

**Jawaharlal Institute of Postgraduate Medical
Education & Research
(JIPMER)
Puducherry**



**BACHELOR
IN
MEDICAL LABORATORY SCIENCES**

2021

CURRICULUM

This curriculum was approved at the 15th meeting of the Standing Academic Committee held on August 8, 2020, and will be applicable for students joining Bachelor's in medical laboratory sciences (BMLS) from the academic year 2021-22. The curriculum document was prepared based on the model curriculum for BMLS issued by the Ministry of Health and Family Welfare, Government of India.

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About JIPMER

Jawaharlal Institute of Postgraduate Medical Education and Research, Puducherry (JIPMER) under Government of India since the year 1956, is one of the leading Medical Institutions of India. Spread over a sprawling 195-acre campus in an urban locale of Puducherry (formerly Pondicherry), JIPMER is 170 kms by road from Chennai.

JIPMER has been declared as an “Institution of National Importance” by an Act of Parliament, JIPMER, Puducherry, Act, 2008. A copy of the Act was Gazette notified on 14-7-2008 to enforce this Act. Prior to this, the Institute was functioning under the administrative control of Directorate General of Health Services, Ministry of Health and Family Welfare, New Delhi. The Institution is now empowered to award Medical Degrees under the clauses 23 & 24 of the said Act. Such Degrees shall be deemed to be included in the schedules to the respective Acts governing Medical Council of India/National Medical Commission, Indian Nursing Council, and Dental Council of India, entitling the holders to the same privileges as those attached to the equivalent awards from the recognized Universities of India.

JIPMER imparts Undergraduate (UG), Postgraduate (PG) and Super Specialty Medical Training through a large hospital complex (JIPMER Hospital) and a Nursing College. Some of the courses offered are MBBS, BSc, MSc, MD, MS, DM, and MCh courses. Full-time Ph.D. programs are available in several disciplines.

COURSE DETAILS

Nomenclature: Bachelor in Medical Laboratory Sciences (BMLS)

Introduction:

This is a bachelor course in which students are trained with a wide spectrum of knowledge in Laboratory practices. The course was originally referred as BSc Medical Laboratory Technology which was renamed as Bachelor in Medical Laboratory Sciences (BMLS). The total course period is divided into 3 phases. phase-I includes basic medical foundation subjects. In phase-II & III students, gain theoretical and practical knowledge in Biochemistry, Microbiology and Pathology lab practices.

Course overview:

Bachelor in Medical Laboratory Sciences (BMLS) is a four-year course with three and half years academic program divided into three phases; first and second phases of one year each, third phase one and a half year followed by six months of compulsory internship period.

First phase: one year

In addition to the subjects of foundation course, Anatomy, and Physiology, students will get trained in Histological, Anatomical techniques and basics of haematology.

Second phase: one year

In the Second phase, the students will learn in detail about the general aspects of Biochemistry, haematology, and blood banking. They will also be taught General microbiology, immunology, bacteriology, and serology. The students will be posted in various laboratories in the Departments of Biochemistry, Pathology and Microbiology

Third phase: one and a half year

In the Third phase, the students will be trained in Analytical, applied and clinical biochemistry. Students will get a hands-on laboratory experience in Histopathology, Cytology, Medical parasitology, entomology, mycology, and virology. The students will be posted in laboratories in the Departments of Biochemistry, Pathology and Microbiology and will be trained under supervision to handle various equipment. In addition, The students will also be taught Community health, research methodology and biostatistics

Internship: six months

Internship of six months is compulsory. The interns will be given hands-on training in laboratory equipment. They will be trained to operate, manage and trouble shoot analysers and instrumentation, also helping in the reporting process as well. The internship shall include one-month elective posting (to be chosen from a list of elective postings). The internship duration shall be divided as follows: Biochemistry - 45 days, Microbiology - 45 days, Pathology - 45 days, Blood bank - 15 days and elective - one month.

Eligibility for the course:

- The Applicant should be an **Indian National**.
- He/she should have completed **17 years** at the time of application cut-off date.
- There is **no upper age limit**.

The applicants should have passed the qualifying examinations in the manner mentioned below:

- The Higher / Senior Secondary Examination or the Indian School Certificate Examination which is equivalent to 10+2 Higher/Senior Secondary Examination after a period of 12 years study, the last two years of such study comprising Physics, Chemistry, Biology/ Botany & Zoology (which shall include practical tests in these subjects) and with English as a subject.
- The applicant must have passed in the subjects of Physics, Chemistry, Biology/Botany & Zoology and English individually and must have obtained a minimum of 50% marks taken together in Physics, Chemistry, Biology/Botany & Zoology at the qualifying examination
- Candidates belonging to the Scheduled Castes/Scheduled Tribe or Other Backward Classes must have obtained a minimum of 40% marks in the subjects of Physics, Chemistry, Biology / Botany & Zoology taken together in the qualifying examination.
- For PwD candidates in general and EWS categories, the minimum marks in Physics, Chemistry, Biology/ Botany & Zoology taken together in the qualifying examination is 45%.

Candidates intake per year:

37 candidates will be admitted to the course every year. There is no provision for sponsored / nominated candidates.

Duration of the course

4 years (48 months) duration including 3 and a half years of classes and six months of compulsory internship.

Medium of instruction:

English

Vacation: Students will be eligible for 4 weeks of vacation in summer and 2 weeks in winter.

Subject details:

Phase	Paper	Title of the paper
I (One year)	I	Foundation course (T & P)
	II	Anatomy (T & P)
	III	Physiology (T & P)
II (One year)	I	General Biochemistry (T & P)
	II	Haematology and blood banking
	III	General Microbiology, Immunology, Bacteriology and Serology
III (One and a half year)	I	Analytical, applied and clinical biochemistry
	II	Histopathology and Cytology
	III	Medical parasitology, entomology, mycology and virology
	IV	Community health, research methodology and biostatistics
IV (Six months)	Internship period	

T- Theory, P- Practical

Teaching hours:

Phase	Subject	Theory	Practical	Others
I	Foundation course	80	40	
	Anatomy	100	280	
	Physiology	100	280	
	Self-study/Library			60
	Total			
II	General Biochemistry	60	120	
	Haematology and blood banking	90	320	
	General Microbiology, Immunology, Bacteriology and Serology	90	320	
	Self-study/Library			60
	Total			
III	Analytical, applied and clinical biochemistry	90	360	
	Histopathology and Cytology	90	360	
	Medical parasitology, entomology, mycology, and virology	90	360	
	Community health, research methodology and biostatistics	60	80	
	Self-study/Library			60
	Total			
IV	Internship			

SYLLABUS

Phase I

Paper I: Foundation course

Theory:

Introduction to National Healthcare System

The course provides the students a basic insight into the main features of Indian health care delivery system and how it compares with the other systems of the world. Topics to be covered under the subject are as follows:

1. Introduction to healthcare delivery system
 - a. Healthcare delivery system in India at primary, secondary and tertiary care
 - b. Community participation in healthcare delivery system
 - c. Health system in developed countries.
 - d. Private Sector
 - e. National Health Mission
 - f. National Health Policy
 - g. Issues in Health Care Delivery System in India
2. National Health Programme- Background objectives, action plan, targets, operations, achievements, and constraints in various National Health Programme.
3. Introduction to AYUSH system of medicine
 - a. Introduction to Ayurveda.
 - b. Yoga and Naturopathy
 - c. Unani
 - d. Siddha
 - e. Homeopathy
 - f. Need for integration of various system of medicine
4. Health scenario of India- past, present, and future
5. Demography & Vital Statistics-
 - a. Demography – its concept
 - b. Vital events of life & its impact on demography
 - c. Significance and recording of vital statistics
 - d. Census & its impact on health policy
6. Epidemiology
 - a. Principles of Epidemiology
 - b. Natural History of disease
 - c. Methods of Epidemiological studies

d. Epidemiology of communicable & non-communicable diseases, disease transmission, host defence immunizing agents, cold chain, immunization, disease monitoring and surveillance.

Medical terminologies and record keeping

This course introduces the elements of medical terminology. Emphasis is placed on building familiarity with medical words through knowledge of roots, prefixes, and suffixes. Topics include origin, word building, abbreviations and symbols, terminology related to the human anatomy, reading medical orders and reports, and terminology specific to the student's field of study. Spelling is critical and will be counted when grading tests.²⁵ Topics to be covered under the subject are as follows:

1. Derivation of medical terms.
2. Define word roots, prefixes, and suffixes.
3. Conventions for combined morphemes and the formation of plurals.
4. Basic medical terms.
5. Form medical terms utilizing roots, suffixes, prefixes, and combining roots.
6. Interpret basic medical abbreviations/symbols.
7. Utilize diagnostic, surgical, and procedural terms and abbreviations related to the integumentary system, musculoskeletal system, respiratory system, cardiovascular system, nervous system, and endocrine system.
8. Interpret medical orders/reports.
9. Data entry and management on electronic health record system.

Basic computers and information science

The students will be able to appreciate the role of computer technology. The course has focus on computer organization, computer operating system and software, and MS windows, Word processing, Excel data worksheet and PowerPoint presentation. Topics to be covered under the subject are as follows:

1. Introduction to computer: Introduction, characteristics of computer, block diagram of computer, generations of computer, computer languages.
2. Input output devices: Input devices (keyboard, point and draw devices, data scanning devices, digitizer, electronic card reader, voice recognition devices, vision-input devices), output devices (monitors, pointers, plotters, screen image projector, voice response systems).
3. Processor and memory: The Central Processing Unit (CPU), main memory.
4. Storage Devices: Sequential and direct access devices, magnetic tape, magnetic disk, optical disk, mass storage devices.

5. Introduction of windows: History, features, desktop, taskbar, icons on the desktop, operation with folder, creating shortcuts, operation with windows (opening, closing, moving, resizing, minimizing, and maximizing, etc.).
6. Introduction to MS-Word: introduction, components of a word window, creating, opening and inserting files, editing a document file, page setting and formatting the text, saving the document, spell checking, printing the document file, creating and editing of table, mail merge.
7. Introduction to Excel: introduction, about worksheet, entering information, saving workbooks and formatting, printing the worksheet, creating graphs.
8. Introduction to power-point: introduction, creating and manipulating presentation, views, formatting and enhancing text, slide with graphs.
9. Introduction of Operating System: introduction, operating system concepts, types of operating system.
10. Computer networks: introduction, types of networks (LAN, MAN, WAN, Internet, Intranet), network topologies (star, ring, bus, mesh, tree, hybrid), components of network.
11. Internet and its Applications: definition, brief history, basic services (E-Mail, File Transfer Protocol, telnet, the World Wide Web (WWW)), www browsers, use of the internet.
12. Application of Computers in clinical settings.

Medical law and ethics

Legal and ethical considerations are firmly believed to be an integral part of medical practice in planning patient care. Advances in medical sciences, growing sophistication of the modern society's legal framework, increasing awareness of human rights and changing moral principles of the community at large, now result in frequent occurrences of healthcare professionals being caught in dilemmas over aspects arising from daily practice.²⁶

Medical ethics has developed into a well based discipline which acts as a "bridge" between theoretical bioethics and the bedside. The goal is "to improve the quality of patient care by identifying, analysing, and attempting to resolve the ethical problems that arise in practice".²⁶ Doctors are bound by, not just moral obligations, but also by laws and official regulations that form the legal framework to regulate medical practice. Hence, it is now a universal consensus that legal and ethical considerations are inherent and inseparable parts of good medical practice across the whole spectrum. Few of the important and relevant topics that need to focus on are as follows:

1. Medical ethics - Definition - Goal - Scope
2. Introduction to Code of conduct
3. Basic principles of medical ethics – Confidentiality
4. Malpractice and negligence - Rational and irrational drug therapy
5. Autonomy and informed consent - Right of patients
6. Care of the terminally ill- Euthanasia

7. Organ transplantation
8. Medico legal aspects of medical records – Medico legal case and type- Records and document related to MLC - ownership of medical records - Confidentiality Privilege communication - Release of medical information - Unauthorized disclosure - retention of medical records - other various aspects.
9. Professional Indemnity insurance policy
10. Development of standardized protocol to avoid near miss or sentinel events
11. Obtaining an informed consent.

Communication and soft skills

Major topics to be covered under Communication course –

1. Basic Language Skills: Grammar and Usage.
2. Business Communication Skills. With focus on speaking - Conversations, discussions, dialogues, short presentations, pronunciation.
3. Teaching the different methods of writing like letters, E-mails, report, case study, collecting the patient data etc. Basic compositions, journals, with a focus on paragraph form and organization.
4. Basic concepts & principles of good communication
5. Special characteristics of health communication
6. Types & process of communication
7. Barriers of communication & how to overcome

Introduction to Quality and patient safety

1. Quality assurance and management - The objective of the course is to help students understand the basic concepts of quality in health Care and develop skills to implement sustainable quality assurance program in the health system.
 - a. Concepts of Quality of Care
 - b. Quality Improvement Approaches
 - c. Standards and Norms
 - d. Quality Improvement Tools
 - e. Introduction to NABH guidelines
2. Basics of emergency care and life support skills - Basic life support (BLS) is the foundation for saving lives following cardiac arrest. Fundamental aspects of BLS include immediate recognition of sudden cardiac arrest (SCA) and activation of the emergency response system, early cardiopulmonary resuscitation (CPR), and rapid defibrillation with an automated external defibrillator (AED). Initial recognition and response to heart attack and stroke are also

considered part of BLS. The student is also expected to learn about basic emergency care including first aid and triage. Topics to be covered under the subject are as follows:

- a. Vital signs and primary assessment
- b. Basic emergency care – first aid and triage
- c. Ventilations including use of bag-valve-masks (BVMs)
- d. Choking, rescue breathing methods
- e. One- and Two-rescuer CPR
- f. Using an AED (Automated external defibrillator).
- g. Managing an emergency including moving a patient

At the end of this topic, focus should be to teach the students to perform the manoeuvres in simulation lab and to test their skills with focus on airways management and chest compressions. At the end of the foundation course, each student should be able to perform and execute/operate on the above-mentioned modalities.

3. Bio medical waste management and environment safety- The aim of this section will be to help prevent harm to workers, property, the environment, and the general public. Topics to be covered under the subject are as follows:

- a. Definition of Biomedical Waste
- b. Waste minimization
- c. BMW – Segregation, collection, transportation, treatment, and disposal (including colour coding)
- d. Liquid BMW, Radioactive waste, Metals / Chemicals / Drug waste
- e. BMW Management & methods of disinfection
- f. Modern technology for handling BMW
- g. Use of Personal protective equipment (PPE)
- h. Monitoring & controlling of cross infection (Protective devices)

4. Infection prevention and control - The objective of this section will be to provide a broad understanding of the core subject areas of infection prevention and control and to equip AHPs with the fundamental skills required to reduce the incidence of hospital acquired infections and improve health outcomes. Concepts taught should include –

- a. Evidence-based infection control principles and practices [such as sterilization, disinfection, effective hand hygiene and use of Personal protective equipment (PPE)],
- b. Prevention & control of common healthcare associated infections,
- c. Components of an effective infection control program, and
- d. Guidelines (NABH and JCI) for Hospital Infection Control

5. Antibiotic Resistance-

- a. History of Antibiotics
- b. How Resistance Happens and Spreads
- c. Types of resistance- Intrinsic, Acquired, Passive
- d. Trends in Drug Resistance
- e. Actions to Fight Resistance
- f. Bacterial persistence
- g. Antibiotic sensitivity
- h. Consequences of antibiotic resistance
- i. Antimicrobial Stewardship- Barriers and opportunities, Tools and models in hospitals

6. Disaster preparedness and management- The objective of this section will be to provide knowledge on the principles of on-site disaster management. Concepts to be taught should include-

- a. Fundamentals of emergency management,
- b. Psychological impact management,
- c. Resource management,
- d. Preparedness and risk reduction,
- e. Key response functions (including public health, logistics and governance, recovery, rehabilitation, and reconstruction), information management, incident command and institutional mechanisms.

Professionalism and values

The module on professionalism will deliver the concept of what it means to be a professional and how a specialized profession is different from a usual vocation. It also explains how relevant professionalism in terms of healthcare system is and how it affects the overall patient environment.

1. Professional values- Integrity, Objectivity, Professional competence and due care, Confidentiality
2. Personal values- ethical or moral values
3. Attitude and behaviour- professional behaviour, treating people equally
4. Code of conduct, professional accountability and responsibility, misconduct
5. Differences between professions and importance of team efforts
6. Cultural issues in the healthcare environment

Research Methodology and Biostatistics

The objective of this module is to help the students understand the basic principles of research and methods applied to draw inferences from the research findings.

1. Introduction to research methods
2. Identifying research problem
3. Ethical issues in research
4. Research design
5. Basic Concepts of Biostatistics
6. Types of Data
7. Research tools and Data collection methods
8. Sampling methods
9. Developing a research proposal

Principles of Management

The course is intended to provide a knowledge about the basic principles of Management.

1. Introduction to management
2. Strategic Management
3. Foundations of Planning
4. Planning Tools and Techniques
5. Decision Making, conflict and stress management
6. Managing Change and Innovation
7. Understanding Groups and Teams
8. Leadership
9. Time Management
10. Cost and efficiency

Community orientation and clinical visit

The objective of this section of the foundation course is to sensitize potential learners with essential knowledge; this will lay a sound foundation for their learning across the undergraduate program and across their career. Innovative teaching methods should be used to ensure the attention of a student and make them more receptive such as group activities, interactive fora, role plays, and clinical bed-side demonstrations.

1. The community orientation and clinical visit will include visit to the entire chain of healthcare delivery system -Sub centre, PHC, CHC, SDH, DH and Medical College, private hospitals, dispensaries, and clinics.

2. The student will also be briefed regarding governance at village level including interaction and group discussion with village panchayat and front-line health workers.
3. Clinical visit to their respective professional department within the hospital.

Practical:

Fundamentals of computers

1. Learning to use MS office: MS word, MS PowerPoint, MS Excel
2. To install different software.
3. Data entry efficiency

Paper II: Anatomy

Theory: Anatomy (Gross anatomy, histology, and anatomical techniques)

General Anatomy:

Introduction – Anatomical terms, planes, position, movements; epithelium – classification, structure & examples; Tissues – classification and structure; skin – structure, thick and thin skin; cartilage – types, structure, hyaline, elastic, and white fibrocartilage; bones – classification, structure, growth; muscles - classification & structure; glands - classification & structure.

Musculoskeletal system:

Skeletal system: Axial and appendicular skeleton: classification of the bones with examples; general pattern of blood supply. Definition and classification of joints, general features of different types of joints. Microscopic anatomy of articular cartilage.

Muscular system: Muscle groups and regions muscles, main attachments, with nerve supply and action. Microscopic anatomy of muscles and the nerve terminations.

Cardiovascular and lymphatic system:

Structure of pericardium, heart: External features and parts of the heart; internal features of the chambers of heart, names of the blood vessels and venous drainage of the organs, conducting system of heart.

Major blood vessels – arteries, veins, and lymphatic system – classification and structure of lymphoid organs – thymus, spleen, lymph node, tonsil, and major lymphatic vessels such as thoracic duct and its tributaries.

Respiratory system:

Parts, position, relations, bronchopulmonary segments, blood supply of lungs, pleura and its reflections, structure of external nose, paranasal air sinuses, nasal cavity, nasopharynx, larynx, trachea, and diaphragm.

Gastrointestinal system:

Position, extent, parts, relations, blood supply, nerve supply, lymphatic drainage and sphincters of gastrointestinal system: salivary glands, oral cavity, oropharynx and laryngopharynx, esophagus, stomach, small intestine, large intestine, liver, gallbladder, extrahepatic biliary apparatus, and pancreas.

Excretory system:

Parts, position, relations, blood supply, nerve supply and lymphatic drainage of excretory system – structure of kidney, ureter, urinary bladder & urethra.

Male and female reproductive systems:

Structure and parts of male reproductive system, external genitalia, teste blood supply, nerve supply and lymphatic drainage, epididymis, vasdeferens, seminal vesicle and prostate.

Structure & parts of female reproductive system, uterus, ovary, fallopian tubes, and mammary gland

Endocrine system:

Location and structure, blood supply, nerve supply and lymphatic drainage of thyroid, parathyroid, pituitary, adrenal glands.

Special senses:

Structure of eyeball, extra ocular muscles their nerve supply and actions, external, middle & internal ear; tongue: papillae, musculature, blood supply.

Nervous system:

Parts of nervous system: Neuron, neuroglia, classification, autonomic nervous system, meninges, parts of brain, cerebrum, cerebellum, basal nuclei, limbic system, thalamus, hypothalamus, ventricles, spinal cord and its blood supply, circulation of cerebrospinal fluid.

Histology:

General histology:

Microscopy – Types of microscopes, parts of microscope, cleaning, and maintenance of microscope. Principles of light, and fluorescent microscopy.

Microscopic features of

1. Epithelium: types, functions, distribution, specialization of the cell surface
2. Cartilages
 - 2.1 Hyaline,
 - 2.2 Elastic
 - 2.3 White fibro cartilages
3. Bones
 - 3.1 Longitudinal section of compact bone
 - 3.2 Cross section of compact bone
4. Muscles
 - 4.1 Skeletal muscle
 - 4.2 Cardiac muscle
 - 4.3 Smooth muscle
5. Glands
 - 5.1 Serous gland
 - 5.2 Mucous gland
 - 5.3 Mixed gland
6. Blood vessels
 - 6.1 Medium sized artery
 - 6.2 Large sized artery
 - 6.3 Medium sized vein

- 6.4 Large sized vein
- 7. Nervous tissue
 - 7.1 Peripheral nerve H & E stain
 - 7.2 Peripheral nerve Osmic acid stain
 - 7.3 Dorsal root (spinal) ganglia
 - 7.4 Autonomic ganglia
- 8. Lymphoid organs
 - 8.1 Thymus
 - 8.2 Lymph node
 - 8.3 Spleen
 - 8.4 Tonsil
- 9. Skin
 - 9.1 Thick skin
 - 9.2 Thin skin

Systemic histology:

- 1. Organs of digestive system
 - 1.1 Papillae of tongue
 - 1.2 Oesophagus and Stomach
 - 1.3 Duodenum, Jejunum and Ileum
 - 1.4 Colon and appendix
 - 1.5 Liver, gallbladder, and pancreas
- 2. Organs of excretory system
 - 2.1 Kidney
 - 2.2 Ureter
 - 2.3 Urinary bladder
- 3. Organs of reproductive system
 - 3.1 Uterus
 - 3.2 Fallopian tube
 - 3.3 Ovary
 - 3.4 Testis
 - 3.5 Vasdeferens
 - 3.6 Epididymis
 - 3.7 Prostate
- 4. Organs of respiratory system
 - 4.1 Trachea
 - 4.2 Lungs
- 5. Organs of endocrine system
 - 5.1 Pituitary
 - 5.2 Thyroid
 - 5.3 Parathyroid
 - 5.4 Adrenal glands
 - 5.5

6. Special senses
 - 6.1 Eye-Cornea and retina
7. Organs of nervous system
 - 7.1 Spinal cord
 - 7.2 Cerebellum
 - 7.3 Cerebrum

Anatomical techniques:

Techniques related to histology:

Procurement of tissues for processing and labelling
Microscope slides and coverslips - dimensions

Steps in tissue processing

- Fixation – principle, types of fixatives, advantages, and disadvantages
- Dehydration – procedure, dehydrating agents
- Clearing – principle and procedure, clearing agents
- Impregnation and infiltration
- Embedding – method, embedding media – types
- Paraffin wax - properties
- Microtomy – Parts of microtome – types of microtomes and their uses
- Sharpening of microtomy blades – Automatic knife sharpener, disposable blades
- Sectioning – Trouble shooting
- Mounting sections on slide – slide adhesives – Egg albumin and other adhesive agents
- Decalcifying techniques
- Confirmation of decalcification
- Tissue processing for electron microscopy

Hematoxylin & Eosin staining procedure

- Hematoxylin & Eosin stain – source, types, and principle
- Steps in Hematoxylin & Eosin staining
- Progressive & regressive staining
- Deparaffinization
- Hydration
- Hematoxylin staining
- Bluing
- Differentiation – agents
- Counter staining – agents
- Eosin stain
- Mounting – media

Special stains: Principles and their applications,
Immunohistochemistry – Principle, technique and uses

Other laboratory techniques:

- Karyotyping – Principle and steps involved
- Museum techniques,
- Plastination – Principle and types
- Corrosion casting
- Embalming – principle, procedure, methods, and legal aspects

Practical: Anatomy (Gross anatomy, histology, and anatomical techniques)

1. Demonstration of bones
2. Demonstration of various parts of body
3. Demonstration of parts of digestive system
4. Demonstration of parts of respiratory system
5. Demonstration of parts of reproductive system
6. Demonstration of parts of excretory system
7. Demonstration of various parts of circulatory system
8. Demonstration of various parts of nervous system
9. Histology of organs of digestive system
10. Histology of organs of excretory system
11. Histology of organs of reproductive system
12. Histology of organs of respiratory system
13. Histology of organs of nervous system
14. Histology of organs of special senses
15. Hematoxylin & Eosin staining

Textbooks Recommended (Latest edition):

General anatomy:

1. General Anatomy: Vishram Singh- Elsevier
2. Handbook of General Anatomy – B.D. Chaurasia - CBS Publishers
3. Textbook of General Anatomy: V Subhadra Devi-Jaypee

Systemic Anatomy:

1. Textbook of Anatomy: Vol I,II,III – Vishram Singh – Elsevier
2. B.D. Chaurasia's Human Anatomy: Vol I,II,III,IV – CBS Publishers
3. Clinical Anatomy by regions – R. Snell- Vandana Mehta- Wolters Kluwer

4. Manipal Manual of Anatomy For Allied Health Science Courses

Histology:

1. Di Fiore's Atlas of Histology – Eroschenko – Lippincott Williams & Wilkins
2. Wheater's Functional Histology: A Text and Colour Atlas- Barbara Young- Elsevier
3. Textbook of Histology: A practical guide: JP Gunasekaran- Elsevier
3. Textbook of Human Histology: Yogesh Sontakke- CBS Publications
4. Textbook of Histology: GP Pal- Paras Medical Publisher

Anatomical techniques:

1. Principles of Histological Techniques: Yogesh Sontakke- Paras Medical books
2. Histopathology Techniques and its management: Ramdas Nayak- Jaypee
3. Embalming and Whole-body donation- A practical guide: Rajasekhar.S.S.S.N- Paras Medical Books
4. Embalming Principles and Legal Aspects: ML Ajmani- Jaypee

Reference textbook:

1. Gray's Anatomy: The Anatomical Basis of Clinical Practice – Susan Standring – Elsevier
2. Junqueira's Basic Histology: Text and Atlas: Anthony Mescher- Lange
3. Bancroft's Theory and Practice of Histological Techniques: S. KIM Suvarna—Churchill Livingstone

Paper III: Physiology

Theory: Physiology

1. General Physiology

- a. Principle of homeostasis
- b. Cell membrane, cell organelles, intercellular junctions
- c. Transport across cell membrane
- d. Body fluids: Classification of body fluid compartments, ionic composition, measurement
- e. Resting membrane potential

2. Blood

- a. Composition of blood
- b. Plasma proteins: classification and functions
- c. RBC: development, morphology, counts, functions and dysfunctions
- d. Hemoglobin: types, structure, synthesis, function, degradation, anemia
- e. WBC: development, classification, morphology, counts, functions and dysfunctions
- f. Immunity: definition, classification, Innate, Cellular and Humoral Immunity
- g. Platelets: morphology, counts, development, functions and dysfunctions
- h. Blood coagulation: clotting factors, mechanism, dysfunctions
- i. Anticoagulants
- j. Blood grouping: classification, cross matching, blood transfusion, Rh factor and incompatibility

3. Nerve

- a. Structure, function, classification of neurons
- b. Neuronal action potential: ionic basis and properties
- c. Conduction of nerve impulses
- d. Nerve Injuries
- e. Neuromuscular junction: structure, mechanism of transmission & applied aspects

4. Muscle

- a. Structure of skeletal muscle & sarcotubular system
- b. Mechanism of contraction and relaxation of skeletal muscle
- c. Isotonic and isometric contraction
- d. Properties of skeletal muscle
- e. Smooth muscle: structure, properties and mechanism of contraction
- f. Differences between skeletal, smooth, and cardiac muscles

5. Autonomic nervous system

- a. Divisions and functions

6. Gastrointestinal (GI) system

- a. Functional anatomy of GIT
- b. Gastrointestinal hormones
- c. Principles & Functions of GI secretions, applied aspects
- d. Movements of GIT, applied aspects

7. Endocrine system

Hormones, actions, and dysfunctions of various endocrine glands:

- a. Hypothalamus
- b. Pituitary
- c. Thyroid
- d. Parathyroid and hormones involved in calcium homeostasis
- e. Adrenal gland
- f. Endocrine pancreas

8. Reproductive System

- a. Male and female gametogenesis
- b. Structure and function of male reproductive system
- c. Structure of female reproductive system, menstrual cycle, pregnancy, parturition, lactation
- d. Contraceptives

9. Kidney

- a. Structure & function of kidney, structure of nephron, composition of urine
- b. Glomerular filtration rate: definition, values, regulation and measurement
- c. Mechanism of urine formation: tubular functions, concentration of urine, acidification of urine
- d. Micturition reflex
- e. Diuretics
- f. Dialysis

10. Cardiovascular system

- a. Functional anatomy of heart
- b. Circulatory system: arterial, venous, capillary circulation
- c. Structure and properties of cardiac muscle
- d. Electrophysiology of heart and conduction of impulse

- e. ECG: waveforms and physiological basis
- f. Cardiac cycle, heart sounds, Jugular venous pulse
- g. Stroke volume, heart rate, cardiac output – definition, normal values and their regulation
- h. Blood pressure and regulation
- i. Coronary circulation
- j. Lymphatic circulation
- k. Applied aspects: shock, hypertension, hypotension, tachycardia, bradycardia, heart failure

11. Respiratory system

- a. Functional anatomy of respiratory system
- b. Mechanics of breathing, lung volumes and capacities, compliance, surfactant
- c. Alveolar ventilation, dead space, pulmonary circulation, ventilation-perfusion ratio
- d. Diffusion and gas exchange
- e. Transport of oxygen and carbon dioxide
- f. Brief account of respiratory regulation
- g. Acclimatization, definition & types of hypoxia, oxygen therapy, cyanosis, asphyxia.
- h. Methods of artificial respiration

12. Central nervous system

- a. Parts and functions of brain and spinal cord
- b. Sensory system: receptors and ascending pathways
- c. Motor system: motor neurons, motor units, muscle spindle, stretch reflex, and descending tracts with emphasis on corticospinal tract
- d. Cerebellum- functional anatomy, functions, and dysfunctions
- e. Basal ganglia- functional anatomy, functions, and dysfunctions
- f. Functions of hypothalamus
- g. Functions of Thalamus
- h. Types of sleep and EEG
- i. Cerebrospinal fluid
- j. Higher functions: types of memory, centers of speech, types of aphasia in brief, Cerebral cortex-lobes and functions
- k. Blood-brain barrier

13. Special senses

- a. Vision: Components of visual apparatus, visual acuity, color vision, accommodation, errors of refraction, visual pathway, pupillary reflexes
- b. Hearing: External, middle ear, inner ear and their functions, auditory pathway, hearing tests.
- c. Taste – receptors and pathway
- d. smell: receptors and pathway

14. Integrative Physiology

- a. Structure and functions of skin
- b. Regulation of temperature

Practical: Physiology

1. Hematology

- a. Methods of collection of blood
- b. Microscopy
- c. Haemocytometry
- d. Total RBC count
- e. Estimation of hemoglobin
- f. Calculation of blood indices
- g. Demonstration of osmotic fragility of red blood cells
- h. Determination of ESR
- i. Total leucocyte count
- j. Absolute eosinophil count
- k. Peripheral blood smear
- l. Differential leukocyte count
- m. Arneht count
- n. Determination of blood group
- o. Bleeding time, Clotting time
- p. Demonstration of reticulocyte count
- q. Demonstration of platelet count
- r. Demonstration of PCV

2. Clinical

- a. General physical examination
- b. Clinical examination of Radial pulse
- c. Determination of blood pressure
- d. Recording of Electrocardiogram
- e. Examination of cardiovascular system
- f. Examination of respiratory system
- g. Demonstration of spirometry
- h. Determination of vital capacity and effect of posture of vital capacity
- i. Examination of sensory system
- j. Examination of motor system
- k. Visual acuity
- l. Color vision
- m. Pupillary reflexes
- n. Perimetry

- o. Tests of hearing
- p. Mosso's ergography

Textbooks recommended: (Latest edition)

1. Textbook of Medical Physiology by G.K. Pal (Theory)
2. Textbook of Practical Physiology by G.K. Pal & Pravati Pal (Practical)
3. Text & Practical Physiology for MLT by Dr. A K Jain

Teaching learning methodology:

The course content in Physiology will be covered by:

1. Interactive Lectures
2. Group Discussions
3. Practical classes & demonstrations
4. Seminars
5. Assignments

Phase II**Paper I: General Biochemistry****General Biochemistry:**

- Role of Medical Laboratory technologists – ethics of laboratory practice. Laboratory safety – Common lab accidents their prevention and their first aid. General laboratory layout as applicable to biochemistry.
- Laboratory glassware and its uses – Types of pipettes, calibration of pipettes, cleaning of glassware.
- Preparation of solutions – units of weights and volume, Calculation of concentration and methods of expressing concentration of solution. Types of water, their properties, uses and method of production.
- Basic and elementary concepts of chemistry and properties of carbohydrates as applicable to the human body.
- Basic and elementary concepts of chemistry and properties of lipids as applicable to the human body.
- Basic and elementary concepts of chemistry and properties of proteins & amino acids as applicable to the human body.
- Basic and elementary concepts of chemistry and properties of nucleic Acids as applicable to the human body,
- Basic concepts of principles of nutrition and nutrients macro and micro nutrients. Vitamins & Minerals, Vitamins- Fat soluble vitamins , Water soluble vitamins sources, Biochemical role, RDA, deficiency manifestations. Minerals – Calcium, Phosphorous, Iron, Copper, Zinc, Magnesium, Manganese, Iodine.
- Working Principles and application of photometry, and atomic absorption, Spectrophotometry.
- Fundamental concepts of biophysical phenomena like osmosis, dialysis, colloidal state, viscosity, absorption, osmotic pressure, surface tension and their application in relation to the human body.
- Definition, basic concepts of classification mechanism of action and properties of enzymes, factors influencing enzyme action.
- Definition and basic concepts of acids, bases, indicators and buffer, their application in laboratory.
- Elementary concepts of radioactivity, radioisotopes, their application in medicines and agriculture isotopic dilution analysis, radioactivity counting techniques.

- Working principles Types and applications of Electrophoresis – Paper, Agarose Gel, Cellulose Acetate and PAGE.
- Working principles, types and applications of Chromatography - Paper Chromatography, TLC, Ion Exchange
- Working principles, types and application of centrifugation
- Specimen handling, Collection & Preservation

Practical

1. General reactions of carbohydrates
2. Identification of unknown carbohydrates
3. General reactions of proteins
4. Identification of unknown proteins
5. Colorimetry
6. Verification of Beer-Lambert law
7. Determination of pH
8. Analysis of food mixture

Recommended Textbooks: (latest editions):

1. DM. Vasudevan, Textbook of Biochemistry for Medical Students. Jaypee
2. U Satyanarayana, U Chakrapani. Biochemistry. Elsevier India

Paper II: Hematology and blood banking

Basic Haematology

Students will learn about the composition of blood and methods of estimating different components of blood, basic concepts of Haematology & routine clinical investigations of Haematology laboratory.

1. Introduction to Haematology

- Definition
- Importance
- Important equipment used

2. Laboratory organization and safety measures in Haematology Laboratory

3. Introduction to blood, its composition, function and normal cellular components

4. Anticoagulants: types, mode of action and preference of anticoagulants for different hematological studies

5. Collection and preservation of blood sample for various hematological investigations

6. Formation of cellular components of blood (Haemopoiesis)

- Erythropoiesis
- Leucopoiesis
- Thrombopoiesis

7. Hemoglobin: definition, types, structure, synthesis and degradation

8. Morphology of normal blood cells

9. Normal Hemostasis & physiological properties of coagulation factors

10. Radioactivity: definition, half-life, physical decay and units

11. Urine analysis

12. Quality assurance in Haematology

- Internal and external quality control including reference preparation
- Routine quality assurance protocol
- Statistical analysis i.e. Standard deviation, Co-efficient of variation, accuracy and precision

Applied Haematology

Students will learn the basic concepts of staining and coagulation in Haematology laboratory. The students will be made aware of the safety precautions in Haematology, basic concepts of Automation, quantitative assay of coagulation factors, Karyotyping etc. and will learn about concepts such as safety precautions, quality assurance, biomedical waste management and automation in haematology. It will also cover bone marrow examination, red cell anomalies, disorder of leucocytes, L.E. cell phenomenon.

1. Haemoglobinometry: Different methods to measure Haemoglobin with merits and demerits
2. Haemocytometry: Introduction, Principle, Reagent preparation, procedure, errors involved and means to minimize errors.
 - RBC Count,
 - Total leucocytes count (TLC)
 - Platelet Count.
 - Absolute Eosinophil count
3. Principle mechanism and different methods with merit and demerits for the measuring Erythrocyte Sedimentation Rate(ESR) and its significance
4. Different methods with merit and demerits for packed cell volume/Haematocrit value
5. Preparation of blood films
 - 5.1 Types, Methods of preparation (Thick and thin smear/film) and utility
6. Staining techniques in Haematology (Romanowsky's stains):Principle, composition,preparationofstainingreagentsandprocedureofthefollowing
 - Giemsa's stain
 - Leishman's stain
 - Wright's stain
 - Field's stain
 - JSB stain.
7. Differential leucocytes count(DLC)
8. Normal and absolute values in Haematology
9. Physiological variations in Hb, PCV, TLC and Platelets
10. Macroscopic and microscopic examination of seminal fluid
11. Examination of CSF and other body fluids for cytology i.e. pleural, peritoneal and synovial fluid etc.
12. Preparation of Reagents for coagulation studies:
 - M/40 Calcium chloride
 - Brain Thromboplastin

- Cephalin
 - Adsorbed Plasma
13. Screening Tests for coagulation Studies and their significance
14. Safety precautions in Haematology
15. Basic concepts of automation in Haematology with special reference to:
- Blood cell counter
 - Coagulometer
16. Bone marrow examination
- Composition and functions
 - Aspiration of bone marrow (Adults and children)
 - Processing of aspirated bone marrow (Preparation & staining of smear)
 - Brief knowledge about examination of aspirated bone marrow (differential cell counts and cellular ratios)
 - Processing and staining of trephine biopsy specimens
17. Red cell anomalies
- Morphological changes such as variation in size shape & staining character.
18. Reticulocytes: Definition, different methods to count, Absolute reticulocyte count and IRF (Immature reticulocyte fraction) and significance of reticulocytes.
19. Lupus Erythematosus (L.E) cell phenomenon.
- Definition of L.E. cell.
 - Demonstration of L.E. cell by various methods.
 - Clinical significance.
20. Correction studies for Factor deficiency
21. Quantitative assay of coagulation factors
- Principle
 - Procedure
22. Screening of inhibitors
- Inhibitors against coagulation factors
 - APLA
23. Karyotyping: Chromosomal studies in hematological disorders (PBLC and Bone marrow)
24. Cyto-chemical staining: Principles, method and significance
25. Biomedical waste management in Haematology laboratory (Other than Radioactive material)

Advanced Haematology

The students will learn different types of anemia, Leukemia, chromosomal studies, bleeding disorders and radiation hazards

1. Laboratory diagnosis of Iron deficiency anemia
2. Laboratory diagnosis of Megaloblastic anemia & Pernicious anemia
3. Classification and Laboratory diagnosis of Hemolytic anemia
4. Definition, classification and laboratory diagnosis of Leukemia
5. Chromosomal studies in various hematological disorders and their significance.
6. Laboratory diagnosis of bleeding disorders with special emphasize to
 - Hemophilia A, B & Von-Willebrand disease
 - DIC
 - Platelet disorder (Qualitative and quantitative)
7. Laboratory approach for investigating thrombosis.
8. Using radioisotopes measurement of:
 - Blood volume
 - Determination of Red cell volume and Plasma volume
 - Red cell life span
 - Platelet life span
 - Radiation hazards and its prevention
 - Disposal of radioactive material

Blood Banking

Students learn about blood grouping & blood transfusion. The students will learn about the concept of blood grouping, compatibility testing in blood transfusion & screening of donated blood for various infectious diseases. **Blood Banking**

1. Introduction to Blood Banking
2. History and discovery of various blood group systems
3. ABO blood group system
4. Rh and other major blood group system
5. Sources of error in blood grouping and their elimination.
6. ABO grouping: Forward and reverse grouping. Causes of discrimination between forward and reverse grouping
7. Rh grouping

8. Compatibility test in blood transfusion
 - 8.1 Collection of blood for cross matching from a blood bag
 - 8.2 Major cross matching
 - 8.3 Minor cross matching
 - 8.4 Use of enzymes in blood bank specially Papain
9. Complications and hazards of blood transfusion
10. Laboratory investigations of transfusion reactions and mismatched blood transfusion.
11. Precautions while procurement and storage of grouping antisera
12. Various anticoagulants used to collect blood for transfusion purposes
13. Selection of donor and procedure for collection of blood from a healthy donor
14. Preparation of various fractions of blood for transfusion and therapeutic purposes such as:
 - 14.1 Packed red cells, washed red cells and FROZEN Red cells
 - 14.2 Platelet Rich Plasma (PRP), Platelet concentrate and frozen platelets.
 - 14.3 Fresh plasma (FP), Fresh Frozen Plasma (FFP) and cryoprecipitate
15. Brief introduction of blood substitute/artificial blood
16. Haemopheresis: pertaining to Leucocytes, platelets and plasma.
17. Quality control in blood bank

Practical

Basic Haematology

1. Preparation of various anticoagulants:
 - 1.1 EDTA
 - 1.2 Sodium Citrate,
 - 1.3 Oxalate with Fluoride
2. Collection of blood sample for various Lab Investigations
3. Familiarization and working of routine Haematology Lab. Instruments
 - 3.1 Microscopes
 - 3.2 Haemocytometers
 - 3.3 Colorimeter
 - 3.4 Spectrophotometer
 - 3.5 Glass pipettes & Auto pipettes

3.6 Glassware

3.7 Sahli's Apparatus

4. Identification of Normal blood cells

5. Urine Analysis:

5.1 Routine biochemistry of Urine for:

5.1.1 pH

5.1.2 Specific Gravity

5.1.3 Glucose

5.1.4 Ketones

5.1.5 Bilirubin

5.1.6 Albumin

5.2 Microscopic Examination of Urine

Applied Haematology

1. Hb Estimation

1.1 Sahli's method

1.2 Cyanmethaemoglobin method

1.3 Oxyhaemoglobin method

2. Total leukocyte count

3. Platelets count

4. Absolute Eosinophil count

5. Preparation of smear and staining with Giemsa and Leishman stain.

6. ESR(Wintrobe and Westergren method)

7. Packed cell volume (Macro & Micro)

8. Cytological examination of CSF and other body fluids

9. Physical and Microscopic examination of seminal fluid including sperm count

10. Perform normal DLC

11. Preparation of M/40 Calcium chloride

11.1 Brain thromboplastin and standardization

11.2 Cephalin

11.3 Adsorbed plasma

12. Perform BT, CT, Hess test, PT and APTT

1. Review the morphology of Normal and abnormal RBCs
2. Review the morphology of normal and immature WBCs
3. WBCs anomalies
4. Calculating INR and determining the ISI of thromboplastin
5. Quantitative Factor assays:
 - 5.1 Factor VIII
 - 5.2 Factor IX
 - 5.3 Factor VII
 - 5.4 Factor X
 - 5.5 Factor V
6. Quantification of inhibitors (Bethesda method)
7. APLA : Lupus Anticoagulant (LA)
8. Anti-cardiolipin antibodies (ACA)
9. Perform Euglobulin clot lysis test (ELT)
10. Urea clot solubility test for factor XIII.

Advanced Haematology

1. Study and interpretation of Histogram of Automated Blood cell counter
2. To estimate serum iron and total iron binding capacity.
3. Screening tests for enzymes deficiency: Pyruvate Kinase, G6PD
4. To estimate Hb-F, Hb-A2 in a given blood sample.
5. To estimate plasma and urine Hemoglobin in the given specimens.
6. To demonstrate the presence of Hb-S by Sickling and Solubility tests.
7. Perform Hb electrophoresis (alkaline)
8. Perform osmotic red cell fragility.
9. Detection of Fibrin degradation products (FDPs)
10. To perform various platelet function tests such as whole blood clot retraction test, prothrombin consumption index (PCI) Platelet adhesion, aggregation and PF3 availability test.
11. Estimation of Protein C, S
12. Peripheral Blood Lymphocyte Culture for chromosome studies in Leukemia.

Blood Banking - Practical

1. To prepare Acid Citrate Dextrose (ACD) and Citrate Phosphate Dextrose (CPD) Solutions
2. Screening of blood donor: physical examination including medical history of the donor
3. Collection and preservation of blood for transfusion purpose
4. Screening of blood for Malaria, Microfilaria, HBs Ag, Syphilis and HIV
5. To determine the ABO & Rh grouping
 - 5.1 Direct or preliminary grouping
 - 5.2 Indirect or proof grouping
 - 5.3 Rh grouping and determination of Du in case of Rh negative
6. To perform Direct and Indirect Coomb's test
7. To perform cross matching
 - 7.1 Major cross matching
 - 7.2 Minor cross matching
8. Preparation of various fractions of blood.

Suggested Readings(Latest edition):

1. Textbook of Medical Laboratory Technology by Praful B. Godkar
2. Medical Laboratory Technology by K L Mukherjee Volume-I
3. Practical Haematology by J.B. Dacie
4. Clinical Diagnosis & Management by Laboratory methods (20th edition) by John Bernard Henry
5. Atlas of Haematology by G.A. McDonald
6. De Gruchy's clinical Haematology in medical practice
7. Wintrobe's Clinical Haematology– 2013 by John P. Greer, Daniel A. Arber, Bertil E. Glader, Alan F. List

Paper III: General Microbiology, Immunology, Bacteriology and Serology

General Microbiology, Immunology, Bacteriology and Serology:

General Medical Microbiology

Rationale: This subject gives a general insight into the history and basics of medical microbiology, imparts knowledge about equipment used in Medical Microbiology and basic procedures done in a medical microbiology laboratory i.e. microscopy, sterilization, disinfection, culture methods required to perform different microbiological tests in clinical microbiology lab and biomedical waste management.

1. Introduction to Medical Microbiology:

1.1 Definition

1.2 History

1.3 Host - Microbe relationship

2. Safety measures in Clinical Microbiology

3. Glassware used in Clinical Microbiology Laboratory:

3.1 Introduction

3.2 Care and handling of glassware

3.3 Cleaning of glassware

3.4 Equipment used in clinical Microbiology Laboratory:

3.4.1 Introduction

3.4.2 Care and maintenance including calibration

4. Microscopy

4.1 Introduction and history

4.2 Types, principle and operation mechanism of following microscopes

4.2.1 Light microscope

4.2.2 DGI

4.2.3 Fluorescent

4.2.4 Phase contrast

4.2.5 Electron microscope: Transmission/ Scanning

5. Sterilization:

5.1 Definition

5.2 Types and principles of sterilization methods

- 5.2.1 Heat (dry heat, moist heat with special Reference to autoclave)
- 5.2.2 Radiation
- 5.2.3 Filtration
- 5.2.4 Efficiency testing to various sterilizers
- 6. Antiseptics and disinfectants:
 - 6.1 Definition.
 - 6.2 Types and properties
 - 6.3 Mode of action - Uses of various disinfectants
 - 6.4 Precautions while using the disinfectants - Qualities of a good disinfectant
 - 6.5 Testing efficiency of various disinfectants
- 7. Biomedical waste management in a Medical Microbiology laboratory:
 - 7.1 Types of the waste generated – Segregation – Treatment – Disposal
- 8. General characteristics & classification of Microbes: (Bacteria &fungi)
 - 8.1 Classification of microbes with special reference to prokaryotes & eukaryotes
 - 8.2 Morphological classification of bacteria
 - 8.3 Bacterial anatomy (Bacterial cell structures)
- 9. Growth and Nutrition of Microbes:
 - 9.1 General nutritional & other requirements of the bacteria
 - 9.2 Classification of bacteria on the basis of their nutritional requirements
 - 9.3 Physical conditions required for growth.
 - 9.4 Normal growth cycle of bacteria (growth curve)
 - 9.5 Types of microbial cultures: Synchronous, Static, continuous culture.
- 10. Culture media:
 - 10.1 Introduction
 - 10.2 Classification of culture media (Example & Uses) solid media, liquid media, semisolid, Media, routine/synthetic/defined media, basal media, enriched, enrichment, Selectivedifferential media, sugar fermentation media, transport media, preservation media and anaerobic culture media
 - 10.3 Quality control in culture media
 - 10.4 Automation in culture media preparation
- 11. Aerobic & anaerobic culture methods:
 - 11.1 Concepts
 - 11.2 Methods Used for aerobic cultures

11.3 Methods used for anaerobic cultures

12. Introductions to Immunology

12.1 Immunity

12.2 Antigens and Antibodies

13. Care & handling of laboratory animals:

13.1 Introduction

13.2 General care & handling

13.3 Ethics & legality in use of laboratory animals

Systematic Bacteriology

The students will learn about the different types of bacterial culture procedures, staining procedures and biochemical tests used for identification of bacteria. The students will learn the morphology cultural characteristics, biochemical characteristics & laboratory diagnosis of various bacteria.

1. Bacterial culture

1.1 Instruments used to seed culture media

1.2 Culture procedures – seeding a plate

2. Staining techniques in bacteriology

2.1 Significance of staining in bacteriology

2.2 Principle, Reagent preparation, procedures and interpretation of the following

2.2.1 Simple staining

2.2.2 Negative staining

2.2.3 Gram stain

2.2.4 Albert's stain

2.2.5 Neisser's stain

2.2.6 Ziehl –Neelsen staining

2.2.7 Capsule staining

2.2.8 Flagella staining

2.2.9 Spore staining

2.2.10 Fontana stain for spirochetes

3. Principle, procedures and interpretation of the following biochemical tests for identification of different bacteria.

- 3.1 Catalase
- 3.2 Coagulase
- 3.3 Indole
- 3.4 Methyl Red
- 3.5 VogesProskauer
- 3.6 Urease
- 3.7 Citrate
- 3.8 Oxidase
- 3.9 TSIA
- 3.10 Nitrate reduction
- 3.11 Carbohydrate fermentation
- 3.12 Huger and Leifson
- 3.13 Bile solubility
- 3.14 H₂S production
- 3.15 Demonstration of motility
- 3.16 Decarboxylases
- 3.17 CAMP
- 3.18 Hippurate hydrolysis
- 3.19 Nagler's reaction
- 3.20 Cholera-red reaction

4. Definition, Classification, Various characteristics (morphological, cultural and biochemical), pathogenesis and laboratory diagnosis of the following bacteria

- 4.1 Staphylococcus
- 4.2 Streptococcus
- 4.3 Pneumococcus
- 4.4 Neisseria gonorrhoea and Neisseria meningitidis
- 4.5 Haemophilis
- 4.6 Corynebacterium
- 4.7 Enterobacteriaceae: Escherichia coli, Klebsiella, Citrobacter, Enterobacter, Proteus, Salmonella, Shigella, Yersinia enterocolitica and Yersinia pestis
- 4.8 Vibrio, Aeromonas and Plesiomonas

- 4.9 Clostridia of wound infection
- 4.10 Mycobacterium tuberculosis complex, Atypical Mycobacteria and M. leprae
- 4.11 Spirochetes – Treponema, Borrellia and leptospira
- 4.12 Bordetella and brucella
- 4.13 Mycoplasma and Ureaplasma
- 4.14 Rickettsia
- 4.15 Chlamydia
- 4.16 Actinomyces
- 4.17 Pseudomonas and Burkholderia
- 4.18 Brief introduction about non sporing anaerobic cocci and bacilli

Applied Bacteriology

Students will learn about the laboratory strategy in the diagnosis of various infective syndromes i.e. choice of samples, collection and transportation and processing of samples for isolation of bacterial pathogens and then to put antibiotic susceptibility testing. This will also cover bacteriological examination of water, milk, food, air, I/V fluids and nosocomial infections. Further it will make the candidate familiar to epidemiology, epidemiological markers and preservation of microbes.

1. Laboratory strategy in the diagnosis of various infective syndromes: Samples of choice, collection, transportation and processing of samples for laboratory diagnosis of the following complications:

- 1.1 Septicemia and bacteremia
- 1.2 Upper Respiratory tract infections
- 1.3 Lower respiratory tract infections
- 1.4 Wound, skin, and deep sepsis
- 1.5 Urinary tract infections
- 1.6 Genital Tract infections
- 1.7 Meningitis
- 1.8 Gastro intestinal infections
- 1.9 Enteric fever
- 1.10 Tuberculosis (Pulmonary and Extra-pulmonary)
- 1.11 Pyrexia of unknown origin

2. Antibiotic susceptibility testing in bacteriology
 - 2.1 Definition of antibiotics
 - 2.2 Culture medium used for Antibiotic susceptibility testing
 - 2.3 Preparation and standardization of inoculum
 - 2.4 Control bacterial strains
 - 2.5 Choice of antibiotics
 - 2.6 MIC and MBC: Concepts and methods for determination
 - 2.7 Various methods of Antibiotic susceptibility testing with special reference to Stokes and Kirby-Bauer method
3. Basics of Nucleic acid techniques in diagnostic microbiology with special reference to Polymerase chain reaction (PCR)
4. Automation in bacterial culture detection and antimicrobial susceptibility testing: Principles and importance.
5. Bacteriological examination of water, milk, food and air
 - 5.1 Examination of water
 - 5.1.1 Collection and transportation of water sample
 - 5.1.2 Presumptive coliform count
 - 5.1.3 Eijkman test
 - 5.1.4 Introduction and importance of other bacteria considered as indicators of fecal contamination
 - 5.1.5 Membrane filtration tests
 - 5.1.6 Interpretation of results
 - 5.2 Examination of Milk and milk products
 - 5.2.1 Basic Concepts regarding gradation of milk
 - 5.2.2 Various tests for Bacteriological examination of milk
 - 5.3 Examination of food articles
 - 5.3.1 Basic Concepts regarding classification of food like frozen food, canned food, raw food, cooked food etc.
 - 5.3.2 Various tests for Bacteriological examination with special reference to food poisoning bacteria
 - 5.4 Examination of Air
 - 5.4.1 Significance of air bacteriology in healthcare facilities
 - 5.4.2 Settle plate method

- 5.4.3 Types of air sampling instruments
- 5.4.4 Collection processing and reporting of an air sample
- 6. Sterility testing of I/v fluids
 - 6.1 Collection, transportation and processing of I/v fluids for bacterial contamination
 - 6.2 Recording the result and interpretation
- 7. Nosocomial Infection:
 - 7.1 Introduction, sources and types of nosocomial infections.
 - 7.2 Surveillance of hospital environment for microbial load.
 - 7.3 Role of microbiology laboratory in control of nosocomial infections
- 8. Epidemiological markers:
 - 8.1 Introduction
 - 8.2 Types
 - 8.3 Serotyping
 - 8.4 Phage typing and
 - 8.5 Bacteriocin typing
- 9. Preservation methods for microbes
 - 9.1 Basic concepts of preservation of microbes
 - 9.2 Why do we need to preserve bacteria?
 - 9.3 Principle and procedures of various short term and long term preservation methods with special reference to Lyophilization

Immunology and Bacterial Serology

Rationale: This section will cover the basic aspects of immunity, antigens, antibodies, various serological reactions, techniques and their utility in laboratory diagnosis of human diseases. It will also cover medically important fungi, infections caused by them and their laboratory diagnosis.

- 1. History and introduction to immunology
- 2. Immunity
 - 2.1 Innate
 - 2.2 Acquired immunity
 - 2.3 Basic concepts about their mechanisms
- 3. Definition, types of antigens and determinants of antigenicity

4. Definition, types, structure and properties of immunoglobulin
5. Antigen-Antibody reactions
 - 5.1 Definition
 - 5.2 Classification
 - 5.3 General features and mechanisms
 - 5.4 Applications of various antigen antibody reactions
6. Principle, procedure and applications of under mentioned in Medical Microbiology:
 - 6.1 Complement fixation test
 - 6.2 Immuno- fluorescence
 - 6.3 ELISA
 - 6.4 SDS-PAGE
 - 6.5 Western blotting
7. Principle, procedure and interpretation of various serological tests:
 - 7.1 Widal
 - 7.2 VDRL
 - 7.3 ASO
 - 7.4 CRP
 - 7.5 Brucella tube agglutination
 - 7.6 Rose-Waaler
8. Complement system:
 - 8.1 Definition
 - 8.2 Basic concepts about its components
 - 8.3 Complement activation pathways
9. Immune response:
 - 9.1 Introduction
 - 9.2 Basic concepts of Humoral and Cellular immune responses
10. Hypersensitivity:
 - 10.1 Definition
 - 10.2 Types of hypersensitivity reactions
11. Basic concepts of autoimmunity and brief knowledge about autoimmune diseases
12. Automation in diagnostic serology
13. Vaccines:

13.1 Definition

13.2 Types

13.3 Vaccination schedule

13.4 Brief knowledge about ‘Extended programme of immunization’ (EPI) in India

General Medical Microbiology – Practical

1. To demonstrate safe code of practice for a Microbiology laboratory
2. To prepare cleaning agents & to study the technique for cleaning & sterilization of glassware.
3. To demonstrate the working & handling of Compound microscope.
4. To demonstrate the method of sterilization by autoclave including its efficacy testing.
5. To demonstrate the method of sterilization by hot air oven including its efficacy testing.
6. To demonstrate the method of sterilization of media/solution by filtration.
7. Demonstration of Antiseptics, Spirit, Cetrimide & Povidone-Iodine.
8. To demonstrate the use of disinfectants.
9. Demonstrate the precaution while using disinfectants.
10. To prepare working dilution of commonly used disinfectants.
11. In-use test
12. Rideal-walker phenol co-efficient test.
13. Kelsey-Sykes test
14. To demonstrate the different morphological types of bacteria
15. Preparation of one culture media from each type
16. To demonstrate aerobic culture
17. To demonstrate anaerobic culture
18. Visit to animal house & demonstrate about care of laboratory animals

Systematic Bacteriology – Practical

1. To demonstrate the instruments used to seed culture media
2. To learn techniques for Inoculation of bacteria on culture media
3. To isolate specific bacteria from a mixture of organisms.

4. To demonstrate simple staining (Methylene blue)
5. To prepare India ink preparation to demonstrate negative staining.
6. Bacterial identification: To demonstrate reagent preparation, procedure and interpretation for
 - 6.1 Gram stain
 - 6.2 Albert stain
 - 6.3 Neisser's staining
 - 6.4 Z-N staining
 - 6.5 Capsule staining
 - 6.6 Demonstration of flagella by staining methods
 - 6.7 Spore staining
 - 6.8 To demonstrate spirochetes by Fontana staining procedure
7. To prepare the reagent and demonstrate following biochemical tests with positive and negative control bacteria:
 - 7.1 Catalase
 - 7.2 Coagulase
 - 7.3 Indole
 - 7.4 Methyl Red (MR)
 - 7.5 VogesProskauer (VP)
 - 7.6 Urease
 - 7.7 Citrate
 - 7.8 Oxidase
 - 7.9 TSIA
 - 7.10 Nitrate reduction
 - 7.11 Carbohydrate fermentation
 - 7.12 Huger and Leifson
 - 7.13 Bile solubility
 - 7.14 H₂S production
 - 7.15 Demonstration and motility
 - 7.16 Decarboxylases
 - 7.17 CAMP
 - 7.18 Hippurate hydrolysis

7.19 Nagler's reaction

8. To demonstrate various characteristics (morphological, cultural and biochemical) of bacteria commonly isolated from clinical samples i.e.

8.1 Staphylococcus

8.2 Streptococcus

8.3 Corynebacterium

8.4 Escherichia coli

8.5 Klebsiella

8.6 Citrobacter

8.7 Enterobacter

8.8 Proteus

8.9 Salmonella

8.10 Shigella

8.11 Vibrio cholera

8.12 Mycobacterium tuberculosis

8.13 Pseudomonas

Applied Bacteriology – Practical

1. Inoculation of different culture media

2. Isolation of pure cultures

3. Processing of following clinical samples for culture and identification of bacterial pathogens:

3.1 Blood

3.2 Throat swab

3.3 Sputum

3.4 Pus

3.5 Urine

3.6 Stool for Salmonella, Shigella and Vibrio cholerae

3.7 C.S.F. and other body fluids

4. Demonstration of PCR

5. Demonstration of automation in bacterial culture detection and antimicrobial susceptibility testing

6. Antimicrobial susceptibility testing
 - 6.1 Introduction and terms used
 - 6.2 Preparation and standardization of inoculum
 - 6.3 To demonstrate reference bacterial strains
 - 6.4 To determine MIC and MBC of known bacteria against a known antibiotic
 - 6.5 To perform antibiotic susceptibility testing of clinical isolates by using
 - 6.5.1 Stokes method
 - 6.5.2 Kirby-Bauer method
7. Collection, transportation and processing of following articles for bacteriological examination:
 - 7.1 Water
 - 7.2 Milk
 - 7.3 Food and
 - 7.4 Air
8. To demonstrate sterility testing of intravenous fluid with positive and negative controls
9. Demonstration of serotyping and bacteriocin typing
10. Demonstration of lyophilization and other available preservation methods

Immunology and Bacterial Serology – Practical

1. Collection of blood sample by vein puncture, separation and preservation of serum
2. Performing Haemolysin titration for Rose-Waaler test
3. Preparation of Phosphate buffers, Verinol buffer, ASO buffer, Richardson's buffer, Buffers of different pH and Molarity, Tris buffer, Standardization of cell concentration by Spectrophotometer
4. Performance of Serological tests i.e.
 - 4.1 Widal,
 - 4.2 Brucella Tube Agglutination,
 - 4.3 VDRL (including Antigen Preparation),
 - 4.4 ASO (Anti-Streptolysin O)
 - 4.5 C-Reactive Protein (Latex agglutination)
 - 4.6 Rheumatoid factor (RF) Latex agglutination
 - 4.7 Rose Waaler test,

5. Demonstration of antigen/antibody determination by Immuno fluorescence (IF), Immunodiffusion, precipitation in Agarose gel (Ouchterlony), CCIEP, ELISA, SDS - PAGE and Western blotting.

Suggested Readings:

1. Practical Medical Microbiology by Mackie & McCartney Volume 1 and 2
2. Text book of Microbiology by Ananthanarayanan
3. Medical Microbiology by Paniker & Satish Gupte
4. Medical laboratory Technology Vol. I ,II, III by Mukherjee
5. Medical Laboratory manual for tropical countries Vol II Microbiology by Monica Cheesbrough
6. Hospital Acquired Infections-Power strategies for clinical practice by Dr. V Muralidhar and SumathiMurlidhar
7. Control of Hospital infection-A practical Handbook by GajAyliffe, A.P. Fraise, A.M. Geddes, K. Mitchell

Phase III

Paper I: Analytical applied and clinical biochemistry

Analytical, Applied and Clinical Biochemistry

Analytical Biochemistry - Theory

The students will learn basic principles/mechanisms, procedures and various types of techniques commonly performed in analytical biochemistry such as:

1. Spectrophotometry and colorimetry
 - 1.1 Introduction
 - 1.2 Theory of spectrophotometry and colorimetry
 - 1.3 Lambert`s law and Beer`s law
 - 1.4 Applications of colorimetry and spectrophotometry
2. Photometry
 - 2.1 Introduction
 - 2.2 General principles of flame photometry
 - 2.3 Limitations of flame photometry
 - 2.4 Instrumentation
 - 2.5 Applications of flame photometry
 - 2.6 Atomic absorption spectroscopy – Principle & applications
3. Chromatography
 - 3.1 Introduction
 - 3.2 Types of chromatography
 - 3.3 Paper Chromatography: Introduction, principle, types, details for qualitative and quantitative analysis, application
 - 3.4 Thin layer chromatography: Introduction, experimental techniques, application of TLC, limitations, High performance thin layer chromatography
 - 3.5 Column chromatography: Introduction, principle column efficiency, application of column chromatography
 - 3.6 Gas chromatography: Introduction principle, instrumentation, application
 - 3.7 Ion exchange chromatography: Introduction, Definition and principle, cation and anion exchangers, application
 - 3.8 Gel Chromatography: Introduction Principle and method, application, and advantages
4. Electrophoresis:
 - 4.1 Introduction
 - 4.2 Principle
 - 4.2.1 Instrumentation
 - 4.2.2 Applications

4.3 Types of electrophoresis

4.3.1 Paper electrophoresis

4.3.2 Gel electrophoresis

Applied and Clinical Biochemistry - Theory

The students will be taught about Hazards & safety measures in a clinical biochemistry lab, Quality control and quality assurance, Laboratory organization, management Principles of assay procedures and Radioactivity.

1. Hazards & safety measures in clinical Biochemistry laboratory
2. Quality control and quality assurance in a clinical biochemistry laboratory
3. Laboratory organization, management and maintenance of records
4. Principles of assay procedures, Normal range in blood, Serum, Plasma and Urine and reference values for:
 - 4.1 Glucose
 - 4.2 Proteins
 - 4.3 Urea
 - 4.4 Uric acid
 - 4.5 Creatinine
 - 4.6 Bilirubin
 - 4.7 Lipids
5. Principles, procedures for estimation & assessment of the following including errors involved and their corrections
 - 5.1 Sodium, Potassium and Chloride, Iodine
 - 5.2 Calcium, Phosphorous and Phosphates
6. Applications of Radioisotopes in clinical biochemistry.
7. Enzyme linked immune sorbent assay

The students will learn how to analyze various clinical patients' samples, for estimation of different components which are the cause of the disease or are the diagnostic/prognostic markers. This subject gives information about various clinically important enzymes & automation techniques.

1. Automation in clinical biochemistry
2. Method of estimation and assessment for:
 - 2.1 Glucose tolerance test
3. Qualitative test for:

3.1 Urobilinogens

4. Enzymes:

4.1 Principles

4.2 Clinical significance and

4.3 Procedures for estimation

4.3.2 Alkaline phosphatase

4.3.3 Lactate dehydrogenase

4.3.4 Aspartate transaminase

4.3.5 Alanine transaminase

4.3.6 Creatine phosphokinase

5. Qualitative analysis of Renal calculi.

6. Chemical examination of Cerebrospinal fluid.

7. Brief knowledge about rapid techniques in clinical biochemistry

Analytical Biochemistry- Practical

1. Demonstration of the principle, working & maintenance of spectrophotometer.
2. Demonstration of the principle, working & maintenance of colorimeter.
3. Demonstration of the principle, procedure of paper chromatography.
4. Demonstration of the principle & procedure of Gas chromatography.
5. Demonstration of the principle & demonstration of TLC.
6. Demonstration of the principle & procedure of column chromatography.
7. Demonstration of the principle & procedure of Electrophoresis.
8. Demonstration of the principle & procedure of Chemiluminescence
9. Demonstration of the principle & procedure of ELISA

Applied Clinical Biochemistry – Practical

1. Estimation of Glucose in Urine and in Blood.
2. Estimation of Protein in Urine and Blood.
3. Estimation of Urea in blood.
4. Estimation of uric acid in blood.
5. Estimation of serum Bilirubin
6. Estimation of Total Cholesterol in blood.

7. Estimation of HDL Cholesterol.
8. Estimation of LDL Cholesterol.
9. Estimation of TG
10. Estimation of Creatinine in Blood
11. Estimation of serum calcium, Inorganic phosphate
12. To measure electrolytes Sodium, Potassium & Chloride.
13. Estimation of Glucose tolerance test (GTT).
14. Determination of Uric acid in Urine.
15. Determination of Creatinine clearance.
16. Determination of Urea clearance.
17. Determination of Serum Alkaline phosphatase.
18. Determination of Serum Lactate dehydrogenase.
19. Determination of T3, T4 and TSH
20. Demonstration of PCR, Western blot and Nephelometer
21. Normal and abnormal urinalysis

Recommended Textbooks: (latest editions):

1. DM. Vasudevan, Textbook of Biochemistry for Medical Students. Jaypee
2. U Satyanarayana, U Chakrapani. Biochemistry. Elsevier India

Paper II: Histopathology and Cytology

Histopathology and Cytology

Rationale: In this section, students will be made aware of terminology used in histotechnology, various instruments and their maintenance and also learn the processing of various samples for histopathological investigations.

1. Introduction to Histotechnology
2. Compound microscope:
 - 2.1 Optical system, magnification and maintenance
 - 2.2 Microscopy:
 - 2.2.1 Working principle
 - 2.2.2 Applications of various types of microscopes i.e. dark field, polarizing, phase contrast, interference and fluorescent microscope
3. Care and maintenance of laboratory equipment used in histotechnology
4. Safety measures in a histopathology laboratory
5. Basic concepts about routine methods of examination of tissues
6. Collection and transportation of specimens for histological examination
7. Basic concepts of fixation
8. Various types of fixatives used in a routine histopathology laboratory
 - 8.1 Simple fixatives
 - 8.2 Compound fixatives
 - 8.3 Special fixatives for demonstration of various tissue elements
9. Decalcification
 - 9.1 Criteria of a good decalcification agent
 - 9.2 Technique of decalcification followed with selection of tissue, fixation, and decalcification, neutralization of acid and thorough washing
 - 9.3 Various types of decalcifying fluids: Organic & Inorganic Acid, chelating agents, Use of Ion-exchange resins and Electrophoretic decalcification and treatment of hard tissues which are not calcified
10. Processing of various tissues for histological examination
 - 10.1 Procedure followed by Dehydration, Clearing, Infiltration and routine timing schedule for manual or automatic tissue processing.
 - 10.2 Components & principles of various types of automatic tissue

10.3 Processors

10.4 Embedding:

10.4.1 Definition

10.4.2 Various types of embedding media

11. Section Cutting

11.1 Introduction regarding equipment used for sectioning

11.2 Microtome Knives, Sharpening of Microtome Knives, Honing, Stropping, various types of microtome and their applications

11.3 Freezing Microtome and various types of Cryostats.

11.4 Faults in paraffin section cutting with reason and remedy, spreading the sections and attachment or mounting of sections to glass slides.

12. Staining, Impregnation and Mountants

12.1 Theory of Staining, Classifications of Dyes, Principles of Dye Chemistry

12.2 Stains and Dyes and their uses

12.3 Types of Stains, Chemical Staining Action, Mordants and Accentuators, Metachromasia

12.4 Use of Controls in Staining Procedures

12.5 Preparation of Stains, solvents, aniline water and buffers etc.

12.6 Commonly used mountants in histotechnology lab

12.7 General Staining Procedures for Paraffin Infiltrated and Embedded tissue

12.8 Nuclear Stains and Cytoplasmic stains

12.9 Equipment and Procedure for manual Staining and Automatic Staining Technique

12.10 Mounting of Cover Slips, Labeling and Cataloguing the Slides

13. Routine Staining Procedures

13.1 Haematoxylin and Eosin Staining, various types of Haematoxylin

13.2 Mallory's Phosphotungstic Acid Haematoxylin (PTAH)

Applied Histopathology-II

Rationale: Students will learn about various staining procedures for demonstration of different substances. The students will learn about special staining procedures, its handling & testing of various histological specimens in addition to cryostat sectioning and electron microscopic procedures

1. Cryostat sectioning, its applications in diagnostic histopathology.
2. Special Staining Procedures for detection of
 - 2.1 Connective tissue elements, Trichrome staining, muscle fibers, elastic, reticulin fibers, collagen fibers etc.
 - 2.2 Metachromatic staining such as Toluidine blue on frozen sections
 - 2.3 Principles of metal impregnation techniques.
 - 2.4 Demonstration and identification of minerals and pigments, removal of Pigments/artifacts in tissue sections
3. Demonstration of Proteins & nucleic acids.
4. Demonstration of Carbohydrates, lipids, fat & fat like substances.
5. Demonstration of bacteria and fungi in tissue section.
6. Tissue requiring special treatment i.e. eye ball, bone marrow, and muscle biopsy, under calcified or unclarified bones, whole brain, and whole lungs including other large organs.
7. Enzyme histochemistry: Diagnostic applications and the demonstration of Phosphatases, Dehydrogenases, Oxidases & Peroxidases.
8. Vital staining.
9. Neuro-pathological techniques.
10. Museum techniques.
11. Electron Microscope:
 - 11.1 working principle and its components
 - 11.2 Processing, embedding and ultra-microtomy
12. Micrometry and Morphometry

Cytopathology

The students will learn about various staining procedures for demonstration of different substances & various cytological investigations. This will include special staining procedures & handling & testing of various cytological specimens.

1. Cryostat sectioning, its applications in diagnostic cytopathology
2. Enzyme Cytochemistry:
 - 2.1 Diagnostic applications
 - 2.2 Demonstration of Phosphatases, Dehydrogenases, Oxidases & Peroxidases

3. Vital staining for Sex Chromatin
4. Aspiration cytology:
 - 4.1 Principle
 - 4.2 Indications & utility of the technique with special emphasis on role of cytotechnologist in FNAC clinics
5. Exfoliative cytology (Papanicolaou technique for the staining of cervical smears)
 - 5.1 Cervical cytology
 - 5.2 Fluid Cytology
 - 5.2.1 Urine
 - 5.2.2 CSF
 - 5.2.3 Body Fluids (Pleural, Pericardial, Ascitic)
6. Automation in cytology
7. Liquid based cytology: Principles and preparation, Cytocentrifuge, molecular cytology, Cell Block and Immune-cytochemistry

Applied Histopathology-I - Practical

1. Demonstration of instruments used for dissection
2. Use of antiseptics, disinfectants and insecticides in a tissue culture processing laboratory
3. Reception and labeling of histological specimens
4. Preparation of various fixatives
 - 4.1 Helly's fluid
 - 4.2 Zenker's fluid
 - 4.3 Bouin's fluid
 - 4.4 Corney's fluid
 - 4.5 10% Neutral formalin
 - 4.6 Formal saline
 - 4.7 Formal acetic acid
 - 4.8 Pereyn's fluid
5. Testing of melting point of paraffin wax and perform embedding of given tissue in paraffin block
6. To process a bone for decalcification
7. To prepare ascending and descending grades of alcohol from absolute alcohol

8. Processing of tissue by manual and automated processor method
9. To demonstrate various part and types of microtome
10. To learn sharpening of microtome knife (Honing and stropping technique), and types of disposable blades in use (High and Low Profile).
11. To perform section cutting (Rough and Fine)
12. To practice attachment of tissue sections to glass slides
13. To learn using tissue floatation bath and drying of sections in oven (60-65C)
14. To perform & practice the Haematoxylin and Eosin staining technique
15. To perform & practice the Mallory's Phospho tungstic Acid Haematoxylin (PTAH)
16. To learn mounting of stained smears

Applied Histopathology-II - Practical

1. To cut frozen section and stain for Haematoxylin and Eosin, Metachromatic stain Toluidine blue- and Oil Red O staining for the demonstration of fat
2. To prepare Schiff's reagent in the lab and do Periodic Acid Schiff's (PAS) stain on a paraffin section
3. To prepare ammonical silver bath in the laboratory and stain paraffin embedded section for the demonstration of reticulin fibers.
4. To stain a paraffin section for the demonstration of smooth muscle by Van Gieson's Stain
5. To perform Masson's trichrome stain on a paraffin section for the demonstration of collagen fiber, muscle fiber and other cell elements.
6. To stain the paraffin section for the demonstration of the elastic fibers (EVG).
7. To stain Decalcified paraffin embedded section for the presence of calcium salts (Von Kossa's method).
8. To stain a paraffin section for the following Mucicarmine, Alcian blue.
9. To stain a paraffin section for the demonstration of iron (Perl's stain)
10. To demonstrate the presence of bacteria and fungi in paraffin embedded sections using the following staining procedures:
 - 10.1 Gram's staining
 - 10.2 AFB staining (Ziehl Neilsen's staining) for M. tuberculosis and leprae
 - 10.3 Grocott's stain for fungi
 - 10.4 Schmorl's reaction for reducing substances (melanin)
11. To stain for nucleic acid (DNA and RNA)

11.1 Feulgen Staining

11.2 Methyl Green-Pyronin Staining

11.3 Enzymatic methods

Cytopathology – Practical

1. To perform Papnicolaou's stain on cervical smear
2. To perform Guard's staining for demonstration sex chromatin (Barr bodies on a buccal smear)
3. To perform Shorr's staining for Hormonal assessment
4. To cut frozen sections of Gynaec tissue
5. To perform CSF sample and body fluids by cytospin
6. Should know the various stains used in Cytology lab: May Grunwald Giemsa, H&E, PAS, Grocott's.

Suggested Readings

1. Handbook of Histopathological Techniques by C F A Culling
2. Medical Lab technology by Lynch
3. An Introduction to Medical Lab Technology by F J Baker and Silverton
4. Bancroft's Theory and Practice of Histopathological Techniques by John D Bancroft
5. Diagnostic Cytology by Koss Volume -II

Paper III: Medical parasitology, entomology, mycology and virology

Medical Parasitology and Entomology

The student will be taught about introduction, general characteristics, life cycle and laboratory diagnosis of various medically important parasites.

1. Introduction to Medical Parasitology with respect to terms used in Parasitology.
2. Protozoology/ Protozoal parasites:
 - 2.1 General characteristics of protozoa.
 - 2.2 Geographical distribution, Habitat, Morphology, life cycle, Mode of infection and laboratory diagnosis of Entamoeba sp.
 - 2.3 Geographical distribution, Habitat, Morphology, life cycle, Mode of infection and laboratory diagnosis of Intestinal and vaginal flagellates i.e. Giardia, Trichomonas sp.
 - 2.4 Geographical distribution, Habitat, Morphology, life cycle, Mode of infection and laboratory diagnosis of blood and tissue flagellates i.e. Plasmodium and Toxoplasma sp.
3. Helminthology/ Helminthic parasites:
 - 3.1 General characteristics of Cestodes, Trematodes and Nematodes
 - 3.2 Geographical distribution, Habitat, Morphology, life cycle, Mode of infection and laboratory diagnosis of :
 - 3.2.1 Taeniasolium and saginata
 - 3.2.2 Echinococcusgranulosus
 - 3.2.3 Hymenolepis nana
 - 3.2.4 Schistosoma haematobium and mansoni
 - 3.2.5 Fasciola hepatica and buski
 - 3.2.6 Trichuristrichura
 - 3.2.7 Trichinellaspiales
 - 3.2.8 Strongyloidesstercoralis
 - 3.2.9 Ancylostomaduodenale
 - 3.2.10 Enterobiusvermicularis
 - 3.2.11 Ascarislumbricoides
 - 3.2.12 Wuchereriabancrofti
 - 3.2.13 Dracunculusmedinensis
4. Diagnostic procedures:
 - 4.1 Examination of Stool for parasites

- 4.1.1 For intestinal protozoal infections
- 4.1.2 General rules for microscopic examination of stool samples
- 4.1.3 Collection of stool samples
- 4.1.4 Preparation of material for unstained and stained preparations
- 4.1.5 Staining methods i.e. Iodine staining and permanent staining
- 4.1.6 For Helminthic infections
 - 4.1.6.1 Introduction, direct smear preparation and examination
 - 4.1.6.2 Concentration techniques i.e. Flotation and sedimentation techniques
 - 4.1.6.3 Egg counting techniques
- 4.1.7 Examination of blood for parasites
 - 4.1.7.1 Preparation of thin and thick blood film
 - 4.1.7.2 Leishman staining
 - 4.1.7.3 Examination of thick and thin smear
 - 4.1.7.4 Field's stain
 - 4.1.7.5 JSB stain
- 5. Examination of blood film for Malarial parasite and Microfilariae
- 6. Collection, Transport, processing and preservation of samples for routine parasitological investigations
- 7. Morphology, life cycle and lab-diagnosis of Giardia and Entamoeba
- 8. Morphology, life cycle and lab-diagnosis of Roundworms and Hookworms
- 9. Morphology, life cycle and lab-diagnosis of T. solium and T. saginata
- 10. Morphology, life cycle and lab-diagnosis of Malarial parasite with special reference to P.vivax and P. falciparum
- 11. Laboratory diagnosis of hydated cyst and cysticercosis
- 12. Concentration techniques for demonstration of Ova and Cysts (Principles and applications)

Virology and Mycology

Rationale The student will be taught about introduction, general characteristics, life cycle and laboratory diagnosis of various Medically important Fungi and Viruses. **Virology:**

- 1. Introduction to medical virology
- 2. Introduction to medically important viruses

3. Structure and Classification of viruses.
4. Multiplication of viruses
5. Collection, transportation and storage of sample for viral diagnosis
6. Staining techniques used in Virology
7. Processing of samples for viral culture (Egg inoculation and tissue culture)
8. Rapid diagnosis of viral infections with special reference to HIV, HBV and HCV
 - 8.1 EIA
 - 8.2 Immunofluorescence
 - 8.3 PCR

Mycology:

1. Introduction to Medical Mycology
2. Basic concepts about superficial and deep Mycoses
3. Taxonomy and classification and general characteristics of various medically important fungi
4. Normal fungal flora
5. Morphological, cultural characteristics of common fungal laboratory contaminants
6. Culture media used in mycology
7. Direct microscopy in Medical mycology laboratory
8. Processing of clinical samples for diagnosis of fungal infections i.e. Skin, nail, hair, pus, sputum, CSF and other body fluids
9. Techniques used for isolation and identification of medically important fungi
10. Methods for identification of yeasts and moulds
11. Dimorphism in fungi
12. Antifungal susceptibility tests
13. Preservation of fungal cultures
14. Routine myco-serological tests and skin tests

Medical Parasitology and Entomology – Practical

1. Routine stool examination for detection of intestinal parasites with concentration methods:
 - 1.1 Saline preparation
 - 1.2 Iodine preparation

- 1.3 Flootation method
- 1.4 Centrifugation method
- 1.5 Formal ether method
- 1.6 Zinc sulphate method
2. Identification of adult worms from models/slides:
 - 2.1 Tapeworm
 - 2.2 Tapeworm segments
 - 2.3 Ascaris (Round worm)
 - 2.4 Hookworms
 - 2.5 Pinworms
3. Malarial parasite:
 - 3.1 Preparation of thin and thick smears
 - 3.2 Staining of smears
 - 3.3 Examination of smears for malarial parasites (*P. vivax* and *P. falciparum*)

Virology and Mycology – Practical

1. To prepare culture media used routinely in mycology
2. To perform KOH preparation, Gram stain, Potassium Hydroxide - Calcofluor White method, India Ink preparation, Modified Kinyoun Acid Fast Stain for Nocardia, LCB preparation.
3. To identify given yeast culture by performing various identification techniques studied in theory.
4. To identify given mould culture by performing various identification techniques studied in theory.
5. To demonstrate dimorphism in fungi
6. To collect and process clinical samples for laboratory diagnosis of fungal infections i.e.
 - 6.1 Skin
 - 6.2 Nail
 - 6.3 Hair
 - 6.4 Body fluids and secretions
7. To demonstrate structure of viruses and their multiplication from charts etc.
8. To perform Giemsa stain, Seller's stain, immunofluorescent staining procedures for diagnosis of viral infections

9. Demonstration of fertilized hen egg
10. Demonstration of various inoculation routes in fertilized hen egg

Suggested Readings

1. Parasitology in relation to Clinical Medicine by K D Chhatterjee
2. Medical Entomology by A.K. Hati, Pub. Allied Book Agency
3. Medical Parasitology by D.R. Arora
4. Clinical Parasitology by Paul Chester Beaver
5. Practical Medical Microbiology by Mackie & MacCartney Volume 1 and 2
6. Text book of Microbiology by Ananthanarayanan
7. Medical Microbiology by Panikar & Satish Gupte
8. Medical laboratory Technology Vol. I ,II, III by Mukherjee
9. Medical Laboratory manual for tropical countries Vol. II Microbiology by Monica Cheesbrough
10. Medical Mycology by Dr. JagdishChander

Paper IV: Community Health, research methodology and biostatistics

1. Natural History of Disease

- Determinants of health, multi – factorial causation of disease host, agent, environment relationship primary, secondary, and tertiary levels of prevention with examples related to few diseases of national importance.

2. Mode of transmission of disease

- Air – borne, vector and vehicle transmission. Methods of control with examples for control of each mode.

3. Disinfection

- Disinfection of the infective materials received in the Laboratory by using the appropriate disinfection methods, at the health centre level.

4. Health services

- Brief description of organization of health services at the centre and state levels.

5. Primary Health Care

- Definition, components and principles of primary health care.
- Health for all indicators.
- Primary Health Centre
- The functions, staffing pattern and the role of laboratory technicians in primary Health Centre.
- Laboratory tests for use in Health Centre (See annexure for description)

6. National Programmes of Health and disease eradication /control

- Health Programmes:
- Family Welfare Programme
- National Programme for water supply and sanitation.
- Nutritional Programmes.
- Immunization and universal immunization programme.

7. Disease Eradication programme: Leprosy & Guinea worm.

8. Disease control programmes: Tuberculosis, Malaria, Filariasis, S.T.D, Goitre, Cholera and other diarrhoeal diseases and National Programme for prevention of blindness including trachoma.

9. Demography & Population control.

- The factors influencing population growth, death rate, birth rate and methods of contraception.

10. Environmental sanitation:
 - Methods of water purification and disinfection, collection of water samples, their transport and bacteriological analysis.
 - Methods of excreta disposal.
11. Health education – definition, principles, objectives, purpose, types and AV aids,
12. Communication – definition, process and types
 - Behavioral change communication.
 - IEC (Information education and communication): aims, scope, concept and approaches.
13. Teaching and learning process, concept, characteristics of learner and educator.
14. Role and skill of health professional in Health Education;
15. Inter personal relationship: Co-ordination and co-operation in health education with other members of the health team

Research Methodology and Biostatistics

Rationale: The objective of this module is to help the students understand the basic principles of research and methods applied to draw inferences from the research findings. The students will also be made aware of the need of biostatistics and understanding of data, sampling methods, in addition to being given information about the relation between data and variables. **Research Methodology:**

1. Introduction to research methods
2. Identifying research problem
3. Ethical issues in research
4. Research design
5. Basic Concepts of Biostatistics
6. Types of Data
7. Research tools and Data collection methods
8. Sampling methods
9. Developing a research proposal

Biostatistics:

1. Need of biostatistics
2. What is biostatistics: beyond definition
3. Understanding of data in biostatistics
4. How & where to get relevant data
5. Relation between data & variables
6. Type of variables: defining data set

7. Collection of relevant data: sampling methods
8. Construction of study: population, sample, normality and its beyond (not design of study, perhaps)
9. Summarizing data on the pretext of underlined study
10. Understanding of statistical analysis (not methods)

Research Methodology and Biostatistics – Practical

1. To practice problems on various biostatistics tools.

COURSE AND EXAMINATION REGULATIONS

Attendance:

- Students are required to attend 75% or more of all theory classes held, and 75% or more of practical in each subject to be eligible to appear in the final examination. Under no condition will a student with less than the prescribed attendance in any subject in theory and practical separately shall be allowed to appear in the Annual examination of that subject.
- Students with less than 75% attendance in theory and practical separately at the end of any year must start afresh by joining the junior batch of students. No extra classes will be arranged to make such students eligible for the final annual examinations. The attendance accrued in the previous academic year in those subject(s) will not be transferred. The student will need to secure 75% attendance afresh in theory and practical/laboratory postings after joining the junior batch to become eligible to appear in the final summative examination.
- The 25% leverage in attendance includes all types of leaves (including leave on medical grounds). For absence because of illness or any medical condition, a duly approved medical leave from Dean (Academic) with medical and fitness certificate issued/verified by authorized JIPMER clinical faculty member is mandatory. Certificate must be submitted before or within 10 days after availing medical leave.
- Students who are detained in all the subjects of a year due to lack of attendance should join the classes with junior batch within 7 days of declaration of the eligibility/detention list or when classes commence, whichever is earlier.
- Students who are detained in one or more subject(s) because of lack of attendance but are eligible to appear for final Annual examination in at least one subject of the year should join classes with junior batch within 7 days of completion of the last final theory/practical examination or when classes, whichever is earlier. Attendance will be calculated from the date of joining.
- A show cause notice will be issued to students on continuous unauthorized absence without prior permission for two weeks or more. If such absence extends to a period more than one month for any reason, the student is liable for termination for the course. The decision of the competent authority is final.
- There is **no condonation permissible** for shortage of attendance.

Internal Assessment (IA)

- A minimum of three notified internal assessments will be held periodically in each year (in a one-year period) and one model examination before the final annual examination.
- Each of the notified IA tests will carry 20% weightage and the model examination will carry 40% weightage. The sum of notified IA tests and model examination will decide the eligibility to appear in the examination and for contribution to aggregate marks.

- A student must secure at least 30% of the maximum marks fixed for internal assessment in theory and practical/clinical separately in a particular subject to be eligible to appear for the final annual examination in that subject.
- Of the final total aggregate marks in each subject, internal assessment marks will contribute 40% and annual examination marks will contribute the remaining 60%. This will apply to both theory and practical/clinical papers separately.
- If a student misses up to one notified test because of illness, marks of the remaining notified tests can be considered for calculating the internal assessment, ignoring the absence on medical grounds. To avail this concession, the student should submit a valid medical certificate signed by the treating clinical faculty member of JIPMER before or within 10 days after the missed test. This exemption will not apply to model examination. This is applicable only up to one missed notified internal assessment test.
- No repeat/additional notified internal assessment or model examination will be conducted.
- Students who are detained in all the subjects of a year because of lack of sufficient internal assessment marks should join the classes with junior batch within 7 days of declaration of the eligibility/detention list or when classes of the year commence, whichever is earlier.
- Students who are detained in one or more subject(s) due to lack of sufficient internal assessment marks but are eligible to appear in the annual examination in at least one subject of the year should join classes with junior batch within 7 days of completion of the last annual theory/practical examination or when classes of the year commence, whichever is earlier.
- The internal assessment marks accrued in the previous year will not be transferred to the next year.

Annual Examinations

Number and timing of examinations

- Annual examinations will be held at the end of each academic year. The Institute shall conduct not more than two annual examinations in an academic year, a regular annual and a supplementary examination in each subject. The supplementary examinations will be held within 6 weeks after publication of the result of the regular annual examination.
- Practical Examinations shall be jointly conducted by one internal and one external examiner duly appointed by the Professor of Examinations.
- Students should obtain a minimum of 40% in the annual examination and a minimum of 50% in the final total aggregate (total of internal assessment and annual examination marks) in a subject (theory and practical separately) to be declared as pass in that subject.

Marks scheme:

	Maximum marks
Theory	200
Practical	100
Total	300

Theory

	Maximum marks
Internal Assessment test 1 (weighted)	16
Internal Assessment test 2 (weighted)	16
Internal Assessment test 3 (weighted)	16
Model Examination	32
Annual Theory Examination	100
Viva-voce Examination	20
Total Theory marks	200

Practical

	Maximum marks
Internal Assessment test 1 (weighted)	7
Internal Assessment test 2 (weighted)	7
Internal Assessment test 3 (weighted)	7
Model Examination	14
Record marks	5
Annual Practical Examination	60
Total Practical marks	100

Question paper pattern

	Maximum marks
Section A	50
Section B	50
Total	100

Each section

		Marks
Answer in detail	1 X 10	10
Short notes	5 X 5	25
Brief answers	5 X 3	15
		50

Number of attempts and Training Period

- The academic program of the BSc Allied Health Sciences courses must be completed within 6 years from the date of joining (excluding internship). Maximum permissible duration for each year shall be four years and a maximum four attempts (including the annual and supplementary examinations) in any subject will be permitted.
- If a student does not appear in both theory and practical final examination, it will NOT be considered as an attempt for the purpose of calculation of maximum number of attempts in a subject.
- If a student appears for theory in the Annual Examination but does not appear for Practical Examination or vice-versa, his/her theory or practical appearance shall be counted as an attempt. In the next attempt, the student will have to appear for both Theory and Practical Examinations. Mere submission of application form for examination will not be considered as an attempt.
- Passing in the exams of all the previous year subjects is compulsory before proceeding to the classes of next phase.
- A student who fails in theory and/or practical papers of one or more subjects in the regular annual examinations at the end of each year can appear in the supplementary examination (to be held within 6 weeks of announcement of the regular annual examination results) in those subjects.
- If he/she passes these subjects in the supplementary examination, he/she should join the regular batch within 7 days of declaration of supplementary examination results or when classes commence, whichever is earlier. Attendance calculation for students who join after passing supplementary examination will begin from their date of joining of that year.
- Students who fail in theory and/or practical in one or more subjects in the supplementary examination and those who do not appear in the supplementary examination should join classes with the junior batch within 7 days of declaration of supplementary examination results or when classes, whichever is earlier. These students should secure 75% attendance and 30% internal assessment afresh to be eligible to appear in the final regular annual examination of that year along with the junior batch. Attendance calculation for students who join after failing in supplementary examination will begin from their date of joining the year with junior batch.
- A maximum of four attempts in any subject is allowed. If a student fails even in the 4th attempt, no further chances will be given, and his/her name will be struck off the rolls of JIPMER.
- No grace marks will be awarded for either theory or practical examinations under any circumstances.

Model Question paper

Phase I - Paper I: Foundation course

Maximum marks: 100

Maximum duration: 3 hours

Answer all the questions. Draw suitable diagrams where necessary

Section A

1. Answer the following question in detail: 1 x 10 = 10

- a. Describe in detail healthcare delivery system in India at the primary, secondary, and tertiary levels.

2. Write short notes on the following: 5 x 5 = 25

- a. What is the role of processor and RAM in a computer?
- b. Describe the types of networks in computing.
- c. Write a short note on right to healthcare.
- d. What is medical negligence? What are the laws governing medical negligence in India?
- e. Write in brief about the importance of informed consent and the process.

3. Answer the following questions briefly: 5 x 3 = 15

- a. What are the components of a medical term?
- b. What are the input and output devices of a computer?
- c. What is paralanguage? What are its implications?
- d. Describe the characteristics of good communicator.
- e. What are the alternative medicine systems recognised by the Government of India?

Section B

4. Answer the following question in detail: 1 x 10 = 10

- a. Explain the concepts of quality of care. Describe various approaches to quality improvement.

5. Write short notes on the following: 5 x 5 = 25

- a. Describe the principles of management with suitable examples.
- b. Describe the methods of disinfection in biomedical waste management.
- c. Describe the methods of prevention & control of common healthcare associated infections.
- d. Classify the types of antibiotic resistance and describe each of them.
- e. Write a short note on research study designs.

6. Answer the following questions briefly: 5 x 3 = 15

- a. What are the components of cardiopulmonary resuscitation?
- b. What is integrity and what is its importance of integrity in healthcare practice?
- c. What are the qualities of a good leader?
- d. What are the different types of data?
- e. Describe the concept of ethics and its relevance in healthcare practice.

Model Question paper

Phase I - Paper II: Anatomy

Maximum marks: 100 Maximum duration: 3 hours
Answer all the questions. Draw suitable diagrams where necessary

Section A

- 1. Answer the following question in detail:** 1 x 10 = 10
- a. Describe the position, parts, structure, blood supply and supports of uterus.
- 2. Write short notes on the following:** 5 x 5 = 25
- a. Parts and blood supply of stomach
b. Simple epithelium
c. Histology of lymph node
d. Chambers and valves of heart
e. Surfaces and lobes of lung
- 3. Answer the following questions briefly:** 5 x 3 = 15
- a. Name three major salivary glands.
b. Mention two contents of spermatic cord
c. Name two paranasal air sinuses
d. Name the parts of small intestine
e. Name two upper limb muscles

Section – B

- 4. Write essay answer on the following:** 1 x 10 = 10
- a. Define in detail the steps in tissue processing
- 5. Write short notes on the following:** 5 x 5 = 25
- a. Haematoxylin stain
b. Embedding media
c. Culture steps in Karyotyping
d. Components of embalming fluid
e. Microanatomy of testis
- 6. Answer the following questions briefly:** 5 x 3 = 15
- a. Bluing in H & E staining procedure
b. Tests for confirmation of decalcification
c. Resolution power in microscopy
d. Steps in mounting of museum specimens
e. Types of Eosin

Model Question paper

Phase I - Paper III: Physiology

Maximum marks: 100 Maximum duration: 3 hours
Answer all the questions. Draw suitable diagrams where necessary

Section A

- 1. Write essay answer on the following:** 1 x 10 = 10
a. Define immunity. Mention the different types of immunity. Write briefly about the different types of immunity.
- 2. Write short notes on the following:** 5 x 5 = 25
a. Active transport
b. Movements of small intestine
c. Factors affecting glomerular filtration rate
d. Oxygen haemoglobin (Oxy-Hb) dissociation curve
e. Factors regulating cardiac output
- 3. Answer the following questions briefly:** 5 x 3 = 15
a. Name the hormones secreted from Adrenal gland
b. Mention the Indicators of ovulation
c. Define tidal volume. Mention its normal value.
d. Draw a labelled diagram of lead II ECG.
e. List four functions of hypothalamus.

Section – B

- 4. Write essay answer on the following:** 1 x 10 = 10
a. Define cardiac cycle with the help of a suitable diagram; mention the change occurring in the heart during a cardiac cycle. Describe the physiological basis of measurements of cardiac output.
- 5. Write short notes on the following:** 5 x 5 = 25
a. Pathway for pain sensation
b. Use of spirometer in respiratory function
c. Estimation of Haemoglobin
d. Tests of hearing
e. Short term regulation of Blood Pressure
- 6. Answer the following questions briefly:** 5 x 3 = 15
a. Name the sites where arterial baroreceptors are located.
b. What is tidal volume
c. Recording of Electrocardiogram
d. Receptors for hearing
e. Visual acuity

Model Question paper

Phase II - Paper I: General Biochemistry

Maximum marks: 100 Maximum duration: 3 hours
Answer all the questions. Draw suitable diagrams where necessary

Section A

1. Write essay answer on the following: 1 x 10 = 10

- a. Discuss in detail the dietary sources, biochemical functions, and deficiency manifestations of vitamin D

2. Write short notes on the following: 5 x 5 = 25

- a. Structure of DNA.
- b. Essential amino acids.
- c. Laboratory hazards.
- d. Classification of enzymes.
- e. Polysaccharides.

3. Answer the following questions briefly: 5 x 3 = 15

- a. What are epimers? Give one example.
- b. What is the difference between a nucleoside and a nucleotide?
- c. Name any two antioxidants.
- d. Mention the composition of sucrose and lactose.
- e. State two functions of Phosphorous in the human body.

Section – B

4. Write essay answer on the following: 1 x 10 = 10

- a. State the principle, instrumentation, and applications of colorimetry

5. Write short notes on the following: 5 x 5 = 25

- a. Donnan's membrane equilibrium
- b. Ion Exchange Chromatography
- c. Nitrogen Balance
- d. Scintillation counter
- e. Scurvy

6. Answer the following questions briefly: 5 x 3 = 15

- a. Mention the normal blood PH level.
- b. Name any two factors affecting rate of number electrophoresis.
- c. What is Iodine?
- d. What is isoelectric point?
- e. Name any two microminerals

Model Question paper

Phase II - Paper II: Hematology and blood banking

Maximum marks: 100 Maximum duration: 3 hours
Answer all the questions. Draw suitable diagrams where necessary

Section A

- 1. Write essay answer on the following:** 1 x 10 = 10
- a. Write in detail about the different anticoagulant tubes available in your laboratory. Discuss about their principles and uses. Add a note on peripheral smear preparation and staining
- 2. Write short notes on the following:** 5 x 5 = 25
- a. What is the range of normal platelet count? Mention few causes of thrombocytopenia. How will you perform platelet count?
- b. Describe the stages of ESR estimation. What are the factors influencing ESR?
- c. What are the methods of making thick and thin blood smear? Discuss the utility of both smears.
- d. Hemoglobin electrophoresis.
- e. Romanowsky stains.
- 3. Answer the following questions briefly:** 5 x 3 = 15
- a. Name cytochemical stains in acute leukemia.
- b. Mention two causes of eosinophilia.
- c. Define MCV. How does it help in classifying anemia?
- d. What is a supravital stain and mention its use.
- e. Bleeding time.

Section – B

- 4. Write essay answer on the following:** 1 x 10 = 10
- a. Discuss in detail about various blood components and their uses.
- 5. Write short notes on the following:** 5 x 5 = 25
- a. Discuss in detail about the steps involved in cross matching.
- b. Different methods for performing blood grouping and typing.
- c. Universal safety precautions and its significance.
- d. Complications of mismatched blood transfusion.
- e. What is Bombay Blood group? What are its characteristics?
- 6. Answer the following questions briefly:** 5 x 3 = 15
- a. Who is Universal recipient and why?
- b. Write any two infections transmitted by blood donation.
- c. Reasons for temporary deferral in blood donation.
- d. Universal criteria for blood donor selection.
- e. What are the differences between serum and plasma?

Model Question paper

Phase II - Paper III: General Microbiology, Immunology, Bacteriology and Serology

Maximum marks: 100 Maximum duration: 3 hours
Answer all the questions. Draw suitable diagrams where necessary

Section A

- 1. Write essay answer on the following:** 1 x 10 = 10
- a. List the different antimicrobial susceptibility testing methods. Describe in detail the different disc diffusion based antimicrobial susceptibility testing methods.
- 2. Write short notes on the following:** 5 x 5 = 25
- a. Koch's postulates.
b. Working principle of autoclave.
c. Dark field microscopy
d. Antigen presentation by MHC-II.
e. Immunogenicity and antigenicity.
- 3. Answer the following questions briefly:** 5 x 3 = 15
- a. Enrichment media – principle and example.
b. b) Mention the antibiotic panel used for isolates from urine samples.
c. c) Principle of BACTEC
d. Two applications of agglutination reaction.
e. d) Name two uses of monoclonal antibodies

Section – B

- 4. Write essay answer on the following:** 1 x 10 = 10
- a. Write in detail about the laboratory diagnosis of Typhoid fever. Add a note on prophylaxis
- 5. Write short notes on the following:** 5 x 5 = 25
- a. Laboratory diagnosis of pneumococcal meningitis.
b. Specific tests for syphilis.
c. Toxin demonstration of C.diphtheriae.
d. Laboratory diagnosis of gas gangrene.
e. Write the various culture methods for M.tuberculosis.
- 6. Answer the following questions briefly:** 5 x 3 = 15
- a. Two non-suppurative complications of Streptococcus pyogenes infection.
b. What is Weil Felix test?
c. Satellitism.
d. Coagulase Negative Staphylococci.
e. Write four solid media used for culture of V.cholerae.

Model Question paper

Phase III - Paper I: Analytical applied and clinical biochemistry

Maximum marks: 100 Maximum duration: 3 hours
Answer all the questions. Draw suitable diagrams where necessary

Section A

1. Write essay answer on the following: 1 x 10 = 10

- a. Define chromatography. Discuss the principle, methodology and applications of paper chromatography

2. Write short notes on the following: 5 x 5 = 25

- a. Clinical applications of electrophoresis
- b. Lipid profile
- c. Creatinine clearance test
- d. Alkaptonuria
- e. External versus internal quality control in lab

3. Answer the following questions briefly: 5 x 3 = 15

- a. Name two diseases associated with proteinuria
- b. Name any two Ketone bodies
- c. Name two copper containing enzymes
- d. Name any two clinical importance of enzymes
- e. Give the reference range for glycated haemoglobin to identify (i) Non diabetic individual (ii) Diabetes mellitus patient

Section – B

4. Write essay answer on the following: 1 x 10 = 10

- a. Discuss the steps of polymerase chain reaction with a suitable diagram. Add a note on its applications

5. Write short notes on the following: 5 x 5 = 25

- a. Thyroid function tests.
- b. Kidney mechanisms in acid base homeostasis.
- c. Laboratory tests to differentiate different types of jaundice.
- d. Types of Beriberi and its lab diagnoses.
- e. Iso-enzymes

6. Answer the following questions briefly: 5 x 3 = 15

- a. Mention any two buffer systems in blood.
- b. Name two bile salts.
- c. Name any two good dietary sources of iron.
- d. Mention the nutrient deficiencies associated with
(i) Scurvy (ii) Keshan's disease
- e. Give the reference range for serum level of
(i) Sodium (ii) Potassium

Model Question paper

Phase III - Paper II: Histopathology and Cytology

Maximum marks: 100

Maximum duration: 3 hours

Answer all the questions. Draw suitable diagrams where necessary

Section A

- 1. Write essay answer on the following:** 1 x 10 = 10
- a. Explain in detail the various steps involved in tissue processing. Add a note on the factors affecting tissue processing.
- 2. Write short notes on the following:** 5 x 5 = 25
- a. Formalin as a universal fixative- Advantages and disadvantages
 - b. Decalcification methods
 - c. Two stains highlighting collagen – Principle and interpretation
 - d. Cryostat and its uses
 - e. Special stains for amyloid
- 3. Answer the following questions briefly:** 5 x 3 = 15
- a. Double embedding
 - b. Perls stain – Principle and interpretation
 - c. What is progressive and regressive staining?
 - d. What is step section? What are its uses?
 - e. How do we remove formalin pigment from tissue sections?

Section – B

- 4. Write essay answer on the following:** 1 x 10 = 10
- a. Write in detail about principles, techniques, and importance of Papanicolaou staining in cytology practice
- 5. Write short notes on the following:** 5 x 5 = 25
- a. Coating fixatives
 - b. Acid fast stain – Principle, types, and interpretation
 - c. Methods of cell block preparation
 - d. Prefixation of fluid samples
 - e. Special stains for demonstrating fungal organisms
- 6. Answer the following questions briefly:** 5 x 3 = 15
- a. Principle of Surepath LBC technique.
 - b. Discarding of fluid samples
 - c. Indications for image guided FNAC
 - d. What is Diff Quik stain?
 - e. How do you handle and preserve material in a broken slide?

Model Question paper

Phase III - Paper III: Medical parasitology, entomology, mycology, and virology

Maximum marks: 100 Maximum duration: 3 hours
Answer all the questions. Draw suitable diagrams where necessary

Section A

- 1. Write essay answer on the following:** 1 x 10 = 10
a. Enumerate parasites causing malaria and describe the laboratory diagnosis in detail.
- 2. Write short notes on the following:** 5 x 5 = 25
a. Laboratory diagnosis of visceral leishmaniasis
b. Amoebic liver abscess
c. Trichomoniasis
d. Balantidium coli
e. Cysticercus cellulosae
- 3. Answer the following questions briefly:** 5 x 3 = 15
a. Draw a neat, labelled diagram of trophozoite of Giardia
b. Agent and mode of transmission of Chagas disease
c. Agent of primary amoebic meningoencephalitis
d. Name the definitive host and intermediate host of Diphyllbothrium latum
e. Name two oviparous nematodes

Section – B

- 4. Write essay answer on the following:** 1 x 10 = 10
a. Classify arboviral infections and name the arboviral infections seen in India. Add a note on the pathogenesis & laboratory diagnosis of Dengue fever.
- 5. Write short notes on the following:** 5 x 5 = 25
a. Lab diagnosis of Hepatitis B
b. Laboratory diagnosis of dermatophytic infection
c. Laboratory diagnosis of COVID 19
d. Mucormycosis
e. Laboratory diagnosis of mycetoma
- 6. Answer the following questions briefly:** 5 x 3 = 15
a. Difference between antigenic shift and drift
b. Two hepatitis viruses which are transmitted through feco-oral route.
c. Enumerate four dimorphic fungi
d. Continuous cell lines
e. Write four viruses transmitted by blood transfusion.

Model Question paper

Phase III - Paper IV: Community health, research methodology and biostatistics

Maximum marks: 100 Maximum duration: 3 hours
Answer all the questions. Draw suitable diagrams where necessary

Section A

1. Write essay answer on the following: 1 x 10 = 10

- a. Define natural history of disease. Explain the various levels of prevention and modes of intervention required for the prevention and control of hypertension in the community.

2. Write short notes on the following: 5 x 5 = 25

- a. Sanitation barrier and its public health importance
- b. Diagnostic algorithm for Tuberculosis
- c. Explain the principle of 'appropriate technology' in the context of primary health care with an example
- d. Explain the advantage and disadvantage of chlorination as method of purification
- e. Chi-square test

3. Answer the following questions briefly: 5 x 3 = 15

- f. Define incubation period
- g. List the advantage and disadvantage of using mass media for health education
- h. Mention any two diseases transmitted by ticks
- i. What is role of rapid diagnostic test in the diagnosis of malaria under the National Vector Borne Disease Control Program?
- j. Define Crude Birth Rate

Section – B

4. Write essay answer on the following: 1 x 10 = 10

- a. What are the routine antenatal services delivered at primary health care level? Discuss briefly about the laboratory investigations done during antenatal period.

5. Write short notes on the following: 5 x 5 = 25

- a. Describe methods of disposal/treatment for following items: i) Surgical blade ii) Soiled Cotton iii) Human placenta iv) Urine catheter
- b. Role of ASHA in promoting maternal and child health
- c. Compare and contrast cohort and case control studies
- d. Components of 6x6 strategy under Anaemia Mukh Bharat
- e. COVID 19 vaccines in India.

6. Answer the following questions briefly: 5 x 3 = 15

- a. What is the vitamin A dosage schedule for a child up to 5 years of age as per National Immunization Schedule?
- b. How will you disinfect sputum slide containing acid fast bacilli after microscopic examination?
- c. Describe the characteristics of normal distribution curve.
- d. Mention four health hazards of biomedical waste.
- e. Measures of central tendency
