Ordinance No. V-148 B

Master of Medical Laboratory Science (MMLS)

Date of Academic Council meeting: 11.03.2026

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Department of Medical Laboratory Science
Subharti College of Allied and Healthcare
Faculty of Allied and Health Sciences
Swami Vivekanand Subharti University, Meerut

Subharti College of Allied and Healthcare
Principal
SVSU

Date of Academic Council Meeting- 11.03.2026

V-148.B

Ordinance No.....B

ORDINANCE RELATING TO MASTER OF MEDICAL LABORATORY SCIENCE (MMLS) PROGRAMME CURRICULUM AND SYLLABUS

1. This ordinance may be called the "**Ordinance relating to Master of Medical Laboratory Science (MMLS) Curriculum and Syllabus**". This ordinance has been drafted in accordance with **National Commission for Allied and Healthcare Professions (NCAHP)** guidelines; all future updates issued by the NCAHP will be strictly implemented.
2. It shall come into force with academic session 2026-27.

Learning Objectives

Upon successful completion of the Masters" programme, students will

1. **Demonstrate proficiency in a comprehensive range of laboratory procedures**, including advanced techniques in haematology, clinical chemistry, and microbiology.
2. **Identify and troubleshoot issues across all phases of laboratory testing**—pre-analytical, analytical, and post-analytical—to ensure accuracy and reliability of results.
3. **Operate, maintain, and troubleshoot sophisticated laboratory instrumentation**, applying best practices for quality assurance and control.
4. **Interpret complex laboratory data** within the context of pathophysiology and clinical decision-making, with a sound understanding of diagnostic principles related to various organ systems.
5. **Contribute to the innovation and development of diagnostic techniques and laboratory methodologies**, supporting the advancement of evidence-based clinical practice.
6. **Demonstrate readiness for advanced roles** in healthcare, laboratory management, education, and biomedical research through enhanced critical thinking, ethical decision-making, and leadership skills.

PROGRAMME OUTCOMES (POs)

Upon successful completion of the MMLS programme, students will be able to:

POs	Outcome
PO 1	**Advanced Laboratory Competence** Apply advanced knowledge and technical skills in areas such as clinical chemistry, haematology, microbiology, immunology, transfusion science, molecular diagnostics, and histopathology.
PO 2	**Critical Thinking and Problem-Solving** Critically evaluate laboratory data,

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	troubleshoot complex testing procedures, and apply evidence-based practices in laboratory decision-making.
PO 3	**Research and Innovation** Design, conduct, and interpret research studies; contribute to scientific knowledge through research dissemination and potential innovation in diagnostic techniques.
PO 4	**Quality Management and Accreditation** Demonstrate understanding of quality assurance systems, accreditation processes (e g., ISO 15189), laboratory safety, and regulatory compliance in clinical laboratory operations.
PO 5	**Leadership and Management** Exhibit leadership, strategic planning, and effective resource management in laboratory settings; supervise personnel and contribute to operational excellence.
PO 6	**Interdisciplinary Collaboration** Collaborate with healthcare professionals to provide accurate diagnostic information, participate in interdisciplinary teams, and support patient-centered care.
PO 7	**Ethical and Professional Practice** Adhere to ethical principles, legal frameworks, and professional standards in all aspects of laboratory science and research.
PO 8	**Communication Skills** Effectively communicate scientific and clinical information to peers, healthcare providers, patients (where applicable), and the broader scientific community.
PO 9	**Continuous Learning and Development** Engage in lifelong learning and professional development to stay current with advances in medical laboratory science and emerging diagnostic technologies.
PO 10	**Global and Societal Impact Awareness** Understand the role of medical laboratory science in public health, global health challenges, and the social determinants of health.

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Master of Medical Laboratory Science (MMLS)

Ist SEMESTER
Common for all specializations

Medical Laboratory Management

Theory	Subject Code: MMLS-001
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

Course Rationale: This course will enable the student to manage resources, understand and follow GCLP, minimize errors, implement and maintain quality control measures, maintain equipment and promote a safe working environment, develop good communication skills, foster team work and develop leadership skills.

Learning Objective: At the end of the course, students should be able to

1. Understand the need for efficient and effective laboratory operations, including resource allocation, personnel management, equipment and reagent purchase and maintenance.
2. Comprehend knowledge of relevant regulations, standards, and best practices for overall improvement of laboratory services for patient care.

Unit	Topic	Hours
I	**Principles of Lab management:** Financial management, human resource management and space and facility management. Organisational structure of lab. Laboratory design: functional components of laboratory, Various types of laboratory. A standardized clinical laboratory set up, Factors affecting productivity of a laboratory **Training of technical staff in Clinical laboratory:** Areas of training. Role of lab supervisors in training. Job description of various levels. Hands on approach to various laboratory practices.	6
II	**Work- Flow** of a Clinical Laboratory – sample reception, registration, barcoding, centrifuging, sample processing, result checking, result release, sample storage Scope of laboratory services.	4

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III	**Good Clinical laboratory practices (GCLP)** • Standard operating procedures (SOP): importance of SOP's in a clinical laboratory • Laboratory personnel: Role of lab personnel in a medical Laboratory • Laboratory sample management: request form, sample labelling, sample register, sample storage, sample disposal • Laboratory equipment: Equipment procurement and evaluation. Details of specific instruments / devices for analyte estimations (routine chemistry, hormones, tumour markers, electrolytes, drugs, metals, blood gases, amino acids,) • Laboratory reagents and kits: Procuring kits, inventory, storage, validation	**8**
IV	**Laboratory errors**: Root cause analysis and CAPA (corrective action, preventive action) **Phases of errors** in clinical Laboratory testing process • Preanalytical variables • Analytical variables- Use of stable reference materials-calibrators & controls, LJ charts and Westgard rules. • Standardization / Calibration processes: Calibration of basic equipments by laboratory personnel. Calibration of methods-colorimetric and enzymatic. • Postanalytical variables: transfer of results, documentation, competence and various laboratory processes	**8**
V	**Total Quality management:** • Fundamental principles. TQM framework • External Quality Assessment Schemes • Internal QC Procedures, Use of Internal Quality Control material. Care and procedural steps in reconstitution of	**6**

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	commercial controls.	
VI	**Biological Reference Intervals**: Definition. Establishment. Validation of reference intervals. Diagnostic efficacy. **Documentation** in Laboratory/Maintenance of records: Patient entry registers, Procedure manuals, Registers of Reagents, consumables and accessories, quality control data, patient data and all relevant lab records.	**8**
VII	**Clinical laboratory informatics**: Computer basics. Word processing, spreadsheets, data-base, graphics, statistics, Laboratory Information Systems (LIS).	**4**
VIII	**Laboratory Accreditation and Audit:** ISO guidelines, NABL 15189 standards, Audit in a Medical Laboratory: Introduction and Importance, Responsibility, Planning, internal audit, Horizontal, Vertical and Test audit, Frequency of audit, Documentation. Overview of JCI & CAP.	**6**
IX	**Public relations**: Interpersonal skills at work place, communication with patients, Leadership management, conduction of seminar and CME programmes, performance appraisal of staff, Laboratory approach to patient community, patient/clinician feedback forms, Hospital organization and interactions between the laboratory service and the rest of the hospital.	**5**
X	**Risk Management and safety measures:** Safety responsibility-employer and employee - Safety in a clinical laboratory: personal protection, Laboratory hazards, Laboratory safety- fire, chemical, electrical, radiation, Laboratory infection control, Hazardous waste and transport of Hazardous material, biomedical waste management, HIV: pre- and post-exposure guidelines, Hepatitis B & C: pre- and post-exposure guidelines, drug Resistant Tuberculosis, Needle prick injury and followup, Accident documentation and investigation.	**5**
	Total	**60**

Suggested Readings:

1. MacMillan, D., & Lewandrowski, K. B. The Clinical Laboratories.

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2. Chou, D. (2007). Henry's clinical diagnosis and management by laboratory methods. *JAMA*, *297*(16), 1827-1833.
3. Rifai, N. (2017). *Tietz Textbook of Clinical Chemistry and Molecular Diagnostics-E-Book: Tietz Textbook of Clinical Chemistry and Molecular Diagnostics-E-Book*. Elsevier Health Sciences.
4. Mrinalini Sant (2022) Textbook of Medical Laboratory Technology 2nd Edition 2022.
5. Godkar, P. B., & Godkar, D. P. (2006). *Textbook of medical laboratory technology*. Bhalani publishing house.

Cell and Molecular Biology

Theory	Subject Code: MMLS-002
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

Course Rationale: Molecular Biology knowledge is essential for a Medical Laboratory Science scholar as it provides the foundation to the professional in understanding the latest techniques in Biotechnology. It empowers the graduate to use advanced techniques in disease diagnosis and progression and also in analyzing genetic information which explains genetic and molecular basis of many diseases affecting mankind.

Learning Objective: At the end of the course, students should be able to

1. Comprehend in-depth understanding of fundamentals.
2. Understand and apply techniques for disease diagnosis with extreme accuracy and precision.
3. Develop research attitude that can further help in developing newer techniques in molecular Biology.

Unit	Topic	Hours
I	Basic Concept Of Cell Structure, Function And Processes a) Cell Organelles And Their Functions b) Cell Division, Cell Cycle And Apoptosis	6
II	The Central Dogma Of Molecular Biology-Transfer Of Genetic Information From DNA To RNA To Protein Synthesis • DNA Replication • Transcription-The Process Of Transcription, Inhibition Of	12

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	Transcription, Reverse Transcriptase, Post Transcriptional Modification • Translation- The Process Of Translation, Post Translational Modifications Like Folding, Glycosylation Etc. • Inhibitors Of Protein Synthesis	
III	Gene Expression-Regulation And Significance.	**6**
IV	In Situ Hybridization-To Study Gene Expression Pattern, Localize Gene Amplification, Gene Location.	**6**
V	Concept Of Gene Switching, Gene Transposition, Somatic Recombination.	**8**
VI	Cell Culture: Introduction, Significance, Cell Culture Lab – Instruments, Aseptic Techniques, Media Preparation And Filteration For Cell Culture, Media Composition And Supplements, Types Of Cell Culture- Primary, Secondary. Adherent, Suspension Cells, Commonly Used Cell Lines, Cell Culture Procedure, Contamination In Cell Culture Lab, Biosafety Levels, Ethical Issues. Waste Disposal.	**12**
VII	Basic Principles And Applications Of Molecular Techniques • Recombinant DNA Technology: Restriction Endonuclease, DNA Ligase, Vectors, Chimeric Molecules, Cloning, Gene Library, Cloning Strategies, In-Situ Hybridization, Blot Techniques And Applications, Rflp, Gene Therapy, Tran Genesis, DNA Finger Printing, DNA Sequencing, PCR, DNA Probes, Hybridoma Technology.	**10**
	Total	**60**

Suggested Readings:

1. Veer Bala Rastogi (2015) Principles Of Molecular Biology
2. Wilson, K., Hofmann, A., Walker, J. M., & Clokie, S. (Eds.). (2018). Wilson and Walker's principles and techniques of biochemistry and molecular biology. Cambridge university press.
3. Satyanarayana, U. (2013). Biochemistry. Elsevier Health Sciences.
4. Lodish, H. F. (2008). Molecular cell biology. Macmillan.
5. Karp, G. (2009). Cell and molecular biology: concepts and experiments. John Wiley & Sons.

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Research Methodology & Biostatistics

Theory	Subject Code: MMLS-003
Total Marks for Evaluation- 50	No. of Contact Hours- 30, Credits:2

Course Rationale: This course enables students in medical laboratory science with the knowledge and skills to conduct scientific research and apply biostatistical methods in clinical and laboratory settings.

Learning Objective: At the end of the course, students should be able to

1. Understand the fundamentals, types of research in health sciences, formulate research problems and hypotheses relevant to laboratory medicine.
2. Design appropriate research studies and select suitable data collection methods.
3. Apply statistical tools for data analysis and interpretation.

Unit	Topic	Hours
I	**Introduction to Statistics and Data** • Definition and Scope of Statistics in Health Sciences • Uses of Statistics in Clinical and Preventive Medicine • Types of Variables: • Qualitative vs Quantitative • Discrete vs Continuous • Scales of Measurement: Nominal, Ordinal, Interval, Ratio • Measures of Central Tendency: Mean, Median, Mode • Definitions, Properties, Applications • Measures of Dispersion: • Range, Quartile Deviation, Interquartile Range, Standard Deviation, Variance, Coefficient of Variation • Quartiles and Percentiles	6

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II	**Probability, Distributions, and Sampling** • Normal and Standard Normal Distribution: Properties and Applications • Probability Concepts and Calculations (mean ± SD intervals) • Skewness and Kurtosis: Definitions and Interpretation • Parameters vs Statistics • Population, Sample, Sampling Frame • Sampling Distribution and Central Limit Theorem • Standard Error: Mean, Proportion, Differences • Confidence Intervals for Means and Proportions	**6**
III	**Hypothesis Testing and Statistical Inference** • Hypothesis Testing: • Null and Alternative Hypotheses • Type I and II Errors • One-tailed vs Two-tailed Tests • p-value, Significance Level, Power • Parametric Tests: • Paired and Unpaired t-tests • One-way and Repeated Measures ANOVA • Non-parametric Tests: • Mann-Whitney U, Wilcoxon Signed Rank, Kruskal-Wallis, Friedman's ANOVA • Chi-square Test and McNemar's Test: Concepts and Applications	**6**

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IV	**Correlation, Regression, and Advanced Analysis**
	• Correlation:
	  • Types, Scatter Diagrams, Pearson's and Spearman's Coefficients
	  • Coefficient of Determination
	• Regression Analysis:
	  • Simple and Multiple Linear Regression
	  • Logistic Regression: Concepts and Applications
	• Diagnostic Test Evaluation: Sensitivity, Specificity, Positive Predictive Value (PPV) and Negative Predictive Value (NPV)
	• Receiver Operating Characteristic (ROC) Curve
	• Agreement and Reliability: Bland-Altman Plot and Kappa Statistics
		6

V	**Research Methodology and Epidemiological Applications**
	• Research Process and Types of Research Designs
	• Data Collection Methods and Sources
	• Qualitative Research and Content Analysis
	• Test Construction: Reliability, Validity, Norms
	• Sample Size Estimation for Means and Proportions
	• Rates, Ratios, and Proportions: Definitions and Calculations
	• Epidemiological Study Designs:
	  • Case Reports, Case Series, Cross-sectional, Case-Control, Cohort Studies
	  • Confounding and Methods to Control
	  • Randomized Controlled Trials (RCTs), Randomization, Blinding
		6

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	Total	**30**

Research Methodology & Biostatistics Practical

Practical	Subject Code: MMLS-007
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

Course Rationale: This course provides students in health sciences with practical skills to design, conduct, and analyse scientific research relevant to clinical & laboratory settings.

Learning Objective: At the end of the course, students should be able to

1. Data Handling & Descriptive Statistics

- Collect raw data from a lab or clinical setting.
- Classify variables (qualitative/quantitative, discrete/continuous).
- Organize data into frequency tables.
- Calculate and interpret: Mean, median, mode Range, standard deviation, variance
- Create visual representations: Bar charts, histograms, pie charts, box plots

2. Probability & Distributions

- Plot and interpret normal distribution curves.
- Calculate probabilities using mean ± 1SD, 2SD, 3SD.
- Identify skewness and kurtosis from datasets.

3. Sampling & Estimation

- Demonstrate random sampling techniques (simple, stratified, cluster).
- Calculate standard error and confidence intervals.
- Estimate population parameters from sample data

4. Hypothesis Testing: Perform and interpret:

- One-sample and two-sample t-tests
- Paired t-test
- Chi-square test (2x2 table)
- ANOVA (one-way)
- Use SPSS/R to run tests and interpret outputs.

Suggested Readings:

1. Mahajan, B. (2004). Methods of Biostatistics: For Medical Student and Research work. New Delhi: Jaypee Brothers.

2. Essentials of Research Methodology for all Physiotherapy and Allied Health Sciences Students by Ramalingam Thangamani A

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3. Ramalingam, T. A., & Kumar, S. N. (2018). Essentials of research methodology for all physiotherapy and Allied Health Sciences Students. Jaypee Brothers Medical Publishers.
4. Dawson, B. and Trapp, R.G. (2001) Basic & Clinical Biostatistics. Lange Medical Books/ McGraw-Hill, New York.
5. Rosner, B. A. (2006). Fundamentals of biostatistics (Vol. 6). Belmont, CA: Thomson-Brooks/Cole.
6. Armitage, P., Berry, G., & Matthews, J. N. S. (2013). Statistical methods in medical research. John Wiley & Sons.
7. Daniel, W. W. (2004). Biostatistics: A Foundation for Analysis in the Health Sciences 8th Edition (Wiley Series in Probability and Statistics).
8. WHO Guidelines on Health Research, World Health Organization
9. SPSS/R Software Manuals, IBM (for SPSS), R Core Team (for R)

Advanced Molecular Diagnostic Techniques

Theory	Subject Code: MMLS-004
Total Marks for Evaluation- 50	No. of Contact Hours- 60, Credits:4

Course Rationale: This course provides students with a comprehensive understanding of the advanced molecular techniques and enable them to apply advance methods in the diagnosis.

Learning Objective: At the end of the course, students should be able to

1. Comprehend knowledge and clinical skills of molecular techniques.
2. Use accurate and advance diagnostic tools.

Unit	Topic	Hours
I	**Principle & Role of Molecular Diagnostics:** Basic principles in molecular diagnostics and organizations of molecular diagnostics laboratory. Role of molecular diagnostics in present diagnostic era, Ethical issues related to molecular diagnostics, future of molecular diagnostics, Historical aspects advantage of DNA over traditional serology.	8
II	**PCR and its modifications:** Principle of PCR, types of PCR: Primer designing, Reverse Transcriptase-PCR, Real-Time PCR, Inverse PCR, Multiplex PCR, Nested PCR, In situ PCR, Long-PCR, PCR-ELISA, arbitrarily primed PCR. Applications of PCR in Diagnosis	12

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	and research. PCR modifications: Ligase Chain Reaction, isothermal amplification, nucleic acid sequence-based amplification (NASBA), transcription mediated amplification, strand displacement amplification. specimen collection, advantages and disadvantages of techniques, key factors affecting the performance and reliability.	
III	**Quantitative and Qualitative estimations:** Protein stability, denaturation; amino acid sequence analysis, Hybridization techniques – Southern, Northern, in-situ (including FISH), line probe assay, microarrays – types and applications; Protein extraction and analysis (including PAGE and its variations); Western Blot.	**12**
IV	Instruments and Techniques: Spectrophotometry, HPLC, MS, ELISA, Chemiluminescent, FIA, Flow cytometry, and specific applications; Electron microscopy and its application, Immunohistochemistry, Immunoflourescenes, Immunocytochemistry– principle and techniques.	**12**
V	Recombinant DNA technology: Restriction endonuclease, DNA ligase, vectors, chimeric molecules, cloning, gene library, cloning stratagies, and applications, RFLP, Gene therapy, Trangenesis, DNA finger printing, DNA probes, hybridoma technology.	**8**
VI	Definition, application and advantages of Genomics, Next-generation sequencing technology, Proteomics, Transcriptomics, Metabolomics.	**8**
	Total	**30**

Advanced Molecular Diagnostic Techniques Practical

Practical	Subject Code: MMLS-008
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

Course Rationale: Students will gain practical skills necessary for various laboratory techniques required for the molecular diagnosis

1. DNA Isolation
2. RNA Isolation
3. Polymerase chain reaction

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4. PAGE
5. ELISA
6. Demonstration of western blot
7. HPLC
8. Spectrophotometer analysis- protein Analysis
9. Immunohistochemistry
10. Demonstration of electron microscope

***Clinical laboratory rotation/observation can be incorporated wherever possible**

Suggested Readings:

1. Wilson, K., Hofmann, A., Walker, J. M., & Clokie, S. (Eds.). (2018). Wilson and Walker's principles and techniques of biochemistry and molecular biology. Cambridge university press. 2. Godkar, P. B., & Godkar, D. P. (2006). *Textbook of medical laboratory technology*. Bhalani publishing house.
3. Carson, S., Miller, H. B., Srougi, M. C., & Witherow, D. S. (2019). *Molecular biology techniques: a classroom laboratory manual*. Academic Press.
4. Tagu, D., & Moussard, C. (Eds.). (2006). *Techniques for molecular biology*. Science Publishers.
5. Coleman, W. B., & Tsongalis, G. J. (Eds.). (2007). *Molecular diagnostics: for the clinical laboratorian*. Springer Science & Business Media.
6. Greene, J. (Ed.). (1998). *Recombinant DNA principles and methodologies*. CRC Press.

Digital Health Technologies

Theory	Subject Code: MMLS-005
Total Marks for Evaluation- 100	No. of Contact Hours- 30, Credits:2

Course Rationale: This course aims to equip students with foundational knowledge and practical insights into the application of digital health technologies in the medical laboratory setting. Understanding the course will make students competent in understanding and integrating these technologies essential to enhance diagnostics, quality assurance, data management, and patient care.

Learning Objective: At the end of the course, students should be able to

1.) Understand digital technologies shaping medical laboratory practices.
2.) Apply digital tools for laboratory data management and quality control.
3.) Explore AI and machine learning in laboratory diagnostics.
4.) Assess the role of telehealth and remote diagnostics in laboratory medicine.
5.) Evaluate digital health standards, data security, and regulatory considerations.

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Unit	Topic	Hours
I	Introduction to Digital Health in Laboratory Medicine: Definition and scope of digital health, Evolution and historical perspectives, Current healthcare, big data, and machine learning, artificial intelligence in healthcare applications, predictive analytics in healthcare, WHO classification of digital health interventions.	6
II	Artificial Intelligence and Machine Learning in Diagnostics: AI in hematology: automated WBC differential, RBC morphology, AI in histopathology and cytopathology: image classification and tumor grading, AI in microbiology: colony morphology analysis, resistance prediction, AI in biochemistry: predictive analytics from lab trends (e.g., sepsis prediction), AI in molecular diagnostics: variant classification and pathogenicity prediction, Digital Epidemiology and Health Surveillance.	6
III	Telehealth medicine: Definitions and distinctions: Telehealth vs. Telemedicine vs. Remote Patient Monitoring, trends in telemedicine, Types of telehealth modalities: synchronous, asynchronous, and hybrid, Components of a telehealth ecosystem (software, devices, connectivity, data platforms), Role of laboratory medicine in remote monitoring (e.g., chronic disease management), AI Applications in Remote Patient Monitoring, Mobile Health (mHealth) and Health Apps.	6
IV	Digital Health: Definition and scope of digital health, Key stakeholders: healthcare providers, patients, policymakers, IT developers, Global and national digital health strategies (e.g., WHO Digital Health Strategy, NDHM India), Digital health ethics and data governance, lectronic Health Records (EHR) and Laboratory Information Systems (LIS), Structure and function of EHR systems, Data security and patient confidentiality, Clinical decision support systems (CDSS) integration with LIS, Case studies on digitized lab workflows.	6
V	Ethical and legal challenges of artificial intelligence-driven healthcare: Regulatory classification of AI-powered RPM devices (e.g., FDA SaMD, CDSCO), Requirements for clinical validation and	6

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	safety assessment, Ethical considerations in autonomous health monitoring, Challenges of algorithmic bias and AI transparency, Legal responsibility in automated decision-making.	
	Total	**30**

Suggested Readings:

1. Topol, E. (2019). Deep medicine: how artificial intelligence can make healthcare human again. Hachette UK.
2. Bohr, A., & Memarzadeh, K. (Eds.). (2020). Artificial intelligence in healthcare. Academic Press.
3. World Health Organization. (2023). Classification of digital interventions, services and applications in health: a shared language to describe the uses of digital technology for health. World Health Organization.
4. Global strategy on digital health 2020-2025, WHO
5. LIM., C. P., Vaidya, A., Jain, K., Mahorkar, V. U., & Jain, L. Ç. (2022). Handbook of artificial intelligence in Healthcare. Springer International Publishing.

Elective Course#

Mini project in medical biochemistry/Mini project in Medical Microbiology/Mini project in Haematology and Transfusion Medicine/Mini project in Histology and Cytology	Subject Code: MMLS-006
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

Course Rationale: This course aims to equip students with essential research skills such as critical thinking, problem-solving, and analysis, which are applicable to future work. A mini projects begins with determining research interests. Students are required to choose their respective research interests by considering their understanding, abilities, and references that can be found. Furthermore, students will be guided to find the root of the problem that will be revealed by using the 5W+1H (What, Who, When, Why, Where, and How) questioning flow and applying a fish bone diagram.

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IInd SEMESTER
Medical Biochemistry

Bioorganic & Biophysical Chemistry

Theory	Subject Code: MMLS-B-009
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

Course Rationale: Students will gain comprehensive understanding of biomolecular structure, function, and physicochemical perspective. This course is designed for postgraduate students to explore the principles underlying biological systems and processes.

Learning Objective: At the end of the course, students should be able to

1. Describe the structure-function relationships in biomolecules using principles of organic and physical chemistry.
2. Comprehend knowledge of properties of biological fluid.
3. Understand biochemical reactions and molecular interactions.

Unit	Topic	Hours
I	**Carbohydrates:** Definition, Biological importance and Classification of Carbohydrates. **Monosaccharides-** Classification, Structure and Biological importance of Monosaccharides, Important chemical reactions of Monosaccharides. General Properties in reference to glucose –Structural and Stereo isomerism (Fischer and Haworth Projection formulae), Cyclic structure, Epimers, Anomers and Mutarotation. **Disaccharides** - Structure, Occurrence and Biological importance of Sucrose, Lactose and Maltose. **Polysaccharides: Classification**, Structure, Occurrence and Biological functions. **Homopolysaccharides, Heteropolysaccharides,** Carbohydrates in cell membrane.	**10**
II	**Lipids:** Definition, Biological importance and Classification of lipids. **Simple Lipids:** fats and wax; physical and chemical properties of fats. **Identification of fats and oils:** Saponification, Acetyl number, Rancidity of fats, Reichert-Meissel number. **Compound lipids** - Structure and Biological function of phospholipids, Glycolipids and other compound lipids – lipoproteins.**Derived lipids**	**10**

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	- *Fatty acids:* Structure, Classifications and Properties. *Steroid and Sterols* - Special reference to cholesterol -Structure, Function and Properties of Cholesterol, Other sterols of biological importance- Bile acids and vitamin D.	
III	**Amino acids and Proteins:** Definition, Biological importance of proteins, composition of proteins. **Amino Acids**: Definition, structure of amino acids, Classification, physicochemical properties and reactions of amino acids, Amino acids as ampholytes, Significance of non standard amino acids. **Proteins**: Classification based on nutritional value, biological importance and solubility. General properties of proteins, colour reactions of proteins (end group analysis); **Structural organisation of protein**: Primary structure, Peptide linkage- Structure and significance of peptide bond, amino acid sequencing (Sanger's and Edman methods). Secondary structure (helix and pleated sheets Eg.Collagen), Tertiary structure of proteins (Eg. Myoglobin), Quaternary structures of proteins (Eg.Hemoglobin), motifs and domains, Structure- function relation of protein. Denaturation, renaturation, separation techniques.	**10**
IV	**Enzymes:** Definition, Classification, Mechanism of Action, Models of enzyme – substrate complex formation (lock and key model, induced fit model, substrate strain theory), Enzyme specificity, Factors affecting enzyme activity.	**4**
V	**Nucleic Acids and Nucleoproteins:**Structure of Purines and Pyrimidines, Structure of Nucleosides and nucleotides; nucleotides and nucleosides of biological importance. **Nucleic Acids:** Definition, Structure of DNA, RNA and types of RNA. DNA – Watson & Crick Model, A, B and Z forms of DNA.Properties of DNA - buoyant, density, viscosity, chromic effect, Tm, denaturation, renaturation, hybridization and Cotanalysis.	**8**
VI	**Acids,Bases,Buffers**in biological system, -pH-Henderson Hasse lbalch equation,Acid load in the body, regulation of acid base balance in body.	**6**
VII	**Fluid and electrolyte balance:** Distribution of fluids in body, Water metabolism, Factor influencing the distribution of body water, thirst mechanism, Intake and loss of body water, Electrolyte distribution,	**4**

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	regulation, and their functions, water/electrolyte balance.	
VIII	**Body Fluid properties:** OsmosisandOsmoticpressure-Osmolalityofbodyfluids.Surfacetensionandviscosity-theirapplicationto the human body in relation to normal life and disease processes. Colloidal system – protective action. emulsification - colloidal systems of biological importance - their application and role in the human body. Diffusion and absorption mechanisms - their application to biological systems.	**8**
	Total	**60**

Bioorganic & Biophysical Chemistry Practical

Practical	Subject Code: MMLS-B-013
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

Course Rationale:

Students will gain practical skills with experimental techniques that are fundamental to understanding the chemical and physical principles governing biomolecular structure, function, and interactions.

1. Reactions of Carbohydrates – Molisch, Iodine, Benedict, Modified Barfoed, Osazone, Seliwannof, Foulger, Mucic acid, Bial.

2. Reactions of Proteins

a. Precipitation reactions – Acid, Base, Alcohol, Iso-electric, Half & Full saturation

b. Colour reactions – Biuret, Ninhydrin, Hellers, Aldehyde, Paulis, Sakaguchi, Sulphur, Xanthoproteic, Millons.

3. Reactions of Lipids – Solubility Test, saponification test, bromine water test for unsaturated fatty acids, Acrolein test.

4. Reaction of Nucleic acid – Dische test, Bial Test, Phosphate Test, Quantitative estimation via UV absorption at 260nm or Nano spectrophotometer.

5. Preparation of buffer and determination of pH

6. Demonstration

a. Determination of viscosity using Ostwald's viscometer.

b. Demonstration of osmosis and diffusion using semi-permeable membranes.

***Clinical Laboratory rotation/observation can be incorporated wherever possible**

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Suggested Readings:

1. Lehninger Principles of Biochemistry – David L. Nelson, Michael M. Cox, W. H. Freeman & Co. (Macmillan) . *WH Freeman*; Publication date. 1 January 2017.
2. Biochemistry – Lubert Stryer . *W.H.Freeman & Co Ltd.*
3. Harper's Illustrated Biochemistry – Victor W. Rodwell et al., Edition. 31st . *McGraw Hill / Medical*·
4. Principles of Physical Biochemistry – van Holde, Johnson, Ho : Pearson Education Limited
5. Essentials of Biophysical Chemistry – R. R. Dasgupta.
6. Textbook of Biochemistry for Medical Students – D.M.Vasudevan , Edition. Ninth; *Jaypee Brothers Medical s* ; Publication date. 1 January 2019.

Instrumentation

Theory	Subject Code: MMLS-B-010
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

Course Rationale: The students will have an understanding of the principles, instrumentation and applications of various non-analytical and analytical instrumentation in a clinical laboratory.

Learning Objective: At the end of the course, students should be able to

1. Understand the fundamental principles behind major analytical and non-analytical instruments in clinical Laboratory
2. Operate laboratory instruments with attention to Maintenance and calibration, sensitivity, and reproducibility.
3. Evaluate the advantages, limitations, and applications of each technique in a diagnostic lab or research Lab.

Unit	Topic	Hours
I	**Non -analytical Instrumentation:** Use, calibration and their maintenance – Glass Pipettes and Micropipettes, Weighing balance (analytical and top loading digital), pH meter, Centrifuges, Water bath, hot plate, magnetic stirrer, thermometers, distilled water systems.	4
II	**Centrifugation techniques:** Definition, Basic Principles of sedimentation, instrumentation,	6

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	application in clinical and research laboratory. *Types of centrifugation* :Preparative, analytical centrifugation, differential centrifugation, Density gradient centrifugation , ultra centrifuge.	
III	**Photometry:** Definition, basic Principles of photometry, functions, Beer lamberts law, Instrumentation, applications. Laws of light absorption – visible and UV Spectrophotometry Types of Photometric Techniques:Colorimetry, and spectrophotometry, Flame photometry, Flourimetry, Spectrofluorometry, Atomic absorption spectrometry, Infra red spectrometry.	**8**
IV	**Chromatography:** Definition, basic principles of adsorption and partition, Instrumentation, applications in clinical and research laboratory. Types of chromatographic techniques: Paper (one dimensional & two Dimensional) thin layer, column, affinity, gel filtration (Types of resins, gel and apparatus preparation), ion exchange, gas liquid, HPLC.	**10**
V	**Clinical Chemistry analysers:** Basic principles, instrumentation, function, significance of these analsyers. Types of chemistry analysers – semi –automated and Fully automated.	**6**
VI	**Electrophoresis:** Definition, Basic Principles of electrophoresis, Instrumentation, applications. Types of electrophoretic techniques- Paper, cellulose acetate, agarose gel, PAGE , capillary, Iso electric focussing and Two dimensional gel electrophoresis.	**10**
VII	**Advance Instruments:** Principles, instrumentation, techniques, and applications of Electron	**6**

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	spin resonance, Nuclear Magnetic resonance, crystallography, Mass spectrometry.	
VIII	**Immunochemical techniques:** Basic concepts, function and significance of these Immunoassay analysers, antigen–antibody binding quantitativemethods . Types of assays- sandwich assay, competitive, non-competitive assay. Techniques- ELISA (Enzyme linked immunosorbent assay), FIA, Immunoprecipitation, Turbidometry, Immunofluorescence, Chemiluminescense ,Electrochemiluminescense.	**6**
IX	**Osmometry:** Defnition, principle of osmometry, Instrumentation, applications.	**4**
	Total	**60**

Instrumentation Practical

Practical	Subject Code: MMLS-B-014
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

Course Rationale: Students will be able to gain conceptual understanding and technical application of instruments. They will also gain practical skills in sample preparation, instrument handling, maintenance, troubleshooting, Quality practices, and data acquisition of instrumentation which are vital for professional laboratory work.

1. Calibration of micropipettes and glass pipettes
2. Paper Chromatography- One dimensional
3. Paper chromatography - Two dimensional
4. HPLC
5. Electrophoresis
    a. Gel Electrophoresis
    b. PAGE
    c. Serum protein electrophoresis and Quantification
6. Osmometer
7. ELISA/FIA

***Clinical Laboratory rotation/observation can be incorporated wherever possible**

Suggested Readings:

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1. Principles and Techniques of Biochemistry and Molecular Biology – Keith Wilson & John Walker, . *Cambridge University Press*
2. Instrumental Methods of Analysis – B.K. Sharma, Krishna Prakashan Media (p) Ltd

3. Analytical Biochemistry – David Holme & Hazel Peck, *Prentice Hall*,
4. Introduction to Instrumental Analysis – Robert Braun, . *PharmaMed Press/BSP Books*
5. Clinical Biochemistry: Metabolic and Clinical Aspects – William J. Marshall, Márta Lapsley et al. *Churchill Livingstone*
6. Principles and techniques of Biochemistry & Molecular Biology – Mahalakshmi & Senthil Kumar, Cambridge Univ. Press

Enzymology & Nutrition

Theory	Subject Code: MMLS-B-011
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

Course Rationale: Students will gain in depth knowledge of mechanistic, regulatory roles of enzymes and the biochemical importance of macro- and micronutrients in health and disease.

Learning Objective: At the end of the course, students should be able to

1. Explain the structure, function, and classification of enzymes.
2. Interpret enzyme kinetics, Differentiate types of enzyme inhibition and mechanism of action of enzymes.
3. Describe the functions, sources, and deficiencies of essential vitamins and minerals.
4. Understand the role of nutrition in energy metabolism, growth, immune function, and disease prevention.

Unit	Topic	Hours
I	**Introduction to Enzymes:** Nomenclature, Classification and Characteristics of enzymes, Enzyme specificity, Cofactors, Co-enzyme and Prosthetic group, activators, inhibitors, active site, metalloenzymes, isozymes, monomeric enzymes, oligomeric enzymes and multienzyme complexes, Units of enzyme activity (definition of IU, Katal), specific activity of enzyme, measurement of enzyme activity, enzyme turnover.	6
II	**Mechanism of Enzyme Action:** Nature of active site, identification of functional groups at active site, enzyme substrate complex, Factors	4

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	responsible for catalytic efficiency of enzymes: Proximity and orientation, Covalent catalysis, Acid base catalysis, Strain and distortion theory, Induced fit hypothesis, Reversible and irreversible covalent modification, feedback inhibition, control of enzyme by products, substrates and adenylate energy charge, monocyclic and multicyclic cascade systems.	
III	**Enzyme Kinetics**: MichaelisMenten equation. Derivation of MichaelisMenten equation and determination of Km and Vmax values, Substrate inhibition and activation, Effect of pH and temperature on rate of enzyme catalyzed reactions, Allosteric enzymes.	**8**
IV	**Enzyme inhibition**: reversible and irreversible inhibition, Kinetics of competitive, uncompetitive and non-competitive inhibition, Mechanism of enzymic action - general acid base catalysis, covalent catalysis, role of metal ion in enzyme catalysis, Reversible inhibition - competitive, uncompetitive, noncompetitive, mixed, substrate and allosteric inhibition, Irreversible inhibition.	**6**
V	**Application of Enzymes:**Enzymes as analytical reagents, Immobilized enzymes, Biotechnological applications of enzymes, Application of enzymes in medicine and industry.	**4**
VI	**Clinical enzymology** - Enzymes as thromblytic agents, anti-inflammatory agents, digestive aids. Therapeutic use of asparginase, streptokinase. Enzymes and isoenzymes in diagnosis, Principles of diagnostic enzymology. clinical significance of alkaline and acid phosphatase, SGOT, SGPT, LDH, CPK, aspartate aminotransferase, alanine aminotransferase, creatine kinase.	**6**
VII	**Nutrition:** Caloric values of foods, BMR, respiratory quotient, energy requirements, role of carbohydrates, lipids, proteins and amino acids in diet, nitrogen balance, protein energy malnutrition, glycemic index, planning of diet in pregnancy and lactation, Renal Failure, cardiovascular Disease, diabetes, obesity, Cancer. Nutritional Assessment.	**4**
VIII	**Vitamins:** Definition, Classification, Chemistry, Sources, biochemical functions, deficiency and toxicity manifestations of fat-soluble and water-soluble vitamins.	**8**

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IX	**Minerals:** Definition, Classification, Chemistry, Sources, biochemical functions, deficiency and toxicity manifestations of macro and micro minerals.	**8**
X	**Nutritional Genomics:** Introduction to nutrigenetics and Nutrigenomics, role of genes in metabolism and nutrient utilization, omics technologies in nutrigenomics.	**6**
	Total	**60**

Suggested Readings:

1. Fundamentals of Enzymology – Nicholas C. Price & Lewis Stevens,Oxford university press
2. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry – Trevor Palmer *Horwood Pub*
3. Textbook of Biochemistry with Clinical Correlations – Thomas M. Devlin,wiley
4. Modern Nutrition in Health and Disease – A. Catherine Ross et al.,Wolters Kluwer Health Adis (ESP)

Intermediary Metabolism

Theory	Subject Code: MMLS-B-012
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

Course Rationale: This course provides students with in-depth understanding of metabolic pathways, their interconnections, and the regulatory mechanisms that govern them in various physiological and pathological conditions.

Learning Objective: At the end of the course, students should be able to

1. Explain the biochemical pathways of carbohydrate, lipid, amino acid, and nucleotide metabolism, including their key enzymes and intermediates.
2. Describe the integration of metabolic pathways in various tissues.
3. Analyze the role of regulatory molecules, cofactors, and hormones in modulating metabolic pathways.

Unit	Topic	Hours
I	**Metabolism:** Bioenergetics, free energy, biological oxidations,	**8**

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	electron transport, oxidative phosphorylation.	
II	**Carbohydrate metabolism:**Digestion and absorption, Glycolysis, gluconeogenesis, Uronic acid pathway, TCA cycle, HMP pathway, glycogen metabolism, galactose metabolism, fructose metabolism, Regulation of blood glucose. Disorders of carbohydrate metabolism: Diabetes mellitus and its types, glycosuria and its types, Glycated proteins, urinary albumin excretion, Inborn errors of carbohydrate metabolism.	**12**
III	**Aminoacid and protein metabolism**: Digestion and absorption Transamination, deamination - oxidative deamination and non oxidative, ammonia transport, urea formation. Metabolism of individual aminoacid. Biosynthesis of catacholamines, melanin formation, Nitrogen balance. Disorders of Protein and amino acid metabolism:Inherited disorders associated with urea cycle, proteinuria, proteinemia, Inborn error of amino acid metabolism.	**12**
IV	**Lipid metabolism:** Fatty acid synthesis, fatty acid oxidation, ketogenesis. Metabolism of triglycerides, phospholipids, sphingolipids, lipoproteins and cholesterol. Disorders of lipid metabolism: Dyslipidemia, hyperlipoproteinemias, obesity, fatty liver, lipotropic factors and ketosis, atherosclerosis and coronary heart diseases.	**12**
V	**Purine and Pyrimidine metabolism**: Biosynthesis of purine and pyrimidine. Degradation of purine and pyrimidine and their Disorders.	**8**
VI	**Hemoglobin metabolism:**Heme synthesis, formation of hemoglobin, Structure of hemoglobin, Metabolism of bilirubin.	**8**
	Total	**60**

Suggested Readings:

1. Lehninger Principles of Biochemistry – Nelson & Cox, , W. H. Freeman & Co. (Macmillan)
2. Biochemistry – Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, W. H. Freeman / Palgrave Macmillan.

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3. Harper's Illustrated Biochemistry – Victor W. Rodwell et al. McGraw Hill Medical
3. Lippincott Illustrated Reviews - Biochemistry, a Wolters Kluwer business
4. Principles of Biochemistry – Voet, Voet & Pratt,Global edition.5th edition.wiley.
5. Textbook of Biochemistry for Medical Students – D.M.Vasudevan, Edition. Ninth,. *Jaypee Brothers Medical s* ; Publication date. 1 January 2019

Clinical Posting

Clinical Posting	Subject Code: MMLS-B-015
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

Course Rationale:

The clinical posting provides a structured transition from theoretical understanding to practical competency in medical laboratory sciences. It supports the development of technical skills, ethical responsibility, and professional identity, preparing students to function independently and collaboratively in clinical laboratories and research settings.

Learning Outcomes

1. Preanalytical phase - Safely collect, identify, and manage clinical specimens, follow proper safety precautions.
2. Conduct clinical investigations and interpret findings.
3. Perform equipment quality control and resolve technical issues.
4. Manage documentation, communication, ethics, and teamwork.
5. Demonstrate leadership and entrepreneurship in lab environments.

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DEPARTMENT OF MEDICAL LABORATORY SCIENCES

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SWAMI VIVEKANAND SUBHARTI UNIVERSITY, MEERUT

CLINICAL POSTING LOG BOOK
MMLS SEMESTER II
MEDICAL BIOCHEMISTRY
(YEAR)

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Meerut U P - 250005

STUDENT'S RECORD

Name: .....

Semester: .....

Enrollment No.....

Session: .....

....

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Signature of Principal **Signature of Student**

DECLARATION BY THE STUDENT

Madam/Sir,

I, Mr/Ms. ..... a student of ..... bearing Registration No. ..... declare that I have completed ..... hours of clinical posting, out of the assigned ..... hours and have performed my duties in the hospital/laboratory as stated in my logbook

Students Signature

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Meerut U.P. 250005

DEPARTMENT OF MEDICAL LABORATORY SCIENCES
SUBHARTI COLLEGE OF ALLIED AND HEALTHCARE
SWAMI VIVEKANAND SUBHARTI UNIVERSITY, MEERUT

LOGBOOK CERTIFICATE

This is to certify that the candidate Mr/Ms…… registration number …… admitted in the academic year …… of ……college, has satisfactorily completed/ Not completed all requirements mentioned in this logbook for second semester of Master of Medical Laboratory Sciences, Medical Biochemistry during the period from ……to …… in the ……Hospital/Laboratory.

Signature of the Faculty in-Charge (hospital/laboratory)

Name

Date

Signature of the Principal/Dean HoD (University/College)

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Name

Date

SKILL ASSESSMENT SHEET

Hospital/Laboratory: **Department:**

Date	Name of Experiment	Observed/ Assisted/ Performed	Signature of Supervisor/In-charge

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IInd SEMESTER
Medical Microbiology

Essential and Applied Microbiology

Theory	Subject Code: MMLS-M-009
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

Course Rationale: This course lays the foundation for comprehending genetic continuity, variability, and expression, as well as the molecular basis of mutation and repair mechanisms. It introduces students to biotechnological applications, microbial strain development, and industrial-scale cultivation techniques. It elaborates gene transfer mechanisms, plasmid biology, and their applications in genetic engineering, offering insight into innovations in medicine. It emphasises the different methods of measurement of growth along with a comprehensive description of environmental and ecological factors that influence growth dynamics and microbial behaviour in natural systems. This course also establishes a link between microbes and different environments such as soil, water and food.

Learning Objective: At the end of the course, students should be able to

1. Discuss the mechanisms and patterns of DNA replication.
2. Describe major applications of recombinant DNA technology, including genetically engineered proteins and vaccines.
3. Apply techniques to measure microbial growth in terms of cell number, mass, and activity.
4. Analyse how environmental factors (pH, temperature, radiation, oxygen, solutes) affect microbial growth.
5. Relate microbial indicators to disease prevention and water safety management.
6. Evaluate the ecological and health-related significance of soil microorganisms.
7. Explain the mechanisms of microbial food spoilage and control strategies.
8. Assess the environmental and societal impacts of microbial biotechnology.

Unit	Topic	Hours
I	**Bioreactors and Fermenters** – Principles and Sterilisation Techniques- Definitions and distinctions: bioreactor vs. fermentor, Types of systems: batch, fed-batch, continuous, anaerobic and aerobic setups. Overview of usage: pharmaceutical, food,	8

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	environmental, and biotechnological applications; Cultivation of bacteria, fungi, and recombinant strains, Fermentation of specialty compounds (e.g. amino acids, organic acids); Role of bioreactors/fermentors in BSL-1 to BSL-3 workflows.	
II	**Sterilisation Techniques:** Importance in contamination control and safety, Methods: autoclaving, filtration, chemical sterilant, UV/radiation, Sterilisation of air, media, vessels, and inoculum transfer zones, Validation tools: biological indicators, F_0 value, D-value, and cycle qualification. Role of bioreactors/fermentors in BSL-1 to BSL-3 workflows.	**7**
III	**Industrial Microbiology and Biotechnology** **Choosing microorganisms for industrial Microbiology and Biotechnology** Finding microorganisms in nature Genetic Manipulation of Microorganisms Preservation of Microorganisms **Microorganisms Growth in Controlled Environments:** Medium Development Growth of microorganisms in an industrial setting **Major microbial products of Industrial Microbiology:** Antibiotics, Amino acids, Vitamins, Speciality compounds for use in medicine and Health, **Biotechnological Applications:** Biosensors, Microarrays **Impacts of Microbial Biotechnology**	**10**
IV	**Bacterial Recombination:** General Principles **Bacterial Plasmids:** Fertility factors, Resistance factors, Col plasmids, Other types of	**6**

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	plasmids **Applications of Genetic Engineering:** Medical Applications, Production of genetically engineered Somatotrophin, Other mammalian proteins and products, Genetically engineered vaccines, Engineering metabolic pathways **Gene therapy in Humans** **Social impact of Recombinant DNA technology**	
V	**Measurement of Microbial Growth:** Measurement of cell numbers (Haemocytometer, Electronic Counters, Plating Techniques, Membrane filters) Measurement of cell mass (Turbidity measurements, Wet weight, dry weight measurements) Measurement of cell activity **The influence of environmental factors on growth:** Solutes and water activity, pH, Temperature, Oxygen concentration, Pressure, Radiation **Microbial interactions:** Mutualism, Protocoperation, Commensalism, Predation, Amensalism, Competition, Symbioses in complex ecosystems **Growth Limitation in natural environments:** Growth limitation by Environmental factors, Counting viable but non-culturable (VBNC) vegetative prokaryotes, Quorum sensing and microbial populations, Biofilms.	**15**
VI	**Waters and Disease transmission:** Waterborne pathogens and water purification Sanitary analysis of waters **Wastewater treatment:**	**5**

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	Measuring water quality Waste treatment processes .	
VII	**Soil as an Environment for microorganisms** Microorganisms in the soil environment Soil Microorganisms and Human Health Understanding microbial diversity in the soil	**4**
VIII	**Microorganism Growth in foods:** Intrinsic factors, Extrinsic factors **Microbial Growth and Food Spoilage** **Controlling Food Spoilage:** Removal of microorganisms, Low Temperature, High Temperature, Water availability, Chemical-based preservation, Radiation, Microbial product-based inhibition **Detection of Foodborne Pathogens** **Microorganisms as food and food amendments**	**5**
	Total	**60**

Suggested Readings:

1. Lansing M. Prescott – *Microbiology*, McGraw-Hill.
2. Michael T. Madigan – *Brock Biology of Microorganisms*, Benjamin Cummings, Pearson Education.
3. R. Ananthanarayan & C.K. Jayaram Paniker – *Textbook of Microbiology*, Universities Press
4.Michael J. Pelczar, E.C.S. Chan, Noel R. Krieg – *Microbiology,* McGraw-Hill Education.
5. Peter F. Stanbury, Allan Whitaker, Stephen J. Hall – *Principles of Fermentation Technology,* 3rd Edition, Butterworth-Heinemann (Elsevier), 20162.
6. J. Cassells – *Bioprocess Engineering: Systems, Equipment and Facilities*, Wiley India Pvt Ltd, 2020.
7. World Health Organisation (WHO) – W*HO Technical Report Series on Bioprocess Containment, various volumes including* TRS No. 999 and TRS No. 1033, WHO Publications.

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8. Centres for Disease Control and Prevention (CDC) & National Institutes of Health (NIH) – *Biosafety in Microbiological and Biomedical Laboratories (BMBL)*, 6th Edition, U.S. Department of Health and Human Services, 2020.

Systematic Bacteriology

Theory	Subject Code: MMLS-M-010
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

Course Rationale: This subject provides information about various types of bacterial culture procedures, staining techniques, and biochemical tests used for the identification of bacteria. Students will learn about the morphological and cultural characteristics, biochemical properties, and laboratory diagnosis of different bacterial species.

Learning Objective: At the end of the course, students should be able to

1. Perform bacterial culture techniques.
2. Apply appropriate staining methods.
3. Conduct biochemical tests for bacterial identification.
4. Recognise and interpret the morphological, cultural, and biochemical characteristics of various bacteria.
5. Apply laboratory diagnostic methods for bacterial classification and analysis.

Unit	Topic	Hours
I	**Fundamentals of Bacterial Staining & Diagnostic Overview:** Significance and principles of staining in bacterial taxonomy and diagnostics; Procedures and interpretation of: Simple stain, Negative stain, Gram stain Albert's stain, Neisser's stain Ziehl–Neelsen stain, Capsule, Flagella, Spore stains Fontana stain for spirochetes; Diagnostic relevance tied to bacterial structures and classification; Overview of bacterial groups relevant to human health.	10
II	**Biochemical Identification of Bacteria:** Diagnostic interpretation and significance of the following tests in systematic classification: Catalase, Coagulase, Indole, Methyl Red, Voges–Proskauer, Urease, Citrate, Oxidase, TSIA, Nitrate reduction, Carbohydrate fermentation, Bile solubility, H_2S production, Motility, Decarboxylases; Integration of biochemical patterns into	14

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	genus/species-level diagnosis.	
III	**Gram-Positive & Gram-Negative Cocci**: Study of morphological, cultural, biochemical characteristics, pathogenesis and laboratory diagnosis of – *Staphylococcus, Streptococcus, Pneumococcus, Haemophilus, Neisseria gonorhoeae* and *Neisseria meningitidis.*	**8**
IV	**Enterobacteriaceae:** Study of various characteristics (morphological, cultural and biochemical), pathogenesis and laboratory diagnosis of bacteria- Enterobacteriaceae: *Escherichia, Citrobacter, Enterobacter, coli, Proteus, Klebsiella, Shigella, Yersinia enterocolitica* and *Yersinia pestis.*	**10**
V	**Systemic & Atypical Bacterial Pathogens:** Classification, morphology, pathogenicity, and diagnostics of: *Corynebacterium, Salmonella, Vibrio, Aeromonas, Plesiomonas, Clostridium species, Mycobacterium tuberculosis complex, M. leprae, Atypical Mycobacteria, Spirochetes: Treponema, Borrelia, Leptospira, Bordetella, Brucella, Mycoplasma, Ureaplasma, Rickettsia, Chlamydia, Actinomyces, Pseudomonas, Burkholderia.* Overview of	**16**
VI	Non-sporing anaerobic cocci and bacilli: Classification & Morphology, pathogenicity, and diagnostics of - Anaerobic cocci: *Peptostreptococcus, Veillonella;* Anaerobic Gram-positive bacilli: *Propionibacterium, Actinomyces spp.* (non-sporing); Anaerobic Gram-negative bacilli: *Bacteroides, Fusobacterium, Prevotella.*	**2**
	Total	**60**

Systematic Bacteriology Practical

Practical	Subject Code: MMLS-M-013
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

1. Advanced Specimen Collection & Transport: Selection of specimen type based on clinical suspicion, Aseptic techniques for collection, Transport media and conditions for fastidious organisms.

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2. Bacteriological analysis of food, water, and milk using quantitative methods, interpretation based on permissible limits (ICMR/WHO guidelines).

3. Isolation & Identification from Clinical Samples: Targeted media selection (e.g., XLD, TCBS, CLED), Colony morphology, pigment production, and hemolysis, Biochemical test panels and automated ID confirmation.

4. Integrated Diagnostic Strategies: Stepwise approach to diagnosing UTI, STI, TB, etc., Case-based interpretation and clinical correlation.

5. Automation Platforms (Demo/Simulation): Principle and workflow of VITEK, MALDI-TOF, and Phoenix, Comparative analysis: manual vs. automated results .

6. Case-Based Lab Interpretation: UTI with ESBL-producing *E. coli,* Genital ulcer workup with *Chlamydia* and *Treponema,* TB diagnostics integrating smear, culture, and GeneXpert.

***Clinical Laboratory rotation/observation can be incorporated wherever possible**

Suggested Readings:

1. Mackie & McCartney – *Practical Medical Microbiology*, Elsevier.
2. R. Ananthanarayan & C.K. Jayaram Paniker – *Textbook of Microbiology*, Universities Press.
3.Satish Gupte – *The Short Textbook of Medical Microbiology*, Jaypee Brothers Medical Publishers.
4. Kanai L. Mukherjee – *Medical Laboratory Technology*, McGraw-Hill Education.
5. Bailey & Scott – *Diagnostic Microbiology*, Elsevier.
6. Surinder Kumar – *Essentials of Microbiology*, Jaypee Brothers Medical Publishers.
7. Subhash Chandra Parija – *Textbook of Microbiology and Immunology*, Elsevier.
8. Lansing M. Prescott – *Microbiology*, McGraw-Hill.
9. Apurba Sankar Sastry & Sandhya Bhat K – *Essentials in Medical Microbiology*, Jaypee Brothers Medical Publishers.
10. Praful B. Godkar & Darshan P. Godkar – *Textbook of Medical Laboratory Technology*, Bhalani Publishing.

Medical Entomology and Parasitology

Theory	Subject Code: MMLS-M-011
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

Course Rationale: This course enables students in medical laboratory science to equip students with an in-depth understanding of morphology, pathogenesis, diagnostics, and control strategies of medically important parasites and arthropod vectors. It supports clinical decision-making and laboratory proficiency in detecting and characterising parasitic infections and vector-borne diseases with health significance.

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Learning Objective: At the end of the course, students should be able to

1. Recognise global priority parasitic diseases and research advances.
2. Understand the classification and structure of parasites and arthropods of medical importance.
3. Explain life cycles, disease mechanisms, and host-pathogen interactions of protozoa and helminths.
4. Identify parasites and vectors using microscopy, serology, and molecular methods.
5. Analyse vector ecology and apply integrated control measures.
6. Interpret immunological and molecular diagnostics relevant to parasitology.
7. Recognise global priority parasitic diseases and research advances in their management.

Unit	Topic	Hours
I	**Introduction to Medical Parasitology & Entomology**: scope and relevance; classification of medically important parasites and arthropods; transmission types, host categories, global burden and disease impact, emerging threats. Types of animal association, parasitism, commensalism, symbiosis, host adaptation mechanisms.	6
II	**Protozoa**: morphology, life cycle, pathogenesis, laboratory diagnosis, treatment and prevention of nonpathogenic: Entamoeba coli, Endolimax nana, Iodamoeba butschlii, Free living Amoebae: Naegleria, Acanthamoeba, Flagellates: Trichomonas, Giardia lamblia, Leishmania, Trypanosoma, Sporozoa: Malarial parasites, Bebesia, Toxoplasma gondii, Isospora belli, Cryptosporidium parvum, Cyclospora, Microsporida Ciliate: Balantidium coli. Explain zoonosis and drug resistance; opportunistic pathogens cause disease primarily in immunocompromised hosts.	8
III	**Helminths:** Classify helminths; compare morphological features, transmission routes, and adaptation mechanisms. **Trematodes:** morphology, life cycle, pathogenesis, laboratory diagnosis, treatment and prevention of Schistosoma species, Fasciola species, Fasciolopsis species, Clonorchis species, Paragonimus species **Cestodes**: morphology, life cycle, pathogenesis, laboratory diagnosis,	18

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	treatment and prevention of Taenia species, Echinococcus species, Hymenolepsis nana, Diphyllobothrium latum **Nematodes**: morphology, life cycle, pathogenesis, laboratory diagnosis, treatment and prevention of Intestinal Nematodes: Ascaris lumbricoides, Ancylostoma duodenale, Necator americanus, Strongyloids stercoralis, Trichinella spiralis, Enterobius vermicularis, Trichuris trichiura, Toxocara species Lymphatic Nematodes: Wuchereria bancrofti, Brugia malayi Subcutaneous tissue Nematodes: Loa loa, Onchocerca volvulus, Dracunculus medinensis.	
IV	**Introduction of Arthropods**: classify the arthropods of public health importance; distinguish between vector and vehicle; vector control strategies (environmental control, chemical control, biological control, genetic control) approaches; role of vehicles and vectors in disease spread; Integrated approaches for parasite and vector control in endemic settings; vector surveillance, resistance management. Antiparasitic drugs.	**8**
V	**Arthropods of Medical Importance:** morphology, life cycle, public health importance and control of Mosquitoes, Sandflies, Tse-tse fly, Blackflies, Fleas, Ticks and Mites, Cyclops, Housefly, Reduviid Bug, bed bug, lice.	**8**
VI	**Host–Parasite Immunology:** Immune mechanisms against parasites; antigenic variation; vaccine prospects. hypersensitivity reactions; immunodiagnostic assay interpretation.	**6**
VII	**Molecular Tools & Research Advances:** PCR, LAMP, and sequencing methods; discuss application of proteomics, genotyping in parasite detection; introduce WHO neglected diseases and research foci. Introduces global parasitic disease priorities and current research in diagnostics and vaccines.	**6**
	Total	**60**

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Medical Entomology and Parasitology Practical

Practical	Subject Code: MMLS-M-014
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

1. Specimen Handling and Biosafety-safe specimen collection, transport, labelling, and disposal procedures, Use of PPE and biosafety guidelines, and sample handling.
2. Wet Mount Preparation & Microscopy -Saline and iodine mounts; faecal smear preparation and observation; parasite sketching and labelling.
3. Concentration & Staining Methods- Floatation and sedimentation techniques; basic stains (Giemsa, methylene blue); image-based interpretation.
4. Identification of Helminth Ova and Larvae- Morphology of ova and larval stages under microscope; faecal concentration spotters.
5. Blood Parasite Detection-Thick and thin blood smear preparation; Giemsa staining; malaria and filarial parasite detection.
6. Arthropod Identification - using charts, preserved samples, shared slides.
7. Case Scenario Integration - disease link discussion; mapping activity with clinical cues.
8. Serological Diagnostic Techniques - ELISA and rapid card tests for parasitic infections; result interpretation and trouble-shooting.

***Clinical laboratory rotation/observation can be incorporated wherever possible**

Suggested Readings:

1. C.K. Jayaram Paniker, *Paniker's Textbook of Medical Parasitology*, Jaypee Brothers Medical Publishers.
2. D.R. Arora & B. Arora – *Medical Parasitology*, CBS Publishers & Distributors.
3. P. Chakraborty – *Textbook of Medical Parasitology*, New Central Book Agency.
4. Lynne Shore Garcia – *Diagnostic Medical Parasitology*, ASM Press.
5. K.D. Chatterjee – *Parasitology in Relation to Clinical Medicine*, CBS Publishers & Distributors.
6. Praful B. Godkar – *Textbook of Medical Microbiology and Parasitology*, Bhalani Publishing House.
7. K. Park – *Park's Textbook of Preventive and Social Medicine*, Banarsidas Bhanot Publishers

WHO Technical Reports – *Vector Control and Parasitic Disease Surveillance.*

Immunology and Immunodiagnostics

Theory	Subject Code: MMLS-M-012
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

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Course Rationale: This course enables students in medical laboratory science to equip students with an in-depth understanding of advanced immunological concepts and diagnostic strategies relevant to infectious disease microbiology. It emphasises molecular mechanisms, immune dysfunctions, and clinical applications of immunodiagnostic technologies.

Learning Objective: At the end of the course, students should be able to

1. Describe fundamental immune mechanisms involved in microbial defence, inflammation, and hypersensitivity.
2. Interpret antigen presentation and MHC associations in infection susceptibility, autoimmunity, and transplant contexts.
3. Evaluate immune dysfunctions including immunodeficiencies and autoimmune disorders with reference to microbial interactions.
4. Apply principles of vaccine design and immune modulation to microbial pathogens and emerging clinical scenarios.

Unit	Topic	Hours
I	**Overview of Immunity**: Evolution of immunity; innate and adaptive immunity; immunological memory; inflammation mechanisms; immune regulation and tolerance; relevance in infection detection and host defense mechanisms. **Immune Organs and Cells**: Structure and functions of primary and secondary lymphoid organs; influence of microbiota on lymphoid development. Classification and roles of immune cells including T lymphocytes, B lymphocytes, natural killer cells, and dendritic cells. Mechanisms of antigen processing and presentation, structural and functional diversity of immunoglobulin molecules, and the production and clinical applications of monoclonal antibodies.	8
II	**Complement System & Effector Mechanisms**: Overview of activation pathways—classical, alternative, and lectin—and their regulatory mechanisms. Functional roles in host defense, microbial clearance (e.g. *Neisseria*, *Candida*), inflammation, and autoimmune pathology. Diagnostic applications including CH50 and AH50 assays, and relevance in clinical Immunodiagnostics.	5
III	**Immune Response:** clonal selection theory and its significance in adaptive immune responses; differences between cell-mediated and	8

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	humoral immunity. **Major Histocompatibility Complex & Antigen Presentation**: structure, genetic polymorphism, and expression patterns of Major Histocompatibility Complex molecules; their role in presenting processed antigens to lymphocytes; disease associations involving MHC alleles; and their clinical relevance in infection susceptibility, autoimmune conditions and in organ transplantation.	
IV	**Lymphocyte Biology**: Maturation, activation, differentiation of B lymphocytes and T lymphocytes; structural diversity of T-cell receptors; lymphocyte trafficking and homing mechanisms. **Cytokines & Immune Modulators**: Classification and roles of cytokines; therapeutic applications; cytokine storm phenomena; kinin cascade and immune modulation.	**8**
V	**Hypersensitivity & Immune Dysregulation**: the classification and pathophysiological mechanisms of hypersensitivity reactions (Type I to Type IV) and their clinical implications in transfusion reactions, allergic disorders, and autoimmune conditions; laboratory strategies to identify hypersensitivity responses.	**5**
VI	**Immunodeficiency Syndromes**: Primary immunodeficiencies; molecular mechanisms; diagnostic approaches; secondary infections post-immunosuppression; microbial vulnerability; relevant diagnostics pathways. **Autoimmunity & Tolerance**: the mechanisms of central and peripheral immune tolerance; microbial mimicry in autoimmune diseases (*Campylobacter* in Guillain-Barré); immunological errors leading to autoimmune diseases such as systemic lupus erythematosus and rheumatoid arthritis; diagnostic markers.	**8**
VII	**Transplantation Immunology**: Immune recognition in allografts and xenografts; pathways of rejection; pharmacological and immunological strategies for immunosuppression; significance of human leukocyte antigen matching; and influence of microbial factors on graft survival. **Tumor Immunology**: the identification and roles of tumor-associated antigens; immune evasion by pathogens; mechanisms of	**7**

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	immunosurveillance.	
VIII	**Immunogenetics & Epigenetics**: genetic determinants of immune variability and disease susceptibility; HLA associations with microbial and autoimmune diseases; epigenetic regulation of immune responses; clinical application of immunogenetics and epigenetics in diagnostics and predictive medicine.	4
IX	**Systems Immunology & Immune Profiling**: High-throughput immunological assays; transcriptomic & proteomic responses to pathogens; microbiome-immune interactions; bioinformatics for infection tracking.	3
X	**Vaccine Design and Immunodiagnostics:** Foundational principles of vaccine design and administration, including microbial antigen selection, immune activation, and immunological memory formation. **Immunodiagnostic techniques** ELISA, flow cytometry, and lateral flow assays for detecting microbial infections. Advanced immunotherapies -Chimeric Antigen Receptor T-cell therapy and immune checkpoint blockade therapy and their diagnostic relevance in infection-linked immune modulation.	4
	Total	**60**

Immunology and Immunodiagnostic Practical

Practical	Subject Code: MMLS-M-015
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

1. Sample Collection & Handling - Blood, serum, and tissue sampling for immunological assays; biosafety and ethical protocols.
2. Peripheral Blood Smear Interpretation -Identification of major immune cells and lymphoid structures related to infection defense.
3. Immunoassays -Agglutination, flocculation, ELISA, WIDAL, CRP, Coombs, ASLO, and RPR tests.
4. Immunoblotting & Lateral Flow Techniques -Interpretation of infectious disease strips (e.g. malaria, HIV rapid cards).
5. Antibody Titer Estimation -Dilution-based methods for semi-quantitative antibody analysis

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6. Flow Cytometry -Immunophenotyping of immune cells and gating analysis.
7. Immunofluorescence (Direct & Indirect)-Microscopic detection of immune markers for diagnostic applications.
8. Autoimmune Marker Detection -Rheumatoid Factor, Anti-CCP, and Antinuclear Antibody (ANA) assays.
9. Biosafety & Quality Control in Immunodiagnostics -Practices for accuracy, reproducibility, and documentation in clinical labs.
10. Clinical Case Analysis -Case-based interpretation of immune dysfunction in infectious disease contexts.

***Clinical laboratory rotation/observation can be incorporated wherever possible**

Suggested Readings:

1. Punt, J., Stranford, S., Jones, P., Owen, J.A. – Kuby Immunology, W.H. Freeman
2. Parslow, T.G., Stites, D.P., Terr, A.I. – Medical Immunology, McGraw Hill
3. Delves, P.J., Martin, S.J., Burton, D.R., Roitt, I.M. – Roitt's Essential Immunology, Wiley-Blackwell
4. Kumar, V., Abbas, A.K., Aster, J.C. – Robbins Basic Pathology, Elsevier
5. Gangal, S., Sontakke, S. – Text Sontakke, S. – Textbook of Basic andbook of Basic and Clinical Immunology, Universities Press (India) Pvt. Ltd.
6. Subhash Chandra Parija – *Textbook of Microbiology and Immunology*, Elsevier
7. S.K. Gupta – *Essentials of Immunology*, Jaypee Brothers Medical Publishers

IInd SEMESTER
Haematology and Transfusion Medicine

Haematology and Haematological Disorders

Theory	Subject Code: MMLS-H-009
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

Course Rationale: Students will understand the advanced-level course equips learners with clinical-laboratory expertise to investigate hematologic disorders through morphological, molecular, and algorithmic lenses. It emphasizes interpretation of bone marrow, peripheral blood findings, bleeding profiles, and malignant hematologic conditions using automated and biosafe practices.

Learning Objective: At the end of the course, students should be able to

1. Interpret bone marrow and peripheral blood findings in hematologic disorders.

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2. Apply diagnostic measures for anemia, leukemia, MDS, and hemostatic conditions Perform and analyze molecular, cytogenetic, and immunophenotypic tests.
3. Correlate lab data with clinical symptoms to distinguish hematologic and hemostatic disorders.
4. Use automation tools and quality protocols for hematology lab efficiency.

Unit	Topic	Hours
I	Hematopoiesis and Bone Marrow Dynamics: Regulation of hematopoietic stem cells and stages of differentiation; Identification of maturation blockages and marrow failure syndromes; Role of marrow microenvironment and stromal interactions; Cytokine signaling in stem cell survival and lineage commitment; WHO 2022 marrow grading: fibrosis, cellularity, and blast percentages.	5
II	Red cell structure and metabolism: Red cell morphology and structural variants (size, shape, inclusion bodies); Hemoglobin biosynthesis: heme synthesis, globin chain production; Red cell metabolic pathways: Embden-Meyerhof and Pentose phosphate pathways; Functional implications of morphology and metabolism on red cell survival.	5
III	Red cell destructions- extracellular and intracellular red cell destructions; compensation mechanisms in hemolysis- reticulocytosis, erythroid hyperplasia, bilirubin metabolism; Classification of hemolytic anemia: hereditary vs acquired; Pathophysiology and laboratory diagnosis of: Hereditary spherocytosis and elliptocytosis, G6PD deficiency and its oxidative stress pathways, Paroxysmal nocturnal hemoglobinuria (PNH); diagnostic approaches for hereditary and acquired hemolytic anemias.	6
IV	Nutritional & Hypoproliferative Anemias: Classification, pathophysiology and laboratory diagnosis of nutritional anemias- Iron deficiency, folate deficiency, and megaloblastic anemia; Diagnostic interpretation using - Iron studies, megaloblastic indices, folate deficiency; anemia of chronic disease- pathophysiological mechanisms and cytokine-mediated iron sequestration; Hypoproliferative anemias - reticulocyte indices, erythropoietin response, and marrow hypocellularity; Bone marrow biopsy evaluation: cellularity grading, storage iron stains, and dysplastic features; Reticulocyte production index (RPI) and its relevance in marrow functional assessment; Application of WHO and ICSH	8

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	global anemia classification standards for standardized reporting.	
V	Hemoglobin Variants and Thalassemia Syndromes: Classification, pathophysiology and laboratory diagnosis of hemoglobin variants and thalassemia syndromes; WHO guidelines for sickle cell disease and unstable hemoglobin - Structural abnormalities (e.g., HbS, HbE, HbD) and synthesis defects (α- and β-thalassemia); Role of genetic counseling and prenatal diagnostic protocols.	**8**
VI	Acute & Chronic Leukemias: WHO/FAB classifications, pathophysiology and laboratory diagnosis of AML, ALL, CML, CLL including immunophenotyping (CD markers), cytogenetics, flow cytometry and PCR.	**8**
VII	Myeloproliferative & Myelodysplastic Syndromes: Clinical features and lab diagnosis of Polycythemia Vera, Essential Thrombocythemia, Myelofibrosis, Myelodysplastic Syndromes; marrow dysplasia grading, mutation panels (JAK2, CALR, and MPL), ASH guidelines for diagnosis and classification.	**8**
VIII	Plasma Cell Dyscrasias & Related Disorders: classifications, pathophysiology and laboratory diagnosis of multiple myeloma; paraprotein detection (SPEP, IFE, FLC assay); WHO 2022 criteria for plasma cell neoplasms; beta-2 microglobulin and cytogenetic risk stratification in plasma cell myeloma; WHO 2022 plasma cell definitions.	**6**
IX	Lymphoid Neoplasms: Classification, etiology, and lab findings of B-lymphoblastic and T-lymphoblastic leukemia/lymphoma; immunophenotyping (CD10, TdT, CD7), cytogenetic markers (MLL, ETV6), and clinical correlations. Mature Lymphoid Neoplasms & Advances: CLL, prolymphocytic leukemia, hairy cell leukemia, Hodgkin and Burkitt lymphomas, diagnostic techniques and recent molecular advances- NGS, FISH, IgH rearrangement; WHO 2022 updates on classification and disease behavior.	**6**
	Total	**60**

Haematology and Haematological Disorders Practical

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Practical	Subject Code: MMLS-H-013
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

1. Bone marrow smear review & cellular grading.
2. RBC morphology: Peripheral smear reporting.
3. Reticulocyte indices & anemia profiling.
4. Hemolytic anemia workup: Coombs, osmotic fragility, schistocyte quantification.
5. Hb electrophoresis & variant analysis.
6. Leukemia morphology & cytochemical typing.
7. Lymphoid neoplasm diagnostics: Case sheets and concept mapping of lab workups.
8. Plasma cell studies & paraprotein reporting, case sheets and concept mapping of lab workups.
9. Lab automation & QC documentation: Analyzer histogram reading, calibration reports, QC charting exercises.
10. Integrated case analysis & report writing: Drafting diagnostic algorithms and structured case interpretations.

***Clinical laboratory rotation/observation can be incorporated wherever possible**

Suggested Readings:

1. McKenzie, S. B., Williams, J. L., & Landis-Piwowar, K. (2004). Clinical laboratory hematology (Vol. 1). Pearson education.
2. Wickramasinghe, S. N., & McCullough, J. J. (2003). Blood and bone marrow pathology.
3. Chou, D. (2007). Henry's clinical diagnosis and management by laboratory methods. JAMA, 297(16), 1827-1833.
4. Wintrobe, M. M. (2009). Wintrobe's clinical hematology (Vol. 1). Lippincott Williams & Wilkins.
5. McKenzie, S. B., Williams, J. L., & Landis-Piwowar, K. (2004). Clinical laboratory hematology (Vol. 1). Pearson education.
6. Hoffbrand, A, V. et al (2016). Color Atlas of Clinical Hematology (Fourth ed.). New Delhi, India: Elsevier.
7. Sood, R. (2006). Textbook of medical laboratory technology. Jaypee Brothers Publishers.
8. Dacie, J. V. (2006). Dacie and Lewis practical haematology. Elsevier Health Sciences.
9. Godkar, P. B., & Godkar, D. P. (2006). Textbook of medical laboratory technology. Bhalani publishing house.

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Haemostatic Disorders

Theory	Subject Code: MMLS-H-010
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

Course Rationale: This course equips learners with advanced knowledge of hemostatic physiology, bleeding and thrombotic disorders, and laboratory diagnostic protocols. It bridges molecular mechanisms with practical testing strategies, emphasizing clinical correlations and reflex diagnostics for lifelong laboratory competence.

Learning Objective: At the end of the course, students should be able to

1. Explain normal hemostatic processes and coagulation factor functions in health and disease.
2. Classify and interpret bleeding and thrombotic disorders using laboratory and clinical data.
3. Apply structured diagnostic algorithms and reflex testing protocols for comprehensive hemostasis investigation.
4. Integrate recent advances in coagulation diagnostics into clinical laboratory practices.
5. Use automation tools and quality protocols for hematology lab efficiency.

Unit	Topic	Hours
I	Introduction to Hemostasis & Physiology: Normal hemostatic sequence: vascular constriction, platelet plug formation, coagulation cascade, inhibitors (Protein C/S, ATIII), fibrinolysis; interplay of endothelium, platelets, coagulation proteins.	6
II	Coagulation Factors & Pathways: Intrinsic/extrinsic/common pathways; nomenclature & roles of factors I–XIII; synthesis, vitamin K dependency, activation sequences; global standards on factor assays.	8
III	Primary Hemostasis Disorders: Platelet count and function defects, ITP, qualitative platelet disorders, Bernard-Soulier, Glanzmann's thrombasthenia; bleeding time, aggregation studies, genetic tools.	8
IV	Secondary Hemostasis Disorders: Hemophilia A/B, von Willebrand disease (types, diagnostics, ristocetin cofactor, vWF antigen, collagen binding), factor deficiencies; PT/APTT prolongation patterns.	8
V	Tertiary Hemostasis & Thrombotic Disorders: DIC, thrombotic thrombocytopenic purpura (TTP), hemolytic uremic syndrome	8

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	(HUS), acquired inhibitors, circulating anticoagulants; fibrin degradation products, D-dimer testing.	
VI	Laboratory screening & special testing: Complete Blood Count, Bleeding Time (BT) and Clotting Time(CT), Prothrombin Time (PT) , Activated Partial Thromboplastin Time (APTT), Thrombin Time (TT), clot retraction, solubility; Specific Factor Assays — Factor VIII, IX, vWF antigen & activity, fibrinogen levels , mixing studies, Lupus Anticoagulant Testing - dilute Russell viper venom test (dRVVT), **vWF Subtyping & Multimer Analysis** -for vWD classification, **TEG/ROTEM** -viscoelastic testing for clot formation dynamics Platelet function analyzers- **Platelet Aggregometry & PFA-100** — to assess qualitative platelet disorders, **Circulating Anticoagulant Detection** — therapeutic vs autoimmune sources.	**8**
VII	Reflex Testing & Algorithmic Diagnosis: Reflex testing principles, laboratory role in algorithm design, cascade testing protocols; interpreting abnormal screening results; reference ranges across age groups.	**7**
VIII	Recent Advances & Quality Management in Coagulation: Automation in coagulation labs, POC testing, new reagent technologies, integration with molecular diagnostics; QC/QM protocols; global practice recommendations (ASH/ICSH).	**7**
	Total	**60**

Haemostatic Disorders Practical

Practical	Subject Code: MMLS-H-014
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

1. Perform proper safety precautions.
2. Perform collection, transport, and processing of blood samples for coagulation tests.
3. Platelet Count and Peripheral Smear Interpretation- Platelet estimation accuracy, identification of qualitative abnormalities (e.g., Bernard-Soulier syndrome).
4. Bleeding Time (BT) and Clotting Time, PT/APTT Testing, Mixing study, Coagulation Factor Assays and Dilution Studies and Interpretation, Reflex algorithm application; protocol troubleshooting.

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5. ROTEM/TEG Simulation and Interpretation.
6. D-Dimer and FDP Estimation- Latex agglutination test; immunoassay-based quantification; cut-off setting for DVT/pulmonary embolism.
7. vWF Antigen and Activity Estimation- Differentiating type 1 vs type 2 variants; handling pre-analytical interferences.
8. Lab automation & QC documentation: Analyzer histogram reading, calibration reports, QC charting exercises.
9. Integrated case analysis & report writing: Drafting diagnostic algorithms and structured case interpretations.- Analyze anonymized clinical vignettes; chart diagnostic flow using PT/APTT/mixing study/vWF tools; prepare interpretive report.
10. WHO/ISTH Guidelines Review- Critical reading; global framework contextualization.

***Clinical laboratory rotation/observation can be incorporated wherever possible**

Suggested Readings:

1. McKenzie, S. B., Williams, J. L., & Landis-Piwowar, K. (2004). Clinical laboratory hematology (Vol. 1). Pearson education.
2. Wickramasinghe, S. N., & McCullough, J. J. (2003). Blood and bone marrow pathology.
3. Chou, D. (2007). Henry's clinical diagnosis and management by laboratory methods. *JAMA*, *297*(16), 1827-1833.
4. Wintrobe, M. M. (2009). *Wintrobe's clinical hematology* (Vol. 1). Lippincott Williams & Wilkins.
5. McKenzie, S. B., Williams, J. L., & Landis-Piwowar, K. (2004). *Clinical laboratory hematology* (Vol. 1). Pearson education.

Hoffbrand, A, V. et al (2016). Color Atlas of Clinical Hematology (Fourth ed.). New Delhi, India: Elsevier.

- Sood, R. (2006). *Textbook of medical laboratory technology*. Jaypee Brothers Publishers.
- Dacie, J. V. (2006). *Dacie and Lewis practical haematology*. Elsevier Health Sciences.
- Godkar, P. B., & Godkar, D. P. (2006). *Textbook of medical laboratory technology*. Bhalani publishing house.

Applied Immunopathology in Haematology

Theory	Subject Code: MMLS-H-011
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

Course Rationale: This course equips learners with advanced knowledge of hemostatic physiology, bleeding and thrombotic disorders, and laboratory diagnostic protocols. It bridges

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molecular mechanisms with practical testing strategies, emphasizing clinical correlations and reflex diagnostics for lifelong laboratory competence.

Learning Objective: At the end of the course, students should be able to

1. Explain the immune mechanisms involved in hematological disorderss.
2. Analyze immunopathological basis of hematologic malignancies and autoimmune hematologic diseases.
3. Perform and interpret immunohematological and immunodiagnostic tests relevant to hematology.
4. Correlate laboratory findings with clinical immunopathology in various hematological conditions.

Unit	Topic	Hours
I	Overview of Immune system: Immune system and Immunologic disorders, Cellular and humoral Immunity, Complement system, Cytokines, Human leucocytic antigen, Major Histocompatibility complex and disease.	
II	Immunopathology of Hematologic Disorders: Autoimmune hemolytic anemia (AIHA), Immune thrombocytopenic purpura (ITP), Paroxysmal nocturnal hemoglobinuria (PNH), Hemophagocytic lymphohistiocytosis (HLH), Hypersplenism and immune cytopenias.	
III	Immunopathology in Hematologic Malignancies: Tumor immunology of leukemia and lymphoma, Immunophenotyping in leukemia/lymphoma diagnosis, Role of monoclonal antibodies and immune escape, Minimal residual disease detection via flow cytometry.	
IV	Immunodiagnostics in Hematology: Direct and Indirect Coombs Test (DAT & IAT), Antibody screening and cross-matching, Immunoassays (ELISA, CLIA) for hematological markers, Flow cytometry principles and interpretation, Autoantibody detection in systemic autoimmune diseases.	
V	Immunotherapy and Targeted Therapy: Immunomodulatory drugs in hematology, Monoclonal antibodies (e.g., Rituximab, Daratumumab), CAR-T cell therapy in leukemia and lymphoma, Graft-versus-host disease (GVHD) and immune regulation in bone marrow transplant.	

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	Total	**60**

Applied Immunopathology in Haematology Practical

Practical	Subject Code: MMLS-H-015
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

1. Luminex-based anti-HLA class I & II screening.
2. HLA-A, C, DRB3/4/5 high-resolution typing.
3. Multiparametric flow panels for leukemias.
4. cytometry-based immunophenotyping.
5. Direct and Indirect Coomb's test.
6. Advanced hematology automation (Mindray CAL 6000): includes reflex testing and parameters like IG (immature granulocyte count), Ret-He, NLR (neutrophil-to-lymphocyte ratio) (DEMO).
7. The practicals can be uptaken in workshop mode at any Advanced NABL lab with above mentioned facility or can be sensitized with demo practical.

***Students can be taken for demo visits to labs where the tests are routinely performed**

Suggested Readings:

1. Silberstein, L. E., & Anastasi, J. (2017). Hematology: Basic Principles and Practice. Elsevier Health Sciences.
2. McPherson, R. A., & Pincus, M. R. (2021). Henry's clinical diagnosis and management by laboratory methods E-book. Elsevier Health Sciences.
3. Wintrobe, M. M. (2009). Wintrobe's clinical hematology (Vol. 1). Lippincott Williams & Wilkins.
4. Owen, J, A. (2013). Kuby immunology. New York: W.H. Freeman and Company.

Clinical Pathology

Theory	Subject Code: MMLS-H-012
Total Marks for Evaluation- 100	No. of Contact Hours- 30, Credits:2

Course Rationale: This course integrates foundational and advanced diagnostic principles in clinical pathology, emphasizing fluid-based diagnostics (urine, CSF, serous fluids, semen, feces,

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sputum, cytology). It equips learners to apply structured laboratory techniques, interpret results in clinical contexts, and engage with emerging technologies and automation in pathology.

Learning Objective: At the end of the course, students should be able to

1. Describe and differentiate the physical, chemical, and microscopic characteristics of body fluids in normal and pathological states.
2. Apply appropriate diagnostic techniques including reagent strip, cytology, and special stains for identifying abnormal conditions.
3. Evaluate laboratory findings to correlate with clinical conditions such as renal disorders, meningitis, infertility, and gastrointestinal pathology.
4. Discuss recent advances in fluid-based diagnostics, including automation, molecular integration, and quality assurance.

Unit	Topic	Hours
I	Urine analysis: Collection and preservation; physical, chemical, microscopic exams; urine strip technique; renal pathology; pregnancy tests, urine osmolality, Bence Jones protein, and automation in urinalysis.	4
II	Cerebrospinal Fluid (CSF): CSF formation and handling; differentiation of pathological findings; cell count interpretation; meningitis profiles, CSF glucose/protein ratios, PCR for meningitis pathogens, and cytospin techniques.	3
III	Serous & Synovial Fluids: Formation, collection, exam of pleural, pericardial, peritoneal, synovial fluids; transudates vs exudates; crystals; joint disorder profiles. ADA levels in pleural fluid, synovial fluid viscosity grading, and crystal identification using polarized microscopy.	4
IV	Semen analysis: Sample collection; physical, chemical, microscopic exams; sperm morphology; fertility tests and interpretation. WHO sperm morphology criteria, DNA fragmentation index, and computer-assisted semen analysis (CASA).	4
V	Other Fluids: Amniotic, BAL, Saliva: Composition and analysis of amniotic fluid; maternal urine differentiation; L/S ratio in amniotic fluid, salivary biomarkers. BAL and saliva examination. BAL cytology for infectious diseases.	3

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VI	Fecal Analysis: Composition; collection; physical, chemical, microscopic exams; fecal screening tests (occult blood, fat, Hb); clinical correlations. Fecal calprotectin, PCR for parasitic DNA, and automation in stool analysis.	**4**
VII	Sputum Analysis: Formation of Sputum, collection of Sputum, Analysis of Sputum, sputum cytology, Ziehl-Neelsen staining, and GeneXpert for TB.	**3**
VIII	Integrated Interpretation & Case Correlation: Reflex testing interpretation; integration of fluid analysis in diagnostic decisions; pattern recognition across fluids; specimen quality and result impact; AI-assisted image analysis.	**4**
	Total	**30**

Clinical Pathology Practical

Practical	Subject Code: MMLS-H-016
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

1. Collection and biosafe handling of urine, stool, semen, CSF, and body fluids.
2. Urine - Manual and dipstick urine analysis, Microscopic examination of urine sediments, Comparative analysis using semi-automated urine analyzers, Rapid HCG pregnancy test and interpretation.
3. Stool microscopy for ova, cysts, leukocytes, Detection of fecal occult blood and fecal fat. Semen analysis: volume, motility, morphology (WHO protocol).
4. Physical and microscopic examination of pleural, ascitic, synovial, pericardial, and CSF samples, Total and differential cell counts in body fluids, Cytospin preparation and smear interpretation.
5. Cytological specimen handling, fixation, and smear preparation, Liquid-based cytology demonstration, Papanicolaou (PAP) staining and interpretation.
6. Case-based correlation of lab findings with clinical conditions.
7. Identification and analysis of pre-analytical, analytical, and post-analytical errors.
8. Quality control exercises and documentation practices.

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Suggested Readings:

1. Mundt, L., & Shanahan, K. (2020). *Graff's textbook of urinalysis and body fluids*. Jones & Bartlett Learning.
2. Godkar, P. B., & Godkar, D. P. (2006). *Textbook of medical laboratory technology*. Bhalani publishing house.
3. Strasinger, S. K., & Di Lorenzo, M. S. (2014). *Urinalysis and body fluids*. FA Davis.
4. Sood, R. (2006). *Textbook of medical laboratory technology*. Jaypee Brothers Publishers.
5. Chou, D. (2007). Henry's clinical diagnosis and management by laboratory methods. *JAMA*, *297*(16), 1827-1833.
6. Polansky, V. D. (2014). *Quick Review Cards for Medical Laboratory Science*. FA Davis.
7. World Health Organization. (2021). WHO laboratory manual for the examination and processing of human semen. In *Who laboratory manual for the examination and processing of human semen*.

IInd SEMESTER
Histology and Cytology

Translational Anatomy and Cell Dynamics

Theory	Subject Code: MMLS-C-009
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

Course Rationale: This course explores human anatomy with a translational focus, linking structural insights to cellular functions, pathologies, and laboratory diagnostics. Understanding cell architecture, behavior, and dynamics in health and disease states, can especially serve in terms of targeted therapies towards oncology and regenerative medicine.

Learning Objective: At the end of the course, students should be able to

1. Correlate gross and microscopic anatomy with pathological conditions observed in clinical specimens.
2. Recognize anatomical features in histological slides, including landmarks essential for identifying normal versus diseased tissue.
3. Apply anatomical knowledge to orient, section, and analyze tissue samples correctly in histopathology laboratories.
4. Integrate anatomical context with digital and molecular diagnostics, enhancing interpretation of tissue-based assays and biomarker localization.

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Unit	Topic	Hours
I	Translational anatomy of diagnostic relevance: Overview of systems-based gross anatomy with diagnostic relevance, Surface landmarks and anatomical variations, Regional vs. systemic anatomy, Importance of anatomy in grossing and sectioning protocols, Anatomical changes in disease: atrophy, hypertrophy, neoplasia, regeneration.	12
II	Organ-Specific Applied Anatomy: Histotechnology-oriented anatomical structure of major systems: • Integumentary (skin biopsies, dermopathology) • Respiratory (lung, nasal mucosa, bronchi) • Gastrointestinal tract (liver, pancreas, stomach, intestines) • Genitourinary (kidney, bladder, reproductive organs) • Endocrine (thyroid, adrenal, pituitary) • Nervous system (brain regions, spinal cord, peripheral nerves)	12
III	Microanatomy and Tissue Architecture in Health and Disease: Functional tissue units and compartmentalization, Epithelial, connective, muscular, and nervous tissue orientation, Normal vs. pathological tissue organization, Tumor margins, cellular localization, lymphovascular structures· Microscopic and gross anatomy of nervous and endocrine systems, Advanced cell organelle functions (Golgi, ER, lysosomes, peroxisomes), Lab relevance in hormone-secreting tumors, neurodegeneration.	12
IV	Cell Biology in Health and Disease: Structure and function of cellular organelles, Cell cycle regulation and checkpoints, Apoptosis vs. necrosis – pathways and implications, Cellular senescence and aging, basics of stem cells and regenerative biology.	12
V	Applications in Laboratory and Translational Research: Histopathology and cytopathology applications., In vitro models: spheroids, organoids, and lab-on-chip systems., Cellular imaging and	12

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	live-cell tracking techniques, Molecular diagnostics: cell signaling assays, immunofluorescence, IHC, Application of AI in anatomical image interpretation, Role of anatomy and cell biology in forensic and personalized medicine, Ethical issues in cell and tissue research.	
	Total	**60**

Translational Anatomy and Cell Dynamics Practical

Practical	Subject Code: MMLS-C-013
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

1. Identification of cell and tissue types under light microscope (H&E, special stains).
2. Correlating anatomical landmarks with histological slides.
3. Application of AI in anatomical image interpretation.
4. Virtual dissection and 3D anatomical visualization using software.
5. Clinical case discussions (normal vs pathological tissue morphology).

Suggested Readings:

1. Drake, R, L. et al (2020). Gray's Anatomy for Students (Second ed.). New Delhi, India: Elsevier.
2. Mescher, A, L. (2021). Junqueira's basic histology: text and atlas (16th ed).
3. Lodish, H. F. (2000). Molecular cell biology. 4th ed. W.H. Freeman.
4. Young, B. et al (2015). Wheater's Functional Histology: A Text and Colour Atlas (Sixth ed.). New Delhi, India: Elsevier.
5. Rizzo, D. C. (2015). Fundamentals of anatomy and physiology (4th ed.). Cengage Learning.
6. Ross, M, H., Pawlina, W. (2011). Histology: a text and atlas: with correlated cell and molecular biology (6th ed.).
7. Bancroft, J. D., & Gamble, M. (Eds.). (2008). Theory and practice of histological techniques. Elsevier health sciences.
8. Bancroft, J. D., & Gamble, M. (Eds.). (2008). Theory and practice of histological techniques. Elsevier health sciences.

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Essentials of Histology

Theory	Subject Code: MMLS-C-010
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

Course Rationale: This course equips students with foundational and applied competencies in Histology and Histopathology. By exploring the microscopic architecture of cells and tissues, learners will develop diagnostic insight into disease mechanisms and tissue responses. Emphasis will be placed on laboratory organization, specimen processing, cytological techniques, routine and specialized staining, and the interpretation of morphological changes. Through this, students gain readiness to contribute meaningfully to diagnostic histopathology, cytopathology, and integrated laboratory medicine.

Learning Objective: At the end of the course, students should be able to

1. Apply principles and techniques for tissue fixation, processing, and staining in histological practice.
2. Demonstrate proper specimen collection and handling to uphold diagnostic standards.
3. Interpret cellular and tissue morphology across organ systems, correlating with physiological and pathological changes.
4. Utilize emerging digital tools and automation in histology for quality assurance and diagnostic support.

Unit	Topic	Hours
I	Introduction to Histology and Cell Architecture: Scope and relevance of histology in laboratory medicine, Microscopic anatomy overview, Histological terminology and classification of tissues, Cellular organelles and nuclear-cytoplasmic relationships.	7
II	Cell Biology and Cytological Architecture: Cell membrane, cytoskeletal elements, and intracellular junctions, Nucleus, nucleolus, and chromatin organization, Cell cycle phases and mitotic activity in tissues, Apoptosis and cellular degeneration markers.	7
III	Tissue Preparation and Processing: Fixation techniques: chemical principles and types, Processing steps: dehydration, clearing, embedding, Microtomy principles and troubleshooting, Frozen sections and cryostat applications.	10
IV	Staining Techniques and Interpretation: Principles of staining: dye-	10

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	tissue interactions, Routine stains: H&E, Romanowsky stains, Special stains: PAS, Masson's trichrome, Reticulin, Alcian blue, Histochemical techniques in tissue differentiation, Stain validation, control tissues, and interpretative accuracy.	
V	Systemic Histology – Organ-Based Structure: Microscopic anatomy of major systems: Integumentary System – epidermal layers, dermis, adnexa; Musculoskeletal System – bone histology, cartilage types, marrow ; Respiratory System – nasal mucosa to alveoli; Gastrointestinal Tract – from esophagus to colon; Hepatobiliary System – liver lobules, bile ducts; Renal System – nephron architecture, filtration interfaces ; Endocrine Organs – thyroid, adrenal, pituitary microstructure; Reproductive Organs – ovarian and testicular histology; Nervous System – cortex layers, cerebellum, peripheral nerves; Lymphatic & Immune Organs – lymph nodes, spleen, thymus.	**16**
VI	Emerging Trends and Digital Histology Histology automation: tissue processors, automated strainers; Digital slide scanning and image analysis; AI-assisted diagnosis and computational histology; Role of LIS and telepathology in modern laboratories; Ethical and regulatory aspects of digital diagnostics.	**10**
	Total	**60**

Essentials of Histology Practical

Practical	Subject Code: MMLS-C-014
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

1. Demonstrate receiving, handling, and labelling and specimen rejection criteria of cytological specimen.
2. Prepare and compare fixation using formalin, Bouin's solution, and alcohol-based fixatives. Record effects on tissue integrity.
3. Tissue Processing & Embedding – fixation, dehydration, clearing, impregnation
4. Demonstrate the procedure for knife sharpening - Honing & stropping
5. Perform section cutting of tissue block using a microtome
6. Perform Hematoxylin and Eosin staining with emphasis on nuclear-cytoplasmic contrast and reagent preparation.

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7. Perform mounting of the stained section
8. Special Stains (PAS, Masson's Trichrome)- PAS for carbohydrates and Trichrome for collagen. Assess specificity and interpret stained slides.
9. Identify organs/tissues under microscope (skin, liver, kidney, etc.) and correlate with histological descriptions.

***Clinical laboratory rotation/observation can be incorporated wherever possible**

Suggested Readings:

1. Bancroft, J. D., & Gamble, M. (Eds.). (2008). Theory and practice of histological techniques. Elsevier health sciences.
2. Ramakrishnan, S., & Sulochana, K. N. (Eds.). (2012). Manual of Medical laboratory techniques. Jaypee Brothers Medical Publishers Pvt. Ltd.
3. Culling, C. F. A., & Taylor, H. E. (1963). Handbook of histopathological techniques (including museum technique).
4. Nayak, R., & Nayak, R. (2018). Exam Preparatory Manual for Undergraduates: Pathology. Jaypee Brothers Medical Publishers
5. Carson, F. L., & HLADIK, C. (2015). Histotechnology. A self-instructional text, American-Society.
6. Curran, R. C., & Crocker, J. (2000). Curran's atlas of histopathology.

Essentials of Cytopathology

Theory	Subject Code: MMLS-C-011
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

Course Rationale: This course explores the structure, function, and morphology of normal and abnormal cells. This will aid students to identify various types of cytological specimens and understand their clinical relevance. The course also allows to apply knowledge gained for staining techniques and microscopy in the identification of normal and pathological cytology.

Learning Objective: At the end of the course, students should be able to

1. Demonstrate knowledge of cellular morphology and identify cytological features of normal and diseased states.
2. Perform and troubleshoot cytological specimen preparation, staining, and slide screening techniques.
3. Interpret cytological findings in gynecological, exfoliative, fluid-based, and aspiration cytology with clinical correlation.

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Unit	Topic	Hours
I	General Principles of cytology and its application: Fundamentals: Cell structure and organelles, Cell cycle, division, and death, Cytoskeletal and nuclear changes in disease, Basics of microscopy and image analysis, Cytodiagnosis in various disease, comparison of cells normal vs disease, Molecular cytology and its role in diagnostics.	5
II	**Exfoliative Cytology:** **Introduction to Exfoliative Cytology** • Definition and scope • Types of exfoliation: spontaneous vs. mechanically induced • Advantages and limitations in clinical diagnostics **Sample Collection Techniques** • General principles of collection and fixation • Specific site-based collection: Respiratory tract: sputum, bronchial washings • Urinary tract: voided urine, bladder washings • Female genital tract: Pap smear (conventional and liquid-based cytology) • Serous cavities: pleural, peritoneal, and pericardial fluids • Nipple discharge, oral cavity, gastrointestinal tract	10
III	**Interventional Cytology:** **1. Introduction to Interventional Cytology** • Definition, scope, and evolution • Indications and contraindications • Role in minimally invasive diagnosis	15

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	2. Fine Needle Aspiration Cytology (FNAC) • Techniques: Palpation-guided, USG-guided, CT-guided • Needle types, aspiration vs. non-aspiration (capillary) technique • FNAC of common sites: breast, thyroid, lymph node, salivary gland, soft tissue **3. Sample Collection, Smear Preparation** • Smear techniques (pull, squash, drop, spray) • Cell block preparation and liquid-based cytology	
IV	**Slide Preparation and Staining:** • Smearing techniques • Fixatives used for exfoliative samples Staining methods: • Papanicolaou stain (Pap stain) • Hematoxylin and Eosin • May-Grünwald Giemsa (MGG) • Special stains for infection (Ziehl–Neelsen, PAS) **Microscopic Interpretation:** Criteria for adequacy and cellular preservation, Identification of normal epithelial cells and reactive changes, Recognition of inflammatory and infectious processes, Cellular atypia and malignancy: cytomorphological features, Use of scoring systems (e.g., Bethesda system for cervical cytology)	**10**
V	**Cytodiagnosis and reporting:** **Rapid On-Site Evaluation (ROSE)** • Concept, purpose, workflow • Adequacy assessment criteria	**10**

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	• Communication with clinicians and radiologists **Ancillary Techniques in Interventional Cytology** • Immunocytochemistry (ICC) • Flow cytometry on FNAC samples • Molecular testing (e.g., PCR, FISH on aspirates)	
VI	**Quality Assurance:** Specimen rejection criteria, Internal quality control and proficiency testing, Documentation and reporting format Non-diagnostic and inadequate samples, Artifacts and misinterpretation, Error reduction and internal QC measures.	**10**
	Total	**60**

Essentials of Cytopathology Practical

Practical	Subject Code: MMLS-C-015
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

1. Preparation and staining of Pap smears and other exfoliative samples.
2. Identification of cells from different anatomical sites.
3. Interpretation exercises with normal, reactive, and malignant cells.
4. Comparative analysis of conventional vs. liquid-based cytology.
5. Cytopreparation Techniques
   - Smear techniques (crush, imprint, FNAC smears)
   - Cell block preparation
   - LBC sample preparation
6. Staining Techniques
   - PAP, H&E, MGG, Toluidine blue
   - Special stains (PAS, Ziehl-Neelsen, Alcian Blue)
   - Immunocytochemical markers (ER, PR, TTF-1, Ki67, etc.)
7. Microscopic Evaluation
   - Identification of normal vs abnormal cells
   - Cytodiagnosis in inflammatory, benign, and malignant lesions

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- Cervical cytology (Bethesda system) interpretation
- Effusion fluid cytology with diagnostic pearls

8. Case Discussions & Reporting
   - Integrating cytological, clinical, and histological data
   - FNAC case discussions with differential diagnosis
   - Writing structured cytology reports
9. Visit / Demo (Optional)
   - Digital cytology/automated screening system
   - Cytogenetic/molecular lab interface with cytology

Suggested Readings:

1. Koss, L.G. and Melamed, M.R. (2005) Koss' diagnostic cytology and its histopathologic bases. 5th Edition, JB Lippincott, Philadelphia.
2. ComBibbo, M., & Wilbur, D. (2014). Comprehensive cytopathology. Elsevier Health Sciences.
3. Cibas, Edmund S, and Barbara S Ducatman. Cytology: Diagnostic Principles and Clinical Correlates. Fifth edition. Philadelphia, PA: Elsevier, 2021.

Cancer Epidemiology and Digital Pathology

Theory	Subject Code: MMLS-C-012
Total Marks for Evaluation- 100	No. of Contact Hours- 30, Credits:2

Course Rationale: To equip students with an integrated understanding of cancer burden, population-level trends, risk profiling, and cutting-edge digital tools used in cancer diagnostics and reporting.

Learning Objective: At the end of the course, students should be able to

1. Interpret cancer trends using epidemiological tools and global databases.
2. Correlate tumor biology with diagnostic and prognostic markers.
3. Demonstrate understanding of digital pathology systems and workflow.
4. Apply integrated epidemiological and digital pathology tools to cancer diagnostics.
5. Critically assess ethical, technical, and translational aspects of digital pathology.

Unit	Topic	Hours
I	Principles of Cancer Epidemiology: Definitions, concepts, and scope	6

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	of cancer epidemiology, Cancer classification, Risk factors: genetic, environmental, lifestyle, occupational, Descriptive vs. analytical epidemiological studies, Cancer registries, cohort studies, and surveillance systems.	
II	Global and Regional Cancer Trends: GLOBOCAN, WHO, and IARC databases and tools; Common cancers by geography, gender, and age; Cancer disparities: socioeconomic and environmental determinants; Public health policies, screening guidelines (e.g., HPV, breast, colorectal); Epidemiology of emerging cancers and rare tumors.	**6**
III	Tumor Biology and Molecular Basis of Cancer: Oncogenes, tumor suppressor genes, and hallmarks of cancer, Cancer immunology: immune escape, tumour microenvironment, Pathways of metastasis and angiogenesis, Molecular diagnostics: PCR, FISH, NGS, liquid biopsy, Biomarkers in cancer diagnosis, prognosis, and therapy monitoring.	**6**
IV	Digital Pathology Tools and Workflow: Fundamentals of digital slide scanning and virtual microscopy, Image analysis and whole-slide imaging (WSI) systems, AI and machine learning algorithms in pathology, Quality assurance, interoperability, and regulatory frameworks, Role of digital pathology in telepathology, consultation, and education.	**6**
V	Applications in Diagnostics, Screening, and Research: Integration of epidemiological data with digital histopathology, Use of AI in cancer grading and biomarker quantification, Personalized medicine and predictive pathology, Digital pathology in multicenter trials, biobanks, and data mining, Ethical and data privacy considerations in digital pathology.	**6**
	Total	**30**

Cancer Epidemiology and Digital Pathology Practical

Practical	Subject Code: MMLS-C-016
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

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1. Cancer Registry Data Interpretation - Access and analyze data from sources like NCRP, GLOBOCAN, SEER for specific cancer types and regions.
2. ICD-O Coding Exercise- cancer classification using ICD-O-3 codes for site, histology, behavior, and grade.
3. Board Case Review (Simulated)- cases study- clinical features, pathology, staging, and therapy decisions.
4. Virtual Slide Review: Common Cancers- Interpret digital histopathology slides (e.g., breast, cervical, colorectal) using whole-slide imaging tools.
5. Staining Pattern Recognition- Compare H&E and IHC markers on tumor slides: ER, PR, HER2, Ki-67, p53, etc.
6. AI in Pathology Demo- Explore basic AI software or simulations for image classification, feature detection, and tumor grading.
7. Digital Pathology Workflow Simulation- Understand slide scanning, image storage, data annotation, and telepathology platforms.

Suggested Readings:

1. DeVita, V. T., Jr., Lawrence, T. S., & Rosenberg, S. A. (2023). DeVita, Hellman, and Rosenberg's cancer: Principles & practice of oncology (12th ed.).
2. Hameed, M., & Hanna, M. G. (2024). Digital Pathology: Implementation in Clinical Practice with AI Applications. Elsevier.
3. WHO GLOBOCAN Reports and IARC Monographs
4. Latest publications in the selected field from WHO
5. Coleman, W. B., & Tsongalis, G. J. (Eds.). (2007). Molecular diagnostics: for the clinical laboratorian. Springer Science & Business Media.
6. Kumar, V., Abbas, A. K., Aster, J. C., & Deyrup, A. T. (Eds.). (2022). Robbins & Kumar basic pathology, e-book: Robbins & Kumar basic pathology, e-book. Elsevier Health Sciences.

IIIrd SEMESTER

Medical Biochemistry

Clinical Biochemistry I

Theory	Subject Code: MMLS-B-016
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

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Course Rationale: The Course will equip the student with the knowledge of disorders related to the respective metabolisms taking place in the body. The course emphasizes on the understanding of metabolic pathways and biochemical changes associated with various pathological conditions.

Learning Objective: At the end of the course, students should be able to

1. Understand the principles of biochemical processes and how they relate to normal and diseased states.
2. Identify and explain the significance of common biochemical markers used in diagnostics and monitoring of disease.
3. Perform key biochemical laboratory techniques and follow proper sample handling procedures.

Unit	Topic	Hours
I	**Role of biochemistry in diagnosis of diseases:** Use of Biochemical data in clinical medicine: Specific uses of biochemical tests in screening, diagnosis, prognosis and management, Acquisition & Interpretation of biochemical data. **Specimen receiving and processing:** Types of body fluid specimens received in the lab (Whole blood, Urine, CSF and other fluids) Appropriate specimen collection • Factors affecting test results - Preanalytical variables • Preservatives for combined biochemical analysis in urine. • Basic concepts: random error, systematic error, analytical range, sensitivity, specificity, detection limit, interferences, recovery, Accuracy, Precision • Biological reference intervals • Benchmarking, continuous Quality improvement • Quality indicators (QI): Rejection criteria, Hemolysed rejection rate, TAT (turn around time), critical value reporting, IQC cv% performance, EQA performance; Importance of QI • Selection and evaluation /validation of new methods, Analytical	8

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	performance criteria: Method comparisons, accuracy, within run-precision • Instrument comparison in laboratory for an assay.	
II	**Disorders of carbohydrates metabolism**: • Glucose level in normal blood, renal threshold • Diabetes Mellitus: classification and Pathogenesis of DM • Diabetic ketoacidosis and diabetic coma, secondary degenerative changes associated with diabetes mellitus. • Hyper glycemia, Hypoglycaemia, glycosuria and Renal Glycosuria • **Laboratory diagnosis**: specimen collection, Patient Instructions, storage; principle, estimation, reference range, clinical significance of Plasma glucose (fasting, post prandial, random), Oral Glucose Tolerance Tests, Glucose challenge test, urine microalbumin, Glycated haemoglobin, qualitative tests for sugars in urine, Ketone bodies, Plasma lactate. • Diagnosis of inborn errors of carbohydrate metabolism by qualitative and chromatographic techniques. • Self-monitoring of blood glucose and Contionous glucose monitoring (CGM).	**10**
III	**Disorders of lipid metabolism:** • Plasma triglycerides, Cholesterol, HDL cholesterol, LDL cholesterol levels • Familial hypercholesterolemia, hypo and hyper cholesterolemia, Fatty liver, Hyper and hypo lipoproteinemia, hypertriglyceridemia, Dyslipidemia, Atherosclerosis and Myocardial Infarction, ketosis, fatty liver, coronary heart disease. • **Laboratory diagnosis** : Specimen collection, Patient Instructions Principle, estimation, reference range and clinical significance - lipid profile (serum cholesterol, triglycerides, HDL, LDL, HDL:LDL)	**10**

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	• Diagnosis of inborn errors of lipid metabolism • Diagnosis of various disorders by lipoprotein by electrophoresis	
IV	**Disorders of Amino acid and protein metabolism:** • **Overview** of plasma proteins and their disorders, multiple myeloma, Paraproteinemia • **Laboratory diagnosis** : Specimen collection, Principle, estimation, reference range and clinical significance of : proteins in blood (albumin, α1-antitrypsin, α1-fetoprotein, C-reactive protein, β2-microglobulin), serum Immunoglobulins; • Protein in other body fluids (Urine, CSF, Pleural fluid, Ascitic Fluid) laboratory evaluation of paraproteinemia: Electrophoresis of plasma and urine proteins, quantification for diagnosis of multiple myeloma (M band Quantification) • **Disorders of nitrogen metabolism:** Excretion of nitrogenous waste products, abnormalities of nitrogen metabolism including uremia, Uric aciduria, aminoaciduria • **Laboratory diagnosis**: Principle, estimation, reference range and clinical significance of Ammonia, urea, uric acid, creatinine. • Diagnosis of inborn errors of Amino acid and protein metabolism by qualitative and quantitative methods	**10**
V	**Minerals and Trace Metal disorders:** • Overview of Mineral and trace metal disorders- Anaemia, Hypercalcemia, Phosphatemia, Wilson disease, etc • **Laboratory diagnosis:** Principle, estimation, reference range and clinical significance: disorders related to iron, calcium, phosphorus, magnesium, copper and zinc	**6**
VI	**Lab diagnosis of porphyrias.** • Clinical significance and disease correlation • Urine qualitative tests (porphyrins, coproporphyrin,	**4**

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	uroproporphyrin , d-ALA, porphobilinogen, urobilinogen	
VII	**Clinical Enzymology:** • Sources of plasma enzymes, diagnostic importance and their interpretation • **Laboratory evaluation of enzymes-** Principle, estimation, reference range, and clinical significance: Amylase, Lipase, aminotransferase, gamma glutamyl transferase, alkaline phosphatase, creatinine kinase, cholinesterase, lactate dehydrogenase, lipoprotein lipase, LDH, Acid phosphatase	**6**
VIII	**Fluid and electrolyte balance disorders:** • Disorders of fluid and electrolyte balance • **Laboratory diagnosis** Principle, estimation, reference range, and clinical significance Electrolytes (sodium, potassium, chloride, bicarbonate) **Acid base balance** • Disorders of Acid base balance- Metabolic acidosis, Metabolic alkalosis, Respiartory Acidosis and Respiratory Alkalosis mixed disturbances. • Blood gases. Reference intervals for arterial blood gases. Acquisition of arterial blood gas samples. **Laboratory diagnosis: laboratory** parameters for blood gas analysis: Arterial Blood gas estimation. pCO2, O2 and pH.	**6**
	Total	**60**

Clinical Biochemistry I Practical

Practical	Subject Code: MMLS-B-020
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

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Course Rationale: This course provides a comprehensive understanding of the biochemical basis of health and disease, and the role of biochemical tests in diagnosis. Students will gain practical skills essential for working in diagnostic laboratories in clinical and research lab.

1. Estimation of plasma glucose.
2. Oral Glucose tolerance test.
3. Glucose challenge test.
4. Estimation of Glycosylated hemoglobin.
5. Estimation urine Microalbuminuria.
6. Qualitative Analysis of urine for sugars and ketone bodies.
7. Estimation of plasma lactate.
8. Qualitative Analysis for Fructosuria, galactosemia, pentosuria.
9. Chromatography for separation of sugars.
10. Lipid profile- TG, Cholesterol and HDL cholesterol.
11. Lipoprotein Electrophoresis.
12. Estimation of serum protein and Albumin.
13. Serum protein Electrophoresis and quantification of band.
14. Estimation of C reactive protein.
15. Qualitative Analysis of Urinary protein.
16. Estimation of Urea, Uric acid, Blood urea nitrogen, creatinine.
17. Qualitative methods for Individual aminoacids.
18. Chromatography Techniques (HPLC)- Aminoaciduria and disorder of Amino acid.
19. Estimation of Iron, Calcium, phosphorus, Magnesium, Copper and Zinc.

- Urine qualitative tests for porphyria
- Estimation of clinically important enzymes – SGOT, SGPT, Alkaline phosphatase, GGT, LDH, Lipase, Amylase, CK
- Electrolyte Estimation
- Arterial blood collection and Analysis of Blood gas
- Westgard rule, LJ Graph data analysis

***Clinical laboratory rotation/observation can be incorporated wherever possible**

Suggested Readings:

1. Harper's Biochemistry, 28th edition, Robert K Murray, Tata McGraw publishers.
2. Text book of Medical Biochemistry, MN Chaterjee, Rana Shinde,Jaypee Publishers.
3. Varleys practical clinical biochemistry, Alan gowenlock, cbs publishers.
4. Lehinger Principle of Biochemistry, David L Nelson, 7th edition, WH freeman Publishers.
5. Biochemistry, Debajyoti Das, Academic publishers.

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Clinical Biochemistry II

Theory	Subject Code: MMLS-B-017
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

Course Rationale: The Course will provide the students with the knowledge of disorders related to the respective organs in the body. The course emphasizes on the understanding of biochemical changes associated with various pathological conditions.

Learning Objective: At the end of the course, students should be able to

1. **Describe the biochemical basis** of major diseases such as diabetes, renal failure, liver disorders, and cardiovascular diseases.
2. **Interpret clinical laboratory results**, linking biochemical findings with patient conditions.
3. **Identify and explain** the significance of common biochemical markers used in diagnostics and monitoring of disease.

Unit	Topic	Hours
I	**Liver Function tests** • Overview of Anatomy of liver and its functions • Liver diseases: Liver cirrhosis, Hepatitis, liver failure, hepatic coma and Biliary tract diseases- gall stones and cholecystitis • Indications and Classification of liver function test: Tests based on abnormalities of bile pigment metabolism, Jaundice and differential diagnosis of Jaundice, Test based on changes in plasma proteins, serum enzyme activities, abnormalities of lipids, abnormalities of Carbohydrate metabolism, detoxification function of liver, excretory capacity of liver • Laboratory analysis of gall stones	6
II	**Renal function tests:** • Overview of anatomy of kidney and its functions • Renal diseases: Nephrotic syndrome, Glomerular nephritis, Urolithiasis and nephrolithiasis, renal calculi, renal tabular acidosis, diabetes insipidus, renal hypertension, renal failure	6

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	• Indication and classification of RFT, Test based on glomerular filtration test -Urea, creatinine, Inulin, Cystatin Clearance test, Test based on Renal Plasma flow clearance and tubular filtration • Miscellaneous test • Routine RFT: serum creatinine, urea, uric acid and proteinuria • Early marker of Renal Pathology. - Microalbuminuria, Urine albumin: creatinine ratio • Renal handling of electrolytes- Sodium, potassium, Fractional excretion of Sodium (FeNa) • Renal calculi • Measurement of serum and urine osmolality • Urine analysis for normal and abnormal constituents of urine	
III	**Gastric and pancreatic function tests** • Composition of Gastric juice • Outline of clinical manifestations of gastric, pancreatic and intestinal diseases. • Indications, classification of gastric function test and Pancreas Function test • Qualitative and quantitative analysis of gastric contents and duodenal contents • Pancreatic enzymes: Amylases, lipases	**6**
IV	**Cardiac function tests** • Biochemistry and tissue distribution of cardiac markers. • Cardiac enzymes such as CKMB, CK, homocysteine, hsCRP • Cardiac troponins and myoglobin	**3**
V	**Endocrine function Test:**	**9**

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	• Overview of disorders of Hypothalamus, pituitary, thyroid, adrenal cortex, pancreas, placental, testes, ovaries • Analysis of hormones - T3, T4, TSH, FT3, FT4, anti- TPO, Prolactin, Testosterone, Chorionic gonadotropin (BHCG), FSH, LH, Estradiol, progesterone, Insulin, ACTH, Cortisol. • Dexamethasone suppression test	
VI	**Tumor markers** • Tumor marker and its classification • Potential uses of tumor markers • Marker detection - PSA, β-hCG, AFP, CEA, CA15-3, CA-125, CA 19-9.	**6**
VII	**Toxicology testing in Clinical laboratory:** **1. Therapeutic drugs and their management (TDM):** • Therapeutic drugs – Definition, Mechanism of action, Absorption, Distribution, Biotransformation, Excretion and Clinical utility. • Overview of specific drugs and analysis of Carbamazepine, Phenobarbital, Phenytoin, Valproic acid, Digoxin, Theophylline, Cyclosporine, Lithium **Toxic agents:** Source, Routes of entry and the effect of Carbon monoxide, Alcohol, Arsenic, Lead, chromium, mercury, nickel	**6**
VIII	**Paediatric clinical biochemistry** • Problems of specimen collection • Biological reference intervals • Heavy metal poisoning in children: Pb, Hg . • Overview of Newborn screening - Cystic fibrosis, neonatal TSH, G6PD, PKU and Galactosemia	**6**
IX	**Point-Of-Care-Testing (POCT):**	**4**

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	• Objectives, Biochemical parameter measured by POCT devices, Common POCT devices and Technologies, Requirements, Advantages, Limitation and Challenges	
X	**Automation and AI in Clinical Biochemistry:** • History of automated analyzers, Types of automation, Total laboratory automation • Objectives of AI integration, Application of AI- Diagnostic support, Data Analysis, Lab workflow optimization, Clinical Decision Support System, Predictive and preventive Healthcare • Challenges and Limitations	**8**
	Total	**60**

Clinical Biochemistry II Practical

Practical	Subject Code: MMLS-B-021
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

Course Rationale: This course provides a comprehensive understanding of the biochemical basis of health and disease, and the role of biochemical tests in diagnosis. Students will gain practical skills essential for working in diagnostic laboratories in clinical and research lab.

1. Liver function test – Protein, A/G ratio, Total Bilirubin, direct bilirubin, SGOT, SGPT, ALP, GGT.
2. Renal function test – Urea, Uric acid, Creatinine, Microalbuminuria, Urine albumin: creatinine ratio, Analysis of Renal Calculi, Measurement of serum and urine osmolality.
2. Urine analysis for normal and abnormal constituents of urine.
3. Electrolytes Analysis - Sodium, potassium, Fractional excretion of Sodium (FeNa).
4. Pancreas function Test - Amylase, lipase.
5. Cardiac enzymes – creatinine kinase, CK- MB, CAD risk assessment: Homocysteine, Troponin T, CPK, myoglobin.
6. Hormone Analysis Thyroid profile- T3, T4, TSH, Fertility profile – LH, FSH, prolactin, estradiol, testosterone, cortisol, insulin.
7. Demonstration of Tumor marker.

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***Clinical laboratory rotation/observation can be incorporated wherever possible**

Suggested Readings:

1. Harper's Biochemistry, 28th edition, Robert K Murray, Tata McGraw publishers.
2. Text book of Medical Biochemistry, MN Chaterjee, Rana Shinde,Jaypee Publishers.
3. Varleys practical clinical biochemistry, Alan gowenlock, cbs publishers.
4. Lehinger Principle of Biochemistry, David L Nelson, 7th edition, WH freeman Publishers.
5. Biochemistry, Debajyoti Das, Academic publishers.

Immunology

Theory	Subject Code: MMLS-B-018
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

Course Rationale: A sound knowledge of immunology is required by a Medical Laboratory Science scholar to understand the immune responses which underlie many clinically important states. The in depth theoretical and practical concepts imbibed by the graduate during the course helps in laboratory diagnosis of immune related clinical conditions like hypersensitivity, allergy, immuno pathology etc.

Learning Objective: At the end of the course, students should be able to

1. Understand and diagnosis based on immune reactions.
2. Achieve expertise in immunology techniques.
3. Detect and correct errors in techniques.

Unit	Topic	Hours
I	Overview of the Immune System- Cells, tissues and organs of the immune system.	2
II	Types of Immunity: 1. Innate immunity a) Anatomical barriers-skin, mucous lining, cilia, saliva, tears etc. b) Role of T cells c) Cellular immunity-neutrophils, macrophages, dendritic cells,	12

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	natural killer cells d) Inflammation-vasodilation, extravasation, oedema, chemokines, integrin, ICAMs, cytokines (defensins, cathelicidins, interferons,etc.) e) Acute Phase Response proteins (APR proteins)-C-reactive protein, mannose-binding lectin etc.) f) Receptor system-complement receptor, MBL receptor, Toll-like receptor, scavenger receptor etc g) Signal transduction pathway eg. TLR signaling 2. Adaptive Immune system a) Antigen- types, Antigen properties contributing immunogenicity- molecular size, chemical composition, genotype, dosage, route of entry etc. b) Role of B cells c) Immunoglobulins- types, structure, antibody-mediated effector functions-opsonization, complement activation, ADCC (antibody dependent cell mediated cytotoxicity), transcytosis, d) Avidity, affinity and cross reactivity e) Antigen-antibody interactions: precipitation, agglutination, opsonisation, complement fixation f) Immunoglobulin superfamily	
III	Major Histocompatibility Complex (MHC) molecule class I and class II: Their differences and interactions.	**6**
IV	Hypersensitivity Type I, Type II, Type III and type IV: Allergy, skin tests, transfusion reactions, hemolytic disease of the newborn, Immune Complex diseases, tuberculin test.	**6**
V	Autoimmunity and disorders: SLE, Multiple sclerosis, Rheumatoid arthritis, Mysthenia gravis, Autoimmune Thyroiditis.	**6**

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VI	Immunodeficiency diseases a) Primary immunodeficiency: involving lymphoid immune deficiency (B cells, T cells), involving myeloid lineage, Immune complex diseases b) Secondary immunodeficiency: AIDS	**6**
VII	Tumor immunology: Tumor antigens, tumor immune surveillance, tumor escape and Tumor Markers.	**4**
VIII	Transplantation and rejection: Role of T cells, Immune recognition in Allograft and Xenograft, pathway of rejection.	**6**
IX	Vaccination: Principle, types, vaccine development, adjuvants.	**2**
X	Immunological techniques a) Precipitation reactions: Immuno diffusion, immune electrophoresis, Immunoprecipitation b) Agglutination reactions: Blood group typing, Bacterial agglutination, Agglutination inhibition c) Complement fixation d) Neutralisation e) Opsination f) Immnunofluorescense g) ELISA h) FIA and RIA i) Western Blotting j) Flow cytometry k) Immunoelectron microscopy	**10**
	Total	**60**

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Immunology Practical

Practical	Subject Code: MMLS-B-022
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

Course Rationale: This course equips students with hands-on skills essential for understanding immune responses, diagnostic techniques, and experimental methods used in immunological research and clinical laboratories.

1. Specimen collection and preparation of reagents and buffers
2. ABO and Rh typing using agglutination
3. Qualitative tests - precipitation, agglutination
4. Double Diffusion
5. Radial Immunodiffusion Assay
6. ELISA
7. Detection of rheumatoid factor
8. Estimation of C-reactive protein (CRP)
9. Separation of Immunoglobulins by Chromatography
10. Demonstration of western blot
11. Demonstration of Immunofluorescence.
12. Demonstration of Flow cytometry

***Clinical laboratory rotation/observation can be incorporated wherever possible**

Suggested Readings:

1. Punt, J., Stranford, S., Jones, P., Owen, J.A. – Kuby Immunology, W.H. Freeman.
2. Parslow, T.G., Stites, D.P., Terr, A.I. – Medical Immunology, McGraw Hill.
3. Delves, P.J., Martin, S.J., Burton, D.R., Roitt, I.M. – Roitt's Essential Immunology, Wiley-Blackwell.
4. Kumar, V., Abbas, A.K., Aster, J.C. – Robbins Basic Pathology, Elsevier.
5. Gangal, S., Sontakke, S. – Text Sontakke, S. – Textbook of Basic andbook of Basic and Clinical Immunology, Universities Press (India) Pvt. Ltd.

Endocrinology & Biochemistry of Aging

Theory	Subject Code: MMLS-B-019
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

Course Rationale: This course provides knowledge of endocrine system which plays regulatory role controlling and influencing the functioning of all other systems of the human body. Students

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will also gain knowledge chronic disease burden, a biochemical understanding of aging processes such as oxidative stress, cellular senescence, and hormonal imbalance.

Learning Objective: At the end of the course, students should be able to

1. Describe the structure, synthesis, and regulation of hormones produced by major endocrine glands.
2. Apply the knowledge and the associated techniques for diagnosing hormonal disorders.
3. Understand molecular theories of aging, including oxidative stress, telomere shortening, mitochondrial dysfunction, and genetic regulation.

Unit	Topic	Hours
I	Introduction to Endocrinology; Neuro-endocrinology, Neuro-immuno endocrinology and their general principles. Types of endocrine glands and classification of hormones based on their chemical nature and function.	10
II	Chemistry, synthesis, mechanism of action, physiological effects,catabolism of the hormones of Hypothalamus and Pituitary gland and their disorders.	10
III	Chemistry, synthesis, mechanism of action, physiological effects, catabolism of Thyroid, Parathyroid (calcium homeostasis hormones). GIT hormones, Pancreatic Hormones and their disorders.	10
IV	Chemistry, synthesis, mechanism of action, physiological effects, Catabolism of the hormones of Adrenal glands, Gonads and their disorders. Extra endocrine hormones- ANP, Erythropoietin, Melatonin, etc	10
V	Introduction to aging: Definition and biological aspects of aging. Theories of Aging - Free radical theory, Mitochondrial theory, Telomere shortening and cellular senescence, Genetic and epigenetic regulation of aging, Immunosenescence and inflammation, and Hormonal theories of aging (endocrine dysregulation).	6
VI	Mechanism of Aging: Cellular mechanism: Cellular senescence, Oxidative stress-imbalance between production of ROS, Telomere shortening,Mitochondrial	10

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	dysfunction Genetic mechanism: Genetic blue print in determining susceptibility to Alzhiemer's, cardio vascular diseases, certain cancers, Genetic variability in life span, Telomere length, Metabolic genetic-insulin sentivity, metabolic rate, nutrient utilization, metabolic disorders like diabetes, obesity.	
VII	Age associated common disorders-atherosclerosis, neoplasms, cataracts, macular degeneration, neuro degenerative disorders, neuro endocrine disorders, Cancer and aging: biochemical connections.	**4**
	Total	**60**

Suggested Readings:

1. Kronenberg, H., Williams, R. H. (2008) Textbook of endocrinology
2. Nussey,S. Whitehead, S. A. (2001) Endocrinology: an integrated approach
3. Baulieu,E. E. and Paul A. Kelly, P. A. (1990) Hormones: from molecules to disease
4. Jonsen, A. R., Siegler, M. and Winslade, W. J. (2002) Clinical ethics: a practical approach to ethical decisions in clinical medicine
5. Christopher Meyers, C. (2007) A practical guide to clinical ethics consulting: expertise, ethos, and power.

IIIrd SEMESTER
Medical Microbiology

Medical Virology

Theory	Subject Code: MMLS-M-016
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

Course Rationale: This course is designed to provide postgraduate students in medical laboratory technology with an in-depth understanding of virology, including viral pathogenesis, replication strategies, host-virus interactions, and modern approaches to laboratory diagnosis of viral infections. Emphasis will be placed on molecular virology, emerging and re-emerging viral infections, biosafety practices, and the application of cutting-edge diagnostic tools for clinical and public health use.

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Learning Objective: At the end of the course, students should be able to

1. Describe viral structure, classification, genome organisation, and replication mechanisms of major virus families.
2. Explain host-virus interactions, mechanisms of viral pathogenesis, and immune evasion strategies.
3. Evaluate molecular and serological techniques used in the detection, quantification, and genotyping of viruses.
4. Interpret laboratory results in the context of clinical virology, outbreak investigation, and surveillance.
5. Apply biosafety and biosecurity principles in the handling of clinical viral specimens and high-risk pathogens.
6. Discuss current trends in antiviral therapy, vaccine development, and viral epidemiology

Unit	Topic	Hours
I	**General Properties of Viruses:** Morphology, Viral Hemagglutination, Viral Multiplication, Cultivation of Viruses- Animal inoculations, Egg inoculation, Cell culture, Viral Assay, Assay of Infectivity, Viral Genetics, Non- Genetic Interactions, Classification and Nomenclature of Viruses, Viroids, Prion; Viral genomics and bioinformatics tools.	**10**
II	**Virus- Host Interactions: Viral Infections**: Pathogenesis of Viral Infection, Host Response to Virus Infections; Laboratory Diagnosis of Viral Diseases, Immunoprophylaxis of Viral Diseases, Chemoprophylaxis and Chemotherapy of Virus Diseases.	**8**
III	**Bacteriophages:** Morphology, life cycle, transmission of genetic information, significance of phages.	**6**
IV	**Orthomyxoviruses:** Morphology, Resistance, Antigen classification; Influenza virus- classification, Nomenclature systems, Antigenic variation, Host range, Pathogenicity, Clinical features, Laboratory diagnosis, Immunity, Epidemiology, Immunoprophylaxis, Treatment.	**8**
V	**Paramyxoviruses:** Antigenic Structure and classification • Rubella viruses, Mumps virus: Properties, clinical features, complications, Epidemiology, Immunity, Laboratory Diagnosis, Prophylaxis	**12**

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	• Parainfluenza viruses: • Clinical features, Epidemiology, Laboratory diagnosis, New Castle Disease viruses (NDV) • Pneumovirus- • Respiratory Syncytial virus (RSV): Clinical features, Epidemiology, Laboratory features, Epidemiology, Laboratory diagnosis, Prophylaxis, Treatment • Morbillivirus • Measles virus: Epidemiology, clinical features, complications, Pathogenicity, Laboratory Diagnosis, Prophylaxis • Nipah and Hendra virus • Human Metapnemovirus	
VI	**Hepatitis viruses**: types of viral hepatitis Type A Hepatitis (HAV), Type B Hepatitis (HBV), Type C Hepatitis (HCV), Type D Hepatitis (HDV), Type G Hepatitis (HGV)	**8**
VII	**Human Immunodeficiency Virus (HIV)** Structure, Viral Genes and Antigens, Antigenic Variation and Diversity Of HIV, Resistance, Pathogenicity. **Acquired Immune Deficiency Syndrome (AIDS)** Clinical features of HIV infection, Laboratory diagnosis, Strategies for HIV testing, Applications of serological tests, Epidemiology and prevention, Prophylaxis, Treatment.	**8**
	Total	**60**

Medical Mycology

Theory	Subject Code: MMLS-M-017
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

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Course Rationale: This course is designed to equip postgraduate students in medical laboratory science with advanced knowledge of fungal biology, pathogenesis, host immune response, and modern diagnostic approaches for medical mycology. It emphasises clinically important fungi, emerging fungal infections, antifungal resistance, and laboratory safety in handling fungal pathogens.

Learning Objective: At the end of the course, students should be able to

1. Describe the morphology, classification, and reproductive strategies of medically important fungi.
2. Explain the pathogenesis of superficial, subcutaneous, systemic, and opportunistic fungal infections.
3. Evaluate immune responses to fungal pathogens, including innate and adaptive mechanisms.
4. Apply conventional, biochemical, and molecular techniques for the identification and diagnosis of fungal infections.
5. Interpret antifungal susceptibility testing and understand resistance mechanisms.
6. Implement biosafety protocols and quality assurance in mycology laboratories.

Unit	Topic	Hours
I	**Introduction to Mycology:** Characteristics of fungi, classification, laboratory diagnosis, treatment; immune responses to fungal pathogens, antifungal therapy.	8
II	**Superficial and Subcutaneous Mycosis:** Classification of Mycoses- Superficial Mycoses: • Surface Mycoses: Pityriasis Versicolor (Tinea Versicolor), Tinea Nigra, Piedra • Cutaneous Mycoses- Dermatophytoses Deep Mycoses- Subcutaneous Mycoses: Mycetoma, Chromomycosis, Sporotrichosis, Rhinosporidiosis, Subcutaneous Zygomycosis, Entomophthoromycoses	18
III	**Systemic Mycoses**: Systemic Mycoses (Dimorphic Fungi), Blastomycosis, Paracoccidioidomycosis, Coccidioidomycosis, Histoplasmosis.	12

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IV	**Opportunistic Mycoses**: Aspergillosis, Penicillosis, Zygomycosis (Mucormycosis, Phycomycosis) Candidiasis (Candidiasis, Moniliasis), Cryptococcosis (Torulosis), Pneumocystosis.	**14**
V	**Miscellaneous Mycoses:** Otomycosis, Oculomycosis (Keratomycosis, Fungal Keratitis, Mycotic Keratitis), Mycotic Poisoning.	**8**
	Total	**60**

Medical Mycology & Virology Practical

Practical	Subject Code: MMLS-M-020
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

Medical Mycology

- Biosafety: Containment practices, disinfectant protocols, PPE adherence
- Sample Handling: Proper collection, transport media for fungal pathogens
- Microscopy & Staining: Use of Gram, KOH, Lactophenol Cotton Blue stains; Dalmau slide culture for morphological identification
- Culture & Identification: Media preparation, incubation, colony morphology, pigment and texture evaluation
- Antifungal Susceptibility Testing (AFST): Microbroth dilution technique per CLSI guidelines
- Serological Tests in Mycology: Detection of fungal antigens/antibodies using latex agglutination or ELISA
- Quality Control & Validation: Reagent preparation, positive/negative controls, documentation standards
- Clinical Interpretation: Clinical Case Analysis, Interpretation of lab findings in clinical scenarios

Medical Virology

- Biosafety Practices: Spill management, PPE use, NSI protocols
- Sample Collection & Handling: Viral transport, documentation, cold-chain maintenance
- Serological Testing: ELISA, ICT for antigen/antibody detection
- Molecular Diagnostics: PCR workflow, primer setup, IFA for viral gene localisation
- Virus Isolation (Demo/Simulation): Cell culture, cytopathic effects observation
- Interpretation & Reporting: Test result analysis in clinical/outbreak settings

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- Quality Assurance: QA/QC protocols, recordkeeping, equipment calibration
- Case Analysis: Syndromic profiling, correlation with epidemiological findings

***Clinical laboratory rotation/observation can be incorporated wherever possible**

Suggested Readings:

1. Jagdish Chander – *Textbook of Medical Mycology*, Jaypee Brothers Medical Publishers.
2. George S. Fischer – *Fundamentals of Diagnostic Mycology.*
3. Fields Virology – Editors: David M. Knipe & Peter M. Howley, Published by Lippincott Williams & Wilkins.
4. R. Ananthanarayan & C.K. Jayaram Paniker – *Textbook of Microbiology*, Universities Press.
5. Apurba Sankar Sastry & Sandhya Bhat K – *Essentials in Medical Microbiology*, Jaypee Brothers Medical Publishers.
6. Surinder Kumar – *Essentials of Microbiology*, Jaypee Brothers Medical Publishers.
7. J.G. Collee, A.G. Fraser, B.P. Marmion, A. Simmons – *Mackie & McCartney Practical Medical Microbiology*, Elsevier.

Public Health Microbiology

Theory	Subject Code: MMLS-M-018
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

Course Rationale: This course enables to equip students with an insight into antimicrobial Chemotherapy and incidence of antimicrobial resistance. This course also allows for an in-depth study of the principles and tools of epidemiology, infection dynamics, and how diseases spread in populations, enabling them to interpret disease patterns and outbreaks. It provides comprehensive insights into sources, types, transmission, and control measures for HCAIs. It also introduces to biomedical waste management and highlights the nature of biological warfare.

Learning Objective: At the end of the course, students should be able to

1. Evaluate criteria for the rational selection of antimicrobial drugs, including MIC and therapeutic index.
2. Analyse how infections establish and progress through stages in the host.
3. Recognise community-level significant infectious diseases and public health responses.
4. Describe the role of epidemiologists in epidemic surveillance and control.
5. Apply standard infection control precautions and preventive practices.
6. Classify different types of biomedical waste.

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7. Discuss strategies for detection, prevention, and containment of bioterrorism-related infections.

Unit	Topic	Hours
I	**Antimicrobial Chemotherapy principles:** The origins of antimicrobial drugs, Interaction between drugs and microbes **Major antimicrobial drug groups:** Antibacterial drugs that act on the cell wall, antibiotics that damage bacterial cell membrane, Drugs that act on DNA and RNA, Drugs that interfere with protein synthesis, Drugs that block metabolic pathways **Drugs to treat Fungal, Parasitic and viral infections:** Antifungal drugs, Antiparasitic Chemotherapy **Interactions between microbes and drugs:** The acquisition of drug resistance How does Drug resistance develop? Specific mechanisms of Drug resistance, Natural selection and Drug resistance **Interactions between drugs and Hosts** Toxicity to organs, Allergic responses to drugs, Suppression and Alteration of the microflora by antimicrobials **Considerations in selecting an antimicrobial drug:** Identifying the agent, testing for the susceptibility of microorganisms, The MIC and the therapeutic index, Patient factors in choosing an antimicrobial drug	12
II	**Principles of Epidemiology** The science of Epidemiology, The Vocabulary of Epidemiology, Disease reservoirs and Epidemics, Measuring Frequency: The	12

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	Epidemiologist's Tools **Major factors in the development of an infection:** Phase 1: portals of entry Phase 2: Attachment to the Host Phase 3: Invading the Host and becoming established **The Infectious Disease cycle: Recognition of an Infectious disease in a population:** Remote sensing and Geographic Information Systems: Charting infectious diseases, correlation with a single causative agent, Recognition of an epidemic, Infectious disease transmission, The Host Community **The outcomes of Infection and Disease:** The stages of clinical infection, Patterns of infection, Signs and symptoms-warning signals of disease, the portal of exit-Vacating the Host, The persistence of microbes and pathologic conditions.	
III	**Measures of disease outbreaks:** Procedures used in the investigation of infectious disease outbreaks, Outbreak investigation- team, role of microbiologist in the team, Laboratory diagnosis in public health **Epidemiologically significant infectious diseases in the community** **The recent Epidemics:** The HIV/AIDS Pandemic, Swine-flu-pandemic (H1N1) 2009 Influenza, SARS as a model of epidemiological success, The COVID pandemic, Healthcare associated infections **Emerging and Reemerging Infectious diseases and pathogens:** Reasons for increases in emerging and reemerging infectious diseases	**10**
IV	**Epidemiology and Public Health:**	**6**

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	Public health measures for the control of disease, Global Health considerations **Control of Epidemics:** The role of the Public Health Systems: Epidemiological Guardian Global Travel and Health considerations: Space Travel Nosocomial Infections, The hospital Epidemiologist	
V	**Healthcare associated infections:** Catheter associated UTI, Healthcare -associated bacteremia, Healthcare associated pneumonia and ventilator associated pneumonia, Healthcare associated wound infections (Surgical site infections) Healthcare associated infections due to Hepatitis viruses B and C (Transfusion-associated infections), Healthcare associated episodes of acute gastroenteritis, Healthcare associated episodes of tetanus **Sources and reservoirs of healthcare associated infections:** Endogenous sources of infection, Cross-infection, Infections from environmental sources **Modes of transmission of microorganisms** **Measures to control infection in the healthcare setting:** Standard precautions, Personal protective equipment, Safe injection practices, Environmental cleaning, medical equipment, Respiratory hygiene/Cough etiquette **Precautions in the operating theatre** **Investigation and follow-up of outbreaks of disease** **Monitoring and regulation of HCAI: Hospital Infection Control Committee**	12
VI	**Biomedical waste management** Types of biomedical waste	4

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	General principles of waste management: Reduction, Segregation, Storage, Transportation, Treatment **Methods of waste management** **Waste treatment:** Chemical disinfection, Deep burial, Incineration, Autoclaving, Microwaving, Inertisation Liquid waste disposal **BMW 2016 Rules**	
VII	**Bioterrorism and disaster Management:** Definition of bioterrorism, types of bioterrorism agent (CDC Classification), Biological warfare, Global incidents, Role of microorganism in bioterrorism, Emerging pathogen as potential bioweapons, detection, diagnosis, lab safety protocols, biosafet levels and containment. Phases of disaster management, bioterrorism preparedness and response – Surveillance, warning, emergency response, stockpiling of medicine, decontamination and Quarantine protocols. Use of PPE and infection control, mass casualty management.	**4**
	Total	**60**

Public Health Microbiology Practical

Practical	Subject Code: MMLS-M-021
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

1. Project: Descriptive Epidemiology of a selected Health Problem.
2. Survey Design: Create a Community Health Survey Tool.
3. Demonstration: Use of GIS Tools/Software for Disease Mapping (Virtual/Manual).
4. Case Study Analysis of Disease Outbreak.
5. Detect presence of potential nosocomial pathogens from swabs collected from inanimate objects in a hospital environment.
6. Segregation and Colour-Coding of Biomedical Waste.

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7. Demonstration of Waste Treatment Methods.
8. Case Study: Anthrax or Other Bioterrorism Events.
9. Demonstration/Visit: Public Health Lab or Hospital Epidemiology Unit.

***Clinical laboratory rotation/observation can be incorporated wherever possible**

Suggested Readings:

1. Robert Friis, Thomas Sellers – *Epidemiology for Public Health Practice*, Jones & Bartlett Learning.
2. Prescott, Harley, Klein – *Microbiology*, McGraw-Hill Education.
3. Michael T. Madigan – *Brock Biology of Microorganisms*, Benjamin Cummings, Pearson Education.
4. R. Ananthanarayan & C.K. Jayaram Paniker – *Textbook of Microbiology*, Universities Press.
5. K Park – *Textbook of Preventive and Social Medicine*, Banarsidas Bhanot Publishers.
6. Armed Forces Medical College (AFMC) – *Textbook of Public Health and Community Medicine*, AFMC & WHO India.
7. Leon Gordis – *Epidemiology*, Saunders, Elsevier.
8. Kenneth J Rothman – *Epidemiology*: An Introduction, Oxford University Press.
9. Robert B. Wallace – Maxcy-Rosenau-*Last Public Health and Preventive Medicine*, McGraw-Hill Education.
10. R Bonita, R Beaglehole, T Kjellstrom – *Basic Epidemiology*, World Health Organization, Geneva.

Advances in Microbial Informatics

Theory	Subject Code: MMLS-M-019
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

Unit	Topic	Hours
I	Microbial Informatics: Introduction to Bioinformatics, Information flow, Scope of Bioinformatics, computers and microbes, basics of internet, Network-based services (Cloud & Grid Computing), microbial informatics, environment and diversity.	8
II	Microbial genomes and data platform: Basics of Database designing and modeling, Designing policies, File formats (FASTA, PIR,	10

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	Genbank), data storage, retrieval, Microbial Genomes, Genbank, 5 Pfam, KEGG, Brenda, MBGD, biodiversity databases. String comparison, and Smith–Waterman algorithm, BLAST algorithm, FASTA algorithm comparison, Sequence submission tools (Banklt, Sequin).	
III	• Omics and Microbiome Informatics: • Types of omics in relation to microbiology. • Genomics and metagenomics - Gene structure, Gene finding strategies Glimmer, Genscan, promoter region identification, promoter signals, genome annotation tools, Gene ontology, biological networks; • Proteomics: Protein sequence and structures (primary, secondary and tertiary) and prediction, protparam, Chou–Fasmanalgorithm, GOR method, Concepts of structural modeling and tools PHD, ANOLEA, Transmembrane protein prediction tools, Mass spectrometry data and analysis; • Transcriptomics and Metabolomics • Multi-omics- integration of omics and microbial function	**14**
IV	Phylogenetics and Evolutionary Informatics: Principles of Phylogeny analysis, Phylogenetic reconstruction distance matrix, types of trees, Rooted unrooted, distance-based methods (UPGMA, FM, NJ Methods), Character based methods (Parsimony method, Maximum likelihood method), tree evaluation, (bootstrapping, Jackknifing), functional inferences. Phylogenetic profiles and functional inference.	**10**
V	Diagnostic Informatics in Microbiology: Microscopy, Rapid antigen test, PCR, RFLP, Genome sequencing projects, next-generation sequencing generation (NGS), Computational tool and pipelines, microarray technology, data analysis methods and tools; Applications in public health diagnostics and outbreak tracking.	**10**
VI	Antimicrobial Resistance & Comparative Genomics: Phenotypical and genotypical characterisations of resistance formation, application of NGS in studying the resistance mechanisms, mutations, AMR genes, and relevant genes. Comparison of ancestral microbe with	**8**

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	mutant bacteria using bioinformatic tools; Ethical and regulatory perspectives in AMR data sharing.	
	Total	**60**

Suggested Readings:

1. Sandy B. Primrose, Richard Twyman – Principles of Genome Analysis and Genomics, Wiley-Blackwell.
2. P.B. Gupta – Transcriptomics and Proteomics, Elsevier.
3. Michael Hecker, Ian Humphery-Smith – Microbial Proteomics: Functional Biology of Whole Organisms, John Wiley & Sons.
4. Alexander, Microbial system biology, Alexander , Springer.

Clinical Posting

Clinical Posting	Subject Code: MMLS-M-022
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

Course Rationale:

The clinical posting provides a structured transition from theoretical understanding to practical competency in medical microbiology. It supports the development of technical skills, ethical responsibility, and professional identity, preparing students to function independently and collaboratively in microbiology laboratories and research settings.

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DEPARTMENT OF MEDICAL LABORATORY SCIENCES

SUBHARTI COLLEGE OF ALLIED AND HEALTHCARE

SWAMI VIVEKANAND SUBHARTI UNIVERSITY, MEERUT

CLINICAL POSTING LOG BOOK
MMLS SEMESTER III
MEDICAL MICROBIOLOGY
(YEAR)

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Swami Vivekanand Subharti University,
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STUDENT'S RECORD

Name: .....

Semester: .....

Enrollment No.....

Session: .....

..... **.....**

Signature of Principal **Signature of Student**

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DECLARATION BY THE STUDENT

Madam/Sir,

I, Mr/Ms. ..... a student of ..... bearing Registration No. ..... declare that I have completed ..... hours of clinical posting, out of the assigned ..... hours and have performed my duties in the hospital/laboratory as stated in my logbook

Students Signature

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LOGBOOK CERTIFICATE

This is to certify that the candidate Mr/Ms……registration number ……admitted in the academic year …… of ……college, has satisfactorily completed/ Not completed all requirements mentioned in this logbook for third semester of Master of Medical Laboratory Sciences, Medical Microbiology during the period from ……to …… in the ……Hospital/Laboratory.

Signature of the Faculty in-Charge (hospital/laboratory)

Name

Date

Signature of the Principal/Dean HoD (University/College)

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Name

Date

SKILL ASSESSMENT SHEET

Hospital/Laboratory: **Department:**

Date	Name of Experiment	Observed/ Assisted/ Performed	Signature of Supervisor/In-charge

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IIIrd SEMESTER

Haematology and Transfusion Medicine

Blood Banking and Immunohematology

Theory	Subject Code: MMLS-H-017
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

Course Rationale: The course is designed for students to apply advanced immunohaematological principles. They can also independently execute donor screening, blood collection and preparation of blood components.

Learning Objective: At the end of the course, students should be able to

1. Apply advanced immunohematological principles in laboratory diagnostics.
2. Demonstrate competency in antibody detection, identification, and complex serological problem solving.
3. Execute donor screening, blood collection, and blood component preparation as per national regulatory standards.
4. Evaluate and manage transfusion reactions and special transfusion scenarios.
5. Ensure compliance with quality standards, biosafety, and legal regulations in blood banking.

Unit	Topic	Hours
I	Advanced Immunohematologic Principles: Principles of Immunohematology, Genetics of ABO blood group system, their subgroups, RBC antigens and consecutive antibodies, Genetics of Rh Blood group and antibodies, Minor blood group systems, Bombay blood group, ABO and Rh incompatibility, Hemolytic Disease of newborn and its management, Alloantibodies Vs auto antibodies, High-titer, low-avidity antibodies, Human leucocytic antigen.	15
II	Blood collection and donor selection criteria: **Donor Management:** Donor registration and screening, Phlebotomy in blood banks, blood	10

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	storage, various anticoagulants used in blood bags, types of blood bags used in blood banks **Blood Collection & Processing:** Whole blood collection, Adverse reactions and their management, Blood transmitted disease and their testing, Labelling, storage, and transportation of blood.	
III	Serologic Techniques and Problem Solving: Blood compatibility tests, Antibody screening and identification, DAT and IAT optimization, Enzyme treatment, adsorption/elution techniques.	**10**
IV	Component preparation and storage: Apheresis vs whole blood donation, Component separation techniques, Storage, shelf-life, and transportation protocols, Hemovigilance in component therapy.	**10**
V	Molecular Applications in Immunohematology: Molecular genotyping of blood groups, Discrepancy resolution between serology and molecular testing, Role in prenatal and donor typing.	**5**
VI	Regulatory, QC, and Ethics in Blood Banks: NABH, NACO, FDA, CDSCO guidelines, Quality management system (QMS), Inventory management, Incident reporting & blood bank audits, Regulatory framework: Drugs and Cosmetics Act, licensing of blood banks, GMP, GLP, SOPs, and NABH/NABL accreditation, Standard operating procedures (SOPs), External quality assessment (EQA), Regulatory compliance (FDA, NABL, DGHS), Safety and biosafety in blood banks.	**10**
	Total	**60**

Blood Banking and Immunohematology Practical

Practical	Subject Code: MMLS-H-021

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Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

1. Preparation of Red Cell Suspensions and daily Quality Control of ABO & Rh D Preparation of Papain cystein and Blood Group Regents.
2. Performing ABO Blood Group.
3. Performing Antigen Typing – Indirect.
4. Performing Direct Anti-Globulin Test.
5. Performing Anti-globulin Cross-Match.
6. Study of Labelling of Blood Bags and Blood Components.
7. Study of Storage of Blood and Blood Components.
8. Study of Inventory of Blood Bags and Blood Components.
9. Study of Selection of units for cross matching.
10. Bilirubin Testing.
11. Disposal of Reactive Bags, its components, non-reactive buffy coat units.
12. ELISA/ Rapid card-based identification of blood borne infections.

***** Clinical postings should be incorporated wherever possible**

Suggested Readings:

1. Lee, G. R., Foerster, J., Lukens, J., Paraskevas, F., Greer, J. P., & Rodgers, G. M. (1999). Wintrobe's clinical hematology 10th. Bethseda, Maryland: Lippincort Williams and Wilkins.
2. Klatt, E. C. (2014). Robbins and Cotran atlas of pathology. Elsevier Health Sciences.
3. Firkin, F., Chesterman, C., Rush, B., & Pennigton, D. (2008). De Gruchy's Clinical haematology in medical Practice. John Wiley & Sons.
4. Bain, B. J., Bates, I., & Laffan, M. A. (2016). Dacie and Lewis Practical Haematology E-Book: Dacie and Lewis Practical Haematology E-Book. Elsevier Health Sciences.
5. Ajmani, P. S. (2020). Immunohematology and blood banking: principles and practice. Springer Nature.

Transfusion Medicine

Theory	Subject Code: MMLS-H-018
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

Course Rationale: This course aims to provide students with a comprehensive understanding of the scientific principles, laboratory techniques, and clinical applications involved in blood transfusion services. It covers essential areas such as immunohematology, donor selection and

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screening, blood collection and processing, compatibility testing, transfusion reactions, and hemovigilance systems.

Learning Objective: At the end of the course, students should be able to

1. Explain the immunological basis and principles of transfusion medicine.
2. Evaluate transfusion requirements for different clinical scenarios.
3. Identify and manage transfusion reactions and complications.

Unit	Topic	Hours
I	Hematopoietic stem cells and related cellular products: Bone-Marrow-Derived Hematopoietic Progenitor Cells, Peripheral-Blood-Derived Hematopoietic Progenitor Cells, Umbilical Cord Blood Stem Cells, Mononuclear Cell Preparations.	10
II	Specialized transfusion situations: Management of Acute Bleeding and Massive Transfusion, Evaluation of the Bleeding Patient, Management of Platelet Refractory Patient, Management of Transfusion in Obstetrics: Maternal and Fetal Considerations, Management of Infants and Children, Management of Immunocompromised Patient.	12
III	Transfusion Reactions and Hemovigilance: Classification and types of transfusion reactions, Acute and Delayed Hemolytic Transfusion Reactions, Febrile Nonhemolytic Transfusion Reactions, Allergic Transfusion Reactions, Other Noninfectious Complications of Transfusion, Investigations and reporting protocols of transfusion reactions, Hemovigilance system in India, management of transfusion-related complications.	12
IV	Infectious complications of transfusion Hepatitis, CMV and Other Herpesviruses, HIV and HTLV, Other Transfusion-Transmitted Infections, Bacterial Contamination of Blood Products.	10

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V	Therapeutic apheresis Plasma Exchange, Red Blood Cell Exchange, Extracorporeal Photopheresis, Leukocytapheresis, Thrombocytapheresis, Erythrocytapheresis, Therapeutic Phlebotomy.	**10**
VI	Quality Assurance, Ethics and Regulatory Aspects Regulatory framework: Drugs and Cosmetics Act, licensing of blood banks; GMP, GLP, SOPs, and NABH/NABL accreditation, Ethical issues and patient rights in transfusion medicine, compliance with quality and regulatory standards.	**6**
	Total	**60**

Transfusion Medicine Practical

Practical	Subject Code: MMLS-H-022
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

1. ELISA and rapid tests for HIV, HBV, HCV, syphilis, malaria.
2. Nucleic Acid Testing (NAT) – demonstration or simulation.
3. Principle of HLA typing (serological/molecular methods).
4. Nucleic Acid Testing (NAT) – demonstration or simulation.
5. Blood component separation by apheresis.
6. Anticoagulants used for apheresis.
7. Therapeutic apheresis.
8. Special considerations of therapeutic apheresis in paediatric patients.
9. Extracorporeal photopheresis.
10. Clinical postings can be incorporated.

Suggested Readings:

1. Lee, G. R., Foerster, J., Lukens, J., Paraskevas, F., Greer, J. P., & Rodgers, G. M. (1999). Wintrobe's clinical hematology 10th. *Bethseda, Maryland: Lippincort Williams and Wilkins.*
2. Hillyer, C., Hillyer, K. L., Strobl, F., Jefferies, L., & Silberstein, L. (Eds.). (2001). *Handbook of transfusion medicine*. Academic press.
3. Harmening, D. M. (2018). *Modern blood banking & transfusion practices*. FA Davis.

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4. McCullough, J. (2021). *Transfusion medicine. John Wiley & Sons.*
5. Vengelen-Tyler, V. (2019). Technical Manual, American Association of Blood Banks (AABB). *Bethesda, Maryland: American Assocociation of Blood Banks (AABB).*
6. National Blood Policy and Guidelines – NACO, India.

Molecular Hematology

Theory	Subject Code: MMLS-H-019
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

Course Rationale: This course is designed to provide in-depth knowledge of the molecular mechanisms underlying normal hematopoiesis and a wide spectrum of hematologic conditions. Emphasis will be placed on the application of molecular diagnostic techniques such as PCR, RT-PCR, gene sequencing, and next-generation sequencing (NGS) in hematologic investigations.

Learning Objective: At the end of the course, students should be able to

1. Analyze the molecular pathogenesis of hematological malignancies and inherited blood disorders using current scientific principles.
2. Apply molecular biology techniques (e.g., PCR, NGS, etc.) for the detection, diagnosis, and monitoring of hematologic diseases.
3. Interpret molecular diagnostic results and correlate them with clinical and pathological data for disease classification and prognosis.

Unit	Topic	Hours
I	**Unit 1: Basics of molecular hematology** Central dogma, transcriptional regulation of hemopoeitic cells, Post-transcriptional and translational control, mRNA stability and microRNAs in hematology, Non-coding RNAs and their role in blood cell gene regulation, Epigenetic dysregulation in hematologic malignancies, Transcription factors in hematopoesis.	6
II	**Unit 2: Molecular Basis of Hematologic Malignancies** Chromosomal abnormalities (translocations, deletions, duplications), Oncogenes and tumor suppressor genes, Molecular pathogenesis of leukemia (AML, ALL, CML, CLL), Lymphomas: Molecular classification and biomarkers, Minimal	15

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	Residual Disease (MRD) monitoring.	
III	**Unit 3: Inherited and Acquired Hematologic Disorders** Hemoglobinopathies: Molecular basis of thalassemias and sickle cell anemia, Coagulation disorders: FVIII, FIX gene mutations, von Willebrand disease, Bone marrow failure syndromes (Fanconi anemia, Diamond-Blackfan anemia), Congenital neutropenias and thrombocytopenias, Iron metabolism genes and disorders.	**15**
IV	**Unit 4: Molecular Diagnostic Techniques** PCR, qPCR, RT-PCR, Next-Generation Sequencing (NGS) basics and applications, Microarray and gene expression profiling, FISH and Southern blotting, Bioinformatics tools for hematology (mutation databases, variant interpretation).	**12**
V	**Unit 5: Translational and Precision Hematology** Molecular therapeutics (tyrosine kinase inhibitors, antisense oligonucleotides), Gene editing (CRISPR-Cas9) in hemoglobinopathies, CAR-T cell therapy in hematologic malignancies, Ethical issues in molecular hematology and genetic testing.	**12**
	Total	**60**

Molecular Hematology Practical

Practical	Subject Code: MMLS-H-023
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

1. DNA isolation from EDTA whole blood.
2. PCR for β-thalassemia mutations (e.g., IVS1-5, Codon 41/42).
3. Agarose gel electrophoresis for visualization of amplified products.
4. RNA extraction and cDNA synthesis for gene expression.
5. Real-Time PCR for BCR-ABL fusion transcript quantification.
6. Detection of JAK2 V617F mutation via allele-specific PCR.
7. Multiplex PCR for α-thalassemia deletion screening.

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8. Hands-on data interpretation and mock reporting using anonymized patient results.

Suggested Readings:

1. Hoffbrand, A. V. (2024). Hoffbrand's essential haematology. John Wiley & Sons.
2. Provan, D. (2010). Molecular hematology. D. Provan, & J. Gribben (Eds.). Oxford: Wiley-Blackwell.
3. Kaushansky, Kenneth, ed. Williams Hematology. Ninth edition. New York: McGraw-Hill Education, 2016. Print.
4. Strachan, T. (2018). Human Molecular Genetics (5th ed.). Garland Science.
5. Silberstein, L. E., & Anastasi, J. (2017). Hematology: Basic Principles and Practice. Elsevier Health Sciences.

Advanced Haematological Techniques

Theory	Subject Code: MMLS-H-020
Total Marks for Evaluation- 100	No. of Contact Hours- 30, Credits:2

Course Rationale: The curriculum will bridge the traditional hematological practices with modern diagnostic tools. Fostering a deeper understanding of blood cell morphology, bone marrow examination, flow cytometry, cytogenetics, and molecular approaches used in the diagnosis of hematologic malignancies and other blood disorders.

Learning Objective: At the end of the course, students should be able to

1. Apply advanced hematological techniques in diagnostic and research settings.
2. Understand and operate hematology analyzers, flow cytometers, and molecular diagnostic tools.
3. Correlate laboratory findings with clinical conditions in hematological disorders.

Unit	Topic	Hours
I	**Automation in Hematology** Basics and principles of automated hematology analyzers (3-part, 5-part, 7-part differentials), Automation in Reticulocyte, and platelet analysis by automation, Flags and error codes: troubleshooting and interpretation, Operation, maintenance, and QC on hematology analyzers, Interpreting laboratory results and values, laboratory statistics .	8
II	**Clinical Flow cytometry and cytogenetics**	8

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	Principles of flow cytometry, cell sorting, sample preparation and gating strategies, panel selection, data analysis and reporting, applications of flow cytometry, Karyotyping and chromosomal aberrations in hematological malignancies: principle and applications.	
III	**Laboratory Information Systems (LIS)** Sample tracking from collection to result reporting, Interface with analyzers, middleware, and HIS (Hospital Information Systems), Barcode systems for error reduction and traceability.	7
IV	**Quality Assurance & Advanced Data Interpretation** Laboratory organization and management in hematology lab, Quality Assurance, Ethics in hematology lab, Preanalytic and Postanalytic automation and medical decision, specimen rejection criteria, Point of care testing Hematology in under resourced laboratories.	7
	Total	**30**

Advanced Haematological Techniques Practical

Practical	Subject Code: MMLS-H-024
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

1. Operation, maintenance, and QC on hematology analyzers.
2. Sample prep, acquisition, and basic analysis using flow cytometry.
3. Demonstration of PCR and interpretation of results.
4. Slide preparation, banding techniques, and interpretation (demo-based).
5. Quality logs, data analysis, and case discussions.

Suggested Readings:

1. Hoffbrand, A. V. (2024). Hoffbrand's essential haematology. John Wiley & Sons. 1. McPherson, R. A., & Pincus, M. R. (2017). *Henry's clinical diagnosis and management by laboratory methods.* Edition 23. Elsevier.
2. Bain, B. J., Bates, I., & Laffan, M. A. (2017). Dacie and Lewis practical haematology (12th ed.). Elsevier.
3. Latest CLSI and NABL guidelines.

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IIIrd SEMESTER
Histology and Cytology

Diagnostic Histopathology

Theory	Subject Code: MMLS-C-017
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

Course Rationale: This course delves into complex diagnostic patterns in histopathology, emphasizing integration of advanced staining techniques, immunopathology, and molecular pathology with histomorphology. Students will explore diagnostic algorithms, rare entities, and challenging differentials in routine and subspecialty pathology with emphasis on clinicopathological correlation and laboratory interpretation support.

Learning Objective: At the end of the course, students should be able to

1. Implement and interpret complex diagnostic workflows using histological and molecular tools.
2. Engage confidently in diagnostic discussions and multidisciplinary tumor boards.
3. Recognize limitations and pitfalls in interpretation and resolve them with evidence-based approaches.
4. Conduct audits and propose improvements for diagnostic accuracy and laboratory quality.

Unit	Topic	Hours
I	Diagnostic Histology and Applied Morphology: Cellular adaptation and tissue response: hypertrophy, metaplasia, dysplasia; Inflammatory histology: acute, chronic, granulomatous; Tissue changes in degeneration, necrosis, apoptosis; Histologic architecture of tumors and neoplastic transformations; Correlation with biopsy findings and resection specimens; Integration with cytopathology for comprehensive diagnosis.	12
II	Diagnostic Strategies in Histopathology	12

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	Pattern-based diagnostic approach: architectural vs cytological, Diagnostic pitfalls and mimickers, Use of histochemical and immunohistochemical panels, Integrating histology with clinical, radiologic, and laboratory findings, Role of frozen sections and intraoperative consultations.	
III	Subspecialty Diagnostic Histopathology Hematopathology: Lymph node biopsies, classification of lymphomas, bone marrow pathology, Neuropathology: Gliomas, demyelinating disorders, CNS infections, Dermatopathology: Interface dermatitis, cutaneous lymphomas, bullous disorders, Soft Tissue and Bone Tumors: Histologic subtypes, grading, molecular diagnostics Frozen sections.	**12**
IV	Advanced Diagnostic Frameworks Structured histopathology reports, Diagnostic algorithms based on pattern recognition: glandular, papillary, spindle, blue cell, etc., Integrated histo-cyto-molecular correlation, Frozen section interpretation and real-time reporting challenges, Pitfalls in biopsy diagnosis and mimickers, Tumor grading, staging, and margin assessment from a histopathology perspective.	**12**
V	Quality Assurance, Laboratory Practice, and Research Diagnostic audits and interobserver variability, Reporting formats: structured reporting and SNOMED codes, Internal and external quality control in histopathology, Research in histopathology: retrospective analysis, biobanking, AI training sets, Ethical considerations in diagnostic histopathology.	**12**
	Total	**60**

Diagnostic Histopathology Practical

Practical	Subject Code: MMLS-C-021
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

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1. Demonstrate receiving, handling, and labelling and specimen rejection criteria of cytological specimen.
2. Demonstrate cryostat usage for frozen sections. Compare morphology with paraffin sections.
3. Slide-based case diagnostics with clinical context.
4. Identify organs/tissues under microscope (skin, liver, kidney, etc.) and correlate disease vs normal.
5. Tumor simulation: prepare and present pathology findings.
6. Audit exercise: identify errors, revise diagnosis, and propose QC measures.
7. Slide reading sessions: benign vs malignant.
8. Recognizing tissue patterns (glandular, squamous, mesenchymal, hematopoietic)
9. Preparing a diagnostic report in standard format.

***Clinical laboratory rotation/observation can be incorporated wherever possible**

Suggested Readings:

1. Rosai, J. (2009). Rosai And Ackerman‟ s Surgical Pathology. Juan Rosai. The Lung and Pleura. Elsevier, 387-406.
2. Fletcher, C. D. (2007). Diagnostic histopathology of tumors: 2-volume set with CD-ROMs. Elsevier Health Sciences.
3. Mills, S. E. (2015). Sternberg's diagnostic surgical pathology. Lippincott Williams & Wilkins.
4. WHO Classification of Tumors.

Cytological Techniques

Theory	Subject Code: MMLS-C-018
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

Course Rationale: The course is equipped for students to create foundational and advanced cytological preparation and staining techniques. To train them to use cytological tools, equipment, and interpretation of smears. It will also make them familiarize with quality control, biosafety, and automation in cytology andS develop competence in exfoliative, fluid-based, and FNA cytology.

Learning Objective: At the end of the course, students should be able to

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1. Explain the principles, indications, and clinical relevance of various cytological techniques.
2. Demonstrate proficiency in specimen collection, fixation, and preparation methods for cytological examination
3. Perform and interpret key cytological staining methods including Papanicolaou and Romanowsky stains
4. Identify and distinguish cytological features of normal, reactive, and pathological conditions in various organ systems

Unit	Topic	Hours
I	Principles and Types of Cytological Specimens: Introduction to cytology: definition, scope, clinical significance, Types of specimens: exfoliative, abrasive, aspirated (FNAC), body fluids, Fixation principles: cytological fixatives and preservation, Collection techniques: gynecologic vs. non-gynecologic specimens.	12
II	Cytopreparation Techniques: Smear preparation: direct, sedimentation, filtration, cytocentrifugation, Liquid-based cytology (LBC) vs. conventional smears, Cell block technique: indications and method, Preparation for ancillary testing (IHC, molecular).	12
III	Cytological Staining and Special Techniques: Romanowsky stains (May-Grünwald Giemsa, Leishman), Papanicolaou staining technique and interpretation, Special stains: PAS, Ziehl-Neelsen, mucicarmine in cytology, Artifacts and troubleshooting in staining.	12
IV	Microscopy and Morphological Interpretation: Cellular features of normal, reactive, and malignant cells, Cytomorphology of commonly examined tissues (cervical, thyroid, respiratory tract, urine, serous fluids), Screening techniques and reporting systems (e.g., Bethesda system).	12
V	Automation, Quality Assurance, and Lab Management: Automated slide processors and screeners, Digital cytology and AI-based tools, Internal and external quality control in cytology, Safety	12

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	protocols, documentation, record keeping.	
	Total	**60**

Cytological Techniques Practical

Practical	Subject Code: MMLS-C-022
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

1. Cervical smear preparation (manual and LBC method).
2. Fixation and staining: Pap and MGG.
3. Urine and sputum cytology: processing and reporting.
4. Cytocentrifuge use and body fluid smear preparation.
5. FNA sample smear preparation using phantoms or clinical material.
6. Cell block preparation from fluid specimens.
7. Application of special stains in cytology.
8. Slide review sessions: benign, reactive, atypical, and malignant smears.
9. Cytology report writing with terminology.

***Clinical laboratory rotation/observation can be incorporated wherever possible.**

Suggested Readings:

1. Koss, L.G. and Melamed, M.R. (2005) Koss' diagnostic cytology and its histopathologic bases. 5th Edition, JB Lippincott, Philadelphia.
2. ComBibbo, M., & Wilbur, D. (2014). Comprehensive cytopathology. Elsevier Health Sciences.
3. Cibas, Edmund S, and Barbara S Ducatman. Cytology: Diagnostic Principles and Clinical Correlates. Fifth edition. Philadelphia, PA: Elsevier, 2021. 4. Orell, S. R., Sterrett, G. F., & Whitaker, D. (2005). Fine needle aspiration cytology.
4. WHO Classification of Tumours Series (Latest edition for organ systems).

Immunohistochemistry & Diagnostic Markers

Theory	Subject Code: MMLS-C-019
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:4

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Course Rationale: This course provides in-depth knowledge and hands-on skills in Immunohistochemistry (IHC), emphasizing its application in clinical diagnostics, cancer biology, and biomarker discovery. Students will explore IHC principles, reagents, quality control, and marker interpretation across various disease states.

Learning Objective: At the end of the course, students should be able to

1. Understand the principles and techniques of IHC.
2. Master the selection and validation of diagnostic markers.
3. Interpret IHC results in a diagnostic context.
4. Apply knowledge of tumor and disease-specific biomarkers in histopathology.
5. Ensure quality control and assurance in IHC laboratories.

Unit	Topic	Hours
I	Molecular Foundations of Immunohistochemistry (IHC): Principle of antigen-antibody interaction, Types of antibodies used in diagnostics, Detection systems: Enzymatic (HRP/AP) and fluorescent, Role of gene expression and protein translation in IHC targets, Tissue Preparation for Molecular Studies: FFPE tissue handling, Antigen retrieval methods (heat/enzymatic), Optimization of fixation to preserve nucleic acids and proteins.	12
II	Immunohistology of: Infectious disease, soft tissue, osseous neoplasma, Hodgkins lymphoma, non-hodgkins lymphoma, breast tissue, nervous system, skin tumors, endocrine tumors, pediatric neoplasms, immunocytology and others.	12
III	Analysis through Immunohistochemistry (IHC): Diagnostic and Prognostic Markers: Cytokeratins, EMA, CD markers, BCL2, BCL6, Chromogranin, Synaptophysin, Desmin, Vimentin, SMA, S100, HMB-45, Melan-A, ER, PR, HER2, Lung, colon, prostate markers, Predictive markers and companion diagnostics, Pre-analytical and Analytical Factors: Fixation and tissue processing for IHC, Antigen retrieval methods (HIER, PIER), Blocking steps and reagent optimization, Controls: positive and negative, Troubleshooting: false positives/negatives.	12

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IV	Molecular Techniques in Immunohistologic Diagnosis: Polymerase Chain Reaction (PCR) Applications: HPV, B-cell/T-cell clonality, tuberculosis, Fluorescence In Situ Hybridization (FISH) application-HER2/neu, ALK rearrangement, Chromogenic In Situ Hybridization (CISH), Detection of EBV or HPV in tissue sections, Next-Generation Sequencing (NGS) overview, Gene panels used in solid tumor pathology.	**12**
V	Quality Assurance and Accreditation: Standardization of protocols (CAP, ASCO, WHO), Internal and external quality controls (EQAS), Laboratory accreditation (NABL, ISO), Documentation and result reporting, Regulatory and ethical considerations, Internal and external controls in IHC and molecular assays, Analytical vs. clinical validation.	**12**
	Total	**60**

Immunohistochemistry & Diagnostic Markers Practical

Practical	Subject Code: MMLS-C-023
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

1. Manual IHC staining using HRP-labeled secondary antibody and DAB.
2. Hormonal Receptor Testing in Breast Tissue.
3. Slide-based case diagnostics with clinical context.
4. DNA Extraction from FFPE Tissues.
5. PCR for Infectious Pathogens.0
6. Audit exercise: identify errors, revise diagnosis, and propose QC measures.
7. Slide reading sessions: benign vs malignant.
8. IHC Troubleshooting Workshop.
9. Preparing a diagnostic report in standard format.

***Clinical laboratory rotation/observation can be incorporated wherever possible**

Suggested Readings:

1. Dabbs, D. J. (2014). Diagnostic Immunohistochemistry: Theranostic and genomic application (4th ed.). Elsevier.

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2. Bancroft, J.D. and Gamble, M. (2008) Theory and Practice of Histological Techniques. 6th Edition, Churchill Livingstone, Elsevier 3. Lester, S. C. (2010). *Manual of Surgical Pathology E-Book: Manual of Surgical Pathology*. Elsevier Health Sciences.
3. WHO Classification of Tumors

Molecular Techniques in Histopathology & Cytology

Theory	Subject Code: MMLS-C-020
Total Marks for Evaluation- 100	No. of Contact Hours- 30, Credits:2

Course Rationale: This course provides in-depth knowledge and hands-on skills in Immunohistochemistry (IHC), emphasizing its application in clinical diagnostics, cancer biology, and biomarker discovery. Students will explore IHC principles, reagents, quality control, and marker interpretation across various disease states.

Learning Objective: At the end of the course, students should be able to

1. Understand the principles and applications of molecular biology in tissue and cytological diagnosis.
2. Apply techniques such as PCR, in situ hybridization, and molecular profiling for diagnostic and prognostic purposes.
3. Correlate morphological findings with molecular alterations.
4. Perform nucleic acid extraction and amplification from FFPE and cytology samples.

Unit	Topic	Hours
I	Molecular Biology Fundamentals in Tissue Diagnostics: DNA, RNA, and protein synthesis in pathological states, Gene mutations, translocations, amplifications relevant to neoplasia, Tumor suppressor genes and oncogenes (e.g., TP53, HER2, BRAF), Applications in cancer diagnostics and infectious disease detection.	6
II	Pre-analytical and Analytical Considerations: Fixation and preservation of nucleic acids (FFPE vs fresh/frozen tissue), Nucleic acid extraction from FFPE blocks and cytology smears, Quality control and quantification (spectrophotometry,	6

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	fluorometry).	
III	Core Molecular Techniques: Polymerase Chain Reaction (PCR, RT-PCR, qPCR): principle and applications, In Situ Hybridization (ISH), Fluorescent ISH (FISH): diagnostic relevance, Microdissection techniques (manual and laser capture), Molecular markers in specific cancers (e.g., EGFR, ALK, KRAS), Next-Generation Sequencing (NGS): overview and utility in diagnostics.	**10**
IV	Integration with Histopathology & Cytology: Molecular testing in solid tumors (lung, breast, colon, cervix), Molecular cytology: applications in exfoliative and fine-needle aspiration cytology, Liquid biopsy and cell-free DNA, Role of bioinformatics and digital pathology in molecular diagnostics.	**8**
	Total	**30**

Molecular Techniques in Histopathology & Cytology Practical

Practical	Subject Code: MMLS-C-024
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

1. Extraction of DNA and RNA from FFPE tissue and cytology smears.
2. Demonstration of fixation techniques and their effect on nucleic acid preservation (FFPE vs frozen).
3. Microdissection technique (manual or guided) for tumor cell enrichment.
4. Spectrophotometric quantification of DNA/RNA (A260/280 ratio calculation).
5. Fluorometric quantification and sensitivity comparison.
6. Gel electrophoresis for visualization of extracted nucleic acids.
7. Setup and run of conventional PCR and RT-PCR.
8. Demonstration/interpretation of real-time PCR (qPCR) data.
9. Demonstration of In Situ Hybridization (ISH) and Fluorescent in Situ Hybridization (FISH).
10. Navigation of digital pathology platforms (virtual slides with molecular overlays).
11. Preparation of integrated molecular-histopathology report.
12. Practice of documentation, labeling, and data entry for molecular tests.0

***Clinical laboratory rotation/observation can be incorporated wherever possible**

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Suggested Readings:

1. Coleman, W. B., & Tsongalis, G. J. (Eds.). (2009). *Molecular pathology: the molecular basis of human disease*. academic Press.
2. Coleman, W. B., & Tsongalis, G. J. (Eds.). (2023). *Diagnostic molecular pathology: a guide to applied molecular testing*. Academic Press.
3. WHO Classification of Tumours
4. CAP/ASCO/CAP Guidelines on Molecular Testing in Oncology

IVth SEMESTER

Medical Biochemistry

Dissertation

Dissertation	Subject Code: MMLS-B-023
Total Marks for Evaluation- 600	No. of Contact Hours- 990, Credits:22

IVth SEMESTER

Medical Microbiology

Dissertation

Dissertation	Subject Code: MMLS-M-023
Total Marks for Evaluation- 600	No. of Contact Hours- 990, Credits:22

IVth SEMESTER

Haematology and Transfusion Medicine

Dissertation

Dissertation	Subject Code: MMLS-H-025
Total Marks for Evaluation- 600	No. of Contact Hours- 990, Credits:22

IVth SEMESTER

Histology and Cytology

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Dissertation

Dissertation	Subject Code: MMLS-C-025
Total Marks for Evaluation- 600	No. of Contact Hours- 990, Credits:22

Proforma for submission of M.Sc. MLS dissertation proposal synopsis

1. Name & address of student
2. Email Id of the student
3. Registration number
4. Name of institute
5. Title of the dissertation
6. Name of the guide
7. Address, phone number and email id of the guide
8. Designation of the guide
9. Name of the co-guide
10. Address, phone number and email id of the Co guide
11. Designation of the Co-guide
12. Synopsis of the study Attached (Yes/No)

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Date: Signature of the Guide

Enclosures: Synopsis

Synopsis Proposal /Synopsis Outline

1 Title

2 Purpose of the study

3 Objectives of the study

4 Operational Definitions

5 Conceptual Framework

6 Assumptions/Hypothesis

7 Research Methodology

a) Research Approach

b) Research Design

c) Setting

d) Population, Sample & Sampling Technique

e) Tools &Technique

f) Pilot study

g) Plan for data collection

8. Plan for data analysis Work plan

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9. Ethical Considerations

10. References

Guidelines in Writing Synopsis

1. The research protocol should be of 1200 words (4- 6 pages) on the topic.
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5. The synopsis should be signed by the candidate and forwarded through the Guide, Departmental head and Principal of the Institution.

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Signature of the Guide Signature of the Principal

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Pagination: Number all of the pages of your document, including not only the principle text, but also all plates, tables, diagrams, maps and so on. Roman numerals are used on the preliminary pages (pages up to the first page of text), and Arabic numerals are used on the text pages. The numbers themselves can be placed anywhere on the page; however, they should be consistent.

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References: Vancouver style format.

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Year

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By

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Date:

Abstract

Should be structured
(Include background/Introduction and objectives, methodology, results, and conclusion in a single paragraph limited to 250-300 words)
Keywords: 5-6 words
Table of contents

S. No.	Chapter Title	Page No
1	Introduction	
2	Objectives	
3	Review of literature	
4	Methodology	
5	Results	
6	Discussion	
7	Conclusion	
8	Summary	
9	References	
10	Annexures	

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List of Tables: (14 size bold)

S. No.	Table	Page No

List of Figures: (14 size bold)

S. No.	Figure	Page No

CHAPTER-I

- Introduction (14 size, Bold)
- Sub Headings (12 size, Bold)
- Background of the problem
- Need and significance of the study
- Statement of the problem
- Objectives
- Operational definitions
- Hypothesis
- Conceptual/ theoretical framework

CHAPTER-2 (14 sizes, Bold) Review of literature

- Subheading of the literature reviewed (12sizes, Bold)

CHAPTER-3

- Methodology
- Research approach
- Research design

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- Variables
- Schematic representation of the study
- Setting of the study
- Population
- Sample and sampling technique
- Inclusion criteria
- Exclusion criteria
- Tool/instruments
- Development/selection of the tool
- Description of the tool
- Content validity
- Reliability of the tool
- Pilot-study
- Data collection process
- Plan for data analysis

CHAPTER-4 (14 sizes, bold)

- Analysis and interpretation
- Section title (Section wise presentation of data)

CHAPTER-5 (14 sizes, bold)

- Results
- Objectives
- Hypothesis

CHAPTER-6 (14 sizes, bold)

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- Discussion
- Summary and conclusion
- Implications
- Limitations
- Recommendations

DISSERTATION STYLE: Vancouver style format is used Citations in the text

General Rules:

1. References should be numbered consecutively in the order in which they are cited in the text. Place each reference number in parentheses (5) or as a superscript. Use Arabic numerals if the same references are used again, we use the original number. Square brackets {} or curved Brackets () can be used as long as they are consistent.
2. When multiple references are cited at a given place in a text, use a hyphen to join the first and last numbers that are inclusive (6-9) or use commas (2,6,8,9)
3. Whatever format is chosen, the punctuation must be consistently applied to whole document.

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Tables must be self-explanatory, The data must be clearly organised and should supplement and not duplicate the text. Data may be presented either in a table or pictorial form. Do not use internal horizontal or vertical lines. Explanatory matter should be given as footnotes. Statistical analysis used must be appropriate. Confidence intervals, along with exact probability values, must be stated for the results. Round decimals to two digits. Each table must have a title and should be numbered with Arabic numerical e.g. (1,2). Type or print each table with double spacing on a separate sheet of paper. Number tables consecutively in the order of their first citation in the text and supply a brief title for each. Give each column a Short or an abbreviated heading. Explain all non-standard abbreviations in footnotes. The table should not be carried over to the next page.

Illustrations and figures

- Number each figure in the text in consecutive order
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Abstract

Abstract provides a summary of the dissertation/thesis, summing up clearly the problem examined, the methods used and the main findings. The abstract is a one-paragraph, self contained summary of the most important elements of the paper. The abstract word limit is between 250 and 300 words. All numbers in the abstract (except those beginning a sentence) should be typed as digits rather than words. Key words (max.6) should be given, chosen from subject concerned headings. Each word should be separated by semicolon.

References

1. The reference list should appear at the end of the paper and provide the complete bibliographic information about the sources cited.
2. List all reference in order by number, not alphabetically. Each reference is listed once only, since the same number is used throughout the paper. It should be numbered consecutively in the order in which they are first mentioned in the text. Identify references in text and tables by Arabic numerals in parentheses.
3. The titles of journals should be abbreviated according to the style used in the list of journals. The following information is included for journal articles: author(s), article, title, abbreviated journal title, year, month (if applicable), day, volume number, issue number (if applicable), and page numbers. For books author(s), title, Edition, place of publication, publisher and year.
4. List each author's last name and initials: full first names are not included. List all authors, but if the number exceeds six, give the first six followed by"et al.
5. For books with chapters written by individual authors, list the authors of the chapter first, then the chapter title, followed by"In:"the editors' names, and the book title.
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8. Minimal capitalisation is used for the article title, i.e.only the first word and words that normally would begin with a capital letter are capitalised.
9. Full stops are used after the last authors initials, after the article title, after the abbreviated journal title and at the end of the entry. Gerald Callee J, Andrew G Fraser, Barrie P Marmion, Anthony Simmons. Mackie& MC Cartney Practical medical microbiology, NewYork, Churchill Livingstone, 1996.

Standard journal article (for more than six authors): List the first six contributors followed by *et al*.

Roddy P, Goiri J, Flevaud L, Palma PP, Morote S, Lima N. *et al*., Field Evaluation of a Rapid Immunochromatographic Assay for Detection of *Trypanosoma cruzi* Infection by Use of Whole Blood. J. Clin. Microbiol. 2008; 46: 2022-2027.

Book: Personal author(s):

Parija SC. Textbook of Medical Parasitology. 3rd ed. All India Publishers and Distributors. 2008.

Editor(s), compiler(s) as author

Garcia LS, Filarial Nematodes In: Garcia LS (editor) Diagnostic Medical Parasitology ASM press Washington DC 2007: pp 319-356.

Electronic Sources as reference

Journal article on the Internet: Parija SC, Khairnar K. Detection of excretory Entamoeba histolytica DNA in the urine, and detection of E. histolytica DNA and lectin antigen in the liver abscess pus for the diagnosis of amoebic liver abscess. BMC Microbiology 2007, 7:41.doi:10.1186/1471-2180-7-41.

http://www.biomedcentral.com/1471-2180/7/41

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8. Avrum I. Gotlieb, Fang-I Lu, William Tsui, Heather Shapiro, Theodore J. Brown, G. Scot Hamilton, Danielle C. Bentley, George M. Yousef, Juan Putra, Rachel Zulla, Rita A. Kandel, Professional Master of Health Science in Laboratory Medicine: Training Clinical Laboratory Scientists in an Integrated Programme at a Research-Intensive University, The American Journal of Pathology, Volume 194, Issue 11, 2024, Pages 2000-2006, ISSN 0002-9440, https://doi.org/10.1016/j.ajpath.2024.07.013.

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11. https://clsi.org/standards-development/specialty-areas/
12. Nature 645, 824 (2025) doi: https://doi.org/10.1038/d41586-025-0307

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