DRAFT REGULATIONS FOR BACHELOR OF MEDICAL LABORATORY SCIENCE (MLS) PROGRAMME

SRI GURU RAM DAS UNIVERSITY OF HEALTH SCIENCES, SRI AMRITSAR

Applicable from Academic Session 2025-2026

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

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**

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., & Pennington, 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