M.Tech (Biotechnology):2016-17

COURSE STRUCTURE

I SEMESTER

S. No	Name of the Subject	L	P	C
1	Microbial Technology	4	—	3
2	Bioprocess Engineering	4	—	3
3	Bioinformatics	4	—	3
4	Immuno-technology	4	—	3
5	Elective-I Cancer Biology Protein Engineering Fermentation Technology	4	—	3
6	Elective-II Medical Biotechnology Biological Treatment of Waste water Green Energy Technology	4	—	3
7	Immunology &bio process Lab	—	3	2
	Total			**20**

II SEMESTER

S. No	Name of the Subject	L	P	C
1	Recombinant DNA Technology	4	—	3
2	Metabolic Engineering	4	—	3
3	Bioreactor design	4	—	3
4	Stem cell Technology	4	—	3
5	Elective-III Biopharmaceutical Technology Membrane Biology and Signal Transduction Biofuels	4	—	3
6	Elective-IV Molecular modeling & Drug Design Food Biotechnology Bio-Nanotechnology	4	—	3
7	r-DNA Technology & Bioinformatics lab	—	**3**	**2**
	Total			**20**

III SEMESTER

S. No	Name of the Subject	L	P	C
1	Comprehensive viva	—	—	2
2	Project Work - I	—	—	18
	Total			**20**

IV SEMESTER

S. No	Name of the Subject	L	P	C
1	Seminar	—	—	2
2	Project Work - II	—	—	18
	Total			**20**

SEMISTER- I

Name of the Subject	L	P	C
MICROBIAL TECHNOLOGY	4	—	3

UNIT I- GENERAL MICROBIOLOGY

Principles, Morphology & Cell structure of Prokaryotes and Eukaryotes (Bacteria, fungi, algae and viruses, etc.), Different culture techniques, Isolation & preservation methods, Characteristics of selected group of microbes, Microbial nutrition and growth, Growth measurements techniques, Transformation, Conjugation & transduction in microbial systems. Kinetics of microbial and product formation.

UNIT II- IMPROVEMENT OF INDUSTRIAL MICROORGANISMS

Improvement of industrial microorganisms by selection and mutation, Importance of genetic engineering in Microbial Biotechnology, Basic concepts for design of a new protein/enzyme molecule, Design and construction of novel proteins and enzymes, Visualization and interpretation of protein structure, Site directed mutagenesis for specific protein function-Specific examples of enzyme engineering.

UNIT III- INDUSTRIAL PRODUCTS

Major categories of industrial products (viz. alcohol, organic acids, enzymes, antibiotics, vitamins, surfactants, polymers, microbial biomass, etc.), Production of organic solvents (Beer, Wine), Production of fermented foods (Cheese, Yoghurt), Production of organic acids (Citric acid, Acetic acid and lactic acid), Production of Amino acids (Glutamic acid and Lysine), Production of antibiotics (beta-lactams- Penicillins and Macrolids -erythromycin). Production of IFN, Interleukin, HGF, Vaccines-Production of various vaccines, Microbial pathogenecity, Bioassays.

UNIT IV- ENZYME & BIOCHEMICAL PATHWAYS

Kinetics and mechanism of enzyme action, Major biochemical pathways (Assimilatory, dissimilatory & secondary pathways), Production technology (Solid and liquid phase fermentation, batch and continuous fermentation).

UNIT V- ENVIRONMENTAL MICROBIOLOGY

Bioleaching, Xenobiotic compounds, Bioremediation, Biostimulation, Bioaugmentation, Bioabsorption, and Phytoremediation.

TEXT BOOKS

1. Glazer, A.N. and Nikaido, Microbial biotechnology, 2nd edition Cambridge University Press, 2007
2. Wulf Creuger & Anneliese Creuger, A Textbook of Industrial Microbiology, 2nd edition, Sinauer, 2004

3. A. K. Chatterjee, Environmental Biotechnology, 2nd edition, Prentice Hall, 2011
4. Indu Shekhar Thakur, Environmental Biotechnology: Basic concepts and applications, 2nd edition, I K International Publishing House, 2011.
5. Shuler, M.L. and Kargi, F. Bioprocess Engineering: Basic concepts, 2nd ed. Prentice-Hall, 2002.
6. Doran Pauline M, Bioprocess Engineering Principles, Academic Press, 2nd ed.2012.
7. Stanbury, P.F., Stephen J. Hall & A. Whitaker, Principles of Fermentation Technology, 2007

REFERENCES

1. Foster C.F., John Ware D.A., Environmental Biotechnology, Ellis Horwood Ltd., 2005.
2. Prescott and Dunn, Microbiology, 8th edition, McGraw Hill, Inc, 2010.
3. A. H. Patel, Industrial Microbiology, MacMillan Publishers, 2000.
4. Blanch, H.W., Clark, D.S. Biochemical Engineering, Marcel Dekker, 2010.
5. Lee, James M. Biochemical Engineering, PHI, USA. 1986
6. Bailey J.E. & Oilis, D.F. Biochemical Engineering Fundamentals, 2nd Ed., McGraw Hill, 2010.
7. Wiseman, Alan. Hand Book of Enzyme Biotechnology, 3rd ed., Ellis Harwood 2000.

Name of the Subject	L	P	C
BIOPROCESS ENGINEERING	4	—	3

UNIT I- INTRODUCTION

An overview of traditional and modern applications of biotechnology industry, outline of an integrated bioprocess and the various (upstream and downstream) unit operations involved in bioprocesses, generalized process flow sheets. Characteristic properties of biological fluids, Principles and mechanisms of thermal stabilization by filtration, Single and multiple bubbles aeration. On-ideality and RTD in Bioreactors, Analysis of multiple interacting microbial populations.

UNIT II- MEDIA DESIGN & STERILIZATION

Medium requirements for fermentation processes, Carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, Medium formulation for optimal growth and product formation, Examples of simple and complex media, Design and usage of various commercial media for industrial fermentations, Surface methodology, Response surface methodology, Plackett Burman Designs, Thermal death kinetics of microorganisms, Batch and continuous heat sterilization, Sterilization of liquid media, Filter sterilization of liquid media, Air. Design of sterilization equipment

UNIT III- MONITORING OF BIOREACTORS

On and off-line sensors for a modern bioreactor, Integrated systems of bioreaction, bioseparation biosensors, Characteristics of bio products, Flocculation and conditioning of broth, Mechanical separation, Filtration, Centrifugation and Membrane based separation; Cell disruption.

UNIT IV- RHEOLOGY

Unit operation and process in the Chemical Industry, Fluid statics and Dynamics, Bernoulli's equation, Newtonian and Non-Newtonian fluids, Materials and energy. Balance on reactive and non-reactive systems, Principles of momentum, Heat and Mass transfer.

UNIT V- STABILITY ANALYSIS

Stability analysis, Stability of recombinant cells, Physiology of immobilized cells, Packed-bed reactors, Fluidized-bed bioreactors, Air-lift bioreactors, Bubble-column bioreactors, Immobilized-enzyme bioreactors, Special reactors for animal and plant cells.

TEXTS BOOKS

1. M. L Shuler and F. Kargi., Bioprocess Engineering, 2nd edition, Prentice Hall Inc., 2002.
2. P.M. Doran, Bioprocess Engineering Principles, 2nd edition, acadamic press, 2012.
3. P. B. Kaufman, L. J. Cseke, S. Warber, J. A. Duke, and H. L. Brielmann, Natural Products from Plants, CRC Press LLC, 2005

REFERENCES

1. H. J. Rehm and G. Reed, Biotechnology-A multi- Volume Comprehensive Treatise, 2/e, Vol 6, Wiley-VCH, 2011.
2. M. Moo-Young, Comprehensive Biotechnology, Vol. 4, 1st edition Pergamon Press, 2011.
3. F. Dicosmo and M. Missawa, Plant Cell Culture Secondary Metabolism: Towards Industrial Application. CRC LLC, 2006.

Name of the Subject	L	P	C
BIOINFORMATICS	4	—	3

UNIT I- INTRODUCTION

Introduction to Genomic data and Data Organization: Sequence Data Banks – Introduction to sequence data banks –protein sequence data bank, NBRF-PIR, SWISSPROT, Signal peptide data bank, Nucleic acid sequence data bank –GenBank, EMBL nucleotide sequence data bank, AIDS virus sequence data bank.

UNIT II- PROTEIN STRUCTURE PREDICTION

Fold libraries, Protein folding Fold recognition (threading), Protein structure predictions: Comparative modeling (Homology), Advanced topics, Protein ligand interactions, Molecular Modeling & Dynamics, Secondary Structure predictions, Prediction algorithms, Chao-Fausman algorithm, Hidden-Markov model, Neural Networking, Tertiary Structure predictions, Prediction algorithsms, Chao-Fausman algorithm.

UNIT III- PROTEOMICS

Introduction to proteomics and protein engineering - Protein pre-fractionation and sample preparation - Two dimensional electrophoresis (2-D PAGE) - Protein identification Post translational modification, Proteome analysis: The impact of stable isotope labeling: Sample preparation, 2-D gel separation and analysis, Mass spectrometry: protein identification using MS data, Gel matching, Protein chips and applications. Functional Proteomics tools.

UNIT IV- GENOMICS

Functional Genomics and analysis of gene expression- Reverse genetics, Comparing transcriptomes- subtractive hybridization, differential display, SAGE, Microarrays Genetic diseases in humans, Human Genome project, Genetic counseling, Genetics and society, Functional genomics tools, Functional Genomes- Pharmacogentics -Genomics in relation to molecular Diagnosis -Molecular Therapeutic technologies, Genomics in Biopharmaceutical Industry.

UNIT V- PHYLOGENY

Phylogeny: Concepts of systematic, Molecular evolution, Definition and Different types of phylogenetic trees, Dendograms and interpretations, phylogenetic analysis.

TEXT BOOKS

1. Lesk, Introduction to Bio Informatics, 3rd edition, OUP Oxford, 2013.
2. Attwood, Introduction to Bioinformatics, 1st edition, Pearson Education, 2007.

REFERENCES

1. H.D. Kumar, Molecular Biology, 2nd edition, Vikas Publishing House pvt ltd, 2001.
2. B. Alberts, D. Bray, J. Lewis et al, Molecular Biology of the Cell, 5th edition Garland Pub. N.Y, 2010.
3. S. Sahai, Genomics and Proteomics, “Functional and Computational Aspects, 2nd edition, Plenum Publications, 2011.

Name of the Subject	L	P	C
IMMUNOTECHNOLOGY	4	—	3

UNIT- I IMMUNOLOGY- FUNDAMENTAL CONCEPTS AND ANATOMY OF THE IMMUNE SYSTEM

Components of innate and acquired immunity, Hematopoiesis, Organs and cells of the immune system, Phagocytosis, Inflammatory responses, Immunoglobulins-basic structure, Classes and subclasses of immunoglobulins, Immunoglobulin superfamily, Immunoglobulin gene organization and Generation of antibody diversity.

UNIT II- ANTIGENS AND ADAPTIVE IMMUNITY

Antigens and Immunogens, Factors affecting immunogenicity, Haptens and Adjuvants, B cell maturation, activation and differentiation, B-cell receptor, T-cell maturation, activation and differentiation and T-cell receptors. Major Histocompatibility Complex - MHC genes, Antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens.

UNIT III- ANTIGEN-ANTIBODY INTERACTIONS

Affinity and Avidity, Precipitation, agglutination, Advanced immunological techniques - RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, Flow cytometry and Immunoelectron microscopy, Cytokines-properties, receptors and therapeutic uses, Complement System.

UNIT IV- VACCINE TECHNOLOGY

Live, killed, attenuated, sub unit vaccines, Role recombinant DNA and protein based vaccines, Plant-based vaccines, Reverse vaccinology, Peptide vaccines, Conjugate vaccines, Hybridoma technology-Production of monoclonal antibodies, Antibody engineering- chimeric, Humanized antibodies, Phage Display library.

UNIT V- CLINICAL IMMUNOLOGY

Hypersensitivity – Types, Autoimmunity- Types of autoimmune diseases, Treatment of autoimmune diseases, Transplantation – Immunological basis of graft rejection, Clinical transplantation and immunosuppressive therapy, Tumor immunology – Tumor antigens, Immune response to tumors and tumor evasion of the immune system, Cancer immunotherapy, Immunodeficiency-Primary immunodeficiency's, Acquired or secondary immunodeficiency's.

TEXT BOOKS

1. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt Essential Immunology, 12 edition, Wiley-Blackwell, 2011.
2. Judy Owen , Jenni Punt , Sharon Stranford, Kuby Immunology, 7th Edition, W. H. Freeman,

2013.
3. Janeway et al., Immunobiology; 8 edition, Garland Science, 2011.
4. William E. Paul, Fundamental of Immunology, 7th edition, Lippincott Williams & Wilkins, 2012.
5. A. K. Chakravarthy, Immunology & Immunotechnology, 1st edition, Oxford University Press, 2006.

REFERENCES

1. Benjamin E and Leskowitz S, ELISA Immunological Techniques, 5edition, Wiley-Liss, 2003.
2. Abul Abbas and Lichman, Cellular Molecular Immunology; 1st edition; Saunders, 2011.

Name of the Subject	L	P	C
ELECTIVE-I: CANCER BIOLOGY	**4**	**-**	**3**

UNIT I- INTRODUCTION

Introduction: Causes of cancer: Physical, Chemical, Biological, Diet, Genetic & Hereditary, Types of Cancer, Cell Cycle Events, Regulation of Cell Cycle, Signal Molecules, Signal receptors, Mutations in signal molecules that alters cell cycle, Tumour suppressor genes, Role of tumour suppressor genes in control of cancer.

UNIT II- CARCINOGENS

Carcinogenesis: Chemical Carcinogenesis: History, Examples of known to be human carcinogens, Mechanism of carcinogenesis, Targets of Chemical carcinogens, DNA Adducts, Phase I & Phase II Metabolism of Chemical carcinogens, Physical carcinogens: X ray radiation induced carcinogenesis, Asbestos induced carcinogenesis.

UNIT III- MOLECULAR BIOLOGY OF CANCER & METASTASIS

Molecular Biology Of Cancer**:** Detection of Oncogenes, Identification of Oncogenes, Retroviral oncogenes, Growth factors and Growth factor receptors as oncogenes, metastasis: Factors contributing metastasis, Significance, Heterogeneity, Angiogenesis, Basement membrane disruption, 3step theory if invasion, Cell adhesion molecules in metastasis, Cell motility, proteinases in cell invasions.

UNIT IV- CANCER DETECTION & TREATMENT

Screening Methods, Molecular detection of Cancer, Low throughput assays, SSCP, CGH, Flow cytometry, Southern blot, RFLP, FISH, High throughput techniques: Sequencing, Microarrays. CT scan, MRI scan, PET scan, Resistance to cytotoxic drugs, Early and late side effects of chemotherapy, Anti-Cancer agents- Alkylating agents, Antimetabolites, Topoisomerase inhibitors.

Radiation Therapy: Radical Radiotherapy, Adjuvant radiotherapy, Palliative radiotherapy, Gross Tumour Volume (GTV), Clinical Target Volume (CTV), Planned Target Volume(PTV), Classical radiation biology, Cellular Response to DNA Damage.

UNIT V- IMMUNOTHERAPY

Cancer antigens, Antibody development against cancer antigens, Immune system evasion by cancer; Specific Immunotherapy: T Cells, Dendritic Cells, DC Vaccines, Peptide vaccines; Nonspecific immunotherapy- cytokines.

TEXT BOOKS

1. 'Cellular and Molecular Biology of Cancer', Margaret Knowles and Peter Selby, 4th edition, Oxford University Press, 2005
2. Geoffrey Cooper, The Cell, 4th edition, Sinauer Publications, 6th Edition 2013.
3. 'Kuby Immunology', Thomas J. Kindt, Barbara A. Osborne and Richard Goldsby. 6th edition. W.H. Freeman, 2006
4. 'The Molecular Biology of Cancer', Stella Pelengaris and Michael Khan, 2nd edition. Wiley – Blackwell, 2013
5. 'Cell and Molecular Biology'; Lodish et al, 7th edition, W. H. Freeman, 2012.
6. 'The world of cell'; Becker, Kleinsmith, Hardin. 6th Edition, 2011

REFERENCES

1. Weinberg, Biology of Cancer, 1st edition, Garland Publication, 2006.
2. Rosenberg, principles and practice of oncology. 2013

Name of the Subject	L	P	C
ELECTIVE-I: PROTEIN ENGINEERING	4	—	3

UNIT I- PROTEIN STRUCTURAL FAMILIES

Introduction; Basic structural principles: amino acids and their conformational accessibilities, Ramachandran Plot, Motifs of protein structures and their packing, Schematic and topology diagrams, Families of protein structures: alpha, alpha/beta, beta small.

UNIT II- PROTEIN FOLDING AND ASSEMBLY

Protein folding pathways in prokaryotes and eukaryotes: Single and multiple folding pathways, Protein folding of single domain and multi-domain proteins, Inclusion bodies and recovery of active proteins; osmolyte assisted protein folding, Structure of chaperones and role of chaperones in protein folding.

UNIT III-PROTEIN ENGINEERING

Strategies for protein engineering; Random and site-directed mutagenesis, Various PCR based strategies, Role of low-fidelity enzymes in protein engineering, Gene shuffling and Directed evolution of proteins, Protein backbone changes, Strategies for protein engineering, Random and site-directed mutagenesis, Various PCR based strategies, Role of low-fidelity enzymes in protein engineering, Gene shuffling and Directed evolution of proteins, Protein backbone changes, Antibody engineering, All topics will deal with case studies.

UNIT IV-PREDICTION AND DESIGN OF PROTEIN STRUCTURES

Similar structure and function of homologous proteins, Role of multiple alignment; Homology and ab-initio method for protein structure prediction, Phage display systems, Structure based drug design and case studies, Rational protein design.

UNIT V- PROTEIN STRUCTURE ON THE WORLD WIDE WEB

Different databases for protein structure and their uses: PDB, SWISS PROT, BLASTp, KEGG, OMIM, Pfam, SCOP.

TEXT BOOKS

1. Introduction to Protein structure, 2nd Ed by Carl Branden and John Tooze, Garland Press, 1999.
2. Protein engineering in Industrial biotechnology, Ed. Lilia Alberghina, Harwood Academic Publishers, 2002.

REFERENCES

1. Structure and Mechanism in Protein Science, Alan Fersht, Freeman, 1999.

Name of the Subject	L	P	C
ELECTIVE-I: FERMENTATION TECHNOLOGY	4	—	3

UNIT I- INTRODUCTION TO FERMENTATION TECHNOLOGY

Interaction between chemical engineering, Microbiology and Biochemistry, History of fermentation, Introduction to fermentation processes, Microbial culture selection for fermentation processes, Media formulation and process optimization.

UNIT II- REQUIREMENTS FOR FERMENTERS

Isolation, Preservation and Improvement of industrially important microorganisms, Media for industrial fermentations – media formulation, Development of inoculum for industrial fermentations, Gaden's Fermentation classification.

UNIT III- ENVIRONMENTAL CONCERNS ABOUT FERMENTATION

Environmental regulations and technology, laws and regulations, Technology (waste water), Waste water treatment strategy, Air (emissions of concerns), Selecting a Control Technology, Inorganics, and volatile Organic Compound Emission Control.

UNIT IV- DESIGN AND CONTROL OF FERMENTER

Fermenter design and types-basic functions of a Fermenter for microbial and animal cell culture – alternative vessel design, Common measurements and control systems. Sensors – solutions to common problems in fermentation, anaerobic fermentation, Computers in fermentation, modeling, Software sensors, Control and supervision of fermentation processes. – Off-line / online measurements – PID

UNIT V- APPLICATIONS OF FERMENTATION

Production of Organic Acids (Acetic acid and vinegar) its spoilage and prevention, Production of mushroom production, Vitamins- Vitamin B-2 and Riboflavin.

TEXT BOOKS

1. Fermentation microbiology and biotechnology. Ed. El-mansi. 3rd ed. 2012. Taylor and Francis.
2. Biotechnology: a textbook of industrial microbiology. Crueger and Crueger. 2nd ed.2003.Panima publications.

REFERENCES

1. Prescott LM, Harley JP, Klein DA. Microbiology, Wm. C. Brown Publishers, 2013.
2. Davis BD, Dulbecco R, Eisen HN, Ginsberg HS. Microbiology, Harper Intl. Edition. 2005.
3. Pelczar MJ Jr., Chan ECS, Krieg NR. Microbiology, Tata Mc Graw Hill Publishing Co., 5th edition, 2004.
4. Tortora, Funke, Case, Microbiology – An Introduction, Benjamin-Cummings Publications, 12th edition, 2015.

Name of the Subject	L	P	C
ELECTIVE-II: MEDICAL BIOTECHNOLOGY	4	—	3

UNIT I- CLASSIFICATION OF GENETIC DISEASES

Chromosomal disorders – Numerical disorders e.g. trisomies & monosomies, Structural disorders e.g. deletions, duplications, translocations & inversions, Chromosomal instability syndromes. Gene controlled diseases – Autosomal and X-linked disorders, Mitochondrial disorders.

UNIT II- PATHOGENESIS OF DISEASES

Pathogenesis of diseases like AIDS, Tuberculosis, Malaria, Cancer; Molecular mechanisms involved in pathogenesis, Diagnosis: Conventional, Molecular diagnosis – antibody based, PCR based; Antibiotics: Susceptibility, resistance and recent advances in antibiotics.

UNIT III- EPIDEMIOLOGY AND DISEASE MONITORING

Epidemiology and disease monitoring, Developmental stages in healthcare products: scientific, technical, legal ethical and social implications; Stages: Conceptualisation, R & D, Pre-clinical and clinical trials; production and marketing; Biosafety guidelines and containment facilities; computer aided statistics: STATVIEW, SPSS, STATISTICA, STATSOFT.

UNIT IV- OVERVIEW OF GENE THERAPY

Approaches, Clinical status, technical issues for gene therapy development; Viral & Non-viral vectors for gene therapy, regulations of human gene therapy.

UNIT V APPLICATIONS

Biopharming, DNA vaccines; Edible vaccines; DNA fingerprinting; uses in forensic science, preventive medicine and evolution; Drug targeting, antisense oligonucleotides as drugs, biosensors.

TEXT BOOKS

1. Rehm HJ & Reed G, Biotechnology, Vol. 5a. Recombinant Proteins, monoclonal antibodies and therapeutic genes, Wiley – VCH, 2012.
2. **Banga, K.A** Therapeutic Peptides and Proteins: Formulation, Processing, and Delivery Systems, Third Edition, CRC Press, 2015.

REFERENCES

1. Biotechnology by U. Satyanarayana, 2013.

Name of the Subject	L	P	C
ELECTIVE-II: BIOLOGICAL TREATMENT OF WASTE WATER	4	—	3

UNIT I- ACTIVATED SLUDGE PROCESS-PROCESS ANALYSIS AND SELECTION Characteristics of Activated Sludge (aerobic and anaerobic); Analysis of Data – Mass Balance Analysis, Reactors used in waste water treatment- Up Flow Anaerobic Sludge Blanket (UASB),

Two-stage, Aerobic UNI Tank System (TSU-System, Route Zone Treatment, Submerged Aerobic Fixed Film (SAFF) Reactor, and Fluidized Aerobic Bio – Reactor (FAB).

UNIT II- AEROBIC FIXED-FILM & ANAEROBIC TREATMENT PROCESSES

Biofilm process considerations, Trickling Filters and Biological Towers, Rotating Biological Contactors, Granular – Media Filters, Fluidized – Bed & Circulating Bed- Biofilm reactors. Hybrid Biofilm/suspended growth processes, Anaerobic Processes: Methanogenesis, process chemistry and microbiology, Process kinetics and factors for the design of anaerobic digesters.

UNIT III- ADVANCED WASTE WATER TREATMENT

Technologies used in advanced treatment – Classification of technologies, Removal of Colloids and suspended particles – Depth Filtration – Surface Filtration – Membrane Filtration Absorption – Ion Exchange – Advanced oxidation process - Activated Carbon, Air Stripping, Heavy Metals Removal, Steam Stripping, Chemical Precipitation, and Electrolysis.

UNIT IV- BIOLOGICAL PHOSPHORUS REMOVAL

Nitrification &Denitrification Processes**:** Biochemistry and Physiology of Nitrifying Bacteria, Common process considerations, One – sludge versus two sludge nitrification, Physiology of Denitrifying Bacteria, Tertiary Denitrification, One- sludge denitrification, Normal Phosphorus Uptake into Biomass, Mechanism for Biological Phosphorus Removal, Enhanced Biological Phosphorus Removal by Bacteria and Algae.

UNIT V- ENVIRONMENTAL CONCERNS & RECYCLING OF WASTES

Environmental regulations and technology- Regulatory Concerns, Technology, Laws, regulations and permits- Air, Water, Solid Waste, Environmental Auditing, National Environmental Policy act, Occupational Safety and Health Act (OSHA), Storm Water Regulations, Technology (waste water), Recycling of Industrial wastes : paper, plastics, leather and chemicals.

TEXT BOOKS

1. Wastewater Engineering: Treatment Disposal Reuse by Metcalf & Eddy, 5th edition, 2013.
2. Environmental Biotechnology: Principles and Applications, by Bruce E. Rittmann, 2012.
3. Waste water Engineering Treatment and Reuse: McGraw Hill, G. Tchobanoglous, FI Biston, 2002.

REFERENCES

1. Industrial Waste Water Management Treatment and Disposal by Waste Water McGraw Hill III Edition 2008.
2. Environmental Biotechnology: Principles and Applications by Bruce E. Rittmann, 2012.
3. Biological Wastewater Treatment by C. P. Leslie Grady, Glen T. Daigger, 2011.

Name of the Subject	L	P	C
ELECTIVE-II: GREEN ENERGY TECHNOLOGY	4	—	3

UNIT I- GREEN CHEMISTRY

Introduction to Green Chemistry**:** Principles of Green Chemistry, Reasons for Green Chemistry (resource minimization, waste minimization, concepts), Green reactions solvent free reactions, Catalyzed (heterogeneous/homogeneous) reactions, MW/ Ultrasound mediated reactions, Bio catalysts.

UNIT II- GREEN INNOVATION & SUSTAINABILITY

Criteria for choosing appropriate green energy technologies, life cycle cost; the emerging trends – process/product innovation-, technological/environmental leap-frogging, Eco/green technologies for addressing the problems of Water, Energy, Health, Agriculture and Biodiversity- WEHAB (eco-restoration/ phyto-remediation, ecological sanitation, renewable energy technologies, industrial ecology, agro ecology and other appropriate green technologies), design for sustainability.

UNIT III- GREEN ENERGY AND SUSTAINABLE DEVELOPMENT

The inseparable linkages of life supporting systems, Biodiversity and ecosystem services and their implications for sustainable development: Global warming, Greenhouse gas emissions, Impacts, Mitigation and adaptation; Future energy Systems- clean/green energy technologies, International agreements/ conventions on energy and sustainability - United Nations Framework Convention on Climate Change (UNFCC), sustainable development.

UNIT IV- GREEN NANOTECHNOLOGY

Nano particles preparation techniques, Greener Nano synthesis: Greener Synthetic Methods for Functionalized Metal Nano particles, Greener Preparations of Semiconductor and Inorganic Oxide Nano particles, green synthesis of Metal nanoparticles, Nanoparticle characterization methods, Green materials: biomaterials, biopolymers, bioplastics, and composites. Nanomaterials for Fuel Cells and Hydrogen; Generation and storage, Nanostructures for efficient solar hydrogen production, Metal Nanoclusters in Hydrogen Storage Applications, Metal Nanoparticles as Electro-catalysts in Fuel Cells, Nanowires as Hydrogen Sensors

UNIT V- GREEN MANAGEMENT

Definition: Green techniques and methods, Green tax incentives and rebates (to green projects and Companies), Green project management in action, Business redesign, Eco-commerce models, Environmental reporting and ISO 14001 Climate change business and ISO 14064, Green financing, Financial initiative by UNEP, Green energy management, Green product management.

TEXT BOOKS

1. Energy and the Environment, 2nd Edition, John Wiley, 2006, ISBN: 9780471172482; Authors: Ristinen, Robert Kraushaar, Jack J. A Kraushaar, Jack P. Ristinen, Robert A., Publisher: Wiley, Location: New York, 2006.
2. Energy, Ecology and the Environment, Academic Press Inc, B. R Wilson & W J Jones, 2005.

REFERENCES

1. Renewable energy and environment: a policy analysis for India, Tata McGraw Hill, Ravindranath, N. H.; Rao, K. U.; Natarajan, B. 2002.
2. Fowler, J.M., Energy and the Environment, 2nd Ed., McGraw Hill, New York, 2012.

Name of the Subject	L	P	C
IMMUNOLOGY & BIOPROCESS LAB	-	3	2

1. Bleeding, Serum separation, Storage.
2. Antibody titre by ELISA method.
3. Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion.
4. Blood smear identification of leucocytes by Giemsa stain
5. WIDAL Test
6. latex agglutination
7. Monoclonal antibody production/ IgG Purification from serum/ IgY Purification from Chicken egg.
8. SDS-PAGE.
9. Extraction of proteins by Two-phase separation (PEG 3000 & Ammonium sulphate or Organic solvents)
10. Dialysis.
11. Ion exchange chromatography.
12. Gel filtration chromatography.

SEMESTER-II

Name of the Subject	L	P	C
RECOMBINANT DNA TECHNOLOGY	4	—	3

UNIT I- BASIC CONCEPTS AND CLONING VECTORS IN GENETIC ENGINEERING

Restriction Enzymes, DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase, Labeling of DNA: Nick translation, Random priming. Plasmids, Bacteriophages, M13 mp vectors, PUC19, Phagemids, Lambda vectors, Cosmids, Artificial chromosome vectors (YACs; BACs), Animal Virus derived vectors-SV-40, Plant based vectors: Ti as vectors, Yeast vectors, Shuttle vectors.

UNIT II- CLONING METHODOLOGIES

Ligation techniques: Cohesive and blunt end ligation; Linkers, Adaptors, Homopolymeric tailing, Southwestern and Far-western cloning, Gene transfer techniques: Cacl2 transformation, Electroporation, Liposome mediated transformation, Microinjection, Biolistic method. Selection of clones, Blue white screening, Colony in-situ hybridization, Insertional Inactivation, Eukaryotic Screening: Thymidine kinase method, Green fluorescent protein, Construction of libraries: c DNA and genomic libraries, cDNA and genomic cloning, Jumping /hopping libraries, Protein-protein interactive cloning and Yeast two hybrid system.

UNIT III- MANIPULATION OF GENE EXPRESSION AND HYBRIDIZATION TECHNIQUES

Promoter Selection, Ribosomal Binding Sites, Translational signals, Fusion Proteins, Codon Selection, O_2stress,tandemrepeats,proteinfolding,metabolic load, Protein purification, His-tag, GST-tag, Inclusion bodies-Methodologies to reduce formation of inclusion bodies, Northern, Southern, Western Blotting, Fluorescence, In situ hybridization, Heterologous protein production in eukaryotes-vectors, markers, promoters.

UNIT IV- PCR AND ITS APPLICATIONS

Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, hot start PCR, colony PCR, cloning of PCR products, PCR in gene recombination, Deletion; addition, PCR in molecular diagnostics, Viral and bacterial detection, PCR based, mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test).

UNIT V- SEQUENCING METHODS AND GENE TECHNOLOGIES

DNA sequencing –chemical cleavage and Sanger's di-deoxy methods, Automated DNA sequencing, RNA sequencing, Site-specific and oligonucleotide directed mutagenesis, genetic diagnosis. DNA finger printing and their applications, gene therapy: Somatic cell gene therapy, Germline Gene therapy.

TEXT BOOKS

1. B. R. Glick and J. J. Pasternak, Molecular Biotechnology: Principles and Applications of Recombinant DNA, 3rdEdition, ASM Press, 2003.
2. S. Primrose, R. Twyman, B. Old, and G. Bertola, Principles of Gene Manipulation and Genomics, 7thEdition, Blackwel Publishing Limited, 2006.

REFERENCES

1. B. Alberts, A. Johnson, J. Lewis, M. Raff, K and R. P. Walter, Molecular Biology of the Cell, 4th Edition, Garland, 2002.
2. J. Hammond, P. Mc Garvey and V. Yusibov, Plant Biotechnology: New Products and Applications, 1stedition, Springer, 2010

Name of the Subject	L	P	C
METABOLIC ENGINEERING	4	—	3

UNIT I- INTRODUCTION

Basic concepts of Metabolic Engineering, Overview of cellular metabolism, Different models for cellular reactions, induction , Jacob Monod model and its regulation, Differential regulation by enzymes, Feedback regulation, Feedback repression, Catabolite Repression, optimization and control of metabolic activities. Metabolic pathway manipulations to improve fermentation, the modification of existing - or the introduction of entirely new - metabolic pathways.

UNIT II- PRIMARY METABOLITES

Amino acid synthesis pathways and its regulation at enzyme level and whole cell level, Alteration of feedback regulation, Limiting accumulation of end products. Engineering for L-Lysine Production by Corynebacterium glutamicum-Metabolic Engineering of Pentose Metabolism for Ethanol Production.

UNIT III- SECONDARY METABOLITES

Regulation of secondary metabolite pathways, precursor effects, prophase, idiophase relationship, Catabolite regulation by passing control of secondary metabolism, producers of secondary metabolites, applications of secondary metabolites in pharmaceutical industries, food, agriculture.

UNIT IV- MATERIAL BALANCES AND DATA CONSISTENCY

Material Balances and Data Consistency: Comprehensive models of cellular reactions; stoichiometry of cellular reactions, reaction rates, dynamic mass balances, yield coefficients and

linear rate equations measurement errors.

UNIT V- METABOLIC FLUX

Metabolic Flux Analysis: Theory and applications - metabolic flux analysis of citric acid fermentation, Experimental determination method of flux distribution, optimization and control of metabolic flux, Integrating Methodologies of Molecular Breeding and bioprocess systems engineering, fundamentals of Metabolic control analysis: Control coefficients and the Summation Theorems, Elasticity Coefficients and the Connectivity Theorems, Generalization of MCA Theorems.

TEXT BOOKS

1. Wang.D. I.C Cooney C.L., Demain A.L., Dunnil. P. Humphrey A.E. Lilly M.D., Fermentation and Enzyme Technology, 1st edition John Wiley and sons 1980.
2. Stanbury P.F., and Whitaker A., Principles of Fermentation Technology, 2nded, Butterworth-heinemann, 1999.

REFERENCES

1. Yu Matsuoka and Kazuyuki Shimizu 13C-Metabolic Flux Analysis and Metabolic Regulation, Chemical Biology, 1st Ed, Woodhead Publishing 2013.
2. David T. Dennis, David B. Layzell, Daniel D. Lefebvre, David H. Turpin, Plant Metabolism 2nd edition Prentice Hall College, 2009

Name of the Subject	L	P	C
BIOREACTOR DESIGN	4	—	3

UNIT I- INTRODUCTION

Bioreactor function, utility, types of Bioreactors. Modes of Bioreactor operations, Main components of the Bioreactor and their function. Introduction Methods of Aeration, Surface Aeration, shake flasks, Mechanical stirred Bioreactors, Enzyme catalysis in CSTR. Cell death in batch reactor, endogenous metabolism, maintenance, product and substrate inhibition on chemostat.

UNIT II- BIOREACTORS AND DESIGN FEATURES

Batch reactor, chemostat CSTR, Plug flow Reactor, Fed batch Reactor, Bubble column, Bubble generation at an orifice, bubble coalescence and breakup, gas holdup, interfacial area, immobile and mobile gas liquid interface, regimes of bubbles, design of bubble columns, Cascade Reactor, air lift reactor, Fluidized bed bioreactors, trickle bed reactors, immobilized bioreactors, recycle bioreactors.

UNIT III- GAS-LIQUID MASS TRANSFER IN CELLULAR SYSTEMS

Basic mass transfer concepts, solubility of gases (O_2, CO_2) in biological media, mass balances for two- phase Bioreactor. Mass transfer-introduction to mass transfer between phases, mass transfer in porous solids, quantifying mass transfer, mass transfer & experimental design, oxygen transfer process, factor effecting kLa, Determination of oxygen transfer rates- static method, Dynamic method, Chemical method and Electrochemical method, correlations with kLa in Newtonian and non-Newtonian liquid.

UNIT IV- MASS TRANSFER

Mass transfer for freely rising or falling bodies, forced convection mass transfer, Mass transfer in agitated tanks ,power requirements for sparged and agitated non agitated tanks for Newtonian and Non Newtonian fluid, mass transfer across free surfaces, Heat transfer correlations thermal death kinetics of microorganisms, batch and continuous heat sterilization, sterilization of liquid media, filter sterilization of liquid media, Air. Design of sterilization equipment batch and continuous.

UNIT V- AERATION AND AGITATION IN ANIMAL CELL BIOREACTORS

Introduction, cell damage in animal cell bioreactors, shear damage, bubble damage, methods of minimizing cell damage. Laminar & Turbulent flow in stirred tank bioreactors, turbulent eddies, kolmogrov eddy size, preventing vortex formation, off centre impellers, Baffles. Control of bioreactor, strategy, online and offline monitoring of bioreactors, computerized bioprocess control, scaling up and scale down of mass transfer equipment and bioprocess, Direct regulatory control and cascade control mechanism. Bioprocess design considerations for plant and animal cell cultures.

TEXT BOOKS

1. Bailey JE, Ollis DF, Biochemical Engineering fundamentals, 2nded, Tata McGraw-Hill Education 2010.
2. Blanch HW and Clark DS, Biochemical Engineering Marcel Decker, 2nded, CRC Press, 1997.
3. DG Rao, Introduction to Biochemical Engineering, 2nded, Tata Mc Graw Hill, 2010.

REFFERENCES

1. Wiseman A, Handbook of Enzyme Biotechnology, 1sted, Pharma Med Press/BSP Books Year of Publication 2010.
2. Moser A, Bioprocess technology, kinetics and reactors; 1sted, Springer, Year of Publication 2011.
3. Schugerl K: Bellagart K H; Bioreaction Engineering, Modeling and control, 1st edition, Springer, year of Publication 2003
4. Pauline M DORAN, Bioprocess engineering, 2nded, Elsevier India, Year of Publication 2012.

Name of the Subject	L	P	C
STEMCELL TECHNOLOGY	4	—	3

UNIT I- STEM CELLS INTRODUCTION

Definition and basics of stem cells, Classification of stem cells different types of stem cells- Human embryonic stem cells, Adult stem cells. Sources of stem cells - Fetus and various adult tissues – Advantages of stem cells. Blastocyst culture- Various stages of embryonic development. Cryopreservation of stem cells – Conventional slow-freezing method and Vitrification method. Properties of stem cells - self renewel, clonality and plasticity, Pluripotent nature of stem cells - Extrinsic and Intrinsic factors, Characterization of human embryonic stem cells – Expression of cell surface marker, Karyotyping.

UNIT II- HUMAN EMBRYONIC STEM CELLS

HESCs- Properties, Applications, Derivation and propagation of human embryonic stem cells Sub-cloning and controlled differentiation of human embryonic stem cells, In vitro and in vivo differentiation of human embryonic stem cells, Feeder free culture of human embryonic stem cells, Application of stem cells.

UNIT III- SOMATIC CELL NUCLEAR TRANSFER

Procedure of SCNT, Reproductive cloning, Therapeutic cloning, Interspecies cloning, Applications, Controversies of SCNT, Limitations of cloning – Hurdles to improve the efficiency of therapeutic cloning, Stem cell research and ethics – translational medicine ethics.

UNIT IV- ADULT STEM CELLS

Hematopoietic SC - Basics, Development and Regulation, Clinical Application of HSC – Gene Therapy – using hematopoietic stem cells HSC for Leukemia Mesenchymal SC (MSC) - Differentiation and Identification, Characteristics of mesenchymal stem cells, Clinical medicine, Induced pluripotent SC – History, Reprogramming factors & Mechanisms. Similarities between iPSC's and ESCs, Therapeutic potential

UNIT V- SIGNALLING PATHWAYS IN STEM CELLS

Skeletal muscle stem cells- Plasticity, Activation and Differentiation; Liver stem cells – Organization, activation and functions; Tumor stem cells – Basics differences and Similarities of cancer stem cells and stem cells, Cancer stem cell signaling – NOTCH pathway, Wnt signaling pathways in hematopoietic stem cells, Stem cell therapies in animal models, Use and benefits of stem cell for human beings.

TEXT BOOKS

1. Essentials of stem cell biology; R Lanza, J Gearhart, B Hogan, D Melton, R Pedersen 2nd Edition 2009
2. Ariff Bongso, EngHin Lee -Stem Cells: From Bench to Bedside, 2nd Edition, World Scientific Publishing Company, 2010.
3. C S Potten - Stem Cells; 1st edition; Academic Press, 2008.

REFERENCES

1. Pluripotent Stem cell biology _ Advances in Mechanisms, Methods and Models; Craig S. Atwood and Sivan Vadakkadath Meethal, Intech publishers, 2014
2. Nagy A, Gertenstein M,Vintersten K, Behringer R- Manipulating the Mouse Embryo , 1st edition, New York: Cold Spring Harbor Press, 2003
3. Scott F. Gilbert, Susan Singer- Developmental biology, 8th edition, Sinauer Associates Inc, 2006.

Name of the Subject	L	P	C
ELECTIVE-III: BIOPHARMACEUTICAL TECHNOLOGY	4	—	3

UNIT I- BIOPHARMACEUTICALS INTRODUCTION

An overview Pharmaceutical & Biopharmaceutical technology, current status & future prospects, Biopharmaceuticals: Description, pharmacology, formulation, pharmaceutical concern, clinical use recombinant vaccines, edible vaccines, Production of pharmaceuticals by genetically engineered cells- hormones, interferon's- Microbial transformations for production of important pharmaceuticals -alkaloids, steroids and semi-synthetic antibiotics.

UNIT II- DRUG DEVELOPMENT IN PHARMACEUTICAL PROCESS

Drug discovery, rational drug design, Delivery of biopharmaceuticals, Pre-clinical trials, and clinical trials, the role of regulatory authorities. Strategies in the search for new lead drugs/compounds: Improvement of existing drugs, Pros & cons of therapeutic copies, Systematic screening, including high throughput screening, Exploitation of biological information and planned research & rational approach.

UNIT III- PROTEOMICS IN DRUG DEVELOPMENT

Role of Proteomics in Drug Development - Diagnosis of disease by Proteomics - Separation and identification techniques for protein analysis- Development of antibody based protein assay for diagnosis, Disease Diagnostic and Therapy - ELISA and hybridoma technology - DNA vaccine - Gene Therapy, Toxico-genomics, Techniques for development of new generation antibiotics - Protein engineering, drug design, drug targeting.

UNIT IV- PRODUCTION AND FORMULATION OF BIOTECH COMPOUNDS

Cultivation, production and purification, downstream processing, Excipients, microbiological consideration, shelf life, Doses, Therapeutic response, Route of drug administration, Delivery system, Proteins based drugs: Source, structure, folding, stability, analytical technique, purification, characterization, therapeutic protein, pharmacokinetic and pharmacodynamics of peptides and proteins. Absorption, distribution, metabolism, elimination, protein binding, Protein engineering peptidomimetics.

UNIT V- POST PRODUCTUCTION HANDLING AND DELIVERY

Preparation, storage, handling, administration, Rationale and basic principles, physiologic and mechanistic approaches, approaches using devices, molecular approaches, Nutraceutical: Water soluble and fat soluble vitamins, their functions, GMP, GLP and clean room concept, Role of US-FDA in biotech based industry.

TEXT BOOKS

1. Bala subramanium, Concept in Biotechnology, 2nd Edition University Press, 2004.
2. Gray Walsh & B. Murphy, Biopharmaceuticals and industrial prospective, 1st edition, Kluwer publishers, 2000.
3. Gray Walsh, Wiley John &Sons, Biopharmaceuticals, 1st edition, Inc publisher, 2003.
4. Pharmaceutical Biotechnology by Dann, J.A, Crommelin & Robert D., Sindelar, Taylor & Francis, 3rd edition, Informa Healthcare, 2007.

REFERENCES

1. Epenetos A.A, Monoclonal antibodies: applications in clinical oncology, 1st edition, Chapman and Hall Medical, 2006.
2. Camille G. Wermuth, The practice of Medicinal chemistry, 3 edition, Academic Press, May 2, 2011.

Name of the Subject	L	P	C
ELECTIVE-III: MEMBRANE BIOLOGY AND SIGNAL TRANSDUCTION	4	—	3

UNIT I- MEMRANE STRUCTURE

Structure of biological membranes, lipids and lipid modification, membrane proteins, transmembrane proteins, pumps, channels, transporters, receptors.

UNIT II- TRANSPORT OF PROTEINS

Passive transport – facilitated diffusion, uniport, symport, antiport. Active transport. Artificial membrane –liposome and erythrocyte ghost.

UNIT III- CELL CYCLE REGULATION

Regulation of mitosis, Meiosis, Cell cycle checkpoints, Protein modifications and intracellular transport, glycosylation, vesicular transport, receptor mediated endocytosis, lysosomes, organelle biogenesis, Protein modifications and intracellular transport.

UNIT IV- SIGNAL TRANSDUCTION

Detailed molecular mechanisms, Nerve cells, ion channels, synapse, Ca^{++} regulated events, Immunity and host pathogen interactions, actin-myosin cytoskeleton, extracellular matrix, stem cells and cloning.

UNIT V- SIGNALLING PATHWAYS

G Protein Coupled Receptor Signaling, Receptor and Non-Receptor Tyrosine Kinases, Serine / Threonine Kinase Coupled Receptors, Mitogen-Activated Protein Kinases, Phospholipid Mediated Signaling, Nuclear Receptors, Ions and ion channels, Redox Signaling.

TEXT BOOKS

1. Signal Transduction. 2014. Cold Spring Harbor Laboratory Press. Lewis Cantley, Tony Thunter, Richard Sever and Jeremy Thorner.
2. Molecular Biology of the Cell. 2014. Garland Science. Bruce Alberts and Alexander Johnson
3. Cellular Signaling Processing. 2008. Garland Science. Friedrich Marks, Ursula Kling muller and Karin Muller-Decker.

REFERENCES

1. Biochemistry of Signal Transduction and Regulation. 2014. Wiley-VCH. Gerhard Krauss. 2009
2. Signal Transduction. Academic Press. Bastien D. Gomperts, Ijsbrand M. Kramer and Peter E. R. Tatham. 2015

Name of the Subject	L	P	C
ELECTIVE-III: BIOFUELS	4	—	3

UNIT I- INTRODUCTION TO BIOETHANOL PRODUCTION

Historical Development of Bioethanol as a Fuel, Starch as a Carbon Substrate for Bioethanol Production, The Promise of Lignocellulosic Biomass, Thermodynamic and Environmental Aspects of Ethanol as a Biofuel, Effects on emissions of greenhouse gases and other pollutants,

Ethanol as a First-Generation Biofuel: Present Status and Future Prospects Chemistry, Biochemistry, and Microbiology of Lignocellulosic Biomass, Biomass as an Energy Source.

UNIT II- CELLULASES AND ITS ROLE IN ETHANOL PRODUCTION

Cellulases: Biochemistry, Molecular Biology, and Biotechnology, Enzymology of cellulose degradation by cellulases, Cellulases in lignocellulosic feedstock processing, Molecular biology and biotechnology of cellulase production, Hemicellulases: New Horizons in Energy Biotechnology, A multiplicity of hemicellulases, Hemicellulases in the processing of lignocellulosic biomass, Lignin-Degrading Enzymes as Aids in Saccharification,

UNIT III- BIOTECHNOLOGY OF BIOETHANOL PRODUCTION FROM LIGNO-CELLULOSIC FEEDSTOCKS

Traditional Ethanologenic Microbes, Yeasts, Bacteria, Metabolic Engineering of Novel Ethanologens, Comparison of industrial and laboratory yeast strains for ethanol production, Improved ethanol production by naturally pentose-utilizing yeasts, Assembling Gene Arrays in Bacteria for Ethanol Production, Metabolic routes in bacteria for sugar metabolism and ethanol formation, Genetic and metabolic engineering of bacteria for bioethanol production

UNIT IV- BIOCHEMICAL ENGINEERING AND BIOPROCESS MANAGEMENT FOR FUEL ETHANOL

Biomass Substrate Provision and Pretreatment, Wheat straw — new approaches to complete saccharification, Switchgrass, Corn stover, Softwoods, Sugarcane bagasse, Other large-scale agricultural and forestry, biomass feedstocks, Fermentation Media and the "Very High Gravity" Concept, Fermentation media for bioethanol production, Highly concentrated media developed for alcohol fermentations, Fermenter Design and Novel Fermenter Technologies, Continuous fermentations for ethanol production, Fed-batch fermentations, Immobilized yeast and bacterial cell production designs, Contamination events and buildup in fuel ethanol plants

UNIT V- GENETIC MANIPULATION OF PLANTS FOR BIOETHANOL PRODUCTION

Bioengineering increased crop yield, Optimizing traits for energy crops intended for biofuel production, Genetic engineering of dual-use food plants and dedicated energy crops, Vegetable oils and chemically processed biofuels, Biodiesel composition and production processes, Biodiesel economics, Energetics of biodiesel production and effects on greenhouse gas emissions and Issues.

TEXT BOOKS

1. David M. Mousdale, Biofuel-Biotechnology, Chemistry, and sustainable Development, 1st Ed., CRC Press Taylor & Francis Group, 2008.
2. Ayhan Demirbas, Green Energy and Technology, Biofuels, Securing the Planet's Future Energy Needs, 1st edition, Springer, 2009.

REFERENCES

1. P.M. Doran, Bioprocess Engineering Principles, 2nd edition, acadamic press, 2012

Name of the Subject	L	P	C
ELECTIVE-IV: MOLECULAR MODELLING and DRUG DESIGN	4	—	3

UNIT I- QUANTUM MECHANICS & CONCEPTS IN MOLECULAR MODELING

Introduction – coordinate systems – potential energy surfaces – introduction to quantum mechanics – postulates – Schrodinger wave equation - Time independent Perturbation theory – hydrogen molecule – Born-Oppenheimer approximation, Huckel molecular orbital theory

UNIT II- MOLECULAR MECHANICS AND ENERGY MINIMIZATION

Empirical force field models – Bond stretching – angle bending – torsional term – Nonbonding interactions – The hydrogen bond, hydrophobic effect and solvation energy, Introduction to Force fields. – derived and non-derived energy minimization method - Parameterization of a force field, polarizable force fields, steepest descent method – conjugate gradient method.

UNIT III- MOLECULAR DYNAMICS & MOLECULAR DOCKING

Introduction to Molecular Dynamics, Density Functional Theory, Molecular Dynamics at Constant Temperature and Pressure. Metropolis Method. Monte Carlo Simulation of Molecules. Introduction to molecular docking, Rigid docking, Flexible docking, manual docking, Scoring Functions, Simple Interaction Energies

UNIT IV- HOMOLOGY MODELING & PHARMACOPHORE

Comparative modeling of proteins – comparison of 3D structure – Homology, steps in homology modeling, tools, databases, side chain modeling, loop modeling. Pharmacophores - Validation and Usage, Automated Pharmacophore Generation Methods, Pharmacophores for Hit Identification, Pharmacophores for Human ADME/Tox-related Proteins.

UNIT V- DRUG DESIGN

Stages of drug discovery, identification, validation and diversity of drug targets, Molecular recognition in Ligand- Protein Binding. Structure – Based and Ligand – Based Drug Design. Binding site identification. Forces involved in Drug- Receptor Interaction. Receptor polymorphism

TEXT BOOKS

1. A. R. Leach - Molecular Modeling Principles and Application, 2nd edition, Longman Publications, 2001
2. Textbook of Drug Design and Discovery, Fourth Edition, Author: Povl Krogsgaard-Larsen, Ulf Madsen, Kristian Stromgaard. 2009

3. Modern methods of drug discovery: 1st edition. Hillisch, A., and Hilgenfeld, R. E. J. Wood. 2003

REFERENCES

1. Modern Biopharmaceuticals: Design, Development and Optimization, 1st edition, Editor(s): JorgKnablein. Wiley – VCH, 2005.
2. Satya Prakash Gupta, QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008

Name of the Subject	L	P	C
ELECTIVE-IV: FOOD BIOTECHNOLOGUY	4	—	3

UNIT I- PRESERVATION TECHNOLOGIES

Role and significance of microorganisms in foods. Intrinsic and Extrinsic Parameters of Foods that affect microbial growth, Role of microorganisms in manufacture and spoilage of fermented products, Cereals, Pulses, Nuts and Oil seeds, Fruits and Fruit products, Vegetables and Vegetable Products, Fish and Meat products, Probiotics, prebiotics and synbiotics.

UNIT II- PRODUCTION TECHNOLOGIES

Mechanism of enzyme functions and reactions in process techniques: Enzyme in bakery and cereal products, Enzymes in fat/oil industries, Cold active enzymes in Food processing, Starch and sugar conversion process or baking by amylases, cheese making by proteases, Utilization of food waste for production of valuables: whey, molasses, starch substances and other food wastes for bioconversion to useful products.

UNIT III- TECHNOLOGIES FOR IMPROVED PROCESSES

Technologies used for microbial production of food ingredients, production of carotenoids by gene combination, microbial biotechnology of natural food flavor and color production and polysaccharides in foods, Biotechnology of non-nutritive sweeteners, Biotechnological approach to improve nutritional quality and shelf life of fruits and vegetables, Biotechnological approaches (enzymes/ proteins & effective processing parameters) towards reducing / modifying anti-nutritional factors in foods and food ingredients, Anti-nutritional factors in cereals and legumes.

UNIT IV- APPLICATIONS OF BIOTECHNOLOGY IN TESTING

Testing Application of microbial molecular techniques to food system, Impact of biotechnology on microbial testing of food, current/traditional methodology and new approaches -use of gene probes, RDT, Bioluminescence.

UNIT V- QUALITY AND SAFETY ASPECTS OF FOODS DERIVED FROM BIOTECHNOLOGY

Safety and applicability of modified foods and food ingredients, Safety evaluation of genetically engineered enzyme/novel food products, International Aspects of the quality and safety assessment of foods derived by modern biotechnology.

TEXT BOOKS

1. Angold, Beech and Taggart, Food Biotechnology, 1st edition, Cambridge University Press New York, 1989.
2. Kalidas S., Gopinadhan P., Anthony P., Robert E. L, Food Biotechnology,2nd edition,CRC Press, New York, 2006.

REFERENCES

1. Roger, A., Gordon, B. and John, T, Food Biotechnology, 1st ed, Cambridge University Press, New York, 2010
2. W.C. Frazier, Food Microbiology,2nd edition, McGraw Hill Book Company, New York, 2007.

Name of the Subject	L	P	C
ELECTIVE-IV: BIO NANOTECHNOLOGY	**4**	**-**	**3**

UNIT I- INTRODUCTION

Introduction to Nano Biotechnology**:** Background and Definition of Nano biotechnology-Significance. Supramolecular Chemistry: Definition and examples of main intermolecular forces used in supramolecular chemistry. Self-assembly processes in organic systems. Main supra molecular structures.

UNIT II- NANOSCALED BIOMOLECULES

Chemical approaches to nano structured materials-Molecular Building Blocks to Nanostructures. Nano scaled Biomolecules-Nucleic Acids and Proteins. Chemical Synthesis of Artificial Nanostructures. Structural Control to Designed Properties and Functions. Molecular nano scale engineered devices.

UNIT III- NANOFABRICATION

Nanofabrication: Introduction, Basic techniques, MEMS fabrication techniques, nanofabrication techniques-Equipment and processes needed to fabricate nano devices and structures such as bio-chips.

UNIT IV- NANO ENGINEERING SYSTEMS

Biologically-Inspired nanotechnology basic biological concepts and principles for the development of nano engineering system.

UNIT V- INSTRUMENTATION

Instrumentation for nanoscale characterization, Instrumentation required for characterization of properties on the nanometer scale, the technique, with an emphasis on measurements in the nanometer range.

TEXT BOOKS

1. Jean-Marie Lehn, Supramolecular Chemistry, 1st edition, Wiley VCH, 2006.
2. Ramesh Malothu, Nanotechnology: Biomedical Applications,Siri Publicatins,2015
3. Jonathan Steed & Jerry Atwood, Supramolecular Chemistry, 2nd edition, John Wiley & Sons, 2009.
4. Jacob Israelachvil, Intermolecular and Surface Forces, 3rd edition, Academic Press, London, 2011.

REFERENCES

1. Good Sell, BioNano Technology, 1st edition, Wiley Liss Publications, 2004.
2. Charles. P.Poole Jr and Frank J. Owens Introduction to Nanotechnology, 1st edition, Wiley India Pvt Ltd, 2003.

Name of the Subject	L	P	C
r-DNA TECHNOLOGY & BIO INFORMATICS LAB	-	3	2

1. Isolation of genomic DNA from bacteria.

2. PCR

3. Separation of DNA by agarose gel electrophoresis.

3. Isolation of plasmid from E.coli and gel analysis.

4. Restriction digestion of vector.

5. Ligation of restriction fragments.

6. Transformation.

7. Recombinant Plasmid isolation from transformants and confirmation by PCR.

8. Identification of biologically relevant protein using PSI – BLAST.

9. Database similarity search using WU – BLAST.

10. Genome annotation using ARTEMIS.

11. Protein homology modeling by Swiss Model.

12. Construction of phylogenetic tree by phylodraw.