UNIVERSITY DEPARTMENTS

ANNA UNIVERSITY CHENNAI : : CHENNAI 600 025

REGULATIONS - 2009

CURRICULUM I TO IV SEMESTERS (FULL TIME)

M.TECH. BIOTECHNOLOGY

SEMESTER – I

COURSE CODE	COURSE TITLE	L	T	P	C
THEORY					
BT 9150 BT 9151 BT 9152	Molecular Fundamentals in biology Fundamentals of chemical engineering / Enzyme Technology and Industrial applications	3	0	0	3
BT 9111	Biochemical engineering and Fermentation Technology	3	0	0	3
BT 9112	Computational Biology	2	0	2	3
BT 9113	IPR and Biosafety	3	0	0	3
BT	Elective 1	3	0	0	3
BT	Elective 2	3	0	0	3
BT	Elective 3	3	0	0	3
PRACTICAL					
BT 9114	Preparative and analytical techniques in biotechnology	0	0	6	3
	TOTAL	**20**	**0**	**8**	**24**

SEMESTER II

COURSE CODE	COURSE TITLE	L	T	P	C
THEORY					
BT 9121	Bioseparation Technology	3	0	0	3
BT 9122	Advanced Genetic Engineering	3	0	0	3
BT 9123	Immunotechnology	3	0	0	3
BT 9124	Animal Biotechnology	3	0	0	3
BT	Elective 4	3	0	0	3
BT	Elective 5	3	0	0	3
BT	Elective 6	3	0	0	3
PRACTICAL					
BT 9125	Microbial and Immuno Technology Lab	0	0	6	3
	TOTAL	**21**	**0**	**6**	**24**

SEMESTER III

COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICALS					
BT 9131	Advanced Molecular Biology and Genetic Engineering Lab	0	0	6	3
BT 9132	Advanced Bioprocess and downstream processing Lab	0	0	6	3
BT 9133	Mini Project	0	0	12	6
	TOTAL	**0**	**0**	**24**	**12**

SEMESTER IV

COURSE CODE	COURSE TITLE	L	T	P	C
BT 9141	Project Work	0	0	24	12
	TOTAL	0	0	24	**12**

Code	Course Title	L	T	P	C
ELECTIVES SEMESTER I					
BT 9153	Applied Mathematics for Biotechnologists	3	0	0	3
BT 9154	Applicable Mathematics for Biotechnologists	3	0	0	3
BT 9155	Unix Operating System and Programming Language C++	3	0	0	3
BT 9156	Food Processing and Biotechnology	3	0	0	3
BT 9157	Pharmaceutical Biotechnology	3	0	0	3
BT 9158	Environmental Biotechnology	3	0	0	3
ELECTIVES SEMESTER II					
BT 9160	Bioreactor Engineering	3	0	0	3
BT 9161	Computer aided learning of structure and function of proteins	3	0	0	3
BT 9162	Metabolic process and engineering	3	0	0	3
BT 9163	Advanced process control	3	0	0	3
BT 9164	Bioprocess modeling and simulation	3	0	0	3
BT 9165	Plant Biotechnology	3	0	0	3
BT 9166	Genomics and proteomics	3	0	0	3
BT 9167	Plant Design and Practice	3	0	0	3
BT 9168	Computational fluid dynamics	3	0	0	3
BT 9169	Molecular Therapeutics	3	0	0	3
BT 9170	Clinical Trials and Bioethics	3	0	0	3
BT 9171	Advances in Molecular Pathogenesis	3	0	0	3
BP 9169	Nanobiotechnology	2	0	2	3
BP 9171	Research and research methodology in biotechnology	3	0	0	3

SEMESTERS	**L**	**T**	**P**	**C**
Semester I	20	0	8	24
Semester II	21	0	6	24
Semester III	0	0	24	12
Semester IV	0	0	24	12
Total No of Credits	**41**	**0**	**62**	**72**

BRIDGE COURSE I

BT9150 MOLECULAR FUNDAMENTALS IN BIOLOGY 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

TEXTS / REFERENCES

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

BT9151 FUNDAMENTALS OF CHEMICAL ENGINEERING 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.

BT9152 ENZYME TECHNOLOGY AND INDUSTRIAL APPLICATIONS L T P C
3 0 0 3

UNIT I KINETICS AND MECHANISM OF ENZYME ACTION 8

Classification of enzymes; quantification of enzyme activity and specific activity. 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 II IMMOBILISED ENZYME REACTIONS 9

Techniques of enzyme immobilisation-matrix entrapment, ionic and cross linking, column packing; Analysis of mass transfer effects of kinetics of immobilised enzyme reactions; Analysis of Film and Pore Diffusion Effects on Kinetics of immobilized enzyme reactions; calculation of Effectiveness Factors of immobilized enzyme systems; Bioconversion studies with immobilized enzyme packed -bed reactors.

UNIT III MASS TRANSFER EFFECTS IN IMMOBILISED ENZYME SYSTEMS 5

Analysis of film and Pore diffusion Effects on kinetics of immobilised enzyme reactions; Formulation of dimensionless groups and calculation of Effectiveness Factors

UNIT IV APPLICATION OF ENZYMES 12

Extraction of commercially important enzymes from natural sources; Commercial applications of enzymes in food, pharmaceutical and other industries; enzymes for diagnostic applications. Industrial production of enzymes. Use of enzymes in analysis-types of sensing-gadgetry and methods. Case studies on application - chiral conversion, esterification etc.,

UNIT V ENZYME BIOSENSORS 11

Applications of enzymes in analysis; Design of enzyme electrodes and case studies on their application as biosensors in industry, healthcare and environment.

TOTAL:45 PERIODS

REFERENCES

1. Blanch, H.W., Clark, D.S. Biochemical Engineering, Marcel Dekker, 1997
2. Lee, James M. Biochemical Engineering, PHI, USA.
3. Bailey J.E. & Ollis, D.F. Biochemical Engineering Fundamentals, 2nd Ed., McGraw Hill, 1986
4. Wiseman, Alan. Hand book of Enzyme Biotechnology, 3rd ed., Ellis Harwood 1995.

BT9111 BIOCHEMICAL ENGINEERING AND FERMENTATION TECHNOLOGY L T P C 3 0 0 3

UNIT I INTRODUCTION TO BIOPROCESSES 5

Historical development of bioprocess technology, An overview of traditional and modern applications of biotechnological processes, general requirements of fermentation processes, Basic design and construction of fermentor and ancillaries, Main parameters to be monitored and controlled in fermentation processes.

UNITII METABOLIC STOICHIOMETRY AND ENERGETICS 8

Stoichiometry of Cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield coefficients of biomass and product formation, maintenance coefficients Energetic analysis of microbial growth and product formation, oxygen consumption and heat evolution in aerobic cultures, thermodynamic efficiency of growth.

UNIT III MEDIA DESIGN FOR FERMENTATION PROCESSES 12

Medium requirements for fermentation processes, Carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation of optimal growth and product formation, examples of simple and complex media. Medium for plant cell culture and animal cell culture. Medium design of commercial media for industrial fermentations – Plackett burman design, response surface methodology, simplex design, continuous cultivation method to determine the kinetic parameters and maintenance coefficient and pulse &shift method of medium optimiuzation. Case studies on each medium design methods.

UNIT IV KINETICS OF MICROBIAL GROWTH AND PRODUCT FORMATION 10

Phases of cell growth in batch cultures, Fed batch and continuous cultures. Simple unstructured kinetic models for microbial growth, Monod model, Growth of filamentous organisms & yeast. Growth associated (primary) and non-growth associated (secondary) product formation kinetics, Leudeking-Piret models, substrate and product inhibition on cell growth and product formation.

UNIT V FERMENTATION TECHNOLOGY 10

Case studies on production of Lactic acid, Glutamic acid, Pencillin, Microbial Lipase and Protease, Recombinant Insulin. Case studies should deal with strain improvement, medium designs, process optimization etc.,

TOTAL: 45 PERIODS

REFERENCES

1. Bailey, J.E. and Ollis, D.F. Biochemical Engineering Fundamentals", 2nd ed.,McGraw Hill 1986.
2. Shuler, M.L. and Kargi, F. Bioprocess Engineering : Basic concepts, 2nd ed., Prentice-Hall, 2002.
3. Doran Pauline M, Bioprocess Engineering Principles, Academic Press, 1995
4. Stanbury, P.F., Stephen J. Hall & A. Whitaker, Principles of Fermentation Technology, Science & Technology Books.

BT9112 COMPUTATIONAL BIOLOGY L T P C
2 0 2 3

UNIT I INTRODUCTION TO COMPUTATIONAL BIOLOGY 7

Molecular sequences. Sequence analysis. Dynamic programming. Pairwise and multiple sequence alignment and motifs. Applications.

UNIT II DATABASES 6

Scoring matrices, heuristic methods of database searching: BLAST family of programs, FASTA. Phylogenetic trees.

UNIT III INTRODUCTION TO GENOMICS AND PROTEOMICS 10

Functional, structural and comparative genomics. Gene finding and annotation. Protein structure. Homology modeling. Differential gene expression.

UNIT IV MACHINE LEARNING TECHNIQUES 12

Hidden Markov models, Neural nets, Decision trees and their application in computational biology. Eukaryotic and prokaryotic gene finding. DNA Computing.

UNIT V INTRODUCTION TO PERL 10

Variables, Data types, control flow constructs, arrays, lists and hashes, String manipulation, File handling.

Lab:

Sequence analysis : Pairwise and multiple sequence alignment. Tools available for sequence analysis. Motif generation.
Databases : Exploring biological databases
Database searching : Using BLAST, PSIBLAST and PHIBLAST, FASTA.

Gene finding : Using Genscan, HMMGene etc.
Protein structure Prediction : Tools for protein structure prediction.
Annotation : Functional annotation.
Writing utilities using Perl.

TOTAL: 45 PERIODS

REFERENCES

1. Gusfield, Dan. Algorithms on strings Trees and Sequences, Cambridge University Press.
2. Baldi, P., Brunak, S. Bioinformatics: The Machine Learning Approach, 2nd ed., East West Press, 2003
3. Mount D.W. Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, 2001.
4. Baxevanis A.D. and Oullette, B.F.F. A Practical Guide to the Analysis of Genes and Proteins, 2nd ed., John Wiley, 2002
5. Tisdall, James, Beginning PERL for Bioinformatics, O'Reilley, 2001.6. Durbin, R. et al., Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids. Cambridge University Press, 1998.

BT9113 IPR AND BIOSAFETY L T P C
3 0 0 3

UNIT I INTRODUCTION TO INTELLECTUAL PROPERTY 9

Types of 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 and few Case Studies

UNIT II AGREEMENTS AND TREATIES 9

History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments

UNIT III BASICS OF PATENTS AND CONCEPT OF PRIOR ART 9

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 PATENT FILING PROCEDURES 9

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 9

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

TEXT BOOKS/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

BT9114	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
6. Separation of lipids by TLC.
7) Enzyme Kinetics: Direct and indirect assays – determination of K_m, V_{max} and K_{cat}, K_{cat}/ K_m
8) Restriction enzyme – Enrichment and unit calculation
9) Ion-exchange Chromatagraphy – Purification of IgG and Albumin
10) Gel filtration – Size based separation of proteins
11) Affinity chromatography – IMAC purification of His-tagged recombinant protein
12) Assessing purity by SDS-PAGE Gel Electrophoresis
13) 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.

BT9121 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

Liq- liq 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.

BT9122 ADVANCED GENETIC ENGINEERING L T P C
3 0 0 3

UNIT I CLONING AND EXPRESSION OF GENES 10

Cloning vehicles, restriction enzymes, restriction modification, linkers, adaptors, homopolymeric trailing, restriction mapping

Expression and purification of recombinant proteins, prokaryotic and eukaryotic expression vectors, in vivo homologous recombination, large scale expression and purification of proteins.

UNIT II LIBRARY CONSTRUCTION 8

cDNA & genomic DNA library construction and screening, preparation of DNA, RNA probes immunoscreening and blotting techniques, etc

UNIT III SEQUENCING 10

Methodology – Chemical & enzymatic, Automated sequence, Genome sequencing methods – top down approach, bottom up approach.

UNIT IV PCR AND MUTAGENESIS 7

PCR principle, applications, different types of PCR, mutagenesis and chmeric protein engineering by PCR, RACE, Kuntels' method of mutagenesis.

UNIT V GENE TRANSFER & GENE THERAPY 10

Introduction of foreign genes into plant and animal cells, creation of transgenic plants and animal knockouts, gene therapy, types and vectors.

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

BT9123 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.

BT9124 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

BT9125 MICROBIAL AND IMMUNO TECHNOLOGY LAB L T P C
0 0 6 3

1. Sterilization, disinfection, safety in microbiological laboratory.
2. Preparation of media for growth of various microorganisms.
3. Identification and culturing of various microorganisms.
4. Staining and enumeration of microorganisms.
5. Growth curve, measure of bacterial population by turbidometry and studying the effect of temperature, pH, carbon and nitrogen.

6. Selection of animals, Preparation of antigens, Immunization and methods of bleeding, Serum separation, Storage.
7. Antibody titre by ELISA method.
8. Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion.
9. SDS-PAGE, Immunoblotting, Dot blot assays
10. Blood smear identification of leucocytes by Giemsa stain
11. Separation of mononuclear cells by Ficoll-Hypaque
12. Immunodiagnostics using commercial kits

TOTAL: 90 PERIODS

BT9131	**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

BT9132	**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 : 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

BT9153 APPLIED MATHEMATICS FOR BIOTECHNOLOGISTS L T P C
3 0 0 3

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 9

First order and second order-application to biology.Lagrange's method and Charpits method.

UNIT II PROBABILITY AND STATISTICS 9

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

UNIT III CURVE FITTING 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 SAMPLING DISTRIBUTIONS 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 DESIGN OF EXPERIMENTS 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.

BT9154 APPLICABLE MATHEMATICS FOR BIOTECHNOLOGISTS L T P C
3 0 0 3

UNIT I CALCULUS REVIEW 9

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

UNIT II ORDINARY DIFFERENTIAL EQUATIONS 9

First order differential equations: Exact equations, Integrating factors and Bernoulli equations.

UNIT III SECOND AND HIGHER ORDER DIFFERENTIAL EQUATIONS 9

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 9

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 9

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: 45 PERIODS

TEXT BOOKS/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.

BT9155	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.
Programming Language C++

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.

BT 9156 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, diary 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

BT9157 PHARMACEUTICAL TECHNOLOGY L T P C
3 0 0 3

UNIT I INTRODUCTION 6
History of pharmacy, the pharmaceutical industry & development of drugs; economics and regulatory aspects, quality management; GMP

UNIT II DRUG KINETICS AND BIOPHARMACEUTICS 9
Mechanism of drug absorption, distribution, metabolism and excretion – factors affecting the ADME process, bioequivalence, pharmacokinetics.

UNIT III PRINCIPLES OF DRUG MANUFACTURE 15
Liquid dosage forms – solutions, suspensions and emulsions, Topical applications – ointments, creams, suppositories, Solid dosage forms – powders, granules, capsules, tablets, coating of tablets, Aerosols. Preservation, packing techniques

UNIT IV ADVANCES IN DRUG DELIVERY 5
Advanced drug delivery systems – controlled release, transdermals, liposomes and drug targeting

UNIT V BIOPHARMACEUTICALS 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, hormones.

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.

BT9158 ENVIRONMENTAL BIOTECHNOLOGY L T P C
3 0 0 3

UNIT I OVERVIEW 9
Microbial flora of soil, growth, ecological adaptations, interactions among soil microorganisms, biogeochemical role of soil microorganisms. Environmental monitoring – sampling, physical,chemical and biological analysis, monitoring pollution

UNIT II BIOLOGICAL WASTEWATER TREATMENT 9
Waste water characteristics, The activated sludge process, Design and modeling of activated sludge processes, Aerobic digestion, nitrification, secondary treatment using a trickling biological filter, anaerobic digestion, mathematical modeling of anerobic digestor dynamics, anaerobic denitrification, phosphate removal

UNIT III BIOREMEDIATION 9
Introduction, Inorganic wastes, petroleum based wastes, synthetic organic compounds, phytoremediation, gaseous wastes, desulphurisation of coal and oil.

UNIT IV TREATMENT OF INDUSTRIAL WASTES 9
Dairy, pulp, dye, leather, hospital and pharmaceutical industrial waste management. Solid waste management.

UNIT V MOLECULAR BIOLOGY 9

Latest elements, developements pertaining to environmental biotechnology.

TOTAL : 45 PERIODS

REFERENCES

1. Stanier R.Y., Ingraham J.L., Wheelis M.L., Painter R.R., General Microbiology, Mcmillan Publications, 1989.
2. Foster C.F., John Ware D.A., Environmental Biotechnology , Ellis Horwood Ltd., 1987.
3. Chakrabarty K.D., Omen G.S., Biotechnology And Biodegradation, Advances In Applied Biotechnology Series , Vol.1, Gulf Publications Co., London, 1989.
4. Bailey J.E. & Ollis, D.F. Biochemical Engineering Fundamentals, 2nd Ed., McGraw Hill, 1986
5. Alan Scragg., Environmental Biotechnology, Longman.

BT9160 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

BT9161	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

BT9162 METABOLIC PROCESS AND ENGINEERING L T P C
3 0 0 3

UNIT I REVIEW OF CELLULAR METABOLISM 9

An Overview of Cellular Metabolism, Transport processes, Fuelling reactions: glycolysis, Fermentative pathways, Biosynthetic reactions, polymerization ,cellular energetics

UNIT II MATERIAL BALANCES AND DATA CONSISTENCY 9

Comprehensive models of cellular reactions; stoichiometry of cellular reactions, reaction rates, dynamic mass balances, yield coefficients and linear rate equations, analysis of over determined systems- identification of gross measurement errors

UNIT III METABOLIC FLUX ANALYSIS 9

Theory, overdetermined systems, underdetermined systems- linear programming, sensitivity analysis, methods for the experimental determination of metabolic fluxes by isotope labeling, applications of metabolic flux analysis.

UNIT IV METABOLIC CONTROL ANALYSIS 9

Fundamentals of Metabolic Control Analysis, control coefficients and the summation theorems, Determination of flux control coefficients, MCA of linear pathways, branched pathways, theory of large deviations

UNIT V ANALYSIS OF METABOLIC NETWORKS 9

Control of flux distribution at a single branch point, Grouping of reactions, case studies, extension of control analysis to intermetabolite, optimization of flux amplifications, consistency tests and experimental validation.

TOTAL: 45 PERIODS

REFERENCE

1. Stephanopoulas, G, *et al*., Introduction to Metabolic engineering – Principles and Methodologies. Elsevier Science, 1996.

BT9163 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.

BT9164 BIOPROCESS MODELLING AND SIMULATION L T P C
3 0 0 3

UNIT I INTRODUCTION AND BALANCE EQUATIONS 3

Material and energy balance, General form of dynamic models, dimensionless models. General form of linear systems of equations, nonlinear function.

UNIT II STATE SPACE MODELS FOR LINEAR AND NONLINEAR MODELS 10

Solution of general state-space form. Solving homogeneous, linear ODEs with distinct and repeated Eigenvalues. Solving non-homogeneous equation, equation with time varying parameters, Routh stability criterion.

UNIT III TRANSFER FUNCTION 10

Analysis of first order system, self regulating processes, lead-lag models, transfer function analysis of higher order systems, pole location, Pade approximation for dead time, converting transfer function model to state space form.

UNIT IV BLOCK DIAGRAMS 12

System in series, pole-zero cancellation, block in parallel, Feedback system, Routh stability criterion for transfer functions. Discrete time models and parameter estimation. Phase plane analysis, nonlinear system, Nonlinear dynamics, cobweb diagram, bifurcation and orbit diagram, stability, cascade of period doubling. Bifurcation behavior of single ODR system and two state systems. Lorenz equation and stability analysis. Chaos in chemical systems.

UNIT V CASE STUDIES 10

Related to linear regression and generalization of linear regression technique. Stirred tank heaters: developing the dynamic model, steady state condition. State space model. Adsorption: dynamic model, steady state analysis. Isothermal continuous stirred tank chemical reactors, Biochemical reactors: model equations, steady-state function, dynamic behavior, linearization, phase plane analysis, multiple steady state, bifurcation behavior.

TOTAL : 45 PERIODS

REFERENCES
1. William L. Luyben: Process Modelling, simulation and Control for Chemical engineers. McGraw-Hill publishing company.
2. Coughanowr and Koppel: Process system analysis and control. McGraw-Hill publishing company.
3. Mickley, Sherwood and REED: Applied mathematics in chemical engineering. McGraw-Hill publishing company.
4. George Stephanopoulos: Chemical process control: an introduction to theory and practice. Prentice-Hall of India Private Ltd.

BT9165 PLANT BIOTECHNOLOGY L T P C
3 0 0 3

UNIT I INTRODUCTION TO PLANT MOLECULAR BIOLOGY 5

Genetic material of plant cells – nucleosome structure and its biological significance; transposons, recombinant DNA techniques; outline of transcription and translation.

UNIT II CHLOROPLAST & 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.

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 & 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, Molecular diagnosis of plant diseases.

UNIT V APPLICATIONS OF PLANT BIOTECHNOLOGY 13

Outline of plant tissue culture, transgenic plants, herbicide and pest resistant plants, molecular pharming , theraputic products, functional genomics, whole genome sequencing project eg: Arabidopsis, RNAi

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
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

BT9166 GENOMICS AND PROTEOMICS L T P C
3 0 0 3

UNIT I OVERVIEW OF GENOMES 9

Genomes of Bacteria, archae and eukaryota

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.

BT9167 PLANT DESIGN AND PRACTICE L T P C
3 0 0 3

UNIT I PLANT DESIGN 16

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 3

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, personal, premises and equipment, documentation, production, quality control, contract manufacturing and analysis, complaints and product recall, self inspection. Introduction to 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.

BT9168 COMPUTATIONAL FLUID DYNAMICS L T P C

3 0 0 3

UNIT I FLUID DYNAMICS 8

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 9

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 9

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 9

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.

BT9169 MOLECULAR THERAPEUTICS L T P C

3 0 0 3

UNIT I 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 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 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 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 9

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

TOTAL:45 PERIODS

TEXT BOOKS/REFERENCES

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.

BT9170 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

TEXTBOOKS

1. Clinical Trial: Study Design, Clinical Trial protocol Placebo controlled study, F.P.Miller, AF Vandome and J Mc Brewster, Alphascript Publications, 2009
2. Clinical Ethics: A Practical Approach to Ethical Decisions in Clinical Medicine VI A.Jonson, M.Seegler, w.Winslade, ‘Mc Graw Hill, VI Edition, 2006.
3. Bioethics : An Introduction to history method and practice,N.S.Jecker , A.R.Jonsen , R.A.Pearlman, Jones and Bartlett India pvt.ltd , IInd Edition , 2010.

BT9171 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

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, Phagocytic killing, Colonization, Adherence, Iron acquisition mechanisms, invasion and intracellular residence, Evasion of complement, phagocytes and antibody response.

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

BP9169 NANOBIOTECHNOLOGY L T P C
3 0 0 3

UNIT I NANOSCALES 5

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

UNIT II PROPERTIES AND MEASUREMENTS OF NANOMATERIALS 8

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

UNIT III NANOBIOLOGY 8

Properties of DNA and motor proteins – Measuremnts 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- Fe_3O_4) - Uses of Bioconjugated Nanoparticles

UNIT V NANO DRUG DELIVERY 3

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

PRACTICAL: 15

Preparation of Silver Nanoparticles by Chemical Methods
Characterization of ZnS nanoparticles by Optical Methods.
Templated Synthesis of Fe_3O_4 Nanoparticles
AFM of ZnS nanoparticles.
SEM & HRTEM Analysis of silver and Fe_3O_4 Nanoparticles
Bacterial Synthesis of ZnS Nanoparticles.
Confocal & TIRF Microscopy of ZnS particles Interactiion with Cell lines

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.

BP9171 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 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; 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