

M. Tech. Biotechnology

Course Structure Scheme of Evaluation & Syllabus



**Department of Applied Mechanics (Biotechnology)
Motilal Nehru National Institute of Technology
Allahabad**

M. Tech. (Biotechnology)

Proposed Course Structure and Evaluation Scheme

Ist Semester

Course No.	Subject Name	L	T	P/T	Credits	Distribution of marks out of 100				
						TA#	I Mid Exam	II Mid Exam	Lab	End Sem Exam
BT 901	Engineering Principles	3	1	-	4	20	20	20	-	40
BT 902	Recombinant DNA Technology	3	-	2	4	10	15	15	20	40
BT 903	Molecular Biology	3	-	2	4	10	15	15	20	40
BT 904	Applied Microbiology	3	-	2	4	10	15	15	20	40
BT 905	Elective I	3	1	-	4	20	20	20	-	40
BT 906	Elective II	3	1	-	4	20	20	20	-	40
	Total	18	3	6	24					

IInd Semester

Course No.	Subject Name	L	T	P/T	Credits	Distribution of marks out of 100				
						TA#	I Mid Exam	II Mid Exam	Lab	End Sem Exam
BT 907	Immunotechnology	3	-	2	4	10	15	15	20	40
BT 908	Food Technology	3	1	-	4	20	20	20	-	40
BT 909	Advanced Bioinformatics	3	-	2	4	10	15	15	20	40
BT 910	Bio-chemical Engineering	3	-	2	4	10	15	15	20	40
BT 911	Elective III	3	1	-	4	20	20	20	-	40
BT 912	Elective IV	3	1	-	4	20	20	20	-	40
		18	3	6	24					

IIIrd Semester

Course No.	Subject Name	L	T	P	Credits	Distribution of marks out of 100			
						TA	I Mid Exam	II Mid Exam	End Sem Exam
BT 997	Seminar/Special Study/Industrial Training	-	-	-	4	Periodic Assessment will be carried			
BT 998	Thesis*-I	-	-	-	20				
	Total	-	-	-	24				

IVth Semester

Course No.	Subject Name	L	T	P	Credits	Distribution of marks out of 100			
						TA	I Mid Exam	II Mid Exam	End Sem Exam
BT 999	Thesis*	-	-	-	24				
	Total	-	-	-	24				

LIST OF ELECTIVE COURSES

Elective-I

BT 951. Environmental Biotechnology

BT 952. Tissue Engineering

BT 953. Enzyme Technology

Elective-II

BT 954. Bioprocess Engineering

BT 955. Pharmaceutical Science and Drug Designing

BT 956. Agrobiotechnology

Elective-III

BT 957. Bio-Sensor Technology

BT 958. Nanobiotechnology

AM 975. MEMS and BIOMEMS

Elective-IV

BT 959. Bio Business, IPR and Entrepreneurship

BT 960. Biostatistics and Research Methodology

CE 665. Principles of Biological Waste water Treatment

M. Tech. I st Semester (Biotechnology)

(BT 901) ENGINEERING PRINCIPLES

Unit – I

Historical and more recent developments in chemical engineering, Differential calculus: basic concepts, product rule, quotient rule, function of a function, partial differential equation, Single integral, definite integral with limits and integration by parts.

Unit - II

Law of conservation of mass, momentum and energy and equation of state, Chemical kinetics initiation, thermodynamics and chemical reaction engineering, reversible and irreversible reaction, elementary and non-elementary reaction, molecularity and order of a reaction. Chemical engineering discipline, role of chemical engineering, in biotechnology, concept of unit operations and unit processes, types of unit operations and their application in biotechnology.

Unit – III

Classification of fluid, fluid in motion, Reynolds number, Viscosity; Shell balance: Falling film, Circular tube, Continuity, Motion, Energy, Substantial derivatives, Unidirectional flows: Pipe flow, Variable viscosity falling film, Rotating Sphere, Unsteady flows: Startup Plate flow, Parallel plates etc. Mixing: mixing equipment, flow pattern agitated tank, radial and axial flow impellers, mechanism of mixing.

Unit - IV

Mechanisms of heat transfer, mode of heat transfer, general equipments for heat transfer, shell and tube heat exchanger, heat transfer between fluids, individual and over all heat transfer coefficient, Mechanisms of mass transport, Molecular and diffusion theory, role of diffusion in mass transfer, film theory, types of mass transfer, oxygen uptake in cell culture, oxygen transfer from gas bubble to cell culture, oxygen transfer in fermentation.

Text Books:

1. R.M. Felder and R.W. Rousseau, Elementary Principles of Chemical Processes, 3rd Edition, J. Wiley, New York, 2000.
2. D.M.Himmelblau, Basic Principles and Calculations in Chemical Engineering, 6th Edition, Prentice Hall of India. New Delhi, 1996.
3. B.I.Bhatt and S.M.Vora, Stoichiometry, 3rd Edition, Tata McGraw Hill. New Delhi. 1996.
4. R. B. Bird et al., Transport Phenomena, 2nd Edition, Wiley, 2006.
5. Pauline Doran, Bioprocess engineering principles, 1 Edition, Academic Press, 1995.

(BT- 902) RECOMBINANT DNA TECHNOLOGY

Unit – I

Introduction to recombinant DNA Technology, Safety guidelines of rDNA research. Restriction endonucleases, DNA modifying enzymes, Vectors: plasmids, phage vectors, cosmids, phagemids, Yeast cloning vectors, Animal viruses, yeast artificial chromosomes, bacterial artificial chromosome. Cloning & Cloning strategies in yeast and *E. coli*, cloning of PCR product, construction and screening of genomic and cDNA library.

Unit – II

Sequencing of DNA, Molecular probes, PCR, Blotting and hybridization techniques, mutagenesis, mRNA isolation and cDNA synthesis, RFLP, RAPD, RT PCR. Selection of rDNA clones and their expression products: Direct and indirect methods, Gene Targeting, Gene Silencing.

Unit – III

Tailoring model plants and animals: transgenic animals and plants, techniques and experiments involved in creating transgenic mice, knockout mice.

Unit – IV

Nucleic acid sequence as diagnostic tools, DNA fingerprinting in consideration to clinical diagnosis & forensics, New drugs and therapies for genetic diseases, Metabolite engineering, Metabolic pathway engineering.

Text Books:

1. Ausubel et al. (2002). Short Protocols in Molecular Biology. Wiley
2. Brown (2006). Gene Cloning and DNA Analysis - An Introduction. Blackwell
3. Glick and Pasternak (2003). Molecular Biotechnology. ASM Press
4. Krenzer and Massey (2000). Recombinant DNA and Biotechnology. ASM
5. Robertson et al. (1997). Manipulation & Expression of Recombinant DNA. AP
6. Sambrook et al. (2001). Molecular Cloning. CSHL
7. Primrose and Twyman (2006). Principles of Gene Manipulation and Genomics. Blackwell

RECOMBINANT DNA TECHNOLOGY AND MOLECULAR BIOLOGY - LABORATORY

- Isolation and purification of genomic DNA and plasmid.
- Restriction digestion and ligation of plasmids
- Transformation and screening for recombinants.
- Isolation & visualization of RNA.
- Blotting techniques – southern blotting.
- Amplification of DNA fragments by Polymerase chain reaction (PCR).
- Study of the expression of the protein induced by temperature stresses in drosophila.
- Study of diversity by different techniques

(BT- 903) Molecular Biology

Unit1

Prokaryotic and eukaryotic cell Organization, Biomembrane, Organelles of Eukaryotic cell , Nucleic Acids, Base composition, structure and conformation, Different forms and unusual structures, Nucleic acid chemistry: Denaturation, hybrids, nonenzymatic transformation, methylation, Nucleosome & higher level Organization.

Unit 2

Mutation and DNA repair system, DNA recombination, DNA Replication, DNA polymerases, Replicons, origin and termination, Replisome, Genes controlling replication.

Unit 3

Transcription, Prokaryotic RNA polymerase, sigma factors, initiation and termination, Eukaryotic RNA polymerases and their promoters, Processing of transcripts, Post transcriptional regulation: Genetic code and expansion of genetic code, Alternative splicing, Gene regulation in prokaryotes (lac, trp operon etc) and eukaryotes, Transport and targeting of RNA, Post-transcriptional gene silencing, Translation, General mechanism, control, Post translational modification, Protein targeting .

Unit 4

Functional genomics and Proteomics, Molecular biology of cancer.

Text Books

1. Lodish et al (2004). Molecular Cell Biology. Freeman
2. Gerald Karp (2005). Cell & Molecular Biology. Wiley & Sons
3. Brown (2001). Essential Molecular Biology. AP
4. Alberts et al (1999). The Science of Genetics. Saunders
5. Benjamin (2003). Genetics: A Conceptual Approach. Freeman
6. Berg and Singer (1998). Genes and Genome
7. Dale & Scharz (2003). From genes to Genome. Wiley & Sons
8. Griffiths et al (2002). Modern Genetic Analysis. Freeman

(BT-904) APPLIED MICROBIOLOGY

Unit –I

The microbial world, Conventional and molecular (culturable and nonculturable) methods of studying microbial diversity, Eubacteria, Archaeobacteria (Methanogens, Halopihiles, Thermoacidophiles) Microbial growth, Balanced and Unbalanced growth, Measurement of growth, Control of microbial growth with examples, Microbial metabolism (aerobic, anaerobic and fermentative), Primary and Secondary metabolites.

Unit –II

Microbes and soil fertility; Biogeochemical cycles, Microbial associations and interactions, plant growth promoting microbes, Endophytes; Biofertilizers. Organic composting and Green manuring, Biopesticide, Significance of mycorrhizae.

Unit –III

Aquatic microbiology (Fresh water and Marine), Wastewater treatment methods, treatment of solid wastes, and concept of indicator organisms

Unit –IV

Pathogenic Microbes (Vancomycin resistant, MDRS, AIDS, H1N1), adhesion, colonization, invasion, host parasite interactions, Antibiotics & Vaccines: Overview.

Text Books:

1. Nester, Eugene W., Microbiology: A Human Perspective, 5th eds. NY: McGraw-Hill.
2. Talaro, Kathleen Park, Foundations in Microbiology, 5th ed. McGraw-Hill, NY.
3. Prescott, Lansing M., Microbiology, 5th ed. NY: McGraw-Hill.
4. Brock Biology of Microorganisms (2000), 9th Edition, by M. T. Madigan, J. M. Martinko and Jack Parker.
5. Manual of Environmental Microbiology, 2nd edition, ASM Press
6. Practical Microbiology 2006, S.Chand and Co. New Delhi
7. R.C. Dubey and D. K. Meheshwari 3rd edition A text book of microbiology

APPLIED MICROBIOLOGY-LABORATORY

- Study of guidelines, tools and equipments in microbiology.
- Preparation of media for growth of various microorganisms.
- Use of different staining techniques and enumeration of microorganisms.
- Identification and culturing of microorganisms.
- Growth curve, measurement of bacterial population.
- Effect of temperature, pH, carbon and nitrogen sources.
- Disc Diffusion assay and Estimation of MIC.
- Methylene blue reduction test in milk samples
- Assessment of water quality for physiochemical & biological parameters
- Microbial adhesion and colonization.

(BT- 907) IMMUNOTECHNOLOGY

Unit-I

Phylogeny of Immune System, Innate and acquired immunity. Cells and organ of immune system: Humoral and cell mediated immune responses, Nature of antigens and super antigens, antibody structure, types and function, diversity, , idiotype network, Major Histocompatibility Complex, antigen processing and presentation.

Unit – II

Isolation and Purification of complement components from Human Plasma, Assays for Membrane Complement Receptors Isolation and Functional Assay of the Membrane Complement Inhibitors, Engineering Immune Molecules and Receptors: - Binding of Biotinylated Peptides to MHC Class II Proteins on Cell Surfaces Measurement of MHC/Peptide, Stem cell transplantation technology, CID mice, Antibody engineering.

Unit – III

Immunological Techniques: Immuno-diffusion, immunoelectrophoresis, ELISA, RIA, immunofluorescence, FACS,. HLA typing, complement fixation, Antibody production: polyclonal and monoclonal antibodies for diagnosis and therapy. Production of vaccines, Production of cellular chemicals like interferon, interleukins, cytokines etc.

Unit – IV

Immunogenetics, Immune response to infectious diseases and malignancy, Concept of immunotherapy, Transplantation immunology

Text Books

1. Anthony Moran. (2006). Immunotechnology: Principles, Concepts and Applications, John Wiley & Sons
2. Tim Clackson and Henry Lwman, B. (2004). Phage Display: A Practical Approach. Oxford University Press, USA
3. Andrew George, J T and Catherine Urch, E. (2000). Diagnostic and Therapeutic antibodies (Methods in Molecular Medicine) Humana Press. 1 2000.
4. Current Protocols in Immunology, Vo.1-5, Wiley Inter Sciences, 2006.
- 5 .Kuby (2006). Immunology. Freeman

IMMUNOTECHNOLOGY- LABORATORY

- Antibody labeling with enzyme
- ELISA
- Latex Agglutination test
- Quantitative precipitate test
- Immuno-blot technique
- Lymphocyte separation
- Mitogenic stimulation of lymphocyte culture
- Immuno-electrophoresis
- Immunogen preparation, immunization, antiserum collection
- Isolation/Purification of immunoglobulins

(BT 908) FOOD TECHNOLOGY

Unit -1

Introduction to food science and technology, Nutritive value of foods, Food in health and disease. Food chemistry, importance of water in food, water activity and shelf life of food, Loss of vitamins and minerals during processing.

Unit -II

Types of microorganisms normally associated with foods: mould yeast, and bacteria. Extrinsic and Intrinsic parameters, Food-borne diseases, Food Preservation: Principles and methods.

Unit -III

Biotechnology in relation to food industry, Important enzymes in food and feed industry, Role of starters in fermented foods, Fermented dairy products, Distilled and nondistilled beverages, Pigments in food, food flavours, food additives, Nutraceuticals, and Oriental fermented products, SCP, Probiotics, prebiotic and synbiotics.

Unit -IV

Basic principles, equipment involved in the commercially important food processing methods and unit operations; materials and containers used in food packaging, Canning, Quality control, HACCP Concept. Guidelines of Food and Regulatory Agencies.

Text Books:

- 1 Jay J.M. 1986. Modern Food Microbiology. 3rd Edn. VNR, New York.
- 2 Food processing and Preservation PHI private ltd, New Delhi
- 3 Food Microbiology fourth edition William C.Frazier, Tata Mc Graw Hill
- 4 Food Microbiology 2nd Edition, Michael P.Doyle , ASM press

(BT- 909) ADVANCED BIOINFORMATICS

Unit –I

Software and hardware for interactive computer graphics; Implementation of device drivers; Line and circle drawing algorithms; 3-D transformation, windowing, clipping, perspective and input routines; Sequence databases; Similarity matrices; Pairwise alignment; BLAST; Statistical significance of alignment; Sequence assembly; Multiple sequence alignment; Clustal; Phylogeny: distance based approaches, maximum parsimony, Metabolomics.

Unit – II

Motif representation: consensus, regular expressions; Regulatory sequence identification.

Units III

Experimental determination of structures (X-ray crystallography, NMR); Structure databases; Secondary structure prediction; RNA structure prediction; Protein structure prediction by comparative modeling approaches Energy minimization; Molecular dynamics; Rosetta; Structure comparison (DALI, VAST etc.); CASP; Protein-ligand docking; Computer-aided drug design (pharmacophore identification); QSAR; Protein-Protein interactions and others related softwares (Map maker, QTL Cartographer, Matrix).

Unit – IV

Transcriptomics: Microarray technology, expression profiles, data analysis; SAGE; Proteomics: 2D gel electrophoresis; Mass Spectrometry (MALDI-TOF, LC-MS), Protein arrays.

Texts/References:

1. David W. Mount. Bioinformatics: Sequence and Genome Analysis 2nd Edition, CSHL Press, 2004.
2. A. Baxevanis and F. B. F. Ouellette, Bioinformatics: a practical guide to the analysis of genes and proteins, 2nd Edition, John Wiley, 2001.
3. Jonathan Pevsner, Bioinformatics and Functional Genomics, 1st Edition, Wiley-Liss, 2003.
4. P. E. Bourne and H. Weissig. Structural Bioinformatics. Wiley. 2003.
5. C. Branden and J. Tooze, Introduction to Protein Structure, 2nd Edition, Garland Publishing, 1999.

ADVANCED BIOINFORMATICS- LABORATORY

- Biological sequences retrieval: – DNA sequences and Amino acid sequence from database.
- Pair wise sequence alignment.
- Multiple sequence alignment using Clustal W.
- Construction of phylogenetic tree.
- RNA secondary structure prediction.
- Secondary structure: alpha helices and beta sheets of protein.
- Homology modeling.

(BT- 910) PRINCIPLES OF BIO-CHEMICAL ENGINEERING

Unit – I

Kinetics of cell growth: Phase of cell growth, mathematical models for substrate uptake and product formation, immobilized enzymes and cells methods, Industrial enzymes, mass transfer and bioprocessing operations, description of industrial processes.

Unit – II

Introduction to bioreactors, batch, fed-batch and continuous fermentation, cascade of stirred tanks, multiphase bioreactors, fluidized bed reactor, bubble column, air lift fermenter and others. Description of a conventional bioreactor with all aspects. Design and construction criteria of a bioreactor. Alternate bioreactor configurations, Residence time distribution, concentration, and temperature distributions.

Unit –III

Introduction to chemical engineering principles: Basic principles and methods for design of chemical process, estimation of optimal design conditions, process engineering operations, size reduction, filtration, evaporation, crystallization, drying, humidification, dehumidification, Extraction; Adsorption and chromatography.

Unit –IV

Biomass removal; biomass disruption; membrane-based techniques; Process flow sheeting; process economics.

Texts Books

1. Michael Shuler and Fikret Kargi, Bioprocess Engineering: Basic Concepts, 2nd Edition, Prentice Hall, Englewood Cliffs, NJ, 2002.
2. Baily, J. and D.F. Ollis. “ Biochemical Engineering Fundamentals” McGraw Hill, 1986 (Theoretical Courses).
3. Pauline Doran, Bioprocess engineering principles, 1 Edition, Academic Press, 1995.
4. Colin Ratledge, Bjorn Kristiansen, Basic Biotechnology, 2nd Edition, Cambridge University Press, 2001.
5. Whittaker, Principles of Fermentation Technology

(BT 951) ENVIRONMENTAL BIOTECHNOLOGY

Unit – I

Introduction to environmental biotechnology, Air, water and soil pollution, Treatment of municipal wastes and industrial effluents (Physico-chemical, biological analysis of waste water), waste water treatment, sludge treatment and disposal, treatment of wastes from paper, textile, dairy, petrochemical and pharmaceutical industry, Microbial fuel cell. Global warming, CPCB norms.

Unit – II

Bioremediation and phytoremediation of toxic compounds like pesticides, hydrocarbons, polymers, surfactants. Hydrocarbon yielding plants, Bioindicators, Quorum sensing, Renewable (Hydrogen, methane biodiesel and bioethanol) energy sources, Microbe based fuel cells, environmental regulations.

Unit – III

Air and Soil pollution: cause and control, Global warming and Carbon Sequestration (physio-chemical and biological), Scrubbers.

Unit – IV

Microbial leaching of copper, uranium and others, bioaccumulation and biosorption, Ecotoxicity measurement by Biosensors and biomarkers for Environmental Impact Assessment and Environmental audit.

Text Books:

1. Microbial Ecology – Fundamentals and Applications by Atlas, M.R. and Bartha, R. 1998.
2. Prescott, Lansing M., Microbiology, 5th ed. NY: McGraw-Hill.
3. Brock Biology of Microorganisms .2000, 9th Edition, by M. T. Madigan, J. M. Martinko and Jack Parker

(BT 952) TISSUE ENGINEERING

Unit - I

Special feature and organization of plant cell, regeneration of plants, concept of totipotency, Plant products of industrial importance (Stebeoside, Thaumatin, Shikonin, Plantibodies and Steroids), Design of a plant tissue culture laboratory and its management.

Unit - II

Requirements for animal cell, tissue and organ culture, Establishment of cell culture, types of cell lines and their growth condition. Animal cell metabolism, animal cell growth, characteristics and kinetics, Stem cells: properties and culture, Laboratory design for animal tissue culture,

Unit - III

Nutrient substrate and product transport through mammalian cell, cell culture in continuous, perfusion and hollow carrier reactor, mass transfer in mammalian cell culture, scale up of cell culture process.

Unit- IV

Introduction to Biomaterials, types and composition, Biocompatibility, Medical Application of Animal Tissue Engineering, Microsystem for tissue-engineering, Tissue Scaffolds, Commercialization of tissue culture technology.

Text Books:

1. Robert. P. Lanza, "Principles of Tissue Engineering", Elsevier S&T, 2nd edition, May 2000.
2. Barnhard Palsson, Robert Plonsey, Jeffrey A. Hubbell, "Tissue Engineering", PHI, March 2003.
3. Animal Cell Culture by John R.W. Masters Oxford University Press.
4. Introduction to Cell and Tissue Culture by Jennie P. Matcher and Penelope E. Roberts, Plenum Press, New York and London.
5. Molecular Biotechnology: Primrose.
6. Animal Cell Biotechnology: R.E. Spier and J.B. Griffiths (1988), Academic press.
7. Ranga M.M. Animal Biotechnology, Agrobios India Limited.
8. Ramadass P, Meera Rani S. Text Book of Animal Biotechnology, Akshara Printers.
9. Pinkart C.A. Animal Transgenic Technology, Academic Press.

(BT 953) ENZYME TECHNOLOGY

Unit – I

Enzymes: Introduction and scope, Nomenclature, Mechanism of Catalysis, Enzyme Kinetics: Single substrate steady state kinetics, Inhibitors, modulators and activators; Allosteric enzymes. Multienzyme complexes, Kinetics of enzyme inhibition (competitive, noncompetitive and uncompetitive with examples).

Unit – II

Immobilization of Enzymes: Advantages, Carriers, adsorption, covalent coupling, crosslinking and entrapment methods, Micro-environmental Systems, Effect of pH and temperature on immobilized enzymes.

Unit – III

Reactors for batch/continuous enzymatic processing, Choice of reactor type: idealized enzyme reactor systems, Mass Transfer in Enzyme Reactors: Steady state analysis of mass transfer and biochemical reaction in enzyme reactors.

Unit – IV

Production of enzymes (Amylases, Proteases and Lipases and others) Enzyme catalysis in organic media, Catalytic antibodies and Non-protein enzymes, Artificial enzyme, Biocatalysts from Extremophilic microbes (Extremozymes) Applications of enzyme in Industrial, Analytical, Clinical and Molecular biology, Large scale application of immobilized enzymes,

Text Books:

1. Principles of Biochemistry by Nelson Coks (1987)
2. Biochemical Engineering by James M. Lee, Prentice Hall (1992).
3. Enzyme Technology by Palmer
4. Design and Analysis of Immobilised Enzyme Flow Reactors” by W.R. et. al.
5. Enzymes in Food Processing by Gerald Reed, Academic presses.

(BT 954) BIOPROCESS ENGINEERING

Unit – I

An introduction to fermentation processes - Range of fermentation process. Batch culture, continuous culture, industrial applications of continuous culture processes, fed-batch culture. Basis and Development of Industrial fermentation Processes. Screening, Detection and assay of Fermentation products, Stock Cultures, Fermentation Media, Inoculum Preparation.

Unit II

Design of a fermenter- Basic functions of a fermenter, construction, aeration and agitation, baffles, the achievement and maintenance of aseptic conditions, valves, other fermentation vessels. Aeration and agitation- The oxygen requirements of industrial fermentation processes, Instrumentation and control- Control systems, manual, automatic.

Unit – III

Typical Fermentation Processes: Antibiotic Fermentation (Penicillin, Streptomycin) Anaerobic Fermentation: acetone-butanol Fermentation, Beer and wine, Industrial Alcohol, Organic acid (Lactic Acid and Citric acid), Aminoacid fermentation(Lysine and Glutamic acid)

Unit - IV

Biomass separation (Centrifugation, Sedimentation, Flocculation, Microfiltration) and disruption (Sonication, Bead mills, Homogenizers, Chemical lysis, Enzymatic lysis), Extraction and Membrane based purification: Ultrafiltration, Reverse osmosis, Dialysis, Diafiltration, Pervaporation, Perstraction. Adsorption and chromatography, Precipitation, Drying (Spray and Lyophilization).

Text Books:

1. E L V Harris and S. Angal, Protein Purification Methods, Ed. IRL Press at Oxford University Press, 1989.
2. P.A. Belter, E.L. Cussler and Wei-Shou Hu., Bioseparations- Downstream Processing for Biotechnology, Wiley-Interscience Publication, 1988.
3. J. E. Bailey and D. F. Ollis, Biochemical Engineering Fundamentals, 2nd Edition, Mc-Graw Hill, Inc., 1986.
4. Industrial Microbiology by L.E. Casida, John Wiley and Sons INC.
5. Annual reports on fermentation processes vol. I and II, by D. Perlman. Academic press INC.
6. Prescott and Dunn's Industrial Microbiology, 4th edition (1982) by Gerald Reed.
7. Crueger, W. and Crueger, A. 2000. Bio-Technology; A Textbook of Industrial Microbiology, Panima Publication Co. New Delhi
8. Stanbury, P.F., Whittaker, A and Hall, S.J. 1997. Principles of Fermentation Technology. Aditya Books (P) Ltd.

(BT 955) PHARMACEUTICAL SCIENCE AND DRUG DESIGNING

Unit – I

Introduction to Physical Pharmaceutics - Metrology and Calculations, Molecular structure, properties and States of Matter, Solutions, Phase Equilibria, Micrometric and Powder Rheology, Surface and Interfacial Phenomena, Dispersion Systems, Diffusion & Dissolution, Kinetics and drug stability, Viscosity & Rheology, Introduction to pharmacogenomics.

Unit – II

Polymers and Applications. Formulations and Development, Packaging. Introduction to Industrial Processing, Particulate Technology (Particle Size, Size reduction, Size Separation, Powder Flow and Compaction).

Unit – III

Unit Operations (Mixing, Evaporation, Filtration, Centrifugation, Extraction, Distillation, and Drying with reference to pharmaceuticals) Materials of Pharmaceutical Plant Construction, Quality control and Quality Assessment, Good Manufacturing Practice (GMP's) Guidelines, Regulations in pharma industry with reference to Indian, American and European context, Indian systems of Medicine (merits and demerits), Patenting of drug.

Unit – IV

Drug target classification, Target discovery and validation strategy, design and development of combinatorial library for new lead generation, QSAR: Statistical techniques behind QSAR, classical QSAR, problems and drawbacks on drug discovery and development, Route of drug delivery, Application of nanoparticles and nanomaterial in drug delivery.

Text Books:

Leon Lachman *et al* Theory and Practice of Industrial Pharmacy, 3rd Edition, Lea and Febiger, 1986

Remington's Pharmaceutical Science, Mark Publishing and Co.

A.R. Leach, Molecular Modelling Principles and Applications, Longman, 1996.

J.M. Haile, Molecular Dynamics Simulation Elementary methods, John Wiley and Sons, 1997.

C. Hansch (Ed.); Comprehensive Medicinal Chemistry (Vols. I-VI) Academic Press, 1990.

M. Sandler and H. J. Smith: Design of Enzyme Inhibitors as Drugs. Oxford Univ. Press, 1989.

T. J. Perun and C. L. Propst: Computer Aided Drug Design. Dekker, 1989.

(BT 956) NANO BIOTECHNOLOGY

Unit-I

Quest for nanotechnology, bionanomachines in action (Nano scale with reference to biosystems), general introduction to nanomaterials and their types, methodologies used in synthesis of nanoparticles, nanoparticle synthesis using microbes, characterization of nanoparticles using different techniques (Atomic force microscopy, SEM, TEM, particle size analysis etc)

Unit-II

Nanotechnology in drug delivery, therapy, diagnostics and sensing, Semiconductor quantum dots in cellular and molecular imaging.

Unit-III

DNA-protein nanostructure, DNA-gold particle conjugates, nanoparticles as non-viral transfection agents, protein nanotubes.

Unit-IV

Molecular synthesis, Self assembly, Polymerisation, Nanoscale lithography, e-beam lithography. Heterogenous nano structure and composites, nanoscale biostructures, Future of nanobiotechnology.

Textbooks:

1. M.Ratner and D.Ratner, Nanotechnology –a gentle introduction to the next big idea, Pearson education , 2007.
2. R.R.Birge, Protein based computers, Scientific American , 1995.
3. David S. Goodsell, Bionanotechnology: lessons form nature, Wiley-liss publications, 2004.

(BT 957) BIOSENSOR TECHNOLOGY

Unit - I

Introduction to sensor systems, Basics of transducers and sensors, sensor classification and application of mechanical , chemical, thermal, magnetic, radiation and other smart sensors.

Unit- II

Interdisciplinary aspects of sensor technology, biosensor sensing elements, Classification (Electrochemical, thermometric and optical), biosensor assay, biosensor characteristics, Applications of Biosensor in food, medical, environmental and agricultural sectors, Future trends in biosensors (Insulin delivery).

Unit- III

Design and modeling of various biosensors (Glucose, Urea, Biomass, BOD and others).

Unit - IV

Introduction to micro- and nano- biotechnologies, Micro- Electro- Mechanical- systems, Micro- Opto- Electrical- Mechanical Systems, Applications of Micro- and Nano- biosensors.

Text Books:

1. Robert R. Buck, et. al, “ Biosensor Technology- Fundamentals and Applications” Dekke Publication, New York, 1990.
2. Brian R. Eggins, “ Chemical Sensors and Biosensors” Jon Wiley & Sons, England, 2002.
3. Eggins, B.,” Biosensor : An Introduction”, John Wiley & Sons, New York, 1996.

(BT 958) AGRO BIOTECHNOLOGY

Unit-I

World Food Security: Causes of food insecurity, social economic issues, ensuring food security, BIS regulations, GM food.

Unit-II

Molecular farming: Use of plants and animals for production of nutraceuticals, edible vaccines and other desired products. Biotech feeds. Mushroom Cultivation.

Unit-III

Biofertilizer: Mass cultivation of microbial inoculants, green manuring, algalization, Azolla. Microbial products and plant health: PGPR (plant growth promoting rhizobacteria), significance of mycorrhizae, toxin producing microbes (antibiotics, aflatoxin, and others), microbial herbicides. Transgenic animals and plants.

Unit-IV

Organic Farming: Organic farming and sustainable use of natural and bioresources, Organic standards and certification of organic produce and products, Biological control, Global initiatives and future prospects.

Text Books:

1. Agricultural Biotechnology by Arie Altman. *Marcel Dekker, Inc.* (2001).
2. Plants, Genes and Crop Biotechnology (2003) 2nd Edition by Chrispeels, M.J. & Sadava D.E. American Society of Plant Biologists, *Jones and Bartlett Publishers, USA.*
3. Biochemistry and Molecular Biology of Plants: Edited by Buchanan B.B., Gruissem W, and Jones RL (2000), *American Society of Plant Biologists, USA.*
4. Soil Microorganisms and Plant Growth by Rao Subba S.M. 1977.

(AM 975) MEMS & BIO-MEMS

Unit I

Introduction; photolithography; mask design; wet and dry etching; thin film deposition and growth, electroplating, molding, LIGA, bonding and sacrificial processes.

Unit II

Polymer processing and rapid prototyping, biomaterials and biocompatibility issues, micro total analysis system (μ TAS): Fluid control components, μ -TAS: sample handling, μ -TAS: separation components, μ -TAS: detection, cell handling and characterization systems.

Unit III

Systems for biotechnology and PCR, polynucleotide arrays and genetic screening, miniature biosensors, biosensors arrays and implantable devices, neural interfaces, microsurgical tools, micro needles, and drug delivery.

Unit IV

Microsystems for tissue engineering, tissue scaffolds, optical biosensors, MEMS metrology, MEMS packaging.

Text books

- A. Manz and H. Becker, Eds. *Microsystem Technology in Chemistry and Life Sciences* Springer-Verlag, New York, 1999. ISBN: 3-540-65555-7
- Max.I.Madou, "Fundamentals of Micro Fabrication, the Science of Miniaturization", Nanogen corporation, USA, CRC press, March 2002.

(BT 959) BIO BUSINESS, IPR AND ENTREPRENEURSHIP

Unit –I

General introduction to biotechnology and industry. Scope of industry discussed. Trends and key issues in biotechnology and industry. Technology basis in industry segments, Emerging technologies, technical convergence issues, Scientists, engineers and innovation management.

Unit -II

Industrial R&D and product development. Product development and project management. Transition from R&D to business units. Management of radical innovation technologies

Unit -III

Intellectual property in biotech, definitions. Managing and working with inter-company partnerships and alliances. Product development for commercial partners, Transitioning an idea. Patent laws , Bioethics and current legal issues. Ethics of new technology. Bioethics and current legal issues. Marketing and public perceptions in product development.

Unit –IV

Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs IP as a factor in R&D; IPs of relevance to Biotechnology, 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, Entrepreneurial business. New venture creation, technology transfer and business planning. Financing biotech businesses and project finance. How to make the case for a project budget. SBIR, corporate partners. Case discussion on Surface Logix– entrepreneurship issues.

Text books:

1. Eric Grace Biotechnology unzipped: Promises and realities. Wash. DC: Joseph Henry Press. 1997.
2. Arthur Kornberg. Sausalito, CA The golden helix: University Science Books. 1995.
3. Richard Oliver The coming biotech age: The business of biomaterials. . NY: McGraw Hill. 2000.
4. Ruth Ellen Bulger et al., The ethical dimensions of the biological sciences. NY: Cambridge University Press. 1993.
5. David F. Betsch Principles of Biotechnology.

(BT 960) BIOSTATISTICS AND RESEARCH METHODOLOGIES

Unit -I

Biostatistical tools: mean, median, mode, histogram, frequency distribution, standard deviation, coefficient of variance, standard error, probability, Discrete random variables, Bernoulli, Binomial, Poisson; Geometric distributions.

Unit -II

Sampling distributions: t , chi-square, F distributions; Hypothesis testing: null and alternative hypotheses, Normally distributed data: z , t , Analysis of variance: One-way ANOVA, Randomized block design, List Square Design, Split plot design, Regression and correlation: simple linear regression.

Unit – III

Sampling Techniques: Sampling theory, Types of Sampling, Steps in Sampling, Sampling and Non-sampling error, Sample Size, Advantages and limitations of Sampling. Collection of Data: Primary Data, Meaning, Data Collection Methods, Secondary Data, Meaning, Relevance's, Limitations and Cautions.

Unit – IV

Research – Definition, Importance and Meaning of Research, Characteristics of Research, Types of Research, Steps in Research, Identification, Selection and Formulation of Research Problem, Research Questions, Research Design, Formulation of Hypothesis, Review of Literature. Statistics in Research – Measure of Central Tendency, Dispersion, Skewness and Kurtosis in Research.

Text books

1. Bernard Rosner, Fundamentals of Biostatistics, 5th Edition, Thomson Brooks/Cole, 2000.
2. Richard A. Johnson, Probability and Statistics for Engineers, 6th Edition, Prentice Hall, 2000.
3. Morris H. DeGroot, Mark J. Schervish, Probability and Statistics, 3rd Rev. Edition, Addison-Wesley, 2002.
4. E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley, 2006.
5. Handbook of Agriculture Statistics by S.R.S. Chandel
6. Statistical methods for Agricultural workers by P.V. Sukhatmez and V.N. Amble.
7. Statistical Methods by S.P. Gupta.
8. Research Methodology, Method and Techniques by C.R. Kothari or by Santosh Gupta.

(CE 665) Principles of Biological Waste water Treatment

Unit I

Waste water characterization, BOD, COD and other parameters.

Unit II

Reaction kinetics, type of reactors and analysis.

Unit III

Prokinetic parameters and evaluation.
Aerobic and anaerobic process design.

Unit IV

Diffusion and attached growth process. Stabilization pond, oxidation ditch, aerated lagoons and RBC.