

**KERALA UNIVERSITY OF HEALTH
SCIENCES**

BACHELOR OF SCIENCE IN MEDICAL LABORATORY TECHNOLOGY

Regulations, scheme and syllabus for the degree of Bachelor of Science in medical laboratory technology

Objectives of the course

At the end of the course the candidates shall be:

1. Aware of the principle underlying the organization of a clinical laboratory.
2. Able to do routine and special investigative procedures in medical laboratory practice.
3. Provide a good theoretical and practical education who plan to work with in the field of medical laboratory technology and science.
4. Develop knowledge and skill in accordance with the society's demand in medical Laboratory technology.
5. Qualify the students for official approval as medical laboratory technologist.
6. Able to operate and maintain all equipments used in laboratory diagnostics.
7. Able to establish and manage a clinical or Research laboratory.

Programme description

The course of study enhances student's knowledge and skills in several major categorical areas of medical laboratory technology. The degree in medical laboratory technology provides advanced skills to practicing laboratory professionals in health administration, leadership, quality assurance and health informatics.

Name of the course

Name of the course shall be the

**“BACHELOR OF SCIENCE IN MEDICAL LABORATORY TECHNOLOGY” –
BSc (MLT)**

Eligibility

1. The candidate shall pass +2 or equivalent course recognized by the **Kerala University of Health and Allied Sciences.**
2. A minimum of 50% marks in Physics, chemistry and Biology

Selection

The selection is based on the marks obtained for the qualifying examination and the quotas, reservation etc shall fix by the Government from time to time.

Course structure

The course shall comprise of both theory and practical studies in different branches of Medical laboratory technology and its related subjects such as

1. Anatomy
2. Physiology
3. Medical Laboratory Science and Ethics
4. Biochemistry
5. General Microbiology
6. Immunology
7. Mycology
8. Virology
9. Applied Microbiology

10. Parasitology
11. Entomology
12. Systemic Diagnostic Bacteriology
13. Transfusion technology
14. General and Clinical Pathology
15. Hematology
16. Cytology
17. Histopathology techniques
18. Cytogenetics
19. Molecular biology
20. Electronics and Computer science & Biomedical instrumentation technology related to cardiothoracic surgery, Cardiology, Neurology, Neurosurgery, Nephrology, Gastroenterology, Respiratory medicine, and Nuclear medicine.

Teaching/Learning methods

- Regular clinical Laboratory posting to pick up practical skill and practice techniques on laboratory responsibility and supervision.
- Lecture and practical classes
- Students should present seminars in various clinical subjects in medical laboratory technology to attain presentation skill.

Duration of the course

Duration of the course shall be four academic years. Each academic year spread over a period of 240 working days. The students should undergo training for at least 2weeks in one or more national reputed institutions during the period of the course especially for virology, Mycology and recent advances in medical technology.

Hours distribution for each subject

Subject		Total Hours/subject/year			
		Theory Hours	Practical Hours	Clinical Posting Hours	Total Hours /year
First Year					
Paper-I	Anatomy	100	80	-	180
	Physiology	115	65	-	180
Paper-II	Biochemistry-I	130	230	-	360
Paper III	Basic Microbiology & Immunology	130	230	-	360
Paper IV	Basic Medical Laboratory Science & Haematology – I	130	230	-	360
Second year					
Paper V	Biochemistry II	90	174	96	360
Paper VI	General Microbiology	90	174	96	360
Paper VII	Parasitology & Entomology	90	174	96	360
Paper VIII	Haematology-II& Clinical Pathology	90	174	96	360
Third year					
Paper IX	Biochemistry III	96	174	130	400
Paper X	Bacteriology	96	174	130	400
Paper XI	Cytology and Transfusion technology	96	174	130	400
Paper XII	Electronics and Computer science & Biomedical instrumentation technology	96	74	70	240
Fourth year					
Paper XIII	Biochemistry IV	90	180	160	430
Paper XIV	Mycology, Virology and Applied Microbiology	90	180	160	430
Paper XV	Histotechnology and cytogenetics	90	180	160	430
Paper XVI	Project		150		150

Regulation and scheme of examination

1. University Examinations and Promotion of students.

- 1.1** There shall be university regular examination at the end of each year;
- 1.2 All students** will TEMPORARILY continue to the next semester/year irrespective of the results of the examination.
- 1.3** In case of failed / not appeared candidates, a 'SAY' (Save A Year) examination will be conducted within two weeks after publication of results and candidates need appear for only those papers / subjects in which He/ She has failed and includes theory, practical and viva, of the failed subject , for securing complete pass in the examination
- 1.4** The candidates failed in the 'SAY' examination will not be allowed to continue with the original batch and will be allowed to continue with the Junior Batch only. He/ She will have to write the internal sessional exams with them and will have to undergo examinations in all the subjects.
- 1.5 EXEMPTION will not be granted for regulation 1.4 and** a candidate before appearing the 2nd, 3rd year & 4th year BSc (MLT) examination should have passed in all the subjects of the 1st , 2nd, & 3rd year year BSc (MLT) examinations respectively.

2. Attendance Requirements.

- 2.1** No candidates shall be admitted to any year of BSc (MLT) examination unless he/she has a minimum of 80% attendance .
- 2.2** There is a ONE TIME provision for condonation up to 10% on medical grounds. The condonation can be given by the head of the institution and should be ratified by the UNIVERSITY
- 2.3** A candidate who has not attained 80% attendance and the shortage is beyond the condonable limit shall not be eligible to continue the course with the same batch of students. He/ She may obtain special sanction from the INSTITUTION and the UNIVERSITY to continue with the junior batch of students.

3. Internal Assessment marks.

The internal assessment marks in theory/Practical shall be restricted to a maximum of 20% of the University Examinations - in Theory / Practical separately.

The internal assessment marks in theory/Practical shall be on the basis of the assessment made by the teachers from the candidate's performance in the:

Three (3) sessional examinations conducted by the department,

Laboratory work and seminars during the course of study

(A log book/ Record is to be maintained duly signed by the appropriate teachers)

The marks secured by the candidates in each paper/subject shall be forwarded to the university at the end of the course for university examinations.

The candidates who failed in the university examination will be allowed a separate internal assessment for both theory and practical including viva.

4. Awarding Degree

Those who have secured 50% marks and less than 60% of the total marks shall be placed in the second class and those who have secured 60% and above shall be placed in the first class. Those who have secured 75% or above shall be declared to have passed in first class with Distinction.

All Students shall be allowed to attend the subsequent years irrespective of whether he/she has passed the first, second or third year university examinations. SEE CLAUSE 1.4 The FAILED STUDENTS have to appear for the 'SAY' (Save A Year) examination.

(1.4 The candidates failed in the 'SAY' examination will not be allowed to continue with the original batch and will be allowed to continue with the Junior Batch only. He/ She will have to write the internal sessional exams with them and will have to undergo examinations in all the subjects)

For awarding class in the final BSc(MLT)degree examination, the total marks obtained in the I,II,III&IV BSC(MLT) examination will be taken and the final BSc(MLT) mark list will contain the following details.

	Maximum marks	Minimum marks
Total marks awarded in the I BSc (MLT)		
Total marks awarded in the II BSc (MLT)		
Total marks awarded in the III BSc (MLT)		
Detailed mark list of IV th BSc (MLT)		
Grand total of I, II, III&IV BSC (MLT) examination marks.		

EXAMPLE : 6. First year Mark list
Kerala University of Health and Allied Sciences

Reg.No.....

Thrissur

Dated.....

MEMORAMDUM

The following marks were awarded to Shri/Smt-----
at the First Year B.Sc.(MLT) Degree Examination (2010 admn onwards) of201

Subjects	Marks awarded	Minimum Marks Required for a pass	Maximum Marks
<u>Paper I Anatomy & Physiology</u>			
Theory - University Marks		45	100
Oral - University Marks		-	50
Sessional Marks		-	25
Total		80	175
Practical - University Marks		50	100
Sessional Marks		-	25
Total		62.5	125
Total for the subject		150	300
<u>Paper II Biochemistry – I</u>			
Theory - University Marks		45	100
Oral - University Marks		-	50
Sessional Marks		-	25
Total		87.5	175
Practical - University Marks		45	100
Sessional Marks		-	25
Total		67.5	125
Total for the subject		150	300
<u>Paper III Basic Microbiology & Immunology</u>			
Theory - University Marks		45	100
Oral - University Marks		-	50
Sessional Marks		-	25
Total		87.5	175
Practical - University Marks		50	100
Sessional Marks		-	25
Total		67.5	125
Total for the subject		150	300
<u>Paper IV Basic Medical Laboratory Science & Haematology – I</u>			
Theory - University Marks		45	100
Oral - University Marks		-	50
Sessional Marks		-	25
Total		87.5	175
Practical - University Marks		50	100
Sessional Marks		-	25
Total		67.5	125
Total for the subject		150	300
Grand Total			1200

Marks entered by

Marks checked by.....

Section officer

CONTROLLER OF EXAMINATION

7. Awarding Rank

The First class/First class with Distinction/Rank will be declared based on the total marks obtained for the first, second, third and fourth BSc (MLT) examination provided the candidate has passed all the subjects in the first attempt.

Scheme of Examination

	First year	
Paper-I	Anatomy & Physiology	
	Anatomy including Histology	-Section A
	Physiology	- Section B
Paper-II	Biochemistry-I	- Section A & Section B
Paper III	Basic Microbiology & Immunology	-Section A & Section B
Paper IV	Basic Medical Laboratory Science & Haematology - I	
		-Section A & Section B
Practical examination in Paper I will be for two days, one day for section A and the other for section B. Practical Examination in Paper II,III & IV will be in one day for each paper.		
	Second year	
Paper V	Biochemistry II	-Section A & Section B
Paper VI	General Microbiology	-Section A & Section B
Paper VII	Parasitology & Entomology	
	Parasitology	- Section A
	Entomology	- Section B
Paper VIII	Haematology-II & Clinical Pathology	-Section A & Section B
Practical examination in Paper V & VI will be in two consecutive days for each paper and & paper VIII will be in one day and for Paper VII will be for two days, one day for Parasitology and the other for Entomology.		

	Third year	
Paper IX	Biochemistry III	- Section A & Section B
Paper X	Bacteriology	-Section A & Section B
Paper XI	Cytology and Transfusion technology	-Section A & Section B
Paper XII	Electronics & Biomedical Instrumentation technology	-Section A & Section B
<p>Practical examination in Paper IX & X will be in three consecutive days for each papers and for Paper XI will be two days one day for cytology & the other for Transfusion Technology. Practical examination for paper XII will be one day</p>		
	Fourth year	
Paper XIII	Biochemistry IV	-Section A & Section B
Paper XIV	Mycology, Virology & Applied Microbiology	
	Mycology, Virology	- Section A
	Applied Microbiology	- Section B
Paper XV	Histotechnology and cytogenetics	-Section A & Section B
Paper XVI	Project (should be submitted for evaluation in the fourth year BSc MLT practical examination)	
<p>Practical examination in Paper XIII & XIV will be in three consecutive days for each paper and for paper XV will be two days. Paper XVI shall be valued by the final year university examiners of concerned subject projects.</p>		

Examiners

There shall be two examiners –one internal and one external. The external examiner shall be drawn from other institutions in Kerala under government sector where a similar course is being conducted. Both internal and external examiners should have MD or MSc MLT and those who are full time teachers of Medical Laboratory Technology with at least two years teaching experience in the concerned subject.

One set of Examiners will be sufficient (one external and one internal) to conduct the examination in all the subject except in paper I (Anatomy Physiology) , Paper VII (Parasitology & Entomology) and paper XI (Cytology & Transfusion Technology).

1. Anatomy and Physiology. There shall be one set of examiner for Anatomy and one set of examiner for Physiology.
2. Parasitology and Entomology-. One set of examiner for Entomology and the other set for Parasitology.
3. Cytology and Transfusion technology – One set of examiner for cytology and the other set for Transfusion technology.

The external Examiner will have to hand over the original mark list to the Chairman and the duplicate mark list to the Controller of Examinations.

Question paper setters

Question paper setters shall be posted from among the senior faculties of Kerala University of Health and Allied Sciences.

The Examiners and Question paper setters should be from the panel approved by Kerala University of Health and Allied Sciences.

Setting up of Question Paper

All the question paper should be of standard type. Each theory paper will be of 3 hours duration and shall consist of eight questions with a maximum of 100 marks. Theory paper in all the subjects will consists of 2 sections-Section A&B

Each section carries 50 marks and shall consist of two essay type questions with 10 marks (marks distribution should be subdivided and specified) and six brief answer type questions carrying 5 marks.

Section A&B will have to be answered in separate answer book.

Theory Paper valuation

The theory paper should be double valued by both external and internal examiners and there will be no revaluation.

Syllabus

FIRST YEAR

Paper I Anatomy & Physiology

Section – A ANATOMY

100 hours

1. Electron microscopic structure of Human cell.
2. Classification, functions and Microscopic Structures of Primary tissues Epithelial tissue, connective, tissue, muscular tissue, Nervous tissue
3. **Skeletal system** - Classification of bones, constituents of bone and bone tissue. Functions of Skeleton, Microscopic Structure of compact bones, Organizations of skeleton, Structure of typical vertebrae. Brief study on individual bones: Axial skeleton, appendicular skeleton, cartilages and its classifications. Scapula, Humerus, Sacrum, Clavicle, Hip bones, pelvic bones, femur, tibia, fibula, carpal and tarsal bones. Skull bones - Importance of sutures: coronal, sagittal and lamboid, cranial fossae, foramen magnum (elementary knowledge only).
Bones of Cranium, Auditory meatus, Mandible and Ramus. Difference between foetal and adult skull.
4. **Muscular System**
General function and actions of Nerve supply and blood supply of muscles. Classification of muscles. Diaphragm.
5. **Joints**
Classification of joints, movements, with examples type of ligament.
6. **Thorax**
Thoracic cavity, Mediastinum, Pleura.
7. **Respiratory System**
Trachea and lungs – Position, relation, structure, and blood supply. Bronchopulmonary segments. Bronchiole, alveoli and muscles of respiration.
8. **Heart**
Position, shape, size, structure, borders, blood supply and nerve supply of heart, chambers of heart, valves, pericardium, conducting system of heart. Arterio ventricular node.
9. **Vascular system**
Blood vessels, classification and its structure. Differences in the structure of artery and vein. Portal venous system.
10. **Lymphatic System** Lymph node, spleen, thymus, tonsil, lymphatic duct.
11. **Digestive System**
Oral cavity, salivary glands, teeth, tongue, pharynx, esophagus, stomach, glands, small intestine - duodenum, jejunum, ileum.
Pancreas, liver, gall bladder, gall stone, biliary tract. Large intestine, colon, appendix, rectum-rectovesical and rectouterine pouch.
12. **Urinary System**
Kidney, nephron, blood supply, venous drainage, ureter, urinary bladder and its relation in male and females, urethra.

13. Reproductive system

Male reproductive system – testis, seminiferous tubules, epididymis, seminal vesicles, external genitalia of male. Female reproductive system – vagina, cervix, uterus, fallopian tubes, ovary, ovarian follicles.

14. Nervous System

Classification and structure of neurons, brain - parts, ventricles, cranial nerves, spinal cord, spinal nerves.

15. Integumentary system Skin - parts, function.**16. Endocrine system** Pituitary glands, thyroid, parathyroid, suprarenal gland.**17. Special senses** Olfactory epithelium, taste buds of tongue, structure of ear, eye; functions.**Histology**

1. Epithelia
2. Cartilage – Hyaline, Elastic, fibro cartilage
3. Bone cross section and longitudinal section
4. Muscle, voluntary or striated, cardiac muscle, Smooth muscle or plane muscle.
5. Neuron, Spinal ganglion , Sympathetic ganglion, Nerve Fibre – Optic nerve, Sciatic nerve
6. Vascular Tissue: Large artery – Aorta, Medium sized artery, Large veins – Inferior vena cava, Medium sized vein.
7. Lymphatic tissue – a. Lymph node b. Spleen c. Thymus d. Tonsil
8. Skin – Thick, Thin
9. Digestive System: a. Salivary glands – Serous salivary gland, Mucous salivary gland, Mixed salivary gland .b. Tongue, c. Oesophagus, d. Stomach – Fundus, Pylorus ,e. Duodenum f. Jejunum, g. Ileum, h. Large intestine, i. Appendix, j. Liver, k. Gall Bladder, l. Pancreas
10. Respiratory System: a. Trachea b. Lungs
11. Nervous system – a. Cerebellum b. Cerebrum c. Spinal cord
12. Urinary system – a. Kidney b. Ureter c. Urinary bladder
13. Reproductive system: Male reproductive system
a. Testis b. Vas deferens c. Epididymis d. Prostate
14. Females Reproductive System
a. Ovary b. Fallopian tube c. Uterus – Follicular, secretary
d. Mammary gland active, mammary gland inactive. Placenta f. Umbilical cord
15. Endocrine system: a. Pituitary b. Thyroid & Parathyroid c. Adrenal gland d. Pancreas
16. Special senses : a. Cornea b. Retina

Practical**80 Hours**

Demonstration of gross anatomy – organs identification

Osteology demonstration

Microscopic demonstration for histology as per theory.

Text Books

1. Gross Anatomy – Chaurasia vol 1,2,3
2. Histology I B Singh's text book.
3. General Anatomy – Chaurasia.

Section –B PHYSIOLOGY**115 Hours**

- Introduction to physiology, Homeostasis
- I. Blood**
 Introduction to physiology, Composition and functions of blood
 Plasma proteins – types, functions
 RBC's – Morphology, functions, PCV, ESR, Osmotic fragility, RBC count.
 Hb- Content, functions, catabolism, erythropoietin, factors affecting blood indices – MCH, MCV, and MCHC.
 WBC's – Classification, Morphology, functions, WBC Count, Leucopoiesis.
 Platelets: Normal count, development, homeostasis – mechanisms, coagulation, bleeding time, coagulation time.
 Blood groups: ABO system, determination, importance, mismatch blood transfusion, Rh system.
 - 2. Respiratory System**
 Functional Anatomy: Phases of respiration – Inspiration and expiration, Mechanism
 Lung volumes and capacities – values, spirometry
 Pulmonary gas exchange – (Diffusion of gases)
 Transport of respiratory gases in blood
 O₂ dissociation curve, regulation of respiration – Chemical and neural
 - 3. Digestive System**
 Functional Anatomy – Innervation, Salivary secretion
 Gastric secretion – phases, control, Gastrin – functions
 Pancreatic secretion – functions, regulation
 Liver – functional anatomy, Bile – functions and composition
 Small intestine – secretion,
 GI motility-Deglutition, Peristalsis
 Functions of stomach, small intestine and colon.
 - 4. Cardiovascular system**
 Functional Anatomy, Conducting system and spread of cardiac impulse
 Cardiac cycle – definition, duration of phases.
 Heart sounds, Pulse – Definition, Heart rate
 ECG – Basic principle of recording, types of leads – Normal ECG
 Cardiac output – definition, one method of determination blood pressure normal values, regulation, determination of BP in man.
 Regional Circulation – coronary circulation, cutaneous circulation,
 - 5. Renal System**
 Functional anatomy of kidney, Functions of kidney
 Urine formation – processes involved
 Glomerular filtration rate – definition, measurement, factors affecting.
 Tubular functions – reabsorption of sodium, water, glucose, tubular secretion of H⁺ (Acidification of urine), Diuresis and Diuretics., Dialysis, Micturition
 - 6. Endocrinology**
 General introduction, Hormones – definition
 Endocrine glands – names, their secretions, major functions, (hypothalamus, pituitary, thyroid, parathyroid, pancreas, adrenal glands).

7. Reproductive System

Introduction Genetic basis of sex Role of hormones in sexual differentiation in foetal life.
 Male reproductive system – organs, functions of testis.
 Female reproductive system – cervical and vaginal cycles Functions of ovaries
 Fertilization, pregnancy, functions of placenta, Parturition Pregnancy test principle

8. Muscle and Nerve

Transport across cell membrane, Resting membrane potential and its bands
 Action potential – its basis, refractory period, latent period.
 Neuron – Morphology, properties
 Muscle – Types, difference between them, properties.
 Neuromuscular junction, structure, neuromuscular transmission.

9. Nervous System

Introduction, organization, functions. Synapse – definition, types, synaptic transmission and synaptic inhibition. Reflex action – definition, components, important properties, importance.
 Sensations - Types of sensations, receptors –Classification, Sensory pathways
 Thalamus - functions
 Motor system – LMN and UMN. Control of motor activity
 Cerebellum – Gross structure, functions
 Basal ganglia – functions
 Vestibular apparatus – functions
 Cerebral cortex – Gross structure importance, EEG
 Autonomic nerves system, Hypothalamus – functions
 CSF –Production, circulation, composition, functions, lumbar puncture.

10. Skin and Temperature regulation

Very briefly about mechanism of temperature regulation.

11. Special senses

Vision – Basic optics. Briefly on refractory errors
 Visual, receptors, visual pathway, perimetry
 Audition –Functional anatomy, Functions of ear, Audiometry. Olfaction, Gestation.

Practical**65 Hours**

1. Haemoglobin estimation
2. ESR determination
3. RBC count
4. WBC count
5. Differential count
6. PCV, Red cell indices.
7. Osmotic fragility test
8. Bleeding time, Clotting time
9. Blood grouping
10. Measurement of Blood pressure in man.

Text Books

1. Essentials of Medical Physiology - K. Sambulingam & Prema Sambulingam.
2. Text book of physiology for BDS students – Prof. Jain A.R.
3. Text book of physiology – choudhary
4. Text book of physiology – Ganong 5. Text book of physiology – G.K.Pal.

Paper-II
BIOCHEMISTRY –I

130 hours

- Introduction to the Chemistry of the LIVING THINGS AND CELL.
- Cell structure, cell organelles and bio membrane –structure and function , cell fraction
- Units of measurements
- Laboratory glass wares Glass - composition, properties, varieties, grades of glass wares. General laboratory wares; Glass and plastic- PVC, polycarbonate, Teflon etc.
Advantages and disadvantages of various disposable lab ware.
- Cleaning of laboratory glass wares. Preparation of cleaning solutions.
Care of laboratory wares and utensils.
- Grades of chemicals, storage and handling of chemicals and reagents.
- Laboratory safety - General principles, laboratory hazards and safety measures, universal safety precautions.
- First aid in the laboratory
- Expressing concentrations of solutions in Physical Unit and in Chemical Units
- Water the universal solvent, Ionization of Water, weak acids and weak bases, dissociation constants, buffer systems, Henderson Hasselbach equation, PH and PH meter.
- Method of measuring liquids and weighing solids, care of single pan balance, analytical balance, electrical and electronic balance.
- Calibration of pipette and other volumetric apparatus.
- Primary standard chemicals and secondary standard chemicals.
Volumetric analysis- preparation of normal solutions, percentage solutions, molal solutions, molar solutions. Preparation of standard solutions of Oxalic acid, Sodium hydroxide, Hydrochloric acid, Sulphuric acids, Silver nitrate and Potassium permanganate.

Dilution of solution. Interconversion of concentration - Normal, Molar, Molal and Percentage solution. Preparation of reagents for various biochemical analysis, chemical indicators and theory of indicators.
- Collection, preservation and processing of biological specimens for biochemical analysis, preparation and use of anticoagulants and urine preservatives.
- Preparation and storage of distilled water, double distilled and deionised water. Evaluation of water purity.
- Colorimetric analysis, spectrum of light, monochromatic light, polychromatic light, absorption and transmission of light. Principle of colorimetric analysis, selection of filters,
Colorimetry, spectrophotometry, Fluorimetry, Atomic Absorption
Spectrophotometry, nephelometry, Flame photometry etc

- Radio-Isotopes, basic principles of radioactivity, detection and measurements of radioactivity and applications .
- General laboratory equipments-Principle, use and maintenance of the following, instruments / apparatus - centrifuge, cold centrifuge, homogenizer, desiccator, vortex mixer, magnetic stirrer.
- Viscosity, surface tension, properties of colloids, emulsions, adsorption, partition coefficient and its application to biological systems.
- Osmosis, dialysis and Donnan membrane equilibrium.

CHEMISTRY OF BIOLOGICAL MOLECULES

CARBOHYDRATES :

- Classification, chemistry and properties of monosaccharide, disaccharides and polysaccharides. Stereoisomers, epimers, and reactions of monosaccharide and other carbohydrates.
- Digestion and absorption of carbohydrates.
- Mucopolysaccharides and glycoproteins.

PROTEINS

- Classification, properties and biological function,
- AMINO ACIDS Structure & properties- peptide bond, primary, secondary, tertiary and quaternary structures, sequence analysis.
- Digestion and absorption of proteins.
- Lipo proteins and nucleo proteins, structural proteins.
- Colour reactions of amino acids and proteins

LIPIDS

- Classification of lipids, chemistry and properties of fatty acids - saturated, & unsaturated fatty acids, triglycerides, phospholipids and steroids.
- Saponification number, Iodine number and rancidity. Digestion and absorption of lipids,
- Cell membrane: Structure and function – fluid Mosaic model and, transport mechanisms.

NUCLEIC ACIDS

- Chemistry of purines, pyrimidines, nucleosides, nucleotides, nucleic acids, nucleosomes. Structure of DNA and RNA.

BIOCHEMISTRY PRACTICALS**230 Hours**

- Measurements of liquids, Weighing solids
- Calibration of pipette and other volumetric glass wares
- Preparation of saturated solution and half saturated solutions
- Preparation of standard solutions, % solutions (V/V. W/V normal and molar solutions.
- Preparation of buffers: acetate ,phosphate and tris buffers and measurement of pH
- Cleaning of lab wares and laboratory utensils, preparation of cleaning fluids.
- Preparation of distilled and deionised water
- Preparation of anticoagulants and preservatives for specimen collection.
- Use and proper maintenance of
 - Analytical balance, Electronic balance, Centrifuge, Colorimeter, spectrophotometer, pH meter, Homogenizer, Desiccators
- Measurement of pH, preparation of buffers
- Titration of acids and bases, preparation of standard solution of Sodium hydroxide, Hydrochloric acid, sulphuric acid. Silver nitrate and Potassium permanganate solutions
- Reactions of carbohydrates, reactions of glucose, fructose, maltose, lactose, sucrose, dextrin, starch and glycogen.
- Reactions of Amino acids, colour reactions of albumin, globulin, casein, gelatin and peptone.
- Reactions of fatty acids and cholesterol
- Reactions of NPN substances (urea, uric acid, creatinine)

RECOMMENDED TEXT BOOKS

1. An Introduction to medical laboratory technology - Baker - P Silvertten.
2. Harper's Biochemistry - Robert K. Murray
3. Text Book of Biochemistry - Vasudevan and Sreekumari.
4. Medical Laboratory Technology - Kanai. L. Mukharjee

Paper III Basic Microbiology & Immunology 130 hours

Section – A -Basic Microbiology

- Historical review (Contributions of E.Jenner, L.Pastuer Robert Koch and postulates, Anton van Leeuwenhoek, Alexander Fleming) and scope of microbiology
 - Role of medical microbiology in diagnosis and control of infections.
 - **Sterilizations and disinfection:**
 Definitions of sterilization, disinfection, antiseptics. Classification of sterilization and disinfection.
 Different methods of sterilization: Heat, radiation, filtration, chemical methods (Emphasis should be given to each method)
 Selection of material for sterilization or disinfection
- Autoclaves :** Different types, principles, operating procedures, precautions, applications and quality control.
- Filtration :** Methods, principles, types of filter, applications
- Radiation :** Principles, methods, applications
- Chemical methods:** Factors influencing the performance of the chemical disinfectants.
- Sporicidal disinfection.
 - Different types of chemical agents used for disinfection. Emphasis should be given to its mode of action, MIC, its period of exposure, application and limitations. Quality control tests for each method, Decimal reduction time (D Value).

Testing of disinfectants- In use test, Rideal - Walker test or Chick - Martin test for the phenol co-efficient determination.

(Students should know the sterilization or disinfection of the following - floors, work benches, safety cabinets, rooms, operation theatres, skin, hospital wares, and laboratory equipments. Theatre instruments, different types of media, plastic materials, cotton materials, instruments used in surgery etc.)

- Preparation of disinfectant for laboratory use.
 - Decontamination of equipments and wastes especially in microbiology.
 - Washing, cleaning, packing and sterilization of glasses and storage of sterile articles.
 - Classification of microbes on the basis of hazards.
 - Principles of classifications of laboratory safety cabinet and its applications.
- **Incubators:** design, different models, working principles, precautions, calibration of temperature.
 Anaerobic incubators, Walk in incubator -principles and its applications.
 - **Cell morphology :** Prokaryotic and Eukaryotic cell – structure and function.

- **Morphology of bacteria.**
Anatomy of the bacterial cell. (Special emphasis should give to cell wall, capsules, flagella, plasmid, bacterial spores, spheroplasts, protoplasts, L -forms).
- **Staining**
Definition of stains. Acidophilic, Basophilic and Neutral stains.
Preparation of smears, its fixation and uses.
Principles, preparation of reagents, procedures, modification. Uses, advantages and disadvantages of the following staining methods.
 - Simple staining
 - Differential staining(Gram's staining, A.F.B. staining)
 - Negative staining
 - Fluorochrome staining
 - Staining of volutin granules
 - Staining of spirochetes
 - Special stains for spores, Capsules, Flagella.

Section- B- Immunology

- Definitions of infection, Pathogenicity, Virulence, Primary infection, nosocomial infection
- Description of different sources of infection and how they are transmitted to others.
- A brief introduction of different predisposing factors responsible for bacterial infection.
- Structure and function of Immune system
- An introduction to immunity and immune system, classification of immunity
- Descriptive study of Innate immunity and its determinants
- A descriptive study of Acquired Immunity
- Classification of Acquired Immunity with its detailed description
- Immune responses
- Principles of cell mediated and humoral immunity
- Discussion on cellular immune responses (more emphasis should be given for lymphokines or cytokines, TNF, Interferon)
- Lymphocytes subsets and its functions, Natural killer cells.
- Antigens and their properties, Super Antigens, Hetrophile Antigens.
- Immunoglobulin and their structure and functions.
- Monoclonal antibody
- Major Histocompatibility complex – a brief description of gene organization, structure and its functions, transplantation.
- A brief description of complement and its properties
- Activation and regulation of complement path ways.
- Biological effects of complement
- A brief introduction of Immunodeficiency disease and Hypersensitivity reactions.
- Discussion on Auto immunity.
- A detailed study of Vaccines & adjuvants.

- Descriptive study of *Antigen-antibody reactions* – Precipitation, Agglutination, Complement fixation, Neutralization, ELISA, RIA, IF, (more emphasis should be given to ELISA, IF, Counter current immunoelectrophoresis)

PRACTICALS

230 Hours

- Introduction and demonstration of Laboratory Equipments used in Microbiology.
- Cleaning of new and used glass wares for microbiological purposes. Students should be familiar to use autoclave, hot air oven, water bath, steamer etc.
- Demonstration of different types of physical methods of sterilization
- Sterilization of heat labile fluids, glass wares, liquids, plastic and other laboratory and hospital wares.
- Demonstration of different methods of disinfection
- Students should be familiar to use different types of filters and its decontamination.
- Rideal - Walker test or chick - Martin test for the phenol co-efficient determination.
- Test for minimum inhibitory concentration of at least 2 commercially available disinfectants, In use test
- Students should prepare the working dilutions of common disinfectant.
- Decontamination of wastes and carcasses - method
- Students should be thorough to work with light microscope
- Study of the morphological characters of bacteria
- Detection of motility *- Hanging drop examinations with motile bacteria, non motile bacteria. Method by using semi solid medium.
- Preparation and examination of wet films*. Direct microscopic examination of wet film Preparation of smear, fixation and staining of bacterial smears and its quality control methods
- Simple staining methods* – Pure culture, mixed culture
- Gram's staining and any one modification* – Pure culture - Mixed culture
- A.F.B. staining and its modification *- Normal smear, AFB positive smear Fluorochrome staining and its demonstration
- Special staining technique for the demonstration of bacterial capsule(any two methods)
- Special staining technique for the demonstration of spores (any one method)
- Special staining technique for the demonstration of Flagella (Any one method)
- Special staining technique for the demonstration of volutin granules
- Preparation of stains and reagents used for the above staining technique. Quality control testing for the stains.

(More emphasis should be given and the students should be thorough with these marked techniques)*

RECOMMENDED BOOKS

1. Mackie & Macartney practical medical Microbiology - Collee. Fraser, Marmion, Simmons
2. Medical Laboratory Manual for Tropical Countries Vol-1 & Vol - 2 Monica Cheesbrough
3. Text Book of Microbiology : Baveja
4. Essential Immunology - Roitt
5. Text Book of Microbiology -Ananthanarayanan & Jayaram Panikker

REFERENCE BOOKS

1. Medical Microbiology - David green Wood, Slack Pentherer
2. Topley and Wilson's Microbiology and Microbial infections 9th edi: Leslie Collier, Albert Balow Vol – 2 Systematic Bacteriology
3. Medical Laboratory Technology – Kanai. L. Mukherjee.
4. Sterilization and Disinfection – G. Sykes
5. Sterilization and Disinfection – Black.
6. Bailey and Scott's Diagnostic Microbiology : Forbes Sahn, Weissfeld
7. Foundations in Microbiology -Talaro, Taloro
8. Microbiology an Introduction – Tortora, Funke, Case.
9. Microbiology – Prescott Harly Klein.
10. Laboratory Experiments in Microbiology – Johson Case.
11. Microbiology in practice - Lois Beisheir.
12. Microbiology – A Laboratory Manual.- Cappuccino, Sherman
13. Microbiology – Pelczar, Chan, Krieg.
14. Introductory Immunology - Davie
15. Fundamental Immunology - Paul
16. Basic & Clinical Immunology - Daniel P. Stites.

Paper IV Basic Medical Laboratory Science and Haematology-I 130hours

Medical Laboratory Science and Ethics.

- Role of Laboratory in Health care delivery
- Care of laboratory wares, equipments and chemicals: general principles.
- Glass – composition, properties, varieties, grades of glass wares.
- Making simple glass wares in the laboratory – glass blowing techniques
- Common laboratory wares – PVC, polycarbonate, plastic.
- Advantages and disadvantages of various disposable lab ware.
- Cleaning of laboratory wares. Preparation of cleaning solutions. Care of laboratory wares and utensils.
- Laboratory safety – General principles, laboratory hazards and safety measures, universal safety precautions.
- Biomedical waste management.
- First aids
- Ethics: General principles, special considerations laboratory policy for procedures, types of test and research and recent developments

Microscopes

- History and development of microscopes.
- A brief review of light microscopes, its image formation, numerical aperture & resolution, magnification.
- Different types of objectives, eye piece, condensers and illuminations, their applications.
- Methods of use of microscopes for the demonstration of wet films and dry preparations.
- Care and safe use of microscopes.
- Classification of microscopes.
 - Bright field monocular & binocular microscopes.
 - Phase contrast microscope.
 - Dark ground microscope.
 - Fluorescent microscope.
 - Electron microscope.
 - Principles, methods of safe working, different parts, use, preparation of smears for its examinations and application of the above microscopes.
- Micrometry – Light microscopic micrometry, Photographic micrometry and electron microscopic micrometer.

Haematology-I

- Origin, development, maturation, function and fate of blood cells.
- Capillary and Venous blood. Methods of blood collection.
- Various anticoagulants, their functions, uses, advantages and disadvantages.
- Principles of staining, Romanowsky stains, preparations and staining properties of various Romanowsky stains with emphasis to Leishman's stain. Preparation and use of Buffer solutions in staining.
- Preparation of Blood smears. Thin smear, thick smear, wet preparations and buffy coat preparation.
- Leishman staining,
- Different Leucocyte count in Blood smear with recognition of abnormal blood cells.
- Collection of bone marrow and Preparation of Bone marrow smears, Morphologic study of Marrow films and its differential count. Indications of Bonemarrow aspiration.
- Different types of Haemocytometers, their ruling
- Total count of RBCs, WBC (with correction of NRBC), Eosinophils and platelets. Micropipette methods and Bulk dilution technique, their advantages and disadvantages. Composition, function, preparation and storage of various diluting fluid. Errors in sampling, mixing, diluting and counting, Quality control methods in cell counts.
- Automatic Blood cell counters.
- Haemoglobin and Estimation of Haemoglobin – Principles, techniques, advantages and disadvantages of different methods. Normal and abnormal values. Errors and quality control in various methods.
- Abnormal Heamoglobin Method of identification of abnormal Haemoglobin. Sickling phenomenon. Hb-F and its demonstration.
- Principles and different methods of determining ESR and PCV. Advantages and disadvantages of each method. Clinical significance of ESR and PCV, Normal values.
- Methods of determination of Red Cell Indices (MCV, MCH, MCHC and Colour Indices) and its significance.
- Supravital staining technique – Principles and uses, Demonstration and counting of Reticulocytes. Composition and preparation of Brilliant Cresyl Blue and New methylene blue stains.

Practical

- Care and use of light microscope
- capillary and venous blood collection
- Preparation of anticoagulated bottle
- Preparation of Romanowsky staining solutions
- Preparation of diluting fluids for cell counts.
- Preparation of thick and thin smears and their staining
- Haemoglobin estimation- cyanmethaemoglobin method and Sahli's method

- ESR determination
- RBC count
- WBC count
- Differential count
- Platelet count
- Absolute eosinophil count
- Reticulocyte count
- PCV, Red cell indices.
- Osmotic fragility test

Reference Books

1. Laboratory acquired infections – C.H. Collins.
2. Clinical Diagnosis and Management by Laboratory methods – Todd, Sandford, Davidson
3. Manual of clinical laboratory methods-Copal.E.Hopier
4. Medical laboratory methods-Dr.Ramnik sood
5. Clinical laboratory methods-Beuer.
6. Introduction to Medical laboratory technology-Baker
7. Practical haematology- Dacie and Lewis

SECOND YEAR

PAPER V BIOCHEMISTRY – II

90 hours

1. CARBOHYDRATE METABOLISM:

- Glycolysis, Cori's Cycle, Oxidation of pyruvates. Citric Acid Cycle, Hexose Mono Phosphate Shunt Pathway, Glucuronic acid Pathway, Gluconeogenesis, Glycogenolysis, Regulation of Glycogen Metabolism, Fructose Metabolism, Galactose Metabolism, Glyoxlate Cycle, Hormonal regulation of Blood Glucose,
- Hyperglycemia & Diabetes Mellitus, Diabetic Ketoacidosis, Glycosuria,
- Hypoglycemia, Pentosuria, fructosuria, galactosemia & Glycosycated Hemoglobin.
- Investigation of disorders of carbohydrate metabolism: glucose, Glucose tolerance tests & other tolerance tests

2. METABOLISM OF PROTEINS & AMINO ACIDS :

- Catabolism of Amino Acids, Formation of Ammonia, Transamination and Oxidative deamination. Urea Cycle.
- Formation of Creatine and Creatinine. One Carbon Metabolism, Conversion of amino acids to specialized products.
- Principles and methods for the estimation of Urea, creatine, creatinine ,Total protein and Albumin

3. METABOLISM OF LIPIDS :

- Oxidation of fatty acids, Biosynthesis of fatty acids, Ketogenesis.
- Biosynthesis of Triglycerides, Phospholipids & Sphingolipids
- Biosynthesis of cholesterol & Bile Acids,
- Plasma Lipoproteins, Apolipoproteins & Lipoprotein metabolism
- Obesity, Fatty Liver, Lipotropic factors and ketosis
- PUFA , Lipid per oxidation & Eicosanoids-Prostaglandins & Leukotrienes .
- Lipid and Lipoprotein measurements- blood sampling and storage, Estimation of lipids-Cholesterol, Triglycerides, Phospholipids & lipoproteins- Colorimetric and enzymatic methods

4. Inter – relation between the metabolism of Carbohydrate, lipids and proteins,

- Generation of ATP, substrate level phosphorylation & Oxidative phosphorylation
- Brief out line of Electron transport chain

5. NUCLEIC ACID METABOLISM :

- Biosynthesis of Purine and Pyrimidine nucleotides, denovo and salvage pathway, Degradation of purine and pyrimidine nucleotides.
- Principles & methods for the estimation of Uric acid

6. COMMON INBORN ERRORS OF METABOLISM :

- Disorders of Carbohydrates metabolism - Glycogen storage diseases, galactosemia, fructose & Lactose intolerance.
- Disorders of lipid metabolism-DYSLIPOPROTEINEMIA- Hypolipoproteinemia, Hyper lipo proteinemia , Atherosclerosis and sphingolipidosis.
- Disorders of Amino Acid metabolism, Cystinuria, Homocystinuria, Cystathionuria, Phenyl ketonuria, Alkaptonuria, Albinism. Maple Syrup Urine diseases, Hartnups's diseases.
- Disorders of Nucleic acid metabolism - Gout, Lesch-Nyhan Syndrome, Orotic aciduria.
- Laboratory diagnosis of Inborn errors of metabolism

7. VITAMINS AND CO-ENZYMES :

- Vitamins- water soluble-Chemistry, sources, RDA, Biochemical role ,Deficiency and assay
- Vitamins Fat soluble-chemistry, sources, RDA, biochemical role, Deficiency, toxicity and assay
- Estimation of Vitamin A, C, E and B.

8. NUTRITION :

- Nutritional importance and Calorific value of food- BMR
- Protein energy malnutrition- Kwashiorkor and Marasmus.

9. URINE :

- Composition of normal and abnormal constituents.
- Routine examination of Urine, Specific gravity, reactions, detection of protein, reducing sugar, ketone bodies, bile pigment, bile salts, Urobilinogen and blood in Urine.
- Urinary screening for Metabolic inherited diseases

10. C.S.F AND OTHER BODY FLUIDS:

- Physical and chemical examinations. Estimation of sugar, protein and chloride.
- Composition and Chemical analysis of Synovial, Pleural, Peritoneal, Pericardial, Amniotic fluid etc.
- Estimation of sugar, protein and chloride in CSF

11. Common Laboratory methods, estimation and its interpretation of Glucose, protein, Cholesterol (total & HDL), Uric Acid, Creatine, Creatinine, Urea, Triglyceride, phospholipids, Total lipids, Glycosylated Haemoglobin and tests for inborn errors of Amino acid metabolism

PRACTICAL - BIOCHEMISTRY – II**174 HOURS**

1. Estimation and standardization of Blood/Serum/Plasma constituents glucose, Uream Total protein, Albumin, Cholesterol, Triglyceride, Phospholipids, total lipid - Uric Acid, Creatine, Creatinine, Ammonia, Non-protein nitrogen, Amino Acid Nitrogen.
2. Qualitative detection of normal and abnormal constituents of Urine.
3. Quatitative analysis for Urine protein, Bence-Jone's protein, Reducing sugars and chloride in Urine, Urea, Creatinine, Uric Acid, Aminoacids, Ammonia, Keto acids in Urine.
4. Estimation of sugar, protein and chloride from C.S.F., plural fluid, peritoneal fluid, amniotic fluid - foam test.
5. Glucose tolerance test and GCT.
6. Estimation of Kotone bodies in blood and urine.
7. Estimation of Glycosylycated HB.
8. Estimation of Vitamin A,C,E and Metabolites of Vitamins in Urine (B complex)
9. Tests for inborn errors of Amino Acid metabolism in Urine.

RECOMMENDED TEXT BOOKS:

1. Harper's Biochemistry : R. K. Murray and Grannon
2. Test book of Biochemistry : Vasudevan and Sreekumari
3. Practical – Clinical Biochemistry - Volume 1 : Harold Yarkey
4. Clinical Biochemistry - Principles and Practice : Praful B. Godkar.
5. Clinical Laboratory methods and diagnosis : Gradwohl.

REFERENCE BOOKS :

1. Principles of Biochemistry : Lehniger
2. Biochemistry : Luberrt Strayer
3. Text Bood of Clinical Chemistry : Novert W. Teitz
4. Biochemistry with Clinical Correlation : Devlin.
5. Internal Medicine : Harrison.
6. Clinical Diagnosis and Management by laboratory methods : John Bernard Henry

Paper VI**GENERAL MICROBIOLOGY****90 Hours**

- Classification and taxonomy of Micro organisms.
- Bacterial growth and Nutrition – Batch culture, Continuous culture, and growth curve, total count and viable count.
- A brief description on microbial metabolism, catabolism, respiration and Anabolism.

NUTRIENTS FOR MICROBIAL GROWTH

- Physical conditions required for bacterial growth- Oxygen, CO₂, Temperature, water, pH, Light, osmotic pressure.
- Major requirements and common ingredients of culture media.
- Media for microbial growth – classification of media- Routine laboratory media like
- Basal - Peptone water, Nutrient broth, Nutrient agar
- Enriched - Blood agar, Chocolate agar, R.C.M
- Enrichment- Alk- Peptone Water, Selenite F broth
- Selective - MaC conkey agar, XLD, DCA, TCBSA, L.J.medium, Telurite blood agar
- Differential - MaC conkey agar, CLED.
- Transport media, Anaerobic media.
- Principles and method of preparation, pH adjustments- different methods, sterilization, storage of different types of media.
- Quality control in media preparation.
- Cultivation of Bacteria – Equipments and devices used in the cultivation bacteria.
- Inoculation methods, incubation methods, Inoculation on different types of culture media in Petri dish, Slopes, Butt, Broths.
- Incubation methods
- Morphological study of bacterial colonies on plated media.
- Growth characteristics of bacteria on liquid media.
- Anaerobic culture methods with recent advance.
-

Quantitation of Microorganisms

- Quantitation of micro organism by using photoelectric colorimeter and spectrophotometer.
- A brief description methods of measuring bacterial growth by determining its dry weight, wet weight, Total nitrogen concentration.
- Preparation of Mc Farland standard and its interpretation / Simple opacity tubes.

Typing methods

- Bacteriophage and Bacteriophage typing method.
- Bacteriocin and Bacteriocin typing.

Biochemical Tests

- Tests for identification of bacteria, detailed study of the principle, preparation of media, reagents used different methods, interpretation and quality control for the following identification tests.
- Tests for the metabolism of Carbohydrates- OF test, simple sugar media, TSI/KIA, citrate utilization, MR, VP tests
- Tests for the metabolism of proteins and Amino acids- Indole, PPA, Gelatin liquefaction, Amino acid metabolism test
- Tests for enzymes. - Catalase, Urease, Nitrate reductase, Coagulase, and Oxidase.
- Tests for the metabolism of fat.
- Rapid identification tests.

BACTERIAL GENETICS

- General Principles of Bacterial Genetics
- Genetic Organization and Regulation of the Bacterial cell
- Genotypic Phenotypic variation, Operon model of gene expression
- Mutation - Types of mutation, Mutagens, Isolation of mutants
- Gene transfer – Transformation, Conjugation, Transduction
- Plasmids & Transposons.

CARE AND MANAGEMENT OF LABORATORY ANIMALS

- A Basic knowledge of the feeding, housing, breeding and care of the following animals -rabbit, rat, mouse, guinea pig.
- Handling and care of normal and infected animals in the laboratory and in the animal house.
- Collection of blood samples
- Killing of animals and post- mortem examination
- Different routes of animal inoculations: scarification, subcutaneous injections, intravenous inoculation, intraperitoneal inoculations, intramuscular inoculations, intracerebral, intratesticular inoculation.
- Animal House records
- Disposal of dead animals

PRACTICALS**174 Hours**

- Preparation and use of pH indicator solutions
- Preparation of Reagents used for pH adjustments
- Adjustments of pH for Acidic medium and alkaline medium by using Lovibond Comparator
- Cleaning and preparation of glassware for media preparation and sterilization
- Preparation of sterile Saline.
- Students should be familiar to prepare the commonly used laboratory media and also they should know its sterilization, Quality control and storage.
Peptone water, Nutrient broth, Nutrient agar, Blood agar, Chocolate agar, R.C.M , Alk. Peptone Water, Selenite F broth, MaC conkey agar, XLD, TCBSA, L.J.medium, Transport medium (anyone) and other Media routinely used for the isolation for medically important bacteria.
- Preparation and standardization of bacterial loop.
- Inoculation methods on plate media, liquid media and slope media
- Inoculation and isolation of pure and mixed bacterial culture
- Study of colony characters on different media.
- Viable count of bacteria from a culture. Preparation of standard opacity tubes.
- Aerobic and Anaerobic incubation technique
- Preparation, Sterilization, Quality control, Inoculation and use of Biochemical media and its reagents used in bacteriology.
- Preparation of Reagents like methyl red indicator, V.P.Reagent, Nitrate reagents, Ferric Chloride. ONPG, H₂O₂, Oxidase reagent, Kovac's reagent, Ehrlich's reagent.
- Inoculation, methods and Quality control in different Biochemical media.
- Anaerobic cultivation methods - Anaerobic jar - Other methods-Quality control
- Students should visit an Animal house and observe the organization and management of animal houses and its stock. Also they should observe the management of animals on experiments, safe handling of laboratory animals like Rabbit, Rat, Mouse, Guinea Pig.

RECOMMENDED BOOKS

1. Mackie & McCartney practical medical Microbiology - Colle. Fraser, Marmion, Simmons
2. Medical Laboratory Manual for Tropical Countries Vol - 2 Monica Cheesbrough

REFERENCE BOOKS

1. Medical Microbiology - David green Wood, Slack Pentherer
2. Topley and Wilson's Microbiology and Microbial infections 9th edi: Leslie Collier, Albert Balow Vol – 2 Systematic Bacteriology
3. Cowan & Steel's Manual for the Identification of Medical Bacteria – G.I Barron, K.K.A. Feltham.

Paper - VII**PARASITOLOGY & ENTOMOLOGY****90 hours****Section-A-Parasitology****45 hours**

- An elementary study of the types of animal associations, parasitism commensalism and Symbiosis.
- Types of Parasites. Classification of protozoa & Helminthes.
- An elementary knowledge of the structure, life history of parasites belonging to the following genera with reference to the forms seen in human pathological material and the methods used to identify them.
 - a. **Protozoa** : Entamoeba, Dientamoeba, Iodamoeba, Trichomonas, Trypanosome, Leishmania, Giardia, Plasmodium, Isospora, Balantidium, Toxoplasma, Pneumocystis carinii, Cryptosporidium.
 - b. **Platyhelminthes** : Diphyllbothrium, sparganum, Taenia, Echinococcus, Hymenolepis, Schistosoma, Fasciola, Fasciolopsis, Clonorchis, Paragonimus
 - c. **Nemathelminthes** : Ascaris, Ancylostoma, Necator, Strongyloides, Trichinella, Enterobius, Trichuris, Filaria.
- **Collection, preservation and transport of specimens** for parasitological examination, preservation of specimens of parasite eggs or embryos, preserving fluids.
- **Detection of Intestinal parasites** : Detection and identification of amoeba and other intestinal protozoa and other parasites.
- **Detection of Blood parasites** : Detection and identification of Malaria, Microfilaria and other blood parasites.
- **Examination of biopsy material and other body fluids:** Brief account of spleen puncture for diagnosis of kala-azar, bone marrow biopsy, lymph node, and skin biopsy for parasites.
- Examination of urine for parasites.

Practical**87 Hours**

- Identification of parasites of Medical importance dealt in the theory
- Macroscopic and microscopic examination of stool for adult worms, ova, cysts, larvae.
- Concentration techniques for intestinal parasites in stool.
- Collection of blood and preparation of thick & thin smears.
- Staining of blood smears for blood parasites
- Examination of blood smears for malaria & microfilaria and their identification.

Section- B- Entomology 45 hours

Introduction. Classification of Arthropods of public health importance.

- Role of Arthropods in the transmission of diseases.
- Mosquito: Morphology, Lifecycle, Bionomics and public health importance of anopheles, Culex, Aedes and Mansonia.
- Mosquito Control: Various methods. Mosquito – borne diseases and their control.
- Phlebotomes (Sand fly): Morphology, Life cycle, public health importance and control.
- House Fly: Morphology, life cycle and public Health importance.
- Black Fly (Simulium) morphology, life cycle, public health importance and control.
- Fleas : Morphology, life cycle disease transmitted and control
- Louse: Morphology, lifecycle, disease transmitted and control.
- Bedbug: Morphology, Lifecycle, disease transmitted and control.
- Ticks: Morphology, Lifecycle, disease transmitted and control.
- Trombiculid: Morphology, Lifecycle, disease relationship and control.
- Sarcoptes scabiei: morphology, life cycle, Public Health Importance and control.
- Cyclopes: Morphology, Public Health importance and control.
- Insecticides used for the control of Arthropods of Public Health Importance, Classification, Insecticide, resistance, Bioassay test

Practical

87 Hours

- Identification of arthropods of Medical importance dealt in the theory.
- Identification up to genera of common vectors of Malaria, Filariasis, Japanese Encephalitis and Dengue.
- Collection and preservation of arthropods of public health importance.
- Preparation of permanent mounts of arthropods of public health importance.
(Minimum 10 slides)
- Dissection of Mosquitoes to display mouth parts, wings, and legs.

Books recommended:

1. Medical parasitology: N.C.Dey
2. A guide to medical entomology: W W Service
3. Entomology in human and animal health: Harwood and Maurice T James
4. Text book of Medical parasitology- KD.Chatterjee
5. Medical Laboratory Manual for Tropical Countries Vol-1 Monica Cheesbrough
6. Text Book of Parasitology- Jayaram Panickar

Paper VIII Haematology-II and Clinical Pathology 90 hours

Section- A- Haematology-II

- Morphology of Red cells in Health and diseases.
- Systematic methods of examination of Blood Film (Blood picture) and Reporting.
- Definition, classification and etiology of anaemia.
- Disorders of structure and synthesis of Haemoglobin.
- Principle, method and significance of Ham's test.
- Laboratory diagnosis of various types of anaemia, Polycythaemia, Polycythaemia vera Leucocytosis, Leucopenia, Eosinophilia, Neutrophilia, Basophilia, Lymphocytosis, Monocytosis, Agranulocytosis
- Infectious mononucleosis.
- Definition and classification of Leukaemia,
- Blood and Bone marrow findings in Acute Myeloid Leukaemia (AML) Acute Lymphatic (ALL) Chronic Myeloid Leukaemia (CML), Chronic lymphatic Leukaemia (CLL), Leukaemoid Blood Reactions.
- Multiple myeloma.
- Cytochemistry – Peroxidase, PAS, LAP, esterase.
- Perl's Staining and its significance.
- Identification of parasites (Malaria, Microfilaria, L.D. bodies and Trypanosomes) in Blood and Bone marrow films.
- General introduction to Bone marrow transplantation techniques.
- LE phenomenon and demonstration of LE cell, Principle
- Coagulation factors, mechanism of blood coagulation, Fibrinolytic system, Disorders of coagulations.
- Laboratory methods used in the investigation of haemostasis:- Clotting time, Bleeding time, Partial Thromboplastin time, Plasma prothrombin time, INR. Thromboplastin generation time, Prothrombin consumption time, Thrombin time, Test for fibrinogen degradation product. Test for fibrinolysis. Assay of plasma fibrinogen.
- Haemophilia and its laboratory parameters.
- Disorders of Platelets and Blood vessels.
- Platelet function test.
- Automation and Recent advance in Haematological Techniques.

Section-B- Clinical Pathology

Urine

- Microscopical examination of urine, collection of urine and its preservation, Colour, cloudiness, specific gravity, reaction, pH
- Different methods for detection, importance and its interpretation of – Protein, Sugar, Bile pigment, Bile salt, Urobilinogen, ketone bodies, Bence-Johnes proteins & Blood
- Examination and identification of sediment for: various cells, crystals, casts, parasites.
- Concentration methods for examination identification of urine sediment for: Gonococci, Trichomonas vaginalis, monilia.
- Pregnancy test-Production of HCG, HCG level at various stages of pregnancy, pregnancy test, Different types of pregnancy test such as Gravindex test & card test. Method of urine collection, Compare their advantage, disadvantages & accuracy.

Faeces

- Examination of motion sample for: colour, mucous, consistency, ova, Amoeba, cyst, Parasites, Pus cells, RBCs & crystals.
- Detection of occult blood in stool, measurement of faecal urobilinogen & faecal fat, their importance interpretations.

Sputum

- Method for the collection, examination of sputum for AFB, sputum in disease conditions.

Semen

- Methods of collection, Macroscopic and microscopic examination of semen, Motility, count, other findings.
- Staining and morphological studies of spermatozoa, importance & interpretation in each step of investigation in case of infertility.

CSF

- Collection, transport, preservation, examination and interpretation total and differential count, staining methods, CSF in disease.

Other body fluids

- Examination of Ascitic fluid, Pleural fluid, Pericardial fluid, Synovial fluid.

Practical**174 Hours**

- Peripheral blood smear examination and reporting
- Haemoglobin electrophoresis
- Blood cell cytochemistry- Peroxidase, PAS, LAP, Esterase
- Perl's stain
- Osmotic fragility test
- Sickling tests
- LE cell demonstration
- Bleeding Time, Clotting Time, PT and APTT, clot retraction test, fibrinolysis test
- Ham's test
- Serum electrophoresis of myeloma proteins.
- Familiarisation of automation in Haematology
- Urine analysis, pregnancy test
- Examination of feces, detection of occult blood in stool, fecal urobilinogen and fecal fat detection
- Semen analysis
- Examination of CSF
- Examination of body fluids
- Examination of sputum

Books recommended for reference

1. Lynch's Medical Laboratory Technology - Raphael
2. Gradworl clinical laboratory methods & diagnosis
3. Medical laboratory technology and clinical pathology- Lynch, Raphael, Meller
4. Manual of clinical laboratory methods- Copal.E. Hopier
5. Medical laboratory methods- Dr. Ramnik sood
6. Clinical laboratory methods- Beuer.
7. Introduction to Medical laboratory technology- Baker
8. Clinical pathology and bacteriology- Sachdev
9. Clinical pathology- Batra.
10. Hand book of routine urine analysis- Graft
11. Practical haematology- Dacie and Lewis.

THIRD YEAR

Paper IX Biochemistry-III

Theory: 96 Hrs

1. ENZYMES: Classification, Co-enzymes, Co factors, Mechanism of enzyme action, factors affecting in Enzyme action, Enzyme Kinetics, Michaelis Menton constant, Enzyme Inhibition, Regulatory enzymes, Immobilization of enzymes.

Clinical Enzymology

- Enzyme activity determinations-End point assay and Kinetic assay.
- Principles & Methods for the estimation of Phosphatases, Transaminases, Amylase, lipase, Lactate dehydrogenase, Creatine kinase, Ceruloplasmin, Glucose 6 phosphate dehydrogenase, Aldolase, 5'-Nucleotidase, Leucine Amino peptidase, Gamma glutamyl transpeptidase, Cholin esterase, Enolase, Isocitrate dehydrogenase
- Isoenzymes in Diagnostic Biochemistry.
- Plasma enzyme pattern in diseases- MI, Liver disease, Muscle disease etc

2. HAEMOGLOBIN

- Chemistry and properties of Haemoglobin and myoglobin, Chemistry of respiration, Transport of gases. Oxygen dissociation curve, Isohydric transport of Carbodioxide, Biosynthesis of Haemoglobin, Catabolism of Haem,
- Bile pigments- Bilirubin and related chromoproteins.
- Haemoglobin derivatives, Haemoglobin variants, Jaundice
- Principles & Methods for the estimation of Direct and total Bilirubin, Urobilinogen and urobilin.

3. PORPHYRINS

- Porphyrins and disorders of porphyrin metabolism.
- Chemistry of porphyrins
- Porphyrins: primary and secondary porphyrias and its analytical procedures.
- Methods for the estimation porphyrias and its precursors in urine.

4. Analytical Calculi- Urinary & Biliary calculi.

5 ELECTROPHORESIS

- Theory of electrophoresis, General methods of Electrophoresis- paper, gel, disc and Immunoelectrophoresis, isoelectric focussing.
- Electrophoresis of Serum protein and its interpretations
- Electrophoresis of Haemoglobin and its interpretations.

6. CHROMATOGRAPHY

- Principles and application of Chromatography, Forms of chromatography- absorption, ionexchange, gel, paper, thin layer, HPLC and gas liquid chromatography.
- Chromatography of Aminoacid , Aminogram and chromatography of sugars & lipids.
- Aminoacidurias.

7. IMMUNOLOGICAL METHODS & RELATED TECHNIQUES

- Antigen- Antibody reactions. Immunodiffusions (ID), Immuno electrophoresis, Radioimmunoassay (RIA), ELISA and Fluorescent immunoassay(FIA)
- Receptor assays

PRATICAL

1. Estimation of Clinically important enzymes- Alkaline Phosphates , Acid phosphates, Alanine amino transferase , Aspartate aminotransferase, Amylase, Ceruloplasmin, LDH, CPK and G6 PD
2. Testing and semiquantitative assesment of urobilinogen in urine estimation of urobilin in urine, Estimation of porphyrin and porphobilonogen
3. Estimation of bilirubin - direct and total.
4. Qualitative analysis of Urinary calculi.
5. Estimation of Haemoglobin, myoglobin and abnormal haemoglobins- Hb electrophoresis
6. Identification of substances by column chromatography, Thin layer chromatography, paper chromatography, amino acids (Amino gram) and sugars.
7. Technique of paper electrophoresis, agar gel electrophoresis of serum proteins, Polyacrylamide gel electrophoresis of serum proteins & LDH .
8. Clearance tests - Creatinine and Urea clearance
9. Technique of RIA (T3, T4 and TSH) and ELISA.

Recommended text books

1. Text book of Biochemistry- DM.Vasudevan and Sree kumari. S
2. Practical Clinical Biochemistry- Harold varley
3. Practical biochemistry - Wilson and walker

Reference books

1. Principles of Biochemistry –Lehninger, 2.Biochemistry- Lubert stryer, 3. Text book of Clinical chemistry- Teitz, 4. Clinical chemistry – Kaplan, 5. Clinical chemistry –Marshal

Paper X BACTERIOLOGY Theory : 96 hrs

SYSTEMIC BACTERIOLOGY

Detailed Systematic and diagnostic study of bacteria (emphasis should be given for medically important, pathogenic and related organism). A detailed study of general characters, classification, different pathogenic species, non-pathogenic (brief account only), morphology, staining characters, cultural characteristic in different culture media, susceptible to physical and chemical agents, biochemical reactions, antigenic properties, special tests for identification of species, epidemiology, specimens and its collection, lab diagnosis, antibiotic sensitivity of the following bacteria.

- Staphylococcus, Streptococcus, Pneumococcus, Anaerobic cocci, Neisseria species,
- Listeria, Bacillus, Clostridium, Pseudomonas, Legionella, Nonfermenting gram negative rods, Bordetella, Brucella, Haemophilus, Pasteurella,
- Enterobacteriaceae (brief introduction of all the genus and detailed study for the medically important genus such as Escherichia, Klebsiella, Serretia, Enterobacter, Citrobacter, Proteus, Morganella, Providencia, Salmonella, Shigella, Yersinia),
- Mycobacteria.
- Actinomyces, Nocardia.
- Vibrio, Aeromonas
- Campylobacter, Helicobacter,
- Bacteriodes, Chlamydia, Rickettsiae, Mycoplasma,
- Preservation of bacteria.
- Normal flora in a healthy human body.

DIAGNOSTIC BACTERIOLOGY

Specimen processing

- Collection, preservation, transport and processing of clinical specimens for the diagnosis of bacterial infections.- Urine, Pus, CSF, Blood, Stool, Rectal swab, Body fluids, Exudates, Sputum, Throat swab, Eye specimens, Ear specimens, Tissues, Skin specimens.

Antibiotic susceptibility tests

- Basic knowledge of various antimicrobial agents and their action on microbes.
- Detailed study of different methods of antibiotic susceptibility tests, media used, preparation of antibiotic disc, selection of drugs, quality control drug resistance, beta lactamase detection, antibiotic assay in blood and body fluids.

Bacterial infections and clinical syndromes.

Detailed study of multiple etiology involving microorganisms and their laboratory diagnosis for the following clinical syndromes.

- Pyrexia of unknown origin, Enteric fever.
- Upper and lower respiratory tract infections, plueropulmonary and bronchial infections, Tuberculosis.
- Urinary tract infections.
- Sexually transmitted diseases.
- Gastrointestinal infections, food poisoning, peritonitis.
- Infections in central nervous system – meningitis.
- Skin and soft tissue infections.
- Eye infections.

Students should know lab diagnosis of the following clinical conditions

- Brucellosis, Q fever, Gas gangrene, Diphtheria, Rat bite fever, Relapsing fever, Rheumatic fever, Plague, Leptospirosis, Anthrax, Leprosy.
- Bacterial infections in the immunocompromised patient.

Bacterial Serology

Students should know in detailed the serodiagnosis of bacterial infections such as:

- Enteric fever – Widal test
- Syphilis – STS- VDRL Test, RPR, Treponemal tests-TPHA, TPI, FTA-ABS
- Streptococcal infections- ASO Test, Anti DNAase B, Antihyaluronidase test
- Brucellosis
- Rickettsial fever
- Primary atypical pneumonia.

(An illustrative knowledge of collection of specimens, preservation, principles, preparation of antigens, methods, and interpretation).

Practical

174 Hours

Identification of medically important bacteria from pure culture.

- Staphylococcus.
- Streptococcus.
- Meningococcus, Gonococcus.
- Escherichia , Klebsiella, Serretia, Proteus, Salmonella, Shigella.
- Psuedomonas, Acinetobactor.
- Vibrio.
- Haemophilus.

- Students should be familiar with the collection, transportation and processing of all type of clinical specimens for the diagnosis of bacterial infections discussed in theory.
- Different methods & interpretation of antibiotic sensitivity tests.
- Isolation and identification of Mycobacterium tuberculosis from clinical specimens. Preparation of smear, staining, culture and reporting, concentration technique for the diagnosis of tuberculosis.
- Examination of specimens from patient for the diagnosis of leprosy.

Bacterial Serology

- Antigen preparation and standardization for Widal test. Widal test technique and interpretations
- VDRL Test, RPR, TPHA
- ASO Test
- Brucella agglutination test.

Recommended Books

1. Medical Microbiology - David green Wood, Slack Pentherer
2. Mackie & Macartney practical medical Microbiology - Colle. Fraser, Marmion, Simmons
3. Text Book of Microbiology : Ananthanarayanan & Jayaram Paniker
4. Medical Laboratory Manual for Tropical Countries Vol-2 Monica Cheesbrough.
5. Bailey and Scott's Diagnostic Microbiology :Forbes Sahm, Weissfeld

REFERENCE BOOKS

1. Topley and Wilson's Microbiology and Microbial infections 9th edi: Leslie Collier, Albert Balow Vol – 3 Bacterial Infections
2. Medical Bacteriology - C. H. Collins
3. Principles and Practice of Infectious diseases – Mandell, Bennett, Dolin Vol- 1 &
4. Colour Atlas and Text book of Diagnostic Microbiology Koneman & Allan Janda
5. Basic Laboratory Procedure in clinical Bacteriology WHO, Geneva.
6. Gradwohl's Clinical Laboratory Methods and diagnosis Vol – 2- Alex. C.Sonne.
7. Medical Microbiology – Murray, Kobayashi.
8. Medical Microbiology – Mims, Play fair, Roitt.
9. Microbiology and Infection – Inglis.
10. Microbiology Pelczar, Chan, Krieg.

Paper XI - CYTOLOGY & TRANSFUSION TECHNOLOGY - 96 hours

Section – CYTOLOGY

- History, development and scope of cytology.
- Cell structure, function, cell cycle, division with recent advances.
- Cytology of epithelial and connective tissues.
- Cytopathology Techniques.
 - i) Fixation of Cytology specimens – various fixatives, pre fixation, coating and spray fixation, advantages and disadvantages.
 - ii) Staining – Routine cytology stain Pap, MGG, H&E advantages and disadvantages.
 - iii) Collection, preparation of gynecological and non-gynecological specimens- exfoliative cytology.
 - Gynecological – vaginal, cervical, endocervical, endometrial
 - Non-gynecological – sputum, bronchial, Body fluids (serous effusions), CSF, urine.
 - iv) Concentration technique in cytology - Centrifugation, cyto-centrifugation, membrane filters, cell blocks.
 - v) Liquid based cytology – monolayer preparation.
- Hormone cytology.
- Cervical cytology : Normal cells in cervical smear, Inflammatory lesions of the female genital tract – specific and nonspecific inflammation.
- Respiratory tract cytology – sputum, bronchial materials.
- Urinary cytology – urine.
- Serous effusions.
- CSF.
- GIT.
- FNAC – Scope, advantages and disadvantages,
- Organization of cytology lab.
- Cytology laboratory safety.
- Quality control measures in cytology.
- Automation in cytology – Preparation, staining, Auto screening.

Section – B

TRANSFUSION TECHNOLOGY

- General introduction to Blood Banking.
- Blood group and its inheritance. Laws of Heredity.
- ABO blood group system and its distribution.

- Inheritance and distribution of Rhesus system. General introduction to Rh system.
- Antigen Antibody reactions in immune Haematology.
- Naturally occurring and immune antibodies. Complement and Blood group antibodies.
- Preparation of grouping sera.
- General methods of Antigen and antibody detection.
- ABO grouping methods and factors influencing.
- Rh-typing methods (using complete and incomplete anti-D).
- The MNs blood group system. P-Blood group system. Lutherman Blood group system. Kell Blood group system, Lewis Blood group system. Duffy Blood group system, kid blood group system, Private Blood group, Bombay Blood group. Diego and I / I system. Du Antigen and their importance.
- Collection and storage of Blood sample for blood grouping, preservation of Red cells in Glycerol and in liquid Nitrogen, Storage of sera. Preparation and use of Enzyme treated Red cells in Blood grouping methods of differentiation of group A1 from Group A2. Secretors Non-secretors and the method to detect them.
- Blood grouping for Antenatal work. ABO and Rh Haemolytic disease of new born and principle of coomb's test - Direct and indirect their method and applications. Exchange Blood transfusion. Prevention methods of Rh-Haemolytic disease of Newborn.
- Compatibility test in blood transfusion and abnormal reactions which are not due to ABO or D- incompatibility. Compatibility testing method in urgent and Non-urgent cases. Special problems of compatibility.
- Antibody Titrations: Basic titration technique, Numerical scoring of results.
- General Management and Essential components in Blood Bank.
- Grouping, Cross matching and Serological tests on donor blood.
- Screening of Donors: Physical and clinical Examination. Copper sulphate method for Haemoglobin, Screening for Parasitic infections – Malaria, Filariasis. VDRL test, Icteric Index, grouping and Rh-typing, Antibody screening, Screening for HBs Ag, HCV and HIV.
- Anticoagulant solution used in blood Transfusion. Pyrogen and its complications. Test for detecting pyrogens.
- Temperature for storage of Blood. Preservation / storage of Blood. Transport of Blood. Storage of Plasma. Disadvantage of storage. International colouring of Blood labels.
- Transfusion Reaction, Principles and methods of investigating Transfusion Reactions.
- Transmission of diseases by blood transfusion.
- Component Therapy: Preparation of Transfusion of Leucocytes pure blood, Red cells, concentration. Platelet rich plasma. Platelet concentrate, Factor VIII. Plasma apheresis. Transfusion in Vonwillibrant Disease, Transfusion of plasma, Transfusion of leucocyte / granulocyte, leucopheresis. Transfusion of plasma components and preparation of Cryoprecipitate, its use and advances.

- Automation in recent developments in Blood Banking.

Practical

174 Hours

- Preparation of fixatives used in cytology
- Papanicolaou staining, May Grunwald Giemsa stain
- Shorr stain
- Processing and staining of various fluids for cytological examination
- Examination of normal and inflammatory cervical smears.
- Demonstration of normal cytology of respiratory tract, urinary tract, CSF, effusions.
- Preparation of 5% red cell suspension.
- ABO Blood grouping – cell grouping and serum grouping
- Rh typing methods
- Du typing
- Preparation of IgG coated cells, Direct and Indirect Antiglobulin tests
- Antibody titration
- Secretory status
- Screening tests done in donors
- Collection and storage of blood in blood bank
- Separation of packed red cells, FFP and cryoprecipitate

BOOKS RECOMMENDED FOR CYTOLOGY

1. Diagnostic Cytology and its Histopathologic Basis - Vol 1 & II- E.G. Koss
2. Test Book of Cytology - Walter.V. Bran & i. Eldrige
3. Cytological techniques - J.F. Baker
4. Exfoliative cytology in Gynecological practice - Erisa.G. Wachtel
5. Diagnostic cytopathology in the uterine cervix - Glaudes Gempal
6. Atlas of Diagnostic cytology - Glaudes Gempal
7. Functional medical laboratory technology A comprehensive series of manual histology and cytology -Stanley.L.Lamber, Robert Rothatem Avi
8. Compendium on diagnostic cytology, Tutorial of cytology – Weid, George etal
9. Manual and atlas of fine needle aspiration cytology - Svante R, Orell.

Recommended books for Blood Banking :

1. Basic Essentials of Blood Group Theory and Practice - Boorman and Dodd
2. Introduction to Blood Group serology - Boorman and Dodd
3. Essentials of Blood groupin and clinical applications - K. S. Ranganathan
4. Blood group Serology - Boorman
5. Laboratory Hand book of Blood Transfusion Technique - Farr
6. Blood Grouping Techniques - Schief and Boyd
7. Technical methods and procedures of the American Association of Blood Banks
-Revised 1956
8. Clinical Blood Transfusion - Kay
9. Blood Transfusion - Kelton
10. Blood Transfusion in Clinical Medicine - P. L. Mollison
11. Manual of Clinical Blood Transfusion- Brozovic

Paper XII**ELECTRONICS, COMPUTER SCIENCE & BIOMEDICAL INSTRUMENTATION**Theory – 96 hours**SECTION -A (BASIC ELECTRONICS AND COMPUTER SCIENCE)**

PN junction diode, rectification of AC- half wave and full wave, zener diode and its application, PNP and NPN transistor, Amplifiers-common emitter, common base and common collector, Frequency response, voltage gain, current gain, biological amplifier, differential amplifier, LC oscillator, LED and LCD display.

Introduction to computers, history of computers, Hardware and software, components of computers, classification of memory, Input and Output devices, operating systems, application of computers in medical laboratory, networking of computers LAN and WAN.

SECTION –B (BIOMEDICAL INSTRUMENTATION)

Working principle and maintenance of common laboratory instruments-heating mantle, refrigerator, deep freezer, walk-in cooler, hot air oven , electronic balance, CRO, Multimeter, Calorimeter, spectrophotometer, Centrifuge, Incubator, Laser application in medicine, maintenance of equipments-preventive maintenance and break down maintenance, calibration of equipments, Electrodes, pressure transducers

EEG Recorder, EMG Machine, NCV and evoked potential recording, surgical diathermy, suction apparatus, Echo Encephalography, Ventilators, Nebuliser, humidifier, Spiro meter, multiparameter monitor

Normal ECG, ECG abnormalities, ECG recorder-single channel, multichannel, Tread mill ECG, ECG monitor, cardiac defibrillator, pacemaker, digital subtraction angiography

Oxymetry-transmission oximetry, reflection oximetry, finger tip Pulse oximeter, Eco cardiography, colour Doppler, Heart lung machine, infusion pump, blood gas analyser.

Fibre optics, Endoscope, Sigmoidoscope, Audiometer – Pure tone, speech, Bekesey audiometers, Hearing aids, radioactivity, radiation detectors- ionisation detector, GM counter,

scintillation detector, photomultiplier tube, pulse height analyser, collimator, gamma camera, cyclotron, CT scan, MRI, Positron Emission Tomography, SPECT, dialysis machine – peritoneal and haemodialysis, dialysers.

Speciality Posting

70 hours

Students shall post in the speciality department to familiarize the working principles of equipments and other methods used there. .

NEUROMEDICINE

Posting at EEG and EMG lab, evoked potential recording, and patient preparation.

CARDIOLOGY

ECG lab, Eco cardiograph lab, colour Doppler lab, Treadmill lab, Cardiac Catheterisation lab equipments

THORACIC AND CARDIOVASCULAR SURGERY

Heart-lung machine- parts, operation, other operation theatre equipments like suction apparatus, surgical diathermy, ventilator, infusion pump, cardiac defibrillator etc.

RESPIRATORY MEDICINE - Pulmonary function test- procedure and equipment, respiratory allergy test, spirometer.

GASTROENTEROLOGY

Endoscopy and sigmoidoscopy- handling, maintenance and sterilisation of endoscope, indications and its complications

Get a basic knowledge of other instruments used in Gastroenterology lab.

NEPHROLOGY

Posting in Dialysis room, peritoneal dialysis, haemo dialysis, dialysis machine-parts and working, dialysers.

NUCLEAR MEDICINE

Posting in Nuclear Medicine Laboratory, RIA, Thyroid uptake scan

NUCLEAR PHYSICS

Study the operations and working of CT scan, MRI, PET, SPECT, PHA, Gamma camera, detectives etc.

PRACTICAL

- I. Construct the following circuits and observe the result in CRO
 1. Half wave rectifier
 2. Full wave centre tap rectifier
 3. Full wave bridge rectifier
- II. Plot the characteristics of the following
 1. Characteristics of Silicon diode
 2. Characteristics of zener diode
- III. Design of a common emitter Amplifier

- IV. Practical in Computer

MS DOS,MS Office,Excel,Power point

- V. Simple fault rectification and maintenance of common laboratory equipments

Reference Books

1. Principles of Electronics by VK.Mehta
2. Hand book of Biomedical Instrumentation by RSKhandpur
3. Biomedical Instrumentation by Arumugham

FOURTH YEAR

Paper XIII

BIOCHEMISTRY - IV

90 hours

1. MINERAL METABOLISM AND ESTIMATION

- Calcium, phosphate, magnesium, sodium, potassium, Chloride, Iron, Copper, Zinc, Iodine: metabolism and disorders.
- Methodology of the estimation of the above minerals in blood, plasma and other body fluids

2. FUNCTION TESTS

- Liver function tests: Disease of the liver-Jaundice, acute and chronic hepatitis, Cirrhosis, Cholestasis etc
- Kidney function tests
 - Glomerular function and measurements, clearance tests,
 - Tubular function tests, clinical syndromes
- Gastro intestinal function tests
 - Collection of Gastric Juice. Tests for Gastric Function, Stimulation methods-Test meals, Measurements of other Gastric Components, Malabsorption, Tests for occult blood in faeces, Tests for malabsorption studies, Schilling test, D-xylose absorption test, faecal fat estimation.
 - Estimation of free and total acidity
- Pancreatic function tests
 - Tests in Pancreatic diseases
 - Serum Enzymes and Urinary Enzymes
 - Direct stimulation tests and indirect stimulation of the pancreas-Sweat tests
- THYROID FUNCTION TESTS-hyperthyroidism and hypothyroidism
- GONADAL FUNCTION TESTS –disorders in males and females
- FETAL PLACENTAL FUNCTION TESTS -Hemolytic disease of Newborns, biochemical assay for fetal lung maturity, Biosynthesis of Estriol, measurements and clinical applications.

3. ACID-BASE BALANCE

- Body buffer system
- Respiratory regulation of PH, renal regulation of PH.

- Disturbance in acid base balance, Anion gap, metabolic acidosis, metabolic alkalosis, Respiratory acidosis, Respiratory alkalosis,
- Fluid and Electrolyte balance, osmolality, methodology of Blood PH and Gases estimation.

4. **AUTOMATION**

- Definition, functions, principle. Different parts and functions, merits and demerits of different autoanalyser.
 - Continuous flow analysers
 - Discrete Analysers

1).Batch Analyzers – i) Semi auto analyzer, ii) Fully automated analyser

2).Stat Analyzer. – i) Centrifugal Analyzer, ii) Dry chemistry analyzer

- Recent trends in automation of clinical chemistry.
- Laboratory Informatics.

5. **QUALITY CONTROL**

- Definition of precision, Accuracy, Standard deviation
- Pre –analytical variables and Analytical variables
- Quality control charts, control sera
- Quality control programme

Internal quality control and

External quality control

- Establishment and use of reference values, Analytical and Statistical procedures used in establishing reference values.

6. **HORMONES**

- General properties of hormones. Hormone action, pituitary hormones, hypothalamic hormones, Hormones of Pancreas, Thyroid, Parathyroid hormones, Hormones of adrenal medulla, adrenal cortex and Gonad.
- Different methods for estimation of hormones and hormone metabolites in blood and Urine. Steroid hormones.
- Chemistry & Metabolism. General techniques in steroid determination. 17-Oxo steroids and Oxogenic steroids prostersterone

-Determination of Oestrogens, in plasma and Urine

Urinary oestriol

-Determination of Catecholamines

Urinary VMA

Determination of urinary 5 HIAA

7. Toxicology and drug assay in clinical biochemistry. General methods of analysis- and screening test for common drugs used in therapy.
8. Organization and management of the Clinical biochemistry laboratory
9. Molecular Biology :- replication of DNA – DNA repair
 - Transcription – Genetic code
 - Translation- steps ,factors ,inhibitors,post translational modification,protein folding & protein targeting
 - Molecular genetics, gene expression , recombinant DNA Technology Gene therapy
 - Techniques in Molecular Biology-recombinant DNA technology, southern blotting, PCR, Genomic library, human genome project, cloning.

PRACTICALS

180 Hours

1. Estimation of calcium, phosphorus, magnesium, Iron and Copper, Sodium and Potassium by flame Photometry.
2. Diagnosis of disease with clinical correlation and Biochemical analysis of blood and Urine.
3. Determination of clearance-urea and creatinine
4. Gastric juice analysis
 - Titration acidity
 - Test for malabsorption studies, D-Xylose, Stool fat
 - Occult blood in faeces
5. Blood gas analysis, PH, PO₂, PCO₂.
Estimation of bicarbonates
6. Estimation of hormone metabolites in Urine - 17-Ketosteroids,17-Ketogenic ,Steroids, Urinary oestriol,Urinary VMA, 5 HIAA
7. Familiarization and usage of all types of auto analyser
8. Plotting of quality control charts and calculation of standard deviation

RECOMMENDED TEXT BOOK-BIOCHEMISTRY-PAPER IV

1. Text book of clinical chemistry - Nobert. W. Teitz
2. Practical clinical biochemistry - Harold . Varkey-vol.1 & Vol. II
3. Clinical Biochemistry-Principles & Practice- Praful. B. Godkar

REFERENCE BOOKS

1. Lecture notes on clinical chemistry - L.G. Whitby
2. Biochemistry a care oriented approach- Montgomiry
3. Biochemistry in clinical practice - William's and Marks
4. Clinical chemistry - Kaplan
5. Clinical Chemistry in diagnosis and treatment : Philip .D. Mayne
6. Biochemistry - Trehan
7. Methods in Biostatistics - B.K. Mahajan
8. Clinical chemistry – Michael L.Bishop
9. clinical biochemistry metabolic and clinical aspects –

William. J.marshall 7 stephen k.Bangert

Paper XIV MYCOLOGY, VIROLOGY AND APPLIED MICROBIOLOGY 90 hours**Section- MYCOLOGY & VIROLOGY****MYCOLOGY**

- Introduction to Mycology
 - A brief study of classification of fungi
- Morphology of fungus, yeasts, yeast like fungi
 - Dimorphic fungi, Filamentous fungi
- Reproduction of fungus

Medically important fungi

- Basic knowledge of medically important fungi and actinomycetes-
- *Candida* species, *Cryptococcus*, *Sporothrix*, *Blastomyces*, *Paracoccidioides brasiliensis*, *Coccidioides immitis*, *Histoplasma*,
- Agents of Chromomycosis, *Penicillium*, *Fusarium*, *Cladosporium*, *Curvularia*, *Rhizopus*, *mucor*, *Aspergillus*, *Trichoderma* species, *streptomyces*, *Syncephalastrum*, *Cephalosporium* and other medically important fungi.
- Dermatophytes, *piedra*, *Alternaria*, *Rhinosporidium* *Torulopsis*, *Nocardia*, *Fonsecaea*, *Phialophora*, *Basidiobolus*.
- Mycotoxins.

(Emphasis should be given to its morphology. Growth characteristics on Routine culture media and special media if any, tests used for its identification, pathogenicity, laboratory diagnosis and epidemiology prophylaxis.)

Fungal infections

- Basic knowledge of different types of fungal infections its causative agents and its epidemiology.
 - Superficial mycoses
 - Subcutaneous mycoses
 - Systemic mycoses
 - Opportunistic pathogens and its infections
 - Ophthalmic infection

- Common media and stains used in Mycology
- Culture technique for fungal identification
- Laboratory animals in Mycology
- Special stains in fungus identification
- Types of specimens, its collection, transportation, Preservation and processing for the diagnosis of fungal infections
- Antifungal Susceptibility and its recent developments
- Serological methods for the diagnosis of fungal infection.
- Preservation of fungus

VIROLOGY

INTRODUCTION TO VIROLOGY

- General properties of viruses-Morphology, Replication, effects of viruses on the host cells.
- Principles of virus ,Taxonomy and classification.
- An elementary knowledge of medically important DNA and RNA viruses (Classification, Morphology, Pathogenicity, Host range, Methods of Laboratory diagnosis, prophylaxis and epidemiology).
- More emphasis should be given to HBV, HIV, Flavi virus and other common viral infection in India.
- Emerging viral diseases in Kerala

Cultivation of viruses

- Different methods of cultivation and isolation of viruses.
- Animal inoculation
- Embryonated egg inoculation-Anatomy of embryonated egg, Techniques of various routes of inoculation
- Tissue culture techniques
 - Classification with examples
 - Cell culture containers and cleaning
 - Preparation of media, reagents and solutions
 - Propagation, maintenance, preservation of various cell cultures
 - Description of common cell culture
 - Contamination in cell culture
 - Detection of virus growth in cell culture - C.P.E, Metabolic inhibition, Haemadsorption, Interference, Immunofluorescence
- Cytological and Cytochemical diagnostic methods
- Inclusion bodies- methods of staining and demonstration

DIAGNOSTIC VIROLOGY

- Collections, preservations, Transportation, Processing, Isolation and identification of the following specimens for viral diagnosis.
 - Skin lesion, Vesicle fluid,
 - Biopsy specimens,
 - C.S.F and other sterile fluids, pus, buffy coat,
 - Nasopharyngeal secretions, sputum,
 - Urogenital specimens
 - Faeces or rectal swab.

Serological diagnosis of viral infection,

- Paul Bunnel test
- Haemagglutination and Haemagglutination inhibition test
- viral neutralization tests
- Immunofluorescence
- Immunoelectron microscopy.

Section –B

APPLIED MICROBIOLOGY

Water Bacteriology

- Bacteriology of drinking water
- A brief review of microorganisms causing water borne diseases
- Examination of water - Methods of collection of water,
- Presumptive coli form count, Eijkman test or confirmatory E. coli test
- Membrane filtration methods

Milk and Milk products

- A detailed study of examination of milk and milk products. A brief review of microorganisms causing milk borne diseases.
- Sample collection,
- Methylene blue tests, Phosphatase tests, Turbidity tests, Milk ring tests, whey agglutination test.

Food and food products

- Examination of food and food products.
- A brief review of micro organisms causing food borne diseases.
- Collection of samples and its processing-frozen food, canned food and preserved food.

Air

- Examination of Air-a brief review of micro organisms causing air borne diseases.
- Examination of air in theatre or cabinets. Different methods in detail

Nosocomial infections

- Nosocomial infections, diagnosis and its control
- Infection associated with blood transfusion.
- Infections associated with intra vascular cannula.
- Post operative infections,
- Urinary tract infections,
- Respiratory infection and other hospital acquired infections,
- Antibiotic resistance in hospitalised patients.
- Collection of specimens for sterility tests in operation theatre, its transportation and processing.
- Microbial investigations for epidemiological studies-Epidemiological markers in bacterial infection.
- Molecular diagnostic methods for microbial investigations.
- Automation in microbiology- Principles and its application in diagnostic approach.
- Role of genetic engineering in vaccine developments.
- Principles of immune blotting techniques, Western Blotting, Southern blotting, Northern blotting.
- Principles of Luminescence Assay
- Illustrative knowledge of restriction fragment length polymorphism,
- Illustrative knowledge of PCR and its applications.

SPECIAL SEROLOGICAL TESTS

- Haemolysin production and Titration
- Rheumatoid factor test- Roswaaler test, Latex agglutination test
- Antinuclear Antibody test- Fluorescent Antibody test, Agglutination test
- Detection of C- Reactive protein

PRACTICALS**180 Hours****Virology**

- Demonstration of different type of cell lines.
- Demonstration of egg inoculation,
- Demonstration of CPE, Inclusion bodies, Paul Bunnel test,
- Demonstration of Viral Haemagglutination test, Viral Haemagglutininations inhibition test, Viral neutralization test,
- Demonstration of immunofluorescence technique; Electron microscopy

MYCOLOGY

- Study of growth characteristics, microscopic examination and identification of medically important fungi, collection, transportation and processing of specimens for mycological examination.
- Slide culture technique
- Germ tube test for yeast identification

APPLIED MICROBIOLOGY

- Collection methods for water samples
- Preparation media and reagents for the study of water, food, milk and air
- Presumptive coliform count, Eijkman test
- Presumptive coliform count by filtration method
- Methylene blue test or phosphatase test,colony count test
- Milk ring test.
- Collection, transportation and processing of specimens for the diagnosis of Hospital acquired infection.

Serology

- Rosewaaler test, Latex agglutination test.
- Antinuclear antibody tests.
- Detection of C-Reactive protein.

TEXT BOOKS

1. Medical mycology : Rippon
2. Text Book of Microbiology :Ananthanarayanan & Jayaram Panikker
3. Mackie & Macartney Practical
4. medical microbiology :Collee, Fraser, Marmion, Simmons
5. Bailey and Scott's Diagnostic Microbiology :Forbes Sahn, Weissfeld.
6. Medical Virology : Fenner and White

REFERENCE BOOKS

1. Principles and Practice of Infectious diseases – Mandell, Bennett, Dolin Vol- 1 &
2. Medical Microbiology : David Greenwood, Slack,
 - i. Peutherer
3. Mycology for the Clinical Laboratory
 - i. Gary.S. Moore, Douglass.M. Jaciow
4. Manual of Clinical Mycology : Conant.N.F., Smith, Baker. R.D
5. Human Infections and Fungi, Actinomyces and Algae
 1. Roger Der Baker
6. Essentials of Diagnostic Virology: G. Storch
7. Notes on Medical Virology By Morag.C. Timbury
8. Diagnostic methods in Clinical Virology : N.R. Grist
9. Manual of Clinical Mycology : Normal. F. Conant
10. Medical Microbiology – Jawetz.
11. Clinical Microbiology- B. S. Nagoba.
12. Topley and Wilson's Microbiology and Microbial infections 9th edi:- Leslie Collier, Albert Balow
Vol – 1 Virology & Vol – 4 Medical Mycology.

Histopathological Techniques

- General understanding of the terms – Histology, Histopathology and Histopathological techniques.
- General organization of a Histopathology laboratory and basic requirements for a histopathology laboratory. Role of Histopathology laboratory in the diagnosis of diseases.
- Reception of specimens, identification and recording in the Registers, General introduction to the processing of tissues.
- Methods of examination of Fresh tissue specimens-Teased preparations, squash preparations, impression smears and frozen sections.

Fixation

- Aim of fixation. Qualities of fixatives. Classification of fixatives. Formalin fixative. Advantages and disadvantages of formalin fixatives. Methods of removing formalin pigment and deposits from cut sections. Use, advantages and disadvantages of other simple fixatives like mercuric chloride, potassium dichromate, chromic acid, osmium tetroxide, picric acid, Acetic acid Ethyl alcohol and Trichloroacetic Acid, Composition, uses, advantages and disadvantages of 10% Formol Saline, Buffered Neutral Formalin, Mercuric chloride.
- Choice of Fixatives, Composition uses advantages and disadvantages of Zenker's fluid, Bouins fluid Carnoys fixatives, Hellys fluid, Heidenhain's Susa, Clark's fluid, Flemming's fluid, Champy's fluid, Zenker's formol and Mullers fluid different histochemical fixatives, their merits and demerits
- Post Chromatization, Secondary fixation.

Tissue processing

- Dehydration, aim of dehydration, various dehydrating agents employed, their merits and demerits. Technique of dehydration clearing – aim of clearing, various clearing agents, their advantages and disadvantages.
- Impregnation – need and time requirement for impregnation and technique of paraffin wax impregnation.
- Principles, operation, parts and care of automatic tissue processors
- Special processing techniques: Fixation, processing and section cutting of bones, cartilages, connective tissue, CNS, pancreas, skin, teeth and eyeball.

Decalcification

Aim of decalcification, selection of tissue, Fixation of tissue, various decalcifying agents used, decalcification techniques – end point determination and qualities of ideal decalcifying agents.

Embedding

- Different types of embedding media, advantages disadvantages. Method of embedding, principles uses advantages of vacuum embedding. Uses, advantages and disadvantages of Ester wax embedding, gelatin embedding, Celloidin embedding, double embedding and embedding using water. Resin embedding.

Casting/Blocking

- Types of moulds used. Technique of casting

Sectioning

- Different types of Microtome: - Rocking, Rotary, sledge, sliding and freezing microtome. Their operations and specifications. Different types of microtome knives, knife angle. Choice and care of knives. Sharpening of microtome knives, honing and different types of hone employed and honing technique. Stropping and different types of strops employed and techniques of stropping. Parts care and operation of automatic knives sharpening machine.
- Cutting of paraffin wax embedded sections: - Trimming of blocks, fixing the block on the microtome. Technique of sections cutting. Cutting serial sections recognition and correction of faults in paraffin sections.
- Fixation of sections to slides- water bath method, hot stage method and warmed slide method.
- Cutting of celloidin embedded section – Fixing of celloidin embedded sections on slides.
- Preparation and use of albumenised and starched slides.

Staining

- Principles and Theory of staining, Biological staining, Basic staining technique. Classification of dyes. Principle of dye chemistry. Mordents, accentuators and accelerators. Uses of controls in staining procedure.
- Haematoxylin : - composition, preparation, uses, staining results advantages and disadvantages of all the different haematoxylin.

- Principle, preparation, storage, staining technique observation and interpretation of Haematoxylin and eosin stain.

Staining methods of following in tissue sections.

- Carbohydrates
 - Glycogen
 - Mucins – acid & neutral.
- Lipid – myelin.
- Pigments
 - Endogenous – haemosiderin, bile pigment, melanine, lipofuscins.
 - Artifact - formalin, malarial, schistosome, mercuri, chromic oxide.
- Minerals – Calcium, Copper.
- Connective tissues – collagen, reticular, elastic.
- Fibrin.
- Muscle striations.
- Microorganisms – bacteria, AFB, fungi, viral inclusion-HBs Ag.

Advanced techniques in Histopathology

- Cryostat and their uses. Principle, care and operation of cryostat.
- Automation in histopathology
- Immuno cytochemistry and its application.
- Enzyme histochemistry, Immunofluorescent techniques in tissue sections.
- In situ hybridization.
- Electron microscopy- processing and Techniques.

Postmortem room Technique

- Collection and preservation of tissue, collection of materials for laboratory studies.

Museum Technique

- General introduction, organization of a museum. Source of materials, need for preservational mounting, Reception, preparation, labeling, fixation of various specimens and organs, storage of specimen, mounting of museum specimens, museum jars, perplex and glasses, their advantages and disadvantages, Demonstration of Bone, calculi, Transparent specimen (Fetal skeleton) amyloid. Modern methods in museum technique.

Cytogenetics

- Human sex chromosomes.
- Sampling staining and demonstration of Barr body. Reporting and interpreting Barr test.
- Demonstration of Y-chromosome, Origin and demonstration of drumstick, small clubs, sessile nodules and balloons. Drumstick count and its interpretation.

Karyotyping

- Methods of Chromosome analysis
- Banding techniques.
- Chromosome analysis with blood and bone marrow. Morphology of chromosome and their identification. Criteria for chromosome identification. Identification criteria of group to group of chromosome. Conventional designation.

Chromosome Defects

- Physiologic factors are influencing the aetiology of chromosome defects, Types of chromosome defects- Structural abnormalities and human autosomal syndromes. Philadelphia chromosome and chromosome changes in Neoplasia, abnormalities of sex chromosome at birth, at puberty and in adults.
- Turner's syndrome, Down's syndrome, Klinefelter syndrome,
- Advanced methods in cytogenetic – FISH, SKY.
- Clinical utility of Bone Marrow culture.

Practical

180 HOURS

- Preparation of commonly used fixatives- Formalin, Bouins, Zenkers, Carnoys
- Automatic tissue processors
- Decalcification
- Embedding
- Section cutting
- Cryostat section cutting
- Preparation of haematoxylin stains- Harris, Ehrlich's, Mayers, Weigert's, PTAH, Verhoeff's
- Special stains- PAS, Perl's ,Reticulin, Vangieson, Masson Trichrome, Verhoeff's elastic stain, Masson Fontana, Alcian blue, AFB, Wade- Fite, Methenamine stain, Von Kossa, PTAH, Oil red O stain, Mucicarmine stain.

- Chromosome preparation
- Karyotyping
- Preparation of karyotype from bone marrow specimen
- Barr body demonstration

TEXT BOOK

Hand book of histopathological techniques- CFA culling

BOOKS RECOMMENDED FOR REFERENCE

1. Basic Histology - L.C. Junquera
2. Manual of Histological staining AFTP Fascicle 3rd Edition Reprinted 1982
3. Lynch's Medical Laboratory Technology - Raphael
4. Self Assessment in Histological Techniques- Bancroft
5. Manual of Histological Techniques - Bancroft
6. Histopathology – A step-by-step approach - Lewis
7. Basic Histopathology - Wheather
8. Colour Atlas of Histopathology - Curran
9. Cellular pathology technique - 5th Edition

BOOKS RECOMMENDED FOR CYTOGENETICS

1. Human Chromosomes- Manual of basic techniques – Ram . S. Verma, Arvid Babu.
2. Cytogenetics, FISH and molecular testing in hematologic malignancies – Wojciech Gorczyca

Paper XVI**Project****150 Hours**

Submission of a Project work is a compulsory requirement for the B Sc MLT –course. Each student can choose a topic for the project in any one of the subjects – Microbiology/Biochemistry/Pathology which would be approved by his/her supervising teacher. The topics for project shall be divided equally among total number of students from the three main subjects Microbiology/Biochemistry/Pathology.

The option for topics selection for the project will be based on the following criteria

- Total marks obtained in all the previous university examinations up to 3rd year.
- If total marks obtained equal for more than one student then marks obtained for the optional subject may be considered.

The supervising Teacher should have minimum 3 years full time teaching experience in the concerned subject. The student should be under the guidance of the supervising staff, carry out the work on the topic selected and prepare a project report including results and references. The project report duly certified by the supervising staff and head of the department of MLT one month prior to fourth year university practical examination should be submitted to the fourth year B Sc MLT University practical examination of concerned subject.

The project report evaluation will be conducted by the concerned subject internal and external examiners together in the Fourth year B Sc MLT University practical examination.