Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore

M.Sc. (Biotechnology)

Semester I

SUBJECT CODE	Category	SUBJECT NAME	TEACHING &EVALUATION SCHEME								
			THEORY			PRACTICAL		Th	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
MSBT101	**DC**	**Biomolecules and Metabolism**	60	20	20	0	0	3	1	0	4

Legends: **L**-Lecture; **T**-Tutorial/Teacher Guided Student Activity; **P**-Practical; **C** - Credit;
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Course Objectives:

1. Conferring basic knowledge about structure and functions of biomolecules
2. Understanding of how enzymes and metabolites in the living system work to synthesize different biomolecules and produce energy.
3. Comprehensive knowledge about biochemical pathways involved in intermediary metabolism and regulation of carbohydrate, protein, lipid, and nucleic acid.

Course Outcomes:

1. An understanding of structural and functional fundamentals of carbohydrate, protein, lipid, and nucleic acid.
2. Understanding of the major metabolic processes in the living system.
3. Understanding the mechanism and the importance of enzymes.

UNIT–I: Chemical composition of living matter. Properties of water and aqueous environment.

Carbohydrates: Stereoisomerisms and classification of monosaccharaides. Di, tri and polysaccharides, their functions in energy storage and cell structure; Glyco-conjugates; glycoproteins, proteoglycans and glycolipids.

Lipids: Structure of fatty acids and complex lipids. Functions of complex lipids as components of membrane and storage molecules; Structure and functions of Terpenes and steroids

UNIT–II: Amino acids: Structure, properties and classification.

Proteins: primary, secondary, tertiary and quaternary structure; Ramchandran plot and Protein folding.

Nucleic acids: Structure and properties of DNA and RNA; A, B and Z form of DNA.

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MSBT101 Biomolecules and Metabolism

UNIT–III: Enzymes – nomenclature and classification. Enzyme kinetics and enzyme inhibition; Regulatory enzymes

Vitamins and co-enzymes: Structure, regulation of biochemical reactions and function of water soluble vitamins; Fat soluble Vitamins A, D, E and K.

UNIT–IV: Glycolysis, citric acid cycle and energy generation; Pentose phosphate pathway and its regulation. Gluconeogenesis, glycogenesis and glycogenolysis, glyoxylate and Gamma aminobutyrate shunt pathways, Cori cycle, Entner-Doudoroff pathway, glucuronate pathway.

Lipid Metabolism: biosynthetic pathway for triacylglycerols, phosphoglycerides, sphingomyelin and prostaglandins. Hydrolysis of triacylglycerols and oxidation of fatty acids. Metabolism of cholesterol and its regulation. Ketone bodies biosynthesis.

UNIT–V: Protein metabolism**:** Synthesis and degradation of amino acids – transamination and deamination reactions. Urea cycle and metabolic disorders; metabolism and regulation of cholesterol; biosynthesis of ketone bodies

BOOKS:

1. David L. Nelson, Michael M. Cox (2021). Lehninger Principles of Biochemistry (8thEd.), W H Freeman & Co.
2. Donald Voet, Judith G. Voet, Charlotte W. Pratt (2018). Voet's Principles of Biochemistry (5th Edi), Wiley.
3. Lubert Stryer, Jeremy M. Berg, John L. Tymoczko , Gregory J. Gatto Jr. (2019) Biochemistry(9th Ed.)– W. H. Freeman & Co.
4. Zubey G. L. Parson. W. W. (1995) Principles of Biochemistry - Brown (William C.) Co, U.S.

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SUBJECT CODE	Category	SUBJECT NAME	TEACHING &EVALUATION SCHEME								
			THEORY			PRACTICAL		Th	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
MSBT102	**DC**	**Microbiology**	60	20	20	0	0	3	0	0	3

Legends: **L**-Lecture; **T**-Tutorial/Teacher Guided Student Activity; **P**-Practical; **C** - Credit;
*__Teacher Assessment__ shall be based following components: Quiz / Assignment / Project / Participation in Class, given that no component shall exceed more than 10 marks.

Course Objectives:

1. Introduction to the field of microbiology to understand the significance and importance of microorganisms.
2. Study of general characters of Prokaryotic and Eukaryotic microorganisms for conventional and molecular characterization using modern methods.
3. Basics of microbial growth, nutrition, methods for control of microbes, gene transfer and host microbe interactions.

Course Outcomes:

1. Classification, diversity and identification of microorganisms
2. Nutritional requirement, culture and control the growth of microorganisms
3. Acquaintance with the diversity of viruses and techniques for their cultivation and identification
4. Analysis of gene transfer mechanism in bacteria and interactions between microbes, hosts and environment.

UNIT–I: History, Microbial Diversity and classification

History of Microbiology and major contributions; Microbial diversity-Structure and general characters and overview of classification of Bacteria, Archaea, Fungi and Algae, Protozoa. Bacterial Classification Systems; Advances in Bacterial Taxonomy using Ribotyping, r-RNA sequencing and fatty acid profiling. Microbial evolution and Physiological Diversity

UNIT–II: Characteristics of Bacteria

Nutritional uptake mechanism in bacteria; Nutritional classes of Bacteria; Culture Media, Microbial Growth; Bacterial Growth Curve; Methods of Measurement; Factors affecting bacterial growth: Temperature, Oxygen, pH, Osmotic concentration, and water activity, Batch and Continuous Culture; Synchronous and Diauxic Growth;

MSBT102 Microbiology

Bacterial genetics: mutation and recombination in bacteria, plasmids, transformation, transduction and conjugation; Operon concept (Lac, Trp, Gal, Ara)

UNIT–III: Virology

Morphology and General Properties of Viruses, Viroids and Prions; Classification of Viruses; Plants and Animals Viruses:Ultra structure and Life Cycle of DNA, RNA and Retroviruses;Bacteriophages – Morphology, Genome Organization and Life Cycle of T4, T7, M13, Lambda Phage; Cultivation of Viruses in-ovo, in-vivo, ex-vivo / in- vitro, in plants and plant cell cultures; Viral identification and Diagnosis

UNIT–IV: Control of Microorganisms

Sterilization; Physical and Chemical Methods for Control of Microorganisms; Biological Control of Microorganisms; Antimicrobial agents and Mechanism of action of Antibacterial, Antiviral and Antifungal drugs; Drug Resistance Mechanism; Combination Antibiotic Therapy; Antibiotic sensitivity testing methods.

UNIT–V: Host-Microbe Interactions

Host-microbe interaction and their types, Role of Quorum sensing

Rhizoshpere and Phyllosphere Microorganisms; Symbiosis in Legumes and Ruminants, Plant Pathogens - Disease Symptoms, Transmission, Mechanism of Pathogenicity; Microbial Control of Insects; Bio-control Agents and Bio-pesticides;

Infectious Diseases in Humans – Mechanism of Pathogenesis; Host-pathogen interaction, Evasion of Host Defenses, Beneficial effects: Human microbiome, prebiotics and probiotics.

BOOKS:

1. Cappuccino, J. G., & Welsh, C. (2016). Microbiology: a Laboratory Manual. Benjamin-Cummings Publishing Company.
2. Collins, C. H., Lyne, P. M., Grange, J. M., & Falkinham III, J. (2004). Collins and Lyne's Microbiological Methods (8th Ed.). Arnolds.
3. Matthai, W., Berg, C. Y., & Black, J. G. (2005). Microbiology, Principles and Explorations. Boston, MA: John Wiley & Sons.
4. Pelczar, M. J., Reid, R. D., & Chan, E. C. (2001). Microbiology (5th Ed.). New York: McGraw-Hill.
5. Tille, P. M., & Forbes, B. A., Bailey & Scott's Diagnostic Microbiology. (2018) 14th Edition.
6. Willey, J. M., Sherwood, L., Woolverton, C. J., Prescott, L. M., & Willey, J. M. (2011). Prescott's Microbiology(8th Ed, New York: McGraw-Hill.

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			THEORY			PRACTICAL		Th	T	P	CREDITS
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MSBT103	**DC**	**Genetics**	60	20	20	0	0	3	0	0	3

Legends: **L**-Lecture; **T**-Tutorial/Teacher Guided Student Activity; **P**-Practical; **C** - Credit;
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Course Objectives:

1. Knowledge of basics in genetics and classical genetics covering prokaryotic/phage genetics to yeast and higher eukaryotic domains.
2. Concepts of Mendelian genetics, population genetics, quantitative genetics encompassing complex traits, clinical genetics and genetics of evolution.
3. Sub-disciplines in genetics and their importance in applied biological sciences.

Course Outcomes:

1. Understanding of fundamental molecular principles of genetics and the relationship between phenotype and genotype.
2. Understanding the basics of genetic mapping and regulation of gene expression.
3. Understanding the importance of genetics in applied biological sciences.

UNIT–I: Fundamentals of Genetics

Mendelian genetics; Laws of segregation in plant crosses; Inbreeding; Selfing; Heterosis; Maintenance of genetic purity; Bacterial genetics: mapping of genes in bacterial and phage chromosomes by classical genetic crosses; Fine structure analysis of a gene; Genetic complementation; *Drosophila* genetics; Monohybrid and di-hybrid crosses, back-crosses, test crosses, analyses of autosomal and sex linkages; Screening of mutations based on phenotypes and mapping of mutations; Hypomorphy; Genetic mosaics; Genetic epistasis; *Arabidopsis* as model organism for genetic studies.

UNIT–II: Chromosome Organization, Linkage and Gene Mapping

Chromosome morphology, classification, karyotyping; Specialised chromosomes-Polytene and Lamp brush chromosomes; Cytological proof of crossing over; Phases of linkage, test cross, recombination frequency, gene mapping, determination of map distances based on two and three point test crosses, coincidence, interference; Genetic mapping and physical

mapping; Cross breeding and pedigree analysis; Molecular markers and marker based genetic linkage maps; Cytogenetic techniques- FISH technique in gene mapping, radiation hybrid maps, sequence tagged site mapping; comparative gene mapping; Genome-wide association study (GWAS) and haplotype mapping; Applications of genetic maps.

UNIT–III: Evolution and Organelle Inheritance

Acquisition of new genes- by gene duplication; Origin of gene families- lateral gene transfer, allopolyploidy; Synthetic genomes and their applications; Non- Mendelian Inheritance; Variegation in leaves of higher plants-*Mirabilusjalapa*; Maternal inheritance- Poky in *Neurospora*, Shell coiling in snail, Leber's Optic Atrophy in human; Uniparental inheritance-mutations in extra-nuclear genes in *Chlamydomonas*; Male sterility in Maize, S-gene in *Nicotiana*.

UNIT–IV: Population Genetics and Genetics of Evolution

Elements of population genetics: genetic variation, genetic drift, neutral evolution; mutation selection, balancing selection; natural selection and adaptation; Fisher's theorem; Hardy-Weinberg equilibrium, Linkage disequilibrium; In-breeding depression and mating systems; Population bottlenecks, migrations, Bayesian statistics; adaptive landscape, spatial variation and genetic fitness.

UNIT–V: Human Genetics

Clinical genetics, diagnostic tools and techniques for human genetic disorder; Genetic approaches to complex genetic diseases- hypertension, diabetes and Alzheimer's disease; Gene mapping in humans – Genetic mapping, discordant sib pairs (DSPs), LOD scores, homozygosity mapping, TDT test.

BOOKS:

1. Gardner, E. J., Simmons,M. J., &Snustad,D. P. (2006). Principles of Genetics.(8th Ed.). John Wiley & Sons.
2. Griffiths, A. J.F.,Doebley, J., Peichel, C., &Wassarman, D. A. (2020). An introduction to Genetic Analysis. (12th Ed.).W.H. Freeman publication.
3. Hartl, D. L., & Jones, E. W. (1998). Genetics: Principles and Analysis. (4th Ed.). Sudbury, MA: Jones and Bartlett.
4. Pierce, B. A. (2020). Genetics: a Conceptual Approach. (7th Ed.). New York: W.H. Freeman.
5. Smith, J. M. (1998). Evolutionary Genetics. (2nd Ed.). Oxford: Oxford University Press.
6. Tamarin, R. H., & Leavitt, R. W. (2004). Principles of Genetics. (7th Ed.). McGraw Hill Education.

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			THEORY			PRACTICAL		Th	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
MSBT104	**DC**	**Molecular Biology**	60	20	20	0	0	3	0	0	3

Legends: **L**-Lecture; **T**-Tutorial/Teacher Guided Student Activity; **P**-Practical; **C** - Credit;
*__Teacher Assessment__ shall be based following components: Quiz / Assignment / Project / Participation in Class, given that no component shall exceed more than 10 marks.

Course Objectives:

1. Study of Genome Organization and its dynamics
2. Study of DNA replication, damage and repair
3. Study of transcription and translation

Course Outcomes:

1. Understanding the basic genetic mechanisms at the molecular level
2. Understanding the molecular mechanism of mutation
3. Understanding the process of transcription and translation

UNIT–I: Genome Organization and Dynamics

Organization of prokaryotic and eukaryotic genome; Chromatin organization and remodeling, Chromosome, Centromere, Telomere; Gene clusters, Gene families, Super-families, Pseudogenes; Genome size and C-value paradox; Cot curve analysis; Repetitive and non-repetitive DNA sequences, Palindromes; Satellite DNA; DNA melting and buoyant density; Cot ½ and Rot ½ values; Organization of mitochondrial genome; Organization of chloroplast genome; Transposable elements of Eukaryotes, SINES and LINES, Retrotransposons; Nucleosome phasing; DNase I hypersensitive sites; DNA methylation and Imprinting.

UNIT–II: DNA Replication, Rearrangements and Recombination

Mechanism of replication of Prokaryotic and Eukaryotic DNA; DNA polymerases; Telomere synthesis-telomerases; Replication of viral DNA, rolling circle model; Inhibitors of replication; Complete and segmental duplication of genomes; Insertion, Deletion and Translocation of sequences; Homologous Recombination and Site-specific Recombination; Models for homologous recombination- Holliday junction, Non-homologous End Joining, Proteins involved in recombination- RecA, RuvA, B, C; Molecular mechanisms of gene conversion.

MSBT104 Molecular Biology

UNIT–III: DNA Damage, Repair and Mutations

DNA damage- alkylation, deamination, oxidation, UV radiation; Repair mechanisms- photo-reactivation, nucleotide excision repair, post-replication repair, mismatch repair and SOS repair; Spontaneous and Induced mutations- Physical and Chemical mutagenesis; Molecular mechanisms of mutagenesis- Transition, Transversion, Frame Shift, Mis-sense and Non-sense mutations.

UNIT–IV: DNA Transcription in Prokaryotes and Eukaryotes

Mechanism of transcription in prokaryotes- initiation, elongation, termination; Mechanism of transcription in eukaryotes; Eukaryotic RNA polymerases; Transcription factors, DNA binding motifs of transcription factors; Transcription activators- zinc fingerprints; Homeodomain; *cis*-control elements, Promoters, Enhancers and Mediators; Post transcriptional modifications of mRNA- Capping, polyadenylation, splicing mechanism-alternate splicing, trans splicing, self-splicing, tRNA splicing, spliceosome assembly, splicing editing, Group IV splicing, Processing of tRNA and rRNA; Inhibitors of transcription; Transcriptional and post transcriptional gene silencing, RNAi pathway (siRNA and miRNA).

UNIT–V: Genetic Code and Translation

Correspondence of amino acid sequence in proteins; Properties of genetic code- universal code, degeneracy and redundancy, Wobble hypothesis; Mechanism of translation, assembly of ribosomal subunits, t-RNA structure; Mechanism of initiation, elongation and termination; Co- and post-translational modifications- Antisense RNA, Heme and interferon; Mitochondrial genetic code translation product cleavage, modification and activation.

BOOKS:

1. Alberts, B., Johnson, A. D., Lewis, J.,Morgan D., Raff, M., Roberts, K., & Walter, P. (2015). Molecular Biology of the Cell. (6th Ed.). New York: Garland Science.
2. Brown, T. A. (2017). Genomes 4. (4th Ed.). Wiley Publishers (Asia Pvt Ltd).
3. Freifelder, D. (2012). Molecular Biology. (5th Ed.). Narosa Publishing House, India.
4. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2017). Lewin's Genes XII. (12th Ed.). Jones and Barlett Inc. USA.
5. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Martin, K. C., & Yaffe, M. (2021). Molecular Cell Biology. (9th Ed.). New York: W.H. Freeman.
6. Stryer, L., Berg, J., Tymoczko, J., & Gatto, G. (2019). Biochemistry. (9th Ed.). W.H.Freeman, USA.
7. Watson, J. D., Losick, R., Levine, M., Gann, A., Baker, T. A., & Bell, S. P. (2013). Molecular Biology of the Gene. (7th Ed.). Pearson Education.The Benjamin/ Cummings Publishing Company, New York, USA.

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MSBT105	**DC**	**Cell and Cell Signaling**	60	20	20	0	0	3	0	0	3

Legends: **L**-Lecture; **T**-Tutorial/Teacher Guided Student Activity; **P**-Practical; **C** - Credit;
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Course Objectives:

1. Study of cell structure and organization
2. Study of cell communication
3. Basics of cancer biology

Course Outcomes:

1. Understanding the structure and functions of basic components of prokaryotic and eukaryotic cells
2. Understanding the mechanism of cell signaling
3. Understanding the basics of cancer biology

UNIT–I: Internal Organization of Cell

Basic concept of cells, chemical organization of cells; internal organization and compartmentalization of the eukaryotic cell: Cytosol, mitochondria, chloroplast, endoplasmic reticulum, peroxisome, lysosomes, endosomes.

Membrane structure and transport – lipid bi layer and membrane proteins, Electric properties of membrane (Nerve impulses), Transport across membranes – active transport, ionic gradient, career proteins, Na+ Ka+ pump, ATPase, ABC transportors, Ion channels, Multi drug resistant efflux forms. Intra-cellular transport (vesicular and membrane transport) at molecular level: transport of molecules between the Nucleus and the Cytosol, Transport of Proteins into Mitochondria, Chloroplasts, Peroxisomes, Endoplasmic Reticulum. Vesicular Traffic in the Secretary and Endocytic Pathway, Transport from ER through the Golgi apparatus, Transport from the Trans Golgi network.

MSBT105 Cell and Cell Signaling

UNIT–II: Cell Communication

Overview of extracellular signaling, Basic concepts of Paracrine, endocrine, autocrinesignaling, Extracellular matrix and cell junctions. Signaling at cell surface: second messengers cAMP, lipid derived second messengers, calcium, IP3 and their role in signal transduction. Cell surface receptors in signal transduction: G-protein coupled receptor, Ion channel receptors, Tyrosine kinase linked receptors, Receptors with intrinsic enzyme activity (RTK). Interaction and regulation of cell signaling pathways

UNIT–III:Cellular Processes

Cell cycle and its regulation; role of Cyclins, CDKs and checkpoints in cell cycle. Cell division: mitosis, meiosis and cytokinesis; Role of cytoskeletal elements, motor proteins, cohesins and condensins in cell division. Cell differentiation: stem cells, their differentiation into different cell types and organization into specialized tissues; cell-ECM and cell-cell interactions; cell motility and migration. Cell death: introduction to different modes of cell death Necrosis, Senescence, Apoptosis - Programmed cell death. Mechanisms of apoptosis (extrinsic and intrinsic pathways) and regulation of apoptosis.

UNIT–IV: Cancer Biology

Mutations, proto-oncogenes, oncogenes and tumor suppressor genes, physical, chemical and biological carcinogens; types of mutations: intra-genic and inter-genic suppression; viral and cellular oncogenes; different tumor suppressor genes; function and mechanism of action; activation and suppression of tumor suppressor genes; oncogenes as transcriptional activators. Role of telomeres in cellular immortalization and tumorigenesis

UNIT–V: Modern Methods for the Study of Cell

FRAP, scanning calorimetry, PAS reaction, Enhanced Chemiluminescence (ECL), freeze-etching, freeze- fracturing. Hydrophobicity plot, Flow cytometry, FACS, Lab on Chip and Organ on chip concept

BOOKS:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). Molecular Biology of the Cell (6th Ed.). New York: Garland Science.
2. Cooper, G. M., & Hausman, R. E. (2013). The Cell: a Molecular Approach (6th Ed.). Washington: ASM ; Sunderland.
3. Gerald Karp, Cell Biology, 7th edition, (2014) . John Wiley & Sons., USA.
4. Lodish, H. F. (2021). Molecular Cell Biology (9th Ed.). New York: W.H. Freeman.

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MSBTL106	**DC**	**Biomolecules and Microbiology Laboratory**	0	0	0	30	20	0	0	8	4

Legends: **L**-Lecture; **T**-Tutorial/Teacher Guided Student Activity; **P**-Practical; **C** - Credit;
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PRACTICAL [Biomolecules + Microbiology]

1. SDS-PAGE
2. Enzymology – purification of enzyme & its kinetics
3. Absorption spectroscopy
4. Chromatographic techniques – Gel filtration, ion exchange, affinity chromatography
5. Determination of albumin and A / G ratio in serum.
6. The validity of Beer's law for colorimetric estimation of creatinine.
7. Estimation of blood glucose by Nelson-Somogyi and Orthotoluidine method.
8. Estimation of glycogen and urea.
9. Determination of absorption maxima of hemoglobin.
10. Absorption spectrum of NAD and NADH
11. Estimation (quantitative and qualitative) of DNA and RNA

PRACTICAL [Microbiology]

1. Isolation and characterization of microorganisms from extreme environments
2. Determination of bacterial growth rate and factors influencing it
3. Sterilization, disinfection and safety in microbiological laboratory
4. Preparation of media for cultivation of bacteria
5. Study of colony and growth characteristics of some common bacteria: *Bacillus, E. coli, Staphylococcus, Streptococcus*, etc.
6. Preparation of bacterial smear and Gram's staining.
7. Enumeration of bacteria: standard plate count.
8. Antimicrobial sensitivity test and demonstration of drug resistance
9. Maintenance of stock cultures: slants, stabs and glycerol stock cultures
10. Determination of phenol co-efficient of antimicrobial agents
11. Determination of Minimum Inhibitory Concentration (MIC)
12. Isolation of Bacteriophages
13. Study of colony and growth characteristics of some common fungi: *Penicillium, Rhizopus, Mucor, Aspergillus sp.*

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MSBTL107	DC	Genetics, Molecular Biology and Cell Signaling Laboratory	0	0	0	30	20	0	0	8	4

Legends: **L**-Lecture; **T**-Tutorial/Teacher Guided Student Activity; **P**-Practical; **C** - Credit; ***Teacher Assessment** shall be based following components: Quiz / Assignment / Project / Participation in Class, given that no component shall exceed more than 10 marks.

PRACTICAL II [Genetics + Molecular Biology + Cell and Cell Signaling]

1. Solving problems on monohybrid and dihybrid ratios, multiple alleles, epistasis.
2. Solving problems on quantitative inheritance.
3. Inheritance patterns in human – Pedigree analysis.
4. Solving problems on localization of genes – two & three point test crosses
5. Solving problems on localisation of genes in man by sib pair method &Lod score estimations.
6. Solving problems on gene mapping by Transmission Disequilibrium Test (TDT).

PRACTICAL [Molecular Biology]

1. Isolation of plasmid DNA.
2. Isolation of DNA from plant cells.
3. Isolation of DNA from human whole blood.
4. Determination of purity and concentration of DNA - Spectrophotometric method.
5. Determining melting temperature of DNA.
6. Reassociation kinetics and estimation of cot values, construction of cot curves.
7. Isolation of mRNA and analysis by agarose gel.
8. Induction of mutations by chemical agents.
9. Determination of DNA damage by comet assay.

PRACTICAL [Cell and Cell Signaling]

1. Mitosis and the Cell Cycle in Onion Root-Tip Cells
2. Cell Counting and viability
3. Blood Smear Preparation and visualization of different types of blood cells
4. Buccal smear – Identification of Barr Body
5. Isolation of chloroplast from plant cells
6. Isolation of Mitochondria
7. Histological slides
8. Isolation of PBMC's

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