B. Voc. Medical Laboratory Science

(B. Voc. - MLS)

(Syllabus)

w. e. f. Academic Session 2026-2027

DDU KAUSHAL Kendra

Jamia Millia Islamia

New Delhi-110025

B.VOC. Medical Laboratory Science (B.VOC. MLS)

Duration: Three Years (6 semesters)

B.Voc. Medical Laboratory Science is a three-year, skill-based undergraduate programme that prepares students to work as competent medical laboratory professionals in hospitals, diagnostic centres and research laboratories. It blends theoretical knowledge of human biology and disease with intensive hands-on training in modern laboratory techniques and quality-assured diagnostic practices.

DDU KAUSHAL Kendra is committed to providing the resources and infrastructure required to effectively operate and sustain on the scientific principles and practice of medical laboratory testing for disease diagnosis, prognosis and monitoring. We emphasise employability through vocational training, internships and on-the-job learning aligned with national healthcare skill standards.

Core areas typically include clinical biochemistry, hematology, microbiology, immunology, pathology and basic molecular diagnostics. Supporting subjects often cover anatomy and physiology, laboratory techniques, biomedical waste management, computer skills and professional ethics. Students learn specimen collection, processing and analysis; operation and maintenance of laboratory equipment; and accurate reporting of test results. Training builds competence in quality control, laboratory safety, documentation, teamwork and communication within a healthcare setting.

Graduates can work as medical laboratory technologists/technicians in hospitals, diagnostic labs, blood banks, public health laboratories and physician office labs. With experience and further study, they may progress into specialized laboratory roles, supervisory positions, quality assurance, or roles in laboratory equipment and diagnostic industries.

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Sem.	S. No	Paper Code	Paper Name	Total Hrs	Credit	IA	SE	Total
1	**Knowledge Components**							
	1	MLS 101	Human Anatomy	42	3	40	60	100
	2	MLS 102	Human Physiology	42	3	40	60	100
	3	MLS 103	Biochemistry	42	3	40	60	100
	4	MLS 104	Cell and Molecular Biology	42	3	40	60	100
	Skill Components							
	5	MLS 105	Information Technology	42	3	40	60	100
	6	MLS 106	Communication Skill and Professional Ethics	42	3	40	60	100
	7	MLS 107P	Practical I (MLS101, MLS 102)	168	6	40	60	100
	8	MLS 108P	Practical II (MLS 103, MLS 104)	168	6	40	60	100
			Total	**588**	**30**	**320**	**480**	**800**

Sem.	S. No	Paper Code	Paper Name	Total Hrs	Credit	IA	SE	Total
2	**Knowledge Components**							
	1	MLS 201	Clinical Pathology	42	3	40	60	100
	2	MLS 202	Genetics and Genomics	42	3	40	60	100
	3	MLS 203	Biomedical Instrumentation	42	3	40	60	100
	4	MLS 204	Microbiology and Immunology	42	3	40	60	100
	5	MLS 205	Haematology	42	3	40	60	100
	Skill Components							
	6	MLS 206P	Practical III (MLS 201, MLS 205)	168	6	40	60	100
	7	MLS 207P	Practical IV (MLS 202, MLS 203)	168	6	40	60	100
	8	MLS 208P	Practical V (MLS 204)	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	MLS 301	Clinical Biochemistry	42	3	40	60	100
	2	MLS 302	Bacteriology and Mycology	42	3	40	60	100
	3	MLS 303	Blood Banking & Transfusion Medicine	42	3	40	60	100
	Skill Components							
	4	MLS 304P	Practical VI (MLS 301)	84	3	20	30	50
	5	MLS 305P	Practical VII (MLS 302)	84	3	20	30	50
	6	MLS 306P	Practical VIII (MLS303)	84	3	20	30	50
	7	MLS 307P	Clinical Training I	224	8	-----	200	200
			Total	**602**	**26**	**180**	**470**	**650**

4								
	S. No	**Paper Code**	**Paper Name**	**Total Hrs**	**Credit**	**IA**	**SE**	**Total**
	Knowledge Components							
	1	MLS 401	Diagnostic Endocrinology	42	3	40	60	100
	2	MLS 402	Diagnostic Biomarkers	42	3	40	60	100
	3	MLS 403	Parasitology & Virology	42	3	40	60	100
	4	MLS 404	Molecular and Immunological methods	42	3	40	60	100
	Skill Components							
	4	MLS 405	Data analysis and quality assurance	42	3	40	60	100
	5	MLS 406P	Practical IX (MLS 401, MLS 402)	168	6	40	60	100
	6	MLS 407P	Practical X (MLS 403, MLS 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	MLS 501	Histopathology & Cytology	42	3	40	60	100
	2	MLS 502	Advanced Molecular Diagnostic	42	3	40	60	100
	3	MLS 503	Public Health	42	3	40	60	100
	Skill Components							
	4	MLS 504	Entrepreneurship & Management in Healthcare	42	3	40	60	100
	5	MLS 505P	Practical XI (MLS 501)	84	3	20	30	50
	6	MLS 506P	Practical XII (MLS 502)	84	3	20	30	50
	7	MLS 507P	Clinical Training II	224	8	----	200	200
			Total	**560**	**26**	**200**	**500**	**700**
6								
	Sl No	**Paper Code**	**Paper Name**	**Total Hrs**	**Credit**	**IA**	**SE**	**Total**
	Skill Components							
	2	MLS 601P	Clinical Training & Internship	**616**	**22**		**400**	**400**
			Total	**616**	**22**		**400**	**400**
			Grand total (semester I-VI)	**3542**	**161**	**845**	**3155**	**4000**

Total skill Component Credits in all (I-VI) semesters : **104 Credits**
Total knowledge Component Credits in all (I-VI)semesters: **57 Credits**
Total Credits (I-VI semesters) = **161**
Total Marks (I-VI)semesters = **4000**
Total Hours (I-VI) semesters = **3542** (Skill Components **2744** Hrs & Knowledge Components **798** Hrs.

Semester–I						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MLS 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**
MLS 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**
MLS 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**
MLS 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**
MLS 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**
MLS 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**
MLS 107P	Practical I (MLS 101, MLS 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**
MLS 108P	Practical II (MLS 103, MLS 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**
MLS 201	Clinical Pathology	42	3	40	60	100

Unit I: General Pathology and Cell Injury

Introduction to pathology, its definition and branches. Etiopathogenesis of disease, Common terminologies used in Pathology. Importance of Pathology in diagnostics. Cellular adaptation- Definition and types. Etiology of cell injury and its types. Cellular morphologic changes in reversible and irreversible injury. Cell death and its types. Patterns of necrosis. Intracellular Accumulation- Etiopathogenesis and its types, endogenous and exogenous pigments.

Unit II: Inflammation and Hemodynamics

Inflammation: Overview, hallmarks and its classification, acute and chronic Inflammation- phases and role of its chemical mediators. Granulomatous Inflammation: Pathogenesis, types, formation of granuloma. Wound Repair-Types, role of macrophages and fibroblasts, disease associated with abnormal wound repair. Hemodynamics: Normal physiology of Fluid Balance in tissue and pressure gradients, Etiopathogenesis of edema, transudates and exudate. Hyperaemia and congestion. Thrombosis-Virchow's Triads and Fate of Thrombosis. Ischemia and infarction.

Unit III: Neoplasia

Definition and Overview of Neoplasm, Classification and nomenclature of tumours. Dysplasia, Invasion and Metastasis. Pathways of Metastasis and its clinical importance. Hallmarks of cancer. Carcinogenesis-Overview and types. Diagnosis of Cancer:Clinical features, laboratory investigation including cancer biomarkers, radiological investigations, Gross and microscopic changes. Management of Cancer-Surgery, Chemotherapy, Immunotherapy, Radiotherapy.

Unit IV: Clinical Pathology

Routine urine examination- indication, specimen collection. Examination of urine- physical, chemical and microscopic. Automation in urine examination. Body fluids: CSF, pleural, peritoneal, synovial, pericardial. Indications for collection of body fluids, normal and abnormal findings in body fluids, processing and examination in a body fluid including physical, chemical, TLC, DLC and microscopic examination.

Unit V: Systemic Pathology

Cardiovascular system- atherosclerosis, ischemic heart disease. Respiratory diseases: chronic obstructive lung disease, chronic restrictive lung disease, respiratory infections. Thyroid Goiter, Hashimoto's thyroiditis. Breast benign conditions and carcinoma, types of surgeries in breast carcinoma. Nervous system: infective diseases, ischemic brain damage, cerebral infarction, degenerative diseases. Digestive System-Barret's oesophagus, cirrhosis of liver. Excretory System: glomerulonephritis, nephritic & nephrotic Syndrome, pyelonephritis, hydronephrosis.

Suggested reading:

1. Mohan, H. (2014). Textbook of Pathology. India: Jaypee Brothers Medical Publishers Pvt. Limited.
2. Kumar, V., Abbas, A. K., Abbas MBBS, A. K., Aster, J. C. (2014).
3. Robbins & Cotran Pathologic Basis of Disease. United Kingdom: Elsevier Health Sciences.
4. Bhardwaj, J. R. (2013). Boyd's Pathology. Wolters kluwer india Pvt Ltd.
5. Kawthalkar, S. M. (2018). Essentials of clinical pathology. JP Medical Ltd.

Semester–II						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MLS 202	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 and 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
4. Russell, P. J. (2009). Genetics- A Molecular Approach.III Edition. Benjamin Cummings
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. Introduction to Genetic Analysis. IX Edition. W. H. Freeman and Co.
6. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Edition. Wiley India.

Semester–II						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MLS 203	Biomedical Instrumentation	42	3	40	60	100

Unit I: Laboratory Safety:
Laboratory safety measures, safe handling and storage of chemicals, reagents and solvents, laboratory hazards: chemical, biological, physical, mechanical, electrical, accident types, first aid in laboratory accidents, laboratory contamination, laboratory-associated infections, prevention of laboratory-acquired infections, personal protective equipment, chemical and biological waste disposal, biosafety cabinets: types and classifications, biosafety levels: BSL-1 to BSL-3 concepts, WHO biosafety regulations, basic laboratory practices and safety procedures, emergency response systems, fire safety and extinguishers.

Unit II: Clinical Laboratory Organization:
Laboratory management system, categories of clinical laboratories, safe laboratory layout and design, workflow optimization, laboratory organization standards, laboratory SOPs and manuals, staff roles and responsibilities, staff training and competency programs, quality assurance and quality control fundamentals, internal and external quality assessment, equipment calibration and validation, documentation and record keeping, research and literature sources: medical dictionaries, Merck Index, PubMed, scientific journals, role of seminars, workshops, and conferences.

Unit III: Basic Laboratory Instruments
Centrifuges: importance, principle, components, types, working, care and maintenance, water bath: uses and maintenance, analytical and electronic balances, hot plate, magnetic stirrer, hot air oven, incubator, pH meter principles and calibration, water distillation apparatus, autoclave basics, laminar airflow cabinet, microscopy: types of microscopes (light, phase contrast, fluorescent), components, principles, indications, microtome basics.

Unit IV: Solutions and Reagents:
Definitions of solutions, acids, bases, preparation of reagents, preparation of normal, molar, and percent solutions, stock and working solutions, buffer solutions: types, preparation, pH and physiological significance, titration principles, reagent water grades: Type I, II, III water, diagnostic kits and reagent stability, storage conditions, buffered substrates, osmolarity and tonicity concepts.

Unit V: Laboratory Techniques:
Colorimetry, photometry, spectrophotometry, flame photometry, fluorometry, turbidimetry, nephelometry, densitometry, qualitative and quantitative end-point reaction methods, kinetic assay principles, chromatography: principles, chromatographic performance parameters, paper chromatography, thin-layer chromatography, column chromatography, HPLC basics, electrophoresis: principles, types, electrophoresis of proteins, nucleic acids, agarose and PAGE basics, immunochemical techniques, immunoturbidimetry, ELISA basics.

Suggested Reading:

1. Rashid, N., & Sood, R. Manual of laboratory safety.
2. Godkar, P. B., & Godkar, D. P. Textbook of medical laboratory technology. Bhalani Publishing House.
3. Haven, M. C., Tetrault, G. A., & Schenken, J. R. (1994). Laboratory Instrumentation. John Wiley & Sons.
4. Waheed, U., Arshad, M., Noor e S., Farooq, A., & Wazeer, A. (2020). Handbook of Medical Laboratory Instrumentation (2nd ed.). South Asian Association of Medical Laboratory Scientists.
5. Turgeon, M. L. (2022). Clinical Laboratory Science: Concepts, Procedures, and Clinical Applications (9th ed.). Elsevier.

Semester–II						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MLS 204	Microbiology and Immunology	42	3	40	60	100

Unit I: Introduction to Microbiology

Medical Microbiology: Definition, scope, and applications, Discovery of Microorganisms: Historical overview, Antony van Leeuwenhoek: Simple microscope, first observation of microorganisms, Louis Pasteur: Germ theory of disease, fermentation, pasteurization, spontaneous generation, Robert Koch: Koch's postulates, pure culture techniques, Edward Jenner: Vaccination, smallpox prevention, Metchnikoff: Phagocytosis, cellular immunity, Alexander Fleming: Penicillin, antibiotics.

Unit II: Control of growth of Microorganism & Biomedical Waste management

Control of Microbial Growth: Principles and objectives of microbial control, relative resistance of microorganisms. Physical methods of control: Heat (dry and moist), radiation, filtration, low temperature, desiccation, osmotic pressure. Chemical methods of control: disinfectants, antiseptics, sterilizing agents. Hazardous and Biomedical Waste: Definition, classification, and categories. Central Sterile Services Department (CSSD). Biomedical Waste Generation: Sources and locations in hospitals and laboratories segregation of biomedical waste: Color coding, labeling. Biomedical Waste Management: Collection, storage, transportation, treatment, and disposal methods.

Unit III: Cultivation of Microorganism and Staining techniques:

Cultivation of Microorganisms: Purpose, principles, and laboratory applications. Growth requirements: Chemical, physical, essential growth factors. Culture Media: History, need for culture media, Types of media, preparation, sterilization, storage, and quality control. Microbiological stains: Classification, principles, and applications. Staining Techniques: Simple staining, negative staining, impregnation methods. Differential Staining: Gram staining, Ziehl–Neelsen stain, Special staining methods: Albert stain, endospore, capsule, flagella stains. Rapid Tests: KOH test and its diagnostic significance.

Unit IV: Immune Response:

Cells and organs of the Immune system, Immunity: innate and acquired immunity, humoral and cell mediated immunity, T lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), primary and secondary immune response. Antigen: Classes, properties (foreignness, molecular size, heterogeneity, route and dose of administration, solubility and degradability), Antigenicity, immunogenicity and hapten. Antibodies/Immunoglobulins: Structure, Properties, Types of Immunoglobulins, Introduction to serology. Complement system: Components of the complement activation-classical, alternative and lectin pathways; biological consequence of complement activation. Basic introduction and properties of cytokines: IL-2, IL-4 and IFN-γ.

Unit V: Hypersensitivity, Autoimmunity, and Transplantation:

Allergy and Hypersensitivity: Definition and mechanisms, classification of Hypersensitivity: Type I, Type II, Type III, Type IV. Major Histocompatibility Complex (MHC): Structure, classes, and functions, antigen presentation: Antigen-presenting cells, processing pathways. Tumor Immunity: Anti-tumor immune responses, immune surveillance. Immunological tolerance: Central tolerance, peripheral tolerance, tolerance in T and B Cells: Mechanisms and regulation. Autoimmunity: Incidence of autoimmune diseases, breakdown of tolerance, mechanisms, autoimmune diseases. Transplantation Immunology: Basis of transplantation, Graft Rejection: Hyperacute, acute, and chronic rejection, modern transplantation techniques: Immunosuppression and tissue typing.

Suggested Readings:

1. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2007). Cellular and molecular immunology (6th ed.). Saunders Elsevier.
2. Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2006). Roitt's essential immunology (11th ed.). Wiley-Blackwell.
3. Goldsby, R. A., Kindt, T. J., Osborne, B. A., & Kuby, J. (2007). Kuby's immunology (6th ed.). W. H. Freeman and Company.
4. Murphy, K., Travers, P., & Walport, M. (2008). Janeway's immunobiology (7th ed.). Garland Science.
5. Peakman, M., & Vergani, D. (2009). Basic and clinical immunology (2nd ed.). Churchill Livingstone Elsevier.

Semester–II						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MLS 205	Hematology	42	3	40	60	100

Unit I: Principles of Hematopoiesis and Laboratory Foundations

Overview of the haematology laboratory's role in diagnosis. Principles and sites of hematopoiesis. Basic understanding of hematopoietic stem cells and bone marrow structure. Laboratory procedures for bone marrow aspiration and biopsy: common sites, specimen collection, and slide preparation. Developmental overview of blood cell lineages.

Unit II: Laboratory Diagnosis of Anemias

Definition and laboratory-based classification of anemias (morphological and etiological). Technical protocols for complete blood count (CBC), red cell indices, reticulocyte count, and peripheral smear examination in anemia. Laboratory investigation of impaired production anemias: Iron studies (serum iron, TIBC, ferritin) for iron deficiency anemia and hemochromatosis; vitamin B12 and folate assays for megaloblastic anemia. Diagnostic workup for hemolytic anemias: Principles of direct and indirect antiglobulin test (Coombs' test), osmotic fragility, and enzyme assays for G6PD and Pyruvate Kinase deficiencies.

Unit III: Analysis of Hemoglobinopathies and Blood Parasites

Laboratory definition and classification of hemoglobinopathies. Standard operating procedures for sickle cell testing (sickle solubility test) and hemoglobin electrophoresis (cellulose acetate, alkaline pH). Principles and operation of High-Performance Liquid Chromatography (HPLC) for hemoglobin variant analysis. Laboratory diagnosis of thalassemias. Identification of blood parasites: Microscopic examination of thick and thin blood smears for malaria parasites and concentration techniques for microfilaria detection.

Unit IV: Laboratory Evaluation of White Blood Cell Disorders

Techniques for performing and interpreting manual and automated white blood cell differential counts (TLC, DLC). Laboratory investigation of quantitative WBC disorders. Distinguishing leukemoid reaction from true leukemia. Principles of laboratory diagnosis for leukemias: Peripheral smear morphology, cytochemistry (e.g., myeloperoxidase, Sudan Black B, esterase stains), and introduction to immunophenotyping (flow cytometry) for classification (AML, ALL, CML, CLL). Basic overview of laboratory findings in lymphomas.

Unit V: Coagulation and Hemostasis Laboratory Testing

Laboratory definition and classification of hemostatic disorders. Procedures for platelet count evaluation and investigation of thrombocytopenia/thrombocytosis. Prothrombin Time (PT), Activated Partial Thromboplastin Time (APTT), Thrombin Time (TT), and Fibrinogen assay. Principles of fibrinolysis and D-dimer testing. Laboratory approach to vascular purpuras. Monitoring of anticoagulant therapy: principles and procedures for Heparin monitoring (APTT, Anti-Xa assay) and oral anticoagulant monitoring (PT/INR).

Suggested reading:

1. Kawthalkar, S. M. (2012). Essentials of Haematology. India: Jaypee Brothers Medical Publishers Pvt. Limited.
2. Bain, B. J., Bates, I., Laffan, M. A. (2016). Dacie and Lewis Practical Haematology. United Kingdom: Elsevier.
3. Saxena, R., Pati, H., Mahapatra, M. (2011). Atlas of Hematology. India: Jaypee Brothers Medical Publishers Pvt. Limited.
4. Godkar, P. B., Godkar, D. P. (2003). Textbook of Medical Laboratory Technology. India: Bhalani Publishing House.
5. Sood, R. (2015). Concise Book of Medical Laboratory Technology. India: Jaypee Brothers Pvt. Limited.

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

Clinical Pathology:

1. To study the microscopic features of fatty change and coagulative necrosis.
2. To study the microscopic features of acute and chronic inflammation.
3. Demonstration of microscopic features of chronic granulomatous inflammation and metaplasia.
4. To learn about the sample collection physical & chemical examination by dipstick method.
5. Demonstration of glycosuria by Benedicts method.
6. Demonstration of proteinuria by Sulphosalicylic Acid test.
7. Demonstration of ketonuria by Rothera method.
8. To study the microscopic examination of urine.

Hematology:

1. Demonstration of different anticoagulant used in haematology laboratory, vials, vacutainers, colour codes and order of draw.
2. Preparation and staining of a blood smear.
3. To determine the relative number of each type of white cell present in the blood by performing differential leucocyte count (DLC).
4. Determination of Erythrocyte sedimentation rate – Westergren and Wintobe methods.
5. Procedure for preparation and determination of reticulocyte count.
6. Interpretations of abnormal Heamoglobin HPLC graph.

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

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.

Biomedical Instrument:

1. Preparation of percent solution, Molar solution and Normal solution.
2. Calibration and accuracy check of pipettes and volumetric glassware
3. Preparation of buffers and adjusting their pH by using pH meter.
4. Quantitative estimation of protein by using spectrophotometry.
5. Performing thin layer chromatography.
6. Preparation of agarose gel and SDS-polyacrylamide gel and performing electrophoresis.

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

Microbiology and Immunology:

1. Understanding the autoclave and sterilization procedures.
2. Understanding the laminar flow equipment and its function.
3. Preparation of basic liquid media (broth) for the routine cultivation of bacteria.
4. Preparation of basic solid media and agar slants for the routine cultivation of microoganisms.
5. Inoculation of cultures through loops.
6. Procedure for the growth of microorganisms on solid media by the spread plate technique.
7. Isolation and enumeration of microorganisms from culture by the serial dilution agar plating method or viable plate count methods.
8. Detection of *Salmonella typhi* antibodies by Typhidot Test.
9. Detection of C-reactive protein (CRP) by latex agglutination.

Semester–III						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MLS 301	Clinical Biochemistry	42	3	40	60	100

Unit I: Integration of metabolism

Integration of metabolism in fed, fasting and starvation state. Phases of Starvation and Diabetes. Metabolism of calcium, phosphorus, sulphur etc, disease associated with abnormal metabolism of calcium and phosphorus, metabolism of trace elements. bone metabolism, markers of bone metabolism.

Unit II: 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 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**
MLS 302	Bacteriology and Mycology	42	3	40	60	100

Unit I: Collection, Transport and Examination of specimens:
General principles of specimen collection, aseptic techniques, and biosafety precautions; specimen labeling and documentation; preservation methods and transport media; transportation conditions and time limits; and criteria for specimen acceptance and rejection. Specimen-wise collection and examination: Urine specimens: types, collection methods, and transport; urogenital specimens: urethral, cervical, and vaginal swabs; throat and mouth specimens: swab collection and handling; fecal specimens: collection, preservatives, and examination; blood and bone marrow: aseptic collection and anticoagulants; cerebrospinal fluid: collection and transport; eye specimens: conjunctival swabs and scrapings; Ear discharge: types of ear specimens and transport; pus from wounds, abscesses, burns, etc.

Unit II: Bacterial Identification and Automation in Bacteriology
Culture Media: types of culture media; Culture Methods: aerobic culture methods, anaerobic culture methods (McIntosh & Filde's jar and GasPak system); Identification Methods: morphology and culture characteristics, staining reactions, resistance patterns, metabolic properties; Biochemical Properties: IMViC tests, urea hydrolysis test, TSI test, oxidase test, catalase test, coagulase test (tube and slide), motility test, antibiotic resistance, antimicrobial sensitivity tests; Automation in Bacteriology: BACTEK system, ATB system, VITEK system, API systems, BacT/ALERT 3D automated microbial detection system.

Unit III: Study of Gram-positive bacteria
Morphology, biochemical tests, cultural characteristics, virulence factors, pathogenicity, and laboratory diagnosis of Gram-positive cocci: *Staphylococcu*s and *Streptococcus*; Gram-positive bacilli: *Corynebacterium, Mycobacterium, Listeria, and Lactobacillus*. Anaerobic bacteria; Morphology, biochemical tests, cultural characteristics, virulence factors, pathogenicity, and laboratory diagnosis of *Clostridium* species.

Unit IV: Study of Gram-negative bacteria
Morphology, biochemical tests, culture characteristics, virulence factors, pathogenicity, and laboratory diagnosis of Gram-negative cocci: *Neisseria gonorrhoeae and Neisseria meningitidis*. Gram-negative bacilli: morphology, biochemical tests, culture characteristics, virulence factors, pathogenicity, and laboratory diagnosis of *Enterobacteriaceae, Pseudomonas, Vibrio, Aeromonas, Plesiomonas, Campylobacter, Bacteroides, Bordetella, Brucella, Haemophilus,* and other atypical Gram-negative organisms including *Spirochaetes*, *Chlamydia, Rickettsia and Mycoplasma*, etc.

Unit V: Mycology
Structure, general properties and characteristic features of clinically important fungi, classification of pathogenic Fungi, morphology of fungi, brief idea of dermatophytes, cutaneous mycoses, systemic mycoses; opportunistic mycoses, mycotoxins sample collection - Laboratory diagnosis of fungi; culture and laboratory test for fungus, KOH preparation, LCB mount –India Ink preparation, antifungal susceptibility testing.

Suggested reading:

1. Maheshwari, N. (2021). Clinical Microbiology & Parasitology (3rd ed.). India: Jaypee Brothers Medical Publishers.
2. Kumar, D. R. (2019). Diagnostic Microbiology (2nd ed.). Jaypee Brothers Medical Publishers.
3. C K Jayaram Paniker, R. A. (2020). Ananthanarayan and Paniker's Textbook of Microbiology. India: Orient Blackswan Pvt Limited.
4. Godkar, P. B., & Godkar, D. P. (2016). Textbook of medical laboratory technology. Bhalani Publishing.

Semester–III						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MLS 303	Blood Banking & Transfusion Medicine	42	3	40	60	100

Unit I: Immunohematology Fundamentals for the Blood Bank
Principles of immunity, definitions of antigens, antibodies, and their interactions. Characteristics of red cell antigens and the clinical significance of blood group antibodies, Role of the complement system, ABO and Rh blood group systems: genetics, biochemistry, common variants, and subgroups. Antibody characteristics in ABO and Rh systems. Identification and special handling requirements for Bombay (Oh) phenotype. Overview of other clinically significant blood group systems (e.g., Kell, Duffy, Kidd).

Unit II: Technical Procedures in Pretransfusion Testing
Principles of hemagglutination, factors influencing reaction strength, and standard grading systems. Troubleshooting ABO blood grouping discrepancies. Antihuman globulin (Coombs') test: principles, clinical applications, and its types-Direct Antiglobulin Test (DAT) and Indirect Antiglobulin Test (IAT). Antibody screening procedures, Compatibility testing protocols-major and minor crossmatch techniques.

Unit III: Donor Management and Component Collection
Blood donation and donor classification, donor screening, selection, and eligibility criteria. Technical skills in phlebotomy for whole blood collection. Management of donor adverse reactions. Composition and storage requirements of anticoagulant-preservative solutions (e.g., CPDA-1, SAGM). Principles and operation of apheresis equipment. Types of apheresis procedures (plateletpheresis, plasmapheresis) and their indications. Transfusion-transmitted infections (TTIs) and their methodologies in screening.

Unit IV: Component Preparation and Processing Laboratory
Fundamental principles of blood component preparation using centrifugation. Technical preparation of standard blood components: packed red blood cells, fresh frozen plasma (FFP), platelet concentrates (from whole blood and apheresis), and cryoprecipitate. Indications for leukoreduction: methods and quality control. Preparation and quality standards for irradiated blood components. Storage, handling, and transportation protocols for all blood components.

Unit V: Clinical Transfusion Practice and Investigation
Procedures for special transfusion scenarios: preoperative autologous donation, intraoperative blood salvage, and therapeutic apheresis. Protocols for massive transfusion, exchange transfusion, and neonatal/pediatric transfusions. Recognition, classification, and initial laboratory investigation of acute and delayed transfusion reactions. Overview of blood transfusion alternatives. Laboratory techniques and serological workup for diagnosing and investigating Hemolytic Disease of the New born (HDN), including Rh and ABO incompatibility.

Suggested reading:

1. Mehdi, S. (2013). Essentials of Blood Banking: (A Handbook for Students of Blood Banking and Clinical Residents). India: Jaypee Brothers Medical Publishers Pvt. Limited.
2. Godkar, P. B., Godkar, D. P. (2003). Textbook of Medical Laboratory Technology. India: Bhalani Publishing House.
3. Modern Blood Banking & Transfusion Practices. (2018). United States: F.A. Davis Company.
4. Nayak, R., Nayak, R. (2019). Manual of Transfusion Medicine. India: Jaypee Brothers Medical Publishers Pvt. Limited.
5. Hillyer, C. D., Silberstein, L. E., Ness, P. M., Anderson, K. C., Roback, J. D. (2006). Blood Banking and Transfusion Medicine: Basic Principles and Practice. Switzerland: Churchill Livingstone.

Semester–III						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MLS 304P	Practical VI: MLS 301	84	3	20	30	50

Clinical 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**
MLS 305P	Practical VII: MLS 302	84	3	20	30	50

Bacteriology and Mycology:

1. Preparation of liquid media, solid media and agar slants for the routine cultivation of microorganisms.
2. Procedure of growth of microorganisms in solid media by streaking and spreading method.
3. Gram Staining.
4. Identification of bacteria by IMViC test.
5. To detect the ability of organisms to produce the catalase enzyme.
6. To detect free coagulase and bound coagulase produced by different organisms.
7. Antibiotic Sensitivity Test.
8. Demonstration of fungi in a clinical sample by treatment with 10 % KOH solution.
9. Morphological Examination of Fungi by India Ink Method.

Semester–III						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MLS 306P	Practical VIII: MLS 303	84	3	20	30	50

Blood Banking & Transfusion medicine

1. Demonstration of ABO and Rh grouping by slide method.
2. To determine ABO and Rh grouping by tube test method (forward and reverse method).
3. Determination of Du by test tube method.
4. To demonstrate the presence of H antigen on red cells.
5. To determine subgroups of blood group A by the use of anti-A1 antiserum.
6. To determine the presence of unexpected, incomplete antibody on the surface of red cells by DAT.
7. Indirect Antiglobulin test to determine the presence of unexpected, incomplete antibody.
8. Quantitative determination of Rh antibody titre.
9. To perform Cross match between donor and recipient blood to check compatibility.

Semester–III						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MLS 307P	Clinical Training I	224	8	--	200	200

Semester–IV						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MLS 401	Diagnostic Endocrinology	42	3	40	60	100

Unit I: Fundamentals of Endocrinology and Hypothalamic-Pituitary Axis
Introduction and classification of hormones, difference between hormones and enzymes, regulation and general mechanism of action of hormones, hormone receptors. Overview of hypothalamic releasing and inhibiting hormones. Anterior Pituitary Hormones- Growth hormone, Prolactin, Gonadotropin, Follicle Stimulating Hormone (FSH), Luteinizing Hormone (LH), Thyroid Stimulating Hormone (TSH), Adrenocorticotropic Hormone (ACTH). Posterior Pituitary Hormones (Neurohypophysis)-Oxytocin, Antidiuretic Hormone (ADH), and associated disorders.

Unit II: Thyroid, Parathyroid, and Adrenal Glands
T3 and T4, physiological effects, synthesis, and related disorders (e.g., hyperthyroidism, hypothyroidism). Parathyroid Hormone (PTH), Calcium and phosphate regulation, disorders (e.g., hyperparathyroidism). Adrenal Gland Hormones-Adrenal Cortex: Aldosterone, Glucocorticoids, Mineralocorticoids, Cortisol, Adrenal Medulla: Catecholamines (epinephrine, norepinephrine). Related clinical disorders (e.g., Addison's disease, Cushing's syndrome) and relevant diagnostic tests.

Unit III: Pancreas and Metabolic Regulation
Pancreatic Hormones: Insulin, glucagon, somatostatin. Metabolic Regulation: Role of hormones in glucose homeostasis. Clinical Disorders: Related clinical disorders (e.g., Diabetes Mellitus type 1 & 2) and their diagnostic tests.

Unit IV: Reproductive Endocrinology and Kidney Hormones
Testosterone (male), Estrogens and Progesterone (female), Human Chorionic Gonadotropin (HCG). Associated disorders related to reproductive hormones (e.g., infertility, PCOS, hypogonadism). Introduction to Renin-Angiotensin system and its role.

Unit V: Practical & Quality Assurance
Specimen types (serum, plasma, urine, saliva), handling, transport, storage, stability and common pre-analytical errors in hormone testing. Factors affecting hormone assay results: binding proteins, circadian rhythm, drugs, sample type, storage, and standardization/quality control. Calibration curves, limits of detection, sensitivity, specificity, linearity and reportable range for hormone assays. Interferences: cross-reactivity, heterophile antibodies, high-dose hook effect, macro-hormones (e.g. macroprolactin), lipemia/hemolysis/biotin effects and approaches to detection.

Suggested Readings:

1. Hadley, M. E., & Levine, J. E. (2017). Endocrinology (6th ed.). Pearson Education.
2. Rifai, N. (2023). Tietz fundamentals of clinical chemistry and molecular diagnostics (9th ed.). Elsevier.
3. Negi, S. C., & Chandra, S. (2023). Introduction to endocrinology (5th ed.). New Age International Private Limited; PHI Learning.

Semester–IV						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MLS 402	Diagnostic Biomarkers	42	3	40	60	100

Unit I: Introduction to Biomarkers
Definition and concept of biomarkers. Historical development and importance of biomarkers in modern medicine. Classification of biomarkers: diagnostic, prognostic, predictive, pharmacodynamic, and monitoring biomarkers. Characteristics of an ideal biomarker: specificity, sensitivity, reproducibility, and clinical relevance. Sources of biomarkers: blood, urine, tissues, saliva, cerebrospinal fluid, and other body fluids. Role of biomarkers in disease diagnosis, screening, and patient stratification.

Unit II: Immunological and Biochemical Biomarkers
Immunological biomarkers: Definition and importance of biomarkers. 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). 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.

Unit III: Molecular and Genetic Biomarkers
Introduction to molecular biomarkers. DNA-based biomarkers: mutations, single nucleotide polymorphisms (SNPs), copy number variations, and epigenetic markers. RNA-based biomarkers: mRNA, microRNA (miRNA), and long non-coding RNA (lncRNA). Protein biomarkers: enzymes, hormones, cytokines, and tumor markers. Applications of molecular biomarkers in cancer, infectious diseases, genetic disorders, and personalized medicine. Overview of techniques used for molecular biomarker detection such as PCR, real-time PCR, microarrays, and next-generation sequencing (NGS).

Unit IV: Diagnostic Techniques and Technologies for Biomarker Detection:
Pre-analytical, analytical, and post-analytical phases in biomarker testing. Sample collection, handling, and storage. Conventional and advanced diagnostic techniques for biomarker detection. Point-of-care testing (POCT) and biosensors. Automation in diagnostic laboratories. Role of bioinformatics and data analysis in biomarker discovery and validation. Quality control, standardization, and regulatory considerations in biomarker testing.

Unit V: Clinical Applications and Emerging Trends in Diagnostic Biomarkers
Clinical application of biomarkers in oncology, cardiology, neurology, endocrinology, and infectious diseases. Biomarkers in disease prognosis and therapeutic monitoring. Companion diagnostics and personalized medicine. Emerging biomarkers: liquid biopsy, circulating tumor DNA (ctDNA), exosomes, and metabolomics-based biomarkers. Challenges in biomarker discovery and clinical translation. Ethical, legal, and social issues related to biomarker research and diagnostics.

Suggested Reading:

1. Nayak, S., & Sriwastava, A. K. (2024). Concepts and methodology in cancer diagnostics: molecular approach. Elsevier Science & Technology Books.
2. Nimse, S. B., Park, M. P., & Park, M. (Eds.). (2022). Biomarkers used for the diagnosis of diseases. MDPI Books.
3. Singh, & Chandra, (2025). Protein biomarkers: Discovery and applications in clinical diagnostics. Springer Singapore.
4. Shehzad, A. (Ed.). (2022). Cancer biomarkers in diagnosis and therapeutics. Springer Singapore.
5. Henry, J. B. (Ed.). (2011). Clinical diagnosis and management by laboratory methods. Elsevier Health Sciences.
6. Vasudevan, D. M., Sreekumari, S., & Vaidyanathan, K. (2013). Textbook of Biochemistry for Medical Students (8th ed.). Jaypee Brothers Medical Publishers.
7. Sood, R. (2018). Current Trends in Diagnostic Laboratory Medicine in India. Jaypee Brothers Medical Publishers.

Semester–IV						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MLS 403	Parasitology & Virology	42	3	40	60	100

Unit I: General Parasitology

Basic concepts in Medical Parasitology, association between parasite and host, Surface, Intestinal, Blood and Tissue parasites, Effect of parasites on the host, mechanism of disease production by parasites, classification of medical parasitology. General characteristics of medically important parasites, Protozoa, Helminths, and Arthropods, Medical Entomology.

Unit II: Medically important parasites

General introduction & classification of medically important parasites, Protozoan Parasites- *Entamoeba histolytica*, *Giardia lamblia*, *Plasmodium* spp. (malaria parasite), *Leishmania* spp; Helminths- Tapeworms (cestodes), intestinal nematodes, filarial worms, tissue nematodes, Life cycle, pathogenesis, clinical presentation and laboratory diagnosis of diseases caused.

Unit III: Arthropods of Medical Importance

Importance of Arthropods in parasitology, role of arthropods as vectors, parasites, and reservoirs in disease transmission, classification of medically important Arthropods. Diseases transmitted by arthropods (vector-borne diseases), allergic reactions, toxin-mediated conditions, and mechanical transmission of pathogens.

Unit IV: General Virology and Viral Pathogenesis

Discovery and historical development of virology, General properties of viruses, structure and morphology of viruses, viral replication and growth, classification and nomenclature of medically important viruses. Modes of transmission of viral infections, Common viral diseases: overview; Arboviruses and their medical importance; Influenza and parainfluenza viruses, Measles, mumps, and rubella viruses, Rabies virus, Oncogenic viruses. Prevention and control of viral diseases: Role of interferons in antiviral defense.

Unit V: Laboratory Diagnosis of Viral Infections and Molecular Approaches

Principles of laboratory diagnosis of viral infections, Conventional diagnostic methods in virology, molecular diagnostic techniques in virology polymerase chain reaction-principle and applications, types, Human Immunodeficiency Virus-diagnosis and clinical relevance, Hepatitis viruses: laboratory diagnosis and disease relevance, Bacteriophages: structure and significance; Lytic and lysogenic life cycles; Phage typing and its applications in microbiology

Suggested Readings:

1. Paniker, C. K. J. (2017). Paniker's Textbook of Medical Parasitology. India: Jaypee Brothers Medical Publishers Pvt. Limited.
2. Chatterjee, K. D. (2009). Parasitology: (Protozoology and Helminthology). India: CBS Publishers & Distributors.
3. A & P Textbook Of Microbiology (8th ed.). (2009). India: Orient BlackSwan.
4. Maheshwari, N. (2021). Clinical Microbiology & Parasitology (3rd ed.). India: Jaypee Brothers Medical Publishers.
5. Gupte, S. (2019). The short textbook of medical microbiology (including parasitology) (12th ed.). Jaypee Brothers Medical Publishers.

Semester–IV						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MLS 404	Molecular and Immunological Methods	42	3	40	60	100

Unit I: Basic Principles of Immunological Techniques

Principles of antigen–antibody interactions, specificity, affinity and avidity, and cross-reactivity. Classical immunological reactions including precipitation, agglutination (direct, indirect, passive, reverse, latex agglutination, and hemagglutination), neutralisation, and opsonization along with their mechanisms and clinical significance. Immunodiffusion techniques including single radial immunodiffusion and double diffusion. Immunoelectrophoretic and rocket immunoelectrophoretic for qualitative and quantitative antigen analysis. Factors affecting immunological reactions and their diagnostic significance. Preparation of antigens and antibodies, purification of antibodies, analysis of antibodies and antigens.

Unit II: Labelled Immunoassay Techniques

Enzyme-linked immunosorbent assay (ELISA): types (direct, indirect, sandwich, competitive), principle of enzyme-labelled antibodies/antigens, and substrates and signal detection, clinical applications. Radioimmunoassay (RIA) and safety considerations. Immunofluorescence Techniques: Fluorochrome-labelled antibodies, direct and indirect immunofluorescence, microscopy requirements, applications in molecular immunology and disease diagnosis Chemiluminescence immunoassay (CLIA) in molecular diagnostics, advantages, limitations, sensitivity, and specificity of labelled immunoassays.

Unit III: Advanced Immunological and Molecular Methods

Western blotting for protein and antibody detection and diagnostic applications. Flow Cytometry: Principles (FSC, SSC), instrumentation, fluorochromes, immunophenotyping, clinical applications. Use of monoclonal antibodies in diagnostics. Immunoprecipitation and immune complex analysis. Immunoelectron microscopy for ultrastructural antigen localization.

Unit IV: Diagnostic Immunology: Immunological Methods and Techniques

Qualitative and quantitative immunological and serological tests used for disease diagnosis, including Widal, VDRL, ASO titre, rheumatoid factor (RA), C-reactive protein, (CRP), Hepatitis B Surface Antigen (HBsAg), Hepatitis C Virus antibody (anti-HCV), anti-HIV, Brucella agglutination test, Typhidot, Dengue NS1 antigen and IgM/IgG antibody tests, and TORCH panel.

Unit V: Recombinant DNA Technology and Monoclonal Antibodies

Recombinant DNA methods for gene cloning and expression in immunology. Production of monoclonal antibodies via hybridoma technology. Genetic engineering applications in vaccine development and therapeutic antibodies. Molecular approaches to cytokine analysis and gene expression profiling in immune cells.

Suggested Readings:

1. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2007). Cellular and molecular immunology (6th ed.). Philadelphia, PA: Saunders.
2. Owen, J. A., Punt, J., Stranford, S. A., & Jones, P. P. (2013). Kuby immunology (Vol. 27, p. 109). New York: WH Freeman.
3. Stanley, J. (2002). Essentials of immunology & serology. Cengage Learning.
4. Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2017). Roitt's Essential Immunology (13th ed.). John Wiley & Sons.
5. Richard, C., & Geoffrey, S. (2009). Immunology (6th ed.). Wiley-Blackwell.

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

Diagnostic Endocrinology:

1. Estimation of the concentration of TSH in a blood sample by ELISA method
2. Estimation of the concentration of T3 in a blood sample by ELISA method
3. Estimation of the concentration of T4 in a blood sample by ELISA method
4. Estimation of the concentration of Prolactin in a blood sample by ELISA method
5. Estimation of the concentration of Estradiol in a blood sample by ELISA method

Diagnostic Biomarkers

1. Detection of Cardiac Biomarkers (CK-MB / Troponin) by Rapid Test
2. Estimation of Tumor Markers Using ELISA
3. To estimate Alkaline Phosphatase (ALP) activity in serum as a bone biomarker.
4. To estimate Creatine Kinase-MM (CK-MM) in serum as a biomarker of muscle disease
5. Principle and Demonstration of Molecular Biomarker Techniques (PCR / RT-PCR).
6. Estimation of Carcinoembryonic Antigen (CEA) by ELISA
7. Estimation of Alpha-Fetoprotein (AFP) by Rapid Test.
8. Estimation of Prostate Specific Antigen (PSA) by ELISA / rapid test

Semester–IV						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MLS 407P	Practical X: MLS 403, MLS 404	168	6	40	60	100

Parasitology & Virology:

1. Preparation, staining and examination of a blood smear and performing DLC.
2. To determine the number of eosinophils in a sample of blood by performing absolute eosinophil count (AEC)
3. Preparation of thin & thick blood films for demonstration of blood parasites.
4. Rapid diagnosis of malaria infection by detection of malaria antigen in a blood sample.
5. To perform routine and microscopic examination of stool sample
6. Determination of reducing substance in stool – measurement of unabsorbed sugars in stool.
7. Determination of Occult blood in stool – testing presence of blood in stool
8. Detection of Hepatitis B -- qualitative detection of Hepatitis B Surface Antigen (HBsAg) in serum or plasma.

Molecular and Immunological methods:

1. Principle and procedure of Widal test.
2. Slide test for Rheumatoid factor
3. Estimation of antibody titres using Ouchterlony's double diffusion method
4. Antibody capture by ELISA
5. Estimation of ASO titre by immunological method.
6. Demonstration of cytokine detection / gene expression analysis (ELISA / PCR).
7. Dengue NS1 Antigen and IgM/IgG antibody detection by Rapid Test.
8. TORCH Panel: Detection of IgM and IgG antibodies by Rapid Immunochromatographic Test.

Semester–V						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MLS 501	Histopathology & Cytology	42	3	40	60	100

Unit I: Specimen Reception, Grossing, and Fixation

Identification and basic gross features of major human organ specimens. Core principles of histology: cells, tissues, and organs. Techniques for specimen collection: biopsies and surgical specimens. Overview of autopsy procedures. Fixation: definition, principles, classification and its aim. Specialized processing for bone tissue- methods of decalcification and end point determination.

Unit II: Tissue Processing, Embedding, and Microtomy

Fundamental principles and workflow of tissue processing. Techniques for paraffin block making and orientation. Microtomes-types and uses. Microtome knife geometry, care, maintenance, and sharpening techniques (honing and stropping). Step-by-step procedure for cutting high-quality paraffin sections and their mounting. Frozen section technique: indications, use of cryostat, sectioning, and rapid staining.

Unit III: Routine and Special Staining Techniques

Theory of staining: physical and chemical principles, dye classification (basic, acidic), and factors influencing stain quality. Concepts of metachromasia, mordants, and accentuators. Hematoxylin and Eosin (H&E) staining, differentiation, bluing, and counterstaining with eosin. Special stains: Connective tissue-Masson's Trichrome, Gomori's Trichrome, Reticulin stain. Carbohydrates and Mucins-Periodic Acid-Schiff (PAS), Alcian Blue, Mucicarmine. Pigments and Deposits-Perl's Prussian Blue (for iron), Congo Red (for amyloid), Methyl Violet. Lipids-Sudan Black (on frozen sections).

Unit IV: Cytology Specimen Processing and Staining

Definition and scope of cytopathology. Specimen collection techniques for Fine Needle Aspiration (FNAC) and exfoliative cytology (sputum, body fluids, cervical smears). Methods for sample preservation and fixation, including spray fixatives and alcohol-based solutions. Processing techniques and stains used in cytology, techniques for cell block preparation from fluid specimens and FNA material.

Unit V: Basic Immunohistochemistry (IHC) and Immunocytochemistry (ICC)

Core principle of IHC/ICC: antigen-antibody interaction for marker detection. Overview of common methods: direct, indirect, and polymer-based detection systems. Retrieval techniques, Selection and application of chromogens (DAB, AEC). Introduction to immunocytochemistry applications on cytology samples. Overview of common diagnostic markers and quality control procedures in IHC.

Suggested reading:

1. Singh, D. R. (2018). Principles and Techniques in Histology, Microscopy and Photomicrography. India: CBS Publishers & Distributors.
2. Godkar, P. B., Godkar, D. P. (2003). Textbook of Medical Laboratory Technology. India: Bhalani Publishing House.
3. Vishwakarma, S. (2017). Techniques in Histopathology and Cytopathology: A Guide for Medical Laboratory Technology Students. India: Jaypee Brothers Medical Publishers Limited.

Semester–V						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MLS 502	Advanced Molecular Diagnostic	42	3	40	60	100

Unit I: Fundamentals of Molecular Diagnostics & Laboratory Readiness
Scope and evolution of molecular diagnostics; role of molecular diagnostics in clinical decision-making; molecular diagnostic workflow including pre-analytical, analytical, and post-analytical phases; clinical sample types (blood, serum, plasma, swabs, tissue, CSF, urine); sample collection, transport, storage, and processing; nucleic acid stability and inhibitors; contamination control; molecular laboratory design and unidirectional workflow; biosafety practices; equipment segregation; Good Laboratory Practices (GLP); documentation and record keeping; internal quality control (IQC) and external quality assessment (EQA); ethical considerations; regulatory overview (ICMR).

Unit II: Nucleic Acid–Based Diagnostic Technologies:
Nucleic acid extraction methods (manual and automated); extraction from different clinical samples; yield, purity, and integrity assessment; spectrophotometric and fluorometric quality analysis; PCR principle and workflow; conventional, nested, multiplex, allele-specific, and touchdown PCR; primer design basics; positive, negative, and internal controls; real-time PCR principle; Ct value interpretation; absolute and relative quantification; melt curve analysis; digital PCR isothermal amplification techniques.

Unit III: Hybridization, Sequencing & High-Throughput Diagnostics:
Principles of nucleic acid hybridization; dot blot and reverse dot blot assays; Southern and Northern blot techniques; fluorescence in situ hybridization (FISH) basics; Sanger sequencing workflow and applications; next-generation sequencing (NGS), sequencing platforms, library preparation basics, targeted, whole exome, and whole genome sequencing concepts, introduction to bioinformatics tools (BLAST, sequence alignment, quality control), DNA microarray principles; gene expression profiling, SNP and copy number variation analysis.

UNIT IV: Applications of Molecular Diagnostics
Molecular basis of cancer; oncogenes and tumor suppressor genes; fusion genes and chromosomal translocations; minimal residual disease (MRD) monitoring; microsatellite instability (MSI); BRCA screening concept; molecular diagnosis of genetic diseases including carrier screening, new-born screening, single-gene disorders, and chromosomal disorders; predictive and pre-symptomatic testing; molecular diagnostics of infectious diseases (bacterial, viral, fungal, parasitic); viral load testing; tuberculosis PCR assays; hepatitis and HIV molecular diagnostics; forensic applications including DNA fingerprinting, STR profiling, and parentage testing.

Unit V: Cytogenetics & Molecular Cytogenetic Diagnostics:
Role of cytogenetics in clinical diagnostics; cell culture techniques for cytogenetic analysis; preparation of primary cultures; metaphase chromosome preparation; karyotyping workflow; chromosome banding techniques including G-banding, Q-banding, R-banding, and high-resolution banding; identification of constitutional chromosome patterns; numerical and structural chromosomal abnormalities; mosaicism and aneuploidy; cytogenetic applications in cancer; prenatal cytogenetics overview; molecular cytogenetics including FISH applications and chromosomal microarray analysis.

Suggested Reading

1. Tietz, N. W. (2012). Tietz textbook of clinical chemistry and molecular diagnostics (5th ed.). Elsevier.
2. Chaudhary, M. R. (2014). Laboratory manual for molecular genetic tests. Jaypee Brothers.
3. Chaudhary, K. Molecular biology: Fundamental processes (3rd ed.). IFAS publications.
4. Godkar, P. B. (2016). Textbook of medical laboratory technology (3rd ed.). Bhalani Publications.
5. Rastogi, V. B. (2010). Fundamentals of Molecular Biology. India: Ane Books India.

Semester–V						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MLS 503	Public Health	42	3	40	60	100

Unit I: Concept of Health and Disease

Concept of health and disease, natural history of disease. Determinants of health: biological, environmental, social, economic, and behavioral factors, multifactorial causation of disease, host–agent–environment relationship. Levels of prevention: primary, secondary, and tertiary prevention with examples of diseases of national importance. Indicators of health: mortality, morbidity, disability, and quality-of-life indicators. Modes of transmission of diseases: airborne, vector-borne, and vehicle-borne transmission.

Unit II: Prevention and Control of Diseases

Principles of disease prevention and control. Infection prevention and control practices in healthcare settings. Disinfection and sterilization: definitions, principles, differences, and classification. Physical and chemical methods of disinfection. Disinfection of infective materials received in the laboratory: blood, body fluids, cultures, contaminated glassware, instruments, sharps, and biomedical waste. Standard operating procedures for disinfection at health centre and laboratory level. Hospital-acquired infections (HAIs): sources, transmission, prevention, and control.

Unit III: National and International Healthcare System

Organization of health services: Structure and functions of health services at the central and state levels, role of Ministry of Health and Family Welfare. Health Care Delivery Systems: Primary, secondary, and tertiary health care delivery systems. Primary Health Care: definition, principles, and components. Health Care Infrastructure: Structure, roles, and functions of sub-centres, Anganwadi centres, Primary Health Centres (PHC), Community Health Centres (CHC), district hospitals, and apex/tertiary hospitals; staffing patterns and service delivery. International health agencies: Role of WHO and UNICEF in global health promotion, disease prevention, technical support, and collaboration with national health programs; Immunization and Universal Immunization: Immunization and Universal Immunization Programme (UIP).

Unit IV: Health Program & Organization

National programmes of health and disease eradication, Family Welfare Programme. Disease Eradication Programmes: Leprosy eradication – strategies, case detection, multidrug therapy, and monitoring; role in reducing disease burden. Disease control programmes- Malaria, Goitre, Dengue fever, Lymphatic filariasis, Kala- Azar and Japanese Encephalitis. National AIDS Control Programme (NACP): Prevention, testing, treatment, awareness campaigns, and integration with other health services. Revised National. Tuberculosis Control Programme (RNTCP): DOTS strategy, case detection, treatment protocols, monitoring, and evaluation to control TB incidence and mortality. Iodine Deficiency disorders control programme (NIDDCP).

Unit V: Nutrition and Public Health

Food and nutrition: nutrients and balanced diet. Food-borne diseases of public health importance. Assessment of nutritional status. National nutrition programmes, management of sanitation in public health. Health education: definition, principles, objectives, methods, and role in disease prevention and health promotion. Water sanitation: sources of water, purification methods, disinfection of water, collection and transport of water samples, bacteriological analysis of water.

Suggested Readings:

1. Park, K., & Sunder Lal. (2015). Textbook of Preventive and Social Medicine (3rd ed.). Bhanot Publications.
2. Schneider, M. (2011). Introduction to public health (3rd ed.). Jones & Bartlett Learning.
3. Detels, R., Gulliford, M., Abdool Karim, Q., & Tan, C. C. (Eds.). (2015). Oxford textbook of global public health (6th ed.). Oxford University Press.
4. Lawrence, M., & Worsley, T. (2020). Public health nutrition: From principles to practice (1st ed.). Taylor & Francis.

Semester–V						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MLS 504	Entrepreneurship & Management in Healthcare	42	3	40	60	100

Unit I: Fundamentals of Entrepreneurship and Healthcare Systems

Concept and definition of entrepreneurship. Characteristics of an entrepreneur. Types of entrepreneurship with special reference to healthcare and diagnostic services. Overview of healthcare delivery systems in India. Role of entrepreneurship in healthcare development. Scope and opportunities for entrepreneurship in medical laboratory sciences. Challenges faced by healthcare entrepreneurs. Ethical considerations in healthcare entrepreneurship.

Unit II: Healthcare Organization and Management Principles

Principles and functions of management: planning, organizing, staffing, directing, and controlling. Organizational structure of hospitals and diagnostic laboratories. Leadership styles and motivation in healthcare organizations. Human resource management in laboratories: recruitment, training, performance appraisal, and retention. Communication, teamwork, and conflict management in healthcare settings. Time management and decision-making skills for healthcare managers.

Unit III: Establishment and Operation of Diagnostic Laboratories

Planning and establishment of a clinical laboratory. Feasibility study and site selection. Infrastructure, equipment, and manpower requirements for diagnostic laboratories. Licensing, registration, and regulatory requirements in India. Procurement, inventory management, and vendor selection. Laboratory workflow management and safety practices.

Unit IV: Financial Management, Marketing, and Legal Aspects

Basics of financial management: capital investment, budgeting, cost analysis, pricing of laboratory services, and break-even analysis. Revenue generation and billing systems. Basics of accounting and taxation relevant to healthcare enterprises. Marketing of healthcare and laboratory services: branding, promotion, patient relations, and digital marketing. Legal aspects: consumer protection act, biomedical waste management rules, labor laws, and ethical practices in healthcare business.

Unit V: Innovation, Digital Health, and Sustainable Healthcare Entrepreneurship

Innovation and technology in healthcare entrepreneurship. Role of automation, artificial intelligence, telemedicine, and laboratory information systems (LIS). Start-ups and incubation in healthcare. Business plan preparation for diagnostic laboratories. Risk management and sustainability in healthcare enterprises. Corporate social responsibility (CSR) in healthcare. Future trends and opportunities in healthcare entrepreneurship and management.

Suggested Readings:

1. Gupta, S. P. (2021). Entrepreneurship development (4th ed.). Sultan Chand & Sons.
2. Park, K. (2023). Park's textbook of preventive and social medicine (27th ed.). Banarsidas Bhanot.
3. Kumar, A., & Sethi, J. (2016). Hospital management (2nd ed.). CBS Publishers & Distributors.
4. Saxena, R., & Anand, S. (2018). Quality assurance in clinical laboratories. CBS Publishers & Distributors.
5. Kotler, P., Shalowitz, J., & Stevens, R. J. (2016). Strategic marketing for health care organizations. Wiley India.
6. Gupta, R., & Mishra, S. (2020). Healthcare entrepreneurship in India: Innovation, policy and practice. Bloomsbury India.
7. Government of India. (2020). National digital health mission: Strategy overview. Ministry of Health and Family Welfare.

Semester–V						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MLS 505P	Practical XI: MLS 501	84	3	20	30	50

Histopathology & Cytology:

1. Demonstration of various cells and tissues in the human body.
2. Preparation of 10% buffered formalin for fixation of surgical specimens
3. To study the properties of various fixatives used in histopathology
4. Decalcification of bone specimens for subsequent tissue processing
5. Gross examination of surgical samples
6. Tissue processing and block preparation by manual method
7. Tissue processing and block preparation – Automatic tissue processor
8. Section cutting, floatation and slide preparation
9. Staining and mounting of cut sections by H& E stain.
10. Staining and mounting of cytological smears by Papanicolaou method.

Semester–V						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MLS 506P	Practical XII: MLS 502	84	3	20	30	50

Molecular Diagnostic:

1. Preparation of reagents for DNA isolation
2. Isolation of genomic DNA from clinical samples (blood, nasopharyngeal etc.)
3. Quantification and purity assessment of extracted DNA
4. Agarose Gel electrophoresis
5. Restriction digestion of genomic/plasmid DNA and analysis by agarose gel electrophoresis
6. Polymerase chain reaction
7. Detection of viral markers by PCR Technique.
8. Detection of genetic material by Real time PCR.

Semester–V						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MLS 507P	Clinical Training II	224	8	-	200	200

Semester–VI						
Paper Code	**Paper Name**	**Total Hrs.**	**Credit**	**IA**	**SE**	**Total**
MLS 601P	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.
- MLS students will engage in intensive, hands-on clinical rotations. Under the direct supervision of experienced medical 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 and evaluation by the mentor of Clinical Training & Internship.

Clinical Training & Internship

MLS 601P

Semester: VI **IA: ---**

Credit: 22 **SE:400**

Total Hours: 616 **Total: 400**

The CT & Internship is a clinical training of 5 months duration to be done in a Laboratory /Hospital / Medical College approved by the University. MLS trainee students have to go

for hands- on clinical training during which they will observe and assist in the techniques and procedures under supervision of an experienced staff in the different areas of medical laboratory like blood and sample collection, pathology, Haematology, Microbiology, Biochemistry, Molecular diagnostics, Histopathology & cytopathology, quality assurance & improvement etc.

The students will be required to prepare at least one case study in every section, in all not less than 5 case studies. The case studies will be verified by the supervisor / in charge under whom they work. It is compulsory to submit duly signed case studies to the clinical posting incharge before CT & Internship examination.

The supervisor / in charge will issue a duly signed and stamped certificate after satisfactory completion of the training.

The CT & Internship examination will include presentation of the case studies, written examination of the techniques and viva voce for evaluation of knowledge and skill.

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