B. Voc. Molecular Diagnostics

(B. Voc. - MDS)

(Syllabus)

w. e. f. Academic Session 2026-2027

DDU KAUSHAL Kendra

Jamia Millia Islamia

New Delhi-110025

B.VOC. Molecular diagnostics (B.VOC. MDS)
Duration: Three Years (6 semesters)

Molecular diagnostics is a specialized branch of laboratory and clinical medicine focused on the detection and monitoring of inherited and acquired chromosomal abnormalities, DNA variations, and infectious diseases. Professionals in this field possess advanced expertise in areas such as cell culture, metaphase chromosome preparation and staining, microscopic and microarray-based chromosomal analysis, nucleic acid extraction and quantification, as well as hybridization, amplification, and sequencing techniques for identifying genetic variants. All laboratory and clinical procedures are conducted with strict adherence to patient and family privacy and confidentiality.

Molecular diagnostics is the fastest-growing segment of laboratory testing. Precision diagnostics and therapies made possible by the Human Genome Project are revolutionizing healthcare and making new approaches to the detection and treatment of complex diseases possible

DDU KAUSHAL Kendra is committed to providing the resources and infrastructure required to effectively operate and sustain the B. Voc specialization in Molecular Diagnostics. This program follows a comprehensive, practice-oriented curriculum delivered over three years of full-time study, culminating in a B. Voc degree in Molecular Diagnostics. The program includes extensive hands-on clinical laboratory training, followed by a one-semester (6th semester) clinical training accompanied by a capstone project.

Students are expected to achieve proficiency across all essential domains of cytogenetics and molecular testing, including the principles and techniques of karyotyping, genomic microarray testing and data interpretation, quantitative PCR, massively parallel sequencing, variant analysis, and quality management systems.

Sem.	S. No	Paper Code	Paper Name	Total Hrs	Credit	IA	SE	Total
1	**Knowledge Components**							
	1	MDS 101	Human Anatomy	42	3	40	60	100
	2	MDS 102	Human Physiology	42	3	40	60	100
	3	MDS 103	Biochemistry	42	3	40	60	100
	4	MDS 104	Cell and Molecular Biology	42	3	40	60	100
	Skill Components							
	5	MDS 105	Information Technology	42	3	40	60	100
	6	MDS 106	Communication Skill and Professional Ethics	42	3	40	60	100
	7	MDS 107P	Practical I (MDS101, MDS 102)	168	6	40	60	100
	8	MDS 108P	Practical II (MDS 103, MDS 104)	168	6	40	60	100
			Total	**588**	**30**	**320**	**480**	**800**
II								
	S. No	**Paper Code**	**Paper Name**	**Total Hrs**	**Credit**	**IA**	**SE**	**Total**
	Knowledge Components							
	1	MDS 201	Infectious Disease Biology	42	3	40	60	100
	2	MDS 202	Metabolic and Inherited Diseases	42	3	40	60	100
	3	MDS 203	Immunology & Autoimmune Diseases	42	3	40	60	100
	4	MDS 204	Genetics and Genomics	42	3	40	60	100
	Skill Components							
	5	MDS 205	Statistical Methods in Diagnostics	42	3	40	60	100
	6	MDS 206P	Practical III (MDS 201, MDS 205)	168	6	40	60	100
	7	MDS 207P	Practical IV (MDS 202, MDS 203)	168	6	40	60	100
	8	MDS 208P	Practical V (MDS204)	84	3	20	30	50
			Total	**630**	**30**	**300**	**450**	**750**

Sem.	S. No	Paper Code	Paper Name	Total Hrs	Credit	IA	SE	Total
3	**Knowledge Components**							
	1	MDS 301	Liquid Biopsy and Circulating Biomarkers	42	3	40	60	100
	2	MDS 302	Analytical Biochemistry	42	3	40	60	100
	3	MDS 303	Cytogenetics	42	3	40	60	100
	4	MDS 304	Biomedical Imaging	42	3	40	60	100
	Skill Components							
	5	MDS 305	Omics Technologies in Molecular Diagnostics	42	3	40	60	100
	6	MDS 306P	Practical VI (MDS 301)	84	3	20	30	50
	7	MDS 307P	Practical VII (MDS 302)	84	3	20	30	50
	8	MDS 308P	Practical VIII (MDS 303)	84	3	20	30	50
			Total	**462**	**24**	**260**	**390**	**650**

4	**S. No**	**Paper Code**	**Paper Name**	**Total Hrs**	**Credit**	**IA**	**SE**	**Total**
	Knowledge Components							
	1	MDS 401	Molecular diagnosis of Infectious diseases	42	3	40	60	100
	2	MDS 402	Molecular diagnosis of Cancer	42	3	40	60	100
	3	MDS 403	Advanced Sequencing Techniques	42	3	40	60	100
	4	MDS 404	Cardiovascular and Neurological diseases	42	3	40	60	100
	Skill Components							
	5	MDS 405	Data Analysis and Quality Assurance	42	3	40	60	100
	6	MDS 406P	Practical IX (MDS 401, MDS 402)	168	6	40	60	100
	7	MDS 407P	Practical X (MDS 403, and MDS 404)	168	6	40	60	100
			Total	**546**	**27**	**280**	**420**	**700**

Sem.	**S. No**	**Paper Code**	**Paper Name**	**Total Hrs**	**Credit**	**IA**	**SE**	**Total**
5	**Knowledge Components**							
	1	MDS 501	Emerging Molecular Techniques	42	3	40	60	100
	2	MDS 502	Clinical Molecular Pathology	42	3	40	60	100
	3	MDS 503	Immunological Methods in Diagnostics	42	3	40	60	100
	4	MDS 504	Molecular diagnostics of Genetic and rare diseases	42	3	40	60	100
	Skill Components							40
	5	MDS 505	Genetic Counselling	42	3	40	60	100
	6	MDS 506P	Practical XI (MDS 501, MDS 502)	168	6	40	60	100
	7	MDS 507P	Practical XII (MDS 503, MDS 504)	168	6	40	60	100
			Total	**546**	**27**	**280**	**420**	**700**
6	**S. No**	**Paper Code**	**Paper Name**	**Total Hrs**	**Credit**	**IA**	**SE**	**Total**
	Skill Components							
	2	MDS 601P	Clinical Training & Internship	616	22	---	400	400
			Total	**616**	**22**	**--**	**400**	**400**
			Grand total (semester I-VI)	**3388**	**160**	**1440**	**2560**	**4000**

Total skill Component Credits in all (I-VI) semesters : **100 Credits**

Total knowledge Component Credits in all (I-VI)semesters: **60 Credits**

Total Credits (I-VI semesters) = **160**

Total Marks (I-VI)semesters = **4000**

Total Hours (I-VI) semesters = **3388** (Skill Components **2548** Hrs & Knowledge Components **840** Hrs.

Semester–I						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 101	Human Anatomy	42	3	40	60	100

Unit I: General Anatomy & Musculoskeletal System

Anatomical terms, planes, positions, and body organization, Tissues: definition, classification characteristics, locations, and functions. Skeletal system: Types and structure of bones, Axial and appendicular skeleton, Bone formation and growth; Joints: classification and structural types. Muscular system: Types of muscles, Muscle structure, Basic movements at joints and muscles producing movement.

Unit II: Nervous System & Special Senses

Neurons and neuroglia: structure and classification, Central Nervous System (CNS): brain and spinal cord (gross structure and functions), Peripheral Nervous System (PNS): cranial & spinal nerves, Autonomic Nervous System (ANS): sympathetic & parasympathetic divisions Special senses: Eye, ear, nose; Auditory and olfactory apparatus; Structure of skin.

Unit III: Cardiovascular & Lymphatic Systems

Heart: External and internal structure, chambers, valves, cardiac cycle, functions. Blood Vessels: Arteries, veins, capillaries – structure and functions. Arterial System: Types of arteries, major arteries, functional significance. Venous System: Types of veins, major veins, valves and venous return. Lymphatic System: Lymph, lymphatic vessels, lymph nodes, functions. Lymphoid Tissue: Types of lymphoid organs, microscopic structure of lymph nodes.

Unit IV: Respiratory & Digestive Systems

Respiratory System: Parts of the respiratory tract, Nasal cavity & paranasal air sinuses, Trachea: structure, Lungs: gross and microscopic structure, Diaphragm and pleura Digestive System**:** Parts of digestive system, Structure of tongue & salivary glands, Stomach, intestines, Liver and pancreas.

Unit V: Urinary, Reproductive & Endocrine Systems

Urinary System: Kidney: gross structure and nephron basics; Ureters, urinary bladder and urethra Reproductive System: Gross structure of male reproductive organs, Gross structure of female reproductive organs. Endocrine System**:** Pituitary, thyroid, parathyroid, Pancreas (endocrine part), and Adrenal glands.

Suggested Reading:

1. Chaurasia, B. D. (2024). Human anatomy (Vols. 1–4, 10th ed.). CBS Publishers.
2. Drake, R. L., Vogl, A. W., & Mitchell, A. W. M. (2020). Gray's anatomy for students (42nd ed.). Elsevier.
3. Hamilton, W. J. (n.d.). Textbook of anatomy.
4. Ross, T., & Wilson, A. (2022). Anatomy and physiology in health and illness (14th ed.). Elsevier.

Semester–I						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 102	Human Physiology	42	3	40	60	100

Unit I: Blood, Homeostasis & Introductory Physiology Concepts

Composition and functions of blood, plasma constituents, and morphological features of blood cells. Haematopoiesis, structure and abnormalities of haemoglobin, physiological and pathological types of anaemia, and mechanisms of haemostasis. Introduction to the concept of homeostasis, internal environment, negative and positive feedback mechanisms, and their relevance in physiological regulation. Brief overview of body fluid compartments, distribution of electrolytes, osmolarity, tonicity, and significance of fluid balance.

Unit II: Nerve and Muscle Physiology

Structure and functional properties of neurons and neuroglial cells, resting membrane potential, action potential, and impulse propagation. Excitability, conductivity, all-or-none law, accommodation, adaptation, summation, refractory periods, and fatigability. Neuromuscular junction structure and synaptic transmission. Microscopic and ultrastructural organization of skeletal, smooth, and cardiac muscle. Single-unit and multi-unit smooth muscle, muscle proteins, properties of skeletal muscle, and mechanisms of contraction and relaxation in skeletal and smooth muscles.

Unit III: Cardiovascular and Respiratory Systems

Properties of cardiac muscle, origin and propagation of cardiac impulse, conduction system of the heart, cardiac cycle, and heart sounds. Regulation of cardiac output and blood pressure (short-term and long-term mechanisms). Respiratory muscles, respiratory volumes and capacities, diffusion and transport of oxygen and carbon dioxide, regulation of respiration, types of hypoxia, cyanosis, asphyxia, anatomical and physiological dead space, oxygen and myoglobin dissociation curves and their modifying factors, and factors affecting the carbon dioxide dissociation curve.

Unit IV: Digestive System

Functions of the alimentary canal, physiology of deglutition, movements of the gastrointestinal tract, composition, secretion, and functions of salivary, gastric, pancreatic, intestinal juices, and bile. Mechanisms of digestion and absorption of carbohydrates, lipids, proteins, and nucleic acids. Physiology of hunger, satiety, and gut hormones. Defecation reflex and associated regulation.

Unit V: Excretory and Reproductive Systems

Structure and functions of the kidneys, components of the nephron, measurement and regulation of glomerular filtration rate, renal blood flow regulation, renin–angiotensin system, mechanisms of urine formation, and renal clearance tests. Acid–base balance and its physiological regulation. Functions of ovaries, sex hormones, menstrual cycle, ovulation, pregnancy, parturition, and lactation. Contraceptive methods and their physiological basis. Male reproductive physiology including testosterone regulation and spermatogenesis.

Suggested Reading:

1. Ghai, C. L. A textbook of practical physiology. Jaypee Brothers Medical Publishers.
2. Guyton, A. C., & Hall, J. E. Textbook of medical physiology. Elsevier.
3. Harrison, T. R. Harrison's principles of internal medicine. McGraw Hill.
4. Jain, A. K. Textbook of physiology. Arya Publications.
5. Khurana, I. Medical physiology. Elsevier.
6. William, F., & Ganong, W. B. Review of medical physiology. McGraw Hill.

Semester–I						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 103	Biochemistry	42	3	40	60	100

Unit I: Carbohydrates, and its Biological Oxidation
Definition, structure, classification, and biological functions of carbohydrates. Carbohydrate metabolism: Glycolysis, Catabolic fates of pyruvate, Formation and metabolic fate of acetyl-CoA, Citric acid (TCA) cycle, Gluconeogenesis, Glycogen metabolism (glycogenesis and glycogenolysis), Pentose phosphate pathway, Electron transport chain and oxidative phosphorylation.

Unit II: Proteins and Protein Metabolism
Amino Acids and Proteins: Structure and classification of amino acids, Structural organization of proteins (primary, secondary, tertiary, and quaternary structures), Structure–function relationships in proteins. Plasma Proteins: Major classes of plasma proteins, Synthesis and functions of plasma proteins, Separation and estimation of plasma proteins, Anticoagulants, Aseptic separation of serum and plasma, Protein Metabolism, Non-protein nitrogenous compounds, Urea and Blood Urea Nitrogen (BUN): Creatine and creatinine: synthesis, clinical significance, and estimation, Uric acid: synthesis, clinical significance, and estimation, Ammonia metabolism, Porphyrins and porphyrin metabolism

Unit III: Lipids and metabolic integration
Lipids: Definition, structure, classification, and biological functions of lipids, Fatty acids: structure and classification, Triacylglycerols (triglycerides or neutral fats). Lipid Metabolism: Fatty acid synthesis and β-oxidation, Ketone body metabolism, Metabolic Integration, Integration of carbohydrate, lipid, and protein metabolism, Metabolic adaptations during fed state, fasting, and starvation, Phases of starvation, Metabolic changes in diabetes mellitus

Unit IV: Vitamins, Minerals, and Nutrition
Vitamins: Classification and functions of vitamins, Deficiency disorders, Nutrition, Balanced diet and its nutritional importance, Calorific value of foods, Basal Metabolic Rate (BMR), Protein-energy malnutrition: Kwashiorkor and Marasmus, Minerals and Bone Metabolism, Classification of minerals, Metabolism of calcium, phosphorus, and sulphur, Disorders associated with abnormal calcium and phosphorus metabolism, Metabolism of trace elements, Bone metabolism and markers of bone turnover

Unit V: Nucleic Acids and Enzymes
Structure of nucleotide bases, nucleosides, and nucleotides, Structure and functions of DNA and RNA, Biosynthesis and degradation of nucleic acids, De novo and salvage pathways of nucleotide synthesis. Enzymes: Basic concepts, roles, and classification of enzymes, Types of enzymes, coenzymes, and isoenzymes, Properties and mechanisms of enzyme action, Factors affecting enzyme activity, Measurement of enzyme activity, Enzyme assays and enzyme kinetics, Diagnostic significance of enzymes

Suggested readings:

1. Berg, J. M., Tymoczko, J. L., Gatto Jr., G. J., &Stryer, L. (2023). Biochemistry (10th ed.). W.H. Freeman and Company; Macmillan Learning.
2. Lieberman, M. A., & Peet, A. (2025). Mark's basic medical biochemistry: A clinical approach (7th ed.). Wolters Kluwer Health.
3. Nelson, D. L., Cox, M. M., & Hoskins, A. A. (2021). Lehninger principles of biochemistry (8th ed.). W. H. Freeman and Company; Macmillan Learning.
4. Satyanarayana, U., & Chakrapani, U. (2022). Biochemistry (5th ed., updated & revised). Elsevier India.

Semester–I						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 104	Cell and Molecular Biology	42	3	40	60	100

Unit I: The Cell – Structure and Basic Organization

Cell as a basic unit of life, discovery of the cell, comparison of prokaryotic and eukaryotic cells, unicellular and multicellular organisms, microscopic study of the cell (compound microscope, electron microscope, cell fractionation), ultrastructure of cells, cell wall and plasma membrane (unit membrane concept, fluid mosaic model), membrane transport (passive diffusion, facilitated diffusion, active transport), and cellular movement (exocytosis, endocytosis).

Unit II: Organelles of Cells and Their Functions

Structure and function of Nucleus, Mitochondria, Plastids, Endoplasmic Reticulum, Golgi Complex, Lysosomes, Centrosome, Mesosomes, Vacuole, Cytoskeleton (microtubules, microfilaments, intermediate filaments), cilia, flagella, and ribosomes.

Unit III: Cell Cycle, Division, and Cell Death

Phases of the cell cycle, regulation of cell cycle progression, cell cycle checkpoints, mitosis and meiosis (events of mitotic and meiotic phases), non-disjunction, fertilization, programmed cell death (apoptosis and necrosis), cell senescence and aging, stem cells (embryonic, tissue, and induced pluripotent stem cells), cloning (reproductive and therapeutic), and a basic introduction to the biology of cancer cells and oncogenesis.

Unit IV: Organization of the Genome

Molecular composition of nucleic acids, structure of DNA, structure of RNA, chromosome structure, nucleosome and chromatin organization, euchromatin and heterochromatin, structure of gene, operons and gene clusters, exons and introns, genome size and complexity, repetitive DNA sequences, satellite DNA, minisatellites, microsatellites, transposable elements, mitochondrial genome, plastid genome in microbes, central pathway for transfer of genetic information, and genomic variation including SNPs, VNTRs, and structural variants.

Unit V: Transcription, Translation, and Genetic Regulation

Central dogma, DNA replication, replication enzymes, replication errors, transcription of DNA to RNA, RNA polymerases, transcription factors, promoters and enhancers, translation machinery, genetic code, regulation of gene expression, transcriptional control, epigenetic regulation (DNA methylation, histone modification, imprinting), operon concept, DNA mutations (point mutations, frameshift mutations, silent/missense/nonsense mutations), mutagens, and DNA repair mechanisms including base excision repair, nucleotide excision repair, mismatch repair, double-strand break repair, and SOS repair.

Suggested readings:

1. Alberts, B., Johnson, A. D., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2022). *Molecular biology of the cell* (7th ed.). W. W. Norton & Company.
2. Rastogi, S. C. (2023). Cell biology (5th ed.). New Age International Private Limited.
3. Chaudhary, K. Molecular biology: Fundamental processes.
4. Chaudhary, M. R. Laboratory manual for molecular genetic tests. Jaypee Brothers

Semester–I						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 105	Information Technologies	42	3	40	60	100

UNIT I: Fundamentals of Computers and Operating Systems

Fundamentals of Computers: Definition, characteristics, advantages, limitations, and applications of computers, History and generations of computers, Block diagram of a computer system, Input and output devices, Central Processing Unit: ALU, Control Unit, Memory devices: Primary and secondary memory, Types of Computers. Computer hardware components, Software: System software and application software. Operating Systems: Definition, architecture, functions, and services of operating systems. Introduction to MS Windows and basic commands.

UNIT II: Number Systems, Data Processing, and Programming Concepts

Number Systems: Non-positional and positional number systems, Binary, octal, decimal, and hexadecimal number systems, Conversion between number systems, Fractional number conversion. Data and Information: Concepts and differences, Qualities of good information, Data processing cycle, Types of data processing, Data processing systems, Data Storage Systems. Programming Fundamentals: Introduction to programming concepts. Problem-solving techniques, Algorithms and Flowcharts

UNIT III: Computer Networks, Internet, and Web Technologies

Computer Networks: Basics of computer networks, Types of networks: LAN, MAN, WAN, Network topologies, Networking devices, Network services. Internet and Web Concepts: Definition and brief history of the Internet: WWW, web page, website, URL, IP, HTML, HTTP, TCP/IP, search engine. Cyber Security: Introduction to cyber security, Types of cyber threats, Malware, viruses, and firewalls, Applications of IT in healthcare system.

UNIT IV: Office Automation, Creative Tools, and Data Management

Microsoft Office tools: document formatting, tables, graphics, SmartArt, hyperlinks, and proofreading features. MS Excel: formulas, functions, data formatting, sorting, filtering, charts, and data management. MS PowerPoint: slide design, transitions, animations, and SmartArt. Adobe Photoshop: photo editing, graphic design, and digital illustration. Basic training in data and biological analysis tools: GraphPad Prism, SigmaPlot, and MedCalc.

UNIT V: Data Structures, DBMS, and Artificial Intelligence

Data Structures and File Management: Introduction to data structures. Arrays and strings, Stacks and queues, File organization and management concepts, Types of files. Introduction to Artificial Intelligence: Definition, history, scope, and applications, Intelligent systems and characteristics of AI, Branches of AI, Introduction to Machine Learning, Relationship between AI, ML, and Deep Learning, Types of Machine Learning, Introduction to neural networks and deep learning, Tools and platforms for AI and ML, Ethical issues and social impact of AI, Biological and Data Analysis Software.

Suggested readings:

1. Sinha, P. K., & Sinha, P. (2022). Foundations of Computing: Essential for Computing Studies, Profession and Entrance Examinations. BPB Publications.
2. Balagurusamy, E. (2009). Fundamentals of Computers. McGraw-Hill Education.

Semester–I						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 106	Communication skills and Professional Ethics	42	3	40	60	100

Unit I: Basic Grammar and Structure

Nouns, Pronouns, Adjectives, Adverbs, Verbs (Transitive/Intransitive), Tenses, Sentence Structure: Simple, Compound, and Complex sentences. Active and Passive Voice, Verb agreement, Identifying and correcting common errors in English usage.

Unit II: Vocabulary for the Medical and Scientific Context

Medical Terminology: Definition, importance, word formation, usage in clinical and laboratory settings. Prefixes, Suffixes, and Root Words: Common medical prefixes, suffixes, and roots; combining forms and meanings. Scientific Jargon: Common scientific and laboratory terms, abbreviations, and symbols used in MLS Synonyms and Antonyms: Common medical Synonyms and antonyms for accurate interpretation and reporting. Formal vs. Informal Language: Use of formal medical language in documentation, reports, and professional communication.

Unit III: Reading Comprehension and Interpretation

Comprehension of Technical Texts: Reading strategies for medical and laboratory-related texts.
Scientific Articles: Structure of research papers, interpretation of data, tables, and graphs. Standard Operating Procedures (SOPs): Reading, understanding, and following laboratory SOPs. Research Abstracts: Identification of objectives, methodology, results, and conclusions. Critical Interpretation: Extracting relevant information for clinical and laboratory decision-making.

Unit IV: Formal Correspondence and presentations

Letters and Applications, Letter to the Editor. Professional letter: sales, enquiry, order, complaints and other. Applications for jobs and higher studies: cover letter/ resume/ CV, Structuring a presentation (Introduction, Body, Conclusion) on a technical/scientific topic, speech, extempore, group discussions, Interview, dialogue session. Note-taking/Summary, paraphrasing, briefs of medical assages, E-mail writing, avoiding plagiarism and proper citation of sources.

Unit V: Oral Communication and workplace communication

Pronunciation Practice: Word Accent, Stress, and Intonation, Active listening skills, overcoming communication barriers, and comprehending diverse accents (essential for client/patient interaction). Non-Verbal Communication: Body language, eye contact, gestures, and professional appearance.

Suggested Readings:

1. Chabner, D. E. (2020). The language of medicine (12th ed.). Elsevier.
2. Sharma, R. C., & Mohan, K. (2018). Business correspondence and report writing (6th ed.). Tata McGraw-Hill Publishing Company Limited.
3. Tiwari, A. (2021). Communication skills in English. Khanna Book Publishing Co. Pvt. Ltd.
4. Wren, P. C. (2022). High school English grammar and composition. S. Chand Publishing.
5. Part, A. (2009). English and business communication. S. Chand Publishing.

Semester–I						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 107P	Practical I (MDS 101, MDS 102)	168	6	40	60	100

Human Anatomy:

1. Demonstration of major human tissues through permanent slides.
2. Demonstration of human skeletal system.
3. Demonstration of various joints in the human body.
4. Demonstration of parts of circulatory system through charts and models.
5. Demonstration of parts of respiratory system through charts and models.
6. Demonstration of parts of nervous system through charts and models.
7. Demonstration of parts of eye and ear through charts and models.
8. Demonstration of parts of digestive system through charts and models.
9. Demonstration of parts of urinogenital system through charts and models.

Human Physiology:

1. To estimate the haemoglobin concentration in blood.
2. To determine the total red blood cell (RBC) count.
3. To determine the total white blood cell (WBC) count.
4. To determine bleeding time and clotting time.
5. To determine the blood group of the individual.
6. To measure arterial blood pressure.

Semester–I						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 108P	Practical II (MDS 103, MDS 104)	168	6	40	60	100

Biochemistry:

1. Identification of carbohydrates: Molisch's test, Benedict's test, Fehling's test, Tollen's test, Iodine test, Seliwanoff's test, Barfoed's test, Osazonetest and Bial's test
2. Estimation of blood glucose by GOD POD method.
3. Identification of cholesterol bySalkowski's test.
4. Identification of lipids by Sudan III test.
5. Identification of protein and amino acids by Ninhydrin test, Biuret test, Xanthoproteic test, and Millon's test.
6. Investigating the effect of temperature and pH on enzyme (amylase, urease) activity.
7. Use of anticoagulant (EDTA/citrate/heparin), centrifugation and safe handling of blood specimens.

Cell and Molecular Biology:

1. Parts of a microscope, usage &caring for the microscope.
2. Use of different staining methods (e.g., Methylene Blue, Iodine solution, Acetocarmine, Haematoxylin & Eosin) to highlight different cellular components.
3. Observing stained tissue samples showing signs of apoptosis (programmed cell death) and necrosis (accidental cell death) under the microscope and comparing morphological differences.
4. Mitosis in onion root tip– preparation and observation of a crush smear and comparison with teaching slides.
5. Demonstration of phases of meiosis in grasshopper testes.
6. Agarose Gel electrophoresis and PCR demonstration
7. Analysis of Human Chromosomes using provided photomicrographs.

Semester–II						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 201	Infectious Disease Biology	42	3	40	60	100

Unit I: Fundamentals of Infectious Diseases and Pathogen Classification

Concept and definition of infectious diseases. Classification of infectious agents: bacteria, viruses, fungi, parasites, and prions. Host–pathogen interactions and mechanisms of infection. Routes of transmission and portals of entry. Determinants of infectious diseases: agent, host, and environmental factors. Pathogenicity and virulence factors. Concepts of colonization, infection, disease, and carrier state. Normal microbiota and its role in health and disease. Overview of emerging and re-emerging infectious diseases. Basics of biosafety and biosecurity in infectious disease laboratories.

Unit II: Bacterial Pathogenesis and Virulence Mechanisms

Concepts of pathogenicity and virulence in bacteria. Structural and functional components involved in disease causation including cell wall components, endotoxins, exotoxins, adhesins, invasins, enzymes, capsules, and biofilm formation. Mechanisms of bacterial adherence, invasion, intracellular survival, and spread. Regulation of virulence through quorum sensing and phase variation. Host–pathogen interactions and molecular basis of tissue damage. Overview of laboratory methods for identification and differentiation of pathogenic bacteria relevant to virulence studies.

Unit 3: Viral and Fungal Infections: Replication and Host Interactions

Structure and classification of medically important viruses and fungi. Viral replication cycles of DNA and RNA viruses, mechanisms of viral pathogenesis, cytopathic effects, latency, persistence, and immune evasion. Host immune responses to viral infections. Morphology and classification of pathogenic fungi. Mechanisms of fungal replication and virulence, host–fungus interactions, opportunistic and systemic fungal infections. Overview of laboratory diagnosis, prevention, and control of viral and fungal infections.

Unit 4: Parasitic Diseases and Vector-Borne Pathogens

Classification and biology of medically important parasites including protozoa and helminths. Life cycles, modes of transmission, and pathogenesis of major parasitic diseases such as malaria, amoebiasis, leishmaniasis, filariasis, schistosomiasis, and intestinal helminth infections. Host–parasite interactions, immune evasion, and clinical manifestations of parasitic diseases. Vector-borne pathogens and vectors of medical importance including mosquitoes, sandflies, ticks, and fleas. Biology of vectors, mechanisms of transmission, and vector–pathogen–host interactions. Laboratory diagnosis of parasitic and vector-borne diseases.

Unit 5: Host Defenses, Epidemiology, and Emerging Infectious Threats

Host defense mechanisms against infectious diseases, including innate and adaptive immunity, inflammation, and immunological memory. Interaction between pathogens and host immune responses, immunopathology, and factors influencing susceptibility to infection. Prevention and control of infectious diseases at individual and community levels. Emerging and re-emerging infectious threats, zoonotic diseases, antimicrobial resistance, globalization and climate change in disease spread, and public health challenges in infectious disease control.

Suggested Reading:

1. Ananthanarayan, R., & Paniker, C. K. J. (2022). *Textbook of microbiology* (11th ed.).
2. Topley, W. W. C., Wilson, G. S., & Wilson, R. (2019). Topley and Wilson's microbiology and microbial infections.Jaypee Brothers Medical Publishers**.**
3. Paniker, C. K. J. (2018). Textbook of medical parasitology (8th ed.). Jaypee Brothers Medical Publishers.
4. Park, K. (2023). Park's textbook of preventive and social medicine (27th ed.). Banarsidas Bhanot.

Semester–II						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 202	Metabolic and Inherited Diseases	42	3	40	60	100

Unit I: Introduction to Metabolic and Inherited Diseases
Overview of inborn errors of metabolism (IEMs): definition, classification, frequency and clinical significance in India. Principles of diagnosis: clinical presentation, biochemical markers, molecular confirmation and newborn screening (NBS) concept. Pathophysiology basis: loss-of-function mutations, enzymatic deficiency, substrate accumulation and toxic metabolite formation.

Unit II: Carbohydrate and Glycogen Metabolism Disorders
Glycogen storage diseases (GSD): Type I–XII, galactosemia, classical, transferase-deficient and kinase-deficient forms, neonatal screening (galactose/galactose-1-phosphate levels), enzyme assays and molecular testing. Other carbohydrate disorders: fructose intolerance, fructokinase deficiency, glycogen synthase deficiency; biochemical findings and diagnostic approach.

Unit III: Amino Acid Metabolism Disorders and Organic Acidemias
Phenylketonuria (PKU), Tyrosinemia types I, II and III and treatment monitoring. Other disorders: maple syrup urine disease (MSUD), homocystinuria, alkaptonuria; biochemical profiles (branched-chain amino acids, homocysteine, homogentisic acid), urine organic acids, molecular confirmation. Organic acidemias

Unit IV: Lipid Metabolism Disorders and Storage Diseases
Familial hypercholesterolemia (FH), LDL receptor deficiency, cascade screening and cardiovascular risk assessment. Lysosomal storage diseases– Gaucher disease, Fabry disease, MPS disorders; enzyme deficiencies, substrate accumulation (glucosylceramide, globotriaosylceramide, heparan sulfate) and enzyme replacement therapy (ERT).

Unit V: Mitochondrial Disorders, Peroxisomal Diseases and Molecular Diagnostic Integration
Overview of maternal inheritance, biochemical markers, peroxisomal disorders: Zellweger syndrome, X-linked adrenoleukodystrophy (ALD), plasma/urine biomarkers (VLCFA, plasmalogens, phytanic acid), enzyme assays and molecular genetics.

Suggested readings:

1. Fernandes, J., Saudubray, J. M., van den Berghe, G., & Walter, J. H. (Eds.). (2012). Inborn metabolic diseases: Diagnosis and treatment (5th ed.). Springer-Verlag.
2. Bamji, M. S., Krishnaswamy, K., & Brahmam, G. N. V. (2019). Textbook of human nutrition (4th ed.). Oxford & IBH Publishing Co. Pvt. Ltd.
3. Rodwell, V. W., Bender, D. A., Botham, K. M., Kennelly, P. J., & Weil, P. A. (2018). Harper's illustrated biochemistry (31st ed.). McGraw-Hill Education.
4. Vasudevan, D. M., Sreekumari, S., & Vaidyanathan, K. (2022). Textbook of biochemistry (8th ed.). Jaypee Brothers Medical Publishers (P) Ltd.

Semester–II						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 203	Immunology & Autoimmune Diseases	42	3	40	60	100

Unit I: Immune System
Cells of the immune system: lymphocytes, antigen-presenting cells, granulocytes; Primary and secondary lymphoid organs; Innate and adaptive immunity; Humoral and cell-mediated immune responses; Primary and secondary immune responses; Measurement of immunity: local and herd immunity; Antigens: classes, properties, and determinants; Antibodies and immunoglobulins: structure, properties, and classes; Complement system: components, activation pathways, and biological functions.

Unit II: Immune Regulation and Self-Tolerance
Antigen processing and presentation; Major Histocompatibility Complex (MHC): structure and function; Central and peripheral tolerance mechanisms; Role of thymus and bone marrow in immune education; Clonal deletion, clonal anergy, and immune suppression; Regulatory T cells (Tregs) and immune checkpoints; Cytokines and chemokines in immune regulation; Maintenance of immune homeostasis

Unit III: Breakdown of Immune Tolerance and Immune Dysregulation
Concept of immune tolerance failure; Genetic predisposition and role of HLA genes; Epigenetic regulation of immune responses; Environmental factors influencing immune dysregulation: infections, drugs, hormones; Molecular mimicry, bystander activation, and epitope spreading; Role of autoreactive T and B lymphocytes; Inflammatory pathways and chronic immune activation

Unit IV: Autoimmune Diseases
Definition and classification of autoimmune diseases: Organ-specific autoimmune diseases, Systemic autoimmune diseases; Role of autoantigens and antigen-presenting cells; Autoantibody-mediated and T-cell–mediated mechanisms; Systemic autoimmune disorders: Systemic lupus erythematosus (SLE), Rheumatoid arthritis (RA), Sjogren's syndrome; Organ-specific autoimmune disorders: Type 1 diabetes mellitus, Hashimoto's thyroiditis and Graves' disease, Multiple sclerosis; Basic clinical features and pathophysiology

Unit V: Diagnostic and Therapeutic Approaches in Autoimmune Diseases
Principles of laboratory diagnosis of immune-mediated disorders, Autoantibodies as diagnostic and prognostic markers: ANA, anti-dsDNA, RF, anti-CCP, anti-TPO; Immunological and molecular diagnostic techniques: ELISA, Immunofluorescence, Western blot, Flow cytometry (basic principles), PCR-based assays; Overview of therapeutic strategies: Immunosuppressive agents, Biologics and targeted therapies; Role of molecular diagnostics in disease monitoring and prognosis

Suggested Readings –

1. Stanley, J., Stanley. (2002). Essentials of Immunology & Serology. (n.p.): Cengage Learning.
2. Punt, J., Stranford, S., Jones, P., Owen, J. (2018). Kuby Immunology. United States: W. H. Freeman.
3. Abbas AK, Lichtman AH, Pillai S. Cellular and Molecular Immunology. Elsevier.
4. Murphy K, Weaver C. Janeway's Immunobiology. Garland Science.
5. Rose NR, Mackay IR. The Autoimmune Diseases. Academic Press.
6. Delves PJ, Martin SJ, Burton DR, Roitt IM. Roitt's Essential Immunology. Wiley-Blackwell

Semester–II						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 204	Genetics and Genomics	42	3	40	60	100

Unit I: Principles of Inheritance and Gene Interactions
Concept of gene and alleles; Principles of Mendelian inheritance; Extensions of Mendelian genetics: Incomplete dominance and co-dominance, Multiple alleles and lethal alleles, Penetrance and expressivity; Gene interactions: epistasis and pleiotropy; Sex-linked, sex-influenced, and sex-limited inheritance; Polygenic inheritance with suitable examples and numerical.

Unit II: Linkage, Recombination, and Chromosomal Mapping
Linkage and crossing over**;** Cytological basis of crossing over**;** Recombination frequency and linkage intensity**;** Two-factor and three-factor crosses**;** Linkage maps**;** Coefficient of coincidence and interference**;** Gene mapping by somatic cell hybridization (introductory)**;** Genetic recombination in bacteria: conjugation, transformation, and transduction.

Unit III: Mutations, Chromosomal Aberrations, and Special Modes of Inheritance
Types of gene mutations; Detection of mutations in Drosophila; Mutagens: physical and chemical; Molecular basis of spontaneous and induced mutations; Chromosomal aberrations: numerical and structural variations; Basis of sex determination: genetic and environmental; Sex determination in Drosophila and humans; Mechanism of dosage compensation; Extra-chromosomal inheritance and maternal effects with examples.

Unit IV: Introduction to Genomics and Genome Organization
Definition, scope, and importance of genomics; Difference between genetics and genomics; Organization of prokaryotic and eukaryotic genomes; Human genome organization: coding and non-coding DNA; Overview of the Human Genome Project; Functional elements of the genome: genes, regulatory regions, repetitive DNA; Genome variation: SNPs, CNVs, and structural variants; Nuclear, mitochondrial, and microbial genomes

Unit V: Functional, Clinical and Applied Genomics
Functional genomics and transcriptomics (basic concepts); Genomic technologies (principles only): Sanger sequencing**,** Next-generation sequencing (NGS)**,** DNA microarrays and comparative genomic hybridization (CGH); Epigenomics: DNA methylation and histone modifications; Clinical genomics: Genetic disease diagnosis, Cancer genomics (introductory concepts), Pharmacogenomics and personalized medicine; Ethical, legal, and social issues (ELSI) in genomics; Future perspectives of genomics in molecular diagnostics.

Suggested Readings –

1. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons In.
2. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cumming
3. Pierce B. A. (2012). Genetics-A Conceptual Approach. IV Edition. W. H. Freeman and Company

Semester–II						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 205	Statistical Methods in Diagnostics	42	3	40	60	100

Unit I: **Biostatistics Fundamentals and Diagnostic Study Design**
Fundamentals of Biostatistics and Diagnostic Study Design, Introduction to biostatistics in diagnostics, Types of data: nominal, ordinal, interval, ratio, Descriptive statistics: mean, median, variance, standard deviation, Study designs in diagnostics: cross-sectional, cohort, case-control, Sampling methods and sample size calculation.

Unit II: Probability, Distributions, and Hypothesis Testing
Probability, Distributions, and Hypothesis Testing, Probability theory and rules, Normal, binomial, and Poisson distributions, Central Limit Theorem, Hypothesis formulation, types of errors, p-values, Parametric vs non-parametric tests (t-test, chi-square, ANOVA, Mann-Whitney U).

Unit III: Diagnostic Accuracy and Test Evaluation
Diagnostic Accuracy and Test Evaluation Metrics, Sensitivity, specificity, accuracy, precision, Positive Predictive Value (PPV) and Negative Predictive Value (NPV), Likelihood ratios and diagnostic odds ratios, Prevalence and its impact on test performance, Application to binary and continuous test outcomes.

Unit IV: ROC Analysis and Model Performance
ROC Curve Analysis and Model Performance Evaluation, Receiver Operating Characteristic (ROC) curve: concepts and construction, Area Under the Curve (AUC) and its interpretation, Comparison of diagnostic tests using ROC, Cut-off point optimization and Youden Index, Precision-Recall curves and calibration plots.

Unit V: Regression, Predictive Modeling, and Data Analysis
Regression and Predictive Modeling in Diagnostics, Linear and logistic regression basics, Multivariate modeling: feature selection, interaction terms, Model validation: internal and external, Introduction to survival analysis in diagnostic context (Kaplan-Meier, Cox regression), Practical data analysis using R, SPSS, or GraphPad. Case studies from infectious diseases, cancer, and genetic diagnostics. Reporting standards: STARD guidelines and critical appraisal of diagnostic literature.

Suggested Reading:

1. Zhou, X. H., Obuchowski, N. A., & McClish, D. K. (2011). Statistical methods in diagnostic medicine (2nd ed.). Wiley.
2. Altman, D. G. (1991). Practical statistics for medical research. Chapman and Hall/CRC.
3. Mahajan, B. K. (2010). Methods in biostatistics for medical students and research workers (7th ed.). Jaypee Brothers Medical Publishers.
4. Kumar, R. (2019). Research methodology: A step-by-step guide for beginners (5th ed.). SAGE Publications India.

Semester–II						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 206P	Practical III (MDS 201, MDS 205)	168	6	40	60	100

Infectious Disease Biology Practicals

1. Laboratory biosafety and biosecurity practices; use of PPE and biosafety cabinets.
2. Gram staining and microscopic examination of bacteria
3. Demonstration of bacterial cell structures and virulence factors (capsule staining – demonstration)
4. Motility testing for differentiation of enteric bacteria.
5. Identification of bacteria by IMViC test.
6. To detect the ability of organisms to produce the catalase enzyme.
7. To detect free coagulase and bound coagulase produced by different organisms.
8. Antibiotic Sensitivity test.
9. Laboratory diagnosis of viral infections: antigen–antibody-based tests (ELISA).
10. Identification of fungi by KOH mount and lactophenol cotton blue (LPCB) mount.
11. Identification of protozoan parasites in stool samples (wet mount – demonstration)
12. Identification of helminth eggs and larvae using permanent slides
13. Demonstration of malarial parasite in peripheral blood smear

Statistical Methods in Diagnostics

1. Calculation of descriptive statistics: mean, median, mode,
2. Graphical presentation of data: bar chart, histogram, pie chart, box plot.
3. Normal distribution curve plotting and interpretation
4. Application Problems based on Binomial distribution
5. Application problems based on Poisson distribution
6. Identification of Type I and Type II errors in diagnostic testing
7. Chi-square test for association between disease and test result
8. One-way ANOVA for comparison of multiple diagnostic groups
9. Mann-Whitney U test for non-parametric diagnostic data
10. Calculation of sensitivity and specificity
11. Calculation of accuracy and precision
12. Estimation of Positive Predictive Value (PPV) and Negative Predictive Value (NPV)
13. Software-based ROC analysis (R / SPSS / GraphPad)
14. Comparison of two diagnostic tests using ROC curves
15. Kaplan–Meier survival curve construction
16. Cox proportional hazards regression analysis
17. Hands-on data analysis using R / SPSS / GraphPad
18. Logistic regression for disease prediction
19. Interpretation of regression coefficients and odds ratios
20. Multivariate diagnostic model construction

Semester–II						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 207P	Practical IV (MDS 202, MDS 203)	168	6	40	60	100

Metabolic and Inherited Diseases Practical

1. Dried blood spot (DBS) collection technique (demonstration)
2. Serum ammonia (principle and interpretation)
3. Lactate estimation (colorimetric method)
4. Galactose-1-phosphate uridyltransferase (GALT) – principle and result analysis
5. Guthrie test
6. Mutation analysis (report interpretation)

Immunology and Autoimmune Diseases:

1. Demonstration of ELISA for autoantibody detection
2. Separation of Serum proteins by Paper Electrophoresis
3. Principle, Procedure, and Interpretation of Widal Test
4. Principle and Procedure of Slide Test for Rheumatoid Factor
5. Principle and Procedure of Syphilis Testing Using RPR Test Kit
6. Demonstration of lymphoid organs.
7. Histological study of spleen, thymus and lymph nodes through slides/photographs.

Semester–II						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 208P	Practical V (MDS 204)	84	3	20	30	50

Genetics and Genomics:

1. Simulation exercises using beads or seeds to study the gene interactions: 9:3:4; 12:3:1; 9:7; 9:3:3:1 (comb shapes in roosters) and verification of ratios by using Chi-square analysis.
2. Pedigree analysis of Autosomal Dominant trait, Autosomal recessive trait, X-linked Dominant traits, X-linked recessive traits, Y-linked traits and mitochondrial traits.
3. Use of probability in solving problems of genetics (Sum rule, Multiplication rule & Binomial expansion).
4. Gene mapping (order and distance) using data from interrupted mating experiments in bacteria.
5. Linkage maps based on data (two - point and three - point crossing over) from Drosophila.
6. Human Karyotypes, Human chromosomal disorders & single gene disorders.
7. Smear technique to demonstrate sex chromatin in buccal epithelial cells.

Semester–III						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 301	Liquid Biopsy and Circulating Biomarkers	42	3	40	60	100

Unit 1: Fundamentals of Liquid Biopsy
Historical evolution of liquid biopsy from traditional tissue biopsies to minimally invasive methods using body fluids like blood, urine, and cerebrospinal fluid. Advantages over solid biopsies such as real-time monitoring and reduced patient risk. Types of circulating biomarkers like circulating tumor cells (CTCs), circulating tumor DNA (ctDNA), circulating free DNA (cfDNA), microRNAs, and extracellular vesicles.

Unit 2: Sample Collection and Processing
Standardized protocols for collecting peripheral blood, plasma, serum, and other fluids to preserve biomarker integrity. Venipuncture, centrifugation for plasma isolation, and storage conditions to minimize degradation from nucleases or contamination. Handling challenges such as hemolysis prevention, use of cell-stabilizing tubes (e.g., CellSave or Streck tubes), and quality assessment metrics like cell-free DNA yield quantification.

Unit 3: Detection Techniques for Circulating Biomarkers
Laboratory methods for biomarker enrichment and detection, starting with CTC isolation via density gradient centrifugation, microfluidic chips, or antibody-based capture (e.g., CellSearch system). Digital droplet PCR (ddPCR), next-generation sequencing (NGS) for ctDNA mutation profiling, and bisulfite conversion for methylation analysis. Protein and RNA detection methods like ELISA, flow cytometry, and qRT-PCR.

Unit 4: Data Analysis and Clinical Interpretation
Biomarker data analysis using software tools for variant calling, allele frequency calculation, and tumor mutational burden assessment. Statistical validation, limit of detection (LOD), and concordance with tissue biopsies. Clinical case studies highlight applications in therapy response monitoring, minimal residual disease detection, and early cancer screening.

Unit 5: Quality Control, Regulations, and Future Directions
Laboratory quality assurance per ISO 15189 standards, including proficiency testing, reagent validation, and error tracking. Ethical issues like patient consent, data privacy under HIPAA/GDPR, and equity in access are discussed. Emerging trends cover multi-omics integration, AI-driven analysis, and liquid biopsy in non-oncology fields like cardiology.

Suggested reading:

1. Bhatt, S. (Ed.). (2025). Liquid biopsy in cancer management: Integrating diagnostics and clinical applications. Elsevier.
2. Dey, P. (2023). Basic and advanced laboratory techniques in histopathology and cytology (2nd ed.). Springer. (Note: The second edition includes new chapters on liquid biopsy and related advancements.)
3. Kamal, V. (2025). Textbook of pathology: Systemic pathology and molecular diagnostics (2nd ed., Vol. 2). CBS Publishers & Distributors.
4. Saxena, S. K. (Ed.). (2022). *Biomarkers in medicine*. Bentham Science Publishers.
5. Sharma, I., & Ojha, R. (2025). *Exploring noninvasive disease biomarkers with urinary omics analysis*. Elsevier

Semester–III						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 302	Analytical Biochemistry	42	3	40	60	100

Unit I: Clinical enzymology
Clinical enzymology overview and clinical importance, catalysis, isoenzymes in clinical diagnostics, basic principles of quality control in clinical laboratory, automated analyzers in clinical enzymology. Use of reagent kits and calibration standards. Plasma lipid profile, hypolipoproteinemia, hyperlipidemias. miscellaneous enzymes-glucose-6-phosphate dehydrogenase, urease, glucose oxidase & peroxidase.

Unit II: Biomarkers and tumor markers
Definition andimportance of biomarkers, cardiac markers- creatine kinase, CK-MB, cardiac troponins, TnT, AST, myoglobulins, LDH. Muscle disease biomarkers- CK-MM, aldolase, myoglobulin, IGF, lactate, IL-6. Markers of bone disease-BAP, osteocalcin, type I collagen, TRAP, other ALP isoenzymes. Tumor markers- Alpha feto protein (AFP for liver cancer), CA 19.9 (Pancreatic cancer), CA 15.3 (Breast cancer), CA 125 (ovarian cancer), PSA (Prostrate cancer), CEA (GIT caner).

Unit III: Evaluation of liver & gastric function
Test based on excretory function- serum bilirubin, bile acids and bile salts. Test based on synthetic function-serum albumin, coagulation factors, test based on serum enzymes (AST, ALT, LDH)-serum enzymes as markers of hepatobiliary disease, markers of obstructive liver disease. Assessment of gastric & pancreatic function, malabsorption studies.

Unit IV: Kidney function test
Test to screen for kidney disease-complete urine analysis, plasma urea and creatinine. Test to assess renal function-glomerular filtration rate, clearance tests, glomerular permeability, proteinuria, assessment of tubular function- reabsorption studies, secretion test, concentration and dilution test, renal acidification. Uric acid and cystatin C and newer biomarkers as emerging tools for early kidney injury (NGAL, L-FABP, KIM-1, etc.)

Unit V: Acid-Base balance & pH
Distribution and balance of water and electrolytes in the body, regulatory mechanism and metabolism, buffers of body fluids, respiratory regulation of pH, renal regulation of pH, disturbances in acid-base balance- metabolic acidosis, metabolic alkalosis. Respiratory acidosis & alkalosis, anion gap, determination of blood pH & gases.

Suggested readings:

1. Rifai, N. (2023). Tietz fundamentals of clinical chemistry and molecular diagnostics (9th ed.). Elsevier.
2. Kennelly, P. J., Botham, K. M., McGuinness, O. P., Rodwell, V. W., & Weil, P. A. (2023). Harper's illustrated biochemistry (32nd ed.). McGraw-Hill Education/Medical.
3. Vasudevan, D. M., Sreekumari, S., & Vaidyanathan, K. (2025). Textbook of biochemistry for medical students (11th ed.). Jaypee Brothers Medical Publishers.

Semester–III						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 303	Cytogenetics	42	3	40	60	100

Unit 1: Fundamentals of Cytogenetics
History and principles of cytogenetics, cell division processes including mitosis and meiosis, chromosome nomenclature (ISCN 2020), and banding patterns like G-banding, R-banding, and C-banding. Normal human karyotype (46, XX or 46, XY), sex chromosomes, and autosomal pairs, clinical relevance in congenital disorders and malignancies.

Unit II: Sample Collection, Culture, and Preparation
Standardized protocols for collecting blood, bone marrow, amniotic fluid, chorionic villi, and solid tumors. Cell culture techniques using lymphocyte or fibroblast media, synchronization with colchicine for metaphase arrest, hypotonic treatment, and fixation. Harvesting methods, slide preparation, and staining procedures.

Unit III: Classical Karyotyping and Microscopic Analysis
G-banding for high-resolution chromosome visualization using trypsin and Giemsa staining. Metaphase spreading, microscope setup with oil immersion, and digital imaging for karyotype analysis. Common numerical abnormalities (e.g., trisomy 21 in Down syndrome) and structural variants (e.g., translocations, deletions, inversions).

Unit IV: Molecular Cytogenetic Techniques
Fluorescence in situ hybridization (FISH) for locus-specific probes, spectral karyotyping (SKY), and comparative genomic hybridization (CGH). Array CGH (aCGH) and optical genome mapping for copy number variations (CNVs) and structural variants undetectable by karyotyping. SNP arrays and multicolour FISH applications in oncology (e.g., BCR-ABL in CML) with emphasis on probe selection, hybridization protocols, and signal interpretation.

Unit V: Clinical Applications, Quality Control, and Emerging Trends
Cytogenetic reporting per ISCN standards, integrating findings with clinical history for disorders like Turner syndrome, Klinefelter syndrome, and leukemias. Quality assurance covers proficiency testing (CAP/UK NEQAS), error rates, and ISO 15189 accreditation. Ethical considerations include informed consent and genetic counseling referrals. Future directions explore single-cell sequencing, CRISPR-based cytogenetics, and AI-assisted analysis.

Suggested reading

1. Gupta, P. K. (2022-2023). *Cytogenetics* (2nd ed.). Rastogi Publications.
2. Singh, B. D. (n.d.). *Genetics cytogenetics* (2nd ed.). Medtech.
3. Chandrasekharan, S. N., & Parthasarathy, S. V. (1965). *Cytogenetics and plant breeding* (2nd ed.). P. Varadachary & Co
4. Venkateshwarlu, M. (2021). *Cell biology and cytogenetics* (Vol. 1). Bhumipublishing
5. Kumar, A., & Srivastava, M. (2012). *A text book of molecular cytogenetics*. Narendra Publishing House

Semester–III						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 304	Biomedical Imaging	42	3	40	60	100

Unit I: Foundations of Medical Imaging and Radiation Safety
Introduction to the field of medical imaging and its role in modern diagnostics. Overview of major imaging modalities: Radiography, Computed Tomography (CT), Ultrasound, Magnetic Resonance Imaging (MRI), and Nuclear Medicine. Fundamentals of electromagnetic radiation and sound waves as used in imaging. Essential radiation safety protocols: the ALARA principle (As Low as Reasonably Achievable), use of personal protective equipment (PPE), shielding, and radiation monitoring badges.

Unit II: Radiographic and Fluoroscopic Imaging
Principles of X-ray production and image formation. Components and operation of standard radiographic and fluoroscopic equipment. Techniques for patient positioning for common radiographic examinations. The technician's role in contrast administration for gastrointestinal and genitourinary studies.

Unit III: Computed Tomography (CT) and Image Processing
Principles of CT image acquisition: helical/spiral scanning and multi-slice technology. Common protocols for head, chest, abdomen, and pelvic scans. Techniques for patient preparation, positioning, and instruction for breath-holds. Principles of intravenous and oral contrast media use in CT. Introduction to post-processing techniques, Image archiving and communication: fundamentals of Picture Archiving and Communication Systems (PACS) and Digital Imaging and Communications in Medicine (DICOM) standards.

Unit IV: Ultrasound and Magnetic Resonance Imaging (MRI)
Principles of ultrasound: generation of sound waves, interaction with tissues (reflection, scattering), and image formation. Standard protocols for abdominal, pelvic, obstetric, and vascular ultrasound examinations. Introduction to Magnetic Resonance Imaging (MRI): basic principles of magnetism, radiofrequency pulses, and signal detection. Safety protocols in the MRI suite: screening for ferromagnetic objects, managing implants, and monitoring patients.

Unit V: Diagnostic Support Procedures and Image Analysis
The technician's supportive role in specialized imaging procedures: angiography, myelography, and interventional radiology. Basic principles of image analysis: identifying normal anatomical structures on radiographs, CT, and MRI. Recognition of gross pathological findings (e.g., fractures, masses, effusions, obstructions) to ensure diagnostic quality of images. Introduction to the principles of Mammography and Bone Densitometry.

Suggested readings:

1. Bushong, S. C. (2012). Radiologic Science for Technologists. United Kingdom: Elsevier Health Sciences.
2. Lampignano, J. P., Kendrick, L. E. (2018). Bontrager's Textbook of Radiographic Positioning and Related Anatomy. United Kingdom: Elsevier.
3. Grey, M. L., Ailinani, J. M. (2018). CT & MRI Pathology: A Pocket Atlas, Third Edition. United States: McGraw Hill LLC.
4. Prakash, D., Kotian, R. P. (2025). Fundamentals of X-ray Imaging: Basic Principles, Quality Control, Clinical Applications, and Safety. Singapore: Springer Nature Singapore.
5. Medical Imaging Methods: Theory and Applications. (2021). United Kingdom: CRC Press.

Semester–III						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 305	Omics Technologies in Molecular Diagnostics	42	3	40	60	100

Unit I: Introduction to Omics Technologies and Diagnostic Relevance
Concept and scope of omics technologies; Types of omics: genomics, transcriptomics, proteomics, metabolomics, epigenomics; Difference between single-gene analysis and omics approaches; Role of omics in disease diagnosis, prognosis, and therapy monitoring; Overview of clinical laboratory workflow in omics-based diagnostics; Biosafety, ethical considerations, and data integrity in omics studies.

Unit II: Genomics and Transcriptomics Technologies
DNA extraction and quality assessment (diagnostic perspective)**;** PCR-based techniques in genomics: conventional PCR, qPCR (applications)**;** DNA sequencing technologies: Sanger sequencing (principle and applications), Next-generation sequencing (NGS): workflow overview; Transcriptomics basics: RNA isolation and quality control; Gene expression analysis using RT-PCR and qRT-PCR; Diagnostic applications: genetic disorders, cancer mutations, infectious diseases.

Unit III: Proteomics Technologies in Diagnostics
Basics of proteomics and protein biomarkers; Protein extraction and quantification methods; Electrophoretic techniques: SDS-PAGE and native PAGE (principle and use); Immunoassay-based proteomics: ELISA, Western blot (diagnostic relevance); Mass spectrometry: basic principle and clinical applications; Applications of proteomics in disease diagnosis and therapeutic monitoring.

Unit IV: Metabolomics and Epigenomics Approaches
Introduction to metabolomics and its clinical significance; Sample preparation for metabolomics; Analytical platforms: chromatography and mass spectrometry (overview); Metabolic biomarkers in disease diagnosis; Basics of epigenomics: DNA methylation and histone modifications; Epigenetic biomarkers and their role in cancer and complex diseases.

Unit V: Data Analysis, Interpretation, and Translational Applications
Introduction to bioinformatics in omics (conceptual and practical awareness); Data generation, handling, and interpretation in omics studies; Integration of multi-omics data for clinical decision-making; Omics in personalized medicine and precision diagnostics; Case studies of omics-based diagnostics; Quality control, validation, and regulatory aspects in clinical omics laboratories

Suggested Readings –

1. Brown, T. A. (2018). *Genomes* (4th ed.). Garland Science.
2. Buckingham, L., & Flaws, M. L. (2019). *Molecular diagnostics: Fundamentals, methods, and clinical applications* (2nd ed.). F. A. Davis Company.
3. Primrose, S. B., & Twyman, R. M. (2013). *Principles of gene manipulation and genomics* (7th ed.). Wiley-Blackwell.
4. Lesk, A. M. (2017). *Introduction to genomics* (3rd ed.). Oxford University Press.
5. Twyman, R. M. (2014). *Principles of proteomics* (2nd ed.). Garland Science.
6. Rastogi, S. C., Mendiratta, N., & Rastogi, P. (2017). *Bioinformatics: Methods and applications* (4th ed.). PHI Learning.
7. Gibson, G., & Muse, S. V. (2009). *A primer of genome science* (3rd ed.). Sinauer Associates.

Semester–III						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 306P	Practical VI (MDS 301)	84	3	20	30	50

Liquid Biopsy and Circulating Biomarkers

1. Isolation of Cell-Free DNA (cfDNA) from Plasma Samples
2. PCR-Based Detection of Mutations in Circulating Tumor DNA (ctDNA)
3. Enrichment of Circulating Tumor Cells (CTCs) Using Size-Based Filtration
4. Immunomagnetic Separation of CTCs
5. Isolation of Exosomes from Biofluids
6. Flow Cytometry Analysis of Circulating Biomarkers

Semester–III						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 307P	Practical VII (MDS 302)	84	3	20	30	50

Analytical biochemistry

1. Estimation of total cholesterol and triglycerides in a sample of blood.
2. Estimation of HDL and LDL cholesterol in a sample of blood.
3. Estimation of creatine kinase in a given sample of blood.
4. Estimation of serum enzymes ALT and AST in a given sample of blood
5. Determination of Serum acid phosphatase and alkaline phosphatase.
6. Determination of Serum Lactate dehydrogenase.
7. Estimation of electrolytes (Na, K, Cl) in a given sample of blood.

Semester–III						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 308P	Practical VIII (MDS 303)	84	3	20	30	50

Cytogenetics

1. Human Peripheral Blood Lymphocyte Culture for Chromosome Preparation
2. Giemsa Trypsin G-Banding (GTG-Banding) of Human Chromosomes
3. Silver Staining of Nucleolar Organizer Regions (Ag-NOR)
4. C-Banding for Constitutive Heterochromatin
5. Micronucleus Assay in Human Lymphocytes (Cytokinesis-Block Method)
6. Karyotyping: principle and analysis of normal vs abnormal karyotypes
7. Identification of chromosomal abnormalities (e.g., translocations, deletions) using images
8. Spectral Karyotyping (SKY) or Multicolor FISH (mFISH) – Demonstration & Analysis

Semester–IV						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 401	Molecular diagnosis of Infectious diseases	42	3	40	60	100

Unit I: Fundamentals of Molecular Diagnostics in Infectious Diseases
Concept and scope of molecular diagnostics in infectious diseases. Advantages and limitations compared with conventional microbiological methods. Types of molecular targets: DNA, RNA, plasmids, and genetic markers of pathogenicity and virulence. Clinical specimen selection, collection, transport, storage, and biosafety considerations. Principles and methods of nucleic acid extraction and purification from blood, respiratory samples, stool, urine, tissues, and body fluids. Quality control and contamination prevention in molecular laboratories. Ethical and regulatory considerations in molecular testing.

Unit II: Molecular Techniques Used in Infectious Disease Diagnosis
Principles and applications of polymerase chain reaction (PCR): conventional PCR, nested PCR, multiplex PCR, RT-PCR and real-time PCR. Isothermal amplification techniques: LAMP and TMA. Nucleic acid hybridization methods and probe-based assays. DNA sequencing techniques: Sanger sequencing and next-generation sequencing (NGS). Microarrays and syndromic panels for pathogen detection. Interpretation of molecular test results and limitations of molecular assays.

Unit III: Molecular Diagnosis of Bacterial Infections
Molecular detection of bacterial pathogens: Mycobacterium tuberculosis*, Escherichia coli, Salmonella, Shigella, Vibrio cholerae, and Clostridioides difficile.* Molecular diagnosis of hospital-acquired infections including *Staphylococcus aureus* (MRSA) and *Pseudomonas aeruginosa.* Molecular typing methods: PFGE, MLST, and whole-genome sequencing. Detection of antimicrobial resistance genes (e.g., mecA, bla genes, rpoB). Role of molecular diagnostics in outbreak investigations and infection control.

Unit IV: Molecular Diagnosis of Viral, Fungal, and Parasitic Infections
Molecular detection of viral infections: HIV, hepatitis viruses (HBV, HCV), influenza, dengue, chikungunya, and SARS-CoV-2. Viral load estimation (e.g., HIV, HBV) and genotyping. Molecular diagnosis of fungal infections: Candida, Aspergillus, and opportunistic mycoses. Molecular diagnosis of parasitic infections: malaria, leishmaniasis, toxoplasmosis, and filariasis. Applications of molecular diagnostics in surveillance, disease monitoring, and therapeutic response assessment.

Unit V: Molecular Methods for Treating and Preventing Infectious Diseases
Molecular targets for antimicrobial therapy. RNA interference (RNAi) and CRISPR technologies against pathogens. Vaccines: Design, mRNA vaccines (e.g., COVID-19 vaccines). Recombinant therapeutics. Host-directed therapies: Targeting host pathways to combat infection. Personalized medicine approaches for infectious diseases. Challenges in translating molecular findings into clinical practice. Future directions: Synthetic biology and infectious disease control.

Suggested Reading:

1. Buckingham, L. (2019). Molecular diagnostics: Fundamentals, methods, and clinical applications (3rd ed.). Philadelphia, PA: F.A. Davis Company.
2. Leonard, D. G. B., Caliendo, A. M., Bagg, A., Kaul, K. L., & Deerlin, V. M (2009). Molecular pathology in clinical practice: Infectious diseases (1st ed.). New York, NY: Springer.
3. Willey, J., Sherwood, L., & Woolverton, C. J. (2017). Prescott's microbiology (8th ed.). New Delhi, India: McGraw-Hill Education (Asia).
4. Pommerville, J. C. (2014). Alcamo's fundamentals of microbiology (11th ed.). Sudbury, MA: Jones & Bartlett Learning.
5. Kang, G., & Pulimood, A. B. (2019). Molecular microbiology: Diagnostic principles and practice. New Delhi, India: Elsevier India.
6. Pattnaik, M., & Nayak, R. (2018). Molecular diagnostics: Fundamentals, methods, and clinical applications. New Delhi, India: Springer India.

Semester–IV						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 402	Molecular diagnosis of Cancer	42	3	40	60	100

Unit I: Introduction to Cancer Biology and Molecular Mechanisms

Overview of cancer: Definition, types (benign vs. malignant), and epidemiology. Hallmarks of cancer: Sustained proliferation, evasion of growth suppressors, resistance to cell death, replicative immortality, angiogenesis, invasion, and metastasis. Molecular basis: Oncogenes, tumor suppressor genes, DNA repair genes, and epigenetic modifications. Role of mutations: Point mutations, deletions, amplifications, and translocations (e.g., BCR-ABL in leukemia). Introduction to molecular diagnostics: From histopathology to genomics.

Unit II: Fundamental Molecular Techniques in Cancer Diagnosis

Nucleic acid-based techniques: PCR (Polymerase Chain Reaction), RT-PCR, and qPCR for gene expression analysis. Electrophoresis and gel-based methods for detecting mutations. Hybridization techniques: Southern blotting, Northern blotting, and FISH (Fluorescence in Situ Hybridization) for chromosomal abnormalities. Sequencing basics: Sanger sequencing for targeted gene mutations (e.g., BRCA1/2 in breast cancer).

Unit III: Biomarkers and Genetic Markers in Cancer

Types of biomarkers: Diagnostic, prognostic, and predictive (e.g., HER2 in breast cancer, KRAS in colorectal cancer). Circulating tumor DNA (ctDNA) and exosomes as non-invasive markers. MicroRNAs and proteomics in cancer detection. Tumor heterogeneity and its impact on biomarker selection.

Unit IV: Advanced Diagnostic Tools and Technologies

Next-Generation Sequencing (NGS): Whole exome/genome sequencing for comprehensive mutation profiling. Liquid biopsies: Applications in early detection and monitoring treatment response. Multiplex assays: Gene panels for multiple cancer types (e.g., OncoPanel). CRISPR-based diagnostics and emerging technologies like single-cell sequencing. Integration with imaging: Molecular imaging techniques (e.g., PET-CT with molecular tracers).

Unit V: Clinical Applications, Case Studies, and Future Directions

Molecular diagnosis in breast, lung, colorectal, and hematological cancers. Multidisciplinary approach: Role of lab technicians in oncology teams. Challenges: Drug resistance, false positives/negatives, and cost-effectiveness. Future trends: AI in molecular diagnostics, personalized medicine, and immunotherapy markers. Regulatory aspects: FDA approvals for molecular tests and lab accreditation.

Suggested reading:

1. Nayak. (2024). *Concepts and methodology in cancer diagnostics: An immunological, biochemical and molecular approach* (1st ed.). Elsevier.
2. Shukla, K. K., Sharma, P., & Misra, S. (2023). *Molecular diagnostics in cancer patients*. Springer.
3. Singh, K. P. (Ed.). (2019). Molecular diagnostics in cancer patients. Springer.
4. Roulston, J. E., & Bartlett, J. M. S. (Eds.). (2004). Molecular diagnosis of cancer: Methods and protocols (2nd ed.). Humana Press
5. Tan, D., & Lynch, H. T. (Eds.). (2013). Principles of molecular diagnostics and personalized cancer.

Semester–IV						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 403	Advanced Sequencing Techniques	42	3	40	60	100

Unit I: Evolution and Fundamentals of Sequencing Technologies
Evolution of sequencing technologies, Brief review of Sanger Sequencing and its limitations, transition to next-generation and third-generation sequencing, sequencing chemistry, sequencing-by-synthesis, single-molecule sequencing, signal detection, error profiles, read length, depth, coverage, throughput, and quality scores. Library Preparation: DNA fragmentation, adapter ligation, and PCR amplification vs. PCR-free libraries.

Unit II: Short-Read Sequencing and Library Preparation
Short-read sequencing platforms with emphasis on Illumina technology, cluster generation, sequencing workflow, DNA fragmentation methods, adapter ligation, indexing, PCR-based and PCR-free libraries, targeted sequencing approaches including amplicon and hybrid capture, library and run quality control parameters.

Unit III: Long-Read and Single-Molecule Sequencing Technologies
Long-read sequencing technologies: Sequencing principles, read characteristics, error patterns, structural variant detection, haplotype phasing, genome assembly, epigenetic modification detection, and transcript isoform analysis. Single Molecule Real-Time (SMRT) Sequencing: Principles of Pacific Biosciences (PacBio) and Zero-Mode Waveguides (ZMW). Nanopore Sequencing: Oxford Nanopore Technologies (ONT)—how DNA/RNA translocation through a pore creates electrical signals. Direct RNA Sequencing: Skipping the cDNA synthesis step for real-time epitranscriptomics.

Unit IV: Specialized Sequencing Applications
Specialized sequencing applications, Transcriptomics (RNA-Seq): Total RNA vs. mRNA-seq, and understanding differential gene expression. Epigenomics: Bisulfite sequencing (DNA methylation) and ChIP-seq (protein-DNA interactions). Single-Cell Sequencing (scRNA-seq): Understanding cellular heterogeneity using platforms like 10x Genomics. Metagenomics: 16S rRNA sequencing vs. Shotgun metagenomics for microbiome analysis.

Unit V: Sequencing Data Analysis and Clinical Interpretation
Sequencing data quality assessment, read preprocessing, sequence alignment, variant calling and annotation, interpretation of sequencing results, validation requirements, reporting standards, clinical applications in genetic disorders, oncology, and infectious diseases. Data Formats: Mastering FASTQ, SAM, BAM, and VCF files. Quality Monitoring run metrics (Q-scores, cluster density).

Suggested Reading

1. Brown, T. A. (2020). *Genomes 4* (4th ed.). Garland Science.
2. Goodwin, S., McPherson, J. D., & McCombie, W. R. (2016). Coming of age: Ten years of next-generation sequencing technologies. *Nature Reviews Genetics, 17*(6), 333–351.
3. Mardis, E. R. (2017). DNA sequencing technologies: 2006–2016. *Nature Protocols, 12*(2), 213–218.
4. Shendure, J., & Ji, H. (2008). Next-generation DNA sequencing. *Nature Biotechnology, 26*(10), 1135–1145.

Semester–IV						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 404	Cardiovascular and Neurological diseases	42	3	40	60	100

Unit I: Cardiovascular Diseases – Molecular Basis and Diagnostic Overview
Review of structure and function of the cardiovascular system in health and disease, common cardiovascular diseases- atherosclerosis, hypertension, myocardial infarction and heart failure, molecular and genetic risk factors, role of inflammation and oxidative stress, overview of molecular pathology in cardiovascular diseases.

Unit II: Molecular Diagnostic Techniques in Cardiovascular Diseases
Principles and workflow of molecular diagnostic techniques, sample types including blood, serum and plasma, cardiac biomarkers such as troponins, BNP and CRP, PCR and ELISA applications for detection and quantification of cardiac markers, interpretation of molecular diagnostic results, point-of-care testing and its clinical significance in cardiovascular diagnostics.

Unit III: Neurological Diseases – Molecular Basis and Diagnostic Overview
Review of structure and function of the nervous system, molecular pathology of common neurological diseases including stroke, epilepsy, meningitis, Alzheimer's disease and Parkinson's disease, Down's syndrome, genetic and environmental risk factors, neuroinflammation and neurodegeneration, overview of diagnostic approaches in neurological disorders.

Unit IV: Molecular Diagnostic Approaches in Neurological Diseases
Principles of molecular techniques applied to neurological disorders, CSF and blood-based biomarkers and their significance, PCR-based assays for neurological diseases, genetic testing for neurodegenerative and neurogenetic disorders, molecular diagnostics in infectious neurological diseases, interpretation of molecular diagnostic findings in neurological disorders.

Unit V: Clinical Applications, Case Studies and Ethical Aspects of Molecular Diagnostics
Case-based applications of molecular diagnostics in cardiovascular and neurological diseases, correlation of molecular findings with clinical features, interpretation of laboratory and molecular diagnostic reports, ethical issues in molecular and genetic testing related to cardiovascular and neurological disorders, data privacy and informed consent, role of molecular diagnostics in early detection, risk assessment and preventive healthcare.

Suggested Readings:

1. Mishra, R. C. (2018). *Molecular diagnostics: Principles and applications*. New Delhi: Jaypee Brothers Medical Publishers.
2. Tripathi, K. D. (2023). *Essentials of medical pharmacology* (9th ed.). New Delhi: Jaypee Brothers.
3. Henry, J. B. (2021). Clinical diagnosis and management by laboratory methods (24th ed.). Philadelphia: Elsevier.
4. Rifai, N., Horvath, A. R., & Wittwer, C. T. (2018). Tietz textbook of clinical chemistry and molecular diagnostics (6th ed.). St. Louis, MO: Elsevier.
5. Turnpenny, P., & Ellard, S. (2021). Emery's elements of medical genetics and genomics (16th ed.). London: Elsevier.

Semester–IV						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 405	Data Analysis and Quality Assurance	42	3	40	60	100

Unit I: Quality, an overview

Introduction to laboratory quality management, Essential elements of Quality Assurance Programme, Quality Management System, Quality Laboratory Practices, quality assurance, quality assessment, Indicators of laboratory quality: turnaround time, sample rejection, patient feedback, Quality control: Internal Quality control, external quality control- External Quality Assurance Schemes.

Unit II: Good Laboratory Practice

Control of pre-analytical variables, control of analytical variables, Quality Control of the chemicals, reagent, calibration of equipment, laboratory precision, accuracy & sensitivity, sources of error, verification and validation of new reagents, methods, reference materials, systemic and random errors. Statistical tools for quality control: Westgard rules, Quality control charts, Levey-Jenning chart, corrective methods: Corrective action preventive action, post analytical errors and their prevention and resolution.

Unit III: Basic format of a test report

Reference ranges, abnormal results, critical values, critical value reporting protocol, release of test results, urgent, emergency and routine reporting of results, alteration in reports protocols, quality improvement, introduction to laboratory accreditation, Advantages of accreditation, Brief knowledge about National and International agencies for clinical laboratory accreditation -ISO, NABL, CAP etc.

Unit IV: Data Analysis in Laboratory Quality Assurance

Organization and summarization of laboratory data, Descriptive statistics: mean, median, mode, standard deviation, variance, coefficient of variation, Frequency distribution, histograms, bar charts, and pie charts, Inferential statistics: hypothesis testing, confidence intervals, p-values, Correlation and regression analysis for quality monitoring, Use of software tools for data analysis: MS Excel, SPSS, R.

Unit V: Clinical Applications and Emerging Trends in QA and Data Analysis

Application of QA and QC principles in diagnostic laboratories, monitoring key performance indicators (KPIs), Case studies: laboratory errors, troubleshooting, corrective actions, Laboratory information management systems (LIMS), Automation and point-of-care testing (POCT) quality monitoring, Emerging trends: big data analytics, digital dashboards, automated QC systems, Ethical, legal, and regulatory considerations in laboratory QA and data management

Suggested Readings:

1. Joshi, S. (2014). *Quality management in hospitals* (2nd ed.). Jaypee Brothers Medical Publishers Pvt. Limited.
2. Graham, N. O. (1982). Quality Assurance in Hospitals-Strategies for assessment and implementation. The Journal for Healthcare Quality (JHQ), 4(2), 14.
3. Hospital Quality Assurance: Risk Management and Program evaluation. (1984). United States: Aspen Systems Corporation.
4. Renner-McCaffrey, J., Leyshon, A. H. (1989). Quality Assurance in Hospital Nutrition Services. United States: Aspen Publishers.
5. Vishwakarma, K. (2015). *Biostatistics: A foundation for analysis in the health sciences* (Indian ed.). CBS Publishers.
6. Mahajan, B. K. (2010). *Statistical methods in health sciences* (7th ed.). Jaypee Brothers Medical Publishers.
7. Jha, A. K. (2016). *Health information systems: Concepts and applications*. CBS Publishers.

Semester–IV						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 406P	Practical IX (MDS 401, MDS 402)	168	6	40	60	100

Molecular diagnosis of Infectious diseases

1. Nucleic acid extraction and purification (DNA/RNA) from various specimens.
2. PCR-based detection of *E. coli* or *Salmonella* Pathogens.
3. Molecular detection of clinically significant viral pathogens: HIV, HBV and HCV.
4. Molecular Identification of Candida Species in clinical samples.
5. Genotypic Identification of Plasmodium Species in Malaria Samples.
6. Quantitative estimation of Hepatitis B Viral Load by Real-Time PCR.

Molecular diagnosis of Cancer

1. Agarose gel electrophoresis for DNA analysis
2. PCR Detection of Oncogene Mutations
3. Quantitative PCR (qPCR) for Gene Expression Profiling
4. Fluorescence In Situ Hybridization (FISH) for Gene Rearrangements
5. Western Blotting for Protein Biomarkers
6. Flow Cytometry for Surface Marker Analysis
7. ELISA for Circulating Biomarkers
8. Comparison of tissue biopsy vs liquid biopsy (case-based exercise)

Semester–IV						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 407P	Practical X (MDS 403 and MDS 404)	168	6	40	60	100

Advanced Sequencing Techniques:

1. Isolation of Plasmid DNA
2. Isolation of Total RNA
3. Quality assessment by Spectrometry and interpretation of A260/A280 ratio
4. Purity assessment by Gel Electrophoresis
5. Fragmentation principles for sequencing library preparation
   a) Mechanical
   b) Enzymatic
   c) Fragments length analysis
6. Basic Bioinformatics tools: Introduction to FASTQ, BAM, and VCF file

Cardiovascular and Neurological Diseases

1. To study the molecular basis of common cardiovascular diseases and correlate them with relevant biomarkers.
2. To interpret molecular and genetic diagnostic findings in neurological disorders.
3. To integrate molecular diagnostic findings with clinical data and address ethical considerations.
4. Estimation of Oxidative Stress Markers: Lipid Peroxidation by TBARS (MDA) Assay
5. ELISA for Cardiac Biomarkers: Troponin / CRP / BNP (kit-based or simulated dataset) and interpretation of normal vs elevated cardiac marker levels
6. Estimation of Blood Glucose (GOD-POD Method) and understanding metabolic risk factors in CVD
7. Estimation of C-Reactive Protein (CRP) by Latex Agglutination Slide Test: Relevance in cardiovascular inflammation
8. Identification of Normal vs Abnormal ECG/EEG Tracings

Semester–V						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 501	Emerging Molecular Techniques	42	3	40	60	100

Unit I: Advanced Nucleic Acid Amplification and Detection Technologies
Advanced nucleic acid amplification and detection technologies, digital PCR principles and applications, absolute quantification, isothermal amplification techniques including LAMP and RPA, CRISPR-based diagnostic systems, assay design concepts, and diagnostic sensitivity.

Unit II: Single-Cell and Spatial Molecular Technologies
Single-cell molecular technologies, single-cell RNA sequencing principles, barcoding strategies, data output interpretation, single-cell multi-omics, spatial transcriptomics concepts, and biomedical applications.

Unit III: Emerging Proteomics and Protein Detection Technologies
Proteomics technologies, mass spectrometry fundamentals, protein identification strategies, targeted proteomics, high-sensitivity protein detection methods, digital immunoassays, and biomarker discovery applications.

Unit IV: Microfluidics and Point-of-Care Molecular Diagnostics
Microfluidics and lab-on-chip technologies, microscale fluid manipulation, integration of molecular assays, lateral flow assay advancements, nanotechnology-based detection systems, paper-based diagnostics, and point-of-care testing applications.

Unit V: Translation, Validation, and Ethical Aspects of Emerging Diagnostics
Multi-omics data integration concepts, analytical and clinical validation of molecular assays, quality assurance, regulatory considerations, ethical issues, data privacy, and implementation challenges in healthcare diagnostics.

Suggested Reading

1. Doudna, J. A., & Charpentier, E. (2014). Genome editing: The new frontier of genome engineering with CRISPR-Cas9. *Science, 346*(6213), 1258096.
2. Hindson, B. J., et al. (2011). High-throughput droplet digital PCR system for absolute quantitation of DNA copy number. *Analytical Chemistry, 83*(22), 8604–8610.
3. Macosko, E. Z., et al. (2015). Highly parallel genome-wide expression profiling of individual cells. *Cell, 161*(5), 1202–1214.
4. Whitesides, G. M. (2006). The origins and future of microfluidics. *Nature, 442*(7101), 368–373.

Semester–V						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 502	Clinical Molecular Pathology	42	3	40	60	100

Unit I: Foundations of Molecular Pathology and Disease Mechanisms
Overview of clinical molecular pathology: Scope, history, and integration with traditional pathology. Molecular basis of disease: Genetic mutations, epigenetic changes, oncogenes, tumor suppressors, and inherited disorders. Pathophysiology at the molecular level: Examples in cancer, infectious diseases, and genetic conditions.

Unit II: Core Molecular Techniques in Clinical Diagnostics
Nucleic acid isolation, quantification, and quality assessment. Amplification methods: PCR, RT-PCR, qPCR, and multiplex PCR. Detection techniques: Gel electrophoresis, hybridization (FISH, Southern blotting), and basic sequencing.

Unit III: Molecular Pathology of Cancer and Hematological Disorders
Molecular oncology: Tumor biomarkers, gene fusions, mutations (e.g., EGFR, KRAS, BCR-ABL). Inherited cancers and pharmacogenomics (e.g., BRCA1/2, HER2). Hematopathology: Molecular markers in leukemia and lymphoma. Tumor heterogeneity and minimal residual disease monitoring.

Unit IV: Molecular Diagnostics in Infectious Diseases and Inherited Disorders
Viral, bacterial, and fungal detection: Molecular methods for pathogens (e.g., HPV, HIV, MTB). Identity testing and parentage analysis. Inherited diseases: Cystic fibrosis, hemoglobinopathies, and pharmacogenetic testing. Next-generation sequencing introduction: Targeted panels and clinical applications.

Unit V: Advanced Applications, Quality Management, and Future Trends
Liquid biopsies and circulating biomarkers. Regulatory frameworks: CLIA, CAP, FDA approvals for molecular tests. Ethical issues: Genetic privacy, informed consent, and reporting variants. Emerging technologies: CRISPR diagnostics, single-cell analysis, and AI integration.
Specimen handling and pre-analytical considerations in molecular testing.

Suggested readings:

1. Kamal, V. (2025). *Textbook of pathology: Systemic pathology and molecular diagnostics* (2nd ed., Vol. 2). CBS Publishers & Distributors.
2. Mohan, H. (2015). *Textbook of pathology* (7th ed.). Jaypee Brothers Medical Publishers. (Note: Check for the latest edition, as updates continue to enhance molecular content.)
3. Debnath, M., Prasad, G. B. K. S., & Bisen, P. S. (2010). *Molecular diagnostics: Promises and possibilities*. Springer.
4. Kawthalkar, S. M. (2018). *Essentials of clinical pathology*. JP Medical Ltd.
5. Bhardwaj, J. R. (2013). *Boyd's Pathology*. Wolters kluwer india Pvt Ltd

Semester–V						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 503	Immunological Methods in Diagnostics	42	3	40	60	100

Unit I: Basics of Immunology for Diagnostics
Overview of the immune system; Innate and adaptive immunity; Antigens, haptens, and immunogenicity; Antibodies: structure, classes, and functions; Antigen–antibody interactions; Concept of specificity, affinity, and avidity; Diagnostic relevance of immune responses. Principles of precipitation and agglutination reactions; Slide and tube agglutination tests (e.g., Widal, RF); Immunodiffusion techniques: Single radial immunodiffusion, Ouchterlony double diffusion.

Unit II: Antigen-Antibody Based Diagnostic Techniques
Complement fixation test (principle and applications); Immunoelectrophoresis (basic concept); Applications in infectious and autoimmune disease diagnosis, Enzyme-linked immunosorbent assay (ELISA): Principle, types, and diagnostic applications; Rapid immunochromatographic tests (ICT): principle and uses; Radioimmunoassay (RIA): principle and limitations.

Unit III: Enzyme and Fluorescence-Based Immunoassays
Immunofluorescence techniques: Direct and indirect immunofluorescence, Interpretation of fluorescence patterns (introductory); Applications in autoimmune and viral diagnostics, Principles of Flow Cytometry: Fluidics, Optics, and Electronics; Immunophenotyping: CD4/CD8 counts for HIV monitoring and leukemia/lymphoma screening. Functional Assays: Lymphocyte Proliferation Assays and Nitroblue Tetrazolium (NBT) tests for phagocytic function. HLA Typing: Basics of tissue matching for organ transplantation.

Unit IV: Advanced Immunological Diagnostic Techniques
Western blotting: principle and applications; Flow cytometry: basic principle and clinical relevance; Chemiluminescence immunoassays (CLIA); Multiplex immunoassays; Automated immunoassay analysers used in diagnostic laboratories; Quality control and standardization in immunodiagnostics. Clinical Correlation: Interpreting results in the context of autoimmune diseases, allergies, and primary immunodeficiencies.

Unit V: Clinical Applications, Quality Assurance, and Biosafety
Immunological diagnosis of: Infectious diseases, Autoimmune diseases, Allergic disorders, Cancer (overview of tumor markers); Interpretation of immunological test results; Sensitivity, specificity, and predictive values; Sources of error and limitations of immunological assays; Biosafety, waste disposal, and ethical considerations; Recent advances in immunodiagnostics.

Suggested Readings –

1. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2021). *Basic immunology: Functions and disorders of the immune system* (6th ed.). Elsevier.
2. Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2017). *Roitt's essential immunology* (13th ed.). Wiley-Blackwell.
3. Murphy, K., Weaver, C., & Janeway, C. (2022). *Janeway's immunobiology* (10th ed.). Garland Science.
4. O'Gorman, M. R. G., & Donnenberg, A. D. (2017). *Handbook of human immunology* (2nd ed.). CRC Press.
5. Wild, D. (2013). *The immunoassay handbook: Theory and applications of ligand binding, ELISA and related techniques* (4th ed.). Elsevier.
6. Buckingham, L., & Flaws, M. L. (2019). *Molecular diagnostics: Fundamentals, methods, and clinical applications* (2nd ed.). F. A. Davis Company.
7. Tizard, I. R. (2021). *Veterinary immunology: An introduction* (11th ed.). Elsevier.

Semester–V						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 504	Molecular diagnostics of Genetic and Rare Diseases	42	3	40	60	100

Unit I: Foundations of Human Genetics & Rare Diseases
The Rare Disease Landscape: Principles of human genetics, patterns of inheritance, autosomal and sex-linked disorders, mitochondrial inheritance, genomic imprinting, mosaicism, chromosomal abnormalities, repeat expansion disorders, and genotype–phenotype correlations. Types of Genetic Lesions: Single Nucleotide Variants (SNVs), Indels, Copy Number Variations (CNVs), and Trinucleotide Repeat Expansions.

Unit II: Cytogenetic and Genome-Wide Diagnostic Techniques
Cytogenetic techniques in clinical applications in rare diseases. Karyotyping & G-Banding: Detecting aneuploidies (Down Syndrome, Turner Syndrome). Fluorescence In-Situ Hybridization (FISH): Using fluorescent probes for microdeletion syndromes and gene translocations. Chromosomal Microarray (CMA): Principles of Array CGH (Comparative Genomic Hybridization) for detecting submicroscopic gains and losses. Non-Invasive Prenatal Testing (NIPT): Analyzing cell-free fetal DNA (cffDNA) from maternal blood for trisomies.

Unit III: Molecular Techniques for Genetic Disease Diagnosis
Targeted PCR & Sanger Sequencing: The gold standard for validating known familial mutations (e.g., Sickle Cell Anemia, Thalassemia). MLPA (Multiplex Ligation-dependent Probe Amplification): The primary method for detecting exon-level deletions/duplications in genes like DMD (Duchenne Muscular Dystrophy). Triplet Repeat Analysis: Using TP-PCR for Fragile X Syndrome and Huntington's Disease. Biochemical Genetics: Mass Spectrometry (LC-MS/MS) for Newborn Screening (NBS) of Inborn Errors of Metabolism (IEMs).

Unit IV: Next-Generation Sequencing in Rare Disease Diagnostics
Gene Panels vs. Whole Exome Sequencing (WES): When to use a focused panel vs. sequencing all protein-coding regions. The NGS Wet-Lab Pipeline: Library preparation, target enrichment (hybridization capture), and sequencing runs. The NGS Dry-Lab Pipeline: Alignment & Variant Calling: Mapping reads to the reference genome. Variant Annotation: Using databases like ClinVar, gnomAD, and OMIM. ACMG Guidelines: Classifying variants as Pathogenic, Likely Pathogenic, or VUS (Variant of Uncertain Significance).

Unit V: Clinical Reporting, Genetic Counselling, and Ethical Issues
The Clinical Workflow: Patient consent, pre-test counseling, and specialized sample collection (e.g., amniotic fluid, chorionic villus sampling, or peripheral blood). Variant classification principles, diagnostic reporting, genetic counselling and concepts. Ethics & Regulation: Handling Incidental Findings, patient privacy (HIPAA/GDPR), and the role of Genetic Counselors. Informed consent, incidental findings, ethical issues, data privacy, and regulatory aspects of genetic testing.

Suggested Reading

1. Nussbaum, R. L., McInnes, R. R., & Willard, H. F. (2016). *Thompson & Thompson genetics in medicine* (8th ed.). Elsevier.
2. Strachan, T., Read, A. P., & Lindsay, S. (2018). *Human molecular genetics* (5th ed.). Garland Science.
3. Richards, S., et al. (2015). Standards and guidelines for the interpretation of sequence variants. *Genetics in Medicine, 17*(5), 405–424.
4. Turnpenny, P., & Ellard, S. (2017). *Emery's elements of medical genetics* (15th ed.). Elsevier. data privacy, and regulatory aspects of genetic testing.

Semester–V						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 505	Genetic Counselling	42	3	40	60	100

Unit I: Fundamentals of Genetic Counselling
Concept, definition, and scope of genetic counselling. Objectives and principles of genetic counselling. Indications for genetic counselling. Roles and responsibilities of genetic counsellors and health care professionals. Types of genetic counselling: prospective, retrospective, and crisis counselling. Basic steps in the genetic counselling process: history taking, pedigree construction, risk assessment, communication of genetic information, and follow-up. Psychosocial aspects of genetic counselling. Importance of ethical and non-directive counselling.

Unit II: Pedigree Analysis and Risk Calculation
Introduction to pedigree analysis in genetic counselling. Standard symbols and nomenclature used in pedigree construction. Pedigree drawing using family case histories. Identification of inheritance patterns through case studies: autosomal dominant, autosomal recessive, X-linked, and mitochondrial inheritance. Case-based risk calculation and recurrence risk estimation in single-gene disorders using probability principles. Interpretation of pedigree findings for genetic counselling. Limitations of pedigree analysis and risk estimation in clinical practice.

Unit III: Clinical Applications of Cytogenetics & Molecular Techniques
Tests for assessing chromosomal anomalies, Methods of chromosome analysis- Karyotyping and chromosomal banding, Fluorescent In-Situ Hybridization, Comparative Genomic Hybridization. Molecular diagnostic techniques: PCR, real-time PCR, DNA sequencing (Sanger and NGS), MLPA, microarrays, and cytogenetic methods. Interpretation and limitations of genetic test results. Reporting of results and laboratory support for genetic counselling services.

Unit IV: Prevention of Genetic Disorders
Concept of prevention in genetics: primary, secondary, and tertiary prevention. Carrier detection and premarital counselling. Prenatal diagnostic techniques: amniocentesis, chorionic villus sampling (CVS), and non-invasive prenatal testing (NIPT). Newborn screening programmes. Prevention of congenital anomalies through nutrition (folic acid, iodine), vaccination, and infection control. Community genetics and public health approaches for prevention of genetic disorders in India.

Unit V: Ethical, Legal, and Professional Issues in Genetic Counselling
Ethical principles in genetic counselling: autonomy, beneficence, non-maleficence, justice, confidentiality, and non-directive counselling. Informed consent and privacy of genetic information. Legal and regulatory framework related to genetic testing in India. Social and cultural issues in genetic counselling. Genetic counselling in cancer, metabolic, neurological, and cardiovascular disorders. Emerging trends: precision medicine, pharmacogenomics, direct-to-consumer genetic testing, bioinformatics, and artificial intelligence in genetics. Future challenges and prospects in genetic counselling.

Suggested Reading:

1. Baker, D. L., Schuette, J. L., & Uhlmann, W. R. (2019). *A guide to genetic counseling* (3rd ed.). Wiley-Blackwell.
2. Harper, P. S. (2010). *Practical genetic counselling* (7th ed.). Hodder Arnold.
3. Jorde, L. B., Carey, J. C., Bamshad, M. J., & White, R. L. (2015). *Medical genetics* (5th ed.). Elsevier.
4. Ghai, C. L. (2013). *A textbook of medical genetics* (8th ed.). Jaypee Brothers Medical Publishers.
5. Park, K. (2023). *Park's textbook of preventive and social medicine* (27th ed.). Banarsidas Bhanot.
6. Talwar, P., & Talwar, G. P. (2014). Textbook of human genetics. CBS Publishers & Distributors.
7. Kapoor, A. (2018). Genetic Disorders and Birth Defects in India: A Clinical Approach. Jaypee Brothers Medical Publishers.

Semester–V						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 506P	Practical XI (MDS 501 & MDS 502)	168	6	40	60	100

Emerging Molecular Techniques:

1. Preparation of reagents and master mix for advance nucleic acid amplification
2. Comparative analysis of Conventional PCR and Real-Time PCR
3. Types of PCR

a) Nested PCR
b) Multiplex PCR

4. Protein Quantification: Bradford or BCA assay to measure protein concentration.
5. Multi-omics Data Interpretation: Working with simplified datasets to identify correlations between genomics, transcriptomics, and proteomics.
6. Primer Design Exercise: Designing primers for a given gene using online tools (in silico).

Clinical Molecular Pathology

1. DNA Extraction from Clinical Samples
2. Polymerase Chain Reaction (PCR) for Gene Amplification
3. Restriction Fragment Length Polymorphism (RFLP) Analysis
4. Real-Time Quantitative PCR (qPCR) for Pathogen Detection
5. Reverse Transcription PCR (RT-PCR) for RNA Analysis
6. DNA Microarray for Gene Expression Profiling
7. Molecular Detection of Infectious Agents by PCR

Semester–V						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 507P	Practical XII (MDS 503 & MDS 504)	168	6	40	60	100

Immunological Methods in Diagnostics:

1. Identification of Blood Cells: Peripheral blood smear preparation and identification of immune cells.
2. Demonstration of Antigen–Antibody Binding using colored beads or charts/models.
3. Determination of Antibody Titre (Demo): Using serial dilution concept.
4. Single Radial Immunodiffusion (SRID): Estimation of immunoglobulin concentration (demo).
5. Western Blotting Demonstration: Understanding band patterns and result interpretation.

Molecular diagnostics of Genetic and rare diseases

1. Isolation of genomic DNA from blood.
2. RFLP analysis for genetic variation detection.
3. Analysis of clinical case summaries to correlate genetic mutations with phenotypes.
4. Chromosomal Abnormalities Identification: Karyotype image analysis to detect trisomy, deletions, translocations
5. Interpretation of gel images or reports for disorders like Huntington’s disease or Fragile X syndrome

Semester–VI						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MDS 601	Clinical Training and Internship	616	22	--	400	400

Clinical Training & Internship Guidelines

- -The Clinical Training (CT) & Internship is a mandatory, full-time experiential learning phase of five months. This training must be conducted at a University-approved Laboratory, Hospital, or Medical College.
- MDS students will engage in intensive, hands-on clinical rotations. Under the direct supervision of experienced laboratory professionals and clinical staff, students will observe, assist, and eventually perform procedures.
- Students are required to document their clinical findings or a specific research project in a Dissertation, following the standard Jamia Millia Islamia (JMI) format.
- All data must be verified and authenticated by the designated Supervisor or Departmental In-charge.
- A duly signed and hard-bound dissertation must be submitted to the Centre prior to the commencement of the CT & Internship examination. Completion of this submission is a prerequisite for appearing in the final assessment.
- Upon successful and satisfactory completion of the five-month tenure, the Supervisor/In-charge will issue a Completion Certificate before the submission of dissertation.
- The final assessment of the CT & Internship will be conducted to evaluate both theoretical knowledge and practical proficiency. The examination components include presentation, thesis report and comprehensive oral examination.

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