AFFILIATED INSTITUTIONS

REGULATIONS - 2013

CURRICULUM I TO IV SEMESTERS (FULL TIME)

M.TECH. BIOTECHNOLOGY

SEMESTER I

COURSE CODE	COURSE TITLE	L	T	P	C
THEORY					
MA7161	Applied Statistics for Biotechnologists	3	1	0	4
BY7101	Bioprocess Technology	3	0	0	3
BY7102	Computational Biology	2	0	2	3
BY7103	Entrepreneurship, IPR and Biosafety	3	0	0	3
BY7104	Advanced Genetic Engineering	3	0	0	3
	Elective I	3	0	0	3
	Elective II	3	0	0	3
	Elective III	3	0	0	3
PRACTICAL					
BY7111	Preparative and Analytical Techniques In Biotechnology	0	0	6	3
	TOTAL	**23**	**1**	**8**	**28**

SEMESTER II

COURSE CODE	COURSE TITLE	L	T	P	C
THEORY					
BY7201	Bioseparation Technology	3	0	0	3
BY7202	Immunotechnology	3	0	0	3
BY7203	Animal Biotechnology	3	0	0	3
	Elective IV	3	0	0	3
	Elective V	3	0	0	3
	Elective VI	3	0	0	3
PRACTICAL					
BY7211	Microbial and Immuno Technology Laboratory	0	0	6	3
	TOTAL	**18**	**0**	**6**	**21**

SEMESTER III

COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL					
BY7311	Advanced Molecular Biology and Genetic Engineering Laboratory	0	0	6	3
BY7312	Advanced Bioprocess and Downstream processing Laboratory	0	0	6	3
BY7313	Project Work (Phase I)	0	0	12	6
	TOTAL	**0**	**0**	**24**	**12**

SEMESTER IV

COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL					
BY7411	Project Work (Phase II)	0	0	24	12
	TOTAL	**0**	**0**	**24**	**12**

TOTAL NUMBER OF CREDITS : 73

LIST OF ELECTIVES

SEMESTER – I

COURSE CODE	COURSE TITLE	L	T	P	C
BY7001	Chemical Engineering for Biotechnologists	3	0	0	3
BY7002	Biology for Chemical Engineers	3	0	0	3
BY7003	Applied Mathematics for Biotechnologists	3	0	0	3
BY7004	Applicable Mathematics for Biotechnologists	3	0	0	3
BY7005	Unix Operating System and Programming Language C++	3	0	0	3
BY7006	Food Processing and Biotechnology	3	0	0	3
BY7007	Pharmaceutical Biotechnology	3	0	0	3
BY7008	Environmental Biotechnology	3	0	0	3
BY7009	Communication Skills and Personality Development	3	0	0	3

SEMESTER – II

COURSE CODE	COURSE TITLE	L	T	P	C
BY7010	Bioreactor Engineering	3	0	0	
BY7011	Computer Aided Learning of Structure and Function of Proteins	3	0	0	3
BY7012	Metabolic Process and Engineering	3	0	0	3
BY7013	Advanced Process Control	3	0	0	3
BY7014	Bioprocess Modeling and Simulation	3	0	0	3
BY7015	Plant Biotechnology	3	0	0	3
BY7016	Genomics and Proteomics	3	0	0	3
BY7017	Plant Design and Practice	3	0	0	3
BY7018	Computational Fluid dynamics	3	0	0	3
BY7019	Molecular Therapeutics	3	0	0	3
BY7020	Clinical Trials and Bioethics	3	0	0	3
BY7021	Advances in Molecular Pathogenesis	3	0	0	3
BY7022	Nanobiotechnology	3	0	0	3
BY7023	Research and Research Methodology in biotechnology	3	0	0	3
BY7024	Enzyme Technology and Industrial Applications	3	0	0	3

MA7161 APPLIED STATISTICS FOR BIOTECHNOLOGISTS LT P C
3 1 0 4

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. "Elements of Mathematical statistics" by V.C.Kapoor and Gupta.
2. Vittal, P.R.& V.Malini."Statistical and Numerical Methods".Margham Publications
3. Veerarajan,T. "Probability, Statistics and Random Processes".3rd ed., Tata Mc Graw-Hill,
4. 2008.

REFERENCES:

1. Johnson, R. A."Miller & Freund's Probability and Statistics for Engineers". 6th ed. PHI,2003.
2. Spiegel, Murray R., J.Schiller and R.Alu Srinivasan."Schaum's Outlines Probability and Statistics".2nd ed. Tata Mc Graw-Hill 2000.
3. Comprehensive Statistical Methods by P. N. Arora, Smeet Arora, S. Arora – S. Chand & Co.
4. Kandasamy, P. K. Thilagavathi & K. Gunavathi."Probability Statistics and Queuing Theory". S. Chand &Co., 2004

BY7101 BIOPROCESS TECHNOLOGY LT 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.

BY7102 COMPUTATIONAL BIOLOGY L T P C
2 0 2 3

UNIT I INTRODUCTION TO COMPUTATIONAL BIOLOGY AND SEQUENCE ANALYSIS 9

Molecular sequences, Genome sequencing: pipeline and data, Next generation sequencing data, Biological databases: Protein and Nucleotide databases, Sequence Alignment, Dynamic Programming for computing edit distance and string similarity, Local and Global Alignment, Needleman Wunsch Algorithm, Smith Waterman Algorithm, BLAST family of programs, FASTA algorithm, Functional Annotation, Progressive and Iterative Methods for Multiple sequence alignment, Applications.

UNIT II PHYLOGENETICS 7

Introduction to Phylogenetics, Distance and Character based methods for phylogenetic tree construction: UPGMA, Neighbour joining, Ultrametric and Min ultrametric trees, 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.

BY7103 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 and traits, developing competencies. Project identification, selection and financing. Project report- content and significance, Planning Commission's guidelines for formulating project reports-methods of project appraisals.

UNIT II INTRODUCTION TO INTELLECTUAL PROPERTY 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), PATENT Scope(WIPO), IPO, etc.)

UNIT IV PATENTING PROCEDURES 7

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

UNIT V BIOSAFETY 10

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

TOTAL : 45 PERIODS

TEXTS/REFERENCES:

1. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007
2. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra, Information Solution Pvt. Ltd., 2007
3. S.S.Kanka Entrepreneurship Development, S.Chand and Co, New Delhi 1997

BY7104 ADVANCED GENETIC ENGINEERING LT P C
3 0 0 3

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, Trasnsfection of Embryonic stem cells, recombination. Transgenic plants – Importance, Ti Plasmid, Co integrate and Binary vectors. Overview of Gene therapy.

TOTAL : 45 PERIODS

REFERENCES

1. Primrose S.B., Twyman R.H., and Old R.W. Principles of Gene Manipulation, 6th ed., Blackwell Science, 2001
2. Winnacker E.L. Frome 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 ed., ASM Press, 2003
4. Lemonie, N.R. and Cooper, D.N. Gene therapy, BIOS Scientific, 1996

BY7111 PREPARATIVE AND ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY

L T P C
0 0 6 3

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

BY7201 BIOSEPARATION TECHNOLOGY L T P C
3 0 0 3

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 , dynomill – 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.

BY7202 IMMUNOTECHNOLOGY L T P C
3 0 0 3

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 seperation 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.

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., Osbome, 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

BY7203 ANIMAL BIOTECHNOLOGY LT P C
3 0 0 3

UNIT I INTRODUCTION 4

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

UNIT II MOLECULAR BIOLOGY 9

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

UNIT III CELL CULTURE TECHNOLOGY 11

Culturing of cells, primary and secondary cell lines, Cell culture-Scaling up of animal cell culture-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

BY7211 MICROBIAL AND IMMUNO TECHNOLOGY LABORATORY L T P C
0 0 6 3

PART I MICROBIAL TECHNOLOGY

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

PART II IMMUNO TECHNOLOGY

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

TOTAL : 90 PERIODS

REFERENCES

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.

BY7311 ADVANCED MOLECULAR BIOLOGY AND GENETIC ENGINEERING LABORATORY

L T P C
0 0 6 3

1. Isolation of DNA
2. Electroporation to Yeast
3. Isolation of RNA
4. cDNA synthesis
5. Real-time PCR
6. Enzyme Linked Immunosorbent Assay (ELISA)
7. Western blot with ECL detection
8. Site directed mutagenesis
9. Southern blot (Non-radioactive)
10. Electrophoretic Mobility Shift Assay (Non-radioactive)

TOTAL : 90 PERIODS

REFERENCES:

1. Joe Sambrook and David William Russel. “Molecular cloning: A laboratory manual”, CSHL press.

BY7312 ADVANCED BIOPROCESS AND DOWNSTREAM PROCESSING LABORATORY

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 : Sterlisation 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

BY7001 CHEMICAL ENGINEERING FOR BIOTECHNOLOGISTS L T P C
3 0 0 3

UNIT I INTRODUCTION 5

Introduction to chemical engineering sciences and its role in the design & analysis of chemical processes. Overview of unit operations and processes in the chemical industry. Units and conversion factor. Introduction to Dimensional analysis.

UNIT II MATERIAL AND ENERGY BALANCES 13

Overall and component material balances - Material balances without chemical reactions - Chemical reactions -stoichiometry - conversion and yield - Material balance calculations with chemical reactions – combustion calculations - recycle operations. Energy balances - Entropy - Latent heat - Chemical reactions - combustion. Concepts of chemical thermodynamics, the relation to VLE, solution thermodynamics and reaction thermodynamics.

UNIT III FLUID MECHANICS 9

Properties of fluids; Fluid statics – forces at fluid surfaces, Pressure and measurement of pressure differences; Fluid flow concepts and basic equations of fluid flow – continuity equation and Bernoulli's equation; shear stress relationship and viscous effects in fluid flow; non newtonian fluids; significance of dimensionless groups in fluid flow operations.

UNIT IV TRANSPORTATION OF FLUIDS 9

Different types of pumps, compressors and valves. Measurement of fluid flow using hydrodynamic methods, direct displacement method. Types of agitators, flow patterns in agitated vessels, calculation of power consumption – applications in bioreactor design

UNIT V HEAT TRANSFER 9

Nature of heat flow - Conduction, convection, radiation. Steady state conduction, Principles of heat flow in fluids, Heat transfer by forced convection in laminar and turbulent flow. Heat exchange equipments- principles and design.

TOTAL : 45 PERIODS

REFERENCES

1. Bhatt B.I., Vora S.M. Stoichiometry.3rd ed., Tata McGraw-Hill, 1977.
2. McCabe W.L., *et al*., Unit Operations In Chemical Engineering. 6th ed., McGraw-Hill Inc., 2001.
3. Geankoplis C.J. Transport Processes And Unit Operations. 3rd ed., Prentice Hall India, 2003.

BY7002 BIOLOGY FOR CHEMICAL ENGINEERS L T P C
3 0 0 3

UNIT I INTRODUCTION TO BIOLOGICAL MOLECULES 9

Basic Carbon Chemistry, Types of biomoleules, Molecular structure and function of Biological Macromolecules - Proteins, Nucleic acids, Carbohydrates, Lipids

UNIT II GENES TO METABOLIC END-PRODUCTS 9

Basics of DNA replication, transcription, translation, biocatalysis, pathways and metabolism

UNIT III MOLECULAR CELL BIOLOGY AND ENERGETICS 9

Functional organization of cells at molecular level; membranes, molecular communication across membranes, energetics – proton motive force, ATP synthesis, respiration; photosynthesis

UNIT IV MOLECULAR BASIS OF MICROBIAL FORMS AND THEIR DIVERSITY 9

Structural differences between different microbial cell types; over view of primary and secondary metabolism of microbes, commercial products like antibiotics, vitamins from microbes

UNIT V MOLECULAR BASIS OF HIGHER LIFE FORMS 9

Molecular differences between various eukaryotic cell types, tissue proteins, blood, important molecular components of blood, albumin, antibodies, hormones and their actions

TOTAL : 45 PERIODS

REFERENCES

1. Interactive Concepts in Biochemistry by Rodney Boyer, Copyright 2002, John Wiley & Sons Publishers, Inc.
2. http://www.wiley.com/legacy/college/boyer/0470003790/index.htm
3. Biochemistry by Lubert Stryer, 5th Edition W. H. Freeman and Company, New York
4. Lehninger's Principles of Biochemistry, 4th Edn, by David L. Nelson and Michael M. Cox,
5. Molecular Cell Biology, Sixth Edition., by Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, Hidde Ploegh, Paul Matsudaira Bioenergetics at a Glance: An Illustrated Introduction D. A. Harris, 1995 John Wiley & Sons Publishers, Inc
6. Introduction to General, Organic, and Biochemistry, 8th Edition Morris Hein, Leo
7. R. Best, Scott Pattison, Susan Arena 2004, John Wiley & Sons Publishers, Inc
8. An Introduction to Molecular Biotechnology: Molecular Fundamentals, Methods and Applications in Modern Biotechnology Michael Wink (Editor) 2006, John Wiley & Sons Publishers, Inc

BY7003 APPLIED MATHEMATICS FOR BIOTECHNOLOGISTS L T P C
3 0 0 3

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

UNIT II **9**
Probability –Addition theorem, Multiplication theorem and conditional probability-Baye's theorem. Binomial distribution, Poisson distribution and Normal distribution.

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

UNIT IV **9**
Sampling distributions-Large samples and Small samples. Testing of Null hypothesis-Z test, t test and χ^2 test. Type I and Type II errors. Fisher's F Test. Goodness of fit.

UNIT V **9**
Design of Experiments –One way, Two way classifications – Randomied Block Designs-Latin Square Designs.

TOTAL : 45 PERIODS

TEXT BOOKS
1. Higher Engineering Mathematics 37th Edition. By Grewal.
2. Comprehensive Statistical Methods By P.N.Arora, Sumeet Arora, S.Arora. S.Chand & Co

REFERENCES
1. Probability and Statistics for Engineers 6th Edition. Prentice Hall By R.A.Johnson.
2. Statistical Quality control for the Food Industry. By MERTON R .HUBBARD Mathematical Statistics By V.C.Kapoor and Gupta.

BY7004 APPLICABLE MATHEMATICS FOR BIOTECHNOLOGY L T P C
3 0 0 3

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

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

UNIT I CALCULUS **12**
Calculus (Quick review of concepts): Review of limits, continuity, differentiability; Mean value theorem, Taylor's Theorem, Maxima and Minima; Fundamental theorem of Calculus; Improper integrals; Applications to area, volume; Convergence of sequences and series; Power series; Partial Derivatives; Gradient and Directional derivatives; Chain rule; Maxima and Minima.

UNIT II DIFFERENTIAL EQUATION AND PARTIAL DIFFERENTIAL EQUATIONS 12

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

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.

BY7005 UNIX OPERATING SYSTEM AND PROGRAMMING LANGUAGE C++

L T P C
3 0 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.

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

UNIT I FOOD CHEMISTRY 9

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

UNIT II FOOD MICROBIOLOGY 9

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

UNIT III FOOD PROCESSING 9

Raw material characteristics; cleaning, sorting and grading of foods; physical conversion operations – mixing, emulsification, extraction, filtration, centrifugation, membrane separation, crystallization, heat processing.

UNIT IV FOOD PRESERVATION 9

Use of high temperatures – sterilization, pasteurization, blanching, 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

BY7007 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)

BY7008 **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.

BY7009 COMMUNICATION SKILLS AND PERSONALITY DEVELOPMENT

L T P C
3 0 0 3

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 12

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 12

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 12

Web browsing for information search; search engines and their mechanism of searching;Hidden Web and its importance in scientific research; Internet as a medium of interaction between scientists; Effective email strategy using the right tone and conciseness

TOTAL : 45 PERIODS

TEXT BOOK

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

BY7010 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

BY7011 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 V 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

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

OBJECTIVES

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

UNIT I METABOLIC FLUX ANALYSIS 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. Christiana D. Smolke, “ The Metabolic Pathway Engineering Handbook Fundamentals”, CRC Press Taylor & Francis Group, 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. S. Cortassa, M.A.Aon, A.A. Iglesias and D.Llyod, “ An Introduction to Metabolic and Cellular Engineering”, World Scientific Publishing Co. Pte. Ltd, 2002.
4. Boris N. Kholodenko and Hans V. Westerhoff “Metabolic Engineering in the Post Genomic Era”, Horizon Bioscience, 2004

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

UNIT I ANALYSIS AND DESIGN OF FEED BACK CONTROL SYSTEM 9

Dynamic behaviour, stability analysis, design of feed back controllers, design of feed back control systems using frequency response techniques, PID controller for multicapacity processes.

UNIT II OPTIMUM CONTROLLER SETTING 9

Optimum settings from the plant response, continuous cycling method, damped oscillation method, reaction curved method.

UNIT III ANALYSIS AND CONTROL OF ADVANCED CONTROL SYSTEMS 9

Feedback control of systems with large dead time, control systems with multiple loops, feed forward and ratio control, adaptive and inferential control systems.

UNIT IV AUTOMATIC CONTROLLERS 9

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

UNIT V PROCESS CONTROL USING DIGITAL COMPUTERS: 9

Characteristics and performance of control computers, signals-types, signal transmission, analog feedback control systems. The direct digital control concept, advantages of DDC, computer process interface for data acquisition and control, computer control loops.

TOTAL : 45 PERIODS

REFERENCES

1. George Stephanopolous – Chemical Process Control, An introduction to Theory and Practice, prentice Hall of India Pvt.Ltd., New Delhi 1990.
2. Emanule S. Savas _ Computer control of industrial processes, McGraw Hill, London, 1965.
3. Peter Harriot – Process Control, Tata McGraw Hill Publishing Co, New Delhi 1977.

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

OBJECTIVE

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

UNIT I MODELING OF BIOLOGICAL SYSTEMS 9

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

UNIT II MODELLING OF DIFFUSION SYSTEMS (BIOFILM AND IMMOBILIZED ENZYME SYSTEMS 9

External mass transfer, Internal diffusion and reaction within biocatalysts, derivation of finite model for diffusion-reaction systems, dimensionless parameters from diffusion-reaction models,the effectiveness factor concept, case studies; oxygen diffusion effects in a biofilm, biofilm nitrification

UNIT III MODELING BIOREACTOR 9

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

UNIT IV LINEAR SYSTEM ANALYSIS 9

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

UNIT V HYBRID AND OTHER MODELING TECHNIQUES 9

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

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. 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**.**

BY7015 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 8
Nitrogen fixation, Nitrogenase activity, nod genes, nif genes, bacteroids, plant nodulins, production of secondary metabolites, flavanoid synthesis and metabolic engineering.

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

UNIT V APPLICATIONS OF PLANT BIOTECHNOLOGY 10
Outline of plant tissue culture, 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

BY7016 GENOMICS AND PROTEOMICS L T P C
3 0 0 3

UNIT I OVERVIEW OF GENOMES
Genomes of Bacteria, archae and eukaryota **9**

UNIT II PHYSICAL MAPPING TECHNIQUES 9
Top down and bottom up approach; linking and jumping of clones; genome sequencing; placing small fragments on map; STS assembly; gap closure; pooling strategies; cytogenetic mapping techniques.

UNIT III FUNCTIONAL GENOMICS 9
Gene finding; annotation; ORF and functional prediction; Substractive DNA library screening; differential display and representational difference analysis; SAGE;TOGA.

UNIT IV PROTEOMICS TECHNIQUES 9

Protein level estimation; Edman protein microsequencing; protein cleavage; 2 D gel electrophoresis; metabolic labeling; detection of proteins on SDS gels; pattern analysis; Mass spectrometry- principles of MALDI-TOF; Tandem MS-MS; Peptide mass fingerprinting.

UNIT V PROTEIN PROFILING 9

Post translational modification; protein-protein interactions; glycoprotein analysis; phosphoprotein analysis.

TOTAL : 45 PERIODS

REFERENCES

1. Cantor, C.R. and Smith, C.L. Genomics. The Science and Technology Behind the human genome project, John Wiley & Sons, 1999.
2. Pennington, S.R. and Dunn, M.J. Proteomics: From protein sequence to function, Vina Books, 2002.
3. Liebler,D.C. Introduction to Proteomics: Tools for the New Biology, Humana Press, 2002.
4. Hunt, S.P. and Livesey, F.J. Functional Genomics, Oxford University press, 2000
5. Primrose, S.B. Principles of genome analysis : A guide to mapping and sequencing DNA from different organisms, 2nd ed., Blackwell Science, 1998.

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

UNIT I PLANT DESIGN 12

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

UNIT II PROCESS ECONOMICS 8

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

UNIT III PHARMACEUTICAL WATER SYSTEM 7

Grades of water, sanitary design, water treatment system, Water distribution system, validation

UNIT IV VALIDATION OF BIOPHARMACEUTICAL FACILITIES 8

Introduction, why validation, when does validation occur, validation structure, resources for validation, validation of systems and processes including SIP and CIP

UNIT V GOOD MANUFACTURING PRACTICES 10

Structure – quality management, 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

BY7018 COMPUTATIONAL FLUID DYNAMICS L T 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.

BY7019 MOLECULAR THERAPEUTICS L T P C
3 0 0 3

UNIT I GENE THERAPY 9

Gene therapy; Intracellular barriers to gene delivery; Overview of inherited and acquired diseases for gene therapy; Retro and adeno virus mediated gene transfer; Liposome and nanoparticles mediated gene delivery

UNIT II CELLULAR THERAPY 9

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

UNIT III RECOMBINANT THERAPY 9

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

UNIT IV IMMUNOTHERAPY 9

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

UNIT V GENE SILENCING TECHNOLOGY 9

Gene silencing technology; Antisense therapy; si RNA; Tissue and organ transplantation; Transgenics and their uses; Cloning; Ethical issues

TOTAL : 45 PERIODS

TEXT BOOKS

1. Bernhard Palsson and Sangeeta N Bhatia, Tissue Engineering, 2nd Edition, Prentice Hall, 2004.
2. Pamela Greenwell, Michelle McCulley, Molecular Therapeutics: 21st century medicine, 1st Edition, Sringer, 2008.

BY7020 CLINICAL TRIALS AND BIOETHICS L T P C
3 0 0 3

UNIT I 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 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 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 **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 **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.

BY7021 ADVANCES IN MOLECULAR PATHOGENESIS L T P C
3 0 0 3

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

REFERENCES

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

BY7022 NANOBIOTECHNOLOGY L T P C
3 0 0 3

OBJECTIVES

The 'Nanobiotechnology' course aims to provide fundamental concepts of nanotechnology and advanced knowledge on th e application of nanotechnology to biological sciences including nanomedicine.

OUTCOMES

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

UNIT I NANOSCALE AND NANOBIOTECHNOLOGY 6

Introduction to Nanoscience and Nanotechnology; Milestones in Nanotechnology; Overview of Nanobiotechnology and Nanoscale processes; Physicochemical properties of materials in Nanoscales.

UNIT II FABRICATION AND CHARACTERIZATION OF NANOMATERIALS 10

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

UNIT III PROPERTIES AND MEASUREMENT OF NANOMATERIALS 9

Optical Properties: Absorption, Fluorescence, and Resonance; Methods for the measurement of nanomaterials; Microscopy measurements: SEM, TEM, AFM and STM. Confocal and TIRF imaging.

UNIT IV NANOBIOLOGY AND BIOCONJUGATION OF NANOMATERIALS 10

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

UNIT V NANO DRUG DELIVERY AND NANOMEDICINE 10

Properties of nanocarriers; drug delivery systems used in nanomedicine; Enhanced Permeability and Retention effect; Blood-brain barrier; Active and passive targeting of diseased cells; Health and environmental impacts of nanotechnology.

TOTAL : 45 PERIODS

REFERENCES

1. Nanobiotechnology: Concepts, Applications and Perspectives, Christof M. Niemeyer (Editor), Chad A. Mirkin (Editor) , Wiley-VCH; 1 edition , 2004.
2. NanoBioTechnology: BioInspired Devices and Materials of the Future by Oded Shoseyov and Ilan Levy, Humana Press; 1 edition 2007.
3. NanoBiotechnology Protocols (Methods in Molecular Biology) by Sandra J Rosenthal and David W. Wright , Humana Press; 1 edition, 2005.
4. Bio-Nanotechnology_ Concepts and applications. Madhuri Sharon, Maheshwar Sharon, Sunil Pandey and Goldie Oza, Ane Books Pvt Ltd, 1 edition 2012
5. Microscopy Techniques for Material Science. A. R. Clarke and C. N. Eberhardt (Editors) CRC Press. 1st Edition, 2002.

BY7023 RESEARCH AND RESEARCH METHODOLOGY IN BIOTECHNOLOGY

L T P C
3 0 0 3

UNIT I RESEARCH AND ITS METHODOLOGIES (WITH EXAMPLES) 9

Objectives of research, research process – observation, analysis, inference, hypothesis, axiom, theory, experimentation, types of research (basic, applied, qualitative, quantitative, analytical etc). Features of translational research, the concept of laboratory to market (bench to public) and Industrial R&D.

UNIT II RESEARCH IN BIOTECHNOLOGY – AN OVERVIEW 9

Biological systems and their characteristic:. Type and outcome of research, Exploratory and product-oriented research in various fields of biotechnology (health, agri, food, industrial etc) – types of expertise and facilities required. Interdisciplinary nature of biotech research, sources of literature for biotech research

UNIT III EXPERIMENTAL RESEARCH: BASIC CONCEPTS IN DESIGN AND METHODOLOGY 9

Precision, accuracy, sensitivity and specificity; variables, biochemical measurements, types of measurements, enzymes and enzymatic analysis, antibodies and immunoassays, instrumental methods, bioinformatics and computation, experimental planning – general guidelines

UNIT IV RESULTS AND ANALYSIS 9

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

UNIT V SCIENTIFIC AND TECHNICAL PUBLICATION 9

Different types of scientific and technical publications in the area of biotechnology, and their specifications, Ways to protect intellectual property – Patents, technical writing skills, definition and importance of impact factor and citation index - assignment in technical writing

TOTAL : 45 PERIODS

TEXT BOOKS/REFERENCES

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

BY7024 ENZYME TECHNOLOGY AND INDUSTRIAL APPLICATIONS L T P C
3 0 0 3

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

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

UNIT I INTRODUCTION 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, 1982.
3. Bailey J.E. & Ollis, D.F. “Biochemical Engineering Fundamentals.” 2nd Edition. McGraw Hill, 1986
4. Faber, Kurt “Biotransformations in Organic Chemistry : A Textbook.” 5th Edition. Springer, 2008.
5. Palmer, Trevor. “Enzymes : Biochemistry, Biotechnology, Clinical Chemistry.” 2nd Edition, East West Press, 2008.