

**D.R. BABASAHEB AMBEDKAR
MARATHWADA UNIVERSITY,
AURANGABAD.**



Revised Syllabus of
B.Sc.[Biotechnology]
Second Year
Integrated Three Year Degree Course
(with Credit System)
Semester III & IV

(Effective from 2010-11 & onwards)

**B. Sc. II Biotechnology,
Semester III,**

**Paper XIII-BIM BASIC IMMUNOLOGY Marks 50, (3 Cr)
45 Contact hours**

1. **Types of immunity** : innate, acquired, active and passive. Elements of immune system: Hematopoiesis, T-cells, B-cells, myeloid cells, antigen presenting cells, cell mediated subset of T-Cells, helper and suppressor cells, cell mediated and humor immunity, antibody dependent cell mediated cytotoxicity, natural killer cells. Primary and Secondary organs of immune system
 2. **Cellular and molecular aspects:**
Antigens :- Immunogenicity Vs antigenicity, factors affecting antigenicity, epitopes, haptens, adjuvants.
Antigen antibody interactions :- forces of antigen antibody interaction, principle, methods and applications of precipitation and agglutination.
Antibody structure, function and diversity antigen-antibody reactions, T-Cells receptors, cell activation complement, lymphokines, regulation of immune response, immunological tolerance. Recognition of antigen: MHC, antigen processing and presentation, T-cell and B - cell activation.
 3. **Hypersensitivity:** An allergy, types of hypersensitivity. Immunology of hypersensitivity. Secondary immune response. Autoantibodies – Autoimmune diseases. Examples such as; Rheumatoid Arthritis, Myasthenia Gravis, Systemic Lupes Erythematus, Rhesus incompatibility, Protection of fetus from immune response.
- Immunotechniques:** Immuno diffusion, immunoelectrophoresis ELISA, RIA, fluorescence activated cell sorter, PBMC, immunoblotting.

REFERENCE BOOKS

1. Immunology Kuby, R.A. Goldsby, T.J. Kind 1997, 4th Edition B.A. Osborne.
2. Essential of immunology Ivan Riot-Blakswel 1997, 4th Edition B.A. Osborne
3. Fundamentals of Immunology Paul W.E. (Eds.) 1998 Raven press, New York.
4. Text Book of Microbiology by Panikar and Anantnarayan 2009.
5. General Microbiology by Davis
6. Medical Microbiology by Duguid and Cruikshank

B. Sc. II Biotechnology,**Semester III,****Paper XIV-GVG****General Virology****Marks 50, (3 Cr)****45 Contact hours****Unit 1. General aspects**

Classification and nomenclature of viruses in general, their properties, morphology and ultrastructure typical bacteriophage, animal virus and plant virus, types of envelope, their composition, Viroids and Prions.

Unit 2. Animal Viruses

Classification of animal viruses, life cycle and pathogenicity of important viruses, genome organization and replication of DNA viruses, RNA viruses, Adeno virus, Pox virus, SV40, Vaccinia, Lentivirus. Clinical diagnosis and treatment of HIV, Influenza and Hepatitis.

Unit 3. Plant Viruses

Classification plant viruses, life cycle and pathogenicity of important viruses. Genome organization and replication of common plant viruses, such as; TMV CaMV, Potato X Virus, Gemini Virus. Transmission of plant viruses by vectors and other means. Diagnostic techniques in seed, seed stocks and diseased plants.

Unit 4. Bacteriophages

Structure and organization of bacteriophages, lytic and lysogenic life cycles –T4 and lambda. Genetic switch for control of lytic and lysogeny of lambda phage. Genome organization, infection and multiplication of T odd and T even phages. Lambda phage, M13, Mu phage.

References:

1. General Virology by S. E. Luria
2. Molecular Virology, pathogenesis and control, ASM Press, Washington DC
3. Plant Virology by REF Matthews
4. Dimmock N. J., Primrose S. B. 1994 Introduction to modern Virology, 4th edition, Blackwell scientific Publications, Oxford.
5. Morag C and Embury M. C. 1994, Medical Virology 10th edition, Churchill Livingstone, London.

B. Sc. II Biotechnology,**Semester III,**

Paper XV-DVB Developmental Biology Marks 50, (3 Cr)
45 contact hrs

Unit 1 Developmental Biology an overview

Introduction of animal development: Development among unicellular eukaryotes – *Acetabularis*, *Naegleria*. The origins of sexual reproduction. Fertilization: structure of gametes, recognition of sperm and egg –action at distance and contact of gametes.

Cleavage: Patterns of embryonic cleavage, radial holoblastic cleavage, spiral holoblastic cleavage, mechanisms of cleavage –regulation of cleavage cycles.

Unit 2 Early Embryonic Development Gametogenesis, Fertilization, Embryo sac development and double fertilization in plants, blastula formation, Types of Cleavage, Gastrulation and formation of germ layers in animals.

Unit 3 Morphogenesis and organogenesis in animals

Cell aggregation and differential in *Dictyostelium*; axes and pattern formation in *Drosophila*, organogenesis –vulva formation in *Caenorhabditis elegans*; eye lens induction, limb development in vertebrates, neuron differentiation, -larval formation, metamorphosis; environmental regulation of normal development.

Unit 4 Extra embryonic membrane, Cell death and regeneration

Study of extra-embryonic membrane in chick, concept of regeneration programmed cell death and aging and senescence.

References:

1. Developmental Biology by Scott Gilbert -9th edition
2. Balinsky –An introduction to embryology CBS college Publishers
3. Lodish H, *et. al.*, Molecular Cell Biology
4. Alberts Bruce, *et. al.*, Molecular Biology of the Cell Sinauer
5. Grant –Biology of Development systems, Holt. Reihart, Winston.
6. Developmental Biology website companion to Gilbert -
<http://www.devbio.com/contents.php>

B. Sc. II Biotechnology,**Semester III,**

**Paper XVI-CSI Chromosome Structure and Inheritance Marks 50, (3 Cr)
45 Contact hours**

Unit 1. Genetic material: structural organization

Discovery of genetic material –Experimental evidences. Genomes of bacteria, viruses and eukaryotic cell. Genome complexity in terms of C-value paradox, Denaturation – Renaturation kinetics –Cot Values, repetitive and non-repetitive DNA, Subcellular genomes, extrachromosomal genomes, Organelle genome, DNA topology and manipulation of DNA topology –Feulgen reaction, Structure of DNA and forms of DNA. Chromosome: Structure of a typical circular and linear chromosomes, molecular nature and functioning of centromeres and telomeres, Giant chromosome, Polytene chromosome. Chromatin Organization: Euchromatin, Heterochromatin, Nucleosome as a subunit of chromatin, organization of histone octamer, acetylation and deacetylation of histones, roles of methylation and demethylation of DNA in CpG islands.

Unit 2. Transmission and Dominance of Genetic Material

Mendelian Principles: I Segregation: Mendel's experiment, terminology, testing phenotypes, examples of gene differences and segregation. **Mendelian Principles II: Independent Assortment:** Genotypes of dihybrid crosses, testing dihybrid genotypes, crosses involving three or more gene differences, history of Mendel's Discovery, Correspondence between Mendelian factors and chromosome symbols, segregation and Assortment in haploid organisms. **Tetrad analysis** : *Neurospora crassa*, *Saccharomyces cerevisiae* –gene conversion. Modern Evaluation of Mendel's Conclusion.

Dominance relations and multiple alleles: Incomplete dominance, overdominance, codominance and blood types, multiple alleles, Multiple-Allelic Blood-Group systems, RH and ABO incompatibility, Histocompatibility genes and antibody formation.

Gene interaction and Lethality: Epistasis, Additivity, Interaction between more than two gene pairs, modifiers, lethality, segregation distortion.

Unit 3. Sex determination and cytoplasmic heredity

Sex determination: Simple mechanisms: one or a few genes. The XX-XY mechanism of sex determination, species with heterogametic females. The Sex Chromosome, The Y chromosome: dominant male determinants, but few other genes, compound sex chromosomes, sex determination, meiotic behavior of sex chromosomes and Nondisjunction. The balance concept of sex determination in *Drosophila*. Haplodiploidy and sex determination in Hymenoptera, mosaics and gynandromorphs. Sex linked dominance, sex limited gene expression and sex linked inheritance. Sex linkage, Bridges' demonstration of Nondisjunction, attached-X, Sex Linkage in Moths and Birds, Reptiles (Snake), Detection of Sex linked diseases in humans, Sex ratio, X-inactivation, dosage compensation. X-linked disorder –females as carriers, hemophilia, sickle cell anemia, fragile-X-syndrome, Huntingtons disease, (only introductory).

Maternal Effect and Cytoplasmic heredity: Maternal effect –P element, Pila genetics, mitochondrial DNA (mtDNA), chloroplast DNA (cpDNA), Streptomycin resistance in chlamydomonas, respiratory deficiencies, cytoplasmic DNA criteria for extrachromosomal inheritance, infectious heredity.

Unit 4. Quantitative Inheritance and linkage

Johannsen's pure lines, multiple factors, effect of dominance, genes with multiplying effects and the scale of measurements, polygenes in Discontinuous traits.

Linkage: linkage groups, complete linkage, incomplete linkage and recombination, four-strand crossing over, detection of linkage. Calculation of autosomal recombination frequencies by backcrossing to homozygous recessives, recombination frequencies for Sex-linked genes, recombination frequencies in $F_1 \times F_1$ crosses.

References:

1. Genetics, Third edition by Monroe W. Strickberger First Indian Impression 2006.
2. Principles of Genetics, Eighth edition, Gardner, Simmons and Snustad.2001.
3. Molecular Genetics An introductory Narrative. Second edition, by Gunther S. Stent and Richard Calendar –University of California Berkley 1986 first Indian edition and reprint 2004.
4. Principles of Genetics, Temin Baltimore.
5. Genetics By Wintergreen.

B. Sc. II Biotechnology,**Semester III,****Paper XVII-BEZ****Basic Enzymology****Marks 50, (3 Cr)****45 contact hours****Unit 1. Introduction to enzymes**

Definition of enzymes, importance of enzymes: Physiological and industrial, enzyme classification, chemical nature of enzymes, structure of enzyme proteins determination of enzyme structure by X-ray crystallography.

Unit 2. Enzyme Action

Concept of activation energy, active site of an enzyme, Enzyme specificity : Group specificity Substrate specificity Stereo-Specificity & product specificity. Hypotheses of enzyme action-Hypotheses lock and key Hypothesis, induced fit Hypothesis, Hypotheses involving strain or transition state stabilization Uni-Uni, Bi-Bi, enzyme reactions involving one and two substrate molecules, Ping-pong Bi-Bi mechanism, Random Order mechanism, compulsory order mechanism.

Unit3. Types of Enzymes

Monomeric Enzymes (Serine Proteases) Oligomeric Enzymes (lactate Dehydrogenase) Metalloenzyme Complex (Pyruvate Dehydrogenase) Metalloenzymes & Metal activated enzymes Isozymes Ribozymes, Abzymes & Extremozymes & allosteric Enzymes.

Unit 4. Co-Enzymes & Co-factors

Introduction : NAD, NADP, FMN, FAD, Adenosine Phosphates Co-enzyme A, Thiamine Pyrophosphate, Pyridoxal Phosphate, Lipoic Acid Tetrahydro folate & Vitamin B12.

Reference Books :

- 1) **Enzymes** – Biochemistry, Biotechnology, Clinical chemistry, 2004 by Trevor Palmer, East – West Press Edition.
- 2) Fundamentals of Enzymology 2003 by Nicholas C. Price and Lewis Stevens Oxford University Press.
- 3) Enzyme kinetics by Paul Engal. 1977, John Willey and Sons Inc.
- 4) Enzymes by Dixon and Web. Acad. Press.
- 5) Principles of enzyme kinetics by Athel Cornish. 1976. Bowden and Butterworth and Co.
- 6) Laboratory manual in Biochemistry by J. Jayaraman. 2006, New Age International.
- 7) Source book of Microbiology by Primrose.

B.Sc.II Biotechnology**Semester III****PAPER- XVIII-APL****Animal Physiology****Marks-50, (3 Cr)****45 contact hours****Unit 1. Physiology of digestion and excretion****(10 Lectures)**

Definition of digestion and types of digestion – extra and intracellular. Digestion of Carbohydrates, proteins, lipids and cellulose digestion. Absorption and assimilation of digested food materials. gastrointestinal hormones- control of digestion.

Definition of excretion. Forms of nitrogenous waste material and their formation; classification of animals on the basis of excretory products. Structure and function of Nephron – Counter current mechanism.

Unit 2. Physiology of respiration and circulation**(10 Lectures)**

Types of respiration – external and internal respiration. Transport of oxygen – formation of oxyhaemoglobin and affinity of haemoglobin for Oxygen, Oxygen dissociation curves. Transport of CO₂ – Chloride shift, Bohr effect.

Open and closed circulation. Heartbeat and cardiac cycle. Myogenic and neurogenic hearts. Regulation of heart rate – Tachycardia and Bradycardia.

Unit 3. Physiology of muscle contraction and nerve impulse**(10 Lectures)**

General structure and types of muscles. Ultra structure of skeletal muscle. Sliding filament mechanism of muscle contraction. Chemical changes during muscle contraction – role of calcium, ATP utilization and its replenishment.

Structure of nerve cell. Nature of nerve impulse – resting potential and action potential. Properties of nerve impulse – threshold value, refractory period, all or none response. Conduction of nerve impulse along an axon – local circuit theory and saltatory conduction theory. Structure of synapse, mechanism of synaptic transmission – electrical and chemical transmissions.

Unit 4. Physiology of endocrine system and homeostasis**(15 Lectures)**

Relationship between hypothalamus and pituitary gland. Hormones of hypothalamus. Hormones of Adenohypophysis and Neurohypophysis. Hormones of pineal gland, thyroid gland, parathyroid, thymus, adrenal and pancreas. Endocrine control of mammalian reproduction – Male and female hormones – Hormonal control of menstrual cycle in humans. Concept of Homeostasis and its basic working mechanism. Mechanism of Homeostasis – giving three illustrations viz., Hormonal control of glucose levels, Water and ionic regulation by freshwater and marine animals and temperature regulation in man.

REFERENCE BOOKS

1. 'Essentials of Animal Physiology' by S.C.Rastogi'
2. 'Animal Physiology' by H.C. Nigam.
3. 'Biology' by Campbell & Reece.
4. 'Animal Physiology' – Agarwal, R.A. Srivastava, Kaushal, Anil and Kumar.
5. 'Animal Physiology and Biochemistry' by Dr. B.Annadurai.
6. 'Principles of Animal Physiology' by Christopher D.Moyes, Patricia M Schulte.
7. 'Biology: The Science of Life' by R.A. Wallace, G.P. Sanders & R.J. Ferl.
8. 'Biology: Concepts and Applications' by Starr
9. 'Cell Biology, Genetics, Evolution and Ecology' by P.S.Varma and V.K. Agrawal; S. Chand and Company.
10. 'Animal nutrition' by P.Mc Donald, R.A. Edwards, J.F.D. Greenhalgh, C.A. Morgan.

**B. Sc. II Biotechnology,
Semester III,**

LCVII

Immunology and Virology

Marks 100, (3 Cr)

PRACTICALS

Section A –Basic Immunology

1. Blood film preparation and identification of immune cells
2. Lymphoid organs and their microscopic organization
3. Immunization and collection of serum
4. Double Diffusion
5. Hemagglutination
6. Detection of antigen
7. Separation of monoclonal cells by Ficoll-Hypaque

Section B -Virology

1. Isolation of coliphages
2. Titration of bacteriophages
3. One step growth curve
4. Viral DNA extraction
5. Demonstration of nucleic acid type of viral sample
6. Isolation of plant virus from clinical specimen
7. Isolation of animal virus from clinical specimen.

**B. Sc. II Biotechnology,
Semester III,**

LCVIII Developmental Biology and Inheritance Marks 100, (3 Cr)

PRACTICALS

Section A –Developmental Biology

1. Study of meiosis in Grasshopper testis
2. Study of development of frog embryo from permanent slides (at least five)
3. study of different types of cancer cell

Section B –Chromosome structure and Inheritance

1. Determination of nucleic acid by Feulgen reaction
2. Isolation of Giant chromosome
3. Isolation of Polytene chromosome
4. Estimation of temperature melting
5. Problems based on monohybrid and back cross
6. Problems based on di-hybrid
7. Problems based on tri-hybrid
8. Problems based on pedigree analysis

**B. Sc. II Biotechnology,
Semester III,**

LC IX Enzymology and Animal Physiology Marks 100, (3 Cr)

PRACTICALS

Section A –Basic Enzymology

1. Detection of enzyme production by bacteria & Fungi: Proteases, alpha amylase, lipase, Cellulase.
2. Detection of B-Lactamase Production by Saureus / E coli.
3. Assay of urease.
4. Assay of alpha Amylase in terms of substrate consumpron.
5. Assay of alkaline phosphatane in human serum.
6. Detection of extremozymes production by bacterial isolates from extreme environment e.g. : salted fish.
7. Study of substrate specificity of enzymes.

Section B –Animal Physiology

1. Detection of normal and abnormal constituents of urine – sugar, albumen bile and blood cells.
2. Demonstration of salivary amylase.
3. Effect of temperature and pH on amylase

B. Sc.II Biotechnology,**Semester IV,****Paper XIX-CBG****Cell Biology****Marks 50, (3 Cr)****45 Contact hours****Unit 1. Cell Structure and organelles**

Cell theory. Organisation- prokaryotic and eukaryotic cells. **Origin** of eukaryotic cells- endosymbiotic theory, Giardia- a living fossil. **Overview of cell specializations: Plants-** epidermis, vascular tissue and cortex, **Animals-** epithelia, connective tissue, nervous tissue, muscle, blood, germ cells and sensory cells.

Structure and Functions of Organelles:

Endoplasmic Reticulum, Lysosome, Golgi Complex, Peroxisome (Microbody), Centriole, Mitochondria, Cytoskeleton- microtubules, intermediate filaments, actin filaments, mechanism of muscle contraction, motors and movements, Cilia & Flagella, Nucleus, Special Properties of Plant Cells-cell wall, vacuoles and chloroplast.

Unit 2. Membrane Structure

Membrane models- Overton's lipid nature of membrane, Langmuir's lipid monolayer, Gorter and Grendel's lipid bilayer, Davson and Danielli's lipid bilayer plus protein sheet, Robertson's Unit membrane, Singer and Nicolson's fluid mosaic. **Membrane structure-** 2D Lipid bilayer, composition of lipid bilayer, asymmetric nature, fluidity, membrane proteins and their function.

Unit 3. Membrane Transport

Movement across membranes- **Passive transport:** simple diffusion, facilitated diffusion- transporters (uniporters and cotransporters) and channel proteins. **Active transport:** Pumps, Group Translocation and Electrochemical Gradients

Unit 4. Cell Division and Cell Cycle

Mitosis, Meiosis, and Cytokinesis, role of protein kinases and Cyclin-Cdk complex in controlling cell cycle, control of cell proliferation in multicellular organisms, programmed cell death.

References:

1. Cell Biology by Sadava
2. Molecular Cell Biology, Lodish *et al.*, Freeman and Company, New York, 1999
3. Essential Cell Biology- An introduction to the molecular Biology of the cell- Alberts, Bray, Johnson, Lewis, Raff, Roberts, Walter, Garland Publishing.
4. Molecular Biology of the cell- Bruce Alberts, Garland Publishing Inc.
5. Cell Biology- A short course, Second edition, Stephen R. Bolsover, Wiley Publication
6. Genes IX - Benjamin Lewin, Prentice Hall Publication
7. An introduction to Practical Biochemistry- David T Plummer, Tata McGraw-Hill Edition
8. Developmental Biology, Ninth edition, S. F. Gilbert, Sinauer Associates Inc.

B.Sc.II Biotechnology**Semester IV****Paper- XX-PPL****Plant Physiology****Marks-50,(3 Cr)****45 contact hours****Unit1. Plant water relations :**

Cell as a physiological unit. Osmosis, Imbibition. Diffusion, D.P.D. Water potential, Absorption of water, (active & passive). Plasmolysis, cohesion, tension and transpiration pull theory. Significance, factors affecting transpiration, mechanism of stomatal opening and closing, (k⁺ transport theory). Guttation and antitranspirants. **(10 Lectures)**

Unit2. Photosynthesis :

Significance, site of photosynthesis, pigments, photochemical phase. Electron transport chain. Photophosphorylation, cyclic and non cyclic. Biosynthetic phase, Calvin cycle, C₃ and C₄ pathways. Photorespiration, Crassulacean Acid Metabolism, factors affecting photosynthesis. Law of limiting factors, light, temperature, water, nutrient supply. Leaf factor. Chemosynthesis- a brief account. Essential, non- essential, macro and micro elements, brief account only. **(10 Lectures)**

Unit 3. Plant Growth & Regulation:

Phases of growth, growth curve. Plant growth regulators - Auxins, Gibberillins, Cytokinins Ethylene, Absisic acid - physiological functions only. Senescence - brief account only. **(5 Lectures)**

Unit 4. Photoperiodism And Vernalization :

Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; photoperiodism and biological clocks. Brief account only. **(5 Lectures)**

Unit 5. Stress Physiology:

Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses; mechanisms of resistance to biotic stress and tolerance to abiotic stress **(5 Lectures)**

REFERENCES

1. Bilgrami K.S & Dube - A text book On Modern Plant Pathology. Vikas Publishing House, New Delhi.
2. Develin & Witham - Plant Physiology-C.B.S.Publishers.
3. Fritsch F.E - Structure and reproduction of Algae. Vol 1 and Vol11 Cambridge University Press London.
4. Kumar & Purohith - Plant Physiology. Fundamentals- Agrobios.
5. Kumar. H.D& Singh A.N - A text book on Algae. Chand & Company.
6. Malik C.P & Srivastava.- A text book of Plant Physiology Kalayani Publishing Co. New Delhi.
7. Pandae & Trivedi - A text book of Fungi, Bacteria and Virus Vikas Publishing House New Delhi.
8. Parihar N.S - An introduction to Bryophyta Central Book Depot Allahabad
9. Smith G.M Cryptogamic Botany Vol 11Mc Grae Hill Co. New Delhi.
10. Smith K.M - A text book of Plant diseases S. Chand & Company.
11. Sporne K.R. - Morphology of Pteridophytes.- Hutchins university Library . London.
12. Vashista P.C. - Gymnosperms—S. Chand & Company. New Delhi
13. Vasistha B, - Bryophyta, S. Chand & Company.
14. Willam G. Hopkins. - Introduction to Plant Physiology. John Wiley.
15. Robert A Wallace. Biology, The world of life. Harper Collins

B. Sc. II Biotechnology,**Semester IV,****Paper XXI-GEN****Genetics****Marks 50, (3 Cr)****45 Contact hours****Unit 1. Genes and Mutation**

The enzyme cannot make enzyme paradox, The one gene –one enzyme hypothesis, Bacterial mutants, Temperature sensitive Mutants, Pathway analysis, gene protein relations. **Mutation:** Spontaneous and Induced Mutation. Types of mutations :- point mutations, frameshift mutations, inversion and deletion mutations, null mutation, lethal and conditional lethal mutation. **Mutagenic Suppression:** Reversion of mutation, true reversion, second site suppression. Drug resistant mutants, forward, reverse and suppressor mutations. Scoring of Mutations –Mutation frequencies and mutation rates (Fluctuation test, replica plating), Enrichment of mutant single type, Physical, Chemical and Biological mutagens.

Biological mutable agents: viruses, transposons. In vitro mutagenesis by transposons.

Unit 2. Repair and genetic recombination, complementation

Repair: Base excision repair, Mismatch repair, Photoreactivation, Dark repair, SOS, post replication repair (only at concept level not at molecular level), DNA safeguarding systems. **Genetic Recombination:** Bacterial transformation, bacterial conjugation, bacterial transduction. Phage mutants, the map, mapping pool, heterozygotes, mechanism of recombination, correspondence between genetic map and DNA molecule, **Fine structure analysis;** early evidence that the gene is subdivisible, the *cis-trans* or complementation test for functional allelism, limitations of *cis-trans* test, Fine structure of the phage T4 *rII* locus.

Unit 3. Genetic Code

Amino acid replacements, artificial messenger RNA, the code table, direction of the code, the anticodon and tRNA –structure and classes of tRNA, nonsense codons, nonsense suppression, suppression and anti-suppression at the ribosomal level, intergenic frameshift suppressors, evolution of the code. Wobble pairing, code is degenerate, early evidences of *in vitro* amino acid synthesis, deciphering genetic code, codon usage, codon bias.

Unit 4. Population Genetics

Gene frequencies and Equilibrium; gene frequencies, gene pool, conservation of gene frequencies, attainment of equilibrium at two or more loci, sex linkage. **Estimation of equilibrium frequencies in natural populations;** codominance in natural populations, dominance in natural populations, multiple alleles, mutation rates, selection, fitness, gametic selection, zygotic selection, heterozygous advantage, unstable equilibrium, equilibrium between mutation and selection, estimates of mutation rates and equilibrium frequencies, migration, random genetic drift.

References

1. Genetics, Third edition, by Monroe W. Strickberger, first Indian impression 2006
2. Microbial genetics, by, David Frifelder
3. Molecular Genetics: an introductory narrative, Second edition, by Gunter S. Stent and Richard Calendar, University of California, Berkley, First Indian print 1986, Reprint 2004
4. Principles of Genetics, Eight Edition, by Gardner, Simmons and Snustad, first Indian print 2001, second print 2007.
5. Principles of Genetics by Temin Baltimore
6. Genetics by Wintergreen.

B. Sc.II Biotechnology**Semester IV****Paper XXII-CDG****Central Dogma****Marks 50 (3 Cr)****45 Contact Hours****Unit 1. Perpetuation and its connection with cell division**

Replicon: Definition, types of bacterial replicon, eukaryotic replicon, extrachromosomal replicon –plasmid, virus, mitochondria and chloroplast. Experimental evidences of bidirectional replication.

Replication in Prokaryotes –*Escherichia coli* replication as role model, DNA polymerases –with reference to their functional properties, formation of replication fork, primer formation, replication on leading and lagging strand, termination of replication.

Eukaryotic DNA replication: Origin Recognition Complex, Licensing factor, components of replicase and other polymerases. Replication fork –experimental proof for multiple replication forks in eukaryotes. Process of replication, initiation, elongation and termination.

Replication of extrachromosomal material, plasmid replication –rolling circle, plasmid partitioning, plasmid incompatibility, mitochondrial DNA replication,

Regulation of Replication connection of replication with cell division, segregation. Consequences of mutations in replication assembly, mini-cells and maxi-cells.

Unit 2. Prokaryotic transcription

Transcription in *Escherichia coli* a role model for prokaryotes –RNA polymerase:- structural components and assembly of core and holoenzyme. **Transcription initiation-** Bipartite structure of promoter, factors influencing promoter strength, consensus sequence, sigma mediated recognition of promoter, Formation of open complex, transcription bubble. Promoter clearance, **Transcription elongation** (inchworm mechanism), what are road blocks and regions where polymerase will pause. **Transcription termination** –factor dependent and factor independent terminations. **Antiterminators from bacteria and bacteriophages** – their applications in genetic engineering.

Eukaryotic transcription

RNA polymerases Pol I, Pol II and Pol III –structural components and their roles.

Transcription initiation Promoters, promoter like elements, downstream promoter elements, Up elements, Activators, enhancers. Activation of basal apparatus, pre-initiation and initiation. TAFs, transcription factors,

Transcription elongation specific mechanisms for each type of polymerase.

Transcription termination –processing, formation of 5' Cap, 3' polyadenylation. Splicing, group I intron, spliceosome, nucleoproteins, snRNA, hnRNA, and ribonucleoproteins.

Unit 3. mRNA Translation

Prokaryotic translation –translation initiation, ribosome assembly, RBS –Shine Dalgarno sequence, initiation codon, initiation complex, initiator tRNA, P site, A site and E site –their relevance in translation, translocation,

Translation elongation structural different between initiator tRNA and methionine tRNA during elongation, transpeptidation and chain elongation. Translation fidelity.

Translation termination factors and release of ribosomes and their recycling.

Eukaryotic translation Pre mRNA and mature mRNA –their differences and translocation (–only review). Structural organization of functional ribosome and comparison with *E. coli* apparatus. Cozaks sequence, initiator tRNA, formation of initiation complex, P site, A site and E site, their role during mRNA translation.

Translation elongation comparative studies of elongation with *E. coli*.

Translation termination factors, release of ribosomes and recycling, regulation.

Unit 4 Post translational/co-translational processing for functional aspect

Post translational modification Phosphorylation, Acetylation, Methylation, Glycosylation (introductory only with one popular example).

Protein Trafficking/ transport: types of transport :- cotranslational and post translational transport. Transport apparatus without carrier protein(s), with carrier protein, transport of proteins thru nuclear membrane. Endoplasmic reticulum mediated transport of proteins, need and significance of proteins involved in folding-unfolding of protein during translation, transport and after transport. Roles of chaperons, chaperonin with suitable examples. Protein transport across mitochondria and chloroplast.

References:

1. Molecular Biology –David Frifelder
2. Genes IX –Benjamin Lewin
3. Molecular biology of the gene J. D. Watson and *et. al.*,
4. Molecular Biology of the Cell –Bruce Alberts and *et. al.*,

B.Sc. II Biotechnology**Semester IV****Paper XXIII-AEX****Advanced Enzymology****Marks 50 (3 Cr)****45 contact hours****Unit 1. Extraction & Purification of Enzymes**

Different sources of enzymes, Extraction of soluble enzymes Physical and chemical methods of cell disintegration to obtain enzymes. Extraction of membrane bound enzymes. Preliminary purification of enzymes by various fractionation methods – advanced purification methods : different electrophoresis and chromatographic methods.

Unit 2. Enzyme Kinetics

Effect of pH, temperature, substrate concentration enzyme concentration, reaction time, metal ions on enzyme catalyzed reactions. Kinetics of single substrate enzyme catalyzed reactions (Derivation of Michaelis Mentan Equation and its significance). Transformation of MM plots into Lineweaver Burk plot and Eddle Hofstee plots.

Enzyme inhibitors, Introduction to irreversible and reversible (competitive, uncompetitive and non competitive inhibitions with suitable examples.)

Allosteric enzymes, feed back inhibition and its significance in metabolic regulation. (Sequential and concerted).

Unit 3. Enzyme Immobilizaiton

Importance of enzyme immobilization, different methods of enzyme immobilization. Properties of immobilized enzymes and application of immobilized enzymes.

Unit 4. Applications of Enzymes

Uses of enzymes in food and beverages, textile industries, leather industries and detergents. Enzymes in clinical diagnosis and therapeutic applications. Enzymes as environmental and therapeutic biosensors.

Reference Books

- 1) **Enzymes** – Biochemistry, Biotechnology, Clinical chemistry, 2004 by Trevor Palmer, East – West Press Edition.
- 2) Fundamentals of Enzymology 2003 by Nicholas C. Price and Lewis Stevens Oxford University Press.
- 3) Enzyme kinetics by Paul Engal. 1977, John Willey and Sons Inc.
- 4) Enzymes by Dixon and Web. Acad. Press.
- 5) Principles of enzyme kinetics by Athel Cornish. 1976. Bowden and Butterworth and Co.
- 6) Laboratory manual in Biochemistry by J. Jayaraman. 2006, New Age International.
- 7) Source book of Microbiology by Primrose.

B. Sc. II Biotechnology**Semester IV****Paper XXIV-AIG****Advanced Immunology****Marks 50, (3 cr.)****45 contact hours****Unit 1. Graft and its fate:**

Types of graft, mechanism of graft rejection, prevention of graft rejection. Foetus as graft,

Unit 2. Vaccines

Synthetic vaccines, automatically, hyper-sensitivity, tumor immunity, tissue and organ transplant, idotype network hypothesis, epitope mapping.

Vaccines: Live attenuated, Heat killed with suitable examples (Preparations, standardization and storage) Future developments- Recombinant Vaccines, Vaccines against Alzheimer's disease, Vaccines for AIDS, vaccine for Meningitis C, Super vaccine immunomodulators, vaccine against Cervical Cancer.

3. Fusion on myeloma cell with lymphocytes

Production of monoclonal antibodies. Chimeric antibody, humanized antibody. Methods of preparation, their clinical applications and applications in Research and development. immunodeficiency.

4. Cancer and immunology

Cancer terminology Basic proportion of a cancer cell, the causes of cancer, the genetics of cancer- tumor- Suppressor genes and oncogenes, Tumor antigens, Cancer immunotherapy).

REFERENCE BOOKS

7. Immunology Kuby, R.A. Goldsby, T.J. Kind 1997, 4th Edition B.A. Osborne.
8. Essential of immunology Ivan Riet-Blakswel 1997, 4th Edition B.A. Osborne
9. Fundamentals of Immunology Paul W.E. (Eds.) 1998 Raven press, New York.
10. Text book of Microbiology , Panikar and Anantnarayan 2009
11. General Microbiology by Davis
12. Medical Microbiology by Duguid and Cruikshank.

B.Sc.II Biotechnology

Semester IV

LC X

Cell Biology and plant physiology

Marks-100,(3 Cr)

Section A –Cell Biology

1. Visualization of Chromosomes in mitotic/ meiotic stages in onion root tips / buds.
2. Isolation and confirmation of mitochondria from plant / animal cells.
3. Lipid solubility of membrane
4. Study of osmosis in blood cells
5. Isolation of Chloroplasts from Spinach leaves
6. Study of hill reaction using isolated chloroplast
7. The effect of detergents on the erythrocyte membrane
8. Effect of lipid composition on membrane permeability.

Section B –Plant Physiology

1. Explain with suitable diagrams and working of experiments setup to demonstrate various

physiological phenomena.

- a) Osmosis - Thistle funnel osmoscope.
- b) Effect of stomatal number on rate of transpiration. (Cobalt chloride test)
- c) Effect of root pressure on ascent of sap.
- d) Relation between absorption and transpiration. (Water balance)
- e) Rate of transpiration by Ganong's potometer.
- f) Separation of different photosynthetic pigment using paper chromatography.
- g) Rate of photosynthesis by Wilmot's bubbler.

B. Sc. II Biotechnology,

Semester IV,

LC XI

Genetics and Central Dogma

Marks 100, (3 Cr)

Section A -Genetics

1. Determination of mutation rate
2. Fluctuation analysis
3. Spontaneous mutation –drug resistance phenotype
4. Mutations by UV rays
5. Mutations by chemical agents such as; base analogue, intercalating agents or Alkylating agents.
6. Bacterial transformation
7. Bacterial conjugation
8. Bacterial transduction
9. UV survival curve and Photo and/or Dark repair.

Section B –Central Dogma

1. Demonstration of Mitosis –onion root tips experiment
2. Meiosis slide demonstration (permanent slides)
3. Plasmid DNA isolation
4. Plasmid Curing
5. Isolation of total proteins from bacterial cell.

B.Sc. II Biotechnology

Semester IV

LC XII

Advanced Enzymology and Immunology

Marks 100 (3 Cr)

PRACTICALS

Section A –Advanced Enzymology

1. Production of bacterial / fungal – alpha amylase.
2. Partial purification of – amylase by salt precipitation method.
3. Assay of alpha amylase in terms of reducing sugar produced & calculation of enzyme unit.
4. Extraction of uncase from horse gram seed / jack bean meal & estimation of its activity in terms Ammonia.
5. Extraction of papain form papaya leaves. Estimation of its activity in terms of Ammonia.
6. Characterization of alpha Amylase, invertase using PAGE.

Section B – Advanced Immunology

1. Diagnosis of R.A. by latic agglutination
2. Ames test
3. Visit to serum institute/Immunological institute or laboratory

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