RAJALAKSHMI ENGINEERING COLLEGE

(An Autonomous Institution Affiliated to Anna University Chennai)

DEPARTMENT OF BIOTECHNOLOGY

CURRICULUM AND SYLLABUS REGULATIONS – 2017

M.TECH –BIOTECHNOLOGY

CHOICE BASED CREDIT SYSTEM

VISION OF THE INSTITUTION

To be an institution of excellence in Engineering, Technology and Management Education & Research.

To provide competent and ethical professionals with a concern for society.

MISSION OF THE INSTITUTION

To impart quality technical education imbibed with proficiency and humane values

To provide right ambience and opportunities for the students to develop into creative, talented and globally competent professionals

To promote research and development in technology and management for the benefit of the society

VISION OF THE DEPARTMENT

To be a department of academic excellence focused on education, research and development and to conquer the frontiers of biotechnology, benefitting the society.

MISSION OF THE DEPARTMENT

- To impart quality technical education
- To continuously enhance and enrich the teaching / learning process
- To provide an ambience for overall development of the students to be more creative, innovative and globally competent ethical professionals
- To promote research and develop technologies and products for the sustenance and wellbeing of the society

PROGRAMME EDUCATIONAL OBJECTIVES

I. This program will strengthen the graduates' foundation in different facets of biotechnology, enhance their knowledge, hone their research skills and prepare them for higher studies and become ideal teachers in reputed academic institutes.

II. This program will inspire, motivate, guide and train graduates to become globally competent and find employment in pharma, food and other biotech industries in R&D, quality control, process control and product development sectors.

III. This program will help graduates with their creative thinking, analytical and managerial skills imbibed with ethical values to develop products, become successful entrepreneurs and serve the society.

PROGRAMME OUTCOMES

1. An ability to research, investigate, critically analyse and solve problems in the different areas of Biotechnology

2. An ability to write and present precise and accurate data, publish papers and communicate the findings to scientific community and society

3. An ability to impart knowledge to enthusiastic young minds and become ideal teachers inreputed academic institutions

4. An ability to find employment in pharma, food and other biotech industries in R&D, quality control, process control and product development sectors or become entrepreneurs imbibed with ethical and humane values

CURRICULUM AND SYLLABUS
M.TECH. BIOTECHNOLOGY
REGULATIONS 2017
CURRICULUM

SEMESTER I

Sl. No	COURSE CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C
THEORY							
1	MA17172	Statistical Techniques for Biotechnology	5	3	2	0	4
2	BY17101	Advanced Genetic Engineering	4	4	0	0	4
3	BY17102	Enzyme Technology and Fermentation Technology	3	3	0	0	3
4	BY17103	Bioinformatics and Applications	3	3	2	0	4
5		Professional Elective I	3	3	0	0	3
6		Professional Elective II	3	3	0	0	3
7		Professional Elective III	3	3	0	0	3
PRACTICAL							
8	BY17111	Preparative and Analytical Techniques in Biotechnology	4	0	0	4	2
		TOTAL	**27**	**22**	**4**	**4**	**26**

SEMESTER II

Sl. No	COURSE CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C
THEORY							
1	BY17201	Bio separation Technology	3	3	0	0	3
2	BY17202	Bioprocess Engineering	5	3	2	0	4
3	BY17203	Biopharmaceuticals and Biosimilars	4	4	0	0	4
4	BY17204	Immunotechnology	3	3	0	0	3
5	BY17205	Advanced Genomics and Proteomics	3	3	0	0	3
6		Professional Elective IV	3	3	0	0	3
7		Professional Elective V	3	3	0	0	3
PRACTICAL							
8	BY17211	Immunotechnology Lab	4	0	0	4	2
		TOTAL	**28**	**22**	**2**	**4**	**25**

SEMESTER III

Sl. No	COURSE CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C
PRACTICAL							
1	BY17311	Advanced Molecular Biology and Genetic Engineering Lab	6	0	0	6	3
2	BY17312	Bioprocess and Downstream processing Lab	6	0	0	6	3
PROJECT							
4	BY17313	Project Phase – I	12	0	0	12	6
		TOTAL	**24**	**0**	**0**	**24**	**12**

SEMESTER IV

Sl. No	COURSE CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C
PROJECT							
1	BY17411	Project Phase – II	24	0	0	24	12
TOTAL			**24**	**0**	**0**	**24**	**12**

Total No. of Credits : 75

PROFESSIONAL ELECTIVES - I (SEMESTER I)

Sl. No	COURSE CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C
1	BY17E11	Molecular concepts in Biotechnology (For Engineering Stream)	3	3	0	0	3
2	BY17E12	Basics of Chemical Engineering (For Science Stream)	3	3	0	0	3
3	BY17E13	Metabolic Process and Engineering (For Biotechnology Stream)	3	3	0	0	3

PROFESSIONAL ELECTIVES - II (SEMESTER I)

Sl. No	COURSE CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C
1	BY17E14	Advances in Animal Biotechnology	3	3	0	0	3
2	BY17E15	Analytical Techniques in Biotechnology	3	3	0	0	3
3	BY17E16	Plant Tissue Culture and Gene Manipulation	3	3	0	0	3

PROFESSIONAL ELECTIVES - III (SEMESTER I)

Sl. No	COURSE CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C
1	BY17E17	Oncogenetics	3	3	0	0	3
2	BY17E18	Biotechnology in Food Processing	3	3	0	0	3
3	BY17E19	Computer Aided Learning of Structure and Functions of Proteins	3	3	0	0	3

PROFESSIONAL ELECTIVES - IV (SEMESTER II)

Sl. No	COURSE CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C
1	BY17E21	Bionanotechnology	3	3	0	0	3
2	BY17E22	Medicinal Chemistry	3	3	0	0	3
3	BY17E23	Advances in Molecular Pathogenesis	3	3	0	0	3
4	BY17E24	IPR and Biosafety	3	3	0	0	3

PROFESSIONAL ELECTIVES -V (SEMESTER II)

Sl. No	COURSE CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C
1	BY17E25	Bioreactor Design and Analysis	3	3	0	0	3
2	BY17E26	Bioprocess Modeling and Simulation	3	3	0	0	3
3	BY17E27	Tissue Engineering	3	3	0	0	3
4	BY17E28	Research Methodology in Biotechnology	3	3	0	0	3
5	BY17E29	Biofuels and Platform Chemicals	3	3	0	0	3

SYLLABUS

MA17172 STATISTICAL TECHNIQUES FOR BIOTECHNOLOGY

L T P C
3 2 0 4

OBJECTIVES:

- To introduce the basic concepts of probability, one dimensional and two dimensional Random Variables.
- To provide information about Correlation, Regression and applications.
- To enable the students to use the concepts of Testing of Hypothesis and Design of Experiments.

UNIT I RANDOM VARIABLE AND PROBABILITY DISTRIBUTION 15

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 DISTRIBUTIONAND ESTIMATION THEORY 15

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 15

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 15

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

UNIT V DESIGN OF EXPERIMENTS 15

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

TOTAL:75 PERIODS

OUTCOMES:

On completion of course students will be able to

- Apply the basic concepts of probability, one dimensional and two dimensional Random Variables.
- Apply the concept of sampling distribution for estimation theory and curve fitting.
- Enable the students to use the concepts of Testing of Hypothesis for industrial problems
- Test the hypothesis for population parameter not obeying normal distribution
- Apply the concept of ANOVA in decision making in the industrial problems

REFERENCES:

1. Veerarajan T, Probability, statistics and random process with queueing theory and queueing networks, 4th edition, McGraw - Hill Publishing Company Limited
2. Spiegel Libschutz, " Probability and Statistics ", 4th Edition, McGraw Hill, New Delhi, 2010.
3. J.E. Freund, " Mathematical Statistics ", 5th Edition, Prentice Hall of India.
4. I. Miller and M.Miller, " Mathematical Statistics ", 7th Edition, Pearson Education Inc. (10th impression), 2012.

5. Jay L. Devore," Probability and Statistics for Engineering and Sciences", 8th Edition, Cengage Learning Pvt. Ltd., New Delhi, 2014.
6. Johnson, R.A and Gupta C. B., " Miller and Freund's Probability and Statistics for Engineers ", Pearson Education Int., Asia, 8th Edition, 2011.
7. Gupta, S.C. and Kapoor, V. K, " Fundamentals of Mathematical Statistics ", Sultan Chand and Sons, 14th Edition, 2016.

BY17101 ADVANCED GENETIC ENGINEERING L T P C
4 0 0 4

OBJECTIVES

- To develop an understanding towards the cloning vectors.
- To provide knowledge on the gene isolation and screening strategies.
- To develop an understanding towards the DNA sequencing techniques
- To explain the importance of mutation.
- To explain the fundamentals of gene therapy.

UNIT I CLONING AND EXPRESSION OF GENES 12

DNA Manipulative Enzymes, Cloning vehicles: Plasmids – Host range, Copy number control, Compatibility. λ phage – Insertional and Replacement vectors, in vitro packaging. Single strand DNA vector – M13 Phage. Cosmids, Phasmids,BAC.Yeast vectors-YRp,YEp,YIp andYAC.Mammalian vector-SV40.Isect vector-Transposon. Expression vector – Characteristics, RNA probe synthesis. Genetic Engineering – Introduction, scope and importance. Strategies for gene cloning and large scale production of recombinant proteins. T7 RNA polymerase–based expression vectors, Immobilised metal affinity chromatography purification.

UNIT II CONSTRUCTION OF DNA LIBRARIES 12

cDNA library construction : Full length cDNA cloning – CAPture method and Oligo capping. Strategies for Genomic DNA library construction – Chromosome walking. Screening strategies – Hybridization, PCR, Immunoscreening, Functional Cloning – functional complementation and gain of function, overview on microarray and its applications.

UNIT III DNA SEQUENCING 12

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

UNIT IV PCR AND MUTAGENESIS 12

PCR – Principle and applications. Different types of PCR – Hot start PCR, Touchdown PCR, Multiplex PCR, Inverse PCR, Nested PCR, AFLP-PCR, Allele specific PCR, Assembly PCR, Asymmetric PCR,Colony PCR, in situ PCR,Real-time PCR,RACE PCR – Primer design strategies ,SYBR Green assay, Taqman Probes, Molecular beacons. Site directed mmutagenesis by PCR,Kuntels' method of mutagenesis.

UNIT V GENE TRANSFER & GENE THERAPY 12

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

TOTAL : 60 PERIODS

COURSE OUTCOMES

Upon completion of the course, the students will be able to

1. Understand scientific basics of cloning vectors at the molecular level
2. Comprehend the structure and functions of a gene
3. Understand the importance nucleotide arrangements in DNA molecules.
4. Learn the functions of recombinant proteins
5. Understand the importance of Gene therapy for the treatment of genetic disorders

TEXTBOOKS:

1. T A Brown "Gene cloning and DNA analysis"2006.
2. Mullis kary B ,Ferre Francois,Gibbs "The polymerase chain reaction"1994

REFERENCES:

1. Primrose SB and R. Twyman "Principles Of Gene Manipulation & Geneomic Blackwell Science Publications, 2006.
2. Genomes 3 by T.A.Brown, Third Edition (Garland Science Publishing)

BY17102 ENZYME TECHNOLOGY AND FERMENTATION TECHNOLOGY

L T P C
3 0 0 3

OBJECTIVES

The course intends

- To give advanced knowledge about use of fermentation processes in enzyme production
- To help understand utility of enzymes in producing metabolites and other industrial applications

UNIT I FUNDAMENTALS OF FERMENTATION 9

Overview of fermentation – Microbial biomass – Microbial Enzymes – Microbial Metabolite – Recombinant products – Media for industrial fermentations – Medium optimization – Medium sterilization – Types of culture medium – 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 – Development of inocula for industrial fermentation – 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 – Biocatalysis in organic media using enzymes – Biotransformation with crude enzymes and whole cells.

UNIT III PRODUCTION OF ENZYMES AND METABOLITES 9

Production of Proteases, Cellulases, Lipase, Amylase, Glucose isomerase, Pectinase, Peroxidase – Production of organic acids (Citric acid, Lactic acid) – Production of antibiotics (Penicillin, streptomycin) – Production of vitamins (Vitamin B12, Riboflavin) – production of amino acids (Glutamic acid, Lysine).

UNIT IV ENZYME KINETICS 9

Overview of enzyme and its action – Time course of enzymatic reactions – Effects of substrate concentration on velocity – 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.

UNIT V APPLICATIONS OF ENZYMES 9

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

TOTAL: 45 PERIODS

OUTCOMES

The students will acquire knowledge about

- Fundamentals and important parameters in fermentation processes
- Industrial fermentation process for enzyme production
- Industrially important enzymes and their use in producing biological metabolites
- Enzyme kinetics
- Applications of enzymes as biosensors and in other varied industrial applications

TEXT BOOKS

1. Buchholz, K., Kasche, V. and Bornscheuer, U., "Biocatalysts and Enzyme Technology", WILEY–VCH, 2005.
2. Mansi, E.M.T.EL., Bryce, C.F.A., Demain, A.L. and Allman, A.R., "Fermentation Microbiology and Biotechnology", Taylor and Francis, 2006.

REFERENCE BOOKS

1. Copeland, R. A., "Enzymes", 2 nd Edition, WILEY–VCH, 2008.
2. Najafpour, G.D., "Biochemical Engineering & Biotechnology", Elsevier, 2007.
3. McNeil, B., Harvey, L., "Practical Fermentation Technology", John Wiley & Sons, 2008.

BY17103 BIOINFORMATICS AND APPLICATIONS L T P C
3 2 0 4

OBJECTIVES

- To develop skill in Perl Programming and Linux commands.
- To provide knowledge on DBMS and different Biological Databases.
- To develop data analysis/visualisation skill with basic knowledge of data analysis
- To understand different algorithms of Sequence Alignment/Structural Bioinformatics
- To understand different statistical methods and application in Biology.

UNIT I LINUX OS AND PERL 12

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 DATABANKS 12

Design of Relational database – FTP – Integration of databases – Strategies for integration – Methods of data mining – Management of work flow – Analysis of biological database – Biological databases – Primary databases – Secondary databases – Composite databases.

UNIT III ANALYZING AND VISUALIZING DATA 12

Sequence analysis – Analysis of gene expression – Analysis of protein expression-Gene Network Analysis– Different packages of R for gene expression data analysis. Analysis of mutations in cancer – High-throughput image analysis – High volume scatter plots – Heat maps-visualizing distances – Plotting along genomic coordinates.

UNIT I IV SEQUENCING ALIGNMENT/STRUCTURAL BIOINFORMATICS 12

Models for sequence analysis – Methods of alignment – Scoring matrices: PAM – BLOSUM - Global alignment – Local alignment – FASTA – BLAST – Multiple sequence alignment–SP method – Star alignment – Applications of multiple alignment. Phylogenetic Tree analysis. UPGMA, Neighbor Joining Methods, Tree assessment Bootstrapping. Homology Modeling, ab-initio Modeling, Structural Genomics, Bioinformatics in Drug Design.

UNIT V STATISTICAL ANALYSIS 12

Probability theory – Methods to describe data – Basic probability distribution – Populations and samples – Hypothesis testing – Scoring a pair wise alignment – Probabilistic model of alignments – HMM approach.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Write Perl Program and apply Linux commands.
2. Learn DBMS and come to know about different Biological Databases in detail.
3. Understand data analysis methods and develop skill of data analysis.
4. Apply different algorithm of Sequence Alignment/Structural Bioinformatics
5. Be proficient in application of statistical methods in biology.

TEXT BOOKS

1. Rastogi, S.C., "Bioinformatics Concepts, Skills & Applications", 2nd Edition, CBS Publishers, 2009.
2. Wunschiers, R., "Computational Biology", Springer Verlag Publications, 2004.

REFERENCES

1. Gentleman, R., "Bioinformatics and Computational Biology Solutions using R and Bioconductor", Springer Science and Business media Inc., 2005.
2. Jiang, T. and Xu, Y., "Current Topics in Computational Molecular Biology", MIT Press, 2002.
3. Pevzner, P., "Computational Molecular Biology: An algorithmic approach", 2nd Edition, MIT Press, 2000.

BY17111 PREPARATIVE AND ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY

L T P C
0 0 4 2

OBJECTIVE

To prepare the student in all the latest preparative and analytical techniques required in research or Industry.

EXPERIMENTS

1. Preparation of Acetate, Tris and Phosphate Buffer. Validation of Henderson Hasselbach equation.
2. Reactions of amino acids – Ninhydrin, Pthalaldehyde, Dansyl chloride – measurement using colorimetric and fluorimetric methods.
3. Differential estimations of carbohydrates – reducing vs non-reducing, polymeric vs 13 oligomeric, hexose vs pentose.
4. Estimation of protein concentration using Lowrys' method, Dye-binding method.
5. DNA determination by UV-Vis Spectrophotometer – hyperchromic effect. Separation of lipids by TLC.
6. Enzyme Kinetics: Direct and indirect assays – determination of Km, Vmax and Kcat, Kcat/ Km.
7. Ion-exchange Chromatagraphy – Purification of IgG and Albumin
8. Gel filtration – Size based separation of proteins

9. Affinity chromatography – IMAC purification of His-tagged recombinant protein
10. Assessing purity by SDS-PAGE Gel Electrophoresis
11. Chemical modification of proteins – PITC modification of IgG and Protein Immobilization

TOTAL: 90 PERIODS

COURSE OUTCOME

- Having learned all the techniques in this lab, the student will become capable in enzymology, techniques required in the quantitation of biomolecules, downstream processing and the chemical modification of proteins, which will prepare him for a career in research or employment in the biotech Industry.

REFERENCES

1. Biochemical Methods: A Concise Guide for Students and Researchers, Alfred Pingoud, Claus Urbanke, Jim Hoggett, Albert Jeltsch, 2002 John Wiley & Sons Publishers, Inc,
2. Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry, 2nd Edition, Irwin H. Segel, 1976 John Wiley & Sons Publishers, Inc,
3. Principles and Techniques of Practical Biochemistry- Wilson, K. and Walker, J. Cambridge Press

BY17201 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 with on Downstream processes

UNIT I DOWNSTREAM PROCESSING 8

Introduction to downstream processing principles characteristics of biomolecules and bioprocesses. Cell disruption for product release – mechanical, enzymatic and chemical methods. 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).

UNIT II PHYSICAL METHODS OF SEPERATION 9

Unit operations for solid-liquid separation - Filtration at constant pressure and at constant rate – cake filtration– Types of filtration equipment's – Centrifugation – Basic principles, design characteristics – Types of centrifuges and applicationsand centrifugation.

UNIT III ISOLATION OF PRODUCTS 10

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– Aqueous two-phase extraction process – Adsorption isotherms and techniques – Protein precipitation – Methods of precipitation.

UNIT IV PRODUCT PURIFICATION 10

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 FINAL PRODUCT FORMULATION AND FINISHING OPERATIONS 8

Drying – Mechanism, methods and applications, Types of dryers – Tray, spray, rotary, belt, disc – Crystallization – Nucleation , growth – Types of crystallizers – Freeze drying – Principle, process, applications – Case studies- Citric acid, Penicillin , cephalosporin.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- Define the importance and fundamentals of downstream processing for product recovery.
- Understand the requirements for successful operations of downstream processing in solid liquid separation.
- Describe the components of downstream equipment in liquid- liquid separation.
- Apply the principles of various chromatographic techniques used in downstream processing.
- Learn the mechanism and applications in finishing operations and formulations.

TEXTBOOKS:

1. Belter, P.A. E.L. Cussler And Wei-Houhu – "Bioseparations – Downstream Processing For Biotechnology, Wiley Interscience Pun. (1988).
2. Sivasankar, B. "Bioseparations : Principles and Techniques". PHI, 2005.
3. Ghosh, R., "Principles of Bioseparations Engineering", World Scientific Publishers, 2006.

REFERENCES:

1. R.O. Jenkins, (Ed.) – Product Recovery In Bioprocess Technology – Biotechnology By Open Learning Series, Butterworth-Heinemann (1992).
2. J.C. Janson And L. Ryden, (Ed.) – Protein Purification – Principles, High Resolution Methods And Applications, VCH Pub. 1989.
3. R.K. Scopes – Protein Purification – Principles And Practice, Narosa Pub. (1994).

BY17202 BIOPROCESS ENGINEERING L T P C
3 2 0 4

COURSE OBJECTIVES

- This course will help the students to learn about the design of immobilized enzyme reactors and various structured and unstructured models.
- To gain knowledge about recombinant cell cultivation and the design of reactors for those cultivation.

UNIT I METABOLIC STOICHIOMETRY AND ENERGETICS 12

Mass and energy balance in biological system – Stoichiometry of cell growth and product formation – Elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield coefficients of biomass and product formation – Maintenance coefficients – Oxygen consumption and heat evolution in aerobic cultures – Thermodynamic efficiency of growth.

UNIT II MICROBIAL GROWTH, KINETICS, MAINTENANCE AND PRODUCT FORMATION 12

Phases of cell growth in batch cultures – Simple unstructured kinetic models for microbial growth – Substrate utilization and product formation – Growth associated and non-growth associated product formation kinetics – Monod and Leudeking-Piret models – Effects of inhibition – Determination of kinetic parameters by batch, fed batch and continuous culture and analysis of chemo state performance – Role of maintenance and endogenous metabolism in substrate utilization and growth.

UNIT III STRUCTURED MODELS 12

Structured models for growth and product formation – Compartmental and metabolic models – Product formation kinetics – Gaden's and Deindoerfer's classifications – Chemically and genetically structured models – Kinetics of growth and product formation by filamentous organisms – Considerations for the production of r-DNA products.

UNIT IV MASS TRANSFER IN BIOLOGICAL SYSTEMS 12

Interphase Gas-Liquid mass transfer – General oxygen balances for Gas-Liquid transfer – Volumetric mass transfer co-efficient – 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.

UNIT V DIFFUSION AND BIOLOGICAL REACTION IN IMMOBILIZED BIOCATALYST SYSTEMS 12

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: 60 PERIODS

COURSE OUTCOMES

- The students will learn about the stoichiometry and balances of substrate and biomass.
- The students will learn how to find the different modes of cultivation parameters and its kinetics.
- The students will gain knowledge about the various structured kinetic models and its application techniques.
- The students will gain knowledge about the practical problems arising on the performance of bioreactors.
- The student will learn to work on immobilized bed bioreactors.

TEXT BOOKS

1. Dunn, I.J., Heinzle, E., Ingham, J. and Prenosil, J.E., "Biological Reaction Engineering", 2nd Edition, WILEY-VCH publications, 2003.
2. Dutta, R., "Fundamentals of Biochemical Engineering", Springer, 2008.
3. Shuler, M.L. and Kargi, F., Bioprocess Engineering: Basic concepts, 2nd Ed., Prentice-Hall, 2002.
4. Doran Pauline M, Bioprocess Engineering Principles, 2nd Ed., Academic Press, 1995.
5. Nielsen, J. and Villadsen, J., Bioreaction Engineering Principles, 2nd Ed., Springer, 2007.
6. Blanch,H.WandClarkD.S.,BiochemicalEngineering,2nd Ed., MarcelDekker, 1997.

REFERENCES

1. Najafpour, G.D., "Biochemical Engineering & Biotechnology", Elsevier, 2007.
2. Truskey, G.A., Yuan, F. and Katz, D.F., "Transport Phenomena in Biological Systems", Pearson Prentice Hall, 2004.
3. Katoh, S. and Yoshida, F., "Biochemical Engineering – A Text Book for Engineers, Chemists and Biologists", Wiley publications, 2009.

BY17203 BIOPHARMACEUTICALS AND BIOSIMILARS L T P C
4 0 0 4

OBJECTIVES

- To provide knowledge on drug development approval process.
- To impart knowledge in advanced molecular concepts in Biosimilar production

- To provide knowledge on the lyophilized products

UNIT I DRUG DEVELOPMENT 12

Pharmaceutical products – Impact of genomics and related technologies upon drug discovery – Structural genomics – Preclinical studies – Drug metabolism – Pharmacokinetics – Absorrption, Distribution, Metabolism, Excretion. Pharmacodynamics – Toxicity studies

UNIT II RECOMBINANT BIOPHARMACEUTICALS & DOSAGE FORMS 12

Medically important polypeptides and proteins – Production of recombinant erythropoietin – GMCSF – Factor VIII – Human insulin – Human somatotropin – Interferon – Streptokinase. Formulation of tablet – Tablet coating – Capsules – Oral liquids – Parenteral drugs – Excipients used in biopharmaceuticals – Shelf life of drugs.

UNIT III BIOSIMILARS 12

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 – Strategic perspective – Future.

UNIT IV LYOPHILIZATION AND PRODUCT ANALYSIS 12

Lyophilization equipment – Excipients for use in lyophilized pharmaceutical peptide, protein and other bioproducts – Plasmid DNA based therapeutics during freezing and drying – Protein based contaminants – Detection of protein based product impurities – Immunological approach to detect contaminants – Endotoxin and other pyrogenic contaminants.

UNIT V ADJUVANT TECHNOLOGY AND CONTROLLED RELEASE MEDICATION 12

Safe and potent adjuvant for human use – Development – Mineral adjuvant – ISCOMATRIX adjuvant – Mucosal and non-parenteral – Adjuvants in non-infectious disease vaccine – T cell adjuvants – Clinical evaluation of adjuvants.Controlledrelease medication –oral osmotic pump and osmotic pressure activated drug delivery systems..

TOTAL: 60 PERIODS

COURSE OUTCOMES

1. Understand the basic principles of preclinical trials and clinical trials
2. Obtain knowledge in concept of genetic engineering in the production of recombinant products.
3. Understand the approval process involved in Biosimilar production
4. Learn various techniques to produce lyophilized products.
5. Obtain knowledge on the formulation of advanced druge delivery system

TEXT BOOKS

1. Walsh, G., “Pharmaceutical Biotechnology-Concepts and Application”, John Wiley and Sons Publishers, 2007.
2. Crommelin, D.J.A., Sindelar, R.D. and Meibohm, B., “Pharmaceutical Biotechnology: Fundamentals and application”, 3rd Edition, Informa Health care, 2007.

REFERENCES

1. Carter, S.J., “Cooper and Gunn's Dispensing for Pharmaceutical Students”, CBS Publishers & Distributors, 2008.
2. Schijns, V.E.J.C. and Ohagan, D.T., “Immunopotentiators in Modern Vaccines”, Elsevier academic press, 2006.
3. Gad, S.C., “Handbook of Pharmaceutical Biotechnology” John Wiley & sons, 2007.
4. Reminton”pharmacy practice”

BY17204 IMMUNOTECHNOLOGY L T P C
3 0 0 3

OBJECTIVES

- To impart knowledge about the development of immune cells and their function
- To provide knowledge on immune defense mechanism, through which pathogenelimination occurs
- To explain the principle of various types of immunological techniques
- To provide basic knowledge on various types of vaccines and their development
- To enable the student to lay a strong foundation on immunological oriented research.

UNIT I IMMUNE SYSTEM AND ITS RESPONSE 9

Cells of the immune system and their development – Primary and secondary lymphoid organs – Immunity and their types - Humoral immune response – Cell mediated immune responses – Hypersensitivity and their types – T lymphocyte and B lymphocyte Tolerance – Homeostasis in immune system – Cytokines nad Complement role in immune response.

UNIT II ANTIGEN AND ANTIBODY 9

Antigen – Classification of antigen based in chemical, properties and functions – immunogen – preparation of cellular, bacterial and protein antigen – Antibody- Properties and classification of antibody – Preparation and characterization of polyclonal and monoclonal antibodies – Purification of antibody – Analysis of antigen and antibody reactions (Agglutination and precipitation tests ELISA – RIA – Western Blot – Hybridization – Immunofluorescence nad immunohistochemistry).

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 – Transplantation techniques – T cell cloning.

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

COURSE OUTCOMES

- At the end of the course, students able understand the role of the immune system on elimination of pathogens
- At the end of this course, students able understand the principle of various immunological techniques
- At the end of the course, students acquired ability to separate the immune cells based on CD markers and also acquired the ability to perform cytokine bioassay.
- Students acquired the basic knowledge about the vaccine principle and their advancement.
- Articulate applications of immunology in the modern world.

TEXT BOOKS:

1. Goldsby, R.A., Kindt, T. J., Kuby, J. and Osborne, B. A., "Immunology", Fifth Edition, W H Freeman, 2006.
2. Abbas, A.K., Lichtman, A.H. and Pillai, S., "Cellular and Molecular Immunology", 6th Edition, Elsevier, 2007.
3. Roitt,Ivan.EssentialImmunology,9thEd.,BlackwellScientific,1997.
4. Roitt,I.,Brostoff,J&Male,D. Immunology,6thEd.Mosby,2001.
5. Goldsby, R.A., Kindt, T.J., Osbome, B.A&Kerby, J. Immunology, 5thEd., W.H Freeman,2003.
6. Weir,D.M&Stewart,J.Immunology,8thEd.,Churchill Livingstone,1997.

REFERENCES

1. Fleisher, Dr., "Clinical Immunology Principle", 3rd Edition, Elsevier, 2008.
2. Rabson, A., Roitt, I.M. and Delves, P.J. "Really Essential Medical Immunology". 2nd Edition, Blackwell Publishing, 2005.
3. Domitzer, P.R., Mandl, C.W. and Rappuoli, R., "Replicating Vaccine – A New Generation", Springer, 2011.
4. Kenneth Murphy: Janeway's Immunobiology, 8th Ed. Garland Science, 2011, ISBN: 9780815342434.
5. Ajoy Paul: Immunology, Books & Allied (P) Ltd, Kolkata, 2016. ISBN: 978-93-84294-72-4.

BY17205 ADVANCED GENOMICS AND PROTEOMICS L T P C
3 0 0 3

OBJECTIVES

This course provides a broad outline of the goals, methods, and applications for genomics and proteomics in the life sciences. By the end of this course, each student should:

- Be familiar to the basic biology of modern genomics and the experimental tools that can be used to measure it.
- Be able to discuss the key technological developments that enabled modern genomic and proteomic studies.
- Understand principles and technologies for generating genomic information for biotechnological applications.

UNIT I INTRODUCTION TO GENOME AND GENE STRUCTURE 9

Introduction: Genome, Genomics, Omics and importance, History of genome projects, Organization and structure of genomes in prokaryotes, eukaryotes, and organelles (chloroplast, mitochondrion); Genome mapping methods (Genetic Mapping –i)Cross breeding and pedigree analysis, ii)DNA markers – RFLPs, SSLPs, SNPs and Physical Mapping – Restriction mapping, Fluorescent in situ hybridization, Radiation hybrid mapping and Sequence tagged site mapping); Advances in gene finding and functional prediction.

UNIT II LARGE SCALE GENOMICS/ FUNCTIONAL GENOMICS ANALYSES 9

Genome projects: The Human genome project, HapMap Project, The 1000 genome project, and The ENCODE Project. Structural genomics: Assembly of a contiguous DNA sequence- shotgun method, clone contig method, and whole –genome shotgun sequencing ,Genome-wide association (GWA) analysis; Comparative Genomic Hybridization (CGH); Massively parallel Signature Sequencing (MPSS); Whole genome shot-gun sequencing and its applications. Introduction of Next Generation Sequencing (NGS). Pharmacogenetics – High throughput screening in genome for drug discovery-identification of gene targets, Pharmacogenetics and drug development

UNITIII TRANSCRIPTOMICS 9

Gene expression analysis by cDNA and oligonucleotide arrays; DNA microarray: understanding of microarray (experimental analysis and data analysis), normalizing microarray data, detecting differential gene expression, correlation of gene expression data to biological process and computational analysis tools (especially clustering approaches).Methylome analysis using microarray; ChIP-on Chip analysis. Bioinformatic analysis of large-scale microarray data for comparative transcriptomics.

UNIT IV SEPARATION AND PROCESSING OF PROTEINS FOR PROTEOMICS 9

Over-view of strategies used for the identification and analysis of proteins; Protein extraction from biological samples (Mammalian Tissues, Yeast, Bacteria, and Plant Tissues); 2-DE of proteins for proteome analysis; Liquid chromatography separations in proteomics (Affinity, Ion Exchange, Reversed-phase, and size exclusion); Enzymatic cleavage of proteins. Analysis of complex protein mixtures using Nano-liquid chromatography (Nano-LC) coupled to Mass-spectrometry analysis.

UNIT V MASS SPECTROMETRY AND COMPARATIVE PROTEOMICS 9

Common ionization methods for peptide/protein analysis; Introduction to Mass spectrometers; MALDI-TOF and LC-MS analyses; Comparative proteomics based on global in-vitro and in-vivo abelling of proteins/peptides followed by Mass-spectrometry. Analysis of post translational modification (PTM) of proteins; Characterization of protein interactions using yeast two-hybrid system and Protein microarrays; Proteomics informatics and analysis of protein functions.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of the course, the students will be able to

1. Have basic knowledge about the methods used for genomics and proteomics .
2. Apply functional genomics techniques in the laboratory
3. Familiar with how the methods are applied in real-life scientific research.
4. know where to access the immense volumes of –omics data
5. The students will acquire in-depth knowledge on the methods and approaches in genomics and proteomics areas which help them to carry out cutting edge academic and industrial research.

TEXTBOOKS:

1. S.P. Hunt and F. J. Livesey, (2000) Functional Genomics
2. N. K. Spur, B. D. Young, and S. P. Bryant (1998) ICRF Handbook of Genome Analysis Volume 1 & 2.
3. G. Gibson and S. V. Muse (2002) A primer of Genome Science
4. R. J. Reece (2004) Analysis of Genes and Genomes
5. Rinaldis E. D. And Lahm A (2007)DNA Microarrays. Horizon bioscience.
6. Simpson R. J.“Proteins and Proteomics – A Laboratory Manual”.Cold Spring Harbour Laboratory Press, 2002.
7. Twyman R. M. “Principles of Proteomics”. Taylor & Francis. 2004
8. O’Connor C. D. And Hames B. D. “Proteomics”. Scion, 2008.

REFERENCES

1. Schena M. “Protein Microarrays”. Jones and Bartlett, 2005.
2. Smejkal G. B. And Lazarev A. V. “Separation methods in Proteomics”. CRC Press, 2006.

BY17211 IMMUNOTECHNOLOGY LAB L T P C
0 0 4 2

COURSE OBJECTIVE
To teach advanced techniques and skills required in diagnosis, treatment and research in Immunotechnology. Knowledge concerning the principles and applications of immunoassay procedure.

EXPERIMENTS
1. Selection and handling of animals for immunological experiments
2. Collection of Blood, Serum and Plasma
3. Blood smear identification of leucocytes by Giemsa stain.
4. Isolation and identification of lymphocytes.
5. Preparation microbial antigen from pathogens
6. Administration of antigen and rising of antiserum in test animal
7. Purification of IgG by Precipitation technique.
8. Slide and Tube agglutination reaction
9. Qualitative analysis of antigen or antibody by ELISA
10. Characterisation of antigens by Immunoblotting.
11. Chromatographic immunoassay (CEA)
12. Immunofluorescence Technique

TOTAL: 90 PERIODS

COURSE OUTCOME
After this course the students will be able to:
- Isolate, Identify and characterization of various immune cells.
- Have knowledge on antigen preparation and immunization techniques.
- Learn techniques like developing diagnostic tests, purification of antibody, Antigen –Antibody engineering etc for industrial applications.
- Access health problems with an immunological background.
- Develop approaches for immune intervention.

REFERENCES
1. Antibodies: A Laboratory Manual, Ed Harlow, David P Lane, Cold Spring Harbor Laboratory Press, 2nd Edition, 1998
2. Current protocols in immunology / editorial board John E. Coligan .et al,. 2003, New York : Wiley Interscience, 2003
3. Ashim K. Chakravarthy, Immunology, TataMcGraw-Hill, 1998.

BY17311 ADVANCED MOLECULAR BIOLOGY AND GENETIC ENGINEERING LAB L T P C
0 0 6 3

OBJECTIVES
- To learn and understand the principles behind the cloning and expression of a gene
- To perform nucleic acid assays
- To study the recombinant protein expression

EXPERIMENTS
1. Isolation of Genomic DNA and Plasmid DNA
2. PCR amplification of gene from the genomic DNA
3. Restriction Digestion and ligation of the plasmid vector

4. Transformation to *E.coli*
5. Colony PCR
6. Gel elution of DNA fragments.
7. Electroporation to Yeast
8. Optimisation of inducer time and concentration for recombinant protein expression.
9. Western blotting analysis
10. Extraction of RNA
11. cDNA preparation from RNA
12. Site directed mutagenesis
13. Southern blotting – Non radio active

TOTAL: 90 PERIODS

COURSEOUTCOMES:
Upon completion of the laboratory sessions, the students will be able to

1. Understand the basic principles of molecular biotechnology and assays
2. Obtain practical knowledge in analysing nucleic acid molecules both quantitatively and qualitatively
3. Gain knowledge in concept of genetic engineering
4. Acquire ability to use PCR techniques, to create site directed mutagenesis and detect disease-causing microbes.
5. Learn various techniques to make transgenic plants and transgenic animals.

REFERENCES

1. Green M.R and Sambrook J Molecular cloning -A laboratory manual 4th Edition, Cold spring habor laboratory press, USA, 2012.
2. Zyskind J.W and Bernestin S.I Recombinant DNA laboratory manual Revised edition, Academic press , USA 1992.

BY17312 BIOPROCESS AND DOWNSTREAM PROCESSING LABORATORY

L	T	P	C
0	0	6	3

COURSE OBJECTIVES:

- This course aims to provide hands on training in Bioprocess and Downstream Processing Lab by performing enzyme kinetics, immobilization techniques and medium optimization methods.
- To make the students understand the different methods involved in isolation, extraction of components, purification and preservation of products.

EXPERIMENTS:

1. Enzyme kinetics, inhibition, factors affecting reaction pH, temp.
2. Enzyme immobilization studies – Gel entrapment and adsorption immobilisation.
3. Optimization techniques – PlackettBurman, Response surface methodology.
4. Batch cultivation – recombinant E.coli – growth rate, substrate utilization kinetics.
5. Fed batch cultivation -E.coli, Pichiapastoris
6. Continuous cultivation-E.coli.
7. Plasmid isolation and stability.
8. Metabolite analysis by HPLC
9. Batch sterilization design
10. Bioreactor studies: Sterlisation kinetics.
11. kLa determination-sodium sulphite method, power correlation method, residence time distribution
12. Cell separation methods; Centrifugation and microfiltration

13. Cell disruption methods: Chemical lysis and Physical
14. Product concentration: Precipitation, ATPS, Ultrafiltration
15. High resolution purification; Ion exchange, affinity and Gel filtration chromatography, Freeze drying
16. Animal cell culture production: T-flask, spinner flask, bioreactor
17. Plant cell culture- Photobioreactor.

TOTAL: 90 PERIODS

COURSE OUTCOMES

- The students will be able to explain about enzyme kinetics and characterization and how to use them for practical applications.
- The students will learn about immobilization techniques and optimization methods.
- The students will be able to evaluate the growth kinetics of microorganisms.
- The students will get a better knowledge about isolation, extraction and purification techniques.
- The students will have a good handling experience on plant cell culture and the various media used for its growth.

REFERENCES

1. Shuler, M.L. and Kargi, F., Bioprocess Engineering: Basic concepts, 2nd Ed., Prentice-Hall, 2002.
2. Doran Pauline M, Bioprocess Engineering Principles, 2nd Ed., Academic Press, 1995.

BY17E11 MOLECULAR CONCEPTS IN BIOTECHNOLOGY (FOR ENGINEERING STREAM)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

- To provide knowledge for understanding the molecular machinery of living cells
- To impart knowledgeofadvanced molecular concepts in genetic engineering in the modern era
- To provide knowledge on the importance of human genome project with related to research

UNIT I DNA, RNA AND PROTEIN SYNTHESIS 9

Concept and organization of genetic materials – Types of DNA & RNA – DNA replication, Decoding genetic information – Regulation of gene expression – Protein synthesis, Transcription and translation. Regulation of transcription in bacteria and eukaryotes – Non-coding RNAs – DNA repair mechanism.

UNIT II MANIPULATION OF GENE EXPRESSION IN PROKARYOTE 9

Prokaryotic genome organization - 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 thermostability – 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

Concept of genetic engineering – Techniques in genetic engineering - 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 – Human Genome Project.

TOTAL: 45 PERIODS

COURSE OUTCOMES

At the end of the courses,

- students acquired knowledge of basic concepts in genomics
- acquired knowledge about the importance of cloning vechile on recombinant gene expression
- students understand the need of site directed mutagenesis on recombinant protein development
- acquired knowledge on various advanced techniques in gene transfer with, related to transgenic area
- articulate the need the human genome mapping on address to various diseases

TEXT BOOKS:

1. Glick, B.R., Pasternak, J.J. and Cheryl L. Patten., "Molecular Biotechnology – Principles and Applications of Recombinant DNA", 4th Edition, ASM Press, 2009.
2. Wink, M., "An Introduction to Molecular Biotechnology – Molecular Fundamentals, Methods and Applications in Modern Biotechnology", Wiley-VCH Verlag, 2006.
3. Clark, D.P. and Pazdernik, N.J., "Biotechnology – Applying the Genetic Revolution", Elsevier Inc., 2009.
4. Kun, L.U., "Microbial Biotechnology – Principles and Applications", 2nd Edition, World Scientific Publishing Co. Pte. Ltd., 2006.
5. Walker, J.M. and Rapley, R., "Molecular Biology and Biotechnology", 5th Edition, RSC publishing, 2009.

REFERENCE BOOKS:

1. Ajoy Paul: Cell and Molecular Biology, 4th Ed., Books and Allied (P) Ltd., Kolkata, 2015.

BY17E12 BASICS OF CHEMICAL ENGINEERING (for Science Stream) L T P C 3 0 0 3

OBJECTIVES

To develop skills of the Students in the area of Chemical Engineering with emphasis in Thermodynamics fluid mechanics. This will be necessary for certain other course offered in the subsequent semesters and will serve as a prerequisite

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:

- Understand the conversion factors and physical properties of gases.
- Learn the material balances for overall and component balances in any process.
- Apply the knowledge in energy balance for steady and unsteady state.
- Define the fluid statics and applications in chemical engineering.
- Describe the types of pump and its applications.

TEXT BOOKS

1. mmelblau, D.M. and Riggs, J.B., "Basic Principles and Calculations in Chemical Engineering", International Edition, Prentice Hall, 2003.
2. Ghasem, N. and Henda, R., "Principles of Chemical Engineering Processes", CRC Press, 2008.

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, 2002.
3. McCabe, W.L., Smith, J.C., and Harriott, P.,"Unit Operations of Chemical Engineering" 7th Edition, McGraw-Hill Higher Education, 2005.

BY17E13 METABOLIC PROCESS AND ENGINEERING (FOR BIOTECHNOLOGY STREAM)

L	T	P	C
3	0	0	3

OBJECTIVES

This course work will provide essential knowledge to make career in bioprocess industries and in field of computational systems biology.

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 PATHWAYS 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, Vitamines) – 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, overdetermined and underdetermined 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 STRUCTURE OF METABOLIC NETWORKS 9

Fundamentals of metabolic control analysis (MCA) – Determination of flux control coefficients – MCA of linear and branched pathways – Theory of large deviations – Branched and unbranched networks – Control of flux distribution at a single branch point – Grouping reactions.

TOTAL: 45 PERIODS

COURSE OUTCOMES

At the end of the course, the student should be able to

- Understand the current advances in systems biology
- Gain insights into the field of metabolic engineering
- Biosynthesis of primary & secondary metabolites, bioconversions.

TEXT BOOKS

1. Stephanopoulos, G.N., Aristidou, A.A. and Nielsen.J., "Metabolic Engineering - Principles and Methodologies", Elsevier Science, 2001.
2. Cortossa, S., Aon, M.A., Iglesias, A.A. and Lloyd.D., "An Introduction to Metabolic and Cellular Engineering", World Scientific Publishing Co, 2002.

REFERENCES

1. Scheper, T., "Metabolic Engineering – Advances in Biochemical Engineering Biotechnology", Springer, 2001.
2. Curran, C.P., "Metabolic Processes and Energy Transfers - An Anthology of Current Thought", The Rosen Publishing group, Inc., 2006.
3. Nielsen, J., Villadsen, J. and Liden, G., "Bioreaction Engineering Principles", 2nd Edition, Kluwer Acadmic / Plenum publishers, 2003.

BY17E14 ADVANCES IN ANIMAL BIOTECHNOLOGY L T P C
3 0 0 3

OBJECTIVES
1. To understand the fundamentals of animal cell culture, details of the diseases and therapy
2. To provide the knowledge about the micromanipulation and transgenic animals

UNIT I CELL CULTURE TECHNOLOGY 12
History and Scope of Animal Biotechnology, primary and secondary cell culture, cell lines, Scaling up of animal cell culture-monolayer culture: Multiarray disks, spirals and tubes; Roller culture; Microcarriers; Perfused monolayer cultures; Membrane perfusion; Hollow fibre perfusion; Matrix perfusion; Microencapsulation, Suspension culture: Fluidized bed reactors for suspension, Air-lift fermentor, Chemostat/Turbidostat, Bioreactor process control. Chicken embryo fibroblast culture, Chicken liver and kidney culture

UNIT II THERAPEUTIC PRODUCTS FROM ANIMAL CELL CULTURE 5
Animal Biotechnology for production of regulatory proteins, blood products, viral vaccines, hormones and other therapeutic proteins, Hybridoma technology

UNIT III MOLECULAR BIOLOGY AND GENETIC ENGINEERING 9
Types of animal viral vectors- SV40, adeno virus, retrovirus, vaccinia virus, herpes virus,adeno associated virus and baculo virus. Molecular diagnostics for detection of animal diseases –PCR, Nucleic acid hybridization, DNA based methods for identification of animal species, DNA biosensor chips for GMO detection. Metagenomics in animal gastro intestinal ecosystems

UNIT IV REPRODUCTIVE BIOTECHNOLOGY 12
Biotechnological approaches to reproduction, methodology of super ovulation, Oestrus Synchronization and Timed Artificial Insemination, preparation of sperm for IVF; In vitro maturation; Fertilization and culture of embryos; embryo splitting, embryo sexing by different methods and their limitations; Genetics and Epigenetic alterations involved in Assisted Reproductive Technologies (ARTs), Multiple Ovulation and Embryo Transfer; Rate of Genetic Improvement using AI, MOET, ONBS; Embryo transfer in large and small ruminants. Laparoscopic and Laparoscope guided ET. Cryopreservation of sperm and embryos.

UNIT V APPLICATIONS 7
Knockout mice and mice model transgenesis- methods of transferring genes into animal oocytes, eggs, embryos and specific tissues by physical, chemical and biological methods; Transgenic animals (Mice, Cows, Pigs, Sheep, Goat, Birds and Insects); Biopharming, application of stem cells in animal biotechnology.

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon completion of the course, the students will be able to
1. Learn the scope of animal biotechnology and develop cell culture based products
2. Design animal cell culture based bioreactors
3. Create molecular tools like probes and diagnose animal diseases
4. Analyze the efficiency of different gene transfer methods and gain knowledge on micromanipulation technology.
5. Understand the useof different transgenic animals in various research areas.

TEXT BOOKS
1. Watson, J.D., Gilman, M., WitowskiJ.andZoller, M. Recombinant DNA, 2nd ed., Scientific American Books, 1983
2. Lewin, B. Genes VIII , Pearson Prentice Hall, 2004

3. Davis J.M. Basic Cell Culture: A Practical Approach, IRL Press, 1998 5. Freshney R.I. Animal Cell Culture- a practical approach, 1987
4. Freshney R.I. Animal Cell Culture- a practical approach, 1987

REFERENCES

1. PortnerR Animal cell biotechnology : Methods and Protocols , Humana Press, 2014.
2. Glick, B.R. and Pasternack, J.J. Molecular Biotechnology, 3rd ed., ASM Press, 2003

BY17E15 ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY L T P C
3 0 0 3

OBJECTIVES

- Students will be able to get basic knowledge about the principle and methods of protein crystallization and use of micro fluidics enables crystallization of protein that are available in very small amount.
- Students will acquire knowledge on the different chromatographic methods, immune precipitation and for separation of biological compounds which can be used for high-end research.
- Students will be able to understand the principle behind 2D gel electrophoresis, the different staining methods and their use in estimating the molecular weight of proteins.
- Students will be able to understand the construction and application of various types of microscopy.
- Students will also get a familiarity with different spectroscopic techniques, NMR , FTIR which can be used for characterization of the purified proteins.

UNIT I PROTEIN CRYSTALLOGRAPHY 9

Biological macro-molecules – Principle of protein crystallization – Method – Testing – Cryotechniques – Influence of heterogeneity on crystallization – Progress in structural genomics – Micro crystallization – Utility of microfluidics 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

COURSE OUTCOMES

- Ability to understand the principle and methods of protein crystallization and use of microfluidics enables crystallization of protein that are available in very small amount.
- Expected to acquire knowledge and perform various chromatographic experiments to evaluate the characteristics of a biological component and can also interpret the chromatograms thereby they can have a better understanding about the component to be analyzed using the different chromatographic methods and immunoprecipitation technique for separation of biological compounds which can be used for high-end research.
- Ability to understand the principle behind 2D gel electrophoresis, the different staining methods and their use in estimating the molecular weight of proteins.
- Ability to understand the construction and application of various types of microscopy to understand the components that makeup the sample for analysis.
- Knowledge on different spectroscopic techniques , NMR , FTIR which can be used for characterization of the purified proteins.

TEXT BOOKS

1. Bhowmik, G. and Bose, S., "Analytical Techniques in Biotechnology", Tata McGraw-Hill Publishers, 2011.
2. Simpson, R.J., "Purifying Proteins for Proteomics", Cold Spring Harbor Lab Press, 2004.

REFERENCES

1. Chandler, D. and Roberso, R.W., "Bioimaging: Current Techniques in Light & Electron Microscopy", Jones and Bartlett publishers, 2008.
2. Babine, R.E. and Abdel-Meguid, S.S., "Protein Crystallography in Drug Discovery", Willy-VCH Verlag GmbH& Co., 2004.
3. Pavia, D.L., Lampman, G.M., Kriz, G.S. and Vyvyan, J.R., "Introduction to Spectroscopy", 4th Edition, Brooks/Cole Cengage Learning, 2008.

BY17E16 PLANT TISSUE CULTURE AND GENE MANIPULATION

L T P C
3 0 0 3

OBJECTIVES

- To enable the students to understand details of plant cells, genome and its functions
- To provide the basics of agrobacterium and applications of plant biotechnology

UNIT I INTRODUCTION TO PLANT MOLECULAR BIOLOGY 9

Genetic material of plant cells, nucleosome structure and its biological significance; transposons,; outline of transcription and translation, alternative and trans splicing, constitutive and differentially expressed genes in plants

UNIT II CHLOROPLAST AND MITOCHONDRIA 9

Structure, function: Light and dark reaction and genetic material; rubisco synthesis and assembly, coordination, regulation and transport of proteins. Mitochondria: Genome, cytoplasmic male sterility and import of proteins, comparison and differences between mitochondrial and chloroplast genome, chloroplast transformation

UNIT III PLANT METABOLISM AND METABOLIC ENGINEERING 8

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

UNIT IV AGROBACTERIUM AND PLANT VIRUSES 9

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

UNIT V APPLICATIONS OF PLANT BIOTECHNOLOGY 10

Outline of plant tissue culture, transgenic plants, herbicide and pest resistant plants, molecular pharming , therapeutic products, RNA i, Transgene silencing ,ethical issues

TOTAL : 45 PERIODS

COURSE 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 learn viral vectors and agrobacterium based vectors in creating transgenic plants
- To gain the knowledge about the plant tissue culture and transgenic plants
- To use of the gained knowledge for the development of therapeutic products

TEXT BOOKS:

1. Grierson D. and Covey, S.N. Plant Molecular Biology, 2nd ed., Blackie,1988
2. Slater A et al. Plant Biotechnology : The Genetic Manipulation of Plants, Oxford University Press, 2003 (1st and 2nd edition)
3. Gamburg O.L., Philips G.C. Plant Tissue & Organ Culture: Fundamental Methods. Narosa , 1995.
4. Heldt, Hans-Walter, Plant Biochemistry & Molecular Biology, Oxford University Press, 1997.

REFERENCE BOOKS:

1.Wilkins M.B .Advanced Plant Physiology , ELBS, Longman, 1987

BY17E17 ONCOGENETICS L T P C
3 0 0 3

OBJECTIVES

- To enable the students to know cell cycle dysregulation in cancer and various stages of carcinogenesis.
- To understand the molecular basis of cancer and propose new treatment options for cancer patients

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

COURSE OUTCOMES

Upon completion of this course student will be able

- To know signal transduction pathways and cell cycle in cancer
- To understand the risk factors and stages of cancer
- To learn oncogenes and tumour suppressor genes
- To evaluate cancer metastasis and angiogenesis
- To analyse chemo, radiation and advanced therapy for cancer

TEXTBOOKS

1. Ruddon, R.W., "Cancer Biology", 2nd Edition, Oxford University Press, 2007
2. Weinberg, R.A., "The Biology of Cancer", Taylor & Francis, Garland Science, 2007

REFERENCES

1. Schulz, W.S., "Molecular Biology of Human Cancers – An Advanced Students Text Book", Springer, 2005.
2. Pelengaris, S. and Khan, M., "The Molecular Biology of Cancer", Blackwell Publishing, 2006.
3. Fialho, A. and Chakrabarty, A., "Emerging Cancer Therapy: Microbial Approaches and Biotechnological Tools" 1st Edition, Wiley, 2010.

BY17E18 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, which spoil food and food borne 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

COURSE OUTCOMES

- To gain knowledge about the techniques followed in food processing
- To understand about the food fermentation & the role of enzymes in food processing
- To know about different fermented foods produced
- To understand about food spoilage & different preservation techniques
- To know about the process of quality control in foods

TEXT BOOKS

1. Fellows, P.J., "Food Processing Technology: Principles and Practice", 3rd Edition, CRC Press, 2009.
2. Pometto A, Shetty K, Paliyath G and Levin R. E., "Food Biotechnology", 2nd Edition, CRC press, 2005.

REFERENCES

1. Hutkins R. W., "Microbiology and Technology of Fermented Foods", IFT Press series, Volume 32 of Institute of Food Technologists Series, Wiley-Blackwell, 2006.
2. Zeuthen P. and Bogh-Sorensen, L., "Food Preservation Techniques", 1st Edition, CRC Press, 2003.
3. Adams M., Adams M. R. and Robert Nout M. J., "Fermentation and food safety", Springer, 2001.
4. Da-Wen S., "Emerging Technologies for Food Processing", Academic Press, 2005.
5. Coultate, T.P. Food – The chemistry of its components, 2nd Ed., Royal society, 1992.
6. Sivasankar, B. Food processing and preservation, Prentice Hall of India Pvt. Ltd., 2002.
7. Sivasankar, B. Food processing and preservation, Prentice Hall of India Pvt. Ltd., 2002.
8. Fennema, O.R. Principles of food science: Part I, Food chemistry, Marcel Dekker, 1976.
9. Frazier, W.C. & Westhoff, D.C. Food Microbiology, 4th Ed. McGram-Hill Book Co., 1988.
10. Brenner, J.G., Butters, J.R., Cowell, N.D. & Lilly, A.E.V. Food Engineering Operations, 2nd Ed., Applied Sciences Pub. Ltd., 1979.
11. Pyke, M. Food Science and Technology, 4th Ed., John Murray, 1981.

BY17E19 COMPUTER AIDED LEARNING OF STRUCTURE AND FUNCTION OF PROTEINS

L T P C
2 2 0 3

OBJECTIVES

- To understand basics of Structural Biology
- To provide knowledge onstructures of different complex proteins
- To understand structure function relationship
- To gain knowledge changing of protein structure associated to biosynthesis and degradation pathway.
- To know different methods of protein structure prediction and determination

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 – Disulphidebond 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

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Understand the 2D and 3D structure of Proteins.
2. Learn membrane protein, fibrous protein structure.
3. Understand how structure controls the function of protein.
4. Apply biochemical/3D structure knowledge in Biosynthesis/degradation Pathway
5. Be proficient in Protein Structure determination and Prediction.

TEXT BOOKS

1. Whitford, D.,"Proteins: Structure and Function", John Wiley & Sons Ltd., 2005.
2. Creighton. TE., "Proteins: Structures and Molecular Properties", 2nd Edition, W. H. Freeman and Company, New York, 1993.

REFERENCES

1. Rastogi, S.C., "Bioinformatics Concepts, Skills & Applications", 2nd Edition, CBS publishers, 2009.

2. Petsko, G.A. and Ringe, D., "Protein Structure and Function", 2004.
3. Bujnicki, J.M., "Prediction of Protein Structures, Functions, and Interactions", John Wiley & Sons Ltd., 2009.

BY17E21 BIONANOTECHNOLOGY L T P C
3 0 0 3

OBJECTIVES

- To understand Biological Assembly/Structures in nano scale
- To know principles of structural and functional bio nanotechnology
- To gain knowledge on artificial bio assemblies.
- To understand Biomimetic fabrication
- To understand the concept of nanomedicine,nanopharmaceuticals and bionanosensor.

UNIT I BIOLOGICAL ASSEMBLY AND STRUCTURES AT THE NANO-SCALE 9

Concepts in nanotechnology – Interface between Nanotechnology and Biotechnology – Theoretical basis for Self-Assembly – Combination of Bionanotechnology and Nanobiotechnology – Self-Assembly and Self-Organization of bacterial S-Layers, Viruses, Phospholipids membrane, Fibrillar Cytoskeleton, Nucleic Acids, Oligosaccharides and Polysaccharides, Amyloid Fibrils, Silk, Ribosome – Biological Activity through Self-Assembly – Affinity and Specificity of Biological Interactions – Antibodies as the Molecular Sensors of Recognition.

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 BIOTEMPLATING AND ARTIFICIAL BIOASSEMBLIES 9

Experimental strategies of porin MspA as a Nanotemplate – Nanostructuring by deposition of the MspA porin – MspA-Nanochannels generated by the porin/polymer-template Method – Porin-Transport Assay – Scaffolds as Quantum dots, Organic Chains, polymers, DNA structures, Immobile DNA Junctions, Order in DNA and Proteins – Genetically Engineered S-Layer Proteins and S-Layer-Specific Hetero polysaccharides –Versatile molecular construction kit for applications in Nanobiotechnology.

UNIT IV DNA-BASED NANOSTRUCTURES 9

DNA-Protein nanostructures – Effective Models for Charge Transport in DNA Nanowires - DNA-Based Nanoelectronics - Biomimetic fabrication of DNA based metallic nanowires and networks – DNA-Gold nanoparticle conjugates – Nanoparticles as non-viral transfection agents - Nanocomputing.

UNIT V NANOMEDICINE, NANOPHARMACEUTICALS ANDNANOSENSING 9

Relationships of biotechnology, nanotechnology, and medicine – Promising nanobiotechnologies for applications in medicine – Role of nanotechnology in methods of treatment – Nanomedicine according to therapeutic areas – Nano-Sized Carriers for Drug Delivery and drug carrier systems – Gene and Drug delivery system with soluble inorganic carriers – Cellular behaviors during drug delivery – Nanosensors design using Molecules, Cells, Materials – Bionanosensors in Bioanalytical Technology.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of the course, the students will be able to

1. Understand the concept of bionanotechnology.
2. Learn the principle of bionanotechnology.
3. Apply the knowledge of bio assemblies to design new device.
4. Understand the concept of biomimetic fabrication
5. Gain knowledge about application of nanotechnology in medicine, pharmaceuticals and biosensors.

TEXT BOOKS

1. Niemeyer, C.M. and Mirkin, C.A., "Nanobiotechnology: Concepts, Applications and Perspectives", Wiley- VCH, 2004.
2. Goodsell, D.S., "Bionanotechnology", John Wiley and Sons, 2004.

REFERENCES

1. Shoseyov, O. and Levy I., "Nanobiotechnology: Bioinspired Devices and Materials of the Future", Humana Press, 2007.
2. Bhushan, B., "Springer Handbook of Nanotechnology", Springer-Verlag Berlin Heidelberg, 2004.
3. Freitas Jr, R.A., "Nanomedicine", Vol. II, 1st Edition, Landes Biosciences, 2004.
4. Kohler, M. and Fritzsche, W., "Nanotechnology – An Introduction to Nanostructuring Techniques", Wiley-VCH, 2004.
5. Rosenthal, S.J. & Wright, D. W. NanoBiotechnology Protocols (Methods in Molecular Biology), 1st Ed, Humana Press, 2005.
6. Madhuri, S., Maheshwar, S., Pandey, S. & Oza, G. Bio-Nanotechnology Concepts and applications, 1st Ed, Ane Books Pvt Ltd, 2012.
7. Clarke, A.R. & Eberhardt, C.N. Microscopy Techniques for Material Science, 1st Ed, CRC Press, 2002.

BY17E22 MEDICINAL CHEMISTRY L T P C
3 0 0 3

OBJECTIVES

- To enable the students to know, screen and characterise phytochemicals
- To apply the knowledge and use phytochemicals for therapeutic purpose and produce in large scale

UNIT I INTRODUCTION OF PHYTOCHEMICALS 9

Categories of phytochemicals and their classification (carbohydrates, tannins, alkaloids, glycosides, steroids, saponins, terpenoids, flavonoids, coumarins, mucilage's xanthine) – Phytochemical screening: Physiochemical tests – Moisture content, total ash, water-soluble ash, acid-insoluble ash, sulphate ash, alcohol and water-soluble extractive values –Heavy metal detection by atomic spectroscopy.Macroscopic studies – Shape, apex, base, margin, taste and odour Microscopic-stomatal number, stomatal index, vein islet number and vein termination number.

UNIT II THERAPEUTIC EFFECT OF PLANT PRODUCTS 9

Anti-tumor activity – Anti-coagulation – Anti-bacterial – Anti-inflammatory– Anti-MRSA and Anti-VRE activities of Phytoalexins and Phytoncides. Screening of Plant extracts for antiparasitic activity.

UNIT III BIOACTIVITY STUDIES 9

Screening of drugs for biological activity – Antidiabetic, antinflammatory, antihepatotoxic, antifertility, diuretic, anticancer, antihepatotoxic, antimalarial, antihypertensive and hypolipedemic and adoplogenic agents.

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.

UNIT V LARGE SCALE PRODUCTION OF BIOACTIVE PRODUCTS 9

Secondary metabolite production through cell culture system – Hairy root induction –Methods of gene transfer – Chemical methods – PEG – dextran – Physical method – Electroporation – Microinjection – Lipofection agrobacterium based vector mediated gene transfer – Particle bombardment.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course student will be able

- To know phytochemicals, screening and their
- To know the therapeutic effects like anti tumour, anti inflammatory, anti bacterialetc
- To learn screening of drugs for biological activity
- To analyseseparation and characterisation of phytochemicals
- To understand large scale production of bioactive products by chemical, physical and cell culture methods

TEXT BOOKS

1. Ahamed, I., Aqil, F. and Owais, M., "Modern Phytomedicine", WILEY VCH, Verlag GmbH & Co, KGaA, Weinheim. 2006.
2. Chawla, H.S., "Introduction to Plant Biotechnology", Science Publishers, 2004.

REFERENCES

1. Meskin, M.S., Bidlack, W.R., Davies, A.J. and Omaye, S.T., "Phytochemicals in Nutrition and Health", CRC Press, 2002.
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. and Topham, D.K.W.," Phytochemicals as Bioactive Agents", 1St Edition, CRC Press, 2000.

BY17E23 ADVANCES IN MOLECULAR PATHOGENESIS L T P C
3 0 0 3

OBJECTIVES

- To understand the key concepts of host defense against pathogens and microbial defense strategies
- To learn the techniques of molecular approach to control the microbial pathogens

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

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

1. Describe the basic feature of pathogenesis and how virus involved in disease progress.
2. Learn the knowledge about the host defense strategy against pathogens and fungi defense strategies.
3. Understand the molecular mechanism of virulence and the abilityto perform the cause of bacterial infections.
4. Study the basic knowledge about the molecular mechanism of pathogen (virus) invasion to the host.
5. Learn different molecular techniques to control the mechanism of microbial pathogens.

TEXT BOOKS

1. Groismen, E.A., “Principles of Bacterial Pathogenesis”, Academic Press, 2001.
2. Norkin, L.C., “Virology: Molecular Biology and Pathogenesis”, ASM Press, 2009.

REFERENCES

1. Gyles, C.L., Prescott, J.F., Songer, J.G. and Thoen C.O., “Pathogenesis of Bacterial Infections in Animals”, 3rd Edition, Wiley-Blackwell, 2004.
2. Flint, J., Enquist, L.W., Krug, R.M., Racaniello, V.R. and Skalka, A.M., “Principles of Virology: Molecular Biology, Pathogenesis and Control”, American Society of Microbiology, 2003.
3. Mettenleitter, T.C. and Sobrino, F.,“Animal Viruses: Molecular Biology”, Caister Academic Press, 2008.

BY17E24 IPR AND BIOSAFETY L T P C
3 0 0 3

OBJECTIVES

- To enable the students to designing project report and understand intellectual property rights
- To learn different patent application types, process and prior art search
- To understand national and international guidelines on biosafety level

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

COURSE OUTCOMES

- To acquire relevant knowledge, identifyand develop entrepreneurial projectreport and follow planning commission guidelines
- To understand different intellectual property rights and their relevance to biotechnology agreements
- To understand the patenting procedure, the ability to apply for patent and dopriorart search etc.,
- To develop confidence in PCT filing procedure, patent licensing and agreement
- To get ideas on environmental release of GMO, risk analysis, risk assessment and risk management

TEXT BOOKS

1. Irish, V., "Intellectual Property Rights for Engineers", 2nd Edition, The Institution of Engineering and Technology, 2005.
2. Fleming, D.O. and Hunt, D.L., "Biological Safety: Principles and Practices", 4th Edition, American Society for Microbiology, 2006.
3. BAREACT.IndianPatentAct1970Acts&Rules,UniversalLawPublishingCo.Pvt.Ltd., 2007.
4. Kankanala, C. Genetic Patent Law &Strategy, 1stEd., ManupatraInformation SolutionPvt.Ltd.,2007.
5. Kanka, S.S.EntrepreneurshipDevelopment, 1st Ed., S. ChandandCo,1997.

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. 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.
3. Mueller, M.J., "Patent Law", 3rd Edition, Wolters Kluwer Law & Business, 2009.

BY17E25 BIOREACTOR DESIGN AND ANALYSIS L T P C
4 0 0 4

COURSE OBJECTIVES

- To understand and develop mathematical models for batch and CSTR bioreactors by application of substrate, biomass, and product mass balances.
- To know and apply the transport phenomena principles to bioreactors.
- To frame the requirements needed for the design of reactor.
- To analyse the sterilization and other techniques to bioreactors in scale up process.
- To measure and control the process variables involves in the process.

UNIT I BASIC BIOREACTOR CONCEPTS 9

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

UNIT II AERATION AND AGITATION IN BIOPROCESS SYSTEMS 9

Mass transfer in agitated tanks – Balance between oxygen supply and demand, 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 – 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 9

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 9

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 9

Methods of measuring process variables –Temperature – Flow measurement and control – Pressure measurement and control – Agitation – shaft power, rate of stirring – Foam sensing and control – Microbial biomass – Measurement and control of Dissolved oxygen – Inlet and outlet gas analysis – pH measurement and control.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of Bioreactor Design and analysis course graduates will be able to

- select appropriate bioreactor configurations and operation modes based upon the nature of bioproducts and cell lines and other process criteria.
- apply their knowledge of transport phenomena in designing field.
- Plan a research career or to work in the biotechnology industry with strong foundation.
- design bioreactor, scale up and troubleshooting the problems in bioreactors.
- integrate research lab and Industry; identify problems and seek practical solutions for large scale implementation of Biotechnology with process control expertise.

TEXT BOOKS:

1. Mansi,E.M.T.EL., Bryce,C.F.A., Demain, A.L. and Allman,A.R., "Fermentation Microbiology and Biotechnology", Taylor and Francis, 2006.
2. Mann, U., "Principles of Chemical Reactors Analysis & Design: New tools for Industrial Chemical Reactor Operations ", Willey–VCH, 2009.

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. Shuler, M.L. and Kargi, F., "Bioprocess Engineering: Basic Concepts", 2nd Edition, Prentice Hall, 2001.
3. Towler, G. and Sinnott, R., "Chemical Engineering Design: Principles, Practice, Economics of Plant and Process Design", Butterworth – Heinemann ltd., Elsevier, 2008.

BY17E26 BIOPROCESS MODELING AND SIMULATION L T P C
3 0 0 3

COURSE OBJECTIVES

This course aims at imparting knowledge about the different types of bioreactors and its models for non- ideal behaviour.

The students will learn about the different software solution strategies for bioprocess models.

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

COURSE OUTCOMES

The students will learn

- Basic concepts and principles in bioprocess modelling.
- Study different structured and unstructured models
- Study non-ideal behaviour of different types of bioreactors
- Dynamic simulation of biochemical reactors
- Different software solution strategies for solving bioprocess parameters and models.

TEXT BOOK S

1. Hangos, K.M. and Cameron, I.T., "Process Modelling and Simulation", 2001.
2. Heinzle, E., Biwer, A.P. and Cooney, C.A.L., "Development of Sustainable Bioprocess: Modeling", Wiley, 2007.

REFERENCES

1. Boudreau, M.A. and McMillan, G.K.," New Directions in Bioprocess Modelling and Control", ISA, 2006.
2. Bequette, B.W., "Process Control:Modeling, Design & Stimulating", Prentice Hall, 2003.
3. Bailey, J.A. and Ollis, D. F., Fundamentals of Biochemical Engineering", McGraw Hill –1986.

BY17E27 TISSUE ENGINEERING L T P C
3 0 0 3

OBJECTIVES

1. To learn the fundamentals of tissue engineering ,tissue characteristics and the measurement of cellular components, the type of tissues and growth factors involved in tissue repairing and the wound healing mechanism
2. To study the construction of biomaterials and measurement of its physical and mechanical properties
3. To explore naturally available biomaterials and synthetic nano materials for developing potential scaffolds for drug delivery and other regenerative medicine
4. To get familiarize with the characteristics and the role of stem cells in tissue architecture
5. To acquire knowledge on clinical applications of tissue engineering and associated ethical issues

UNIT I FUNDAMENTAL OF TISSUE ENGINEERING 9

Cells and tissue grade organization in living system - 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 – Scope of tissue engineering.

UNIT II BIOMATERIALS FOR TISSUE ENGINEERING 9

Preparation of biomaterials and their types - 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 BIOMATERIALSAS SCAFFOLDS AND STEM CELLS 9

Synthesis of bio polymer - 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 – Application of stem cells in tissue engineering.

TOTAL: 45 PERIODS

COURSE OUTCOMES

1. Students will gain knowledge on the components of the tissue architecture, the type of tissues and growth factors involved in tissue repairing
2. Students will be able to understand construction of biomaterials and measurement of its physical and mechanical properties
3. Students will be aware about the drug delivery mechanisms and broad applications of biomaterials
4. Students can be familiarized with the stem cell characteristics and their relevance in medicine
5. Students will be able to get ideas on overall exposure to the role of tissue engineering and stem cell therapy in organogenesis and associated patent and ethical issues

TEXT BOOKS

1. Pallua, N. and Suscheck, C.V., “Tissue Engineering: From Lab to Clinic” Springer, 2010
2. Saltzman, W.M., “Tissue Engineering”, Oxford University Press, 2004.

REFERENCES

1. Palsson, B., Hubbell, J.A., Plonsey, R. and Bronzino, J.D., “Tissue Engineering”, CRC Press, 2003.
2. Palsson, B.O. and Bhatia, S., “Tissue Engineering”, Pearson Prentice Hall, 2004.
3. Scheper, T., Lee, K. and Kaplan, D., “Advances in Biochemical Engineering / Biotechnology – Tissue Engineering I”, Volume 102, Springer-Verlag Berlin Heidelberg, 2006.

BY17E28 RESEARCH METHODOLOGY IN BIOTECHNOLOGY

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3	0	0	3

OBJECTIVES

- To enable the students to designing project report and understand intellectual property rights

- To learn different patent application types, process and prior art search
- To understand national and international guidelines on biosafety level

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

COURSE OUTCOMES

At the end of the courses,

1. To acquire relevant knowledge, identify and develop entrepreneurial projectreport and follow planning commission guidelines
2. To understand different intellectual property rights and their relevance to biotechnology agreements
3. To understand the patenting procedure, the ability to apply for patent and do prior art search etc.,
4. To develop confidence in PCT filing procedure, patent licensing and agreement
5. To get ideas on environmental release of risk analysis, risk assessment an drisk management

TEXT BOOKS

1. Marczyk,G.R., DeMatteo, D. and Festinger, D., “Essentials of Research Design and Methodology”, John Wiley & Sons Publishers, Inc., 2005.
2. Korner, A.M., “Guide to Publishing a Scientific paper”, Taylor & Francis group, 2008.
3. Marczyk, G.R., DeMatteo, D. & Festinger, D. Essentials of Research Design and Methodology, John Wiley & Sons Publishers Inc, 2005.
4. Segel, I.H. Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry, 2nd Ed., John Wiley & Sons Publishers Inc, 1976.
5. Korner, A.M. Guide to Publishing a Scientific paper, Bioscript Press, 2004.

REFERENCES

1. Kothari, C.R., “Research Methodology: Methods and Techniques”, New Age Publications, 2008.
2. Malinowski, M.J. and Arnold, B.E., “Biotechnology: Law, Business and Regulation”, Aspen Publishers, 2004.
3. Haaland, P.D., “Experimental Design in Biotechnology”, Marcel Dekker, 1989.

BY17E29 BIOFUELS AND PLATFORM CHEMICALS L T P C
3 0 0 3

OBJECTIVES

To enable the students to

- Have knowledge about Physical and chemical pretreatment of lignocellulosic biomass.
- Know the engineering strains for ethanol production from variety of carbon sources to improved productivity.
- Describe the Energetics of biodiesel production and effects on greenhouse gas emissionsIssues of Eco toxicity and sustainability
- Understand the production of Biodiesel from microalgae and microbesin detail.
- Learn the processes involved in the production of C3 to C6 chemicals in depth.

UNIT I INTRODUCTION 9

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

UNIT II ETHANOL 9

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

UNIT III BIODIESEL 9

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

UNIT IV OTHER BIOFUELS 9

Biodiesel from microalgae and microbes; biohydrogen production; biorefinery concepts

UNIT V PLATFORM CHEMICALS 9

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

TOTAL: 45 PERIODS

OUTCOMES:

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

- Have knowledge about Physical and chemical pretreatment of lignocellulosic biomass.
- Know the engineering strains for ethanol production from variety of carbon sources to improved productivity.
- Describe the Energetics of biodiesel production and effects on greenhouse gas emissions Issues of Eco toxicity and sustainability
- Understand the production of Biodiesel from microalgae and microbes in detail.
- Learn the processes involved in the production of C3 to C6 chemicals in depth.

TEXT BOOKS:

1. Lee, Sunggyu; Shah, Y.T. “Biofuels and Bioenergy”. CRC / Taylor & Francis, 2013.
2. Samir K. Khanal, “Anaerobic Biotechnology for Bioenergy Production: Principles and Applications”, Wiley-Blackwell Publishing, 2008.
3. David M. Mousdale, “Biofuels: Biotechnology, Chemistry, and Sustainable Development “CRC Press, 2008.
4. Gupta, Vijai Kumar; Tuohy, Maria G. (Eds.), “Biofuel Technologies Recent Developments”, Springer, 2013.

5. Robert C. Brown, “Biorenewable Resources: Engineering New Products from Agriculture”, Wiley-Blackwell Publishing, 2003.

REFERENCE BOOKS:

1. Pogaku, Ravindra; Sarbatly, Rosalam Hj. (Eds.), “Advances in Biofuels”, Springer, 2013.