# M.TECH. BIOTECHNOLOGY

## SEMESTER I

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## SEMESTER II

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### SEMESTER IV

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**TOTAL NUMBER OF CREDITS : 73**

### LIST OF ELECTIVES

#### SEMESTER – I

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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,ax²+bx+c,ab⁴ and ax⁵- 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:

REFERENCES:

UNIT I
BLACK BOX MODEL
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, cybernetic 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.

TOTAL : 45 PERIODS

TEXTS BOOKS

REFERENCES

BY7102  COMPUTATIONAL BIOLOGY  L T P C
2 0 2 3

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, Parsimonious trees, Additive trees, Bootstrapping.

UNIT III  PROTEIN STRUCTURE, MODELLING AND SIMULATIONS  9
UNIT IV  MACHINE LEARNING, SYSTEMS BIOLOGY AND OTHER ADVANCED
TOPICS
Machine learning techniques: Artificial Neural Networks and Hidden Markov Models:
Applications in Protein Secondary Structure Prediction and Gene Finding, Introduction to
Systems Biology and its applications in whole cell modelling, Microarrays and Clustering
techniques for microarray data analysis, informatics in Genomics and Proteomics, DNA
computing.

UNIT V  PERL FOR BIOINFORMATICS
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
2. David W. Mount Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor
4. Tisdall, James, Beginning PERL for Bioinformatics, O’Reilly Publications, 2001.
5. Andrew R. Leach, Molecular Modeling Principles And Applications, Second Edition,
   Prentice Hall.

REFERENCES
   West Press, 2003
2. Baxevanis A.D. and Oullette, B.F.F. A Practical Guide to the Analysis of Genes and
5. Proteomics from protein sequence to function: Edited by S.R. Pennington and M.J. Dunn,

BY7103  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 and 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
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; IP’s 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), PATENT Scope(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 Backround; 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 Cartegana Protocol.

TOTAL : 45 PERIODS

TEXTS/REFERENCES:

BY7104  ADVANCED GENETIC ENGINEERING  LT P C
3 0 0 3

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  8

TOTAL : 45 PERIODS

REFERENCES

BY7111  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  4
Characterization of biomolecules and fermentation broth. Guidelines to recombinant protein purification.

UNIT II  SOLID-LIQUID SEPARATION AND CELL DISRUPTION  6

UNIT III  CONCENTRATION AND PURIFICATION  7
Liquid- liquid separation – 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  15
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  13
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

BY7203 ANIMAL BIOTECHNOLOGY LT P C
3 0 0 3

UNIT I INTRODUCTION 4
Scope of Animal Biotechnology, Animal Biotechnology for production of regulatory proteins, blood products, vaccines, hormones and other therapeutic proteins.

UNIT II MOLECULAR BIOLOGY 9
Biology of animal viral vectors- SV40, adeno virus, retrovirus, vaccinia virus, herpes virus, adeno associated virus and baculo virus.

UNIT III CELL CULTURE TECHNOLOGY 11
Culturing of cells, primary and secondary cell lines, Cell culture-Scaling up of animal cell culture-monlayer culture, suspension culture; Various bio-reactors used for animal cell culture-Roller bottle culture; Bioreactor process control, stirred animal cell culture, Air-lift fermentor, Chemostat/Turbidostat; High technology vaccines; Hybridoma technology; Cell lines and their applications

UNIT IV GENETIC ENGINEERING 11
Gene therapy-prospects and problems; Knock out mice and mice model for human genetic disorder; Baculo virus in biocontrol; Enzymes technology, Somatic manipulation of DNA, Nucleic acid hybridization and probes in diagnosis- preparation of probes, evaluation and applications.

UNIT V APPLICATIONS 10
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 animals (Mice, Cows, Pigs, Sheep, Goat, Birds and Insects); Artificial insemination and embryo transfer.

TOTAL : 45 PERIODS

REFERENCES
5. Freshney R.I. Animal Cell Culture- a practical approach, 1987
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

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

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, kLa 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
REFERENCES

REFERENCES
4. Lehninger’s Principles of Biochemistry, 4th Edn, by David L. Nelson and Michael M. Cox,
6. Introduction to General, Organic, and Biochemistry, 8th Edition Morris Hein, Leo
8. An Introduction to Molecular Biotechnology: Molecular Fundamentals, Methods and Applications in Modern Biotechnology Michael Wink (Editor) 2006, John Wiley & Sons Publishers, Inc

BY7002 BIOLOGY FOR CHEMICAL ENGINEERS

UNIT I INTRODUCTION TO BIOLOGICAL MOLECULES
Basic Carbon Chemistry, Types of biomolecules, Molecular structure and function of Biological Macromolecules - Proteins, Nucleic acids, Carbohydrates, Lipids

UNIT II GENES TO METABOLIC END-PRODUCTS
Basics of DNA replication, transcription, translation, biocatalysis, pathways and metabolism

UNIT III MOLECULAR CELL BIOLOGY AND ENERGETICS
Functional organization of cells at molecular level; membranes, molecular communication across membranes, energetics – proton motive force, ATP synthesis, respiration; photosynthesis

UNIT IV MOLECULAR BASIS OF MICROBIAL FORMS AND THEIR DIVERSITY
Structural differences between different microbial cell types; over view of primary and secondary metabolism of microbes, commercial products like antibiotics, vitamins from microbes

UNIT V MOLECULAR BASIS OF HIGHER LIFE FORMS
Molecular differences between various eukaryotic cell types, tissue proteins, blood, important molecular components of blood, albumin, antibodies, hormones and their actions

TOTAL : 45 PERIODS
BY 7003 APPLIED MATHEMATICS FOR BIOTECHNOLOGISTS

UNIT I  9
First order and second order-application to biology. Lagrange’s method and Charpits method.

UNIT II  9

UNIT III  9
Curve fitting – fitting a straight line and second degree curve. Correlation and Regression. Fitting a non linear curve. Bivariate correlation application to biological sciences.

UNIT IV  9
Sampling distributions- Large samples and Small samples. Testing of Null hypothesis- Z test, t test and χ² test. Type I and Type II errors. Fisher’s F Test. Goodness of fit.

UNIT V  9

TOTAL : 45 PERIODS

TEXT BOOKS
2. Comprehensive Statistical Methods By P.N.Arora, Sumeet Arora, S.Arora. S.Chand & Co

REFERENCES
2. Statistical Quality control for the Food Industry. By MERTON R .HUBBARD
Mathematical Statistics By V.C.Kapoor and Gupta.

BY 7004 APPLICABLE MATHEMATICS FOR BIOTECHNOLOGY

OBJECTIVE
To provide basics concepts of probability, sampling theory, analysis of variance and quality control.

OUTCOME
Students will have an exposure of various distribution, sampling distribution including nonparametric test.
able to analyse applications of sampling theory, design of experiments and quality control to technology.

UNIT I  CALCU LUS  12
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

Introduction- Differential Equation and solution-First order, linear differential equation, partial differential equations solution-Various types of partial different equation of the form \( f(p,q)=0, \quad f(x, p, q)=0, \quad f(x, p)=g(y, q). \) 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

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

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

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 BOOKS

BY7005 UNIX OPERATING SYSTEM AND PROGRAMMING LANGUAGE C++

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

BY7006  FOOD PROCESSING AND BIOTECHNOLOGY  L T P C
3 0 0 3

UNIT I  FOOD CHEMISTRY  9
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  9
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  9
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, aseptic 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.

TOTAL : 45 PERIODS

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

15
UNIT I INTRODUCTION
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
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
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
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
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.

UNIT V  
Alternate Source of Energy, Biomass as a source of energy, Biocomposting, Vermiculture, Biofertilizers, Organic farming, Biofuels, Bimineralization, Bioethanol and Biohydrogen, Bioelectricity through microbial fuel cell, energy management and safety.

TOTAL : 45 PERIODS

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

BY7009 COMMUNICATION SKILLS AND PERSONALITY DEVELOPMENT

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

TOTAL : 45 PERIODS

TEXT BOOK
UNIT I TRANSPORT PROCESS IN BIOREACTOR
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
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
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
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
Scaleup by geometry similitude, oxygen transfer, power correlations, mixing time

TOTAL : 45 PERIODS

REFERENCES
3. Lee, James M. Biochemical Engineering, PHI, USA.
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 V PROTEIN MODIFICATIONS
Post translational modifications, Engineering of proteins, Site directed mutagenesis, Fusion Proteins, Chemical derivatization.

TOTAL : 45 PERIODS

REFERENCES

BY7012 METABOLIC PROCESS AND ENGINEERING L T P C 3 0 0 3

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.

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 9
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 9
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.

TEXT BOOKS

REFERENCES

BY7013 ADVANCED PROCESS CONTROL L T P C
3 0 0 3

UNIT I ANALYSIS AND DESIGN OF FEED BACK CONTROL SYSTEM 9
Dynamic behaviour, stability analysis, design of feed back controllers, design of feed back control systems using frequency response techniques, PID controller for multicapacity processes.

UNIT II OPTIMUM CONTROLLER SETTING 9
Optimum settings from the plant response, continuous cycling method, damped oscillation method, reaction curved method.

UNIT III ANALYSIS AND CONTROL OF ADVANCED CONTROL SYSTEMS 9
Feedback control of systems with large dead time, control systems with multiple loops, feed forward and ratio control, adaptive and inferential control systems.

UNIT IV AUTOMATIC CONTROLLERS 9
Electronic, controllers, operational amplifier, electronic controller input and output, PID and on-off control models, microprocessors, general architecture, algorithms, applications in chemical process control.

UNIT V PROCESS CONTROL USING DIGITAL COMPUTERS: 9
Characteristics and performance of control computers, signals-types, signal transmission, analog feedback control systems. The direct digital control concept, advantages of DDC, computer process interface for data acquisition and control, computer control loops.
REFERENCES

BY7014 BIOPROCESS MODELING AND SIMULATION L T P C
3 0 0 3

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 9
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) 9
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 9
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 9
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 9
Advanced modeling techniques such as fuzzy logic, neural network, hybrid systems and fuzzy logic systems; case studies.

TEXT BOOKS

REFERENCES
UNIT I  INTRODUCTION TO PLANT MOLECULAR BIOLOGY  9
Genetic material of plant cells, nucleosome structure and its biological significance; transposons; outline of transcription and translation, alternative and trans splicing, constitutive and differentially expressed genes in plants

UNIT II  CHLOROPLAST AND MITOCHONDRIA  9
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  8
Nitrogen fixation, Nitrogenase activity, nod genes, nif genes, bacteroids, plant nodulins, production of secondary metabolites, flavanoid synthesis and metabolic engineering.

UNIT IV  AGROBACTERIUM AND PLANT VIRUSES  9
Pathogenesis, crown gall disease, genes involved in the pathogenesis, Ti plasmid – T-DNA, importance in genetic engineering. Plant viruses and different types, Viral Vectors: Gemini virus, cauliflower mosaic virus, viral vectors and its benefits, vectors used for plant transformation ,Methods used for transgene identification

UNIT V  APPLICATIONS OF PLANT BIOTECHNOLOGY  10
Outline of plant tissue culture, transgenec plants, herbicide and pest resistant plants, molecular pharming , therapeutic products, RNAi, Transgene silencing ,ethical issues

TOTAL : 45 PERIODS

REFERENCES
1. Grierson D. and Covey, S.N.  Plant Molecular Biology, 2nd ed., Blackie,1988
UNIT IV PROTEOMICS TECHNIQUES 9
Protein level estimation; Edman protein microsequencing; protein cleavage; 2 D gel electrophoresis; metabolic labeling; detection of proteins on SDS gels; pattern analysis; Mass spectrometry- principles of MALDI-TOF; Tandem MS-MS; Peptide mass fingerprinting.

UNIT V PROTEIN PROFILING 9
Post translational modification; protein-protein interactions; glycoprotein analysis; phosphoprotein analysis.

TOTAL : 45 PERIODS

REFERENCES

BY7017 PLANT DESIGN AND PRACTICE L T P C 3 0 0 3

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
UNIT I  FLUID DYNAMICS  5

UNIT II  BASIC NUMERICS  10
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  10

UNIT IV  FINITE VOLUME AND FINITE DIFFERENCE METHODS  10

UNIT V  FINITE ELEMENTS  10

TOTAL : 45 PERIODS

REFERENCES
2. K.A. Hoffman and S. Chiang, Computational fluid dynamics for scientists and engineers, engineering education system.
UNIT I  GENE THERAPY  9
Gene therapy; Intracellular barriers to gene delivery; Overview of inherited and acquired diseases for gene therapy; Retro and adeno virus mediated gene transfer; Liposome and nanoparticles mediated gene delivery

UNIT II  CELLULAR THERAPY  9
Cellular therapy; Stem cells: definition, properties and potency of stem cells; Sources: embryonic and adult stem cells; Concept of tissue engineering; Role of scaffolds; Role of growth factors; Role of adult and embryonic stem cells; Clinical applications; Ethical issues

UNIT III  RECOMBINANT THERAPY  9
Recombinant therapy; Clinical applications of recombinant technology; Erythropoietin; Insulin analogs and its role in diabetes; Recombinant human growth hormone; Streptokinase and urokinase in thrombosis; Recombinant coagulation factors

UNIT IV  IMMUNOTHERAPY  9
Immunotherapy; Monoclonal antibodies and their role in cancer; Role of recombinant interferons; Immunostimulants; Immunosuppressors in organ transplants; Role of cytokine therapy in cancers; Vaccines: types, recombinant vaccines and clinical applications

UNIT V  GENE SILENCING TECHNOLOGY  9
Gene silencing technology; Antisense therapy; si RNA; Tissue and organ transplantation; Transgenics and their uses; Cloning; Ethical issues

TOTAL : 45 PERIODS

TEXT BOOKS

UNIT I  CLINICAL TRIALS AND BIOETHICS  9
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  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  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
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 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; etal., “Clinical Trials or Drugs and Biopharmaceuticals.” CRC / Taylor & Francis, 2011.

BY7021 ADVANCES IN MOLECULAR PATHOGENESIS
UNIT I INTRODUCTION
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
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
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)
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,
parastiparous vacuoles and knob protein transport, Antimalarials based on transport processes.

TOTAL : 45 PERIODS

REFERENCES
1. Bacterial Pathogenesis- A Molecular Approach - Abigail A.Salyers
2. Principles of Bacterial Pathogenesis – Groisman
3. Structural Biology of Bacterial Pathogenesis – Gabriel Waksman, Michael Caparon
4. Bacterial Pathogenesis – Virginia L.Clark
5. Methods in Microbiology – Bacterial Pathogenesis – Peter Williams
6. Microbial Pathogenesis – Bruce A.McClane
7. Biology of Microorganisms – Michael T.Madigan
8. Genetic analysis of Pathogenic bacteria – Stanley
9. Molecular Infection Biology – Jorg Hacker

BY7022 NANOBIOENGINEERING L T P C 3 0 0 3

OBJECTIVES
The ‘Nanobiotechnology’ course aims to provide fundamental concepts of nanotechnology and advanced knowledge on the application of nanotechnology to biological sciences including nanomedicine.

OUTCOMES
The students would have learned the physicochemical properties of nanomaterials; the unique changes that happen at nanoscale; nanoscale view of the natural biomolecular processes; synthesis, modification, and characterization of nanomaterials; and application of nanomaterials to biological problems including nanomedicine.

UNIT I NANOBIOTECHNOLOGY AND NANOBIOENGINEERING 6
Introduction to Nanoscience and Nanotechnology; Overview of Biotechnology and Nanoscales processes; Physicochemical properties of materials in Nanoscales.

UNIT II FABRICATION AND CHARACTERIZATION OF NANOMATERIALS 10
Types of Nanomaterials (Quantum dots, Nanoparticles, Nanocrystals, Dendrimers, Buckyballs, Nanotubes); Gas, liquid, and solid –phase synthesis of nanomaterials; Lithography techniques (Photolithography, Dip-pen and Electron beam lithography); Thin film deposition; Electrospinning. Bio-synthesis of nanomaterials.

UNIT III PROPERTIES AND MEASUREMENT OF NANOMATERIALS 9
Optical Properties: Absorption, Fluorescence, and Resonance; Methods for the measurement of nanomaterials; Microscopy measurements: SEM, TEM, AFM and STM. Confocal and TIRF imaging.

UNIT IV NANOBIOLOGY AND BIOCONJUGATION OF NANOMATERIALS 10
Properties of DNA and motor proteins; Lessons from nature on making nanodevices; Reactive groups on biomolecules (DNA & Proteins); Surface modification and conjugation to nanomaterials. Fabrication and application of DNA nanowires; Nanofluidics to solve biological problems.

UNIT V NANO DRUG DELIVERY AND NANOMEDICINE 10
Properties of nanocarriers; drug delivery systems used in nanomedicine; Enhanced Permeability and Retention effect; Blood-brain barrier; Active and passive targeting of diseased cells; Health and environmental impacts of nanotechnology.

TOTAL : 45 PERIODS

28
REFERENCES

BY7023 RESEARCH AND RESEARCH METHODOLOGY IN BIOTECHNOLOGY

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 characteristic: 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; 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 BOOKS/REFERENCES
OBJECTIVES
The course intends to give advanced knowledge about Enzyme kinetics, immobilization and enzymatic biotransformation of drugs

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

UNIT I INTRODUCTION
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