

JIWAJI UNIVERSITY, GWALIOR-474011
MSc. BIOTECHNOLOGY
CURRICULUM- 2011 -13

Semester	Title of the Paper	Marks	
		EA	IA
First	101. Cell Biology	70	30
	102. Biomolecules and metabolism	70	30
	103. Microbiology	70	30
	104. Bioinstrumentation	70	30
	105. Lab Course I	50	-
	106. Lab Course II	50	-
Second	201. Molecular Biology	70	30
	202. Immunotechnology	70	30
	203. Enzymetechnology	70	30
	204 Part A: Environmental Biotechnology Part B: Animal Biotechnology	70	30
	205. Lab Course III	50	-
	206. Lab Course IV	50	-
Third	301. Genetic Engineering	70	30
	302. Plant Biotechnology	70	30
	303. Bioprocess Engineering and Microbial Technology	70	30
	304. Biostatistics & Computer applications	70	30
	305. Lab Course V	50	-
	306. Lab Course VI	50	-
Fourth	401. Emerging Trends in Biotechnology	70	30
	402. Optional 1: Bioinformatics Optional 2: Entrepreneurship in Biotechnology & IPR Optional 2: Management & Marketing of Biotech. products	70	30
	403. Lab Course VII: Technical / Review writing*	150	

* Evaluated both by the Internal and External examiner at the time of presentation.

There shall be no compulsory project works first three semesters. There are weekly seminars and continuous internal assessment throughout the course. Of the Three internal assessment tests one will be based on seminar in every semester.

101 CELL BIOLOGY

UNIT –I

1. Cell Membrane: Physiochemical properties; molecular organization-asymmetric organization of lipids, Protein and carbohydrates: Biogenesis and function.
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 clamp technique.
- 5.

UNIT- II

1. Structure, function and transport of proteins in to mitochondria and chloroplast.
2. Transport of proteins and RNA-into and Out of Nucleus.
3. Transport of proteins into endoplasmic reticulum and Golgi bodies.
4. Transport by vesicle formation: Endocytosis and exocytosis and molecular mechanism of Vesicular transport.

UNIT III

1. Ultra structure and function of lysosomes, peroxysomes and Vacuoles.
2. Cell motility and shape I: structure and function of microfilaments.
3. Cell motility and shape II: Structure and function of microtubules and intermediate filaments.
4. Intra cellular communication through cell junctions: Occluding junction, anchoring junctions and communicating junctions.

UNIT -IV

1. Molecular mechanism of cell-cell adhesions: Ca^{++} dependent cell-cell adhesions.
2. Molecular mechanism of cell-cell adhesions: Ca^{++} independent cell-cell adherence.
3. Extracellular matrix of animals: organization and function.
4. Extracellular matrix receptors on animal cell: integrins.

Unit -V

1. Cell signaling: Signaling Via G-Protein linked cell surface receptors, MAP kinase pathways and tyrosine kinase pathway: Initiation, interaction and regulation.
2. Eukaryotic cell division cycle: Different phase and molecular events.
3. Control of cell division cycle: in yeast and mammalian cells.
4. Apoptosis: Phases and significance, Morphological and Biochemical changes associated with apoptotic cells, Apoptotic 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), Stories et al
4. Cell and Molecular Biology: concepts and Experiments (3rd Ed.,2002), Gerald Karp
5. The cell: A Molecular Approach, G.M.Cooper
6. The world of 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. BIOENERGETICS & METABOLISM

UNIT I

1. Carbohydrates: Structure, classification, properties, chemical reactions, stereoisomerism and functions.
2. Homo and hetero polysaccharides, animal, plant and microbe specific polysaccharides, bacterial cell wall, carbohydrate derivatives: peptidoglycans, glycolipids, sialic acid.
3. Lipids: classification, Structure, properties and functions of fatty acids, triacylglycerols, Phospholipids, wax, sterols, terpenes, prostaglandins:
4. Lipids with specific biological functions, lipoproteins and biological membrane, micelles and liposomes

Unit II

1. Aminoacids: Structure, classification, properties and functions, peptides and polypeptides
2. Proteins: Properties, Primary , secondary, tertiary and quaternary structure
3. Vitamins and cofactors: Structure, distribution, interaction and biological properties
4. Nucleic acids: DNA: Structure, conformation, Properties of purines and pyrimidine bases, nucleoside and nucleotides; RNA: Structure, types and function of mRNA, tRNA and rRNA.

UNIT III

1. First and second laws of thermodynamics & Concept of free energy.
2. High energy phospho compounds, ATP cycle, structural basis of free energy change during hydrolysis of ATP.
- 3 Carbohydrate metabolism : Basic concepts glycolysis, , glycogenesis, gluconeogenesis: pathway and regulation
4. Krebs cycle, pentose phosphate pathway, glyoxalate pathway, glycogenolysis: pathway and regulation, associated inborn errors

UNIT IV

1. Electron transport and oxidative phosphorylation : electron carriers, complexes I to IV, chemiosmotic theory, substrate level phosphorylation
2. Plant phenolics, alkaloids: classification and functions. Plant hormones: structure and biological functions.
3. Lipid metabolism: Biosynthesis and degradation of odd carbon and even carbon

4. Saturated and unsaturated fatty acids, formation and of ketone bodies ,regulation of lipid metabolism, associated inborn errors.

UNIT V

1. Overview of aminoacid metabolism: biosynthetic families of amino acids, breakdown of amino acids into six (to check) common intermediates.
2. Regulation of amino acid metabolism. (Steps for the biosynthesis and breakdown of amino acids are not required) , associated inborn errors.
3. Nucleic acid metabolism: biosynthesis and breakdown of purine, pyrimidines, nucleotides by *de novo* and salvage pathways,
4. Regulation of metabolism, associated inborn errors.

Practicals

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.

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 Freifelder, W.H. Freeman & Company.
8. Laboratory Techniques in Biochemistry and molecular Biology, Work and Work.
9. ABiologists guide to Principles and Techniques of practical Biochemistry, KWilson & KH Goulding, ELBS Edition, 1986.

103. MICROBIOLOGY

UNIT I

1. Classification of Microorganisms: Bacterial & Fungal Classification.
2. Morphology and fine structure of eubacteria, archeobacterial cell wall and fungal cell wall.
3. Preparation of culture media, pure culture techniques and microbial staining.
4. Cyanobacteria : General account and their economic importance

UNIT II

1. Sterilization: Physical and chemical methods.
2. Microbial growth: Bacterial growth curve, Mathematical expression, measurement of growth and factors affecting growth.
3. Microbial Nutrition: Nutritional 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, superoxidase dismutase, mechanism of oxygen toxicity/ Taxonomic classification of microbes using molecular markers- 16 rRNA typing.

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 Candidiasis.
4. Viral diseases: Chicken Pox, Hepatitis B and Poliomyelitis.

UNIT IV

1. Virus organization, Types, Isolation, cultivation, identification and viral replication.
2. Structure and morphology of bacteriophages, lytic and lysogenic cycle.
3. Life cycle of DNA viruses: SV 40, RNA viruses: Retroviruses.

4. Plant viruses: TMV, Gemini, CMV, Human Viruses: Influenza (SARS), Herpes Simplex virus, Rubella.

UNIT V

1. Mycoplasma and diseases caused by them.
2. Bacterial Recombination: Transformation, conjugation, transduction, Plasmids and Transposons.
3. Chemotherapeutic agents: Classification of Antibiotics, Broad and narrow spectrum antibiotics; Antibiotics from prokaryotes.
4. Anti-fungal and antiviral antibiotics, mode of action of antibiotics and mechanism of drug resistance, origin of drug resistance.

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 Ames'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. Principles of Microscopy – components of microscope – mechanical and optical; Resolving power of different microscopes. Image magnification, contrast & resolution. Resolution power and calculation, Numerical aperture, Refractive index, image illumination,
2. Type of microscopy-Basic structure and function of- Light microscopy- Bright field, Dark field, phase contrast, florescent, Confocal, Scanning & NDIC; Electron microscopes – TEM, SEM, & Scanning Tunneling M.
3. Different methods of fixation and staining techniques of electron microscope. Microtomy: Types, principal and applications. Freeze –etch and freeze fracture techniques.
4. Radio labeling techniques detection and measurement of different types of radio isotopes used in biology and their application in biological science. Half life, Safety guidelines, Molecular imaging of radioactive material.

Unit – II

1. Radio activity: Radio isotropic tracers – Methodology, Radio labeling techniques, Radio metric analysis stable and radioactive isotopes, labeling, detection and measurement of isotopes: Geign-Muller counter, liquid scintillating counter and gamma counter.
2. Centrifugation- Principle, types and applications; centrifugation techniques- preparative and analytical methods, density gradient centrifugation, Ultra centrifugation; sedimentation coefficient and factor affecting centrifugation.
3. Principle, types and application of Electrophoresis – frontal & Zonal Electrophoresis, Paper, agarose gel, PAGE, SDS-PAGE, Capillary electrophoresis (CE).
4. Principles of - Isoelectric focusing, 2D gel electrophoreses and Isotachophoresis, pulse field Gel electrophoresis (PFGE); Application of electrophoresis in the diagnostic laboratory, mutation detection.

Unit III

1. Principles, types and application of chromatography – Partition, adsorption, Gel filiations Paper column, thin layer, Gas, Ion exchange and Molecular sieve; various stationary and mobile phases, sample preparation, matrix materials, Column packing, analyte development & elution.
2. Principle and application of affinity chromabrography- HPLC, FPLC (fast protein liquid chromatography), Gas chromatography, Capillary electro chromatography, Hydroxy apatite chromatography, Hydrophobic interaction chromatography.
3. Photometry: Law of absorpton and radiation, principle, instrumentation and application of UV-visible spectrophotometry, infrared (IR) spectroscopy and Raman spectroscopy.
4. Atomic absorption spectroscopy: Principle instrumentation and application; Fluorescence spectroscopy and Quenching.

Unit -IV

1. Electron spin resonance (ESR) spectroscopy and Nuclear Magnetic resonance (NMR): Principle, Instrumentation and application.
2. Circular Dichrorism spectroscopy (CD): Principle, instrumentation and application.

3. Principle and applications of colorimetry, fluorescence flame photometry, fluorimetry, polarimetry, turbidometry and Viscometry.
4. X-ray crystallography.

Unit - V

1. Mass spectrometry: components of mass spectrometer – vacuum system, ion source, sample inlet, analyzer and detectors; Matrix.
2. Quadrupole mass spectrometry, plasma desorption ionization, MALDI-TOF, Peptide mass determination and other application.
3. Surface plasma resonance methods and its applications.
4. Flow cytometry- FACS, MACS: Principle, instrumentation and application.

Practicals

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

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 Principles and Techniques of Practical Biochemistry by Wilson and Goulding
8. Principles of Instrumental Analysis by Skoog, Holler and Nicman

201: MOLECULAR BIOLOGY

Unit I

1. Nature of Gene: Evolution of Gene Concept, Chemical Nature of Gene, Gene-cistron Relationship in prokaryotes and eukaryotes, Overlapping genes, Nested Genes, Gene families and pseudogenes. Proof of DNA as genetic material.
2. Denaturation and Renaturation of DNA. Molecular Basis of Gene Mutation:, Biological Repair Mechanisms, Repair Defects and Human Diseases
3. DNA Replication: General features of Chromosomal Replication. DNA Replication Machinery in Prokaryotes and its comparison with Eukaryotes.
4. Enzymology of DNA Replication : DNA Polymerases; Primases; Ligases; Helicases; Topoisomerases; Gyases and Single stranded Binding Proteins. Regulation of DNA Replication ; Inhibitors of DNA Replication

Unit II

1. Transcription in prokaryotes: Initiation, elongation and termination
2. Structure and Function of prokaryotic promoter
3. Control of transcriptional initiation in prokaryotes: Structure and function of RNA Polymerase: Sigma factors- Types and functions
4. Control of transcriptional termination: Attenuation and anti termination

Unit III

1. Regulation of gene expression in prokaryotes: Operon concept, induction and repression, Structure and regulation of lactose, arabinose and tryptophan operons
2. Initiation of transcription in Eukaryotes: RNA Polymerases Types and properties
3. Transcription factors- Types and properties; Enhancers- Structure and properties; Response Elements
4. Post-transcriptional Modification Eukaryotes- 5' and 3' modification of mRNA

Unit IV

1. Post- transcriptional Processing of pre mRNA, pre rRNA and pre tRNA transcripts
2. Genetic Code: Evidence and properties; Wobble hypothesis; Transcriptional adaptors and amino acyl tRNA synthases
3. Translation: Successive stages of protein synthesis in prokaryotes and its comparison with eukaryotes
4. Post-translational Modification: Types and Significance

Unit V

1. Regulation of Gene Expression in Eukaryotes: cis- acting DNA elements; Chromatin organization and regulation of gene expression; regulation at the level of processing of transcripts
2. Regulation of Gene Expression in Eukaryotes: RNA editing; Gene Alteration; DNA methylation and gene regulation; Regulation of gene expression by hormones: regulation of gene expression at translational level
3. Transposable elements in Prokaryotes and Eukaryotes: Types and Significance
4. Oncogenes and Tumor Suppressor Genes: Properties and Significance

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 1

1. Immune response: Innate and adaptive immune system: Cells and molecules involved, characteristics and mechanism. hematopoiesis 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 lymphoid organ, secondary lymphoid organs. Ontogeny and phylogeny of lymphocytes, lymphocyte traffic.
3. Cell of immune system: Mononuclear cells and granulocyte, antigen presenting cells; APCs: professional and Nonprofessional; Lymphocytes and their subsets, lymphocyte surface molecules and receptors and flow cytometry. Antigens, Heptanes: factor effecting immunogenicity; super antigen, Antigenicity and immunogenicity.
4. Inflammation: its mediators and the process, cell-adhesion molecules and their role in inflammation, Leukocyte migration, lymphocyte homing, tissue injury and immune response leading to an inflammatory reaction, role of anaphylotoxins, granulocytes in inflammatory process.

Unit II

1. Major histocompatibility systems: Structure of MHC I and II molecule, polymorphism, distribution variation and function. Organization of MHC with complex in Mouse and human. Association of MHC with disease.
2. Recognition of antigens by T and B Cells: 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, activation and differentiation of B-cells, Immunoglobulin's (Class and subclass): Molecular Structures, type and function. Antigenic determinants of immunoglobulins (isotype, allotype and idiootype).

Unit III

1. Molecular mechanism of antibody diversity organization of genes coding for constant and variable regions of heavy and light chain .Mechanism of antibody diversity, Class switching .
2. Antigen-Antibody infestation and affinity amusement.
3. Monoclonal Antibodies: Principle of hybridoma technology, production characterization and application in diagnosis, therapy and basic research, Fusion methods.
4. Compliment system, components, Activation pathway and regulation of activation pathway, complement deficiency, role of complement system in immune responses opsonization (opsonin)

Unit IV

1. Cytokines: Functions and function, cytokine receptors, Signal transduction mediated by cytokine receptors, cytokine regulation of immune response, 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 : Definition, I_gE mediated Hypersensitivity, mechanism of mast cell degranulation, mediators of type I reactions and consequences type II reaction, immune complex mediated Hypersensitivity and delayed type Hypersensitivity.

Unit 5

1. Autoimmunity: Organ specific and systemic diseases, mechanism of autoimmunity.
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, whole organism vaccines, macromolecules as vaccines, Recombinant-vector vaccines, DNA vaccines, synthetic peptide vaccines and sub-unit vaccines, Anti-idiotypic vaccines.
4. Immunodiagnosics: development of immunodiagnosics kits for infectious and non infectious diseases with example. Precipitation techniques, Agglutination, fluorescence techniques (FACS), 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 of 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. ENZYMETECHNOLOGY

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 and expression of velocity of enzyme catalysed reactions, activity, specific activity, turn over number and catalytic centre activity

UNIT II

1. Enzyme purification techniques: Objectives and strategy, methods of homogenization, methods of isolation , purification and crystallization
2. Criteria of purity and tabulation of purification data, stable storage of enzymes
3. Characterization of purified enzyme.
4. Coenzymes and cofactors.

UNIT III

1. Enzyme kinetics: Equilibrium and steady state theory, rate equation and determination of K_m and V_{max}
2. Factors affecting rate of enzyme reaction: pH, temperature and pressure
3. Enzyme inhibition : reversible and irreversible inhibition, their types, inhibitor constant and its significance
4. Rapid reaction techniques

UNIT IV

1. Isoenzymes
2. Protein - ligand binding: types, cooperativity, Hill and Scatchard plot. Allosteric enzymes: Models of allostery, types and kinetics
3. Regulation of enzymes
4. Mechanism of action of dehydrogenases, kinases, metalloenzymes

UNIT V

1. Immobilization : Principle, kinetics of immobilised systems
2. Enzyme immobilisation ; Principle, method, activity, immobilized multienzyme systems and applications
3. Effect of immobilization on : activity, kinetic parameters and stability
4. Applications of immobilized enzymes

Practicals:

1. Urease estimation by titrimetric 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 K_m value
7. Acetylcholinesterase/pseudocholinesterase estimation
8. Enzyme purification

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: ENVIRONMENTAL BIOTECHNOLOGY

UNIT I

1. Environment: Basic concepts, 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. An Integrated pest management- Biopesticides: definition, types and impact on environment.
2. Bioremediation: *In situ* and *Ex situ* techniques, advantages of bioremediation, applications of genetically engineered microbes (GEM) in bioremediation.
3. Phytoremediation: Types and its applications
4. Environmental monitoring: Bioindicators

UNIT III

1. Microbial waste treatments: Aerobic process: Activated Sludge trickling filters, Aerated lagoons and oxidation ponds.
2. Anaerobic processes: biodegradation methods namely VIZ. anaerobic lagoons, up flow anaerobic sludge blanket reactor.
3. Cleaner technologies ; Reducing environmental impact of effluents from paper and tannery industries.

4. 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 xenobiotic 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), Pergamon 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 Olguin et al
5. Environmental Science: Physical Principles and applications by Egbert Boeker et al

204: Part B . ANIMAL BIOTECHNOLOGY

UNIT IV

1. Introduction and organization of animal cell and tissue culture laboratory
2. Primary and established cell line cultures
3. Serum and protein free defined media and their applications
4. Introduction to balanced salt solutions and simple growth medium: rationale of composition of medium, role of CO₂ and supplements

UNIT V

1. Measurement of parameters of growth
2. Scaling up of animal cell culture, Cell synchronization
3. 3-D animal cell culture
4. FISH and applications of animal cell culture

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