

UNIT II KINETICS OF ENZYME ACTION

UNIT III IMMOBILIZED ENZYMES
Techniques of enzyme immobilization; kinetics of immobilized enzymes, effect of solute,partition & diffusion on the kinetics of immobilized enzymes, design and configuration of immobilized enzyme reactors; applications of immobilized enzyme technology, Economic argument for immobilization

UNIT IV ENZYMES IN FUNCTIONAL GROUP TRANSFORMATION
Functional group interconversion using enzymes (hydrolysis reaction, oxidation/reduction reactions, C-C bond formations), Retrosynthetic biocatalysis, Chemoenzymatic synthesis of natural products. Industrial process using enzymes for production of drugs, fine chemicals and chiral intermediates.

UNIT V ENZYMATIC TRANSFORMATION
Reaction engineering for enzyme-catalyzed biotransformations. Catalytic antibodies. Biocatalysts from extreme Thermophilic and Hyperthermophilic microorganisms (extremozymes). The design and construction of novel enzymes, artificial enzymes, Biotransformation of drugs (hydroxylation of Steroids), Host Guest Complexation chemistry, enzyme design using steroid templates, enzymes for production of drugs, fine chemicals and chiral intermediates.

TOTAL: 45 PERIODS

TEXTS/REFERENCES
1. Blanch, H.W., Clark, D.S. Biochemical Engineering, Marcel Dekker, 1997

BP8071 CLINICAL TRIALS AND BIOETHICS L T P C

OBJECTIVES
The course will provide Fundamental ethical to Advanced clinical trial management including drug development and trial planning; Project management in clinical trials; Consent and data protection; Quality assurance and governance.

OUTCOME
The students will acquire knowledge in all aspect of clinical trials, management and ethical standards required to conduct clinical trials.

UNIT I INTRODUCTION TO CLINICAL TRIALS
Fundamentals of clinical trials; Basic statistics for clinical trials; Clinical trials in practice; Reporting and reviewing clinical trials; Legislation and good clinical practice - overview of the European directives and legislation governing clinical trials in the 21st century; International perspectives; Principles of the International Committee on Harmonisation (ICH)-GCP.

UNIT II REGULATIONS OF CLINICAL TRIALS
Drug development and trial planning - pre-study requirements for clinical trials; Regulatory approvals for clinical trials; Consort statement; Trial responsibilities and protocols - roles and responsibilities of investigators, sponsors and others; Requirements of clinical trials protocols; Legislative requirements for investigational medicinal products.

UNIT III MANAGEMENT AND ETHICS OF CLINICAL TRIALS
Project management in clinical trials - principles of project management; Application in clinical trial management; Risk assessment; Research ethics and Bioethics - Principles of research ethics; Ethical issues in clinical trials; Use of humans in Scientific Experiments; Ethical committee system including a historical overview; the informed consent; Introduction to ethical codes and conduct; Introduction to animal ethics; Animal rights and use of animals in the advancement of medical technology; Introduction to laws and regulation regarding use of animals in research.

UNIT IV INFORMED CONSENT
Consent and data protection- the principles of informed consent; Consent processes; Data protection; Legislation and its application; Data management – Introduction to trial master files and essential documents; Data management.

UNIT V QUALITY CONTROL AND GUIDELINES
Quality assurance and governance - quality control in clinical trials; Monitoring and audit; Inspections; Pharmacovigilance; Research governance; Trial closure and pitfalls-trial closure; Reporting and legal requirements; Common pitfalls in clinical trial management.

TOTAL : 45 PERIODS
REFERENCES
1. Lee, Chi-Jen; et al., “Clinical Trials or Drugs and Biopharmaceuticals.” CRC / Taylor & Francis, 2011.

OBJECTIVES
The course will provide advanced information on molecular pathogenesis of infectious diseases.

OUTCOME
The subject will help the student towards understanding the virulence of the pathogen and Host-parasite interactions for advanced academic and industrial research in molecular pathogenesis.

UNIT I INTRODUCTION
5 Discovery of microscope, Molecular Koch’s postulates, Concepts of disease, Virulence, Pathogenic cycle, Vaccines and its historical perspective, Biofilms, quorum sensing, multidrug resistance.

UNIT II HOST DEFENSE AGAINST PATHOGENS AND BACTERIAL DEFENSE STRATEGIES
10 Skin, mucosa, cilia secretions, physical movements, physical and chemical barriers to bacterial colonisation, Mechanism of killing by humoral and cellular defenses, Complement, Inflammatory process, Phagocytosis, Colonization, Adherence, Iron acquisition mechanisms, Bacterial defense strategies.

UNIT III MOLECULAR MECHANISMS OF VIRULENCE
10 Virulence, Colonization factors, Microbial toxins, Secretion systems: General secretory pathway, Two-step secretion, Contact dependent secretion, Conjugal transfer system and Autotransporters.

UNIT IV MECHANISMS UNDERLYING MOLECULAR PATHOGENESIS (COMMON ENTERIC PATHOGENS)

UNIT V MECHANISMS UNDERLYING MOLECULAR PATHOGENESIS (COMMON NON-ENTERIC PATHOGENS)
10 Mycobacterium tuberculosis: The Mycobacterial cell envelope, Route of entry, Uptake by macrophages, Latency and persistence, Entry into and survival in phagocytes, Immune response against MTB, MTB virulence factors, Emergence of resistance. Influenza virus: Intracellular stages, Neuraminidase and Haemagglutinin in entry, M1 & M2 proteins in assembly and disassembly, action of amantadine. Plasmodium: Lifecycle, erythrocyte stages, transport mechanism and processes to support the rapidly growing schizont, parasitophorous vacuoles and knob protein transport, Antimalarials based on transport processes.
TEXTS/REFERENCES
2. Groisman, “Principles of Bacterial Pathogenesis”.
3. Waksman, Gabriel and Michael caparon “Structural Biology of Bacterial Pathogenesis”.
4. Clark, Virginia L. “Bacterial Pathogenesis”
5. Williams, Peter “Bacterial Pathogenesis” (Methods in Microbiology)
6. Mc Clane, Bruce A. “Microbial Pathogenesis”
7. Madigan, Michael T. “Biology of Microorganisms”
8. Stanley, “Genetic analysis of Pathogenic Bacteria”.
9. Hacker, Jorg “Molecular Infection Biology”

BT8073 COMMUNICATION SKILL DEVELOPMENT   L T P C
20 23

OBJECTIVES
To enhance the overall capability of students and to equip them with the necessary communication and soft skills to enable them to excel in their profession

OUTCOME
The course will enhance soft skills and interpersonal skills, which will make their transition from college to work place smoother and help them excel in their job.

UNIT I PROCESS OF COMMUNICATION
Concept of effective communication- Setting clear goals for communication; Determining outcomes and results; Initiating communication; Avoiding breakdowns while communicating; Creating value in conversation; Barriers to effective communication; Non verbal communication- Interpreting non verbal cues; Importance of body language, Power of effective listening; recognizing cultural differences

UNIT II PRESENTATION SKILLS
Formal presentation skills; Preparing and presenting using Over Head Projector, Power Point; Defending Interrogation; Scientific poster preparation & presentation; Participating in group discussions

UNIT III TECHNICAL WRITING SKILLS
Types of reports; Layout of a formal report; Scientific writing skills: Importance of communicating Science; Problems while writing a scientific document; Plagiarism; Scientific Publication Writing: Elements of a Scientific paper including Abstract, Introduction,Materials & Methods, Results, Discussion, References; Drafting titles and framing abstracts

UNIT IV COMPUTING SKILLS FOR SCIENTIFIC RESEARCH
Web browsing for information search; search engines and their mechanism of searching; Hidden Web and its importance in Scientific research; Internet as a medium of interaction between scientists; Effective email strategy using the right tone and conciseness

UNIT V RESUME / REPORT PREPARATION / LETTER WRITING
Students prepare their own resume and report, Presentation- Students make presentations on given topics, Group Discussion- Students participate in group discussions, and Interview Skills- Students participate in Mock Interviews

REFERENCE
OBJECTIVES
The course intends to give advanced theoretical knowledge on genomic organization and Genomic methods like microarray and transcriptome analysis.

OUTCOME
The students will acquire knowledge in advanced molecular methods to carry out cutting edge academic and industrial research.

UNIT I ORGANIZATION AND STRUCTURE OF GENOMES
General organization and structure of genomes of viruses, prokaryotes, eukaryotes, and organelles (chloroplast, mitochondrion).

UNIT II GENOME MAPPING AND SEQUENCING
Isolation and cloning of genomic DNA, Genome mapping (genetic and physical), STS assembly, ESTs, RAPDs, RFLPs, AFLPs, SSLPs, SNPs, linkage analysis, Restriction mapping, FISH, Chromosome painting, microsatellites, Gene finding, annotation, ORF and functional prediction, Chain termination and chemical degradation sequencing methods, Whole genome shot-gun sequencing.

UNIT III LARGE SCALE GENOMICS/ FUNCTIONAL GENOMIC ANALYSES
Genome-wide association (GWA) analysis; Comparative Genomic Hybridization (CGH); Serial Analysis of Gene Expression (SAGE); Massively parallel Signature Sequencing (MPSS); Analysis of alteration in gene expression by Differential Display and Suppression Subtractive Hybridization. Introduction to Next Generation Sequencing (NGS) technologies for genome sequencing.

UNIT IV MICROARRAY TECHNOLOGY AND ANALYSIS
Designing and producing microarrays; cDNA microarray technology; oligonucleotide arrays and designs; Sample preparation, labeling, hybridization, generation and analysis of microarray data.

UNIT V HIGH-THROUGHPUT TRANSCRIPTOMICS ANALYSES
Gene Expression analysis by cDNA and oligonucleotide arrays; Methylome analysis using microarray; ChIP-on-Chip; Bioinformatic analysis of large-scale microarray data for comparative transcriptomics: Data normalization; Cluster analysis; Significance Analysis of Microarrays (SAM); Gene Ontology and Pathway analysis.

TOTAL: 45 PERIODS

TEXTS/REFERENCES
OBJECTIVES
To familiarize the student with quantitative approaches for analyzing cellular metabolism and the use of theoretical and experimental tools that can give insights into the structure and regulation of metabolic networks. A central aspect of the course is to identify the optimal strategy for introducing directed genetic changes in the microorganisms with the aim of obtaining better production strains. Case studies will be taken up on metabolically-engineered products and processes in various expression systems.

OUTCOME
This course work will provide essential knowledge for the students to make their career in bioprocess Industries.

UNIT I METABOLIC FLUX ANALYSIS
Introduction to metabolic engineering, comprehensive models of cellular reactions with stoichiometry and reaction rates; metabolic flux analysis of exactly/over/under determined systems. Shadow price, sensitivity analysis.

UNIT II TOOLS FOR EXPERIMENTALLY DETERMINING FLUX THROUGH PATHWAYS
Monitoring and measuring the metabolome, Methods for the experimental determination of metabolic fluxes by isotope labeling metabolic fluxes using various separation-analytical techniques. GC-MS for metabolic flux analysis, genome wide technologies: DNA /phenotypic microarrays and proteomics.

UNIT III CONSTRAINT BASED GENOMIC SCALE METABOLIC MODEL
Development of Genomic scale metabolic model, Insilico Cells:studying genotype-phenotype relationships using constraint-based models, case studies in E. coli, S.cerevisiae metabolic network reconstruction methods, optimization of metabolic network, Identification of targets for metabolic engineering; software and databases for genome scale modeling

UNIT IV METABOLIC CONTROL ANALYSIS AND KINETIC MODELING
Fundamental of Metabolic Control Analysis, control coefficients and the summation theorems, Determination of flux control coefficients. Multi-substrate enzyme kinetics, engineering multifunctional enzyme systems for optimal conversion, and a multi scale approach for the predictive modeling of metabolic regulation.

UNIT V CASE STUDIES IN METABOLIC ENGINEERING
Metabolic engineering examples for bio-fuel, bio-plastic and green chemical synthesis. Study of genome scale model in various systems for the production of green chemicals using software tools. Validation of the model with experimental parameters.

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES
OBJECTIVES
The course will provide advanced knowledge in the field of Nanobiology and Nanomedicine.

OUTCOME
After the completion of the course, the students would have learnt advanced theoretical knowledge in nano science and its application in new bioconjugation and nano delivery system to carry out cutting edge research in future.

UNIT I  NANO SCALES

UNIT II  PROPERTIES AND MEASUREMENTS OF NANOMATERIALS
Optical Properties – Absorption and Fluorescence – Microscopy measurements – SEM – TEM - AFM and STM. Confocal and TIRF. Imaging

UNIT III  NANO BIOLOGY

UNIT IV  BIOCONJUGATION OF NANOMATERIALS TO BIOLOGICAL MOLECULES
Reactive Groups on biomolecules (DNA & Proteins) - Conjugation to nanoparticles (ZnS-Fe₃O₄) - Uses of Bioconjugated Nanoparticles

UNIT V  NANO DRUG DELIVERY

PRACTICALS
1. Preparation of Silver Nanoparticles by Chemical Methods
2. Characterization of ZnS nanoparticles by Optical Methods.
3. Templated Synthesis of Fe₃O₄ Nanoparticles
4. AFM of ZnS nanoparticles.
5. SEM & HRTEM Analysis of silver and Fe₃O₄ Nanoparticles
7. Confocal & TIRF Microscopy of ZnS particles Interaction with Cell lines

TOTAL: 45 PERIODS

TEXTS/REFERENCES
OBJECTIVES
The course intends to give advanced theoretical knowledge on advanced proteomics and Mass Spectroscopy analysis.

OUTCOME
The students will acquire knowledge in advanced Protein methods to carry out cutting edge academic and industrial research.

UNIT I PROTEOMICS AND BIOLOGICAL MASS-SPECTROMETRY
Over-view of strategies used for the identification and analysis of proteins; Basics of Mass-spectrometry (MS) and bimolecular analysis; One-dimensional (1-D) polyacrylamide gel electrophoresis (PAGE) of proteins; Enzymatic cleavage of proteins in solution; In-gel digestion of protein bands; Electrophoretic transfer of proteins on to membranes (PVDF).

UNIT II MASS-SPECTROMETRY IN PROTEOMICS
Common ionization methods for peptide/protein analysis (MALDI and ESI); Principles of Time of Flight (TOF), Ion Trap (IT), Quadrupole (Q), Fourier Transform-Ion cyclotron Resonance (FT-ICR), and Orbitrap mass analyzers; Collision-Induced Dissociation (CID) of peptides; Introduction to Ion detectors.

UNIT III SEPARATION AND PROCESSING OF PROTEINS FOR PROTEOMIC ANALYSIS
Protein extraction from biological samples (Mammalian Tissues, Yeast, Bacteria, and Plant Tissues); 2-DE of proteins for proteome analysis; Difference in-gel electrophoresis (Dige); Liquid chromatography separations in proteomics (Affinity, Ion Exchange, Reversed-phase, and size exclusion); Strategies for multidimensional liquid chromatography in proteomics; Analysis of complex protein mixtures using Nano-liquid chromatography (Nano-LC) coupled to Mass-spectrometry analysis.

UNIT IV COMPARATIVE AND QUANTITATIVE PROTEOMICS
Rapid identification of Bacteria based on spectral patterns using MALDI-TOF-MS. Comparative proteomics based on global in-vitro and in-vivo labeling of proteins/peptides followed by Mass-spectrometry analysis: ICAT, iTRAQ, SILAC. Analysis of Post-translational modification (PTM) of proteins; Enrichment and analysis of phospho- and glyco-proteins; Characterization of protein interactions using yeast two-hybrid system, Co-immunoprecipitation followed by MS, and Protein microarrays.

UNIT V PROTEOMICS INFORMATICS
Identification of proteins by PMF and MS/MS data; Database search engines for MS data analysis (Mascot, Sequest, and others); Proteomics informatics strategies for biomarker discovery, analysis of protein functions and pathways. Applications of proteomics (Disease diagnosis, drug development, and plant biotechnology).

TOTAL : 45 PERIODS

TEXTS/REFERENCES

BT8078 RESEARCH AND RESEARCH METHODOLOGY IN BIOTECHNOLOGY  L T P C 3 0 0 3

OBJECTIVES
The course will provide knowledge about the objectives to perform research and for interpretation of data from experimental results and presenting technical publications.

OUTCOME
After the completion of course, students will be able to design, conduct, and interpret research outcomes for academic and industrial research needs.

UNIT I RESEARCH AND ITS METHODOLOGIES (WITH EXAMPLES) 9
Objectives of research; research process – observation, analysis, inference, hypothesis, axiom, theory, experimentation; Types of research (basic, applied, qualitative, quantitative, analytical etc); Features of translational research, the concept of laboratory to market (bench to public) and Industrial R&D.

UNIT II RESEARCH IN BIOTECHNOLOGY – AN OVERVIEW 9
Biological systems and their characteristics that influence the type and outcome of research; Exploratory and product-oriented research in various fields of biotechnology (health, agri, food, industrial etc). Types of expertise and facilities required; Interdisciplinary nature of biotech research; Sources of literature for biotech research.

UNIT III EXPERIMENTAL RESEARCH: BASIC CONCEPTS IN DESIGN AND METHODOLOGY 9
Precision, accuracy, sensitivity and specificity; major experimental variables, biochemical measurements, types of measurements, enzymes and enzymatic analysis, antibodies and immunoassays, instrumental methods, bioinformatics and computation, experimental planning – general guidelines.

UNIT IV RESULTS AND ANALYSIS 9
Importance and scientific methodology in recording results, importance of negative results, different ways of recording, industrial requirement, artifacts versus true results, types of analysis (analytical, objective, subjective) and cross verification, correlation with published results, discussion, outcome as new idea, hypothesis, concept, theory, model etc.

UNIT V SCIENTIFIC AND TECHNICAL PUBLICATION 9
Different types of scientific and technical publications in the area of biotechnology, and their specifications, Ways to protect intellectual property – Patents, technical writing skills, definition and importance of impact factor and citation index; Assignment in technical writing.

TOTAL: 45 PERIODS

TEXT/REFERENCES
OBJECTIVES
The course intends to give advanced theoretical knowledge on tissue engineering, Stem cells and its biological applications

OUTCOME
The students will acquire knowledge in advanced methods to carry out cutting edge academic and industrial research.

UNIT I INTRODUCTION
Introduction to tissue engineering: Basic definition; current scope of development; use in therapeutics, cells as therapeutic agents, cell numbers and growth rates, measurement of cell characteristics morphology, number viability, motility and functions. Measurement of tissue characteristics, appearance, cellular component, ECM component, mechanical measurements and physical properties.

UNIT II TISSUE ARCHITECTURE
Tissue types and Tissue components, Tissue repair, Basic wound healing events, Applications of growth factors: Role of VEGF, Angiogenesis, Basic properties, Cell-Matrix & Cell-Cell Interactions, Control of cell migration in tissue engineering.

UNIT III BIOMATERIALS
Biomaterials: Properties of Biomaterials, Surface, bulk, mechanical and biological properties. Scaffolds & tissue engineering, Types of Biomaterials, biological and synthetic materials, Biopolymers, Applications of biomaterials, Modifications of Biomaterials, Role of Nanotechnology.

UNIT IV BASIC BIOLOGY OF STEM CELLS
Stem Cells: Introduction, Types & sources of stem cell with characteristics: hematopoietic differentiation pathway, Potency and plasticity of stem cells, sources, embryonic stem cells, hematopoietic and mesenchymal stem cells, Stem Cell markers, FACS analysis, Differentiation, Stem cell systems- Liver, neuronal stem cells, cancer stem cells, induced pluripotent stem cells.

UNIT V CLINICAL APPLICATIONS

TOTAL: 45 PERIODS

TEXTS/REFERENCES