DRAFT REGULATIONS FOR CURRICULUM-MASTER OF MEDICAL LABORATORY SCIENCE (MMLS) PROGRAMME

SRI GURU RAM DAS UNIVERSITY OF HEALTH SCIENCES, SRI AMRITSAR

Applicable from Academic Session 2025

AS PER THE NATIONAL COMMISSION FOR ALLIED AND HEALTHCARE PROFESSIONS (NCAHP) ACT, 2021

Master of Medical Laboratory Science - MMLS

Introduction:

The Master of Medical Laboratory Science (MMLS) is specifically aimed at those pursuing a professional career in medical laboratory science. It is designed to provide specialized training both in basic scientific principles of modern laboratory science and in the application of these principles to laboratory diagnosis and management. It is designed as a higher degree program suitable for graduates having experience in Medical Laboratory Science The program aims to enhance the scientific skills of non-medical graduates with insight into clinical problems that will allow them to work in multidisciplinary teams.

Learning Objectives:

Upon successful completion of the Masters‟ program, students will

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

Career Opportunities:

Upon successful completion of the course, Post Graduates can have the following career opportunities

Clinical labs – senior scientist, specialist, or lab manager.

Research & biotech – R&D, clinical trials, molecular diagnostics.

Academia – lecturer, trainer, or pursuing PhD.

Public health & regulation – surveillance, quality assurance, accreditation.

Industry – medical science liaison, product specialist, lab informatics.

Global & entrepreneurial roles – international practice, diagnostic startups, or work with WHO/NGOs.

Program Learning Outcomes for Master of Medical Laboratory Science (MMLS)

Following outcomes reflect the expected competencies and professional capabilities of a graduate upon completion of the program:

Core Program Learning Outcomes:

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

Expectations from Future Graduates in Providing Patient Care

Future graduates of medical laboratory science programs are expected to play an increasingly integral role in healthcare delivery. Key expectations include:

1. **Accurate and Timely Diagnostics**: Delivering high-quality laboratory results that are critical for early detection, diagnosis, prognosis, and monitoring of diseases.
2. **Interdisciplinary Collaboration**: Working closely with physicians, nurses, and other healthcare professionals to interpret lab results and support clinical decisions.
3. **Patient-Centered Focus**: Understanding the impact of laboratory findings on patient outcomes and ensuring test appropriateness, especially in personalized and precision medicine.
4. **Continual Learning**: Keeping pace with rapid advancements in diagnostics and adopting innovations that improve efficiency and accuracy.
5. **Public Health Contribution**: Supporting disease surveillance, outbreak investigations, and screening programs, especially in resource-limited settings.
6. **Ethical Practice and Leadership**: Upholding integrity, ensuring patient confidentiality, and leading initiatives in quality improvement, laboratory safety, and policy development.

Eligibility for admission:

1. Bachelor of Medical Laboratory Science from any recognised Indian University with atleast 50% aggregate

2. Admission to MMLS shall be made on the basis of University entrance exam followed by interview. No direct Admission will be entertained.

3. Entrance exams will be conducted based on the syllabus of BMLS. Successful candidates who cleared Exam should be called for the interview

4. Interview panel should have Dean/Principal/Head of the department (Chairman of the board) Professor/ Associate professor and other members as per the policy of the institution whose recommendations shall be final for the selection of students

Duration of the program

Duration of the program is 2 years or 4 semesters with 1340 hours of Lecture & 900 hours of practical Training.

Total number of hours: 2240

Total Credits: 86

Medium of instruction:

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

Attendance:

A candidate has to secure minimum -

1. 80% attendance in theoretical
2. 80% in Skills training (practical) for qualifying to appear for the final examination.

No relaxation, whatsoever, will be permissible to this rule under any ground including indisposition etc.

Assessment:

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

Marks qualifying for a passing

For University examination subjects: 50% in internal assessment, 50% in university theory examination, 50% in university practical examination and 50% in aggregate

For thesis and defence: For successful thesis defence, the candidate will make a brief presentation of about 30 minutes followed by viva-voce. A candidate must secure at least 50% marks to pass.

MMLS Curriculum outline

Semester I –Common for all specializations

Course Name	Course code	Lecture	Tutorial	Practical	Credits	Contact Hours
Medical Laboratory Management	MMLS.501	4	0	0	4	60
Cell and Molecular Biology	MMLS.502	4	0	0	4	60
Research Methodology & Biostatistics	RMB.501	2	0	0	2	30
Advanced Molecular Diagnostic Techniques	MMLS.503	4	0	0	4	60
Digital Health Technologies	MMLS.504	2	0	0	2	30
Universal Human Values (Elective)	UHV.501	0	0	2	2	60
Research Methodology & Biostatistics Practical	RMB.525	0	0	2	2	60
Advanced Molecular Diagnostic Techniques Practical	MMLS.525	0	0	2	2	60
TOTAL		16		6	22	420

* To be decided by respective institute

Semester II- Medical Biochemistry

Course Name	Course code	Lecture	Tutorial	Practical	Credits	Contact Hours
Bioorganic & Biophysical Chemistry	MMLS.505B	4	0	0	4	60
Instrumentation in Biochemistry	MMLS.506B	4	0	0	4	60
Enzymology & Nutrition	MMLS.507B	4	0	0	4	60
Intermediary Metabolism	MMLS.508B	4	0	0	4	60
Bioorganic & Biophysical Chemistry Practical	MMLS.525B	0	0	4	2	60
Instrumentation Practical	MMLS.526B	0	0	4	2	60
Clinical posting	MMLS.550B	0	0	4	2	90
TOTAL		**16**	0	**12**	**22**	**450**

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Semester II Medical Microbiology

Course Name	Course Code	Lecture	Tutorial	Practical	Credits	Contact Hours
Essential and Applied Microbiology	MMLS.505M	3	1	0	4	60
Systematic Bacteriology	MMLS.506M	3	1	0	4	60
Systematic Bacteriology practical	MMLS.507M	0	0	4	2	60
Medical Entomology and Parasitology	MMLS.508M	3	1	0	4	60
Medical Entomology and Parasitology practical	MMLS.525M	0	0	4	2	60
Immunology and Immunodiagnostics	MMLS.509M	3	1	0	4	60
Immunology and Immunodiagnostics practical	MMLS.526M	0	0	4	2	60
TOTAL		16	4	12	22	420

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Semester II- Histology and Cytology

Course Name	Course Code	Lecture	Tutorial	Practical	Credits	Contact Hours
Translational Anatomy and Cell Dynamics	MMLS.505H	4	0	0	4	60
Essentials of Histology	MMLS.506H	4	0	0	4	60
Essentials of Cytopathology	MMLS.507H	4	0	0	4	60
Cancer epidemiology and Digital Pathology	MMLS.508H	2	0	0	2	30
Translational Anatomy and Cell Dynamics Practical	MMLS.525H	0	0	0	2	60
Essentials of Histology Practical	MMLS.526H	0	0	0	2	60
Essentials of Cytopathology Practical	MMLS.527H	0	0	0	2	60
Cancer epidemiology and Digital Pathology Practical	MMLS.528H	0	0	0	2	60
Total		14	0	8	22	450

Semester III- Medical Biochemistry

Course Name	Course Code	Lecture	Tutorial	Practical	Credits	Contact Hours
Clinical Biochemistry I	MMLS.510B	4	0	0	4	60
Clinical Biochemistry II	MMLS.511B	4	0	0	4	60
Immunology	MMLS.513B	4	0	0	4	60
Endocrinology & Biochemistry of aging	MMLS.514B	4	0	0	4	60
Clinical Biochemistry I Practical	MMLS.527B	0	0	2	2	60
Clinical Biochemistry II Practical	MMLS.528B	0	0	2	2	60
Immunology Practical	MMLS.529B	0	0	2	2	60
TOTAL		16	0	6	22	420

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Semester III Medical Microbiology

Course Name	Course Code	Lecture	Tutorial	Practical	Credits	Contact Hours
Medical Virology	MMLS.510M	3	1	0	4	60
Medical Mycology	MMLS.511M	3	1	0	4	60
Medical Mycology & Virology practical	MMLS.527M	0	0	4	2	60
Public Health Microbiology	MMLS.512M	3	1	0	4	60
Public Health Microbiology practical	MMLS.528M	0	0	4	2	60
Advances in Microbial Informatics	MMLS.513M	3	1	0	4	60
Clinical posting	MMLS.551M	0	0	4	2	90
TOTAL		**12**	**4**	**12**	**22**	**450**

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Semester III- Histology and Cytology

Course name	Course code	Lecture	Tutorial	Practical	Credits	Contact Hours
Diagnostic Histopathology	MMLS.510H	4	0	0	4	60
Cytological Techniques	MMLS.511H	4	0	0	4	60
Immunohistochemistry & Diagnostic Markers	MMLS.512H	4	0	0	4	60
Molecular Techniques in Histopathology & Cytology	MMLS.513H	2	0	0	2	30
Diagnostic Histopathology Practical	MMLS.529H	0	0	0	2	60
Cytological Techniques Practical	MMLS.530H	0	0	0	2	60
Immunohistochemistry & Diagnostic Markers Practical	MMLS.531H	0	0	0	2	60
Molecular Techniques in Histopathology & Cytology Practical	MMLS.532H	0	0	0	2	60
Total		14	0	8	22	450

Semester IV –COMMON FOR ALL SPECIALIZATION

S. No	SEMESTER IV	Course code	Credits	Contact Hours
1	**Dissertation**	**MMLS.599**	22	990
	Total		**22**	**990**

Marks Distribution

MMLS Semester I (Common for All Specialisations)

S. No	Course Name	Continuous Assessment	End Semester Examination	Total
1	Medical Laboratory Management	30	70	100
2	Cell and Molecular Biology	30	70	100
3	Research Methodology & Biostatistics	30	70	100
4	Advanced Molecular Diagnostic Techniques	30	70	100
5	Digital Health Technologies	30	70	100
6	Elective Course*	30	70	100
7	Research Methodology & Biostatistics practical	30	70	100
8	Advanced Molecular Diagnostic Techniques	30	70	100
	TOTAL			**800**

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Semester II Medical Biochemistry

S. No	Course Name	Continuous Assessment	End Semester Examination	Total
1	Bioorganic & Biophysical Chemistry	30	70	100
2	Instrumentation	30	70	100
3	Enzymology & Nutrition	30	70	100
4	Intermediary Metabolism	30	70	100
5	Bioorganic & Biophysical Chemistry Practical	30	70	100
6	Instrumentation Practical	30	70	100
7	Clinical posting – log book and viva	30	70	100
	TOTAL			**700**

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Semester II Medical Microbiology

S. No	Course Name	Internal	External (ESE)	Total
1	Essential and Applied Microbiology	30	70	100
2	Systematic Bacteriology	30	70	100
3	Systematic Bacteriology practical	30	70	100
4	Medical Entomology and Parasitology	30	70	100
5	Medical Entomology and Parasitology practical	30	70	100
6	Immunology and Immunodiagnostics	30	70	100
7	Immunology and Immunodiagnostics practical	30	70	100
	TOTAL			**700**

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Semester II Histology and Cytopathology

S NO	Course Name	Continuous assessment	End Semester Examination	Total
1	Translational Anatomy and Cell Dynamics	30	70	100
2	Essentials of Histology	30	70	100
3	Essentials of Cytopathology	30	70	100
4	Cancer epidemiology and Digital Pathology	30	70	100
5	Translational Anatomy and Cell Dynamics Practical	30	70	100
6	Essentials of Histology Practical	30	70	100
7	Essentials of Cytopathology Practical	30	70	100
8	Cancer epidemiology and Digital Pathology Practical	30	70	100
	TOTAL			**800**

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Semester III Medical Biochemistry

S. No	Couse name	Continuous assessment	End Semester Examination	Total
1	Clinical Biochemistry I	30	70	100
2	Clinical Biochemistry II	30	70	100
3	Immunology	30	70	100
4	Endocrinology & Biochemistry of aging	30	70	100
5	Clinical Biochemistry I Practical	30	70	100
6	Clinical Biochemistry II Practical	30	70	100
7	Immunology Practical	30	70	100
	TOTAL			**700**

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Semester III Medical Microbiology

S. No	Course Name	Internal	External (ESE)	Total
1	Medical Virology	30	70	100
2	Medical Mycology	30	70	100
3	Medical Mycology & Virology practical	30	70	100
4	Public Health Microbiology	30	70	100
5	Public Health Microbiology practical	30	70	100
6	Advances in Microbial Informatics	30	70	100
7	Clinical posting – log book and viva	30	70	100
	TOTAL			**700**

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Semester III Histology and Cytopathology

Course Name	Continuous assessment	End Semester Examination	Total
Diagnostic Histopathology	30	70	100
Cytological Techniques	30	70	100
Immunohistochemistry & Diagnostic Markers	30	70	100
Molecular Techniques in Histopathology & Cytology	30	70	100
Diagnostic Histopathology Practical	30	70	100
Cytological Techniques Practical	30	70	100
Immunohistochemistry & Diagnostic Markers Practical	30	70	100
Molecular Techniques in Histopathology & Cytology Practical	30	70	100
TOTAL			800

S. No	Course Name	Continuous assessment	End Semester Examination	Total
1	Dissertation viva	100	200	300
2	Dissertation Logbook	100	200	300
	Total			**600**

MMLS SEMESTER IV (COMMON FOR ALL SPECIALIZATION)

Credit Distribution: Each semester would consist of a minimum of 22 credits. The credit distribution hours for Lecture, Tutorial, Practical, and Clinics are as follows:
Credit Details:

Lecture / Tutorial: 1 credit = 15 hours; Practical: 1 credit = 30 hours; Clinical/ Lab Posting: 1 credit = 45 hours
Credit Includes: L – Lectures, T- Tutorials, P- Practical
Post graduate Program Requirements: A minimum of **88** credits is required for the MMLS A program of 2 years duration, inclusive of six months research dissertation.

Promotion Criteria to higher semesters:
The eligibility for promotion to the next academic year is subject to securing the minimum academic performance as specified below

- First to second year: a minimum of 70% of the credits at the end of the first year (includes first and second semester)
- Students will be eligible for internship research dissertation only after successful completion of the entire coursework, i.e. 100% credits to be accrued by the end of the third semester.

The student must complete all the coursework requirements within a maximum of double the program duration. For example, in a 2-year program, all the academic coursework needs to be completed within 4 years. Failure to do so will result in exit from the program.

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Semester -1

Medical Laboratory Management **Credit = 4 (60 hours)**

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

Unit	Topic	Hours
III	**Good Clinical laboratory practices (GCLP)** ● Standard operating procedures (SOP): importance of SOP's in a clinical laboratory ● Laboratory personnel: Role of lab personnel in a medical Laboratory ● Laboratory sample management: request form, sample labelling, sample register, sample storage, sample disposal ● Laboratory equipment: Equipment procurement and evaluation. Details of specific instruments / devices for analyte estimations (routine chemistry, hormones, tumour markers, electrolytes, drugs, metals, blood gases, amino acids,) ● Laboratory reagents and kits: Procuring kits, inventory, storage, validation	8
IV	**Laboratory errors**: Root cause analysis and CAPA (corrective action, preventive action) **Phases of errors** in clinical Laboratory testing process ➢ Preanalytical variables ➢ Analytical variables- Use of stable reference materials-calibrators & controls, LJ charts and Westgard rules. Standardization / Calibration processes**:** Calibration of basic equipments by laboratory personnel. Calibration of methods-colorimetric and enzymatic. ➢ Postanalytical variables: transfer of results, documentation, competence and various laboratory processes	8
V	**Total Quality management:** ➢ Fundamental principles. TQM framework ➢ External Quality Assessment Schemes ➢ Internal QC Procedures, Use of Internal Quality Control material. Care and procedural steps in reconstitution of commercial controls.	6
VI	**Biological Reference Intervals**: Definition. Establishment. Validation of reference intervals. Diagnostic efficacy. **Documentation** in Laboratory/Maintenance of records: Patient entry registers, Procedure manuals, Registers of Reagents, consumables and accessories, quality control data, patient data and all relevant lab records	8
VII	**Clinical laboratory informatics**: Computer basics. Word processing, spreadsheets, data-base, graphics, statistics, Laboratory Information Systems (LIS).	4

Unit	Topic	Hours
VIII	**Laboratory Accreditation and Audit:** ISO guidelines, NABL 15189 standards, Audit in a Medical Laboratory: Introduction and Importance, Responsibility, Planning, internal audit, Horizontal, Vertical and Test audit, Frequency of audit, Documentation. Overview of JCI & CAP.	6
IX	**Public relations**: Interpersonal skills at work place, communication with patients, Leadership management, conduction of seminar and CME 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	4
X	**Risk Management and safety measures:** Safety responsibility- employer and employee - Safety in a clinical laboratory: personal protection, Laboratory hazards, Laboratory safety- fire, chemical, electrical, radiation, Laboratory infection control, Hazardous waste and transport of Hazardous material, biomedical waste management, HIV: pre- and post-exposure guidelines, Hepatitis B & C: pre- and post-exposure guidelines, drug Resistant Tuberculosis, Needle prick injury and followup, Accident documentation and investigation	4
	Total	**60**

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 **Credit = 4 (60 hours)**

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	Topic	Credit Hours
I	Basic Concept Of Cell Structure, Function And Processes a) Cell Organelles And Their Functions b) Cell Division, Cell Cycle And Apoptosis	6
II	The Central Dogma Of Molecular Biology-Transfer Of Genetic Information From Dna To Rna To Protein Synthesis ● Dna Replication ● Transcription-The Process Of Transcription, Inhibition Of Transcription, Reverse Transcriptase, Post Transcriptional Modification ● Translation- The Process Of Translation, Post Translational Modifications Like Folding, Glycosylation Etc. ● Inhibitors Of Protein Synthesis	12
III	Gene Expression-Regulation And Significance	6
IV	In Situ Hybridization-To Study Gene Expression Pattern, Localize Gene Amplification, Gene Location	6
V	Concept Of Gene Switching, Gene Transposition, Somatic Recombination	8

Unit	Topic	Credit Hours
VI	Cell Culture: Introduction, Significance, Cell Culture Lab – Instruments, Aseptic Techniques, Media Preparation And Filteration For Cell Culture, Media Composition And Supplements, Types Of Cell Culture- Primary, Secondary. Adherent, Suspension Cells, Commonly Used Cell Lines, Cell Culture Procedure, Contamination In Cell Culture Lab, Biosafety Levels, Ethical Issues.Waste Disposal	12
VII	Basic Principles And Applications Of Molecular Techniques ● Recombinant Dna Technology: Restriction Endonuclease, Dna Ligase, Vectors, Chimeric Molecules, Cloning, Gene Library, Cloning Strategies, In-Situ Hybridization, Blot Techniques And Applications, Rflp, Gene Therapy, Tran Genesis, Dna Finger Printing, Dna Sequencing, Pcr,Dna Probes, Hybridoma Technology.	10

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 **Credit = 4 (60 hrs)**

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	Topic	Hours
I	**Principle & Role of Molecular Diagnostics:** Basic principles in molecular diagnostics and organizations of molecular diagnostics laboratory. Role of molecular diagnostics in present diagnostic era, Ethical issues related to molecular diagnostics, future of molecular diagnostics, Historical aspects advantage of DNA over traditional serology.	**8**
II	**PCR and its modifications:** Principle of PCR, types of PCR: Primer designing, Reverse Transcriptase-PCR, Real-Time PCR, Inverse PCR, Multiplex PCR, Nested PCR, In situ PCR, Long-PCR, PCR-ELISA, arbitrarily primed PCR. Applications of PCR in Diagnosis 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.	**12**
III	**Quantitative and Qualitative estimations:** Protein stability, denaturation; amino acid sequence analysis, Hybridization techniques – Southern, Northern, in-situ (including FISH), line probe assay, microarrays – types and applications; Protein extraction and analysis (including PAGE and its variations); Western Blot	**12**

Unit	Topic	Hours
IV	Instruments and Techniques: Spectrophotometry, HPLC, MS, ELISA, Chemiluminescent, FIA, Flow cytometry, and specific applications; Electron microscopy and its application, Immunohistochemistry, Immunoflourescenes, Immunocytochemistry– principle and techniques	**12**
V	Recombinant DNA technology: Restriction endonuclease, DNA ligase, vectors, chimeric molecules, cloning, gene library, cloning stratagies, and applications, RFLP, Gene therapy, Trangenesis, DNA finger printing, DNA probes, hybridoma technology	**8**
VI	Definition, application and advantages of Genomics, Next-generation sequencing technology, Proteomics, Transcriptomics, Metabolomics	**8**
	Total	**60**

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Advance Molecular Diagnostics techniques Practical Credit = 2 (60 hrs)

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

1. DNA Isolation
2. RNA Isolation
3. Polymerase chain reaction
4. PAGE
5. ELISA
6. Demonstration of western blot
7. HPLC
8. Spectrophotometer analysis- protein Analysis
9. Immunohistochemistry
10. Demonstration of electron microscope

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

Suggested Readings:

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

Digital Health Technologies **Credit = 2 (30 hours)**

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

Unit	Topic	Hours
I	Introduction to Digital Health in Laboratory Medicine: Definition and scope of digital health, Evolution and historical perspectives, Current healthcare, big data, and machine learning, artificial intelligence in healthcare applications, predictive analytics in healthcare, WHO classification of digital health interventions,	6
II	Artificial Intelligence and Machine Learning in Diagnostics: AI in hematology: automated WBC differential, RBC morphology, AI in histopathology and cytopathology: image classification and tumor grading, AI in microbiology: colony morphology analysis, resistance prediction, AI in biochemistry: predictive analytics from lab trends (e.g., sepsis prediction), AI in molecular diagnostics: variant classification and pathogenicity prediction, Digital Epidemiology and Health Surveillance	6
III	Telehealth medicine: Definitions and distinctions: Telehealth vs. Telemedicine vs. Remote Patient Monitoring, trends in telemedicine, Types of telehealth modalities: synchronous, asynchronous, and hybrid, Components of a telehealth ecosystem (software, devices, connectivity, data platforms), Role of laboratory medicine in remote monitoring (e.g., chronic disease management), AI Applications in Remote Patient Monitoring, Mobile Health (mHealth) and Health Apps	6

Unit	Topic	Hours
IV	Digital Health: Definition and scope of digital health, Key stakeholders: healthcare providers, patients, policymakers, IT developers, Global and national digital health strategies (e.g., WHO Digital Health Strategy, NDHM India), Digital health ethics and data governance, lectronic Health Records (EHR) and Laboratory Information Systems (LIS), Structure and function of EHR systems, Data security and patient confidentiality, Clinical decision support systems (CDSS) integration with LIS, Case studies on digitized lab workflows	6
V	Ethical and legal challenges of artificial intelligence-driven healthcare: Regulatory classification of AI-powered RPM devices (e.g., FDA SaMD, CDSCO), Requirements for clinical validation and safety assessment, Ethical considerations in autonomous health monitoring, Challenges of algorithmic bias and AI transparency, Legal responsibility in automated decision-making	6
	Total	**30**

Suggested Readings:

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

Course Name: Research Methodology & Biostatistics …..Credit = 2 (30 hours)

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

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

II	**Probability, Distributions, and Sampling** • Normal and Standard Normal Distribution: Properties and Applications • Probability Concepts and Calculations (mean ± SD intervals) • Skewness and Kurtosis: Definitions and Interpretation • Parameters vs Statistics • Population, Sample, Sampling Frame • Sampling Distribution and Central Limit Theorem • Standard Error: Mean, Proportion, Differences • Confidence Intervals for Means and Proportions	6

Unit	Topic	Hours

III	**Hypothesis Testing and Statistical Inference**
	• Hypothesis Testing:
	  • Null and Alternative Hypotheses
	  • Type I and II Errors
	  • One-tailed vs Two-tailed Tests
	  • p-value, Significance Level, Power
	• Parametric Tests:
	  • Paired and Unpaired t-tests
	  • One-way and Repeated Measures ANOVA
	• Non-parametric Tests:
	  • Mann-Whitney U, Wilcoxon Signed Rank, Kruskal-Wallis, Friedman's ANOVA
	• Chi-square Test and McNemar's Test: Concepts and Applications	

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

Unit	Topic	Hours

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

Research Methodology & Biostatistics Practical **Credit = 2 (60 hours)**

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

1. **Data Handling & Descriptive Statistics**
   - Collect raw data from a lab or clinical setting.
   - Classify variables (qualitative/quantitative, discrete/continuous).
   - Organize data into frequency tables.
   - Calculate and interpret: Mean, median, mode
   - Range, standard deviation, variance
   - Create visual representations: Bar charts, histograms, pie charts, box plots
2. **Probability & Distributions**
   - Plot and interpret normal distribution curves.
   - Calculate probabilities using mean ± 1SD, 2SD, 3SD.
   - Identify skewness and kurtosis from datasets.
3. **Sampling & Estimation**
   - Demonstrate random sampling techniques (simple, stratified, cluster).
   - Calculate standard error and confidence intervals.
   - Estimate population parameters from sample data
4. **Hypothesis Testing:** Perform and interpret:
   - One-sample and two-sample t-tests
   - Paired t-test
   - Chi-square test (2x2 table)
   - ANOVA (one-way)
   - Use SPSS/R to run tests and interpret outputs.

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Suggested Reading:

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

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SEMESTER II - Medical Biochemistry

Course: Bioorganic & Biophysical Chemistry **Total Credits: 4 (60 hours)**

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

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

Unit	Topic	Hours
I	**Carbohydrates:** Definition, Biological importance and Classification of Carbohydrates. ***Monosaccharides***- Classification, Structure and Biological importance of Monosaccharides, Important chemical reactions of Monosaccharides.General Properties in reference to glucose –Structural and Stereo isomerism (Fischer and Haworth Projection formulae), Cyclic structure, Epimers, Anomers and Mutarotation.***Disaccharides*** - Structure, Occurrence and Biological importance of Sucrose, Lactose and Maltose. ***Polysaccharides: Classification***, Structure, Occurrence and Biological functions. ***Homopolysaccharides, Heteropolysaccharides,*** Carbohydrates in cell membrane	**10**

Unit	Topic	Hours
II	**Lipids:**Definition, Biological importance and Classification of lipids.***Simple Lipids:*** fats and wax;physical and chemical properties of fats. ***Identification of fats and oils:*** Saponification, Acetyl number, Rancidity of fats, Reichert-Meissel number. ***Compound lipids*** - Structure and Biological function of phospholipids, Glycolipids and other compound lipids – lipoproteins.***Derived lipids -*** *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.	**10**
III	**Amino acids and Proteins:** Definition**,** Biological importance of proteins, composition of proteins.***Amino Acids***: Definition,structure of amino acids,Classification, physicochemicalpropertiesandreactionsofaminoacids, Amino acids as ampholytes, Significance of non standard amino acids.***Proteins***: Classification based on nutritional value, biological importance and solubility.general properties of proteins, colour reactions of proteins (end group analysis); ***Structural organisation of protein***: Primary structure, Peptide linkage- Structure and significance of peptide bond, amino acid sequencing (Sanger's and Edman methods). Secondary structure (helix and pleated sheets Eg.Collagen), Tertiary structure of proteins (Eg. Myoglobin), Quaternary structures of proteins (Eg.Hemoglobin), motifs and domains, Structure-function relation of protein. Denaturation, renaturation, separation techniques	**10**
IV	**Enzymes:** Definition, Classification, Mechanism of Action, Models of enzyme – substrate complex formation (lock and key model, induced fit model, substrate strain theory), Enzyme specificity, Factors affecting enzyme activity	**4**

Unit	Topic	Hours
V	**Nucleic Acids and Nucleoproteins:**Structure of Purines and Pyrimidines, Structure of Nucleosides and nucleotides; nucleotides and nucleosides of biological importance. **Nucleic Acids:** Definition, Structure of DNA, RNA and types of RNA. DNA – Watson & Crick Model, A, B and Z forms of DNA.Properties of DNA - buoyant, density, viscosity, chromic effect, Tm, denaturation, renaturation, hybridization and Cotanalysis.	**8**
VI	**Acids,Bases,Buffers**in biological system, -pH-HendersonHasselbalchequation,Acid load in the body, regulation of acid base balance in body.	**6**
VII	**Fluid and electrolyte balance:** Distribution of fluids in body, Water metabolism, Factor influencing the distribution of body water, thirst mechanism, Intake and loss of body water, Electrolyte distribution, regulation, and their functions, water/electrolyte balance.	**4**
VIII	**Body Fluid properties:** OsmosisandOsmoticpressure-Osmolalityofbodyfluids.Surfacetensionandviscosity-theirapplicationto the human body in relation to normal life and disease processes. Colloidal system – protective action. emulsification - colloidal systems of biological importance - their application and role in the human body. Diffusion and absorption mechanisms - their application to biological systems.	**8**
	Total	**60**

4.

Course: Bioorganic & Biophysical Chemistry Practical

Total Credits 2 (60 hours)

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

1. **Reactions of Carbohydrates** – Molisch, Iodine, Benedict, Modified Barfoed, Osazone, Seliwannof, Foulger, Mucic acid, Bial
2. **Reactions of Proteins**
   a) Precipitation reactions – Acid, Base, Alcohol, Iso-electric, Half & Full saturation
   b) Colour reactions – Biuret, Ninhydrin, Hellers, Aldehyde, Paulis, Sakaguchi, Sulphur, Xanthoproteic, Millons,
3. **Reactions of Lipids** – Solubility Test, saponification test, bromine water test for unsaturated fatty acids, Acrolein test
4. **Reaction of Nucleic acid** – Dische test, Bial Test, Phosphate Test, Quantitative estimation via UV absorption at 260nm or Nano spectrophotometer
5. **Preparation of buffer and determination of pH**
6. **Demonstration**
   a) Determination of viscosity using Ostwald's viscometer.
   b) Demonstration of osmosis and diffusion using semi-permeable membranes.

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

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.

Course name: Instrumentation **Total Credits 4 (60 hours)**

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	Topic	Hours
I	**Non -analytical Instrumentation:** Use, calibration and their maintenance – Glass Pipettes and Micropipettes, Weighing balance (analytical and top loading digital), pH meter, Centrifuges, Water bath, hot plate, magnetic stirrer, thermometers, distilled water systems	4
II	**Centrifugation techniques:** Definition, Basic Principles of sedimentation, instrumentation, application in clinical and research laboratory. *Types of centrifugation* :Preparative, analytical centrifugation, differential centrifugation, Density gradient centrifugation , ultra centrifuge	6
III	**Photometry:** Definition, basic Principles of photometry, functions, Beer lamberts law, Instrumentation, applications. Laws of light absorption – visible and UV Spectrophotometry Types of Photometric Techniques:Colorimetry, and spectrophotometry, Flame photometry, Flourimetry, Spectrofluorometry, Atomic absorption spectrometry, Infra red spectrometry.	8

Unit	Topic	Hours
IV	**Chromatography:** Definition, basic principles of adsorption and partition, Instrumentation, applications in clinical and research laboratory. Types of chromatographic techniques: Paper (one dimensional & two Dimensional) thin layer, column, affinity, gel filtration (Types of resins, gel and apparatus preparation), ion exchange, gas liquid, HPLC	10
V	**Clinical Chemistry analysers:** Basic principles, instrumentation, function, significance of these analsyers. Types of chemistry analysers – semi –automated andFully automated	6
VI	**Electrophoresis:** Definition, Basic Principles of electrophoresis, Instrumentation, applications. Types of electrophoretic techniques- Paper, cellulose acetate, agarose gel, PAGE , capillary, Iso electric focussing and Two dimensional gel electrophoresis.	10
VII	**Advance Instruments:** Principles, instrumentation, techniques, and applications of Electron spin resonance, Nuclear Magnetic resonance, crystallography, Mass spectrometry	6
VIII	**Immunochemical techniques:** Basic concepts, function and significance of these Immunoassay analysers, antigen–antibody binding quantitativemethods . Types of assays- sandwich assay, competitive, non-competitive assay. Techniques- ELISA (Enzyme linked immunosorbent assay), FIA, Immunoprecipitation, Turbidometry, Immunofluorescence, Chemiluminescense ,Electrochemiluminescense	6
IX	**Osmometry :** Defnition, principle of osmometry, Instrumentation, applications	4
	Total	**60**

Course name: Instrumentation Practical **Total Credits 2 (60 hours)**

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

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

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

Suggested Readings:

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

Course name: Intermediary Metabolism **Total Credits 4 (60 hrs)**

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

Unit	Topic	Hours
V	**Purine and Pyrimidine metabolism**: Biosynthesis of purine and pyrimidine. Degradation of purine and pyrimidine and their Disorders.	**8**
VI	**Hemoglobin metabolism:**Heme synthesis, formation of hemoglobin, Structure of hemoglobin, Metabolism of bilirubin.	**8**
	Total	**60**

Suggested 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

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Course name: Enzymology and Nutrition **Total Credits 4 (60 hours)**

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

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

Unit	Topic	Hours
IX	**Minerals:** Definition, Classification, Chemistry, Sources, biochemical functions, deficiency and toxicity manifestations of macro and micro minerals	8
X	**Nutritional Genomics:** Introduction to nutrigenetics and Nutrigenomics, role of genes in metabolism and nutrient utilization, omics technologies in nutrigenomics.	4

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)

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SEMESTER II - Medical Microbiology

Course Name: Essential and Applied Microbiology Total Credit = 4 (60 hours)

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.

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Unit	Topic	Hours
I	**Bioreactors and Fermenters** – Principles and Sterilisation Techniques- Definitions and distinctions: bioreactor vs. fermentor, Types of systems: batch, fed-batch, continuous, anaerobic and aerobic setups. Overview of usage: pharmaceutical, food, 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	8
II	**Sterilisation Techniques:** Importance in contamination control and safety, Methods: autoclaving, filtration, chemical sterilant, UV/radiation, Sterilisation of air, media, vessels, and inoculum transfer zones, Validation tools: biological indicators, F_0 value, D-value, and cycle qualification. Role of bioreactors/fermentors in BSL-1 to BSL-3 workflows	7
III	**Industrial Microbiology and Biotechnology** **Choosing microorganisms for industrial Microbiology and Biotechnology** Finding microorganisms in nature Genetic Manipulation of Microorganisms Preservation of Microorganisms **Microorganisms Growth in Controlled Environments:** Medium Development Growth of microorganisms in an industrial setting **Major microbial products of Industrial Microbiology:** Antibiotics, Amino acids, Vitamins, Speciality compounds for use in medicine and Health, **Biotechnological Applications:** Biosensors, Microarrays **Impacts of Microbial Biotechnology**	10

Unit	Topic	Hours
IV	**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**	6
V	**Measurement of Microbial Growth:** Measurement of cell numbers (Haemocytometer, Electronic Counters, Plating Techniques, Membrane filters) Measurement of cell mass (Turbidity measurements, Wet weight, dry weight measurements) Measurement of cell activity **The influence of environmental factors on growth:** Solutes and water activity, pH, Temperature, Oxygen concentration, Pressure, Radiation **Microbial interactions:** Mutualism, Protocoperation, Commensalism, Predation, Amensalism, Competition, Symbioses in complex ecosystems **Growth Limitation in natural environments:** Growth limitation by Environmental factors, Counting viable but non-culturable (VBNC) vegetative prokaryotes, Quorum sensing and microbial populations, Biofilms	15
VI	**Waters and Disease transmission:** Waterborne pathogens and water purification Sanitary analysis of waters **Wastewater treatment:** Measuring water quality Waste treatment processes	5
VII	**Soil as an Environment for microorganisms** **Microorganisms in the soil environment** **Soil Microorganisms and Human Health** **Understanding microbial diversity in the soil**	4

Unit	Topic	Hours
VIII	**Microorganism Growth in foods:** Intrinsic factors, Extrinsic factors **Microbial Growth and Food Spoilage** **Controlling Food Spoilage:** Removal of microorganisms, Low Temperature, High Temperature, Water availability, Chemical-based preservation, Radiation, Microbial product-based inhibition **Detection of Foodborne Pathogens** **Microorganisms as food and food amendments**	5
Total		**60 hours**

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), 20162
6. J. Cassells – *Bioprocess Engineering: Systems, Equipment and Facilities*, Wiley India Pvt Ltd, 2020
7. World Health Organisation (WHO) – W*HO Technical Report Series on Bioprocess Containment, various volumes including* TRS No. 999 and TRS No. 1033, WHO Publications
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

Course Name: Systematic Bacteriology **Total Credit = 4 (60 hours)**

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.

Unit	Topic	Hours
I	**Fundamentals of Bacterial Staining & Diagnostic Overview:** Significance and principles of staining in bacterial taxonomy and diagnostics; Procedures and interpretation of: Simple stain, Negative stain, Gram stain Albert's stain, Neisser's stain Ziehl–Neelsen stain, Capsule, Flagella, Spore stains Fontana stain for spirochetes; Diagnostic relevance tied to bacterial structures and classification; Overview of bacterial groups relevant to human health.	10
II	**Biochemical Identification of Bacteria:** Diagnostic interpretation and significance of the following tests in systematic classification: Catalase, Coagulase, Indole, Methyl Red, Voges–Proskauer, Urease, Citrate, Oxidase, TSIA, Nitrate reduction, Carbohydrate fermentation, Bile solubility, H_2S production, Motility, Decarboxylases; Integration of biochemical patterns into genus/species-level diagnosis	14
III	**Gram-Positive & Gram-Negative Cocci**: Study of morphological, cultural, biochemical characteristics, pathogenesis and laboratory diagnosis of – *Staphylococcus, Streptococcus, Pneumococcus, Haemophilus, Neisseria gonorhoeae* and *Neisseria meningitidis*	8

Unit	Topic	Hours
IV	**Enterobacteriaceae:** Study of various characteristics (morphological, cultural and biochemical), pathogenesis and laboratory diagnosis of bacteria- Enterobacteriaceae: *Escherichia, Citrobacter, Enterobacter, coli, Proteus, Klebsiella, Shigella, Yersinia enterocolitica* and *Yersinia pestis*	10
V	**Systemic & Atypical Bacterial Pathogens:** Classification, morphology, pathogenicity, and diagnostics of: *Corynebacterium, Salmonella, Vibrio, Aeromonas, Plesiomonas, Clostridium species, Mycobacterium tuberculosis complex, M. leprae, Atypical Mycobacteria, Spirochetes: Treponema, Borrelia, Leptospira, Bordetella, Brucella, Mycoplasma, Ureaplasma, Rickettsia, Chlamydia, Actinomyces, Pseudomonas, Burkholderia.* Overview of	16
VI	Non-sporing anaerobic cocci and bacilli: Classification & Morphology, pathogenicity, and diagnostics of - Anaerobic cocci: *Peptostreptococcus, Veillonella;* Anaerobic Gram-positive bacilli: *Propionibacterium, Actinomyces spp.* (non-sporing); Anaerobic Gram-negative bacilli: *Bacteroides, Fusobacterium, Prevotella*	**2**
	Total	**0**

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Course Name: Systematic Bacteriology Practical Total Credit = 2 (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:

- Mackie & McCartney – *Practical Medical Microbiology*, Elsevier
- R. Ananthanarayan & C.K. Jayaram Paniker – *Textbook of Microbiology*, Universities Press
- Satish Gupte – *The Short Textbook of Medical Microbiology*, Jaypee Brothers Medical Publishers
- Kanai L. Mukherjee – *Medical Laboratory Technology*, McGraw-Hill Education
- Bailey & Scott – *Diagnostic Microbiology*, Elsevier
- 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

Course Name: Medical Entomology and Parasitology Total Credit = 4 (60 hours)

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

Unit	Topic	Hours
III	**Helminths:** Classify helminths; compare morphological features, transmission routes, and adaptation mechanisms. **Trematodes:** morphology, life cycle, pathogenesis, laboratory diagnosis, treatment and prevention of Schistosoma species, Fasciola species, Fasciolopsis species, Clonorchis species, Paragonimus species **Cestodes**: morphology, life cycle, pathogenesis, laboratory diagnosis, treatment and prevention of Taenia species, Echinococcus species, Hymenolepsis nana, Diphyllobothrium latum **Nematodes**: morphology, life cycle, pathogenesis, laboratory diagnosis, treatment and prevention of Intestinal Nematodes: Ascaris lumbricoides, Ancylostoma duodenale, Necator americanus, Strongyloids stercoralis, Trichinella spiralis, Enterobius vermicularis, Trichuris trichiura, Toxocara species Lymphatic Nematodes: Wuchereria bancrofti, Brugia malayi Subcutaneous tissue Nematodes: Loa loa, Onchocerca volvulus, Dracunculus medinensis	18
IV	**Introduction of Arthropods**: classify the arthropods of public health importance; distinguish between vector and vehicle; vector control strategies (environmental control, chemical control, biological control, genetic control) approaches; role of vehicles and vectors in disease spread; Integrated approaches for parasite and vector control in endemic settings; vector surveillance, resistance management. Antiparasitic drugs.	8
V	**Arthropods of Medical Importance:** morphology, life cycle, public health importance and control of Mosquitoes, Sandflies, Tse-tse fly, Blackflies, Fleas, Ticks and Mites, Cyclops, Housefly, Reduviid Bug, bed bug, lice.	8
VI	**Host–Parasite Immunology:** Immune mechanisms against parasites; antigenic variation; vaccine prospects. hypersensitivity reactions; immunodiagnostic assay interpretation,	6

Unit	Topic	Hours
VII	**Molecular Tools & Research Advances:** PCR, LAMP, and sequencing methods; discuss application of proteomics, genotyping in parasite detection; introduce WHO neglected diseases and research foci. Introduces global parasitic disease priorities and current research in diagnostics and vaccines.	6
Total		60

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Course: Medical Entomology and Parasitology Practical
Total Credit = 2 (60 hours)

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

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

Suggested 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*

SEMESTER II

Course: Immunology and Immunodiagnostics Total Credit = 4 (60 hours)

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

Unit	Topic	Hours
III	**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.	8
IV	**Lymphocyte Biology**: Maturation, activation, differentiation of B lymphocytes and T lymphocytes; structural diversity of T-cell receptors; lymphocyte trafficking and homing mechanisms. **Cytokines & Immune Modulators**: Classification and roles of cytokines; therapeutic applications; cytokine storm phenomena; kinin cascade and immune modulation	8
V	**Hypersensitivity & Immune Dysregulation**: the classification and pathophysiological mechanisms of hypersensitivity reactions (Type I to Type IV) and their clinical implications in transfusion reactions, allergic disorders, and autoimmune conditions; laboratory strategies to identify hypersensitivity responses.	5
VI	**Immunodeficiency Syndromes**: Primary immunodeficiencies; molecular mechanisms; diagnostic approaches; secondary infections post-immunosuppression; microbial vulnerability; relevant diagnostics pathways. **Autoimmunity & Tolerance**: the mechanisms of central and peripheral immune tolerance; microbial mimicry in autoimmune diseases (*Campylobacter* in Guillain-Barré); immunological errors leading to autoimmune diseases such as systemic lupus erythematosus and rheumatoid arthritis; diagnostic markers.	8

Unit	Topic	Hours
VII	**Transplantation Immunology**: Immune recognition in allografts and xenografts; pathways of rejection; pharmacological and immunological strategies for immunosuppression; significance of human leukocyte antigen matching; and influence of microbial factors on graft survival. **Tumor Immunology**: the identification and roles of tumor-associated antigens; immune evasion by pathogens; mechanisms of immunosurveillance.	7
VIII	**Immunogenetics & Epigenetics**: genetic determinants of immune variability and disease susceptibility; HLA associations with microbial and autoimmune diseases; epigenetic regulation of immune responses; clinical application of immunogenetics and epigenetics in diagnostics and predictive medicine.	3
IX	**Systems Immunology & Immune Profiling**: High-throughput immunological assays; transcriptomic & proteomic responses to pathogens; microbiome-immune interactions; bioinformatics for infection tracking.	2
X	**Vaccine Design and Immunodiagnostics:** Foundational principles of vaccine design and administration, including microbial antigen selection, immune activation, and immunological memory formation. **Immunodiagnostic techniques** ELISA, flow cytometry, and lateral flow assays for detecting microbial infections. Advanced immunotherapies -Chimeric Antigen Receptor T-cell therapy and immune checkpoint blockade therapy and their diagnostic relevance in infection-linked immune modulation.	4
Total		**60 hours**

Course Name: Immunology and Immunodiagnostics Practical
Total Credits: 2 (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:

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

SEMESTER II Histology and Cytology

Course name:Translational Anatomy and Cell Dynamics
Total credits: 4 (60 hours)

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	Topic	Hours
I	Translational anatomy of diagnostic relevance: Overview of systems-based gross anatomy with diagnostic relevance, Surface landmarks and anatomical variations, Regional vs. systemic anatomy, Importance of anatomy in grossing and sectioning protocols, Anatomical changes in disease: atrophy, hypertrophy, neoplasia, regeneration.	12

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

Course name: Translational Anatomy and Cell Dynamics Practical
Total credits: 2 (60 hours)

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

Suggested Readings:

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

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Course: Essentials of Histology **Total Credits: 4 (60 hours)**

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

Unit	Topic	Hours
IV	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.	10
V	Systemic Histology – Organ-Based Structure: Microscopic anatomy of major systems: Integumentary System – epidermal layers, dermis, adnexa; Musculoskeletal System – bone histology, cartilage types, marrow ; Respiratory System – nasal mucosa to alveoli; Gastrointestinal Tract – from esophagus to colon; Hepatobiliary System – liver lobules, bile ducts; Renal System – nephron architecture, filtration interfaces ; Endocrine Organs – thyroid, adrenal, pituitary microstructure; Reproductive Organs – ovarian and testicular histology; Nervous System – cortex layers, cerebellum, peripheral nerves; Lymphatic & Immune Organs – lymph nodes, spleen, thymus.	16
VI	Emerging Trends and Digital Histology Histology automation: tissue processors, automated strainers; Digital slide scanning and image analysis; AI-assisted diagnosis and computational histology; Role of LIS and telepathology in modern laboratories; Ethical and regulatory aspects of digital diagnostics	10
Total Hours		**60**

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Course Name: Essentials of Histology Practical Total Credits: 2 (60 hours)

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

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

Suggested Readings:

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

Course name: Essentials of Cytopathology **Total credits: 4 (60 hours)**

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	Topic	Hours
I	General Principles of cytology and its application: Fundamentals: Cell structure and organelles, Cell cycle, division, and death, Cytoskeletal and nuclear changes in disease, Basics of microscopy and image analysis, Cytodiagnosis in various disease, comparison of cells normal vs disease, Molecular cytology and its role in diagnostics	5

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Unit	Topic	Hours
II	**Exfoliative Cytology:** **Introduction to Exfoliative Cytology** • Definition and scope • Types of exfoliation: spontaneous vs. mechanically induced • Advantages and limitations in clinical diagnostics **Sample Collection Techniques** • General principles of collection and fixation • Specific site-based collection: o Respiratory tract: sputum, bronchial washings o Urinary tract: voided urine, bladder washings o Female genital tract: Pap smear (conventional and liquid-based cytology) o Serous cavities: pleural, peritoneal, and pericardial fluids o Nipple discharge, oral cavity, gastrointestinal tract	10
III	**Interventional Cytology:** **1. Introduction to Interventional Cytology** • Definition, scope, and evolution • Indications and contraindications • Role in minimally invasive diagnosis **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	15

Unit	Topic	Hours
IV	**Slide Preparation and Staining:** • Smearing techniques • Fixatives used for exfoliative samples • Staining methods: o Papanicolaou stain (Pap stain) o Hematoxylin and Eosin o May-Grünwald Giemsa (MGG) o Special stains for infection (Ziehl–Neelsen, PAS) **Microscopic Interpretation:** Criteria for adequacy and cellular preservation, Identification of normal epithelial cells and reactive changes, Recognition of inflammatory and infectious processes, Cellular atypia and malignancy: cytomorphological features, Use of scoring systems (e.g., Bethesda system for cervical cytology)	10
V	**Cytodiagnosis and reporting:** **Rapid On-Site Evaluation (ROSE)** • Concept, purpose, workflow • Adequacy assessment criteria • 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)	10
VI	**Quality Assurance:** Specimen rejection criteria, Internal quality control and proficiency testing, Documentation and reporting format Non-diagnostic and inadequate samples, Artifacts and misinterpretation, Error reduction and internal QC measures	10
	Total	**60**

Course name: Essentials of Cytopathology Practical
Total credits: 2 (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.

Course Name: Cancer Epidemiology and Digital Pathology
Total Credits: 2 (30 hours)

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	Topic	Credit Hours
I	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	6
II	Global and Regional Cancer Trends: GLOBOCAN, WHO, and IARC databases and tools; Common cancers by geography, gender, and age; Cancer disparities: socioeconomic and environmental determinants; Public health policies, screening guidelines (e.g., HPV, breast, colorectal); Epidemiology of emerging cancers and rare tumors	6
III	Tumor Biology and Molecular Basis of Cancer: Oncogenes, tumor suppressor genes, and hallmarks of cancer, Cancer immunology: immune escape, tumour microenvironment, Pathways of metastasis and angiogenesis, Molecular diagnostics: PCR, FISH, NGS, liquid biopsy, Biomarkers in cancer diagnosis, prognosis, and therapy monitoring	6
IV	Digital Pathology Tools and Workflow: Fundamentals of digital slide scanning and virtual microscopy, Image analysis and whole-slide imaging (WSI) systems, AI and machine learning algorithms in pathology, Quality assurance, interoperability, and regulatory frameworks, Role of digital pathology in telepathology, consultation, and education	6

Unit	Topic	Credit Hours
V	Applications in Diagnostics, Screening, and Research: Integration of epidemiological data with digital histopathology, Use of AI in cancer grading and biomarker quantification, Personalized medicine and predictive pathology, Digital pathology in multicenter trials, biobanks, and data mining, Ethical and data privacy considerations in digital pathology	6
	Total	**30**

Course Name: Cancer Epidemiology and Digital Pathology
Total Credits:2(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

Course: Clinical Biochemistry 1 **Total Credits : 4 (60 Hours)**

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

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

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

Unit	Topic	Hours
IV	**Disorders of Amino acid and protein metabolism:** ● **O**verview of plasma proteins and their disorders, multiple myeloma, Paraproteinemia ● ***Laboratory diagnosis*** : Specimen collection, Principle, estimation, reference range and clinical significance of : proteins in blood (albumin, α1-antitrypsin, α1-fetoprotein, C-reactive protein, β2-microglobulin), serum Immunoglobulins; ● Protein in other body fluids (Urine, CSF, Pleural fluid, Ascitic Fluid) laboratory evaluation of paraproteinemia: Electrophoresis of plasma and urine proteins, quantification for diagnosis of multiple myeloma (M band Quantification) ● **Disorders of nitrogen metabolism:** Excretion of nitrogenous waste products, abnormalities of nitrogen metabolism including uremia, Uric aciduria, aminoaciduria ● ***Laboratory diagnosis***: Principle, estimation, reference range and clinical significance of Ammonia, urea, uric acid, creatinine. ● Diagnosis of inborn errors of Amino acid and protein metabolism by qualitative and quantitative methods	10
V	**Minerals and Trace Metal disorders :** ● Overview of Mineral and trace metal disorders- Anaemia, Hypercalcemia, Phosphatemia, Wilson disease, etc ● ***Laboratory diagnosis:*** Principle, estimation, reference range and clinical significance: disorders related to iron, calcium, phosphorus, magnesium, copper and zinc	6
VI	***Lab diagnosis of porphyrias.*** • Clinical significance and disease correlation • Urine qualitative tests (porphyrins, coproporphyrin, uroproporphyrin , d-ALA, porphobilinogen, urobilinogen	2

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

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Course: Clinical Biochemistry I Practicals **Total Credits: 2 (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 Chaterjee, Rana Shinde,Jaypee Publishers
3. Varleys practical clinical biochemistry, Alan gowenlock, cbs publishers
4. Lehinger Principle of Biochemistry, David L Nelson, 7th edition, WH freeman Publishers
5. Biochemistry, Debajyoti Das, Academic publishers

Course: Clinical Biochemistry II **Total Credits: 4 (60 Hours)**

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	Topic	Hours
I	**Liver Function tests** ● **O**verview 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	Topic	Hours
II	**Renal function tests:** Overview of anatomy of kidney and its functions • Renal diseases: Nephrotic syndrome, Glomerular nephritis, Urolithiasis and nephrolithiasis, renal calculi, renal tabular acidosis, diabetes insipidus, renal hypertension, renal failure • Indication and classification of RFT, Test based on glomerular filtration test -Urea, creatinine, Inulin, Cystatin Clearance test, Test based on Renal Plasma flow clearance and tubular filtration • Miscellaneous test • Routine RFT: serum creatinine, urea, uric acid and proteinuria • Early marker of Renal Pathology. - Microalbuminuria, Urine albumin: creatinine ratio • Renal handling of electrolytes- Sodium, potassium, Fractional excretion of Sodium (FeNa) • Renal calculi • Measurement of serum and urine osmolality • Urine analysis for normal and abnormal constituents of urine	
III	**Gastric and pancreatic function tests** • Composition of Gastric juice • Outline of clinical manifestations of gastric, pancreatic and intestinal diseases. • Indications, classification of gastric function test and Pancreas Function test • Qualitative and quantitative analysis of gastric contents and duodenal contents • Pancreatic enzymes: Amylases, lipases	
IV	**Cardiac function tests** • Biochemistry and tissue distribution of cardiac markers. • Cardiac enzymes such as CKMB, CK, homocysteine, hsCRP • Cardiac troponins and myoglobin	

Unit	Topic	Hours
V	**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	
VI	**Tumor markers** • Tumor marker and its classification • Potential uses of tumor markers • Marker detection - PSA, β-hCG, AFP, CEA, CA15-3, CA-125, CA 19-9.	
VII	**Toxicology testing in Clinical laboratory:** **1. Therapeutic drugs and their management (TDM)**: • Therapeutic drugs – Definition, Mechanism of action, Absorption, Distribution, Biotransformation, Excretion and Clinical utility. • Overview of specific drugs and analysis of Carbamazepine, Phenobarbital, Phenytoin, Valproic acid, Digoxin, Theophylline, Cyclosporine, Lithium **2. Toxic agents:** Source, Routes of entry and the effect of Carbon monoxide, Alcohol, Arsenic, Lead, chromium, mercury, nickel	
VIII	**Paediatric clinical biochemistry** • Problems of specimen collection • Biological reference intervals • Heavy metal poisoning in children: Pb, Hg . • Overview of Newborn screening - Cystic fibrosis, neonatal TSH, G6PD, PKU and Galactosemia	

Unit	Topic	Hours
IX	**Point-Of-Care-Testing (POCT):** ● Objectives, Biochemical parameter measured by POCT devices, Common POCT devices and Technologies, Requirements, Advantages, Limitation and Challenges	
X	**Automation and AI in Clinical Biochemistry:** ● History of automated analyzers, Types of automation, Total laboratory automation ● Objectives of AI integration, Application of AI-Diagnostic support, Data Analysis, Lab workflow optimization, Clinical Decision Support System, Predictive and preventive Healthcare ● Challenges and Limitations	
	Total	**60**

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Course: Clinical Biochemistry II Practicals **Total Credits : 2 (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 Chaterjee, Rana Shinde,Jaypee Publishers
3. Varleys practical clinical biochemistry, Alan gowenlock, cbs publishers
4. Lehinger Principle of Biochemistry, David L Nelson, 7th edition, WH freeman Publishers
5. Biochemistry, Debajyoti Das, Academic publishers

Course: Immunology **Total Credits: 4 (60 Hours)**

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

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Unit	Topic	Hours
I	Overview of the Immune System- Cells, tissues and organs of the immune system	2
II	Types of Immunity: 1. Innate immunity a) Anatomical barriers-skin, mucous lining, cilia, saliva, tears etc. b) Role of T cells c) Cellular immunity-neutrophils, macrophages, dendritic cells, natural killer cells d) Inflammation-vasodilation, extravasation, oedema, chemokines, integrin, ICAMs, cytokines (defensins, cathelicidins, interferons,etc.) e) Acute Phase Response proteins (APR proteins)-C-reactive protein, mannose-binding lectin etc.) f) Receptor system-complement receptor, MBL receptor, Toll-like receptor, scavenger receptor etc g) Signal transduction pathway eg. TLR signaling 2. Adaptive Immune system a) Antigen- types, Antigen properties contributing immunogenicity- molecular size, chemical composition, genotype, dosage, route of entry etc. b) Role of B cells c) Immunoglobulins- types, structure, antibody-mediated effector functions-opsonization, complement activation, ADCC (antibody dependent cell mediated cytotoxicity), transcytosis, d) Avidity, affinity and cross reactivity e) Antigen-antibody interactions: precipitation, agglutination, opsonisation, complement fixation f) Immunoglobulin superfamily	12
III	Major Histocompatibility Complex (MHC) molecule class I and class II: Their differences and interactions	6
IV	Hypersensitivity Type I, Type II, Type III and type IV: Allergy, skin tests, transfusion reactions, hemolytic disease of the newborn, Immune Complex diseases, tuberculin test	6
V	Autoimmunity and disorders: SLE, Multiple sclerosis, Rheumatoid arthritis, Mysthenia gravis, Autoimmune Thyroiditis	6

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

Course: Immunology Practical **Credits: 2 (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
1. Qualitative tests - precipitation, agglutination
2. Double Diffusion
3. Radial Immunodiffusion Assay
3. ELISA
4. Detection of rheumatoid factor
5. Estimation of C-reactive protein (CRP)
6. Separation of Immunoglobulins by Chromatography
7. Demonstration of western blot
8. Demonstration of Immunofluorescence.
9. 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.

Course: Endocrinology and Biochemistry of Aging
Total Credits: 4 (60 Hours)

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

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

Unit	Topic	Hours
I	Introduction to Endocrinology; Neuro-endocrinology, Neuro-immuno endocrinology and their general principles. Types of endocrine glands and classification of hormones based on their chemical nature and function.	10.
II	Chemistry, synthesis, mechanism of action, physiological effects,catabolism of the hormones of Hypothalamus and Pituitary gland and their disorders.	10
III	Chemistry, synthesis, mechanism of action, physiological effects, catabolism of Thyroid, Parathyroid (calcium homeostasis hormones). GIT hormones, Pancreatic Hormones and their disorders.	10
IV	Chemistry, synthesis, mechanism of action, physiological effects, Catabolism of the hormones of Adrenal glands, Gonads and their disorders. Extra endocrine hormones- ANP, Erythropoietin, Melatonin, etc	10

Unit	Topic	Hours
V	Introduction to aging: Definition and biological aspects of aging. Theories of Aging - Free radical theory, Mitochondrial theory, Telomere shortening and cellular senescence, Genetic and epigenetic regulation of aging, Immunosenescence and inflammation, and Hormonal theories of aging (endocrine dysregulation)	6
VI	Mechanism of Aging: Cellular mechanism: Cellular senescence, Oxidative stress-imbalance between production of ROS, Telomere shortening,Mitochondrial dysfunction Genetic mechanism: Genetic blue print in determining susceptibility to Alzhiemer's, cardio vascular diseases, certain cancers, Genetic variability in life span, Telomere length, Metabolic genetic-insulin sentivity, metabolic rate, nutrient utilization, metabolic disorders like diabetes, obesity	10
VI	Age associated common disorders-atherosclerosis, neoplasms, cataracts, macular degeneration, neuro degenerative disorders, neuro endocrine disorders, Cancer and aging: biochemical connections	4
	Total	**60**

Suggested Readings:

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

SEMESTER III - Medical Microbiology

Course: Medical Virology **Total Credits: 4 (60 hours)**

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	Topic	Hours
I	**General Properties of Viruses:** Morphology, Viral Hemagglutination, Viral Multiplication, Cultivation of Viruses- Animal inoculations, Egg inoculation, Cell culture, Viral Assay, Assay of Infectivity, Viral Genetics, Non-Genetic Interactions, Classification and Nomenclature of Viruses, Viroids, Prion; Viral genomics and bioinformatics tools	**10**
II	**Virus- Host Interactions: Viral Infections**: Pathogenesis of Viral Infection, Host Response to Virus Infections; Laboratory Diagnosis of Viral Diseases, Immunoprophylaxis of Viral Diseases, Chemoprophylaxis and Chemotherapy of Virus Diseases;	**8**
III	**Bacteriophages:** Morphology, life cycle, transmission of genetic information**, s**ignificance of phages	**6**

Unit	Topic	Hours
IV	**Orthomyxoviruses:** Morphology, Resistance, Antigen classification; Influenza virus- classification, Nomenclature systems, Antigenic variation, Host range, Pathogenicity, Clinical features, Laboratory diagnosis, Immunity, Epidemiology, Immunoprophylaxis, Treatment	**8**
V	**Paramyxoviruses:** Antigenic Structure and classification • Rubella viruses, Mumps virus: Properties, clinical features, complications, Epidemiology, Immunity, Laboratory Diagnosis, Prophylaxis • Parainfluenza viruses: • Clinical features, Epidemiology, Laboratory diagnosis, New Castle Disease viruses (NDV) • Pneumovirus- • Respiratory Syncytial virus (RSV): Clinical features, Epidemiology, Laboratory features, Epidemiology, Laboratory diagnosis, Prophylaxis, Treatment • Morbillivirus • Measles virus: Epidemiology, clinical features, complications, Pathogenicity, Laboratory Diagnosis, Prophylaxis • Nipah and Hendra virus • Human Metapnemovirus	**12**
VI	**Hepatitis viruses**: types of viral hepatitis Type A Hepatitis (HAV), Type B Hepatitis (HBV), Type C Hepatitis (HCV), Type D Hepatitis (HDV), Type G Hepatitis (HGV)	**8**
VIII	**Human Immunodeficiency Virus (HIV)** Structure, Viral Genes and Antigens, Antigenic Variation and Diversity Of HIV, Resistance, Pathogenicity **Acquired Immune Deficiency Syndrome (AIDS)** Clinical features of HIV infection, Laboratory diagnosis, Strategies for HIV testing, Applications of serological tests, Epidemiology and prevention, Prophylaxis, Treatment	**8**
	Total	**60**

Course: Medical Mycology **Total Credits 4 (60 hours)**

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

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

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Course: Medical Mycology and Virology Practical Total Credits 2 (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:

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

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Course: Public Health Microbiology **Total Credits: 4 (60 hours)**

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.

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

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Unit	Topic	Hours
II	**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.	12
III	**Measures of disease outbreaks:** Procedures used in the investigation of infectious disease outbreaks, Outbreak investigation- team, role of microbiologist in the team, Laboratory diagnosis in public health **Epidemiologically significant infectious diseases in the community** **The recent Epidemics:** The HIV/AIDS Pandemic, Swine-flu-pandemic (H1N1) 2009 Influenza, SARS as a model of epidemiological success, The COVID pandemic, Healthcare associated infections **Emerging and Reemerging Infectious diseases and pathogens:** Reasons for increases in emerging and reemerging infectious diseases	10

Unit	Topic	Hours
IV	**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	6
V	**Healthcare associated infections:** Catheter associated UTI, Healthcare -associated bacteremia, Healthcare associated pneumonia and ventilator associated pneumonia, Healthcare associated wound infections (Surgical site infections) Healthcare associated infections due to Hepatitis viruses B and C (Transfusion-associated infections), Healthcare associated episodes of acute gastroenteritis, Healthcare associated episodes of tetanus **Sources and reservoirs of healthcare associated infections:** Endogenous sources of infection, Cross-infection, Infections from environmental sources **Modes of transmission of microorganisms** **Measures to control infection in the healthcare setting:** Standard precautions, Personal protective equipment, Safe injection practices, Environmental cleaning, medical equipment, Respiratory hygiene/Cough etiquette **Precautions in the operating theatre** **Investigation and follow-up of outbreaks of disease** **Monitoring and regulation of HCAI: Hospital Infection Control Committee**	12

Unit	Topic	Hours
VI	**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**	4
VII	**Bioterrorism and disaster Management:** Definition of bioterrorism, types of bioterrorism agent (CDC Classification), Biological warfare, Global incidents, Role of microorganism in bioterrorism, Emerging pathogen as potential bioweapons, detection, diagnosis, lab safety protocols, biosafet levels and containment. Phases of disaster management, bioterrorism preparedness and response – Surveillance, warning, emergency response, stockpiling of medicine, decontamination and Quarantine protocols. Use of PPE and infection control, mass casualty management.	4
Total		**60**

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Course: Public Health Microbiology Practical Total Credits: 2 (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

Course: Advances in Microbial Informatics **Total Credits :4 (60 hours)**

Unit	Topic	Hours
I	Microbial Informatics: Introduction to Bioinformatics, Information flow, Scope of Bioinformatics, computers and microbes, basics of internet, Network-based services (Cloud & Grid Computing), microbial informatics, environment and diversity	8
II	Microbial genomes and data platform: Basics of Database designing and modeling, Designing policies, File formats (FASTA, PIR, Genbank), data storage, retrieval, Microbial Genomes, Genbank, 5 Pfam, KEGG, Brenda, MBGD, biodiversity databases. String comparison, and Smith–Waterman algorithm, BLAST algorithm, FASTA algorithm comparison, Sequence submission tools (Banklt, Sequin).	10
III	• Omics and Microbiome Informatics: • Types of omics in relation to microbiology. • Genomics and metagenomics - Gene structure, Gene finding strategies Glimmer, Genscan, promoter region identification, promoter signals, genome annotation tools, Gene ontology, biological networks; • Proteomics: Protein sequence and structures (primary, secondary and tertiary) and prediction, protparam, Chou– Fasmanalgorithm, GOR method, Concepts of structural modeling and tools PHD, ANOLEA, Transmembrane protein prediction tools, Mass spectrometry data and analysis; • Transcriptomics and Metabolomics • Multi-omics- integration of omics and microbial function	14
IV	Phylogenetics and Evolutionary Informatics: Principles of Phylogeny analysis, Phylogenetic reconstruction distance matrix, types of trees, Rooted unrooted, distance-based methods (UPGMA, FM, NJ Methods), Character based methods (Parsimony method, Maximum likelihood method), tree evaluation, (bootstrapping, Jackknifing), functional inferences. Phylogenetic profiles and functional inference.	10

Unit	Topic	Hours
V	Diagnostic Informatics in Microbiology: Microscopy, Rapid antigen test, PCR, RFLP, Genome sequencing projects, next-generation sequencing generation (NGS), Computational tool and pipelines, microarray technology, data analysis methods and tools; Applications in public health diagnostics and outbreak tracking.	10
VI	Antimicrobial Resistance & Comparative Genomics: Phenotypical and genotypical characterisations of resistance formation, application of NGS in studying the resistance mechanisms, mutations, AMR genes, and relevant genes. Comparison of ancestral microbe with mutant bacteria using bioinformatic tools; Ethical and regulatory perspectives in AMR data sharing.	8
	Total	**60**

Suggested Reading:

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

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SEMESTER III - Histology and Cytology

Course Name: Diagnostic Histopathology **Total Credits: 4 (60 hours)**

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

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

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Course Name: Diagnostic Histopathology Practical Credit: 2 =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

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Course Name: Cytological techniques **Total Credit: 4 =60 hours**

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

Learning 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	Topic	Hours
I	Principles and Types of Cytological Specimens: Introduction to cytology: definition, scope, clinical significance, Types of specimens: exfoliative, abrasive, aspirated (FNAC), body fluids, Fixation principles: cytological fixatives and preservation, Collection techniques: gynecologic vs. non-gynecologic specimens	12
II	Cytopreparation Techniques: Smear preparation: direct, sedimentation, filtration, cytocentrifugation, Liquid-based cytology (LBC) vs. conventional smears, Cell block technique: indications and method, Preparation for ancillary testing (IHC, molecular)	12
III	Cytological Staining and Special Techniques: Romanowsky stains (May-Grünwald Giemsa, Leishman)**,** Papanicolaou staining technique and interpretation**,** Special stains: PAS, Ziehl-Neelsen, mucicarmine in cytology**,** Artifacts and troubleshooting in staining	12

Unit	Topic	Hours
IV	Microscopy and Morphological Interpretation: Cellular features of normal, reactive, and malignant cells, Cytomorphology of commonly examined tissues (cervical, thyroid, respiratory tract, urine, serous fluids), Screening techniques and reporting systems (e.g., Bethesda system)	12
V	Automation, Quality Assurance, and Lab Management**:** Automated slide processors and screeners, Digital cytology and AI-based tools, Internal and external quality control in cytology, Safety protocols, documentation, record keeping	12
	Total Hours	**60**

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Course Name: Cytological techniques **Total Credits: 2 (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.
5. WHO Classification of Tumours Series (Latest edition for organ systems)

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Course Name: Immunohistochemistry and Diagnostic markers
Total Credit: 4 (60 hours)

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

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

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Course: Immunohistochemistry and Diagnostic Markers Practical
Total Credits: 2 (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.
4. WHO Classification of Tumors

Course: Molecular techniques in histopathology and cytology
Total Credits: 2 (30 hours)

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	Topic	Hours
I	Molecular Biology Fundamentals in Tissue Diagnostics: DNA, RNA, and protein synthesis in pathological states, Gene mutations, translocations, amplifications relevant to neoplasia, Tumor suppressor genes and oncogenes (e.g., TP53, HER2, BRAF), Applications in cancer diagnostics and infectious disease detection	6
II	Pre-analytical and Analytical Considerations: Fixation and preservation of nucleic acids (FFPE vs fresh/frozen tissue), Nucleic acid extraction from FFPE blocks and cytology smears, Quality control and quantification (spectrophotometry, fluorometry)	6
III	Core Molecular Techniques: Polymerase Chain Reaction (PCR, RT-PCR, qPCR): principle and applications, In Situ Hybridization (ISH), Fluorescent ISH (FISH): diagnostic relevance, Microdissection techniques (manual and laser capture), Molecular markers in specific cancers (e.g., EGFR, ALK, KRAS), Next-Generation Sequencing (NGS): overview and utility in diagnostics	10

Unit	Topic	Hours
IV	Integration with Histopathology & Cytology: Molecular testing in solid tumors (lung, breast, colon, cervix), Molecular cytology: applications in exfoliative and fine-needle aspiration cytology, Liquid biopsy and cell-free DNA, Role of bioinformatics and digital pathology in molecular diagnostics	8
	Total Hours	**30**

Course: Molecular techniques in histopathology and cytology
Total Credits 2 (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

Course Name: Dissertation **Credit = 22 (990 hours)**

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

1. Name & address of student
2. Email Id of the student
3. Registeration 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)

Date: Signature of the guide

Enclosures

Synopsis

Proposal /synopsis outline

1. Title
2. Purpose of the study
3. Objectives of the study
4. Operational Definitions
5. Conceptual Framework
6. Assumptions/Hypothesis
7. Research Methodology
    a) Research Approach
    a) Research Design
    b) Setting
    a) Population, Sample & Sampling Technique
    b) Tools &Technique
    c) Pilot study
    d) Plan for data collection
    e) Plan for data analysis
8. Work plan
9. Ethical Considerations
10. References

Guidelines in writing synopsis

1. The research protocol should be of 1200 words (4- 6 pages) on the topic.
2. It should be submitted along with a cover letter.
3. The work and writing of protocol/dissertation should be done under the Guide.
4. The Guide must be as per University norms.
5. The synopsis should be signed by the candidate and forwarded through the Guide, Departmental head and Principal of the Institution.

Date: Signature of the Student

Signature of the Guide Signature of the Principal

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Abstract:

Should be structured

(Include background/Introduction and objectives, methodology, results, and conclusion in a single paragraph limited to 250-300 words)

Keywords: 5-6 words

Table of contents

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

List of Tables: (14 size bold)

S. No	Table	Page No
1		

List of Figures (14 size bold)

S. No	Figures	Page No
1		

CHAPTER-I

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

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

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

CHAPTER-3

- Methodology
- Research approach
- Research design
- Variables
- Schematic representation of the study
- Setting of the study
- Population
- Sample and sampling technique
- Inclusion criteria
- Exclusion criteria
- Tool/instruments
- Development/selection of the tool
- Description of the tool

- Content validity
- Reliability of the tool
- Pilot-study
- Data collection process
- Plan for data analysis

CHAPTER-4 (14sizes,bold)

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

CHAPTER-5(14sizes,bold)

- Results
- Objectives
- Hypothesis

CHAPTER-6 (14sizes,bold)

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

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

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- Full stops are used after the last authors initials, after the article title, after the abbreviated journal title and at the end of the entry. Gerald Callee J, Andrew G Fraser, Barrie P Marmion, Anthony Simmons. Mackie& MC Cartney Practical medical microbiology, NewYork, Churchill Livingstone, 1996.

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

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

Book: Personal author(s):

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

Editor(s), compiler(s) as author

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

Electronic Sources as reference

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

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

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References and websources:

1. Narayan, K Kar, S Gupta, N. From 'Paramedics' to 'Allied Health Professionals' : Landscaping the Journey and Way Forward. Public Health Foundation of India: New Delhi, India, 2012.
2. Size, composition, and distribution of human resource for health in India: new estimates using National Sample Survey and Registry data, BMJ Open, 2019
3. Amerson MH, Pulido L, Garza MN, Ali FA, Greenhill B, Einspahr CL, Yarsa J, Sood PK, Hu PC. A professional development model for medical laboratory scientists working in the microbiology laboratory. Clin Lab Sci. 2012 Spring;25(2):74-7. PMID: 22693775.
4. Gilligan PH, McGee MH. Mapping the Road to the Future: Training the Next Generation of Clinical Microbiologists, from Technologist to Laboratory Director. Clin Lab Med. 2019 Sep;39(3):487-497. doi: 10.1016/j.cll.2019.05.007. Epub 2019 Jul 2. PMID: 31383270.
5. Xu Y, Yu H, Chen J, Tong Y, Wang Y, Liang Y, Wu S. Exploration of a Training Model for Laboratory Personnel Based on ISO 15189. Clin Lab. 2025 Jun 1;71(6). doi: 10.7754/Clin.Lab.2024.241134. PMID: 40497605.
6. Ifeoma EA, Rebecca EF, Ezekiel OO, Mary-Jane O, Uyime EC, Obiageri EN, Tola A, James D. A cross-sectional study of the knowledge and attitude of medical laboratory personnel regarding continuing professional development. Niger Med J. 2015 Nov-Dec;56(6):425-8. doi: 10.4103/0300-1652.171617. PMID: 26903702; PMCID: PMC4743294.
7. Pearse C, Scott S. A Review of Clinical Laboratory Education, Training and Progression: Historical Challenges, the Impact of COVID-19 and Future Considerations. Br J Biomed Sci. 2023 Apr 12;80:11266. doi: 10.3389/bjbs.2023.11266. PMID: 37125390; PMCID: PMC10130196.
8. Avrum I. Gotlieb, Fang-I Lu, William Tsui, Heather Shapiro, Theodore J. Brown, G. Scot Hamilton, Danielle C. Bentley, George M. Yousef, Juan Putra, Rachel Zulla, Rita A. Kandel, Professional Master of Health Science in Laboratory Medicine: Training Clinical Laboratory Scientists in an Integrated Program at a Research-Intensive University, The American Journal of Pathology, Volume 194, Issue 11, 2024, Pages 2000-2006, ISSN 0002-9440, https://doi.org/10.1016/j.ajpath.2024.07.013.
9. Adekoya, A.; Okezue, M.A.; Menon, K. Medical Laboratories in Healthcare Delivery: A Systematic Review of Their Roles and Impact. *Laboratories* **2025**, *2*, 8. https://doi.org/10.3390/laboratories2010008
10. Andrea Bennett, Edna Garcia, Matthew Schulze, Mark Bailey, Kay Doyle, William Finn, Dave Glenn, E. Blair Holladay, Jeff Jacobs, Steven Kroft, Sara Patterson, Junell Petersen, Patricia Tanabe, Sue Zaleski, Building a Laboratory Workforce to Meet the Future: ASCP Task Force on the Laboratory Professionals Workforce, American Journal of Clinical Pathology, Volume 141, Issue 2, February 2014, Pages 154–167, https://doi.org/10.1309/AJCPIV2OG8TEGHHZ
11. https://clsi.org/standards-development/specialty-areas/
12. Nature 645, 824 (2025) doi: https://doi.org/10.1038/d41586-025-0307