

UNIVERSITY DEPARTMENTS
ANNA UNIVERSITY : CHENNAI 600 025
REGULATIONS - 2013

I TO IV SEMESTERS CURRICULUM AND SYLLABUS (FULL TIME)
M.TECH. BIOTECHNOLOGY

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	COURSE TITLE	L	T	P	C
THEORY					
BT8201	Animal Biotechnology	3	0	0	3
BT8202	Bioseparation Technology	3	0	0	3
BT8203	Immunotechnology	3	0	0	3
BT8251	Advanced Genetic Engineering	3	0	0	3
	Elective IV	3	0	0	3
	Elective V	3	0	0	3
	Elective VI	3	0	0	3
PRACTICAL					
BT8211	Microbial and Immuno Technology Lab	0	0	6	3
TOTAL		21	0	6	24

SEMESTER III

CODE	COURSE TITLE	L	T	P	C
PRACTICALS					
BT8311	Advanced Bioprocess and Downstream Processing Lab	0	0	6	3
BT8312	Advanced Molecular Biology and Genetic Engineering Lab	0	0	6	3
BT8313	Project Work Phase –I	0	0	12	6
TOTAL		0	0	24	12

SEMESTER IV

COURSE CODE	COURSE TITLE	L	T	P	C
BT8411	Project Work Phase-II	0	0	24	12
TOTAL		0	0	24	12

LIST OF ELECTIVES

M. TECH. BIOTECHNOLOGY

COURSE CODE	COURSE TITLE	L	T	P	C
BT8001	Advanced Technologies in Omics Sciences	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
BT8072	Biocatalysts and Enzyme Technology	3	0	0	3
BP8071	Clinical Trials and Bioethics	3	0	0	3
BT8071	Advances in Molecular Pathogenesis	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

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.

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.

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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.

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
3 1 0 4**

OBJECTIVES

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

OUTCOME

On the completion of the course the students are expected to have learnt, Understanding and applying Statistical methods of analysis for Biological applications

UNIT I **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 Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

TOTAL : 45 PERIODS

TEXTS/REFERENCES

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 Chromatography – Purification of IgG and Albumin
9. Gel filtration – Size based separation of proteins

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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.

BT8201

ANIMAL BIOTECHNOLOGY

**L T P C
3 0 0 3**

UNIT I INTRODUCTION 4

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

UNIT II MOLECULAR BIOLOGY 9

Biology of animal viral vectors- SV40, adeno virus, retrovirus, vaccinia virus, herpes virus, adeno associated virus and baculo virus.

UNIT III CELL CULTURE TECHNOLOGY 11

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

UNIT IV GENETIC ENGINEERING 11

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

UNIT V APPLICATIONS 10

Rumen manipulation- probiotics embryo transfer technology, invitro fertilization, transgenesis- methods of transferring genes into animal oocytes, eggs, embryos and specific tissues by physical, chemical and biological methods; Biopharming -Transgenic animals (Mice, Cows, Pigs, Sheep, Goat, Birds and Insects); Artificial insemination and embryo transfer.

TOTAL : 45 PERIODS

REFERENCES

1. Watson, J.D., Gilman, M., Witowski J. and Zoller, M. Recombinant DNA, 2nd ed., Scientific American Books, 1983
2. Glick, B.R. and Pasternack, J.J. Molecular Biotechnology, 3rd ed., ASM Press, 2003
3. Lewin, B. Genes VIII, Pearson Prentice Hall, 2004
4. Davis J.M. Basic Cell Culture: A Practical Approach, IRL Press, 1998
5. Freshney R.I. Animal Cell Culture- a practical approach, 1987.

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UNIT I	INTRODUCTION TO BIOSEPARATION	4
Characterization of biomolecules and fermentation broth. Guidelines to recombinant protein purification.		
UNIT II	SOLID-LIQUID SEPARATION AND CELL DISRUPTION	6
Solid liquid separation- microfiltration and centrifugation – theory and design for scaleup operation. Cell disruption – Homogeniser , dynamill – principle, factors affecting disruption, batch and continuous operation. Cell disruption by chemical methods		
UNIT III	CONCENTRATION AND PURIFICATION	7
Liquid- liquid extraction – theory and practice with emphasis on Aqueous two phase extraction. Solid liquid extraction. Precipitation techniques using salt and solvent. Separation by ultrafiltration, Dialysis, Electrophoresis.		
UNIT IV	CHROMATOGRAPHY	15
Theory, practice and selection of media for – Gelfiltration chromatography, Ion exchange chromatography, Hydrophobic interaction chromatography, reverse phase chromatography, Affinity chromatography – Metal affinity chromatography, dye affinity chromatography, immunosorbent affinity chromatography & Expanded bed chromatography. Scaleup criteria for chromatography, calculation of no of theoretical plates and design		
UNIT V	FINAL POLISHING AND CASE STUDIES	13
Freeze drying, spray drying and crystallization. Purification of cephalosporin, aspartic acid, Recombinant Streptokinase, Monoclonal antibodies, Tissue plasminogen activator, Taq polymerase, Insulin.		

TOTAL : 45 PERIODS**REFERENCES**

1. Belter,P.A. et al., Bioseparations: Downstream Processing For Biotechnology, John-Wiley , 1988
2. Janson J.C, & Ryden L. Protein Purification: Principles, High Resolution Methods And Applications, VCH Pub. 1989.
3. Scopes R.K. – Protein Purification – Principles And Practice, Narosa , 1994.

UNIT I	INTRODUCTION	12
Cells of the immune system and their development; primary and secondary lymphoid organs; humoral immune response; cell mediated immune responses; complement.		
UNIT II	ANTIBODIES	10
Monoclonal antibodies and their use in diagnostics; ELISA; Agglutination tests; Antigen detection assay; Plaque Forming Cell Assay.		
UNIT III	CELLULAR IMMUNOLOGY	12
PBMC separation from the blood; identification of lymphocytes based on CD markers; FACS; Lymphoproliferation assay; Mixed lymphocyte reaction; Cr51 release assay; macrophage cultures; cytokine bioassays- IL2, gamma IFN, TNF alpha.; HLA typing.		

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

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

TOTAL : 45 PERIODS

REFERENCES

1. Roitt, Ivan. Essential Immunology, 9th ed., Blackwell Scientific, 1997
2. Roitt I., Brostoff J. and Male D. Immunology, 6th ed. Mosby, 2001
3. Goldsby , R.A., Kindt, T.J., Osborne, B.A. and Kerby J. Immunology, 5th ed., W.H. Freeman, 2003
4. Weir, D.M. and Stewart, J. Immunology, 8th ed., Cheerchill, Linvstone, 1997

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

OBJECTIVE

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

OUTCOME

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

UNIT I CLONING AND EXPRESSION OF GENES 10

Overview of Restriction and Modification system. Cloning vehicles: Plasmids – Host range, Copy number control, Compatibility. λ phage – Insertional and Replacement vectors, *in vitro* packaging. Single strand DNA vector – M13 Phage. Cosmids, Phasmids, PAC, BAC and YAC. Expression vector – Characteristics, RNA probe synthesis, High level expression of proteins, Protein solubilization, purification and export.

UNIT II CONSTRUCTION OF DNA LIBRARIES 10

DNA library – Types and importance. cDNA library: Conventional cloning strategies – Oligo dT priming, self priming and its limitations. Full length cDNA cloning – CAPture method and Oligo capping. Strategies for gDNA library construction – Chromosome walking. Differences between gDNA and cDNA library. Screening strategies – Hybridization, PCR, Immunoscreening, South-western and North-Western. Functional cloning – Functional complementation and gain of function. Difference cloning: Differential screening, Subtracted DNA library, differential display by PCR. Overview on microarray and its applications.

UNIT III DNA SEQUENCING 8

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

UNIT IV PCR AND MUTAGENESIS 9

PCR – Principle and applications. Different types of PCR – Hot start PCR, Touchdown PCR, Multiplex PCR, Inverse PCR, Nested PCR, AFLP-PCR, Allele specific PCR, Assembly PCR, Asymmetric PCR, LATE-PCR, Colony PCR, *in situ* PCR, Long PCR. Real-time PCR – SYBR Green assay, Taqman Probes, Molecular beacons. Mutagenesis and chimeric protein engineering by PCR, RACE, Kuntels' method of mutagenesis.

UNIT V GENE TRANSFER & GENE THERAPY**8**

Introduction of foreign genes into animal cells – Importance, DNA Microinjection, Retroviral vectors, Transfection of Embryonic stem cells, recombination. Transgenic plants – Importance, Ti Plasmid, Cointegrate and Binary vectors. Overview of Gene therapy.

TOTAL : 45 PERIODS**TEXTS/REFERENCES**

1. Primrose S.B., Twyman R.H., and Old R.W. "Principles of Gene Manipulation". 6th Edition., Blackwell Science, 2001
2. Winnacker E.L. "From Genes to clones : Introduction to Gene Technology". Panima, 2003
3. Glick B.R. and Pasternak J.J. "Molecular Biotechnology: Principles and applications of recombinant DNA" 3rd Edition., ASM Press, 2003
4. Lemonie, N.R. and Cooper, D.N. Gene Therapy, BIOS, 1996.

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

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

PART II IMMUNO TECHNOLOGY

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

TOTAL : 90 PERIODS**REFERENCES**

1. Antibodies: A Laboratory Manual, Ed Harlow, David P Lane, Cold Spring Harbor Laboratory Press, 2nd Edition, 1998
2. Molecular cloning : A laboratory manual / Joseph Sambrook, David W. Russell. 3rd ed. Cold Spring Harbor, N.Y. : Cold Spring Harbor Laboratory, 2001
3. Current protocols in immunology / editorial board John E. Coligan .et al., 2003, New York : Wiley Interscience, 2003.

BT8311 ADVANCED BIOPROCESS AND DOWNSTREAM PROCESSING LAB

**L T P C
0 0 6 3**

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

TOTAL : 90 PERIODS

BT8312 ADVANCED MOLECULAR BIOLOGY AND GENETIC ENGINEERING LAB

**L T P C
0 0 6 3**

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

TOTAL : 90 PERIODS

UNIT I MICRO ARRAY SINGENOMICS 9

Designing and producing microarrays; types of microarrays; cDNA microarray technology; oligonucleotide arrays; Sample preparation, labeling, hybridization, generation of microarray data. Gene Expression analysis by cDNA and oligonucleotide arrays; ChIP-on-Chip; Bioinformatic analysis of large-scale microarray data for comparative transcriptomics

UNIT II NEXT GENERATION SEQUENCING TECHNOLOGIES 9

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

UNIT III PROTEIN MICRO ARRAYS 9

Types of protein arrays; Protein microarray fabrication; Experimental analysis of proteins arrays. Data acquisition and processing; Applications of protein microarray types.

UNIT IV TWO-DIMENSIONAL GELELECTRO PORESIS 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-chromatography coupled to Mass-spectrometry; Mass-spectrometry analysis of Post-Translational Modifications of proteins (Phosphorylation and glycosylation). Accurate quantitation of peptides and small molecules using SRM/MRM approach.

TOTAL : 45 PERIODS**REFERENCES**

1. Schena M. (2000) DNA Microarrays _ A Practical Approach. Oxford University Press.
2. Rinaldis E. D. and Lahm A (2007) DNA Microarrays. Horizon bioscience. Causton, H.C
3. Muller H. J. and Roder T. (2006) Microarrays. Elsevier Academic Press
4. Causton H. C., Quackenbush J., and Brazma A. (2004) A Beginner's Guide
5. 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.

UNIT I CALCULUS 12

Calculus (Quick review of concepts): Review of limits, continuity, differentiability; Mean value theorem, Taylor's Theorem, Maxima and Minima; Fundamental theorem of Calculus; Improper integrals; Applications to area, volume; Convergence of sequences and series; Power series; Partial Derivatives; Gradient and Directional derivatives; Chain rule; Maxima and Minima.

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UNIT II DIFFERENTIAL EQUATION AND PARTIAL DIFFERENTIAL EQUATIONS**12**

Introduction- Differential Equation and solution-First order, linear differential equation, partial differential equations solution-Variety types of partial differential 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**LT 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 emissions Issues of ecotoxicity and sustainability with ; expanding biodiesel production

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

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

TOTAL: 45 PERIODS

REFERENCE

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 MODELING OF BIOLOGICAL SYSTEMS 9
Modeling Principles, model development from first principles. Modeling approaches for Biological systems – structured and unstructured systems; Compartment models; Deterministic and stochastic approaches for modeling structured systems.

UNIT II MODELLING OF DIFFUSION SYSTEMS (BIOFILM AND IMMOBILIZED ENZYME SYSTEMS) 9
External mass transfer, Internal diffusion and reaction within biocatalysts, derivation of finite model for diffusion-reaction systems, dimensionless parameters from diffusion-reaction models, the effectiveness factor concept, case studies; oxygen diffusion effects in a biofilm, biofilm nitrification

UNIT III MODELING BIOREACTOR 9
Bioreactor modelling: Ideal and non-ideal bioreactors; Stirred tank models; characterization of mass and energy transfer distributions in stirred tanks, Tower Reactor Model; Flow modeling, bubble column flow models, mass transfer modeling, structured models for mass transfer in tower reactors, process models in tower reactors, airlift models,

UNIT IV LINEAR SYSTEM ANALYSIS 9
Study of linear systems, linearization of non-linear systems; Simulation of linear models using MATLAB; Parameter estimation and sensitivity analysis; Steady state and unsteady state systems; stability analysis; Case study of recombinant protein production.

UNIT V HYBRID AND OTHER MODELING TECHNIQUES 9
Advanced modeling techniques such as fuzzy logic, neural network, hybrid systems and fuzzy logic systems; case studies.

TOTAL : 45 PERIODS

TEXT BOOKS

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. Bequette, 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.

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 k_{la} estimation and power requirements for sparged and agitated vessels, mass transfer across free surfaces, other factors affecting k_{la} , non Newtonian fluids, Heat transfer correlations, thermal death kinetics of microorganisms, batch and continuous heat, sterilisation of liquid media, filter sterilisation of liquid media, Air. Design of sterilisation equipment batch and continuous.

UNIT II MONITORING OF BIOPROCESSES 6

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

UNIT III MODERN BIOTECHNOLOGICAL PROCESSES 14

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

UNIT IV DESIGN AND ANALYSIS OF BIOLOGICAL REACTORS 11

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

UNIT V SCALEUP OF REACTORS 5

Scaleup by geometry similitude, oxygen transfer, power correlations, mixing time

TOTAL : 45 PERIODS

REFERENCES

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

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. thermodynamics of compressible flow, scalar conservation 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 conservation 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 conservation 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 interpolation. 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 smoothers 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, Finite 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

Attested

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Centre For Academic Courses
Anna University, Chennai-600 025.

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.

*Attested**Sobhan*
DIRECTOR

Centre For Academic Courses
Anna University, Chennai-600 025.

UNIT V**9**

Alternate Source of Energy, Biomass as a source of energy, Biocomposting, Vermiculture, Biofertilizers, Organic farming, Biofuels, Biomineralization, Bioethanol and Biohydrogen, Bioelectricity 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) Naves 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.

PROGRESS THROUGH KNOWLEDGE

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.

Attested

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DIRECTOR

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Anna University, Chennai-600 025.

UNIT IV FOOD PRESERVATION 9

Use of high temperatures – sterilization, pasteurization, blanching, aseptic canning; frozen storage – freezing curve characteristics. Factors affecting quality of frozen foods; irradiation preservation of foods

UNIT V MANUFACTURE OF FOOD PRODUCTS 9

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

TOTAL : 45 PERIODS

REFERENCES

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 LT 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.

Attested

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DIRECTOR

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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. Brahmkar D M, Jaiswal S B, Biopharmaceuticals 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** **LT 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.

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

REFERENCES

1. Yang, Victor C. "Biosensors and their Applications". Kluwer Academic / Plenum Publishers, 2000.
2. Cooper, Jon., and Cass, A.E.G. "Biosensors : A Practical Approach". 2nd Edition. Oxford University Press, 2004.
3. Freitag, Ruth. "Biosensors in Analytical Biotechnology". Academic Press, 1996.
4. Wise Donald L. "Bioinstrumentation and Biosensors". Marcel Dekker, 1991.
5. Hall, E.A.H. "Biosensors". Open University Press, 1990.

BT8015 UNIX OPERATING SYSTEM AND PROGRAMMING LANGUAGE C++ **LT 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.

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, pseudocholesterase, 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)

BP8071

CLINICAL TRIALS AND BIOETHICS

L T P C
3 0 0 3

OBJECTIVES

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

OUTCOME

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

UNIT I INTRODUCTION TO CLINICAL TRIALS 9

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

UNIT II REGULATIONS OF CLINICAL TRIALS 9

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

UNIT III MANAGEMENT AND ETHICS OF CLINICAL TRIALS 9

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

UNIT IV INFORMED CONSENT 9

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

UNIT V QUALITY CONTROL AND GUIDELINES 9

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

TOTAL : 45 PERIODS

REFERENCES

1. Lee, Chi-Jen; et al., "Clinical Trials of Drugs and Biopharmaceuticals." CRC / Taylor & Francis, 2011.
2. Matoren, Gary M. "The Clinical Research Process in the Pharmaceutical Industry." Marcel Dekker, 1984.

BT8071

ADVANCES IN MOLECULAR PATHOGENESIS

L T P C
3 0 0 3

OBJECTIVES

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

OUTCOME

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

UNIT I INTRODUCTION 5

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

UNIT II HOST DEFENSE AGAINST PATHOGENS AND BACTERIAL DEFENSE STRATEGIES 10

Skin, mucosa, cilia secretions, physical movements, physical and chemical barriers to bacterial colonisation, Mechanism of killing by humoral and cellular defenses, Complement, Inflammatory process, Phagocytosis, Colonization, Adherence, Iron acquisition mechanisms, Bacterial defense strategies.

UNIT III MOLECULAR MECHANISMS OF VIRULENCE 10

Virulence, Colonization factors, Microbial toxins, Secretion systems: General secretory pathway, Two-step secretion, Contact dependent secretion, Conjugal transfer system and Autotransporters.

UNIT IV MECHANISMS UNDERLYING MOLECULAR PATHOGENESIS (COMMON ENTERIC PATHOGENS) 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; Enterohaemorrhagic *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, parasitophorous vacuoles and knob protein transport, Antimalarials based on transport processes.

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; oligonucleotide 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

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OBJECTIVES

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

OUTCOME

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

UNIT I METABOLIC FLUX ANALYSIS 9

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

UNIT II TOOLS FOR EXPERIMENTALLY DETERMINING FLUX THROUGH PATHWAYS 9

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

UNIT III CONSTRAINT BASED GENOMIC SCALE METABOLIC MODEL 9

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

UNIT IV METABOLIC CONTROL ANALYSIS AND KINETIC MODELING 9

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

UNIT V CASE STUDIES IN METABOLIC ENGINEERING 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 Properties – Absorption and Fluorescence – 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.

UNIT IV BIOCONJUGATION OF NANOMATERIALS TO BIOLOGICAL MOLECULES 6

Reactive Groups on biomolecules (DNA & Proteins) - Conjugation to nanoparticles (ZnS-Fe₃O₄) - 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 Interaction 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.

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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.

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.

OBJECTIVES

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

OUTCOME

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

UNIT I INTRODUCTION**9**

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

UNIT II TISSUE ARCHITECTURE**9**

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

UNIT III BIOMATERIALS**9**

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

UNIT IV BASIC BIOLOGY OF STEM CELLS**9**

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

UNIT V CLINICAL APPLICATIONS**9**

Stem cell therapy, Molecular therapy, In vitro organogenesis, Neurodegenerative 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 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 et al (Eds), Essential of Stem Cell Biology, 2006, Elsevier Academic press.

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7. J. J. Mao, G. Vunjak-Novakovic et al (Eds), "Translational Approaches In Tissue Engineering & Regenerative 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.

