ANNA UNIVERSITY : CHENNAI 600 025
UNIVERSITY DEPARTMENTS
R-2013
M. TECH. COMPUTATIONAL BIOLOGY
CURRICULUM AND SYLLABUS (FULL TIME)

SEMESTER I

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### LIST OF ELECTIVES

**M.TECH COMPUTATIONAL BIOLOGY**

### SEMESTER I

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**SEMESTER II & III**

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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, 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
UNIT I INTRODUCTION TO COMPUTATIONAL BIOLOGY AND SEQUENCE ANALYSIS
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
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

UNIT IV MACHINE LEARNING, SYSTEMS BIOLOGY AND OTHER ADVANCED TOPICS

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
4. Tisdall, James, Beginning PERL for Bioinformatics, O'Reilley Publications, 2001.
REFERENCES

BT8151 APPLIED STATISTICS FOR BIOTECHNOLOGISTS L T P C
4 0 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^x and ax^b- 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.,
3. Spiegel, Murray R., J.Schiller and R.Alu Srinivasan."Schaum’s Outlines Probability and
S. Chand & Co., 2004

BT8152 ENTREPRENEURSHIP, IPR AND BIOSAFETY

UNIT I ENTREPRENEURSHIP 10
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 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
BT8111  PREPARATIVE AND ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY

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
Algorithm, Applications of profile HMMs for multiple alignment of proteins and for finding genes in the DNA.

UNIT III DNA AND RNA RELATED ALGORITHMS

UNIT IV DYNAMIC PROGRAMMING AND SEQUENCE BASED ALGORITHMS
Dynamic programming Principles and its uses. Local and Global alignment principles, Finding longest common subsequences, Heuristics second generation alignment tools for database searching: (Blast, FASTA, ClustalW), Statistical and Similarity based methods for gene prediction, Models of evolution.

UNIT V SEQUENCE ASSEMBLY AND PROTEIN STRUCTURE
Graph Algorithms, DNA sequencing, shortest superstring problem, Sequencing by Hybridization as a Hamiltonian Path Problem, Consecutive ones problem (CIP) for aligning clones based on SNPs, Randomized algorithms: Gibbs Sampling, Protein sequencing and identification, spectral graphs and spectral alignment, Protein structure prediction- Secondary structure prediction algorithms, algorithm, Threading, Comparative Modeling.

TOTAL : 45 PERIODS

REFERENCES

BC8202 ANALYTICAL TECHNIQUES AND METHODS

UNIT I MICROSCOPY

UNIT II SPECTROSCOPY
UNIT III SEPARATION METHODS
Introduction to Chromatographic Separation, Column Chromatography, Thin Layer Chromatography, Gas Chromatography, Liquid Chromatography, High Performance Liquid Chromatography.

UNIT IV ELECTROANALYTICAL TECHNIQUES
Fundamentals of Electrochemistry, Electrodes, Potentiometry, Electrolysis, Electrogravimetric Analysis, Coulometry, Voltammetry- Polarography, Faradaic and Charging Currents, Square Wave Voltammetry, Microelectrodes

UNIT V BIOCHEMICAL TECHNIQUES
Estimation of Carbohydrates, Estimation of Lipids, Estimation of Proteins and Nucleic Acids

TOTAL : 45 PERIODS

REFERENCES

BC8203 BIOMOLECULAR SIMULATIONS L T P C 2023

UNIT I MOLECULAR MECHANICS

UNIT II POTENTIAL ENERGY SURFACE

UNIT III MOLECULAR DYNAMICS SIMULATION
Molecular Dynamics Simulation-Introduction, Radial distribution functions, Pair Correlation function, Newtonian dynamics, Integrators- Leapfrog and Verlet algorithm, Potential truncation and shifted-force potentials, Implicit and explicit Solvation models, Periodic boundary conditions, Temperature and pressure control in molecular dynamics simulations

UNIT IV QUANTUM MECHANICS
Black body radiation, photoelectric effect, Bohr’s Model of Hydrogen atom, De Broglie’s Hypothesis, Harmonic wave function, wave packets, Heisenberg uncertainty principle, Eigen states and eigen values, Pauli Exclusion Principle, Schrodinger equation

UNIT V MOLECULAR MODELLING IN DRUG DESIGN
Note: For Lab sessions tutorials on Gromacs, Autodock and Modeller will be given.

REFERENCES

BC8204 MACHINE LEARNING AND DATA MINING L T P C 2023
UNIT I MACHINE LEARNING 9

UNIT II MODELS AND METHODS 9

UNIT III DATA MINING 9
Data Mining Introduction, Relational databases and Datawarehouses, Data Mining functionalities, Concept/Class Description, Data mining Task primitives, Data Preprocessing: Descriptive Data Summarization: Statistical measures, measuring central tendency, dispersion of data, box plots. Data cleaning, integration, transformation and reduction.

UNIT IV DMQL AND MULTIDIMENSIONAL DATA MODELS 9
Use of Data mining Query Language DMQL, Multidimensional Data Models: Tables, Stars, Snowflakes and Fact Constellations. Data cubes, Curse of dimensionality, Data Warehouse and Online Analytical Processing Technologies: OLAP, Data visualization.

UNIT V ASSOCIATION MINING AND CORRELATION ANALYSIS 9
Frequent itemsets, Interestingness measures: Support, Confidence. Frequent Itemset Mining methods- Apriori algorithm, Frequent Pattern tree algorithm, Association mining-correlation analysis.
Note: Lab demos to include examples for machine learning with biological data

TOTAL : 45 PERIODS
REFERENCES

BC8205 PROGRAMMING LANGUAGES

UNIT I INTRODUCTION TO JAVA
Introduction to Object Oriented Programming and Procedural Programming, Java, JAVA - Keywords, Constants, Variables, Operators, Expressions, Decision Making, Branching and Looping, Classes – Objects – Methods, Arrays, Strings and Vectors.

UNIT II MULTI-THREAD PROGRAMMING
Java Interfaces - Multiple Inheritance, Packages, Multithreading, Exception handling – Event handling, Managing Inputs/Output Files in Java

UNIT III JAVA APPLETS AND DATABASE CONNECTION
Graphics - Applet basics – passing parameters to applets – applet display methods – drawing lines, ovals, rectangles and polygons – Threads and Animation, Java and Database connection

UNIT IV INTRODUCTION TO PYTHON
Introduction to Python Expressions, tuples, lists, dictionaries, and sets, Functions - Modules – Files, Control Statements-Loops-Iterations, Pattern Matching- Fixed length and Variable length matching

UNIT V PYTHON CLASSES AND BIOPYTHON
Python Classes-Objects-Methods, Inheritance, Biopython – Introduction- Biopython Components – Alphabet, Seq, MutableSeq, SeqRecord, Align, ClustalW, SeqIO, AlignIO, Blast, PDB

Total: 45 Periods

REFERENCES
1. Herbert Schildt, Java: The completer Reference. (7th Ed.) by TMH. 2012

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025
LIST OF EXPERIMENTS
1. Java programs to demonstrate decision making, and loops
2. Working with Arrays
3. Working with Classes and objects in java, Use of constructor
4. Simple, multiple and multilevel inheritances.
5. Operator Overloading, Exception handling,
6. Multithreading
7. Applets.
8. Animation and Threads
9. Java and Database connection
10. Python – Simple Programs, Control statements
11. Python - Tuples, Lists
12. Dictionaries, Modules
13. Python Classes
14. Reading/Writing Protein/DNA sequences using Biopython
15. BiopythonClustalW and other components

TOTAL : 60 PERIODS

BC8201 ADVANCED SYSTEMS BIOLOGY L T P C 3 0 0 3

UNIT I

UNIT II
Kinetic modeling of biochemical reactions, describing dynamics with ODEs, rate equations, deriving a rate equation, incorporating regulation of enzyme activity by effectors, E-cell platform and erythrocyte modeling

UNIT III

UNIT IV
Network motifs, Feed forward loop network motif. Gene circuits, robustness of models, Chemotaxis model, Integration of data from multiple sources: Building genome scale models.
UNIT V
Tools and databases for modeling: Pathway databases KEGG, EMP, Metacyc, Enzymekinetics database BRENDA, Gene expression databases, Biomodels database, Basics of Systems Biology Markup Language (SBML), SBML editors.

TOTAL : 45 PERIODS

REFERENCES
1. Systems Biology a Textbook by ByEddaKlipp, Wolfram Liebermeister, Christoph
5. Foundations of Systems Biology Edited by Hiroaki Kitano (MIT Press)

BC8302 HIGH PERFORMANCE COMPUTING
UNIT I PARALLEL PROCESSING FUNDAMENTALS
Parallel Processing Concepts - Levels of parallelism - task, thread, memory, function; Models (SIMD, MIMD, Dataflow Models etc), Architectures- multi-core, multi-threaded.

UNIT II PARALLEL PROGRAMMING MODELS

UNIT III PARALLEL PROGRAMMING LANGUAGES
Parallel Programming Languages – Overview, OpenMP, History of GPUs leading to their use and design for HPC, Introduction to the GPU programming model and CUDA, host and device memories, Basic CUDA program structure, kernel calls, threads, blocks, grid, thread addressing, predefined variables

UNIT IV CUDA
CUDA - example code: vector and matrix addition, matrix multiplication, Using Windows and Linux environments to compile and execute simple CUDA programs, Linux make files, Timing execution time, CUDA events, Host synchronization

UNIT V BIOINFORMATICS AND PARALLEL COMPUTING
Bioinformatics and Parallel Computing- Bioinformatics Applications, Recent developments in Computational Biology and Nanotechnology and its impact on HPC

TOTAL : 45 PERIODS

REFERENCES
1. Highly Parallel Computing”, by George S. Almasi and Alan Gottlieb
3. CUDA by Example- An Introduction to General-Purpose GPU Programming by Jason Sanders and Edwards Kandrot Addison-Wesley, 2011.

BP8071 CLINICAL TRIALS AND BIOETHICS L T P C 3 0 0 3

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 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 REGULATIONS OF CLINICAL TRIALS 9
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 9
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 9
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  9
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.

BT8001  ADVANCED TECHNOLOGIES IN OMICS SCIENCES  L T P C  3 0 0 3

UNIT I MICRO ARRAY SINGENOMICS  9
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  9
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  9
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  9
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  9
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 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.

TOTAL: 45 PERIODS
REFERENCES
3. Causton, H.C

BT8002 APPLICABLE MATHEMATICS FOR BIOTECHNOLOGY L T P C
3 1 0 4

UNIT I CALCULUS
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
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, 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
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

UNIT I INTRODUCTION

UNIT II ETHANOL
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
Chemistry and Production Processes; Vegetable oils and chemically processed biofuels; Biodiesel composition and production processes; Biodiesel economics; Energetics of biodiesel production and effects on greenhouse gas emissions; Issues of ecotoxicity and sustainability with expanding biodiesel production.

UNIT IV OTHER BIOFUELS
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

REFERENCES
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.

TOTAL : 45 PERIODS

TEXTBOOKs

REFERENCES
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 II BASIC NUMERIC 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

REFERENCES
2. K.A. Hoffman and S. Chiang, Computational fluid dynamics for scientists and engineers, engineering education system.

TOTAL : 45 PERIODS

BT8007 COMPUTATIONAL TECHNIQUES IN BIOPROCESS L T P C 2023

UNIT I 9
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 9
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

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
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
7
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
11
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
9

UNIT IV
9
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
9
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

BT8010 FOOD PROCESSING AND BIOTECHNOLOGY

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
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
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
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
BT8012   PLANT BIOTECHNOLOGY    L T P C
                     3 0 0 3

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  9
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, transgenic plants, herbicide and pest resistant plants, molecular pharming, therapeutic products, RNA i, Transgene silencing, ethical issues

TOTAL : 45 PERIODS

REFERENCES
1. Grierson D. and Covey, S.N.  Plant Molecular Biology, 2$^{nd}$ ed., Blackie,1988
UNIT I PLANT DESIGN
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
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
Grades of water, sanitary design, water treatment system, Water distribution system, validation.

UNIT IV VALIDATION OF BIOPHARMACEUTICAL FACILITIES
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
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.

REFERENCES

TOTAL : 45 PERIODS

BT8014 SENSORS AND INSTRUMENTATION FOR BIOAPPLICATIONS
UNIT I
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
Various types of sensors and biosensors– mass, chemical, biochemical, optical, electrical, magnetic, electrochemical and thin film sensors; matrices, sensor arrays, protein immobilization techniques and biosensors.

TOTAL : 45 PERIODS

BT8015 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
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
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

TEXTS/REFERENCES
2. Grosisman, “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)
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
BT8073 COMMUNICATION SKILL DEVELOPMENT

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 workplace 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

TOTAL: 45 PERIODS
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
BT8075                      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.

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

UNIT I                  METABOLIC FLUX ANALYSIS                          9
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                9
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       9
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
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

BT8076 NANOBIOTECHNOLOGY L T P C 2023

OBJECTIVES
The course will provide advanced knowledge in field of Nanobiology and Nano medicine

OUTCOME
After the completion of 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 NANOSCALES 5

UNIT II PROPERTIES AND MEASUREMENTS OF NANOMATERIALS 8
Optical Prperties – Absorption and Fluoroscence – Microscopy measurements – SEM – TEM - AFM and STM. Confocal and TIRF. Imaging

UNIT III NANOBIOLOGY 8
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  

BT8077  PROTEOMICS AND MASS-SPECTROMETRY  
L T P C  
3 0 0 3

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 PROTEOMICS 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

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 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

BT8079 TISSUE ENGINEERING AND REGENERATIVE MEDICINE L T P C 3 0 0 3

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  9
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  9
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  9
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  9
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  9

TOTAL : 45 PERIODS

TEXTS/REFERENCES
UNIT I
Introduction to Drugs: Drug nomenclature, Routes of drug administration and dosage forms, Principles of Pharmacokinetics and Pharmacodynamics: ADME, Bioavailability of drugs - Lipinski’s rule; How drugs work - Drug targets, drug-target interaction and dose-response relationships.

UNIT II
New Drug Discovery & Development: Overview of new drug discovery, development, cost and time lines. Target Identification & Validation. Lead Discovery: Rational and irrational approaches - Drug repurposing, Natural products, High-throughput screening (HTS), Combinatorial chemistry and computer aided drug design (CADD).

UNIT III
Preclinical Testing of New Drugs: Pharmacology - In vitro/in vivo Pharmacokinetics and Pharmacodynamics testing; Toxicology - Acute, chronic, carcinogenicity and reproductive toxicity testing; Drug formulation testing. Clinical Trial Testing of New Drugs: Phase I, Phase II and Phase III testing; Good clinical practice (GCP) guidelines - Investigators brochures, Clinical trial protocols and trial design; Ethical issues in clinical trials - How are patient rights protected?

UNIT IV
Drug Regulatory Agencies: US Food & Drug Administration (US FDA) and Central Drugs Standard Control Organization (CDSCO), India. Regulatory Applications & New Drug Approval: Investigational new drug (IND) application & New drug application (NDA); Regulatory review and approval process. Regulatory Requirements for Drug Manufacturing: Current Good manufacturing practice (cGMP) and GMP manufacturing facility inspection & approval.

UNIT V

REFERENCES
1. Drugs: From discovery to approval 2nd ed by Rick NG. Wiley Blackwell (2009)
UNIT I

UNIT II
The concept of homology in molecular evolution. Role of transitions and transversions; chromosomal deletions and insertions in evolution. Role of repetitive DNA, transposable elements and junk DNA in evolution.

UNIT III
Neutral theory (Kimura) and nearly neutral theory (Ohta) of molecular evolution (Kimura). Phylogenetic tree. Reconstruction of phylogenetic trees using distance matrix methods, the Maximum Parsimony method, Maximum likelihood and Bayesian inference. Selection at the molecular level.

UNIT IV
The concept of the Molecular Clock. Calibration. Limitation of molecular clock models. Human molecular clock: deducing evolutionary histories through mitochondrial DNA and Y chromosome.

UNIT V
Evolution of the genome: Human Genome Project, ENCODE, Genome 10 K, Genome duplication (Ohno’s hypothesis), Gene duplication, Exon Shuffling, Concerted evolution.

TOTAL: 45 PERIODS

REFERENCES

UNIT I
NGS Platforms: Introduction to NGS, Roche/454 FLX, Illumina/Solexa Genome Analyzer, Applied Biosystems SOLiD system, Helicos Heliscope, Pacific Biosciences/single molecule real time (SMRT) sequencing, Genome assembly algorithms: Alignment of short-reads to reference genome using spaced seed (ELAND, SOAP), index-filtering algorithm (SeqMap), quality-score (RMAP), q-filter algorithm (SHRiMP), FM-index (Bowtie, BWA, SOAP2), suffix tree (MUMmer). Sequence Alignment formats: Sequence Alignment/Map (SAM) format, Binary Alignment/Map (BAM) format, Tools for conversion (SAMtools), Alignment viewers (IGV, MGAviewer).

UNIT II
De-novo assembly: Overlap-layout-consensus (OLC) approach (Arachne, Phusion), de Bruijn and Euler path approach (Euler, SOAPdenovo), string graph assembler (SGA). Scaffold: Supercontig, contig orientation, contig ordering, contig distancing and gap closing using SOAPdenovo, ABySS, OPERA and RACA.
UNIT III
Application of R in NGS analysis: Introduction to Bioconductor, Reading of RNA-seq data (ShortRead, Rsamtools, GenomicRanges), annotation (biomaRt, genomIntervals), reads coverage and assign counts (IRanges, GenomicFeatures), differential expression (DESeq).

UNIT IV
Biological applications of NGS: Whole-genome sequencing, Exome sequencing, Transcriptome sequencing, Epigenome sequencing, Interactome sequencing, methylome sequencing.

UNIT V
BIG DATA in OMICS: Big data industry standards, Data acquisition, cleaning, distribution, and best practices, Visualization and design principles of big data infrastructures, Biological databases for big data management, High Performance Computing, grid, and cloud computing for omics sciences, Real-Time Processing of Proteomics Data Using Hadoop.

TOTAL : 45 PERIODS

REFERENCES
UNIT V  BAYESIAN DETECTION AND ESTIMATION  9
Bayesian Detection and Estimation-Bayesian statistics: Incorporating prior knowledge-Minimum mean square error -Linear MMSE estimator-Maximum A Posteriori Probability detection

REFERENCES

BC8005  STRUCTURAL BIOLOGY  L T P C
3 0 0 3

UNIT I  9

UNIT II  9
Enzyme catalysis and structure. Membrane proteins, signal transduction, proteins of the immune system. Structure of Spherical viruses, Folding and flexibility, Prediction, engineering and design of protein structures. Methods to identify secondary structural elements

UNIT III  9

UNIT IV  9
X-ray scattering: Atomic scattering factor - diffraction by a space lattice - structure factor equation - electron density and Fourier series - Fourier Transform and crystal diffraction - diffraction by real crystals - Lorentz and polarization factor - primary and secondary extinctions.

UNIT V  9

REFERENCES

TOTAL : 45 PERIODS

BP8008 PHARMACOGENOMICS L T P C 3 0 0 3

OBJECTIVES: The course intends to provide knowledge about Pharmacogenomics and drug design using genomic applications for drug action and toxicity.

OUTCOME: At the completion of course, the student would have learnt advanced pharmacogenomics enabling him for cutting edge academic and industrial research.

UNIT I INTRODUCTION TO PHARMACOGENOMICS 9
Pharmacogenetics-The roots of pharmacogenomics, It is not just pharmacogenomics, Genetic drug response profiles, the effect of drugs on Gene expression, pharmacogenomics in drug discovery and drug development.

UNIT II THE HUMAN GENOME 9
Expressed sequence Tags (EST) and computational biology, Microbial genomics, computational analysis of whole genomes, computational genome analysis, Genomic differences that affect the outcome of host pathogen interactions: A template for the future of whole genome-based pharmacological science.

UNIT III ASSOCIATION STUDIES IN PHARMACOGENOMICS 9
Viability and ADR in drug response: contribution of genetic factor, Multiple inherited genetic factors influence the outcome of drug treatments, Plasma binding proteins, Drug targets.

UNIT IV GENOMICS APPLICATIONS FOR DRUG ACTION AND TOXICITY 9
Genomics, Proteomics, Bioinformatics, The pharmaceutical process, applications of pharmaceutical industry, Understanding biology and diseases, Target identification and validation, Drug candidate identification and optimization.

UNIT V PHARMACOGENOMICS AND DRUG DESIGN 9
The need of protein structure information, protein structure and variation in drug targets-the scale of problem, Mutation of drug targets leading to change in the ligand binding pocket.

TOTAL: 45 PERIODS
OBJECTIVES:
- To understand big data analytics as the next wave for businesses looking for competitive advantage
- To understand the financial value of big data analytics
- To explore tools and practices for working with big data
- To understand how big data analytics can leverage into a key component
- To understand how to mine the data
- To learn about stream computing
- To know about the research that requires the integration of large amounts of data

UNIT I - INTRODUCTION TO BIG DATA

UNIT II - DATA ANALYSIS

UNIT III - STREAM COMPUTING

UNIT IV - PREDICTIVE ANALYTICS AND VISUALIZATION
UNIT V        FRAMEWORKS AND APPLICATIONS

IBM for Big Data – Map Reduce Framework - Hadoop – Hive - – Sharding – NoSQL Databases
- S3 - Hadoop Distributed file systems – Hbase – Impala – Analyzing big data with twitter – Big
data for E-Commerce – Big data for blogs.

TOTAL : 45 PERIODS

OUTCOMES:
Upon Completion of the course, the students will be able to
- Identify the need for big data analytics for a domain
- Use Hadoop, Map Reduce Framework
- Apply big data analytics for a give problem
- Suggest areas to apply big data to increase business outcome
- Contextually integrate and correlate large amounts of information automatically to gain
  faster insights.

REFERENCES: