SYLLABUS

M.Sc. Biotechnology

[For Colleges]

Session: ~~2019-21~~ 2020-22

SCHOOL OF STUDIES IN BIOTECHNOLOGY

JIWAJI UNIVERSITY

GWALIOR 474 011

JIWAJI UNIVERSITY, GWALIOR-474011
M.SC. BIOTECHNOLOGY

CURRICULUM ~~2019-2021~~ 2020-22

Semester	Title of the Paper	Marks	
		EA	IA
First	101. Cell Biology	85	15
	102. Biomolecules and Metabolism	85	15
	103. Microbiology	85	15
	104. Bioinstrumentation	85	15
	105. Lab Course I	100	
	106. Lab. Course II	100	
Second			
	201. Molecular Biology	85	15
	202. Immuno-technology	85	15
	203. Enzyme-technology	85	15
	204. Part A: Environmental Biotechnology Part B: Animal Biotechnology	85	15
	205. Lab Course III	100	
	206. Lab Course IV	100	
Third			
	301. Genetic Engineering	85	15
	302. Plant Biotechnology	85	15
	303. Bioprocess Engineering and Microbial Technology	85	15
	304. Biostatistics and Computer Applications	85	15
	305. Lab Course V	100	
	306. Lab Course VI	100	
Fourth			
	401. Emerging Trends in Biotechnology	85	15
	402. Bioinformatics	85	15
	403. Lab Course VII : Technical/ Review writing	100	
	404. Project Work*	300	

*Evaluated both by the Internal & External examiner at the time of presentation. There shall not be compulsory project works during first three semesters. There are weekly seminars and continuous internal assessment throughout the course.

101: CELL BIOLOGY

UNIT I

1. Cell Membrane: Physicochemical Properties; Molecular Organization – asymmetrical organization of lipids, proteins and carbohydrates; Biogenesis and Functions
2. Transport of Small Molecules Across Cell Membranes: Types and Mechanism
3. Active Transport by ATP-Powered Pumps Types: p-type, V-type, F-type ABC transporters.
4. Properties and mechanisms of transporters; Patch pump technique

UNIT II

1. Protein targeting- Cell map: Signal hypothesis and default protein secretary pathway
2. Protein glycosylation- N and O-linkages
3. Protein targeting- ER, Golgi Body and Lysosomes
4. Proteins targeting- Mitochondria, Chloroplast and Nucleus

UNIT III

1. Ultra structure and function of lysosomes, peroxisomes and Vacuoles.
2. Cell motility: Structure and functions of microfilaments
3. Cell motility: Structure and functions of microtubules and intermediary filaments
4. Cell junctions: Occluding junctions, anchoring junctions and communicating junctions

UNIT IV

1. Molecular mechanism of Ca^{++} dependent cell-cell adhesion
2. Molecular mechanism of Ca^{++} independent cell-cell adhesion
3. Organization and functions of Extra-cellular matrix of animals
4. Extra-cellular matrix receptors on animal cells: integrins

UNIT V

1. Cell Signaling: G-Protein signaling, Initiation and Regulation of MAP kinase and tyrosine kinase pathway
2. Molecular events accompanying eukaryotic cell cycle
3. Cell cycle control proteins: Cyclins
4. Apoptosis: Morphology and biochemical changes, pathways and regulators

Practical Exercises

1. Sub cellular fractionation
2. Chromosome preparation: Mitosis – Onion root tip, rat/mouse cornea, rat/mouse bone marrow, human lymphocytes
3. Chromosome preparation: Meiosis – Rat/mouse testis, Grasshopper testis
4. Polytene chromosome preparation from Drosophila salivary gland
5. Identification of tissue typing: Histological preparation of tissue
6. Identification of different biomolecules in different tissues by histochemical techniques
7. Electron microscopy: Demonstration and good photographs for interpretation.

Reference Books

1. Molecular Biology of the Cell (2002), Alberts et al
2. Molecular Cell Biology (2004), Lodish et al
3. Working with Molecular Cell Biology: A study Companion (2000), Storrie et al
4. Cell and Molecular Biology: Concepts and Experiments (3rd Ed., 2002), Gerald Karp
5. The Cell: A Molecular Approach (2004), G.M. Cooper
6. The Word of the Cell (1996), Becker et al
7. Cell Proliferation and Apoptosis (2003), Hughes and Mehnet
8. Essential Cell Biology (1998), Alberts et al
9. Biochemistry and Molecular Biology of Plants (2000), Buchanan et al
10. Harpers Biochemistry Murray et al

102. BIOMOLECULES & METABOLISM

UNIT I

1. Carbohydrates: Structure, classification, properties, chemical reactions, stereoisomerism and functions.
2. Animal, plant and microbe specific polysaccharides, bacterial cell wall, peptidoglycans, glycolipids, sialic acid.
3. Lipids; Classification, structure, properties. Functions of triacylglycerols, phospholoipids, wax, sterols, terpenes, prostaglandins.
4. Structure and functions of micelles and liposomes, applications of lysosomes

UNIT II

1. Amino acids: Structure, classification, properties and functions, peptides and polypeptides.
2. Proteins: Properties, primary, secondary, tertiary and quaternary structure, Ramachandran plot
3. Nucleic acids: DNA: Structure, conformation, properties of purines and pyrimidine bases, nucleosides and nucleotides;
4. RNA: Structure, types and functions of mRNA, tRNA, rRNA, mi RNA and siRNA

UNIT III

1. Laws of thermodynamics & concept of free energy, enthalpy and entropy
2. ATP Synthesis and its importance in biological reactions
3. Basic concepts of glycolysis and regulation.
4. Reactions and regulations of citric acid cycle, glyoxalate cycle.

UNIT IV

1. Electron transport and oxidative phosphorylation, chemiosmotic theory, substrate level phosphorylation
2. Photophosphorylation-mechanism
3. Plant phenolics and alkaloids: Classification and functions
4. Plant hormones: Structure and biological functions.

UNIT V

1. Overview of amino acid metabolism
2. Regulation of amino acid metabolism
3. Nucleic acid metabolism by *de novo* and salvage pathways
4. Entry and exit of Biomolecules from central pathways

Practical Exercises

1. Titration of amino acids.
2. Colorometric determination of pK.
3. Model building using space filling/ ball and stick models.
4. Reactions of amino acids, sugars and lipids.
5. Quantitation of proteins and sugars.
6. Analysis of oils- iodine number, saponification value, acid number.

Reference Books

1. Principles of Biochemistry by Nelson, Cox and Lehninger.
2. Biochemistry by G. Zubay
3. Biochemistry by Stryer
4. Biochemistry by Garrett and Grisham
5. Biochemical Calculations, Irwin H. Segel, john Wiley and sons Inc
6. Biochemistry,DVoet and jG Voet , J Wiley and Sons.
7. Biochemistry, D Freifilder, W.H. Freeman & Company.
8. Laboratory Techniques in Biochemistry and molecular Biology, Work and Work.
9. A Biologists guide to Principles and Techniques of practical Biochemistry, K.Wilson & K.H. Goulding, ELBS Edition,

103. MICROBIOLOGY

UNIT I

1. Classification of Microorganisms
2. Morphology and fine structure of cell wall; eubacteria, archeobacteria and fungi
3. Preparation of culture media, pure culture techniques and microbial staining.
4. General account and their economic importance of Cyanobacteria

UNIT II

1. Sterilization: Physical and chemical methods.
2. Microbial growth: growth curve, measurement of growth and factors affecting growth
3. Nutrition based classification of microorganisms, Different carbon and nitrogen sources, mode of nutrition, transport of nutrition across the bacterial membrane.
4. Oxygen toxicity: Study of catalase, peroxidase, superoxide dismutase, mechanism of oxygen toxicity

UNIT III

1. Infection and disease, types of infection, Mechanism of pathogenesis of bacterial and viral disease.
2. *Staphylococccal* and *Clostridial* food Poisoning, Bacterial Diseases: Salmonellosis and Shigellosis.
3. Fungal Diseases: Histoplasmosis, Aspergillosis and Candidasis.
4. Viral diseases: Hepatitis B and HIV

UNIT IV

1. Virus: Types, Isolation, cultivation, identification
2. Lytic and lysogenic cycle of bacteriophages
3. Life cycle of DNA viruses: SV 40, RNA viruses: Retroviruses.
4. Plant viruses: TMV, Gemini, CaMV

UNIT V

1. Bacterial Recombination: Transformation, conjugation, transduction, F-duction
2. Chemotherapeutic agents: Classification of Antibiotics, Broad and narrow spectrum antibiotics; Antibiotics from prokaryotes.
3. Anti-fungal and antiviral antibiotics, mode of action of antibiotics
4. Mechanism of drug resistance, plasmids and transposons

Practical Exercises

1. Preparation of Liquid and Solid media for growth of microorganisms.
2. Isolation and maintenance of organisms by plating, streaking and serial dilution method, slant and stab cultures, storage of microorganisms.
3. Isolation of pure cultures from soil and water
4. Growth; Growth curve; Measurement of bacteria population by turbidometry and serial dilution methods. Effect of temperature, pH and carbon and nitrogen sources on growth.

5. Microscopic examination of bacteria, Yeast and mold and study of organism by Gram's stain, acid fast stain and staining for spores
6. Study of mutation by Ame's Test.
7. Assay of antibiotics and demonstration of antibiotic resistance
8. Analysis of water for potability and determination of MPN.
9. Bacterial transformation.
10. Biochemical Characterization of selected microbes.
11. One Step growth curve of coliphage.

Reference Books

1. General microbiology, R.Y. Ingraham, J.L. Wheelis, M.L. and Painter, P.R. The Macmillan Press Ltd.
2. Brock Biology of microorganism, M.T. Martinko, J.M. and Parker, J. Prentice-Hall.
3. Microbiology, Pelczar, M.J., Chan E.C.S. and Kreig, N.R., Tata McGraw Hill.
4. Microbial Genetics, Malloy, S.R., Cronan, J.E. Jr and Freifelder, D.Jones, Bartlett Publishers
5. Microbiology-A Laboratory Manual, cappuccino, J.G. Sherman, N. Addison Wesley.
6. Microbiological Applications (A Laboratory Manual in General microbiology) Benson, H.J. WCB: Wm C Brown Publishers

104. BIOINSTRUMENTATION

UNIT I

1. Centrifugation: Principle, types and applications, factor affecting centrifugation
2. Photometry: Principle, instrumentation and application of UV-visible spectrophotometry
3. Infrared (IR) spectroscopy and its applications
4. Fluorescence spectroscopy: Principle, instrumentation and applications

UNIT II

1. Atomic absorption spectroscopy: Principle, instrumentation and application
2. Chromatography: Principle and applications of -Paper, thin layer and HPLC
3. Column chromatography: Gel filtration, Ion exchange and affinity chromatography
4. Electrophoresis: Principle, types and applications; 2-D gel electrophoresis

UNIT III

1. Electron spin resonance (ESR) spectroscopy: Principle, Instrumentation and applications
2. Nuclear Magnetic resonance (NMR) Spectroscopy: Principle, Instrumentation and Applications
3. Circular dichrorism spectroscopy (CD): Principle, Instrumentation and applications:
4. X-ray crystallography: Principle, instrumentation and applications

UNIT IV

1. Mass spectrometry: Principle and components of mass spectrometer
2. Mass analyzers: Magnetic sector, Time of flight (TOF), Quadruople, advantages and disadvantages; LC-MS
3. Surface plasma resonance methods and its applications.
4. Flow cytometry: Principle, instrumentation and application

UNIT V

1. Microtomy and sample preparation for microtomy.
2. Microscopy: Basic Principle and components of microscope, Compound microscope, phase contrast and Fluorescent
3. Electron microscopes: TEM and SEM- Principle and applications
4. Radioactivity: Principle, Autoradiography, Fluorography, types of radio isotopes used in biology and their applications

Practical Exercises

1. Verification of Beer's law
2. Determination of absorption maxima
3. Electrophoresis of Proteins- native and under denaturing conditions.
4. Amino acid and carbohydrate separations by paper & thin layer chromatography
5. Gas chromatography
6. Ion exchange and gel filtration chromatography
7. Separation of subcellular organelles by differential centrifugation
8. Separation of blood cells by density gradient centrifugation

Reference Books

1. Physical Biochemistry: Applications to Biochemistry and Molecular Biology by Freifelder
2. Biochemical Techniques: Theory and Practice by Robyt and White
3. Principles of Instrumental Analysis by Skoog and West
4. Analytical Biochemistry by Holme and Peck
5. Biological Spectroscopy by Campbell and Dwek
6. Organic Spectroscopy by Kemp
7. A Biologist's Guide to Pronciples and Techniques of Practical Biochemistry by Wilson and Goulding
8. Principles of Instrumental Analysis by Skoog, Hollar and Nicman

201. MOLECULAR BIOLOGY

UNIT I

1. Nature of Gene: Evolution of Gene Concept, Chemical Nature of Gene, split gene, overlapping genes, Nernst Genes, Gene families and pseudogenes
2. DNA Replication: General features of Chromosome Replication. DNA Replication Machinery in Prokaryotes and its comparison with Eukaryotes.
3. DNA damage, Repair Mechanisms, repair Defects in Human diseases
4. Enzymology of DNA Replication: DNA Polymerases; Primases; Ligases; Helicases; Topoisomerases and Gyrases. Single stranded binding proteins. Regulation of DNA Replication; Inhibitors of DNA Replication

UNIT II

1. Transcription in prokaryotes: Structure and Function of prokaryotic promoter
2. Structure and function of RNA Polymerase: Sigma factors- Types and functions
3. Control of transcriptional termination: Attenuation and anti termination
4. Operon concept, Structure and regulation of lactose, arabinose and tryptophan operons

UNIT III

1. Initiation of transcription in eukaryotes: RNA Polymerases Types and properties
2. Transcription factors- Types and properties; Enhancers- Structure and properties
3. Post-transcriptional Modification Eukaryotes
4. Splicing and RNA editing

UNIT IV

1. Genetic code: Wobble hypothesis
2. Translation: Stages of protein synthesis in prokaryotes and eukaryotes
3. Post-translational Modification: Types and Significance
4. Translational proof reading

UNIT V

1. Regulation of Gene Expression in Eukaryotes: cis elements and trans factors
2. Chromatin organization and regulation of gene expression
3. DNA methylation and its role in gene regulation; Regulation of gene expression by hormones
4. Oncogenes and Tumor Suppressor Genes

Practical Exercises

1. Isolation of Genomic DNA and restriction Digestion
2. Size fractionation of restricted DNA fragments by Agarose Gel Electrophoresis
3. Quantitations of DNA
4. Determination of Amax of purified DNA fragments
5. Determination of Tm of nucleic acid
6. Isolation of RNA
7. Fractionation of poly (A) RNA
8. *In vitro* transcription

9. *In vitro* translation
10. Metabolic labeling of proteins and immunoprecipitation
11. Protein-DNA interaction

Reference Books

1. Genes IX Benjamin Lewin
2. Molecular Biology , turner et al
3. Cell and Molecular Biology: Concepts and Experiments, Gerald Karp
4. Translational regulation in eukaryotes (2000), Carey and Smale
5. Translational control of Gene Expression (2000), Sonenberg et al
6. Chromatin and Gene Regulation (2001), Turner
7. An Introduction to Genetic Analysis, Griffiths et al
8. Genome (1999), Brown
9. Concepts pf Genetics, Klug and Cummings
10. Proteins, Creighton
11. Molecular Cell Biology, Lodish et al
12. Biochemistry and Molecular Biology of Plants (2000), Buchanan
13. Plant Biochemistry and Molecular Biology, Lea and Leegood
14. Plant Biochemistry (1997), Dey and Harborne

202 IMMUNOTECHNOLOGY

UNIT I

1. Immune response: Innate and adaptive immune system. Hematopoietic and differentiation of hematopoietic cells by cytokines. Toll-like receptor-component of innate immune system; clonal selection theory.
2. Anatomical organization of immune system: Primary & secondary lymphoid organs. Ontogeny and phylogeny of lymphocytes, lymphocyte traffic.
3. Cell of immune system: Mononuclear cells and granulocyte, antigen presenting cells, Lymphocytes and their subsets. Heptanes: factors effecting immunogenicity; super antigen, Antigenicity and immunogenicity.
4. Inflammation: its mediators and the process, immune response leading to an inflammatory reaction, role of anaphylaxis

UNIT II

1. Major histocompatibility systems: Organization of MHC with complex in Mouse and human. Association of MHC with disease.
2. Antigen processing: role of MHC molecules in antigen presentation and co-stimulatory signals.
3. T-cell receptor complex, T-cell accessory membrane molecules, activation of T-cell, organization and arrangement of T-cell receptor genes.
4. B-cell receptor complex, Immunoglobulin's (Class and subclass): Molecular Structures, type and function. Antigenic determinants of immunoglobulins (isotype, allotype and idiotype).

UNIT III

1. Molecular mechanism of antibody diversity Class switching
2. Antigen-Antibody infestation and affinity amusement.
3. Monoclonal Antibodies and hybridoma technology, and its application
4. Compliment system, components, Activation pathway, complement deficiency, role of complement system in immune responses, opsonization (opsonin)

UNIT IV

1. Cytokines: Suctions and function, cytokine related diseases and therapeutic application of cytokine.
2. Cytotoxic T-Cell and their mechanism of action, NK cell and mechanism of target cell destruction, Antibody dependent cell mediated cytotoxicity, techniques of cell mediated immunity.
3. Immunoregulation by antigens, Antibodies, immune complexes, MHC and cytokines.
4. Hypersensitivity and delayed type Hypersensitivity.

UNIT V

1. Autoimmunity and its mechanism
2. Immune response during bacterial (tuberculosis), Parasitic (malaria) and viral (HIV) infection, congenital and acquired immunodeficiency, diagnosis and therapeutic approaches.
3. Vaccines: Active and passive immunization, Recombinant-vector vaccines, DNA vaccines, synthetic peptide vaccines and sub-unit vaccines, Anti-idiotype vaccines.

4. Immunodiagnostics: development of immunodiagnostics kits for infectious and non infectious diseases with example. Precipitation techniques, Agglutination, ELISA, RIA, western Blotting and immuno-histochemical techniques (Avidin and Biotin system), Antibody engineering.

Practical Exercises

1. Blood Film Preparation and identification of cells.
2. Lymphoid organs and their microscopic organization.
3. Immunization and production of polyclonal antibodies.
4. Double diffusion and Immuno-electrophoresis.
5. Radial immunodiffusion.
6. Purification of IgG from serum.
7. Separation of mononuclear cell by Ficoll-paque.
8. Con-A induced proliferation of thymocytes (by MTT Method).
9. Western blotting.
10. ELISA
11. Preparation o antibody-enzyme conjugates.

Reference Books

1. Immunology, Kubey, R.A. Goldsby, Thomas J.Kindt, Barbara, A. Osbarne (Freeman).
2. Immunology- A short Course, Eli Benamini, Richard Coico, Geoffrey Sunshine.
3. Immunology by Tizzard
4. Fundamentals of Immunology, William Paul.
5. Immunology by Roitt and others.
6. Immunology by Abbas

203. ENZYME TECHNOLOGY

UNIT I

1. Enzyme: Historical aspects, classification and nomenclature, EC number
2. Mechanism of enzyme action and properties of enzymes as catalysts
3. Sub-cellular localization and organization of enzymes
4. Methods of enzyme assay: continuous and sampling techniques, coupled enzyme assays, specific activity, turn over number

UNIT II

1. Enzyme purification: Objectives and strategy, methods of isolation overview of purification techniques and crystallization
2. Criteria of purity and tabulation of purification data, stable storage of enzymes
3. Characterization of purified enzyme.
4. Non-aqueous biocatalysis and enzyme engineering

UNIT III

1. Enzyme kinetics: Equilibrium and steady state theory, rate equation and determination of Km and V_{max}
2. Factors affecting rate of enzyme reaction: pH, temperature and pressure
3. Enzyme inhibition: reversible and irreversible inhibition, Applications of inhibitors
4. Rapid reaction techniques

UNIT IV

1. Isoenzymes and their physiological significance
2. Allosteric enzymes: co-operativity, MWC and KNF Models
3. Regulation of enzymes
4. Ribozymes and abzymes

UNIT V

1. Enzyme Immobilization: methods, applications and its effect on kinetic parameters
2. Enzyme Biosensor: Principle, components of biosensor, types
3. Development of enzyme biosensors
4. Applications of biosensor for clinical diagnosis

Practical Exercises

1. Urease estimation by tritrimetric method
2. Urease estimation by colorimetric method
3. Acid phosphatase estimation
4. Alkaline phosphatase estimation
5. Determination of optimum time, optimum temperature & optimum pH
6. Determination of Km value
7. Acetylcholine esterase/pseudocholinesterase estimation
8. Enzyme purification

Reference Books

1. The nature of Enzymology by R.L. Foster
2. Enzymes by Dixon and Webb
3. Fundamentals of Enzymology by Price and Stevens
4. Enzyme Catalysis and Regulation by Hammes
5. Enzyme Reaction Mechanisms by Walsch
6. The Enzymes vol I and II by Boyer
7. Enzyme Structure and Mechanism by Alan Fersht
8. Enzyme Assays : A Practical Approach by Eisenthal and Danson

204. PART A: ENVIORNMENTAL BIOTECHNOLOGY

UNIT I

1. Environment pollution: types, methods for measurement of pollution
2. Solid waste treatment: Composting process, Vermicomposting and its advantages.
3. Biomedical waste and its management
4. Xenobiotics and its degradation

UNIT II

1. Microbial waste treatments: aerobic and anaerobic processes
2. An Integrated pest management- Biopesticides: types and impact on environment.
3. Bioremediation: *In situ* and *Ex situ* techniques advantages and applications of genetically engineered microbes (GEM) in bioremediation.
4. Phytoremediation: Types and its applications, Bioindicators, GMOs and assessment of environmental impact and monitoring.

Practical Exercises

1. Determination of dissolved oxygen concentration of water sample
2. Determination of biological oxygen demand (BOD) of sewage sample
3. Determination of Chemical oxygen demand (COD) of sewage sample
4. Isolation of xenobiot ic degrading bacteria by selective enrichment technique
5. Test for the degradation of aromatic hydrocarbons by bacteria
6. Survey of degradative plasmids in microbes growing in polluted environment
7. Study on biogenic methane production in different habitats

Reference Books

1. Comprehensive Biotechnology. Vol. 4,M. moo- young (Ed-in-chief), Pergmon Press Oxford
2. Environmental chemistry. A.K.De, Wiley Eastern Ltd., New Delhi
3. Introduction to Biodeterioration. D.Allsopp and Seal, ELBS/ Edward Arnold
4. Environmental Biotechnologies and Cleaner Bioprocess by Eugenia J Olguuin et al
5. Environmental Science: Physical Principles and applications by Egbert Boeker et al

204: Part B ANIMAL BIOTECHNOLOGY

UNIT III

1. Animal cell culture: Organization of animal cell and tissue culture laboratory
2. Culture Medium: types, functions of different constituents of media, role of Co_2
3. Primary and established cell line cultures
4. Measurement of parameters of growth

UNIT IV

1. Scaling up of animal cell culture, Cell synchronization
2. Cell cloning and micromanipulation
3. Measurement of cell viability, methods of separation of cell types
4. Stem cell cultures, embryonic stem cells and their applications

UNIT V

1. Commercial applications of cell culture: cytotoxicity and diagnostic tests
2. Cell culture based vaccines
3. 3-D animal cell culture
4. Transgenic animals

Practical Exercises: Part B

1. Preparation of tissue culture medium and membrane filtration
2. Preparation of single cell suspension from spleen and thymus
3. Cell counting and viability
4. Macrophage monolayer from PEC and measurement of phagocytic activity
5. Cell fusion with PEG

Reference Books

1. Culture of Animal Cells by RI Freshney
2. Animal Cell Culture: Practical Approach John R W Masters
3. Animal Cell Culture Techniques by Ed. Martin Clynes
4. Methods in Cell Biology Vol. 57, Animal cell culture methods

301. GENETIC ENGINEERING

UNIT I

1. Concept and Principle of recombinant DNA Technology
2. Restriction endonucleases – properties and types
3. Polynucleotide kinase; DNA ligase; DNA polymerase I; reverse transcriptase; terminal deoxynucleotidyl transferase; poly A polymerase
4. Prokaryotic host-vector system : Characteristics of *E. coli* as host; vectors for cloning in *E. coli* (plasmid, bacteriophage and cosmids)
5. Characteristics of Gram positive and Gram negative organisms as host and suitable vectors for cloning; Shuttle Vectors

UNIT II

1. Design and characteristics of expression vectors for cloning in prokaryotes, factors that affect expression.
2. Cloning in yeast,YACs
3. Methods of introduction of foreign DNA in animal system; Vectors for cloning- SV-40, vaccinia virus and retrovirus, pMal, GST, pET based vectors, Pichia based vectors.
4. Plant transformation technology: Features of Ti and Ri plasmids

UNIT III

1. Methods for constructing rDNA and cloning
2. Screening methods and selection of recombinant clones
3. DNA Libraries: types, advantages and disadvantages
4. Restriction mapping of the insert

UNIT IV

1. DNA sequencing: chemical and enzymatic methods, High throughput sequencers.
2. Localization of cloned segments in genomes – molecular and chromosomal location
3. Methods for determination of copy number of a cloned gene in genome
4. Site directed mutagenesis

UNIT V

1. Blotting techniques – Southern, Northern, Western and Eastern blotting
2. Polymerase Chain reaction and types (multiplex, nested, RT, real time, touchdown PCR, hot start PCR, colony PCR)
2. Gel Mobility Shift Assay, DNA Fingerprinting and DNA Foot printing, Restriction fragment length polymorphism
3. Applications of Recombinant DNA Technology in Medicine and Industry
4. Si RNA and Si RNA technology and its applications

Practical Exercises

1. Bacterial Culture and antibiotic selection media. Preparation of competent cells
2. Isolation of plasmid DNA
3. Isolation of phage DNA
4. Quantitation of nucleic acids

5. Restriction mapping of plasmid DNA
6. Cloning in plasmid/phagemid vectors
7. Preparation of helper phage and its titration
8. Preparation of single stranded DNA template
9. Gene expression in *E .coli* and analysis of gene product
10. Polymerase Chain Reaction

Reference Books

1. Recombinant DNA – By Watson et al
2. Principles of Gene Manipulation, Old and Primrose
3. Gene Cloning: An introduction , Brown
4. Biotechnology: Theory and Techniques (Vol I & II), Chirikjian
5. Molecular Genetics of Bacteria , Dale
6. Molecular Cloning (Vol I, II & III, 2001), Sambrook & Russell
7. Applied Molecular Genetics (Latest Edition), Miesfeld
8. Genes and Genome (Latest Edition), Singer & Berg
9. Molecular Biotechnology, Glick & Pasternak
10. Plant Molecular Biology (Vol I & II, 2002), Gilmartin & Bowler

302. PLANT BIOTECHNOLOGY

UNIT I

1. Objectives, roles and landmarks in plant breeding.
2. Special breeding techniques: Mutational breeding and distant hybridization.
3. Genetically modified crops for resistance against biotic and abiotic stresses and nutritional quality.
4. Seed production techniques: release of new varieties.

UNIT II

1. Introduction to plant tissue culture: Tissue Culture Media preparation.
2. Initiation of callus culture and its maintenance.
3. Cell synchronization
4. Organogenesis: Somatic embryo hybridization.

UNIT III

1. Somaclonal variation and its application for plant improvement
2. Anther culture: haploid and diploid plant cell production and their applications
3. Protoplast isolation and fusion, selection of hybrid cell and cybrids, synthetic seed
4. Cryopreservation techniques and application

UNIT IV

1. Plant cloning vectors: *Ti* Plasmid and direct gene transfer
2. Transgenic crops : Pest and herbicide resistance
3. Morphological, Biochemical and Molecular markers, advantages and disadvantages, Choice of mapping populations, Association mapping in plants
4. Plant DNA fingerprinting: Hybridization, PCR (RFLP, SSR's, RAPD, SCAR, AFLP) and sequence based markers

UNIT V

1. Plant Genome mapping: Physical and molecular maps, Gene tagging
2. Insect resistance: Bt genes, Non-Bt like protease inhibitors, lectins, PR proteins
3. Plant breeders' right: UPOV 369,370, 372. Germplasm maintenance
4. Intellectual property right (IPR) and Patenting of Biological material

Practical Exercises

1. Preparation of media
2. Surface sterilization
3. Organ Culture.
4. Callus propagation, organogenesis, transfer of plants to soil.
5. Protoplast isolation and culture.
6. Anther culture, production of Haploids.
7. Agrobacterium culture, selection of transformants, receptor gene (GUS) assays.
8. Genomic DNA isolation from seeds and plant tissues, electrophoretic analysis
9. Restriction digestion of plant genomic DNA
10. Setting up of PCR reactions.

Reference Books

1. Plant Biotechnology. Springer Verlag, 2000. J. Hammond,P. McGarvey and V.Yusibov (Eds)
2. Introduction to plant tissue culture by Kalyan Kumar
3. Plant tissue culture by Bhojwani
4. Practical applications of plant molecular biology by Henry et al
5. Principles of Plant Biotehcnology by Montell SH et al
6. Plant Genome analysis by PM Gresshoff
7. Essentials of plant breeding by Phundan Singh
8. Biotechnology: Theory and Techniques Vol I & II by Jack Chirikjian
9. Genetic engineering by Sandhya Mitra
10. Plant Molecular Biology Vol I & II by Phillip M Gimartin & Chris Bowler

303. BIOPROCESS ENGINEERING AND MICROBIAL TECHNOLOGY

UNIT I

1. Introduction and basic principle of Biochemical engineering
2. Isolation, preservation and maintenance of industrially important microbes: Strain improvement of industrially important microorganisms
3. Kinetics of microbial growth and death
4. Media for industrial fermentation, media formulation; Sterilization; Aeration and agitation in bioprocess. Air sterilization

UNIT II

1. Scale of fermentation process: small scale, large scale and pilot scale fermentations
2. Biorecators: Principle, types, design and applications
3. Types of fermentation processes; batch, fed-batch, and continuous bioreactions.
4. Measurement and control of fermentation: pH, temperature, pressure, media, air, Automation of the monitoring and control process

UNIT III

1. Upstream processing and down stream processing: Introduction and concept.
2. Down stream processing: removal of microbial cells and solid matter, foam separation, precipitation, centrifugation, cell disruption, chromatography, reverse osmosis
3. Extraction: Solvent, two phases, liquid extraction
4. Product recovery process. Crystallization, storage, packaging and quality control

UNIT IV

1. Industrial production of important bioproducts: Vitamins and amino acids (Vit B12 & Glutamic acid)
2. Industrial production of important bioproducts: antibiotics-Penicillin; and streptomycin
3. Enzyme- Amylase, Protease, Production, recovery and scaling up of enzymes and their role in food and other industries.
4. Immobilization of enzymes and their industrial applications.

UNIT V

1. Microbial production of alcoholic beverages: Distilled alcoholic beverages-Beer, microbial production of Vinegar.
2. Microbial production of organic acids: Citric acid and Acetic acid
3. Microbial production of solvents: Ethanol and acetone
4. Microbial production of food- SCP Mushroom cultivation, Biofertilizers and their applications

Practical Exercises

1. Isolation of industrially important microbes from the environment
2. Determination of TDP and TDT of microorganisms for a design of a sterilizer

3. Determination of growth curve of a industrial organism and compute substrate, degradation profile, specific growth rate and growth yield
4. Screening and enrichment for a primary/ secondary metabolite from the environment
5. Strain improvement for higher yield of a product
6. Random and strategic screening for a metabolite
7. Media balancing experiments
8. Alcohol fermentation using different substrates and its downstream processing

Reference Books

1. Biochemical Engineering, Aiba, S., Humphrey, A.E. and millis, N.F. Univ. Tokyo Press, Tokyo.
2. Biochemical Reactors, Atkinson, B., Pion Ltd. London.
3. Biochemical Engineering Fundamentals, Baily. J. E. and ollis , D.F. Mcgraw- Hill Book Co. New York.
4. Bioprocess Technology: Fundamentals and Applications , KTH, Stockhlom.
5. Process Engineering in Biotechnology, Jackson, A.T. , Prentice Hall, Engelwood Cliffs.
6. Bioprocess Engineering: Basic Concepts Shuler, M.L. and Kargi , F., Prentice Hall, Englewood Cliffs..
7. Principles of fermentation Technology, Stanbury,P.F. and Whitakar A., Pergmon Press, Oxford.
8. Bioreaction Engineering Principles, Nielson, J and Villadsen , J., Plenum Press.
9. Chemical Engineering, Problems in Biotechnology, Shuler, M.L.(Ed.), AICHE.
10. Biochemical Engineering, Lee, J.M., Prentice Hall Inc.
12. Bioprocess Engineering- Kinetics, Mass Transport, Reactiors and Gene Expression, Vieth, W.F., John Wiley & Sons, Inc.

304. BIOSTATISTICS AND COMPUTER APPLICATIONS

UNIT I

1. Introduction to Biostatistics, population and Sampling Methods
2. Classification, tabulation and graphical presentation of data
3. Frequency Distribution, Measures and central value
4. Measures of variability, Standard deviation, Standard error, Coefficient of variation, Analysis of variance(ANOVA)

UNIT II

1. Tests of Significance, t-test, chi-square test.
2. Regression: regression analysis, estimation, testing, prediction, checking and residual analysis.
3. Multivariate Analysis
4. Design of Experiment, randomization, replication, local control, randomized block design

UNIT III

1. Computer basics, windows and LINUX
2. Hardware, software, interface
3. Concepts of file, folders, directories and their management
4. Open file on LINUX: Word Processor, spread sheets, Impress

UNIT IV

1. Introduction to data management
2. Programming concepts and tools
3. Introduction to programming languages
4. Statistical packages: Sigma plot

UNIT V

1. Improving communication skills
2. Basics of scientific writing
3. Thesis and assignment writing
4. Nonverbal communication

Reference Books

1. An Introduction to Computational Biochemistry by C Stan T sai
2. Statistics for Agricultral Sciences by Nageswara Rao, G.
3. Fundamentals of Statistics by Goon et al, 1962..
4. Methods in Biostatistics by B.K. Mahajan
5. Statistical Methods by S.P. Gupta
6. Statistical Methods by G.W. Snedecor and W.G. Cochran
2. Fundamental of Artificial Neural Networks, Prentice-Hall of India, N.Delhi

305 Lab Course: V

Consists of Practical Exercises listed out under 301 and 302

305 Lab Course: VI

Consists of Practical Exercises listed out under 303 and 304.

401. EMERGING TRENDS IN BIOTECHNOLOGY

UNIT I

1. Stem cell Technology
2. Manipulation of stem cells and applications in medicine.
3. *In vitro* fertilization: Principle, Methods, applications and ethics.
4. Cloning of animals: Methods and applications.

UNIT II

1. Genome & Genomics: Concept and methods of genome analysis
2. Transcripome & Transcriptomics: Concept and methods.
3. Proteome and Proteomics: Concept and methods of Proteome analysis.
4. Metabolome and Metabolomics.

UNIT III

1. Nano biotechnology: Introduction and biological materials-example and uses.
2. DNA nanotechnology:-Structural DNA assembl
3. Nanoparticles-biological arrays-nanoprobes for analytical applications.
4. Nano biosensors-nano scale organization-characterization-quantum size effects-sensors of the future.

UNIT IV

1. Biochemical Diagnostics: Biochemical markers of disease diagnosis
2. Concept of Molecular Diagnostics: DNA diagnostics
3. Microarray Technology, Array-based diagnostics, SNP's and GMPs and diagnostic significance.
4. Western blot diagnostics, Phage display concept and applications of phage display.

UNIT V

1. Biosensors: Concept, principle, Organization of biosensor and types.
2. Biosensors: Health and medicine.
3. Biosensors: Food technology, Environmental monitoring.
4. Bacterial biosensors; Array Biosensors

Practical Exercises

Appropriate exercises based on theory.

Reference Books

1. DNA Microarrays and gene expression by P. Baldi & GW Hatfield
2. Protein – Protein Interactions by Erica Golemis
3. A passion for DNA (Genesm genomes and Soceity) By JD Watson
4. Modern Genetic analysis by Anthony JF Griffiths et al.
5. Nanobiotechnology- next big idea by Mark, Ratner, Daniel Ratner
6. Gene cloning by TA Brown
7. Latest information on academic Web sites.

402: BIOINFORMATICS

UNIT I

1. Overview of Bioinformatics: Merger of life sciences with computers.
2. Search engines: Google, Pub Med, NCBI, EMBL,
3. Protein and DNA databases: Swiss port, PIR, OMIM, Embark, ENTREZ, DDJB, MIPS, Hovered, ECDC, Cambridge small molecular crystal structure data bank
4. Software for bioinformatics and web based analysis

UNIT II

1. Sequence Databases: Human Genome Databases, Plant Genome Databases
2. Retrieving and installing a program (Tree Tool), Multiple sequence alignment program- Clustal W & X
3. Genome analysis program: BLAST and FASTA
4. Phylogenetic analysis: Phylogenetic reconstruction, distance matrices, Parasimony, Phylip.

UNIT III

1. Methods of sequence predication: Proteins, DNA, RNA
2. Computer aided drug designing: Basic principles, docking
3. Functional genomics, EST clustering gene discovery, ORF prediction.
4. Use of genome analysis programs, primer designing tools.

UNIT IV

1. Sequence comparison and Cluster analysis
2. Homology modeling: Protein structure prediction
3. Molecular energy minimization, molecular dynamics simulation
4. Tagging of genes and molecular modeling.

UNIT V

1. Government schemes for commercialization of technology (Eg. Biotech Consortium)
2. Public policy, regulatory and ethical challenges facing in enterpreneurship
3. Biotech enterprises: Small, Medium and Large, Kaizen Quality Control in Biotech industries
4. Business Development for Medical products and consumable products

Reference Books

1. Introduction to Bioinformatics: A theoretical and practical approach by Stephen A Krawetz and DD Womble
2. Bioinformatics Genes, Proteins & Computers by CA Orengo, DT Jopnes and JM Thornton
3. An Introduction to Computational Biochemistry by C Stan T Sai

4. Instant notes on Bioinformatics by DR Westhead, JM Perish & RM Toyman
5. Essential Bioinformatics by Jin Xiong
6. An Introduction to Bioinformatics Algorithms by Neil C. Jones, Pavel Pevzner
7. Bioinformatics: Sequence and Genome Analysis by David W. Mount
8. Statistical Methods in Bioinformatics: An Introduction by Stephen Misener, Stephen A. Krawetz.
9. Bioinformatics: databases and Algorithms by N. Gautham
10. Bioinformatics Technologies by Yi-Ping Phoebe Chen
11. Data Mining: Multimedia, Soft Computing and Bioinformatics by Sushmita Mitra, Tinku Acharya