ACADEMIC REGULATIONS
COURSE STRUCTURE
AND
DETAILED SYLLABUS

M.Tech.
Bio-Technology

(Effective for the students admitted from the Academic Year 2007-08)

Jawaharlal Nehru Technological University
Hyderabad – 500 085

Jawaharlal Nehru Technological University, Hyderabad
M.Tech. (Bio-Technology) w.e.f. 2007-08

COURSE STRUCTRURE AND SYLLABUS

I SEMESTER

SUBJECT CODE	SUBJECT TITLE	Contact Hrs /Wk
BT-101	Microbial Engineering	4
BT-102	Molecular Biology & Virology	4
BT-103	Preparatory Core Course-I	4
BT-104	Preparatory Core Course-II	4
BT-105	Elective-I from unassigned course list	4
BT-106	Elective-II from unassigned course list	4
BT-107	Techniques in Microbiology and Biochemistry Lab	8
	TOTAL:	**32**

II SEMESTER

SUBJECT CODE	SUBJECT TITLE	Contact Hrs /Wk
BT-201	Microbial Bioreactors Engineering	4
BT-202	Genetic Engineering	4
BT-203	Downstream Processing	4
BT-204	Elective-III from unassigned course list	4
TO	Elective-IV from unassigned course list	4
BT-209 BT - 210	Elective-V from unassigned course list	4
	Bioprocess and r-DNA Technology Lab	8
	TOTAL:	**32**

III & IV SEMESTERS

SUBJECT CODE	SUBJECT TITLE	Contact Hrs /Wk
BT-301	Seminar	12
BT-302	Research Project	64
	TOTAL:	**76**

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LIST OF PREPARATORY CORE / ELECTIVES
UNASSIGNED SUBJECTS/COURSES

I SEMESTER

PREPARATORY CORE COURSES:

(Any two from the following Course 1, Course 2)

BT-XX	General and Industrial Microbiology
BT-XX	Biochemistry and Metabolic Regulation
BT-XX	Process Engineering Principles
BT-XX	Basic Engineering Mathematics.

ELCTIVES I and II: (Any Two of the following)

BT-XXX	Immunology
BT-XXX	Computer Applications and Biostatistics
BT-XXX	Enzyme Engineering

II SEMESTER

ELCTIVES III, IV and V (any three of the following)

BT-XXX	Environmental Biotechnology
BT-XXX	Immunotechnology
BT-XXX	Plant Biotechnology
BT-XXX	Biochemical and Biophysical Techniques
BT-XXX	Bioinformatics
BT-XXX	Animal Cell Science and Technology

NOTE-XX: Depending on the elective number and semester under which a particular course from the above given list is offered, it will be assigned the same number under elective as given in the course structure.

M.Tech. (BIOTECHNOLOGY) - FIRST SEMESTER

BT-101 MICROBIAL ENGINEERING

Unit 1:
Introduction to biotechnology and biochemical engineering, Chronological development of industrial biotechnology, Range of biotechnology products, Components of a microbial bioprocess.

Unit 2:
Sterilization: Media sterilization; kinetics of thermal death of cells & spores, design of batch and continuous thermal sterilization, sterilization of air and filter design. Radiation and chemical sterilization.

Unit 3:
Bioenergetics and stoichiometry: Thermodynamics, mass and energy balances in microbial metabolism, cell growth and product formation; metabolic heat generation.

Unit 4:
Kinetics of microbial growth, substrate utilization and product formation; growth phases of a batch culture, Monod's model including the effects of inhibition, determination of kinetic parameters by batch, fed batch and continuous culture and analysis of chemostat performance.

Unit 5:
Role of maintenance and endogenous metabolism in substrate utilization & growth.

Unit 6:
Structured models: compartmental & metabolic models; Product formation kinetics:

Unit 7:
Gaden's and Deindoerfer's classifications, chemically & genetically structured models; Kinetics of growth & product formation by filamentous organisms.

Unit 8:
Considerations for the production of r-DNA products.

TEXT BOOKS :

1. "Biochemical Engineering fundamentals" by J E Bailey and D F Ollis, 2nd ed, McGraw-Hill (1986).
2. "Principles of fermentation technology" by P F Stanbury and A Whitaker, Pergamon press (1984).
3. "Principles of Cell Energetics" : BIOTOL series, Butterworth – Heinemann.
4. "Bioprocess Technology - Kinetics & Reactors" by A Moser, Springer-Verlag (1981).
5. "Biotechnology" Vol.4 Meanning Modeling and Control Ed. K.Schugerl, VCH (1991).
6. "Biochemical Engineering and Biotechnology Handbook" by B.Atkinson & F.Mavituna, 2nd Ed. Stockton Press (1991).

M.Tech. (BIOTECHNOLOGY) - FIRST SEMESTER
BT-102 MOLECULAR BIOLOGY AND VIROLOGY

Unit 1:
DNA Structure, Replication and repair. Genes arrangement.
Different classes of RNA and their functions. RNA synthesis and other post transcriptional modifications.

Unit 2:
Protein synthesis and translational control.
Eukaryotic chromosome Structure and replication. Repetitive DNA. CpG islands, Gene amplification.

Unit 3:
Control of gene expression in prokaryotes. Transcriptional control in Eukaryotes.

Unit 4:
Plasmids, Transposable elements and TY elements.

Unit 5:
Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping,

Unit 6:
Biochemistry of ribozyrne; hammer- head, hairpin and other ribozymes, strategies for designing ribozymes, Applications of antisense and ribozyme technologies.

Unit 7:
Structure and classification of viruses and Replication of bacteriophages.

Unit 8 :
Replication of animal viruses. A note on SV40 and Retroviruses in transformation.

TEXT BOOKS :

1. "Molecular Biology of the gene" by Waston et al 4th ed.
2. "Genes VI" by Benjamin Lewis

Reference Books :

1. "Genetics" by Ursula Goodenough
2. "Cytogenetics" by lGarl P. Swanson, Mertz & Young
3. "General Virology" by Luria & Darnell
4. "Biochemistry" by Stryer.

M.Tech. (BIOTECHNOLOGY) - FIRST SEMESTER
PREPARATORY CORE COURSES
BT-XX GENERAL AND INDUSTRIAL MICROBIOLOGY

The Beginning of Microbiology: Discovery of the microbial world by Antony van Leeuwenhoek, Controversy over spontaneous generation, Role of microorganisms in transformation of organic matter and in the causation of diseases, Development of pure culture methods; Enrichment culture methods, developments of microbiology in the twentieth century.

Methods in Microbiology :
Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial Growth : The definition of growth, mathematical expression of growth, growth curve, availability and oxygen; Culture collection and maintenance of cultures.
Media formulation: Principles of microbial nutrition, formulation of culture media, selective media, factors influencing the choice of various carbon and nitrogen sources, vitamins, minerals, precursors & antifoam agents. Importance of pH.
History and development of fermentation industry. Shake flask, batch and continuous operations. Solid state fermentation. Primary and secondary metabolites.
Antibiotics: penicillin, streptomycin, tetracycline and other antibiotics; biological production considerations; large scale production.
Organic acids: Lactic, citric, acetic, gluconic, fumaric and itaconic acids; process variables and large scale production.
Alcohols and alcoholic beverages: Ethanol production and purification, production of beer, wine and related beverages.
Industrial Enzymes, Vitamins: Their importance and role as coenzymes; production of B, C and A.
Food industry: Bakers yeast and bread making, rennet and other proteolytic enzymes in cheese making, production of different cheeses; other products from diary industry, sweeteners, single cell protein. Biofertilizers. Fuels: Methane generation, biological production of hydrogen. r-DNA proteins.
Bacterial Genetic System: Transformation, Conjugation, Transduction

TEXT BOOKS:

1. "General Microbiology" 5th Edition Stanier et al.
2. "Enzymes in food processing" by Gerald Reed, Academic press.
3. "Comprehensive Biotechnology" Vols III & IV, Editor M.Moo young.
4. "Industrial Microbiology" by Prescott
5. "Principles of fermentation technology" by P F Stanbury and A Whitaker, Pergamon press (1984)
6. "Industrial Microbiology" by Casida

M.Tech. (BIOTECHNOLOGY) - FIRST SEMESTER
BT-XX BIOCHEMISTRY AND METABOLIC REGULATION

Structure of Biomolecules, Metabolism of Carbohydrates, Lipids, Proteins, Amino acids and Nucleic acids.

Photosynthesis.

Introduction to Enzymes, specificity, catalysis, kinetics, inhibition and allosteric enzymes.

Metabolic Organization and Regulation of metabolism.

Signal Transduction.

Regulation of Metabolism for the production of Primary and Secondary Metabolites with Case studies.

Plasma Membrane: Structure and Transport.

Protein Targeting.

TEXT BOOKS

1. Biochemistry L.Stryer Third Edition
2. Biochemistry White, Handler and R.B.Smith 7th Ed. 1983
3. Principles of Biochemistry A.Lehninger 1987.

BT-XX PROCESS ENGINEERING PRINCIPLES

Role of process engineering principles in biotechnological industries, Brief overview of fundamentals of chemical engineering - concepts of unit operation & unit processes

Introduction to engineering calculations; variables, their dimensions and units; Dimensionally homogenous and Non-homogenous equations; standard conditions and ideal gases; Physical and chemical property data; Basics of Material and energy balances in a macroscopic view point.

Fluid mechanics: Fluids vs solids, Fluid statics and applications including manometer; Mass and energy balances in fluid flow, Newton's law of viscosity, Measurement of viscosity of fermentation broths, flow curves for Non-Newtonian fluids, and examples from bioprocess fluids.

Pressure drop due to skin friction by Rayleigh's method of Dimensional Analysis - significance of friction factor and Reynold's number. Boundary layer theory and form friction, Pressure drop due to form friction.

Flow past immersed bodies and drag coefficients. Pressure drop in flow through packed beds. Fluidization and Pressure drop across fluidized beds. Flow machinery and control: overview of valves and pumps.

Heat transfer: Models of heat transfer and examples. Fourier's law of heat conduction and analogy with momentum transfer, heat transfer through a cylindrical pipe wall.

Convection and concept of heat transfer coefficient, application of dimensional analysis to heat transfer from pipe to a flowing fluid. Thermal boundary layer and Prandtl number. Overall heat transfer coefficient. Correlations for heat transfer coefficients in natural and forced convection, significance of dimensionless numbers. Overview of heat exchangers and concept of LMTD.

Diffusion and mass transfer: Fick's law of diffusion, analogy with momentum and energy transport, diffusivities of gases and liquids; Fundamentals of mass transfer: Theories of mass transfer, concept of mass transfer coefficient, Dimensional analysis of some mass transfer operations, dimensionless numbers and significance, correlation for mass transfer coefficients.

TEXT BOOKS :

1. Bioprocess Engineering Principles" by Pauline M.Doran, Academic Press
2. "Unit operations of Chemical Engineering" 5th ed. by W L McCabe, J C Smith and P. Harriot Mc Graw-Hill (1993).

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M.Tech. (BIOTECHNOLOGY) - FIRST SEMESTER
BT – XX BASIC ENGINEERING MATHEMATICS

UNIT I:
Sets- union, intersection, complement, Demorgan's laws, functions – types of functions, inverse of a function,

UNIT II:

Trigonometry- relations related to compound angles, multiple and sub-multiples, transformations, hyperbolic functions

Unit III :
Concepts of limit, continuity, differentiation, product rule, quotient rule. Differentiation of trigonometric, logarithmic, exponential functions.

Unit IV
Applications of differentiation – problems on tangent, sub tangent normal, sub normal.
Introduction to partial differentiation, Euler's theorem.

UNIT V: Introduction, Integration of different functions, methods of Integration, Integration by parts. Concept of definite integrals.

Unit VI : Applications of definite integrals – problems on areas.

Unit VII: Forming of differential equation by eliminating arbitary constants, first order and first degree – variables and seperables, exact, homogeneous and linear.

Unit VIII :
Laplace transforms of some standard functions. linear property, shifting theorems, change of scale property, multiplication by powers of t, division by t.
Inverse Laplace Transforms
Shifting property, finding inverse laplace by partial fractions, multiplication by powers of s, division by s.
Applications of laplace transforms for solving ordinary differential equations.

Textbooks:

1. Engineering Mathematics - N.P. Bali and others.
2. Engineering mathematics - B.V. Ramana

References :

1. Differential Calculus - Shanthi Narayan
2. Integral Calculus - Shanthi Narayan

M.Tech. (BIOTECHNOLOGY) - FIRST SEMESTER
ELECTIVES
BT-XXX IMMUNOLOGY

Types of immunity: innate and acquired, acute phase reactants. Acquired immunity: humoral and cell mediated immune response.

Immunochemistry: Immunogens, immunogenicity, haptens, adjuvants. Immunoglobulin (antibody) structure and function. Monoclonal antibodies, recombinant and chimeric antibodies. Abzymes. Antigen-antibody interaction. Immunological techniques.

Cellular immunology: Lymphocytes- T and B, Macrophages- identification using CD markers. Lymphoid tissues, lymphocyte development.

Antigen receptors on B and T cells. Antigen recognition, Role of MHC antigens. Lymphocyte activation.

T-cell cloning and its applications in vaccine development

Antibody secretion and cell mediated immune responses. Cytokines: Monokines, lymphokines and interleukins.

Immunological tolerance, Immunosuppressive drugs and transplantation.

Vaccines. conventional, subunit and recombinant. Antiidiotypic vaccines.

Tumor immunology: Immunotoxins.

TEXT BOOKS :

1. "Essential Immunology" by Ivan M.Roitt(1980). (Blackwell Scientific Publications, Oxford, London) fourth edition.

2. "Immunology" by Ivan M. Roitt, Jonathan Brostoff and David K. Male (1985) (Glower Medical Publishing, London) first edition.

3. "Immunology Today".

4. Current topics in Microbiology & Immunology.

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M.Tech. (BIOTECHNOLOGY) - FIRST SEMESTER
BT-XXX COMPUTER APPLICATIONS & BIOSTATISTICS

1. Introduction of digital computers: Organization; low-and high level languages; binary number system, Operating systems.
2. Microsoft-Office packages (MS-Word, MS-Excel, MS-PowerPoint)
3. Descriptive Statistics:
   Develop frequency distributions,Calculate measures of central tendency and Dispersion,Utilize Microsoft® Excel®'s graphic and tabular techniques to represent descriptive statistical data
4. Probability Distribution
   Define terminology related to probability, Differentiate between probability and non-probability sampling designs,Describe the probability distribution of a random variable, Explain the concept of a normal probability distribution
5. Confidence Intervals
   Explain the standard normal distribution,Describe the value of the central limit theorem,Calculate point and interval estimates,Evaluation of confidence Intervals using MS-Excel
6. Hypothesis Testing
   Assess circumstances when hypothesis testing is appropriate, Analyze research, which employs various hypothesis tests, Identify and assess when various inferential tests should be used, Hypothesis testing using MS-Excel
7. Simple linear regression and correlation
   Apply correlation analysis to solve research issues, Apply linear regression analysis to solve research issues, Regression and correlation using MS-Excel
8. Flow charts and algorithms
9. Introduction to programming –
   - Fundamentals of 'C' Language - Typical structure of a C Program. Introduction to programming - Flow charts and algorithms - Fundamentals of 'C' Language - Typical structure of a C Program,Data Types - Variables - Constants - Arithmetic expressions – Use of operators – program examples.
   Decision making in C - relational operators - Logical operators - Precedence of operators
   - IF and IF ... ELSE statements - Looping concepts in C _ WHILE loop - DO ... WHILE
   - and FOR loops - Programming examples.
   Functions - User defined Functions - Local and Global variables - Parameters - Programming examples.
   Arrays - BREAK statement - Strings and character arrays - examples.
10. Introduction to data structures and database concepts
    Database architecture and concepts of Relational database management System, SQL and PL/SQL ,Introduction to Oracle RDBMS

TEXT BOOKS :

1. "Computer Fundamentals" by B.Ram
2. "Fundamentals of Computers" by V.Rajaraman
3. "C Programming" by G.Kochan
4. "The Spirit of C" by Mullish Cooper

M.Tech. (BIOTECHNOLOGY) - FIRST SEMESTER
BT-XXX ENZYME ENGINEERING

Enzymes: Introduction, Free, immobilized and allosteric enzymes: Applications in Industrial, Medical, Analytical, Chemical, Pharmaceutical and Food sectors.

Enzyme isolation, purification, immobilization and assay methods.

Enzyme kinetics in free,immobilized and allosteric enzymes: Michaelis-Menten kinetics, kinetics for reversible reactions.

Effect of various types of inhibition, Evaluation of kinetic parameters.

Micro environmental effects on enzyme kinetics, Enzyme deactivation.
Structure and activity of the enzymes Mechanism of action of chymotrypsin, glyceraldehyde 3 Phosphate dehydrogenase, lysoenzyme, carboxy peptidase, ribonuclease, aldolase etc.

Applications of various types of reactors in enzymatic reactions: Immobilized bioreactors, fluidized bed reactors, Air lift reactors and recycle reactors.

Internal and external mass transfer effects in immobilized-enzyme reactors. Intra-particle diffusion and reaction, interaction between mass transfer and biochemical reaction. Concept of Thiele modulus and effectiveness factor, operational stability and optimization, general design considerations.

Enzyme reactions in organic media.

TEXT BOOKS :

1. "Biochemical Engineering" by James M. Lee , Prentice Hall (1992).

2. "Priciples of Biochemistry" by A.Lehninger (1987).

3. "Design and Analysis of immobilised Enzyme Flow Reactors " by W.R.Vieth et al.

FIRST SEMESTER LABORATORY COURSES

BT-107 TECHNIQUES IN MICROBIOLOGY AND BIOCHEMISTRY

List of Experiments:

1. Basic techniques in handling microbes - sterilization, media preparation, precautions etc.,
2. Study of growth rate and the factors affecting it.
3. Chromatography - including Paper, TLC, GLC, Gel filtration chromatography (HPLC) and Ion exchange chromatography (FPLC)
4. Electrophoresis and Blotting Techniques - PAGE and SDS-PAGE. Determination of molecular weight. Western Blot Technique.
5. Quantitative determination of carbohydrate content: e.g.Preparation of Starch from various sources, starch hydrolysis and determination of carbohydrate content.
6. Estimation of proteins by Lowry's and Biuret methods e.g. in milk, legumes and pulses.
7. Isolation and Estimation of DNA by Diphenylamine reaction and UV spectroscopic method.

M.Tech. (BIOTECHNOLOGY) - SECOND SEMESTER
CORE COURSES
BT-201 MICROBIAL BIOREACTOR ENGINEERING

Analysis of ideal bioreactors : The Ideal Batch reactor, Continuous Stirred Tank Reactor (CSTR), series of CSTRs, Fed-batch and Plug flow Reactors., Reactor dynamics. Non-idealities of bioreactors: Models for Non-ideal bioreactor,

Transport phenomena in bioprocess systems: Examples of transport of mass, momentum and energy. Oxygen requirements of microbial cultures. Oxygen mass transfer fundamentals, Oxygen transfer and oxygen demand. Oxygen transfer by aeration and agitation. Determination of oxygen transfer coefficient by various methods including sulfite oxidation, dynamic gassing out and oxygen balance methods. Factors affecting oxygen transfer coefficient.

Mixing-bioreaction interactions.

Momentum transport by agitation: Determination of aerated and unaerated power consumption from nomographs both for Newtonian and non-Newtonian cultivation broths. Correlation for oxygen transfer coefficient. Heat transfer requirements of microbial cultivations.

Overview of methods for online and offline monitoring of bioreactors; bioprocess control methodologies.

Scale-up of microbial bioreactors: Various approaches to scale-up including regime analysis and scale-down; Scale -up methods by currently used rules-of-thumb viz. constant P/V, kLa etc.

Analysis of alternate bioreactor configurations.

Stability and analysis of bioreactors

Types of reactors for filamentous, non filamentous, animal and plant cells.

TEXT BOOKS:

1. "Biochemical Engineering fundamentals" 2nd ed. by J E Bailey and D F Ollis, McGraw-Hill (1986) Chapters 8,9&10.
2. "Biochemical Engineering" by S Aiba, A E Humphrey and N Millis , Prentice-Hall (1978).
3. "Biotechnology" Vols. 3 & 4 Eds. H S Rehm and G Reed. VCH (1991).
4. "Bio-reactors in biotechnology - A practical approach" by AH Scragg.
5. "Biochemical Engineering and Biotechnology Handbook" 2nd Ed. B.Atkinson & F.Mavituna, Stockton Press (1991).
6. "Bioprocess engineering : Basic concepts" 2 nd ed., Michael L shuler and Fikret kargi, Prentice Hall of India , New Delhi(2003).

M.Tech. (BIOTECHNOLOGY) - SECOND SEMESTER
BT-202 GENETIC ENGINEERING

Theory

Unit 1:

Scope of Genetic Engineering

Milestones In Genetic Engineering - Isolation of enzymes, DNA sequencing, synthesis and mutation, detection and separation, cloning, gene expression. Cloning and patenting of life forms. Genetic Engineering Guidelines.

Unit 2:

Nucleic Acid Purification, Yield Analysis

Nucleic Acid Amplification and Its Applications

Unit 3:

Molecular Tools in genetic engineering: Restriction enzymes, ligases, s1 nuclease, terminal deoxynucleotides, transferases, Poly A polymerases, Reverse Transcriptase, Alkaline phosphatase etc., modification enzymes, DNA, and RNA markers.

Unit 4:

Gene Cloning Vectors --Plasmids, bacteriophages, phagemids, cosmids, Artificial chromosomes.

Restriction Mapping of DNA Fragments and Map Construction. Nucleic Acid Sequencing.

Unit 5:

cDNA Synthesis and cDNA library preparations. Cloning mRNA enrichment, reverse transcription, DNA primers, Linkers, adaptors and their chemical synthesis, Library construction and screening. Genomic libraries (complete sequencing projects).

Unit 6:

Alternative Strategies of Gene Cloning Cloning interacting genes- Two-and three hybrid systems, cloning differentially expressed genes. Nucleic acid microarray arrays.

Site-directed Mutagenesis and Protein Engineering

Unit 7:

How to Study Gene Regulation? DNA transfection, Northern blot, Primer extension, S1 mapping, RNase protection assay, Reporter assays.

Expression Strategies for Heterologous Genes Vector engineering and codon optimization, host engineering, In vitro transcription and translation, expression in bacteria, expression in Yeast, expression in insects and insect cells, expression in mammalian cells, expression in plants.

Processing of Recombinant Proteins Purification and refolding, characterization of recombinant proteins, stabilization of proteins.

Unit 8:

Phage Display

T-DNA and Transposon Tagging Role of gene tagging in gene analysis, T-DNA and transposon tagging, Identification and isolation of genes through T-DNA or transposon.

Transgenic and Gene Knockout Technologies Targeted gene replacement, Chromosome engineering.

Gene Therapy Vector engineering. Strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing.

Practical

1. Bacterial culture and antibiotic selection media, Preparation of competent cells.
2. Isolation of plasmid DNA.
3. Isolation of Lambda phage DNA.
4. Quantitation of nucleic acids.
5. Agarose gel electrophoresis and restriction mapping of DNA.
6. Construction of restriction map of plasmid DNA.
7. Cloning in plasmid/phagemid vectors.
8. Preparation of helper phage and its titration.
9. Preparation of single stranded DNA template.
10. DNA sequencing.
11. Gene expression in E. coli and analysis of gene product.
12. PCR
13. Reporter Gene assay (Gus/CAT/b-GAL).

Books

1. Molecular Cloning: a Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
2. DNA Cloning: a Practical Approach, .M. Glover and B.D. Hames, IRL Press, Oxford, 1995.
3. Molecular and Cellular Methods in Biology and Medicine, P.B. Kaufman, W. Wu. D. Kim and L.J; Cseke, CRC Press, Florida, 1995.
4. Methods in Enzymology vol. 152, Guide to Molecular Cloning Techniques, S.L. Berger and A.R. Kimmel, Academic Press, Inc. San Diego, 1998
5. Methods in Enzymology Vol 185, Gene Expression Technology, D.V. Goeddel, Academic Press, Inc., San Diego, 1990
6. DNA Science. A First Course in Recombinant Technology, D,A. Mickloss and G.A. Froyer. Cold Spring Harbor Laboratory Press, New YorK, 1990.
7. Molecular Biotechnology (2nd Edn.), S.B. Primrose. Blackwell Scientific Publishers, Oxford, 1994
8. Milestones in Biotechnology. Classic papers on Genetic Engineering, J.A. Davies and W.S. Reznikoff, Butterworth-Heinemann, Boston, 1992.
9. Route Maps in Gene Technology, M.R. Walker and R. Rapley, Blackwell Science Ltd., Oxford, 1997.
10. Genetic Engineering. An Introduction to gene analysis and exploitation in eukaryotes, S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford, 1998
11. Molecular Biotechnology - Glick.

M.Tech. (BIOTECHNOLOGY) - SECOND SEMESTER
BT-203 DOWNSTREAM PROCESSING

Characteristics of biotechnology products.

Overview of a bioprocess including upstream and downstream processing.

Principles, operation, design and scale-up of the following:
Mechanical methods:, separation of particulate by filtration, centrifugation, cell disintegration, flocculation and sedimentation.

Primary isolation methods -solvent extraction, precipitation.

Membrane-based separations -micro filtration , ultra filtration and Reverse osmosis.

Purification methods: electrophoretic separations (all electrophoresis techniques including capillary electrophoresis) and various kinds of chromatography and adsorption
Product polishing- dialysis, crystallization
Product recovery trains - a few examples.

New and Emerging techniques: Pervaporation , Super critical extraction , Foam based separation.

TEXT BOOKS:

1. "Biochemical Engineering fundamentals" 2nd ed. by J E Bailey and D F Ollis, McGraw-Hill (1986)
2. "Principles of fermentation technology" by P F Stanbury and A Whitaker, Pergamon press (1984)
3. "Comprehensive Biotechnology" Vol.2 Ed.: M. Moo-Young (1985)

M.Tech. (BIOTECHNOLOGY) - SECOND SEMESTER - ELECTIVES
BT-204 ENVIRONMENTAL BIOTECHNOLOGY

Role of Biotechnology in Environment Protection: What is Environmental Biotechnology? Current Status of Biotechnology in Environment Protection, Future .

Microbiology and Biochemistry of Waste Water Treatment: Biological Treatment,Impact of Pollutatnts on Biotreatment, Cell Physiology and Important Microorganisms, Plasmid Borne Metabolic Activities, Bioaugmentation, Packaged Microorganisms, Use of Genetically Engineered Organisms .

Bioreactors for Waste Water Treatment: Biological Processes for Industrial Effluent Treatment, Aerobic Biological Treatment, Anaerobic Biological Treatment,Periodic Biological Reactors, Membrane Bioreactors,Use of Immobilized Enzymes and Microbial Cells .

Removal of Specific Pollutants: Sources of Heavy Metal Pollution, Microbial Systems for Heavy Metal Accumulation, Biosorption, Bioleaching.

Bioremediation: What is Bioremediation? Case Histories, Constraints and Priorities of Bioremediation, Bioaugmentation for Bioremediation, Bioreactors for Remediation Processes, Types of Bioremediation, Applications - Examples, Biotechnology and Oil Spills .

Biotechnology for Hazardous Waste Management: Xenobiotic Compounds, Recalcitrance, Hazardous Wastes, Biodegradation of Xenobiotics, Biological Detoxification, Biotechnology Applications to Hazardous Waste Management, Examples of Biotechnological Applications to Hazardous Waste Management.

Biotechnology for Pesticide Industry: Tannery Industry and Biotechnology. Paper Industry and Biotechnology.

Biotechnology for Waste Treatment of Food and Allied Industries: Biological Treatment Methods, SCP and Biomass from Waste, Distillery Industry.

Biotechniques for Air Pollution Abatement and Odor Control: Deodorization Process, Applications. Solid Waste Management .

Novel Methods for Pollution Control: Vermitechnology, Waste Water Treatment Using Aquatic Plants, Root Zone Treatment. Aiming for Biodegradable and Ecofriendly Products .

TEXT BOOKS :

1. "Waste water Engineering Treatment and Disposal and Reuse" by Metcalf & Eddy.
2. "Water Pollution Management Hand Book" by Lepathak.
3. "Waste Water Management" by Arceivala.
4. "Environmental Biotechnology" by C. F. Forster and D. A. J. Wase.
5. "New Processes of Waste water treatment and recovery" by G. Mattock (ED) Ellis Horwood.
6. "Biochemical Engineering fundamentals" 2nd ed. by J E Bailey and D F Ollis , McGraw - Hill (1986). Chapters 13 & 14.
7. "Environmental Biotechnology" by Jogdand.

BT-205 IMMUNOTECHNOLOGY

Hybridoma techniques and monoclonal antibody production - myeloma cell lines- fusion of myeloma cells with antibody producing B- cells- fusion methods- selection and screnning methods for positive hybrids- cloning methods -production, purification and characterization of monoclonal antibodies. Application of monoclonals in biomedical research, in clinical diagnosis and treatment. Production of human monoclonal antibodies and their applications.

T-cell cloning- mechanism of antigen recognition by T and B- lymphocytes. Structure, function and synthesis of lymphokines- Importance of antigen presentation and MHC class II molecules in T- cell cloning -antigen specific and alloreactive T-cell cloning- use of T-cell cloning in understanding the immunologically relevant antigens and T-cell epitopes - application of T-cell cloning in vaccine development.

Immunity to virus, bacteria and parasites- Genetic control of immune response - MHC associated predisposition to diseases- infectious diseases, leprosy, tuberculosis, malaria, filariasis, amoebiasis, rabis, typhoid, hepatitis, AIDS.

Principles and strategy for developing vaccines- newer methods of vaccine preparation

Immunodiagnosis of infectious diseases.

Recent advances in immunotechnology.

TEXT BOOKS :

1. "Monoclonal antibodies: Principles and practice" by J.W. Goding. Academic Press.
2. "Hybridoma Technology in the Biosciences and Medicine" T.A.Sringer (Editor) Plenum Press, N.Y.
3. "Hybridoma Techniques: A Laboratory Course" by VR. Muthukkaruppan, S. Baskar and F. Sinigagalia. Macmillan India Ltd.
4. "Basic and Clinical Immunology" by D.P. Stites, J.D.Stobo, H.H.Fudenberg J.V. Wells. 5th Edition Large medical publications.
5. "Isolation, Characterization and Utilization of T-lymphocyte clones" by C.Garrison Fathman , F.W. Fitch academic Press.

M.Tech. (BIOTECHNOLOGY) - SECOND SEMESTER - ELECTIVES

BT-206 PLANT BIOTECHNOLOGY

Unit 1:
Different areas and applications of plant tissue culture. Nutritional components of tissue culture media. Totipotency.

Unit 2:
Establishment of aseptic cultures, Initiation of callus and suspension cultures, Regeneration of plants, Organogenesis, Micropropagation with shoot apex cultures
(Clonal Propagation), Somatic Embryogenesis.
Regulation of cell differentiation, biochemical and molecular events in vitro.

Unit 3:
Isolation and culture of protoplasts, protoplast fusion and somatic hybridization, Selection systems for somatic hybrids / Cybrids and their characterization .

Unit 4:
Anther Pollen culture, Production of haploids and their application.
Induction of mutation, Somoclonal variation.
Storage of plant genetic resources (Cryopreservation)

Unit 5:
Production of Secondary metabolites by plant cell cultures, commercial production of secondary metabolites
Technology for yield enhancement and bioreactor system and models for mass cultivation of plant cells.
Biotransformations using plant cell cultures.

Unit 6:
Genetic Transformation methods for production of transgenic plants (Direct, Indirect)

Unit 7:
Production of genetically modified (GM) plants for Agronomic traits.

Unit 8:
Application of Plant Biotechnology for the production of quality oil, Industrial enzymes, theraputic proteins (plantibodies, plantigens, edible vaccines etc.,)

TEXT BOOKS :

1. "Plant Cell, Tissue, and Organ culture" by J Reinert and Y P S Bajaj.
2. "Plant Cell and Tissue Culture" by S.Narayanaswamy.

REFERENCE BOOKS

1. "Hormones at Cellular Level" Ed. by Scott, T.K.
2. "Plant Tissue Culture" Thorpe, T.A. (Ed.).
3. "Handbook of Plant Cell Culture" Eds. Sharp et al.
4. "Plant Biotechnology" Eds. Mantell & Smith

M.Tech. (BIOTECHNOLOGY) - SECOND SEMESTER - ELECTIVES
BT-207 BIOCHEMICAL AND BIOPHYSICAL TECHNIQUES

Unit 1: Colloidal solutions of biopolymers and their electrochemical properties Hydrodynamic properties: Viscosity, diffusion etc of biopolymers; molecular weight determination, osmotic pressure, reverse osmosis and Donnan effect. Structure Biomembrances and their electrochemical properties, membrane potential, action potential and propagation of impulses.

Unit 2: Electrophoresis: Different methods of electrophoresis for protein, nucleic acids, small molecular weight compounds and immuno precipitates (Immuno electrophoresis). eptide mapping and combination of electrofocussing and SDS-PAGE.

Unit 3: Theory of centrifugation and application to biological systems. Rotors angle/vertical/zonal/continuous flow centrifuge, differential centrifugation density gradient centrifugation. Ultra centrifugation principle and application.

Unit 4: Chromatography – adsorption, affinity, partition, lon exchange, gel permeation, GLC, TLC, RPC, HPLC etc.

Unit 5: Introduction to principles and applications of (a) spectroscopic methods (UV, Vis, IR, Fluorescence, ORD, CD & PAS) (b) NMR, ESR & Mass spectrometry.

Unit 6: Use of radioactive and stable isotopes and their detection in biological systems.

Unit 7: Introduction to principles and working of light & Electron microscope.

Unit 8: Automatic analyzer for amino acids, protein sequenater, peptide synthesizer & nucleic acid synthesizer. Cell sorters and their applications. Theory of lyophillization and its applications to biological systems.

M.Tech. (BIOTECHNOLOGY) - SECOND SEMESTER - ELECTIVES
BT-208 BIOINFORMATICS

Unit 1: Introduction and Bioinformatics and Biological Databases:

- Introduction to Bioinformatics- History, overview, Applications
- Emerging area of Genomics and Proteomics
- Biological databases and their management-Protein Sequence databases, Protein structure databases, DNA databases, drug databases

Unit 2: Nucleotide Sequence Analysis.

- Nucleotide sequence analysis
- DNA Sequence Analysis- Nucleic acid codes, Introduction to whole genome analysis, restriction site checks, Sequence assembly, finding overlaps and contigs, shotgun projects, walking primers, ORF analysis, Identification of transcription signals and other sequence patterns, Restriction enzyme databases, Coding region identification, EST analysis, SNP analysis.

Unit 3: RNA Structures:

- RNA sequence and structure Analysis – Different types of RNA, si-RNA design and development, micro RNA identification strategies, RNA secondary structure, RNA structure Prediction Methods, Introduction to Small nuclear RNAs, Applications of Small nuclear RNA
- DNA/Protein Sequence Alignments

Unit 4: Statistical Methods in Bioinformatics:

- Dynamic programming methods – derivation and algorithms
- Sequence Alignment concepts, Pair-wise alignment, Heuristic alignments, Multiple alignment, Matrices (PAM, BLOSUM)
- Statistics and Scoring systems

Unit 5: Structure of Proteins:

- Protein sequence analysis
- Protein Physical properties – Molecular weight and amino composition, Iso-electric point, extinction coefft, Studies of protein hydrophobicity on kyte and Doolittle scale and other physic0-chemical properties of primary protein sequence
- Structural properties – Secondary structures, Hydrophobic patterns, structural motifs, Poot translational modifications, Floding domain motifs, protein families
- Principles of Protein Structure

Unit 6: Protein Modeling.

- Secondary Structure prediction methodologies, Threading methods
- Protein Folds, protein domains, Tertiary structure prediction
- Hormology Modeling of proteins-methodology and applications
- Ab initio protein structure prediction
- Energy minimization-concept, applications and methodology
- Molecular Dynamics simulations-concept and methodology

Unit 7: Drug Modeling

- QSAR and Drug Designing Concepts
- 2D descriptors
- 3D descriptors
- Drug Discovery
  Drug Discovery Overview
  Stages of drug discovery
  Introduction to drug discovery tools-MoE and Accelyrs suite

Unit 8: Bioinformatics Applications

- Bioinformatics applications in experimental biotechnology
- Automatic 2D Gel analysis-Tools, Principles and methodology
- Restriction analysis of DNA sequences
- Insilico Primer Design
- Micro-array image and data analysis
- Protein Interaction Mapping (Yeast 2 Hybrids)
- Functional genomics tools
- Functional proteomics tools

Text Books:

1. Bioinformatics: Genome and sequence analysis by Dravid W Mount.
2. Bioinformatics: A practical guide to analysis of genes and protein by Baxevanis, Andreas D Wiley – Interscience publishers.

Reference Books:

1. Computational Molecular Biology-An Introduction by Peter Clote, Rolf Backofen, Jhon Wiley & Sons
2. Essential Bioinformatics: by Jin Xiong, Cambridge University Press
3. Informatics in Proteomics by Srivasthava CRC Publishers
4. Protein Structure Prediction: Bioinformatics approach by Igor F. Tsigelny International University Line
5. An introduction to bioinformatics algorithms by Neil C. Jones, Pavel A Pevzner

M.Tech. (BIOTECHNOLOGY) - SECOND SEMESTER - ELECTIVES
BT – 209 ANIMAL CELL SCIENCE AND TECHNOLOGY

THEORY

1. Structure and organization of animal cell
2. Equipments and materials for animal cell culture technology
3. Primary and established cell line cultures
4. Introduction to the balanced salt solutions and simple growth medium, Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Role of carbon dioxide. Role of serurn and supplements.
5. Serum & protein free defined media and their application.
6. Measurement of viability and cytotoxicity.
7. Biology and characterization of the cultured cells, measuring parameters of growth.
8. Basic techniques of mammalian cell culture *in vitro;* disaggregation of tissue and primary culture, maintenance of cell culture; cell separation.
9. Scaling-up of animal cell culture.
10. Cell synchronization.
11. Cell cloning and micromanipulation.
12. Cell transformation.
13. Application of animal cell culture.
14. Stem cell cultures, embryonic stem cells and their applications
15. Cell culture based vaccines
16. Somatic cell genetics.
17. Organ and histotypic cultures.
18. Measurement of cell death
19. Apoptosis
20. Three dimensional culture and tissue engineering

PRACTICAL

1. Preparation of tissue culture medium and membrane filtration
2. Preparation of single cell suspension from spleen and thymus
3. Cell counting and cell viability.
4. Macrophage monolayer from PEC, and measurement of phagocytic activity.
5. Trypsinization of monolayer and subculturing.
6. Cryopreservation and thawing,

BOOKS:

- Culture of Animal Cells, (3rd Edition), Fl. !an Froshney. Wiley-Liss.
- Animal Cell Culture - Practical Approach, Ed. John R.W. Masters, OXFORD,
- Cell Growth and Division: A Practical Approach. Ed. R. Basega, IRL Press.
- Cell Culture Lab Fax. Eds. M Butler & M. Dawson, Bios Scientific Publications Ltd..Oxford.
- Animal Cell Culture Techniques. Ed. Martin Clynes, Springer.
- Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods. Ed. Jenni P Mather and David Barnes. Academic Press.

SECOND SEMESTER LABORATORY COURSES
BT-207 BIOPROCESS AND R-DNA TECHNOLOGY

List of Experiments:

1. Immobilization of whole cells (Yeast) and enzymes (Amylase).

2. Various bioprocesses followed by product recovery e.g.
   (I) Citric acid production from *A. niger*
   (ii) Ethanol production from *S. cereviceae*

3. Isolation of plasmid, phage and human DNA

4. Agarose gel electrophoresis and visualization of DNA on gels.

5. Restriction enzyme digestion

6. Ligation

7. Transformation

8. Screening.

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