SYLLABUS

M. Sc. Biotechnology, Semester System

Department of Biotechnology



Jamia Millia Islamia New Delhi-110 025

Contents

- Syllabi for semester I to IV
- Tentative list of practicals
 - List of suggested books

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EXAMINATION RULES

40% marks in each paper or part thereof
40% marks in Practical/Project/Viva voce/Dissertation
40% marks in Internal Assessment of each paper (if any); and
40% marks in the aggregate of each part

Format of course: Semester System as per UGC Norms

Number of semester: 4 (four; I, II, III and IV)

Number of Papers per Semester

Semester I : 06 Semester II : 06 Semester III : 06 Semester IV : 01

Laboratory Course per Semester

Semester I: 01Semester II: 01Semester III: 01Semester IV: 01

Credits per Semester

Semester I	:24
Semester II	:24
Semester III	:24
Semester IV	:16
Total Credits	: 88

Marks per Semester

Semester I	: 600
Semester II	: 600
Semester III	: 600
Semester IV	: 400

Total Marks: 2200

JAMIA MILLIA ISLAMIA NEW DELHI

COURSE OUTLINE

M.Sc. BIOTECHNOLOGY, SEMESTER I

		Marks			
Subject Code	Title of paper	Internal Assessment	Semester Exam	Total	Page no.
BTM-101	Biomolecules	25	75	100	6
BTM-102	Microbiology	25	75	100	7
BTM-103	Molecular Genetics	25	75	100	8
BTM-104	<u>Molecular Cell</u> <u>Biology</u>	10	40	50	9
BTM-105	Molecular Biophysics	10	40	50	10
BTM-106	<u>Computer</u> <u>applications &</u> <u>Biostatistics</u>	10	40	50	11
BTM-107	Lab Course I	50	100	150	12

Subject		Marks			
Code	Title of paper	Internal Assessment	Semester Exam	Total	Page no.
BTM-201	<u>Metabolism &</u> <u>Enzymology</u>	25	75	100	13
BTM-202	Immunology	25	75	100	14
BTM-203	Animal Biotechnology	10	40	50	15
BTM-204	<u>Molecular Biology of</u> <u>Eukaryotic systems</u>	10	40	50	16
BTM-205	<u>Cellular & Molecular</u> <u>Physiology</u>	10	40	50	17
BTM-206	<u>Recombinant DNA</u> <u>Technology</u>	10	40	50	18
BTM-207	Seminar Presentation	-	-	50	19
BTM-208	Lab Course II	50	100	150	19

M.Sc. BIOTECHNOLOGY, SEMESTER II

Subject	Title of paper	Marks			
Code		Internal Assessment	Semester Exam	Total	Page no.
BTM-301	Bioprocess Technology	25	75	100	20
BTM-302	<u>Fermentation &</u> <u>Downstream</u> <u>Processing</u>	25	75	100	21
BTM-303	<u>Medical</u> <u>Biotechnology &</u> <u>Molecular Medicine</u>	25	75	100	22
BTM-304	IPR Issues in Biotechnology	10	40	50	23
BTM-305	Environmental Biotechnology	10	40	50	24
BTM-306	Plant Biotechnology	10	40	50	25
BTM-307	Lab Course III	50	100	150	26

M.Sc. BIOTECHNOLOGY, SEMESTER III

Subject Code	Title of paper	Marks			
Cour		Internal Assessment	Semester Exam	Total	Page no.
BTM-401	Project	-	200	200	27
BTM-402	Seminar Presentation	-	-	50	27
BTM-403	<u>Laboratory Course</u> <u>IV</u>	50	100	150	28

M.Sc. BIOTECHNOLOGY, SEMESTER IV

List of Suggested Books ------ Page nos. 29-39 Semester I Semester II Semester III

(Semester I) M. Sc. Biotechnology 4 credits Biomolecules

Unit 1: Amino Acids & Proteins

Amino acids of protein: classification, characteristics, peptide bonds, Acid base properties, Nomenclature, primary structure of protein and its determination, Secondary, Tertiary and Quaternary Structure of proteins, Protein stability and denaturation.

Unit 2: Carbohydrates

Monosaccharides, Classification, Configuration and Conformation, Biologically important sugar derivatives Disaccharides, Polysaccharides, glycosaminoglycans, Glycoproteins.

Unit 3: Lipids

Fatty acids, Triacyl glycerols, phospholipid, sphingolipids & cholesterol & lipoproteins.

Unit 4: Biophysical Chemistry

Units & dimensions, water and its unique properties in Biology: Acid, Bases & Buffers, Biochemical relevance of pH, Background thermodynamics, chemical equilibrium & coupling, Application of Thermodynamics into Biochemistry; Oxidation-Reduction reactions.

Unit 5: Vitamins & Enzyme

Fat soluble vitamins; structure and function, water soluble vitamins: structure, coenzyme forms and biochemical functions – Enzymes: Introduction, units of activity, Nomenclature, Enzyme catalytic mechanisms, Factors affecting enzyme activity, Effect of substrate, pH & temp on Enzyme activity. Simple Michalis-Menten kinetics. Significance of Ks, Kcat and Km. Isozymes & allosteric enzymes.

(Semester I) M. Sc. Biotechnology 4 credits Microbiology

BTM-102

Unit 1: Basic Concepts and Tools in Microbiology

History and Scope of Microbiology: The Microscope, spontaneous generation, Biogenesis, Fermentation, Germ theory of diseases, Koch's Postulates, Microbiology as a basic Science, Applied Microbiology. Techniques used in observation of microorganisms. Light microscopy: Bright-Field microscope, Dark-Field microscope Phase-Contrast microscope, Preparation and staining of Specimen, Electron microscopy: Transmission electron microscope.

Unit 2: Morphology and Taxonomy

Bacterial size, shapes and pattern of arrangement Structures external to cell wall; Flagella, Pili, Capsule, Sheath, Prosthecae and Stalk, Structure and chemical composition of cell wall, Structure internal to cell wall: Cytoplasmic membrane, Protoplast, Spheroplast, Cytoplasmic inclusions, Genetic material, Spores, and Cysts. Major Characteristics used in classification of Microorganisms, Classification systems: Numerical Taxonomy, Phylogenetic system, Bacterial taxonomy and Bergey's manual of Bacteriology.

Unit 3: Nutrition, Growth and Metabolism

Nutritional types of bacteria. Bacteriological media, Physical conditions influencing growth: Salutes and water activity, pH, temperature, Oxygen concentration, Pressure, Radiation etc. Modes of cell division, Growth curve, Syntchronous growth, Batch culture, Continuous culture, Quantitative measurement of growth Bacterial Metabolism: Breakdown of glucose to pyruvate, TCA cycle, Electron transport and Oxidative phosphorylation, Fermentation and Anaerobic respiration.

Unit 4: Control of Microorganisms, (Physical Agent/Processes and Chemical Agents)

Definitions and fundamentals of control, Conditions influencing antimicrobial action, physical agent processes and for control: Heat, Filtration, Radiations, Phenolics, Alcohols, Halogens, Heavy metals, Quarternary ammonium compounds, Aldehydes, Sterilizing gasses. Evaluation of antimicrobial agent effectiveness.

Unit 5: Control of Microorganisms (Chemotherapeutics and Antibiotics)

History of chemotherapy, General characteristics, sulfonamides, Penicillin, Cephalosporin, Aminoglycosides, Chloramphenical and other antibiotics, Antifungal drugs. Drug Resistance, Mechansim of drug resistance, Origin and transmission

Unit 6: Industrial Microbiology- Application process related to microbes in industry with a general account of meat, dairy products and other fermented products.

(Semester I) M. Sc. Biotechnology 4 Credits Molecular Genetics

Unit 1:Perpetuation of nucleic acid

Semiconservative replication of double stranded DNA; models of DNA replication. Origin of replication, replicons, priming, initiation and elongation; models of replication of RNA as genetic material. Enzymes of DNA replication: Properties of DNA polymerases I, II, III, reverse transcriptase, RNA polymerases and their types. Mutational studies in DNA polymerases. Primosomes and replisomes, events at the leading and lagging strands.

Unit 2: Mutation, mutagenesis and DNA repair

General account. Physical and chemical mutagens. Types of mutations: frame-shift, transition, translation and transversion. The molecular basis of gene mutation. Site-directed mutagenesis. Repair mechanisms: photoreactivation, excision, post replication and SOS repair mechanisms.

Unit 3:Genome in flux

Mechanisms of genome transfer during conjugation, transformation and transduction. Generalized and specialized transduction Hfr strains, sex pili transducing phages, Insertion sequences and transposons elements.

Unit 4: Regulation of gene expression

Induction and repression. Repressor as a regulator molecule. Coordinated control of gene clusters. Positive and negative regulation. Transcription units and cis elements. Promoter: consensus sequences affecting the promoter function. Constitutive and inducible promoters. Operon sequences as regulatory cis sequences. Initiation: Interaction of polymerase with the promoter and control at initiation. Attenuation. Elongation. Termination: rho dependent and rho independent termination. Control at termination: attenuation. Antitermination. Regulation of transcription of lac, trp, his,ara and gal operons. Transcriptional regulation in bacteriophage lambda. Lytic and lysogenic switch.

Unit 5: Translation

Genetic code. Essential components of translation. Ribosoms: The site for translationsubunit composition and assembly. Role of ribosomal RNA in translation. tRNA: Salient features of tRNA. Aminocyl tRNA synthetases. Difference between initiator fmet RNA and met tRNA supressor tRNAs, frameshift supression. Codon-Anticodon recognition: Wobble hypothesis. Process of translation: Activation, Initiagtion, elongation translocation and termination. Transport of bacterial proteins: Co transational and Post-translational mechanisms, Control of gene expression at transational level.

(Semester I) M. Sc. Biotechnology 2 Credits Molecular Biology of Cell

BTM-104

Unit 1: Evolution of Cells

Introduction of Evolution, Prebiotic Synthesis, RNA catalysis: A basis for a precellular genetic system, A reconstruction analysis of cell lineages, Evolution of gene structure: lessons from present day introns distribution.

Unit 2: Plasma Membrane

Early membrane models, Principles of membrane organization, Detailed structure of erythrocyte membrane, Transport across membrane – Diffusion of small molecules across phospholipid bilayer, overview of membrane transport proteins. Intracellular Ion environment and membrane electric potentials. GLUTI transport glucose into mammalian cells, Ca⁺⁺-ATPase, Na⁺/K⁺ATPase, Na⁺linked symporters, import amino acids and glucose, Na⁺-linked Antiporter Ca⁺⁺from cardiac muscle cells

Unit 3: Internal membrane

Compartmentalisation of eukaryotic cells, Structure and functional features of Endoplasmic reticulum, Golgi complex, Lysosome, Peroxisome Mitochondria,

Unit 4: Nucleus and Cell Cycle

Nuclear envelope: morphology, ultrastructie and biochemical role of nuclear envelope in nucleocytoplasmic interaction Cell Cycle.

Unit 5: Cancer and Cell Death

Characteristic of tumour cells, Use of cell culture in cancer research, DNA viruses and transforming agents. Human tumour viruses, Chemical carcinogenesis. The role of radiation and DNA repair in carcinogenesis, Oncogene and their proteins; Classification and characterization. The role of cellular oncogenes in carcinogenesis, Apoptosis.

Books recommended:

- 1. Molecular Biology of the Cell, Albert B, Bray D, Raff M, Roberts K, Watson JD, IIIrd ed., Garland Publilshing Inc., New York, 1994.
- 2. Molecular Cell Biology Lodish H, Berk A, Zipursky SI, Matsudaira P. Baltimore D, Darnell J, IV ed., W.H. Freeman and companyh, 2000

(Semester I) M. Sc. Biotechnology 2 Credits Molecular Biophysics

Unit 1: Bioenergetics

Laws of thermodynamics, Free energy of physiochemical processes, Rates of reactions, Activation Energy, Photochemical & photosynthesis, phosphate bond energy, photophosphorylation & oxidative phosphorylation, Mitchell's concept of proton motive force (Chemi-osmotic) theory.

Unit 2: Membrane Biophysics

Nernst Plank Equation. Nernst Equation, Electro-kinetic phenomena, Donnan potential Cell membrane potential, Ion ,Action Potential & its propagation, Visual receptors, Chemical receptors.

Unit 3: Structure of Nucleic acid

Chemical & physical structure of DNA (Watson Crick Model) as deduced from X-ray diffraction pattern, variability of DNA structure, structure of RNA, Super coiling, Multiplex structure of DNA & its relevance. Denaturation & Renaturation of nucleic acids.

Unit 4: Biophysical & Biophysical Technique

Principle & application of:

- (a) Spectroscopy Basic concepts, UV & visible, Beer- Lambert Law, Infra red, fluorescence, phosphorescence
- (b) Chromatography Ion Exchange, paper, gel filtration, affinity etc.
- (c) Membrane filtration & dialysis, Osmosis & reverse Osmosis
- (d) Electrophoresis paper, gel, SDS, PAGE, Iso-electric focusing, capillary
- (e) Centrifugation Sedimentation (differential) and Ultra centrifugation.

(Semester I) M. Sc. Biotechnology 2 Credits Computer Application & Biostatistics

BTM-106

Unit 1: Permutation and Combination

The factorial introduction, Fundamental principle of counting, Permutation as arrangement, practical problems on permutations, permutations under certain conditions. Combinations, practical problems on Combinations, Combinational identities.

Unit 2: Probability

Random experiment and associated sample space, events, definition of probability of an event, algebra of events, addition and multiplication theorems on probability (without proof), use of permutations and combinations in calculation of probabilities, conditional probability, independent events.

Unit 3: Measure of Central tendency, correlation and Regression

Measures of Central tendency (mean, median and mode), measure of variation (mean deviation and standard deviation). Frequency distribution and its graphical representation. Random variables, probability distribution of random variable, Binomial, Poisson and Normal distributions. Relationship between variables, covariance, calculation of covariance, meaning of covariance, correlation, Karl Pearson's coefficient of correlation, interpretation of correlation coefficient, method of least square, Regression. Regression, calculation of regression coefficient.

Unit 4: Hypothesis Testing and Analysis of variance

Sample statistics and parameters, null hypothesis, level of significance, Chi-square distribution, Chi-square test, t and F distribution and their applications.

(Semester I) M. Sc. Biotechnology 6 Credits Laboratory Course-1

BTM-107

(Internal Assessment: 50 marks and Semester Exam: 100 marks)

We train students to understand the principle of each lab exercise, generation & recording of data, analysis & interpretation of data and final presentation of data. Our labs are very well equipped and we provide hands on experience to our students where they have an opportunity to handle each and every equipment that they use during the course of lab exercises. The list provided for all semester are tentative and likely to change according to circumstances:

- 1. Good lab practice
- 2. Growth curve studies
- 3. Plasmid isolation (mini preparation)
- 4. Gel electrophoresis
- 5. Transformation
- 6. Conjugation
- 7. Phage titration
- 8. Media preparation and Inoculation
- 9. Estimation of microbial population by spreading
- 10. Isolation of microbe from soil
- 11. MIC test
- 12. Gram staining
- 13. Positive-negative staining
- 14. Thin Layer Chromatography
- 15. Paper chromatography
- 16. Determination of acid value of fatty acid
- 17. Isolation of casein protein from milk and determination of % yield
- 18. Fractionation of rat liver
- 19. Bioinformatics database (NCBI, EMBL)
- 20. Data retrieval from database (Nucleotide, PubMed)
- 21. Protein visualization (RasMol, PDBViewer)
- 22. BLAST and ClustalW
- 23. Primer designing

(Semester II) M. Sc. Biotechnology 4 Credits Metabolism & Enzymology

Unit 1: Introduction to Metabolism

Characteristics of metabolic pathways, Experimental approaches to the study of metabolism, use of inhibitors, growth studies, isotopes, genetic defects and manipulation, isolated organs, cells and subcellular organelles. Thermodynamics of phosphate compounds; phosphoryl-transfer reactions, high energy compounds, central role of ATP as energy currency. Thermodynamics of metabolic control.

Unit 2: Carbohydrate metabolism

Glycolysis: history, reactions, enzymes, energetic and regulation, Metabolic fates of pyruvate, Entry of important hexoses in glycolysis, HMP pathway, Gluconeogenesis, Glycogen synthesis and degradation, TCA cycle: history, reactions, enzymes, energetics and regulation, Glyoxylate pathway.

Unit 3: Lipid Metabolism

Transport of lipids, Fatty acid activation and transport into mitochondria, Beta-oxidation, oxidation of odd chain & unsaturated fatty acids, Formation and oxidation of ketone bodies, Fatty acid biosynthesis, Elongation and desaturation of fatty acids, Arachidonate metabolism, Cholesterol biosynthesis, Biosynthesis of triacylglycerol and glycerophospholipids.

Unit 4: Amino acid Metabolism

Transamination reactions, Transport of amino groups, Urea cycle, Metabolic breakdown of invidual amino acids, Biosynthesis of non-essential and essential amino acids, Heme biosynthesis and degradation, Genetic defects in amino acid metabolism.

Unit 5: Nucleotide Metabolism

Structures of nucleotides, Catabolism of Purine & Pyrimidines, Fates if uric acid, Synthesis of purine and pyrimidine ribonucleotides, Formation of deoxyribonucleotides, Genetic defects in nucleotide metabolism, Enzymes of nucleotide metabolism as targets of anticancer agents.

Unit 6: Enzymology

Mostly applied enzymology, Industrial uses of enzymes.

(Semester II) M. Sc. Biotechnology 4 Credits Immunology

Unit 1: Antigens, Antigenicity and Immunity

The antigen and concept of self and non-self discrimination. Antigenicity and immunogenecity. Factors contributing to antigenecity. Epitoper mapping, Haptens. Humoral and Cellular Immune Response. Innate and adaptive immunity. The organs involved in the immune response. The cells involved in immune response. Lymphocyte traffic.

Unit 2: Immunoglobulins

The immunoglobulin molecule: Structure and function of Ig Molecules, Domains of Ig heavy and light chains Antigenic determinants of Ig molecules. Antigen binding and effector functions. Affinity and Avidity.

Unit 3: Antibody diversity, Antigen-Antibody interactions

Generation of antibody diversity V-J and V-D-J rearrangements in Ig genes. The Ig supergene family, Isotype switching and allelic exclusion. The antigen-antibody interaction. Specificity. Cross reactions. Methods for studying antigen-antibody reactions.

Unit 4: Immunological Methods in Biotechnology

Immunological Methods in Biotechnology, Monoclonal Antibodies and Hybridoma Technology. Advantages over polyclonal antibodies.

Unit 5: MHCs and related mechanisms

Major Histocompatibility Complex. Antigen Presentation. B Cell activation. Formation & secretion of Ig. complement Transplantation Immunity, Tolerance. Red Cell alloantigens.

Unit 6: Vaccines and Diseases

Vaccines. Tumor Immunology, Immunodeficiency diseases. AIDS.

(Semester II) M. Sc. Biotechnology 2 Credits Animal Biotechnology

Unit 1: Introduction to Animal Biotechnology & its Applications

Introduction to animal biotechnology: vaccines, immunoneutralization, transgenics, and production of recombinant vaccines using mammalian tissue culture.

Unit 2: Immunoregulation and Recombinant DNA Technology

Immunoregulation of reproduction and growth immunization against peptide hormones: LHRH somatostatin, Problems. Vaccine production by recombinant DNA technology: Selection of target antigens for vaccine development, Identification and cloning of genes for target antigens, immunoprophylaxis by non-replicating target antigens, Expression of target antigens in prokaryotic and Eukaryotic hosts.

Unit 3: Chomeric Proteins, Immunoprophylaxis and Nucleic Acid Hybridization

Construction of chimeric proteins as target antigens, conjugation of target antigens with antigen carrier molecules. Immunoprophylaxis by live attenuated recombinant viruses: Attenuated *Vaccinia* virus and adenovirus as vectors for heterologous target antigens. Application of nucleic acid hybridization to diagnosis of microbial infections and to genotype analysis.

Unit 4: Embryo Biotechnology

The micro manipulation of farm animal embryos: Anatomy and physiology of embryos in relation to micro manipulation, instrumentation, culture methods, combining embryo cells, intracellular manipulations and conservation of manipulated embryos.

Unit 5: Animal Genetic Engineering and Tissue Culture

Gene transfer through micro injection: Production of transgenic animals and prospects of transgenic livestock. Embryo and gamete sex selection: Nuclear transplantation, sperm separation, embryonic sex selection: cytological methods, detection of X-linked enzymes, immunological methods and by use of Y-chromosome specific gene probes. Biotechnology in animal breeding strategies and improvement of livestocks. Animal Cell lines and tissue culture. Hybridoma technology & its application.

(Semester II) M. Sc. Biotechnology 2Credits Molecular Biology of Eukaryotic Systems BTM-204

Unit 1: Organization of the Eukaryotic Genome

Genome size and genetic content. C-value paradox. The Eukaryotic gene, conserved exons and unique introns, repetitive and non-repetitive DNA sequences. Organelles genomes: (Chloroplast and mitochondrial genomes). Mobile element

Unit 2: Organization of simple sequence DNA

Satellite and mini satellite DNA. Hierarchical repeats. Variable and hyper variable DNA repeats. Evolution of hierarical variations in the satellite.Genetic mapping and DNA fingerprinting.

Unit 3: Genome packaging

Nucleus, Chromatin and heterochromatin. Condensing viral genomes. Loops, domains, and scaffolds in Eukaryotic DNA. Lampbrush and polytene chromosomes. Chromosomes ends. Nucleosomes, Gene expression and methylation.

Unit 4: Eukaryotic Transcription

Building the transcription complex, promoters, factors, and RNA polymerase. Regulation of transcription, factors that activate the basal apparatus, zinc finger motif, leucine zippers. The apparatus for nuclear splicing. RNA as catalyst.

Unit 5:

Gene regulation in development, gradients and cascades.

(Semester II) M. Sc. Biotechnology 2 Credits Cellular & Molecular Physiology

BTM-205

Unit 1: Medical Physiology and Cell Signaling

Cellular basis of medical physiology and regulatory processes, Basic characteristics of cell signaling system, 2nd messengers and G proteins – coupled receptors, Role of calcium as secondary messenger, Receptor tyrosine kinases, Cross talk between different signaling pathways.

Unit 2: Endocrinology and Molecular mechanism of Hormone Action

Hormones, Receptors and Endocrinology, Classes of hormone molecules and their communication, Hormone receptors and cascade system, Regulation of hormone secretion & feed back, Molecular mechanism of hormone action (transcription factors), Cell growth factors

Unit 3: Neurochemistry, Nerve Conduction and Neuroregeneration

Excitable membranes (Neuron & Neural communication), Ionic basis of nerve conduction, Synapses and synthesis/trafficking of Neuronal protein, Neurotransmitters and secondary messengers, Modulation of synaptic transmission, Pharmacology of synapses, Formation and regeneration of synapses, Neuroregeneration

Unit 4: Brain, Memory, Sensory Transduction, Muscles, BP and Reproduction

Functional Areas of Brain & higher order functions, Cellular mechanism of learning & Memory, Visual processing by retina and sensory transduction, Neuromuscular Jn., Ionic basis of smooth, cardiac and muscles, Rennin Angiotensin system and BP regulation, Endothelium and blood flow, CO_2 , O_2 & pH sensing mechanism, Molecular basis of reproduction

(Semester II) M. Sc. Biotechnology 2 Credits Recombinant DNA Technology

BTM-206

Unit 1: Tools/enzymes of Genetic Engineering

Tools of genetic engineering, restriction endonucleases, DNA polymerases, ligases, kinases phosphatases, reverse transcriptase, exonucleases, ribonucleases, proteinases.

Unit 2: Cloning Vectors, Nucleic Acid Labeling Techniques

Cloning Vectors. Plasmids & cosmids. Phages, BAC, YAC, transponsons. Labelling of nucleic acids. Radioactive and non radioactive labeling techniques. Nick translation, end labelling, pimer extension, random priming.

Unit 3: Gene Cloning and related Techniques

Gene cloning. Genomic and cDNA libraries. Chromosome walking, gene tagging, subtraction hybridization, difference hybridization. Hybrid arrested translation, hybrid released translation. *In vivo* expression techniques, southern blotting, northern blotting.

Unit 4: rDNA Technology, Molecular Markers, PCR and Cell Transformation

Latest techniques in rDNA technology. DNA Fingerprinting RFLP, RAPD, DNA Footprinting. PCR, immuno-PCR, Sequencing of DNA. Site-directed mutagenesis, pulse field gel electrophoresis. Cell Transformations: Methods of plant cell transformations. Vectors for plant cell transformation.

(Semester II) M. Sc. Biotechnology Lab and other courses

Seminar Presentation	2 Credits	BTM-207
Laboratory Course II	6 Credits	BTM-208

- 1. PCR
- 2. Elution of PCR product
- 3. Restriction digestion
- 4. TA Cloning and ligation
- 5. Screening and selection of recombinant clone
- 6. Genomic DNA isolation from animal tissue
- 7. Bilirubin, Cholesterol, inorganic phosphate, creatinine, urea and uric acid estimation
- 8. Estimation of glucose by Anthrone reagent and toluidine method
- 9. Protein estimation by Folin-Lowry method
- 10. Determination of amylase, alkaline phosphatase, and SGOT activity
- 11. ELISA
- 12. Ouchterlony double diffusion test
- 13. Rocket immunoelectrophoresis
- 14. Immunohistochemistry
- 15. Isolation and estimation of Na^+/k^+ ATPase
- 16. Identification and purification of Na^+/k^+ ATPase

(Semester III) M. Sc. Biotechnology 4 Credits Bioprocess Technology

BTM-301

Unit 1: Growth and Yield Parameters

Growth Rate Analysis: Growth rate parameters: specific growth rate, doubling time, validity of exponential growth validity of exponential growth law; growth yield, metabolic quotient, Effect of substrate concentration, Monod Kinetics, Determination of Ks, Definition of lag period. Estimation of Biomass: Factors influencing choice of method; Dry and wet mass, volume, yields, metabolic rates, light scattering cell count.

Unit 2: Stoichiometry of Biological Reactions, Batch Culture

Stoichiometry: Balance equation, carbon, nitrogen balance, oxidation– reduction principles, product formation. Batch & Fed-Batch Culture : Open and closed system, growth phases, and mathematical model of simple batch culture.

Unit 3: Chemostat and related Parameters

Chemostat Culture: General principle, balance equations, critical dilution rate, biomass productivity, comparison with batch cultures. Elaboration of Chemostat: Turbidostat, pH stat, D.O. stat cultures control mechanisms,

Unit 4: Microbial Cultures and Products

Product formation in microbial cultures: Growth associated and non-growth-associated kinetics, product decomposition, balance equations for batch and continuous systems, effect of environmental conditions.

Unit 5: Aeration, Agitation and Oxygen Demand

Aeration and Agitation: Agitation and mixing, Baffled, vortex and airlift systems, Impeller design, Effect of stirring, sparging and other parameters, Oxygen Demand and Supply: Oxygen demand, solubility, and measurement of DOT, redox potential oxygen transfer, measurement of K_{la}

(Semester III) M. Sc. Biotechnology 4 Credits Fermentation Technology & Downstream Processing BTM-302

Unit 1: Fermentation, Industrial Microbes

Introduction, Range of fermentation processes, chronological development, component parts of a fermentation process. Isolation of industrially important microorganisms. Preservation and quality control.

Unit 2: Industrial Microbiology and its Improvement, Media Designing

The Improvement of Industrial Micro-organisms: Mutants overproducing primary metabolites mutants overproducing secondary metabolites. The use of recombination systems. Improvement of properties other than the yield of product. Media Design: Introduction, Typical media, media formulation Energy sources, carbon and Nitrogen sources, other components.

Unit 3: Media Optimization and Sterilization

Media optimization and statistical analysis. Sterilization: Medium sterilization, design of a batch sterilization process, calculation of del factors, holding time, scale up of sterilization continuous methods, filter sterilization.

Unit 4: Downstream Processing and Effluent Treatment

Downstream Processing and Effluent Treatment: Introduction, Removal of microbial cells and solid matter, foam separation, precipitation theory, use of filter aids, Batch and continuous systems cross flow filtration.

Unit 5: Centrifugation, Cell Disruption, Chromatographic Techniques

Centrifugation: Theory types of centrifuges. Cell Disruption Physical mechanical methods; chemical methods. Liquid-Liquid Extraction: Adsorption, ion exchange gel permeation, Affinity, reverse phase, HPLC, continuous chromatography.

Unit 6: Membrane Processes, BOD, COD and Effluents

Membrane Processes: Ultra filtration, reverse osmosis, Liquid membranes. Drying and Crystallization Effluent Treatment. Introduction, BOD and COD, treatment and disposal of effluents.

(Semester III) M. Sc. Biotechnology 4 Credits Medical Biotechnology & Molecular Medicine BTM-303

Unit 1: Molecular Technology & Medical Genetics

- a) Introduction to medical Biotechnology , DNA Mapping, DNA Amplification, Cloning of DNA, DNA Sequencing, Expression of r DNA (Recombinant DNA). Mutation & Polymorphism, Eugenics.
- b) Introduction of Medical Genetics and Genetic Diseases, Clinical Cytogenetics. Thalassaemia – Model for Molecular Genetics, Autosomal Recessive Disorders, Chromosomal Disorders, Stem cell and its application.

Unit 2: Fetal and Neonatal Medicine:

Introduction, Prenatal Diagnosis, Newborn Screening and Therapy, Genetic counseling.

Unit 3: Medical Oncology:

Introduction, Oncongenes, Tumour Suppressor genes, Genetic Models and Cancer, Diagnostic Application & Therapeutics.

Unit 4: Therapeutics:

rDNA derived Drugs, Gene Therapy, Hybridoma Technology, Monitoring & Response to Therapy Immunotherapy.

UNIT 5: Bioethical issues and Forensic Medicine:

- i). Introduction, Bioethics in Research, ELSI of Human Genome Project.
- ii). Forensic Medicine: Introduction, DNA profiling, Tissue identification, Human Genome Project.

(Semester III) M. Sc. Biotechnology 2 Credits Intellectual Property Rights Issues in Biotechnology

BTM-304

Unit 1: Intellectual Property and related Issues, Patents, Copy Rights, Trade Marks

Intellectual Property: History of intellectual property system in India. Intellectual property; patents, trade secrets, copyright, trademarks. Choice of intellectual property protection GATT and TRIPS.

Unit 2: Patents and related Issues, Applications

Patent: Patent: meaning of patent, types, laws. Rights of patent and other owners of patents, Obligations of patentee, Patent specifications. Patents and rights: Patentable inventions. Patent protection for inventions in special areas. Plant protection for inventions in special areas. Plant breeders' right and farmers' rights.

Unit 3: Patents and GMOs, International Conventions and Cooperation

Patenting of biological material: International conventions and cooperation. Patents for higher plants and animals. Patenting transgenic organisms and isolated genes.

Unit 4: Trade Marks and Related Issues

Trademark: Trade mark and its importance. Classes and goods covered. Rights of a registered proprietor. Rights of employer-employee in protecting intellectual property.

(Semester III) M. Sc. Biotechnology 2 Credits Environment Biotechnology

BTM-305

Unit 1: Environmental Monitoring

Level and type of contaminants; Physical, chemical and biological analysis of samples; use of recombinant DNA technology for the study of bacterial community; Determination of Dissolved Oxygen and biological Oxygen demand; Pollution monitoring (bioinficators and biomarkers); Biossensors

Unit II Solid Waste management and Sewage treatment

Basic aspects of solid waste management; Aerobic and anaerobic treatments of solid wastes; Function of the waste treatment system; Sewage – treatment methods (Lagoons, trickling filters, activated sludge process, operating parameters, operating factors, sludge residence time, plant and sludge loading, sludge settling and recirculation and mode of operation); Modifications to existing processes; Removal of nitrogen and phosphorous (nitrification and denitrifications); Sludge treatment and disposal.

Unit III: Bioremediation, Biotransformation and Biodegradation

Bioremediation strategies, in situ and ex situ bioremediation; phytoremediation, Applications of genetic engineering to phytoremediation; Metals and gaseous bioremediation; Factors affecting process of biodegradation, Xenobiotics; Persistence and biomagnification of xenobiotic; molecules.

Unit IV Biotechnology for Management of Resources and Sustainable technology

Need for management of resources. Biogas and Biofuel production, Integrated waste management, industirall process and clean technology.

(Semester III) M. Sc. Biotechnology 2 Credits Plant Biotechnology

BTM-306

Unit 1: Protoplast Culture: Methods and Applications

Protoplast culture technology in crop improvement: Isolation, culture and preservation of protoplast, enzymes used, viability of protoplasts. Immobilization and cryopreservation of plant protoplast. Regeneration of plants from protoplasts of cereals, legumes and vegetables.

Unit 2: Somatic Hybridization, Protoplast Fusion and Molecular Markers

Somatic hybridization and its role in crop improvements: Protoplast fusion and somatic hybridization, fusion of protoplast technique, methods of protoplast fusion, markers for identifying somatic hybrids, gross phenotypic differences, selectable genetic markers and biochemical markers.

Unit 3: Medicinal Plant Biotechnology, Plant Tissue Culture and Its Applications

Biotechnology of medicinal and aromatic plants: Micropropagation of medicinal and aromatic plants, cryopreservation and retention of biosynthetic potential in cell cultures of medicinal and alkaloid producing plants. Exploitation of in vitro culture techniques in crop improvement and conservation of plant genetic resources.

Unit 4: Plant Genetic Engineering, Molecular Markers, Transgenic Plants

Strategies in plant genetic engineering for improvement of crop plants: Genome libraries and cDNA libraries, achievements and prospects, exploitation of molecular techniques like RFLP, PCR and DNA fingerprinting. *In vitro* technique for plant manipulations: Comparison of strategies of crop improvements. *In vitro* manipulation of plant manipulation of plant cell through protoplast culture and fusion, somatic hybrids and cybrids. Development of transgenic plants, and their commercial exploitation.

(Semester III) M. Sc. Biotechnology Laboratory Course-III

6 Credits

BTM-307

(Internal Assessment: 50 marks; Semester Exam: 100 marks)

- 1. DNA finger printing (RAPD)
- 2. DNA finger printing (RFLP)
- 3. Western Blotting /southern blotting
- 4. Isolation of RNA
- 5. Isolation of different species of *Aspergillus* from soil
- 6. Estimation of citric acid production by A. niger
- 7. Immobilization of bacterial cells by membrane entrapment technique
- 8. Verification of immobilization by biochemical test
- 9. Determination of quality of milk sample by MBRT
- 10. Litmus milk reaction
- 11. Determination of COD of water sample
- 12. Determination of BOD of water sample
- 13. SDS-PAGE electrophoresis

(Semester IV) M. Sc. Biotechnology

Project

12 Credits

BTM-401

Every student is assigned a lab and a supervisor in any Indian Lab where candidate has to carry out research work on given problem/objective.

Seminar Presentation

2 Credits

BTM-402

(Semester IV) M. Sc. Biotechnology 6 Credits Laboratory Course-IV

BTM-403

(Internal Assessment: 50 marks; Semester Exam: 100 marks)

- 1. SSCP
- 2. Protein isolation
- 3. Bacterial gene expression and PAGE
- 4. RT-PCR
- 5. SNP's analysis
- Prepare a list of all the experiments we do in each lab course, including: Manufacturer of equipments and their supplier with complete address, make, model, principle, and potential applications.

Department of Biotechnology Jamia Millia Islamia

List of Books suggested for M. Sc. Biotechnology Program

SEMESTER I

BTM-101 and BTM -201: Biochemistry:

- Introduction to Protein Structure, 2nd Ed Dec.1998, Carl-Ivar Branden, John Tooze Garland Publishing, ISBN-0815323050
- **Proteins: Structure and Function, 1st Ed,** Mar 2005 by David Whitford John Wiley and Sons Ltd, **ISBN-10:** 0471498947
- **Proteins : Structure and Molecular properties** 2nd Ed (1994), T.E. Greigton; Freeman publication, New York
- **Biochemistry**, 3rd edition, Feb 2004 by Donald Voet, Judith G. Voet, Wiley, John & Sons, Incorporated , ISBN: 047119350X
- Lehninger Principles of Biochemistry, 3rd edition, May 2000, David L. Nelson, David L. Nelson, Albert L. Lehninger, Michael M. Cox, Worth Publishing, ISBN: 1572599316
- **Biochemistry**, 5th Ed, February 2002, Lubert Stryer, John L. Tymoczko, Jeremy Mark Berg, Pub.W. H. Freeman Company, ISBN: 0716730510
- **Principles of Biochemistry** (February 1995) by Geoffrey Zubay, W.W. Parson, D.E. Vance, Pub: William C. Brown, **ISBN-10**: 0697241726
- Harper's Illustrated Biochemistry; 26th Ed March, 2003 by Robert K. Murray, Darryl K. Granner, Peter A. Mayes, Victor W. Rodwell Pub:McGraw-Hill Medical ISBN-10: 0071389016

BTM-102: Microbiology:

- **Brock Biology of Microorganisms** 11th Ed Jun 2005 by Michael T. **Madigan**, John Martinko Prentice-Hall; **ISBN-10**: 0132017849
- General Microbiology 4th Ed March 1977 by R.Y. Stanier, Pub: Macmillan; ISBN-10: 0333220137
- Foundations in Microbiology; 6th Ed September, 2006 by Kathleen Park Talaro, Pub: McGraw-Hill Science/Engineering/Math, ISBN-10: 0073305405

- Alcamo's Fundamentals of Microbiology, 8th Ed December, 2006 by Jeffrey C. Pommerville; Jones & Bartlett Publishers, **ISBN-10**: 0763737623
- **Microbiology**, 6th Ed July 2007 by Lansing **Prescott**, John P. Harley, Donald A. Klein McGraw Hill Higher Education, **ISBN-10**: 0072951753
- Microbiology: An Introduction 8th Ed September, 2003 by Gerard J. Tortora, Berdell R. Funke, Christine L. Case, Benjamin-Cummings Publishing Company; ISBN-10: 0805376135
- Microbiology: Concepts and Applications 5th Ed Jan 1993 by Michael J. Pelczar, E. C. S. Chan, Noel R. Krieg; McGraw-Hill Companies, ISBN-10: 0070492581
- Microbial Ecology Fundamentals and Applications. 4th Ed. 1998 by R. M. Atlas and R. Bartha, Addison Wesley Longman, Inc. or Cummings Science Publishing
- **Microbiology**; 4th Sub Ed January 1990 by Bernard D. **Davis**, Renato Dulbecco, Herman N. Eisen, Harold S. Ginsberg; Lippincott Williams & Wilkins, **ISBN-10**: 0397506899
- Essentials of Medical Microbiology 5th Ed January 1996 by Wesley A. Volk, Bryan M., Ph.D. Gebhardt Marie-Louise, M.D. Hammarskjold, Robert J., Ph.D. Kadner; Lippincott Williams & Wilkins, ISBN-10: 0397513089
- Industrial Microbiology: An Introduction October, 2001 by Michael J. Waites, Gary Higton, Neil L. Morgan, John S. Rockey; Blackwell Publishing Limited, ISBN-10: 0632053070
- **Prescott and Dunn's Industrial Microbiology** 4th Sub Ed April 1981 by Gerald **Reed**; Chapman & Hall, **ISBN-10**: 0870553747
- **Food Microbiology**; 2nd Ed May 2000 by M.R. Adams, Maurice O. Moss (Pub: The Royal Society of Chemistry, **ISBN-10**: 0854046119)
- **Food Processing Technology: Principles and Practice**; 2Rev Ed edition, May 2000 by P.J. Fellows Woodhead Publishing, **ISBN-10:** 1855735334
- Fermentation Microbiology and Biotechnology, 2nd Ed October, 2006 by E. M. T. El-Mansi C. F. A. Bryce, Arnold L. Demain, A.R. Allman; CRC publication, ISBN-10: 0849353343

BTM-103: Molecular Genetics:

- Essentials of Molecular Biology 3rd Ed Jan 1998 by David Freifelder, George M. Malacinski; Jones and Bartlett publishers; ISBN-10: 0867208600
- Molecular Biology of the Gene; 5th Ed Jan 2004 by James D. Watson, Tania A. Baker, Stephen Bell, Alexander Gann, Michael Levine, Richard Losick Addison Wesley, ISBN-10: 0321248643

- Genes IX 9th Ed, Mar 2007 by Benjamin Lewin; Jones & Bartlett Publishers Inc.,U.S, ISBN-10: 0763752223
- DNA Structure and Function, 1st Ed, Jan 1994. R.R. Sinden; Academic Press, ISBN-10: 0126457506
- Genomes, 3rd Edition, 2006. Garland Science: New York. 711p. ISBN: (Paperback) 9780815341383.

BTM-104: Molecular Cell biology and BTM-204: Molecular Biology of Eukaryotic Systems:

- **Molecular Biology of the Cell**, 4th ed, May 2002 by **Bruce Alberts**, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Pub: Garland science, ISBN: 0815332181
- **Molecular Cell Biology**, 5th Ed Aug 2003 by Harvey **Lodish**, James E. Darnell W.H.Freeman & Co Ltd, **ISBN-10**: 0716743663.
- **The Cell**, 4th ed, Jan,2007 by Geoffrey M. **Cooper**, Robert E. Hausman, Pub: Sinauer Associates, Incorporated, ISBN: 0878932194
- **Cell and Molecular Biology**; 2001 by **De Robertis**, E.D.P. & De Robertes, E.M.F.; Lea & Febiger publication
- Molecular Biology of the Cell : A Problems Approach 4th Ed Sep 2002, by John H. Wilson, Tim Hunt, Bruce Alberts, Garland Publishing Inc,US; ISBN-10: 0815335776
- Eukaryotic Gene Transcription (Frontiers in Molecular Biology) July 1996) by Stephen Goodbourn; Oxford University Press, USA, ISBN-10: 0199634866
- DNA'Protein Interactions: Principles and Protocols (Methods in Molecular Biology); 2nd Ed April, 2001 by Tom Moss; Humana Press
- **Transcription Factors and DNA Replication**, 1994, D.S. **Pederson** and N.H. Heintz; CRC Press/R.G. Landes Company
- mRNA Metabolism & Post-Transcriptional Gene Regulation (Modern Cell Biology) March 1997) by Joe B. Harford, David R. Morris; Wiley-Liss publication. ISBN-10: 0471142069
- **RNA-Protein Interaction**, 1995 **Nagai** K and Mattaj I (eds.), Oxford University Press, ISBN: 0199635056
- Translational Control of Gene Expression 2nd Ed Jun 2000 by Nahum Sonenberg, John W. B. Hershey, Michael Mathews; Cold Spring Harbor Laboratory Press, ISBN-10: 0879695684

BTM-105: Molecular Biophysics:

- **Physical Biochemistry: Applications to Biochemistry and Molecular Biology** 2nd Ed Aug1982 by David M. **Freifelder**; W. H. Freeman, **ISBN-10**: 0716714442
- **Biophysics 1st Ed** Mar 2002 by V. **Pattabhi**, N. Gautham , Springer, and Narosa Publishing House, New Delhi. **ISBN-10:** 1402002181
- Molecular Biophysics: Structures in Motion, March 1999 by Michel Daune, David Blow, W. J. Duffin; Oxford University Press, ISBN-10: 0198577826
- **Biophysics** Corr. 2nd printing edition Nov 2004 by Roland **Glaser**, Springer publication, **ISBN-10**: 3540670882
- Molecular and Cellular Biophysics March 2006 by Meyer B. Jackson Cambridge University Press, ISBN-10: 0521624703
- **Physical Biochemistry: Principles and Applications** 2nd Ed Sep 2006 by David Sheehan; John Wiley & Sons, **ISBN-10:** 0470856025
- Thermodynamics and Kinetics for the Biological Sciences 1st Ed June 2000 by Gordon G. Hammes; Wiley-Interscience; ISBN-10: 0471374911
- Atkins' Physical Chemistry, 7th Ed. Dec 2002 by P.W. Atkins, Julio de Paula, Julio De Paula Oxford University Press, ISBN-10: 0198792859

BTM-106: Computer application and Biostatistics:

- **Probability and Statistics**, Schaum's Outline Series,1980, Murray R. **Spiegel**, McGraw-Hill Book Co.
- Biostatistics 2002, Arora P.N. and Malhan, P.K., Himalaya Publishing House.
- Biostatistical Analysis 4th Ed October 1998 by Jerrold H. Zar; Prentice Hall, ISBN-10: 013081542X
- Mathematical Models in Biology, New Ed edition Feb 2005 by Leah Edelstein-Keshet, Robert O'Malley Society for Industrial & Applied Mathematics, U.S.; ISBN-10: 0898715547
- Computer Basics, by Raja Raman, TATA McGraw Hill Publication

SEMESTER II

BTM-202: Immunology:

- Immunology, 6th Ed Oct 2006 by Janis Kuby, Thomas J. Kindt, Barbara A. Osborne, Richard A. Goldsby; W.H.Freeman & Co Ltd, ISBN-10: 0716767643
- **Roitt's Essential Immunology,** 11th Ed Jul 2006 by Peter J. Delves, Seamus Martin, Dennis Burton, Ivan **Roitt**, Blackwell Publishing, **ISBN-10**: 1405136030
- **Immunology** 7th Ed May 2006 by David **Male**, Jonathan Brostoff, David Roth, Ivan Roitt; Mosby publication, **ISBN-10**: 0323033997)
- Fundamental Immunology 4th Bk&Cdr Ed Jan 1999 by William E. Paul; Lippincott Williams & Wilkins, ISBN-10: 0781714125
- **Fundamental Immunology** 2nd Ed Jun1999 by Robert M. Coleman, Mary F Lombard, Raymond E Sicard; McGraw-Hill Science/Engineering/Math; **ISBN-10**: 0072357479

BTM-203: Animal Biotechnology:

- Culture of Animal Cells: A Manual of Basic Technique; 5th Ed Jul 2005 by R. Ian Freshney, Wiley-Liss publication., ISBN-10: 0471453293
- Methods of Tissue Engineering; 1st Ed Oct 2001 by Anthony Atala, Robert Lanza; Academic Press, ISBN-10: 0124366368
- General Techniques of Cell Culture (Handbooks in Practical Animal Cell Biology) Oct, 1997 by Maureen A. Harrison, Ian F. Rae, Cambridge University Press; ISBN-10: 052157496X.
- Animal Cell Culture: A Practical Approach 3rd Ed Aug 2000 by John R. W. Masters; Oxford University Press, USA; ISBN-10: 0199637962
- Animal Cell Culture and Technology: The Basics; 1st Ed 1997 by M. Butler Bios Scientific Publishers, ISBN-10: 0199634165
- **Basic Cell Culture (Practical Approach Series)** 2nd Ed Feb 2002 by J. M. **Davis**, Oxford University Press USA; **ISBN-10**: 0199638535

BTM-205: Cellular and Molecular Physiology:

• **Textbook of Medical Physiology** 10th Ed Aug 2000 by Arthur C. **Guyton**, John E. Hall, A.C. and Hall, J.E., W.B. Saunders Company, **ISBN-10**: 072168677X

- **Review of Medical Physiology,** 21st Ed 2003 by William F. **Ganong,** H; McGrawHill.
- Human Anatomy & Physiology, 6th Ed May, 2003 by Elaine N. Marieb; Benjamin Cummings, ISBN-10: 080535462X

BTM-206: Recombinant DNA Technology:

- Recombinant DNA: Genes and Genomes, 3rd Ed, Feb 2007, by James D. Watson, Amy A. Caudy, Richard M. Myers , Jan A. Witkowski; W.H.Freeman & Co Ltd, ISBN-10: 1429203129.
- **Principles of Gene Manipulation and Genomics,** 7th Ed, Jan 2006 by Richard M Twyman, Sandy B Primrose; Blackwell Publishing; **ISBN-10**: 1405135441
- Gene Cloning and DNA Analysis 5th Ed Jan 2006 by Terry Brown; Blackwell Publishing; **ISBN-10**: 1405111216
- Analysis of Genes and Genomes 1st Ed Nov 2003 by R.J.R. Reece; John Wiley and Sons Ltd, ISBN-10: 0470843802
- Molecular Biotechnology Principles and applications of recombinant DNA, 3rd Ed 2003, Glick, R. & Jack J. Pasternok; American Society for Microbiology Press. ISBN-10: 1555812244
- From Genes to Clones (Introduction to Gene Technology) 1987, Ernst, L. Winnacker, VCH Verlags Gesellschoft mbh, D-6940, Weinheim, Germany. ISBN-10: 0895736144

SEMESTER III

BTM 301 Bioprocess technology and BTM 302: Fermentation technology:

- **Principles of Fermentation Technology**; 2nd Ed May 1999 by **P F Stanbury**, A. Whitaker, S. Hall; Butterworth-Heinemann, **ISBN-10: 0750645016**
- Fermentation and Biochemical Engineering Handbook: Principles, Process Design, and Equipment 2nd Sub Ed October 1996 by Henry C. Vogel, Celeste C. Todaro; Noyes Publications, ISBN-10: 0815514077
- Computer Control of Fermentation Processes October 1989 by Daniel R. Omstead; CRC publication, ISBN-10: 084935496X
- Metabolic Engineering (Advances in Biochemical Engineering / Biotechnology); 1st Ed October, 2001 by Jens Nielsen; Springer publication, ISBN-10: 3540418482
- **Bioprocess Engineering Principles** May 1995 by **Pauline** M. Doran; Academic Press, **ISBN-10**: 0122208560
- **Bioprocess Engineering**; 1st Ed April 1994 by **Bjorn** K. Lydersen, Nancy A. D'Elia, Kim L. Nelson; Wiley-Interscience, **ISBN-10**: 0471035440
- **Bioprocess Engineering: Basic Concepts 2nd Ed,** October, 2001 Michael L. **Shuler** Fikret Kargi; Prentice Hall PTR; **ISBN-13:** 978-0130819086

BTM-303: Medical Biotechnology and Molecular Medicine:

- Human Molecular Genetics, 3rd Ed Nov 2003 by Strachan & Reed; Garland Publishing Inc,US, ISBN-10: 0815341849
- Molecular Medicine, 3rd Ed Apr 2005 by R. Trent; Academic Press, ISBN-10: 012699057
- Thompson & Thompson Genetics in Medicine 6th Ed Aug 2001 by Robert L. Nussbaum, Roderick R. McInnes, Huntington F. Willard; W.B. Saunders Company, **ISBN-10**: 0721669026.
- Genomes 3, 3rd Ed, Jun 2006, by Terry Brown; Garland Publishing Inc, US. ISBN-10: 0815341385
- Clinical Bioinformatics (Methods in Molecular Medicine) 1st Ed Dec 2007 by Ronald J.A. Trent; Humana Press, **ISBN-10**: 1588297918
- An Introduction to Systems Biology: Design Principles of Biological Circuits, 1st Ed Aug 2006 by Uri Alon; Chapman & Hall/CRC, ISBN-10: 1584886420

- Human Molecular Genetics, 2nd Ed, by Sudbery; Prentice-Hall, pearson education.
- Cancer Biology 3rd Ed, May 2006 by R.J.B. King, Mike Robins (Pub: Prentice-Hall; ISBN-10: 0131294547
- Molecular Diagnostics Jun 2005 by George Patrinos, Wilhelm Ansorge; Academic Press, ISBN-10: 0125466617
- Medical Molecular Genetics 1998 Hoffee, P.A; Fence Creek Publishing, Madison Connecticus, USA.
- Genetics The Centinity of life 1999, Daniel J. Fairbank and W.R. Andersen; Brook/ Cole Publishing company International Thomson Publishing Company Inc. USA.
- Genetic Engineering (Medical Perspectives) 1st Ed Dec 2000 by A CECCARELLI; Garland Science, ISBN-10: 1859960723.
- **THE HUMAN GENOME (Medical Perspectives)** 1st Ed Jun 2003 by T. Strachan; Garland Science, **ISBN-10:** 1872748805

BTM-304: IPR Issues in Biotechnology:

www.oecd.org/dataoecd/16/9/40181372.pdf www.**patentoffice**.nic.in/ http://www.biotechnology.gov.au/assets/documents/bainternet/BA_IPManual200504 01114445.pdf http://www.bicpu.edu.in/ipr_ppt/15/kulkarni.pdf

BTM-305: Environmental Biotechnology:

- Wastewater Engineering Treatment and Reuse, 4th Ed 2005 by Metcalf & Eddy, Inc. from C.H.I.P.S.
- Introduction to Environmental Biotechnology 2002, Chatterji, A.K; Prentice Hall of India Pvt. Ltd., New Delhi.
- **Renewable Energy Sources and their Environmental Impact,** 2002, Abbasi, S.A. and Abbasi, N; Prentice-Hall of India Pvt. Ltd., New Delhi.
- Environmental Chemistry, De, A.K., 1993, Wiley Eastern Ltd.
- **Biotechnology for Waste Water Treatment** 2001, Nicholas P. Cheremisinof; Printice Hall of India Private Ltd. New Delhi
- **Biochemistry of Microbial Degradation** 1994, C. Ratledge; Kulwer Academic Publisher.

BTM-306: Plant Biotechnology:

- **Biotechnology and Plant Genetic Resources**, 1997, **Callom**, J.A., Ford Lloyd, B.V. and Newbury, H.J., Conservation and use, CAB International, Oxon, U.K.
- Plants Cell Culture 1994, Chrispeds, M.J. and Sadana, D.E., Bios Sceintific Publishers, Oxford, U.K.
- **Plant Cell and Tissue Culture**, 1994, Vasit, I.K. and Thorpe, T.A., Klmeer Academic Press, The Netherlands.
- An Introduction to Plant Tissue Culture, 1993, Razdan, M.K., Published by Oxford and I.B.H. Publishing Co. Pvt. Ltd. New Delhi.
- Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture, 3rd Ed 1992, Rienert, J. and Bajaj Y.P.S.; Narosa Publishing House, New Delhi.
- **Plant Tissue Culture : Theory and Practice,** 1996, **Bhojwanee,** S.S. and Razdan, M.K., Elsvier Science Publishers, New York, USA.

Additional Books (Bioinformatics, Ecology and Evolution):

- **Bioinformatics, Sequence & Genome Analysis,** 2nd Ed Jul 2004 by David W. **Mount**; Cold-Spring Harbor Lab Press, **ISBN-10**: 0879697121
- **Bioinformatics, Concept, Skills & Applications**, 2003, **Rastogi**, S C , Mendiratta, Namita , Rastogi, Parag; CBS Publications. ISBN-8123908857
- **Bioinformatics: Sequence, Structure and databanks** 1st Ed Oct 2000, D. **Higgins** and W. Taylor; Oxford University Press. **ISBN-10:** 0199637903
- Molecular Evolution: A Phylogenetic Approach 1st Ed Oct 1998 by R.D.M. Page, Edward C. Holmes, Blackwell Science Ltd ISBN-10: 0865428891.
- **Phylogenetic Trees Made Easy: A How-to Manual** 3rd Ed Aug 2007 by Barry G. **Hall**; Sinauer Associates Inc.,U.S.; **ISBN-10**: 0878933107
- Concept of Ecology, 1989, Kormondy, E.J.; Prentice-Hall of India Pvt. Ltd. NewDelhi
- Environmental Biology and Toxicology, 1993. Sharma, P.D.
- Environmental Biology Principles of Ecology, 1998, Verma, P.S., V.K. Agarwal; S. Chand & Co. Ltd., NewDelhi

Laboratory Manuals:

- Molecular Cloning (3-volume set): A Laboratory Manual 3rd Ed Dec 2000 by J. Sambrook, D. Russell Cold Spring Harbor Laboratory Press, U.S.; ISBN-10: 0879695773
- Short Protocols in Molecular Biology, 5th Ed Dec 2002 by Frederick M. Ausubel, Roger Brent, Robert E. Kingston, David D. Moore, J.G. Seidman, John A. Smith and Kevin Struhl John Wiley & Sons Inc, **ISBN-10**: 0471250929
- **Practical Skills in Biomolecular Sciences**; 2nd Ed Feb 2003 by Rob Reed, David Holmes Prentice-Hall, **ISBN-10**: 0130451428.
- Principles and Techniques of Biochemistry and Molecular Biology, 6th Ed Mar 2005 by Keith Wilson, John Walker, Cambridge University Press, ISBN-10: 0521535816
- Laboratory Manual and Workbook in Microbiology, 8th Ed January, 2005, by Josephine A. Morello, Paul A Granato, Helen Eckel Mizer, McGraw-Hill Science/Engineering/Math; ISBN-10: 0072827181
- Food Microbiology: A Laboratory Manual Lab Manual edition June 2002 by Ahmed E. Yousef, Carolyn Carlstrom, Ahmed Yousef; Wiley-Interscience, ISBN-10: 0471391050.
- A Photographic Atlas for the Microbiology Laboratory 3rd Ed October 2004 by Michael J. Leboffe, Burton E. Pierce; **ISBN-10**: 0895826569.

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