SRI VENKATESWARA COLLEGE OF ENGINEERING
(An Autonomous Institution, Affiliated to Anna University, Chennai)
SRIPERUMBUDUR TK - 602 117

REGULATION – 2018
M.TECH BIOTECHNOLOGY
Choice Based Credit System
I-IV Semesters CURRICULUM & SYLLABI

SEMESTER I

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C	Prerequisites	Fixed/Movable
THEORY										
1.	MA18183	Mathematics for Biotechnologists	FC	4	3	1	0	4	-	F
2.	BY18101	Bioprocess Technology	PC	3	3	0	0	3	-	F
3.	BY18102	Computational Systems Biology	PC	4	3	1	0	4	-	F
4.	BY18103	Food Processing and Biotechnology	PC	3	3	0	0	3	-	M
5.		Professional Elective I	PE	3	3	0	0	3	-	F
6.		Professional Elective II	PE	3	3	0	0	3	-	F
7.		Professional Elective III	PE	3	3	0	0	3	-	M
PRACTICAL										
8.	BY18111	Preparative and Analytical Techniques in Biotechnology Laboratory	PC	6	0	0	6	3	-	F
TOTAL				**29**	**21**	**2**	**6**	**26**		

SEMESTER II

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT HOURS	L	T	P	C	Prerequisites	Fixed/Movable
THEORY										
1.	BY18201	Bioseparation Technology	PC	3	3	0	0	3	BY18101	F

2.	BY18202	Immunotechnology	PC	3	3	0	0	3	-	F
3.	BY18203	Genetic Engineering and Genomics	PC	3	3	0	0	3	-	F
4.	BY18204	Research and Research Methodology in Biotechnology	PC	3	3	0	0	3	-	M
5.		Professional Elective IV	PE	3	3	0	0	3	-	F
6		Professional Elective V	PE	3	3	0	0	3	-	M
7		Professional Elective VI	PE	3	3	0	0	3	-	F
PRACTICAL										
8	BY18211	Microbial and Immunotechnology Laboratory	PC	6	0	0	6	3	-	F
TOTAL				**27**	**21**	**0**	**6**	**24**		

SEMESTER III

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT HOURS	L	T	P	C	Prerequisites	Fixed/Movable
PRACTICAL										
1.	BY18312	Molecular Biology and Genetic Engineering Laboratory	PC	6	0	0	6	3	-	F
2.	BY18313	Bioprocess and Downstream Processing Laboratory	PC	6	0	0	6	3	-	F
PROJECT										
3.	BY18311	Project Work (Phase I)	EEC	12	0	0	12	6	-	F
TOTAL				**24**	**0**	**0**	**24**	**12**		

SEMESTER IV

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT HOURS	L	T	P	C	Prerequisite	Fixed/Movable
PROJECT										
1.	BY18411	Project Work (Phase II)	EEC	24	0	0	24	12	BY18311	F
TOTAL				**24**	**0**	**0**	**24**	**12**		

Total Credits: 74

PROFESSIONAL ELECTIVES (PE) - I

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT HOURS	L	T	P	C	Prerequisites
1.	BY18001	Chemical Engineering For Biotechnologists	PE	3	3	0	0	3	-
2.	BY18002	Biology for Chemical Engineers	PE	3	3	0	0	3	-
3.	BY18003	Pharmaceutical Biotechnology	PE	3	3	0	0	3	-
4.	BY18004	Bioreactor Engineering	PE	3	3	0	0	3	-
5.	BY18005	Metabolic Process and Engineering	PE	3	3	0	0	3	-

PROFESSIONAL ELECTIVES (PE) – II

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT HOURS	L	T	P	C	Prerequisites
1.	MA18091	Applied Mathematics for Biotechnologists	PE	3	3	0	0	3	-
2.	MA18092	Applied Statistics for Biotechnologists	PE	3	3	0	0	3	-
3.	BY18006	Animal Biotechnology	PE	3	3	0	0	3	-
4.	BY18007	Plant Biotechnology	PE	3	3	0	0	3	-
5.	BY18008	Marine Biotechnology	PE	3	3	0	0	3	-

PROFESSIONAL ELECTIVES (PE) – III

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT HOURS	L	T	P	C	Prerequisites
1.	BY18009	Environmental Biotechnology	PE	3	3	0	0	3	-
2.	BY18010	Entrepreneurship, IPR and Biosafety	PE	3	3	0	0	3	
3.	BY18011	Clinical Trials and Bioethics	PE	3	3	0	0	3	-

4.	BY18012	Unix Operating System and Programming Language C++	PE	3	3	0	0	3	-
5.	BY18013	Communication Skills and Personality Development	PE	3	3	0	0	3	-

PROFESSIONAL ELECTIVES (PE) – IV

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT HOURS	L	T	P	C	Prerequisites
1.	BY18014	Enzyme Technology and Industrial Applications	PE	3	3	0	0	3	-
2.	BY18015	Advanced Process Control for Biotechnologists	PE	3	3	0	0	3	-
3.	BY18016	Bioprocess Modeling and Simulation	PE	3	3	0	0	3	-
4.	BY18017	Plant Design and Practices	PE	3	3	0	0	3	-
5.	BY18018	Biofuels and Bioenergy	PE	3	3	0	0	3	-

PROFESSIONAL ELECTIVES (PE) – V

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT HOURS	L	T	P	C	Prerequisites
1.	BY18019	Computer Aided Learning of Structure and Function of Proteins	PE	3	3	0	0	3	-
2.	BY18020	Computational Fluid Dynamics for Biotechnologists	PE	3	3	0	0	3	-
3.	BY18021	Protein Engineering and Proteomics	PE	3	3	0	0	3	-

4.	BY18022	Nanobiotechnology	PE	3	3	0	0	3	-
5.	BY18023	Analytical Techniques in Biotechnology	PE	3	3	0	0	3	-

PROFESSIONAL ELECTIVES (PE) – VI

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT HOURS	L	T	P	C	Prerequisites
1.	BY18024	Molecular Therapeutics	PE	3	3	0	0	3	-
2.	BY18025	Advances in Molecular Pathogenesis	PE	3	3	0	0	3	-
3.	BY18026	Advanced Molecular Biology	PE	3	3	0	0	3	-
4.	BY18027	Cancer Biology	PE	3	3	0	0	3	-
5.	BY18028	Tissue Engineering and Stem Cell Techniques	PE	3	3	0	0	3	-

MA18183 MATHEMATICS FOR BIOTECHNOLOGISTS

L	T	P	C
3	1	0	4

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 12

First order partial differential equations - Lagrange's and Charpits method – Second order partial differential equations – simple applications to biology.

UNIT II LINEAR PROGRAMMING 12

Formulation – Graphical solution – Simplex method – Big M method - Two phase method - Transportation and Assignment models.

UNIT III STATISTICAL METHODS 12

Correlation coefficient, properties-problems-Rank correlation-Regression equations problems-curve fitting by the method of least squares-fitting curves of the form $y = ax + b$, $y = ax^2 + bx + c$ y, $y = ab^x$ and $y = ax^b$ - Bivariate correlation application to biological problems

UNIT IV TESTING OF HYPOTHESIS 12

Sampling distributions and Standard error– Type I and Type II errors – Critical region– Tests based on Normal, t, χ^2 and F distributions for testing of mean, difference between two means, proportion, difference between two proportions, variance, ratio of two variances – Independence of attributes ($r \times c$ contingency table) - Goodness of fit.

UNIT V DESIGN OF EXPERIMENTS 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. Grewal, B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, 2015
2. Taha, H.A., "Operations Research, An Introduction"**,** 9th Edition, Pearson education, New Delhi, 2016.
3. Johnson, R. A."Miller & Freund's Probability and Statistics for Engineers". 6th ed. PHI, 2003.
4. Vittal, P.R. & V.Malini."Statistical and Numerical Methods".Margham Publications
5. Veerarajan,T. "Probability, Statistics and Random Processes".3rd ed., Tata Mc Graw- Hill, 2008.
6. Comprehensive Statistical Methods by P. N. Arora, Smeet Arora, S. Arora – S. Chand & Co.

BY18101	BIOPROCESS TECHNOLOGY	L	T	P	C
		3	0	0	3

UNIT I BLACK BOX MODEL 9

Yield coefficients, black box stoichiometries, elemental balances, heat balance, degrees of reduction balances, systematic analysis of black box stoichiometries, and identification of gross measurement errors.

UNIT II MODELING OF VARIOUS FERMENTATION PROCESSES 9

Principles of model building for biotechnological processes, structured and unstructured models, modeling of recombinant systems, Design of experiments using PBD, RSM etc.

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

TEXT BOOKS:

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

BY18102	COMPUTATIONAL SYSTEMS BIOLOGY	L	T	P	C
		3	1	0	4

UNIT I INTRODUCTION TO COMPUTATIONAL BIOLOGY AND SEQUENCE ANALYSIS **9+3**

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+2**

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+3**

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+4**

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+3**

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: 60 PERIODS

TEXT BOOKS:

1. Dan Gusfield. Algorithms on Strings Trees and Sequences, Cambridge University Press, 1997.
2. David W. Mount Bioinformatics: Sequence and Genome Analysis, 2nd Ed., Cold Spring Harbor Laboratory Press, 2004.
3. Arthur M. Lesk, Introduction to Bioinformatics, 3rd Ed., Oxford University Press, 2008.
4. Tisdall, James, Beginning PERL for Bioinformatics, O'Reilley Publications, 2001.
5. Andrew R. Leach, Molecular Modeling Principles and Applications, 2nd Ed., Prentice Hall, 2001.

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 Models of Proteins and Nucleic Acids. Cambridge University Press, 1998.
4. Pennington. S.R and Dunn. M.J. Proteomics from protein sequence to function, Taylor and Francis Group, 2001.

BY18103	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, aseptic canning; frozen storage – freezing curve characteristics. Factors affecting quality of frozen foods; irradiation preservation of foods.

UNIT V MANUFACTURE OF FOOD PRODUCTS **9**

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

TOTAL: 45 PERIODS

REFERENCES:

1. Coultate, T.P. Food – The chemistry of its components, 2nd Ed., Royal society, 1992.
2. Sivasankar, B. Food processing and preservation, Prentice Hall of India Pvt. Ltd., 2002.
3. Fennema, O.R. Principles of food science: Part I, Food chemistry, Marcel Dekker, 1976.
4. Frazier, W.C. & Westhoff, D.C. Food Microbiology, 4th Ed. McGram-Hill Book Co., 1988.
5. Brenner, J.G., Butters, J.R., Cowell, N.D. & Lilly, A.E.V. Food Engineering Operations, 2nd Ed., Applied Sciences Pub. Ltd., 1979.
6. Pyke, M. Food Science and Technology, 4th Ed., John Murray, 1981.

BY18111	PREPARATIVE AND ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY LABORATORY	L	T	P	C
		0	0	6	3

1. Preparation of buffers & Determination of their pH and Validation by Henderson Haselbalch equation.
2. Qualitative analysis of Sugars such as Monosaccharides, Disaccharides and Polysaccharides
3. Quantitative Estimation of Starch by Anthrone Method and amino acids by Ninhydrin Method
4. Estimation of protein concentration using Biuret and Lowrys' method
5. Quantitative Estimation of DNA by Diphenyl amine and RNA by Orcinol Method
6. Estimation of Ascorbic acid (Vitamin C) by Colorimetric analysis
7. Qualitative analysis of milk and isolation of casein from milk.
8. Determination of optimum pH, Temperature and Substrate concentration of acid phosphatase enzyme from potato
9. Separation of Amino acids by TLC and separation of leaf pigments by column chromatography
10. Separation of amino acids and proteins by Ion exchange chromatography
11. Separation of proteins by gel filtration and affinity chromatography
12 Characterization of DNA by Agarose gel electrophoresis and Characterization of proteins by PAGE

TOTAL: 90 PERIODS

REFERENCES:

1. Pattabiraman, T.N., Laboratory Manual in Biochemistry, 4th Ed., All India Publishers, 2004
2. Wilson, K. & Walker, J., Principles and Techniques of Practical Biochemistry, 5thEd., Cambridge University Press, 2000.
3. Plummer, D.T., An Introduction to Practical Biochemistry 3rd Ed., Tata McGraw Hill, 2008 (Re edited)

BY18201	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 scale up operation. Cell disruption: Homogenizer and Dynomill – Principle and 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 & Reverse Micellar Extraction. Solid liquid extraction. Precipitation techniques using salt and solvent. Separation by Ultrafiltration, Dialysis and Electrophoresis.

UNIT IV CHROMATOGRAPHY 15

Gel filtration chromatography, Ion exchange chromatography, Hydrophobic interaction chromatography, Reverse phase chromatography, Expanded bed chromatography &. Affinity chromatography – Metal affinity chromatography, Dye affinity chromatography, Immunosorbent affinity chromatography: Theory, practice and selection of media. Scale up criteria for chromatography, calculation of number 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 and Insulin.

TOTAL: 45 PERIODS

TEXT BOOKS/ REFERENCES:

1. Belter, P.A., Cussler, E.L., & Hu, W.S. Bioseparations: Downstream Processing For Biotechnology, John- Wiley, 1988.
2. Janson, J.C. Protein Purification: Principles, High Resolution Methods and Applications, 3rd Ed., VCH Pub., 2011.
3. Scopes, R.K. Protein Purification – Principles and Practice, 3rd Ed., Springer, 1994.

BY18202	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 separation from the blood; identification of lymphocytes based on CD markers; FACS; Lympho -proliferation 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

TEXT BOOKS/ REFERENCES:

1. Roitt, Ivan. Essential Immunology, 9th Ed., Blackwell Scientific, 1997.
2. Roitt, I., Brostoff, J & Male, D. Immunology, 6th Ed. Mosby, 2001.
3. Goldsby, R.A., Kindt, T.J., Osbome, B.A & Kerby, J. Immunology, 5th Ed., W.H Freeman, 2003.
4. Weir, D.M & Stewart, J. Immunology, 8th Ed., Churchill Livingstone, 1997.

BY18203 GENETIC ENGINEERING AND GENOMICS L T P C
3 0 0 3

UNITI CLONING AND EXPRESSION OF GENES 9

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, High level expression of proteins, RNA probe synthesis.

UNITII CONSTRUCTION OF DNA LIBRARIES 9

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 genomic DNA 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

UNITIII DNA SEQUENCING 9

DNA sequencing – Chemical & Enzymatic methods, Genome sequencing methods – top down approach, bottom up approach, Next Generation Sequencing (NGS) - Automated DNA sequencing, Pyrosequencing, Illumina Sequencing, Ion Torrent Sequencing, Nanopore sequencing.

UNITIV 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, Scorpion probes. Site Directed Mutagenesis and Chimeric protein engineering.

UNITV GENE THERAPY AND GENE EDITING 9

Introduction of foreign genes into animal cells – Importance, DNA Microinjection, Viral vectors, Transfection of Embryonic stem cells. Gene Editing using CRISPR/Cas9, Knockout mice creation using Cre-Lox recombination, Overview of Gene therapy

TOTAL: 45 PERIODS

REFERENCES:

1. Primrose, S.B., Twyman, R.H., & Old, R.W., Principles of Gene Manipulation, 6th Ed., Blackwell Science, 2001.

2. T.A. Brown, “Genomes 3”, 3rd Edition, Garland Science Publishing, 2007.
3. Glick, B.R., & Pasternak, J.J., Molecular Biotechnology: Principles and applications of recombinant DNA, 3rd Ed., ASM Press, 2003.
4. Winnacker, E.L., From Genes to clones: Introduction to Gene Technology, Panima Publishing Corporation, 2003.
5. Ansubel FM, Brent R, Kingston RE, Moore DD, “Current Protocols In Molecular Biology”, Greene Publishing Associates, 1988.
6. Lemonie, N.R., & Cooper, D.N., Gene therapy, Oxford BIOS Scientific Publishers, 1996.

BY18204 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

REFERENCES:

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

BY18211 MICROBIAL AND IMMUNOTECHNOLOGY 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
3. Enumeration of microorganisms by serial dilution
4. Growth curve, measure of bacterial population using spectrophotometer

PART II IMMUNOTECHNOLOGY

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

TOTAL:90 PERIODS

REFERENCES

1. Harlow, E.D. & David, P. L. Antibodies: A Laboratory Manual, 2nd Ed., Cold Spring Harbor Laboratory Press, 1998.
2. Joseph, S & David, W. R. Molecular cloning: A Laboratory Manual, 3rd Ed., Cold Spring Harbor Laboratory Press, 2001.
3. John, E. C. Current Protocols in Immunology, Wiley Interscience, 2003.

BY18312	MOLECULAR BIOLOGY AND GENETIC ENGINEERING LABORATORY	L	T	P	C
		0	0	6	3

LIST OF EXPERIMENTS

1. Isolation of DNA
2. Restriction Digestion and Ligation
3. Chemical Transformation and Electroporation of Bacteria
4. Isolation of RNA
5. cDNA synthesis
6. Real-time PCR
7. Enzyme Linked Immunosorbent Assay (ELISA)
8. Western blot
9. Site directed mutagenesis
10. Southern blot (Non-radioactive)

TOTAL:90 PERIODS

REFERENCES

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

BY18313	BIOPROCESS AND DOWNSTREAM PROCESSING LABORATORY	L	T	P	C
		0	0	6	3

OBJECTIVES:

- To train the students in production and purification of bioproducts.

LIST OF EXPERIMENTS:

1. Enzyme kinetics, inhibition, factors affecting reaction pH, temp.
2. Enzyme immobilization studies – Gel entrapment, adsorption and ion exchange
3. Optimization techniques – Plackett burman, Response surface methodology.
4. Batch cultivation – recombinant *E. coli* – growth rate, substrate utilization kinetics,
5. Plasmid stability, product analysis after induction, Metabolite analysis by HPLC
6. Fed batch cultivation *E. coli*, *Pichia pastoris*
7. Continuous cultivation – x - d construction, kinetic parameter evaluation, gas analysis, carbon balancing, Pulse and shift techniques.
8. Bioreactor studies : Sterilization kinetics, k_La determination, residence time distribution
9. Animal cell culture production: T-flask, spinner flask, bioreactor
10. Cell separation methods; Centrifugation and microfiltration
11. Cell disruption methods: Chemical lysis and Physical methods
12. Product concentration: Precipitation, ATPS, Ultrafiltration
13. High resolution purification; Ion exchange, affinity and Gel filtration
14. Freeze drying

TOTAL: 90 PERIODS

OUTCOMES:

At the end of the course the students would have learnt.

- The appropriate use of enzymes for reactions and bioreactors in its immobilized form.
- The optimization of media components and process parameters and the different kinds bioreactors.
- The importance of mixing time, residence time and oxygen demand in the growing cultures.
- The use of different kinds of bioreactors for animal cell culture production.
- The various separation techniques for product purification and preservation.

REFERENCES:

1. Bailey, J.E & Ollis, D.F., “Biochemical Engineering Fundamentals”, 3rd edition, McGraw Hill, 2011.
2. Belter, P.A., Cussler, E.L., and Houhu, W “Bioseparations – Downstream Processing For Biotechnology”, Wiley Interscience Publication, 2011.
3. Janson J.C. and L. Ryden, (Ed.) – Protein Purification – Principles, High Resolution Methods And Applications, 3rd Edition, Wiley-VCH Publication, 2011.

BY18001 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 Inc., 1977.
2. McCabe W.L., Smith, J.C. & Harriott, P., 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.

BY18002	BIOLOGY FOR CHEMICAL ENGINEERS	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION TO BIOLOGICAL MOLECULES 9

Basic Carbon Chemistry, Types of biomolecules, 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

TEXT BOOKS:

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

BY18003	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 BIOENERGIC RECOMBINANTS **9**

Advanced drug delivery systems – controlled release, transdermals, liposomes and drug target in 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 micro heterogeneity.

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, 2nd Ed., John Wiley, 2007.
2. Katzung B.G., Basic and Clinical Pharmacology, 12th Ed., Mc Graw Hill, 2011.
3. Ramabhadran, T.V., Pharmaceutical Design And Development: A Molecular Biology Approach, Ellis Horwood Publishers, 2005.
4. Goodman & Gilman's., The Pharmacological Basis of Therapeutics, 11th ed., McGraw- Hill Medical Publishing Division, 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 Ed., Wiley Liss, 2003.
7. Brahmankar D M & Jaiswal S B., Biopharmaceutics and Pharmacokinetics A Treatise, Vallabh Publisher, 2008.

BY18004	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, sterilization of liquid media, filter sterilization of liquid media, Air. Design of sterilization 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 maximizing 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 SCALE UP OF REACTORS 5

Similitude, oxygen transfer, power correlations, mixing time.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Anton Moser, Bioprocess Technology: Kinetics and Reactors, Springer-Verlag, 1988.
2. Bailey J.E. & Ollis, D.F., Biochemical Engineering Fundamentals, 2nd Ed., McGraw Hill Inc., 1986.
3. James M. Lee, Biochemical Engineering, Prentice Hall Inc., 1992.
4. Blanch, H.W. & Clark, D.S., Biochemical Engineering, Marcel Decker, 1996.
5. Atkinson, B., Biochemical Reactor, Pion Ltd., London, UK, 1974.

BY18005	METABOLIC PROCESS AND ENGINEERING	L	T	P	C
		3	0	0	3

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 analytical separation 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, in silico 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

Fundamentals 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, 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., Aristidou A. A. & Nielsen, J. Metabolic Engineering Principles and Methodologies, 1st Ed., Academic Press, 1998.
2. Lee, S.Y. & Papoutsakis, E.T. Metabolic Engineering, 1st ed., Marcel Dekker, 1998.
3. Nielsen, J., Villadsen, J. & Lidén, G. Bioreaction Engineering Principles, 3rd ed., Springer, 2011.
4. Smolke, C D. The Metabolic Pathway Engineering Handbook Fundamentals, 1st ed., CRC Press, 2010.

REFERENCES:

1. Voit, E.O. Computational Analysis of Biochemical Systems: A Practical Guide for Biochemists and Molecular Biologists, 1st ed., Cambridge University Press, 2000.
2. Scheper, T. Metabolic Engineering Advances in Biochemical Engineering / Biotechnology, Vol 73 Springer, 2001.
3. Cortassa, S., Aon, M. A., Iglesias, A. A. & Llyod, D. An Introduction to Metabolic and Cellular Engineering, 1st ed., World Scientific Publishing Co. Pte. Ltd, 2002.
4. Kholodenko, B.N. & Westerhoff H.V. Metabolic Engineering in the Post Genomic Era,1st ed., Horizon Bioscience, 2004.

MA18091 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 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 –Randomized Block Designs- Latin Square Designs.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Grewal, Higher Engineering Mathematics, 43rd Ed., Khanna publishers, 2014.
2. Arora, P.N., Sumeet Arora & Arora, S., Comprehensive Statistical Methods, S. Chand & Co, 2010.

REFERENCES:

1. Johnson, R.A., Miller and Freund's Probability and Statistics for Engineers, 6th Ed., Prentice Hall, 2004.
2. Merton R, Hubbard, Statistical Quality control for the Food Industry, Kluwer Academic/Plenum publishers, 2003.
3. Kapoor, V.C & Gupta., Mathematical Statistics, 2000.

MA18092 APPLIED STATISTICS FOR BIOTECHNOLOGISTS

L	T	P	C
3	0	0	3

UNIT I **9**

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 **9**

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 **9**

Correlation coefficient, properties-problems-Rank, correlation-Regression equations-problems-curve fitting by the method of least squares-fitting curves of the form ax+b, ax2+bx+c, abx and axb- Bivariate correlation application to biological problems.

UNIT IV **9**

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 **9**

Basic principles of experimentation-Analysis of variance-one-way, Two-way classifications-Randomised block design, Latin square design-problems.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Kapoor, V.C & Gupta. Fundamentals of Mathematical statistics.10th Ed., S. Chand & sons publications, 2000.
2. Vittal,P.R. & V. Malini. Statistical and Numerical Methods, Margham Publications, 2003.
3. Veerarajan, T. Probability, Statistics and Random Processes, 3rd Ed., Tata McGraw-Hill Publications Limited, 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 McGraw-Hill publications, 2000.
3. Arora, P.N., Smeet Aroral & S. Arora. Comprehensive Statistical Methods, 3rd Ed., S. Chand & Co, 2007.
4. Kandasamy, P. K., Thilagavathi & K. Gunavathi. Probability Statistics and Queuing Theory, Revised Ed., S. Chand & Co., 2010.

BY18006 **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, 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.

UNIT IV GENETIC ENGINEERING **11**

Gene therapy-prospects and problems; Knockout mice and mice model for human genetic disorder; Baculo virus in bio control; 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, *in vitro* fertilization, transgenesis - methods of transferring genes into animal oocytes, eggs, embryos and specific tissues by physical, chemical and biological methods; Bio-pharming-Transgenic animals (Mice, Cows, Pigs, Sheep, Goat, Birds and Insects); Artificial insemination and embryo transfer.

TOTAL: 45 PERIODS

TEXTBOOKS/REFERENCES

1. Watson, J.D., Gilman, M., Witowski, J. & Zoller, M. Recombinant DNA, 2nd ed., Scientific American Books, 1983.
2. Glick, B.R. & Pasternack, J.J. Molecular Biotechnology, 3rd ed., ASM Press, 2003.
3. Lewin, B. Genes IX, 11th ed., Pearson Prentice Hall, 2004.
4. Davis, J.M. Basic Cell Culture: A Practical Approach, 1st ed, IRL Press, 1998.
5. Freshney, R.I. Animal Cell Culture- a practical approach, 5th ed, Wiley-Liss, 2005.

BY18007	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 and nuclear 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, RNAi, Transgene silencing, ethical issues.

TOTAL: 45 PERIODS

REFERENCES:

1. Grierson, D. & Covey, S.N. Plant Molecular Biology, 2nd Ed., Blackie, 1988.
2. Slater, A., Scott W.N. & Fowler. M.R. Plant Biotechnology: The Genetic Manipulation of Plants, 1st and 2nd Ed., Oxford University Press, 2003.
3. Gamburg, O.L. & Philips, G.C. (Eds.) Plant Tissue & Organ Culture: Fundamental Methods. Springer, 1995.
4. Heldt Hans-Walter, Plant Biochemistry & Molecular Biology, 1st Ed. Oxford University Press, 1997.
5. Wilkins, M.B. Advanced Plant Physiology, ELBS, Longman, 1987.

BY18008	MARINE BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

UNIT I ECONOMICAL IMPORTANCE OF MARINE RESOURCES 9

Wealth of the sea - Economically important marine animals – finfishes, shrimp, crab, edible oysters and pearl oysters.

UNIT II TOXINS AND THEIR ACTION 9

Marine toxins from animals – sources and pharmacological potentials of tetrodotoxins, conotoxins and ciguateratoxins.

UNIT III POTENTIAL BIOACTIVE COMPOUNDS 9

Bioactive compounds from the sea - source and benefits of antioxidants, collagen, gelatin, heparin, chitosan, omega 3 fatty acids and carotinoids.

UNIT IV OIL AND SOLID WASTE DEGRADATION 9

Oil spillage – methods of degradation in coastal waters, Algal blooms- Biodegradation of pesticides and heavy metals discharged coastal waters- Management of solid wastes disposed into coastal waters.

UNIT V DISEASE AND WATER QUALITY MANAGEMENT 9

Diseases associated with cultured shrimps and fishes-disease management - antibiotics, Immunostimulants, diagnostic kits. Water quality management in hatcheries and grow out ponds.

TOTAL: 45 PERIODS

REFERENCES:

1. Milton Fingerman and Rachakonda Nagabhushanam, “Recent Advances in Marine Biotechnology (Series) Biomaterials and Bioprocessing”, Science Publishers, 2009.
2. Proksch and Werner E.G.Muller, Frontiers in Marine Biotechnology, Horizon Bioscience, 2006.
3. Le Gal, Y., Ulber, R, “Marine Biotechnology I: Advances in Biochemical Engineering/Biotechnology”, (Series editor: T. Scheper) Springer-Verlag Berlin Heidelberg. Vol. 96, 2005.

BY18009 ENVIRONMENTAL BIOTECHNOLOGY L T P C
3 0 0 3

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., 1989.
2. Metcalf and Eddy, Waste water Engineering Treatment, Disposal and Reuse. 3rd Ed., Mc Graw Hill, 1991.
3. Forster, C. F and Waste, D.A. J. Environmental Biotechnology, Ellis Horwood Halsted Press. 1987.
4. Bailey, J. E. and Ollis, D. F., Biochemical Engineering Fundamentals, 2nd Ed., MacGraw Hill, 1986.

5. Alan Scragg, Environmental Biotechnology, Longman, 1999.
6. Bruce E. Rittmann, Eric Seagren, Brian A.Wrenn and Albert J. Valocchi, Chittaranjan Ray, Lutgarde Raskin, In-situ Bioremediation, 2nd Ed., Nayes Publication, 1991.
7. Old R.W., and Primrose, S.B., Principles of Gene Manipulation, 3rd Ed., Blackwell Science Publication, 1985.

REFERENCES:

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

BY18010	ENTREPRENEURSHIP, IPR AND BIOSAFETY	L	T	P	C
		3	0	0	3

UNIT I ENTREPRENEURSHIP **10**

Definition – Types of Entrepreneurs. 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. 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

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, Espacenet (EPO), PATENT Scope (WIPO), IPO), Indian Patent Act 1970 & recent amendments, Case Studies.

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 and case studies.

UNIT V BIOSAFETY 10

Introduction, Historical Background, Introduction to Biological Safety Cabinets, Primary Containment for Biohazards, Biosafety Levels, Biosafety Levels of Specific Microorganisms, Recommended Biosafety Levels for Infectious Agents and Infected Animals, Biosafety guidelines - Government of India. Definition of GMOs & LMOs, Roles of Institutional Biosafety Committee, RCGM, GEAC 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 Ed., Manupatra Information Solution Pvt. Ltd., 2007.
3. Kanka, S.S. Entrepreneurship Development, 1st Ed., S. Chand and Co, 1997.

BY18011	**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 Harmonization (ICH)-GCP.

UNIT II 7

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, Bioethics in Clinical Management.

UNIT IV **11**

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; Fraud and Misconduct in Clinical Trials, 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., Clinical Trials or Drugs and Biopharmaceuticals, CRC / Taylor &Francis, 2011.
2. Salah Abdel-aleem, The Design and Management of Medical Device clinical Trials: Strategies and Challenges, John Wiley & Sons, 2011
3. Gary M. Matoren, The Clinical Research Process in the Pharmaceutical Industry, Marcel Dekker, 1984.

BY18012	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.

TOTAL: 45 PERIODS

TEXT BOOKS:

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, P. & Deitel, H. C++ How to Program, 2nd Ed. Prentice Hall, 1998.
5. Balagurasamy, E. , Object-Oriented Programming using C++, Tata McGraw - Hill, 2002

BY18013	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; Nonverbal communication - Interpreting nonverbal 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 BOOKS:

1. Mohan Krishna and N.P. Singh, Speaking English effectively, 2nd Ed., Macmillan, 2003.

BY18014	ENZYME TECHNOLOGY AND INDUSTRIAL APPLICATIONS	L	T	P	C
		3	0	0	3

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 – Acetyl cholinesterase, Angiotensin Converting Enzyme (ACE), ACE Inhibitors, HMG CoA Reductase inhibitors, Pseudocholinesterase, 5 -Nucleotidase (5NT), Glucose-6-Phosphate Dehydrogenase (GPD), Creatine Kinase (CK) isoforms, Immuno Reactive Trypsinogen (IRT) Chymotrypsin and Amylase isoenzymes.

UNIT II KINETICS OF ENZYME ACTION **9**

Methods for investigating the kinetics of Enzyme catalyzed 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 PRODUCTION, PURIFICATION AND CHARACTERIZATION OF ENZYMES **9**

Production and purification of crude enzyme extracts from plant, animal and microbial sources – Methods of characterization of enzymes – Development of enzymatic assays. The design and construction of novel enzymes and artificial enzyme.

UNIT V APPLICATIONS OF ENZYMES **9**

Enzymes in organic synthesis – Enzymes as biosensors – Enzymes for food, pharmaceutical, tannery, textile, paper and pulp industries – Enzyme for environmental applications- Enzymes for analytical and diagnostic applications – Enzymes for molecular biology research.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Blanch, H.W. & Clark, D.S. “Biochemical Engineering.” 2nd ed., Marcel Dekker, 1997.
2. James, M L. “Biochemical Engineering.” 1st ed., Prentice-Hall Inc., 1982.
3. Bailey, J.E. & Ollis, D.F. “Biochemical Engineering Fundamentals.” 2nd ed., McGrawHill, 1986.
4. Faber, K. “Biotransformations in Organic Chemistry: A Textbook.” 5th ed., Springer, 2008.

BY18015	ADVANCED PROCESS CONTROL FOR BIOTECHNOLOGISTS	L	T	P	C
		3	0	0	3

UNIT I ANALYSIS AND DESIGN OF FEED BACK CONTROL SYSTEM 9

Dynamic behavior, Stability analysis. Design of feedback controllers, design of feedback control systems using frequency response techniques, PID controller for multi-capacity processes.

UNIT II OPTIMUM CONTROLLER SETTING 9

Optimum settings from the plant response: continuous cycling method, damped oscillation method and 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

TEXT BOOKS:

1. George, S. Chemical Process Control- An introduction to Theory and Practice, 1st Ed., Prentice Hall of India Pvt.Ltd, 1990.
2. Emanule, S. S. Computer control of industrial processes, 1st Ed., McGraw Hill, 1965.
3. Peter, H. Process Control, 1st Ed., Tata McGraw Hill Publishing Co, 1977.

BY18016	BIOPROCESS MODELING AND SIMULATION	L	T	P	C
		3	0	0	3

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. Bequettre, B.W. Bio Process Dynamics Modeling, 1st Ed., Analysis and Simulation, Prentice-Hall, 1998.
2. Said, S.E.H & Elnashaie, G. P. Conservation Equations and Modeling of Chemical and Biochemical Processes, 1st Ed., Taylor & Francis, 2003.

REFERENCES:

1. Dunn, I.J. Biological Reaction Engineering: Dynamic Modeling Fundamentals with Simulation Examples, 2nd Ed., Wiley-VCH Publishing, 2003.

BY18017	PLANT DESIGN AND PRACTICES	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.

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, Personnel, Premises and Equipment, Documentation, Production, Quality control, Contract manufacturing and analysis, Complaints and product recall, Self inspection. GLP and its principles.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Peters, M., Timmerhaus, K & West, R. Plant Design and Economics for Chemical Engineers, 4th Ed., McGraw-Hill Publishing Company Limited, 1991.
2. Butterworth, H. A compendium of Good Practices in Biotechnology, BIOTOL Series, 1993.
3. Seiler, J P. Good Laboratory Practice - the Why and the How? 2nd Ed., Springer, 2005.
4. Lydersen, B.K., D'Elia, N. A. & Nelson K.L. Bioprocess Engineering: Systems, Equipment and Facilities, Wiley, 1994.

BY18018	BIOFUELS AND BIOENERGY	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION AND FUNDAMENTALS OF BIOFUELS 9

Problems relating demand and supply of non-renewable resources; Biofuel as Renewable resource; Fundamental concepts in understanding biofuel and bioenergy production: proximate and ultimate analysis, calorific value, density, moisture content.

UNIT II BIOFUEL FEEDSTOCKS 9

Biofuel feedstocks: ligno-cellulosic, starch based, sugar based, algae, oilseeds, municipal residual waste, organic waste, sewage sludge, manure.

UNIT III TYPES OF BIOFUEL 9

Various Biofuels: biochar; bioethanol - first and second generation; biobutanol; biodiesel and three generation of biodiesel; biogas; Syngas - Fischer Tropsch Fuels. Microbial fuel cells

UNIT IV BIOFUEL CONVERSION PROCESS 9

Pretreatment of biomass (pelleting; chipping; biodrying, etc.), Thermochemical conversion (pyrolysis, gasification, reforming, combustion), Biochemical conversion (anaerobic digestion, fermentation), Oil extraction and esterification.

UNIT V BIOFUEL ECONOMY AND ENVIRONMENTAL IMPACT 9

Biorefinery and circular economy. Environmental impact of the bioeconomy: Land use, Pollution and Climate change. Economics of biorenewable resources: Feedstock costs, Capital costs, Operating costs

TOTAL: 45 PERIODS

REFERENCES:

1. Samir K. Khanal, “Anaerobic Biotechnology for Bioenergy Production: Principles and Applications”, Wiley-Blackwell Publishing, 2008.
2. David M. Mousdale, “Biofuels: Biotechnology, Chemistry, and Sustainable Development “CRC Press, 2008.
3. Robert C. Brown, “Biorenewable Resources: Engineering New Products from Agriculture”, Wiley-Blackwell Publishing, 2003.

BY18019	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

TEXT BOOKS:

1. Voet, D.J., Voet, G.J. & Pratt, C.W. Fundamentals of Biochemistry, 3rd ed., John Wiley & Sons Inc, 2004.
2. Branden, C & Tooze, J. Introduction to Protein Structure, 2nd ed., Garland Science, 1999.
3. Creighton, T E. Proteins: Structures and Molecular Properties, 2nd ed., W. H. Freeman, 1993.

BY18020	COMPUTATIONAL FLUID DYNAMICS FOR BIOTECHNOLOGISTS	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 thermodynamics 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. 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, and the algebraic problem. Stability, the LBB condition, mass conservation.

TOTAL: 45 PERIODS

REFERENCES:

1. Randall, J. L. Finite Volume Methods for Hyperbolic Problems, 2nd ed., Cambridge University Press, 2004.
2. Klaus, A. H & Steve, T. C. Computational fluid dynamics, 4th ed., Engineering Education system, 2000.
3. Tannehill, J.C., Anderson, D.A & Pletcher, R.H. Computational Fluid Mechanics and Heat Transfer, 3rd ed., CRC Press, 2012.

BY18021	PROTEIN ENGINEERING AND PROTEOMICS	L	T	P	C
		3	0	0	3

UNIT I BONDS, ENERGIES, BUILDING BLOCKS OF PROTEINS 9

Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vander walls interactions in protein structure. Interaction with electromagnetic radiation (infrared, visible, ultraviolet) and elucidation of protein structure. Amino acids (the students should be thorough with three and single letter codes) and their molecular properties (size, solubility, charge, pKa), post-translational modification (involving amino, carboxyl, hydroxyl, thiol, imidazole groups).

UNIT II PROTEIN STRUCTURE 9

Primary structure: peptide mapping, peptide sequencing - automated Edman method & Mass- spec. High-throughput protein sequencing setup Secondary structure: Alpha, beta and loop structures and methods to determine Super-secondary structure: Alpha-turn-alpha, beta-turn- beta (hairpin), beta-sheets, alpha-beta-alpha, topology diagrams, up and down & TIM barrel structures nucleotide binding folds.

UNIT III TERTIARY STRUCTURE 9

Prediction of substrate binding sites, Tertiary structure: Domains, folding, denaturation and renaturation, overview of methods to determine 3D structures- X-ray, crystallography, NMR and Computational methods, Quaternary structure: Modular nature, formation of complexes.

UNIT IV STRUCTURE-FUNCTION RELATIONSHIP 9

DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, Trp repressor, Eukaryotic transcription factors, Zn fingers, helix-turn helix motifs in homeodomain, Leucine zippers, Membrane proteins: General characteristics, Trans-membrane segments, prediction, bacteriorhodopsin and Photosynthetic reaction center, Immunoglobulins: IgG Light chain and heavy chain architecture, abzymes and Enzymes: Serine proteases, understanding catalytic design by engineering trypsin, chymotrypsin and elastase, substrate-assisted catalysis other commercial applications.

UNIT V PROTEOMICS 9

Introduction to the concept of proteome, components of proteomics, proteomic analysis, importance of proteomics in biological functions, cross linking methods, affinity methods, yeast hybrid systems and protein arrays.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Branden, C &Tooze, J. Introduction to Protein Structure, 2nd ed., Garland Science, 1999.
2. Creighton, T E. Proteins: Structures and Molecular Properties, 2nd ed., W. H. Freeman, 1993.
3. Pennington, S.R. and Dunn, M.J., "Proteomics: Protein Sequence to Function", Viva Books, 2002.
4. Primrose, S.B. and Twyman, R.M. **"**Principles of Gene Manipulation and Genomics" 7th Edition,Blackwell Publishing, 2006.

BY18022	NANOBIOTECHNOLOGY	L	T	P	C
		3	0	0	3

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. Niemeyer, C.M. & Mirkin, C.A. Nanobiotechnology: Concepts, Applications and Perspectives, 1st Ed, Wiley-VCH, 2004.
2. Shoseyov, O. & Levy, I. NanoBioTechnology: BioInspired Devices and Materials of the Future, 1st Ed, Humana Press, 2007.
3. Rosenthal, S.J. & Wright, D. W. NanoBiotechnology Protocols (Methods in Molecular Biology), 1st Ed, Humana Press, 2005.
4. Madhuri, S., Maheshwar, S., Pandey, S. & Oza, G. Bio-Nanotechnology Concepts and applications, 1st Ed, Ane Books Pvt Ltd, 2012.
5. Clarke, A.R. & Eberhardt, C.N. Microscopy Techniques for Material Science, 1st Ed, CRC Press, 2002.

BY18023 ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY

L	T	P	C
3	0	0	3

UNIT I ELECTROPHORETIC TECHNIQUES **9**

Biological macromolecules, Strategies – Separation of proteins using 2D gel electrophoresis – Electrophoresis method for purifying proteins – *in situ* enzyme detection – Staining method – Separation of peptide mixture – Pulse field gel electrophoresis – Denaturing gradient gel electrophoresis.

UNIT II CHROMATOGRAPHIC TECHNIQUES **9**

Chromatographic methods for protein and peptide purification – Multidimensional chromatography – High throughput screening of soluble recombinant proteins – Immunoprecipitation – Affinity chromatography for antibody purification – Role of reverse phase HPLC in proteomic research.

UNIT III SPECTROSCOPIC TECHNIQUES **9**

Methods for characterizing purified proteins – IR absorption process, IR spectrometer and sample preparation – Instrumentation and applications of UV – Over view of mass spectrometry, ionization methods, mass analysis, detection and quantitation – Circular dichroism (CD) spectroscopy – NMR – Fourier transform infrared spectroscopy (FTIR).

UNIT IV MICROSCOPIC TECHNIQUES **9**

Microscopy with light and electrons – Electrons and their interaction with the specimen – Electron diffraction – Instrument, specimen preparation and application of TEM and SEM – Fluorescence microscopy – Laser confocal microscopy – Phase contrast – Video microscopy – Scanning probe microscopy.

UNIT V ADVANCED MOLECULAR BIOLOGY TECHNIQUES **9**

Polymerase Chain Reaction, DNA sequencing, ELISA, Nano biotechnology in molecular diagnosis: current techniques and applications- Biosensors; principle, methods and applications in biotechnology- microfluidics and Biochips technology.

TOTAL: 45 PERIODS

TEXT BOOKS/ REFERENCES:

1. Bhowmik, G. and Bose, S. Analytical Techniques in Biotechnology. Tata McGraw-Hill Publishers, 2011.
2. Chandler, D. and Roberso, R.W. Bioimaging: Current Techniques in Light & Electron Microscopy. Jones and Bartlett publishers, 2008.
3. Pavia, D.L., Lampman, G.M., Kriz, G.S. and Vyvyan, J.R. Introduction to Spectroscopy. 4th Edition, Brooks/Cole Cengage Learning, 2008.
4. Simpson, R.J. Purifying Proteins for Proteomics. Cold Spring Harbor Lab Press, 2004.
5. Keith Wilson and John Walker, Practical Biochemistry - Principles and Techniques. 5th Edition, Cambridge University Press, 2003.

BY18024	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 cell, 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, CRISPR- Cas9 Gene Editing for therapeutic strategies.

UNIT IV IMMUNOTHERAPY 9

Immunotherapy - Monoclonal antibodies and their role in cancer, Role of recombinant interferons, Immuno-stimulants, Immuno-supressors in organ transplants, Role of cytokine therapy in cancers, Vaccines - types, recombinant vaccines and clinical applications. Recombinant antigens as vaccines, reverse vaccinology.

UNIT V GENE SILENCING TECHNOLOGY 9

Gene silencing technology - Antisense therapy, si RNA, Tissue and organ transplantation, Transgenics and their uses, Cloning, Gene therapy-prospects and problems; Knockout mice and mice model for human genetic disorder, Ethical issues.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Bernhard, O. P & Sangeeta, N. B. Tissue Engineering, 2nd ed., Prentice Hall, 2009.
2. Pamela, G & Michelle, M. Molecular Therapeutics: 21st Century Medicine, John Wiley & Sons Limited, 2008.
3. James Kozubek., Modern Prometheus: Editing the Human Genome with Crispr-Cas9, 1st Online Edition. 2018
4 Primrose, S.B., Twyman, R.H., & Old, R.W., Principles of Gene Manipulation, 6th Ed., Blackwell Science, 2001.
5 Winnacker, E.L., From Genes to clones: Introduction to Gene Technology, Panima Publishing Corporation, 2003.

BY18025	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 colonization, 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*: Entero-toxigenic *E. coli* (ETEC), labile & stable toxins, Entero-pathogenic E. coli (EPEC), type III secretion, Cytoskeletal changes, intimate attachment; Entero-haemerrohogic *E. coli* (EHEC), Mechanism of bloody diarrhea and Hemolytic Uremic Syndrome, Entero-aggregative *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

TEXT BOOKS:

1. Abigail, A.S. Bacterial Pathogenesis- A Molecular Approach, 3th ed., ASM press, 2010.
2. Groisman. Principles of Bacterial Pathogenesis, 1st ed., Academic Press, 2000.
3. Gabriel, W & Michael,C. Structural Biology of Bacterial Pathogenesis, ASM press, 2005.
4. Virginia, L.C. Bacterial Pathogenesis, 1st ed., Academic press, 2002.
5. Peter, W., Julian, K & George, S. Methods in Microbiology – Bacterial Pathogenesis, 1st ed., Academic press, 1998.
6. Bruce, A.M. Microbial Pathogenesis, 1st ed, Wiley-blackwell, 1999.
7. Michael, T.M. Biology of Microorganisms, 13th ed., Benjamin Cummings, 2010.
8. Stanley. Genetic analysis of Pathogenic bacteria, A Laboratory Manual. CSHL press, 1996.
9. Jorg, H. Molecular Infection Biology, Spektrum Akademischer , 2002.

BY18026 ADVANCED MOLECULAR BIOLOGY L T P C

3 0 0 3

UNIT I INTRODUCTION 4

Mendelian genetics, linkage, crossing over, classical experiments – Hershey and Chase, Avery McLeod & McCarty.Bacterial conjugation, transduction and transformation, central dogma of biology Prokayotic & eukaryotic gene organization

UNIT II MOLECULAR AND GENETICS 9

Conformation of DNA and RNA; replication in prokaryotes, D-loop and rolling circle mode of replication, replication of linear viral DNA. Organization of eukaryotic chromosome – cot value, replication of telomeres in eukaryotes, Animal genetic engineering and cloning, Plant genetic engineering

UNIT III TRANSCRIPTION 11

In prokaryotes and eukaryotes, features of promoters and enhancers, transcription factors, nuclear RNA splicing, ribozyme, Posttranscriptional Gene Silencing

UNIT IV TRANSLATION 11

Elucidation of genetic code, mechanism, codon usage, suppressor mutation. Posttranslational modifications, Biological Roles of microRNAs, Recombination and Transposition

UNIT V REGULATION OF GENE EXPRESSION 10

Phage life cycle, mutation and repair of DNA, Lac and Trp operon, vectors, hosts, molecular cloning, Clone verification and blotting methods, DNA sequencing and PCR

TOTAL: 45 PERIODS

TEXTBOOKS/REFERENCES

1. Watson, J.D., Gilman, M., Witowski, J. & Zoller, M. Recombinant DNA, 2nd ed., Scientific American Books, 1983.
2. Glick, B.R. & Pasternack, J.J. Molecular Biotechnology, 3rd ed., ASM Press, 2003.
3. Lewin, B. Genes IX, 11th ed., Pearson Prentice Hall, 2004.
4. Watson JD, "Molecular Biology of the Gene", 5th Edition, Pearson Education, 2004.
5. Friefelder David, "Molecular Biology", 2nd edition Narosa Publ. House. 1999.

BY18027	CANCER BIOLOGY	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION 9

Definition for Cancer, Mutagens, carcinogens, and mutations Tumor viruses and the discovery of oncogenes, Tumor cells possess genetic abnormalities, Mechanisms of oncogene activation, Role of growth factors and receptors in carcinogenesis

UNIT II CELLULAR MECHANISM 9

Cellular senescence, Telomeres, cellular immortalization, and tumorigenesis, Multi-step tumorigenesis and the evolution of cancer, Tumor-promoting stimuli, Cancer stem cells

UNIT III TUMOR SUPPRESSOR GENES 9

RAS signaling in cancer, Familial cancer syndromes and the discovery of tumor suppressors,Cell cycle control and the pRb tumor suppressor, Apoptosis and the p53 tumor suppressor

UNIT IV DNA DEFECTS AND METABOLISM 9

DNA repair mechanisms, DNA repair defects and their relationship to cancer, Angiogenesis, Metastasis, Tumor Immunology, Cancer cell metabolism,

UNIT V DIAGNOSIS AND TREATMENT 9

Treatment- traditional chemotherapeutics, Treatment- Immunotherapies Treatment-targeted therapy, New Genomic and proteomic technologies, Applications of new technologies in prevention, assessing risk, diagnostics, and treatment.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Thomas, J. Kindt, Barbara, A. Osborne and Richard, Goldsby, Kuby. "Immunology", 6th Edition. W.H. Freeman, 2007.

2 Stella, Pelengaris and Michael, Khan. "The Molecular Biology of Cancer", 2nd Edition. Wiley– Blackwell, 2013.

3 Roitt, I, Brostoff, J. and Male, D. "Immunology", 6th Edition, Mosby, 2001.

4 Tannock, I. and Hill, R.P. "The basic science of oncology", 3rd Edition, McGraw-Hill, 1998.

BY18028 TISSUE ENGINEERING AND STEM CELL TECHNIQUES

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION 9

Introduction to tissue engineering: cells as therapeutic agents, enumeration of cell numbers and growth rates, measurement of cell characteristics morphology, number viability, motility and functions. Tissue appearance and measurement of tissue characteristics, cellular component, ECM components, mechanical measurements and physical properties.

UNIT II TISSUE ARCHITECTURE 9

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

UNIT III BIOMATERIALS 9

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

UNIT IV BASIC BIOLOGY OF STEM CELLS 9

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

UNIT V CLINICAL APPLICATIONS 9

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

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Bernhard O.Palsson,Sangeeta N.Bhatia,"Tissue Engineering" Pearson Publishers 2009.

2 Meyer, U.; Meyer, Th.; Handschel, J.; Wiesmann, H.P. .Fundamentals of Tissue Engineering and Regenerative Medicine.2009.

3 Bernard N. Kennedy (editor). New York : Nova Science Publishers, c2008.Stem cell transplantation, tissue engineering, and cancer applications