

NIMS UNIVERSITY, JAIPUR



SYLLABUS

**BACHELOR OF SCIENCE
(BIOTECHNOLOGY)**

B.Sc. (Biotechnology)

	Distribution of Marks			
	Theory	Practical	Internal	Total
Year - I				
• Introduction to Chemistry	70	30		100
• Fundamentals of Biophysics	100	-		100
• Elements of Genetics	100	-		100
• Basic Microbiology	70	30		100
• Introductory Cell Biology & Molecular Biology	70	30		100
• Mathematics	100			100
• Plant Tissue Culture Technology	100			100
• Elementry Plant Biotechnology	100			100
• English	100			100
Year II				
• Introduction to Industrial Biotechnology	100	-		100
• Developmental Biology	100	-		100
• Elements of Medical Biotechnology	100	-		100
• Fundamentals of Bioinformatics	100	-		100
• Genomic Analysis	100	-		100
• Agriculture and Forest Biotechnology	100	-		100
• Application of Biotechnology	100			
• Biotransformation and Biocatalyst	100			
• Metabolic Regulation	100			
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Year III				
• Introduction to Biostatics	100	-		100
• Basic Pharmaceutical Biotechnology	100	-		100
• Biotechnological Techniques	70	30		100
• Environmental Biotechnology	70	30		100
• Animal Biotechnology	100	-		100
• Introduction to Genetic Engineering	100	-		100
• Dairy and Food Technology	100			
• Biodiversity and Systemic	100			
• Waste Production Utilization Technology	100			

INTRODUCTION TO CHEMISTRY

Unit –I

Chemical bond: type of bonding, general characteristics, hybridization involving s, p, d, orbital, dipole moment. Hydrogen bond: theories of hydrogen bonding valance bond, weak intermolecular and intra molecular force of attraction, V S E P R theory. Molecular orbital theory: detailed description of L C A O & concepts of united atom in M.O. Configurations of simple diatom molecules (H_2 , O_2 , NO).

Unit –II

Alkanes: nomenclature, mechanism of free radical halogenations activation energy. Alkenes: chemical reactivity stability of carbonium ions, Markownikoff rule. Free radical Mechanism, stability of free ion. Dienes: methods for preparation of conjugated dienes, Diels, alder reaction, electrophilic mechanism.

Unit- III

Stereochemistry of organic compounds: different types of stereoisomerism, geometrical isomerism, optical isomerism –optical activity, R& S configuration, asymmetry synthesis. Carbohydrate; classification, reaction, constitution of glucose & fructose, mutarotation, anomers, epimerization, conversion of glucose into fructose and vice versa.

Unit-IV

Thermodynamics; laws of thermodynamic, thermodynamic state of system, molar heat capacity relation between ΔH & ΔE , Joule Thomson effect, Carnot cycle, entropy, Helmholtz free energy, Gibb' energy, Nernst heat thermo.

Unit-V

Chemical equilibrium: law of mass action, Chatelier principle, law of distributions law, hydrolysis, Oswald dilution law, pH value and Hazel –Henderson equation, Electrode: standard electrode potential, chemical cells.

Practicals:

Practicals based on above topics will be conducted.

Books:

1. University General Chemistry by C.N. R. Rao, Macmillan
2. Principles of Physical Chemistry, 4th edition by S.H. Marron and C.F. Prutton
3. Essentials of Physical Chemistry by B.S. Bahel and G.D. Tuli
4. College Chemistry by Linus Pauling
5. Concise Inorganic Chemistry by J. D. Lee 5th Edition
6. Basic Inorganic Chemistry by Cotton and Wilkinson
7. Organic Chemistry, 5th Edition by Morrison Prentice Hall of India Pvt. Ltd. Boyd, New Delhi
8. Guide book to Mechanism in Organic Chemistry by Peper Sykes, 6th Edition, Orient Longman
9. Organic Chemistry by I.L. Finar, Volume-II, 5th Edition
10. An introduction to Electrochemistry by Samuel Glasstene
11. The elements of Physical Chemistry by P.W. Atkins
12. Physical Chemistry for biological sciences by Raymond Chang (University science)
13. Physical Chemistry by David Ball

FUNDAMENTALS OF BIOPHYSICS

Unit- I

Conformation of Nucleic acids (A, B, Z, DNA), t RNA, micro RNA. Stability of protein and nucleic acid structure.

Unit- II

Stabilizing interaction (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, disulphide bond linkages). Conformation of proteins secondary, tertiary and quaternary structure; domain, motifs and folds, α helices, β pleated sheets.

Unit-III

Biophysics of membrane contraction (contraction cycle in striated muscles). Biophysics of nerve impulse conduction, saltatory conduction. Transportation across biomembranes; passive transport, facilitated transport, active transport (Na^+ , K^+ and ATPase pump).

Unit- IV

Concept of viscosity, surface tension and their importance in cell ecology.

Unit-V

Introduction to Bioenergetics:- Thermodynamic, terms and basic concepts, first law of thermodynamics, formulation of first law of thermodynamics, relation between H and E, Second law of thermodynamics. Entropy, Helmholtz free energy, Third law of thermodynamics in brief.

Books:

1. Cantor & Freeman W.H. –Biophysical Chemistry.
2. Molecular cell biology – Ladish, Berk, Matsudara, Kaiser, Krieger, Zipursky, Darnell (W.H. Freeman and Co.)
3. Biophysics - Cotrell (Eastern Economy Edition)
4. Clinical Biophysics: Principles and Techniques- P.Narayanan (Bhalani Pub., Mumbai)
5. Biophysics – Pattabhi and Gautham (Narosa Publishing House)

ELEMENTS OF GENETICS

Unit- I

Mendelism: Brief history of genetics and Mendel work, Mendelian laws, their significance and current status, chromosomal theory of inheritance. Genetic interaction: supplementary genes, complementary genes. Duplicate genes, epistasis, inhibitory and polymorphic genes.

Unit- II

DNA is a genetic material, DNA and RNA structure and type, nucleic acid, sugars, phosphodiester bond. nucleosome structure, euchromatin, heterochromatin, satellite DNA, telomeres, centromeres. Polytene chromosome and lamp chromosome. Genetic code, triplet codon, characteristics of triplet codon.

Unit- III

Chromosomal mutation: classification of chromosomal mutations, translocation, inversion, deletion and duplication. Variation in chromosome numbers, haploidy, diploidy, polyploidy, aneuploidy, euploidy and polysomy. Linkage and crossing over. Hereditary defects: Klinefelter syndrome, Down syndrome. Applications of polyploidy

Unit- IV

Mitosis: phases and process of mitosis structure and function of spindle apparatus, anaphasic movement. Meiosis: phases and process of meiosis synapses and synaptonemal complex, formation and fate of chiasmata and significance of the crossing over. Interphase nucleus and cell cycle: S, G₁, G₂ and M phase.

Unit-V

Microbial Genetics: Recombination in bacteria: Molecular mechanism of recombination.

Transformation, Transduction (Generalized and Specialized), Conjugation. Cytoplasmic inheritance.

Practicals: Based on the above topics

Books:

1. Genetics: Ahluwalia, K.B. Wiley Eastern Ltd New Delhi.
2. Genetics: Altenbery Oxford and IBH, New Delhi
3. Genetics: Gupta P.K
4. Principles of Genetics: Gardner E.J: Wiley Eastern New Delhi

BASIC MICROBIOLOGY

Unit- I

History of Microbiology. Bacterial nomenclature: classification, methods of classification, Whittaker 5 kingdom classification, Haeckel's three kingdom concept, Bergey's manual of systematic bacteriology. Characteristics & structure of microbes: Algae, Fungi, Mycoplasma, Virus, Protozoa & Helminthes.

Unit- II

Cells-prokaryotes & eukaryotes. Morphology & Structure of bacteria. Bacteria: Gram positive, Gram-ve, size, shape, arrangement of bacterial cells, cell wall, cytoplasmic membrane, flagella & pilli etc. Staining technique, Simple (monochrome & negative) and Differential (Gram & Acid fast) staining.

Unit- III

Bacterial Nutrition. Culture Media, Types of Media, Preparation of different Media, Isolation of Bacteria.

Unit- IV

Microbial Growth, growth curve, Factors affecting growth. Batch and continuous culture.

Measurement of bacterial growth. Gene transfer in bacteria: Conjugation, transformation, transduction.

Unit-V

Sterilization and disinfection. Bacteriology of water, milk and air. Food microbiology: Spoilage and Preservation.

Practicals:

Practicals based on above topics will be conducted

Books:

1. Brock TD, Madigan MT,(1993) Biology of microorganisms. Prentice Hall Int. Inc.
2. Ananthanarayanan R. and C. K. Jayaram Paniker (1997) Text of microbiology, Orient Longman.
3. Stanier RY, Ingraham JL, Wheelis, ML Painter PR (1986).General Microbiology
4. Topley & Wilson's (1995) Text book on principles of bacteriology, virology & immunology IX ed. Edward Arnold, London.
5. Michael J. Pelczar JR et al. (1993) Microbiology: Concepts and Applications, Mc Graw- Hill. Inc. (ISBN. 0- 07- 049258-1).
6. Prescott Harley Klein :(1996) Microbiology III ed. ECB Pub.

INTRODUCTORY CELL BIOLOGY & MOLECULAR

Unit- I

Cell as a basic unit of living organism- Development of cell theory. Eukaryotic and prokaryotic cells, cell division and cell cycle, anomalies in cell division, ultra structure of the cytoplasm, cytoskeleton microtubules, microtubular organelles, microfilaments The (endo membrane system), nuclear envelope, endoplasmic reticulum and golgi complex. Membrane organelles, mitochondria, chloroplast, lysozyme, peroxisomes. Molecular organization of cell membrane, passive and active transport, $\text{Na}^+\text{-K}^+$ pump, Ca^{2+} -ATPase pumps, lysosomal and vacular membrane. ATP dependent protein pumps, co-transport into prokaryotic cells, endocytosis and exocytosis, entry of viruses and toxins in to cells

Unit- II

Cell-cell interaction, receptors and models of extra-cellular signaling: cytosolic, nuclear and membrane bound receptors, autocrine, paracrine and endocrine model of action. Muscles and nerve cells, cell senescence and death, cell differentiation. Signal transduction: signal amplification and different models, cyclic AMP, role of inositol phosphatase messenger. Biosynthesis of inositol phosphatase messenger, cyclic GMP and glycoproteins in signal transduction. Calcium model of signal amplification, phosphorylation of protein kinases.

Unit- III

. Cell culture: Techniques of culturing of prokaryotic and eukaryotic cells, cell lines and cell line generation. Maintenance of cell culture, characterization of cell, immunochemistry, morphological analysis techniques in cell culture, primary cultures, contamination, differentiation and three dimensional culture.

Unit- IV

DNA and inheritance. Genetic and biochemical experiments to prove nucleic acid as a genetic material. Prokaryotes and Eukaryotes. Organization of genes. Coding and non-coding sequences. Unique, moderately repetitive and highly repetitive DNA sequence. Stellite DNA DNA replication in prokaryotes. Semi consertive mode of replication. Replication eye, forks, okazaki fragments and RNA primers. Different enzymes involved in DNA replication

Unit-V

Replication in E-coli. Initiaiton, elongation and termination of replication. Fidelity of replication. Circular DNA. DNA polymerases. Inhibition of DNA replication , DNA repair of damages caused by different agents. Mutation and its types such as spontaneous, induced and point mutations. Chromosomes aberrations. Vectors and DNA recombinant technology. Restriction and endonucleases. Plasmid, cosmid cloning vectors. Molecular cloning and application of recombinant DNA technology.

Practicals:

Practicals based on above topics will be conducted.

Books:

1. Cell and Molecular Biology by De Robertis, Lea and Febig.
2. Cell and Molecular Biology by Baltimore, WH and Freeman, WH
3. Cell Biology by Kimble, T. W.

MATHEMATICS

Unit- I

Sets, Number system (in brief), Complex numbers: addition, subtraction, multiplication, division, De-Moiver's theorem, finding roots of polynomial equation.

Unit- II

Sequences and series: definition of convergent, divergent and oscillatory sequence. Following results without proof. (i) A monotonic increasing sequence bounded above is convergent.

(ii) Geometric sequence $\{a_n\}$ is convergent if $-1 < r < 1$. Definition of convergent, divergent, oscillatory series. Convergence of i) geometric series, ii) P-series (without proof). Tests of convergence i) comparison test, ii) D'Alembert's ratio test (limit form), iii) Cauchy's root test (limit form). Taylor's theorem, Maclaurin's theorem (without proof). Power series expansion of e^x , $\sin x$, $\cos x$, $(1+x)^n$.

Unit- III

Partial Differentiation :-Maxima and minima (up to 2 variables). Rules of partial differentiation. Higher order partial derivatives

Matrices: Definition, types of matrices, addition, multiplication of matrices, inverse of a matrix. System of linear equations, row echelon form, rank of a matrix, homogeneous and non-homogeneous systems $AX = B$, consistency, Gaussian elimination method.

Unit- IV

Differential equations :- Limits, differentiation, integration (brief). Graphs of standard functions:- X , X^2 , X^3 , $1/X$, $\log_a X$, e^X Unit. Homogeneous and non-homogeneous differential equations, exact d.e. (including integrating factor). Linear differential equation. Applications to growth and decay, law of cooling.

Unit-V

Vector spaces:- \mathbb{R}^n and $M_{m \times n}(\mathbb{R})$, subspace of a vector space, linear dependence of vectors, eigenvalues and eigenvectors, diagonalization

References Books:

1. Mallick, S.C. and Arora Mathematical Analysis
2. Jenny Olive – Maths :- a self study Guide – Cambridge Low prices edition
3. R.G. Bartle and D.R. Sherbert (2nd edition)-1992, John Wiley, New York
4. E.D. Rainville and P.E. Bedient (1989), Elementary, Differential equations – McMillan, New York
5. System of Linear Equations
6. Eigen values and Eigen vectors
7. Partial Differentiation and differential equations
8. Sequences and series.

PLANT TISSUE CULTURE TECHNOLOGY

Unit- I

Historical background and terminology used in cell & tissue culture. Basic techniques of cell and tissue culture, sterilization, aseptic tissue transfer, concept of totipotency. Nutritional requirement of cell in vitro, various types of nutrient media.

Unit- II

Somatic embryogenesis and organogenesis in plants. Variability in tissue cultures, somaclonal and other variation. Isolation of cells, single cell cultures and cloning.

Unit -III

Micropropagation and cloning of plants, applications, micropropagation in agriculture, horticulture & forestry. Haploid production, various techniques, applications.

Unit- IV

Production of disease free plants by tissue culture methods. Protoplast isolation and culture, fusion of protoplasts.

Unit- V

Somatic hybrids, selection methods, gene expression in somatic hybrid. Asymmetric Hybridization, Symmetric Hybridization, Cybrid formation and applications.

Practicals: Based on the above topics

Books:

1. Introduction to Plant Tissue culture : M.K. Razdan
2. Plant Tissue Culture : Theory & Practice : S.S. Bhojwani & M.K. Razdan
3. Micropropagation : Debergh & Zimmermann
4. Plant tissue culture : Kalyankumar Dey

ELEMENTARY PLANT BIOTECHNOLOGY

Unit- I

Tool of plant biotechnology: inducible gene expression systems Tools for plant functional genomics, somatic embryogenesis system. Artificial seed production. Plant genetic transformation: Methods and emerging trends. Screening procedures. Micropropagation seed verses somatic, use of micropropagation in multiplication of specific genotype, rare and improved varieties, endangered species, hardening of micropropagated plants and their transfer to soil.

Unit- II

Micropropagation methods for the following category of plants (one example for each category)-(a)Floriculture (b)Horticulture (c) Medicinal and ornamental plants (d)Cereal, pulse, oil seed and fiber crops (e)forest trees, fruit trees-problems in propagating trees namely systemic contaminates, phenolic leaching, seasonal variation in response to genotypic recalcitrance. Designing plant genotypes with enhanced resistance to salinity.

Unit- III

The engineering of recombinant plasmid in higher plants. Isolated microscope embryo-genesis in cereals: Aspects and prospects. *In vitro* propagation of tropical and sub-tropical fruit crops. Application of biotechnology: In Indian ginseng (Ashwagandha) Ornamental foliage plants: improvement through biotechnology. Wild species of *Oryza* as important reservoir of useful alleles. *In vitro* propagation of tropical and sub-tropical fruits.

Unit- IV

Genetic transformation of food grains, legumes, fruits and horticultural crops Somaclonal variation: Application and limitation, Exploitation for selecting superior phenotype-disease resistant, stress tolerant high secondary metabolite producing. Disease elimination. morphogenesis, regeneration of plant, multiplication of plantlets, rooting. Commercial production of tissue cultured plants. Technology transfer, equipment and procedures. Aseptic technique and control of contamination in a commercial laboratory, quarantine, pathological indexing, packing, cost analysis, marketing.

Unit- V

Genetic improvement of plants through tissue culture. Comparison with classical methods (a) Transgenic plants, antiserum RNase, tissue specific sequences, elimination of plant viruses. Homozygous plant production through anther, ovule, pollen culture. *In vitro* pollination and fertilization, embryo rescue, Endospore culture and production of seedless plants. Protoplast culture and its genetic improvement: (1) somaclonal hybridization, cybrids: limitations (ii) Micromanipulation of genes using protoplast. Genetic engineering in plants: Identity reservation of genetically modified plants.

Practicals: Based on the above topics

Books

1. Plant Biotechnology- J.Hammond, P. McGarvey and V.Yasibov.
2. Plant Cell and Tissue Culture for production of Food Ingredients- T.J. G.Singh and W.R.Curties
3. Biotechnology in Crop Improvement- H.S.Chawla

ENGLISH

Unit -I

Phonetics and Vocabulary:

Transcription of Phonetics Symbols, Words stress, Synonyms and Antonyms, Word Formation- Prefix, Suffix Grammar and usage : Transformation of sentences: Direct and Indirect Narration, Active and Passive Voice, Interchange of Degrees of Comparison, Modals

Unit- II

Comprehension, Sequences of Tenses, Elements of a Clause, Compositional Skills
CVs and Job Applications , Paragraph Writing

Unit III

Letters- Formal and Informal Technical letter writing: Purpose of writing, space/layout, economy of words, use of verb/ passive voice, type face (.italics, bold, underline) and use of indentation.

Unit IV

Report writing: Preparation, report structure (purpose of report, scope, shape, presentation of report, introduction of report, style of report and index of report). Public communication: meetings, planning and discussion, planning procedure, timing, degree of formality, behavior, repetitive, interviews (complexity of situation, preparation of thinking, preparation of setting, opening of the interview, style of interview).

Recommended Readings.

- I. Sasikumar, V., Dutta And Rajeevan, A Course in Listening and Speaking-I Foundation Books. 2005.
- II. Sawhney, Panja and Verma eds. English at the Workplace, Macmillan 2003.
- III. Singh, R.P. Professional Communication. OUP. 2004
- IV. Judith Leigh. CVs and Job Applications OUP. 2004.
- V. Arthur Waldhorn and Arthur Zeiger, English made Simple Rupa and Company. **Unit- I**

Second Year

INTRODUCTON OF INDUSTRIAL BIOTECHNOLOGY

Unit-I

Introduction, classification of microbial products Microbial process for production of organic acids, solvents, antibiotics. Enzymes polysaccharides, lipids, pigments and aroma. Equipments and accessories for industrial processes. Stabilize enzymes. Enzymes stabilization by selection and genetic engineering protein engineering. Reaction environment rebuilding, chemical modification. Molecular cross linking, immobilization. Application of enzymes in industry, analytical purpose and therapeutic.

Unit-II

Microbial production of therapeutic agents: Pharmaceuticals of interferon, cDNAs Engineering human interferon and growth hormone; optimizing gene expression. Enzymes lyase I and alinate lyase againsts cyatic fibrosis. Monoclonal antibody as therapeutic agents-Production of antibodies in *E.coli*, therapeutic agents. Vaccines: subunit vaccines herpes simplex virus , foot and mouth disease tuberculosis peptide vaccines , genetic immunization attenuated vaccines, vector vaccines.

Unit-III

Synthesis of commercial products by recombinant organisms. Restriction endonucleases, small Biomolecules, L-sorbic acid, indigo, amino acids, antibiotics, biopolymers. Bioremediation and biomass utilization.

Unit- IV

Microbial degradation xenobiotics, commercial production of fructose and alcohol, silage fermentation, utilization of cellulose.

Unit-V

Economically important primary and secondary metabolites function of single cell protein from carbohydrates n-alkanes. Methanol for use in food and feed. Liquid and gaseous fuel. Production of beer, wine, vinegar and distilled beverages, microbial food products.

Practicals: Based on the above topics

Books:

1. Casida, Industrial -Microbiology, New Age Publications 2001.
2. Prescott and Dunn- Industrial Microbiology, CBS Publications,1999.
3. Trevor, Harwood -Enzymes, 2001.
4. Old and Primose –Gene Manipulations. Blackwell Sciences.2001.
5. Lilia Alberghina-Protein Engineering Harward Academy,2003.

DEVELOPMENTAL BIOLOGY

Unit-I

Plant and animal development, development of plant embryo, development of seed, shoot apex organization of vegetative and floral apex, root, shoot, leaf and flower, development, Programmed cell death , ageing and senescence.

Unit-II

Genes and their role in development, signal transduction, cell division cycle, cytoskeleton, cell adhesion and extra cellular matrix: unicellular models sporulation in *Bacillus subtilis* mating type switching in yeast aggregation and culmination in *Dicyostelium discordeum*.

Unit-III

Sex gametes and fertilization, germline speciation, germ cell migration, gametogenesis, gastrulation in invertebrates, vertebrate cell lineage, Axis specification in vertebrates, fate of ectoderm, mesoderm and endoderm.

Unit-IV

Cell differentiation mechanism and factors affecting developmental gradients in hydra, axial gradients in *Drosophila* development.

Unit- V

Organogenesis in invertebrate sand vertebrates.

Books:

1. R.M.Twyman 2001 Developmental biology. Viva Books private New Delhi.
2. Gilbert S. 1997, Developmental Biology, 6th edition, Seneaur Associate.
3. Slack JMV 1991, from egg to embryo, 2nd edition Cambridge Uni. Press U.K.
4. Wolpert L. 1997, Principles of Development, Oxford University.

ELEMENTS OF MEDICAL BIOTECHNOLOGY

Unit-I

General introduction to biomedical engineering. Application of engineering in medicine, electro potential in human body. Neuromuscular System: Neurons, synapses and muscles, electrical properties of nerves and muscles, electrical properties of nerves and muscles, problems and diagnostics. Cardiovascular System: Anatomy and Physiology of heart, ECG and cardiac cycle, problems and solutions to electrical problems in heart, blood and vascular modeling. Excretory System (including dialysis): Renal anatomy and Physiology, the nephron, dialysis machine and mass transport. Medical Imaging: X-Rays, design considerations of x-ray tubes, CAT, NMR, PET/SPECT, cellular engineering and genetic engineering consideration in medical research.

Unit-II

Innate and acquired Immunity. Antigen: Types of antigens, antigen specificity, haptens, antibody (structure and functions). MHC, Complement system. Cell mediated cytotoxicity: Origin, maturation, and characterization of T-lymphocytes, monocytes and macrophages, mechanism of T-cell and NK Cell mediated lysis, ADCC, macrophage mediated cytotoxicity, lymphokines (the product of t-cell activation). Humoral Immune Response: Origin, maturation and characterization of B-Lymphocytes, activation and proliferation of B-cells, formation of plasmoblast, plasma cells and memory cells, interaction of B and T cells.

Unit- III

Hypersensitivity, monoclonal antibodies and its applications. Radioimmunoassay, ELISA, immunoblotting, immunofluorescence and flow cytometry. Characteristics of infectious diseases, herd immunity. Disease cycle (source of disease, reservoir, carriers). Transmission of pathogens (air borne, contact transmission and vector transmission).

Unit- IV

Bacterial Disease: Epidemiology, pathogenicity, laboratory diagnosis, prevention and control of the following disease-tuberculosis, typhoid, whooping cough, tetanus, diphtheria, leprosy. General account of fungal diseases-mycosis, subcutaneous and deep.

Unit- V

General account of viral and protozoan diseases: pneumonia, influenza, mumps, measles, polio, hepatitis-B, chicken pox, AIDS, malaria, leishmaniasis. Brief account of Sexually Transmitted Disease.

Books:

1. Ananthnarayanan, R. Jayaram Panicker 1997 Text Book of Microbiology.
2. Macleod and Mc Cartney, Churchill Livingstone. 1996. Medical Microbiology.
3. Bailey and Scott's Diagnostic Microbiology: Baron and Peterson, LR and Finegold, Mosby, SM 1990.
4. Broude, AI. 1981 Medical Microbiology, Infections and Diseases, WB Saunders & Co. Philadelphia.

FUNDAMENTALS OF BIOINFORMATICS

Unit- I

Introduction to database, Flat file data base, relational database: object oriented databases.

Unit -II

Sequence analysis and phylogeny: Internet sequence on the net- sequence DNA, RNA and protein, determination of protein structure, gene and protein expression data- protein interaction data. File formats-sequences databases- genome and organism specific database- retrieval, entrez, SRS; similarity searches- amino acid substitution matrices- FASTA, BLASTA- various types of BLAST.

Unit- III

Multiple sequence alignment, protein families- protein domain families. Building trees- evolution of macro molecular sequences-genome annotaton.

C-language: introduction, operators, expressions, variables, input, output statements, control statement, function, arrays, pointers, structures, unions, file handling and case studies. Introduction to PERL, variables, strings and numbers, lists analysis, hashes, conditional loops, pattern matching and application.

Unit- IV

Introduction to structural database- models of protein structure- structure, function and relationship, structural alignment- classification of 3D structure. CATH and SCOP- concepts in protein prediction.

Unit- IV

Micro array data and analysis: tools and resources, proteomics data analysis, Bioinformatics in drug discovery.

Books:

1. Bioinformatics 1998. Baxevanis.
2. Bioinformatics 2000. Higgins & Taylor. OUP.
3. Nucleic Acids Research. 2001. Jan. Genome Database issue.
4. Introduction to Bioinformatics- Attwood.
5. Instant Notes in Bioinformatics.

GENOMIC ANALYSIS

Unit- I

Basic structure of prokaryotic and eukaryotic genome. Chromatin model, concept of gene, linkage and crossing linkage analysis in *Drosophila* and *Neurospora*.

Unit- II

Pedigree analysis in human. Genetic mapping and its genetic mapping of complex character. Multigene families in human genome and repetitive DNA valve paradox and complexity of genome.

Unit- III

Physical mapping genome- chromosome walking. Chromosome painting, FISH, GISH ZOO BLOT, DOT BLOT, VNTR, RFLP, RAPD, SNPs, QTLs, EST, CpG island identification.

Unit- IV

Exon trapping and sequence analysis. Rice genome project and its applicability.

Unit - V

Human genome project and its application to future of man.

Books:

1. Genetics: Griffith and Suzuki
2. Principles of Genetics: Gardner 8th Ed. 2002 Oxford University
3. Genes VIII: Benjamin Lewin 1st Edition, 2003, Oxford University.
4. Genome: T.A. Brown 1999 John Wiley & sons

AGRICULTURE AND FOREST BIOTECHNOLOGY

Unit I

Introduction to conventional methods for growing forest trees and agricultural crops. Crop improvement:-pedigree breeding, heterosis breeding, mutation breeding. Tissue culture in improvement. Micropropagation for virus free plants. Somaclonal variations, somatic hybridation, haploids in plant breeding.

Unit-II

Genetic engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation, nutrient uptake efficiency. Genetic engineering for biotic stress, drought, flooding, salt and temperature.

Unit-III

Genetic engineering for crop quality improvement, protein, lipid, carbohydrates, vitamin and mineral nutrients.

Unit- IV

Plants as bioreactor. Molecular breeding, constructing molecular maps.

Unit - V

Molecular tagging of genetic traits. Marker-assisted selection of qualitative.

Practicals: Based on the above topics

Books:

1. Simmonds,N.W.1979. Principles of Crop Improvement, Longman, London
2. Sharma J.R. 1994. Principles and Practice od Plant Breeding. TMH Publishers
3. Persley, G. J. 1996 Biotechnology and Integrated Management. CAB Internationals.
4. Kumar, A. and Roy, S, -Plant Biotechnology and its applications in tissue culture.IK Internationals, New Delhi.

APPLICATION OF BIOTECHNOLOGY

Unit-I

Proteins as biotechnology products, commercial and medical use of proteins. Protein production and purification methods. Microbial biotechnology uses of micro-organisms infectious diseases, vaccines diagnostics, bioterrorism, eukaryotic vectors. Lifecycle and gene regulation, post translation modification, comparison of transcription in prokaryotes eukaryotes and archaea.

Unit-II

Plant biotechnology: introduction and historical background. G.E basic patent rules, ethical issues and biosafety guideline. Enzymes used in molecular cloning; restriction enzymes, ligases and other enzymes. Isolation of DNA, RNA, Bacteriophage, Extraction and analysis of mRNA from eukaryotic cells. Introduction of Recombinant DNA technology: Attenuation and Anti termination mechanism in bacteria, enzyme used recombinant technology. Bacterial plasmid, Bacteriophage lambda structure gene regulation & assay, Plasmid vector and Cosmid vector, gene therapy, strategies for crop improvement. Restriction modification system in bacteria, F factor and conjugation, Transformation, Viruses, Generalized and Specialized transduction, bacteriophage lambda vector M13 based vector, Transposon element, strategies for crop improvement.

Unit-III

Animal biotechnology: animal cloning and transgenic animals. Forensic analysis, methods of DNA Fingerprinting, rules of evidence, paternity testing, Biotechnology, diagnostics, Genetics: Tissue Engineering and Regenerating. Medicine as an energy source.

Unit-IV

Aquatic/environmental biotechnology: Aquaculture practices, application of genetically modified aquatic organism.

Unit-V

Biotechnology in crop improvement: cell and tissue culture *in vitro* selection for biotic and abiotic stresses, protoplasts and somatic hybridization, plant gene transfer methods and transgenic plants. Molecular marker and marker mediated application in plants breeding techniques.

Practicals: Based on the above topics

Books:

1. An introduction to practical biochemistry by-DJ Plummer, Tata Mc Graw Hill Publishing Company Ltd. New Dehli. Molecular Biology of the Gene: Waston J. D.
2. Molecular Biotechnology: Glick
3. Milestones in Biotechnology : Classic papers in Genetic Engineering: J. A. Davis, W. S. Resnikoff
4. DNA Cloning – A Practical approach: D. M. Glover and B. D. Hames
5. Principles of Gene Manipulation & Genomics-Primrose and Twyman (2006, 7th Edn)
6. Molecular cloning – A laboratory manual – Sambrook and Russell (Vol. 1-3)

BIOTRANSFORMATION AND BIOCATALYST

Unit- I

Basic organic reaction mechanism. Common prejudices against enzymes. Advantage and disadvantage of biocatalyst.

Unit- II

Isolated enzyme versus whole cell systems. Mechanistic aspects and enzymes sources. Biocatalyst applications.

Unit- III

Hydrolytic reaction, region selective hydrolysis. Reduction reaction, Bakers yeast reductions. Oxidation reaction. Hydroxylation of steroids at inactivated carbon centers.

Unit- IV

Enzyme of organic solvent reaction. Engineering for enzyme. Catalytic Antibodies. Biocatalyst from extreme thermophilic and hyperthermophilic bacteria.

Unit- V

Metallo enzymes and role of metal ions in catalysts. Modulators of enzymes activity. The catalytic sites of lysozyme and ribonuclease.

Practicals: Based on the above topics

Books:

1. A text book of enzymology by Palmer .
2. A references book of Biochemistry by Harper.

METABOLIC REGULATION

Unit- I

The Essence of metabolic engineering. Importance of metabolic engineering, metabolic regulation. Mechanism involved in metabolic regulation, digestion, intestinal absorption, organs and tissues.

Unit- II

Important endocrine organs and hormones. Integration of carbohydrates, fat and protein metabolism in whole body. The nervous system and metabolism. Coping with some extreme situations. Lipoprotein metabolism, Diabetes Mellitus, Energy balance and body weight regulation.

Unit- III

Review of cellular metabolism . An overview of cellular metabolism. Transport Process - Passive transport fueling reaction- Glycolysis, fermentative pathways, TCA Cycle and Oxidative phosphorylation, anaerobic pathway, catabolism of fats, organic acids and amino acids.

Unit- IV

Biosynthetic Reactions: Biosynthesis of amino acids, nucleic acids, fatty acids and other building blocks, Polymerization.

Unit- V

Metabolites and enzymes compartmentation in two prokaryotic and eukaryotic organisms. Futile metabolic pathways involving unidirectional reactions. Kinetics of metabolic regulation. Product inhibition and regulatory enzymes cascade systems. Induction and repression of lacoperon.

Books:

1. Outlines of Biochemistry: Conn & Stumpf
2. Principles of Biochemistry: Voet & Voet
3. Principles of Biochemistry: Jeffery Zubey
4. Clinical Biochemistry: D.C Deb
5. Biochemistry: Stryer
6. Lehninger's Principles of Biochemistry : Nelson & Cox

INTRODUCTION TO BIOSTATISTICS

Unit-I

Introduction to statistics with scope in biosciences (examples). Statistics and statistical data: various types of data (Raw data, grouped data). Representation of data using frequency distribution diagram (Simple/Multiple/Subdivided bar diagram, Pie diagram), Graphs (Histogram, polygon, curve) Population, sample, sampling methods (SRS, Stratified sampling).

Unit-II

Descriptive statistics (a) Measure of central tendency: Mean (Definition & simple problems), Median, Quartiles (Definition, Graphical calculation). Mode (Definition, graphical calculation). Situations where one is preferred over others. (b) Measures of dispersion: Variance (Definition, simple problems). Standard deviation. Coefficient of variance. (c) Skewness (Definition, types of skewness and graphical representation, no formula, and real life example), (d) Kurtosis (Definition, types of Kurtosis, graphical representation, no formula, and real life example).

Unit-III

Probability (a) Classical definition and its limitations, axiomatic approach (laws of probability only statement and no proof) (b) Independence and conditional probability (real life examples in biology). Standard probability distribution (a) Binomial (Definition, biological example, additive property (only statement), simple examples). (b) Poisson (Definition, biological example), additive property (only statement), simple examples. (c) Normal (Definition, biological example), linear property (only statement, simple examples (using statistical tables), central limit theorem).

Unit-IV

Inferential statistics (a) Hypothesis- definition, types (one tailed, two tailed). (b) Sampling distribution and errors (c) Types of errors (Type I, II). Testing of hypothesis (two tailed only). (a) For mean (one population), Mean (2 populations- dependent and independent) (b) For variance (one population), Variance (2 populations) (c) Chi-square test, fitting of distribution. Independence of attributes. ANOVA 1) one way, 2) two way followed by t test (pair wise).

Unit-V

Correlation (Definition, types of correlation with simple biological problems). Scatter diagram. Covariance Multiple correlation (definition, formula when matrix is given). Partial correlation (definition, formula when matrix is given).

Books

1. Mallick, S.C. and Arora Mathematical Analysis
2. Jenny Olive – Maths :- a self study Guide – Cambridge Low prices edition
3. R.G. Bartle and D.R. Sherbert (2nd edition)-1992, John Wiley, New York
4. E.D. Rainville and P.E. Bedient (1989), Elementary, Differential equations – McMillan, New York
5. System of Linear Equations
6. Eigen values and Eigen vectors
7. Partial Differentiation and differential equations

BASIC PHARMACEUTICAL BIOTECHNOLOGY

Unit- I

Pharmacokinetics. Physiologically based Pharmacokinetics (PB-PK). Pharmacokinetics / Pharmacodynamics (PK/PD) modeling. Application of pharmacometric in Drug development. Clinical trial, design and simulation. Biostatistical methodologies.

Unit- II

Project planning and management. Matrix management. Decision making. Cross functional team communications. Resource allocation. Time management.

Unit- III

Laws, regulation, guidelines, polices and proceeding. Clinical development, process and phases. Phase- IV commitments. Labeled driven drug development. Interaction with regulatory agencies: Do's and Don'ts.

Unit- IV

Clinical Trials: First time in humans. First entry. Multiple dose time. AME/Radiolabeled studies. Food effects studies. Drug-drug interaction studies. Accelerating the clinical trial process.

Unit- V

Enzyme immobilization. Techniques employed for enzymes immobilization and its application in industry. Factors affecting enzyme Kinetics. Immobilization of microbial and plant cells. Study of hyaluronidase, penicillinase, streptokinase amylases and proteases. Biosensors.

Practicals: Based on the above topics

Books

1. Goodman Gillman's The Pharmacological Basis of Therapeutics (2001) Ed. Hardfman JG, Limbird LE (10 edition) McGraw Hill Press, New York.
2. Applied Biopharmaceutics and Pharmacokinetics (1999) Ed. Sargel L; (4 edition), prentice Hall International, London.
3. Fundamentals of Experimental Pharmacology. (1984) Ed. Ghosh MN. Scientific book Agency, Kolkata.
4. Textbook of Receptor Pharmacology, Eds. Forman JC, Johansen TJ, CRC Press, New York, 1996.
5. Drug Discovery & Evaluation – Pharmacological Assays. (1997) Ed. Vogel HG & Vogel WH. Springer New York.

BIOTECHNOLOGICAL TECHNIQUES

Unit- I

Microbial Biotechnology: Uses of microorganisms; Infectious diseases; Vaccines; Diagnostics; Bioterrorism. Eukaryotic vectors- life cycle and gene regulation; Posttranslational modifications. Comparison of transcription in Prokaryotes, Eukaryotes and Archaea.

Unit- II

Plant Biotechnology: Introduction and historical background of GE, basic patent rules. Ethical issues and biosafety guidelines. Enzymes used in molecular cloning ; restriction enzymes, ligases, and other enzymes. Isolation of DNA, RNA, Bacteriophage and plasmid DNA. Extraction and analysis of mRNA from Eukaryotic cell. Biotechnology in crop improvement- Cell and tissue culture *in vitro* selection for biotic and abiotic stresses, Protoplasts and somatic hybridization. Plant gene transfer methods and transgenic plants; molecular markers and marker mediated application in plant breeding techniques.

Unit- III

Introduction of Recombinant DNA technology: attenuation and anti termination mechanism in bacteria. Enzymes used in recombinant technology. Bacterial plasmids; bacteriophage lambda structure, gene regulation & assay; Plasmid and cosmid vectors. Restriction modification in bacteria; F factor and conjugation. Bacteriophage lambda vectors; M13 base vectors; transposable elements; yeast vectors; *E.coli* expressing system; cloning strategies. Virus cloning strategies for screening DNA libraries; Methods in creating transgenic plants; Strategies for crop improvement and intended benefits. Environmental, Health and Socio-economic issues regarding Genetically modified plants and foods.

Unit- IV

Animal Biotechnology: Animals in research; Animal cloning and transgenic animals. Forensic analysis; Methods of DNA finger printing; Rules of evidence; Paternity testing; Medical biotechnology; diagnostics; Genetic screening; Pharmacogenome. Medical Products; Gene therapy. Tissue Engineering and regeneration. Medicine as an energy source.

Unit- V

Aquatic/ Environmental Biotechnology: Aqua culture practices; Application of genetically modified organisms. Biotechnology I crop improvement cell and tissue culture *in vitro* selection for Biotic and Abiotic stresses, Protoplasts and somatic hybridization. Plant gene transfer and transgenic plants; molecular markers and marker mediated application in plant breeding techniques.

Practicals: Practical based on above topic will be conducted.

Books:

1. An Introduction to Practical Biochemistry by-DJ Plummer, Tata Mc Graw Hill Publishing Company Ltd. New Dehli. Molecular Biology of the Gene: Watson J. D.
2. Molecular Biotechnology: Glick
3. Milestones in Biotechnology : Classic papers in Genetic Engineering: J. A. Davis, W. S. Resnikoff
4. DNA Cloning – A Practical approach: D. M. Glover and B. D. Hames
5. Principles of Gene Manipulation & Genomics – Primrose and Twyman (2006, 7th
6. Edition)
7. Molecular cloning – A laboratory manual – Sambrook and Russell (Vol. 1-3)

ENVIRONMENTAL BIOTECHNOLOGY

Unit-I

Environmental pollution: Water, air & noise (introduction sources and effects). Waste water: Communal, sewage and industrial effluents: types of wastes, properties and step involve in aerobic and anaerobic treatments. Microbial analysis of water. Waste water management.

Unit -II

Principle and design aspects of various waste treatment methods, with advance bioreactor configuration: activated sludge process, trickling filter, fluidized expanded reactor, up flow anaerobic sludge Blanket reactor, contract process, fixed/ packed reactor.

Unit - III

Biopesticides: Bacterial & fungal, genetically modified crops containing insecticidal genes. Biofertilizers: nitrogen fixer, PSB, mycorrhizae & VAM, kinetic models for biological wastes treatment: in conversion of agricultural and of highly organic waste material to gainfully utilizable products, biogas, H₂, cellular and food and feed, cellulose degradation or combustible fuels and their environmental impact.

Unit -IV

Waste disposal and management, legislation of environmental problems, Microbiological and biochemical aspects of waste water treatment process, microbial improvement with a view to develop scavengers, bioremediation.

Unit -V

Biosensor and biopolymers, biochip, biofilm and bioplastics. Microorganisms as bioindicators. Biological weapons and bioterrorism.

Practicals: Practical based on above topic will be conducted

Books:

1. Winter, J. Environmental Processes I-III Wiley Publications
2. Metcalf Eddy- Waste water Biotechnology.
3. Metcalf Eddy- Waste water Engineering III Ed. TMH Publications.
4. R.S. Ramalho, R.S. Introduction to waste water treatment
5. Ted Munin- Encyclopaedia of Global Environmental changes. 5vol. Wiley Publications.

ANIMAL BIOTECHNOLOGY

Unit- I

Introduction to animal tissue culture, Historical background, the application of tissue culture, terminology, stages in cell culture. Outline of the key techniques of animal cell culture, setting up the laboratory, culturing cell, maintaining the culture, quantification of cells in cell culture, cloning and selecting cell lines. Physical methods of cell separation. Hazards and safety in the cell culture.

Unit- II

Animal cell culture media. General cell culture media design. Natural media, synthetic media. Further consideration in media formulation. Nutritional components of media. The role of serum in cell culture choosing a medium for different cell types. Characterization of cell lines. Species verification. Intraspecies contamination. Characterization of cell type and stage of differentiation, microbial contamination.

Unit III

Preservation of animal cell lines. Variation and instability in cell lines. Preservation of these cell lines. Freezing of cells. Quantification of cell viability. Cell banks.

Unit IV

Hybridism. The Limitation of traditional antibody preparation, The basis of Hybridoma technology. Long -term storage of hybridoma cell line, human hybridoma, and commercial scale production of monoclonal antibodies.

Unit V

Large Scale animal cell culture, Culture parameters, Scale up of anchorage-dependent cells, suspension culture.

Practicals: Based on the above topics

Books

1. Animal Cell Culture Techniques-Martin Clynes
2. Culture of Animal Cells- R.Ian Froshney
3. Animal Cell Culture- Practical Approach-John R.W.Misters.

INTRODUCTION TO GENETIC ENGINEERING

Unit- I

Scope and history of genetic engineering. Basic requirement of genetic engineering – Isolation and Plasmid DNA from Bacteria, Plants and Animal cells. Enzymes required for recombinant DNA technology (Restriction and other enzymes). Macromolecular synthesis; Chromosome Structure replication-DNA structure, DNA replication. Replication bacterial Chromosome. Gene Expression- Genetic code and its features, Decipher of gene code.

Unit- II

Cloning Vectors- nomenclature, Properties of good vectors. Phage Lamda , M-13 Vectors Yeast Vectors-YAC. Plant Vectors- *Agrobacterium tumefaciens*, *A. rhizogenes*. Animal Vectors- SV-40, Retrovirus vectors, Vaccinia virus. RNA Structure and function. Transcription, Process of mRNA. rRNA, tRNA Reverse Transcription, ribosome structure. Translation, details of protein synthesis, regulation of protein. Synthesis with 'LAC' Operon as model, inhibition of translation. Post translation, modification of the Protein.

Unit- III

Construction of genomic and cDNA library. Manipulation of purified DNA and introduction of DNA into living cells. Mutation elementary concept; Types of mutation; Point mutation (Basic pair change, frame Shift, deletion etc). Plasmids: Properties (replication, functions of on region incompatibility). Plasmid genetics: Plasmid cloning vectors. Conjugation (Gene transfer, chromosomes Transfer by Plasmid-Transformation-Bacteriophage-transposition and non homologous recombinant.

Unit- IV

Blotting- Southern, Northern, Western, Dot-blot. Introduction to PCR, RAPD and RFLP. Recombinant DNA techniques and cloning-Restriction endonuclease and recombinant DNA. DNA cloning with restriction endonucleases. Cloning bacterial genes. Polymerase chain reaction (PCR). Genomic and cDNA library.

Unit- V

Gene therapy (Basic Principle and introduction). Introduction of gene Mapping. Biosafety guidelines, Intellectual Property Right, Recombinant DNA Safety guidelines.

Practicals: Based on the above topics

Books

1. Molecular Biology of the Gene: Watson J. D.
2. Molecular Biotechnology: Glick
3. Milestones in Biotechnology : Classic papers in Genetic Engineering: J. A. Davis, W. S. Resnikoff
4. DNA Cloning – A Practical approach: D. M. Glover and B. D. Hames
5. Principles of Gene Manipulation & Genomics – Primrose and Twyman (2006, 7th Edition)
6. Molecular cloning – a laboratory manual – Sambrook and Russell (Vol. 1-3)

DIARY AND FOOD TECHNOLOGY

Unit- I

Microbial role in food processes operation & production; new protein foods –mushroom, food yeasts algal proteins. Fermentation as method of preparing & preserving foods. Food additives like coloring, flavors vitamins. Organisms & that use for production of fermented foods beverages; pickling, alcoholic beverages cheese sauerkraut, idli, vinegar.

Unit- II

Deoxygenation & desgaring by glucose oxidase, b-mashing & chill proofing or cheese making by protease in for various other enzyme catalytic actions in food processing, classification of fruit juice. Post harvest technology & process of food preservation.

Unit- III

Milk: define, composition chemical & functional properties of milk components, physiochemical properties of milk Protein, aggregation of casein micelles factor's affecting milk composition milk secretion & location. Micro-organism: importance in dairy science & technology, microbial spoilage of milk, hydrolytic rancidity milk Product auto oxidation of milk, fats & effect of milk quality.

Unit- IV

Milk processing operations: milk pasteurization homogenization & sterilization, effect of processing of milk components & their functions properties. Skimming of milk, cream & cream characteristics, manufacture of yoghurt & other fermented milk products ice cream Manufacture, butter making technology, technology of cheese & processing of concentrated milk & drink milk power.

Unit- V

Milk quality control, sanitation in dairy plant adulteration of milk, dairy equipment maintenance & waste disposal.

Practicals: Practical based on above topics will be conducted.

Books:

1. Frazier, Food Microbiology TMH Publication.
2. Heller Genetic Engineering of food: Detection of genetic Modifications, Wiley Publications.
3. Keshav Trehan –Biotechnology, New Age International Publishers
4. Lel, A *et al.*, Microorganisms & Fermentations.

WASTE PRODUCTION UTILIZATION TECHNOLOGY

Unit- I

Biomass utilization of food, fuel and chemicals. Biodiversity and its characterization, use of glob positioning system in bioresource management. Problems associated with Solid waste disposal. Generation of Solid Wastes: Goals and objectives of solid waste management, classification of solid waste. Solid waste generation, factors influencing generation of solid waste. Charecterstics of solid waste, analysis of solid waste.

Unit- II

On site Handling, Storage and Processing: Public health and aesthetics, onsite handling, onsite storage, dustbins. Community containers, container locations, onsite processing methods. Solid waste collection, transfer and transport: Collection systems, equipment and labour requirement, collection routes, option for transfer and transport system.

Unit- III

Processing and disposal methods: processing and disposal methods: Processing techniques and methods of disposal, sanitary land filling, composting, incineration and bioremediation. Recovery of resources, conversion products and energy: material, recovery, energy generation and recovery operation, reuse in other industry.

Unit- IV

Industrial solid waste: Nature, treatment and disposal methods. Biowaste including medical waste, disposal and safety regulations.

Unit- V

Municipal wastes and disposal: Sewage and sludge and their treatment methods. Domestic wastes and their treatment methods.

Practicals: Practicals based on above topics will be conducted.

Books:

1. G. Tehobanogious, H. Theisen and R. Blassen – Solid Waste Engineering, Principles and management issues, McGraw Hill book co. New York.
2. Mantell Cl, Solid Waste Management John Wiley, New York 1975.
3. Bhide and Sundareshan , Solid waste management in Developing countries.

BIODIVERSITY AND SYSTEMICS

Unit-I

Biodiversity-Concept, definition, species, diversity, ecosystem diversity, genetic diversity. Magnitude of biodiversity, distribution of biodiversity, assessment of biodiversity, utilization of biodiversity, conservation of biodiversity.

Unit-II

Population dynamics (a) Population density & relative abundance (b) Population age distribution (c) Growth forms & carrying capacity (d) Population structure: isolation & territoriality (e) Interactions. The species & individual in the ecosystem (a) Habitat & niche (b) Ecological equivalence (c) Biological clock (d) Basic behavioral patterns.

Unit-III

Biodiversity & major biomes of world. Biogeography: Specific flora & fauna. Conservation of Biodiversity (a) Importance (b) Conservation strategies – *in situ* and *ex situ* methods – advantages, limitations and applications. Conservation laws, policies & organizations

Unit-IV

Bioprospecting (microbes, plants and animals). Biological systematics-principles and practices (a) Aims & objective. (b) Tools & techniques of biological systematics [systematics of microorganisms, plants, & animals].w.r.t. following sources of data as applicable for the group,(a) Morphology (b) Anatomy (c) Histology(d) Chemistry (e) Cytology (f) Molecular biology (g) Micromorphology (h) Paleontology (i) Embryology.

Unit-V

Biosystematics: Analysis of Biodiversity (a) biodiversity indices (b) Mathematical modeling for analysis of population, variation

Practicals: Practical based on above topics will be conducted.

Books:

1. Ecology : Begon & Hareper
2. The biology of biodiversity : M.Kato
3. Biodiversity : E.O. Willson
4. Evolution : Stearns & Hoekstra
5. Animal behaviour : Alcock
6. Ecological analysis : Freeman & Herron
7. Elements of taxonomy : E. Mayor
8. Plant Taxonomy & Biodiversity : Stace
9. Fundamentals of Plant Systematics : Radford
10. Taxonomy of Angiosperms : Naik, V.N.