ANNA UNIVERSITY:: CHENNAI 600 025
AFFILIATED INSTITUTIONS
M. TECH. BIOTECHNOLOGY
REGULATIONS – 2017
CHOICE BASED CREDIT SYSTEM

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

I. To provide students with solid fundamentals and strong foundation in statistical, scientific and engineering subjects required to create and innovate in the field of biotechnology.
II. To train students with good scientific and technical knowledge so as to comprehend,
analyze, design, and create novel products and solutions for developing novel therapeutics and enzymes.
III. To prepare students to excel and succeed in Biotechnology research or industry through the latest state-of-art post graduate education.
IV. To sensitize students about scientific temper and the necessity of bioethics, social responsibility and awareness of the environment.
V. This course enables the student to develop good communication and leadership skills, respect for authority, loyalty and the life-long learning needed for a successful scientific and professional career.

PROGRAMME OUTCOMES (POs):

On successful completion of the Masters in Biotechnology graduates will be able to

1. Acquire in depth knowledge of Biological science and Bioengineering for gaining ability to develop and evaluate new ideas
2. Demonstrate Scientific and technological skills to design and perform research through modern techniques for the development of high throughput process and products.
3. Analyze Biotechnological problems and formulate intellectual and innovative vistas for research and development
4. Provide potential solutions for solving technological problems in various domains of Biotechnology considering the societal, public health, cultural environmental factors.
5. Examine the outcomes of Biotechnological issues critically and gain knowledge for composing suitable corrective measures.
6. Create and apply modern engineering tools for the prediction and modeling of complex bioengineering activities
7. Posses self management and team work skills towards collaborative, multidisciplinary scientific endeavors in order to achieve common goals
8. Develop entrepreneurial and managerial skills for the implementation of multidisciplinary projects
9. Demonstrate adherence to accepted standards of professional bioethics and social responsibilities
10. Posses the attitude necessary for lifelong and acquire communication skills relevant to professional positions

Programme Educational Objectives	Programme Outcomes									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
I	✓	✓	✓	✓	✓	✓				
II	✓	✓	✓	✓		✓				
III	✓	✓	✓	✓	✓			✓	✓	✓
IV			✓	✓			✓	✓	✓	✓
V						✓	✓	✓	✓	✓

S.No	Sem	Subjects	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10
First Year	Sem I	Statistical Techniques for Biotechnologists	✓		✓	✓		✓				
		Advanced Genetic Engineering	✓	✓	✓	✓	✓	✓	✓			
		Enzyme Technology and Fermentation Technology	✓	✓	✓	✓	✓	✓				
		Bioinformatics and Applications			✓	✓	✓	✓	✓	✓		
		Professional Elective – I										
		Professional Elective – II										
		Professional Elective – III										
		Preparative and Analytical Techniques in Biotechnology	✓	✓	✓	✓	✓	✓	✓			
	Sem II	Bio separation Technology	✓	✓	✓	✓	✓	✓				
		Bioprocess Engineering	✓		✓	✓	✓	✓				
		Bioreactor Design and Analysis		✓	✓	✓	✓	✓				
		Immunotechnology		✓	✓	✓	✓	✓				
		Advanced Genomics and Proteomics				✓	✓		✓		✓	✓
		Professional										

		Elective – IV										
		Professional Elective – V										
		Immunotechnology Laboratory			✓	✓	✓	✓			✓	
Second year	**Sem III**	Advanced Genetic Engineering Laboratory	✓	✓		✓	✓	✓	✓		✓	
		Bioprocess and Downstream Processing Laboratory		✓	✓	✓	✓		✓		✓	
		Project Work Phase – I		✓	✓	✓	✓		✓	✓		✓
	Sem IV	Project Work Phase - II		✓	✓	✓	✓		✓	✓		✓

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I TO IV SEMESTERS CURRICULUM AND SYLLABUS

SEMESTER I

S.No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	MA5166	Statistical Techniques for Biotechnology	FC	4	4	0	0	4
2	BY5101	Advanced Genetic Engineering	PC	3	3	0	0	3
3	BY5102	Enzyme Technology and Fermentation Technology	PC	3	3	0	0	3
4	BY5103	Bioinformatics and Applications	PC	3	2	2	0	3
5		Professional Elective I	PE	3	3	0	0	3
6		Professional Elective II	PE	3	3	0	0	3
7		Professional Elective III	PE	3	3	0	0	3
PRACTICAL								
8	BY5111	Preparative and Analytical Techniques in Biotechnology	PC	6	0	0	6	3
			TOTAL	**28**	**21**	**2**	**6**	**25**

SEMESTER II

S.No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	BY5201	Bio Separation Technology	PC	3	3	0	0	3
2	BY5202	Bioprocess Engineering	PC	5	3	2	0	4
3	BY5203	Bioreactor Design and Analysis	PC	4	4	0	0	4
4	BY5204	Immunotechnology	PC	3	3	0	0	3
5	BY5205	Advanced Genomics and Proteomics	PC	3	3	0	0	3
6		Professional Elective IV	PE	3	3	0	0	3
7		Professional Elective V	PE	3	3	0	0	3
PRACTICAL								
8	BY5211	Immunotechnology Laboratory	PC	6	0	0	6	3
			TOTAL	**30**	**22**	**2**	**6**	**26**

SEMESTER III

S.No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
PRACTICAL								
1	BY5311	Advanced Genetic Engineering Laboratory	PC	6	0	0	6	3
2	BY5312	Bioprocess and Downstream Processing Laboratory	PC	6	0	0	6	3
PROJECT								
4	BY5313	Project Work (Phase I)	EEC	12	0	0	12	6
			TOTAL	**24**	**0**	**0**	**24**	**12**

SEMESTER IV

S.No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
PROJECT								
1	BY5411	Project Work (Phase II)	EEC	24	0	0	24	12
			TOTAL	**24**	**0**	**0**	**24**	**12**

TOTAL CREDITS : 75

SEMESTER I, PROFESSIONL ELECTIVES I

S.No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1	BY5001	Molecular Concepts in Biotechnology (For Engineering Stream)	PE	3	3	0	0	3
2	BY5002	Principles of Chemical Engineering (For Science Stream)	PE	3	3	0	0	3
3	BY5003	Metabolic Process and Engineering (For Biotechnology Stream)	PE	3	3	0	0	3

SEMESTER I, PROFESSIONL ELECTIVES II

S.No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1	BY5004	Animal Biotechnology	PE	3	3	0	0	3
2	BY5005	Computer Aided Learning of Structure and Function of Proteins	PE	4	2	2	0	3
3	BY5006	Analytical Techniques in Biotechnology	PE	3	3	0	0	3
4	BY5007	Bio Thermodynamics	PE	3	3	0	0	3
5	BY5008	Plant Biotechnology	PE	3	3	0	0	3

SEMESTER I, PROFESSIONL ELECTIVES III

S.No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1	BY5009	Environmental Biotechnology	PE	3	3	0	0	3
2	BY5010	Cancer Biology	PE	3	3	0	0	3
3	BY5011	Technology Management	PE	3	3	0	0	3
4	BY5012	Computational Methods in Fluid Dynamics	PE	3	3	0	0	3
5	BY5013	Biotechnology in Food Processing	PE	3	3	0	0	3

SEMESTER II, PROFESSIONL ELECTIVES IV

S.No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1	BY5014	Bio Nanotechnology	PE	3	3	0	0	3
2	BY5015	Phytochemistry	PE	3	3	0	0	3
3	BY5016	Advances in Molecular Pathogenesis	PE	3	3	0	0	3
4	BY5017	Spectroscopy for Biotechnologists	PE	3	3	0	0	3
5	BY5018	IPR and Bio safety	PE	3	3	0	0	3

SEMESTER II, PROFESSIONL ELECTIVES V

S.No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1	BY5019	Biopharmaceuticals and Biosimilars	PE	3	3	0	0	3
2	BY5020	Bioprocess Modelling and Simulation	PE	3	3	0	0	3
3	BY5021	Tissue Engineering	PE	3	3	0	0	3
4	BY5022	Research Methodology in Biotechnology	PE	3	3	0	0	3
5	BY5023	Biofuels and Platform Chemicals	PE	3	3	0	0	3

FOUNDATION COURSE (FC)

S.No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1	MA5166	Statistical Techniques for Biotechnologists	FC	5	3	2	0	4

PROFESSIONAL CORE (PC)

S.No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
Theory								
1	BY5101	Advanced Genetic Engineering	PC	4	4	0	0	4
2	BY5102	Enzyme Technology and	PC	3	3	0	0	3

		Fermentation Technology						
3	BY5103	Bioinformatics and Applications	PC	4	3	2	0	4
4	BY5201	Bio Separation Technology	PC	3	3	0	0	3
5	BY5202	Bioprocess Engineering	PC	4	3	2	0	4
6	BY5203	Bioreactor Design and Analysis	PC	4	4	0	0	4
7	BY5204	Immunotechnology	PC	3	3	0	0	3
8	BY5205	Advanced Genomics and Proteomics	PC	3	3	0	0	3
9	BY5111	Preparative and Analytical Techniques in Biotechnology Laboratory	PC	4	0	0	4	2
10	BY5211	Immunotechnology Laboratory	PC	4	0	0	4	2
11	BY5311	Advanced Genetic Engineering Laboratory	PC	4	0	0	6	3
12	BY5312	Bioprocess and Downstream Processing Laboratory	PC	4	0	0	6	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
PROJECT								
1	BY5313	Project Work (Phase I)	EEC	12	0	0	12	6
2	BY5411	Project Work (Phase II)	EEC	24	0	0	24	12

MA5166 STATISTICAL TECHNIQUES FOR BIOTECHNOLOGY L T P C
4 0 0 4

OBJECTIVES:

- This course is designed to provide a solid foundation on topics in statistics that can be useful for the biotechnologists to conduct research on different types of data arising in public health and clinical studies. It is framed to address the issues in biotechnology using the concepts on probability, regression, sampling, estimation theory, testing of hypothesis and design an analysis of experiments.

UNIT I RANDOM VARIABLE AND PROBABILITY DISTRIBUTION 12

Discrete random variable – Probability mass function – Properties – Continuous random variable – Probability density function – Properties – Moments : Mean and variance with properties –Special distributions : Binomial, Poisson, Geometric, Uniform, Exponential, Gamma, Weibull and Normal – Properties - Simple Problems.

UNIT II SAMPLING DISTRIBUTION AND ESTIMATION THEORY 12

Random sampling – Sample mean and variance – Standard error – Simple problems – Estimator : Unbiasedness – Maximum likelihood estimation – Method of moments – Curve fitting by the method of least squares : Fitting curves of the form $y = ax + b,\ y = ax^2 + bx + c,\ y = ab^x$ and $y = ax^b$ - Multiple regression lines.

UNIT III TESTING OF HYPOTHESIS 12

Sampling distributions – Type I and Type II errors – 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 x c contingency table) - Goodness of fit.

UNIT IV NON-PARAMETRIC STATISTICS 12

One sample sign test–Sign test for paired samples – Signed rank test – Ranksumtest : The U-test – Rank-sum test : The H-test – Test based on runs.

UNIT V DESIGN OF EXPERIMENTS 12

Completely random design–Randomized complete block design – Analysis of variance : One - way and Two - way classifications – Latin square design - 2^2 factorial design.

TOTAL : 60 PERIODS

OUTCOMES :

After completing this course, students should demonstrate competency in the following topics:

- Basic probability axioms and rules and the moments of discrete and continuous random variables.
- Distributions and their properties.
- Least squares, correlation, regression, consistency, efficiency and unbiasedness of estimators, method of maximum likelihood estimation and Central Limit Theorem.
- Sampling and use statistical tests in testing hypotheses on data.

- List the guidelines for designing experiments, recognize the key historical figures in Design of Experiments, conduct statistical tests and analyze the results.
- Analyze the experiments by applying suitable non-parametric tests

The students should have the ability to use the appropriate and relevant, fundamental and applied mathematical and statistical knowledge, methodologies and modern computational tools.

REFERENCES :

1. Devore, J.L., "Probability and Statistics for Engineering and Sciences", 8th Edition, Cengage Learning Pvt. Ltd., New Delhi, 2014.
2. Freund, J.E., "Mathematical Statistics", 5th Edition, Prentice Hall of India, 2001.
3. Gupta, S.C. and Kapoor, V. K, "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, 14th Edition, 2016.
4. Johnson, R.A and Gupta C. B., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education Int., Asia, 8th Edition, 2011.
5. Libschutz, S. "Probability and Statistics", 4th Edition, McGraw Hill, New Delhi, 2010.
6. Miller, I. and Miller, "Mathematical Statistics", 7th Edition, Pearson Education Inc. (10th impression), 2012.

BY5101 ADVANCED GENETIC ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To understand the gene cloning methods and the tools and techniques involved in gene cloning and genome analysis and genomics.
- To explain the heterologous expression of cloned genes in different hosts, production of recombinant proteins and PCR techniques.
- To understand comparative genomics and proteomics.

UNIT I CLONING WITH SPECIALIST-PURPOSE VECTORS 9

M13 based vectors, production of RNA probes and interfering RNA - controllable promoters for maximal expression of cloned gene – λP_L, trc, T_7 and pBAD - factors affecting the expression of cloned genes - purification tags for purification of cloned gene product – vectors for solubilization of expressed proteins - gateway system of transferring DNA fragments to vectors

UNIT II cDNA LIBRARY CONSTRUCTION 9

Oligo dT priming, self priming and its limitations. Full length cDNA cloning – CAPture method and Oligo capping. 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.

UNIT III MUTAGENESIS AND ALTERED PROTEIN SYNTHESIS 9

Random mutagenesis **-** Error-prone PCR, Rolling circle error-prone PCR, use of mutator strains, temporary mutator strains, Insertion mutagenesis, ethyl methanesulfonate, DNA Shuffling, signature tagged mutagenesis and transposon mutagenesis. Incorporation of unnatural amino acids into proteins – Phage and cell-surface display for selection of mutant peptides

UNIT IV GENOME ENGINEERING 9

DNA damage – sources and types - DNA double stranded break repair mechanisms - Engineered nucleases in genome engineering - meganucleases, ZFNs, TALEN and CRISPR-Cas system – Mechanisms and applications – Benefits of genome engineering – targeted gene mutation, creating chromosome rearrangement, studying gene function with stem cells, transgenic animals, endogenous gene labelling and targeted transgene addition – genome engineering -prospects and limitations.

UNIT V GENETIC MANIPULATION OF CELLS AND ANIMALS 9

Overview - principle of gene transfer - methods of gene transfer to animal cell culture - selectable markers for animal cells - Isolation and manipulation of mammalian embryonic stem cells - Using gene transfer to study gene expression and function - creating disease models using gene transfer and gene targeting technology - potential of animal for modelling human disease

TOTAL: 45 PERIODS

OUTCOMES:

- The students after completing this course would be aware of clone methods of commercially important genes.
- The students would be aware of producing the commercially important recombinant proteins.
- The students would be aware of gene and genome sequencing techniques.
- The students would be aware of microarrays, Analysis of Gene expression and proteomics.

REFERENCES

1. Benjamin Lewin, “Gene IX”, Oxford University Press, Cambridge, U.K. 2011.
2. Brown, T.A., “Gene cloning and DNA analysis: An introduction”, 6th Edition, Wiley-Blackwell, 2010.
3. Glick, B.R. and Pasternak J.J., “Molecular Biotechnology: Principles and Applications of Recombinant DNA”, 3rd Edition, ASM Press, 2003.
4. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vol 1-3, CSHL, 2001.
5. Primrose, S.B., and Twyman., “Principles of Gene Manipulation and Genomics”, 7th Edition, Blackwell Science, 2006.
6. Winnacker, E.L., “Frome Genes to Clones: Introduction to Gene Technology”, Wiley-Blackwell, 2006.
7. Yamamoto, Takashi (Ed.). “Targeted Genome Editing Using Site-Specific Nucleases”, Springer, Japan, 2015.

BY5102 ENZYME TECHNOLOGY AND FERMENTATION TECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

To enable the students

- To learn enzyme reactions and its characteristics along with the production and purification process
- To give the student a basic knowledge concerning biotransformation reactions with the usage of enzymes
- To understand the production process of Primary and Secondary metabolites

UNIT I FUNDAMENTALS OF FERMENTATION 9

Overview of fermentation – Microbial biomass – Microbial Enzymes – Microbial Metabolites – Types of fermentation – Media for industrial fermentations –– Medium sterilization-– Development of inoculum for industrial fermentation -Medium optimization – Oxygen requirements of industrial fermentation – Mass transfer in fermentation – Determination of K_La values – Factors affecting K_La values in fermentation.

UNIT II INDUSTRIAL FERMENTATION PROCESSES 9

Aerobic and anaerobic fermentations –Batch culture, continuous culture, fed batch culture – Comparison of batch and continuous culture – Submerged and solid state fermentation for the production of enzymes – Immobilization of enzymes and techniques for enzyme immobilization – Biocatalysis in organic media using enzymes – Biotransformation with crude enzymes and whole cells.

UNIT III PRODUCTION OF ENZYMES AND METABOLITES 9

Production of Proteases, Cellulas, Lipase, Amylase, Glucose isomerase, Pectinase, Peroxidase Production of primary metabolites– organic acids (Citric acid, Lactic acid), amino acids (Glutamic acid, Lysine),alcohols (ethanol, butanol). Production of secondary metabolites – aminoacids (Glutamic acid, Lysine), antibiotics (Penicillin, streptomycin), Vitamins (Vitamin B12, Riboflavin)

UNIT IV ENZYME KINETICS 9

Overview of enzyme and its action – Time course of enzymatic reactions – Effects of substrate concentration on velocity – Rapid equilibrium model of enzyme kinetics – Steady state model of enzyme kinetics – Significance of *kcat* and *Km* – Experimental Measurement of *kcat* and *Km* – Linear transformations of enzyme kinetic data – Bi Bi reaction mechanisms – Modes of reversible inhibition- Allosteric regulation of enzymes.

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.

OUTCOMES:

- The knowledge on enzyme and enzyme reactions will be the key step in to proceed towards various concepts in biotechnology.
- The theoretical and practical aspects of kinetics will provide the importance and utility of enzyme kinetics towards research.
- The process of immobilization has been increased steadily in food, pharmaceutical and chemical industries and thus this study will provide simple and easy method of implementation.
- Ideas on Processing, Production and Purification of enzymes and metabolites at an industrial scale will be helpful to work technologically.

TOTAL: 45 PERIODS

REFERENCES

1. Buchholz, K., Kasche, V. and Bornscheuer, U., “Biocatalysts and Enzyme Technology”, Completely revised and enlarged edition, WILEY–VCH, 2012.
2. Copeland, R. A., “Enzymes- A Practical Introduction to Structure, Mechanism and data analyses” 2nd Edition, WILEY–VCH, 2012.

3. Mansi, E.M.T.EL., Bryce, C.F.A., Dahhou, B., Sanchez, S., Demain, A.L. and Allman, A.R., "Fermentation Microbiology and Biotechnology", 3rd Edition, Taylor and Francis, 2012.
4. McNeil, B., Harvey, L., "Practical Fermentation Technology", John Wiley & Sons, 2008.
5. Palmer, T., Bonner, P., "Enzymes Biochemistry, Biotechnology, Clinical chemistry", 2nd edition, WoodHead Publishing, 2007.

BY5103 BIOINFORMATICS AND APPLICATIONS L T P C
2 2 0 3

OBJECTIVES:

- To improve the programming skills of the student in the field of Biological research
- To let the students know the recent evolution in biological databank usage

UNIT I LINUX OS AND PERL 9+3

File system – Listing Directories – Working with files – Text processing – Shell programmes – Programming in PERL: Name conventions – Variables – Operators – Functions – Control structures – File input and output.

UNIT II BIOLOGICAL SEQUENCES AND DATABANKS 9+3

Introduction to Biological sequences and methods of sequencing, Biological databases: Primary, Secondary and Composite databanks - Scoring matrices: PAM, BLOSUM - Data lifecycle

UNIT III SEQUENCE ANALYSIS 9+3

Pairwise Sequence alignment: Dynamic Programming Algorithms, Needleman-Wunch Algorithm, Smith-Waterman Algorithm, FASTA, BLAST – Multiple sequence alignment: Progressive methods, Iterative methods, Applications – Motif representation- PSSM - Gene finding-Artificial Neural Network – Hidden Markov Model

UNIT IV DATAANALYSIS AND VISUALIZATION 9+3

Analysis of gene expression – Analysis of protein expression – Analysis of mutations in cancer – High-throughput image analysis – High volume scatter plots – Heat maps-visualizing distances – Plotting along genomic coordinates. Introduction to Phylogenetic analysis

UNIT V STRUTURAL ANALYSIS 9+3

Protein structure visualization and prediction: Pymol, Rasmol, *ab initio* folding, Threading, Homology modelling - RNA structure prediction, Mfold - Molecular dynamics: Rosetta - protein-ligand docking – QSAR-Protein-protein interaction

TOTAL: 60 PERIODS

OUTCOMES:

Upon completion of this course, students will be able to

- Develop bioinformatics tools with programming skills.
- Apply computational based solutions for biological perspectives.

REFERENCES

1. Baldi, P. and Brunak, S., "Bioinformatics: The Machine Learning Approach" 2nd Edition, MIT Press, 2001.
2. Gentleman, R., "Bioinformatics and Computational Biology Solutions using R and Bioconductor", Springer Science and Business media Inc., 2005.
3. Lesk, A. K., "Introduction to Bioinformatics", 4th Edition, Oxford University Press, 2013

4. Liebler, “Introduction to Proteomics” Humana Press, 2002.
5. Mount, D.W., “Bioinformatics Sequence and Genome Analysis” 2nd Edition, Cold Spring Harbor Laboratory Press, 2004
6. Rastogi, S.C., “Bioinformatics Concepts, Skills & Applications”, 2nd Edition, CBS Publishers, 2009.

BY5111 PREPARATIVE AND ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY L T P C
0 0 6 3

OBJECTIVES

- To learn and understand the principles behind the qualitative and quantitative estimation of bio molecules and laboratory analysis of the same in the body fluids
- To have a practical hands on experience on Absorption Spectroscopic methods and to validate spectrometric and microscopic techniques
- To acquire experience in the purification by performing chromatography
- To design processes for the recovery and subsequent purification of target biological products.

EXPERIMENTS

1. Estimation of amino acids by Ninhydrin method
2. Estimation of total sugars by Phenol sulphuric acid method
3. Estimations of carbohydrates – reducing vs non-reducing, polymeric vs oligomeric, hexose vs pentose.
4. Estimation of protein concentration using Lowrys’ and Bradford method
5. DNA determination by UV-visible spectrophotometer – hyperchromic effect.
6. Separation of amino acids and lipids by TLC.
7. Enzyme kinetics: Determination of Km, Vmax and Kcat, Kcat/ Km.
8. Restriction enzyme – Enrichment and unit calculation.
9. Ion-exchange chromatography – Purification of IgG and Albumin.
10. Gel filtration – Size based separation of proteins.
11. Affinity chromatography – IMAC purification of His-tagged recombinant protein.
12. Extraction and characterization of photochemical using UV-visible spectrophotometer.
13. Separation of compounds using Column chromatography.

TOTAL: 90 PERIODS

OUTCOMES

Upon success completion of this lab course, the students will be able to

- Quantify Bio molecules using spectroscopy methods
- Purify enzymes and metabolites using Chromatography techniques
- Solve problems related Enzyme involved reactions and kinetics

REFERENCES

1. Pingoud, A., Urbanke, C., Hoggett, J. and Jeltsch, A., “Biochemical Methods: A Concise Guide for Students and Researchers”, Wiley-VCH, 2002.
2. Segel, I.H., “Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry”, 2nd Edition, John Wiley & Sons, 2004.
3. Wilson, K. and Walker, J., “Principles and Techniques of Biochemistry and Molecular Biology”, 7th Edition, Cambridge University Press, 2010.

BY5201 BIOSEPARATION TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

To enable the students to

- Understand the methods to obtain pure proteins, enzymes and in general about product development R & D
- Have depth knowledge and hands on experience on Downstream processes to commercial therapeuticaly important proteins.

UNIT I DOWNSTREAM PROCESSING IN BIOTECHNOLOGY 9

Role and importance of downstream processing in biotechnological processes – Problems and requirements of bio product purification – Economics of downstream processing in Biotechnology, cost-cutting strategies – Separation characteristics of proteins and enzymes – size, stability, properties – Flocculation and conditioning of broth – Process design criteria for various classes of bio products (high volume, low value products and low volume, high value products) – Upstream production methods affect downstream purification strategies.

UNIT II PHYSICO-CHEMICAL BASIS OF BIO-SEPARATION PROCESSES 9

Cell disruption methods for intracellular products – Physical, chemical, mechanical – Removal of insoluble, biomass and particulate debris separation techniques – Filtration at constant pressure and at constant rate – Empirical equations for batch and continuous filtration – Types of filtration - Centrifugal and cross – flow filtration – Types of filtration equipments – Centrifugation – Basic principles, design characteristics – Types of ccentrifuges and applications – Sedimentation.

UNIT III MEMBRANE SEPARATIONS AND ENRICHMENT OPERATIONS 9

Theory, Design consideration and configuration of membrane separation processes – Reverse osmosis, microfiltration, ultra filtration, dialysis and pervaporation – Structure and characteristics of membranes – Membrane modules – Enrichment Operations – Extraction–equipment for extraction – Aqueous two-phase extraction process – Evaporators – Types of evaporators – Adsorption isotherms and techniques – Protein precipitation – Methods of precipitation.

UNIT IV MECHANISM AND MODES OF CHROMATOGRAPHIC SEPARATION 9

Chromatography – Classification of chromatographic techniques – General description of column chromatography – Chromatographic terms and parameters – Practice of chromatography – Partition, normal-phase, displacement, reversed-phase, size exclusion, ion exchange, hydrophobic, affinity chromatography – Scale-up of chromatography – Process considerations in Preparative liquid chromatography and HPLC .

UNIT V FINISHING OPERATIONS AND FORMULATIONS 9

Drying – Mechanism, methods and applications, Types of dryers – Tray, spray, rotary, belt, disc – Crystallization – Nucleation , growth – Types of crystallizers – Tank, scrapped surface, Oslo, Circulating-magma evaporator – Freeze drying – Principle, process, applications – Case studies- Citric acid, Penicillin , Cephalosporin, Recombinant Streptokinase, Interferon.

TOTAL: 45 PERIODS

OUTCOMES:

Upon success completion of this course, the students will be able to:

- Define advanced downstream processing methods for product recovery.

- Describe the components of downstream equipment and to understand the requirements for successful operations.
- To enchance problem solving techniques required in multi-factorial manufacturing environment in a structured and logical fashion.

REFERENCES

1. Belter, P.A., Gussler, E.L. and Hu, W.S., "Bioseparation: Downstream Processing for Biotechnology", John Wiley and Sons, 2011.
2. Forciniti, D., "Industrial Bioseparation: Principles & Practice", Blackwell, 2008.
3. Ghosh, R., "Principles of Bioseparations Engineering", World Scientific Publishers, 2006.
4. Ladisch, M.R., "Bioseparations Engineering: Principles, Practice, and Economics", John Wiley & Sons, 2001.
5. Roger, H., "Bioseparations Science and Engineering", Oxford University Press, 2006.

BY5202 BIOPROCESS ENGINEERING L T P C
3 2 0 4

OBJECTIVES:

- To impart knowledge on design and operation of fermentation processes with all its prerequisites.
- To endow the students with the basics of microbial kinetics, metabolic stoichiometry and energetics.
- To develop bioengineering skills for the production of biochemical product using integrated biochemical processes.

UNIT I METABOLIC STOICHIOMETRY AND ENERGETICS 9

Outline of Stoichiometry and energetics – Growth yields, Growth yields based on total energy and ATP generation – Conservation of mass principles - Carbon and oxygen balances, ATP generation during growth – Relationship between substrate consumption, growth, respiration and noncellular products – Growth energetics of aerobic and anaerobic process – Case studies on mass and energy balance for Embden–Meyerhoff–Parnas pathway, continuous ethanol fermentation, penicillin production.

UNIT II MICROBIAL GROWTH, KINETICS, MAINTENANCE AND PRODUCT FORMATION 9

Establishment of growth kinetic equations for batch, fed batch and continuous culture – Basic unstructured kinetic models of growth and product substrate utilization – Negative biokinetic rates – Multisubstrate kinetics – Mixed population kinetics - Kinetic models for microbial product formation - Kinetic model equations for inhibition by substrates and products.

UNIT III STRUCTURED MODELS 9

Structured models for growth and product formation – Compartmental and metabolic models – Mechanistic models - Product formation kinetics – Gaden's and Deindoerfer's classifications – Chemically and genetically structured models – Kinetics models of heterogenous bioprocesses – Biofilm kinetics, Unstructured models of pellet growth – Considerations for the production of r-DNA products.

UNIT IV MASS TRANSFER IN BIOLOGICAL SYSTEMS 9

Interphase Gas-Liquid mass transfer – General oxygen balances for Gas-Liquid transfer – Models for oxygen transfer in large scale bioreactors – Case studies for large scale bioreactors – Model for oxygen gradients in a bubble column bioreactor, air lift bioreactor – Model for a multiple impeller fermenter – Gas-liquid mass transfer of components other than oxygen.

UNIT V DIFFUSION AND BIOLOGICAL REACTION IN IMMOBILIZED BIOCATALYST 9

External mass transfer – Internal diffusion and reaction within biocatalysts – Derivation of finite difference model for diffusion – Reaction systems – Dimensionless parameters from diffusion – Reaction models – Effectiveness factor concept – Case study for diffusion with biological reaction – Estimation of oxygen diffusion effects in a biofilm.

TOTAL: 45+30 PERIODS

OUTCOMES:

Upon completion of the course in Bioprocess Principles graduates will be able to

- Apply engineering principles to systems containing biological catalysts to meet the needs of the society.
- Interpret the kinetics of living cells and to develop a strategy to solve the issues emerging during fermentation processes.

REFERENCES

1. Blakebrough, N., T. K. Ghose, and A. Fiechter, eds. “Advances in biochemical engineering”. Springer-Verlag, volume 3, 2013.
2. Dunn, I.J., Heinzle, E., Ingham, J. and Prenosil, J.E., “Biological Reaction Engineering: Dynamic Modelling Fundamentals with simulation examples”, 3rd Revised Edition, WILEY-VCH publications, 2016.
3. Moser, Anton., “Bioprocess technology: kinetics and reactors”, Springer Science & Business Media, 2012.
4. Najafpour, G.D., “Biochemical Engineering & Biotechnology”, 2 nd Edition, Elsevier, 2015.
5. Truskey, G.A., Yuan, F. and Katz, D.F., “Transport Phenomena in Biological Systems”, Pearson Prentice Hall, 2007.

BY5203 BIOREACTOR DESIGN AND ANALYSIS L T P C
4 0 0 4

OBJECTIVES:

- To provide the students with the design and scaleup of bioreactors.
- To develop bioengineering skills for the production of biochemical product using integrated biochemical processes.

UNIT I BASIC BIOREACTOR CONCEPTS 12

Bioreactor Operation – Batch operation, semi-continuous and fed-batch operation, Continuous Operation – Chemostat, turbidostat – Microbiological reactors, enzyme reactors – Tank-type, Column-type biological reactors – Case studies – Continuous Fermentation with Biomass Recycle, Tanks-in-series, Tubular plug flow bioreactors.

UNIT II AERATION AND AGITATION IN BIOPROCESS SYSTEMS 12

Mass transfer in agitated tanks – Effect of agitation on dissolved oxygen - Correlations with k_La in Newtonian and non Newtonian liquid – Power number, Power requirement for mixing in aerated

and non aerated tanks for Newtonian and non Newtonian liquids – Agitation rate studies - Mixing time in agitated reactor, residence time distribution – Shear damage, bubble damage, Methods of minimizing cell damage – Laminar and Turbulent flow in stirred tank bioreactors.

UNIT III SELECTION AND DESIGN OF BIOPROCESS EQUIPMENT 12

Materials of construction for bioprocess plants – Design considerations for maintaining sterility of process streams processing equipments, selection, specification – Design of heat and mass transfer equipment used in bioprocess industries – Requirements, design and operation of bioreactor for microbial, plant cell and animal cell.

UNIT IV SCALE UP AND SCALE DOWN ISSUES 12

Effect of scale on oxygenation, mixing, sterilization, pH, temperature, inoculum development, nutrient availability and supply – Bioreactor scale-up based on constant power consumption per volume, mixing time, impeller tip speed (shear), mass transfer co-efficients – Scale up of downstream processes – Adsorption (LUB method), Chromatography (constant resolution etc.), Filtration (constant resistance etc.), Centrifugation (equivalent times etc.), Extractors (geometry based rules) – Scale–down related aspects.

UNIT V BIOREACTOR INSTRUMENTATION AND CONTROL 12

Bioreactor controlling probes – Characteristics of bioreactor sensors - Methods of measuring process variables –Temperature – Flow measurement and control – Pressure measurement and control – Agitation – shaft power, rate of stirring – Detection and prevention of foam – Measurement of Microbial biomass – Measurement and control of Dissolved oxygen – Inlet and outlet gas analysis – pH measurement and control - Biosensors.

TOTAL: 60 PERIODS

OUTCOMES:

Upon completion of Bioprocess Engineering course graduates will be able to

- Select appropriate bioreactor configurations and operation modes based upon the nature of bio products and cell lines and other process criteria.
- Apply modelling and simulation of bioprocesses so as to reduce costs and to enhance the quality of products and systems.
- Integrate research lab and Industry; identify problems and seek practical solutions for large scale implementation of Biotechnology.

REFERENCES

1. Impre, J.F.M.V., Vanrolleghem, P.A. and Iserentant, D.M., “Advanced Instrumentation, Data Interpretation and Control of Biotechnological Processes”, Kluwer Academic Publishers, 2010.
2. Mann, U., “Principles of Chemical Reactors Analysis & Design: New tools for Industrial Chemical Reactor Operations”, Willey–VCH, 2009.
3. Mansi, E.M.T.EL., Bryce, C.F.A., Demain, A.L. and Allman, A.R., “Fermentation Microbiology and Biotechnology”, 3 rd edition Taylor and Francis, 2012.
4. Towler, G. and Sinnott, R., “Chemical Engineering Design: Principles, Practice, Economics of Plant and Process Design”, 2 nd edition, Butterworth – Heinemann ltd., Elsevier, 2012.

BY5204 **IMMUNOTECHNOLOGY** **L T P C**
3 0 0 3

OBJECTIVES:

- To understand the structure, functions and integration of immune system.
- To explain the antigen-antibody interactions that offers defence mechanism
- To explain various techniques of therapeutically significant monoclonal and engineered antibodies production

UNIT I IMMUNE SYSTEM AND ITS RESPONSE 9

Cells of the immune system and their development – Primary and secondary lymphoid organs – Humoral immune response – Cell mediated immune responses – T lymphocyte and B lymphocyte Tolerance – Homeostasis in immune system – Complement.

UNIT II ANTIGEN AND ANTIBODY 9

Production of antibodies – Polyclonal, monoclonal – Hybridoma technology – Antibody – Isolation and identification – Validation and their use – Agglutination and precipitation tests – Coomb's test – ELISA types – ELISPOT– Plaque forming cell assay, Epitope mapping, Antigen detection assay, SDS-PAGE- immunoblotting and immunoprecipitation – Immunofluorescence and immunohistochemistry – Measurement of Ag-Ab interaction.

UNIT III CELLULAR IMMUNOLOGICAL TECHNIQUES 9

PBMC separation from the blood – Ficoll-hypaque method – Identification of lymphocytes based on CD markers – FACS – Lymphoproliferation assay – Cr5I release assay – Macrophage cultures detection assays – Rosette assay – Cytokine bioassays: IL2, IFNγ, TNFα – Mixed lymphocyte reaction – HLA typing.

UNIT IV VACCINE TECHNOLOGY 9

Principles in vaccine development – Adjuvant, Immunization (Active and Passive immunization) – Vaccine validation – Protein based vaccines – DNA vaccines – Plant based vaccines – Edible vaccine – Recombinant antigens as vaccines – Multivalent subunit vaccine – Reverse vaccinology – New Types of Replicating vaccines.

UNIT V IMMUNOTHERAPEUTICS 9

Engineered antibodies – Catalytic antibodies, idiotypic antibodies, plantibodies – Combinatorial libraries for antibody isolation. Cancer immunotheraphy and Immunosuprressive therapy – Cytokine therapy – Immunoglobulin therapy: Replacement and immunomodulators – Gene transfer techniques for immunological diseases.

TOTAL: 45 PERIODS

OUTCOMES:

- The students after completing the course would be aware of immune system structure and functions, immunity to various pathogens
- To produce the therapeutic and diagnostic molecules and to aware of tumour, allergy and hypersensivity reactions

REFERENCES

1. Emily P. Wen, Ronald Ellis and Narahari S. Pujar, "Vaccine Development and Manufacturing" Wiley, 1st Edition, 2014.
2. Gerd-Rudiger Burmester, Antonio Pezzutto and Jurgen Wirth, "Color Atlas of Immunology", Thieme Medical Publishers, 1st Edition, 2003.

3. Judith A. Owen, Jenni Punt and Sharon Stranford, “Kuby Immunology”, W.H. Freeman and Company, 7th Edition, 2013.
4. Peter J. Delves, Seamus J. Martin, Dennis R. Burton and Ivan M. Roitt, “Roitt’s Essential Immunology” Wiley-Blackwell Publication, 12th Edition, 2011.
5. Robert R. Rich, Thomas A Fleisher, William T. Shearer, Harry Schroeder, Anthony J. Frew and Cornelia M. Weyand, “Clinical Immunology-Principles and Practice” Elsevier, 4th Edition, 2013.

BY5205 ADVANCED GENOMICS AND PROTEOMICS L T P C
3 0 0 3

OBJECTIVES:

- To understand the gene cloning methods, tools and techniques involved in genome analysis and genomics.
- To explain the heterologous expression of cloned genes in different hosts, production of recombinant proteins and PCR techniques.
- To identify the importance of protein bio molecules and the structure-function relationships in proteins.
- To explain comparative genomics and proteomics.

UNIT I GENE ANDGENOME ANALYSIS 9

Gene prediction in prokaryotes and eukaryotes - Genome-wide association (GWA) analysis - Massively parallel Signature sequencing (MPSS), Whole genome Shotgun sequencing,Next Generation Sequencing (NGS) - Cytogenetic and physical mapping - GDB, NCBI, OMIM, NGI/MGD - Structural annotation - Functional annotation - Limitation of genomics

UNIT II GENOME INFORMATICS 9

Functional genomics: Developmental biology and Differential gene expression, Microarray analysis - Epigenomics: Histone modification assays-ChIP-Chip and ChIP-Seq, DNA Methylation assays-DNA hybridization technique - Metagenomics: *de novo* transcriptome assembly

UNIT III GENOMIC DIVERSITY 9

Study systems: Cyanobacteria, Plasmodium, Yeast, Virus, *Arabidopsis thaliana*, *Homo sapiens*, Worm, Zebra fish - Comparative databases: COG, KEGG, MBGD, PEDANT, Organism Specific databases

UNIT IV PROTEOME INFORMATICS 9

2D Electrophoresis - Spot visualization and picking - Database for 2D gel - Tryptic digestion of protein - Peptide fingerprinting - Data analysis: Mass spectrometry; ion source (MALDI, spray sources); analyzer (ToF, quadrupole, quadrupole ion trap) and detectors - Ramachandran plot - Post-translational modifications of proteins - Limitation of proteomics

UNIT V APPLICATIONS OF GENOMICS ANDPROTEOMICS 9

Genomicmedicine - Synthetic biology and bioengineering - Conservation genomics - Interaction proteomics - Protein networks - Expression proteomics – Biomarkers - Proteogenomics

TOTAL: 60 PERIODS

OUTCOMES:

- The students after completing this course would be aware of how to clone commercially important genes and recombinant proteins.
- The students would be aware of gene and genome sequencing techniques.
- The students would be aware of microarrays, Analysis of Gene expression and proteomics.
- To analyze the various interactions in protein makeup and different levels of protein structure.
- To practice the latest application of protein science in their research.

REFERENCES

1. Campbell, A.M. and Heyer, L.J., "Discovering Genomics, Proteomics and Bioinformatics", 2nd Edition, Benjamin Cummings, 2007.
2. Dunham, I., "Genome Mapping and sequencing", Horizon Scientific, 2003.
3. Hartwell, L.H., Hood, L., Goldberg, M. L., Reynolds, A.E., Silver, L.M. and Veres, R.G., "Genetics from Genes to Genomes", McGraw Hill, 2004.
4. Primrose, S.B., and R.M. Twyman, "Principles of gene manipulation and Genomics", Blackwell Publishing, MA. USA, 2006.
5. Read, T.D., Nelson, K.E., Fraser, C.M., "Microbial Genomes", Humana Press, Inc., USA, 2004.
6. "The Arabidopsis Genome", Nature, Vol. 408, 2000.
7. "The Human Genome", Nature, Vol. 409, 2001.

BY5211 IMMUNOTECHNOLOGY LABORATORY L T P C
0 0 6 3

OBJECTIVES:

- To give practical exposure in the clinical diagnosis.
- To give laboratory training in different immunotechnological techniques.

1. Preparation of antigen and Routes of immunization (Intra-peritonial, Sub-cutaneous, Intramuscular, Intra- nasal, Oral)
2. Methods of bleeding (Eg. Tail bleeding, Intravenous, intraorbital)
3. Collection of serum, storage and purification of total IgG (salt precipitation).
4. Evaluation of Antibody titre by direct ELISA
5. Evaluation of Antigen by Sandwich ELISA
6. Characterization of antigens by native and SDS-PAGE
7. Characterizations of antigens by Western blot analysis – Wet and semidry transfer
8. Conjugation of Immunoglobins (Streptavidin, colloidal gold)
9. Methods for prototype development of Immunodiagnostics (ICT card)
10. Blood smear identification of leucocytes by Giemsa stain
11. Separation of mononuclear cells by Ficoll-Hypaque
12. Separation of spleenocytes and proliferation against mitogens

Required Equipments:

Microscopes, restainer (mouse, rat, rabbit), purification columns, microplate reader, UV spectrometer, PAGE apparatus, Western blot apparatus (dry/semi-dry/wet), centrifuge, Haemocytometer, required strains & consumables

TOTAL : 90 PERIODS

OUTCOMES:

- The students would be aware of immune system cells and tissues.
- The students would have knowledge on immunological /clinical tests.

REFERENCES

1. Antibodies: A Laboratory Manual, Edward A. Greenfield, Cold Spring Harbor Laboratory Press, 2nd Edition, 2014
2. Current protocols in immunology / editorial board John E. Coligan.*et al*,. 2003, New York : Wiley Interscience, 2003.
3. Practical Immunology Frank C. Hay and Olwyn M.R. Westwood, Blackwell Science Ltd., 4th edition, 2002

BY5311 ADVANCED GENETIC ENGINEERING LABORATORY L T P C
0 0 6 3

OBJECTIVES:

- Provide hands-on experience in performing basic recombinant DNA techniques.
- To understand the principle behind each techniques and applications of each methodology in applied biological research.

1. Isolation of DNA
2. Electroporation to Yeast
3. Isolation of RNA
4. cDNA synthesis
5. Primer designing
6. Real-time PCR
7. Plasmid isolation and confirming recombinant by PCR and RE digestion.
8. Confirmation of the presence of insert by colony PCR
9. Induction and expression of recombinant protein
10. Western blot with ECL detection
11. Site directed mutagenesis
12. Southern blot (Non-radioactive)
13. RFLP analysis of the recombinant DNA

Required Equipments:

- Microscopes, PCR, purification columns, microplate reader, UV spectrometer, PAGE apparatus, Western blot apparatus (dry/semi-dry/wet), Southern blot apparatus, centrifuge, Haemocytometer, required stains, chemicals, enzymes & consumables

TOTAL : 90 PERIODS

OUTCOMES:

By the end of this course, students should be able to:

- Describe the main principles, methods for preparation and cloning of DNA in various organisms.
- Express clearly about the gene amplification and methods for analysis of DNA, such as hybridization, restriction analysis and gene expressions.
- Use genetic and biotechnological techniques to manipulate genetic materials and develops new and improved living organisms.

REFERENCES

1. Sambrook, J. and Russsel, D.W., "Molecular cloning – A laboratory manual", Third edition, Cold Spring Harbor Laboratory Press, Cold Spring harbor, New York, USA, 2001

BY5312 BIOPROCESS AND DOWNSTREAM PROCESSING LABORATORY L T P C
0 0 6 3

OBJECTIVES:

- The course applies earlier learned knowledge about mass transfer in bio reactors and sterilization kinetics.
- To provide hands on training in Downstream processing through simple experimentations in the laboratory.
- To understand the nature of the end product, its concentration, stability and degree of purification required for targeted biological products.
- Skills and knowledge gained is useful by analogy when solving problems typical for the bio industry or for research.

1. Enzyme immobilization studies – Gel entrapment, adsorption and cross linking immobilisation.
2. Batch cultivation – *E.coli* – growth rate, substrate utilization kinetics, product analysis after induction, metabolite analysis by HPLC.
3. Fed batch cultivation - *E.coli* - growth rate, substrate utilization kinetics, product analysis after induction, metabolite analysis by HPLC.
4. Continuous cultivation – x - D construction, kinetic parameter evaluation, gas analysis, carbon balancing.
5. Optimization techniques – Plackett Burman, Response surface methodology.
6. Bioreactor studies: Sterilization kinetics, k_La determination, residence time distribution.
7. Cell separation methods-Centrifugation and microfiltration
8. Cell disruption methods- ultrasonicator, homogeniser.
9. Aqueous two phase extraction of biologicals.
10. Protein precipitation by salting –out method (ammonium sulphate).
11. Protein purification method- Column chromatography.
12. Product polishing- dryers, crystallizers.

Required Equipments:

Centrifuge, Column for purification, Ultrasonicator, Homogeniser, Microfiltration capsule, Hot air oven, Incubator, Laminar air flow chamber, HPLC, required chemicals & stains.

TOTAL : 90 PERIODS

OUTCOMES:

At the end of this course,

- Graduates gain ability to investigate, design and conduct experiments, analyze and interpret data, and apply the laboratory skills to solve complex bioprocess engineering problems.
- Acquired knowledge for the separation of whole cells and other insoluble ingredients from the culture broth.
- Learned the basic principles and techniques of chromatography to purify the biological products and formulate the products for different end uses.

REFERENCES

1. J.C. Janson – Protein Purification – Principles, High Resolution Methods And Applications, 3rd Edition, Wiley, 2011.
2. Pauline Doran, Bioprocess Engineering Calculation, Blackwell Scientific Publications
3. Shuler and Kargi, " Bioprocess Engineering ", 3rd Edition, Prentice Hall, 2017.

BY5001	MOLECULAR CONCEPTS IN BIOTECHNOLOGY (FOR ENGINEERING STREAM)	L T P C 3 0 0 3

OBJECTIVES:

- Familiarize students with the cell and molecular biology of both Prokaryotes and Eukaryotes.
- By doing this course students will acquire basic fundamental knowledge and explore skills in molecular biology and become aware of the complexity of the cells.
- This course will emphasize the molecular mechanism of DNA replication, repair, transcription, protein synthesis and gene regulation in various organisms.

UNIT I DNA, RNA AND PROTEIN SYNTHESIS 9

Structure of DNA – DNA replication, Decoding genetic information – Transcription and translation. Regulation of transcription in bacteria and eukaryotes – Non-coding RNAs.

UNIT II MANIPULATION OF GENE EXPRESSION IN PROKARYOTE 9

Regulatable promoters, fusion proteins – Construction, cleavage and use of fusion proteins – Unidirectional tandem gene arrays and translation expression vectors – Protein stability – Oxygen limitation, protease deficient host strains, bacterial hemoglobin *Vitreoscill* sp. – Increased protein secretion – Factor Xa and bacteriocin.

UNIT III DIRECTED MUTAGENESIS AND PROTEIN ENGINEERING 9

Directed mutagenesis – Oligonucleotide-directed mutagenesis with M13 virus and plasmid DNA – PCR amplified oligonucleotide directed mutagenesis – Protein thermo stability – Addition of disulfide bonds, reduction in free sulfhydryl residues – Increasing enzyme activity – Modifying the substrate binding specificity, modifying metal cofactor requirements – Restriction modification enzymes – Zinc finger proteins.

UNIT IV TRANSGENIC ANIMALS 9

Transgenic animals – Gene transfer methods – Retroviral vector method, DNA microinjection, engineered embryonic stem cell, nuclear transfer, YAC –Applications of transgenic animals – Transgenic livestock – Production of donor organs, pharmaceuticals, disease resistant livestock – Improving milk quality and animal production traits.

UNIT V HUMAN MOLECULAR GENETICS 9

Genetic linkage and gene mapping – Genetic polymorphism, RFLP, SNP, STRP – Physical mapping of the human genome – Sequence tagged site (STS) for constructing physical maps from YAC, BAC or PAC – Genomic libraries – Transcriptional mapping – Cloning human disease genes and methods.

TOTAL: 45 PERIODS

OUTCOMES:

By the end of this course, students should be able to:

- Describe the basic structure and biochemistry of nucleic acids and proteins and discriminate between them;
- Identify the principles of DNA replication, transcription and translation and explain how they relate to each other.
- Discuss clearly about gene organization and mechanisms of control the gene expression in various organisms.
- Articulate applications of molecular biology in the modern world.

REFERENCES

1. Bernard R. Glick, Jack J. Pasternak and Cheryl L. Patten., "Molecular Biotechnology: Principles and Applications of Recombinant DNA", ASM Press, 4th Edition, 2010.
2. Jeremy W. Dale, Malcolm von Schantz and Nicholas Plant, "From Genes to Genomes: Concepts and Applications of DNA Technology, John Wiley and Sons Publishers, 3rd Edition, 2012.
3. Jocelyn E. Krebs, Elliotts. Goldstein and Stephen T. Kilpatrick, "Lewin's GENES XI", Jones and Bartlett Publishers, 11th Revised edition, 2013.
4. Sandy B. Primrose and Richard Twyman, "Principles of Gene Manipulation and Genomics", John Wiley and Sons Publishers, 8th Revised Edition, 2016.
5. Tom Strachan and Andrew P. Read, "Human Molecular Genetics" Garland Publishing, 3rd Edition, 2004.

BY5002	PRINCIPLES OF CHEMICAL ENGINEERING (FOR SCIENCE STREAM)	L T P C 3 0 0 3

OBJECTIVES:

The course aims to develop skills of the students in the area of Chemical Engineering with emphasis in process calculations and fluid mechanics. The objectives are to enable the students

- To perform calculations pertaining to processes and operations.
- To apply fluid mechanics principles to applied problems

UNIT I FUNDAMENTALS OF CHEMICAL ENGINEERING 9

Concepts of unit operation and unit process with examples – Units and dimensions, conversion factors, dimensional analysis – Presentation and analysis of data – Mole, density, Specific gravity – Mass fraction, Mole fraction – Analysis of multicomponent system – Concentration.

UNIT II MATERIAL AND ENERGY BALANCES 9

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 – Concepts of chemical thermodynamics – Relation to VLE, solution thermodynamics and reaction thermodynamics.

UNIT III FLUID MECHANICS 9

Laminar and turbulent flow – Basic equations of fluid flow, continuity equations and Bernoulli's equation – Shear – Stress relationships – Non-Newtonian fluids, friction factor and its calculation in

laminar and turbulent flow – Operational principles of different types of pumps, compressors and valves – Measurement of fluid flow using venturimeters, orifice meters – Rotameters, pivot tube.

UNIT IV HEAT TRANSFER 9

Conduction – Concept of heat conduction, Fourier's law of heat conduction: one dimensional steady state heat conduction, equation for flat plate, hollow cylinder – Individual and overall heat transfer coefficients and relationship between them – Convection – Concept of heat transfer by convection, natural and forced convection, equations for forced convection – Operational principles of heat exchangers – Double pipe heat exchangers, shell and tube heat exchangers.

UNIT V MASS TRANSFER 9

Fick's law of diffusion – Analogy with momentum and heat transfer, diffusivities of gases and liquids, diffusion in binary mixtures, Interphase mass transfer – Film theory of mass transfer, determination of volumetric mass transfer coefficient – Overview of separation operations with examples, ideal stage concept – Mass transfer equipment – Distillation, liquid extraction, gas absorption, drying.

TOTAL: 45 PERIODS

OUTCOMES:

Upon success completion of this course, the students will be able to:

- Solve problems related to units and conversions and fit the given data using the methodologies
- Solve problems related to material and energy balance concepts and design reactors for biochemical processes
- Apply their knowledge in the field of biochemical engineering from the principles of thermodynamics.

REFERENCES

1. Coulson, J.M. and Richardson, J.F., “Chemical Engineering”, Vol. I, 6th Edition, Butterworth-Heinemann Ltd., 2007.
2. Geankoplis, C.J., “Transport Processes and Unit Operations”, Prentice Hall India, 2003.
3. Ghasem, N. and Henda, R., “Principles of Chemical Engineering Processes”, 2nd Edition, Kindle edition, 2014.
4. McCabe, W.L., Smith, J.C., and Harriott, P., “Unit Operations of Chemical Engineering” 7th Edition, McGraw-Hill Higher Education, 2014
5. Melblau, D.M. and Riggs, J.B., “Basic Principles and Calculations in Chemical Engineering”, 8th Edition, Kindle edition, 2012.

BY5003 METABOLIC PROCESS AND ENGINEERING (FOR BIOTECHNOLOGY STREAM) L T P C 3 0 0 3

OBJECTIVES:

- To provide a quantitative basis, enzyme kinetics, for the understanding of metabolic networks in single cells and at the organ level
- To enable the students to use organisms to produce valuable substances on an industrial scale in cost effective manner

UNIT I CELLULAR METABOLISM 9

Transport Processes – Fueling reactions – Glycolysis, fermentative pathways – TCA cycle and oxidative phosphorylation, anaplerotic pathways –Catabolism of fats, organic acids, and aminoacids - Biosynthesis of aminoacids, nucleic acids, and fatty acids – Polymerization – Growth energetics.

UNIT II REGULATION, MANIPULATION AND SYNTHESIS OF METABOLIC PATHWAY 9

Regulation of enzyme activity – Regulation of enzyme concentration – Regulation of metabolic networks – Regulation at the whole cell level – Metabolic pathway manipulations – Enhancement of Product yield and productivity – Extension of substrate range, product spectrum and novel products (Antibiotics, Polyketides, Vitamins) – Improvement of cellular properties – Metabolic pathway synthesis algorithm – Lysine biosynthesis.

UNIT III ANALYSIS AND METHODS FOR THE METABOLIC FLUX 9

Metabolic flux map – Fluxes through the catabolic pathways in microbes– Metabolic flux analysis for determined, over-determined and under-determined systems –Sensitivity analysis – Direct flux determination from fractional label enrichment – Applications involving complete enumeration of metabolite isotopomers – Carbon metabolite balances.

UNIT IV APPLICATION OF METABOLIC FLUX ANALYSIS 9

Amino acid production – Biochemistry and regulation– Metabolic flux analysis of lysine biosynthetic network and specific deletion mutants – Metabolic fluxes in mammalian cell cultures – Intracellular fluxes, validation of flux estimates by ^{13}C labeling studies – Design of cell culture media.

UNIT V ANALYSIS OF METABOLIC CONTROL AND INDUSTRIAL CASE STUDIES 9

Fundamental of Metabolic Control Analysis (MCA), MFA, and MPA and their application, relating system variables to enzyme kinetics, Multi-substrate enzyme kinetics, Metabolic engineering examples for bio-fuel, bio-plastic and green chemical synthesis and industrial case studies..

TOTAL: 45 PERIODS

OUTCOMES:

After completion of metabolic engineering, students will be able

- To learn stoichiometry and energetics of metabolism.
- To apply practical applications of metabolic engineering in chemical, energy, medical and environmental fields.
- To integrate modern biology with engineering process to meet desired needs

REFERENCES

1. Christiana D. Smolke, " The Metabolic Pathway Engineering Handbook Fundamentals", CRC Press Taylor & Francis Group, 2010.
2. Cortossa, S., Aon, M.A., Iglesias, A.A. and Lloyd.D., "An Introduction to Metabolic and Cellular Engineering", 2nd Edition,World Scientific Publishing Co, 2011
3. Curran, C.P., "Metabolic Processes and Energy Transfers - An Anthology of Current Thought", The Rosen Publishing group, Inc., 2006.
4. Nielsen, J., Villadsen, J. and Liden, G., "Bioreaction Engineering Principles",3rd Edition, Springer, 2011

5. Stephanopoulos, G.N., Aristidou, A.A. and Nielsen.J., "Metabolic Engineering - Principles and Methodologies", Elsevier Science, 2001.

BY5004 ANIMAL BIOTECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To provide the fundamentals of animal cell culture, diseases and therapy
- To offer the knowledge about the micromanipulation and transgenic animals

UNIT I CELL CULTURE 9

Culturing of cells– Primary and secondary cell lines – Genetics of cultured cells – Scaling up in suspension –Monolayer culture – Bio-reactors used for animal cell culture –Roller bottle culture– Bioreactor process control –Stirred animal cell culture –Air-lift fermentor, Chemostat/Turbidostat– Cell lines and their applications.

UNIT II GENE CLONING VECTORS AND IMMUNOLOGY 9

Viral disease in animals–Animal viral vectors –Vector design–SV40, adeno virus, retrovirus, vaccinia virus, herpes virus, adeno associated virus and baculo virus– Immune response – Lymphocyts, immune system – Baculo virus expression vectors–Vaccines and their applications in animal infections –High technology vaccines – Hybridoma technology.and production of monoclonal antibodies.

UNIT III STEM CELL AND CLONING 9

Characteristics of ES cells –Types of stem Cells – ES cell research–*In vitro* derivation of gametes –Maintenance of stem cells in culture and applications – Somatic cell nuclear transfer –Gene expression of pluripotent cells –Cellular reprogramming –Induced pluripotency– Cloning techniques in animals and therapeutic cloning.

UNIT IV GENETIC ENGINEERING 9

Gene therapy –Prospects and problems – Single gene – Gene mapping – Hematopoietic cells for cellular gene therapy of animal disease –Knockout mice and mice model for human genetic disorder –Baculo virus in biocontrol– Enzymes technology – Somatic manipulation of DNA – Nucleic acid hybridization and probes in diagnosis– Preparation of probes, evaluation and applications.

UNIT V APPLICATIONS 9

Rumen manipulation– Probiotics embryo transfer technology – *Invitro* fertilization, transgenesis– Methods of transferring genes into animal oocytes, eggs, embryos and specific tissues by physical, chemical and biological methods–Biopharming– Transgenic animal technology, application to production and therapeutics (mice, sheep, cattle) – Artificial insemination and embryo transfer – Transgenic growth hormone genes.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completion of this subject the student will be able to

- Understand the animal cell culture, animal diseases and its diagnosis
- Gain the knowledge for therapy of animal infections
- Know the concepts of micromanipulation technology and transgenic animal technology

- Use the knowledge gained in this section to apply in the field of clinical research

REFERENCES

1. Freshney R.I. Cultures of Animal cells: A manual of Basic Techniques and specialized applications, 6th Edition, John Wiley and Sons, 2010.
2. Glick, B.R. and Pasternack, J.J. and Pattern ,C. Molecular Biotechnology, 4th Edition ASM Press, 2003
3. Lewin, B. Genes VIII , Pearson Prentice Hall, 2004
4. Portner, R, Animal Cell Biotechnology, Methods and Protocol, 2nd Edition, Humana Press, 2007

BY5005 COMPUTER AIDED LEARNING OF STRUCTURE AND FUNCTION OF PROTEINS

L	T	P	C
2	2	0	3

OBJECTIVES:

To enable the students

- To identify the importance of protein bio molecules.
- To realize the structure-function relationships in proteins

UNIT I AMINO ACIDS AND 3D STRUTURE 9

Amino acids – Acid-base properties – Stereo chemical representations – Chemical and Physical properties – Primary structure – Secondary structure and motifs – Tertiary structures and domains – Quaternary structures – Classifications – CATH, SCOP – Protein Data Base analysis.

UNIT II FIBROUS AND MEMBRANE PROTEINS 9

Amino acid composition and organization of fibrous proteins – Keratins – Fibroin – Collagen – Molecular organization of membranes – Bacteriorhodopsin – Structure of the Bacterial reaction centre – Oxygenic photosynthesis – Membrane proteins based on transmembrane beta barrels – Structure of ATP synthetase.

UNIT III FUNCTION AND CONTROL OF FUNCTION 9

Protein flexibility – Hydrogen exchange – Rotations of side chains – Enzyme Catalysis – Steady state kinetics – Transition state stabilization – Allostery – Multiple binding sites and interactions – Allosteric properties of Hemoglobin – Negative Cooperativity.

UNIT IV BIOSYNTHESIS AND DEGRADATION 9

Post translational covalent modifications – Proteolytic processing – Alteration of the chain Termini – Glycosylation – Lipid attachment – Hydroxylation – Phosporylation – Disulphide bond formation – Chemical aging – Factors determine the rate of degradation – Proteases – Lysosomes – Ubiquitin mediated pathway.

UNIT V DETERMINATION AND PREDICTION OF 3D STRUCTURE 9

Experimental physical methods – X-Ray crystallography, NMR, Cryo-EM, Neutron diffraction – Vibrational spectroscopy – Raman spectroscopy – Computational methods – Homology modeling – Fold recognition and Threading.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course, students will be able:

- To analyze the various interactions in protein makeup.
- To be familiar with different levels of protein structure.
- To know the role of functional proteins in various field of study.
- To practice the latest application of protein science in their research.

REFERENCES

1. Bujnicki, J.M., "Prediction of Protein Structures, Functions, and Interactions", John Wiley & Sons Ltd., 2009.
2. Creighton. TE., "Proteins: Structures and Molecular Properties", 2nd Edition, W. H. Freeman and Company, New York, 1993.
3. Petsko, G.A. and Ringe, D., "Protein Structure and Function", 2004.
4. Rastogi, S.C., "Bioinformatics Concepts, Skills & Applications", 2nd Edition, CBS publishers, 2009.
5. Whitford, D.,"Proteins: Structure and Function", John Wiley & Sons Ltd., 2005.

BY5006 ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

To enable the students

- To have a fundamental knowledge about the Light spectrum, Absoprtion, Fluorescence, NMR, Mass spectroscopy
- To acquire knowledge on the different chromotographic methods for separation of biological products.
- Understand the methods to obtain pure proteins, enzymes and in general about product development R & D

UNIT I PROTEIN CRYSTALLOGRAPHY 9

Biological macromolecules – Principle of protein crystallization – Method – Testing – Cryotechniques – Influence of heterogeneity on crystallization – Progress in structural genomics – Micro crystallization – Utility of micro fluidics for crystallization.

UNIT II PROTEIN AND PEPTIDE PURIFICATION 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 ELECTROPHORETIC TECHNIQUES 9

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 IV MICROSCOPY 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 SPECTROSCOPY 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).

TOTAL: 45 PERIODS

OUTCOMES :

- On completion of the course, students will have a better understanding of spectroscopy and the separation techniques used for biological products.
- Apply principles of various unit operations used in downstream processing and enhance problem solving techniques

REFERENCES

1. Babine, R.E. and Abdel-Meguid, S.S., "Protein Crystallography in Drug Discovery", Willy-VCH Verlag GmbH& Co., 2004.
2. Bhowmik, G. and Bose, S., "Analytical Techniques in Biotechnology", Tata McGraw-Hill Publishers, 2011.
3. Chandler, D. and Roberso, R.W., "Bioimaging: Current Techniques in Light & Electron Microscopy", Jones and Bartlett publishers, 2008.
4. Pavia, D.L., Lampman, G.M., Kriz, G.S. and Vyvyan, J.R., "Introduction to Spectroscopy", 4th Edition, Brooks/Cole Cengage Learning, 2008.
5. Simpson, R.J., "Purifying Proteins for Proteomics", Cold Spring Harbor Lab Press, 2004.

BY5007 BIOTHERMODYNAMICS L T P C

3 0 0 3

OBJECTIVE:

- To enable the students to learn about basic concepts of classical and statistical thermodynamics
- To demonstrate the capability to analyze the energy conversion performance in a variety of modern applications in biological systems.

UNIT I CONCEPTS AND LAWS OF THERMODYNAMICS 9

Basic concepts of thermodynamics – First Law of Thermodynamics – Second law of thermodynamics – Zeroth Law and Third Law of thermodynamics – Laws of thermodynamics and biology – Thermodynamics of equilibrium – Behavior of systems far from equilibrium – Dissipative structures in non-equilibrium systems – Thermodynamic features of small systems – Thermodynamics of macromolecular processes in cells – Thermodynamics of energy interactions in ecosystems – Conservation of energy.

UNIT II ENERGY TRANSFORMATION AND BIOENERGETICS 9

Distribution of energy – Carbon, energy and life – Molecular level energy storage – Biothermodynamics of energy use by plant and animals – Methods for measuring the thermodynamic stability of membrane proteins – Protein folding – Modeling the native state ensemble of proteins using statistical thermodynamics – Energetic profiles of proteins derived from thermodynamics of the native state ensemble – Principle of components analysis of energetic profile space – Energetic profiles are conserved between homologus proteins.

UNIT III GIBB'S FREE ENERGY AND ITS APPLICATIONS 9

Theory and derivation of Gibbs free energy – Free energy of reactions – Lipid membrane phase transitions – Thermodynamics of cellular metabolism – Sugar metabolism – Energy transport in ATP and NAD – Substrate recycling – Donnan Equilibrium – Enzyme-substrate interaction – Free energy of transfer of amino acids – Differences between heat engines and biological energy processes – Temperature regulation in organisms – Humidity and temperature effects on organisms – Non-equilibrium thermodynamics and life.

UNIT IV STASTICAL THERMODYNAMICS AND BINDING EQUILIBRIA 9

Diffusion – Boltzman distribution – Partition function – Analysis of thermodynamic data – Multi-state equlibria – Protein heat capacity functions – Cooperative transitions – Interaction free energy – Helix coil transition theory – Binding equlibria – Single site model – Multiple independent sites – Oxygen transport – Scatchard plots and Hill plots – Ligand binding in macromolecules.

UNIT V REACTION KINETICS TO BIOLOGICAL SYSTEM 9

Free energy analysis of chemical reactions – Chemical coupling to drive reactions in biological systems – First order and second order reactions – Collision theory – Transition state theory – Free energy of activation – Arrhenius rate constant equation – Applications – Temperature and concentration effects on enzyme kinetics – Reaction mechanism of lysozyme – Kinetic identification of reaction intermediates – Sequential enzyme reactions in metabolism and analysis.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the student would have the ability

- To explain the theoretical concepts of thermodynamics and how it applies to energy
- conversion in technological applications and biological systems.
- To design and carry out bioprocess engineering experiments, and analyze and
- interpret fundamental data to do the design and operation of bioprocesses.
- To describe the criteria when two phases coexist in equilibrium and the vapour liquid equilibrium calculations microbial growth and product formation.

REFERENCES

1. Cengel, Y.A. and Boles, M.A., "Thermodynamics, an Engineering Approach", McGraw Hill, Sixth Edition, 2006.
2. Hammes, G.G., "Thermodynamics and Kinetics for the Biological Sciences for Biological System", Wiley, 2000.
3. Haynie, D.T., "Biological Thermodynamics", Second Edition, Cambridge University Press, 2008.
4. Johnson, M.L., Holt, J.M. and Ackers, G.K., "Bio thermodynamics", Part 1, Academic Press, 2009.
5. Timasheff, S.N., "Protein Hydration, Thermodynamic Binding, and Preferential Hydration, Biochemistry", 13473-13482, 2002.

BY5008 PLANT BIOTECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

- To give the details of plant cells and its functions
- To provide the basics of agro bacterium and applications of plant biotechnology

UNIT I PLANT TISSUE CULTURE 9

Concept of cellular totipotency– Cytodifferentiation– Organogenic differentiation – Nutritional requirements – Seed culture, embryo culture, Protoplast culture, Micropropagation, Cell suspension –*Invitro* production of haploids–Somaclonal variation –Germplasm storage and cryopreservation.

UNIT II CHLOROPLAST AND MITOCHONDRIA 9

Structure, function –Light and dark reaction and genetic material –Rubisco synthesis and assembly, coordination, regulation and transport of proteins– Mitochondria: Genome – Cytoplasmic male sterility and import of proteins – Comparison and differences between mitochondrial and chloroplast genome –Chloroplast transformation

UNIT III PLANT METABOLISM AND METABOLIC ENGINEERING 9

Nitrogen fixation – Nitrogenase activity – Nod genes, nif genes, bacteroids – Plant nodulins Production of secondary metabolites – Flavanoid synthesis and metabolic engineering.

UNIT IV GENE TRANSFER IN PLANTS 9

Tranisent and stable gene expression –Marker genes –Vector mediated gene transfer, *Agrobacterium* mediated DNA transformation–Tumor inducing principle, Ti plasmid – TDNA transfer – Transformation techniques using *Agrobacterium,*importance in genetic engineering– Agrobacterium vectors – Viruses mediated gene transfer, status and expression of transferred genes.

UNIT V TRANSGENICS IN CROP IMPROVEMENT 9

Resistance to biotic stresses and abiotic stresses – Herbicide resistance –Transgenics for quality –Transgenics plants as bioreactors – commercial transgenic crops and impact of recombinant DNA technology–Molecular Pharming – Therapeutic products –Transgene silencing and ethical issues.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completion of the course, the student would be able

- To understand the fundamentals of plant cells, structure and functions
- To learn the nitrogen fixation mechanism and significance of viral vectors
- To gain the knowledge about the plant tissue culture and transgenic plants
- To use of the gained knowledge for the development of therapeutic products

REFERENCES

1. Adrian, Scott, Nigel W., Fowler, Mark R.Plant Biotechnology: The Genetic Manipulation of Plants by Slater 2nd Edition Oxford University Press, 2008
2. Chawla, H.S, Introduction to Plant Biotechnology, 2nd edition, 2007
3. Gamburg ,O.L., and Philips G.C. Plant Tissue & Organ Culture: Fundamental Methods. Narosa Publishing House,2005
4. Grierson D. and Covey, S.N. Plant Molecular Biology, 2nd Edition, Blackie,1988
5. Heldt, Hans-Walter, Plant Biochemistry & Molecular Biology, 1stEditionOxford University Press,1997

BY5009 ENVIRONMENTAL BIOTECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

The proposed course is designed

- To understand the scientific and engineering principles of microbiological treatment technologies to clean up contaminated environments
- To replace of conventional treatment methodologies by molecular biology and genetic engineering strategies
- To seek the way for the alternate sources of energy to avoid environmental issues

UNIT I BIODEGRADATION AND BIOREMEDIATION 9

Aerobic and Anaerobic degradation of aliphatic and aromatic compounds – Biodegradation of herbicides and pesticides. Bioremediation technologies – Biostimulation, Bioaugmentation, Bioventing, biosparging and Phytoremediation – Bioleaching, bioprecipitation, bioaccumulation and biosorption of heavy metals.

UNIT II MICROBIAL METABOLISM IN WASTEWATER TREATMENT 9

Decomposition of organic compounds in natural ecosystems – Co-metabolic degradation of organo-pollutants - Hydrolysis of biopolymers by aerobic and anaerobic microorganisms – Anaerobic degradation of carbohydrates, proteins, lipids – Nitrogen removal – Ammonification, nitrification, denitrification

UNIT III BIOLOGICAL TREATMENT OF WASTEWATER 9

Physico-chemical characteristics of wastewater – Overview of aerobic and anaerobic treatment processes – Process design of aerobic and anaerobic system – Activated sludge process – Trickling filter – Rotating biological contactors – Fluidized bed reactor – Up flow anaerobic sludge blanket reactor (UASB) – Membrane bioreactors – Algal photosynthesis in wastewater treatment.

UNIT IV BIOTECHNOLOGY FOR AIR POLLUTION AND WASTE MANAGEMENT 9

Air pollution control and treatment strategies – Biotechnology for treating air pollutants – Biofilters and Bioscrubbers – Biotechnology for the management of agricultural, plastic, dairy, paper and pulp, textile, leather, hospital and pharmaceutical industrial wastes.

UNIT V BIOPRODUCTS FROM RENEWABLE SOURCES 9

Overview of renewable sources – Production of biocompost and vermicompost – Production of biofertilizers and biopesticides – Production of biomethane, bioethanol, biohydrogen, biodiesel – Production of bioplastics and biopolymers – Bioelectricity generation and value added products from renewable sources.

TOTAL: 45 PERIODS

OUTCOMES:

Upon successful completion of the course

- Environmental Pollution or problems can be solved
- Scientific solutions and participation can be served for the environmental Protection
- improvement for the alternate sources of energy to avoid environmental disasters

REFERENCES

1. Chakrabarty K.D., Omen G.S., Biotechnology And Biodegradation, Advances In Applied Biotechnology Series , Vol.1, Gulf Publications Co., London, 1989.

2. Evans, G.G. and Furlong, J., Environmental Biotechnology: Theory and Application, 2nd Edition, John Wiley & Sons, 2011.
3. Henze, M., Harremoes, P., Jansen, J.C. and Arvin, E., "Wastewater Treatment: Biological and Chemical Processes", 2nd Edition, Springer, 2013.
4. Jordening, H.J. and Winter, J., "Environmental Biotechnology: Concepts and Application", Wiley-VCH Verlag GmbH & Co., 2005.
5. Wong J.W-C., Tyagi R.D., and Pandey. A., "Current Developments in Biotechnology and Bioengineering Solid waste" Elsevier, 2016.
6. Zarook, S. and Ajay,S., Biotechnology for Odor and Air Pollution Control, Springer, 2005.

BY5010 CANCER BIOLOGY L T P C
3 0 0 3

OBJECTIVES:

To enable the students to understand

- Basic biology of cancer
- Impact of antibodies against cancer in the human body leading to more effective treatments
- Enhanced immunology based detection methods and imaging techniques
- Development of cell based and cytokine based immunotherapy against cancer

UNIT I PRINCIPLES OF CANCER BIOLOGY 9

Cancer: Definition, causes, properties, classification, clonal nature – Cell Cycle: Regulation of cell cycle, cell proliferation and apoptosis – Signal transduction pathways – Apoptosis: apoptotic pathways, signal molecules, effects on receptor, signal switches – Modulation of cell cycle in cancer – Mechanism of spread.

UNIT II PRINCIPLES OF CARCINOGENESIS 9

Cancer risk factors – Theory of carcinogenesis – Chemical carcinogenesis – Physical carcinogenesis: x-ray radiation – mechanisms of radiation carcinogenesis – Stages of cancer: initiation, promotion, progression.

UNIT III MOLECULAR BIOLOGY OF CANCER 9

Signal targets and cancer – Growth factors – Transformation – Activation of kinases – Oncogenes: c-Myc, Ras, Bcl-2 family – Mechanism of oncogene activation – Retroviruses and oncogenes – Detection of oncogenes – Oncogenes/proto oncogene activity – Tumor suppressor genes: Rb, p53, APC, BRCA paradigms – Telomerases.

UNIT IV CANCER METASTASIS 9

Clinical significances of invasion – Heterogeneity of metastatic phenotype – Metastatic cascade: basement membrane disruption, invasion – Recent approach to identify key factors controlling metastasis – Angiogenesis.

UNIT V CANCER THERAPY 9

Therapy forms – Surgery, chemotherapy, radiation therapy - Detection of cancers – Prediction of aggressiveness of cancer – Advances in cancer detection – Tumor markers; New approaches of cancer therapy – mAbs, vaccines, gene therapy, stem cell therapy.

TOTAL: 45 PERIODS

OUTCOMES:

The course would facilitate the students

- To appreciate the role of immune system in cancer
- To understand the cancer microenvironment and its influence on immune cells
- To medical applications of cytokines and immune cells against cancer.

REFERENCES

1. Fialho, A. and Chakrabarty, A., "Emerging Cancer Therapy: Microbial Approaches and Biotechnological Tools" 1st Edition, Wiley, 2010.
2. Pelengaris, S. and Khan, M., "The Molecular Biology of Cancer", Blackwell Publishing, 2006.
3. Ruddon, R.W., "Cancer Biology", 2nd Edition, Oxford University Press, 2007
4. Schulz, W.S., "Molecular Biology of Human Cancers – An Advanced Students Text Book", Springer, 2005.
5. Weinberg, R.A., "The Biology of Cancer", Taylor & Francis, Garland Science, 2007

BY5011 TECHNOLOGY MANAGEMENT L T P C

3 0 0 3

OBJECTIVE:

- To impart the knowledge of various aspects of Creativity, Innovation and New Product Development

UNIT I TECHNOLOGY MANAGEMENT 9

Concept and meaning of technology – Evolution and growth of technology – Role and significance of management of technology – Impact of technology on society and business – Process and product technology. Competitive advantages through new technologies: product development from scientific breakthrough to marketable product – Role of Government in Technology Development – Managing Intellectual Property.

UNIT II TECHNOLOGICAL FORECASTING & ASSESSMENT 9

Intuitive – Extrapolation – Growth Curves – Technology Monitoring. Normative: Relevance Tree – Morphological Analysis – Mission Flow Diagram - Technology Choice –Technological Leadership and Followership – Technology Acquisition. Meaning of Innovation and creativity – Innovation management.

UNIT III TECHNOLOGY STRATEGY 9

Strategy concept – Types – Key principles – Framework for formulating technology strategy - Technology forecasting: techniques and application – Technology diffusion and absorption: Rate of Diffusion – Innovation Time and Innovation Cost – Speed of Diffusion – Project management in adoption and implementation of new technologies.

UNIT IV TECHNOLOGY TRANSFER MANAGEMENT 9

Technology transfer process – Outsourcing strategic issues – Joint ventures – Technology sourcing. Integration of People and Technology – Organizational and Psychological Factors – Organizational Structure – Social Issues in Technology Management: Technological Change and Industrial Relations – Technology Assessment – Environmental Impact Analysis.

UNIT V TECHNOLOGY TRANSFER AND ACQUISITION 9

Import regulations – Implications of "Uruguay Round" and WTO – Bargaining process –Transfer option – MOU. Adopting technology – Human interactions – Organizational redesign and re-engineering – Technology productivity. Technology Absorption and Innovation: present status in India – Need for new outlook – Absorption strategies for acquired technology – Creating new/improved technologies – Innovations – Technology Measurement – Technology Audit.

TOTAL: 45 PERIODS

OUTCOME:

- On completion of the course, students will have gained knowledge on various issues related to Patents, Quality, Creativity, Innovation, New Product Development, Planning and Evaluation.

REFERENCES

1. Khalli,T., "Management of Technology", McGraw-Hill, 2009.
2. Narayanan,V.K., "Managing Technology and Innovation for Competitive Advantage" Pearson Education, 2007.
3. Schilling, M.A., "Strategic Management of Technological Innovation", McGraw-Hill, 2008.
4. Thamhain, H.J., "Management of Technology: Managing Effectively in Technology-Intensive Organizations", 2nd Edition, Wiley, 2005

BY5012 COMPUTATIONAL METHODS IN FLUID DYNAMICS L T P C
3 0 0 3

OBJECTIVES:

The course aims to develop skills of the students in the area of Chemical Engineering with emphasis in process calculations and fluid mechanics. The objectives are to enable the students

- To perform calculations pertaining to processes and operations.
- To apply fluid mechanics principles to applied problems

UNIT I GOVERNING EQUATIONS 9

Fluid flow and its mathematical descriptions; conservation laws – Continuity equations – Momentum equation, energy equation – Navier-Stokes equations – Boundary conditions, Solutions of Governing Equations – Finite difference method, Finite element method, Finite Volume Method, Euler's Equations – Non-Newtonian Constitutive Equations – Curvilinear coordinates and Transformed equations – CFD as Research tool and Design tool – Validation Strategies.

UNIT II NUMERICAL ANALYSIS 9

Solving System of Algebraic equations – Gauss Elimination, Gauss-Seidel – LU-Decomposition – Jacobi – Simpson Rule – Laplace solution – Euler's method – R-K method – Fourier analysis of first and second upwind.

UNIT III COMPRESSIBLE FLOW COMPUTATION 9

Euler equations – Conservative and non-conservative from thermodynamics of compressible flow – Scalar conservations laws – Conservation – Weak solutions – Non-uniqueness – Entropy conditions – Godunov methods – Flux vector splitting Method – Reconstruction of dependent variables – Fluxes – Preconditioning of low speed Flows – Projection methods.

UNIT IV TURBULENT FLOW COMPUTATION 9

Physical Considerations – Survey of theory and models – Relation of High – Resolution Methods and Flow Physics – Large Eddy Simulation – Standard and Implicit – Numerical Analysis of Sub grid Models – ILES Analysis – Explicit Modeling – Implicit Modeling – Limiters – Energy Analysis – Computational Examples – Burgers' Turbulence – Convective Planetary Boundary Layer.

UNIT V FINITE ELEMENT METHOD 9

Finite Element formulation – Errors, Solutions of Finite difference equations – Elliptic equations – Parabolic Equations – Hyperbolic Equations – Burger's Equations – Nonlinear Wave equation (Convection Equation) – Primitive Variable method for Incompressible viscous flows; Taylor-Galerkin Method and Pertov-Galerkin Method for Compressible Flows.

TOTAL: 45 PERIODS

OUTCOMES:

Upon success completion of this course, the students will be able to:

- Solve problems related to units and conversions and fit the given data using the methodologies
- Solve problems related to material and energy balance concepts and design reactors for biochemical processes
- Apply their knowledge in the field of biochemical engineering from the principles of thermodynamics.
- Acquire knowledge related to fluid statics and dynamics, agitators and applications of various pumps.

REFERENCES

1. Blazek, J., "Computational Fluid Dynamics: Principles and Applications", Elsevier Publications, 2005.
2. Cebeci, T., Shao, J.P., Kafyeke, F. and Laurendeau, E., "Computational Fluid Dynamics for Engineers", Springer - Horizons Publishing Inc., 2005.
3. Drikakis, D. and Rider, W.J., "High - Resolution Methods for Incompressible and Low-Speed Flows", Springer-Verlag Berlin Heidelberg, 2005.
4. Knight, D.D., "Elements of Numerical Methods for Compressible Flows Cambridge" University Press, 2006.

BY5013 BIOTECHNOLOGY IN FOOD PROCESSING L T P C
3 0 0 3

OBJECTIVES:

To enable the students

- To know about the constituents and additives present in the food.
- To gain knowledge about the microorganisms, food spoilage diseases.
- To know different techniques used for the preservation of foods.

UNIT I FOOD PROCESSING 9

Heat Processing using steam or water (Blanching, Pasteurization) – Heat sterilization (Evaporation and distillation) – Heat processing using hot air (Dehydration, baking and roasting) – Heat processing using hot oils – Processing by the removal of heat (chilling , Freezing) – High pressure processing of foods – Pulsed electric field processing of liquids and beverages – Non-thermal processing by radiofrequency electric fields.

UNIT II FOOD FERMENTATION 9

Fermentative production of foods – Single cell protein (yeast, mushroom) – Microorganisms responsible for production of fermented foods – Enzyme in bakery and cereal products – Enzymes in fat/oil industries – Protease in cheese making and beverage production – Production of Pectinases and Utilization in Food Processing – Food Flavour Production – Utilization of food waste for production of valuables.

UNIT III FERMENTED FOODS 9

Overview of fermented foods – Bean-based – Grain-based – Vegetable-based – Fruit-based – Honey-based – Dairy-based – Fish-based – Meat-based – Tea-based – Advantages of fermented foods Health benefits of fermented foods – Nutritive value of fermented food – Biotechnological approaches to improve nutritional quality – Microbial changes in fermented food.

UNIT IV FOOD PRESERVATION TECHNIQUES 9

Spoilage of food - Microbiology of water, meat, milk, vegetables – Food poisoning – Cold preservation – Heat conservation – Ionizing radiation – High pressure – Electric field – Chemical food preservation – Combination of techniques for food preservation – Natural antioxidants – Antimicrobial enzymes – Edible coatings – Control of pH and water activity.

UNIT V FOOD QUALITY AND CONTROL 9

Analysis of food – Major ingredients present in different product – Food additives, vitamins – Analysis of heavy metal, fungal toxins, pesticide and herbicide contamination in food – Microbial safety of food products – Chemical safety of food products – Good manufacturing practice

TOTAL: 45 PERIODS

OUTCOMES:

Through this subject the student can understand about

- Different constituents present in food and microorganism involved in processing of food.
- Principles and different preservations techniques of food can also be known.
- Unit operations in modern food processing and impact of the process on food quality

REFERENCES

1. Adams M., Adams M. R. and Robert Nout M. J., “Fermentation and food safety”, Springer, 2001.
2. Da-Wen S., “Emerging Technologies for Food Processing”, Academic Press, 2005.
3. Fellows, P.J., “Food Processing Technology: Principles and Practice”, 3rd Edition, CRC Press, 2009.
4. Hutkins R. W., “Microbiology and Technology of Fermented Foods”, IFT Press series, Volume 32 of Institute of Food Technologists Series, Wiley-Blackwell, 2006.
5. Pometto A, Shetty K, Paliyath G and Levin R. E., “Food Biotechnology”, 2nd Edition , CRC press, 2005.
6. Zeuthen P. and Bogh-Sorensen, L., “Food Preservation Techniques”, 1st Edition, CRC Press, 2003.

BY5014 **BIONANOTECHNOLOGY** **L T P C**
3 0 0 3

OBJECTIVES:

To enable the students

- To learn about basis of nanomaterial science, preparation method, types and application

UNIT I NANOSCALE PROCESSES AND NANOMATERIALS 9

Overview of nanoscale processes and characterization of nanomaterials – Physicochemical properties of nanomaterials – Concepts in nanotechnology – Natural nanomaterials –Types of Nanomaterials (Quantum dots, Nanoparticles, Nanocrystals, Dendrimers, Polymeric nanoparticles, Buckyballs, Nanotubes) – Interaction between biomolecules and nanoparticle surface –Synthesis and assembly of nanoparticles and nanostructures using bio-derived templates.

UNIT II STRUCTURAL AND FUNCTIONAL PRINCIPLES OF BIONANOTECHNOLOGY 9

Biomolecular structure and stability – Protein folding – Self-assembly – Self-organization – Molecular recognition – Flexibility – Information-Driven nanoassembly – Energetics – Chemical transformation – Regulation – Biomaterials – Biomolecular motors – Traffic across membranes – Biomolecular sensing – Self-replication – Machine-phase bionanotechnology.

UNIT III PROTEIN-BASED NANOTECHNOLOGY 9

Overview of protein nanotechnology – Nanotechnology with S-Layer protein – Engineered nanopores – Bacteriorhodopsin and its potential – Protein assisted synthesis of metal nanoparticles – Synthesis of protein-based nanoparticles – Protein nanopaticle-hybrids – Covalent and non-covalent protein nanoparticle conjugates – Protein-carbon nanotube conjugates.

UNIT IV DNA-BASED NANOTECHNOLOGY 9

DNA-based nanostructures – Biomimetic fabrication of DNA based metallic nanowires and networks – Self assembling DNA structures – DNA-nanoparticle conjugates – DNA-carbon nanotube conjugates – DNA templated electronics – DNA nanostructures for mechanics and computing – DNA nanomachine.

UNIT V NANOMEDICINE AND NANOSENSING 9

Promising nanobiotechnologies for applications in medicine – Role of nanotechnology in methods of treatment – Liposomes in nanomedicine – Therapeutic applications of nanomedicine – Nano-Sized carriers for drug delivery and drug carrier systems – Protein and peptide nanoparticles, DNA based nanoparticles, Lipid matrix nanoparticles for drug delivery – Design and development of bionanosensors using DNA, enzymes – Nanobiosensors for imaging and diagnosis.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completing this course, the students

- Will familiarize about the science of nanomaterials
- Will demonstrate the preparation of nanomaterials
- Awareness about the properties and broad applications of biomaterials

REFERENCES

1. Gazit, E., and Mitraki, A., “Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology”, Imperial College Press, 2013.

2. Goodsell, D.S., “Bionanotechnology”, John Wiley and Sons, 2004.
3. Jesus M. de la Fuente and Grazu, V., “Nanobiotechnology: Inorganic Nanoparticles Vs Organic Nanoparticles” Elsevier, 2012.
4. Niemeyer, C.M. and Mirkin, C.A., “Nanobiotechnology: Concepts, Applications and Perspectives”, Wiley- VCH, 2006.
5. Shoseyov, O. and Levy I., “Nanobiotechnology: Bioinspired Devices and Materials of the Future”, Humana Press, 2008.

BY5015 PHYTOCHEMISTRY L T P C
3 0 0 3

OBJECTIVES:

- To give the details of plant derived value added compounds and its functions
- To provide knowledge on biotech based production of agro medicines

UNIT HERBAL DRUGS 9

Phytochemicals and their classification–Phytochemical screening –Physiochemical tests — .Macroscopic and microscopic techniques –Traditional plant and Herbal remedies — Herbal drugs WHO guidelines–Standardization of Herbal Drugs Derivatives with Special Reference to Brazilian Regulations

UNIT II PHYTOCOMPOUNDS 9

Plant extract used to Bacterial, Fungal and Parasitic infection – Biological and Toxicology Properties of plant extract –Anti-MRSA and Anti-VRE activities of Phytoalexins and Phytoncides– Anti microbial and targeted screening of Plant extract – Plant derived compound against drug resistant microorganisms –Antioxidant and antitumor Plant metabolites (fruits and vegetables)– Bioactive compounds as food

UNIT III PHYTOMEDICINE 9

Medicinal Plants for Development of Phytomedicine and Use in Primary Health Care– Immunostimulants and adaptogen from Plants –Polyphenols for Atherosclerosis and Ischemic Heart disease –Cancer Chemopreventive agents –Lipidoxidation nitrogen Radicals– Phytochemicals in oilseeds – Flavonoids in Cardiovascular disease – Bioengineering and Breeding approaches in improving phytochemical content of plants.

UNIT IV SEPARATION TECHNIQUES AND STRUCTURE ELUCIDATION 9

Thin layer chromatography– HPTLC– Column chromatography – GC-MS – LC-MS –HPLC – Partition chromatography – Gas chromatography – FT-IR – UV- NMR (1D&2D) – X-ray diffraction – QSAR and Molecular Modeling

UNIT V SECONDARY METABOLITE 9

Secondary metabolite production through cell culture system–Hairy root induction–Methods of gene transfer–Chemical methods– PEG – dextran–Physical method– Electroporation– Microinjection–Lipofection delivery for herbal therapeutics–Quality Control –Germplasm improvement

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of the course, the student would be able

- To understand the fundamentals of phytochemicals and its functions

- To learn the separation techniques of herbal agromedicines and its analysis
- To gain the knowledge about the plant tissue culture based secondary metabolite
- To use of the gained knowledge for the development of therapeutic products

REFERENCES

1. Ahamed, I., Aqil, F. and Owais, M.,"ModernPhytomedicine",Turning medicinal Plants into drugs. WILEY VCH, Verlag GmbH & Co, KGaA, Weinheim. 2006.
2. Arnason, J.T., Arnason, J.E. and Arnason, J.T.,"Phytochemistry of Medicinal Plants", Kluwer Academic Publishers, 1995.
3. Bidlack, W.R., Omaye, S.T., Meskin, M.S.andTopham, D.K.W.," Phytochemicals as Bioactive Agents", 1St Edition, CRC Press, 2000.
4. Meskin, M.S., Bidlack, W.R., Davies, A.J. and Omaye, S.T., "Phytochemicals in Nutrition and Health", CRC Press, 2002.
5. Rasooli, I, "Bioactive compounds in Phytomedicine" , Intech Open access Publishers , 1st Edition, 2011

BY5016 ADVANCES IN MOLECULAR PATHOGENESIS L T P C
3 0 0 3

OBJECTIVES:

To enable the students

- To understand about the microbial toxins and modern molecular pathogenesis
- To know about the host pathogen interaction and identifying virulence factors
- To control pathogens by modern approaches.

UNIT I VIRAL PATHOGENESIS 9

Various pathogen types and modes of entry – Viral dissemination in the host – Viral virulence – Injury induced by virus – Host susceptibility of viral disease – Pattern of infection - Acute infection – Persistant infection – Latent infection – Slow infection – Methods for the study of pathogenesis – Foot and mouth disease virus, Pestiviruses, Arteriviruses, Blue tongue virus and Animal herpesviruses

UNIT II FUNGAL PATHOGENESIS 9

Innate humoral immunity to fungi – Acquired cellular immunity – Mucosal immunity – Intracellular pathogenesis of *Histoplasma capsulatum* – Facultative intracellular pathogen of *Cryptococcus neoformans* – Fungal interaction with leukocytes – Fungal vaccine development – Host defence against chronic disseminated *Candidiasis* – Study fungal virulence by using Genomics – Functional genomic approaches to fungal pathogenesis.

UNIT III BACTERIAL PATHOGENESIS 9

Epidemology and Clinical disease – Clinical course and basic immunology – *In vitro* models of *Salmonella* virulence – Antibiotic resistant *Salmonella* – *Salmonella* based vaccines – *Shigella* cellular models of infection – Influenza virus – Pathogenic *Escherichia coli* – *Vibrio cholerae* – Streptococcal disease – *Haemophilus influenzae* infection.

UNIT IV MANIPULATION OF HOST CELLS AND IMMUNE FUNCTION BY VIRAL PROTEINS 9

Clinical importance of understanding host defence – Interference with cytokine and Chemokine function – impairment of host mediated killing of infected cells – inhibition of apoptosis –

Immunological structure of proteins – Class I and II MHC mediated antigen – Evasion from natural killer cells.

UNIT V MOLECULAR APPROACHES TO CONTROL 9

Classical approaches based on serotyping – Modern diagnosis based on highly conserved virulence factors, immune and DNA based techniques – New therapeutic strategies based on recent findings on molecular pathogenesis – Viral Vaccines – Immune modulators – New vaccine technology.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course, the student will be able to understand the

- Host pathogen interactions at the level of cellular and molecular networks.
- Diagnosis of diseases through the examination of molecules.
- Modern therapeutic strategies on various pathogens.

REFERENCES

1. Flint, J., Enquist, L.W., Krug, "Principles of Virology: Molecular Biology, Pathogenesis and Control", American Society of Microbiology, 2003.
2. Groismen, E.A., "Principles of Bacterial Pathogenesis", Academic Press, 2001.
3. Gyles, C.L., Prescott, J.F., Songer, J.G. and Thoen C.O., "Pathogenesis of Bacterial Infections in Animals", 3rd Edition, Wiley-Blackwell, 2004.
4. Mettenleitter, T.C. and Sobrino, F.,"Animal Viruses: Molecular Biology", Caister Academic Press, 2008.
5. Norkin, L.C., "Virology: Molecular Biology and Pathogenesis", ASM Press, 2009.

BY5017 SPECTROSCOPY FOR BIOTECHNOLOGISTS L T P C

3 0 0 3

OBJECTIVES:

To enable the students

- To have a fundamental knowledge about the Light spectrum, Absoprtion, Fluorescence NMR, Mass spectroscopy
- To deliver the knowledge of spectroscopic techniques and its functions
- To provide the technical information of spectroscopy for biological applications

UNIT I ELECTRONIC SPECTRA 9

Overview of electronic spectra – Absorption spectra – Ultraviolet spectra of proteins – Nucleic acid spectra – Prosthetic groups – Difference spectroscopy – X-ray absorption spectroscopy – Fluorescence and phosphorescence – Helicase activity monitored by fluorescence – Fluorescence energy transfer – Molecular ruler-application of energy transfer to biological systems.

UNIT II CIRCULAR DICHROISM, OPTICAL ROTARY DISPERSION AND FLUORESCENCE POLARIZATION 9

Optical rotary dispersion – Circular dichroism – Optical rotary dispersion and circular dichroism of proteins – Optical rotation and circular dichroism of nucleic acids – Small molecule binding to DNA – Protein folding – Interaction of DNA with zinc finger proteins – Fluorescence polarization – Integration of HIV genome into host genome and alpha – Ketoglutarate.

UNIT III IR AND RAMAN SPECTROSCOPY 9

Infrared spectroscopy – Raman spectroscopy – IR and Raman spectroscopy of biological materials – Structure determination with vibrational spectroscopy – Structure of enzyme-substrate complexes – Biological vibrational spectroscopic imaging – FT-IR and FT-Raman in biomedical research.

UNIT IV NUCLEAR MAGNETIC RESONANCE AND ELECTRON SPIN RESONANCE 9

NMR spectrometers – Chemical shifts – Spin-spin splitting – Relaxation times –Multidimensional NMR – Magnetic resonance imaging – Electron spin resonance – Regulation of DNA transcription – Protein – DNA interactions – Dynamics of protein folding – RNA folding – Lactose permease.

UNIT V MASS SPECTROMETRY 9

Mass analysis – Tandem Mass Spectrometry – Ion detectors – Ionization of the sample – Sample preparation/analysis – Proteins and peptides – Protein folding – Mass spectrometry of biomolecules.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course, the student would be able understand

- Basics of optical rotary dispersion methods and nuclear magnetic resonance
- Principles and applications of mass spectrometry and X-ray diffraction
- The spectroscopic techniques and its applications for various biological applications

REFERENCES

1. Gremlich, H. and Yan, B., "Infrared and Raman Spectroscopy of Biological Materials", CRC Press, 2000.
2. Greve, J., Puppels, G.J. and Otto, C., "Spectroscopy of Biological Molecules: New Directions 1st Edition, Springer", 1999.
3. Hammes, G.G., "Spectroscopy for the Biological Sciences", 1st Edition, Wiley-Inter Science, 2005.
4. Pretsch, E., Bühlmann, P. and Badertscher, M., "Structure Determination of Organic compounds: Tables of Spectral Data", 4th Edition, Springer, 2009.
5. Ramamoorthy, A., "NMR Spectroscopy of Biological Solids", CRC Press, 2005.

BY5018 IPR AND BIOSAFETY L T P C

3 0 0 3

OBJECTIVES:

- To create awareness about IPR and engineering ethics
- To follow professional ethics and practices in their careers
- To create awareness and responsibilities about the environment and society

UNIT I AGREEMENTS, TREATIES AND CONCEPT OF PRIOR ACT 9

History of GATT Agreement – Madrid Agreement – Hague Agreement – WIPO Treaties – Budapest Treaty – PCT – Indian Patent Act 1970 & recent amendments Ordinary – PCT – Conventional – Divisional and Patent of Addition – Specifications – Provisional and complete – Forms and fees Invention in context of "prior art" – Patent databases – Searching International Databases – Country-wise patent searches (USPTO,esp@cenet(EPO) – PATENT Scope (WIPO) – IPO, etc.

UNIT II IPR **9**

Intellectual property rights – Origin of the patent regime – Early patents act & Indian pharmaceutical industry – Types of patents – Patent Requirements – Application preparation filing and prosecution – Patentable subject matter – Industrial design, Protection of GMO's IP as a factor in R&D,IP's of relevance to biotechnology and few case studies.

UNIT III PATENT FILING PROCEDURES **9**

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

UNIT IV BIOSAFETY **9**

Introduction – Historical Backround – Introduction to Biological Safety Cabinets – Primary Containment for Biohazards – Biosafety Levels – Biosafety Levels of Specific Microorganisms – Recommended Biosafety Levels for Infectious Agents and Infected Animals – Biosafety guidelines – Government of India.

UNIT V GENETICALLY MODIFIED ORGANISMS **9**

Definition of GMOs & LMOs – Roles of Institutional Biosafety Committee – RCGM – GEAC etc. for GMO applications in food and agriculture – Environmental release of GMOs – Risk Analysis – Risk Assessment – Risk management and communication – Overview of National Regulations and relevant International Agreements including Cartegana Protocol.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course, the student would be able

- To understand the ethics and responsibility for safety
- To create awareness for the professional responsibilities and rights

REFERENCES

1. Bouchoux, D.E., "Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets for the Paralegal", 3rd Edition, Delmar Cengage Learning, 2008.
2. Fleming, D.O. and Hunt, D.L., "Biological Safety: Principles and Practices", 4th Edition, American Society for Microbiology, 2006.
3. Irish, V., "Intellectual Property Rights for Engineers", 2nd Edition, The Institution of Engineering and Technology, 2005.
4. Mueller, M.J., "Patent Law", 3rd Edition, Wolters Kluwer Law & Business, 2009.
5. Young, T., "Genetically Modified Organisms and Biosafety: A Background Paper for Decision-Makers and Others to Assist in Consideration of GMO Issues" 1st Edition, World Conservation Union, 2004.

BY5019 BIOPHARMACEUTICALS AND BIOSIMILARS **L T P C**
3 0 0 3

OBJECTIVES:

The aim of the course is to give strong foundation and advanced information on

- Core responsibilities for the development and monitoring of the drug and the preparation of medicines according to the norms.

- To gain knowledge in physicochemical properties, pharmacology and the formulation of commonly used biopharmaceuticals.

UNIT I INTRODUCTION 9

Drug sources – Discovery and Development phases – Drugs and Cosmetics Act and regulatory aspects – Role of patents in the drug industry – Biopharmaceutical classification system – Drug Target – Drug metabolism – Pharmacokinetics – Pharmacodynamics – Bioavailability – Bioequivalence – Toxicity studies – Pharmacogenomics.

UNIT II DOSAGE FORMS 9

Classification of dosage forms – Excipients – Formulation – Tablets, Capsules, Emulsion, Suspension, Lotion, Liniments, Ointments, Cream, Paste, Suppositories, Parenterals – Pressurized dosage forms – Packaging techniques.

UNIT III ADVANCED DRUG DELIVERY SYSTEMS 9

Controlled release dosage forms – Rationale – Principle and factor influencing – Design and Fabrication – Microencapsulation – Liposomes – Niosomes – Transdermal drug delivery – Ocular, Vaginal and Uterine controlled release.

UNIT IV BIOSIMILARS 9

Biosimilar medicine – Importance – INN nomenclature system – Key trends in biosimilar product development – Production of biosimilar products – Difficulties with biosimilar drugs – Non clinical and clinical study – Regulation and approval process – Future prospects.

UNIT V CASE STUDIES ON BIOPHARMACEUTICALS 9

Erythropoietin – Insulin – Somatotropin – Interleukin – Interferon – GMCSF – Blood clotting Factors – Tissue plasminogen activator – Monoclonal antibodies and engineered antibodies.

OUTCOMES:

The knowledge gained in this course would be used to understand and evaluate different

- Pharmaceutical parameters for the current and future biotechnology related products on the market.
- To acquire knowledge on novel biotechnological and pharmaceutical products, current medicines and their applications in therapeutic and diagnostic fields.
- To demonstrate knowledge and understanding of current topical and newly emerging aspects of pharmaceutical biotechnology.
- Understand the legal steps involved in progressing a new drug to market. Grasping the current regulatory acts and safety norms of the modern pharmaceutical industries.

TOTAL: 45 PERIODS

REFERENCES

1. Crommelin Dwan J.A., Robert D. Sindelar and Bernd Meibohm, “Pharmaceutical Biotechnology: Fundamentals and application”, Springer, 4th Edition, 2013.
2. Gary Walsh, “Pharmaceutical Biotechnology-Concepts and Application”, John Wiley and Sons Publishers, 1st Edition, 2007.
3. James Swarbrick, “Encyclopedia of Pharmaceutical Technology”, CRC Press, 4th Edition, 2013.
4. Shayne Cox Gad, “Pharmaceutical Manufacturing Handbook: Production and Processes”, Wiley, 2nd Edition, 2011.

5. Shein-Chung Chow, “Biosimilars: Design and Analysis of Follow-on Biologics”, CRC Press, 3rd Edition, 2013.

BY5020 BIOPROCESS MODELING AND SIMULATION L T P C
3 0 0 3

OBJECTIVES:

- To make the students aware of the overall industrial bioprocess so as to help them to manipulate the process to the requirement of the industrial needs.
- To impart knowledge on design and operation of fermentation processes with all its prerequisites.
- Provide the students with the basics of bioreactor engineering.
- To develop bioengineering skills for the production of biochemical product using integrated biochemical processes.

UNIT I CONCEPTS AND PRINCIPLES 9

Introduction to modelling – Systematic approach to model building – Material and energy balance – Classification of models – General form of dynamic models dimensionless models – General form of linear systems of equations nonlinear function – Conservation principles thermodynamic principles of process systems

UNIT II MODELS 9

Structured kinetic models – Compartmental models (two and three) – Product formation Unstructured models – Genetically structured models – Stochastic model for thermal sterilization of the medium – Modelling for activated sludge process – Model for anaerobic digestion – Models for lactic fermentation and antibiotic production

UNIT III MODELLING OF BIOREACTORS 9

Modelling of non-ideal behaviour in Bioreactors – Tanks-in-series and Dispersion models – Modelling of PFR and other first order processes – Analysis of packed bed and membrane bioreactors Recombinant Cell Culture Processes – Plasmid stability in recombinant Cell Culture limits to over-expression

UNIT IV MONITORING OF BIOPROCESSES 9

On-line data analysis for measurement of important physico-chemical and biochemical parameters – State and parameter estimation techniques for biochemical processes – Biochemical reactors-model equations – Steady-state function – Dynamic behaviour – Linearization – Phase plane analysis – Multiple steady state – Bifurcation behaviour

UNIT V SOLUTION STRATEGIES 9

Solution strategies for lumped parameter models – Stiff differential equations – Solution methods for initial value and boundary value problems – Euler’s method – R-K method – shooting method – Finite difference methods – Solving the problems using MATLAB/SCILAB – ISIM-Simulation of bioprocesses using models from literature sources

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of Bioprocess Engineering course graduates will be able to

- Select appropriate bioreactor configurations and operation modes based upon the nature of bio products and cell lines and other process criteria.

- Apply modelling and simulation of bioprocesses so as to reduce costs and to enhancethe quality of products and systems.
- Plan a research career or to work in the biotechnology industry with strong foundation about bioreactor design and scale-up.
- Integrate research lab and Industry; identify problems and seek practical solutions for large scale implementation of Biotechnology.

REFERENCES

1. Bailey, J.A. and Ollis, D. F., Fundamentals of Biochemical Engineering", McGraw Hill – 1986.
2. Bequette, B.W., "Process Control:Modeling, Design & Stimulating", Prentice Hall, 2003.
3. Boudreau, M.A. and McMillan, G.K.," New Directions in Bioprocess Modelling and Control", ISA, 2006.
4. Hangos, K.M. and Cameron, I.T., "Process Modelling and Simulation", 2001.
5. Heinzle, E., Biwer, A.P. and Cooney, C.A.L., "Development of Sustainable Bioprocess: Modeling", Wiley, 2007.

BY5021 TISSUE ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

To enable the students

- To learn the fundamentals of tissue engineering and tissue repairing
- To acquire knowledge on clinical applications of tissue engineering
- To understand the basic concept behind tissue engineering focusing on the stem cells, biomaterials and its applications

UNIT I FUNDAMENTAL OF TISSUE ENGINEERING 9

Cell cycle – Stem cells – Types, factors influencing stem cells – Mechanical properties of cells and tissues, cell adhesion – Extracellular matrix – Glycans, laminin, fibronectin, collagen, elastin, extracellular matrix functions – Signalling – Mechanics and receptors – Ligand diffusion and binding, trafficking and signal transduction – *In vitro* cell proliferation.

UNIT II BIOMATERIALS FOR TISSUE ENGINEERING 9

Measurement of protein adsorption – Direct and indirect methods, fibrinogen adsorption – Displaceable and non-displaceable – Changes in protein conformation upon adsorption – Vroman effect principle to maximize the amount of fibrinogen adsorption – Devices for tissue engineering transplant cells.

UNIT III DELIVERY OF MOLECULAR AGENTS AND CELL INTERACTIONS WITH POLYMERS 9

Molecular agents in tissue engineering – Controlled released of agents – Methods, in time and space – Future applications of controlled delivery – Microfluidic systems – Microfluidics and microfluidic devices – Cell interactions – Factors influencing cell interactions – Cell interactions with polymer surfaces and suspension – Cell interactions with three-dimensional polymer.

UNIT IV POLYMERS AND CONTROLLED DRUG DELIVERY 9

Natural and synthetic biodegradable Polymers – Engineered tissues – Skin regeneration – Nerve regeneration – Liver, cartilage, bone – Biodegradable polymers in drug delivery –Polymeric drug delivery systems – Applications of biodegradable polymers.

UNIT V BIOPOLYMER- BASED BIOMATERIALS AS SCAFFOLDS AND STEM CELLS 9

Natural polymers – Structural and chemical properties, scaffold processing, mechanical properties and biodegradability – Biocompatibility and host response – Application of scaffolds in tissue engineering. Use of stem cells in tissue engineering – Embryonic stem cells, mesenchymal stem cells (MSC), adult stem cells, markers for detection of stem cells – Risks with the use of stem cells.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course, the students would get

- Ability to understand the components of the tissue architecture
- Opportunity to get familiarized with the stem cell characteristics and their relevance in medicine
- Awareness about the properties and broad applications of biomaterials
- Overall exposure to the role of tissue engineering and stem cell therapy in organogenesis

REFERENCES

1. Pallua, N. and Suscheck, C.V., “Tissue Engineering: From Lab to Clinic” Springer, 2010
2. Palsson, B., Hubbell, J.A., Plonsey, R. and Bronzino, J.D., “Tissue Engineering”, CRC Press, 2003.
3. Palsson, B.O. and Bhatia, S., “Tissue Engineering”, Pearson Prentice Hall, 2004.
4. Saltzman, W.M., “Tissue Engineering”, Oxford University Press, 2004.
5. Scheper, T., Lee, K. and Kaplan, D., “Advances in Biochemical Engineering / Biotechnology – Tissue Engineering I”, Volume 102, Springer-Verlag Berlin Heidelberg, 2006.

BY5022 RESEARCH METHODOLOGY IN BIOTECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

- To impart the knowledge of various methods of research strategy
- To understand Biotech research constraints and its analysis
- To emphasise the Creativity, Innovation and New Product Development

UNIT I RESEARCH AND ITS METHODOLOGIES 9

Motivation – Objective and significance of research – Research process – Observation – Axiom – Theory – Experimentation – Types of research (basic, applied, qualitative, quantitative, analytical etc). Features of translational research – Concept of laboratory to market (bench to public) – Industrial R&D.

UNIT II RESEARCH IN BIOTECHNOLOGY 9

Laboratory policy and procedure of academic research – Types of expertise and facilities required. Technology and product transfer research – Grant funding – Sources of literature – Interdisciplinary nature – Collaboration based research.

UNIT III EXPERIMENTAL RESEARCH 9

Research direction – Understanding biotechnology research by experimentation – Strategies for experimentation – Selecting an experimental design – Sample size – Enzymes and enzymatic analysis – Antibodies and immunoassays – Instrumental methods – Bioinformatics and computation.

UNIT IV RESULTS AND ANALYSIS 9

Scientific methodology in recording results – Importance of negative results – Ways of recording – Industrial requirement – Artifacts versus true results – Types of analysis (analytical, objective, subjective) and cross verification – Correlation with published results – Discussion – Hypothesis – Concept – Theory and model.

UNIT V PUBLISHING SCIENTIFIC AND TECHNICAL PAPERS 9

Guide to publishing scientific papers – Types of scientific and technical publications in biotechnology – Specifications – Ways to protect intellectual property – Patents – Technical writing skills – Importance of impact factor and citation index.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, students will have gained knowledge on

- Biotechnology research planning and execution and result analysis
- innovation and New product development
- Issues related to Patents, Quality, Evaluation

REFERENCES

1. Haaland, P.D., “Experimental Design in Biotechnology”, Marcel Dekker, 1989.
2. Korner, A.M., “Guide to Publishing a Scientific paper”, Taylor & Francis group, 2008.
3. Kothari, C.R., “Research Methodology: Methods and Techniques”, New Age Publications, 2008.
4. Malinowski, M.J. and Arnold, B.E., “Biotechnology: Law, Business and Regulation”, Aspen Publishers, 2004.
5. Marczyk,G.R., DeMatteo, D. and Festinger, D., “Essentials of Research Design and Methodology”, John Wiley & Sons Publishers, Inc., 2005.

BY5023 BIOFUELS AND PLATFORM CHEMICALS L T P C

3 0 0 3

OBJECTIVES:

- To impart the knowledge Bioconversion of renewable lignocelluloses biomass to bio fuel and value added products
- To demonstrate a drive towards products benign to natural environment increasing the importance of renewable materials
- To emphasise the development of Biomass an inexpensive feedstock considered sustainable and renewable to replace a wide diversity of fossil based products

UNIT I INTRODUCTION 9

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

UNIT II ETHANOL 9

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

UNIT III BIODIESEL 9

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

UNIT IV OTHER BIOFUELS 9

Biodiesel from microalgae and microbes; biohydrogen production; biorefinery concepts

UNIT V PLATFORM CHEMICALS 9

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

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, students will have gained knowledge on

- The use of Biomass an inexpensive feedstock as sustainable and renewable energy
- To replace fossil based products with Biodiesel
- To source other alternate energy such as bio hydrogen and bio refinery

REFERENCE

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