



MALLA REDDY VISHWAVIDYAPEETH

**SCHOOL OF ALLIED HEALTHCARE SCIENCES
AND
TECHNOLOGY**

Suraram X Roads, Jeedimetla,
Hyderabad-500055
Web: <https://mrvv.edu.in/>

Program

Master of Medical Laboratory Science

2026

MALLA REDDY VISHWAVIDYAPEETH
SCHOOL OF ALLIED HEALTHCARE SCIENCES AND TECHNOLOGY
MASTERS OF MEDICAL LABORATORY SCIENCES

Vision

To be a center of excellence in Medical Laboratory Sciences by developing advanced, globally competent professionals in diagnostics, research, and quality healthcare.

Mission

To deliver advanced, competency-based training in medical laboratory diagnostics, fostering analytical and research skills, ensuring quality and ethical practice, promoting interdisciplinary collaboration, encouraging innovation, and supporting lifelong professional growth.

Program Educational Objectives (PEOs)

- Apply comprehensive knowledge of medical laboratory sciences for accurate diagnosis and patient care in diverse healthcare settings.
- Demonstrate professional competence, ethical responsibility, and accountability in laboratory practice.
- Engage in multidisciplinary healthcare teams to improve clinical outcomes and healthcare delivery.
- Adapt to advancements in laboratory technologies including automation, molecular diagnostics, and quality assurance systems.
- Contribute to community health through disease prevention, health promotion, and evidence-based practices.
- Pursue lifelong learning, research, and professional development in medical laboratory sciences.

PROGRAM OUTCOMES (POs)

- Apply knowledge of basic and clinical sciences for laboratory diagnosis and interpretation of results.
- Perform laboratory procedures accurately with adherence to quality control and biosafety protocols.
- Analyze, interpret, and correlate laboratory findings with clinical conditions.
- Communicate effectively with patients, clinicians, and healthcare teams.
- Demonstrate ethical practices, professionalism, and accountability in laboratory services.
- Function effectively as a member of a multidisciplinary healthcare team and contribute to patient-centered care.

PROGRAM SPECIFIC OUTCOMES (PSOs)

- Perform hematological, biochemical, microbiological, immunological, and molecular diagnostic tests with precision.

- Operate and maintain laboratory instruments, analyzers, and automation systems efficiently.
- Implement quality assurance (QA) and quality control (QC) practices in laboratory settings.
- Identify and troubleshoot errors in pre-analytical, analytical, and post-analytical phases.
- Apply advanced diagnostic techniques including molecular diagnostics and immunocytochemistry.
- Interpret laboratory data and assist clinicians in disease diagnosis, monitoring, and prognosis.

COURSE OUTCOMES (COs)

- Describe fundamental principles of laboratory sciences including hematology, microbiology, and biochemistry.
- Demonstrate laboratory skills such as specimen collection, staining, microscopy, and biochemical assays.
- Apply analytical techniques to perform routine and specialized laboratory investigations.
- Analyze laboratory results and correlate them with pathological conditions.
- Evaluate quality control data and ensure accuracy and reliability of laboratory reports.
- Develop problem-solving skills for troubleshooting laboratory errors and improving diagnostic efficiency.

MALLA REDDY VISHWAVIDYAPEETH

SCHOOL OF ALLIED HEALTH SCIENCES AND TECHNOLOGY

MASTER OF MEDICAL LABORATORY SCIENCES

Course Structure

I SEM I YEAR (COMMON FOR ALL SPECIALIZATIONS)

S.NO	SUBJECT CODE	SUBJECT	L	T	P	C	Max. Marks		
							INT	EXT	TOTAL
1		Medical Laboratory Management	4	-	-	4	30	70	100
2		Cell and Molecular Biology	4	-	-	4	30	70	100
3		Research Methodology & Biostatistics	2	-	-	2	30	70	100
4		Advanced Molecular Diagnostic Techniques	4	-	-	4	30	70	100
5		Digital Health Technologies	2	-	-	2	30	70	100
6		Elective Course	-	-	2	2	30	70	100
7		Research Methodology & Biostatistics Practical	-	-	2	2	30	70	100
8		Advanced Molecular Diagnostic Techniques Practical	-	-	2	2	30	70	100
9	MDC	Public Health & Epidemiology	2	-	-	2	30	70	100
TOTAL			18	-	6	24	270	630	900

II SEM I YEAR -MEDICAL MICROBIOLOGY

S.NO	SUBJECT CODE	SUBJECT	L	T	P	C	Max. Marks		
							INT	EXT	TOTAL
1		Essential and Applied Microbiology	3	1	-	4	30	70	100
2		Systematic Bacteriology	3	1	-	4	30	70	100
3		Systematic Bacteriology Practical	-	-	2	2	30	70	100
4		Medical Entomology and Parasitology	3	1	-	4	30	70	100
5		Medical Entomology and Parasitology Practical	-	-	2	2	30	70	100
6		Immunology and Immunodiagnostics	3	1	-	4	30	70	100
7		Immunology and Immunodiagnostics Practical	-	-	2	2	30	70	100
8		Clinical postings	-	-	2	2	100	-	-
TOTAL			12	4	8	24	310	490	700

II SEM I YEAR -HAEMATOLOGY & TRANSFUSION MEDICINE

S.NO	SUBJECT CODE	SUBJECT	L	T	P	C	Max. Marks		
							INT	EXT	TOTAL
1		Haematology and Haematological Disorders	4	-	-	4	30	70	100
2		Haemostatic Disorders	4	-	-	4	30	70	100
3		Applied Immunopathology in Haematology	4	-	-	4	30	70	100
4		Clinical Pathology	2	-	-	2	30	70	100
5		Haematology and Haematological Disorders Practical	-	-	2	2	30	70	100
6		Haemostatic Disorders Practical	-	-	2	2	30	70	100
7		Applied Immunopathology in Haematology Practical	-	-	2	2	30	70	100
8		Clinical Pathology Practical	-	-	2	2	30	70	100
TOTAL			14	-	8	22	240	560	800

II SEM I YEAR – HISTOLOGY & CYTOLOGY

S.NO	SUBJECT CODE	SUBJECT	L	T	P	C	Max. Marks		
							INT	EXT	TOTAL
1		Translational Anatomy and Cell Dynamics	4	-	-	4	30	70	100
2		Essentials of Histology	4	-	-	4	30	70	100
3		Essentials of Cytopathology	4	-	-	4	30	70	100
4		Cancer Epidemiology and Digital Pathology	2	-	-	2	30	70	100
5		Translational Anatomy and Cell Dynamics Practical	-	-	2	2	30	70	100
6		Essentials of Histology Practical	-	-	2	2	30	70	100
7		Essentials of Cytopathology Practical	-	-	2	2	30	70	100
8		Cancer Epidemiology and Digital Pathology Practical	-	-	2	2	30	70	100
TOTAL			14	-	8	22	240	560	800

II SEM I YEAR – MEDICAL BIOCHEMISTRY

S.NO	SUBJECT CODE	SUBJECT	L	T	P	C	Max. Marks		
							INT	EXT	TOTAL
1		Bioorganic & Biophysical Chemistry	4	-	-	4	30	70	100
2		Instrumentation in Biochemistry	4	-	-	4	30	70	100
3		Enzymology & Nutrition	4	-	-	4	30	70	100
4		Intermediary Metabolism	4	-	-	4	30	70	100
5		Bioorganic & Biophysical Chemistry Practical	-	-	2	2	30	70	100
6		Instrumentation Practical	-	-	2	2	30	70	100
7		Clinical Posting	-	-	2	2	100	-	100
TOTAL			16	-	6	22	280	420	700

III SEM II YEAR- MEDICAL MICROBIOLOGY

S.NO	SUBJECT CODE	SUBJECT	L	T	P	C	Max. Marks		
							INT	EXT	TOTAL
1		Medical Virology	3	1	-	4	30	70	100
2		Medical Mycology	3	1	-	4	30	70	100
3		Medical Mycology & Virology Practical	-	-	2	2	30	70	100
4		Public Health Microbiology	3	1	-	4	30	70	100
5		Public Health Microbiology Practical	-	-	2	2	30	70	100
6		Advances in Microbial Informatics	3	1	-	4	30	70	100
7		Clinical Posting-II	-	-	2	2	100	-	-
TOTAL			12	4	6	22	310	490	700

III SEM II YEAR- HAEMATOLOGY & TRANSFUSION MEDICINE

S.NO	SUBJECT CODE	SUBJECT	L	T	P	C	Max. Marks		
							INT	EXT	TOTAL
1		Blood Banking & Immunohematology	4	-	-	4	30	70	100
2		Transfusion Medicine	4	-	-	4	30	70	100
3		Molecular Hematology	4	-	-	4	30	70	100
4		Advanced Haematological Techniques	2	-	-	2	30	70	100
5		Blood Banking & Immunohematology Practical	-	-	2	2	30	70	100
6		Transfusion Medicine Practical	-	-	2	2	30	70	100
7		Molecular Hematology Practical	-	-	2	2	30	70	100
8		Advanced Haematological Techniques Practical	-	-	2	2	30	70	100
9		Clinical Posting-II	-	-	2	2	100	-	-
TOTAL			14	-	10	24	370	630	900

III SEM II YEAR- HISTOLOGY & CYTOLOGY

S.NO	SUBJECT CODE	SUBJECT	L	T	P	C	Max. Marks		
							INT	EXT	TOTAL
1		Diagnostic Histopathology	4	-	-	4	30	70	100
2		Cytological Techniques	4	-	-	4	30	70	100
3		Immunohistochemistry & Diagnostic Markers	4	-	-	4	30	70	100
4		Molecular Techniques in Histopathology & Cytology	2	-	-	2	30	70	100
5		Diagnostic Histopathology Practical	-	-	2	2	30	70	100
6		Cytological Techniques Practical	-	-	2	2	30	70	100
7		Immunohistochemistry & Diagnostic Markers Practical	-	-	2	2	30	70	100
8		Molecular Techniques in Histopathology & Cytology Practical	-	-	2	2	30	70	100
9		Clinical Posting-II	-	-	2	2	100	-	-
TOTAL			14	-	10	24	370	630	900

III SEM II YEAR- MEDICAL BIOCHEMISTRY

S.NO	SUBJECT CODE	SUBJECT	L	T	P	C	Max. Marks		
							INT	EXT	TOTAL
1		Clinical Biochemistry I	4	-	-	4	30	70	100
2		Clinical Biochemistry II	4	-	-	4	30	70	100
3		Immunology	4	-	-	4	30	70	100
4		Endocrinology & Biochemistry of Aging	4	-	-	4	30	70	100
5		Clinical Biochemistry I Practical	-	-	2	2	30	70	100
6		Clinical Biochemistry II Practical	-	-	2	2	30	70	100
7		Immunology Practical	-	-	2	2	30	70	100
8		Clinical Posting-II	-	-	2	2	100	-	-
TOTAL			16	-	8	24	340	560	800

IV SEM II YEAR- (COMMON FOR ALL SPECIALIZATIONS)

S.NO	SUBJECT CODE	SUBJECT	L	T	P	C	Max. Marks		
							INT	EXT	TOTAL
1		Dissertation Viva	-	-	22	22	100	200	300
2		Dissertation Logbook	-	-	-	-	100	200	300
3		Swayam: Basic course in biomedical research							
TOTAL			-	-	22	22	200	400	600

1.1 Post Graduate Programme

Sl. No.	Course	Duration	Eligibility for admission
1	M.Sc. Medical Laboratory Technology	2 years	Passed BSc in Medical Lab Technology or equivalent examination of a recognized Indian University or a duly constituted Board with pass marks (50%)

1.2. Medium of Instruction:

English shall be the medium of instruction for all subjects of study and for examinations.

1.3. Duration of the Course

Duration details are mentioned under clause no. 1.1 of this booklet.

1.4 Examination Regulations

1.4.1 Attendance

A candidate shall secure the following minimum attendance to be eligible to appear for the university examinations:

- Minimum **80% attendance in theory classes**
- Minimum **80% attendance in practical / skill training**

No relaxation shall be permitted under any circumstances including illness or any other reason.

1.4.2 Internal Assessments

The internal assessment shall be based on continuous evaluation of cognitive, psychomotor, and affective domains through the following methods:

Cognitive Assessment

- Structured Logbook
- Viva-voce Examination
- Structured Case Presentation
- Formative Assessment
- Summative Assessment
- Case Presentation

Psychomotor Assessment

- Objective Structured Clinical Examination (OSCE)
- Objective Structured Practical Examination (OSPE)
- Mini Clinical Evaluation Exercise (Mini-CEX)
- Direct Observation of Procedural Skills (DOPS)
- Simulation-based Assessment

Exam Pattern for Internal Assessment

Component	Marks Distribution
Sessional / Periodic Tests	20 Marks
Assignments / Seminars / Case Presentation	5 Marks
Practical Record / Logbook	5 Marks
Attendance & Professional Conduct	5 Marks
Practical Internal Assessment	15 Marks
Total Internal Assessment	50 Marks

1.4.3 University Examinations (External)

The university examination shall consist of:

Theory Examination

- Conducted at the end of each semester
- Evaluates theoretical knowledge, analytical ability, and clinical correlation

Practical / Clinical Examination

- Includes practical exercises, viva voce, interpretation, and procedural skills

Dissertation Evaluation (Semester IV)

- Dissertation submission
- Dissertation viva-voce
- Logbook evaluation

Passing Criteria

A candidate shall be declared to have passed if he/she secures:

- Minimum **50% marks in Internal Assessment**

- Minimum **50% marks in University Theory Examination**
- Minimum **50% marks in University Practical Examination**
- Minimum **50% marks in aggregate**

For dissertation defence, the candidate must secure at least **50% marks** in dissertation presentation and viva voce examination.

COURSE STRUCTURE

Semester -I

I SEM I YEAR (COMMON FOR ALL SPECIALIZATIONS)

S.NO	SUBJECT CODE	SUBJECT	L	T	P	C	Max. Marks		
							INT	EXT	TOTAL
1		Medical Laboratory Management	4	-	-	4	30	70	100
2		Cell and Molecular Biology	4	-	-	4	30	70	100
3		Research Methodology & Biostatistics	2	-	-	2	30	70	100
4		Advanced Molecular Diagnostic Techniques	4	-	-	4	30	70	100
5		Digital Health Technologies	2	-	-	2	30	70	100
6		Elective Course	-	-	2	2	30	70	100
7		Research Methodology & Biostatistics Practical	-	-	2	2	30	70	100
8		Advanced Molecular Diagnostic Techniques Practical	-	-	2	2	30	70	100
9	MDC	Public Health & Epidemiology	2	-	-	2	30	70	100
TOTAL			18	-	6	24	270	630	900

Medical Laboratory Management

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 outcomes: At the end of the course the student should be able to

- Understand the need for efficient and effective laboratory operations, including resource allocation, personnel management, equipment and reagent purchase and maintenance.

- Comprehend knowledge of relevant regulations, standards, and best practices for overall improvement of laboratory services for patient care

UNIT-I

6 hours

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

UNIT-II

4 hours

Work- Flow of a Clinical Laboratory – sample reception, registration, barcoding, centrifuging, sample processing, result checking, result release, sample storage
Scope of laboratory services

UNIT-III

8 hours

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

UNIT-IV

8 hours

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

UNIT- V

6 hours

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 commercial controls.

UNIT-VI

8 hours

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

UNIT- VII

4 hours

Clinical laboratory informatics: Computer basics. Word processing, spreadsheets, database, graphics, statistics, Laboratory Information Systems (LIS)

UNIT- VIII

6 hours

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.

UNIT- IX

4 hours

Public relations: Interpersonal skills at work place, communication with patients, Leadership management, conduction of seminar and CME programs, 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

UNIT- X

4 hours

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

Suggested Readings:

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

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 objectives: At the end of the course students will be able to

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

UNIT-I

6 hours

Basic Concept Of Cell Structure, Function And Processes

- a) Cell Organelles And Their Functions
- b) Cell Division, Cell Cycle And Apoptosis

UNIT-II

12 hours

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 Transcription, Reverse Transcriptase, Post Transcriptional Modification
- Translation- The Process Of Translation, Post Translational Modifications Like Folding, Glycosylation Etc.
- Inhibitors Of Protein Synthesis

UNIT-III

6 hours

Gene Expression-Regulation And Significance

UNIT-IV

6 hours

In Situ Hybridization-To Study Gene Expression Pattern, Localize Gene Amplification, Gene Location

UNIT- V

8 hours

Concept Of Gene Switching, Gene Transposition, Somatic Recombination

UNIT-VI

12 hours

Cell Culture: Introduction, Significance, Cell Culture Lab – Instruments, Aseptic Techniques, Media Preparation And Filtration 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

UNIT- VII

10 hours

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, Transgenesis, Dna Finger Printing, Dna Sequencing, Pcr, Dna Probes, Hybridoma Technology.

Suggested books

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.

Advance Molecular Diagnostics Techniques

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 outcome: At the end of the course students should be able to:

- comprehend knowledge and clinical skills of molecular techniques
- Use accurate and advance diagnostic tools

UNIT-I

6 hours

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.

UNIT-II

12 hours

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 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.

UNIT-III

6 hours

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

UNIT-IV

6 hours

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

UNIT- V

8 hours

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

UNIT-VI

8 hours

Definition, application and advantages of Genomics, Next-generation sequencing technology, Proteomics, Transcriptomics, Metabolomics

Advance Molecular Diagnostics techniques Practical

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

60 hours

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

- 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.

- Carson, S., Miller, H. B., Srougi, M. C., & Witherow, D. S. (2019). *Molecular biology techniques: a classroom laboratory manual*. Academic Press.
- Tagu, D., & Moussard, C. (Eds.). (2006). *Techniques for molecular biology*. Science Publishers.
- Coleman, W. B., & Tsongalis, G. J. (Eds.). (2007). *Molecular diagnostics: for the clinical laboratorian*. Springer Science & Business Media.
- Greene, J. (Ed.). (1998). *Recombinant DNA principles and methodologies*. CRC Press.

Digital Health Technologies

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 outcomes: At the end of the course the student should be able to:

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

UNIT-I

6 hours

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

UNIT-II

6 hours

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

UNIT-III

6 hours

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

UNIT-IV

6 hours

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, Electronic 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

UNIT- V

6 hours

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

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. C. (2022). Handbook of artificial intelligence in Healthcare. Springer International Publishing.

Research Methodology & Biostatistics

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 Objectives: At the end of the course, students will be able to

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

UNIT-I

6 hours

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

UNIT-II

6 hours

Probability, Distributions, and Sampling

- Normal and Standard Normal Distribution: Properties and Applications
- Probability Concepts and Calculations (mean $\pm$ 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

UNIT-III

6 hours

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

UNIT-IV

6 hours

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

UNIT- V

6 hours

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

Research Methodology & Biostatistics Practical

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

60 hours

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 $\pm$ 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 Reading:

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

Public Health & Epidemiology

COURSE OBJECTIVES

The course aims to:

1. Introduce postgraduate students to concepts of Public Health and Epidemiology.
2. Develop understanding of disease distribution and determinants.
3. Familiarize students with epidemiological methods and surveillance systems.
4. Promote interdisciplinary understanding of community health issues.
5. Apply epidemiological principles in healthcare research and practice.

COURSE OUTCOMES

After completion of the course, students will be able to:

- Explain principles of public health and epidemiology.
- Interpret epidemiological data and health indicators.
- Understand communicable and non-communicable disease patterns.
- Analyze public health problems using epidemiological approaches.

- Participate in health promotion and disease prevention activities.

UNIT I — INTRODUCTION TO PUBLIC HEALTH

8 Hour

Concept and scope of Public Health

Determinants of health

Dimensions of health

Natural history of disease

Levels of prevention

Primary Health Care

Healthcare delivery system in India

National Health Programs

UNIT II — BASIC EPIDEMIOLOGY

10 Hours

Definition and scope of Epidemiology

Epidemiological triad

Incidence and prevalence

Morbidity and mortality

Epidemic, endemic, and pandemic

Disease transmission

Screening tests

Sensitivity and specificity

UNIT III — PUBLIC HEALTH ISSUES & SURVEILLANCE

12 Hours

Communicable Diseases

- Tuberculosis
- HIV/AIDS
- Dengue
- Malaria

Non-Communicable Diseases

- Diabetes mellitus
- Hypertension

- Cancer
- Obesity

Public Health Surveillance

- Disease surveillance systems
- Outbreak investigation
- Vaccination and immunization
- Role of WHO and national health agencies

Introduction to Biostatistics

- Types of data
- Data presentation
- Mean, median, mode
- Graphical representation of health data

Activities

- Health survey preparation
- Public health awareness presentation

RECOMMENDED BOOKS

1. Park's Textbook of Preventive and Social Medicine
2. Gordis Epidemiology
3. Basic Epidemiology – WHO
4. Textbook of Public Health and Community Medicine
5. Biostatistics for Health Sciences

SEMESTER II

Medical Biochemistry

II SEM I YEAR – MEDICAL BIOCHEMISTRY

S.NO	SUBJECT CODE	SUBJECT	L	T	P	C	Max. Marks		
							INT	EXT	TOTAL
1		Bioorganic & Biophysical Chemistry	4	-	-	4	30	70	100
2		Instrumentation in Biochemistry	4	-	-	4	30	70	100
3		Enzymology & Nutrition	4	-	-	4	30	70	100
4		Intermediary Metabolism	4	-	-	4	30	70	100
5		Bioorganic & Biophysical Chemistry Practical	-	-	2	2	30	70	100
6		Instrumentation Practical	-	-	2	2	30	70	100
7		Clinical Posting	-	-	2	2	100	-	100
TOTAL			16	-	6	22	280	420	700

Bioorganic & Biophysical Chemistry

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 Outcomes: At the end of the course students will be able to

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

UNIT-I

10 hours

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

UNIT-II

10 hours

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** - *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.

UNIT-III

10 hours

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

UNIT-IV

4 hours

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

UNIT- V

8 hours

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, T_m , denaturation, renaturation, hybridization and Cot analysis.

UNIT- VI

6 hours

Acids, Bases, Buffers in biological system, $-pH$ -Henderson-Hasselbalch equation, Acid load in the body, regulation of acid base balance in body.

UNIT- VII

4 hours

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, regulation, and their functions, water/electrolyte balance.

UNIT- VIII

8 hours

Body Fluid properties:

Osmosis and Osmotic pressure - Osmolality of body fluids. Surface tension and viscosity - their application to 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.

Bioorganic & Biophysical Chemistry Practical

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.

60 hours

1. **Reactions of Carbohydrates** – Molisch, Iodine, Benedict, Modified Barfoed, Osazone, Seliwanoff, Foulger, Mucic acid, Bial
2. **Reactions of Proteins**
3. Precipitation reactions – Acid, Base, Alcohol, Iso-electric, Half & Full saturation
4. Colour reactions – Biuret, Ninhydrin, Hellers, Aldehyde, Paulis, Sakaguchi, Sulphur, Xanthoproteic, Millons,
5. **Reactions of Lipids** – Solubility Test, saponification test, bromine water test for unsaturated fatty acids, Acrolein test
6. **Reaction of Nucleic acid** – Dische test, Bial Test, Phosphate Test, Quantitative estimation via UV absorption at 260nm or Nano spectrophotometer

7. **Preparation of buffer and determination of pH**
8. **Demonstration**
9. Determination of viscosity using Ostwald's viscometer.
10. Demonstration of osmosis and diffusion using semi-permeable membranes.

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

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

Instrumentation

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 outcomes: At the end of the course students will be able to

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

UNIT-I

4 hours

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

UNIT-II

6 hours

Centrifugation techniques:

Definition, Basic Principles of sedimentation, instrumentation, application in clinical and research laboratory.

Types of centrifugation :Preparative, analytical centrifugation, differential centrifugation, Density gradient centrifugation , ultra centrifuge

UNIT-III

8 hours

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, Fluorimetry, Spectrofluorometry, Atomic absorption spectrometry, Infra red spectrometry.

UNIT-IV

10 hours

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

UNIT- V

6 hours

Clinical Chemistry analysers:

Basic principles, instrumentation, function, significance of these analysers. Types of chemistry analysers – semi –automated andFully automated

UNIT- VI

10 hours

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.

UNIT- VII

6 hours

Advance Instruments:

Principles, instrumentation, techniques, and applications of Electron spin resonance, Nuclear Magnetic resonance, crystallography, Mass spectrometry

UNIT- VIII

6 hours

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, Chemiluminescence ,Electrochemiluminescence

UNIT- IX

4 hours

Osmometry :

Definition, principle of osmometry, Instrumentation, applications

Instrumentation Practical

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.

60 hours

1. Calibration of micropipettes and glass pipettes
2. Paper Chromatography- One dimensional
3. Paper chromatography - Two dimensional
4. HPLC
5. Electrophoresis:
 - Gel Electrophoresis
 - PAGE
 - Serum protein electrophoresis and Quantification
6. Osmometer

7. ELISA/FIA

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

Suggested Readings:

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

Intermediary Metabolism

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 Outcome: At the end of the course, students will be able to

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

UNIT-I

8 hours

Metabolism: Bioenergetics, free energy, biological oxidations, electron transport, oxidative phosphorylation.

UNIT-II

12 hours

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.

UNIT-III

12 hours

Aminoacid and protein metabolism: Digestion and absorption Transamination, deamination - oxidative deamination and non oxidative, ammonia transport, urea formation. Metabolism of individual aminoacid. Biosynthesis of catecholamines, 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.

UNIT-IV

12 hours

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.

UNIT- V

8 hours

Purine and Pyrimidine metabolism: Biosynthesis of purine and pyrimidine. Degradation of purine and pyrimidine and their Disorders.

UNIT- VI

8 hours

Hemoglobin metabolism: Heme synthesis, formation of hemoglobin, Structure of hemoglobin, Metabolism of bilirubin.

Suggested Reading:

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

Enzymology and Nutrition

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 Outcome: At the end of the course, students will be able to

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

UNIT-I

6 hours

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.

UNIT-II

6 hours

Mechanism of Enzyme Action: Nature of active site, identification of functional groups at active site, enzyme substrate complex, Factors 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.

UNIT-III

8 hours

Enzyme Kinetics: MichaelisMenten equation. Derivation of MichaelisMenten equation and determination of K_m and V_{max} values, Substrate inhibition and activation, Effect of pH and temperature on rate of enzyme catalyzed reactions, Allosteric enzymes

UNIT-IV

6 hours

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.

UNIT- V

4 hours

Application of Enzymes: Enzymes as analytical reagents, Immobilized enzymes, Biotechnological applications of enzymes, Application of enzymes in medicine and industry.

UNIT- VI

6 hours

Clinical enzymology - Enzymes as thrombolytic agents, anti-inflammatory agents, digestive aids. Therapeutic use of asparaginase, 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.

UNIT- VII

4 hours

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.

UNIT- VIII

8 hours

Vitamins: Definition, Classification, Chemistry, Sources, biochemical functions, deficiency and toxicity manifestations of fat-soluble and water-soluble vitamins.

UNIT- IX

8 hours

Minerals: Definition, Classification, Chemistry, Sources, biochemical functions, deficiency and toxicity manifestations of macro and micro minerals

UNIT- X

4 hours

Nutritional Genomics:

Introduction to nutrigenetics and Nutrigenomics, role of genes in metabolism and nutrient utilization, omics technologies in nutrigenomics.

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)

SEMESTER II

Medical Microbiology

II SEM I YEAR -MEDICAL MICROBIOLOGY

S.NO	SUBJECT CODE	SUBJECT	L	T	P	C	Max. Marks		
							INT	EXT	TOTAL
1		Essential and Applied Microbiology	3	1	-	4	30	70	100
2		Systematic Bacteriology	3	1	-	4	30	70	100
3		Systematic Bacteriology Practical	-	-	2	2	30	70	100
4		Medical Entomology and Parasitology	3	1	-	4	30	70	100
5		Medical Entomology and Parasitology Practical	-	-	2	2	30	70	100
6		Immunology and Immunodiagnostics	3	1	-	4	30	70	100
7		Immunology and Immunodiagnostics Practical	-	-	2	2	30	70	100
8		Clinical postings	-	-	2	2	100	-	-
TOTAL			12	4	8	24	310	490	700

Essential and Applied Microbiology

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 Objectives:

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

UNIT-I

8 hours

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, 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

UNIT-II

7 hours

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

UNIT-III

10 hours

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

UNIT-IV

6 hours

Bacterial Recombination: General Principles

Bacterial Plasmids:

Fertility factors, Resistance factors, Col plasmids, Other types of 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

UNIT- V

15 hours

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

UNIT- VI

5 hours

Waters and Disease transmission:

Waterborne pathogens and water purification

Sanitary analysis of waters

Wastewater treatment:

Measuring water quality

Waste treatment processes

UNIT- VII

4 hours

Soil as an Environment for microorganisms

Microorganisms in the soil environment

Soil Microorganisms and Human Health

Understanding microbial diversity in the soil

UNIT- VIII

5 hours

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

Suggested Reading:

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), 2016
6. J. Cassells – *Bioprocess Engineering: Systems, Equipment and Facilities*, Wiley India Pvt Ltd, 2020
7. World Health Organisation (WHO) – *WHO Technical Report Series on Bioprocess Containment, various volumes including TRS No. 999 and TRS No. 1033*, WHO Publications
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

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 Outcome: By the end of this course, students will be able to

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

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.

UNIT-II

14 hours

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, H₂S production, Motility, Decarboxylases; Integration of biochemical patterns into genus/species-level diagnosis

UNIT-III

8 hours

Gram-Positive & Gram-Negative Cocci: Study of morphological, cultural, biochemical characteristics, pathogenesis and laboratory diagnosis of – *Staphylococcus*, *Streptococcus*, *Pneumococcus*, *Haemophilus*, *Neisseria gonorrhoeae* and *Neisseria meningitidis*

UNIT-IV

10 hours

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*

UNIT- V

16 hours

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*.

UNIT- VI

2 hours

Non-spore-forming anaerobic cocci and bacilli: Classification & Morphology, pathogenicity, and diagnostics of - Anaerobic cocci: *Peptostreptococcus*, *Veillonella*; Anaerobic Gram-positive bacilli: *Propionibacterium*, *Actinomyces* spp. (non-spore-forming); Anaerobic Gram-negative bacilli: *Bacteroides*, *Fusobacterium*, *Prevotella*

Systematic Bacteriology Practical

60 hours

- **Advanced Specimen Collection & Transport:** Selection of specimen type based on clinical suspicion, Aseptic techniques for collection, Transport media and conditions for fastidious organisms
- **Bacteriological analysis** of food, water, and milk using quantitative methods, interpretation based on permissible limits (ICMR/WHO guidelines)
- **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
- **Integrated Diagnostic Strategies:** Stepwise approach to diagnosing UTI, STI, TB, etc., Case-based interpretation and clinical correlation
- **Automation Platforms (Demo/Simulation):** Principle and workflow of VITEK, MALDI-TOF, and Phoenix, Comparative analysis: manual vs. automated results
- **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

Subhash Chandra Parija – *Textbook of Microbiology and Immunology*, Elsevier

Lansing M. Prescott – *Microbiology*, McGraw-Hill

Apurba Sankar Sastry & Sandhya Bhat K – *Essentials in Medical Microbiology*, Jaypee Brothers Medical Publishers

Praful B. Godkar & Darshan P. Godkar – *Textbook of Medical Laboratory Technology*, Bhalani Publishing

Medical Entomology and Parasitology

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.

Learning Objectives:

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

UNIT-I

8 hours

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

UNIT-II

8 hours

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*, Microsporidia Ciliate: *Balantidium coli*.

Explain zoonosis and drug resistance; opportunistic pathogens cause disease primarily in immunocompromised hosts.

UNIT-III

18 hours

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, treatment and prevention of *Taenia* species, *Echinococcus* species, *Hymenolepis 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*

UNIT-IV

8 hours

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.

UNIT-V

8 hours

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.

UNIT-VI

6 hours

Host-Parasite Immunology: Immune mechanisms against parasites; antigenic variation; vaccine prospects. hypersensitivity reactions; immunodiagnostic assay interpretation,

UNIT-VII

6 hours

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.

Medical Entomology and Parasitology Practical

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- Flootation 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 Reading

- C.K. Jayaram Paniker, *Paniker's Textbook of Medical Parasitology*, Jaypee Brothers Medical Publishers
- D.R. Arora & B. Arora – *Medical Parasitology*, CBS Publishers & Distributors
- P. Chakraborty – *Textbook of Medical Parasitology*, New Central Book Agency
- Lynne Shore Garcia – *Diagnostic Medical Parasitology*, ASM Press
- K.D. Chatterjee – *Parasitology in Relation to Clinical Medicine*, CBS Publishers & Distributors
- Praful B. Godkar – *Textbook of Medical Microbiology and Parasitology*, Bhalani Publishing House
- 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

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 Objectives:

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

UNIT-I

8 hours

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.

UNIT-II

5 hours

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 Immunodiagnosics.

UNIT-III

8 hours

Immune Response: clonal selection theory and its significance in adaptive immune responses; differences between cell-mediated and 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.

UNIT-IV

8 hours

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

UNIT- V

5 hours

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.

UNIT- VI

8 hours

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.

UNIT- VII

7 hours

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 immunosurveillance.

UNIT- VIII

3 hours

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.

UNIT- IX

2 hours

Systems Immunology & Immune Profiling: High-throughput immunological assays; transcriptomic & proteomic responses to pathogens; microbiome-immune interactions; bioinformatics for infection tracking.

UNIT- X

4 hours

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.

Immunology and Immunodiagnostics Practical

60 hours

- Sample Collection & Handling - Blood, serum, and tissue sampling for immunological assays; biosafety and ethical protocols

- Peripheral Blood Smear Interpretation -Identification of major immune cells and lymphoid structures related to infection defense
- Immunoassays -Agglutination, flocculation, ELISA, WIDAL, CRP, Coombs, ASLO, and RPR tests
- Immunoblotting & Lateral Flow Techniques -Interpretation of infectious disease strips (e.g. malaria, HIV rapid cards)
- Antibody Titer Estimation -Dilution-based methods for semi-quantitative antibody analysis
- Flow Cytometry -Immunophenotyping of immune cells and gating analysis
- Immunofluorescence (Direct & Indirect)-Microscopic detection of immune markers for diagnostic applications
- Autoimmune Marker Detection -Rheumatoid Factor, Anti-CCP, and Antinuclear Antibody (ANA) assays
- Biosafety & Quality Control in Immunodiagnostics -Practices for accuracy, reproducibility, and documentation in clinical labs
- Clinical Case Analysis -Case-based interpretation of immune dysfunction in infectious disease contexts

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

Suggested Reading:

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. – Textbook 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

SEMESTER II

Haematology and Transfusion Medicine

II SEM I YEAR -HAEMATOLOGY & TRANSFUSION MEDICINE

							Max. Marks
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S.NO	SUBJECT CODE	SUBJECT	L	T	P	C	INT	EXT	TOTAL
1		Haematology and Haematological Disorders	4	-	-	4	30	70	100
2		Haemostatic Disorders	4	-	-	4	30	70	100
3		Applied Immunopathology in Haematology	4	-	-	4	30	70	100
4		Clinical Pathology	2	-	-	2	30	70	100
5		Haematology and Haematological Disorders Practical	-	-	2	2	30	70	100
6		Haemostatic Disorders Practical	-	-	2	2	30	70	100
7		Applied Immunopathology in Haematology Practical	-	-	2	2	30	70	100
8		Clinical Pathology Practical	-	-	2	2	30	70	100
TOTAL			14	-	8	22	240	560	800

Haematology and haematological disorders

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 Outcomes:

- Interpret bone marrow and peripheral blood findings in hematologic disorders
- Apply diagnostic measures for anemia, leukemia, MDS, and hemostatic conditions
Perform and analyze molecular, cytogenetic, and immunophenotypic tests.
- Correlate lab data with clinical symptoms to distinguish hematologic and hemostatic disorders.
- Use automation tools and quality protocols for hematology lab efficiency

UNIT-I

5 hours

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.

UNIT-II

5 hours

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

UNIT-III

6 hours

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.

UNIT-IV

8 hours

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 global anemia classification standards for standardized reporting

UNIT- V

8 hours

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.

UNIT- VI

8 hours

Acute & Chronic Leukemias: WHO/FAB classifications, pathophysiology and laboratory diagnosis of AML, ALL, CML, CLL including immunophenotyping (CD markers), cytogenetics, flow cytometry and PCR.

UNIT- VII

8 hours

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,

UNIT- VIII

6 hours

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

UNIT- IX

6 hours

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.

Clinical Haematology - Practical

60 hours

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.

Haemostatic Disorders

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 Outcomes:

- Explain normal hemostatic processes and coagulation factor functions in health and disease.
- Classify and interpret bleeding and thrombotic disorders using laboratory and clinical data.
- Apply structured diagnostic algorithms and reflex testing protocols for comprehensive hemostasis investigation.
- Integrate recent advances in coagulation diagnostics into clinical laboratory practices.

- Use automation tools and quality protocols for hematology lab efficiency

UNIT-I

6 hours

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

UNIT-II

8 hours

Coagulation Factors & Pathways: Intrinsic/extrinsic/common pathways; nomenclature & roles of factors I–XIII; synthesis, vitamin K dependency, activation sequences; global standards on factor assays

UNIT-III

8 hours

Primary Hemostasis Disorders: Platelet count and function defects, ITP, qualitative platelet disorders, Bernard-Soulier, Glanzmann's thrombasthenia; bleeding time, aggregation studies, genetic tools

UNIT-IV

4 hours

Secondary Hemostasis Disorders: Hemophilia A/B, von Willebrand disease (types, diagnostics, ristocetin cofactor, vWF antigen, collagen binding), factor deficiencies; PT/APTT prolongation patterns

UNIT- V

8 hours

Tertiary Hemostasis & Thrombotic Disorders: DIC, thrombotic thrombocytopenic purpura (TTP), hemolytic uremic syndrome (HUS), acquired inhibitors, circulating anticoagulants; fibrin degradation products, D-dimer testing

UNIT- VI

8 hours

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

UNIT- VII

7 hours

Reflex Testing & Algorithmic Diagnosis: Reflex testing principles, laboratory role in algorithm design, cascade testing protocols; interpreting abnormal screening results; reference ranges across age groups

UNIT- VIII

7 hours

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).

Haemostatic Disorders Practical

60 hours

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.
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.
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.

Applied Immunopathology in Hematology

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 Outcomes: At the end of the course, Students would be able to:

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

UNIT-I

10 hours

Overview of Immune system: Immune system and Immunologic disorders, Cellular and humoral Immunity, Complement system, Cytokines, Human leucocytic antigen, Major Histocompatibility complex and disease

UNIT-II

13 hours

Immunopathology of Hematologic Disorders: Autoimmune hemolytic anemia (AIHA), Immune thrombocytopenic purpura (ITP), Paroxysmal nocturnal hemoglobinuria (PNH), Hemophagocytic lymphohistiocytosis (HLH), Hypersplenism and immune cytopenias

UNIT-III

13 hours

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

UNIT-IV

12 hours

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

UNIT- V

12 hours

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

Applied Immunopathology in Hematology Practical

60 hours

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. Flow 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

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

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

UNIT-I

4 hours

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.

UNIT-II

3 hours

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 cytopsin techniques.

UNIT-III

4 hours

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.

UNIT-IV

4 hours

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).

UNIT- V

3 hours

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.

UNIT- VI

4 hours

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.

UNIT- VII

3 hours

Sputum Analysis:
Formation of Sputum, collection of Sputum, Analysis of Sputum, sputum cytology, Ziehl-Neelsen staining, and GeneXpert for TB.

UNIT- VIII

4 hours

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.

Clinical Pathology Practical

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
4. Semen analysis: volume, motility, morphology (WHO protocol)
5. 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
6. Cytological specimen handling, fixation, and smear preparation, Liquid-based cytology demonstration, Papanicolaou (PAP) staining and interpretation
7. Case-based correlation of lab findings with clinical conditions
8. Identification and analysis of pre-analytical, analytical, and post-analytical errors
9. Quality control exercises and documentation practices

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*.

SEMESTER II

Histology and Cytology

II SEM I YEAR – HISTOLOGY & CYTOLOGY

S.NO	SUBJECT CODE	SUBJECT	L	T	P	C	Max. Marks		
							INT	EXT	TOTAL
1		Translational Anatomy and Cell Dynamics	4	-	-	4	30	70	100
2		Essentials of Histology	4	-	-	4	30	70	100
3		Essentials of Cytopathology	4	-	-	4	30	70	100
4		Cancer Epidemiology and Digital Pathology	2	-	-	2	30	70	100
5		Translational Anatomy and Cell Dynamics Practical	-	-	2	2	30	70	100
6		Essentials of Histology Practical	-	-	2	2	30	70	100
7		Essentials of Cytopathology Practical	-	-	2	2	30	70	100
8		Cancer Epidemiology and Digital Pathology Practical	-	-	2	2	30	70	100
TOTAL			14	-	8	22	240	560	800

Translational Anatomy and Cell Dynamics

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 Outcome: At the end of the course, Students would be able to:

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

UNIT-I

12 hours

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.

UNIT-II

12 hours

Organ-Specific Applied Anatomy:

Histotechnology-oriented anatomical structure of major systems:

Integumentary (skin biopsies, dermatopathology)

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)

UNIT-III

12 hours

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

UNIT-IV

12 hours

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

UNIT- V

12 hours

Applications in Laboratory and Translational Research:

Histopathology and cytopathology applications., In vitro models: spheroids, organoids, and lab-on-chip systems., Cellular imaging and 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

Translational Anatomy and Cell Dynamics Practical

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.

Essentials of Histology

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 Outcome: At the end of the course the students will be able to:

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

UNIT-I

7 hours

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

UNIT-II

7 hours

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.

UNIT-III

10 hours

Tissue Preparation and Processing: Fixation techniques: chemical principles and types, Processing steps: dehydration, clearing, embedding, Microtomy principles and troubleshooting, Frozen sections and cryostat applications.

UNIT-IV

10 hours

Staining Techniques and Interpretation: Principles of staining: dye-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.

UNIT- V

16 hours

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.

UNIT- VI

10 hours

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

Essentials of Histology Practical

60 hours

1. Demonstrate receiving, handling, and labelling and specimen rejection criteria
2. of cytological specimen.
3. Prepare and compare fixation using formalin, Bouin's solution, and alcohol-based fixatives. Record effects on tissue integrity.
4. Tissue Processing & Embedding – fixation, dehydration, clearing, impregnation
5. Demonstrate the procedure for knife sharpening - Honing & stropping
6. Perform section cutting of tissue block using a microtome
7. Perform Hematoxylin and Eosin staining with emphasis on nuclear-cytoplasmic contrast and reagent preparation.
8. Perform mounting of the stained section
9. Special Stains (PAS, Masson's Trichrome)- PAS for carbohydrates and Trichrome for collagen. Assess specificity and interpret stained slides.
10. 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

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 outcomes: At the end of the course students will be able to:

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

UNIT-I

5 hours

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, Cytopathology in various disease, comparison of cells normal vs disease, Molecular cytology and its role in diagnostics

UNIT-II

10 hours

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

UNIT-III

15 hours

Interventional Cytology:

1. Introduction to Interventional Cytology

- Definition, scope, and evolution
- Indications and contraindications
- Role in minimally invasive diagnosis

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

UNIT-IV

10 hours

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)

UNIT- V

10 hours

Cytodiagnosis and reporting:

Rapid On-Site Evaluation (ROSE)

- Concept, purpose, workflow
- Adequacy assessment criteria
- 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)

UNIT- VI

10 hours

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

Essentials of Cytopathology Practical

60 hours

- 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
 - 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

Course outcome: 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 Outcome: At the end of the course students will be able to

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

UNIT-I

6 hours

Principles of Cancer Epidemiology: Definitions, concepts, and scope of cancer epidemiology, Cancer classification, Risk factors: genetic, environmental, lifestyle, occupational, Descriptive vs. analytical epidemiological studies, Cancer registries, cohort studies, and surveillance systems

UNIT-II

6 hours

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

UNIT-III

6 hours

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

UNIT-IV

6 hours

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

UNIT- V

6 hours

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

Cancer Epidemiology and Digital Pathology Practical

60 hours

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. Tumor 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 books

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.

SEMESTER III

Biochemistry

S.NO	SUBJECT CODE	SUBJECT	L	T	P	C	Max. Marks		
							INT	EXT	TOTAL

1		Clinical Biochemistry I	4	-	-	4	30	70	100
2		Clinical Biochemistry II	4	-	-	4	30	70	100
3		Immunology	4	-	-	4	30	70	100
4		Endocrinology & Biochemistry of Aging	4	-	-	4	30	70	100
5		Clinical Biochemistry I Practical	-	-	2	2	30	70	100
6		Clinical Biochemistry II Practical	-	-	2	2	30	70	100
7		Immunology Practical	-	-	2	2	30	70	100
8		Clinical Posting-II	-	-	2	2	100	-	-
TOTAL			16	-	8	24	340	560	800

Clinical Biochemistry 1

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 Outcomes: At the end of the course, students will be able to

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

UNIT-I

10 hours

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 performance criteria: Method comparisons, accuracy, within run-precision
- Instrument comparison in laboratory for an assay.

UNIT-II

10 hours

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 Continuous glucose monitoring (CGM)

UNIT-III

10 hours

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)
- Diagnosis of inborn errors of lipid metabolism
- Diagnosis of various disorders by lipoprotein by electrophoresis

UNIT-IV

10 hours

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, α 1-antitrypsin, α 1-fetoprotein, C-reactive protein, β 2-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

UNIT- V

6 hours

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

UNIT- VI

2 hours

Lab diagnosis of porphyrias.

- Clinical significance and disease correlation
- Urine qualitative tests (porphyrins, coproporphyrin, uroporphyrin , d-ALA, porphobilinogen, urobilinogen)

UNIT- VII

6 hours

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

UNIT- VIII

6 hours

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, Respiratory 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.

Clinical Biochemistry I Practicals

60 Hours

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 Chatterjee, Rana Shinde, Jaypee Publishers
3. Varley's 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

CLINICAL BIOCHEMISTRY- II

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 Outcomes:

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

UNIT-I

10 hours

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

UNIT-II

10 hours

Renal function tests:

- Overview of anatomy of kidney and its functions
- Renal diseases: Nephrotic syndrome, Glomerular nephritis, Urolithiasis and nephrolithiasis, renal calculi, renal tubular acidosis, diabetes insipidus, renal hypertension, renal failure
- 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

UNIT-III

10 hours

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

UNIT-IV

4 hours

Cardiac function tests

- Biochemistry and tissue distribution of cardiac markers.
- Cardiac enzymes such as CKMB, CK, homocysteine, hsCRP
- Cardiac troponins and myoglobin

UNIT- V

8 hours

Endocrine function Test:

- 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

UNIT- VI

6 hours

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.

UNIT- VII

8 hours

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

2. Toxic agents: Source, Routes of entry and the effect of Carbon monoxide, Alcohol, Arsenic, Lead, chromium, mercury, nickel

UNIT- VIII

8 hours

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

UNIT- IX

4 hours

Point-Of-Care-Testing (POCT):

- Objectives, Biochemical parameter measured by POCT devices, Common POCT devices and Technologies, Requirements, Advantages, Limitation and Challenges

UNIT- X

8 hours

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

Clinical Biochemistry II Practicals

60 Hours

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
3. Urine analysis for normal and abnormal constituents of urine
4. Electrolytes Analysis - Sodium, potassium, Fractional excretion of Sodium (FeNa)
5. Pancreas function Test - Amylase, lipase
6. Cardiac enzymes – creatinine kinase, CK- MB, CAD risk assessment: Homocysteine, Troponin T, CPK, myoglobin
7. Hormone Analysis Thyroid profile- T3, T4, TSH, Fertility profile – LH, FSH, prolactin, estradiol, testosterone, cortisol, insulin
8. Demonstration of Tumor marker

***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 Chatterjee, 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

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 will be able to

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

UNIT-I

2 hours

Overview of the Immune System- Cells, tissues and organs of the immune system

UNIT-II

12 hours

Types of Immunity:

- 1 Innate immunity
 - Anatomical barriers-skin, mucous lining, cilia, saliva, tears etc.
 - Role of T cells
 - Cellular immunity-neutrophils, macrophages, dendritic cells, natural killer cells
 - Inflammation-vasodilation, extravasation, oedema, chemokines, integrin, ICAMs, cytokines (defensins, cathelicidins, interferons,etc.)
 - Acute Phase Response proteins (APR proteins)-C-reactive protein, mannose-binding lectin etc.)
 - Receptor system-complement receptor, MBL receptor, Toll-like receptor, scavenger receptor etc
 - Signal transduction pathway eg. TLR signaling
- 2 Adaptive Immune system
 - Antigen- types, Antigen properties contributing immunogenicity- molecular size, chemical composition, genotype, dosage, route of entry etc.
 - Role of B cells
 - Immunoglobulins- types, structure, antibody-mediated effector functions- opsonization, complement activation, ADCC (antibody dependent cell mediated cytotoxicity), transcytosis,
 - Avidity, affinity and cross reactivity
 - Antigen-antibody interactions: precipitation, agglutination, opsonisation, complement fixation
 - Immunoglobulin superfamily

UNIT-III

6 hours

Major Histocompatibility Complex (MHC) molecule class I and class II: Their differences and interactions

UNIT-IV

6 hours

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

UNIT- V

6 hours

Autoimmunity and disorders: SLE, Multiple sclerosis, Rheumatoid arthritis, Myasthenia gravis, Autoimmune Thyroiditis

UNIT- VI

6 hours

Immunodeficiency diseases

- a. Primary immunodeficiency: involving lymphoid immune deficiency (B cells, T cells), involving myeloid lineage, Immune complex diseases
- b. Secondary immunodeficiency: AIDS

UNIT- VII

4 hours

Tumor immunology: Tumor antigens, tumor immune surveillance, tumor escape and Tumor Markers

UNIT- VIII

6 hours

Transplantation and rejection: Role of T cells, Immune recognition in Allograft and Xenograft, pathway of rejection.

UNIT- IX

2 hours

Vaccination: Principle, types, vaccine development, adjuvants

UNIT- X

10 hours

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. Immunofluorescence
- g. ELISA
- h. FIA and RIA
- i. Western Blotting
- j. Flow cytometry
- k. Immunoelectron microscopy

Immunology Practical

60 hours

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 Reading

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 and Biochemistry of Aging

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

Learning objectives: At the end of the course, students will be able to

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

UNIT-I

10 hours

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.

UNIT-II

10 hours

Chemistry, synthesis, mechanism of action, physiological effects, catabolism of the hormones of Hypothalamus and Pituitary gland and their disorders.

UNIT-III

10 hours

Chemistry, synthesis, mechanism of action, physiological effects, catabolism of Thyroid, Parathyroid (calcium homeostasis hormones). GIT hormones, Pancreatic Hormones and their disorders.

UNIT-IV

10 hours

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

UNIT- V

6 hours

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)

UNIT-VI

10 hours

Mechanism of Aging:

Cellular mechanism: Cellular senescence, Oxidative stress-imbalance between production of ROS, Telomere shortening, Mitochondrial dysfunction

Genetic mechanism: Genetic blue print in determining susceptibility to Alzheimer's, cardiovascular diseases, certain cancers, Genetic variability in life span, Telomere length, Metabolic genetic-insulin sensitivity, metabolic rate, nutrient utilization, metabolic disorders like diabetes, obesity

UNIT- VI

4 hours

Age associated common disorders-atherosclerosis, neoplasms, cataracts, macular degeneration, neuro degenerative disorders, neuro endocrine disorders, Cancer and aging: biochemical connections

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.

SCIENTIFIC WRITING

RATIONALE OF THE COURSE

Scientific Writing is essential for postgraduate students to communicate research findings effectively through dissertations, journal articles, conference presentations, and scientific reports. The course develops skills in academic writing, literature review, referencing, publication ethics, and scientific communication, which are important for research-oriented and evidence-based healthcare education.

The course aligns with the objectives of NEP 2020 and UGC postgraduate curriculum frameworks that promote research competency, multidisciplinary learning, academic integrity, and publication-oriented education.

COURSE OBJECTIVES

After completion of the course, students will be able to:

1. Understand the principles of scientific and academic writing.
2. Develop skills in writing research papers, abstracts, and dissertations.
3. Perform literature review and reference management.
4. Apply ethical principles in scientific publication.
5. Improve scientific communication and presentation skills.

COURSE OUTCOMES

Students will be able to:

- Write scientific reports and research manuscripts.
- Prepare structured abstracts and review articles.
- Use citation and referencing styles appropriately.
- Identify plagiarism and publication misconduct.
- Present scientific findings effectively.

UNIT I — INTRODUCTION TO SCIENTIFIC WRITING

8 Hours

Meaning and importance of scientific writing

Characteristics of scientific writing

Types of scientific documents

Research articles

Review articles

Case reports

Thesis and dissertation

Conference abstracts

Structure of scientific papers (IMRAD format)

UNIT II — LITERATURE REVIEW & REFERENCE MANAGEMENT 8 Hours

Literature search techniques

Sources of scientific literature

PubMed

Google Scholar

Scopus

Review of literature

Citation styles

Vancouver style

APA style

Reference management tools

Mendeley

Zotero

Avoiding plagiarism

UNIT III — MANUSCRIPT & DISSERTATION WRITING 8 Hours

Title writing

Abstract and keyword preparation

Writing introduction, methodology, results, and discussion

Tables, graphs, and figures

Scientific language and grammar

Dissertation formatting

Writing acknowledgements and bibliography

UNIT IV — PUBLICATION ETHICS & SCIENTIFIC COMMUNICATION 6 Hours

Publication ethics

Authorship criteria

Plagiarism and predatory journals

Copyright and intellectual property

Peer-review process

Scientific presentations

Poster and oral presentation techniques

RECOMMENDED BOOKS

1. Cargill & O'Connor – Writing Scientific Research Articles
2. Day & Gastel – How to Write and Publish a Scientific Paper
3. APA Publication Manual
4. Medical Writing: A Guide for Clinicians, Educators and Researchers
5. Research Methodology and Scientific Writing

SEMESTER III

Medical Microbiology

S.NO	SUBJECT CODE	SUBJECT	L	T	P	C	Max. Marks		
							INT	EXT	TOTAL

1		Medical Virology	3	1	-	4	30	70	100
2		Medical Mycology	3	1	-	4	30	70	100
3		Medical Mycology & Virology Practical	-	-	2	2	30	70	100
4		Public Health Microbiology	3	1	-	4	30	70	100
5		Public Health Microbiology Practical	-	-	2	2	30	70	100
6		Advances in Microbial Informatics	3	1	-	4	30	70	100
7		Clinical Posting-II	-	-	2	2	100	-	-
TOTAL			12	4	6	22	310	490	700

Medical Virology

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.

Learning Objectives:

- Describe viral structure, classification, genome organisation, and replication mechanisms of major virus families.
- Explain host-virus interactions, mechanisms of viral pathogenesis, and immune evasion strategies.
- Evaluate molecular and serological techniques used in the detection, quantification, and genotyping of viruses.
- Interpret laboratory results in the context of clinical virology, outbreak investigation, and surveillance.
- Apply biosafety and biosecurity principles in the handling of clinical viral specimens and high-risk pathogens.

- Discuss current trends in antiviral therapy, vaccine development, and viral epidemiology

UNIT-I

10 hours

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

UNIT-II

8 hours

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;

UNIT-III

6 hours

Bacteriophages: Morphology, life cycle, transmission of genetic information, significance of phages

UNIT-IV

8 hours

Orthomyxoviruses: Morphology, Resistance, Antigen classification; Influenza virus- classification, Nomenclature systems, Antigenic variation, Host range, Pathogenicity, Clinical features, Laboratory diagnosis, Immunity, Epidemiology, Immunoprophylaxis, Treatment

UNIT- V

12 hours

Paramyxoviruses: Antigenic Structure and classification

- Rubella viruses, Mumps virus: Properties, clinical features, complications, Epidemiology, Immunity, Laboratory Diagnosis, Prophylaxis
- 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 Metapneumovirus

UNIT- VI

8 hours

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)

UNIT- VII

8 hours

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

Medical Mycology

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 Objectives:

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

UNIT-I

8 hours

Introduction to Mycology: Characteristics of fungi, classification, laboratory diagnosis, treatment; immune responses to fungal pathogens, antifungal therapy.

UNIT-II

18 hours

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

UNIT-III

12 hours

Systemic Mycoses: Systemic Mycoses (Dimorphic Fungi), Blastomycosis, Paracoccidioidomycosis, Coccidioidomycosis, Histoplasmosis

UNIT-IV

14 hours

Opportunistic Mycoses: Aspergillosis, Penicillosis, Zygomycosis (Mucormycosis, Phycomycosis) Candidiasis (Candidiasis, Moniliasis), Cryptococcosis (Torulosis), Pneumocystosis

UNIT- V

8 hours

Miscellaneous Mycoses: Otomycosis, Oculomycosis (Keratomycosis, Fungal Keratitis, Mycotic Keratitis), Mycotic Poisoning

Medical Mycology and Virology Practical

60 hours

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
- **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 Reading:

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

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 Objectives:

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

UNIT-I

12 hours

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

UNIT-II

12 hours

Principles of Epidemiology

The science of Epidemiology, The Vocabulary of Epidemiology, Disease reservoirs and Epidemics, Measuring Frequency: The 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.

UNIT-III

10 hours

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

UNIT-IV

6 hours

Epidemiology and Public Health:

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

UNIT- V

12 hours

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

UNIT- VI

4 hours

Biomedical waste management

Types of biomedical waste

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

UNIT- VII

4 hours

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, biosafety 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.

Public Health Microbiology Practical

60 hours

- Project: Descriptive Epidemiology of a selected Health Problem
- Survey Design: Create a Community Health Survey Tool
- Demonstration: Use of GIS Tools/Software for Disease Mapping (Virtual/Manual)
- Case Study Analysis of Disease Outbreak
- Detect presence of potential nosocomial pathogens from swabs collected from inanimate objects in a hospital environment.
- Segregation and Colour-Coding of Biomedical Waste
- Demonstration of Waste Treatment Methods
- Case Study: Anthrax or Other Bioterrorism Events
- Demonstration/Visit: Public Health Lab or Hospital Epidemiology Unit

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

Suggested Reading:

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

UNIT-I

8 hours

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

UNIT-II

10 hours

Microbial genomes and data platform: Basics of Database designing and modeling, Designing policies, File formats (FASTA, PIR, 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 (BankIt, Sequin).

UNIT-III

14 hours

- 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– Fasman algorithm, 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

UNIT-IV

10 hours

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.

UNIT- V

10 hours

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.

UNIT- VI

8 hours

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

SEMESTER III

Haematology and Transfusion Medicine

							Max. Marks
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S.NO	SUBJECT CODE	SUBJECT	L	T	P	C	INT	EXT	TOTAL
1		Blood Banking & Immunohematology	4	-	-	4	30	70	100
2		Transfusion Medicine	4	-	-	4	30	70	100
3		Molecular Hematology	4	-	-	4	30	70	100
4		Advanced Haematological Techniques	2	-	-	2	30	70	100
5		Blood Banking & Immunohematology Practical	-	-	2	2	30	70	100
6		Transfusion Medicine Practical	-	-	2	2	30	70	100
7		Molecular Hematology Practical	-	-	2	2	30	70	100
8		Advanced Haematological Techniques Practical	-	-	2	2	30	70	100
9		Clinical Posting-II	-	-	2	2	100	-	100
TOTAL			14	-	10	24	340	560	900

Blood Banking and Immunohematology

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 outcome: At the end of the course the students can

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

UNIT-I

15 hours

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

UNIT-II

10 hours

Blood collection and donor selection criteria:

Donor Management:

Donor registration and screening, Phlebotomy in blood banks, blood 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

UNIT-III

10 hours

Serologic Techniques and Problem Solving:

Blood compatibility tests, Antibody screening and identification, DAT and IAT optimization, Enzyme treatment, adsorption/elution techniques,

UNIT-IV

10 hours

Component preparation and storage:

Apheresis vs whole blood donation, Component separation techniques, Storage, shelf-life, and transportation protocols, Hemovigilance in component therapy

UNIT- V

5 hours

Molecular Applications in Immunohematology:

Molecular genotyping of blood groups, Discrepancy resolution between serology and molecular testing, Role in prenatal and donor typing

UNIT- VI

10 hours

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

Blood Banking and Immunohematology Practical

60 hours

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. *Bethesda, Maryland: Lippincott 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

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

Learning Outcome: At the end of the course the student will be able to:

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

UNIT-I

10 hours

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

UNIT-II

12 hours

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

UNIT-III

12 hours

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.

UNIT-IV

10 hours

Infectious complications of transfusion
Hepatitis, CMV and Other Herpesviruses, HIV and HTLV,
Other Transfusion-Transmitted Infections, Bacterial Contamination of Blood Products

UNIT- V

10 hours

Therapeutic apheresis
Plasma Exchange, Red Blood Cell Exchange, Extracorporeal Photopheresis,
Leukocytapheresis, Thrombocytapheresis, Erythrocytapheresis, Therapeutic Phlebotomy

UNIT- VI

6 hours

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.

Transfusion Medicine Practical

60 hours

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. *Bethesda, Maryland: Lippincott 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.
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 Association of Blood Banks (AABB).*
6. National Blood Policy and Guidelines – NACO, India

Molecular Hematology

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 Outcome: At the end of the course students will be able to:

- Analyze the molecular pathogenesis of hematological malignancies and inherited blood disorders using current scientific principles.
- Apply molecular biology techniques (e.g., PCR, NGS, etc.) for the detection, diagnosis, and monitoring of hematologic diseases.
- Interpret molecular diagnostic results and correlate them

UNIT-I

6 hours

Unit 1: Basics of molecular hematology

Central dogma, transcriptional regulation of hemopoietic 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 hematopoiesis

UNIT-II

15 hours

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 Residual Disease (MRD) monitoring

UNIT-III

15 hours

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

UNIT-IV

12 hours

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)

UNIT- V

12 hours

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 .

Molecular Haematology Practical

60 hours

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.
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 Hematological Techniques

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 Outcome: At the end of the course the student will be able to:

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

UNIT-I

8 hours

Unit 1: 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

UNIT-II

8 hours

Unit 2: Clinical Flow cytometry and cytogenetics

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

UNIT-III

7 hours

Unit 3: 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.

UNIT-IV

7 hours

Unit 4: 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

Advanced Hematological Techniques Practical

60 hours

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

*****Compulsory clinical postings for hands on experience for hematoanalyzers, PCR and case discussions. This will compensate the hours against credits.**

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

SEMESTER III

Histology and Cytology

S.NO	SUBJECT CODE	SUBJECT	L	T	P	C	Max. Marks		
							INT	EXT	TOTAL

1		Diagnostic Histopathology	4	-	-	4	30	70	100
2		Cytological Techniques	4	-	-	4	30	70	100
3		Immunohistochemistry & Diagnostic Markers	4	-	-	4	30	70	100
4		Molecular Techniques in Histopathology & Cytology	2	-	-	2	30	70	100
5		Diagnostic Histopathology Practical	-	-	2	2	30	70	100
6		Cytological Techniques Practical	-	-	2	2	30	70	100
7		Immunohistochemistry & Diagnostic Markers Practical	-	-	2	2	30	70	100
8		Molecular Techniques in Histopathology & Cytology Practical	-	-	2	2	30	70	100
9		Clinical Posting-II	-	-	2	2	100	-	-
TOTAL			14	-	10	24	340	560	800

Diagnostic Histopathology

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 Outcome: At the end of the course students will be able to:

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

UNIT-I

12 hours

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.

UNIT-II

12 hours

Diagnostic Strategies in Histopathology

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

UNIT-III

12 hours

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

UNIT-IV

12 hours

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

UNIT- V

12 hours

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

Diagnostic Histopathology Practical

60 hours

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

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 and develop competence in exfoliative, fluid-based, and FNA cytology.

Learning Outcome: By the end of the course, students will be able to:

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

UNIT-I

12 hours

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

UNIT-II

12 hours

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)

UNIT-III

12 hours

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

UNIT-IV

12 hours

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)

UNIT- V

12 hours

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 protocols, documentation, record keeping

Cytological techniques

60 hours

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 and Diagnostic markers

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 Outcome: At the end of the course students will be able to:

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

UNIT-I

12 hours

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

UNIT-II

12 hours

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

UNIT-III

12 hours

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

UNIT-IV

12 hours

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

UNIT- V

12 hours

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

Immunohistochemistry and Diagnostic Markers Practical

60 hours

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
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.
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 and cytology

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 Outcome: By the end of the course, students will be able to:

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

UNIT-I

6 hours

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

UNIT-II

6 hours

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, fluorometry)

UNIT-III

10 hours

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

UNIT-IV

8 hours

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

Molecular techniques in histopathology and cytology practical

30 hours

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

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

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

SEMESTER IV**Common to All Specialisations**

S.NO	SUBJECT CODE	SUBJECT	L	T	P	C	Max. Marks		
							INT	EXT	TOTAL
1		Dissertation Viva	-	-	22	22	100	200	300
2		Dissertation Logbook	-	-	-	-	100	200	300
3		Swayam: Basic course in biomedical research							
TOTAL			-	-	22	22	200	400	600

Dissertation**990 hours****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)