

Swami Ramanand Teerth Marathwada University, Nanded

Syllabus M.Sc. Biotechnology (Revised)
Choice Base Credit System (CBCS) (June - 2014)

M. Sc. Biotechnology First Year (First Semester)

Paper No.	Paper Title	External (ESE)	Internal (CA)	Total
BT-I	Cell and Developmental Biology	75 Marks	25 Marks (2Test: 15 Marks + Assignments:10 Marks)	Credit :4 (100 Marks)
BT-II	Microbiology & Virology	75 Marks	25 Marks (2Test: 15 Marks + Assignments:10 Marks)	Credit :4 (100 Marks)
BT-III	Biochemistry	75 Marks	25 Marks (2Test: 15 Marks + Assignments:10 Marks)	Credit :4 (100 Marks)
*BT-IV (Elective)	Techniques in Biology	75 Marks	25 Marks (2Test: 15 Marks + Assignments:10 Marks)	Credit :4 (100 Marks)
BT-V	Seminar	25 Marks		Credit:1
			Total for Sem.: I	Credit:17

M. Sc. Biotechnology First Year (Second Semester)

Paper No.	Paper Title	External (ESE)	Internal (CA)	Total
BT -VI	Molecular Genetics	75 Marks	25 Marks (2Test: 15 Marks + Assignments:10 Marks)	Credit :4 (100 Marks)
BT -VII	Immunotechnology	75 Marks	25 Marks (2Test: 15 Marks + Assignments:10 Marks)	Credit :4 (100 Marks)
BT -VIII	System Physiology	75 Marks	25 Marks (2Test: 15 Marks + Assignments:10 Marks)	Credit :4 (100 Marks)
* BT -IX (Elective)	Process Biotechnology	75 Marks	25 Marks (2Test: 15 Marks + Assignments:10 Marks)	Credit :4 (100 Marks)
BT -X	Seminar	25 Marks		Credit:1
			Total for Sem.: II	Credit:17

Lab Course Work (Annual Practical)	Lab Course Work-I	75 Marks	25 Marks	Credit :4 (100 Marks)
	Lab Course Work- II	75 Marks	25 Marks	Credit :4 (100 Marks)
	Lab Course Work- III	75 Marks	25 Marks	Credit :4 (100 Marks)
	Lab Course Work-IV	75 Marks	25 Marks	Credit :4 (100 Marks)
			Total for Lab Course Work (Annual)	Credit: 16
			Total for M.Sc. I Year: Sem. I+ Sem. II +Lab Course Work (Annual)	Credit: 50

M. Sc. Biotechnology Second Year (Third Semester)

Paper No.	Paper Title	External (ESE)	Internal (CA)	Total
BT -XI	Genetic Engineering	75 Marks	25 Marks (2Test: 15 Marks + Assignments:10 Marks)	Credit :4 (100 Marks)
BT -XII	Industrial Biotechnology	75 Marks	25 Marks (2Test: 15 Marks + Assignments:10 Marks)	Credit :4 (100 Marks)
BT -XIII	Animal Biotechnology	75 Marks	25 Marks (2Test: 15 Marks + Assignments:10 Marks)	Credit :4 (100 Marks)
* BT -XIV (Elective)	Plant & Agriculture Biotechnology	75 Marks	25 Marks (2Test: 15 Marks + Assignments:10 Marks)	Credit :4 (100 Marks)
BT- XV	Seminar	25 Marks		Credit:1
			Total for Sem.: III	Credit:17

M. Sc. Biotechnology Second Year (Fourth Semester)

Paper No.	Paper Title	External (ESE)	Internal (CA)	Total
BT -XVI	Computational Biology & Biostatistics	75 Marks	25 Marks (2Test: 15 Marks + Assignments:10 Marks)	Credit :4 (100 Marks)
BT -XVII	Pharmaceutical Biotechnology	75 Marks	25 Marks (2Test: 15 Marks + Assignments:10 Marks)	Credit :4 (100 Marks)
BT -XVIII	Environmental Biotechnology	75 Marks	25 Marks (2Test: 15 Marks + Assignments:10 Marks)	Credit :4 (100 Marks)
* BT -XIV (Elective)	Applied Biotechnology	75 Marks	25 Marks (2Test: 15 Marks + Assignments:10 Marks)	Credit :4 (100 Marks)
BT- XX	Seminar	25 Marks		Credit:1
			Total for Semester IV	Credit:17

Lab Course Work (Annual Practical)	Lab Course Work- V	75 Marks	25 Marks	Credit :4 (100 Marks)
	Lab Course Work- VI	75 Marks	25 Marks	Credit :4 (100 Marks)
	Lab Course Work-VII	75 Marks	25 Marks	Credit :4 (100 Marks)
	Lab Course Project Work-VIII (Dissertation/ Elective Lab Course Work)	75 Marks	25 Marks	Credit :4 (100 Marks)
			Total for Lab Course Work (Annual)	Credit: 16
			Total for M.Sc. II Year: Sem. III +Sem. IV + Lab Course Work (Annual)	Credit:50
			Total For M.Sc. (I Year + II Year)	Credit:100

Note: *Paper IV (Elective): Transfer of Credit as per Students Choice

** The Evaluation of Seminar should be from Panel of Experts

BT -I : Cell and Developmental Biology**Marks: 100****Hours: 45****Unit I: Study of Cell & its architecture**

Diversity of cell size and shape, History & Evolution, Cell as the basic unit of life, cell theory, Structural organization of prokaryotes and eukaryotes. Biogenesis of Mitochondria, Chloroplast. Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes. Structure and function of Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility

Unit II: Cell-cell interactions General principles of cell communication cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins. Neurotransmission and its regulation. Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two component systems, light signaling in plants, bacterial chemotaxis and quorum sensing. Regulation of hematopoiesis,

Unit III: Cell division & Cancer genetics

Mechanism of cell division mitosis, meiosis and genetic recombination; regulation of cell cycle; factors and genes regulating cell cycle. Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth

Unit IV: Developmental Biology

Gametogenesis, Fertilization, cleavage, blastulation, Gastrulation & formation of germ layers in animals, Concepts of competence, determination, commitment and differentiation (dedifferentiation, redifferentiation, transdifferentiation) developmental plasticity in plant and animal development. Embryo sac development and double fertilization in plants, seed formation and germination, Meristem structure and activity, Sex determination in plants & animals.

Unit V: Gene patterning & stem cells

Role of gene/s in patterning and development e.g. *Arabidopsis thaliana* (root, shoot, leaf & flower) & *Drosophila melanogaster* (maternal genes, bicoid, gap genes), Stem cells.

Text and Reference:

1. David Sadava; Cell and Molecular biology- Jones & Bartlett Publishers
2. Cell & molecular biology - Gerald karp :John Wills
3. Developmental biology- SF Gilbert Sinauer associates.
4. T.A. Brown – Genomes – Garland Science
5. Molecular Biology of the Cell- Alberts, B –Garland Science
6. Molecular cell Biology - Darnell, Lodish, Baltimore,-W.H. Freeman
7. Reproduction in Eukaryotic cells- DM Prescott, Academic Press.
8. Cell in Developmental and Inheritance- EB Wilson, MacMilan New York.
9. Fertilization-F T logo-Chapman and Hall
10. Molecular Biology of Steroid and Nuclear Hormone Receptors- LP Freedman,
11. Molecular Cloning: a Laboratory Manual- J. Sambrook, -CSHL Press,

PRACTICALS:

1. Microscopy : Bright field & phase contrast & fluorescence microscopy
2. Cell types of plants- Microtomy/ maceration of various tissue explants and identification
3. Study of Mitosis and Meiosis (root tips and anthers)
4. Study of karyotypes of genetic disorders and normal
5. Cell fractionation and separation at cell organelles chloroplast and Mitochondria
6. Pigment separation by TLC & Chromatography.
7. Analysis of chlorophyll amount by Spectrophotometer.
8. Drosophila culture: Cultivation, maintenance and *Drosophila* genetics study
9. Study of chick/ Frog/ Plant embryo for developmental study.

BT -II: Microbiology and Virology**Marks 100****Hours 45****UNIT I: The Beginning of Microbiology:**

Controversy over spontaneous generation, Development of pure culture methods.

Bacteria: Purple and green bacteria, Cyan bacteria, Homoacetogenic bacteria. Budding and append aged bacteria, Spirilla, Spirochetes, Gliding and sheathed bacteria, Pseudomonades; Lactic and prop ionic acid bacteria, Endospore forming rods and cocci, Mycobacterium, Rickettsias, Chlamydias and Mycoplasmas.

Archaea: Archaea as earliest life forms, Halophiles, Methanogens, Hyperthermophilic archaea, Thermo plasma.

UNIT II: Methods in Microbiology

Theory and practice of sterilization, - Principles of microbial Nutrition, Construction of culture media. Microbial Evolution, Systematics and Taxonomy Evolution of earth and earliest life forms: Primitive organisms and their metabolic strategies and molecular coding; New approaches to bacterial taxonomy classification including Ribotyping; Ribosomal RNA sequencing; Characteristics of primary domains; Taxonomy, Nomenclature and Bergey's Manual.

UNIT III: Microbial Growth

The definition of growth, mathematical expression of growth, growth curve, measurement of Growth and growth yields; Synchronous growth: Continuous culture; Growth as affected by Environmental factors like temperature, acidity, alkalinity, water availability and oxygen.

UNIT IV: General virology Discovery of viruses, Nomenclature, Classification, Structure of viruses, morphology and ultra structure. Virus receptors & entry into cell, Virus related agents Overview of viral replication; Assembly, Maturation & release from cell, Diagnostic Virology; Cultivation of viruses in embryonated eggs, animal cells and experimental animals, transgenic systems, Virus infectivity Assay (chemical and physical methods), PCR based diagnosis of viruses.

UNIT V: Viruses: Life cycle of – Bacterial viruses (Lambda, M13), Plant viruses (TMV, and CMV) Animal viruses (Herpes and Retro)

Text and Reference:

1. General Microbiology-Stainer.- MacMillan Press Ltd.
2. Brock, Biology of Microorganisms, Madigan, M.T., Martinko. -Prentice Hall.
3. Microbiology, Pelczar, M.J. Jr., Chan, E.C.S. and Kreig, N.R., -Tata McGraw Hill.
4. Microbial Genetics, Freifelder, D. -Jones, Bartlett Publishers.
5. Microbiology - A Laboratory Manual, Cappuccino, J.G. and Sherman, N. -Addison Wesley.
6. Bacterial and Bacteriophage Genetics- Edward Birge- Springer
7. Mathews Plant Virology- Academic Press
8. Virology Principles and Applications- John Carter, Venetia A. Saunders-Wiley
9. Introduction to Modern Virology IV 1 edition- Dimmock, Primrose
10. Plant Virus- M.V. Nayudu- Tata McGraw Hill

Practicals :

1. Preparation of liquid and solid media for growth of microorganisms.
2. Isolation and maintenance of organisms from soil and water by plating, streaking and serial dilution
3. Plate, Slants and stab cultures, Storage of microorganisms.
4. Study of microbial growth and factors affecting on growth temperature, pH, carbon and nitrogen
5. Staining and Microscopic examination of bacteria, yeast and molds
6. Assay of antibiotics and demonstration of antibiotic resistance.
7. Analysis of potable water and determination of MPN.
8. Biochemical characterization of selected microbes.
9. Measurement of Size of microorganism by Micrometry
10. Cultivation and study of Coli phage and one step growth curve of coli phage.
11. Cultivation study of virus in embryonated chicken eggs, Hemagglutination assay
12. Cultivation and Study of plant viruses

BT - III: Biochemistry**Marks : 100****Hours: - 45****UNIT I:**

Chemical foundations of Biology- Structure of atoms, molecules and chemical bonds; Ionization of water, properties of water, The pH scale, concept of acids and bases, Henderson-Hasselbach equation, biological buffer systems. Thermodynamic principles in biology, Concept of free Energy and redox potential

UNIT: II

Carbohydrates: Classification occurrence, structure, function and properties of monosaccharide, oligosaccharide and polysaccharides.

Lipids: Classification, structure and functions of major lipids, Triglycerides, Phospholipids, Steroids and terpenes. Glycolipids and lipoproteins-structure and function. Role of lipids.

UNIT: III

Amino acids: Classification and chemical reactions and physical properties. Peptide bond, peptide classification, biologically important peptides.

Proteins: Properties and classification, primary, secondary, tertiary and quaternary structure of proteins with example, structural comparison at secondary and tertiary levels. Ramachandran plot.

Enzymes: Historical perspectives, general characteristics, nomenclature and classification. Methods of isolation, purification and characterization of enzymes. Concept of enzyme assay, enzyme activity, coenzymes and isoenzymes.

UNIT: IV

Nucleic acids: Primary, secondary and tertiary structure of nucleic acids, double stranded DNA and biological significance, forms of DNA, Physical properties of double stranded DNA, Types of RNAs and their biological significance. DNA Supercoiling.

UNIT:V

Hormones: Structure and function; **Vitamins:** Types, structure and functions; Prostaglandins; Silk fibroin, coiled coils, collagen triple helix and hemoglobin.

Text and Reference:

1. Principles of Biochemistry - Lehninger , Nelson, Cox, CBS publishers
2. Fundamentals of Biochemistry - Voet and Voet- John Wiley and Sons, Inc.
3. Biochemistry - Zubay - WCB publishers
4. Harper's Biochemistry - R.K.Murray, D.K.Granner, P.A.Mayes –McGraw Hill
5. Biochemistry - L. Stryer-W.H. Freeman
6. Biochemistry –Rawn
7. Biochemistry- U Satyanarayana

Practicals:

1. Study of General and Safety Rules of Biotechnology Laboratory
2. Concept of Buffers, pH, Normality and Normality (Problem solving and preparation)
3. Reaction of amino acids, sugars, lipids
4. Estimations of Carbohydrates and Sugars
5. Estimation of amino acids, proteins
6. Titration of amino acids and determination of pKa
7. Estimations of DNA & RNA
8. Analysis of oils, iodine number, saponification value, acid number
9. Cholesterol estimation
10. UV visible fluorescence & IR spectroscopy absorption spectra
11. Enzyme activity study

BT- IV: Techniques in Biology**Marks 100****Hours 45****UNIT I : Microscopy:**

Light microscope, Fluorescence microscope, Phase contrast microscope, Electron microscope. Centrifugation: Principles, RCF and Types of centrifuges, types of rotors, preparative and analytical ultra centrifuge.

Electrochemical techniques: Principles of electrochemical techniques, redox reactions, the pH electrode, ion-sensitive and gas-sensitive electrodes, The Clark oxygen electrode.

UNIT II: Chromatographic techniques:

Principles of chromatography, Ion-exchange and affinity chromatography. High performance liquid chromatography (HPLC), Gas liquid chromatography (GLC), Thin layer chromatography (TLC), Paper chromatography, GC-MS, LC-MS, Maldi Tof.

Electrophoresis: General principles, SDS-PAGE, Native gels, Gradient gel, Iso electric focusing, 2-D gel electrophoresis (2-D PAGE), Detection, estimation and recovery of proteins, Western blotting. Electrophoresis of nucleic acids: agarose gel electrophoresis of DNA, DNA sequencing gels, Pulse field gel electrophoresis, Capillary electrophoresis.

UNIT III: Spectroscopic techniques:

Properties of electromagnetic radiation, interaction with matter. Gamma ray spectroscopy, X-ray spectroscopy, UV and Visible spectroscopy, Infrared and Raman spectroscopy, Electron spin resonance spectroscopy, Nuclear magnetic resonance spectroscopy, Circular dichroism spectroscopy, Atomic spectroscopy, x-ray diffraction, x-ray crystallography. Spectrofluorimetry, turbidometry and nephelometry.

UNIT IV : Radio isotope techniques:

The nature of radioactivity, detection and measurement of radioactivity: detection based on gas ionization- Geiger Muller counter- principles and applications. Detection based on excitation-Liquid Scintillation counter-principle and applications. Supply, storage and purity of radiolabelled compounds, specific activity, inherent advantages and restrictions of radiotracer experiments, safety aspects, applications- of radio isotopes in biological sciences. Flowcytometry, ELISA, immunoblotting.

UNIT V: Biosensor

Principle, construction, mechanism and applications of biosensor with one example. (Enzyme and cell based)

Text and Reference:

1. Physical Biochemistry by D. Freifelder W. H. Freeman
2. Practical Biochemistry- Principles and techniques-Wilson & Walker.; Cambridge Press
3. Practical Biochemistry -David T Plummer, Tata McGraw- Hill
4. Instrumental methods of chemical analysis - P.K. Sharma
5. Biophysical chemistry - Upadhyay. Upadhyay and Nath-Himalaya
6. Handbook of Biomedical Instrumentation - R.S. Khandpur, Tata McGraw Hill
7. Principles Of Physical Biochemistry-K Holde, W Johnson-Pearson/Prentice Hall
8. Biosensors-Cooper and Cas- Oxford

Practicals :

1. Study of standard operating protocols, validation and calibrations of instruments
2. Electrophoresis of proteins under native and denaturing conditions (PAGE)
3. Separation of proteins / pigments using column chromatography
4. Demonstration of techniques : GC,HPLC and atomic absorption spectroscopy AAS
5. Theory & Principal, operation of microscopes centrifuges, spectrophotometers, chromatographic techniques, electrophoresis, radio isotopic techniques
6. Methods based on centrifugation, electrochemical techniques, spectrophotometer
7. Methods on TLC, Paper Chromatography
8. SDS PAGE, 2D Gel electrophoresis capillary, electrophoresis western blotting,
9. ELISA, Immunoblotting
10. Demonstration of flowcytometry liquid scintillation counter, Geiger Muller counter

BT VI: Molecular Genetics**Marks 100****Hours 45**

Unit I: Principles of Mendelian inheritance and Gene interactions: incomplete dominance, codominance, epistasis, complementary genes, duplicate genes, polymeric genes, modifying genes, lethal genes. Population and gene frequencies; The Hardy Weinberg Law. Genetic diseases due to defects in Autosome and Sex chromosomes. Gene transfer in Prokaryotes, Recombination.

Unit II: Genome organization of Prokaryotes-Bacteria and virus system. Genome organization of Eukaryotes- Structure and types of chromosome, heterochromatin, euchromatin, nucleosome. Variation in chromosome number, chromosome structure. Denaturation and Renaturation DNA, C-value paradox, Cot curve.

Unit III: DNA as genetic material, Genome Replication in prokaryote & eukaryotes, enzymes involved, replication origin and replication fork, mechanism of replication, elongation and termination. DNA damage and repair mechanisms. Homologous and site-specific recombination, transposition.

Unit IV: RNA synthesis and processing, transcription factors and machinery, RNA polymerases, co and post transcriptional RNA processing. RNA transport, RNA Stability and Half life period. Protein synthesis- Ribosome, Genetic code, t-RNA, initiation, elongation, termination of translation. Post translational modification of proteins.

Unit V: Gene regulation in prokaryotes-operon concept, Lactose, Tryptophan and Arabinose. Role of cAMP and CRP in lac operon, trp operon. Catabolite repression. Gene regulation in eukaryotes at transcription and translation level. Regulation of gene expression in phages, viruses, role of chromatin in gene expression and gene silencing.

Reference Books-

1. Understanding DNA-The molecule how it works - Chris R.Calladine, Elsevier Pub.
2. Gene IX-Benjamin Lewin -Jones and Bartlett Pub.
3. Principles of Genetics -Simmons and Snustad- Wiley International Pub.
4. Molecular Biology of the Gene -J.D. Watson-Pearson Pub.
5. The Biochemistry of Nucleic Acids -Adams, Knowler And Leader-Chapman Hall Pub.
6. Molecular Biology of the Cell -Lodish, Berk-Freeman Pub.
7. Developmental Biology -Scott F. Gilbert-Sinahauer associate Pub.
8. Developmental genetics-G.S.Miglani-I.K.InternationalPub.
9. Molecular Biology of the Cell- Albert Bruce- Garland Science Publication
10. Genome- T.A. Brown- John Wiley
11. Fundamentals of Cell and Molecular biology-Baig, Telang and Ingle-Amruta
12. Genetics a Molecular Approach- T.A Brown- John Wiley

Practicals

- 1) Problems based on Gene linkage, Sex linked inheritance and Crossing over.
- 2) Genetic recombination (conjugation, transformation, transduction) in bacteria
- 3) Study of mutations, Ames test
- 4) Study and isolation of mutants by Replica plate technique
- 5) Isolation of antibiotic resistant bacteria by gradient plate method
- 6) Study to mutation and repair in bacteria /yeast
- 7) Study of spontaneous mutation by Fluctuation test
- 8) Isolation of genomic DNA/RNA from bacteria, animal and plant cells.
- 9) Isolation of plasmid DNA /Phage DNA.
- 10) Spectroscopic analysis of DNA/ RNA
- 11) Agarose gel electrophoresis.
- 12) Study of in vitro transcription and translation

BT VII: Immunotechnology**Marks :100****Hours : 45**

UNIT I: Basic concepts of Immune system Cells and organs of immune system, Immunity Humoral and cell mediated, Hematopoiesis and differentiation.

Antigens- General properties, types, epitope, hapten, adjuvant.

Antibodies- Types, biological functions. Biology of Superantigen. BCR & TCR (structure & properties), MHC Antigen processing and presentation Maturation and Activation of B-cells Maturation and Activation of T-cells

UNIT II: Complement system; complement activation pathways, biological consequences of complement activation.

Hypersensitivity: Components, Mechanisms of degranulation, Mediators, Consequences, Transfusion reactions, Localized reactions, generalized reactions, Delayed type hypersensitivity

UNIT III: Autoimmunity: Organ specific autoimmune diseases (Hashimoto's thyroiditis, Autoimmune anemia, Insulin dependent diabetes mellitus) Systemic autoimmune diseases (SLE, Multiple sclerosis, Rheumatoid arthritis) Treatment of autoimmune diseases

Transplantation Immunology: Types of graft, Specificity and memory of rejection response, Mechanisms involved in graft rejection, Clinical manifestations of graft rejection Immunity to infectious diseases, Tumor Immunology

UNIT IV Immunodeficiency: Primary immunodeficiency (SCID, X-linked agammaglobulinemia, Defects in complement system), Secondary immunodeficiency (AIDS), Treatment of immunodeficiency diseases. Immunity to Infectious agents Bacteria Viruses Malaria Anthrax and Helminthes

Immunological reactions: Precipitation. Agglutination, Radioimmunoassay, ELISA, Western Blotting, Flow cytometry and Fluorescence. Immunoelectron microscopy, RIA

UNIT V: Vaccine technology and recombinant vaccines, Identifications of B and T epitopes for vaccine development. *in situ* characterization of cells in tissues. Hybridoma technology, monoclonal antibody production and applications. Catalytic antibodies, FACS.

Reference Books

1. Kuby Immunology- Goldsby, Kindt, Osborne.-W,H Freeman
2. Cellular & Molecular Immunology- Abbas, Lichtman, Pillai.-Elsevier publications.
3. Roitt's Essential Immunology- Deives, Martin, Burton, Roitt-Blackwell publications.
4. Cellular interactions & Immunobiology- Butterwort & Heinemann.
5. Review of Medical Microbiology & Immunology- Warren Levinson.-McGraw Hill
6. Immunology an introduction- Tizard- Thomson publications.
7. Immunology. B, Hannigan- Viva books Pvt. Ltd.
8. Immunology & Serology- K.R.Joshi, N.O. Osamo. Student edition.

Practicals

- 1) Determination of ABO Blood group
- 2) Determination of total leukocyte count
- 3) Determination of differential leukocyte count
- 4) Determination of bleeding time & clotting time of blood.
- 5) Dissection and identification of thymus, spleen & lymph nodes
- 6) Radial immunodiffusion, double diffusion
- 7) Study of Ag-Ab reactions Widal, VDRL
- 8) Immuno electrophoresis
- 9) Latex agglutination
- 10) ELISA, Western Blotting
- 11) Rocket immuno electrophoresis
- 12) Radioimmunoassay

BT VIII: System Physiology**Marks :100****Hours : 45**

Unit- I: Enzyme Classification, Characteristics of enzymes, enzyme substrate complex. Concept of active centre, binding sites, stereo specificity. Effect of temperature, pH and substrate concentration on reaction rate. Activation energy. Transition state theory. Enzyme catalysis: Factors affecting catalytic efficiency proximity and orientation

Unit-II: Enzyme kinetics: Michaelis - Menten Equation - form and derivation, steady state enzyme kinetics. Significance of V_{max} and K_m . Bisubstrate reactions. Allosteric Reactions and regulation: Protein ligand binding including measurements, analysis of binding isotherms, Cooperativity, Hill and Scatchard plots and kinetics of allosteric enzymes. Enzyme regulation: Product inhibition, feedback control, enzyme induction and repression and covalent modification.

UNIT - III: Enzyme inhibition - types of inhibitors - competitive, non-competitive and uncompetitive, their mode of action and experimental determination. Enzyme activity, international units, specific activity, turnover number, end point kinetic assay.

UNIT -IV: Immobilized Enzymes: Relative practical and economic advantage for industrial use, effect of partition on kinetics and performance with particular emphasis on charge and hydrophobicity (pH, temperature and K_m). Various methods of immobilization ionic bonding, adsorption, covalent bonding (based on R groups of amino acids), microencapsulation and gel entrapment. Immobilized multienzyme systems

Unit V: Photosynthesis - Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms; CO₂ fixation-C₃, C₄ and CAM pathways. Respiration- Glycolysis, Citric acid cycle; mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratory pathway. Nitrogen metabolism - Nitrate and ammonium assimilation; amino acid biosynthesis, Nucleotide biosynthesis- de novo and salvage.

Reference Books

1. Fundamentals of Enzymology- Price and Stevens-Oxford
2. Enzymes - Dixon and Webb
3. Fundamentals of Enzyme Kinetics- Athel Cornish-Bowden- Wiley Blackwell
4. Enzyme Kinetics: Principles and Methods- Hans Bisswanger-Wiley
5. Enzymes-Paul F. Cook, W. W. Cleland- Taylor and Francis
6. Enzymes- Palmer & Bonner - Woodhead Publishing
7. Isoenzymes - By D. W. Moss
8. Nelson and Cox- Lehninger Principles of Biochemistry- W.H. Freeman
9. Basic Biochemical Methods- 2nd ed by R.R.Alexander and J.M.Griffith.
10. Hawk's Physiological Chemistry- ed. by Bernard L Oser.
11. A Textbook of Practical Biochemistry -by David Plummer
12. Cohn and Stumpf- Outline of Biochemistry- Wiley India

Practicals

1. Identification and quantitation of activity of Amylase, cellulose, invertase
2. Alkaline phosphatase (salivary/microbial/animal/plant source).
3. Determination of specific activity, in presence of activators/ inhibitors.
4. Study of effect of pH/ temperature /inhibitor on enzyme activity.
5. Separation and identification of amino acid mixture by chromatography technique.
6. Separation and identification of serum proteins by PAGE
7. Separation of proteins (hemoglobin & cytochrome c) chromatography
8. Study of Immobilization of enzymes
9. Purification of protein by ion exchange chromatography.[DEAE cellulose chromatography]
10. Determination of activity of invertase from immobilized cells of *Saccharomyces cerevisiae*.

BT IX: Process Biotechnology**Marks: 100****Hours: - 45****Unit I**

Isolation, Screening, Preservations and maintenance of Microorganisms, Strain improvement, Mutagenesis, Genetic Engineering for Strain Improvement. Selection of Mutants producing improved level of Primary Metabolites with suitable Example. Isolation of mutants which do not produce feedback inhibitors or repressors. Isolation of mutants which do not recognize presence of inhibitors or repressors. Modification of Permeability.

Unit II

Basic aspect of Bioreactor Designing, Types of Bioreactors, Ideal Properties of Bioreactor, Body Construction, Agitator, Impeller, Baffles, etc. Types of Bioreactor: Packed-bed reactor, Air -lift, Trickle bed, Photo bioreactors, Rotating Biological Reactors

Unit III

Fluid flow and mixing, Classification of fluids, concept of Reynolds's number, Rheological properties of fermentation process (Viscosity, cell concentration, product concentration etc) Mass transfer in bioreactors (Oxygen and heat transfer). Measurement and control of Bioprocess parameters, Automation for monitoring and Control (online and offline sensors, Biosensors) Use of Computers: Data logging, data analysis, and process control, Process scale up: factors involved, steps involved, Immobilization techniques for cell and enzyme

Unit IV

Media formulation & optimization its need and significance, Sterilization of media and air, exhaust air, Batch sterilization; Del factor D and Z value, Continuous Sterilization: Design and Methods, sterilization kinetics, inoculum development.

Unit V

Microbial growth and its kinetics (Batch & Continuous) Types of processes-Batch, fed batch, continuous, concept of scale up of fermentation. Comparative account of batch and continuous sterilization. Types of fermentation processes, Comparison between SSC and SLC, Factors affecting solid-state fermentations, Economic Applications.

Reference Books:

1. Basic Biotechnology- Colin Ratledge – Cambridge Publication
2. Fundamentals of Biochemical Engineering -Bailay & ollis- TataMcGraw Hill
3. Principles of Bioprocess Engineering.-Pauline M. Doran – Elsevier Publication
4. Basic of Bioprocess Engineering- Shuler and Kargi
5. Comprehensive Biotechnology Vol III- Mooyoung Elsevier Publication
6. Principles of Fermentation Technology- Stanbury Whitkar – Elsevier Publication
7. Introduction to Industrial microbiology- Cruger-ACS Publication
8. Industrial microbiology- Casida- ACS Publication

Practicals

- 1) Media formulation and optimization
- 2) Study of Growth Kinetics of Bacteria and Yeast by turbidometry & SCP
- 3) Screening of industrially important microorganism- Acids, Antibiotics, Enzymes
- 4) Study of scale up of fermentation
- 5) Study of design of bioreactor
- 6) Determination of TDP
- 7) Determination of TDT and design of sterilizer
- 8) Study of types of fermentation process (Surface and submerged)
- 9) Problems based on: - Growth kinetics, fluid flow, Reynolds's number
- 10) Visit to fermentation Industry