ANNA UNIVERSITY : CHENNAI 600 025

UNIVERSITY DEPARTMENTS

R-2013

M. TECH. COMPUTATIONAL BIOLOGY

CURRICULUM AND SYLLABUS (FULL TIME)

SEMESTER I

CODE	COURSE TITLE	L	T	P	C
THEORY					
BT8101	Bioprocess Technology	3	0	0	3
BT8102	Computational Biology	2	0	2	3
BT8151	Applied Statistics for Biotechnologists	3	1	0	4
BT8152	Entrepreneurship, IPR and Biosafety	3	0	0	3
	Elective I	3	0	0	3
	Elective II	3	0	0	3
	Elective III	3	0	0	3
PRACTICAL					
BT8111	Preparative and Analytical Techniques in Biotechnology	0	0	6	3
	TOTAL	**20**	**1**	**8**	**25**

SEMESTER II

CODE	SUBJECT TITLE	L	T	P	C
THEORY					
BC8201	Algorithms in Computational Biology	3	0	0	3
BC8202	Analytical Techniques and Methods	2	0	2	3
BC8203	Biomolecular Simulations	2	0	2	3
BC8204	Machine Learning and Data Mining	2	0	2	3
BC8205	Programming Languages	3	0	0	3
	Elective IV	3	0	0	3
	Elective V	3	0	0	3
PRACTICAL					
BC8211	Programming Languages Lab	0	0	4	2
	TOTAL	**20**	**0**	**6**	**23**

Attested

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SEMESTER III

CODE	SUBJECT TITLE	L	T	P	C
THEORY					
BC8301	Advanced Systems Biology	3	0	0	3
BC8302	High Performance Computing	2	0	2	3
	Elective VI	3	0	0	3
PRACTICAL					
BC8311	Project Work- Phase I	0	0	12	6
	TOTAL	**7**	**0**	**16**	**15**

SEMESTER IV

CODE	SUBJECT TITLE	L	T	P	C
BC8411	Project Work – Phase II	0	0	24	12
	TOTAL	**0**	**0**	**24**	**12**

LIST OF ELECTIVES

M.TECH COMPUTATIONAL BIOLOGY

SEMESTER I

COURSE CODE	COURSE TITLE	L	T	P	C
BP8071	Clinical Trials and Bioethics	3	0	0	3
BT8001	Advanced Technologies in Omics Technologies	3	0	0	3
BT8002	Applicable Mathematics for Biotechnology	3	1	0	4
BT8003	Biofuels and Platform Chemicals	3	0	0	3
BT8004	Bioprocess Modelling and Simulation	2	0	2	3
BT8005	Bioreactor Engineering	3	0	0	3
BT8006	Computational Fluid Dynamics	3	0	0	3
BT8007	Computational Techniques in Bioprocess	2	0	2	3
BT8008	Computer Aided Learning of Structure and Function of Proteins	2	0	2	3
BT8009	Environmental Biotechnology	3	0	0	3

BT8010	Food Processing and Biotechnology	3	0	0	3
BT8011	Pharmaceutical Biotechnology	3	0	0	3
BT8012	Plant Biotechnology	3	0	0	3
BT8013	Plant Design and Practice	3	0	0	3
BT8014	Sensors and Instrumentation for Bioapplications	2	0	2	3
BT8015	Unix Operating System and Programming Language C++	2	0	2	3
BT8071	Advances in Molecular Pathogenesis	3	0	0	3
BT8072	Biocatalysts and Enzyme Technology	3	0	0	3
BT8073	Communication Skill development	2	0	2	3
BT8074	Genomics and Transcriptomics	3	0	0	3
BT8075	Metabolic Process and Engineering	3	0	0	3
BT8076	Nanobiotechnology	2	0	2	3
BT8077	Proteomics and Mass Spectroscopy	3	0	0	3
BT8078	Research and Research Methodology in Biotechnology	3	0	0	3
BT8079	Tissue Engineering and Regenerative Medicine	3	0	0	3

SEMESTER II & III

CODE	SUBJECT TITLE	L	T	P	C
BC8001	Drug Discovery	3	0	0	3
BC8002	Molecular Evolution and Phylogeny	3	0	0	3
BC8003	Next Generation Sequencing	2	0	2	3
BC8004	Signal Processing in Biotechnology	3	0	0	3
BC8005	Structural Biology	3	0	0	3
BP8008	Pharmacogenomics	3	0	0	3
CP8018	Big Data Analytics	3	0	0	3

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BT8101 **BIOPROCESS TECHNOLOGY** **L T P C**
3 0 0 3

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

1. Shuler, M.L. and Kargi, F. Bioprocess Engineering : Basic concepts, 2nd ed., Prentice- Hall, 2002.
2. Doran Pauline M, Bioprocess Engineering Principles, Academic Press, 1995
3. Nielsen, J. and Villadsen, J. “Bioreaction Engineering Principles”. Springer, 2007.
4. Blanch, H.W and Clark D.S., “Biochemical Engineering”, Marcel Dekker,1997

REFERENCES

1. Bailey, J.E. and Ollis, D.F. Biochemical Engineering Fundamentals", 2nd ed.,McGraw Hill 1986.
2. Stanbury, P.F., Stephen J. Hall & A. Whitaker, Principles of Fermentation Technology, Science & Technology Books.

BT8102 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, Parsimonous trees, Additive trees, Bootstrapping.

UNIT III PROTEIN STRUCTURE, MODELLING AND SIMULATIONS 9

Protein Structure Basics, Visualization, Prediction of Secondary Structure and Tertiary Structure, Homology Modeling, Structural Genomics, Molecular Docking principles and applications, Molecular dynamics simulations.

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

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 9

Variables, Data types, control flow constructs, Pattern Matching, String manipulation, arrays, lists and hashes, File handling, Programs to handle biological data and parse output files for interpretation

Laboratory Demonstrations for

Biological Databases, Sequence alignment: BLAST family of programs, FASTA, ClustalW for multiple sequence alignment, Phylogenetics software, Homology Modeling and Model evaluation, AutoDock, GROMACS, Prokaryotic and Eukaryotic Gene finding software, Programs in PERL.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Dan Gusfield. Algorithms on Strings Trees and Sequences, Cambridge University Press.
2. David W. Mount Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, Second Edition, 2004.
3. Arthur M. Lesk, Introduction to Bioinformatics by Oxford University Press, 2008.
4. Tisdall, James, Beginning PERL for Bioinformatics, O'Reilley Publications, 2001.
5. Andrew R. Leach, Molecular Modeling Principles And Applications, Second Edition, Prentice Hall.

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REFERENCES

1. Baldi, P., Brunak, S. Bioinformatics: The Machine Learning Approach, 2nd ed., East West Press, 2003
2. Baxevanis A.D. and Oullette, B.F.F. A Practical Guide to the Analysis of Genes and Proteins, 2nd ed., John Wiley, 2002
3. Durbin, R. Eddy S., Krogh A., Mitchison G. Biological Sequence Analysis: Probabilistic
4. Models of Proteins and Nucleic Acids. Cambridge University Press, 1998.
5. Proteomics from protein sequence to function: Edited by S.R.Pennington and M.J.Dunn, Taylor and Francis Group, 2001.

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 **12**

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 **12**

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 **12**

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 **12**

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 **12**

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".
2. Vittal, P.R. and V.Malini."Statistical and Numerical Methods". Margham Publications.
3. Veerarajan,T. "Probability, Statistics and Random Processes".3rd Edition., Tata Mc Graw-Hill, 2008.

REFERENCES
1. Johnson, R. A."Miller & Freund's Probability and Statistics for Engineers". 6th ed. PHI, 2003.
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 Statistics".2nd Edition. Tata Mc Graw-Hill 2000.
4. Kandasamy, P. K. Thilagavathi & K. Gunavathi."Probability Statistics and Queuing Theory". S. Chand & Co., 2004

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

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

1. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing
2. Co. Pvt. Ltd., 2007

3. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd., 2007
4. S.S.Kanka Entrepreneurship Development, S.Chand and Co, New Delhi 1997

BT8111 PREPARATIVE AND ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY

L T P C
0 0 6 3

1. Preparation of Acetate, Tris and Phosphate Buffer systems and validation of Henderson-Hasselbach equation.
2. Reactions of amino acids – Ninhydrin, Pthaldehyde, Dansyl chloride – measurement using colorimetric and fluorimetric methods.
3. Differential estimations of carbohydrates – reducing vs non-reducing, polymeric vs oligomeric, hexose vs pentose
4. Estimation of protein concentration using Lowrys' 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 Chromatagraphy – 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

1. Biochemical Methods: A Concise Guide for Students and Researchers, Alfred Pingoud, Claus Urbanke, Jim Hoggett, Albert Jeltsch, 2002 John Wiley & Sons Publishers, Inc,
2. Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry, 2nd Edition, Irwin H. Segel, 1976 John Wiley & Sons Publishers, Inc,
3. Principles and Techniques of Practical Biochemistry- Wilson, K. and Walker, J. Cambridge Press.

BC8201 ALGORITHMS IN COMPUTATIONAL BIOLOGY L T P C
3 0 0 3

UNIT I INTRODUCTION TO ALGORITHMS 9

Algorithms-Complexity of algorithms and running time, Polynomial, NP complete problems, Recursion, Linear, Exhaustive search, Branch and Bound, divide and conquer algorithms, Travelling sales man problem, sorting.

UNIT II EXACT MATCH AND HIDDEN MARKOV MODELS 9

Knuth-Morris- Pratt and Boyer-Moore algorithm for exact match and graph and maximum likelihood algorithm , Hidden Markov Model: Forward and Backward Algorithms, Most probable state path: Viterbi algorithm, Parameter Estimation for HMMs:-Baum-Welch Algorithm, EM

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

UNIT III DNA AND RNA RELATED ALGORITHMS 9

Restriction enzyme mapping algorithms: algorithms for partial digest- double digest problem, Motif finding, Finding regulatory motifs in DNA, DNA computing, Genome alignment, Suffix Trees, RNA secondary structure prediction: Base pair maximisation and the Nussinov folding algorithm, Energy minimization and the Zuker folding algorithm, Design of covariance models, Application of RNA Fold.

UNIT IV DYNAMIC PROGRAMMING AND SEQUENCE BASED ALGORITHMS 9

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 9

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

1. Neil C.JonesandPavel .A Pevzner An introduction to Bioinformatics Algorthims.(computational Molecular Biology) (2004) MIT press. ISBN-10: 0262101068
2. R. Durbin, S.Eddy, A.Krogh, G.Mitchison Biological sequence analysis : Probabilistic models of Proteins and Nucleic acids (2005) Cambridge University Press 0521540798
3. Michael.S.Waterman Introduction to Computational Biology : Maps, Sequences and Genomes . Waterman. Edition 2 (2012) Chapman and Hall/ CRC Press ISBN: 1439861315
4. Dan GusfieldAlgorthims on Strings, Trees and Sequences : Computer Science and Computational Biology (1997) Cambridge University Press. ISBN-10: 0521585198
5. Horowitz, S. Sahini, and Rajasekharan : Fundamentals of Computer Algorithms , Galgotia Publications

BC8202 ANALYTICAL TECHNIQUES AND METHODS L T P C
2 0 2 3

UNIT I MICROSCOPY 9

Identification of microorganisms using light and compound microscopy, Phase Contrast Microscopy, Fluorescence Microscopy, Confocal Microscopy, Microscopy with Light and Electrons, Electrons and Their Interactions with the Specimen, Electron Diffraction, The Transmission Electron Microscope, The Scanning Electron Microscope, Atomic Force Microscopy.

UNIT II SPECTROSCOPY 9

Introduction to Spectroscopic Methods, Ultraviolet-Visible Molecular Absorption Spectrometry, Fluorescence Spectrometry, Infrared Spectrometry, Raman Spectroscopy, Nuclear Magnetic Resonance Spectroscopy, Molecular Mass Spectroscopy.

UNIT III SEPARATION METHODS 9

Introduction to Chromatographic Separation, Column Chromatography, Thin Layer Chromatography, Gas Chromatography, Liquid Chromatography, High Performance Liquid Chromatography.

UNIT IV ELECTROANALYTICAL TECHNIQUES 9

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

UNIT V BIOCHEMICAL TECHNIQUES 9

Estimation of Carbohydrates, Estimation of Lipids, Estimation of Proteins and Nucleic Acids

TOTAL : 45 PERIODS

REFERENCES

1. Skoog, Holler, Crouch, Instrumental Analysis Brooks/Cole *2007* ISBN-13: 978-81-315-0542-7.
2. Robert D. Braun, Introduction to Instrumental Analysis Pharma Book Syndicate. ISBN 891-88449-15-6

BC8203 BIOMOLECULAR SIMULATIONS L T P C
2 0 2 3

UNIT I MOLECULAR MECHANICS 9

Molecular Mechanics- Introduction, The Morse Potential, The Harmonic Oscillator Model for Molecules, Comparison of Morse and Harmonic Potential, Two atoms connected by a bond, Poly atomic Molecules, Energy due to Stretch, Bend, Stretch-Bend, Torsional strain, van der Waals and Dipole-Diploe interactions. Types of Potentials: Lennard-Jones, Truncated Lennard-jones, Types of Force Fields: AMBER, CHARMM, Consistent Force Fields.

UNIT II POTENTIAL ENERGY SURFACE 9

Potential Energy Surface- Convergence Criteria, Characterizing Stationary Points, Search for Transition States. Optimization:- multivariable Optimization Algorithms, level Sets, Level Curves, Gradients, Optimization Criteria, Unidirectional Search, Finding Minimum Point, Gradient based Methods-Steepest Descent and Conjugate Gradient Methods

UNIT III MOLECULAR DYNAMICS SIMULATION 9

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 9

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 9

Drug discovery process. Conformational analysis, lead identification, optimizationand validation. Methods and Tools in Computer-aided molecular Design, Analog Based drug design:- Pharmacophores and QSAR. Structure based drug design:- Docking, De Novo Drug Design, Virtual screening.

Note: For Lab sessions tutorials on Gromacs, Autodock and Modeller will be given.

TOTAL : 45 PERIODS

REFERENCES

1. Ramachandran, Deepa and NambooriComputational Chemistry and Molecular Modeling-Principles and ApplicationsSpringer_Verlag2008 Reference for Unit 1 and 2.ISBN-13 978-3-540-77302-3.
2. Andrew R. LeachMolecularModeling Principles and Applications (2nd Ed.). Prentice Hall USA. 2001ISBN-13: 978-0582382107
3. Alan HinchliffeMolecular Modelling for Beginners, (2nd Edition) John Wiley & Sons Ltd. 2008ISBN: 978-0-470-51314-9
4. Tamar Schlick Molecular Modeling and Simulation – An interdisciplinary Guide Springerverlag 2000ISBN 978-1-4419-6350-5
5. Patrick Bultinck, Marcel Dekker Computational medicinal chemistry for drug discovery CRC Press 2004ISBN 9780824747749

BC8204 MACHINE LEARNING AND DATA MINING L T P C
2 0 2 3

UNIT I MACHINE LEARNING 9

Machine learning Introduction: goals and applications, Supervised and Unsupervised learning - Inductive Classficationconcepts and Learning aspects. Clustering : k-means, Outlier analysis, Techniques of machine learning – Artificial Neural Networks: Feed Forward Networks, Error correction and Back propagation algorithm, Updating weights, case and epoch updating, Genetic algorithms, operators, crossover and mutation rates, fitness functions. Decision trees, Computing average disorder of trees, searching of simple trees and computational complexity-Occam's razor, noisy data and pruning.

UNIT II MODELS AND METHODS 9

Bayesian Classification, Bayes theorem, Naive Bayes classification, Support Vector Machines, Concept of Hyperplanes and Support Vectors. Reinforcement Learning, Ensemble Learning - Bagging and Boosting. Graphical models, Evolutionary systems-Probabilistic methods. Markov chain Monte Carlo (MCMC).

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

Attested

TOTAL : 45 PERIODS

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REFERENCES
1. Jiawei Han, MichelineKambler "Data Mining: Concepts and Techniques", Third Edition (2011) Morgan kaufman Publishers.ISBN-13: 978-0123814791
2. Ian H.WittenEibe Frank Data Mining : "Practical machine learning tools and Techniques with java implementation" (2005) ISBN 1-55864-552-5
3. Tom Mitchell "Machine Learning" McGraw-Hill (1997) ISBN-13: 978-0070428072
4. Petra PernerAzrielRosenfield Machine Learning and data mining in pattern recognition in third International conference MLDM (2003) Springer ISBN 978-3-540-40504-7.

BC8205 PROGRAMMING LANGUAGES L T P C
3 0 0 3

UNIT I INTRODUCTION TO JAVA 9

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 9

Java Interfaces - Multiple Inheritance, Packages, Multithreading , Exception handling – Event handling, Managing Inputs/Output Files in Java

UNIT III JAVA APPLETS AND DATABASE CONNECTION 9

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 9

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 9

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
2. E. Balagurusamy, Programming with Java: A Primer, Tata McGraw-Hill Education, 2010
3. Mitchell L Model, Bioinformatics Programming Using Python- Practical Programming for Biological Data, O'Reilly Media, 2009
4. Sebastian Bassi, Python for Bioinformatics (Chapman & Hall, CRC Mathematical and Computational Biology), CRC Press, 2009
5. John Zelle , Python Programming: An Introduction to Computer Science, 2nd Ed. Paperback , Franklin Beddle and Associates Inc 2010

BC8211 **PROGRAMMING LANGUAGES LAB** **L T P C**
0 0 4 2

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 **9**

Introduction to Systems Biology, Systems level understanding of biological systems. Basic concepts in Systems modeling, Networks and graph theory**:** Basic properties of Network: Degree, average degree and degree distribution. Adjacency matrix, eighted and unweighted networks, Bipartite network, Paths and distances, Random Networks**:**Erdos-Renyi model, Small-world effect,clustering coefficient, Scale-free networks**:** Power laws, Hubs, ultra-small property, degree exponent, The Barabasi-Albert Model. Degree correlations: assortativity and disassortativity.

UNIT II **9**

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 **9**

Introduction to Flux balance analysis, Construction of stoichiometric matrices, Constraint based models. Network basics, examples of mathematical reconstruction of transcriptional networks and signal transduction networks.

UNIT IV **9**

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 **9**

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
2. Wierling Wiley-BlackWell Publications (2009 Edition).
3. An introduction to Systems Biology: Design Principles of Biological Circuits by Uri Alon(Chapman and Hall / CRC 2007 Edition)
4. Systems Biology in practice : concepts, implementation and application by EddaKlipp, Ralf Herwig, Axel kowald, ChristophWierling, Hans Lehrach. (Wiley – VCH 2005)
5. Foundations of Systems Biology Edited by Hiroaki Kitano (MIT Press)
6. Systems Biology: Definitions and perspectives by Lilia Albhergina (Springer Publications 2008)

BC8302 HIGH PERFORMANCE COMPUTING L T P C
3 0 0 3

UNIT I PARALLEL PROCESSING FUNDAMENTALS **9**

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 **9**

Parallel Programming and Multiprogramming, Programming Models in high performance computing architectures – Shared memory and Message passing paradigms - Fundamental Design Issues in Parallel Computing – Synchronization - Interconnect, Communication, Memory Organization - Memory hierarchy and transaction specific memory design - Thread Organization.

UNIT III PARALLEL PROGRAMMING LANGUAGES **9**

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 **9**

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 **9**

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
2. Advanced Computer Architecture: Parallelism, Scalability, Programmability, by Kai Hwang, McGraw Hill 1993

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3. CUDA by Example- An Introduction to General-Purpose GPU Programming by Jason Sanders and Edwards Kandrot Addison-Wesley, 2011.
4. "Parallel Computer Architecture: A hardware/Software Approach", by David Culler Jaswinder Pal Singh, Morgan Kaufmann, 1999.
5. Jeffrey S. Vetter (Editor), Contemporary High Performance Computing: From Petascale toward Exascale (Chapman & Hall/CRC Computational Science) CRC Press, 2013
6. Georg Hager, Gerhard Wellein, Introduction to High Performance Computing, CRC Press, 2011
7. Wagner, S., Steinmetz, M., Bode, A., Müller, M.M. (Eds.),, High Performance Computing in Science and Engineering, Garching/Munich, Springer Verlog, 2010

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.

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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; etal., "Clinical Trials or Drugs and Biopharmaceuticals." CRC / Taylor & Francis, 2011.
2. Matoren, Gary M. "The Clinical Research Process in the Pharmaceutical Industry." Marcel Dekker, 1984.

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; oligonucleatide 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-Ion cyclotron Resonance (FT-ICR), and Orbitrap mass analyzers; Collision-Induced Dissociation (CID) of peptides; Analysis of complex protein mixtures using Nano-liquid chromatography (Nano-LC) coupled to Mass-spectrometry analysis; Analysis of metabolites using Gas-chromatograpgy 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
1. Schena M. (2000) DNA Microarrays _ A Practical Approach. Oxford UniversityPress.
2. Rinaldis E. D. and Lahm A (2007) DNA Microarrays. Horizon bioscience.
3. Causton,H.C
4. Muller H. J. and Roder T. (2006) Microarrays. Elsevier Academic Press
5. Causton H. C., Quackenbush J., and Brazma A. (2004) A Beginner's Guide _ Microarray. Gene Expression Data Analysis. Blackwell Publishing.
6. Schena M. (2005) Protein Microarrays. Jones and Bartlett Publishers
7. O'Connor C. D. and Hames B. D. (2008) Proteomics. Scion Publishing Ltd.
8. Hoffman E. D. and Stroobant V. (2007) Mass Spectrometry – Principles and Applications. John Wiley & Sons Ltd.

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 andDirectional derivatives; Chain rule; Maxima and Minima.

UNIT II DIFFERENTIAL EQUATION AND PARTIAL DIFFERENTIAL EQUATIONS 12

Introduction- Differential Equation and solution-First order, linear differerential 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

1. G. B. Thomas and R. L. Finney, Calculus and Analytic Geometry, 9th Edition, ISE Reprint, Addison-Wesley, 1998.
2. E. Kreyszig, Advanced engineering mathematics, 8th Edition, John Wiley, 1999.

3. W. E. Boyce and R. DiPrima, Elementary Differential Equations, 8th Edition, John Wiley, 2005.
4. Higher Engineering Mathematics,37th Edition By Grewal.

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

UNIT I INTRODUCTION 9

Cellulosic Biomass availability and its contents. Lignocellulose as a chemical resource. Physical and chemical pretreatment of lignocellulosic biomass. Cellulases and lignin degrading enzymes.

UNIT II ETHANOL 9

Ethanol as transportation fuel and additive; bioethanol production from carbohydrates; engineering strains for ethanol production from variety of carbon sources to improved productivity.

UNIT III BIODIESEL 9

Chemistry and Production Processes; Vegetable oils and chemically processed biofuels; Biodiesel composition and production processes; Biodiesel economics; Energetics of biodiesel production and effects on greenhouse gas emissionsIssues of ecotoxicity and sustainability with ; expanding biodiesel production

UNIT IV OTHER BIOFUELS 9

Biodiesel from microalgae and microbes; biohydrogen production; biorefinery concepts

UNIT V PLATFORM CHEMICALS 9

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

TOTAL: 45 PERIODS

REFERENCES

1. Lee, Sunggyu; Shah, Y.T. “Biofuels and Bioenergy”. CRC / Taylor & Francis, 2013.

BT8004 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 MODELINGOFBIOLOGICALSYSTEMS 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 TECHNIQUES9

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

TOTAL : 45 PERIODS

TEXTBOOKs

1. B. Wayne Bequette, Process Dynamics: Modeling, Analysis and Simulation, 1998, Prentice-Hall
2. Said S.E.H. Elnashaie, Parag Garhyan, Conservation Equations and Modeling of Chemical and Biochemical Processes, 2003, Marcel Dekker

REFERENCES

1. Process Dynamics, Modelling, Analysis and Simulation, B.W. Bequettre, Prentice Hall International series (1998). ISBN 0132107333.
2. Conservation Equations and Modelling of Chemical and Biochemical Processes. Said. E.H. Elnashaie and P. Garhyan, Marcel Dekker, Inc (2003). ISBN 0824709578.
3. Biological Reaction Engineering: Dynamic Modelling Fundamentals with Simulation Examples, I.J. Dunn, Wiley-VCH (2003). ISBN 3527307591**.**

Attested

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BT8005 BIOREACTOR ENGINEERING L T P C
3 0 0 3

UNIT I TRANSPORT PROCESS IN BIOREACTOR 9

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

UNIT II MONITORING OF BIOPROCESSES 6

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

UNIT III MODERN BIOTECHNOLOGICAL PROCESSES 14

Recombinant cell culture processes, guidelines for choosing host-vector systems, plasmid stability in recombinant cell culture, limits to over expression, Modelling of recombinant bacterial cultures; Bioreactor strategies for maxmising 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

1. Moser, Anton, Bioprocess Technology: Kinetics and Reactors, Springer Verlag, 1988.
2. Bailey J.E. & Ollis, D.F. Biochemical Engineering Fundamentals, 2nd ed., McGraw Hill, 1986
3. Lee, James M. Biochemical Engineering, PHI, USA.
4. Atkinson, Handbook of Bioreactors, Blanch,H.W. Clark, D.S. Biochemical Engineering, Marcel Decker, 1999

BT8006 COMPUTATIONAL FLUID DYNAMICS LT P C
3 0 0 3

UNIT I FLUID DYNAMICS 5

Introduction, Reasons for CFD. Typical examples of CFD codes and their use. Validation strategies. Derivation of Governing Equations of Fluid Dynamics: Mass conservation and divergence, Navier-Stokes and Euler equations. Energy equations. Conservation formulation and finite volume discretisation. Partial differential equations: classification, characteristic form. PDEs in science and engineering.

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

Euler equations, conservative/non-conservative form. ther-modynamics of compressible flow, scalar conservations laws: Conservation, weak solutions, non-uniqueness, entropy conditions. Shock formation, Rankine-Hugoniot relations. Numerical methods for scalar conservation laws. Properties of the numerical scheme such as CFL-condition, conservation and TVD. First order methods. System of conservations laws. Numerical methods for Euler equations: MacCormack and artificial viscosity for non-linear systems. Numerical/physical boundary conditions. Shock tube problem. High resolution schemes for conservations laws. Numerical methods for Euler equations. Boundary conditions, Riemann invariants. Compressible flow in 2D. Numerical methods for Euler equations, cont. Grids, algebraic mesh generation by transfinite inter-polation. Flow around an airfoil.

UNIT IV FINITE VOLUME AND FINITE DIFFERENCE METHODS 10

Laplace equation on arbitrary grids, equivalence with finite-differences, linear systems: Gauss-Seidel as smothers for multi-grid. Staggered grid/volume formulation + BC. Unsteady equations: projection and MAC method, discrete Poisson pressure equation. Time step restrictions. Steady equations: distributive iteration and SIMPLE methods.

UNIT V FINITE ELEMENTS 10

Diffusion problem. Variational form of the equation, weak solutions, essential and natural boundary condition. Finite-element approximations, stability and accuracy, the algebraic problem, matrix assembly. Navier–Stokes equations. Mixed variational form, Galerkin and FE approximations, the algebraic problem. Stability, the LBB condition, mass conservation.

TOTAL : 45 PERIODS

REFERENCES

1. Copies from Randall J LeVeque, Fininte Volume Method for Hyperbolic Problems, Cambridge University Press.
2. K.A. Hoffman and S. Chiang, Computational fluid dynamics for scientists and engineers, engineering education system.
3. J.C. Tannehill, D.A. Anderson, R.H. Pletcher, Computational Fluid Mechanics and Heat Transfer, Taylor and Francis.

BT8007 COMPUTATIONAL TECHNIQUES IN BIOPROCESS L T P C
2 0 2 3

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 **9**

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

UNIT IV **9**

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

UNIT V **9**

ODEs: Boundary Value Problems- Shooting method; Finite differences; Over/Under Relaxation (SOR).PDEs: Introduction to Partial Differential Equations.

Note:

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

TOTAL : 45 PERIODS

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

UNIT I COMPONENTS OF PROTEIN STRUCTURE **9**

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 **9**

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 **9**

Classes of Proteins and their Structure Function Relationships – alpha, beta, alpha/beta proteins, DNA-binding proteins, Enzymes, IgG, membrane proteins

UNIT IV PROTEIN STRUCTURAL CLASSIFICATION DATABASES **9**

SCOP and CATH. Evolutionary relationships and Phylogenetic Studies

UNIT IV PROTEIN MODIFICATIONS **9**

Post translational modifications, Engineering of proteins, Site directed mutagenesis, Fusion Proteins, Chemical derivatization.

TOTAL : 45 PERIODS

REFERENCES

1. Biochemistry, 3rd Edition by Donald J. Voet, Judith G. Voet, 2004 John Wiley & Sons Publishers, Inc
2. Introduction to Protein Structure, 2nd Edition, Carl Branden and John Tooze, 1999, Garland Publications, New York
3. Proteins – Structures and Molecular Properties, 2nd Edition, Thomas E. Creighton, W. H. Freeman and Company, New York

BT8009 **ENVIRONMENTAL BIOTECHNOLOGY** **L T P C**
3 0 0 3

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**

Industrial waste management- Dairy, Paper & Pulp, Textile, leather, hospital and pharmaceutical industrial waste management, e-waste- radioactive and nuclear power waste management- Solid waste management.

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, Biomineralization, Bioethanol and Biohydrogen, Bio-electricity through microbial fuel cell, energy management and safety.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Chakrabarty K.D., Omen G.S., Biotechnology And Biodegradation, Advances In Applied Biotechnology Series , Vol.1, Gulf Publications Co., London, 1989.
2. Waste water Engineering Treatment, Disposal and Reuse. Metcalf & Eddy (1991) Mc Graw Hill.
3. Environmental Biotechnology, Forster, C. F and Waste, D.A. J. (1987) Ellis Horwood Halsted Press.
4. Biochemical Engineering Fundamentals 2nd Ed. Bailey, J. E. and Ollis, D. F. (1986) Mac Graw Hill, New York.
5. Environmental Biotechnology by Alan Scragg (1999); Longman.

6. Bruce E. Rittmann, Eric Seagren, Brian A.Wrenn and Albert J. Valocchi, Chittaranjan Ray, Lutgarde Raskin, "In-situ Bioremediation" (2nd Edition) Nayes Publication, U.S.A, 1991.
7. Old R.W., and Primrose, S.B., Principles of Gene Manipulation (3rd Edition) Blackwell Science Publication, Cambridge, 1985.

REFERENCES

1. Stanier R.Y., Ingraham J.L., Wheelis M.L., Painter R.R., General Microbiology, Mcmillan Publications, 1989.
2. New Processes of Waste water treatment and recovery. G.Mattock E.D. (1978) Ellis Horwood.
3. Environmental Biotechnology, Jogdand, S.N. (1995) Himalaya Publishing House, New Delhi.
4. Comprehensive Biotechnology (Vol. 1-4) Young Murray Moo (Ed.) (1985) Elsever Sciences.
5. Standard Method for Examination of Water & Waste water 14th Ed.(1985) American Public Health Ass.
6. Lee, C.C. and Shun dar Lin, Handbook of Environmental Engineering Calculations, Mc Graw Hill, New York, 1999.
7. Hendricks, D. 'Water Treatment Unit Processes – Physical and Chemical' CRC Press, New York 2006
8. Martin, A.M., Biological Degradation of Wastes, Elsevier Appl. Science, New York, 1991.
9. Sayler, Gray S. Robert Fox and James W. Blackburn," Environmental Biotechnology for Waste Treatment, Plenum Press, New York, 1991.

BT8010 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, asceptic canning; frozen storage – freezing curve characteristics. Factors affecting quality of frozen foods; irradiation preservation of foods

UNIT V MANUFACTURE OF FOOD PRODUCTS 9

Bread and baked goods, dairy products – milk processing, cheese, butter, ice-cream, vegetable and fruit products; edible oils and fats; meat, poultry and fish products; confectionery, beverages.

TOTAL : 45 PERIODS

REFERENCES

1. Coultate T.P. Food – The chemistry of its components, 2nd ed., Royal society, London, 1992
2. Sivasankar B. Food processing and preservation, Prentice Hall of India Pvt.Ltd., New Delhi, 2002

3. Fennema O.R. ed. Principles of food science : Part I, Food chemistry, Marcel Dekker, New York, 1976
4. Frazier W.C. and Westhoff D.C. Food Microbiology, 4th ed. McGram-Hill Book Co., New York, 1988.
5. Brenner, J.G., Butters, J.R., Cowell, N.D. and Lilly, A.E.V. Food engineering operations, 2nd ed., Applied Sciences Pub.ltd., London,1979
6. Pyke, M. Food Science and Technology , 4th ed., John Murray, London, 1981

BT8011 PHARMACEUTICAL BIOTECHNOLOGY L T P C
3 0 0 3

UNIT I INTRODUCTION 8

History of pharmaceutical industry, Drugs discovery and Development phases; Drugs and Cosmetics ACT and regulatory aspects; Definition: Generics and its advantages; Biogenerics and Biosimilars; The role of patents in the drug industry; Protein-based biopharmaceuticals; International Non-proprietary Names (INN) nomenclature system biosimilars regulation

UNIT II DOSAGE FORM: SCIENCE, PHARMACOKINETICS AND PHARMACODYNAMICS 10

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

UNIT III DRUG DELIVERY AND CHARACTERISATION OF BIOGENERIC RECOMBINANTS 9

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

UNIT IV PHARMACOLOGY PRINCIPLES, CLASSIFICATION OF DRUGS AND MECHANISM 10

Understanding principles of pharmacology, pharmacodynamics Study of a few classes of therapeutics like laxatives, antacids and drugs used in peptic ulcers, drugs used in coughs and colds, analgesics, contraceptives, antibiotics (folate inhibitors, protein synthesis inhibitors, DNA inhibitors), hormonal agonists and antagonists.

UNIT V CASE STUDIES ON BIOPHARMACEUTICAL PRODUCT DEVELOPMENT 8

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

1. Gareth Thomas. Medicinal Chemistry. An introduction. John Wiley. 2000.
2. Katzung B.G. Basic and Clinical Pharmacology, Prentice Hall of Intl. 1995.
3. T.V.Ramabhadran. Pharmaceutical Design And Development : A Molecular Biology Approach, Ellis Horwood Publishers, New York, 2005
4. Goodman & Gilman's The Pharmacological Basis of Therapeutics,11th edition, Mc Graw-Hill Medical Publishing Division New York, 2006.

5. Sarfaraz K. Niazi, Handbook of Biogeneric Therapeutic Proteins: Regulatory, Manufacturing, Testing, and Patent Issues, CRC Press, 2006.
6. Rodney J Y Ho, MILO Gibaldi, Biotechnology & Biopharmaceuticals Transforming proteins and genes into drugs, 1st Edition, Wiley Liss, 2003.
7. Brahmankar D M, Jaiswal S B, Biopharmaceutics and Pharmacokinetics A Treatise, Vallabh Publisher, (1995, reprint 2008)

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, 2nd ed., Blackie,1988
2. Slater A et al. Plant Biotechnology : The Genetic Manipulation of Plants, Oxford University Press, 2003 (1st and 2nd edition)
3. Gamburg O.L., Philips G.C. Plant Tissue & Organ Culture: Fundamental Methods. Narosa , 1995.
4. Heldt, Hans-Walter, Plant Biochemistry & Molecular Biology, Oxford University Press, 1997
5. Wilkins M.B .Advanced Plant Physiology , ELBS, Longman, 1987.

BT8013 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, personnrl, 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

1. Peter, Max S. and Timmerhaus, Klaus D. Plant Design and Economics for Chemical Engineers, 4th ed., McGraw Hill, 1991.
2. A compendium of Good Practices in Biotechnology, BIOTOL Series, Butterworth-Heiemann, 1993
3. Seiler, Jiing P. Good Laboratory Practice: The why and How? Springer, 2001
4. Lydersen, B.K. et al., Bioprocess Engineering: Systems, equipment and facilities, John-Wiley, 1994

BT8014 SENSORS AND INSTRUMENTATION FOR BIOAPPLICATIONS L T P C
3 0 0 3

UNIT I 9

Basic concepts in molecular interactions – types of forces involved (electrostatic, H-bonding, hydrophilic and hydrophobic), characterization of molecular recognition – affinity, avidity, binding and dissociation constants; basic design and characterization of sensor instrumentation - precision, sensitivity, resolution and specificity, errors and standard deviation, linear regression analysis.

UNIT II 9

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.

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UNIT III **9**

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 **9**

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.

Sensor applications in biotechnology: Agriculture, food, healthcare, environmental and industrial. Practical aspects of biosensor development: fabrication of an immune biosensor and an enzymatic biosensor.

TOTAL : 45 PERIODS

BT8015 UNIX OPERATING SYSTEM AND PROGRAMMING LANGUAGE C++

L T P C
2 1 0 3

UNIT I UNIX Operating System **8**

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++ **10**

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 **10**

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 **10**

Overloading operators- Functions- Friends- Class derivation-Virtual functions-Abstract base classes-Multiple inheritance.

UNIT V TEMPLATES AND FILE HANDLING **7**

Class templates-Function templates-Exception handling- File Handling

Lab: Exercises for all the topics.

TOTAL : 45 PERIODS

REFERENCES

1. Kochen, S.J. & Wood, P.H. Exploring the Unix System, Techmedia, 1999
2. Bach M.J., The design of Unix operating systems, Prentice Hall of India, 1999.
3. Lippman S.B., The C++ Primer, Addison Wesley, 1998.
4. Deitel and Deitel, C++ How to Program, Prentice Hall, 1998.
5. Balagurasamy E. , Object-Oriented Programming using C++, Tata McGraw- Hill, 2002.

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BT8071 ADVANCES IN MOLECULAR PATHOGENESIS L T P C
3 0 0 3

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

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

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

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

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

UNIT IV MECHANISMS UNDERLYING MOLECULAR PATHOGENESIS (COMMON ENTERIC PATHOGENS) 10
Shigella: Entry, Induction of macropinocytosis, Invasion of epithelial cells, Intracellular motility and spread, Apoptotic killing of macrophages, Virulence factors involved. ***E.coli***: Enterotoxigenic *E.coli* (ETEC), labile & stable toxins, Entero-pathogenic *E.coli* (EPEC), type III secretion, Cytoskeletal changes, intimate attachment; Enterohaemerrohogic *E.coli* (EHEC), Mechanism of bloody diarrhea and Hemolytic Uremic Syndrome, Enteroaggregative *E.coli* (EAEC). **Vibrio Cholerae:** Cholera toxin, Co-regulated pili, filamentous phage, survival.

UNIT V MECHANISMS UNDERLYING MOLECULAR PATHOGENESIS (COMMON NON-ENTERIC PATHOGENS) 10
Mycobacterium tuberculosis: The Mycobacterial cell envelope, Route of entry, Uptake by macrophages, Latency and persistence, Entry into and survival in phagocytes, Immune response against MTB, MTB virulence factors, Emergence of resistance. **Influenza virus:** Intracellular stages, Neuraminidase and Haemagglutinin in entry, M1 & M2 proteins in assembly and disassembly, action of amantadine. **Plasmodium:** Lifecycle, erythrocyte stages, transport mechanism and processes to support the rapidly growing schizont, parastiparous vacuoles and knob protein transport, Antimalarials based on transport processes.

TOTAL: 45 PERIODS

TEXTS/REFERENCES

1. Salyers, Abigail A. "Bacterial Pathogenesis: A Molecular Approach"
2. Groisman, "Principles of Bacterial Pathogenesis".
3. Waksman, Gabriel and Michael caparon "Structural Biology of Bacterial Pathogenesis"
4. Clark, Virginia L. "Bacterial Pathogenesis"
5. Williams, Peter "Bacterial Pathogenesis" (Methods in Microbiology)

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6. Mc Clane, Bruce A. “Microbial Pathogenesis”
7. Madigan, Michael T. “Biology of Microorganisms”
8. Stanley, “Genetic analysis of Pathogenic Bacteria”.
9. Hacker, Jorg “Molecular Infection Biology”

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

OBJECTIVES

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

OUTCOME

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

UNIT I BASICS OF ENZYMES AS BIOCATALYSIS 9

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 9

Methods for investigating the kinetics of Enzyme catalysed reactions – Initial velocity Studies, Estimation of Michaelis Menten parameters, Effect of pH and temperature on enzyme activity, kinetics of inhibition. Modeling of rate equations for single and multiple substrate reactions.

UNIT III IMMOBILIZED ENZYMES 9

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 9

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 9

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

TOTAL: 45 PERIODS

TEXTS/REFERENCES

1. Blanch, H.W., Clark, D.S. Biochemical Engineering, Marcel Dekker, 1997
2. Lee, James M. Biochemical Engineering, PHI, USA, 1982.
3. Bailey J.E. & Ollis, D.F. Biochemical Engineering Fundamentals, 2nd Ed., McGraw Hill, 1986
4. Faber, Kurt "Biotransformations in organic chemistry : A Textbook" 5th Edition. Springer 2008.
5. Enzyme catalysis in organic synthesis (Vol I-III); Eds by K.Drauz and H. Waldmann. Willey-VCH (ISBN: 3-527-29949-1)
6. Hydrolases in organic synthesis (regio and stereoselective biotransformations). U. T. Bornscheuer and R. J. Kazlauskas. Willey-VCH. (ISBN: 3-527-30104-6).
7. Stereoselective biocatalysis. Ed. R.N. Patel. Marcel Dekker. (ISBN: 0-8247- 8282-8)

BT8073 COMMUNICATION SKILL DEVELOPMENT L T P C
2 0 2 3

OBJECTIVES

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

OUTCOME

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

UNIT I PROCESS OF COMMUNICATION 9

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 9

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 9

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 9

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 9

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

Attested

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REFERENCE

1. Mohan Krishna and N.P. Singh, Speaking English effectively,Macmillan, 2003.

BT8074 GENOMICS AND TRANSCRIPTOMICS L T P C
3 0 0 3

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 9

General organization and structure of genomes of viruses, prokaryotes, eukaryotes, and organelles (chloroplast, mitochondrion)

UNIT II GENOME MAPPING AND SEQUENCING 9

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 GENOMICS ANALYSES 9

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 9

Designing and producing microarrays; cDNA microarray technology; oligonucleatide arrays and designs; Sample preparation, labeling, hybridization, generation and analysis of microarray data.

UNIT V HIGH-THROUGHPUT TRANSCRIPTOMICS ANALYSES 9

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

1. S.P. Hunt and F. J. Livesey, (2000) Functional Genomics
2. S. B. Primose (1998) Principles of Genome Analysis
3. C. R. Cantor and C. L. Smith (1999) Genomics_ The Science and Technology behind the Human Genome Project
4. N. K. Spur, B. D. Young, and S. P. Bryant (1998) ICRF Handbook of Genome Analysis Volume 1 & 2.
5. G. Gibson and S. V. Muse (2002) A primer of Genome Science
6. R. J. Reece (2004) Analysis of Genes and Genomes

7. S. Suhai (2002) Genomics and Proteomics_Functional and computational aspects. Kluwer Academic
8. Hans Joac and Thomas Roeder (2005) Microarrays
9. Steve Russell, Lisa A. Meadows and Roslin R. Russell (2009) Microarray Technology in Practice
10. Allison D. B., Page G. P., Beasley T. M., and Edwards J. W. (2006) DNA microarrays and related genomics techniques – Design, Analysis, and Interpretation of Experiments. Chapman & Hall/CRC
11. Pevsner J. (2009) Bioinformatics and Functional Geneomics. Wiley-Balckwell
12. Rinaldis E. D. and Lahm A (2007)DNA Microarrays. Horizon bioscience.
13. Stekel D. (2003) Microarray Bioinformatics. Cambridge University Press

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.

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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.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Stephanopoulos, G.N. "Metabolic Engineering: Principles and Methodologies". Academic Press / Elsevier, 1998.
2. Lee, S.Y. and Papoutsakis, E.T. "Metabolic Engineering". Marcel Dekker, 1998.
3. Nielsen, J. and Villadsen, J. "Bioreaction Engineering Principles". Springer, 2007.
4. Smolke, Christiana D., "The Metabolic Pathway Engineering Handbook Fundamentals", CRC Press Taylor & Francis, 2010.

REFERENCES

1. Voit, E.O. "Computational Analysis of Biochemical Systems : A Practical Guide for Biochemists and Molecular Biologists". Cambridge University Press, 2000.
2. Scheper, T. "Metabolic Engineering" Vol 73 (Advances in Biochemical Engineering Biotechnology) Springer, 2001.
3. Cortassa, S. et al, " An Introduction to Metabolic and Cellular Engineering", World Scientific Publishing, 2002.
4. Kholodenko, Boris N and H. V. Westerhoff "Metabolic Engineering in the Post Genomic Era", Horizon Bioscience, 2004.

BT8076 NANOBIOTECHNOLOGY L T P C
2 0 2 3

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

What is meant by Nanoscale – Nanoscale Processes – Physical and Chemical Properties of Materials in the Nanoscales - Nanoscale Measurements.

UNIT II PROPERTIES AND MEASUREMENTS OF NANOMATERIALS 8

Optical Prperties – Absorption and Fluroscence – Microscopy measurements – SEM – TEM - AFM and STM. Confocal and TIRF. Imaging

UNIT III NANOBIOLOGY 8

Properties of DNA and motor proteins – Measurements of Conductivity of DNA nanowires and angular properties of motor - Lessons from Nature on making nanodevices.

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UNIT IV BIOCONJUGATION OF NANOMATERIALS TO BIOLOGICAL MOLECULES 6

Reactive Groups on biomolecules (DNA & Proteins) - Conjugation to nanoparticles (ZnS-Fe_3O_4) - Uses of Bioconjugated Nanoparticles

UNIT V NANO DRUG DELIVERY 3

Various Drug Delivery Systems – aerosol - Inhalants - Injectibles – Properties of Nanocarriers – Efficiency of the Systems.

PRACTICALS 15

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
6.Bacterial Synthesis of ZnS Nanoparticles.
7.Confocal & TIRF Microscopy of ZnS particles Interactiion with Cell lines

TOTAL : 45 PERIODS

TEXTS/REFERENCES

1. Niemeyer, Cristof M and Mirkiu, Chad A. “Nanobiotechnology: Concepts, Applications and Perspectives” Wiley-VCH, 2004.
2. Shoseyov, Oded and Ilan Levy ”NanoBioTechnology: BioInspired Devices and Materials of the Future”, Humana Press, 2007.
3. Rosenthal, Sandra J and D. W. Wright “NanoBiotechnology Protocols” Humana Press, 2005.

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 9

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 9

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.

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UNIT III SEPARATION AND PROCESSING OF PROTEINS FOR PROTEOMICS ANALYSIS 9

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 9

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 9

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

1. Simpson R. J."Proteins and Proteomics - A Laboratory Manual". Cold Spring Harbour Laboratory Press, 2002.
2. Pennington S. R. and Dunn M. J. "Proteomics - From Protein Sequence to Function. Viva Books, 2002.
3. Twyman R. M. "Principles of Proteomics". Taylor & Francis. 2004
4. O'Connor C. D. and Hames B. D. "Proteomics". Scion, 2008.
5. Dassanayake R. S. and Gunawardene Y.I.N. S. "Genomic and Proteomic Techniques". Narosa, 2011.
6. Siuzdak G. "Mass Spectrometry for Biotechnology". Academic Press. 1996.
7. Hoffman E. D. and Stroobant V. "Mass Spectrometry – Principles and Applications". John Wiley & Sons, 2007
8. Chapman J. R. "Mass Spectrometry of Proteins and Peptides" (Methods in Molecular Biology – Vol 146) Humana Press. 2000.
9. Rosenberg I. M. "Protein analysis and Purification – Benchtop Techniques". Springer, 2005.
10. Scopes R. K. "Protein Purification – Principles and Practice". Springer, 1994.
11. Schena M. "Protein Microarrays". Jones and Bartlett, 2005.
12. Smejkal G. B. and Lazarev A. V. "Separation methods in Proteomics". CRC Press, 2006.

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

OBJECTIVES

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

OUTCOME

After the completion of course, students will 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

1. Essentials of Research Design and Methodology Geoffrey R. Marczyk, David DeMatteo, David Festinger, 2005 John Wiley & Sons Publishers, Inc
2. Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry, 2nd Edition, Irwin H. Segel, 1976 John Wiley & Sons Publishers, Inc
3. Guide to Publishing a Scientific paper, Ann M. Korner, 2004, Bioscript Press.

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 pleuripotent stem cells.

UNIT V CLINICAL APPLICATIONS 9

Stem cell therapy,Molecular therapy,In vitro organogenesis, Neurodegenrative diseases, spinal cord injury, heart disease,diabetes, burns and skin ulcers, muscular dystrophy, orthopedic applications, Stem cells and Gene therapy, Physiological models,tissue engineering therapies,product characterization,components,safety,efficacy.Preservation –freezing and drying. Patent protection and regulation of of tissue-engineered products,ethical issues.

TOTAL : 45 PERIODS

TEXTS/REFERENCES

1. Bernhard O.Palsson,Sangeeta N.Bhatia,"Tissue Engineering" Pearson Publishers 2009.
2. Meyer, U.; Meyer, Th.; Handschel, J.; Wiesmann, H.P. .Fundamentals of Tissue Engineering and Regenerative Medicine.2009.
3. Bernard N. Kennedy (editor). New York : Nova Science Publishers, c2008.Stem cell transplantation, tissue engineering, and cancer applications
4. Raphael Gorodetsky, Richard Schäfer. Cambridge : RSC Publishing, c2011.Stem cell-based tissue repair.
5. R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, Handbook of Stem Cells, Two-Volume, Volume 1-2: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells, 2004, Academic Press.
6. R. Lanza, J. Gearhart etal (Eds), Essential of Stem Cell Biology, 2006, Elsevier Academic press.
7. J. J. Mao, G. Vunjak-Novakovic et al (Eds), Translational Approaches In Tissue Engineering & Regenrative Medicine" 2008, Artech House, INC Publications. Naggy N. Habib, M.Y. Levicar, , L. G. Jiao,., , and N. Fisk, Stem Cell
8. Repair and Regeneration, volume-2, 2007, Imperial College Press.

Attested

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BC8001 **DRUG DISCOVERY** **L T P C**
3 0 0 3

UNIT I **9**

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 **9**

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 **9**

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 **9**

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 **9**

Intellectual Property Rights (IPR): IPR Definition and implications for discovery & development. Forms of IPR Protection - Copyright, Trademark and Patents. International organization and treaties for IPR protection – World Trade Organization (WTO) & Trade Related Aspects of Intellectual Property Rights (TRIPS) Agreements. Importance of IPR in Indian Scenario & Indian laws for IPR protection. Patents: National and international agencies for patenting - US Patent & Trademark office (USPTO), Controller General of Patents, Designs & Trade Marks, India (CGPDTM), World Intellectual Property organization (WIPO)-Patent Cooperation Treaty (PCT); Requirements for patentability, Composition of a patent, How to apply and get patents – US, Indian and PCT.

TOTAL : 45 PERIODS

REFERENCES

1. Drugs: From discovery to approval 2nd ed by Rick NG. Wiley Blackwell (2009)
2. Intellectual Property Rights by Deborah E. Bouchoux,. Delmar Cenage Learning. 2005
3. Burger's Medicinal Chemistry and Drug discovery. Volume 2, Drug Discovery and development.6th Edition. Ed Donald J AbrahamWiley-Interscience.
4. Essentials of Medical Pharmacology, 6the Edition (Hardcover) by TripathiKd. Publisher: Jaypee Brothers (2008)
5. Laws of Patents: Concepts and Cases Edited by A. V. Narasimha Rao © 2005 The ICFAI University Press
6. Intellectual Property Rights In India: General Issues And Implications by Prankrishna Pal. Publisher: Deep & Deep Publications Pvt.ltd (2008)

BC8002 MOLECULAR EVOLUTION AND PHYLOGENY L T P C
3 0 0 3

UNIT I **9**

History of evolution of life on earth: Chemical basis of evolution, Evolution of DNA, RNA and proteins, origin of the genetic code. Hardy-Weinberg equilibrium; Evolutionary changes by mutation, gene flow, genetic drift and natural selection.

UNIT II **9**

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 **9**

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

UNIT IV **9**

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

UNIT V **9**

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

1. Molecular Evolution by Wen Hsiung-Li, 1997, Sinauer Associates, Sunderland, MA. ISBN 0878934634.
2. Evolution (3rd Edition) by Ridley, M., 2004, Blackwell Science. ISBN 1-4051-0345-0

BC8003 NEXT GENERATION SEQUENCING L T P C
2 0 2 3

UNIT I **9**

NGS Platforms: Introduction to NGS, Roche/454 FLX, Illumina/Solexa Genome Analyzer, Applied BiosystemsSOLiD system, HelicosHeliscope, 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 **9**

De-novo assembly: Overlap-layout-consensus (OLC) approach (Arachne, Phusion), de Bruijn and Euler path approach (Euler, SOAPdenovo), string graph assembler (SGA).Scaffolding: Supercontig, contig orientation, contig ordering, contig distancing and gap closing using SOAPdenovo, ABySS, OPERA and RACA.

UNIT III **9**

Application of R in NGS analysis: Introduction to Bioconductor, Reading of RNA-seq data (ShortRead, Rsamtools, GenomicRanges), annotation (biomaRt, genomeIntervals), reads coverage and assign counts (IRanges, GenomicFeatures), differential expression (DESeq).

UNIT IV **9**

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

UNIT V **9**

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

1. Stuart M. BrownNext-generation DNA sequencing Informatics Cold Spring Harbor Laboratory 2013 *ISBN 1936113872*
2. EijaKorpelainen, JarnoTuimala, PanuSomervuo, Mikael Huss, Garry Wong. RNA-seq Data Analysis: A Practical Approach. Chapman & Hall/CRC, 2014.ISBN-13: 978-1466595002
3. Hillman Chris, Ahmad Yasmeen, Whitehorn Mark, and CobleyAndyNear real-time processing of proteomics data using HADOOP Mary annLiebert, Inc- Big Data. 2014 2 (1): BD44- BD49.
4. SoweSulayman K. and ZettsuKojiCurating Big Data Made Simple: Perspectives from Scientific CommunitiesBig Data. 2014 2 (1): 23-33
5. Melanie Swan The quantified self: Fundamental Disruption in Big Data Science and Biological Discovery Mary annLiebert, Inc. Big data ,2013, 1(2): BD85-99
6. Wong Lee-Jun C. (ed.)Next generation sequencing: Translation to Clinical Diagnostics Springer 2013ISBN 978-1-4614-7001-4
7. Michal JanitzNext-generation genome sequencing: Towards Personalized Medicine Wiley-VCH, 2008 *ISBN 3527644733*

BC8004 SIGNAL PROCESSING IN BIOTECHNOLOGY L T P C
3 0 0 3

UNIT I SIGNALS AND SYSTEMS **9**

Signals and Systems -Example Signals: Sinusoids, complex exponentials, impulse and step signals, - LTI Systems and properties: impulse response, convolution, Eigenfunctions of LTI systems-Example: Biological time series signals from gene expression microarrays

UNIT II TRANSFORMS **9**

Transforms-Discrete time fourier transform-Fast fourier transform-Sampling theorems-Biological example: Fourier transform of DNA sequences reveal inherent periodicities

UNIT III DETECTION THEORY (NON-BAYESIAN) **9**

Detection theory (Non-Bayesian)-Hypothesis testing-Neyman-Pearson lemma-Likelihood ratio test-Matched filter-Metrics: ROC curve, area-under-the-ROC curve, sensitivity, specificity

UNIT IV ESTIMATION THEORY (NON-BAYESIAN) **9**

Estimation theory (Non-Bayesian)-Sufficient statistic-Bias and Minimum Variance unbiased estimators-Maximum likelihood estimators-Efficient estimation

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

1. A. Oppenheim and A. Willsky, “Signals and Systems,” Prentice Hall
2. S. M. Kay, "Fundamentals of Statistical Signal Processing: Estimation Theory", Prentice Hall PTR, 1993.
3. S. M. Kay, "Fundamentals of Statistical Signal Processing: Detection Theory", Prentice Hall PTR, 1998.

BC8005 STRUCTURAL BIOLOGY L T P C
3 0 0 3

UNIT I 9

Fundamentals of protein structure, Structural Hierarchy, Motifs and domains: domain structures, Types of proteins, Complex proteins, Principles of nucleic acid structure - Watson and Crick's base-pairings and their implications. Non Watson and Crick pairing schemes - base stacking interactions - DNA polymorphism - structure of ADNA, BDNA and ZDNA - helical transitions. Non-uniform helical DNA Structure. Unusual DNA structures - hairpins, bulges, cruciform, triplexes, tetraplexes

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

Elementary crystallography: Introduction: symmetry in crystals, lattices and unit cells, crystal systems, Bravais lattices, Elements of symmetry, Symmetry operation: classes of symmetry operations, classification of symmetry point groups and molecular space groups and equivalent points. X-ray diffraction - Laue equations - Bragg's law - reciprocal lattice and its application to geometrical Crystallography.,

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

Nuclear Magnetic Resonance:- Introduction, Nuclear spin, NMR sensitivity, shielding and deshielding effects of NMR, nuclear Overhauser effect. Spectral parameters: chemical shift, spin-spin splitting, coupling, non-equivalent proton. Carbon-13 NMR spectra of protein, FTNMR, spin-spin splitting, proton spin decoupling, off-resonance decoupling. 1D- NMR spectra, 2D-NMR spectroscopy.

TOTAL : 45 PERIODS

REFERENCES

1. K.P.Murphy. Protein structure, stability and folding (2001) Humana press. ISBN 0-89603682-0
2. Arthur M.LeskIntroduction to protein architechcture (2001) Oxford University Press. ISBN 0198504748

3. A.McPherson, Introduction to Macromolecular Crystallography. 2nd edition (2009)., John Wiley Co.
4. Carl Branden and John Tooze and Carl Brandon Introduction to Protein Structure, (1999) John Garland, Publication Inc. ISBN 0815323050
5. N.Gautham Bioinformatics (2006) Narosa publications. ISBN-13: 9781842653005
6. VasanthaPattabhai and N.Gautham Biophysics (2002) Narosa Publishers ISBN 1-4020-0218-1
7. George H. Stout , Lyle H. Jensen ,X-Ray Structure Determination: A Practical Guide, 2nd Edition.ISBN 0471607118.
8. G. E. Schulz. Principles of Protein Structure. Springer 2009
9. Rick NG, Wiley Blackwell. Drugs: From discovery to approval 2nd edition (2009)
10. Ed Donald J AbrahamWiley-Interscience. Burger's Medicinal Chemistry and Drug discovery. Volume 2, Drug Discovery and development.6th Edition (2003). ISBN 0471370282
11. TripathiKd. Essentials of Medical Pharmacology, 6the Edition. Publisher: Jaypee Brothers (2008). ISBN 978-9350259375

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 out come 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

Attested

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TEXTS/REFERENCE:

1. Licinio, Julio and Ma-Li Wong, "Pharmacogenomics: The Search for the Individualized Therapies", Wiley-VCH, 2002
2. Chabrabarthy, Chiranjb and Bhattacharyya, Atane, "Pharmacogenomics: An Approach to New Drugs Development", 2004.
3. Othstein, Mark, A. "Pharmacogenomics: Social, Ethical and Clinical Dimensions", Wiley-Liss, 2003

CP8018 BIG DATA ANALYTICS L T P C
3 0 0 3

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 9

Analytics – Nuances of big data – Value – Issues – Case for Big data – Big data options Team challenge – Big data sources – Acquisition – Nuts and Bolts of Big data. Features of Big Data - Security, Compliance, auditing and protection - Evolution of Big data – Best Practices for Big data Analytics - Big data characteristics - Volume, Veracity, Velocity, Variety – Data Appliance and Integration tools – Greenplum – Informatica

UNIT II DATA ANALYSIS 9

Evolution of analytic scalability – Convergence – parallel processing systems – Cloud computing – grid computing – map reduce – enterprise analytic sand box – analytic data sets – Analytic methods – analytic tools – Cognos – Microstrategy - Pentaho. Analysis approaches – Statistical significance – business approaches – Analytic innovation – Traditional approaches – Iterative

UNIT III STREAM COMPUTING 9

Introduction to Streams Concepts – Stream data model and architecture - Stream Computing, Sampling data in a stream – Filtering streams – Counting distinct elements in a stream – Estimating moments – Counting oneness in a window – Decaying window - Realtime Analytics Platform(RTAP) applications IBM Infosphere – Big data at rest – Infosphere streams – Data stage – Statistical analysis – Intelligent scheduler – Infosphere Streams

UNIT IV PREDICTIVE ANALYTICS AND VISUALIZATION 9

Predictive Analytics – Supervised – Unsupervised learning – Neural networks – Kohonen models – Normal – Deviations from normal patterns – Normal behaviours – Expert options – Variable entry - Mining Frequent itemsets - Market based model – Apriori Algorithm – Handling large data sets in Main memory – Limited Pass algorithm – Counting frequent itemsets in a stream – Clustering Techniques – Hierarchical – K- Means – Clustering high dimensional data Visualizations - Visual data analysis techniques, interaction techniques; Systems and applications:

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UNIT V FRAMEWORKS AND APPLICATIONS 9

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:

1. Frank J Ohlhorst, "Big Data Analytics: Turning Big Data into Big Money", Wiley and SAS Business Series, 2012.
2. Colleen Mccue, "Data Mining and Predictive Analysis: Intelligence Gathering and Crime Analysis", Elsevier, 2007
3. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
4. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 2012.
5. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", Wiley and SAS Business Series, 2012.
6. Paul Zikopoulos, Chris Eaton, Paul Zikopoulos, "Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data", McGraw Hill, 2011.
7. Paul Zikopoulos, Dirk deRoos, Krishnan Parasuraman, Thomas Deutsch , James Giles, David Corrigan, "Harness the Power of Big data – The big data platform", McGraw Hill, 2012.
8. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007
9. Pete Warden, Big Data Glossary, O'Reilly, 2011.
10. Jiawei Han, Micheline Kamber "Data Mining Concepts and Techniques", Second Edition, Elsevier, Reprinted 2008.