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–: પરિપત્ર :–

યુનિવર્સિટી સંલગ્ન તમામ Medical Laboratory Science કોલેજોના આચાર્યશ્રીઓને જણાવવાનું કે, The National Commission for Allied and Healthcare Profession દ્વારા Medical Laboratory Sciences ના Bachelor of Medical Laboratory Science અને Master of Medical Laboratory Science પ્રોગ્રામના જાહેર કરવામાં આવેલ અભ્યાસક્રમો અને નીતિ–નિયમો Medical Laboratory Science વિષયની નિયુકત એડહોક અભ્યાસ સમિતિની તા.૨૨/૦૪/૨૦૨૬ ની સભાના ઠરાવ ક્રમાંકઃ૦૧ થી મંજૂર કરી તબીબી વિદ્યાશાખાને કરેલ ભલામણ અંતર્ગત તબીબી વિદ્યાશાખાના ઈ.ચા.ડીનશ્રીએ તબીબી વિદ્યાશાખાવતી મંજૂર કરી એકેડેમિક કાઉન્સિલને કરેલ ભલામણ એકેડેમિક કાઉન્સિલવતી માનનીય કુલપતિશ્રી દ્વારા મંજૂર કરેલ છે. જેનો અમલ કરવા આથી જાણ કરવામાં આવે છે.

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सत्यमेव जयते

National Commission for Allied and Healthcare Professions

Competency Based Curriculum for Medical Laboratory Sciences

As per NCAHP Act 2021

APPROVED SYLLABUS

2025

Ministry of Health and Family Welfare

NATIONAL COMMISSION FOR ALLIED AND HEALTHCARE PROFESSIONS
स्वास्थ्यम् सर्वार्थसाधनम्
NCAHP
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Chapter 1
Introduction to Handbook

Chapter 1: Introduction to the Handbook

The report "From Paramedics to Allied Health Professionals: Landscaping the Journey and Way Forward" that was published in 2012, marked the variance in education and training practices for the allied health courses offered by institutions across the country. This prompted the Ministry of Health and Family Welfare to envisage the creation of national guidelines for education and career pathways of allied health professionals, with a structured curriculum based on skills and competencies. Thus, as a first step in this direction, a handbook, "Model Curriculum Handbook - Medical Laboratory Sciences 2015-2016" was designed to familiarize universities, colleges, healthcare providers as well as educators offering allied health courses with these national standards.

The Government of India notified the National Commission for Allied and Healthcare Professions (NCAHP) Act on March 28, 2021. As a common regulatory body, the NCAHP Act provides for regulation and maintenance of standards of education and services by Allied and Healthcare Professionals, assessment of institutions, maintenance of a Central Register and State Register, and creation of a system to improve access, research and development and adoption of latest scientific advancement and connected matters. NCAHP Act covers 57 Allied and Healthcare Professions categorized under 10 broad recognized categories.

As mandated under the Act, NCAHP initiated the process of revising the curricula as per the proposed minimum consensus guidelines for Allied and Healthcare Professions (A&HP). The current Handbook therefore represents an updated and revised version of the 2015-2016 handbook

The current edition of Curriculum Handbook for Medical Laboratory Science has been designed to serve as a comprehensive resource for educators offering Bachelor's and Master's level A&HP courses in Medical Laboratory Sciences. The handbook aims to minimise educational discrepancies by introducing standardized nomenclature, curricula and other relevant details for the Medical Laboratory Science Profession. In alignment with the recommendations of NCAHP, the proposed minimum standard curricula for MLS courses has been designed with the aim to equip professions with necessary skills and knowledge, aligned with global standards, to deliver the highest quality of service in medical laboratories.

Who is an Allied Health Professional?

The National Commission for Allied and Healthcare Professions Act 2021 defines allied and healthcare professions as

Allied and Healthcare Professional

Allied and healthcare professionals (AHPs) perform any technical and practical task to support diagnosis and treatment of illness, disease, injury or impairment, and to support implementation of any healthcare treatment and referral plan recommended by a medical, nursing or any other healthcare professional, who has obtained any qualification of diploma or degree under this Act, the duration of which shall not be less than two thousand hours spread over a period of two years to four years divided into specific semesters.

Healthcare Professional

Healthcare Professional includes a scientist, therapist or other professional who studies, advises, researches, supervises or provides preventive, curative, rehabilitative, therapeutic or promotional health services and who has obtained any qualification of degree under this Act, the duration of which shall not be less than three thousand six hundred hours spread over a period of three years to six years divided into specific semesters

Scope and need for Medical Laboratory Science professionals in the Indian Healthcare system

In recent decades, rapid advancements in medical technology have significantly improved the quality of healthcare. However, these innovations have also introduced new layers of complexity into healthcare delivery. Today, it is widely recognised that effective healthcare is a multidisciplinary endeavour, requiring the coordinated efforts of a broad spectrum of professionals—both clinical and non-clinical—beyond just physicians and nurses. The growing reliance on sophisticated equipment and standardised protocols has created a strong demand for professionals trained to manage healthcare services independently. As technology becomes central to diagnosis and treatment, these healthcare professionals play a crucial role in ensuring the efficiency, safety, and success of modern healthcare systems. Medical Laboratory Professionals work in close collaboration with physicians and medical laboratory technicians to diagnose and monitor disease processes, as well as to assess the effectiveness of treatment. Their expertise is critical in generating accurate and timely laboratory data that guide clinical decision-making. The training of medical laboratory scientists spans a wide range of disciplines, including microbiology, clinical chemistry, haematology, immunology, transfusion medicine, toxicology, and molecular diagnostics, equipping them to perform complex analyses and ensure quality in laboratory testing.

India's rapidly evolving healthcare landscape has intensified the demand for skilled medical laboratory science professionals. With increasing patient loads, the rise of non-communicable diseases, and the growing emphasis on evidence-based medicine, accurate and timely diagnostics have become a cornerstone of effective healthcare delivery. However, a significant shortage of trained medical laboratory scientists exists, particularly in rural and underserved regions. As diagnostic technologies become more sophisticated—encompassing molecular testing, automation, and personalised medicine—the need for professionals trained in advanced laboratory methods has become more urgent. Strengthening the medical laboratory workforce is crucial not only for improving diagnostic accuracy but also for ensuring the quality and reliability of healthcare across India.

India has an estimated shortfall of almost eight times (~57.5-58 lakh) of the current availability of allied healthcare professionals. This shortage is even higher if it is adjusted for workforce with proper qualifications, which takes the number of professionals to five lakh, increasing the shortfall to nearly 60 lakhs (13 times).[1]

Learning goals and objectives for allied health professionals

The handbook is structured to emphasise performance-based outcomes at various educational levels. Both undergraduate and postgraduate programs will define their learning goals and objectives based on expected performance levels. These goals will clarify the purpose of teaching each concept (learning goals) and what students are expected to achieve (learning objectives). Through this framework, students will develop the ability to apply their knowledge, skills, and competencies in practical settings within the healthcare field. These learning objectives are categorised into nine key areas, with the level of participation varying depending on the qualification level and professional roles

1. Clinical care
2. Communication
3. Membership of a multidisciplinary health team
4. Ethics and accountability at all levels (clinical, professional, personal and social)
5. Commitment to professional excellence
6. Leadership and mentorship
7. Social accountability and responsibility
8. Scientific attitude and scholarship (only at higher level- PhD)
9. Lifelong learning

1. **Clinical Care**

Using a patient/family-centered approach and best evidence, each student will organise and implement the prescribed preventive, investigative and management plans; and will offer appropriate follow-up services. Program objectives should enable the students to:

- Apply the principles of basic science and evidence-based practice
- Use relevant investigations as needed
- Identify the indications for basic procedures and perform them in an appropriate manner
- Provide care to patients – efficiently and in a cost-effective way – in a range of settings, and maintain foremost the interests of individual patients
- Identify the influence of biological, psychosocial, economic, and spiritual factors on patients' well-being and act in an appropriate manner
- Incorporate strategies for health promotion and disease prevention with their patients

2. **Communication**

The student will learn how to communicate with patients/clients, care-givers, other health professionals and other members of the community effectively and appropriately. Communication is a fundamental requirement in the provision of health care services. Program objectives should enable the students to:

- Provide sufficient information to ensure that the patient/client can participate as actively as possible and respond appropriately to the information
- Clearly discuss the diagnosis and options with the patient, and negotiate appropriate treatment plans in a sensitive manner that is in the patient's and society's best interests
- Explain the proposed healthcare service – its nature, purpose, possible positive and adverse consequences, its limitations, and reasonable alternatives wherever they exist
- Use effective communication skills to gather data and share information including attentive listening, open-ended inquiry, empathy and clarification to ensure understanding
- Appropriately communicate with, and provide relevant information to, other stakeholders including members of the healthcare team
- Use communication effectively and flexibly in a manner that is appropriate for the reader or listener

- Explore and consider the influence that the patient‘s ideas, beliefs and expectations have during interactions with them, along with varying factors such as age, ethnicity, culture and socioeconomic background
- Develop efficient techniques for all forms of written and verbal communication including accurate and timely record keeping
- Assess their own communication skills, develop self-awareness and be able to improve their relationships with others
- Possess skills to counsel for lifestyle changes and advocate health promotion

3. Membership of a multidisciplinary health team

The student will put a high value on effective communication within the team, including transparency about aims, decisions, uncertainty and mistakes. Team-based health care is the provision of health services to individuals, families, and/or their communities by at least two health providers who work collaboratively to accomplish shared goals within and across settings to achieve coordinated, high quality care. Program objectives will aim at making the students being able to:

- Recognise, clearly articulate, understand and support shared goals in the team that reflect patient and family priorities
- Possess distinct roles within the team; to have clear expectations for each member‘s functions, responsibilities, and accountabilities, which in turn optimises the team‘s efficiency and makes it possible for them to use division of labor advantageously, and accomplish more than the sum of its parts
- Develop mutual trust within the team to create strong norms of reciprocity and greater opportunities for shared achievement
- Communicate effectively so that the team prioritizes and continuously refines its communication channels creating an environment of general and specific understanding
- Recognise measurable processes and outcomes, so that the individual and team can agree on and implement reliable and timely feedback on successes and failures in both the team‘s functioning and the achievement of their goals. These can then be used to track and improve performance immediately and over time.

4. **Ethics and accountability**

Students will understand core concepts of clinical ethics and law so that they may apply these to their practice as healthcare service providers. Program objectives should enable the students to:

- Describe and apply the basic concepts of clinical ethics to actual cases and situations
- Recognise the need to make health care resources available to patients fairly, equitably and without bias, discrimination or undue influence
- Demonstrate an understanding and application of basic legal concepts to the practice
- Employ professional accountability for the initiation, maintenance and termination of patient-provider relationships
- Demonstrate respect for each patient's individual rights of autonomy, privacy, and confidentiality

5. **Commitment to professional excellence**

The student will execute professionalism to reflect in his/her thought and action a range of attributes and characteristics that include technical competence, appearance, image, confidence level, empathy, compassion, understanding, patience, manners, verbal and non-verbal communication, an anti-discriminatory and non-judgmental attitude, and appropriate physical contact to ensure safe, effective and expected delivery of healthcare. Program objectives will aim at making the students being able to:

- Demonstrate distinctive, meritorious and high-quality practice that leads to excellence and that depicts commitment to competence, standards, ethical principles and values, within the legal boundaries of practice
- Demonstrate the quality of being answerable for all actions and omissions to all, including service users, peers, employers, standard-setting/regulatory bodies or oneself
- Demonstrate humanity in the course of everyday practice by virtue of having respect (and dignity), compassion, empathy, honour and integrity
- Ensure that self-interest does not influence actions or omissions, and demonstrate regards for service-users and colleagues

6. Leadership and mentorship

The student must take on a leadership role where needed in order to ensure clinical productivity and patient satisfaction. They must be able to respond in an autonomous and confident manner to planned and uncertain situations, and should be able to manage themselves and others effectively. They must create and maximise opportunities for the improvement of the health seeking experience and delivery of healthcare services. Program objectives should enable the students to:

- Act as agents of change and be leaders in quality improvement and service development, so that they contribute and enhance people's wellbeing and their healthcare experience
- Systematically evaluate care; ensure the use of these findings to help improve people's experience and care outcomes, and to shape clinical treatment protocols and services
- Identify priorities and effectively manage time and resources to ensure the maintenance or enhancement of the quality of care
- Recognise and be self-aware of the effect their own values, principles and assumptions may have on their practice. They must take charge of their own personal and professional development and should learn from experience (through supervision, feedback, reflection and evaluation)
- Facilitate themselves and others in the development of their competence, by using a range of professional and personal development skills
- Work independently and in teams. They must be able to take a leadership role to coordinate, delegate and supervise care safely, manage risk and remain accountable for the care given; actively involve and respect others 'contributions to integrated person-centered care; yet work in an effective manner across professional and agency boundaries. They must know when and how to communicate with patients and refer them to other professionals and agencies, to respect the choices of service users and others, to promote shared decision-making, to deliver positive outcomes, and to coordinate smooth and effective transition within and between services and agencies.

7. Social Accountability and Responsibility

The students will recognise that allied health professionals need to be advocates within the health care system, to judiciously manage resources and to acknowledge their social accountability.[10]They have a mandate to serve the community, region and the nation and will hence direct all research and service activities towards addressing their priority health concerns. Program objectives should enable the students to:

- Demonstrate knowledge of the determinants of health at local, regional and national levels and respond to the population needs
- Establish and promote innovative practice patterns by providing evidence-based care and testing new models of practice that will translate the results of research into practice, and thus meet individual and community needs in a more effective manner
- Develop a shared vision of an evolving and sustainable health care system for the future by working in collaboration with and reinforcing partnerships with other stakeholders, including academic health centres, governments, communities and other relevant professional and non-professional organizations
- Advocate for the services and resources needed for optimal patient care

8. Scientific attitude and Scholarship

The student will utilise sound scientific and/or scholarly principles during interactions with patients and peers, educational endeavours, research activities and in all other aspects of their professional lives. Program objectives should enable the students to:

- Engage in ongoing self-assessment and structure their continuing professional education to address the specific needs of the population
- Conduct evidence-based practices by applying principles of scientific methods
- Take responsibility for their educational experiences
- Acquire basic skills such as presentation skills, giving feedback, patient education and the design and dissemination of research knowledge; for their application to teaching encounters

9. **Lifelong learning**

The student should be committed to continuous improvement in skills and knowledge while harnessing modern tools and technology. Program objectives will aim at making the students being able to:

- Perform objective self-assessments of their knowledge and skills; learn and refine existing skills; and acquire new skills
- Apply newly gained knowledge or skills to patient care
- Enhance their personal and professional growth and learning by constant introspection and utilising experiences
- Search (including through electronic means), and critically evaluate medical literature to enable its application to patient care
- Develop a research question and be familiar with basic, clinical and translational research in its application to patient care
- Identify and select an appropriate, professionally rewarding and personally fulfilling career pathway

Teaching Learning Methodologies

Teaching and learning in Medical Laboratory Sciences (MLS) require an approach that integrates **theoretical knowledge, practical laboratory skills, clinical application, and professional behaviour.** Since MLS is competency-based, methodologies must promote both cognitive development and hands-on proficiency, ensuring graduates can function effectively in diverse laboratory settings.

1. Didactic Teaching (Foundational Knowledge)

- **Lectures & Seminars**: Useful for introducing core concepts in haematology, microbiology, biochemistry, immunology, and pathology.
- **Interactive Tutorials**: Encourage discussion of principles, test interpretation, and clinical correlations.
- **E-learning & Flipped Classroom**: Online modules, pre-class readings, and video demonstrations to optimise in-class application.

2. Laboratory-Based Learning (Skill Development)

- **Demonstrations & Hands-On Practicals**: Students practice microscopy, staining, biochemical assays, serological tests, and molecular techniques.
- **Simulation-Based Training**: Virtual labs and mannequin-based simulations for specimen handling, biosafety, and troubleshooting errors.
- **Objective Structured Practical Examinations (OSPE)**: Structured assessments of technical and procedural competence.

3. Problem-Based & Case-Based Learning

- **Problem-Based Learning (PBL)**: Students solve diagnostic cases using integrated knowledge from different subjects.
- **Case Discussions**: Linking lab results to patient scenarios builds analytical and interpretive skills.
- **Error Analysis Workshops**: Identifying pre-analytical, analytical, and post-analytical errors enhances critical thinking.

4. Clinical Exposure & Work-Integrated Learning

- **Clinical Rotations/Internships**: Immersion in real laboratory environments to perform tests, validate results, and maintain quality control under supervision.
- **Workplace-Based Assessments**: Portfolios, logbooks, and direct observation of procedural skills (DOPS) assess workplace competence.
- **Interdisciplinary Collaboration**: Opportunities to work with physicians, nurses, and other healthcare professionals to understand the diagnostic continuum.

5. Research and Innovation-Oriented Learning

- **Capstone Projects**: Students design and execute mini-research projects in diagnostics, molecular testing, or quality assurance.
- **Evidence-Based Learning**: Critical appraisal of scientific literature and application of findings to practice.
- **Innovation Challenges**: Encouraging students to design SOPs, propose automation workflows, or suggest diagnostic improvements.

6. Professionalism and Soft Skills Training

- **Communication Skills Workshops**: For accurate reporting and interaction with healthcare teams.
- **Ethics & Biosafety Training**: Embedded in all practical and clinical modules.
- **Team-Based Learning**: Encourages collaboration and accountability in laboratory settings.

A blended approach—combining **didactic methods, experiential laboratory training, problem-solving, clinical immersion, and research exposure**—is essential in Medical Laboratory Sciences. When guided by educational frameworks such as **Bloom's Taxonomy and Miller's Pyramid**, these methodologies ensure that learners progress from acquiring foundational knowledge to demonstrating competence and ultimately practicing independently as professional laboratory scientists.

By weaving Bloom's Taxonomy (cognitive depth) with Miller's Pyramid (competence in practice), the curriculum ensures that graduates not only master theoretical knowledge but also translate it into safe, accurate, and independent laboratory practice.

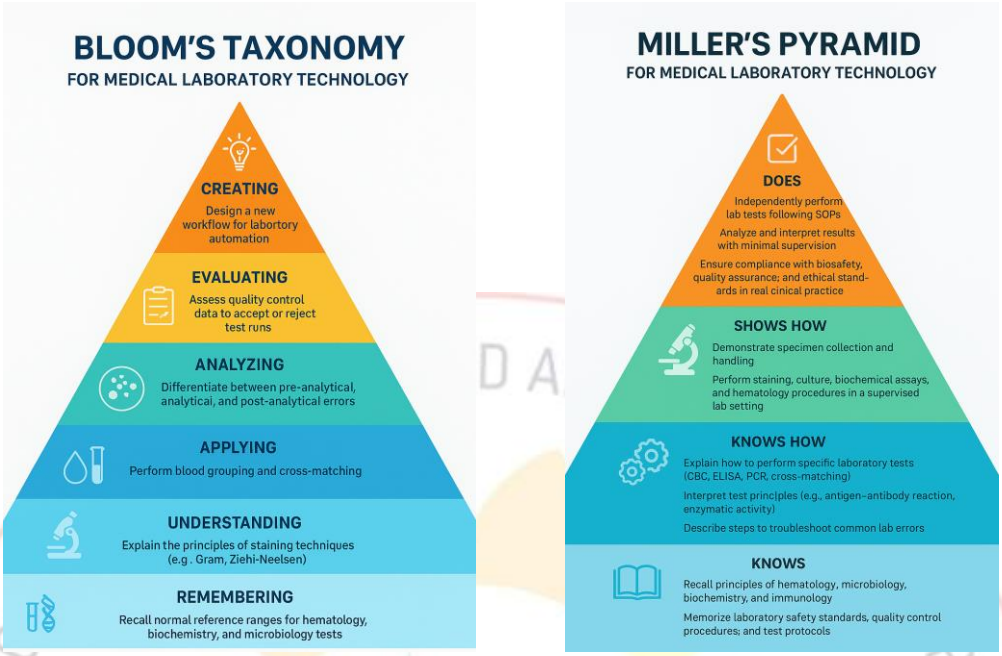

Figure I: Double pyramid emphasising cognitive progression and competence in practice

Table 1: Integrating Bloom's taxonomy and Miller's pyramid into Medical Laboratory Science curriculum

Cognitive Learning Levels	Examples	Competence Levels	Examples
Remembering – Recall facts, concepts, ranges	Recall hematology reference values, list parts of microscope, specimen handling steps	**Knows** – Possesses theoretical knowledge	Recall principles of hematology, microbiology, QC procedures
Understanding – Explain ideas, concepts	Explain principles of Gram stain or ELISA	**Knows How** – Understands application of knowledge	Explain how to perform PCR, interpret antigen–antibody reactions
Applying – Use knowledge in practice	Perform blood grouping, biochemical assays, follow biosafety	**Shows How** – Demonstrates skills in a controlled/simulated setting	Demonstrate specimen collection, perform staining and assays in supervised lab
Analyzing – Break down and compare	Distinguish pre-analytical, analytical, post-analytical errors; analyze microbial growth	—	—
Evaluating – Judge, assess, critique	Assess QC charts, evaluate diagnostic reliability, interpret results in context	**Does** – Performs tasks in real practice	Independently conduct tests, analyze results, ensure QA and biosafety compliance
Creating – Design, innovate, propose	Develop SOPs, design workflows, propose research	—	—

Table 2: Integration of Learning outcomes, Competence levels and Assessment methods for medical Laboratory Science with illustrative examples

Subject Area	Learning Outcomes	Competence Level	Teaching Methods	Assessment Methods
Hematology I (Basics)	Recall normal blood cell morphology, describe hematopoiesis (Remember, Understand)	**Knows**	Lectures, e-modules, textbooks	MCQs, short answers
Clinical Biochemistry I	Explain principles of spectrophoto-metry, demonstrate basic assays (Understand, Apply)	**Knows How**	Tutorials, lab demonstrations	Written tests, practical reports
Microbiology I (Bacteriology)	Perform Gram staining, culture handling, identify colony morphology (Apply, Analyze)	**Shows How**	Supervised practicals, simulations	OSPE, lab records
Immunology & Serology	Interpret antigen–antibody reactions, troubleshoot false positives/negatives (Analyze, Evaluate)	**Shows How Does**	Case-based learning, problem-solving	OSPE, viva voce, case analysis
Histopathology & Cytology	Evaluate tissue processing techniques, identify common artifacts (Evaluate)	**Shows How**	Practical labs, supervised demonstrations	Practical exams, slide evaluation

Subject Area	Learning Outcomes	Competence Level	Teaching Methods	Assessment Methods
Hematology II (Advanced)	Correlate abnormal blood smears with disease conditions (Analyze, Evaluate)	**Shows How Does**	Case discussions, advanced lab practice	Structured viva, case-based OSPE
Clinical Biochemistry II	Design SOP for a new biochemical test, validate QC data (Create, Evaluate)	**Does**	Project work, QC workshops	Project presentation, QC audit
Molecular Diagnostics	Apply PCR techniques, interpret electrophoresis results, design primers (Apply, Create)	**Shows How Does**	Wet labs, problem-based learning	OSPE, practical logs, supervisor feedback
Internship/Clinical Rotation	Independently perform tests, interpret results in clinical context, follow QA & biosafety (Evaluate, Create)	**Does**	Clinical postings, real lab rotations	Workplace-based assessment, portfolios, supervisor evaluation
Research & Innovation Project	Develop a mini research study, propose diagnostic innovations (Create)	**Does**	Independent project, mentorship	Project thesis, viva, publication/presentation

Assessment methods

Assessment in MLS must evaluate not only **knowledge acquisition** but also **practical skills, clinical reasoning, professionalism, and workplace competence.** A blended approach using both **formative** (ongoing feedback) and **summative** (final evaluation) assessments ensures that students achieve the required competencies.

1. Knowledge-Based Assessment (Cognitive Domain – Bloom's)

- **Written Exams**: MCQs, short-answer questions, essays to test recall, understanding, and application.
- **Case-Based Questions (CBQs)**: Assess higher-order thinking—analysis, evaluation, and clinical reasoning.
- **Online Quizzes & Open-Book Tests**: For self-directed learning and application of principles.

2. Practical/Skill-Based Assessment (Psychomotor Domain – Miller's "Shows How")

- **Objective Structured Practical Examination (OSPE)**: Students rotate through stations demonstrating lab techniques, instrument handling, or result interpretation.
- **Direct Observation of Procedural Skills (DOPS)**: Real-time evaluation of specific lab tasks (e.g., pipetting, staining, microscopy).
- **Simulation-Based Assessment**: Virtual labs, mannequins, or computer simulations for biosafety, troubleshooting, or rare test scenarios.

3. Workplace-Based Assessment (Clinical Competence – Miller's "Does")

- **Logbooks & Portfolios**: Record of performed tests, reflections, and supervisor feedback.
- **Mini-Clinical Evaluation Exercises (Mini-CEX)**: Focused assessment of interpretation and decision-making in real or simulated lab cases.
- **Case Presentations & Viva Voce**: Assess the ability to correlate lab results with clinical conditions.
- **Workplace Performance Evaluation**: Supervisors assess accuracy, efficiency, teamwork, and adherence to SOPs during internships/rotations.

4. Research & Innovation Assessment

- **Capstone/Research Projects**: Evaluation based on design, execution, data analysis, and presentation.
- **Poster/Oral Presentations**: Test communication of scientific findings.
- **Quality Improvement Projects**: Assess ability to identify lab errors and propose solutions.

5. Professionalism & Affective Domain

- **Peer Assessment**: Students evaluate teamwork and collaboration.
- **Reflective Writing/Portfolios**: Assess ethical decision-making and professional growth.
- **Supervisor Feedback (360° Evaluation)**: Input from faculty, clinicians, and peers on behaviour, responsibility, and communication.

Assessment in Medical Laboratory Sciences must be **multi-dimensional**—moving beyond traditional written exams to include **skills testing, workplace evaluations, and professional behaviour assessments.** By aligning with **Bloom's Taxonomy** (knowledge progression) and **Miller's Pyramid** (competence in action), programs can ensure that graduates are **knowledgeable, skilled, and practice-ready.**

Table 3: Assessment method matrix for Medical laboratory Science with illustrative examples

Assessment Method	Domain	Bloom's Level	Miller's Level	Examples in MLT
Written Exams (MCQs, SAQs, Essays)	Cognitive	Remember, Understand, Apply	Knows	Recall normal values, explain principles of spectrophotometry
Case-Based Questions (CBQs)	Cognitive	Analyze, Evaluate	Knows How	Interpret QC charts, analyze pre-analytical errors
Objective Structured Practical Examination (OSPE)	Psychomotor	Apply, Analyze	Shows How	Demonstrate Gram staining, identify parasites under microscope
Direct Observation of Procedural Skills (DOPS)	Psychomotor	Apply, Evaluate	Shows How	Perform venipuncture, operate auto-analyzer under supervision
Simulation-Based Assessment	Psychomotor/Cognitive	Apply, Analyze	Shows How	Troubleshoot instrument error in simulated setting
Logbooks & Portfolios	Affective/Psychomotor	Evaluate, Create	Does	Maintain record of performed tests with reflection

Assessment Method	Domain	Bloom's Level	Miller's Level	Examples in MLT
Mini-CEX (Lab-based evaluation)	Cognitive/Clinical	Analyze, Evaluate	Shows How Does	Correlate lab results with clinical conditions
Workplace Performance Evaluation	Affective/Clinical	Evaluate, Create	Does	Independently run biochemistry panels, ensure QA compliance
Research Projects/Capstone	Cognitive/Research	Create	Does	Design SOP for new assay, conduct molecular diagnostics project
Poster/Oral Presentations	Affective/Communication	Evaluate, Create	Shows How	Present findings of hematology research
Reflective Writing/360° Feedback	Affective	Evaluate	Does	Reflection on biosafety errors, peer/teamwork evaluation

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Chapter 2
Methodology of Curriculum Development

Chapter 2: Methodology of Curriculum Development

The Interim Commission for Allied and Healthcare Professions (ICAHP), recognising the critical need for standardisation across education, practice, and development within allied and healthcare professions, established three committees to address these crucial aspects. Committee 3 was specifically tasked with the essential responsibility of standardising the curriculum for the Allied and Healthcare professions. In pursuit of this objective, the Ministry of Health and Family Welfare already took a proactive step by developing and publishing a model curriculum handbook for Medical Laboratory Science during the period of 2015-16. This handbook served as a foundational document aimed at ensuring uniformity in the curriculum for diploma, undergraduate, and postgraduate education in A&HP courses across India. Recognising the dynamic nature of healthcare and technological advancements, as well as the evolving global landscape, efforts were made to continually upgrade and revise the curriculum. This iterative process aimed to align with national and international standards in the field of dialysis education, ensuring that professionals in India are equipped with the latest knowledge and skills. To achieve this, the commission engaged the expertise of professionals in academia, practice, and research from esteemed government and private institutions nationwide. These experts were instrumental in constituting a task force committee specifically focused on Medical Laboratory Science

Leveraging their collective knowledge and experience, the task Force members meticulously redesigned the curricula based on a standardised framework, ensuring relevance and effectiveness. Guided by the commission's directives, the task force committee diligently worked to revise and recommend updated guidelines regarding the education and practice of Medical Laboratory Science in India. This collaborative effort aimed to enhance the quality and availability of Medical laboratory technologists and Scientists in alignment with international standards and guidelines, thereby meeting the growing demands of the healthcare sector. The curriculum was developed in accordance with the guidelines framed by the Interim Commission for Allied and Healthcare Professions and guiding principles for the curriculum development is mentioned below (Table 4)

Table 4: Minimum Consensus Guidelines for curriculum development proposed by ICAHP

Sl. No	Thematic issues/areas of deliberation	Consensus of the group on guiding principles
1	**Scope of Curriculum**	**Minimum curricula guidelines** are to be designed for each level of the program for each profession. • Curricula should be patient-centric and futuristic. • Must include the latest advancement in technology. • Should be aligned with global standards and allow global mobility
2	**Mode of education for all allied and healthcare program**	**All programs should be delivered in full-time mode** and no institution should deliver any part-time or distance program in the allied and healthcare sciences.

Sl. No	Thematic issues/areas of deliberation	Consensus of the group on guiding principles
3.	**Components of the curriculum**	**Curricula must consider:** • Definition of the profession • Entry criteria to the profession • Entry qualification to the profession- Diploma/ Bachelor level and levels of program desired in the profession other than entry qualification • Nomenclature of the qualifications • Duration of each level of the program with the duration of the internship. • Must-have competencies at the end of each level and competencies must drive the curriculum content. • Program evaluation framework/ assessment at the end of each program • Number of desired faculty (with hierarchy/ designation) and defined minimum qualifications for each level of the program • Batch size and student and faculty ratios • Details of reference books, journals and desirable and essential equipment must also be considered.
4.	**Alignment with choice-based credit system (CBCS) encouraging multiple entries and multiple exits under the National Education Policy framework.**	**A pre-determined credit-based system is to be followed for all the allied and healthcare programs** that ensure a basic minimum competency in essential subjects: • **Credits and the number of hours** must be allocated to each subject. • While lateral entry and bridge programs can be devised for existing professionals for entry, multiple exits may not be implemented.

Sl. No	Thematic issues/areas of deliberation	Consensus of the group on guiding principles
5.	**Entrance mechanism and entry criteria**	**Common entrance mechanism to be considered for all programs:** • **Universities can consider NEET appeared candidates** along with **50% in 10+2 science** (Biology and/or Mathematics as per the requirement of the professions) or **University/State entrance examination** for admissions in the allied and healthcare programs. • **Remedial Biology/ Mathematics is to be considered if knowledge is desired in the domain** and the entry criteria allow students without qualifying the same subjects in 10+2.
6.	**Medium of instruction**	**The medium of teaching should be 'English'** • Students from other boards without English as a compulsory subject may be encouraged to pick English as an elective from available resources on Swayam and similar platforms. • The completion of the course will not lead to any university course credit (non-university course).
7.	**Desired competencies and skills**	**Competency framework** (including performance criteria and related knowledge, skill and behaviours) to be included in each level of the program. • **Competencies should be measurable and aligned with assessments.** • **Foundations Courses –** may be spread across the length of the program and weightage to the content/ number of hours/ credits may vary as per the requirement of individual professions. • Soft skills and communication to be focused.

Sl. No	Thematic issues/areas of deliberation	Consensus of the group on guiding principles
8.	**Common pre-clinical and para-clinical subjects**	• **All curricula MUST have fundamental subjects for the course to have in-depth knowledge of the basics.** • **Common pre-clinical subjects and para-clinical subjects** applicable to the program should be reviewed and considered in the first two years of the program. Content depth and weightage may however differ by program.
9.	**Levels and length of the program**	**Duration of a program may vary across different programs;** however, the minimum duration should be: • **Diploma should be at least 2.5 years** including 6 months of internship (Professions where applicable) • **Bachelor-level program should be at least 4 years** (including internship) • **Masters level program should be of at least 2 years** focused on specialization in the field **The majority of the groups agreed to phase out Diploma programs in the timeframe of 5 years and introduce bridge program/ lateral entry pathways to upgrade the existing diploma holders, where applicable.** (Other than specific groups such as OT technologists, dialysis, radiotherapy, etc. where the workforce is required in large numbers and may not be addressed only through the Bachelor program immediately to meet patient needs in the population)

Sl. No	Thematic issues/areas of deliberation	Consensus of the group on guiding principles
10.	**Semester versus Annual system**	**The curriculum is to be devised in a semester system,** • However, implementation flexibility for semester/annual assessments will be with the institutions and universities. • In case a program is suggested for an annual examination, a compatibility table must be included in the curriculum.
11.	**Internships and practical exposure to the students**	**All programs must have a mandatory internship** • The length of the internship will be determined by the extent of competencies to be attained by the candidate after the program. • Clinical programs can also mandate **rotatory internships** to increase the level of clinical exposure to the students • **Teaching institutions should be accountable for ensuring the internship of the students in the affiliated hospital,** as it is part of the academic program**.** o **Standalone institutions** must have an MoU with either a medical college or hospital or healthcare facility as per the guidelines (desired number of beds/ OPD etc.) defined in the curriculum to ensure practical exposure to the students. o MoU to also define the clinical supervision of the students - institutional staff or clinical preceptors can be considered. • **Stipends of a reasonable amount must be paid for internships.** • Internships cannot be reflected as work experience as those are part of the academic program.

Sl. No	Thematic issues/areas of deliberation	Consensus of the group on guiding principles

		• **Studentship or observership** must also be inbuilt into the curriculum.
		  ○ Simulation and skill labs can be used for practising skills specific to the program if available in the initial years of observership/ studentship.
		  ○ Some hours in every semester can be considered for seminars/workshops on new developments/ technologies.
		• If the clinical facility is not within the same campus, transportation should be provided to the students and interns.
		All practical skills must be supervised and recorded in a digital **Logbook and skills to be evaluated after the completion of the internship.**

12.	**Focus of Masters program and faculty development**	• Masters programs should be promoted to develop specialization in the field and generate trained faculty in the field • All Master programs must focus on research and engage with industry partners to promote innovation and development in the field • Industry experts can be engaged as guest faculty/ conduct seminars under the framework of programs.
13.	**Exit Examination**	It was agreed upon that an exit examination (including testing of skills and competencies) can be potentially conducted by a third-party agency or organisation as eventually identified by the ICAHP/ NCAHP. This can also evolve as a licensure examination for all allied and healthcare professionals.

The development of the Medical Laboratory Science curriculum was a meticulous and collaborative effort. The MLS task force was officially notified by NCAHP on May 14, 2025 and was tasked with submitting the revised minimum standard curriculum for Bachelor's and Master's level courses in Medical Laboratory Science. Deliberations began with a physical meeting in NCAHP, New Delhi followed by more than 30 virtual meetings of the task force of expert members. This comprehensive endeavour aimed to establish a standardised educational framework for Undergraduate and Postgraduate programs nationwide, drawing upon curricula from various universities and institutions across India. It was unanimously decided not to propose revised curriculum for Diploma in Medical Laboratory Science, in alignment with the consensus guidelines. Extensive research was conducted through a comprehensive literature review, which served as the foundation for drafting the curriculum. The process included integration of competency/outcome and skills-based models, both nationally and internationally recognised, along with the exploration of various methodologies for curriculum development and assessment protocols.

Throughout the development process, there was a concerted effort to foster consensus among task force committee members, leveraging their diverse expertise and experiences in their respective fields. Each suggestion was carefully evaluated, with decisions made collaboratively to ensure the applicability and effectiveness of the curriculum.

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Chapter 3
Background of the Profession

Importance of Medical Laboratory Science Profession

Medical laboratory science is the branch of science which deals with all the clinical laboratory investigations on clinical samples for laboratory diagnosis of various diseases. Blood, tissue and body fluids are analysed and examined for various types of foreign organisms and abnormalities. This information is then used by the medical team to make decisions regarding a patient's medical care. 60-70% of all medical decisions are based on the results of clinical laboratory investigation reports.

Medical Laboratory Science is an important subject in the field of Medicine. In each system of Medicine, diagnosis of disease is a primary step because no treatment is possible without a proper diagnosis. It is the Medical Laboratory Technocrat, who performs this important task by various scientific tools and techniques.

In today's modern world of technology, the diagnosis, treatment & prognosis of various diseases depends upon the results of investigations carried out in a clinical laboratory. Thus, these professionals play a key role in the field of health care. Medical Laboratory Science has played a significant role in the advancement in the field of Medicine, especially in past few decades. As modern medicine becomes more of a team effort, the Medical Laboratory Scientist/Technologist is an important member and integral part of the Medical team.

Scope of practice

The scope of practice for a Medical Laboratory Science Professional encompasses a wide range of responsibilities related to the collection, preparation, analysis, and interpretation of biological samples to aid in the diagnosis, treatment, and monitoring of disease.

1. Sample Collection and Handling

- Collect blood, urine, stool, sputum, and other body fluids following proper protocols.
- Label, store, and transport specimens safely to avoid contamination or degradation.

2. Laboratory Testing and Analysis

- Perform tests in key laboratory disciplines:
    - **Haematology** (e.g., CBC, ESR, coagulation studies)
    - **Clinical Chemistry** (e.g., liver/kidney function tests, blood glucose)
    - **Microbiology** (e.g., culture & sensitivity, Gram staining)
    - **Immunology and Serology** (e.g., HIV, Hepatitis, CRP)
    - **Transfusion Medicine** (e.g., blood grouping, cross-matching)
    - **Histopathology/Cytology** (e.g., tissue processing, slide preparation)
    - **Molecular Diagnostics** (e.g., PCR, RT-PCR, gene mutation testing)

3. Instrumentation and Technology

- Operate and maintain laboratory equipment such as analysers, microscopes, centrifuges.
- Calibrate, troubleshoot, and ensure quality control of instruments.
- Use Laboratory Information Systems (LIS) for data entry and reporting.

4. Quality Assurance and Control

- Implement internal and external quality control measures.
- Participate in audits and accreditation processes (e.g., NABL, ISO 15189).
- Maintain records for traceability and legal compliance.

5. Data Interpretation and Reporting

- Validate and interpret test results within clinical context.
- Report critical values promptly to healthcare providers.
- Collaborate with clinicians for re-testing or confirmatory tests when needed.

6. Research and innovation

- Participate in development and validation of new diagnostic tests.
- Contribute to clinical trials or laboratory-based research projects.

7. Infection Control and Biosafety

- Follow biosafety protocols and handle infectious samples with care.
- Dispose of biomedical waste as per guidelines.

8. Education and Training

- Train junior staff, interns, or students.
- Laboratory instructor/trainer
- Curriculum development and policy
- Educational Administrator -Head of Department, Dean/Principal of Allied health sciences, academic coordinator
- Stay updated with continuing education, workshops, and certifications.
- Teaching and academic role - undergraduate and postgraduate MLS courses

Definition of Medical Laboratory Science Professional

"A medical laboratory professional (also referred to as a Medical Laboratory Technologist, a Clinical Laboratory Scientist or Clinical Laboratory Technologist) is a healthcare professional who performs chemical, hematological, immunologic, microscopic and microbiological diagnostic analyses on body fluids such as blood, urine, sputum, stool, cerebrospinal fluid (CSF), peritoneal fluid, pericardial fluid, and synovial fluid, as well as other specimens. Medical laboratory scientists work in clinical laboratories at hospitals, reference laboratories, biotechnology laboratories and non-clinical industrial labs."

Recognition of Title and Qualification in Various Sectors

Medical Laboratory Scientists (MLS/MLTs) play a vital role in diagnostics, research, and healthcare systems. Career progression in laboratories typically follows a structured pathway, from entry-level technical roles to leadership, specialised, and academic/research positions.

1. Entry-Level Roles (Fresh Graduates / Early Career)

- **Medical Laboratory Technologist**
  - Perform routine diagnostic tests in haematology, microbiology, chemistry, immunology, histopathology, and transfusion medicine.
  - Operate analysers, maintain equipment, and ensure quality control.
  - Work under supervision in hospitals, private labs, or blood banks.

2. Core Professional Roles

- **Medical Laboratory Scientist (MLS)**
  - Independently conduct complex laboratory tests, interpret results, and validate findings.
  - Troubleshoot instruments, ensure biosafety, and implement SOPs.
  - Collaborate with clinicians to provide diagnostic support.
- **Specialised MLS** (by discipline):
  - **Haematology Specialist** – Focus on blood disorders, coagulation, bone marrow studies.
  - **Microbiologist** – Culture & sensitivity testing, infection control.
  - **Clinical Biochemist** – Metabolic and biochemical assays, endocrinology testing.
  - **Histopathology/Cytology Specialist** – Tissue diagnosis, cancer screening.
  - **Molecular Diagnostics Specialist** – PCR, sequencing, genetic testing.

3. Senior/Leadership Roles

- **Senior Medical Laboratory Scientist**
  - Supervise staff, manage workflow, maintain accreditation standards.
  - Oversee quality assurance and regulatory compliance.
- **Section Head / Department In-Charge**
  - Lead a specialty department (e.g., microbiology or haematology).
  - Manage budgets, training, and technical advancements.
- **Laboratory Manager / Director**
  - Responsible for overall operations, strategy, and coordination with hospital administration.
  - Ensure compliance with national/international standards (e.g., NABL, CAP, ISO).

4. Specialised/Advanced Pathways

- **Clinical Research Associate** – Conduct clinical trials, monitor lab-based endpoints.
- **Public Health Laboratory Scientist** – Work on surveillance, outbreak investigations, epidemiology labs.
- **Forensic Laboratory Scientist** – Apply lab science in legal and criminal investigations.
- **Transfusion Medicine Specialist** – Manage blood banks, donor screening, transfusion safety.
- **Molecular/Genomics Scientist** – Focus on next-generation sequencing, genetic markers, personalised medicine.

5. Academic & Research Pathways

- **Assistant Professor/Associate Professor/Professor in MLS** – Train future lab professionals.
- **Research Scientist** – Work in universities, research institutes, or pharma companies.
- **Doctoral/Postdoctoral Researcher** – Advance diagnostic science through innovation.

6. Industry & Non-Traditional Roles

- **Application Specialist (Diagnostic Companies)** – Train labs on new equipment and assays.
- **Product Development Scientist** – Innovate diagnostic kits, reagents, and technologies.
- **Quality & Regulatory Specialist** – Ensure diagnostic products comply with global standards.
- **Entrepreneur** – Establish independent diagnostic laboratories or biotech start-ups.

Table 5: Vertical Career Progression for Laboratory Cadre

Clinical/Diagnostic Laboratories	Qualification and experience	Roles and Responsibilities
Medical Laboratory Associate*	Diploma in Medical Laboratory Science (2 yrs Course + 6 months internship) * Only for Diploma obtained before 2021	Preparing biological specimens, recording information, and perform more of the lab maintenance tasks such as cleaning equipment and stocking supplies. They are expected to work under supervision of a medical laboratory Technologist/Scientist
Medical laboratory Technologist	• BMLS – 4 year course with internship OR • *Diploma MLS (2 years + 6 months Internship) + 5 years experience in cinical setting * Only for Diploma obtained between 2015 and 2021.	A medical lab technician performs more of the routine lab work and is often supervised by a medical lab scientist.
Technical Officer I Technical Officer II	• BMLS + 5years experience in Clinical setting or MMLS with 50% marks • BMLS + 8 years experience or • MMLS with 3 years experience in clinical setting as Medical laboratory Technologist	Medical laboratory scientists will collaborate very closely with physicians and medical laboratory Associate and Technologists. Their roles include: Involvement with specialised laboratory assays Relaying test results to Physicians Establishing quality assurance programs Overseeing the work of Laboratory Associates and Technologists Training of Medical Lab technologists and interns

Clinical/Diagnostic Laboratories	Qualification and experience	Roles and Responsibilities
Senior Technical Officer	By promotion from Technical Officer II +3 years' experience	Medical laboratory scientists will collaborate very closely with physicians and medical laboratory Associate and Technologists. Their roles include: Involvement with specialised laboratory assays Relaying test results to Physicians Establishing quality assurance programs Overseeing the work of Laboratory Associates and Technologists Training of Medical Lab technologists and interns
Chief Technical Officer	By promotion from Senior technical officer + 3years experience	Medical laboratory scientists will collaborate very closely with physicians and medical laboratory Associate and Technologists. Their roles include: Involvement with specialised laboratory assays Relaying test results to Physicians Establishing quality assurance programs Overseeing the work of Laboratory Associates and Technologists Training of Medical Lab technologists and interns

Table 6: Vertical career progression for Medical laboratory Science Professionals engaged in Academia

Job Title	Qualification and experience
Tutor/Demonstrator	Bachelor's degree in Medical Laboratory Science (4 year course with internship), with at least 55% marks, (or an equivalent grade in a point-scale wherever the grading system is followed) from an Indian University, or an equivalent degree from an accredited foreign University. Hands on expertise in routine lab techniques, special lab techniques, hematology, blood banking, serology, clinical pathology, clinical biochemistry, histology, cytology, parasitology, medical genetics, blood cell analysis.
Assistant Professor (Entry level) *	A Master's degree with 55% marks (or an equivalent grade in a point-scale wherever the grading system is followed) in a concerned/relevant /allied subject Medical Laboratory Science/Biomedical Science/Biochemistry (Allied & Healthcare), Microbiology (Allied & Healthcare) from an Indian University, or an equivalent degree from an accredited foreign University. ** 50% entry level Assistant Professor positions to be reserved for candidates with Master of Medical Laboratory Science*
Assistant Professor II	An Assistant Professor who has completed four years of service with a PhD degree or Five years with a PG Degree and Attended at least one faculty development Program recognised by NCAHP And has contributed at least one research publication in indexed peer reviewed journal

Job Title	Qualification and experience
Assistant Professor III	An Assistant Professor who has completed five years of service as Assistant Professor II, with a PhD degree in relevant/allied field and Attended at least one faculty development Program recognised by NCAHP And has contributed at least one research publication in peer reviewed journal/ chapter in book And has contributed at least three research publication in indexed peer reviewed journal
Associate Professor	• A good academic record, with a Ph.D. Degree in the concerned/allied/relevant disciplines. • A Master's degree with 55% marks (or an equivalent grade in a point-scale wherever the grading system is followed) in a concerned/relevant /allied subject Medical Laboratory Science/Biomedical Science/Biochemistry (Allied & Healthcare), Microbiology (Allied & Healthcare) from an Indian University, or an equivalent degree from an accredited foreign University. • A minimum of five (5) years of experience of teaching and/or research in an academic/research position equivalent to that of Assistant Professor in a University • a minimum of five publications in indexed peer-reviewed journals

Job Title	Qualification and experience
Professor	• A good academic record, with a Ph.D. Degree in the concerned/allied/relevant disciplines. • A Master's degree with 55% marks (or an equivalent grade in a point-scale wherever the grading system is followed) in a concerned/relevant /allied subject Medical Laboratory Science/Biomedical Science/Biochemistry (Allied & Healthcare), Microbiology (Allied & Healthcare) from an Indian University, or an equivalent degree from an accredited foreign University. • A minimum of five (5) years of experience of teaching and/or research in an academic/research position equivalent to that of Associate Professor in a University • a minimum of ten publications in the peer-reviewed journals
Head of the Department	Head of the Department should be the senior most professor in the department. If no Professor is available or eligible, senior most Associate Professor may be appointed as Head of the Department. In the absence of both, Dean of the faculty may perform the duties. Tenure should be for three years, after which a replacement should be made. Rotation policy for appointment of the Head of the department should be adopted.
Dean	A professor who has completed at least 3 years of service with significant contributions to the field as demonstrated by At least 10 publications in indexed peer reviewed journals Supervised at least 2 doctoral candidates or co-supervised at least 4 doctoral candidates

Job Title	Qualification and experience
Senior Professor	A professor who has completed at least 10 years of service with significant contributions to the field as demonstrated by At least 10 publications in indexed peer reviewed journals Supervised at least 5 doctoral candidates or co-supervised at least 10 doctoral candidates
Principal	Professor /Associate Professor with a total of at least 12years of Teaching/Research/Administrative experience in Universities/Colleges and other Institutes of Higher Education At least 10 publications in indexed peer reviewed journals Supervised at least 5 doctoral candidates or co-supervised at least 10 doctoral candidates

Table 7: Vertical career progression for Medical laboratory Science Professionals engaged in Research and Development

Job Title	Qualification and Experience
Scientist B	Postgraduate degree in Medical Laboratory Science/Biomedical Science/ Biochemistry (Allied & Healthcare), Microbiology (Allied & Healthcare) with at least 55% marks for a recognised University of Institution Or Second class Post graduate with PhD from a recognised University or Institution in Medical Laboratory Science/Biomedical Science/Medical Biochemistry, Medical Microbiology/Genetics/Molecular biology/Molecular Genetics
Scientist C	Postgraduate degree in Medical Laboratory Science/Biomedical Science/ Biochemistry (Allied & Healthcare), Microbiology (Allied & Healthcare)/Genetics/Molecular biology/Molecular Genetics with at least 55% marks for a recognised University of Institution, with 4 years of Research/Teaching experience in Government/Public/Private Institutions Or Second class Post graduate with PhD from a recognised University or Institution in Medical Laboratory Science/Biomedical Science/ Biochemistry (Allied & Healthcare), Microbiology (Allied & Healthcare) /Genetics/Molecular biology/Molecular Genetics, with 4 years of Research/Teaching experience in Government/Public/Private Institutions
Scientist D	Postgraduate degree with at least 55% marks and PhD in Medical Laboratory Science/Biomedical Science/ Biochemistry (Allied & Healthcare), Microbiology (Allied & Healthcare)/Genetics/Molecular biology/Molecular Genetics from a recognised University of Institution, with 4 years of Research/Teaching experience in Government/Public/Private Institutions

Job Title	Qualification and Experience
Scientist E	Postgraduate degree with at least 55% marks and PhD in Medical Laboratory Science/Biomedical Science/ Biochemistry (Allied & Healthcare), Microbiology (Allied & Healthcare)/Genetics/Molecular biology/Molecular Genetics, from a recognised University of Institution, with 6 years of Research/Teaching experience in Government/Public/Private Institutions
Scientist F	Postgraduate degree with at least 55% marks and PhD in Medical Laboratory Science/Biomedical Science/ Biochemistry (Allied & Healthcare), Microbiology (Allied & Healthcare)/Genetics/Molecular biology/Molecular Genetics, from a recognised University of Institution, with 10 years of Research/Teaching experience in Government/Public/Private Institutions
Scientist G	Postgraduate degree with at least 55% marks and PhD in Medical Laboratory Science/Biomedical Science/ Biochemistry (Allied & Healthcare), Microbiology (Allied & Healthcare)/Genetics/Molecular biology/Molecular Genetics, from a recognised University of Institution, with 14 years of Research/Teaching experience in Government/Public/Private Institutions
Head/Director	Postgraduate degree with at least 55% marks and PhD in Medical Laboratory Science/Biomedical Science/ Biochemistry (Allied & Healthcare), Microbiology (Allied & Healthcare)/Genetics/Molecular biology/Molecular Genetics, from a recognised University of Institution, with 16 years of Research/Teaching experience in Government/Public/Private Institutions. Preferably 5 years in managerial position to handle R&D projects independently, including at least 2 years as Scientist F.

Education of the Medical Laboratory Science professional

When developing any education programme, it is necessary that programme planning should be outcome-based and should meet local and national manpower requirements. It should also provide personal satisfaction and career potential for the professionals with supporting pathway in the development of the profession. One of the major changes is the shift from a focus based on traditional theoretical knowledge, to a skills-and competencies-based education and training. Optimal education/training requires that the student is able to integrate knowledge, skills and attitude in order to be able to perform a professional act adequately in a given situation.

Thus, the following curriculum is prescriptive, aims to focus on a skills- and competencies-based approach for learning and is designed accordingly to standardise the content across the nation.

Entry requirements

- Students seeking admission to BMLS program should have completed recognised secondary school studies, 10+2 or equivalent examination with science subjects including Physics, Chemistry, Biology (Min 50% marks) from a recognised university or board. Admission shall be on the basis of the candidate having appeared for the National Eligibility Entrance Test (NEET).
- Students from other boards without English as a compulsory subject may be encouraged to choose English as an elective from available resources on Swayam and similar platforms. The completion of the course will not lead to any university course credit (non-university course).

Course duration

It is recommended that any programme developed from this curriculum should have the following minimum duration for students to qualify as entry level professionals in laboratory Science –

- 4-year program (including 1 year of compulsory internship (Laboratory rotation /Research dissertation)- Bachelor's degree level
- 2-year program including six months of Research Dissertation - Master's degree level

Initially, the academic content should emphasize on establishing a strong scientific basis and in the latter year, it should focus on the application of theory to clinical/reflective practice. The aim of the degree program is to enable the development of a Medical Laboratory Technologist as a key member of the multidisciplinary team and to enable him/her to prepare in advance, plan and execute laboratory testing with assured quality.

With the change in disease dynamics and multifold increase in cases needing medical laboratory science for the purpose of diagnosis, it is imperative that a well-structured programme of postgraduate education is also encouraged so as to enhance research capacity within the country, to widen the scope of clinical practice for the profession and to produce well trained teaching faculty from within the profession. Thus, a **Master's degree programme is** recommended with a minimum of two years of education including dissertation/thesis, to specialise in the field of Medical Laboratory Science. Postgraduate students can contribute significantly in academics and research.

Ph.D. also plays a significant role in the academic system of Medical Laboratory Science; however, the curriculum has not indicated any prescriptive guidelines for that level apart from mapping it on the career and qualification map. The same needs to be promoted, for strengthening the faculty development and significant contribution of Medical Laboratory Professionals in the field of Research and development.

Stipend to the students during the internship period

The Task Force strongly recommends providing a stipend to students during their internship period. It is advisable for the University/Institution to determine and set a reasonable amount for this stipend, ensuring that students are adequately supported during their practical training experience.

Infrastructure and Teaching Faculty Requirements

The importance of providing an adequate learning environment for students needs to be emphasized. Both the physical infrastructure and the teaching staff must be adequate.

Teaching areas should facilitate different teaching methods. Where students share didactic lectures with other disciplines (e.g. diagnostic radiographers, nurses) large lecture theatres may be appropriate, but smaller teaching areas should also be provided for tutorial and problem/case- based learning approaches. In all venues where students are placed the health and safety standards must be adhered to.

It is recommended that a faculty and student ratio of 1:15 is to be followed for the undergraduate programmes and 1:10 for the Post graduate programmes.

Minimum Standard Recommendations

Infrastructure

The importance of providing an adequate learning environment for the students cannot be over emphasised. Both the physical infrastructure and the teaching staff must be adequate. Teaching areas should facilitate different teaching methods. While students may share didactic lectures with other disciplines in large lecture theatres, smaller teaching areas should also be provided for tutorial and problem/case-based learning approaches. In all venues that accommodate students, health and safety standards must be adhered to. It is recommended that a faculty and student ratio of 1:15 for undergraduate courses and 1:10 for postgraduate courses be followed. For institutions sharing premises with either NMC recognised Medical Colleges and Hospitals, adequate facilities must be available for enrolled students for clinical postings/internships. For stand-alone institutions, memorandum of understanding (MOU) with NABH recognised Hospitals, with minimum 100 beds in-patient facility, with attached laboratories or NABL recognised diagnostic laboratories (medium sized as defined by NABL) must be available for providing clinical postings/internships to students.

Teaching Infrastructure

Classrooms

It is recommended that each institution must have the following minimum teaching infrastructure available for MLS courses. In institutions offering multiple A&HP courses, lecture rooms and seminars rooms and laboratory spaces and infrastructure may be shared. However, it is the responsibility of the institution to enable uninterrupted instructions to all students enrolled in A&HP courses. At least one class room/lecture hall is expected to be equipped with smart board and internet facilities for audio visual teaching. For institutions offering postgraduate courses, additional classrooms and seminar rooms for each A&HP course may be provided.

Laboratories

Each institution is expected to have at least the following laboratories, to cater to the needs of undergraduate courses, size of which must be appropriate to accommodate each batch of MLS students. Laboratory space may be shared with other A&HP courses

- Anatomy laboratory*
- Physiology laboratory*
- Biochemistry laboratory
- Microbiology laboratory
- Haematology and clinical pathology laboratory
- Histopathology and cytopathology laboratories

*Anatomy and Physiology labs may be combined into one laboratory

Details of minimum requirements in terms of equipment/instruments and consumables for MLS courses is provided in the below

Table 8: Minimum recommended requirements for laboratory equipments/instruments

Anatomy and Physiology		Biochemistry		Microbiology		Hematology		Histology	
Item	**Nos**	**Item**	**Nos**	**Item**	**Nos**	**Item**	**Nos**	**Item**	**Nos**
Human Skeleton	1	Hot plate	2	Hot plate	1	Binocular Microscope	15	Binocular Microscope	5
Disarticulated Bone set	1	Hot air oven	1	Hot air oven	1	Hot air oven	1	Hot air oven	2
Spirometer	10	Water bath	1	Water bath	1	Water bath	1	Tissue Floatation bath	1
Specimen/model for soft parts [heart, lung, brain, spinal cord, lower limb, upper limb, spine, GI system, male and female urogenital system	1	Digital pH meter	1	Digital pH meter	1	Digital pH meter	1	Incubator	1
Display charts	As per Requirement	Photoelectric colorimeter	2	Photoelectric colorimeter	1	Photoelectric colorimeter	1	Rotary Microtome	1
Mannequin for CPR	1	Electronic Weighing balance	2	Electronic Weighing balance (mg and gm measurement)	2	Electronic Weighing balance (mg and gm measurement)	1	Microcentrifuge	1

Anatomy and Physiology		Biochemistry		Microbiology		Hematology		Histology	
Item	**Nos**	**Item**	**Nos**	**Item**	**Nos**	**Item**	**Nos**	**Item**	**Nos**
Needle Destroyer	1	Refrigerator	1	Refrigerator	1	Refrigerator	1	Staining bucket	1
Colour coded dustbins-biomedical Waste management (red, yellow, blue, white, green)		Needle destroyer	1	Needle destroyer	1	Needle destroyer	2	Cytospin	1
Bp apparatus with stethoscope	10	Incubator	1	Incubator	1	Incubator	1	Colour coded dustbins-biomedical Waste management (red, yellow, blue, white, green)	1
Pulse oximeter	5	Centrifuge (small)	1	Centrifuge (small)	1	Centrifuge (small)	1	Grossing Board	1
		Semi Automated Analyser	1	Binocular Microscope	15	Remi Centrifuge	1	Vacuum Impregnation Unit for tissue	1
		Remi Centrifuge	2	Remi Centrifuge	1	Vortex Shaker	2	Automatic Tissue processor (optional)	1
		Colour coded dustbins (red, yellow, blue, white)	1	Colour coded dustbins-biomedical Waste management (red, yellow, blue, white, green)	1	Colour coded dustbins-biomedical Waste management (red, yellow, blue, white, green)	1		

Anatomy and Physiology		Biochemistry		Microbiology		Hematology		Histology	
Item	**Nos**	**Item**	**Nos**	**Item**	**Nos**	**Item**	**Nos**	**Item**	**Nos**
		Analytical Balance With Weight Box-Chemical	1	Steam Sterilizer	1	Semi Automatic Urine Analyser	1		
		Vortex Shaker	2	Vortex Shaker	1	Hematology Analyser 5 parts (Optional)			
		Glucometer with strips	2	Autoclave	1	DLC counter	15		
		Desiccators	2	Laminar Air flow	1	Pulse oximeter	3		
		Bunsen burner with Gas supply	10	Biosafety Cabinet	1	Bp Apparatus with Stethoscope	15		
		Distilled water	1	Distilled water	1	Distilled water	1		
		Infrared Thermo-meter	2	Bunsen burner with Gas supply	10	Dummy Arm for blood collection	1		
				Anaerobic Jar	1				

Table 9: Additional recommended instruments for MMLS

Chromatography Chamber
Vertical Gel Electrophoresis with Power pack
Horizontal Gel Electrophoresis with Power Pack
HPLC
Hematology Analyser
Thermal Cycler (PCR Machine)
Hematology 5 parts Coulter
Blood mixer
Soxhlet Apparatus
Refrigerated Centrifuge
Deep Freezer -20
Deep Freezer -80
Spectrophotometer
Colony Counter
Automated Rotary Microtome
Digital Microscope
FIA Analyzer (Optional)
Coagulometer
Ice Flaking making machine
Micropipettes (0.2-2, 1-10, 2-20,20-200,100-1000µl)- each 1 set
ELISA Reader
Multichannel Pipette

For institutions offering postgraduate course in MLS, it is also recommended that at least two (2) separate laboratories equipped with the following additional instruments are provided.

Recommended lab wares

Following is the list of minimum recommended laboratory lab ware that must be available in the laboratories. Based on the actual requirement and recurrent usage, lab ware may be purchased accordingly

Table 10: Recommended lab wares

Apparatus name/glassware/plastic ware	Quantity
Hemoglobinometer	30
Hemocytometer	30
Westergren tube	30
Wintrobe tubes	30
Disposable ESR tubes	100
ESR stand	6
Coplin jar	50
L Mould	10
Tissue processing cassette	30
Microscopic slides	300
Concavity Slides	30
Stop Watch	20
Staining dropper bottle	30
Petri plate (plastic/glass)	30
Petri plate -disposable	100
BHIB Bottle	30
Covers lIP	30
Staining Jars	10

Apparatus name/glassware/plastic ware	Quantity
Slide storage Box	10
Slide keeping tray	10
Slide drying tray	10
Durham tube	20
Beaker 500ml	20
Beaker 250ml	20
Beaker 100ml	20
Beaker 500 ml (Plastic)	10
Measuring cylinder 500ml	20
Measuring cylinder 250ml	20
Funnel	20
Conical flask 500ml	30
Conical flask 250ml	30
Round bottle flask 100ml	10
Volumetric flask	20
Wash bottle	20
Test tube stand	30
Test tube 10ml	600
Test tube 5ml	600
Test tube holder	30
Glass pipette 5ml	10
Glass pipette 2ml	10
Glass pipette 10ml	10

Apparatus name/glassware/plastic ware	Quantity
Pipette pump	15
Rubber bulb (bulbar)	30
Pasteur pipette (disposable)	500
Micropipette tips 10ul, 200ul, 1ml	3 set each
Micro centrifuge Vial (1.5ml)	300
Urine containers	500nos
Borosilicate bottle for media preparation	20
Bijou Bottles	20
Forceps (big & medium)	10 each
Agitator	2
Cover Slips (small and big)	10 boxes each
Spatula (small, medium, big)	10 each
Test tube cleaning brush	50
Reagent bottles (200 ml)	15
Reagent bottles amber (200 ml)	15
Torniquet	30
Needle and syringe (2ml, 5ml, wing infusion set)	500
Heparin Vacutainer	300
EDTA Vacutainer	300
Sodium Citrate Vacutainer	200
Clot retractor Tube (Yellow Cap) Vacutainer	200
Sodium fluoride Vacutainer	300

Apparatus name/glassware/plastic ware	Quantity
Plain vacutainers	300
Vacutainer needles	300
Vacutainer holder	30
Cotton roll (Absorbent)	2
Cotton roll (Non Absorbent)	2
Lancet	500
Diamond marker pencil	10
Beaker 1L plastic	10
Glass rod	30
Watch glass	30
Tripod stand with wire gauze	30
Glass thermometers	5
Porcelain Dish (China Dish)	30
Mortar and Pestle	5
Ryle Tube	10
Urinometer	10
Staining bottles	20
Filter Paper	As per requirement
Droppers	30

Library

It is recommended that the institution must have a well stocked library with required text books/reference books, periodicals and Journals for use by students and faculty. It is also recommended that each institution must subscribe to the One nation One Subscription (ONOS) initiative of the Government of India to facilitate access to wide range of scholarly research content to all students and faculties. Necessary hardware for this must be provided by the institution. At least five (5) terminals/desktops must be available. Recommended list of text and reference books for undergraduate and postgraduate courses is provided with the detailed syllabus. The institution must provide sufficient copies to the students.

Computer facility

Each institution is recommended to have a computer facility with at least fifteen (15) desktop computers with internet access for students. This facility may be used for imparting practical training to students as part of the "Basics of Computer Applications" Course as detailed in the BMLS syllabus. The facility may also be made available to students for their assignments/project work. Wherever possible, separate desktops for postgraduate students may be provided that can be shared by students for their research work and data analysis. Required softwares and applications may be made available as necessary.

Human Resource Requirements

Teaching Faculty

Teaching posts in each institution as far as feasible, may be created in a pyramidal order. For instance, for one post of Professor, there shall be two posts of Associate Professors and four posts of Assistant Professors and five Demonstrators.

1. Professor – 1
2. Associate Professor – 2
3. Assistant Professors – 4
4. Tutors / Demonstrators – 5 (1 in each lab)

For postgraduate MLS course, following additional faculty strength is recommended

1. Professor – 1
2. Associate Professor – 3
3. Assistant. Professors – 2

Note: Only Assistant Professor with at least one year experience, Associate professor, Professor are eligible to guide PG students for their research dissertation.

Following is the recommended essential qualifications and experience criteria for faculty for teaching courses in Medical Laboratory Sciences.

Table 11: Recommended Qualifications and experience for Teaching faculty appointment

Job Title	Qualification and experience
Tutor/Demonstrator	• Bachelor's degree in Medical Laboratory Technology (4 year course with internship), with at least 55% marks, (or an equivalent grade in a point-scale wherever the grading system is followed) from an Indian University, or an equivalent degree from an accredited foreign University. • Hands on expertise in routine lab techniques, special lab techniques, hematology, blood banking, serology, clinical pathology, clinical biochemistry, histology, cytology, parasitology, medical genetics, blood cell analysis.

Job Title	Qualification and experience
Assistant Professor (Entry level) *	A Master's degree with 55% marks (or an equivalent grade in a point-scale wherever the grading system is followed) in a concerned/relevant /allied subject Medical Laboratory Science/Biomedical Science/ Biochemistry (Allied & Healthcare), Microbiology (Allied & Healthcare) from an Indian University, or an equivalent degree from an accredited foreign University. ** 50% entry level Assistant Professor positions to be reserved for candidates with Master of Medical Laboratory Science*
Assistant Professor II	An Assistant Professor who has completed four years of Service with a PhD degree or Five years with a PG Degree and Attended at least one faculty development Program recognised by NCAHP And has contributed at least one research publication in indexed peer reviewed journal
Assistant Professor III	An Assistant Professor who has completed Five years of Service as Assistant Professor II, with a PhD degree in relevant/allied field and Attended at least one faculty development Program recognised by NCAHP And has contributed at least one research publication in indexed peer reviewed journal And has contributed at least three research publication in indexed peer reviewed journal

Job Title	Qualification and experience
Associate Professor	• A good academic record, with a Ph.D. Degree in the concerned/allied/relevant disciplines. • A Master's degree with 55% marks (or an equivalent grade in a point-scale wherever the grading system is followed) in a concerned/relevant /allied subject Medical Laboratory Science/Biomedical Science/ Biochemistry (Allied & Healthcare), Microbiology (Allied & Healthcare) from an Indian University, or an equivalent degree from an accredited foreign University. • A minimum of five (5) years of experience of teaching and/or research in an academic/research position equivalent to that of Assistant Professor in a University • a minimum of five publications in the indexed peer-reviewed journals
Professor	• A good academic record, with a Ph.D. Degree in the concerned/allied/relevant disciplines. • A Master's degree with 55% marks (or an equivalent grade in a point-scale wherever the grading system is followed) in a concerned/relevant /allied subject Medical Laboratory Science/Biomedical Science/ Biochemistry (Allied & Healthcare), Microbiology (Allied & Healthcare) /Genetics/Molecular biology/Molecular Genetics from an Indian University, or an equivalent degree from an accredited foreign University. • A minimum of five (5) years of experience of teaching and/or research in an academic/research position equivalent to that of Associate Professor in a University • a minimum of ten publications in the indexed peer-reviewed journals

Job Title	Qualification and experience
Dean	A professor who has completed at least 3 years of service with significant contributions to the field as demonstrated by At least 10 publications in indexed peer reviewed journals Supervised at least 5 doctoral candidates or co-supervised at least 10 doctoral candidates
Senior Professor	A professor who has completed at least 10 years of service with significant contributions to the field as demonstrated by At least 10 publications in indexed peer reviewed journals Supervised at least 5 doctoral candidates or co-supervised at least 10 doctoral candidates
Principal	Professor /Associate Professor with a total of at least 12years of Teaching/Research/Administrative experience in Universities/Colleges and other Institutes of Higher Education At least 10 publications in indexed peer reviewed journals Supervised at least 5 doctoral candidates or co-supervised at least 10 doctoral candidates

Faculty from other non-MLS subjects Anatomy, Physiology, Pharmacology, Preventive social medicine, English, Computer Sciences, Research Methodology may be appointed on full-time basis in institutions offering other A&HP courses. However, for institutions offering only MLS courses, part-time faculties may be appointed. Adjunct/Visiting faculty may also be appointed as per NCAHP regulations.

For institutions initiating new undergraduate MLS courses, following is the recommended faculty appointment schedule to ensure uninterrupted instruction.

Table 12: Recommended faculty strength for new institutions/colleges

Before the start of 1st year of BMLS	Professor-1 Associate prof-1 Assistant professor-2 Tutor- 2
Before the start of 2nd year of BMLS	Professor-1 Associate prof-1 Assistant professor-3 Tutor- 3
Before the start of 3rd year of BMLS	Professor-1 Associate prof-2 Assistant professor-4 Tutor- 5
Before the start of 4th year of BMLS	Professor-1 Associate prof-2 Assistant professor-4 Tutor- 5

Table 13: Recommended non faculty staff to be appointed

Post	**Strength**
Librarian	1
Asst. Librarian	1
Office Assistant Clerk/DEO	1
Lab Attendants	3
Peon/Sweepers/Cleaners	As Per Requirement

Faculty Development Program

Each semester, faculty members are required to attend a minimum of 2 Faculty Development Programs (FDPs) to familiarize themselves with the use of new technologies in teaching and research.

Modalities for exit Exam/Licensure Exam

Modalities for exit/licensure exam as notified by NCAHP and must be strictly adhered to.

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Chapter 4
Curriculum -Bachelor of Medical Laboratory Science

Background

Bachelor of Medical Laboratory Science (BMLS) is an undergraduate degree program designed to prepare students for a professional career in **clinical laboratory science**, which plays a critical role in diagnosing, treating, and monitoring diseases. The course is designed to be of 4 years duration (including one year compulsory internship).

- **Eligibility for admission:** The candidate must have passed Higher Secondary (10+2) or equivalent examination recognised by any Indian Board or a duly constituted Board or National Open School with at least 50% marks in aggregate of physics, chemistry and biology (botany & zoology).
- Admission to Bachelor of Medical Laboratory Science program shall be made on the basis of NEET examination and merit list based on 10+2 marks.
- Candidates who have studied abroad and have possess equivalent qualification as determined by the Association of Indian Universities and Equivalence Committee of the NCAHP and fulfil the above criteria shall also be eligible for admission.
- Candidates must be 17 years as on December 31 of the year of admission to first year of BMLS course.
- Candidates must furnish a certificate of Physical fitness from an Authorized Medical Professional, at the time of application, to ascertain that the candidate does not have any physical disability
- **Degree Awarded:** Bachelor's of Medical Laboratory Science (BMLS)
- **Medium of instruction:** English
- **Lateral Entry for candidates with Diploma in Medical Laboratory Science:** Candidates who have obtained Diploma in Medical Laboratory Science from recognised Universities/Institutions will be eligible for direct admission to Second year of BMLS course. Only 10% of sanctioned strength of BMLS course can be allotted to Lateral entry candidates, based on on merit.

Program Objectives:

- Equip students with knowledge of laboratory procedures across **haematology**, **clinical biochemistry**, **microbiology**, **immunology**, **histopathology**, and **molecular diagnostics**.
- Train students to operate, maintain, and troubleshoot modern diagnostic equipment.
- Emphasize quality control, laboratory safety, and ethical practice.
- Develop critical thinking and diagnostic interpretation skills.

Core Subjects included in the curriculum are:

1. Human Anatomy & Physiology
2. Biochemistry
3. Pathology
4. Microbiology
5. Hematology
6. Immunology & Serology
7. Blood Banking & Transfusion Science
8. Clinical Biochemistry
9. Histopathology & Cytology
10. Molecular Biology & Genetics
11. Laboratory Management & Quality Assurance
12. Research Methodology

The course curriculum is designed to provide special emphasis on hands-on lab sessions in hospital or diagnostic laboratories, Internships in clinical settings, in the final year

Career Opportunities:

Upon successful completion of the course, Graduates can work as:

- **Medical Laboratory Technologists**
- **Clinical Research Assistants**
- **Clinical Lab Managers**
- **Quality Control Officers**
- **Molecular Lab Technologists**

In Hospitals, Diagnostic labs, Blood banks, pharmaceutical companies, public health organizations, Research institutions

Students also have higher studies options including, Master of Medical Laboratory Science, M.Sc. in disciplines like Microbiology, Biochemistry, or Biotechnology, MBA in Hospital or Healthcare Management

Learning objectives

1. Foundational Knowledge

- Understand the normal structure and function of the human body.
- Explain the pathophysiological basis of disease and how laboratory tests aid diagnosis.
- Apply knowledge of microbiology, hematology, biochemistry, immunology, and molecular biology to clinical scenarios.

2. Laboratory Skills

- Perform routine and specialized laboratory tests accurately in various disciplines (e.g., hematology, microbiology, clinical chemistry, histopathology).
- Operate, calibrate, and maintain laboratory instruments and equipment.
- Collect, handle, and process biological specimens following safety and quality standards.

3. Quality Assurance & Safety

- Implement quality control procedures to ensure accuracy and reliability of test results.
- Adhere to biosafety and infection control guidelines in all laboratory practices.
- Identify and troubleshoot pre-analytical, analytical, and post-analytical errors.

4. Critical Thinking & Problem Solving

- Analyze and interpret laboratory data for clinical relevance.
- Recognize abnormal results and understand their diagnostic implications.
- Apply logical reasoning to solve technical problems and improve procedures.

5. Communication & Collaboration

- Communicate effectively with healthcare professionals, patients, and laboratory teams.
- Maintain clear and accurate laboratory records and reports.
- Demonstrate professional and ethical behavior in a clinical setting.

6. Research & Lifelong Learning

- Understand the principles of scientific research and evidence-based practice.
- Participate in small-scale research or projects related to laboratory science.
- Stay updated with current advances in laboratory medicine and emerging technologies.

7. Professional Development

- Demonstrate responsibility, initiative, and time management in professional duties.
- Understand legal and ethical issues in laboratory practice.
- Prepare for national certification or licensing exams, if applicable.

PROGRAM OUTCOMES (POs)

Upon successful completion of the BMLS program, students will be able to:

POs	Outcome
PO1	**Apply scientific knowledge** in professional healthcare practice.
PO2	**Demonstrate clinical and technical skills** to deliver quality healthcare services.
PO3	**Collaborate effectively in teams** within an interdisciplinary healthcare setting to improve societal health.
PO4	**Uphold ethical values and professionalism** within the legal framework of society.
PO5	**Communicate effectively** with healthcare teams and the community.
PO6	**Practice evidence-based medicine** to ensure high-quality professional performance.
PO7	**Engage in continuous learning** and adapt to technological advancements for professional growth.
PO8	**Exhibit entrepreneurial, leadership, and mentorship skills** for independent practice and collaborative work in healthcare.
PO9	Demonstrates an appropriate use of information and communication technology relevant to their field.
PO 10	**Takes responsibility for personal and professional development** and demonstrates an obligation to maintain competency by applying newly acquired knowledge or abilities to patient care

Program Specific Outcomes (PSO)

POs	Outcome
PSO-1	Proficiently perform a full range of clinical laboratory tests, develop and evaluate test systems and interpretive algorithms and should be able to work on automated machines.
PSO-2	Manage information to enable effective, timely, accurate, and cost-effective reporting of laboratory-generated information and make specimen-oriented decisions on predetermined criteria, including working knowledge of critical values.
PSO-3	Process information and ensure quality control as appropriate to routine laboratory procedures.

GRADUATE ATTRIBUTES

Upon graduation, students from this **institution** will possess the following attributes:

S. No.	Attribute	Description
1	**Knowledge and Understanding**	Apply scientific knowledge and critical thinking in their field.
2	**Communication & Professionalism**	Communicate effectively with diverse audiences in various formats.
3	**Critical Thinking**	Analyse information and solve problems logically.
4	**Inquiry and Research**	Ask questions, investigate, and pursue new knowledge.
5	**Digital Literacy**	Use digital tools and technologies effectively and responsibly.
6	**Professionalism & Ethics**	Act ethically, responsibly, and professionally.

S. No.	Attribute	Description
7	**Lifelong Learning**	Continuously seek and acquire new knowledge and skills.
8	**Leadership & Teamwork**	Lead and work effectively in diverse teams.
9	**Interdisciplinary Skills**	Work effectively across different fields of study.
10	**Social Responsibility**	Contribute positively to society and understand global issues.
11	**Multi-cultural Competence**	Work respectfully and effectively in diverse cultural settings.
12	**Competence & Capability**	Perform their professional duties effectively and skillfully.

CURRICULUM OUTLINE

BMLS FIRST SEMESTER

COURSE NAME	Lecture	Tutorial	Practical	Credits	Contact Hours
Human Anatomy	3	1	0	4	60
Human Physiology	3	1	0	4	60
Fundamentals of the Healthcare System and Medical Laboratory Science (MLS) #	2	0	0	2	30
Communication and Professionalism#	2	0	0	2	30
Basic Emergency care and First aid	1	1	0	2	30
Basics of Computer Application	1	0	1	2	45
Human Anatomy practical	0	0	4	2	60
Human Physiology practical	0	0	4	2	60
Total	**12**	**3**	**9**	**20**	**375**

BMLS SECOND SEMESTER

COURSE NAME	Lecture	Tutorial	Practical	Credits	Contact Hours
Fundamentals of Microbiology	4	0	0	4	60
Basics of Biochemistry	4	0	0	4	60
Fundamentals of Haematology	4	0	0	4	60
Preventive and Social Medicine	2	0	0	2	30
Fundamentals of Microbiology Practical	0	0	4	2	60
Basics of Biochemistry Practical	0	0	4	2	60
Fundamentals of Haematology Practical	0	0	4	2	60
Total	**14**	**0**	**12**	**20**	**390**

BMLS THIRD SEMESTER

COURSE NAME	Lecture	Tutorial	Practical	Credits	Contact Hours
Bacteriology	4	0	0	4	60
Intermediary Metabolism and Endocrinology	4	0	0	4	60
Clinical Haematology	4	0	0	4	60
Basics of Pharmacology	2	0	0	2	30
Bacteriology Practical	0	0	4	2	60
Intermediary Metabolism and Endocrinology Practical	0	0	4	2	60
Clinical Haematology- Practical	0	0	4	2	60
Total	**14**	**0**	**12**	**20**	**390**

BMLS FOURTH SEMESTER

COURSE NAME	Lecture	Tutorial	Practical	Credits	Contact Hours
Virology and Immunology	4	0	0	4	60
Genetics and Molecular Biology	4	0	0	4	60
Clinical Pathology	4	0	0	4	60
Medical Laboratory Management and Quality Control	2	0	0	2	30
Virology and Immunology Practical	0	0	4	2	60
Genetics and Molecular Biology Practical	0	0	4	2	60
Clinical Pathology Practical	0	0	4	2	60
Total	**14**	**0**	**12**	**20**	**390**

BMLS FIFTH SEMESTER

COURSE NAME	Lecture	Tutorial	Practical	Credits	Contact Hours
Mycology & Parasitology	4	0	0	4	60
Analytical Biochemistry	4	0	0	4	60
Immunohematology and Transfusion Medicine	4	0	0	4	60
Medical Law and Ethics	2	0	0	2	30
Mycology & Parasitology Practical	0	0	4	2	60
Analytical Biochemistry Practical	0	0	4	2	60
Immunohematology and Transfusion Medicine Practical	0	0	4	2	60
Total	**14**	**00**	**12**	**20**	**390**

BMLS SIXTH SEMESTER

COURSE NAME	Lecture	Tutorial	Practical	Credits	Contact Hours
Applied Pathobiology	4	0	0	4	60
Cytology and Histopathology	4	0	0	4	60
Clinical Biochemistry	4	0	0	4	60
Biostatistics and Research Methodology	2	0	0	2	30
Cytology and Histopathology Practical	0	0	4	2	60
Clinical Biochemistry Practical	0	0	4	2	60
Applied Pathobiology Practical	2	0	0	2	60
TOTAL	**16**	**0**	**8**	**20**	**390**

BMLS SEVENTH & EIGHTH SEMESTER

Course Name	Credit	Contact Hours
INTERNSHIP (clinical lab posting/research dissertation)	20+20	900+900
TOTAL	**40**	**1800**

Total credits = 160 credits
Total Contact hours = 4125
Contact hours of all semesters = (375+ 390+390+390+390+390) + (900+900)

Credit Details:

- **Lecture / Tutorial: 1 credit = 15 hours**
- **Practical: 1 credit = 30 hours**
- **Clinical Lab postings: 1 credit = 45 hours**

Credit Includes: L – Lectures, T - Tutorials, P - Practical.

MARKS DISTRIBUTION

BMLS FIRST SEMESTER

COURSE NAME	Continuous assessment	End Semester Examination	Total
Human Anatomy	30	70	100
Human Physiology	30	70	100
Fundamentals of the Healthcare System and Medical Laboratory Science (MLS) #	15	35	50
Communication and Professionalism#	15	35	50
Basic Emergency care and First aid	30	70	100
Basics of Computer Application	30	70	100
Human Anatomy practical	30	70	100
Human Physiology practical	30	70	100
TOTAL			**700**
# Non-University Exams			

BMLS SECOND SEMESTER

COURSE NAME	Continuous assessment	End Semester Examination	Total
Fundamentals of Microbiology	30	70	100
Basics of Biochemistry	30	70	100
Fundamentals of Haematology	30	70	100
Preventive and Social Medicine	30	70	100
Fundamentals of Microbiology Practical	30	70	100
Basics of Biochemistry Practical	30	70	100
Fundamentals of Haematology Practical	30	70	100
Total			**700**

BMLS THIRD SEMESTER

COURSE NAME	Continuous assessment	End Semester Examination	Total
Bacteriology	30	70	100
Intermediary Metabolism and Endocrinology	30	70	100
Clinical Haematology	30	70	100
Basics of Pharmacology	30	70	100
Bacteriology Practical	30	70	100
Intermediary Metabolism and Endocrinology Practical	30	70	100
Clinical Haematology- Practical	30	70	100
Total			**700**

BMLT FOURTH SEMESTER

COURSE NAME	Continuous assessment	End Semester Examination	Total
Virology and Immunology	30	70	100
Genetics and Molecular Biology	30	70	100
Clinical Pathology	30	70	100
Medical Laboratory Management and Quality Control	30	70	100
Virology and Immunology Practical	30	70	100
Genetics and Molecular Biology Practical	30	70	100
Clinical Pathology Practical	30	70	100
Total			**700**

BMLS FIFTH SEMESTER

COURSE NAME	Continuous assessment	End Semester Examination	Total
Mycology & Parasitology	30	70	100
Analytical Biochemistry	30	70	100
Immunohematology and Transfusion Medicine	30	70	100
Medical Law and Ethics	30	70	100
Mycology & Parasitology Practical	30	70	100
Analytical Biochemistry Practical	30	70	100
Immunohematology and Transfusion Medicine Practical	30	70	100
Total			**700**

BMLS SIXTH SEMESTER

COURSE NAME	Continuous assessment	End Semester Examination	Total
Applied Pathobiology	30	70	100
Cytology and Histopathology	30	70	100
Clinical Biochemistry	30	70	100
Biostatistics and Research Methodology	30	70	100
Cytology and Histopathology Practical	30	70	100
Clinical Biochemistry Practical	30	70	100
Applied Pathobiology Practical	30	70	100
TOTAL			**700**

BMLS SEVENTH & EIGHTH SEMESTER

COURSE NAME	Continuous Assessment	End Semester Examination	Total
Lab Posting/ Research Dissertation (Logbook and Viva)	90	210	300
Lab Posting/Research Dissertation (Logbook and Viva)	90	210	300
Total			**600**

Credit Distribution: Each semester would consist of a minimum of 20 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

Undergraduate Program Requirements: A minimum of **160** credits is required for the BMLS

A program of 4 years duration, inclusive of a one-year internship (Lab posting /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)
- Second to third year: a cumulative minimum of 80% of the credits at the end of the second year (includes first, second, third and fourth semester)
- Third year to Internship/group project: Students will be eligible for internship (Lab posting/ research dissertation) only after successful completion of the entire coursework, i.e. 100% credits to be accrued by the end of the third year.

The student must complete all the coursework requirements within a maximum of double the program duration. For example, in a 4-year program, all the academic coursework needs to be completed within 8 years. Failure to do so will result in exit from the program.

Weightage distribution

Item	Weightage (%)
Formative	
Class participation/presentation	5%
Assignment & quizzes	5%
Sessional exams	20%
Summative	
End-of-Semester University exam	70%
Total	100 %

- Any components/ activities that need to be evaluated as part of the internship, without reflecting them in the CGPA

Point grading system (credit value)

Letter Grade	A+	A	B	C	D	E	F/I/DT
Credit value	10	9	8	7	6	5	0

F- Fail, DT - Detained/Attendance shortage, I – Incomplete

Internals Weightage (%)	**End semester Exam Weightage (%)**
30	70

Calculation of GPA & CGPA: An example is provided

Course code	Course	Credits (a)	Grade obtained by the student	Credit value (b)	Grade Points (a x b)
BMLS 1	Course - 1	4	D	6	24
BMLS 2	Course - 2	4	B	8	32
BMLS 3	Course - 3	3	A+	10	30
BMLS 4	Course - 4	4	C	7	28
BMLS 5	Course - 5	5	A	9	45
TOTAL		**20**	**-**	**-**	**159**

1st Semester GPA = Total grade points / total credits

159/20 = **7.95**

Suppose in **the 2nd semester, GPA** = **8.35** with respective course credit 20

$$Then, 1^{st} YearCGPA = \frac{(7.95x20) + (8.35x20)}{20 + 20} = 8.15$$

Progression Criteria to Higher Semesters

Eligibility for promotion to the next academic year is based on the following minimum academic performance requirements:

- **First Year to Second Year**:
- A student must secure a minimum of **70% of the total credits** at the end of the first year (i.e., completion of both the first and second semesters).
- **Second Year to Third Year**:
- A student must secure a **cumulative minimum of 80% of the total credits** at the end of the second year (i.e., completion of the first to fourth semesters).

- **Third Year to Internship/Group Project**:
- A student will be eligible to commence the **Internship (Lab posting/ Research Dissertation)** only after the **successful completion of all coursework**, i.e., **100% of the credits** must be earned by the end of the third year.

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.

Program Completion Timeline

- All academic coursework must be completed within a maximum of **double the program duration**.
- For example, in a **4-year program**, all requirements must be fulfilled within **8 years** from the date of admission.

Note: Failure to complete the program within the stipulated maximum duration will result in **automatic exit** from the program.

7th and 8th Semester: Internship (Lab posting/ Research dissertation):

A compulsory internship (Lab posting/ Research dissertation) of one year - equivalent to 12 months, 52 weeks, or 1800 hours - carrying 40 credits, must be completed by each student to be eligible for the award of the **Bachelor of Medical Laboratory Science (BMLS).**

If a student opts for Research dissertation, it must be of a minimum duration of 6 months.

During the internship period, students are required to adhere to the rules and regulations of the host organisation.

Upon successful completion, students will receive an Internship Certificate that includes:

A summary of activities undertaken

Details of clinical or relevant departmental postings with corresponding hours

Information on any research project completed during research dissertation

The certificate must be authenticated by the **Dean/ Head of Department (HoD)/Coordinator and the Head of the Institution (HoI).**

Note: The Bachelor's Degree will be awarded only upon successful completion of the Internship requirements.

SEMESTER 1

Course Name: Fundamentals of the Healthcare System and Medical Laboratory Science Credit = 2 (30 hours)

Course Rationale: This course provides students with a comprehensive understanding of the Indian health care delivery system and the Clinical Laboratory in the health care system. Students will also understand the roles, responsibilities, and regulatory bodies of medical laboratory sciences.

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

- Comprehend knowledge of the healthcare delivery system in India
- Identify the laboratory safety measures and biomedical safety management
- Understand the organisation, the importance of Clinical labs, Lab professionals and regulatory professional bodies

Unit	Topic	Hours
I	Introduction to healthcare delivery system - Healthcare delivery system in India at primary, secondary and tertiary care, classification of hospitals based on system of medicine, Community participation in healthcare delivery system, National Health Mission, National Health Policy, Issues in Health Care Delivery System in India	6
II	Visit to Clinical laboratories, Introduction to clinical Laboratory, Classification of Laboratory, Introduction to various sections/departments in clinical laboratories, Lab space and designing, Knowledge of lab organisational chart, Role of Laboratory in patient care	8
III	Lab safety measures- Infection control, Universal precautions, PPE, Vaccination, Chemical, physical, electrical and fire safety. Biomedical waste management	4

Unit	Topic	Hours
IV	Records and their importance in a hospital, Records maintained in the Laboratory as per ISO 15189, importance of records and reports, Data entry and management on an electronic health record system	3
V	Medical terminology - Derivation of medical terms, Basic medical terms, form medical terms utilising roots, suffixes, prefixes, and combining roots, Interpret basic medical abbreviations/symbols	6
VI	Regulatory Bodies & Professional Organisations: Roles & Responsibilities – MoHFW, NCAHP, State Council, Registration	3
	Total	**30**

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Suggested Readings:

1. Textbook of Medical laboratory Technology, Mirnali Sant, CBS publishers. 2022
2. Textbook of Medical laboratory Technology, Ramnik Sood, Jaypee Publishers, 2006
3. Textbook of Medical laboratory Technology, Godkar PB, Bhalani Publishing House, 2024

Course Name: Communication Skills and Professionalism

Course Rationale: The course comprises the study and development of the English language, listening, speaking, reading, and writing, which help students communicate well in academic and professional environments

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

- Develop good communication skills
- Trains the students in oral presentations, expository writing, logical organisation and structural support.
- Develops professionalism, understands professional ethics and values for professional success

Unit	Topic	Unit
I	Communication Skills: The Importance of Communication, The Communication Process. Barriers to communication: Physiological, Physical, Cultural, Language, Gender, Interpersonal, Psychological and Emotional barriers	4
II	Perspectives in Communication: Introduction, Visual Perception, Language, Other factors affecting our perspective - Past Experiences, Prejudices, Feelings, Environment. Elements of Communication: Introduction, Face-to-Face Communication, Tone of Voice, Body Language (Non-verbal communication), Verbal Communication.	4
III	Developing personal etiquette: personal appearance, importance of grooming, acknowledging and respecting, maintaining professionalism, cubicle etiquette, time management, attending classes, meetings, seminars, etc, table manners, greeting, Netiquette and Telephonic conversation	4
IV	Developing presentation and career skills: Introduction, Importance of Resume and CV, preparing Resume and CV, Interview Skill Tips, FAQ During Interviews, Mock interviews	8
IV	Professional values - Integrity, Objectivity, Confidentiality, Professional competence and due care, professional risks, professional responsibility, accountability, professional success	3
V	Personal Values - Ethical and Moral values, Attitude and behaviour, Personal Hygiene and Mental Health	3
	Total	**30**

Suggested Reading:

1. Graham Lock, Functional English Grammar: Introduction to Second Language Teachers. Cambridge University Press, New York, 1996.
2. Gwen Van Servellen. Communication for Health care professionals: Concepts, practice and evidence, Jones & Bartlett Publications, USA, 2009

Course Name: Basic Emergency Care and First Aid Credit 2 (30 hours)

Course Rationale: Students will be able to perform basic emergency procedures and provide first aid in everyday medical situations.

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

- Assess emergencies quickly and accurately to ensure personal and victim safety.
- Demonstrate basic life-saving techniques, including CPR (Cardiopulmonary Resuscitation) and the recovery position.
- Provide appropriate first aid for common injuries such as wounds, burns, fractures, sprains, and poisoning.

Unit	Topic	Hours
I	First Aid-Introduction, Aims & objectives of first aid, Priorities of first aid, Golden rules of first aid, Qualities & responsibilities of first aider, Simple first aid measures in selected conditions like Food poisoning, Snake bite, Scorpion bite, Dog bite, foreign bodies in various organs, Burns, Haemorrhage	**10**
II	Shock- Definition, Types of shock, General Features of shock, Investigations of shock, Initial management & first aid of shock	**4**
III	Poisoning- Definition, Causes of poisoning, Sources of Poisoning, Symptoms of poisoning, First aid & Management, Antidotes, Common drugs poisoning, Carbon monoxide poisoning	**4**
IV	Introduction: Chain of survival, team dynamics & multi-rescuer resuscitation. Vital signs of patients- Body temperature, Pulse, Blood Pressure, Respiration	**4**
V	Basic Life Support (BLS) in adults: Flowchart approach, approach to victim, techniques of CPR, BLS in paediatric Victims: checking pulse in children, chest compressions techniques, Bag mask ventilation technique	**8**
	Total	**30**

Suggested Reading:

1. Manual of first aid, 1st edition, Gupta Abhitabh, 2012, Jaypee Publishers
1. Emergency medicine, 5th edition, SN Chugh, Ashimachugh 202, CBS publishers

Course Name: Human Anatomy **Credit =4 (60 hours)**

Course Rationale: Students will understand the structure and function of organs and organ systems in the human body.

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

- Comprehend the gross, functional and applied anatomy of various structures in the human body.
- Identify the microscopic structures of various tissues and organs in the human body and correlate the structure with the functions.
- Comprehend the basic structure and connections between the various parts of the central nervous system so as to analyse the integrative and regulative functions of the organs and systems.

Unit	Topic	Hours
I.	**General Anatomy:** Introduction to Anatomy, terms and terminology. Regions of Body, Cavities and Systems. Surface anatomy – Musculoskeletal, vascular, cardio-pulmonary system. General Embryology.	**4**
II	**Tissues**- Classification and description of the basic tissues of the body. Histology: Epithelium, compact bone, muscles, connective tissue, nervous tissue, artery, vein and lymphatic tissue. Connective tissue & its modification, tendons, membranes, and special connective tissue.	**4**
III	**Musculoskeletal system:** • Bone structure, blood supply, ossification, and classification. • Muscle classification, structure, types and functional aspects. • Joints–classification, structures of joints, movements, range, blood supply, nerve supply, dislocations	**8**
IV	**Respiratory system:** Structure of the upper and lower respiratory tract. Thorax: Pleural cavities & pleura, Lungs and respiratory tree, Heart and great vessels, Diaphragm	**6**
V	**Digestive system -** Parts/Structure of digestive system, Abdominal cavity - divisions, Muscles of abdominal wall, Liver, Pancreas, Spleen, Alimentary canal, Gall bladder, Intestine (small & large), and accessory organs of digestion	**6**
VI	**Excretory System:** Anatomy of the Kidney. Structure of the kidney, ureter, urinary bladder, male and female urethra. General description of pelvic organs. **Lymphatic system-** Lymphatic vessels and lymph, lymph nodes, Spleen. Mediastinum – division and contents	**6**

Unit	Topic	Hours
VII	**Cardiovascular system:** Circulatory system – major arteries and veins of the body, structure of blood vessels, Heart structure, positions, chambers, valves, internal & external features, Blood supply to heart, Conductive system of heart	**8**
VIII	**Nervous system:** Classification of the nervous system. Nerve – structure, classification, microscopy with examples. Spinal cord- anatomy, structure and features of Meninges, Ventricles of the brain, CSF circulation	**6**
IX	**Sensory system:** Structure of the Visual system, Auditory system, Gustatory system, Olfactory system, Somatosensory system, Skin	**6**
X	**Reproductive system:** Structure of male and female reproductive organs. **Endocrine system:** Pituitary gland, Thyroid, Parathyroid	**6**
	Total	**60**

Course Name: Human Anatomy Practical **Credit =2 (60 hours)**

Course Rationale: Students will be able to identify and demonstrate anatomical structures of various organ systems.

1. Study of anatomical plans and positions
2. Histological study of tissues
3. Study of Skeletal system
4. Study of respiratory system
5. Study of digestive system
6. Study of urinary system
7. Study of Cardiovascular system
8. Study of Nervous system
9. Study of sensory organs: eye, ear, nose, tongue and skin
10. Study of reproductive system

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

Suggested Readings:

- Ross and Wilson – *Anatomy and Physiology in Health and Illness*, 11th Ed., Elsevier
- Chaurasia B.D. – *Human Anatomy*, 7th Ed., CBS Publishers
- Gerard J. Tortora & Bryan H. Derrickson – *Principles of Anatomy and Physiology*, 14th Ed., Wiley
- Frank H. Netter – *Atlas of Human Anatomy*, 7th Ed., Elsevier
- Frederic H. Martini et al. – *Fundamentals of Anatomy and Physiology*, 9th Ed., Pearson
- Gray's Atlas of Anatomy – Richard Drake, Elsevier
- Manju Chugani & Preysi Chauhan – *Simplified Anatomy and Physiology for Paramedical Students*, Jaypee

Course Name: Human Physiology **Credit = 4 (60 hours)**

Course Rationale: Students will gain knowledge of the organisation of human body cells, tissues, blood and physiological functions of various organ systems of the human body

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

- Understand the functioning of various organ systems of the body and their interactions
- Elucidate the physiological aspects of normal growth and development.

Unit	Topic	Hours
I.	**General Physiology**- Cell: morphology, structure and function of cell organelles, Structure of cell membrane, Transport across cell membrane, Intercellular communication, Homeostasis	**4**
II	**Blood**-Introduction-composition & function of blood, WBC, RBC, Platelets formation & functions, Immunity, Plasma: composition, formation & functions, Plasma Proteins:-types & functions, Blood Groups- types, significance, determination, Haemoglobin, Haemostasis.	**4**
III	**Nervous system and muscle:** Organisation of the nervous system. Structure and function of muscle and nerve cells. Functions of the brain, the Spinal cord, the cranial and spinal nerves, and the Motor system.Sensory system. ANS, Synapse, neuromuscular transmission reflex arc, reflex action and reflexes, Cerebrospinal fluid	**8**
IV	**Respiratory System:** General organisation, Mechanics of respiration, Regulation of respiration, Gaseous exchange in lungs and tissues, Pulmonary ventilation, volumes and capacities, Effect of exercise on respiration, hypoxia.	**6**
V	**Digestive System-**Digestion & absorption of nutrients, Gastrointestinal secretions & their regulation, Functions of Liver, pancreas & stomach, Gastrointestinal tract disorders	**6**
VI	**Renal System:** Functions of the kidney, urine formation, Glomerular filtration rate, clearance, Tubular function. Water excretion, concentration of urine-regulation of Na+, Cl-, K+ excretion, Physiology of urinary bladder	**6**
VII	**Lymphatic and immunological system:** Lymph glands and circulation of lymph, Spleen structure and function, Immunity – Formation of T-cells and B-cells, Antigen, Antibody and Immune response.	**6**

Unit	Topic	Hours
VIII	**Cardiovascular system:** Functions of the heart, organisation of the cardiovascular system, structure and properties of cardiac muscles. Cardiac output, cardiac cycle, and conducting system of the heart. Heart sounds, regulation of heart rate, pulse, blood pressure and its regulation. ECG, cardio-respiratory changes during exercise	**8**
IX	**Endocrine system-** Physiology of the endocrine glands – Pituitary, Pineal Body, Thyroid, Parathyroid, Adrenal, Gonads, Thymus, Pancreas. Hormones secreted by these glands, their classifications, and their functions.	**8**
X	**Male and female reproductive system:** Male: functions of testes & penis, pubertal changes in males, testosterone: action & regulations of secretion, ejaculatory mechanism & dysfunction Female: functions of ovaries and uterus, pubertal changes, menstrual cycle, oestrogens and progesterone action and regulation. Physiological changes during pregnancy, Placenta and placental circulation.	**6**
	Total	**60**

Course Name: Human Physiology Practical Credit = 2 (60 hours)

Course Rationale: Students will develop an understanding of the normal functioning of human organ systems and explain their physiological processes.

1. Perform blood collection
2. Estimation of Hemoglobin
3. Demonstrate blood cell count – RBC count and WBC count
4. Prepare blood smear and staining
5. Measure Blood pressure and Pulse Rate
6. Demonstration of ECG
7. Demonstration of EMG
8. Perform Reflexes testing
9. Spirometry and PFT (Pulmonary function test)

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

Suggested Readings:

- Guyton & Hall – *Textbook of Medical Physiology*, Elsevier
- C.C. Chatterjee – *Human Physiology*, Medical Allied Agency
- K. Sembulingam – *Essentials of Medical Physiology*, Jaypee
- Gerard J. Tortora & Bryan H. Derrickson – *Principles of Anatomy and Physiology*, 14th Ed., Wiley
- Ross and Wilson – *Anatomy and Physiology in Health and Illness*, 11th Ed., Elsevier

Course Name: Basic Computer Applications

Credit = 2 (1 credit theory =15 hours; 1 credit practical = 30 hours)

Course Rationale: Students will be familiarised with computer operating systems, using Microsoft Office tools, and internet use in healthcare.

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

- Identify the basic components and functions of computer hardware and software
- Use word processing software to create, format, and edit professional documents.
- Created and managed spreadsheets with basic formulas and designed presentations.

Unit	Topic	Hours
I	Introduction to Computers: Generations of computers, Applications of computers, Parts of a Computer, I/O devices, computer uses in healthcare	**3**
II	Basics of Operating System: Introduction to OS, Features of Windows OS, File management, User interface basics	**2**
III	Microsoft Word and PowerPoint: Introduction to Word, Typing medical documents, formatting, tables, inserting images, Introduction to powerpoint, slide creation	**3**
IV	Microsoft Excel, Access: Introduction to Excel and Access, Entering data, basic formulas, formatting cells, simple charts	**2**
V	Internet & Email: Definition, types of network, using browsers, opening email, attaching reports, basic internet safety	**2**
VI	Computers in Healthcare: Electronic health record, Hospital Information System basics, digital patient records, lab reporting usage	**3**
	Total	**15**

Practical **Credit: 1 (30 hours)**

Course Rationale: This course enables students to gain practical computer literacy skills to create Word files, spreadsheets, and PowerPoint presentations

1. MS Word – Document Creation- Resume, lab report typing, alignment, save & print
2. MS Word – Formatting & Tables- Medical charts, tables for patient information
3. MS Excel – Data Entry- Entering blood test reports and patient data
4. MS Excel – Basic Formulas- Average, sum, and conditional formatting
5. PowerPoint – Basic Slides- Creating a 5-slide presentation on hospital safety
6. Internet Browsing & Searching- Using Google for medical topics, downloading forms
7. Email Usage- Create an email, send a lab report with an attachment
8. MS Access database creation- Patient database creation
9. MS Access HTML integration in the database- Patient database creation view HTML webpage
10. Demonstrate use of Artificial Intelligence tools

Suggested Readings:

1. V. Rajaramana, *Computer basics and programming*, PHI Learning Pvt. Ltd.
2. Michael Miller, *Computer Basics and Absolute Beginner's Guide*, Que Publishing

SEMESTER II

Course Name: Fundamentals of Haematology **Credit = 4 (60 hours)**

Course Rationale: Students will be made aware of the composition of blood and methods of estimating different components of blood. Students will learn the basic concepts of Hematology and routine clinical investigations of the Haematology laboratory.

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

- Understand the composition of blood and the function of blood cells.
- Identify the normal and abnormal blood cells \, viz erythrocytes, leucocytes and thrombocytes.
- Comprehend the process of hemostasis and its physiological properties
- Demonstrate knowledge of haematological techniques used to analyse basic parameters in the Laboratory

Unit	Topic	Hours
I	Introduction to blood, composition and function of normal cellular components. Haematopoiesis: Site of haematopoiesis, Bone marrow and Bone marrow collection; Cellular ratio, bone marrow biopsy and aspiration techniques and their indications for collection	10
II	Erythrocytes: Normal Structure, Function, and Fate of Erythrocytes along with Clinical Indications of Jaundice, Normal Range. Abnormal Red Blood Cells: Anisocytes, Poikilocytes, and their clinical significance Hemoglobin: Structure, composition and function, synthesis and regulation of hemoglobin, oxygen association and dissociation curve Various types of hemoglobin with clinical significance - Fetal hemoglobin, Meth-hemoglobin, Sulf-haemoglobin, Carboxyhemoglobin, Sickle hemoglobin, Glycosylated hemoglobin, different methods of estimation	10

Unit	Topic	Hours
III	Leucocytes: Structure, functions, normal range, lifespan of normal White Blood Cells. Quantitative and qualitative disorders of White Blood Cells: physiological and pathological causes	**10**
IV	Thrombocytes: Structure, functions, normal range, lifespan of normal Platelets. Quantitative disorder of Platelets: physiological and pathological causes Normal hemostasis and physiological properties of coagulation factors. Primary, secondary and tertiary hemostasis. Role of the platelets, coagulation factors, coagulation inhibitory system and fibrinolysis.	**10**
V	Hematocrit and Erythrocyte Sedimentation Rate: **p**hysiological and pathological causes	**5**
VI	Automation in Haematology lab: principles and analysis Quality assurance in Haematology, Internal and external quality control, including reference preparation, Routine quality assurance protocol, Statistical analysis, i.e. Standard deviation, Coefficient of variation, accuracy and precision	**8**
VII	Anticoagulants: types, mode of action and preference of anticoagulants for different haematological studies. Different types of blood collection, including the preservation of blood samples for various haematological investigations. Principles of Romonowsky stain with examples and its applications	**7**
	Total	**60**

Course Name: Fundamentals of Haematology practical Credit: 2 (60 hours)

Course Rationale: Students will acquire comprehensive knowledge and skills in fundamental laboratory techniques and patient safety. They will understand and apply knowledge regarding sample collection, transport, storage, and preservation. Perform laboratory investigations using appropriate methods and instruments, while adhering to safety protocols and equipment care.

1. Demonstrate laboratory safety and biomedical waste management
2. Pre-analytical variables in clinical Laboratory: Patient and test request form identification, Patient preparation for phlebotomy, Sources of error in venous blood sample collection
3. Sample transport, processing, Sample acceptance and rejection criteria
4. Perform blood collection and demonstrate the order of draw
5. Estimation of hemoglobin by Drabkin's method
6. Perform Packed Cell Volume
7. Perform ESR by the Westergren method
8. Stain and examine the blood smear using Romanowsky stain
9. Perform Differential Leucocyte Count
10. Perform RBC count
11. Perform WBC count
12. Perform Absolute Eosinophil count
13. Perform Platelet count
14. Calculation of Red Cell Indices
15. Perform Bleeding Time and Clotting Time
16. Operate automated cell counters and interpret results
17. Perform Reticulocyte count

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

Suggested books

- Godkar, P. B., & Godkar, D. P. (2006). *Textbook of medical laboratory technology*. Bhalani publishing house.
- Dacie, J. V. (2006). *Dacie and Lewis practical haematology*. Elsevier Health Sciences.
- Firkin, F., Chesterman, C., Rush, B., & Pennigton, D. (2008). *De Gruchy's Clinical haematology in medical Practice*. John Wiley & Sons.
- McPherson, Richard A.. (2022). *Henry's clinical diagnosis and management by laboratory methods, 24th ed.* (24). : Elsevier.
- M.D., H, T., M.D, H, D. (2004). Color Atlas of Hematology Practical Microscopic and Clinical Diagnosis. New York: Thieme.
- Greer, J. P., Arber, D. A., Glader, B., & List, A. F. (2018). Wintrobe's clinical hematology (14th ed.). Wolters Kluwer.
- Kanai, L Mukherjee, (2010). Medical Laboratory Technology, CBS publishers

Course Name: Basics of Biochemistry **Credit =4 (60 hours)**

Course Rationale: Students will learn the basic concepts of Biochemistry, chemistry of carbohydrates, proteins, lipids, nucleic acids, enzymes, vitamins, minerals and nutritional requirements.

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

- Describe the structure and function of key biomolecules, including carbohydrates, proteins, lipids, and nucleic acids.
- Explain the fundamental principles of enzyme action, including enzyme kinetics, inhibition, and regulation.
- Demonstrate knowledge of biochemical techniques used to analyse biomolecules.

Unit	Topic	Hours
I.	**Introduction to Biochemistry:** Units of weight and volume, Preparation of solutions (percentage, Molarity, Normality), Basic concepts of acids, bases, and buffers, their application in the Laboratory. Definition and determination of pH. Preparation of distilled water, double-distilled water, and deionised water. Fundamental concepts on biophysical phenomena like osmosis, dialysis, colloidal state, viscosity, adsorption, osmotic pressure, and surface tension.	**4**
11	**Chemistry of Carbohydrates**: Introduction to carbohydrates, biological importance of carbohydrates, classification, physical and chemical properties	**7**
III	**Chemistry of lipids:** Introduction to lipids, biological importance of lipids, Classification of lipids, Physical and chemical properties, Cholesterol and lipoproteins	**7**
IV	**Chemistry of Amino acids & Proteins:** Introduction to amino acids, biological importance of Amino acids, classification of amino acids. Introduction to proteins, the biological importance of proteins. Classification of proteins, Structural organisation of Proteins, Physical and chemical properties of Proteins and Amino acids	**10**

Unit	Topic	Hours
V	**Chemistry of Nucleic acids**: Introduction to Nucleic acids, nucleotides, nucleosides, biological importance of Nucleic acids, Structure of DNA and RNA, Difference between DNA and RNA	8
VI	**Chemistry of Enzymes:** Introduction of enzymes, classification of enzymes, Coenzymes and Cofactors, Active site, Mechanism of action, Factors influencing enzyme action, Enzyme inhibition and regulation.	8
VII	**Vitamins & Minerals:** Introduction to vitamins, Classification, RDA, Chemistry and biochemical function, deficiencies and toxic manifestations Introduction to minerals, Classification, RDA, Chemistry and biochemical function, deficiencies and toxic manifestations, Special references to calcium, phosphorus, magnesium, iron, zinc and copper	12
VII1	**Nutrition:** Calorie Requirements, SDA and BMR, Respiratory Quotient, Glycemic Index, Balanced Diet and Energy Calculations, Formulation of diet and dietary fibre, Starvation, obesity, and Protein Energy Malnutrition	4
	Total	60

Course Name: Basics of Biochemistry- Practical Credit =2 (60 hours)

Course rationale: Students will learn the essential laboratory practices, which include the Preparation of Lab reagents and qualitative analysis of carbohydrates, proteins and lipids.

1. Demonstrate the use of Laboratory Apparatus, Micropipettes, and their uses
2. Demonstrate cleaning of glassware
3. Demonstrate the use of a laboratory balance
4. Prepare and label common Laboratory reagents (Percentage, Molarity, Normality)
5. Preparation of distilled water, double-distilled water, and deionised water.
6. Measure pH for laboratory reagents/ biological samples
7. Perform qualitative analysis of carbohydrate and identification of unknown carbohydrate- Molisch test, Benedict test, Modified Bareford test, Seliwanoff test, Bial test, Mucic acid test, Iodine test, Foulger's test, osazone test
8. Perform qualitative analysis of protein and amino acids- Precipitation test - Heat and acetic acid Test, Heller's test, alkali, alcohol, Isoelectric point precipitation. Colour reaction – Ninhydrin, Nitroprusside test, Xanthoproteic test, Million test, Sakaguchi test
9. Perform qualitative analysis of lipids – Solubility test

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

Suggested Readings:

- U. Sathyanarayana – *Biochemistry*, Elsevier
- Robert K. Murray et al. – *Harper's Illustrated Biochemistry*, Tata McGraw-Hill
- M.N. Chatterjee & Rana Shinde – *Textbook of Medical Biochemistry*, Jaypee
- Alan Gowenlock – *Varley's Practical Clinical Biochemistry*, CBS
- David L. Nelson & Michael M. Cox – *Lehninger Principles of Biochemistry*, W.H. Freeman
- D.M. Vasudevan – *Textbook of Biochemistry*, Jaypee
- A.C. Deb – *Fundamentals of Biochemistry*, New Central Book Agency
- Y.K. Joshi – *Basics of Clinical nutrition*, Jaypee publishers

Course Name: Fundamentals of Microbiology **Credit : 4= 60 hours**

Course Rationale: Students will acquire knowledge on the Historical Development of Microbiology, various types of microscopes, bacterial anatomy and staining methods, sterilisation methods, culture media, culture methods, biochemical tests and antibiotic susceptibility tests, and understand the underlying concepts of bacterial genetics and its applications in recombinant DNA technology.

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

- Comprehend knowledge of Microscopes, their types and applications
- Explain microbial structure, physiology, growth, and reproduction.
- Identify common methods used in the control and prevention of microbial growth and infection.
- Demonstrate knowledge of aseptic techniques and basic microbiological laboratory procedures.

Unit	Topic	Hours
I	Historical Development of Microbiology: Infection and Contagion, Discovery of Microorganisms, Conflict over Spontaneous Generation, Role of Microorganisms in Diseases, Scientific Development of Microbiology - Louis Pasteur, Joseph Lister, Robert Koch, Paul Ehrlich, Edward Jenner, Ignaz Semmelweis, Antony van Leeuwenhoek.	3
II	Microscopy: Light Microscopy, Bright-field microscopy, Dark-ground microscopy, Phase-contrast microscopy, Fluorescence microscopy, Electron microscopy	7
III	Morphology of Bacteria: Comparison of Prokaryotic Cells–Eukaryotic cells, size of bacteria, arrangement of bacterial cells, Anatomy of the bacterial cell- the structure, function, and clinical significance of - Cell wall, Cell membrane, Cell surface appendages, Bacterial Capsule, Cell organelles, plasmid, Spore. Principles of staining - Simple staining, Negative staining, Differential staining, Gram's and acid-fast staining, Albert's, Flagella staining, Capsule staining, Endospore staining	7
IV	Physiology of Bacteria: generation time of bacteria, bacterial growth curve, bacterial nutrition, bacterial metabolism	6

Unit	Topic	Hours
V	Bacterial Genetics: Different gene transfer methods: Transformation, Transduction, Lysogenic conversion, Conjugation.	5
VI	Sterilisation and Disinfection: Classify sterilisation methods - Dry heat sterilisation, Moist heat sterilisation, Radiation, Filtration. Disinfection- Classify disinfectants, general features of disinfectants - Alcohols and aldehydes, Dyes, halogens and phenols - Gases, surface active agents and metallic salts, Testing of disinfectants - Rideal Walker method, Chick Martin test, Disinfectant kill time test, Kelsey-Sykes test, In-use test, Advanced techniques in Sterilisation of Heat-Sensitive Articles.	7
VII	Culture Media and Methods: Culture Media- common ingredients of culture media, classification of media. Culture Methods- Methods of bacterial culture, aerobic culture, anaerobic culture, methods of anaerobiosis, methods of isolating pure cultures.	5
VIII	Identification of Bacteria: Methods used to identify bacteria, phenotypic characteristics, genomic characterisation, Bacterial Taxonomy-Taxonomy, Identification, classification systems, Identification of Bacteria by biochemical tests and automated systems: - Bac T alert and BACTEC systems, -VITEK and Phoenix systems - RTPCR, MALDI-TOF	8
IX	Antibiotic susceptibility testing (AST): A. Diffusion methods 1. Kirby–Bauer disk diffusion method 2. Stokes disk diffusion method B. Dilution methods 1. Broth dilution method 2. Agar dilution method. Epsilometer or E-test, Minimum inhibitory concentration (MIC) and Minimum bactericidal concentration (MBC) of antibiotics,	6
X	Human Normal Microbial Flora and Microbiome: Microbial Infections- Microorganisms and Host, Infection and Infectious Disease, Classification of Infections, Sources and Modes of Transmission of Infection, Epidemiological Terminologies	6
Total		60

Course Name: Fundamentals of Microbiology Practical Credit: 2= 60 hours

Course Rationale: Students will acquire knowledge to demonstrate and perform basic microbiological tests in the identification of microorganisms.

1. Demonstrate the collection of various clinical specimens and their transport and processing.
2. Demonstrate a safe code of practice in the Microbiology laboratory
3. Demonstrate cleaning and sterilisation of glassware
4. Perform microscopy and specimen processing
5. Operate the autoclave and hot air oven, including its efficacy testing.
6. Demonstrate the sterilisation of reagents and culture media
7. Demonstrate sterilisation of media/solution by filtration.
8. Demonstrate the proper precautions to take when using disinfectants and dilution of commonly used disinfectants.
9. Demonstrate Simple staining
10. Demonstrate Gram's staining
11. Demonstrate Preparation of stains, reagents and culture media, quality control of reagents and media, and sterility check
12. Identify QC strains used for culture media

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

Suggested reading

- Mackie & McCartney – *Practical Medical Microbiology*, Elsevier
- Bailey & Scott – *Diagnostic Microbiology*, Elsevier
- R. Ananthanarayan & C.K. Jayaram Paniker – *Textbook of Microbiology*, Universities Press
- 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: Preventive and Social Medicine **Credit: 2 = 30 hours**

Course Rationale: Through this course, students learn the principles of primary health care, the significance of health programs, and the role of communication and education in behaviour change. The inclusion of first aid and patient care in communicable diseases prepares allied health professionals to actively contribute to health promotion and disease prevention at all levels of healthcare delivery.

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

- Describe the epidemiology, prevention, and control of communicable and non-communicable diseases
- Understand the concepts and principles of public health, disease prevention, and health promotion.
- Identify the determinants of health and disease, including environmental, social, economic, and behavioural factors.

Unit	Topic	Hours
I.	**Basic Epidemiology:** Epidemiological Triad, Carrier, Reservoir, Host for infection and diseases, Various methods of disinfection used at each level of healthcare, Incubation period, Nosocomial Infections	03
II.	**Primary Health Care:** Principles, Elements, Health Programmes - Maternal and Child Health, Nutrition, Environment, older adults, Central Government Health Schemes, Occupational Health, Voluntary Health Agencies, Role of NGOs in the Health Team.	07
III	**Demography and Family Welfare:** Definition, Demographic cycle, Population Explosion, Factors influencing population growth, death rate, birth rate, and methods of contraception. Family Welfare – Definition, Objectives of Family Planning. Types: Temporary and Permanent methods, Follow-up of contraceptive methods, Family planning counselling.	03
IV	**Environmental Health:** Air Pollution, Noise Pollution, Water Pollution, with the causes, effects, and preventive measures. Solid Waste Management - Swachh Bharat Abhiyan, Nirmal Bharat Abhiyan. Biomedical Waste Management Rules 2016 - colour coding and disposal into correctly colour-coded bags. Disease Elimination and Disease Eradication: Examples.	07

Unit	Topic	Hours
V	**Communication and Health Education:** Health education–definition, principles, objectives, purpose, types, and AV aids. Communication–definition, process, and types. Behavioural change communication. IEC (Information, education, and communication): aims, scope, concept, and approaches. First-aid–Definition, Principles, Golden rules, and bandages. First-aid for fracture, bleeding, drowning, Convulsions, Foreign Bodies, poisoning, Shock, and Cardio-Pulmonary Resuscitation. Role and skill of health professional in Health Education; Interpersonal relationship: coordination and cooperation in health education with other members of the health team.	**08**
VI	**Patient care in Communicable Diseases:** Care of patients with communicable diseases, Isolation methods, Standard safety measures (Universal precautions). Role and skill of the Health professional in the management of patients with communicable diseases.	**02**
Total		**30**

Suggested Readings

- Textbook of Preventive and Social Medicine – J.E.Park
- Manual for Laboratory Technician – 1985. DGHS, Ministry of Health, Govt of India

SEMESTER III

Course Name: Intermediary Metabolism & Endocrinology Credit = 4 (60 hours)
Course Rationale: To familiarise the students with the metabolism of carbohydrates, lipids, proteins, nucleic acids, haemoglobin and minerals. Students will also gain knowledge of the basics of endocrinology.

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

- Explain the fundamental principles of metabolism, including anabolic and catabolic pathways.
- Describe the key metabolic pathways such as glycolysis, the citric acid cycle (TCA cycle), oxidative phosphorylation, and beta-oxidation.
- Understand the regulation of metabolic pathways and the role of enzymes, cofactors, and hormones in metabolic control.

Unit	Topic	Hours
I	**Metabolism of carbohydrates**: Digestion and absorption, Glycolysis, TCA cycle, Gluconeogenesis, Glycogenesis and Glycogenolysis, Significance of HMP shunt and uronic acid pathway. Regulation of blood glucose. Disorders of Carbohydrate metabolism: Diabetes mellitus, glycosuria, glycogen storage diseases, galactosemia, pentosuria, fructosuria.	9
11	**Biological oxidation and Electron transport chain:** Redox potentials, Biological oxidation and high-energy compounds, organisation of electron transport chain, Chemiosmotic theory, ATP synthase, inhibitors of ATP synthase, uncouplers of oxidative phosphorylation.	6
111	**Metabolism of lipid:** Digestion and absorption, Beta-oxidation of fatty acids, Synthesis and breakdown of cholesterol, lipoproteins, and ketogenesis. Disorders of lipid metabolism: Hyperlipidemia, hyperlipoproteinemias, Atherosclerosis, fatty liver	8

Unit	Topic	Hours
1V	**Metabolism of protein and amino acid:** Digestion and absorption, transamination, Oxidative and non-oxidative deamination, Urea cycle, Creatine synthesis and degradation, Metabolism of aromatic amino acids. Disorders of Protein metabolism and amino acid metabolism: Inherited disorders associated with the urea cycle, Phenylketonuria, Alkaptonuria	9
V	**Integration of Metabolism**: Metabolism in a well-fed state and starvation. **Mineral metabolism:** Regulation of the blood level of calcium, phosphorus and iron. **Water and electrolyte balance:** Distribution of fluids in the body, water metabolism, factors influencing the distribution of body water, thirst mechanism, intake and loss of body water, electrolyte distribution, function and regulation, and dehydration.	6
VI	**Purine and Pyrimidine metabolism**: Biosynthesis of purines, pyrimidines, Breakdown of purine and pyrimidines	8
V11	**Haemoglobin metabolism**: Oxygen dissociation curves and abnormal haemoglobin, formation and breakdown of hemoglobin.	6
VIII	**Hormones:** Introduction, Classification, Major endocrine glands and their hormones, Hypothalamus, Pituitary, Thyroid, Parathyroid, Adrenal cortex, Pancreas and gonads. Mechanism of action of hormones.	8
	Total	60

Course Name: Intermediary Metabolism & Endocrinology -Practical

Credit =2 (60 hours)

Course Rationale: Students will be taught a relevant diagnostic test and gain hands-on experience in estimating biochemical parameters using standard kit methods used in laboratories.

1. Operate the colourimeter and spectrophotometer
2. Estimation of Plasma Glucose by GOD - POD method
3. Estimation of Total Protein by Biuret Method
4. Estimation of Albumin by the BCG method. Calculation of A/G ratio
5. Estimation of Cholesterol by modified CHOD-POD method
6. Estimation of Urea by Urease method
7. Estimation of Uric acid by uricase method
8. Estimation of creatinine by picric acid method
9. Demonstration of serum electrolytes
10. Estimation of Calcium
11. Perform qualitative urine analysis - 5-hydroxy indole acetic acid (HIAA), total porphyrins, Coproporphyrin

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

Suggested Readings:

- U. Sathyanarayana – *Biochemistry*, Elsevier
- Robert K. Murray et al. – *Harper's Illustrated Biochemistry*, Tata McGraw-Hill
- M.N. Chatterjee & Rana Shinde – *Textbook of Medical Biochemistry*, Jaypee
- Alan Gowenlock – *Varley's Practical Clinical Biochemistry*, CBS
- David L. Nelson & Michael M. Cox – *Lehninger Principles of Biochemistry*, W.H. Freeman
- D.M. Vasudevan – *Textbook of Biochemistry*, Jaypee
- A.C. Deb – *Fundamentals of Biochemistry*, New Central Book Agency
- Y.K. Joshi – *Basics of Clinical nutrition*, Jaypee publishers
- Nader Rifai et al, *Tietz Textbook of Clinical Chemistry and Molecular Diagnostics,* Saunders / Elsevier

Course Name: Bacteriology **Credit : 4= 60 hours**

Course outcomes: Students will identify medically important bacteria, understand their pathogenic mechanisms, and apply diagnostic methods for bacterial infections and hospital-acquired infections.

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

- Identify clinically significant bacteria that cause human disease.
- Describe the pathogenesis, clinical features, and modes of transmission of common infectious diseases.
- Demonstrate proper techniques for specimen collection, handling, and processing in a clinical bacteriology laboratory.

Unit	Topic	Hours
I	Gram-positive bacteria: Staphylococcus species, Streptococcus species, Corynebacterium diphtheriae, Bacillus species	8
II	Mycobacteria: Classification and morphology	4
III	Anaerobes: Non-spore-forming anaerobes. Classify anaerobes, infections caused, and laboratory diagnosis of non-sporing anaerobes	5
IV	Spore-forming anaerobes: Classify Clostridia species: Clostridium perfringens, Clostridium tetani, Clostridium botulinum, Clostridium difficile	5
V	Gram Negative Cocci: Neisseria meningitidis, Neisseria gonorrhoeae	5
VI	Enterobacteriaceae: Escherichia coli, Klebsiella species, Proteus species, Salmonella species, Shigella species	10

Unit	Topic	Hours
VII	Vibrio species, Pseudomonas and Burkholderia. Spirochetes: Classification of Spirochetes - Treponema pallidum, Leptospira, Borrelia	8
VIII	Mycoplasma, Actinomycetes and Nocardia, Candida	5
IX	Types of infections & diagnosis - Skin and soft tissue infections, Respiratory tract infections, Cardiovascular System & Central Nervous System infections, Otitis media, Gastrointestinal tract infections, Urinary tract infections, Genital tract Infections	6
X	Nosocomial Infection - Hospital Acquired Infections (HAI), risk factors, sources and route. Investigation, prevention and control of hospital-acquired infections. Bacteriology of air, food, water and milk	4
Total		60

Course Name: Bacteriology Practical Credit: 2= 60 hours

Course outcomes: Students will demonstrate and perform bacterial culture, identification, and antibiotic susceptibility testing using manual and automated methods.

1. Perform pure culture study of common pathogens. (*Staphylococcus aureus, Staphylococcus pyogenes, Enterococcus species, Corynebacterium diphtheriae, E. coli, Salmonella spp, Shigella spp, Pseudomonas, Proteus spp, K. pneumoniae, Vibrio cholerae, Pseudomonas aeruginosa, C. albicans).*
2. Apply diagnostic Scheme for Respiratory Tract Infections.
3. Apply diagnostic Scheme for Urinary Tract Infections.
4. Apply diagnostic for Gastrointestinal Tract Infections.
5. Apply diagnostic for Central Nervous System Infections and Bacteraemia.

6. Apply diagnostic for Skin Infections.
    - (demonstrate specimen processing by manual method, including specimen receiving, Specimen inoculation into appropriate culture media, using appropriate staining method, biochemical reactions, and serological grouping for aerobic bacteria)
7. Demonstrate bacterial identification and antibiotic susceptibility testing using manual /automated methods
8. Processing of specimens for anaerobic bacteria
9. Processing of specimens for mycobacteria
10. Perform serological tests for the diagnosis of bacterial diseases
11. Identify the quality control used in the manual and automated methods

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

Suggested Reading

- R. Ananthanarayan & C.K. Jayaram Paniker – *Textbook of Microbiology*, Universities Press
- C.P. Baveja – *Textbook of Microbiology*, Arya Publications
- Subhash Chandra Parija – *Textbook of Microbiology and Immunology*, Elsevier
- Dubey R.C. – *A Textbook of Microbiology*, S. Chand Publishers
- Arora D.R. – *Textbook of Microbiology,* CBS Publishers
- Apurba Sankar Sastry & Sandhya Bhat K – Essentials in Medical Microbiology, Jaypee Brothers Medical Publishers
- Mackie & McCartney – *Practical Medical Microbiology*, Elsevier
- Henry D. Isenberg – *Clinical Microbiology Procedures Handbook*, ASM Press
- Bailey & Scott – *Diagnostic Microbiology*, Elsevier
- Koneman et al. – *Colour Atlas and Textbook of Diagnostic Microbiology*, Lippincott

Course Name: Clinical Haematology **Credit : 4 = 60 hours**

Course Rationale: Students will understand the pathophysiology and laboratory diagnosis of haematological disorders, including anaemia, leukocyte abnormalities, coagulation defects, and related morphological changes in blood cells.

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

- Comprehend knowledge of Qualitative and Quantitative disorders of Erythrocytes, leucocytes and thrombocytes
- Describe the pathophysiology and clinical features of common pathological diseases
- Demonstrate the proper techniques for specimen collection, handling, and diagnosis of the pathological diseases

Unit	Topic	Hours
I.	Red cell indices: Definition, normal range, and calculations with their application in diagnosing anaemia	**5**
II.	Anaemia - Morphological and etiological classification: Signs, symptoms, aetiology, pathophysiology, and laboratory findings associated with Iron deficiency anaemia, Megaloblastic anaemia, Aplastic anaemia, Hemolytic anaemia, Thalassemia, Sickle cell anaemia, Hereditary spherocytosis, Paroxysmal nocturnal hemoglobinuria. Recent advances in laboratory diagnosis of anaemia	**16**
III	Leukaemia: Leukaemia: Leukemoid reaction- Definition and clinical implications, Leukaemia- Classification, definition and clinical implications, Pathophysiology, signs, symptoms, and laboratory diagnosis of Acute lymphoid leukaemia (ALL), Acute myeloid leukaemia (AML), Chronic lymphoid leukaemia (CLL), Chronic myeloid leukaemia (CML). Pathophysiology, signs, symptoms, and laboratory diagnosis of Polycythemia vera, Multiple Myeloma. Recent advances in laboratory diagnosis of leukaemia	**16**

Unit	Topic	Hours
IV	Haemostasis Disorders: Coagulation pathways- Extrinsic and Intrinsic Cell-Based Model of Coagulation. Coagulation Tests and Interpretation of Prothrombin, PT/INR, Activated Partial Thromboplastin Time (APTT), Thrombin Time (TT), Fibrinogen, Platelet, D-dimer test, Mixing study, and factor assay Pathophysiology, signs, symptoms, and laboratory diagnosis of common bleeding / clotting disorders - Haemophilia A & B, Von-Willebrand disease, Bernard-Soulier syndrome, Glanzman's thrombasthenia, Disseminated intravascular coagulation (DIC), Immune Thrombocytopenic Purpura (ITP). Recent advances in laboratory diagnosis of coagulation disorders	**16**
V	Cytogenetics, Karyotyping, FISH, chromosome analysis for interpretation of malignancies	**4**
VI	Basics of Flow Cytometry with CD markers	**3**
Total		**60**

Course Name: Clinical Haematology - Practical **Credit : 2 = 60 hours**

Course Rationale: Students will gain practical skills necessary for various laboratory investigations required for the diagnosis of haematological disorders and compare them with normal values and clinical conditions.

1. Preparation and staining of peripheral smear using Leishman's stain.
2. Identification of normal and abnormal morphology of red blood cells, white blood cells, and platelets.
3. Peripheral smear study, its correlation with clinical symptoms and comparison of peripheral smear results with complete blood count (CBC).
4. Reticulocyte count and its correlation with clinical symptoms
5. Demonstration of bone marrow aspiration and smear preparation.
6. Staining of bone marrow smears (Pearls 'Prussian blue stain) and its correlation with clinical symptoms

7. Preparation of iso-osmotic sucrose solution and performance of sucrose lysis test.
8. Identification of tests for hemoglobin variants and thalassemia. Explanation and interpretation of hemoglobin electrophoresis (e.g., sickle cell anaemia, thalassemia).
9. Sickling test. Performance and interpretation of the osmotic fragility test
10. Bleeding time, Clotting time, Prothrombin time (PT), Activated partial thromboplastin time (aPTT). Thrombin time, Platelet count, Fibrinogen count, and interpretation of first-line hemostasis tests. Blood collection procedures related to coagulation testing. Performance and interpretation of: Clot retraction, Inhibitor assays. Platelet function tests.
11. Identify the tests to detect hereditary haemolytic anaemia. Prepare reagents for the osmotic fragility test. Perform the osmotic fragility test and interpret the results. Integrate clinical symptoms and laboratory investigations to identify haematological disorders

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

Suggested Readings:

- Sood, R. (2009). *Medical Laboratory Technology, Vol-1 : Methods of Interpretation* (6th). India: Jaypee Brothers.
- Dacie, J. V. (2006). *Dacie and Lewis practical haematology*. Elsevier Health Sciences.
- McKenzie, S. B., Williams, J. L., & Landis-Piwowar, K. (2004). *Clinical laboratory hematology* (Vol. 1). Pearson education.
- Ramakrishnan, S., & Sulochana, K. N. (Eds.). (2012). *Manual of Medical laboratory techniques*. Jaypee Brothers Medical Publishers Pvt. Ltd.
- Godkar, P. B., & Godkar, D. P. (2006). *Textbook of medical laboratory technology*. Bhalani publishing house.

Course Name: Basics of Pharmacology **Credit: 2 = 30 hours**

Course Rationale: Students will gain foundational knowledge in pharmacokinetics and pharmacodynamics, adverse drug effects, commonly used drugs in infectious and metabolic disorders, and the pharmacology relevant to laboratory diagnostics and interpretation.

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

- Explain fundamental concepts of pharmacology
- Identify major classes of drugs, their therapeutic uses, mechanisms of action, and common side effects.
- Recognise signs and symptoms of common drug toxicities and the role of the laboratory in monitoring drug therapy.

Unit	Topic	Hours
I	General Pharmacology: Branches of Pharmacology, Routes of Drug Administration, Pharmacokinetics (Absorption, Distribution, Metabolism, Excretion), Pharmacodynamics, Adverse Drug Reactions, Overview of Clinical Trials and Phases, Essential Drug Concepts for Laboratory Professionals (e.g., drug half-life, therapeutic drug monitoring)	8
II	Antimicrobial Chemotherapy: Classification of Antibacterial Drugs, Mechanism of Action and Resistance, Sulfonamides, Trimethoprim, Beta-lactams: Penicillin, Cephalosporins. Protein Synthesis Inhibitors: Aminoglycosides, Tetracyclines, Macrolides, Antitubercular and Antileprotic Drugs, Antifungals and Antivirals, Relevance of Antibiotic Sensitivity Testing, Laboratory Role in Monitoring Antimicrobial Therapy	12
III	Drugs Related to Hormonal and Metabolic Disorders: Insulin and Oral Hypoglycemic Agents, Thyroid and Antithyroid Drugs, Corticosteroids (overview and lab monitoring), Drugs affecting Calcium Balance, Antidiuretics, Relevance of Drug-induced Metabolic Changes in Lab Tests	6
IV	Drugs Acting on Blood and Blood-forming Organs: Hematinics and Use in Anaemia, Coagulants and Anticoagulants, Blood Products and Plasma Expanders, Overview of Anticoagulant Therapy and Its Relevance to Laboratory Monitoring (e.g., PT, INR, aPTT), Effects of Drugs on Haematological Parameters	4
	Total hours	30

Suggested Reading

- K.D. Tripathi – Essentials of Medical Pharmacology, Jaypee
- Padmaja Udaykumar – Pharmacology for Nurses
- Satoskar et al. – Pharmacology and Pharmacotherapeutics
- Relevant Laboratory Manuals/Drug Interaction Charts for Lab Technicians

SEMESTER IV

Course Name: Clinical Pathology **Credit: 4 (60 hours)**

Course Rationale: Students will understand the principles and procedures for analysing urine, faeces, semen, sputum, and body fluids. They will learn to differentiate normal from abnormal findings and apply analytical techniques in clinical diagnosis.

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

- Comprehend knowledge of formation, composition and function of body fluids
- Demonstrate proper technique for specimen collection, handling, and processing in a clinical Pathology laboratory.
- Apply standard laboratory techniques for the identification of the aetiology of infection.

Unit	Topic	Hours
I	**Urine analysis:** Formation and Normal Composition of urine, Indication of urine analysis, collection of urine, preservatives used for urine sample, examination of urine – Manual methods, dipstick method, urine analysers • Physical examination of urine and interpret the result - Volume, colour, odour, specific gravity, pH, turbidity • Chemical examination of urine and interpret the result for - Glucose - Protein - Blood - Ketones - Bile salt - Bile pigment • Examination for hemosiderin, chyluria, fat globules, and myoglobin detection in urine • Microscopic examination of urine- cells, casts, crystals, organisms, others • Characteristics of a normal and abnormal urine sample. List advanced techniques used in the field of diagnosis, Sources of errors, and Clinical conditions using laboratory results of urine analysis	12
II	**Faecal analysis:** Formation and Normal composition of stool, specimen collection, scotch tape preparation, Preservatives of stool specimen, Physical, chemical and microscopic faecal analysis • Physical examination-Volume, colour, consistency, odour, Blood, Mucus and Adult parasites • Test for occult blood • Saline and Iodine wet preparation, Concentration method, floatation method, and methylene blue stain	10

Unit	Topic	Hours
III	**Semen analysis:** Formation of semen, method of collection**,** importance and method of semen analysis - Normal and abnormal morphology of sperms Physical and chemical characteristics, sperm count, and Medico-legal aspects of specimen analysis	**8**
IV	Sputum Analysis: Formation of Sputum, Collection of Sputum, Analysis of Sputum	6
V	**Body fluids:** Different body fluids and methods of aspiration, characteristics of normal and abnormal body fluids, physical, chemical, and microscopic analysis of body fluids, procedure of cell count, clinical conditions - CSF, peritoneal, pericardial, pleural and synovial fluid **Other body fluids:** Function, volume and chemical composition, specimen collection, handling of amniotic fluid, examination of amniotic fluid, special tests performed in amniotic fluid Examination of bronchoalveolar Lavage, saliva, sweat, and tears.	**15**
VI	Recent advances in clinical pathology that have led to the use of special stains in clinical pathology, and outline sample processing using automation in clinical pathology	4
	Total	**60**

Course Name: Clinical Pathology Practical **Credit: 2 (60 hours)**

Course Rationale: Students will demonstrate and perform physical, chemical, and microscopic examinations of clinical specimens using manual and automated methods.

Preanalytical: Proper method of sample identification for inpatients and Outpatients, Sample transport and processing, Sample acceptance and rejection criteria

1. Identify and process clinical specimens (urine, stool, semen, sputum, CSF, pleural, peritoneal, synovial, pericardial fluids)
2. Perform physical, chemical, and microscopic analysis of urine and stool
3. Conduct special test in urine -hemoglobin & myoglobin, pregnancy test
4. Perform Stool analysis – Physical, Chemical and Microscopic Examination
5. Perform semen analysis- Physical, Chemical and Microscopic Examination
6. Perform Cerebrospinal Fluid (CSF) examination - Physical, Chemical, and Microscopic Examination
7. Perform Sputum Analysis- physical, chemical, and microscopic examination

8. Perform Pleural Fluid examination -physical, chemical, and microscopic examination
9. Perform Synovial fluid examination- physical, chemical, and microscopic examination
10. Perform Peritoneal Fluid examination- physical, chemical and microscopic examination
11. Perform Pericardial Fluid examination- physical, chemical, and microscopic examination
12. Operate the automation system used in Clinical pathology

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

Suggested Readings

- Godkar, P. B., & Godkar, D. P. (2006). *Textbook of medical laboratory technology*. Bhalani publishing house.
- Sood, R. (2006). *Textbook of medical laboratory technology*. Jaypee Brothers Publishers.
- Mundt, L., & Shanahan, K. (2020). *Graff's textbook of urinalysis and body fluids*. Jones & Bartlett Learning.
- Strasinger, S. K., & Di Lorenzo, M. S. (2014). *Urinalysis and body fluids*. FA Davis.

Course Name: Genetics & Molecular Biology **Credit= 4(60 hours)**

Course Rationale: Students will learn the fundamentals of Genetics and molecular biology in order to understand the molecular basis of disease, perform and interpret basic molecular diagnostic tests.

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

- Explain how genetic information is copied, transferred, and used in cells
- Describe how genes are inherited and how traits are passed through generations.
- Identify common laboratory techniques used to study genes

Unit	Topic	Hours
I	**Introduction to Genetics:** Mendelian genetics –Principle of dominance, Principle of segregation, Principle of Independent Assortment, Genotype & phenotype; homozygous & heterozygous; dominant& recessive; gene & allele, Trait Inheritance – ABO blood groups in human; Polygenic Inheritance –Kernel colour in Maize, skin colour in man, Sex-linked Inheritance – haemophilia and colour blindness in man, Non-Mendelian Inheritance-Maternal inheritance	8
II	**Chromosomal basis of Inheritance:** Chromosome morphology- size and shape; Euchromatin and Heterochromatin- constitutive and facultative heterochromatin Chromosomes: Packaging of DNA in to Chromosomes, structure (centromere and telomere), karyotype, Structural chromosomal aberrations - duplications, deletions, inversions & translocations with examples, Genetic consequences, Numerical chromosomal aberrations – aneuploidy, euploidy auto-polyploidy and allo-polyploidy, Genetic consequences	12
III	**Cell division and chromosome segregation:** Mitosis – Stages in mitotic cell division- significance of mitosis. Meiosis – Formation of Synaptonemal complex, crossing over, chiasma formation, significance of meiosis. stages of mitosis, meiosis I&II& fertilization	6
IV	**Molecular basis of Inheritance** Structure of DNA and RNA, DNA replication, Mutations: types of mutations- transition, transversion, frame shift, silent, missense and nonsense	10

Unit	Topic	Hours
V	**Gene expression and regulation** Structure of eukaryotic gene, Transcriptional machinery in eukaryotes (RNA polymerases) and their structural and functional features; Genetic code, Transcription, translation	12
VI	**Molecular Diagnostics** ● Spectroscopy – principle, instrumentation, ultraviolet and visible light spectroscopy, and its applications ● Chromatography– types of chromatographic techniques (paper, ion exchange, chromatography, size exclusion chromatography)- principle & applications ● Centrifugation–principle and applications ● Electrophoretic techniques- types (Agarose gel electrophoresis, SDS PAGE), principle & applications ● Microscopy- principle & applications of Phase contrast microscope and bright field and fluorescence microscopy ● PCR - principles and applications ● Quantitative Real Time PCR– principle and applications. ● DNA Sequencing – principle and applications. ● Microarray- DNA and protein arrays - principle and applications. ● Blotting techniques- Southern blot, Northern blot and Western blot- principle and applications. ● Fluorescence &Chemiluminescence Imaging- principle and applications	12
	Total	60

Course Name: Genetics &Molecular biology Practical Credit: 2 = 60 hours

Course Rationale: Students will demonstrate and perform diagnostic tests widely used in molecular biology labs

1. Extraction of genomic DNA
2. Quantification of DNA by spectrophotometer
3. Agarose gel electrophoresis of DNA
4. Estimation of DNA by DPA method
5. Estimation of RNA by orcinol method
6. Estimation of Protein by BSA method
7. Western blotting
8. Karyotyping (normal male/normal female)
9. Identification of chromosome anomalies using Idiograms– Autosomal disorders (Down
   Syndrome / Edward's syndrome, Klienefelter's syndrome / Turner's syndrome)

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

Suggested Reading

- Molecular Cell Biology 6th edition (2007) Harvey F Lodish
- Techniques for molecular biology, D.Tagu C. Moussard, CRC Press
- Molecular diagnostics: for the clinical laboratorian by William B. Coleman and Gregory J. Tsongalis. Publisher: Humana Press

Course Name: Virology & Immunology **Credit= 4(60 hours)**

Course Rationale: Students will understand the morphology and general features of viruses and gain comprehensive knowledge of the immune system, immune response, and diagnostic immunological techniques.

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

- Identify clinically significant viruses that cause human disease and understand immunology
- Describe the pathogenesis, clinical features, and modes of transmission of common infectious diseases.
- Demonstrate proper techniques for specimen collection, handling, and processing in a clinical laboratory.

Unit	Topic	Hours
I	Introduction to virology: History of viruses, Viral taxonomy, Virus replication, Viral pathogenesis, Viral factors, Viral Growth Curve, Viral Growth Cycle. Host response, Environmental factors	5
II	Cultivation of Viruses, Detection of Virus Growth in Cell Culture, Different methods of cultivation of viruses, animal inoculations, egg inoculation, cell culture, Viral Assay, Viral Genetics, Classification of Viruses	5
III	Laboratory Diagnosis of Viral Infections:(1) direct detection of viruses/viral antigens, (2) demonstration of virus-induced cytopathic effects (CPEs) in the cells, (3) virus isolation, (4) viral assays, (5) detection of viral proteins and other enzymes, (6) detection of the viral genome and (7) viral serology	7
IV	Classify medically important viruses, Morphology, cultural characteristics, pathogenesis, lab diagnosis and treatment of Herpes virus, Poxviruses, Rhabdovirus, Orthomyxoviruses, Paramyxoviruses, Polio virus, Hepatitis virus, HIV, Oncogenic viruses, Arboviruses	15
IV	Prevention and Precautions in Virology: Safety precautions in the virology laboratory, Antiviral drugs	3
V	Immunology: The Immune Response, Innate immunity, adaptive immunity, acquired immunity- active and passive immunity	3

Unit	Topic	Hours
VI	Immune system: components of the immune system, immune cells and their functions, organs of the immune system - primary and secondary immune organs	3
VII	Antigen and antibody: Types of antigens and determinants of antigenicity, Structure and functions of different immunoglobulins, Properties and functions of antibodies- monoclonal and polyclonal antibodies. Antigen-Antibody reactions- Definition, Classification, General features, and mechanisms, applications of various antigen-antibody reactions	5
	Immune response: Classify immune response- Primary &Secondary Basic concept of humoral and cell-mediated immunity, Cytokines- define, classify, properties and functions	3
VII	Complement system: definition, components and activation pathways. Hypersensitivity- definition, types of hypersensitivity reactions	5
VIII	Autoimmune diseases: Primary and secondary immune deficiency disorders. Autoimmunity: Basic concepts of autoimmunity, risk factors and mechanisms of autoimmunity	4
IX	Immunisation/Vaccination: Active and passive immunisation, classification of vaccines, and immunisation schedule in India. Brief knowledge about the extended programme of immunisation (EPI) in India	2
Total		**60**

Course Name: Virology & Immunology Practical **Credit : 2 = 60 hours**

Course Rationale: Students will demonstrate and perform diagnostic tests for viral infections and immunological disorders using serological and molecular techniques.

1. Collection, transport and processing of various clinical specimens for Virology
2. Identify the tests used for the diagnosis of viral infections
3. Integrate knowledge in the diagnosis of given clinical cases
4. Identify viruses and their replication using charts.
5. Perform Staining- Giemsa stain, Seller's stain, immunofluorescent staining procedures for the diagnosis of viral infections.
6. Demonstrate various inoculation routes in a fertilised hen egg
7. Perform serological tests, i.e. Widal, Brucella Tube Agglutination, VDRL (including Antigen Preparation), ASO Anti-Streptolysin O, C-Reactive Protein (Latex agglutination), Rheumatoid factor (RF) Latex agglutination, Rose Waaler test, RPR
8. Demonstrate ELISA, immunodiffusion, immunofluorescence, and Western blotting.

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

Suggested Reading

- 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
- Subhash Chandra Parija – *Textbook of Microbiology and Immunology*, Elsevier
- Fields Virology – Editors: David M. Knipe & Peter M. Howley, Published by Lippincott Williams & Wilkins
- P. Daniel Fudenberg, H. Hugh Fudenberg & John Stites – *Basic & Clinical Immunology*, Lange Medical Books
- Kuby Immunology – Authors: Jenni Punt, Sharon Stranford, Patricia Jones & Judy Owen, Published by W.H. Freeman
- S.K. Gupta – *Essentials of Immunology*, Jaypee Brothers Medical Publishers

Course Name: Medical Laboratory Management and Quality Control Credit = 2 (30 hours)

Course Rationale: Students are introduced to medical laboratories, quality management, laboratory information management systems applied in diagnostic laboratories, laboratory automation and point of care testing

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

- Explain the principles of effective laboratory organisation, administration, and workflow planning
- Demonstrate knowledge of quality assurance (QA) and quality control (QC) practices in laboratory settings.
- Understand laboratory accreditation standards and regulatory requirements

Unit	Topic	Hours
I	Total quality management of clinical laboratories: Define a quality management system, the three phases of the laboratory testing process, laboratory error, and quality indicators. List the quality indicators in the preanalytical phase and the sources of errors in the preanalytical, analytical, and postanalytical phases. Define the Root Cause Analysis (RCA) process. Define corrective actions and preventive actions (CAPA), CAPA for the control and prevention of errors in the clinical laboratory. Classify quality control: Internal quality control method, formulating quality control charts, Levey-Jenning charts, and Interpretation of Westgard rules. Explain external quality control method, the proficiency testing method in the clinical laboratory, and illustrate good laboratory practice	6
II	Accreditation and certification of laboratories: Define accreditation, certification and accreditation bodies. Explain the National Accreditation Board for Testing and Calibration Laboratories (NABL) and the International Organisation for Standardisation (ISO). Summarise the benefits of accreditation. Audit in a Medical Laboratory - Introduction and Importance, Responsibility, Planning, Horizontal, Vertical and Test audit, Frequency of audit, Documentation, Procurement of equipment and Inventory Control	4

Unit	Topic	Hours
III	Automation in Laboratory Workflow: Definition, Automation in Preanalytical, Analytical, and Post-analytical Phases. Types of Analyzers: Continuous Flow, Discrete and Dry Chemistry Analyzers. Automation in Immunology, Microbiology, Histopathology, Haematology, Biochemistry, Clinical Pathology. Total Laboratory Automation (TLA)- Robotic Process Automation (RPA), Laboratory Information Management System (LIMS), AI & Machine Learning – Predictive diagnostics and image analysis, Point-of-Care Testing (POCT) – Portable diagnostic devices, Automated Storage and Retrieval Systems (ASRS) – Efficient sample archiving. Point-of-Care Testing (POCT): Definition, types, goal, advantages and disadvantages. Working Principles of POCT Devices – *Glucometer, Urine Dipstick, Lateral Flow Immunoassay (LFIA)* Explain Waived vs. Non-Waived Tests, Calibration and Validation, Essential for quality assurance, regulatory compliance, and patient safety.	12
IV	Introduction to Laboratory information system (LIS), Laboratory Information Management Systems (LIMS). Operations: sample management, Instrument and application integration, electronic data exchange. Languages of Informatics and LIS, LIMS, and Middleware. Document Control, Data Mining Methods, Security, LIS Validation, components and working of LIS, applications of LIS	4
V	Sustainability of Clinical Laboratories: Waste Management, Energy Efficiency, Water Conservation, Green Procurement, Digitalisation. Introduction and awareness of financial management in a clinical laboratory	4
	TOTAL	30

Suggested Readings:

- Mirnali Sant, *Textbook of Medical laboratory Technology*, CBS publishers
- Godkar PB, *Textbook of Medical laboratory Technology,* Bhalani publishing house
- Paszko Christine, Turner Elizabeth (2001*) Laboratory Information Management Systems* (2nd edition) CRC Press Inc
- Douglas Shawn (2023). *The Complete Guide to LIMS and Laboratory Informatics* (1st edition) LabLynx Press

SEMESTER V

Course Name: Analytical Biochemistry

Credit = 4 (60 hours)

Course Rationale: Students will gain knowledge on the principles and uses of analytical instruments such as photometry, chromatography, electrophoresis and automation used in Clinical laboratories or Research labs

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

- Understand the principles and applications of common analytical techniques used in biochemistry.
- Demonstrate the ability to prepare samples and use laboratory instruments accurately for biochemical analysis.
- Apply quantitative and qualitative techniques to analyse biomolecules such as proteins, nucleic acids, carbohydrates, and lipids.

Unit	Topic	Hours
I	**Photometry:** Theory of colourimetry, Beer-Lambert's law, Principles and applications of colourimetry, spectrophotometry, atomic absorption Spectroscopy, Fluorimetry and flame photometry in clinical laboratory	10
II	**Centrifugation:** Basic principles and units of centrifugation, Types of centrifugation and centrifuges, Rotors and tubes, Safety and maintenance, Applications of centrifugation in the laboratory.	4
III	**Chromatography:** Principles, types, Components and applications of Chromatography – Paper Chromatography, TLC, Ion Exchange, Affinity Gel Filtration, Gas Chromatography and HPLC in the laboratory.	10
IV	**Electrophoresis:** Principles, Types and applications – Agarose gel, Cellulose acetate and PAGE, and capillary electrophoresis. Electrophoresis of serum and urine protein, lipoprotein and isoenzymes	10
V	**Osmometry:** Principle and role of osmometry in clinical laboratory	6
VI	**Radioactivity:** Introduction, properties of alpha, beta and gamma radiations, radioisotopes, measurement of radioactivity, radiation hazards, radiation safety and precaution, Uses of radioisotopes.	6

Unit	Topic	Hours
VII	**Types of immunoassays and their principle:** Competitive and Non-competitive, immunometric assay and Turbidometry. RIA, ELISA, FIA and ECLIA	8
VIII	**Automation:** Principle of Automation, Semi-automated and fully automated chemistry analyser used in a clinical laboratory.	6
	Total	**60**

Course Name: Analytical Biochemistry – Practical Credit = 2 (60 hours)

Course Rationale: Students will be equipped with various diagnostic tests and hands-on experience in a semi-automated analyser.

1. Estimation of biochemical parameters using a Semi-automatic analyser
    a. Plasma Glucose
    b. Serum protein
    c. Serum Albumin
    d. Serum Urea
    e. Serum Uric acid
    f. Serum Creatinine
2. Demonstration of Analytical Techniques
    a. Thin-layer chromatography
    b. Serum protein electrophoresis
    c. ELISA
    d. AAS
    e. HPLC
3. Paper chromatography and staining techniques

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

Suggested Readings

- Wilson and walker's *Principles and techniques of biochemistry and molecular biology,* Cambridge university press.
- U. Sathyanarayana – *Biochemistry*, Elsevier
- Robert K. Murray et al. – *Harper's Illustrated Biochemistry*, Tata McGraw-Hill
- M.N. Chatterjee & Rana Shinde – *Textbook of Medical Biochemistry*, Jaypee
- Alan Gowenlock – *Varley's Practical Clinical Biochemistry*, CBS
- Textbook of Clinical Chemistry by Teitz

Course Name: Medical Law and Ethics **Credit : 2= 30 hours**

Course Rationale: Students are formulated to impart the basic concept of medical ethics, guidelines about human ethics, and animal ethics. Students will also learn about the Indian legal system, medico-legal cases and essential acts.

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

- Comprehend knowledge of medical and bioethics
- Follow good laboratory practice and appropriate ethical guidelines while conducting research on animal and human samples.
- Understand the Indian Legal system, medico legal records, human rights act, disaster management, Human Organ Transplantation Act, mental Health act, professional indemnity insurance policy and IPR

Suggested reading:

- Bonnie F. Fremgen – *Medical Law and Ethics, Pearson Education*
- Jonathan Herring – *Medical Law and Ethics, Oxford University Press*
- ICMR – *Ethical Guidelines for Biomedical Research on Human Participants (2017)*
- John D. Angelo-*Ethics in Science (2012). Ethical Misconduct in Scientific Research.* CRC Press, Taylor & Francis Group
- Hazel Biggs-*Healthcare Research Ethics and Law. Regulation, Review &Responsibility. (2010).* Cavendish Biomedical Law & Ethics Library
- Graf, C. et al.- *Best practice guidelines on publication ethics: a publisher's perspective.* (2007). International journal of clinical practice, 61, 1-26
- Gluck et al. *Applied ethics in animal research: philosophy, regulation, and laboratory applications*, (2002) Purdue University Press

Course Name: Mycology & Parasitology **Credit = 4 (60 hours)**

Course Rationale: Students will gain comprehensive knowledge of medically important fungi and parasites, including their classification, morphology, pathogenesis, and laboratory diagnosis.

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

- Identify clinically significant fungi and parasites that cause human disease
- Describe the pathogenesis, clinical features, and modes of transmission of common infectious diseases.
- Demonstrate proper techniques for specimen collection, handling, and processing in a clinical laboratory.

Unit	Topic	Hours
I	Introduction to Mycology: Taxonomy and classification of various medically important fungi, Characteristic features of fungi, reproductive methods of fungi, Normal fungal flora. Classification of mycoses.	4
II	Superficial mycoses- general characteristics of superficial mycoses Morphology, pathogenesis, laboratory diagnosis, and treatment of Piedra, Malassezia, Dermatophytoses, and Subcutaneous mycoses are the general characteristics of subcutaneous mycoses. Morphology, cultural characteristics, pathogenesis and lab diagnosis and treatment of Mycotic mycetoma, Sporotrichosis, Chromoblastomycoses, Subcutaneous phycomycosis, Rhinosporidiosis, Lobomycosis Systemic Mycoses -general characteristics of opportunistic systemic mycoses- Histoplasmosis, Blastomycosis, Coccidioidomycosis, Paracoccidioidomycosis General characteristics of opportunistic systemic mycoses- Morphology, cultural characteristics, pathogenesis and lab diagnosis and treatment of Candidiasis, Cryptococcosis, Aspergillosis, Penicillosis, Mucormycosis	15
III	Mycotoxicosis: Definition of Mycotoxin, Mycetismus, Method of Mycotoxins, preventive measures and treatment.	4

Unit	Topic	Hours
IV	Common fungal laboratory contaminants, Culture media used in mycology, Direct microscopy examination of fungi, Processing of clinical samples for diagnosis of fungal infections i.e. Skin, nail, hair, pus, sputum, CSF and other body fluids, Techniques used for isolation and identification of medically important fungi, Antifungal susceptibility tests, preservation of fungal cultures, Routine myco-serological tests and skin tests	7
V	Introduction of arthropods: Define and classify the arthropods of importance in public health. The sources and modes of transmission of infections are contaminated soil and water, foods, and vectors. Role of arthropods in the transmission of diseases Insects of medical importance: Morphology, life cycle, disease transmitted and control of Mosquitoes, Tse-tse fly, Fleas, Ticks, Housefly, Sand fly, Types of animal association- parasitism, commensalism, symbiosis	4
VI	Protozoology/ Protozoal parasites: General characteristics of protozoa. Geographical distribution, Habitat, Morphology, life cycle, Mode of infection, laboratory diagnosis, treatment and prevention of ● Amoebae (Entamoeba histolytica, non-pathogenic amoebae), ● Flagellates (Trichomonas, Giardia lamblia, Trypanosoma, Leishmania), ● Sporozoa (Plasmodium species, Toxoplasma species)	6
VII	Helminthology/ Helminthic parasites: Platyhelminthes: General characters of Platyhelminths. Geographical distribution, Habitat, Morphology, life cycle, Mode of infection, laboratory diagnosis, treatment and prevention of Cestodes (Diphyllobothrium, Taenia, Echinococcus, Hymenolepis) - Trematodes (Schistosoma, Fasciola, Fasciolopsis, Clonorchis and Paragonimus)	7
VIII	Nemathelminthes: General characters of Nemathelminthes, Geographical distribution, Habitat, Morphology, life cycle, Mode of infection, laboratory diagnosis, treatment and prevention of Nematodes (Ascaris lumbricoides, Ancylostoma duodenale, Strongyloides stercoralis, Trichinella spiralis, Enterobius vermicularis, Trichuris trichura, Wuchereria bancrofti and Dracunculus medinensis)	8

Unit	Topic	Hours
IX	Laboratory diagnosis of parasitic diseases: Collection, preparation of specimens for the diagnosis of parasitic infection- Stool, Blood, Urine, sputum, Cerebrospinal fluid (CSF), Tissue and aspirates, Genital specimens Examination of Stool for parasites - intestinal protozoal infections, Macroscopic and microscopic examination of stool samples, Staining methods, i.e. Iodine staining and permanent staining, Concentration methods- Principles and applications, Chemical examination of stool, Occult blood, Bile pigment Examination of blood for parasites- Staining, examination of thin and thick blood film Immunology and Serology Tests- Skin Test, Animal Xenodiagnosis, Inoculation, Imaging and Haematology	5
	Total	**60**

Course Name: Mycology & Parasitology Practical **Credit : 2 = 60 hours**

Course Rationale: Students would be able to identify various fungal strains and parasites. Students will also be correlated with the diseases associated with them.

1. Collection, transport and processing of various clinical specimens for fungal culture - Skin, nail, hair, pus, sputum, CSF and other body fluids and secretions
2. Prepare culture media, reagents and stains used for fungal analysis
3. Perform KOH preparation, Gram stain, Potassium Hydroxide - Calcofluor White method, India Ink preparation, Modified Kinyoun Acid Fast Stain for Nocardia, Lactophenol Cotton Blue preparation
4. Identification of pathogenic fungi - yeast, moulds, dimorphism in fungi
5. Perform stool examination for the detection of intestinal parasites with concentration methods- sedimentation and floatation methods
6. Identify adult worms, ova, and hemoparasites from slides or models
7. Examination of blood smears for hemoparasites.

***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*
- 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
- J.G. Collee, A.G. Fraser, B.P. Marmion, A. Simmons – *Mackie & McCartney Practical Medical Microbiology*, Elsevier
- 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

Course Name: Immunohaematology and Transfusion Medicine
Credit: 4= 60 hours

Course Rationale: Students will learn about blood grouping and blood transfusion. The students will learn about the concept of blood grouping, compatibility testing in blood transfusion, and screening of donated blood for various infectious diseases.
Learning Outcome: At the end of the course, students will be able to

- Understand the principles of immunohematology, including blood group systems and their clinical significance
- Demonstrate knowledge of donor selection, blood collection, processing, storage, and component preparation.
- Perform routine blood grouping, cross-matching, antibody screening, and compatibility testing using standard laboratory techniques.
- Apply safety and quality control procedures in all aspects of blood banking and transfusion services.

Unit	Topic	Hours
I	History of transfusion, Types of blood bags and their advantages and disadvantages, Blood donor selection criteria and donor preparation for collection, Autologous transfusion: Types of autologous blood collection, Hemapheresis: pertaining to Leucocytes, platelets and plasma, Donor adverse reaction and its management	**10**
II	History and discovery of various blood group systems, Genetics and inheritance of the ABO blood group system, Weak variants of the ABO blood groups, Bombay phenotype, Other phenotypes. Rh blood group system, weak D, Rh null, Rh mod	**10**
III	Components of blood for transfusion- Packed red cells, washed red cells, frozen Red cells, platelet-rich plasma (PRP), Platelet concentrate and frozen platelets. Fresh plasma (FP), Fresh Frozen Plasma (FFP) and cryoprecipitate, process of component preparation, storage, indications, transfusion dosage, and quality control	**12**

Unit	Topic	Hours
IV	Transfusion reactions- causes, clinical features, management and laboratory investigation, Pretransfusion tests and their clinical significance. Compatibility test in blood transfusion: Collection of blood for cross-matching from a blood bag, Major cross-matching, Minor cross-matching, use of enzymes in the blood bank, especially Papain	**12**
V	Transfusion-transmitted diseases and their laboratory investigations. Hemolytic disease of the newborn (HDN) and its investigations	**6**
VI	HLA Human Leucocytic antigen, Introduction to basic concepts of HLA and clinical applications of HLA testing, Techniques and principles of histocompatibility testing	**5**
VII	Regulatory agency that governs activities in the blood bank, Total quality management in transfusion service, including premises, personnel, instruments and reagents, Biosafety, external/internal quality control in Transfusion Medicine	**5**
Total		**60**

Course Name: Immunohaematology and Transfusion Medicine practical
Credit: 2 = 60 hours

Course Rationale:

Students will gain practical knowledge in donor selection, phlebotomy, and managing donor reactions. They will be trained in pre-transfusion testing, investigating transfusion reactions, and diagnosing hemolytic disease of the fetus and newborn. The course also equips them with skills in blood collection, disease prevention, laboratory investigations, and interpretation of results.

1. Demonstrate the procedure for pooled cell preparation
2. Demonstrate the preparation of 5% cell suspension
3. Demonstrate the preparation of sensitised cells
4. Demonstrate the procedure for cell washing
5. Perform ABO and Rh grouping:
    a. Direct (preliminary) and indirect (proof) grouping.
    b. Rh grouping and Du determination.
6. Demonstrate Antibody screening:
    a. Forward (cell) grouping
    b. Reverse (serum) grouping
7. Donor Screening and Blood Collection
8. Preservation of blood for transfusion
9. Cross-matching: Major and minor cross-matching.
10. Coombs test: Direct and indirect Coombs test
11. Preparation of blood components

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

Suggested Reading

- Mamak, N., & Aytekin, İ. (2012). Principles of Blood Transfusion. *Blood Cell-An Overview of Studies in Hematology*.
- AABB. (2017). Technical manual (19th ed.). AABB.
- Sood, R. (2006). *Textbook of medical laboratory technology*. Jaypee Brothers Publishers.
- Godkar, P. B., & Godkar, D. P. (2006). *Textbook of medical laboratory technology*. Bhalani publishing house.
- Klein, H. G., & Anstee, D. J. (2013). *Mollison's blood transfusion in clinical medicine*. John Wiley & Sons.
- Harmening, D. M. (2018). *Modern blood banking & transfusion practices*. FA Davis.

SEMESTER VI

Course Name: Clinical Biochemistry **Credit = 2 (60 hours)**

Course Rationale: Students will understand organ function tests, disorders related to abnormalities, and lab techniques used to diagnose disorders

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

- Explain the principles and clinical significance of biochemical tests used to assess organ function and disorders of metabolism
- Perform routine and specialised biochemical analyses on clinical specimens
- Demonstrate knowledge of automation, instrumentation, and data management in clinical biochemistry.

Unit	Topic	Hours
I	**GCLP:** laboratory safety and Universal precaution, Introduction to Phases in Laboratory, Preanalytical - Specimen collection, processing and handling in clinical laboratory, Sample acceptance and rejection criteria, Sources of error.	3
II	**Analytical Phase:** SOP, Laboratory equipment- maintenance, lab reagents and kits, calibrators, concept of accuracy, precision, reliability, reproducibility, Quality control (IQC and EQA), Basic statistics (Mean, Median, SD, CV), Westgard rule, LJ graph, Types of error in analytical phase.	3
III	**Post Analytical Phase:** Report generation, Types of error in post analytical, storage and retention of sample, Documentation of report	3
IV	**Laboratory diagnosis of Diabetes mellitus** – Plasma glucose (Fasting, Random, Post Prandial, OGTT, glycosylated haemoglobin. **Screening test for inborn errors of metabolism-** PKU, Alkaptonuria, Fructosuria, galactosemia, hypercholesterolemia.	8
V	**Liver Function Test:** Indications and classification of LFT, Test based on bile pigment metabolism, classification of jaundice, Test-based serum enzymes	6

Unit	Topic	Hours
VI	**Renal Function Test:** Indications and classification of RFT. Test based on glomerular filtration, renal plasma flow, and tubular functions. Acid-base balance, including blood gas analysis	6
VII	**Gastric Function Test:** Indication and classification of GFT, Examination of resting content. **Pancreatic Function Test:** Indication of Pancreas function test-Lipases and Amylases	6
VIII	**Thyroid Function Test:** Indications and classification of thyroid function test, tests based on primary function, and blood levels of thyroid hormones.	4
IX	**Cardiac Function Test:** Indications of Cardiac function test, Cardiac markers, lipid profile, Enzyme pattern in AMI	5
X	**Biochemistry of cancer:** Properties of cancer cells, morphological and biochemical changes in cancer cells, carcinogenesis, carcinogens, diagnosis of cancer – oncogenic markers (AFP, PFA, CEA, bHCG, Myeloma -Bence Jones protein, M band)	4
	Total	**60**

Course Name: Clinical Biochemistry-Practical Credits = 2 (60 hours)

Course Rationale: Students will be able to understand and critically diagnose various organ function tests and enzyme markers.

1. Construction of the Levey-Jennings (LJ) graph and interpretation of Westgard rule
2. Oral Glucose Tolerance Test (OGTT)

Estimation of following profile test using the kit method

3. Lipid profile
    a. Triglycerides
    b. Cholesterol
    c. HDL

4. Renal Function Test
    a. Urea
    b. Uric acid
    c. Creatinine
5. Liver function test
    a. Total Protein
    b. Albumin
    c. Total Bilirubin
    d. Direct bilirubin
    e. SGOT
    f. SGPT
    g. Alkaline Phosphatase
    h. Urinary Bile salt, Bile pigment, urobilinogen
6. Electrolytes
    a. Sodium
    b. Potassium
    c. Chloride

Demonstration of the following

7. Glycosylated Hemoglobin (HbA1C)
8. Thyroid Function Test
    a. T3
    b. T4
    c. TSH

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

Suggested Reading

- U. Sathyanarayana – *Biochemistry*, Elsevier
- Robert K. Murray et al. – *Harper's Illustrated Biochemistry*, Tata McGraw-Hill
- M.N. Chatterjee & Rana Shinde – *Textbook of Medical Biochemistry*, Jaypee
- Alan Gowenlock – *Varley's Practical Clinical Biochemistry*, CBS
- Nader Rifai et al, *Tietz Textbook of Clinical Chemistry and Molecular Diagnostics,* Saunders / Elsevier

Course Name: Biostatistics and Research Methodology ….Credit 2= 30 hours

Course Rationale: Students will understand statistical concepts and research methods applicable to laboratory sciences and be able to analyse and interpret data in clinical research.

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

- Understand basic concepts of biostatistics, including types of data, measures of central tendency, and variability.
- Demonstrate knowledge of sampling techniques, study designs and data collection methods.
- Apply appropriate statistical methods to analyse and interpret health and biomedical data.

Unit	Topic	Hours
I	Introduction to biostatistics: Concepts, types, significance and scope of statistics, meaning of data, sample and parameter, Types and levels of data and their measurement, Organisation and presentation of data-tabulation of data, Frequency distribution, Graphical and tabular presentation	**3**
II	Descriptive statistics: Measures of dispersion- Range, Inter-quartile range, Variance, Standard deviation and Coefficient of variation	**6**
III	Introduction to probability and normal distribution. Normal distribution - characteristics of normal distribution	**3**
IV	Sampling methods: Need for sampling and the advantages of sampling over complete enumeration, Sampling and non-sampling error, Probability and nonprobability sampling methods	**3**
V	Measures of relationship: Correlation – need and meaning, Rank order correlation, Scatter plot, Simple linear regression and prediction	**4**
VI	Testing of significance: Hypothesis, Non-Parametric test- Chi-square, t-test, ANOVA, Mann-Whitney U test. Use of statistical software for data analysis	**6**
VII	Introduction to research methodology: Research methodology, research design and review of literature, Different methods of data collection and data sources	**5**
	Total hours	**30**

Suggested reading

- S.P. Gupta – *Statistical Methods*, Sultan Chand & Sons
- B.K. Mahajan – *Methods in Biostatistics for Medical Students*, Jaypee Brothers Medical Publishers
- Himanshu Tyagi – *RPG Biostatistics*, CBS Publishers & Distributors
- World Health Organisation (2001) – *Health Research Methodology: A Guide for Training in Research Methods*, WHO Press

Course Name: Cytology and Histopathology **Credit: 4 =60 hours**

Course Rationale: Students will develop a comprehensive understanding of the principles and practices in Cytology and Histopathology. Students will also learn about the organisation of laboratories, specimen collection and processing, cytological and histological techniques, routine and special staining methods, and the interpretation of cellular and tissue morphology.

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

- Understand the principles and techniques involved in the preparation, fixation, processing, and staining of tissue and cytological specimens
- Demonstrate proper techniques for specimen collection, labelling, and handling to preserve diagnostic quality.
- Perform routine and special staining techniques used in histopathology and cytopathology.

Unit	Topic	Hours
I	Introduction to Cytology: Definition of cytology, organisation of cytology laboratory, Types of cytology, Cytological sampling techniques, Sample acceptance and rejection criteria, fixation, reception, processing, and mounting of cytological specimens, Quality control in cytology	5
II	Exfoliative Cytology: Cervical cytology, Fluid cytology-Urinary tract, Respiratory system, CSF, Body fluids. Sex chromatin demonstration and karyotyping, Vital staining for sex chromatin, Aspiration cytology, Cytology staining techniques- PAP, MGG, Shorr's stain, Aceto-orcein stain	10
III	Automation in Cytology: Liquid-based cytology: principles and preparation, Molecular cytology, Cell block technique	5
IV	Introduction to histopathology laboratory: Definition of biopsy and autopsy, Types of tissues received, Storage and documentation, Steps in tissue preparation, Grossing procedures, Handling tiny tissue specimens, Quality assurance	6
V	Fixatives: Definition and classification, Qualities of ideal fixatives, Common fixatives used, Methods of fixation, Methods for removing excess fixative	4
VI	Tissue processing: Definition and methods of decalcification, acid-containing decalcifying fluids, determination of endpoint of decalcification, steps in tissue processing - Dehydration, clearing, impregnation. Embedding moulds and media, Automated tissue processor: parts and working	5
VII	Section cutting: Definition and classification of microtomes, Care and maintenance of microtomes, Microtome knives and sharpening techniques, Automated knife sharpener, Disposable blades, Requirements and process of section cutting, Adhesives preparation, Causes and remedies for improper sections, Frozen section-Importance, Technique, Freezing microtome and cryostat	10

Unit	Topic	Hours
VIII	Routine staining technique: Theories of staining, Definitions: dye, mordents, alum. Classification of haematoxylin, H&E staining and rapid technique, Automated stainer, Mounting media: classification, preparation, purpose. Immunohistochemistry-Tissue preparation and staining, detection of artefacts and remedies	5
IX	Special stains in histopathology- Principle and use of staining procedure o Mucosubstances: PAS, Alcian Blue, Colloidal iron, High iron diamine, Mayer's Mucicarmine o Connective tissue: Vangieson, Masson's Trichrome o Reticulin fibres: Gomori's silver, Gordon and Sweets o Elastic fibres: Verhoff's stain o Pigments and minerals: Pearls Prussian blue o Microorganisms: AFB stain o Amyloid: Congo red o Lipids and fats: Oil Red O o Metachromatic staining: Toluidine blue (frozen section	7
X	Museum Techniques: Specimen mounting steps, fixation of specimens, Museum technique steps	3
Total hours		60

Course Name: Cytology and Histopathology Practical Credit: 2 =60 hours

Course Rationale: Students will gain practical knowledge of techniques used in Cytology and Histopathology laboratories, including specimen collection, preservation, and processing of various cytological samples. They will also learn to perform routine and special staining procedures and identify chromosomal abnormalities

1. Demonstrate receiving, handling, and labelling and specimen rejection criteria of cytological specimen.
2. Fine needle aspiration cytology
3. Preparation of fixatives in cytology laboratory and fixation of cytological specimens
4. Demonstrate cytological specimen preservation.
5. Demonstrate specimen processing in cytology – Gynaecological, Urine, Body fluids, Cerebrospinal fluid (CSF), sputum, - Liquid-based cytology.
6. Preparation for Papanicolaou (Pap) stain
7. Demonstrate staining - May-Grunwald Giemsa (MGG) staining, Myeloperoxidase staining, Sudan black B (SBB), Nonspecific esterase, Per Iodic acid Schiff staining (PAS), Neutrophil alkaline phosphatase (NAP), Gabbet's modified Ziehl Neelsen staining.
8. Quality control in a cytology laboratory
9. Demonstrate the preparation of fixatives- 10% Neutral buffered formalin, Formal Saline.
10. Demonstrate preparation of decalcifying fluid - Gooding & Stewart's fluid
11. Perform the tissue processing – fixation, dehydration, clearing, impregnation
12. Demonstrate the procedure for knife sharpening - Honing & stropping
13. Perform section cutting of tissue block using a microtome
14. Haematoxylin and Eosin staining
15. Perform mounting of the stained section
16. Demonstrate staining for carbohydrates, lipids, amyloid collagen, reticulin, elastic fibres, pigments, and Acid-Fast Bacillus (AFB).
17. Demonstrate immunohistochemistry techniques, Enzyme histochemistry-diagnostic applications and the demonstration of phosphates, dehydrogenases, oxidases and peroxidases

***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.
- Koss, L. G., & Melamed, M. R. (Eds.). (2006). *Koss' diagnostic cytology and its histopathologic bases* (Vol. 1). Lippincott Williams & Wilkins.
- Ramakrishnan, S., & Sulochana, K. N. (Eds.). (2012). *Manual of Medical laboratory techniques*. Jaypee Brothers Medical Publishers Pvt. Ltd.
- Lynch, M. J., & Raphael, S. S. . Lynch's Medical laboratory technology.
- Baker, F. J., & Silverton, R. E. (2014). *Introduction to medical laboratory technology*. Butterworth-Heinemann.
- Koss, L.G. and Melamed, M.R. eds., 2006. *Koss' diagnostic cytology and its histopathologic bases* (Vol. 1). Lippincott Williams & Wilkins.
- Nayak, R., & Nayak, R. (2023). *Review of Postgraduate Pathology (Systemic Pathology): Two Volume Set*. JP Medical Ltd.
- Carson, F. L., & Cappellano, C. H. (2009). Histotechnology: A self-instructional text (3rd ed.). ASCP Press.
- Curran, R. C., & Crocker, J. (2000). Curran's atlas of histopathology. *(No Title)*.
- Sadhana Vishwakarma (2017). Edition : 1/e. **Techniques in Histopathology and Cytopathology**.
- Cibas, E. S., & Ducatman, B. S. (2003). *Cytology: Diagnostic principles and clinical correlates*. Gulf Professional Publishing.

Course Name: Applied Pathobiology **Credit = 4 (60 hours)**

Course Rationale: This course provides an in-depth study of the cellular and tissue-level mechanisms that underlie disease processes. It covers key principles of cell injury, inflammation, healing, immune pathology, and neoplasia, with an emphasis on histopathological changes and their clinical implications.

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

- Understand the fundamental concepts of disease processes, including cell injury, inflammation, repair, and neoplasia
- Explain the mechanisms of cellular adaptation, degeneration, necrosis, apoptosis, and other pathological changes.
- Apply knowledge of general pathology to interpret basic histological findings and laboratory results relevant to common diseases.

Unit	Topic	Hours
I	Introduction to Pathobiology & Cell Injury: Definition and scope of pathology, Cellular adaptations: hypertrophy, hyperplasia, atrophy, metaplasia, Mechanisms of cell injury: physical, chemical, biological, Morphology of reversible and irreversible injury, Cell death: necrosis (types), apoptosis, Intracellular accumulations – Lipids, cholesterol, proteins, glycogen and pigments; examples, Pathologic calcification – Types and examples.	8
II	**Inflammation and Repair: Definition and symptoms,** Acute inflammation: signs, vascular and cellular events, Chemical mediators of inflammation, Chronic inflammation and granuloma formation, Healing: Regeneration and fibrosis, wound healing stages, factors affecting wound healing.	12
III	**Hemodynamic and Immune Disorders:** Edema, hyperemia, haemorrhage, thrombosis, embolism, infarction, Difference between transudate and exudate, Shock: types and pathology, Hypersensitivity reactions (I–IV), autoimmunity: examples (SLE, rheumatoid arthritis), Diabetes, HIV, Tuberculosis	12
IV	**Neoplasia:** Definitions and nomenclature of tumours, Differences between benign and malignant tumours, Histological features: anaplasia, differentiation, invasion, carcinogenesis: chemical, radiation, and viral, mode of tumour spread, Clinical aspects of neoplasia, grading and stages of tumour, Tumour markers and lab diagnosis (AFP, PSA, CEA, etc.)	16
V	**Infectious and Parasitic Diseases:** Anthrax, Whooping Cough (Pertussis), Candidiasis, Amoebiasis, Malaria, TORCH Complex, Hepatitis type laboratory diagnosis, Pulmonary tuberculosis and lab diagnosis	12
	Total	**60**

Course Name: Applied Pathobiology Practical **Credit: 2 =60 hours**

Course Rationale: The course will bridge the diagnostic foundation of disease mechanisms including anatomy, physiology, and microbiology. The course emphasizes the integration of clinical knowledge with laboratory practice, enabling students to understand how cellular and tissue changes reflect disease processes.

1. Basic interpretation of histopathological slides (normal vs diseased tissue)
2. Microscopic Identification of Cellular Changes: (i) Hypertrophy, (ii) atrophy (iii) dystrophy
3. Microscopic pattern recognition in (i) inflammation, (ii) neoplasia, (iii) necrosis
4. Identification of pathological features in gross specimens: (i) liver, (ii) lung, (iii) kidney, (iv) heart, and any other organs
5. Correlation with clinical symptoms and microscopic imaging of disease- case based studies
6. Reporting practice in histopathology and cytology (minimum 15-20 different case studies can be incorporated).

   *** If the Institutes are having limitations with biological samples educational slides are readily available which can help them to learn the basic needs of the practical. The remaining hours can be compensated by clinical lab rotations.

Suggested Reading:

- Mohan, H. (2015). Textbook of pathology. Jaypee Brothers Medical Publishers.
- Kumar, V., Abbas, A. and Aster, J. (2020) Robbins and Cotran Pathologic Basis of Diseases. 10th Edition, Elsevier
- MOHAN, Harsh. (2013). Pathology Practical Book. New Delhi: Jaypee Brothers Medical.
- Klatt, E. C. (2014). Robbins and Cotran atlas of pathology. Elsevier Health Sciences.
- Godkar, P. B., & Godkar, D. P. (2006). *Textbook of medical laboratory technology*. Bhalani publishing house.

SEMESTER VII & VIII

Course Name: Internship **Credit: 40 (1800 hours)**

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

By rotating through specialized disciplines, students deepen their understanding of diagnostic procedures, automation, specimen handling, and healthcare workflows. This experience fosters critical thinking, interdisciplinary collaboration, and readiness for national/global healthcare environments.

Internship Duration: 12 months (Semester VII & VIII)

Schedule: 42 hours/week (7 hours/day, 6 days/week)

Learning Outcome

- Preanalytical phase - Safely collect, identify, and manage clinical specimens, follow proper safety precautions
- Conduct clinical investigations and interpret findings
- Perform equipment quality control and resolve technical issues
- Manage documentation, communication, ethics, and teamwork
- Demonstrate leadership and entrepreneurship in lab environments
- Write and critique scientific literature reviews

Internship Rotation Structure & Competencies

Area	Duration (Months)	Competencies
Pathology	2	Sample processing, staining, cryostat handling, FNAC
Hematology & Clinical Pathology	2	Phlebotomy, smear reading, automation, urinalysis
Transfusion Medicine	2	Blood component preparation, donor monitoring, transfusion-transmitted disease screening
Clinical Biochemistry	2	Biochemical analysis, automated system, Quality control
Microbiology	2	Culturing, antimicrobial susceptibility testing, media preparation, QC strains
Research (Individual/group projects can be included)	2	Literature review, topic formulation, manuscript drafting

Internship Rotation Plan

- **Posting Guidelines**: Each student completes all rotations with documented competent acquisition.
- **Attendance & Conduct**: Minimum 90% attendance and adherence to institutional guidelines required.
- **Assessment**: Non-CGPA contributing; qualitative evaluations are documented.
- **Certification**: Granted upon satisfactory completion, verified by HOD/Coordinator and HOI.

Competency Domains for Alignment

Domain	Representative Competencies
Cognitive & Technical	Clinical reasoning, diagnostic accuracy, QC protocols
Affective & Ethical	Professionalism, patient safety, lab ethics
Psychomotor	Skill-based performance, automation handling, specimen processing
Communication & Collaboration	Documentation, interdisciplinary teamwork
Research & Innovation	Literature review, evidence synthesis, scientific writing
Leadership & Entrepreneurship	Initiative, mentorship, resource management

Internship Logbooks

- **Daily Tracking**: Structured entries with dates, tasks, and supervisor validation
- **Weekly Goals**: Intern sets rotation-specific targets
- **Competency Checklist**: Per module, includes skill validation (e.g., staining, cryostat handling)
- **Supervisor Feedback**: 5-point scale on independence, safety, and professional behavior

Formative Assessment

- Objective Structured Practical Examination (OSPE)
- Mini Clinical Evaluation Exercise (Mini-CEX)
- Reflective Portfolios
- Supervisor Evaluations
- Peer-Reviewed Research Logs
- Recorded Demonstrations

Certification: Internship completion certificate includes:

- Clinical rotation postings and total hours
- Externship and research details
- Authenticated by HOD/Coordinator and HOI
- **Note**: Degree awarded only upon validated internship completion

SEMESTER VII & SEMESTER VIII (LOG BOOK AND SKILL ASSESSMENT PAGES

Cover Page of Log book

University/College logo

University/ College Name

INTRENSHIP LOG BOOK

BMLS (VII/VIII SEMESTER)

(YEAR)

STUDENT'S RECORD

Name : ……..….

Semester : ……...

Enrollment No. :……..…

Session : ……..…….

……..…….. ……..……..

Signature of Principal **Signature of Student**

DECLARATION BY THE STUDENT

Madam/Sir,

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

Students Signature

(COLLEGE/UNIVERSITY LOGO)

INSTITUTE/UNIVERSITY/ COLLEGE NAME

LOGBOOK CERTIFICATE

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

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

Name

Date

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

Name

Date

SKILL ASSESSMENT SHEET

Hospital/Laboratory: **Department:**

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

NATIONAL COMMISSION FOR ALLIED AND HEALTHCARE PROFESSIONS
राष्ट्रीय सहबद्ध और स्वास्थ्य देख-रेख पेशा आयोग
स्वास्थ्यम् सर्वार्थसाधनम्
NCAHP
Since-2021

Chapter 5
Curriculum -Master of Medical Laboratory Science

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 specialisations

Course Name	Lecture	Tutorial	Practical	Credits	Contact Hours
Medical Laboratory Management	4	0	0	4	60
Cell and Molecular Biology	4	0	0	4	60
Research Methodology & Biostatistics	2	0	0	2	30
Advanced Molecular Diagnostic Techniques	4	0	0	4	60
Digital Health Technologies	2	0	0	2	30
Elective Course*	0	0	2	2	60
Research Methodology & Biostatistics Practical	0	0	2	2	60
Advanced Molecular Diagnostic Techniques Practical	0	0	2	2	60
TOTAL	16		6	22	420

* To be decided by respective institute

Semester II- Medical Biochemistry

Course Name	Lecture	Tutorial	Practical	Credits	Contact Hours
Bioorganic & Biophysical Chemistry	4	0	0	4	60
Instrumentation in Biochemistry	4	0	0	4	60
Enzymology & Nutrition	4	0	0	4	60
Intermediary Metabolism	4	0	0	4	60
Bioorganic & Biophysical Chemistry Practical	0	0	4	2	60
Instrumentation Practical	0	0	4	2	60
Clinical posting	0	0	4	2	90
TOTAL	**16**	0	**12**	**22**	**450**

Semester II Medical Microbiology

Course Name	Lecture	Tutorial	Practical	Credits	Contact Hours
Essential and Applied Microbiology	3	1	0	4	60
Systematic Bacteriology	3	1	0	4	60
Systematic Bacteriology practical	0	0	4	2	60
Medical Entomology and Parasitology	3	1	0	4	60
Medical Entomology and Parasitology practical	0	0	4	2	60
Immunology and Immunodiagnostics	3	1	0	4	60
Immunology and Immunodiagnostics practical	0	0	4	2	60
TOTAL	16	4	12	22	420

Semester II Haematology and Transfusion Medicine

Course name	Lecture	Tutorial	Practical	Credits	Contact Hours
Haematology and Haematological Disorders	4	0	0	4	60
Haemostatic Disorders	4	0	0	4	60
Applied Immunopathology in Haematology	4	0	0	4	60
Clinical Pathology	2	0	0	2	30
Haematology and Haematological Disorders Practical	0	0	2	2	60
Haemostatic Disorders Practical	0	0	2	2	60
Applied Immunopathology in Haematology Practical	0	0	2	2	60
Clinical Pathology Practical	0	0	2	2	60
Total	14	0	8	22	450

Semester II- Histology and Cytology

Course Name	Lecture	Tutorial	Practical	Credits	Contact Hours
Translational Anatomy and Cell Dynamics	4	0	0	4	60
Essentials of Histology	4	0	0	4	60
Essentials of Cytopathology	4	0	0	4	60
Cancer epidemiology and Digital Pathology	2	0	0	2	30
Translational Anatomy and Cell Dynamics Practical	0	0	0	2	60
Essentials of Histology Practical	0	0	0	2	60
Essentials of Cytopathology Practical	0	0	0	2	60
Cancer epidemiology and Digital Pathology Practical	0	0	0	2	60
Total	14	0	8	22	450

Semester III- Medical Biochemistry

Course Name	Lecture	Tutorial	Practical	Credits	Contact Hours
Clinical Biochemistry I	4	0	0	4	60
Clinical Biochemistry II	4	0	0	4	60
Immunology	4	0	0	4	60
Endocrinology & Biochemistry of aging	4	0	0	4	60
Clinical Biochemistry I Practical	0	0	2	2	60
Clinical Biochemistry II Practical	0	0	2	2	60
Immunology Practical	0	0	2	2	60
TOTAL	16	0	6	22	420

Semester III Medical Microbiology

Course Name	Lecture	Tutorial	Practical	Credits	Contact Hours
Medical Virology	3	1	0	4	60
Medical Mycology	3	1	0	4	60
Medical Mycology & Virology practical	0	0	4	2	60
Public Health Microbiology	3	1	0	4	60
Public Health Microbiology practical	0	0	4	2	60
Advances in Microbial Informatics	3	1	0	4	60
Clinical posting	0	0	4	2	90
TOTAL	12	4	12	22	450

Semester III- Haematology and Transfusion Medicine

Course Name	Lecture	Tutorial	Practical	Credits	Contact Hours
Blood Banking and Immunohematology	4	0	0	4	60
Transfusion Medicine	4	0	0	4	60
Molecular Hematology	4	0	0	4	60
Advanced Haematological Techniques	2	0	0	2	30
Blood Banking and Immunohematology Practical	0	0	2	2	60
Transfusion Medicine Practical	0	0	2	2	60
Molecular Hematology Practical	0	0	2	2	60
Advanced Haematological Techniques Practical	0	0	2	2	60
Total	14	0	8	22	450

Semester III- Histology and Cytology

Course name	Lecture	Tutorial	Practical	Credits	Contact Hours
Diagnostic Histopathology	4	0	0	4	60
Cytological Techniques	4	0	0	4	60
Immunohistochemistry & Diagnostic Markers	4	0	0	4	60
Molecular Techniques in Histopathology & Cytology	2	0	0	2	30
Diagnostic Histopathology Practical	0	0	0	2	60
Cytological Techniques Practical	0	0	0	2	60
Immunohistochemistry & Diagnostic Markers Practical	0	0	0	2	60
Molecular Techniques in Histopathology & Cytology Practical	0	0	0	2	60
Total	14	0	8	22	450

Semester IV –COMMON FOR ALL SPECIALIZATION

S. No	SEMESTER IV	Credits	Contact Hours
1	Dissertation	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**

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**

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**

Semester II Haematology and Transfusion Medicine

S. No	Course Name	Continuous Assessment	End Semester Examination	Total
1	Haematology and Haematological Disorders	30	70	100
2	Haemostatic Disorders	30	70	100
3	Applied Immunopathology in Haematology	30	70	100
4	Clinical Pathology	30	70	100
5	Haematology and Haematological Disorders Practical	30	70	100
6	Haemostatic Disorders Practical	30	70	100
7	Applied Immunopathology in Haematology Practical	30	70	100
8	Clinical Pathology Practical	30	70	100
	Total			700

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**

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**

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**

Semester III Haematology and Transfusion Medicine

Course Name	Continuous Assessment	End Semester Examination	Total
Blood Banking and Immunohematology	30	70	100
Transfusion Medicine	30	70	100
Molecular Hematology	30	70	100
Advanced Haematological Techniques	30	70	100
Blood Banking and Immunohematology Practical	30	70	100
Transfusion Medicine Practical	30	70	100
Molecular Hematology Practical	30	70	100
Advanced Haematological Techniques Practical	30	70	100
Total			800

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.

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**

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.

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)

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

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)

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.

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**

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

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 - Haematology and Transfusion Medicine

Course: Haematology and haematological disorders
Total Credits :4 (60 hours)

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

Learning Outcomes:

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

Unit	Topic	Hours
I	Hematopoiesis and Bone Marrow Dynamics: Regulation of hematopoietic stem cells and stages of differentiation; Identification of maturation blockages and marrow failure syndromes; Role of marrow microenvironment and stromal interactions; Cytokine signaling in stem cell survival and lineage commitment; WHO 2022 marrow grading: fibrosis, cellularity, and blast percentages.	**5**
II	Red cell structure and metabolism: Red cell morphology and structural variants (size, shape, inclusion bodies); Hemoglobin biosynthesis: heme synthesis, globin chain production; Red cell metabolic pathways: Embden-Meyerhof and Pentose phosphate pathways; Functional implications of morphology and metabolism on red cell survival	**5**

Unit	Topic	Hours
III	Red cell destructions- extracellular and intracellular red cell destructions; compensation mechanisms in hemolysis- reticulocytosis, erythroid hyperplasia, bilirubin metabolism; Classification of hemolytic anemia: hereditary vs acquired; Pathophysiology and laboratory diagnosis of: Hereditary spherocytosis and elliptocytosis, G6PD deficiency and its oxidative stress pathways, Paroxysmal nocturnal hemoglobinuria (PNH); diagnostic approaches for hereditary and acquired hemolytic anemias.	**6**
IV	Nutritional & Hypoproliferative Anemias: Classification, pathophysiology and laboratory diagnosis of nutritional anemias- Iron deficiency, folate deficiency, and megaloblastic anemia; Diagnostic interpretation using - Iron studies, megaloblastic indices, folate deficiency; anemia of chronic disease- pathophysiological mechanisms and cytokine-mediated iron sequestration; Hypoproliferative anemias - reticulocyte indices, erythropoietin response, and marrow hypocellularity; Bone marrow biopsy evaluation: cellularity grading, storage iron stains, and dysplastic features; Reticulocyte production index (RPI) and its relevance in marrow functional assessment; Application of WHO and ICSH global anemia classification standards for standardized reporting	**8**
V	Hemoglobin Variants and Thalassemia Syndromes: Classification, pathophysiology and laboratory diagnosis of hemoglobin variants and thalassemia syndromes; WHO guidelines for sickle cell disease and unstable hemoglobin - Structural abnormalities (e.g., HbS, HbE, HbD) and synthesis defects (α- and β-thalassemia); Role of genetic counseling and prenatal diagnostic protocols.	**8**
VI	Acute & Chronic Leukemias: WHO/FAB classifications, pathophysiology and laboratory diagnosis of AML, ALL, CML, CLL including immunophenotyping (CD markers), cytogenetics, flow cytometry and PCR.	**8**

Unit	Topic	Hours
VII	Myeloproliferative & Myelodysplastic Syndromes: Clinical features and lab diagnosis of Polycythemia Vera, Essential Thrombocythemia, Myelofibrosis, Myelodysplastic Syndromes; marrow dysplasia grading, mutation panels (JAK2, CALR, and MPL), ASH guidelines for diagnosis and classification,	**8**
VIII	Plasma Cell Dyscrasias & Related Disorders: classifications, pathophysiology and laboratory diagnosis of multiple myeloma; paraprotein detection (SPEP, IFE, FLC assay); WHO 2022 criteria for plasma cell neoplasms; beta-2 microglobulin and cytogenetic risk stratification in plasma cell myeloma; WHO 2022 plasma cell definitions	**6**
IX	Lymphoid Neoplasms: Classification, etiology, and lab findings of B-lymphoblastic and T-lymphoblastic leukemia/lymphoma; immunophenotyping (CD10, TdT, CD7), cytogenetic markers (MLL, ETV6), and clinical correlations. Mature Lymphoid Neoplasms & Advances: CLL, prolymphocytic leukemia, hairy cell leukemia, Hodgkin and Burkitt lymphomas, diagnostic techniques and recent molecular advances- NGS, FISH, IgH rearrangement; WHO 2022 updates on classification and disease behavior.	**6**
Total		**60**

Course Name: Clinical Haematology - Practical Total Credit : 2 (60 hours)

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

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

Suggested Readings:

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

Course Name: Haemostatic Disorders **Credit : 4 (60 hours)**

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

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

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

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

Course: Haemostatic Disorders Practical **Total Credits: 2 (60 hours)**

1. Perform proper safety precautions
2. Perform collection, transport, and processing of blood samples for coagulation tests,
3. Platelet Count and Peripheral Smear Interpretation- Platelet estimation accuracy, identification of qualitative abnormalities (e.g., Bernard-Soulier syndrome).
4. Bleeding Time (BT) and Clotting Time, PT/APTT Testing, Mixing study, Coagulation Factor Assays and Dilution Studies and Interpretation, Reflex algorithm application; protocol troubleshooting.
5. ROTEM/TEG Simulation and Interpretation
6. D-Dimer and FDP Estimation- Latex agglutination test; immunoassay-based quantification; cut-off setting for DVT/pulmonary embolism
7. vWF Antigen and Activity Estimation- Differentiating type 1 vs type 2 variants; handling pre-analytical interferences.
8. Lab automation & QC documentation: Analyzer histogram reading, calibration reports, QC charting exercises.
9. Integrated case analysis & report writing: Drafting diagnostic algorithms and structured case interpretations.- Analyze anonymized clinical vignettes; chart diagnostic flow using PT/APTT/mixing study/vWF tools; prepare interpretive report.
10. WHO/ISTH Guidelines Review- Critical reading; global framework contextualization.

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

Suggested Readings:

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

Course: Applied Immunopathology in Hematology **Credit : 4 (60 hours)**

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

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

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

Unit	Topic	Hours
I	Overview of Immune system: Immune system and Immunologic disorders, Cellular and humoral Immunity, Complement system, Cytokines, Human leucocytic antigen, Major Histocompatibility complex and disease	10
II	Immunopathology of Hematologic Disorders: Autoimmune hemolytic anemia (AIHA), Immune thrombocytopenic purpura (ITP), Paroxysmal nocturnal hemoglobinuria (PNH), Hemophagocytic lymphohistiocytosis (HLH), Hypersplenism and immune cytopenias	13
III	Immunopathology in Hematologic Malignancies: Tumor immunology of leukemia and lymphoma, Immunophenotyping in leukemia/lymphoma diagnosis, Role of monoclonal antibodies and immune escape, Minimal residual disease detection via flow cytometry	13
IV	Immunodiagnostics in Hematology: Direct and Indirect Coombs Test (DAT & IAT), Antibody screening and cross-matching, Immunoassays (ELISA, CLIA) for hematological markers, Flow cytometry principles and interpretation, Autoantibody detection in systemic autoimmune diseases	12

Unit	Topic	Hours
V	Immunotherapy and Targeted Therapy: Immunomodulatory drugs in hematology, Monoclonal antibodies (e.g., Rituximab, Daratumumab), CAR-T cell therapy in leukemia and lymphoma, Graft-versus-host disease (GVHD) and immune regulation in bone marrow transplant	12
Total		**60**

Course Name: Applied Immunopathology in Hematology Practical
Credits: 2 (60 hours)

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

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

Suggested Readings:

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

Course: Clinical Pathology **Credit: 2 (30 hours)**

Course Rationale: This course integrates foundational and advanced diagnostic principles in clinical pathology, emphasizing fluid-based diagnostics (urine, CSF, serous fluids, semen, feces, sputum, cytology). It equips learners to apply structured laboratory techniques, interpret results in clinical contexts, and engage with emerging technologies and automation in pathology.

Learning Outcome:

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

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

Unit	Topic	Credit Hours
V	Other Fluids: Amniotic, BAL, Saliva: Composition and analysis of amniotic fluid; maternal urine differentiation; L/S ratio in amniotic fluid, salivary biomarkers. BAL and saliva examination. BAL cytology for infectious diseases.	3
VI	Fecal Analysis: Composition; collection; physical, chemical, microscopic exams; fecal screening tests (occult blood, fat, Hb); clinical correlations. Fecal calprotectin, PCR for parasitic DNA, and automation in stool analysis.	4
VII	Sputum Analysis: Formation of Sputum, collection of Sputum, Analysis of Sputum, sputum cytology, Ziehl-Neelsen staining, and GeneXpert for TB.	3
VIII	Integrated Interpretation & Case Correlation: Reflex testing interpretation; integration of fluid analysis in diagnostic decisions; pattern recognition across fluids; specimen quality and result impact; AI-assisted image analysis.	4
Total		**30**

Course: Clinical Pathology Practical **Credit: 2 (60 hours)**

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

Suggested Readings:

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

SEMESTER II Histology and Cytology

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.

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**

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

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:
	  ○ Respiratory tract: sputum, bronchial washings
	  ○ Urinary tract: voided urine, bladder washings
	  ○ Female genital tract: Pap smear (conventional and liquid-based cytology)
	  ○ Serous cavities: pleural, peritoneal, and pericardial fluids
	  ○ Nipple discharge, oral cavity, gastrointestinal tract
		10

III	**Interventional Cytology:** **1. Introduction to Interventional Cytology** • Definition, scope, and evolution • Indications and contraindications • Role in minimally invasive diagnosis **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:
	  ○ Papanicolaou stain (Pap stain)
	  ○ Hematoxylin and Eosin
	  ○ May-Grünwald Giemsa (MGG)
	  ○ Special stains for infection (Ziehl–Neelsen, PAS)
	Microscopic Interpretation:
	Criteria for adequacy and cellular preservation, Identification of normal epithelial cells and reactive changes, Recognition of inflammatory and infectious processes, Cellular atypia and malignancy: cytomorphological features, Use of scoring systems (e.g., Bethesda system for cervical cytology)
		10

V	**Cytodiagnosis and reporting:** **Rapid On-Site Evaluation (ROSE)** • Concept, purpose, workflow • Adequacy assessment criteria • 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

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

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

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**

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

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**

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

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.

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

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**

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

SEMESTER III - Haematology and Transfusion Medicne

Course name: Blood Banking and Immunohematology
Total credits: 4 (60 hours)

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

Learning outcome: At the end of the course the students can

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

Unit	Topic	Hours
I	Advanced Immunohematologic Principles: Principles of Immunohematology, Genetics of ABO blood group system, their subgroups, RBC antigens and consecutive antibodies, Genetics of Rh Blood group and antibodies, Minor blood group systems, Bombay blood group, ABO and Rh incompatibility, Hemolytic Disease of newborn and its management, Alloantibodies Vs auto antibodies, High-titer, low-avidity antibodies, Human leucocytic antigen	15
II	Blood collection and donor selection criteria: **Donor Management:** Donor registration and screening, Phlebotomy in blood banks, blood storage, various anticoagulants used in blood bags, types of blood bags used in blood banks **Blood Collection & Processing:** Whole blood collection, Adverse reactions and their management, Blood transmitted disease and their testing, Labelling, storage, and transportation of blood	10

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

Course name: Blood Banking and Immunohematology Practical
Credit: 2= 60 hours

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

*** Clinical postings should be incorporated wherever possible

Suggested Readings:

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

Course: Transfusion Medicine **Total credits: 4 (60 hours)**

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

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

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

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

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

Course Name: Transfusion Medicine Practical Total Credits:2 (60 hours)

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

Suggested Readings:

1. Lee, G. R., Foerster, J., Lukens, J., Paraskevas, F., Greer, J. P., & Rodgers, G. M. (1999). Wintrobe's clinical hematology 10th. *Bethseda, Maryland: Lippincort Williams and Wilkins*.
2. Hillyer, C., Hillyer, K. L., Strobl, F., Jefferies, L., & Silberstein, L. (Eds.). (2001). *Handbook of transfusion medicine*. Academic press.
3. Harmening, D. M. (2018). *Modern blood banking & transfusion practices*. FA Davis.
4. McCullough, J. (2021). *Transfusion medicine*. John Wiley & Sons.
5. Vengelen-Tyler, V. (2019). Technical Manual, American Association of Blood Banks (AABB). *Bethesda, Maryland: American Assocociation of Blood Banks (AABB)*.
6. National Blood Policy and Guidelines – NACO, India

Course Name: Molecular Hematology **Total Credits: 4 (60 hours)**

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

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

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

Unit	Topic	Hours
I	**Unit 1: Basics of molecular hematology** Central dogma, transcriptional regulation of hemopoeitic cells, Post-transcriptional and translational control, mRNA stability and microRNAs in hematology, Non-coding RNAs and their role in blood cell gene regulation, Epigenetic dysregulation in hematologic malignancies, Transcription factors in hematopoesis	6
II	**Unit 2: Molecular Basis of Hematologic Malignancies** Chromosomal abnormalities (translocations, deletions, duplications), Oncogenes and tumor suppressor genes, Molecular pathogenesis of leukemia (AML, ALL, CML, CLL), Lymphomas: Molecular classification and biomarkers, Minimal Residual Disease (MRD) monitoring	15
III	**Unit 3: Inherited and Acquired Hematologic Disorders** Hemoglobinopathies: Molecular basis of thalassemias and sickle cell anemia, Coagulation disorders: FVIII, FIX gene mutations, von Willebrand disease, Bone marrow failure syndromes (Fanconi anemia, Diamond-Blackfan anemia), Congenital neutropenias and thrombocytopenias, Iron metabolism genes and disorders	15

Unit	Topic	Hours
IV	**Unit 4: Molecular Diagnostic Techniques** PCR, qPCR, RT-PCR, Next-Generation Sequencing (NGS) basics and applications, Microarray and gene expression profiling, FISH and Southern blotting, Bioinformatics tools for hematology (mutation databases, variant interpretation)	12
V	**Unit 5: Translational and Precision Hematology** Molecular therapeutics (tyrosine kinase inhibitors, antisense oligonucleotides), Gene editing (CRISPR-Cas9) in hemoglobinopathies, CAR-T cell therapy in hematologic malignancies, Ethical issues in molecular hematology and genetic testing	12

Course:Molecular Haematology Practical **Total credits 2 (60 hours)**

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

Suggested Readings:

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

Course name: Advanced Hematological Techniques
Total credits: 2 (30 hours)

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

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

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

Sr. No.	Title of the Unit	No. of Contact Hours
I	**Unit 1: Automation in Hematology** Basics and principles of automated hematology analyzers (3-part, 5-part, 7-part differentials), Automation in Reticulocyte, and platelet analysis by automation, Flags and error codes: troubleshooting and interpretation, Operation, maintenance, and QC on hematology analyzers, Interpreting laboratory results and values, laboratory statistics	8
II	**Unit 2: Clinical Flow cytometry and cytogenetics** Principles of flow cytometry, cell sorting, sample preparation and gating strategies, panel selection, data analysis and reporting, applications of flow cytometry, Karyotyping and chromosomal aberrations in hematological malignancies: principle and applications	8
III	**Unit 3: Laboratory Information Systems (LIS)** Sample tracking from collection to result reporting, Interface with analyzers, middleware, and HIS (Hospital Information Systems), Barcode systems for error reduction and traceability.	7

Sr. No.	Title of the Unit	No. of Contact Hours
IV	**Unit 4: Quality Assurance & Advanced Data Interpretation** Laboratory organization and management in hematology lab, Quality Assurance, Ethics in hematology lab, Preanalytic and Postanalytic automation and medical decision, specimen rejection criteria, Point of care testing Hematology in under resourced laboratories	7

Course Name:Advanced Hematological Techniques Practical:
Total credits 2 (60 hours)

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

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

Suggested Readings:

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

SEMESTER III - Histology and Cytology

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**

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

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**

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)

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**

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

Endorsement by the Head of the Institution

The information provided by the teacher is verified from the office records and found to be correct. He/She is eligible to be recognised as a PG teacher to guide the dissertation work of PG students.

Place:

Date

Signature of Principal/Dean

Format of the submission of Dissertation Hard & Soft copy

Instructions to candidates

Although your dissertation may be prepared on a computer, consider the following requirements for meeting the standards.

Paper: Use only one side of high-quality, plain white bond paper. Erasable paper should not be used.

Type Size and Print:

Select font type Times New Roman and a size of 12 characters. The size of the titles should be 14 and Bold, the size of subtitles should be 12 and Bold. Print should be letter quality or laser printing with dark black characters that are consistently clear and dense. Use the same type of print and print size throughout the document.

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

Spacing: Use double spacing except for long quotations and footnotes, which are single-spaced.

Margins: To allow for binding, the left-hand margin must be 1.5.Other margins should be 1.01. Diagrams or photographs in any form should be a standard page size, or if larger, folded so that a free left-hand margin of 1.5 remains and the folded sheet is not larger than the standard page.

Professional-quality black-and-white photographs are necessary for clear reproduction. Colours are allowed, but you should be certain the colored figure will copy clearly and will not be confusing when printed in black and white.

File Format

Dissertation format should be in Doc (MS Word Document) or PDF (Portable Document Format). Image files in JPG or TIFF format and Audio Visual in AVI (Audio Video Interleave),GIF, MPEG (Moving Picture Expert) files format, Labelling on CD (title, name of the candidate, degree name, subject name, guide name, name of the department, college, place and year.

References: Vancouver style format.

GUIDELINES OF DISSERTATIONS FOR MMLS DEGREE (COVER PAGE)

Title (Capital)

Logo (University/College)

DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF MEDICAL LABORATORY SCIENCE (university/College).

Year

Title

By

Name of the Candidate

Dissertation Submitted to the University/College

In partial fulfilment of the requirements for the degree of _____

Under the guidance of Name of the Guide

Name of the Course

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Year

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation/thesis entitled _____ _____is a bonafide and genuine research work carried out by me under the guidance of Name and designation of the guide.

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This is to certify that this dissertation/thesis entitled _____ _____is a bonafide and genuine research work done by Name of the candidate in partial fulfillment of the requirement for the degree of MMLS.

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Place:

Date:

Acknowledgement

Signature of the candidate

Name:

Place:

Date:

Abstract:

Should be structured

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

Keywords: 5-6 words

Table of contents

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

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

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

General Rules:

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

Tables

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

Illustrations and figures

- Number each figure in the text in consecutive order
- Abbreviations and symbols: Use only standard abbreviations; the use of non-standard abbreviations can be confusing to readers. Avoid abbreviations in the title of the manuscripts. The spelt-out abbreviation in parentheses should be used on first mention unless the abbreviation is a standard unit of measurement

Abstract

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

References

- The reference list should appear at the end of the paper and provide the complete bibliographic information about the sources cited.
- List all reference in order by number, not alphabetically. Each reference is listed once only, since the same number is used throughout the paper. It should be numbered consecutively in the order in which they are first mentioned in the text. Identify references in text and tables by Arabic numerals in parentheses.
- The titles of journals should be abbreviated according to the style used in the list of journals. The following information is included for journal articles: author(s), article, title, abbreviated journal title, year, month (if applicable), day, volume number, issue number (if applicable), and page numbers. For books author(s), title, Edition, place of publication, publisher and year.
- List each author's last name and initials: full first names are not included. List all authors, but if the number exceeds six, give the first six followed by"et al.
- For books with chapters written by individual authors, list the authors of the chapter first, then the chapter title, followed by"In:"the editors' names, and the book title.
- Initials follow the family names of authors and editors, with no space or full stops between the initials of an author, e.g.Halpern SD, Ubel PA, Caplan AI.
- Commas are used to separate each author's name. Note that "and" is not used to separate the last two names.
- Minimal capitalisation is used for the article title, i.e.only the first word and words that normally would begin with a capital letter are capitalised.
- 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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2. Size, composition, and distribution of human resource for health in India: new estimates using National Sample Survey and Registry data, BMJ Open, 2019
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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