CURRICULUM

VI SEMESTER

S. No.	Subject Name	L	P	M
Theory				
1.	Bioprocess Engineering	**4**	**0**	**100**
2.	Genomics and Proteomics	**4**	**0**	**100**
3.	Principles of Chemical Engineering	**4**	**0**	**100**
4.	* Elective - I	**4**	**0**	**100**
5.	Nanobiotechnology	**4**	**0**	**100**
6.	Environmental Biotechnology	**4**	**0**	**100**
Practicals				
1.	Bioprocess Engineering	**0**	**3**	**100**
2.	Chemical Engineering	**0**	**3**	**100**

* Elective – I

Stem Cell Biology
Metabolic Engineering
Material Sciences and Technology

BIOPROCESS ENGINEERING

AIM

This course aim to develop the skills of the students in the area of Bioprocess Engineering. This will help the students to undertake project in Bioprocess Technology.

OBJECTIVES

- To study the historical development of Bioprocess technology, Design and Construction of Fermentors
- To study the kinetics of Microbial growth and Product formation
- To strengthen the knowledge on Design operation and Stability analysis of Bioreactors
- Bioreactor Scale-up
- Methods of Online and Offline monitoring of Bioprocess.

UNIT I

INTRODUCTION TO BIOPROCESS AND FERMENTATION

Historical development of Bioprocess Technologies, Outline of an integrated bioprocess and the various (Upstream, Downstream) unit operations involved in bioprocess, Overview of fermentation industry, General requirements of fermentation process, Basic configuration of fermentor and ancillaries, Main parameters to be monitored and controlled in fermentation processes.

UNIT II

KINETICS OF MICROBIAL GROWTH AND PRODUCT FORMATION

Modes of operation – Batch, Fed batch and Continuous culture processes, Simple unstructured kinetic models for microbial growth, Monod model, Substrate and product inhibition on cell growth and product formation, Stirred tank reactor – non-ideality, RTD and stability analysis. Modelling of non ideal behaviour in bioreactors, Tanks in series and dispersion models – Application to design of continuous sterilizers.

UNIT III

DESIGN AND ANALYSIS OF BIOREACTORS

Design and operation of Bioreactors – Immobilized enzyme bioreactors – Design and analysis of Packed bed and Membrane bioreactors – Design and operation of Novel bioreactors – Airlift loop reactor, Fluidized bed and Trickle bed bioreactors, Stability analysis of bioreactors.

UNIT IV

BIOREACTOR SCALE-UP

Regime analysis of bioreactor processes, Oxygen mass transfer in bioreactors – Microbial oxygen demands. Methods for the determination of Mass transfer coefficients, Mass transfer correlations, Scale-up criteria for bioreactors based on oxygen transfer, Power consumption and Impeller tip speed.

UNIT V

MONITORING OF BIOPROCESSES

Online data analysis for measurement of important physico-chemical and biochemical parameters, Methods of online and offline Biomas estimation, Microbial colorimetry, Flow injection analysis for measurement of substrates, Products and other metabolites.

TEXT BOOKS

1. Shule and Kargi, 1992. Bioprocess Engineering. *Prentice Hall*.
2. James E. Bailey and David F. Ollis, 1986. Biochemical Engineering Fundamental. 2nd Edn. *Mc Graw Hill*.

REFERENCES

1. Trevan, Boffey, Goulding and Stanbury. Biotechnology. *Tata Mc Graw Hill Publishing Co*.
2. Anton Moser. Bioprocess Technology, Kinetics and Reactors. *Springer Verlag*.
3. James M. Lee. Biochemical Engineering. *PHI, USA*.
4. Atkinson. Handbook of Bioreactors.
5. Harvey W. Blanch, Douglas S. Clark. Biochemical Engineering. *Marcel Decker Inc*.

GENOMICS AND PROTEOMICS

AIM

To develop advance level skills in the areas of Genomics and Proteomics.

OBJECTIVES

To emphasize the concepts of

- Genome organisation
- Mapping techniques
- Micro array techniques
- 2DE and Mass spectrometry
- Application of Proteomics

UNIT I

OVERVIEW OF GENOMES OF PROKARYOTES, EUKARYOTES AND HUMAN

Organisation of genes, Coding and non-coding chromosomes and high order structures, Genome relatedness, Introduction of genomics.

UNIT II

MAPPING TECHNIQUES

Mapping strategies, Maps – Physical maps – Comparative map, Integrated map, Restriction map, Top down and bottom up approach, linking and jumping of clones, STS maps, Cytogenetic mapping techniques – Linkage map and Transcript map, Genome sequencing, Human Genome Project.

UNIT III

FUNCTIONAL GENOMICS

Gene identification and prediction, Annotation, ORF and functional prediction, Gene expression and micro arrays, Substractive DNA library screening, differential display and representational difference analysis, SAGE.

UNIT IV

PROTEOMICS TECHNIQUES

Edman protein microsequencing, Proteome analysis, 2D gel electrophoresis, Metabolic labeling, Detection of protein on SDS gels. Mass spectrometry – Principles of MALDI – TOF, Tandem MS – MS, Peptide mass finger printing.

UNIT V

PROTEIN PROFILING AND APPLICATION OF PROTEOMICS

Protein – protein interaction, Post translational modification, Proteomics in drug discovery.

TEXT BOOKS

1. Rastogi, S.C., Mendiratta, N. and Rastogi, P. Bioinformatics Methods and Applications.
2. Cantor and Smith, 1999. Genomics. *John Wiley and Sons*.
3. Pennington and Dunn, 2001. Proteomics. *BIOS Scientific Publishers*.
4. Andreas D. Baxevanis and Francis Oueliette, B.F. Bioinformatics A Practical Guide to the Analysis of Genes and Proteins. *John Wiley and Sons Inc*.
5. Ignacimuthu, S., 2005. Basic Bioinformatics. *Narosa Publishing House*.
6. Westhead, D.R., Parish, J.H. and Twyman, R.M., 2003. Instant Notes Bioinformatics. 1st Edn., *Viva Books Private Limited*.

REFERENCES

1. Liebler, 2002. Introduction to Proteomics. *Humana Prem*.
2. Hunt and Livesey, 2000. Functional Genomics. *Oxford University Press*.
3. Primrose and Twyman, 2003. Principles of Genome Analysis and Genomics. *Blackwell Publishing Co*.
4. Suhai, 1999. Genomics and Proteomics. Functional and Computational Aspects. *Pienum Publications*.
5. David W. Mount, 2001. Bioinformatics, Sequence and Genome Analysis. *Cold Spring Harbor Laboratory Press*.

PRINCIPLES OF CHEMICAL ENGINEERING

AIM

To make the students knowledgeable and help them to understand the principles of stoichiometry in Biochemical processes.

OBJECTIVES

To emphasize the concepts of

- Mass and energy conservation
- Laws of thermodynamics
- Principles of fluid mechanics
- Pumps and compressors.

UNIT I

OVERVIEW OF PROCESS INDUSTRY

Mass and energy conservation, SI unit, Conversion factors, Applied mathematics for experimental curve fitting, Numerical differentiation, Integration.

UNIT II

MATERIAL BALANCES

Overall and component balances, Material balances without and with chemical reactions, Recycle and bypass, Humidity calculation.

UNIT III

FIRST AND SECOND LAW OF THERMODYNAMICS

Energy Balances – Sensible heat – Latent heat, Vapour pressure, Steady and unsteady state calculations.

UNIT IV

FLUID MECHANICS

Fluids, Fluid statics and application in chemical engineering, Fluid flow; Laminar, Turbulent pressure drops, Compressible fluid flow concepts.

UNIT V

FLOW THROUGH PACKED COLUMNS

Fluidization, Centrifugal and piston pumps, Characteristics, Compressors, Work.

TEXT BOOKS

1. Bhatt, B.I. and Vora, S.M., 1977. Stoichiometry. 3rd Edition. Tata McGraw Hill.
2. Anantharaman. Process Calculation.
3. Hougen, O.A. and Watson, K.M. Chemical Process Principles. Vol - I, *CBS Publication.*
4. Geankoplis, C.J., 2002. Transport Processes and Unit Operations. *Prentice Hall India.*

REFERENCES

1. Himmelblau, D., 1994. Basic Principles and Calculations in Chemical Engineering. 5th Edn., *Prentice Hall India Ltd.,* India.
2. McCabe, W.L., Smith, J.C. and Harriot, P., 1993. Unit Operations in Chemical Engineering. 5th Edn., *McGraw Hill Inc*.

STEM CELL BIOLOGY (ELECTIVE – I)

AIM

To understand the fundamental concept of Stem cell technology.

OBJECTIVES

At the end of the course the student would have gained extensive knowledge on

- Types of Stem cell and its characterization
- Cell lines and Tissue engineering
- Isolation and Cloning of Stem cells
- Types of Stem cell transplantation
- Applications and Ethics

UNIT I

INTRODUCTION

Stem cell – Definition, Embryonic stem cells, Adult stem cells, Origin and characterization of human stem cells and potential applications for stem cell research, Cord blood stem cells, Stem cell marker

UNIT II

CELL LINES AND TISSUE ENGINEERING

Cell types and sources, Human tissue culture media, Culturing of cell lines, Biology and characterization of cultured cells, Maintenance and management of cell lines, Reconstruction of connective tissues, Reconstruction of epithelial or endothelial surfaces – Cells embedded in extracellular matrix material, Culture on a single surface and sandwich configuration, Bioreactor design on tissue engineering – Hollow fibre systems, Microcarrier based systems, Liver tissue engineering.

UNIT III

ISOLATION AND CLONING OF STEM CELLS

Protocols for isolation and identification of stem cells, Culturing and subculturing human neurospheres, Differentiation of human – Neurospheres into neurons, Astocytes and Oligodentrocytes, Immunolabeling procedures, Stem cells and cloning.

UNIT IV

TRANSPLANTATION AND TRANSFECTION

Types of stem cell transplantation – Autologous, Allogeneic, Syngeneic; Nuclear transplantation, Therapeutic transplantation, Transfection methods – Lipofection, Electroporation, Microinjection, Embryonic stem cell transfer and Targetted gene transfer.

UNIT V

APPLICATIONS AND ETHICS

Neural stem cells for Brain / Spinal cord repair, Miracle stem cell heart repair, Stem cell and future of regenerative medicine, Haematopoietic stem cell therapy for autoimmune disease, Prenatal diagnosis of genetic abnormalities using foetal CD $^{34+}$ stem cells, Embryonic stem cell – A promising tool for cell replacement therapy, Germ-line therapy, Human stem cell research in India, Human embryonic stem cell ethics and Public policy.

TEXT BOOKS

1. Bernhard Palsson, Jeffery A. Hubble, Robert P. Lonsey and Joseph D. Bronzino, 2005. Tissue Engineering, Principles and Applications in Engineering. *CRC Press*.
2. John R.W. Master .,2004. A Practical Approach. *Oxford University Press*.

REFERENCES

1. Stewart sell. Stem Cell Handbook. *Humana Press*.
2. Campbell, N. A. and Jane B. Reece, 2002. Biology.6th Edition. *Pearson Education*, Inc. San Francisco, California.
3. Freshney, R. and Ian. Alan, R. Culture of Animal Cells : A Manual of Basic Techniques. Liss Inc.
4. Gamborg, O. L. and Phillips, G.C., 1995. Plant cell, Tissue, and Organ culture : Fundamental Methods. *Springer-Verlag,* Berlin Heidelberg.
5. Modlinske JA, Reed MA, Wagner TE and Karasiewicz J. (1996) Embryonic Stem Cells: Developmental Capabilities and their Possible Use in Mammalian Embryo Cloning. *Animal Reproduction Science* 42 : 437 – 446.

METABOLIC ENGINEERING (ELECTIVE I)

AIM

To provide an in-depth understanding of the various aspects of Metabolic engineering.

OBJECTIVES

To understand the concepts of

- Regulation of Biomolecules
- Synthesis of Primary metabolites
- Biosynthesis of Secondary metabolites
- Bioconversions
- Regulation of Enzyme production.

UNIT I

INTRODUCTION

Introduction – Jacob Monod model, Catabolite regulation, Glucose effect, cAMP deficiency, Feed back regulation, Regulation in branched pathways, Differential regulation by isoenzymes, Concerted feed back regulation, Cumulative feed back regulation, Amino acid regulation of RNA synthesis, Energy charge, Regulation, Permeability control passive diffusion, Active transport group transportation.

UNIT II

SYNTHESIS OF PRIMARY METABOLITES

Alteration of feed back regulation, Limiting accumulation of end products, Feed back, Resistant mutants, Alteration of permeability, Metabolites.

UNIT III

BIOSYNTHESIS OF SECONDARY METABOLITES

Precursor effects, Prophophase, Idiophase relationship, Enzyme induction, Feed back regulation, Catabolite regulation by passing control of secondary metabolism, Producers of secondary metabolites.

UNIT IV

BIOCONVERSIONS

Advantages of bioconversions, Specificity, Yields, Factors important to bioconversion, Regulation of enzyme synthesis, Mutation, Permeability, Co-metabolism, Avoidance of product inhibition, Mixed or sequential bioconversions, Conversion of insoluble substances.

UNIT V

REGULATION OF ENZYME PRODUCTION

Strain selection, Improving fermentation, Recognizing growth cycle peak, Induction, Feed back repression, Mutants resistant to repression, Gene dosage.

TEXT BOOKS

1. Wang, D.I.C., Cooney, C.L., Demain, A.L., Dunnil, P., Humphery, A.E. and Lilly, M.D., 1980. Fermentaion and Enzyme Technology. John Wiley and Sons.
2. Stanbury, P.F. and Whitaker, A., 1984. Principles of Fermentation technology. Pergamon Press.

REFERENCE

1. Zubay, G., 1989. Biochemistry. Mac Millan Publishers.

MATERIAL SCIENCES AND TECHNOLOGY (ELECTIVE – I)

AIM

To study about the Structure and functions of Biomolecules and Biomaterials.

OBJECTIVES

To understand

- The solid crystalline structure and properties of Biomolecules
- Structure and functional relationship of Proteins and Nucleic acid
- Techniques to study Biomolecular structure
- Production and uses of Biomaterials
- Synthesis and uses of Biopolymers.

UNIT I

BIOMATERIALS

Definition, Classification, Mechanical properties, Visco elasticity, Wound healing, Body responses to implant materials.
Carbohydrates, Modified carbohydrates for biomedical applications, Polydextrose.
Proteins, Collagen, Fibroin their structure and production.
Biopolymers – Definition, Synthesis, Dextrans, Polyhydroxybutyrate (PHB), Polycaprolactone (PCL), Polyphenol resins; Production of a copolymer of PHB and PHV (polyhydrovaleric acid), Biodegradable polymers.

UNIT II

BIOPHYSICAL PROPERTIES

Strong and weak interactions in biomolecules, Dielectric properties of biomolecules, Electronic properties of biomolecules – Conductivity, Photoconductivity and Piezoelectric effect.
Unit cells, Crystal structures (Bravais Lattices), Theoretical density computations, Crystallography and Miller indices.

UNIT III

IDENTIFICATION OF BIOMOLECULES

X-ray crystallography, Plane polarised light, Circular and elliptical polarised light, Definition of Circular Dichroism (CD), Optical, Rotatory Dispersion (ORD) and their comparative studies, Application to biomolecules, Phenomenon of Luminescence, Fluorescence, Phosphorescence.

UNIT IV

CONFORMATIONS OF PROTEINS AND NUCLEIC ACIDS

Conformation of proteins and enzymes, Energy status, Modification of structure, Dynamics of protein folding, Helix coil transformation, Structure in relation to function, Co-operative properties of enzymes.
Conformation of nucleic acids, Helix coil transformation, Thermodynamics of DNA denaturation, Changes in nucleic acid structure.

UNIT V

APPLICATIONS OF BIOMATERIALS

Artificial heart, prosthectic, cardiac, limb prosthesis, externally procured limb prosthesis and dental implants, Soft tissue replacements, sutures, percutaneous and skin implants,maxillofacial augumentation, heart tissue replacement implants, fracture fixation devices, joint replacements.

TEXT BOOKS

1. Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen and Jack E. Lemons, 2004. Biomaterial Science – An Introduction to Materials in Medicine. 2nd Edn., *Academic Press*.
2. Park, J.B., 1984. Biomaterials Science and Engineering. *Plenum Press*.

REFERENCES

1. Ratledge, C. and Kristiansen, B., 2001. Basic Biotechnology. 2nd Edn., *Cambridge University Press*.
2. Doi, Y., 1990. Microbial Polyesters. *VCH Weinheim*.

NANOBIOTECHNOLOGY

AIM

To introduce the concepts of Nanotechnology and to understand its applications in Biotechnology.

OBJECTIVES

To study about

- The basic concepts of Nanotechnology
- Fabrication and Characterisation of Nanomaterials
- Nanoparticles in Biosystems
- Role of Microbes in Nanotechnology
- Applications of Nanobiotechnology.

UNIT I

INTRODUCTION

Introduction, Overview of nanodevices and techniques. Inorganic nanoscale systems for biosystems – Nanostructured materials – Fullerness : Properties and characterization – Carbon Nanotubes : Characterisation and application – Quantum dots and wires – Gold Nanoparticles – Nanopores.

UNIT II

FABRICATION AND CHARACTERISATION

Fabrication – Bottom-up Vs. Top-down, Epitaxial growth, Self assembly.
Characterisation – X-Ray Diffraction (XRD), Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), Scanning Tunnelling Microscopy (STM), Atomic Force Microscopy (AFM).

UNIT III

NANOMOLECULES IN BIOSYSTEMS

Proteins, Lipids, RNA, and DNA – Nanoscale elements for delivery of materials into cells – Peptide coupled nanoparticles – DNA based artificial nanostructures – Proteins as components in nanodevices.

Nanotechnology in cell – Cell motility : Nanomotors and cellular navigation – Chemotaxis – Transmembrane signalling and related proteins.

UNIT IV

MICRO ORGANISMS AND NANOBIOTECHNOLOGY

Nanobiotechnology and micro organisms – Polyhydroxyalkanoates (PHA) – Cyanophycin inclusions – Magnetosomes – Alginates – Bacteriophages – Bacterial spores – Bacterial protein complexes – s-layer proteins – Bacteriorhodopsin.

UNIT V

APPLICATIONS OF NANOBIOTECHNOLOGY

Nanomedicine, Nanobiosensor – Electrochemical DNA sensors, Nanobiochips, Nanocrystals in Biological Detection, Fabrication of Novel biomaterials through molecular self-assembly, Small scale systems for *in vivo* drug delivery, Nanotechnology for diagnosis and treatment, Commercializing Nanobiotechnology.

TEXT BOOKS

1. Bhushan Bharat. Handbook of Nanotechnology. *Springer*.
2. Ajayan, P.A. and Schadler, L. Nanocomposite Science and Technology. *Wiley – VCH*.
3. Nlemeyer, C.M. and Mirkin, C.A. Nanobiotechnology – Concepts, Applications and Perspectives. *Wiley – VCH*.
4. Geoff Ozin and Arsenault, A., 2005. Nanochemistry : A Chemical Approach to Nanomaterials. 1st Edn., *Royal Society of Chemistry*.
5. Charles P. Poole and Junior Frank J. Owens, 2003. Introduction to Nanotechnology. *John Wiley and Sons*.
6. Jain, K.K., 2006. Nanobiotechnology Molecular Diagnostics : Current Techniques and Applications. Horizon Bioscience, *Taylor and Francis*.
7. Bernard, H. and Relim, A. Microbial Bionanotechnology.

REFERENCES

1. Rosenthal, S.J. and Wright, D.W. Nanobiotechnology Protocols in methods in Molecular Biology Series. *Humana Press*.
2. Michael Crichton. Undestanding Nanotechnology. *Scientific American Publisher*.
3. RalphS. Greco, Fritz B. Prinz and Lane Smithm, R., 2005. Nanoscale Technology in Biological systems. *CRC Press*.
4. Nalwa, H.S. Cancer Nanotechnology. *American Scientific Publishers*.
5. Salata, O.V., 2004. Applications of Nanoparticles in Biology and Medicine. *J. Nanobiotechnol.,* **2 :** 3.

ENVIRONMENTAL BIOTECHNOLOGY

AIM

To understand the role of Micro organisms and Biotechnology in combating the various aspects of Environmental pollution.

OBJECTIVES

To discuss in detail about the

- Microorganisms and Biodiversity
- Degradation of Xenobioitic compounds
- Industrial waste water management
- Treatment of Industrial wastes
- Applications of Molecular biology in relation to Environmental Biotechnology.

UNIT I

ENVIRONMENT AND ITS COMPONENTS

Water, Air and Land, Ecosystem concept, Microbial flora of soil, Growth, Ecological adaptations, Interactions among soil micro organisms, Biogeochemical cycles.

Concepts of Biodiversity, Endangered species, Sustainable development, *In situ* and *Ex situ* conservation, Gene banks.

UNIT II

DEGRADATION OF XENOBIOTIC COMPOUNDS

Biosensors to detect environmental pollution, Simple aromatics, Chlorinated polyaromatic petroleum products, Pesticides and surfactants, Waste minimisation techniques, Engineering interventions in waste treatment.

UNIT III

INDUSTRIAL WASTE WATER MANAGEMENT

Waste water characteristics, Biological waste water treatment, Unit operations, Design and modelling of activated - sludge process, Mathematical modelling of anaerobics – Digested dynamics.

UNIT IV

ENVIRONMENTAL BIOTECHNOLOGY – RECENT TRENDS

Treatment of industrial waste – Dairy, Pulp, Dye, Leather and Pharmaceuticals, Solid waste management, Recent developments pertaining to Environmental biotechnology.

UNIT V

ENVIRONMENT MANAGEMENT

Existing environmental issue – Global, National and Regional, Laws governing environment, Changing climates, Report preparations regarding environmental changes / Case studies – Quadrat study on campus,.

TEXT BOOKS

1. Stainr, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter, R.R., 1989. General Microbiology. *Mac Millan Publications.*
2. Foster, C.F. and John Ware, D.A., 1987. Environmental Biotechnology. *Ellis Honwood Ltd*.
3. Jogdand, S.N., 2003. Environmental Biotechnology. 2nd Edn., *Himalaya Publishing House*, Mumbai. Website : WWW. Himpub.com.
4. Dhameja, S.K., 1999. Environmental Engineering and Management. *S.K. Kataria and Sons*, New Delhi.
5. Masters, J.G., 1997. Introduction of Environmental Engineering and Science. Prentice Hall, New Delhi.
6. Sharma, B.K. Environmental Chemistry.

REFERENCES

1. Karnley, D., Chakrabarty, K. and Omen, G.S., 1989. Biotechnology and Biodegradation, Advances in Applied Biotechnology. *Gulf Publications Co., London*.