

KANNUR UNIVERSITY
(Abstract)

M.Sc. Medical Micro Biology/ M.Sc. Medical Bio Chemistry/ M.Sc. Medical Laboratory Technology Programmes under Choice Based Credit Semester System in the University Department- Revised Scheme, Syllabus & Model Question Papers Implemented with effect from 2015 admission- Orders issued.

ACADEMIC 'C' SECTION

U.O. No. Acad/C4/ 9343/2015

Civil Station P.O, Dated, 15-12-2015

- Read:
1. U.O No. Acad/C3/2049/2009 dated 11.10.2010.
 2. U.O No. Acad/C3/2049/2009 dated 05.04.2011.
 3. Meeting of the Syndicate Sub-Committee held on 16.01.2015.
 4. Meeting of the Curriculum Committee held on 10.04.2015.
 5. U.O No. Acad/C4/14536/2014 dated 29.05.2015.
 6. Meeting of the Department Council held on 15.06.2015.
 7. Letter from the Director, School of Health Sciences, Thalassery Campus, Palayad.
 8. Meeting of the Curriculum Committee held on 03.09.2015.

ORDER

1. The Regulations for Post Graduate Programmes under Choice Based Credit Semester System were implemented in the Schools/Departments of the University with effect from 2010 admission as per the paper read (1) above and certain modifications were effected to the same vide paper read (2).
2. The meeting of the Syndicate Sub-Committee recommended to revise the Scheme and Syllabus of all the Post Graduate Programmes in the University Schools/Departments under Choice Based Credit Semester System (CCSS) with effect from 2015 admission vide paper read (3) above.
3. As per the paper read (4) above, the meeting of the Curriculum Committee recommended certain modifications/ additions to the Regulations for Post Graduate Programmes under Choice Based Credit Semester System and the Regulations were modified in the University w.e.f. 2015 admission vide paper read (5).
4. The Department Council vide paper read (6) above has approved the Scheme, Syllabus & Model Question Papers for **M.Sc. Medical Micro Biology/ M.Sc. Medical Bio Chemistry/ M.Sc. Medical Laboratory Technology Programmes under Choice Based Credit Semester System(CCSS) for implementation with effect from 2015 admission.**
5. The Director, School of Health Sciences vide paper read (7) above, has forwarded the Scheme, Syllabus & Model Question Papers for **M.Sc. Medical Micro Biology/ M.Sc. Medical Bio Chemistry/ M.Sc. Medical Laboratory Technology Programmes in line with the revised Regulations for Choice Based Credit Semester System for implementation with effect from 2015 admission.**

P.T.O.

6. The meeting of the Curriculum Committee held on 03.09.2015 approved the Scheme; Syllabus & Model Question Papers for M.Sc. Medical Micro Biology/ M.Sc. Medical Bio Chemistry / M.Sc. Medical Laboratory Technology under Choice Based Credit Semester System in the Department vide paper read (8) above.

7. The Vice Chancellor after considering the matter in detail, and in exercise of the powers of the Academic Council conferred under section 11(1) of KU Act 1996, and all other enabling provisions read together with, has accorded sanction to implement the Scheme, Syllabus & Model Question Papers for M.Sc. Medical Micro Biology/ M.Sc. Medical Bio Chemistry/ M.Sc. Medical Laboratory Technology Programme under Choice Based Credit Semester System, offered in the University Department w.e.f 2015 admission, subject to report to the Academic Council.

8. Orders are, therefore, issued accordingly.

9. The revised Scheme, Syllabus and Model Question Papers of M.Sc. Medical Micro Biology/ M.Sc. Medical Bio Chemistry/ M.Sc. Medical Laboratory Technology Programme effective from 2015 admission are appended.

Sd/-
JOINT REGISTRAR (ACADEMIC)
FOR REGISTRAR

To

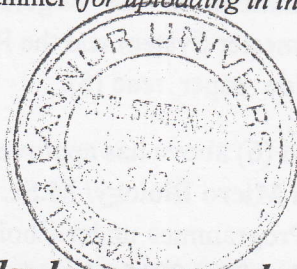
The Director, School of Health Sciences
Thalassery Campus, Palayad

Copy To:

1. The Examination Branch (through PA to CE)
2. PS to VC/PA to PVC/PA to R/PA to CE/PA to FO
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Forwarded/By Order

SECTION OFFICER



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KANNUR UNIVERSITY



SCHOOL OF HEALTH SCIENCES

DEPARTMENT OF MEDICAL LABORATORY TECHNOLOGY

REGULATION AND SYLLABUS FOR

M.Sc. MEDICAL LABORATORY TECHNOLOGY PROGRAMME

UNDER CHOICE BASED CREDIT AND SEMESTER SYSTEM

(Applicable from 2015 Admission onwards)

ELIGIBILITY FOR ADMISSION

Candidates seeking admission to M.Sc. programme (Two yrs.) in Medical Laboratory Technology should have passed Bachelors degree in MLT from institutions affiliated to Kannur University or from other universities considered equivalent by Kannur University. Candidates passing BSC MLT through correspondence course shall not be eligible.

DURATION OF THE PROGRAMME

The minimum duration for completion of a two year PG Programme is four Semesters. The maximum period for completion is eight (8) Semesters. Even if a candidate earns the required number of credits in less than 4 Semesters, he/she has to necessarily study for four Semesters of the two year PG Programme .

MODE OF SELECTION

As per the Regulations prescribed by the University from time to time.

COURSE STRUCTURE

MSc MEDICAL LABORATORY TECHNOLOGY (FACULTY OF MODERN MEDICINE)
SEMESTER WISE DISTRIBUTION OF COURSES, CONTACT HOURS, MARKS AND CREDITS
 (EFFECTIVE FROM 2015 ADMISSION)

Semester I

Sl. No.	Course Code	Title of the Course	Contact Hours/Week			Marks			Credits
			L	T/S	P	ESE	CE	Total	
1	MLT C101	Biomedical Techniques and Laboratory management	4	1	-	60	40	100	4
2	MLT C 102	General Microbiology	4	1	-	60	40	100	4
3	MLT C 103	Haematology and Clinical Pathology	4	1	-	60	40	100	4
4	MLT P 104	Biomedical Techniques and Laboratory management- Practicals and Viva voce	-	-	6	60	40	100	3
5	MLT P 105	General Microbiology Practicals and Viva voce	-	-	6	60	40	100	3
6	MLT P 106	Haematology and Clinical Pathology- Practicals and Viva voce	-	-	6	60	40	100	3
7	MLT E 107	Elective 1*	3	1	-	60	40	100	3
Total			15	4	18	420	280	700	24

Semester II

Sl. No.	Course Code	Title of the Course	Contact Hours/Week			Marks			Credits
			L	T/S	P	ESE	CE	Total	
1	MLT C108	Immunology and Immunological Techniques	4	1	-	60	40	100	4
2	MLT C109	Clinical Biochemistry	4	1	-	60	40	100	4
3	MLT C110	Molecular Biology and Medical Genetics	4	1	-	60	40	100	4
4	MLT P 111	Immunology and Immunological Techniques- Practicals and Viva voce	-	-	6	60	40	100	3
5	MLT P 112	Clinical Biochemistry- Practicals and Viva voce	-	-	6	60	40	100	3
6	MLT P 113	Molecular Biology and Medical Genetics- Practicals and Viva voce	-	-	6	60	40	100	3
7	MLT E 114	Elective 2 *	3	1	-	60	40	100	3
Total			15	4	18	420	280	700	24

Semester III

Sl. No.	Course Code	Title of the Course	Contact Hours/Week			Marks			Credits
			L	T/S	P	ESE	CE	Total	
1	MLT C 115	Immunopathology	4	1	-	60	40	100	4
2	MLT C 116	SPECIALISATION I- CLINICAL BIOCHEMISTRY 1. Vitamins, Hormones and Enzymes SPECIALISATION II- MICROBIOLOGY AND IMMUNOLOGY 1. Virology, Mycology and Parasitology of Diseases SPECIALISATION III- HAEMATOLOGY AND TRANSFUSION TECHNOLOGY 1. Haematology	4	1	-	60	40	100	4
3	MLT P 117	Immunopathology- Practicals and Viva voce	-	-	6	60	40	100	3
4	MLT P 118	SPECIALISATION I- CLINICAL BIOCHEMISTRY 1. Vitamins, Hormones and Ezymes- Practicals and Viva voce SPECIALISATION II- MICROBIOLOGY AND IMMUNOLOGY 1. Virology, Mycology and Parasitology of Diseases - Practicals and Viva voce SPECIALISATION III- HAEMATOLOGY AND TRANSFUSION TECHNOLOGY 1. Haematology- Practicals and Viva voce	-	-	6	60	40	100	3
5	MLT E 119	Elective 3*	3	1	-	60	40	100	3
6	MLT E 120	Elective 4*	3	1	-	60	40	100	3
7	MLT C 121	Internship	-	6	-	60	40	100	3
Total			14	10	12	420	280	700	23

Semester IV

Sl. No .	Course Code	Title of the Course	Contact Hours/Week			Marks			Credits
			L	T/S	P	ESE	CE	Total	
1	MLT C 122	SPECIALISATION I- CLINICAL BIOCHEMISTRY 2. Diagnostic Biochemistry and Organ Function Tests SPECIALISATION II- MICROBIOLOGY AND IMMUNOLOGY 2.Systematic Bacteriology SPECIALISATION III- HAEMATOLOGY AND TRANSFUSION TECHNOLOGY 2.Transfusion Technology	4	2	-	60	40	100	4
2	MLT C 123	SPECIALISATION I- CLINICAL BIOCHEMISTRY 3.Metabolism, Inborn Errors of Metabolism and Advanced Clinical Biochemistry SPECIALISATION II- MICROBIOLOGY AND IMMUNOLOGY 3.Clinical Microbiology SPECIALISATION III- HAEMATOLOGY AND TRANSFUSION TECHNOLOGY 3.Advanced Techniques in Blood Banking	4	2	-	60	40	100	4
3	MLT P 124	SPECIALISATION I- CLINICAL BIOCHEMISTRY 2.Diagnostic Biochemistry and Organ Function Tests - Practicals and Viva voce SPECIALISATION II- MICROBIOLOGY AND IMMUNOLOGY 2.Systematic Bacteriology- Practicals and Viva voce SPECIALISATION III- HAEMATOLOGY AND TRANSFUSION TECHNOLOGY 2.Transfusion Technology- Practicals and Viva voce	-	-	6	60	40	100	3
4	MLT P 125	SPECIALISATION I- CLINICAL BIOCHEMISTRY		-	6	60	40	100	3

		3. Metabolism, Inborn Errors of Metabolism and Advanced Clinical Biochemistry - Practicals and Viva voce SPECIALISATION II- MICROBIOLOGY AND IMMUNOLOGY 3. Clinical Microbiology - Practicals and Viva voce SPECIALISATION III- HAEMATOLOGY AND TRANSFUSION TECHNOLOGY 3. Advanced Techniques in Blood Banking - Practicals and Viva voce							
5	MLT C 126	Project and Viva voce	-	12	-	120	80	200	10
Total			8	16	12	360	240	600	24

ELECTIVES

- 1. ETHICAL CONSIDERATIONS IN MEDICAL RESEARCH**
- 2. LABORATORY INFORMATICS, SUPPLY AND INSTALLATION OF LABORATORY EQUIPMENTS AND REAGENT PRODUCTION**
- 3. BIOSTATICS & RESEARCH METHODOLOGY**
- 4. CYTOLOGY AND HISTOPATHOLOGY**
- 5. ADVANCED CLINICAL MICROBIOLOGY**
- 6. ORGAN SPECIFIC METABOLISM AND CLINICAL TOXICOLOGY**

SCHEME OF EVALUATION

Evaluation shall be done on the basis of continuous evaluation and end semester examination. The proportion of the distribution of marks among ESE and CE shall be 60:40.

	End Semester Examination	Continuous Evaluation	Total
Theory	60	40	100
Practicals*	30	20	100
Viva Voce*	50	--	
Grand Total	140	60	200

*Practicals and Viva voce component is only for Core paper

Continuous evaluation of the course shall be based on periodic written tests, seminars, assignments and attendance in respect of theory courses and based on tests, lab skill and attendance in respect of practical courses. The percentage of marks assigned to various components for continuous evaluation is as follows.

Weightage to the components of internal marks

Theory

1. Test papers - 40%
2. Seminars - 20%
3. Assignment - 20%
4. Attendance - 20%

Practicals

1. Tests - 50%
2. Lab skills - 30%
3. Attendance - 20%

Test papers

At least three class tests will be conducted during a semester. Average of the Best two will be counted.

Seminar

Each student shall deliver at least one seminar as an internal component of each course

Assignments

Each student shall be required to do at least 2 assignments for each course.

ATTENDANCE

The minimum attendance required for each course shall be 75% of the total number of classes conducted for that semester. Those who secure the minimum attendance in a semester alone will be allowed to register for the End Semester Examination. Condonation of attendance to a maximum of 10 days in a Semester subject to a maximum of two spells within a Programme will be granted by the Vice-Chancellor. Benefit of Condonation of attendance will be granted to the students on health grounds, for participating in University Union activities, meetings of the University Bodies and participation in extracurricular activities on production of genuine supporting documents with the recommendation of the Head of the Department concerned. A student who is not eligible for condonation shall repeat the course along with the subsequent batch.

CONDUCT OF END SEMESTER EXAMINATION

Pattern of Double valuation will be followed for Choice based Credit Semester System.

The Head of the Department will have to submit to the Controller of Examinations, the details of the Core and Elective of each semester along with the syllabus, Model Question Papers and Panel of Experts for setting the questions, immediately after starting of each semester. The Controller of Examinations in turn shall set, print and supply one set of question paper in sealed cover to the Head of the Dept./ Course Director within a maximum of 60 days.

Viva voce examination of semester II will cover all the papers both theory and practicals of I and II semesters. Viva Voce examination at the end of IV semester will cover all the papers, both theory and practical of III and IV semester.

PATTERN OF QUESTIONS

For the end semester examination each question paper shall consists of three sections:

Section A, B and C carrying a total of 60 marks

Section A consists of two essay type questions, each carrying 10 marks.

Section B consists of five short note questions, each carrying 5 marks.

Section C consists of five brief note questions, each carrying 3 marks.

PROJECT WORK

Written account of the project shall be submitted by the students with in prescribed time before registering for IV semester examination.

The evaluation of the project will be on the following basis.

Project content	-	60marks
Presentation	-	30marks
Defence/Viva voce	-	30marks
Continuous evaluation	-	80 marks
Total	-	200 marks

Students scoring less than 50% (100 out of 200) marks in project evaluation shall be required to re submit and re appear for project evaluation.

Students failing to secure pass in any paper (Theory& practicals) shall reappear for that paper/those papers in subsequent semester examination. Students will be permitted to appear for project evaluation only after appearing for all the semester examinations.

GRADING

1. An alphabetical grading system shall be adopted for the assessment of a student's performance in a Course. The grade is based on a 6 point scale. The following table give the range of marks %, grade points and alphabetical grade.

Range of Marks%	Grade Points	Alphebetical Grade
90-100	9	A+
80-89	8	A
70-79	7	B+
60-69	6	B
50-59	5	C
BELOW 50	0	F

2. A minimum of grade point 5 (Grade C) is needed for successful completion of a course.
3. Performance of a student at the end of each semester is indicated by the Grade Point Average (GPA) and is calculated by taking the weighted average of grade points of the courses successfully completed. Following formula is used for the calculation. The average will be rounded off to two decimal places.

$$\text{GPA} = \frac{\text{Sum of (grade points in an average multiplied by its credit)}}{\text{Sum of credits of courses.}}$$

4. At the end of the programme, the overall performance of a student is indicated by the Cumulative Grade Point Average (CGPA) and is calculated using the same formula given above.
5. Emperical formula for calculating the percentage of marks will be $\text{CGPA} \times 10 + 5$.
6. Based on the CGPA overall letter grade of the student shall be in the following way.

CGPA	Overall Letter Grade
8.5 and above	A+
7.5 and above but less than 8.5	A
6.5 and above but less than 7.5	B+
5.5 and above but less than 6.5	B
4.5 and above but less than 5.5	C

7. Conversion of Grades into Classification

Overall Letter Grade	Classification
A+ and A	First class with Distinction
B+ and B	First Class
C	Second Class

8. A student who has failed in a course can reappear for the End Semester Examination of the same course along with the new batch without taking re-admission or choose another Course in the subsequent Semesters of the same Programme to acquire the minimum credits needed for the completion of the Programme.
9. Appearance for Continuous Evaluation (CE) and End Semester (ESE) are compulsory and no Grade shall be awarded to a candidate if he/she is absent for CE/ESE or both.
10. 'A student who fails to complete the Programme /Semester can repeat the full Program me/Semester once, if the Department Council Permits to do so.
11. There shall not be provision for improvement of CE and ESE.
12. No student shall be allowed to take more than eight consecutive Semesters for completing a four Semester Programme from the date of enrollment.
13. Ranking will be confined to only those students who qualify the examinations in first attempt.
14. No Candidate shall be permitted to work outside the institution while studying the course.
15. The candidate has to choose the specialization of his/ her choice during the time of admission. No change of specialization will be permitted once he/ she get admitted.

GRIEVANCE REDRESSAL MECHANISM

Committees will be constituted at the Department and University levels to look into the written complaints regarding Continuous Evaluation (CE). Department Level Committee (DLC) will consist of the Department Council and student nominee of the Department Students' Union from the concerned Faculty.

University Level Committee (ULC) will consist of the Pro– Vice-Chancellor (Chairman & Convenor), the convenor of the Curriculum Committee (Vice-Chairman), the Head of the Department concerned and a nominee of the students' Union. Department Level Committee will be presided over by the HOD and University Level Committee by the Pro- Vice Chancellor. Department Level Committee will have initial jurisdiction over complaints against Continuous Evaluation and University Level Committee will hear appeals against Department level decisions. Complaints will have to be submitted to the Department concerned within two weeks of publication of results of Continuous Evaluation (CE) and disposed

of within two weeks of receipt of complaint. Appeals to University Level Committee should be made within one month of the decisions taken by Department level Committee and disposed of within two months of the receipt of the complaint.

Complaints unsolved by the University level Grievance Committee shall be placed before the Vice Chancellor.

MSc. MEDICAL LABORATORY TECHNOLOGY

MLT C 101: BIOMEDICAL TECHNIQUES AND LABORATORY MANAGEMENT (Common to all specializations)

THEORY

Unit 1

Methods of qualitative analysis of biomolecules:

Principles, experimental procedures and applications of chromatography – paper, thin-layer, ion-exchange, affinity, gel filtration, molecular exclusion chromatography, gas-liquid and HPLC.

Principles, procedures and applications of Electrophoresis – paper, polyacrylamide gel, agarose gel, capillary and cellulose acetate, isoelectric focusing, immune electrophoresis,

Unit 2

Centrifugation Techniques:

Principle and technique of preparative and analytical centrifugation, differential centrifugation, density gradient centrifugation, ultra-centrifuge and its application

Unit 3

Quantitative methods:

Principles and applications of photometry, spectrophotometry, fluorometry, Flame photometry, atomic absorption spectrometry, Mass spectrometry, MALDI TOF, ion selective electrodes and their applications in Medicine, Nephelometry, Turbidometry

Unit 4

Luminometry – Bioluminescence & chemiluminescence, Immunofluorescence

Unit 5

Isotopes: Detection and measurement of radioactive isotopes, application of isotopes in research and clinical biochemistry, RIA, IRMA, Radiation safety, storage and disposal of radioactive materials

Unit 6

Cell fractionation, Biochemical activities of different fractions, marker enzymes.

Unit 7

Purification of enzymes from cells, purification of proteins, characterisation and criteria of purity

Unit 8

Electrolyte balance, pH and buffers, pH measurements

Unit 9

Bioenergetics and Biological oxidation : concept of free energy change, high energy compounds, ATP generation, redox potential, Electron transport chain, oxidative phosphorylation, inhibitors, Uncouplers, ionophores.

Unit 10

Bio-medical waste: Types, potential risks and their safe management.

LABORATORY MANAGEMENT

1. Preparation of operating budgets: general aspects of financial management of laboratories:
2. Cost-analysis (tests and instruments): justification of providing new services or rejecting existing ones: lease and purchase decision analysis: delegation of budget responsibilities, work load statistics.
3. Laboratory design: Designing laboratories for different types and sizes of institutions: selection of equipment and systems for the laboratory, concepts of workstation consolidation, workflow analysis, concepts in laboratory automation (Sample transportation systems, modular systems, robotics).
4. Laboratory safety: Fire, chemical, radiation and infection control (body substance precautions), hazardous waste and transport of hazardous materials.
5. Training of technical staff: Familiarity is needed with the syllabi of various training . programmes; knowledge of the teaching requirements and level of knowledge technical staff; understanding of qualifications of technologists trained in other countries.
6. Maintenance of records: Procedure manuals, ward manuals, quality control programs, patient data retrieval.
7. Personnel management: personnel policy manual; job descriptions; labor, supervision relations; conducting job interviews: motivation, recognizing job distress syndrome; delegation to a laboratory manager. .
8. Hospital organization; interactions between the laboratory service and the rest of the hospital.
9. Laboratory accreditation standard - ISO 9000 and ISO15189
10. Professional ethics .
11. Quality assurance: total quality management: development and monitoring of performance indicators.
12. Public relations; hospital and community.
13. Basic clinical epidemiology

14. Use of computers in quality control and management: use of computers for calculating analytical results (eg. non-linear functions).
15. General aspects of system design: central vs. stand-alone systems, host computers and equipment interfaces.
16. Hospital information systems (HIS).
17. Personal computer use; word processing spreadsheets. Data-base, graphics, statistics, presentations, email, internet. Security and privacy of data storage and transmission.
18. Data base structures and data mining.
19. Appropriate access control to patient information

**MLT P 104: PRACTICALS BIOMEDICAL TECHNIQUES AND LABORATORY
MANAGEMENT**

1. Chromatography: paper, thin-layer, gel, ion-exchange, demonstration of HPLC and GLC
2. Electrophoresis : slide gel, PAGE, agarose gel, native SDS PAGE of blood sample (Demonstration only)
3. Photometry, spectrophotometry, flame photometry, atomic absorption spectrophotometry, ISE
4. Cell fractionation – methods.
5. Chemiluminescence & Immunofluorescence (demonstration)
6. pH determination, preparation of buffers
7. Calibration of equipments & laboratory wares

MLT C 102: GENERAL MICROBIOLOGY

(Common to all specializations)

THEORY

Unit 1

Historical background, classification of microorganisms, eukaryote and prokaryotes, methods for studying microbes: staining, microscopy, electron microscopes and specimen preparation for EM, culture methods and media, sterilisation, methods for identification of bacteria, application of molecular techniques for identification of bacteria.

Unit 2

Bacterial morphology: size, shape and arrangement of bacterial cells, ultrastructure of cell wall, cytoplasmic membrane, outer envelope, flagella, fimbriae and pili, cytoplasmic matrix, nucleoid, cytoplasmic inclusions, endospores – formation and germination, cell-wall synthesis.

Unit 3

Bacterial metabolism and growth: Growth requirements, nutritional classification, transport of solutes across the cell membrane, effect of pH, oxygen, temperature, etc. on growth, generation time, growth curve, batch cultures and continuous cultures, chemostat, turbidostat, assessment of bacterial growth-different methods, bacterial nutrition and design of culture media.

Unit 4

Antimicrobial agents: chemical and physical agents, mode of action, methods for testing, antimicrobial as therapeutics-antibacterial, antifungal, antiviral agents, mode of action, MIC and MBC, development of resistance, antimicrobial sensitivity testing.

Unit 5

Bacterial genetics: bacterial genome, extra chromosomal genome, bacterial transformation-types of mechanisms (eg. Natural Transformation in *Streptococcus pneumoniae*, and *Haemophilus influenzae*.), role of plasmids, artificial transformation, bacterial conjugation – properties of plasmid, Hfr strains, conjugation in Gram negative and Gram positive organisms, transduction-generalised and specialised, bacteria in genetic engineering.

Unit 6

Bacteria useful to man: making of wine, beer and bread, milk products, butyric acid bacteria, microbes as sources of protein, microbial production of chemotherapeutic agents-antibiotics (e.g. Penicillin, streptomycin), transformation of steroids, biopesticides, genetic engineering products.

MLT P 105 : PRACTICALS GENERAL MICROBIOLOGY

1. Review of the following methods.
 - (a) Staining techniques – simple, Grams, AFB, Spore, flagella, cell-wall, capsule, spirochaetes, volutin granules, etc.
 - (b) Preparation and sterilization of different types of media
 - (c) Culture methods
2. Antimicrobial sensitivity testing – disc diffusion, MIC & MBC
3. Growth curve of bacteria
4. Bacterial conjugation
5. Isolation of antibiotic resistant strains.

MLT C 103: HAEMATOLOGY AND CLINICAL PATHOLOGY

(Common to all specializations)

HAEMATOLOGY

THEORY

Unit 1

Haematopoiesis – origin, development, function and fate of blood cells.

Erythropoiesis – origin and development of RBCs, biosynthesis of Hb, control of erythropoiesis.

Unit 2

Disorders of red blood cells, erythrocyte indices, Red cell inclusion bodies

Anaemia – definition, pathophysiology, classification – morphologic and etiologic

Diagnostic strategy of different morphologic types – normocytic, microcytic, and macrocytic.

Haemolytic anaemia – general considerations, classification, diagnostic strategy of each

Aplastic anaemia, Pancytopenia, and other disorders associated with anaemia

Polycythemia,

Unit 3

Disorders of WBC – Leucopaenia, leukocytosis, Leukaemoid reaction, Myelodysplastic syndrome (MDS) Leukaemia – Acute leukaemia, classification, clinical features, lab features and diagnostic criteria of each subtype

Unit 4

Myeloproliferative disorders – general features, classification, diagnostic criteria of CML

Lymphoproliferative disorders (CLL/Lymphoma) – general features, classification and diagnostic criteria of CLL.

Unit 5

Plasma cell disorders – classification,

Plasma cell myeloma – definition, clinical features, investigations.

Unit 6

Haemorrhagic disorders :

Definition - Pathogenesis, Clinical feature, Classification- vascular disorders

Platelet disorders, coagulation disorders, Fibrinolysis.

Normal haemostasis

Investigation of haemorrhagic disorders

Tests of vascular and Platelet function- Bleeding time, Clot retraction, Platelet count

B.M Aspiration, Platelet Aggregation Studies.

Tests for Coagulation Disorders

Screening test- First line tests

Prothrombin time(PT), Activated Partial Thromboplastin Time (APTT), Thrombin Time(TT)

Second line tests- Mixing experiments. Urea Solubility Test [Test for Factor XIII]

Disseminated intravascular Coagulation [DIC] - Definition, Pathophysiology, Clinical Features and Laboratory investigations. Fibrinogen assay

Unit 7

Thrombotic disorders - Classification, pathogenesis, Clinical Features and Laboratory investigations. Antiphospholipid antibody Syndrome.

Unit 8

Automation in Haematology
Haemoparasites

CLINICAL PATHOLOGY

Unit 1

Collection, transport, preservation and processing of various clinical specimens

Unit 2

Urine – Examination of urine: physical, chemical, and microscopical, analysis by strip method, test for Haemosiderin pigment

Unit 3

Sputum – Physical examination, Microscopic – Grams stain, Ziehl Neelsen staining for AFB, chemical examination.

Unit 4

Semen – physical and chemical examination, liquifaction, volume, colour reaction, pH, motility, sperm count, morphology of sperm – importance and interpretation.

Unit 5

CSF – examination for colour, turbidity, total count, differential count, tests for antigens.

Unit 6

Pregnancy tests – HCG, advantages and disadvantages, RIA.

Unit 7

Faeces – examination of samples for parasites – concentration, floatation techniques

Unit 8

Body fluids – microscopic examination of pleural, pericardial, synovial, ascitic, and peritoneal fluids.

MLT P 106: PRACTICALS HAEMATOLOGY AND CLINICAL PATHOLOGY

HAEMATOLOGY

Blood collection, anticoagulants used in Haematology.

Red cell indices

ESR,PCV, Platelet count, Absolute eosinophil count.

Reticulocyte count.

Stains used in Haematology.

Preparation of blood film.

Preparation of Leishman's stain,Giemsa stain and MGG stain.

peripheral smear staining by Leishmans stain.Interpretation of peripheral smear
differential Count

Microcytic hypochromic anaemia

Investigations including serum iron and TIBC,

Macrocytic anaemia- Investigations including B₁₂, folate assay,schilling test

Haemolytic anaemia-General lab investigations

Haemolytic anaemia-Special tests.

Osmotic fragility test

Sickling test

Hb electrophoresis

Investigations of G6PD deficiency

Auto immune haemolytic anaemia investigations

Coomb's test

Detection of blood parasites

Aspiration smears-Demonstration of Iron stain

Leukemia-Interpretation of peripheral smears in leukemia

Cytochemical stains-demonstration

Haemorrhagic Disorders

Collection and anticoagulants used-demonstration

BT,CT-Demonstration

PT,INR,APTT,TT Demonstration.

Mixing Experiments-Demonstration

Test for D-Dimers-Demonstration

Assay of coagulation factors-Demonstration

Factor VIII C inhibitor study-Demonstration

CLINICAL PATHOLOGY

Examination of urine – physical and chemical

Urine for microscopy

Sputum – macroscopy, microscopic examination for eosinophils and AFB

Examination of CSF

Pregnancy tests

Stool examination – concentration and flotation methods

Examination of semen

MLT C 108: IMMUNOLOGY AND IMMUNOLOGICAL TECHNIQUES

THEORY

Unit 1

History of immunology, innate and acquired immunity, mechanisms of innate immunity, inflammation- inflammatory cells, mediators, NSAIDs, inflammatory response-types, antigens, fate of antigens in tissues, superantigens and organs of immune system, evolution of immunity.

Unit 2

Immunoglobulin : structure and function, classes and subclasses. Cryoglobulins, pyroglobulins, immunoglobulin genes-organisation and expression, antibody diversity, class switching. Monoclonal antibodies – hybridoma technique and MAb production, purification and characterisation, application in biomedical research, clinical diagnosis, treatment, drug delivery system.

Unit 3

Immune response: Clonal selection theory and related theories, primary and secondary response, humoral and cell mediated response, antigen processing and presentation, role of MHC and accessory molecules, MHC – structure and role in Ag presentation, MHC genes, Maturation, activation and differentiation of B cells and T cells, lymphocyte trafficking, TCR – structure and generation of diversity, cytokines-properties and functions, cytokine receptors, relation to diseases, therapeutic uses, cytokine antagonists, ADCC, NK cells, regulation of immune response.

Immunomodulation and vaccines: advances in the development of vaccines (eg. Haemophilus B conjugate, pertussis, cholera, malaria, hepatitis B, polio, HIV, antitumour), Adjuvants. Immunosuppressive agents.

Unit 4

Complement system: Functions, complement receptors, activation pathways, control mechanisms, role in inflammation, kinins cascade, kinins in disease.

Unit 5

Immunity against bacteria, virus, fungi and parasites

Unit 6

Immunological methods in clinical laboratories: Methods, interpretation, and applications of following methods – double diffusion in agar, single radial immunodiffusion, electrophoresis and immunoelectrophoresis, chromatography (ion-exchange, gel, affinity), MIF, TRC, Immunofixation, RIA, ELISA, Western blotting, detection of immune complexes, nephelometry, immunofluorescence, agglutination tests-direct and indirect, haemagglutination and haemagglutination inhibition, complement assays-CFT, haemolytic assays, Detection of cellular immunity – delayed hypersensitivity skin tests, assays for lymphocyte (T and B cell assays), flow cytometry, FACS, mixed lymphocyte culture, NK cells, Neutrophil function tests, histocompatibility testing.

Unit-7

Hypersensitivity reactions –Types and mechanisms

Autoimmunity: immunological tolerance, Immunological surveillance, Examples and underlying mechanisms.
Transplantation immunology
Tumor immunology
Immunology of AIDS

MLT P 111: PRACTICALS IMMUNOLOGY AND IMMUNOLOGICAL TECHNIQUES

1. Double diffusion technique
2. Radial immunodiffusion
3. Haemagglutination test
4. Haemagglutination inhibition test
5. Latex agglutination test.
6. Complement fixation test
7. Immuno-electrophoresis
8. Counter current immuno-electrophoresis
9. FITC conjugation of antibody
10. Lymphocyte culture.
11. Isolation of lymphoid organs of mice.
12. ELISA
13. RIA demonstration
14. Western blotting demonstration
15. WIDAL test
16. VDRL test
17. Demonstration and assay of B-cells and T cells.
18. CD4⁺ and CD8⁺ counts

MLT C 109: CLINICAL BIOCHEMISTRY
(Common to all specializations)

THEORY

1 CHEMISTRY OF CARBOHYDRATES

- Definition and Function
- Classification
- Isomerism of Monosaccharides
- Properties of Monosaccharides
- Modified Monosaccharides
- Polysaccharides

2. CHEMISTRY OF PROTEINS

- Definition, Function of Proteins
- Classification and Properties of Proteins
- Structural organization of proteins

3.CHEMISTRY OF LIPIDS

- Definition and Function of Lipids
- Classification of Lipids
- Properties of Lipids

4. NUCLEIC ACIDS

- Nucleotides and its bases
- DNA in detail
- RNA and its classification
- High energy compounds

5.ENZYMES

- Classification of enzymes
- Factors affecting enzyme activity
- Inhibitors
- Specificity
- Enzyme kinetics
- Enzymes in clinical diagnosis

6.CLINICAL SIGNIFICANCE : PRINCIPLES OF ESTIMATIONS

- Bilirubin general types and jaundice
- Liver function tests
 1. Bilirubin estimation(Mallory and Evelyn method, Jendrassik and Groff method direct spectrometry method)
 2. Alkaline phosphatase and Acid phosphatase estimation by King's method
 3. SGOT SGPT Reitman Frankel method
- Glucose Tolerance Test (GTT) Importance and Principles and Techniques of GTT.
- Insulin Tolerance test
- Gastric juice analysis
- Xylose absorption test
- Analysis of calculi
- Cerebrospinal fluid analysis
 1. Composition and function of CSF
 2. Clinical significance of CSF analysis
 3. Estimation of sugar and proteins in CSF

7. URINE CHEMISTRY

- automation in urine chemistry
- physical and chemical examination of urine sample .Qualitative tests for inorganic urinary ingredients
- Common qualitative and quantitative tests of urine
- Clearance tests for urine function

- 1.Electrolytes: Sodium, Pottassium, Chloride,Carbon dioxide (HCO_3^-)
total and Ionised calcium, phosphorus(inorganic) , magnesium
2. Blood gases and Ph , carboxy haemoglobin,CO, Meth Hb,Oxygen saturation
3. Disorders of carbohydrate metabolism
4. Abnormalities of proteins in plasma
5. Disorders of plasma lipids and lipoproteins
6. Blood collection procedures-theory of anti coagulation.

MLT P 112: PRACTICALS CLINICAL BIOCHEMISTRY

1. Physical and chemical analysis of urine
pH, specific gravity, osmolality, reducing substances, protein, ketone bodies, pigments
2. Urinary aminogram
3. Urinary stones and pancreatic stones
4. Creatinine tolerance test
5. Estimation of the following in blood and urine
Sugar, urea, creatine and creatinine, uric acid, calcium, phosphate
6. Electrophoresis of serum proteins.

MLT C 110: MOLECULAR BIOLOGY AND MEDICAL GENETICS

(Common to all specializations)

THEORY

Unit 1

DNA – Structure, types, coiling and supercoiling, topoisomerases, replication, satellite DNA, DNA polymerase, DNA repair, Organisation of prokaryotic and eukaryotic genome, chromosomes-structure, number, sex chromosomes, human karyotype, methods for chromosome analysis-chromosome banding, FISH, CGH, flow cytometry, Cell cycle, mitosis and meiosis.

Unit 2

Transcription and translation: factors involved RNA processing, types of RNA, genetic code, Lac operon, Tryptophan operon, regulation in eukaryotes, gene dosage and gene amplification, generation of antibody diversity.

Unit 3

Mutation: spontaneous, induced, point mutation and silent mutation, frame-shift mutation, physical and chemical mutagens, molecular basis, site directed mutagenesis, significance of mutagenesis, DNA repair, isolating mutants, Ames test.

Unit 4

Recombinant DNA technology: necessary elements – enzymes and their properties, DNA ligase, DNA modifying enzymes, cloning vectors – plasmids, cosmids, bacteriophages, shuttle vectors, expression vectors, construction of rDNA and cloning strategies – various methods, genomic libraries (eg. Using phage vectors), cDNA libraries, introduction of rDNA into host-methods, restriction maps and sequencing.

Unit 5

Genetics in medicine: Haemoglobin and haemoglobinopathies, phenylketonuria, alkaptonuria, homocystinuria, Lesch-Nyhan syndrome, genetics of cancer, Down's syndrome, Di-George syndrome, Klinefelters syndrome, Turner's syndrome, Hermaphroditism, cystic fibrosis, haemophilia, prenatal diagnosis of genetic diseases, application of recombinant DNA technology in medicine-PCR, RFLP, DNA finger printing, therapeutic proteins, vaccines, antibodies, transgenic organisms, gene therapy, human genome project.

MLT P 113: PRACTICALS MOLECULAR BIOLOGY AND MEDICAL GENETICS

2. Isolation of DNA and RNA from bacterial cells
3. Estimation of DNA and RNA
4. Isolation of plasmids from bacterial cells
5. DNA electrophoresis
6. Study of mitotic stages-onion root tip
7. Study of meiotic stages-grass hopper testes
8. Preparation of polytene chromosomes
9. Demonstration of PCR and southern blotting
10. Karyotype preparation
11. Bacterial gene expression using lac promoter system

MLT C 115: IMMUNOPATHOLOGY

(Common to all specializations)

THEORY

Unit 1

Mechanism of Ab-mediated inactivation: direct and indirect Eg. Diabetes mellitus, thyroid diseases, pernicious anaemia, polyendocrinopathy, infertility, haemophilia, myasthenia gravis, anti-idiotypes and diseases.

Unit 2

Immune deficiency disorders

Unit 3

Immunohaematologic diseases: Transfusion reactions, erythroblastosis foetalis, warm-antibody diseases, cold-antibody diseases, drug and haemolytic diseases, agranulocytosis, thrombocytopenic purpura, immune suppression of blood cell production, vascular purpura, demonstration of cytotoxic antibodies in vitro

Unit 4

Immune complex reactions : arthus reaction, serum sickness, glomerulonephritis, skin diseases mediated by immune complexes, evaluation of circulating immune complexes.

Unit 5

Connective tissue diseases: Polyarthritis, SLE, dermatomyositis, rheumatic fever, rheumatoid arthritis, progressive systemic sclerosis.

Unit 6

Atopic anaphylactic reactions : reaginic antibody, anaphylaxis, atopic allergy – factors involved, asthma, hay fever, food allergy, insect allergy, atopic eczema, delayed hypersensitivity reactions, contact dermatitis, viral infections, graft-host relationship in pregnancy

Unit 7

Autoallergic diseases: encephalomyelitis, multiple sclerosis, orchitis, thyroiditis, Sjogren's syndrome.

Unit 8

Granulomatous reactions: infectious diseases like tuberculosis, leprosy.

Unit 9

Auto immune diseases – organ specific and systemic

Unit 10

Immuno modulators

Unit 11

Clinical transplantation – Kidney, Bone marrow, Heart

Unit 12

Immunology of AIDS, Tumour and Transplantation.

Unit 13

Immunohaematology – compatibility testing

MLT P 117: PRACTICALS IMMUNOPATHOLOGY

1. Serological (screening and diagnostic) tests used in different pathological conditions.
2. Delayed type hypersensitivity testing.
3. Detection of tumour markers
4. Histocompatibility testing
5. Blood grouping and cross matching.
6. Coomb's test – Direct & Indirect

SPECIALIZATION - I CLINICAL BIOCHEMISTRY

MLT C 116: VITAMINS, HORMONES AND ENZYMES

THEORY

Unit 1

Vitamins : Chemistry, properties, biological importance and deficiency manifestations of fat soluble vitamins. Chemistry, properties, biological importance, deficiency manifestations and coenzyme functions of water soluble vitamins, estimation of vitamins.

Unit 2

Hormones : Classification of hormones, mechanism of hormone action, regulation of hormone secretion Chemistry, metabolism, biological functions and disorders of-Thyroid hormones, Parathyroid hormones, Pancreatic hormones, Adrenal hormones, Gonadal hormones, Pituitary hormones, GIT hormones

Unit 3

Enzymology: Classification, co-enzymes, cofactors, mechanisms of enzyme action, factors affecting enzyme action, enzyme kinetics, enzyme inhibition, regulatory enzymes, enzyme immobilization. Clinical Enzymology.

MLT P 118: PRACTICALS VITAMINS, HORMONES AND ENZYMES

1. Estimation of ascorbic acid in food and biological fluids.
2. Estimation of amylase, lipase, G6PD, GGT, Troponin
3. Estimation of T3, T4, TSH, FT₃, FT₄, Thyroglobulin
4. Estimation of Cortisol in blood
5. Estimation of FSH, LH, Prolactin and oestradiol

SPECIALIZATION II : MICROBIOLOGY AND IMMUNOLOGY

MLT C 116: VIROLOGY, MYCOLOGY AND PARASITOLOGY OF DISEASES

THEORY

Unit 1

Virology : Systematic study of the following viruses : their biological properties, pathogenicity, epidemiology, isolation and identification from clinical specimens, lab diagnosis and treatment, immunoprophylaxis against Parvoviruses, Adenoviruses, Herpes viruses, Pox viruses, Hepatitis viruses, Picorna viruses, Rota viruses, Orthomyxoviruses, Paramyxoviruses, Rubella viruses, Rabies viruses, Arboviruses, Papova viruses, HIV, Oncogenic viruses

Unit 2

Mycology : Systematic study of following fungi : Epidemiology, pathogenesis, laboratory diagnosis, treatment and prophylaxis.

Superficial mycoses-Pityriasis versicolor, Tinea nigra, Piedra, Dermatophytes,

Subcutaneous mycoses – Mycetoma, Sporotrichosis, Chromoblastomycosis, Phaeohyphomycosis, Rhinosporidiosis, Lobomycosis,

Systemic mycoses- Histoplasmosis, Blastomycosis, Coccidioidomycosis, Paracoccidioidomycosis,

Opportunistic mycosis- Cryptococcosis, Candidiasis, Aspergillosis, Zygomycosis, Keratomycosis and Otomycosis, Allergic fungal diseases, Mycotoxicosis and Mycetismus

Unit 3

Parasitology

Study of morphology, important developmental stages, symptoms, pathogenesis, epidemiology, diagnosis, treatment, prevention of following parasites.

Entamoeba, Naegleria, Giardia, Trichomonas, Balantidium, Isospora, Cryptosporidium, Malarial parasites, Trypanosoma, Leishmania, Toxoplasma gondii, Pneumocystis carinii, Schistosoma, Paragonimus, Diphyllbothrium, Taenia, Ascaris, Enterobius, Ancylostoma, Trichuris trichiuri, Wucheraria, Dracunculus, Trichinella spiralis.

MLT P 118 PRACTICALS: VIROLOGY, MYCOLOGY AND PARASITOLOGY OF DISEASES

1. Common diagnostic tests used for detection of viral infections
2. Cell culture methods
3. Identification of fungal pathogens in clinical specimens.
4. Calcaufluor staining for fungus
5. Diagnostic tests for detection of parasitic infections- methods for demonstration of parasites in clinical specimens
6. Preparation of blood smear for detection of malarial parasites
7. Preparation of blood smear for detection of filarial parasites.

SPECIALIZATION III- HAEMATOLOGY AND TRANSFUSION TECHNOLOGY

MLT C 116: HAEMATOLOGY

THEORY

Unit 1

- a. Haematopoiesis ; origin, development, functions and fate of blood cells.
erythropoiesis, Biosynthesis of Hb, Control of erythropoiesis, polycythemia, Aplastic anaemia, pancytopenia.
- b. Anaemia – Definition, Clinical features, Pathophysiology – diagnostic strategy of anaemia in general

Unit 2

- Megaloblastic anaemia
Pernicious anaemia and other causes of Vitamin B12 and Folate deficiency.
Inherited and drug induced

Unit 3

- Disorders of iron metabolism and haeme synthesis
Iron deficiency anaemia
Anaemia of chronic disorder
Sideroblastic anaemia
Porphyrias

Unit 4

- Haemolytic anaemia – General considerations, Pathogenesis, Classification Clinical features, Lab findings, Diagnostic approach to haemolytic anaemia in general

Unit 5

- Inherited haemolytic disorders.
Defect in erythrocyte membrane- HS, HE
Defect in erythrocyte glycolytic enzyme – G6PD, Pyruvate Kinase
Defect in globin structure and synthesis –
Haemoglobinopathies, Thalassemia

Unit 6

- Acquired haemolytic disorders.
Immune haemolytic anaemia
Traumatic/ Microangiopathic haemolytic anaemia
Infection/chemical agents/physical agents/drugs

Unit 7

- Haemostasis
Platelets in haemostasis and thrombosis
Blood coagulation and fibrinolysis
Regulation of haemostasis

Unit 8

- Disorders of haemostasis and coagulation
Thrombocytopaenia- pathophysiology, classification,

Diagnosis of ITP
Thrombocytosis
Qualitative disorders of platelets
Coagulation disorders
Inherited-haemophilia A & B, von Willibrands
Acquired- Vitamin K
Bleeding disorder caused by vascular abnormality

Unit 9

White blood cell disorders Leucopenia, leucocytosis, Leukaemoid reactions, acute leukaemia, FAB classification and diagnostic criteria, REAL classification, clinical features, Lab features.

Classification of myeloproliferative disorders-general Feature CML in detail
Classification of lymphoproliferative disorders- general features, CLL in detail

Unit 10

Plasma cell disorders : classification, general features, multiple myeloma, Walden Stromes macroglobulinemia

Unit 11

Recent advances in haematology, Molecular techniques in Haematology
Immunological basis of Haematological disorders, Quality control in Haematology
8. Automation in Haematology.

MLT P 118 : PRACTICALS HAEMATOLOGY

1. Routine learning of peripheral smear and bone marrow
2. Vitamin B₁₂ assay,
3. Folate-serum, red cell
4. Deoxyuridine suppression test
5. Serum iron, serum ferritin, TIBC, Marrow iron stain
6. Plasma Hb, Foetal Hb, Hb electrophoresis
7. Microcolumn chromatography for quantitative estimation of Hb
8. Sickling test
9. Solubility test.
10. Detection of enzyme deficiencies like G6PD.
11. Hams test, osmotic fragility with incubation
12. Glycerol lysis test
13. Leukaemia-cytochemical and immunohistochemical stains, peroxidase,
 - a. SB, PAS, esterase, leucocyte alkaline phosphatase,
 - b. Immunohistochemical stains for various markers to type
 - c. leukemia
14. Plasma cell disorders- serum electrophoresis/immunoelectrophoresis
15. Bleeding disorders- PT, PTTK,TT, Platelet count, INR,
 - a. Prothrombin index, Fibrinogen estimation,
 - b. Factor assay, Clot retraction, Euglobulin
 - c. lysis time, FDP, Platelet function test,
 - d. Platelet aggregation

SPECIALIZATION - I CLINICAL BIOCHEMISTRY

MLT C 122: DIAGNOSTIC BIOCHEMISTRY AND ORGAN FUNCTION TESTS

THEORY

Unit 1

HEPATO BILIARY FUNCTION TESTS

- Clinical utility of measuring hepatic enzymes (e.g. aspartate aminotransferase, alanine aminotransferase, gamma-glutamyltransferase, alkaline phosphatase, and lactate dehydrogenase).
- The biochemical assessment of liver function by nonenzyme analytes such as albumin, ammonia, bile acids, bilirubin, urea nitrogen, cholesterol, total protein, and triglycerides.
- Bilirubin metabolism, fractionation of bilirubin (conjugated, unconjugated, (delta)-bilirubin, direct vs indirect) and unique aspects of neonatal bilirubin. Understand the conditions and genetic defects that affect bilirubin metabolism, transport and clearance (e.g., Gilbert disease and Dubin-Johnson syndrome).
- Jaundice.

Unit 2

RENAL FUNCTION TESTS

- Basic physiology of renal function. The basic categories of renal diseases (e.g. pre renal azotemia, obstructive azotemia, glomerulonephritis, acute vs chronic renal failure, uremic syndrome) The laboratory analytical methods (e.g. Jaffe vs creatinase) for the assessment of renal function (creatinine, urea nitrogen glomerular filtration rate) and proteinuria. The concept of creatinine clearance, how it can be used to estimate glomerular filtration rate and the various methods employed to measure it. Renal handling of electrolytes and key metabolites and the interpretation of urinary electrolyte measurements.
- The definition of osmolality, molecules in serum that contribute to osmolality, and calculation of osmolal gap as well as the principle of the osmometer. The common pitfalls and sources of error during estimation of the osmolal gap (e.g. hyperproteinemia, hyperlipidemia, hypermagnesemia). The differential diagnosis of an unexplained, increased osmolal gap, including alcohol or glycol ingestion, alcoholic or diabetic ketosis or ketoacidosis, and osmotherapy (e.g. mannitol or glycerol administration), among others. The principles of fluid balance.

Unit 3

GASTRIC & PANCREATIC FUNCTION TESTS

- Clinical manifestations of gastric, pancreatic, and intestinal disease and diagnostic methodologies such as the breath tests for *Helicobacter pylori*, faecal occult blood, lipase and amylase (e.g. fractionation of amylase; pancreatic vs salivary and amylase/creatinine clearance ratio)
- Role of gastrointestinal hormones and enzymes in digestion and the evaluation of malabsorption and diarrheal syndromes.

Unit 4

ACID-BASE CHEMISTRY WATER AND ELECTROLYTES BALANCE

- Define the Henderson-Hasselbach equation. Physiologic buffers systems and the role of respiratory and renal compensation. Categories of clinical disorders of acid-base balance (metabolic and respiratory acidosis, metabolic and respiratory alkalosis, mixed disorders) Blood gas analysis.
- The differential diagnosis of common electrolyte disorders

Unit 5

TUMOR BIOMARKERS

- The definition, classification, biochemistry and distribution of tumor markers, both protein and carbohydrate, including, but not limited to, prostate-specific antigen, calcitonin, human chorionic gonadotropin, alpha fetoprotein, carcinoembryonic antigen CA15-3, CA 125, and CA19-9.
 - Limitations of laboratory assessment of various tumor markers and the factors affecting the results of different analytical procedures.
 - Conceptual basis of assays used to screen for malignancy, including Bayes theorem.
- Recent developments in identifying proteomic patterns for cancer detection.

Unit 6

Mineral metabolism and its disorders

Absorption, biochemical roles, requirements, deficiency manifestations of bulk, trace and ultra trace elements, effects of toxic metals

Sodium and potassium, chlorine, phosphorus, magnesium, sulphur, calcium, copper, zinc iron, manganese, molybdenum, cobalt, selenium, Iodine, fluorine , chromium

MLT P 124 : PRACTICALS DIAGNOSTIC BIOCHEMISTRY AND ORGAN FUNCTION

TESTS

1. Estimation of alpha fetoprotein
2. Estimation of creatine kinase, LDH
3. Biochemical tests for assessing the following
Pancreatic function, gastric function, kidney function, liver function, renal function
4. Analysis of body fluids, CSF, pleural, peritoneal, pericardial, synovial
5. Blood gas analysis
6. Estimation of PSA, BHCG, CEA, CA125
7. Estimation of iron, ferritin, TIBC and transferrin
8. Estimation of sodium, potassium, chloride, calcium, phosphorus
9. Estimation of copper, ceruloplasmin

SPECIALIZATION - I CLINICAL BIOCHEMISTRY

MLT C 123: METABOLISM, INBORN ERRORS OF METABOLISM AND ADVANCED CLINICAL BIOCHEMISTRY

THEORY

Unit 1

Carbohydrate metabolism : details of metabolic pathways involving carbohydrates in mammals, Embden-Mayerhof pathway, hexose monophosphate shunt pathway, other minor pathways, fructose and galactose metabolism, digestion and absorption, blood glucose homeostasis, Clinical features and laboratory findings in insulin resistance, Type 1 , Type 2 and gestational diabetes mellitus; diagnostic and monitoring criteria for diabetes; investigation of hypoglycemic syndromes.

Glucose tolerance test procedures and interpretation ; in pregnancy.

Ketosis and lactic acidosis.

Differential diagnosis of coma; hyperosmolar coma .

Hemoglobin A1C ; fructosamines, C-peptide.

Insulin tolerance test; glucagon and somatostatin

Use and dangers of provocative tests e.g tolbutamide and glucagon.

Albuminuria, Antibodies (anti- GAD, Anti-insulin, etc).

Unit 2

Amino acid metabolism : Protein digestion and absorption, absorption of amino acids, metabolism of individual amino acids.

Clinical features and laboratory findings in disorders of the plasma proteins; acute phase

Proteins Serum protein and albumin, serum and urine protein electrophoresis.

Causes of hypoalbuminemia; hypo-and hyperglobulinemias. Alpha-1-antitrypsin deficiency.

Amino acidurias, screening test for amino acid disorders.

Methods for protein detection in body fluids.

Unit 3

Lipid metabolism : digestion and absorption, transport and storage, fatty acid synthesis, fatty acid oxidation pathways, biosynthesis of phospholipids, glycolipids, cholesterol metabolism, plasma lipoprotein metabolism,

Clinical features and laboratory findings in disorders of triglycerides, lipoproteins and cholesterol metabolism.

Investigation and principles of treatment of hyperlipidemias.

Assessment of risk factors for atherosclerosis.

Lipoprotein(a), lecithin: cholesterol acyltransferase (LCAT).

Lipid profile, Separation of lipoproteins

Unit 4

Nucleotides and their bases, DNA, RNA, High energy compounds, major role of purines and pyrimidines, Purine and pyrimidine metabolism: synthesis and degradation of bases and nucleotides, gout

Unit 5

Energy metabolism and nutrition:

Food calories, RQ, BMR, calorie requirements, proteins in nutrition, fats in nutrition, carbohydrates in nutrition, fibers in nutrition, protein - energy malnutrition, starvation balanced diet, diet for normal adults, pregnant women, children etc.

Unit 6

Inborn errors of : carbohydrate metabolism, lipid metabolism, protein and amino acid metabolism, nucleic acid metabolism, vitamins and mineral metabolism, hormone metabolism, neurotransmitter metabolism.

Unit 7

PEDIATRIC CLINICAL BIOCHEMISTRY

Problems of specimen collection; capillary specimens.

Reference range differences in infants and children: Those that vary significantly with age and sex (inorganic phosphorus, creatinine, alkaline phosphatase, aspartate aminotransferase, creatine kinase).

Special problems in pediatrics: Respiratory distress syndrome, gastrointestinal disease (fat absorption, disaccharide intolerance, protein-losing enteropathy, neonatal hyperbilirubinemia; cystic fibrosis; neuroblastoma (VMA, HIAA);, Heavy metal poisoning in children, biochemical changes during pregnancy

Unit 8

Diseases of CNS and CSF analysis

Unit 9

Biochemistry of ageing, Alzheimers disease, Prions, Beta amyloid, acute phase proteins

Unit 10

Point of care testing, enzyme histochemistry

Unit 11

THERAPEUTIC DRUG MONITORING OF SPECIFIC DRUG CLASSES

- The principles and practice of therapeutic drug monitoring of antidepressants, mood stabilizers, and antipsychotics; anticonvulsants; cardioactive drugs; bronchodilators; antibiotics; and immunosuppressants.
- The relative significance of peak and trough levels for monitoring of these drug Classes

**MLT P 125 PRACTICALS; METABOLISM, INBORN ERRORS OF METABOLISM AND
ADVANCED CLINICAL BIOCHEMISTRY**

1. Detection/estimation of C reactive proteins
2. Detection of hypolipoproteinaemias and hyperproteinaemias
3. Investigation of alkaptonuria, cystinuria, pentosuria, glycogen storage diseases, galactosaemia.
4. Estimation of VMA, HIAA, 17 Keto steroids
5. Estimation of therapeutic drugs-digoxin, phenytoin, carbamazepine, phenobarbitone, lithium.

SPECIALIZATION - II : MICROBIOLOGY AND IMMUNOLOGY

MLT C 122: SYSTEMATIC BACTERIOLOGY

THEORY

Unit 1

Systematic study of morphologic, cultural, biochemical and antigenic characters, epidemiology, pathogenesis, lab diagnosis, treatment, and prophylaxis of following bacterial pathogens.
Staphylococci, Streptococci, Pneumococci, Neisseria

Unit 2

Corynebacterium, Bacillus, Mycobacterium, Clostridium, Non-sporing anaerobes

Unit 3

E.coli, Klebsiella, Salmonella, Shigella, Proteus, Vibrio, Pseudomonas, Pasteurella, Francisella, Haemophilus, Brucella

Unit 4

Spirochaetes,

Unit 5

Listeria, Erysipelothrix, Alcaligenes, Campylobacter, Acinetobacter, Rickettsiae, Chlamydiae, Mycoplasma, Actinomycetes.

MLT P 124 PRACTICALS : SYSTEMATIC BACTERIOLOGY

Study of morphological, cultural and biochemical characters of common bacterial pathogens.

SPECIALIZATION II : MICROBIOLOGY AND IMMUNOLOGY

MLT C 123: CLINICAL MICROBIOLOGY

THEORY

Unit 1

Normal flora of human body

Unit 2

Collection, transport, Processing of specimens for diagnosis of bacterial, viral and fungal infections in following cases

Respiratory tract infections, Gastrointestinal tract infections, Genital tract infections, CNS infections, Wound and abscesses, Eye, ear and sinus infections, Infections of the blood, Tissue samples for culture.

Biological safety in clinical laboratory. Quality control, Modern techniques employed in clinical laboratory.

Unit 3

Nosocomial infections : epidemiology, bacterial and viral infections, infections in paediatric patients, surveillance and control programmes, organizations and associations involved, role of microbiology lab in prevention and control, device-associated intravascular infections and its control, sterilisation, disinfection and antisepsis in hospitals

Unit 4

Respiratory tract infections: aetiology, transmission, pathogenesis, epidemiology and clinical features of the following

Upper respiratory tract- Common cold, pharyngitis and tonsillitis, otitis and sinusitis, acute epiglottitis, oral cavity infections, laryngitis and tracheitis, diphtheria

Lower respiratory tract- whooping cough, bronchitis, RSV infections, bacterial pneumonia, viral pneumonia, tuberculosis, cystic fibrosis, lung abscesses

Diagnosis of respiratory tract infections.

Unit 5

Urinary tract infections

Bacterial, viral and fungal infections of urinary tract-aetiology, pathogenesis, transmission, clinical features, complications and diagnosis.

Sexually transmitted diseases -Aetiology, transmission, clinical features, and diagnosis of syphilis, gonorrhoea, chlamydial infections, HIV, bacterial vaginosis, genital herpes, papilloma virus infections, opportunistic STDs.

Unit 6

Gastrointestinal tract infections : Aetiology, pathogenesis, clinical features and diagnosis of diarrheal diseases (bacterial and viral), H.pylori, food poisoning, parasites in the GI tract, systemic infections from GI tract.

Unit 7

Central nervous system infections : meningitis caused by bacteria, virus, fungi and protozoa, viral encephalitis, brain abscesses, tetanus, botulism.

Unit 8

Infections of the skin, ear and eye : Aetiology, transmission, diagnosis and prevention.

Unit 9

Microbiology of air, water and milk: common pathogens encountered, methods for microbial analysis, methods for purification

Unit 10

Infection affecting the cardiovascular systems and body cavities, and their diagnosis.

MLT P 125: PRACTICALS CLINICAL MICROBIOLOGY

Study of normal flora of human body

Isolation, characterization and identification of pathogens from various clinical specimens

Study of antibiotic sensitivity of common pathogens – Disc diffusion, MIC

Assay of antimicrobial agents in body fluids

Study of microbial flora of air in various localities

Microbial analysis of water

Microbial analysis of milk.

Procedure for skin clipping for *Mycobacterium leprae* bacilli

Preservation of stock culture

SPECIALIZATION III HAEMATOLOGY AND TRANSFUSION TECHNOLOGY

MLT C 122: TRANSFUSION TECHNOLOGY

THEORY

1. History of Transfusion Medicine
2. Blood groups and genetics
ABO System- ABO sub groups
Bombay group, secretors, non secretors. Rh system - Importance of Rh system
Du red cells (A variant of Rh system)
MNS system - clinical significance
3. Blood transfusion- indications for blood transfusion
4. Blood donation, Donor registration, Donor selection, Blood collection. Adverse donor reaction
5. Anticoagulants used to store blood
Changes occurring in the stored blood
6. Blood group systems-antigen-antibody reaction, ABO system-forward grouping reverse grouping
7. Rh system inheritance&nomenclature Rh grouping- Rh antigen and antibodies, Du Variant Anti D type of reagents and their application
8. Coomb's test- Application- DCT, ICT Rh antibody titre
9. Compatibility testing- Major
Minor
Coomb' s cross match ,Computer crossmatch
- 10 . Antibody titration
11. Preparation and quality control of antiserum

MLT P 124: PRACTICALS TRANSFUSION TECHNOLOGY

1. Blood grouping- ABO grouping, forward grouping (slide&tube method)
2. Reverse grouping - preparation of pooled A,B & O cells
3. Grading of Reaction. Other methods of grouping
4. ABO antibody titration, Cold antibody titration.
5. Rh grouping & Rh typing (slide & tube method)
6. Du Testing
7. Rh-antibody titration
8. Antiglobulin Testing- Direct and Indirect
9. Preparation of Coomb' s Control Cells.
10. Compatibility Testing
11. Selection of blood
12. Crossmatching Technique- Major, Minor, Saline, Albumin, Coomb's
13. Emergency - Cross matches

SPECIALIZATION III HAEMATOLOGY AND TRANSFUSION TECHNOLOGY

MLT C 123 : ADVANCED TECHNIQUES IN BLOOD BANKING

THEORY

- 1.Recent advances in Blood banking
- 2.Amniocentesis
3. Transplantation science
4. Flow cytometry
5. Blood components- Indications preparation of blood components
6. Autologous transfusion
- 7 Transfusion transmitted disease
- 8 Haemolytic disease of the new born and exchange transfusion
- 9 Transfusion Therapy
- 10 Transfusion in special situations-Auto immune haemolytic anaemia
- 11 Transfusion reactions and investigations of transfusion reaction
12. Transfusion transmitted infections
13. Immuno modulation and graft versus host reactions
14. Haemapheresis-Definition, types of Pheresis, Machines and Techniques
15. Tissue banking
16. Cord blood banking
17. Stem cell processing storage and transplantation
18. Disposal of wastes and biologically hazardous substance in the blood bank
19. Medico legal aspects of blood transfusion
- 20 Technical advances and future trends in blood banking
21. Paternity testing
- 22 Orientation of a routine blood bank
23. Quality Assurance- General condition
 - Equipment
 - Reagents
 - Donor processing
24. Drugs control regulation and Blood Bank
- 25.Laboratory control of anticoagulant, thrombotic and platelet therapy,Immuno phenotyping

MLT P 125: PRACTICALS ADVANCED TECHNIQUES IN BLOOD BANKING

1. Donor selection
2. Blood collection [Phlebotomy]
3. Post donation Care
4. Preservation and Storage of blood
5. Preparation and Storage of blood Components
6. Packed cells, Fresh Frozen plasma [FFP], Platelet Concentrate, Cryoprecipitate
7. Component transfusion - selection of blood group
8. Crossmatching in Special Situations
9. Exchange transfusion- selection of blood group
10. Autoimmune haemolytic anaemia
11. Investigation of Blood Transfusion reaction
12. Testing for transfusion Transmitted Diseases.
13. ELISA-HIV, HBsAg, HCV, VDRL Test, Malaria

- 14. Quality control-Methods,Reagents,Test methods,Products,Documents,Equipment
- 15. Apheresis procedures- Types of pheresis, Machines and Techniques

NB: Teaching and training will be organized in collaboration with major research institutions/ hospitals/ Medical Colleges.

MLT C 126 – PROJECT

Students in the Fourth Semester after completion of their Practical/ Clinical Training will progress to the curricular Research Project. Each student is required to undertake and carry out a brief research work on a topic in Bio-Medical Sciences of current importance. After completion of the research project in the stipulated time, each student has to submit 3 hard copies and 2 soft copies of the dissertation report of the work before registering for the final Semester Examinations.

M.Sc. MEDICAL LABORATORY TECHNOLOGY- ELECTIVES

1.ETHICAL CONSIDERATIONS IN MEDICAL RESEARCH

1. Ethical consideration in medical research
2. Recent development of various ethical guidelines
Principles of essentiality, voluntariness, informed consent and community agreement.
Principle of non exploitation and professional competence
Principle of precaution and risk minimization, principle of accountability and transparency,
principle of maximization of the public interest and distributive justice, principle of institutional arrangements
3. Ethical committee
4. Ethical and legal issues in research involving human and animal subjects
5. Handling of laboratory animals
- 6 .Intellectual property rights- general aspects and perspective
7. Post trial access
8. Intellectual property rights and patenting

2. LABORATORY INFORMATICS, SUPPLY AND INSTALLATION OF LABORATORY EQUIPMENTS AND REAGENT PRODUCTION

1. Laboratory information systems (LIS). Hospital information systems (HIS).
2. E-Health and Telemedicine
2. Laboratory Data Processing:

General principles of methods for reduction of data into forms suitable for electronic data handling systems (computerized accessioning functions, sample identification and tracking (e.g. bar code systems) result reporting storage and retrieval, electronic data transfer).

3. Design simple digital systems.

Use basic digital tools and devices such as digital oscilloscopes , PALS, PROMS and VHDL .

Work in a design team that can propose, design, successfully implement and report on a digital circuit design.

4. Communicate purpose and results of a design project in written and oral presentation.
5. Preparation assessment and storage of antisera (Polyclonal and monoclonal)
6. Methods of assessing analytical sensitivity ,specificity and standardization
7. Reagent Production -Manufacturing, storage and handling (Also reagent kit production)
8. Basic electricity and electronics
9. SOP of installation and maintenance of laboratory equipments
10. Public relation; laboratory personnel and industry

3.BIOSTATISTICS & RESEARCH METHODOLOGY

1. Introduction to Biostatistics

Definition, role of statistics in health, science and health care delivery system

2. Sampling Population, sample, sampling, reasons for sampling, probability and non probability sampling

Methods of probability sampling-simple random, stratified, systematic-procedure, merits and demerits, Use of random number table.

3. Organization of data

Frequency table, histogram, frequency polygon, frequency curve, bar diagram, pie chart

4. Measures of location Arithmetic mean, median, mode, quartiles and percentiles definition computation(for raw data) merits, demerits and applications.

5. Measures of variation

Range, inter-quartile range, variance, standard deviation, coefficient of variation definition computation (for raw data), merits demerits and applications

6. Basic probability distributions and sampling distributions

Concept of probability distribution. Normal, Poisson and Binomial distributions, parameters and application. Concept of sampling distributions. \standard error and confidence intervals. [Skewness and Kurtosis]

7. Tests of significance:

Basic of testing of hypothesis- Null and alternate hypothesis, type I and type II errors, level of significance and power of the test, p value.

Tests of significance (Parametric)-t-test(paired and unpaired), Chi square test and test of proportion, one way analysis of variance.

8. Correlation and Regression:

Scatter diagram, concept and properties of correlation coefficient, examples (No computation simple correlation) Pearson's and spearman's, testing the significance of correlation coefficient. Linear and multiple regression.

9. Research methodology :

The aim of this Module is to provide the student with experience of research methods and techniques while working alongside research laboratory staff on a designated research

project.

By the end of this study Module students should be able to:

- (i) Design, carry out, write up and critically appraise a selected research topic:
- (ii) Demonstrate knowledge of skills in appropriate research laboratory practices;
- (iii) Carry out a range of laboratory techniques using appropriate methodologies.

These module are intended for students who wish to learn research methods and techniques and perhaps do a PhD in the future. Some experience of laboratory practice would help the student to take full advantage of this module, although in most instances students will be fully trained in all necessary techniques.

This is a module designed to introduce to a variety of research techniques and to give them the opportunity of using these techniques in conducting a novel research project. Each student will choose an individual research project and will be directly supervised by an expert in the field. This Module will necessitate long working hours in some cases and may involve some students studying at institutions other than the parent Institution.

This module is entirely laboratory based, with no formal teaching or lectures. Teaching is on a one-to-one basis with a designed supervisor. Students must be highly motivated and be prepared to work long hours in order to make a success of this module.

Reviewing the literature

This Study Module aims to describe and illustrate the methods available for identifying and reviewing quantitative and qualitative literature.

By the end of the Study Module students be able to:

Carry out an appropriate, rigorous review of the literature; and understand the strengths and weakness of different methods of identifying, assessing and synthesizing literature.

This module will cover all stages in carrying out an appropriate and rigorous review.

1. Planning the review: the role of the literature review and specification of the task
2. Identification of the relevant literature, both published and unpublished: developing a search strategy and using bibliographic databases
3. Appraising the literature: methods for assessing the quality of quantitative and qualitative research.

4. Synthesizing the evidence: integration of the evidence using both quantitative and qualitative methods; principles of meta-analysis.

Formulating recommendations and writing the review.

Using some of the databases available through the RGUHS' s HELINET network. The format of the seminars will encourage both a practical application and critical appraisal of methods. Each student can choose his or her own topic and question for their assessed literature review. Students should consider possible topics and questions in preparation for the Study Module. There will be three sessions during the Study Module for general advice on the assessment.

4.CYTOLOGY AND HISTOPATHOLOGY

CYTOLOGY

1. Morphology and physiology of cells

Identification of mammalian cells

Epithelial cells – types and functions

Immune system – macrophages, lymphocytes and plasma cells.(cellular immunity)

2. Cellular response to injury- cell m\necrosis and apoptosis

3. General pathology and cytology of tumors

Difference between benign and malignant tumors cell cells

Classification and nomenclature of human tumors

Grading of tumors

4. Collection ,preservation, fixation and processing of various cytological specimens

Preparation and quality control of various stains and reagents used in cytology

Routine and special staining staining techniques in cytology

FNAC

Immunocytochemistry

Flow Cytometry

5. Normal and abnormal cytology of :

FGT, UT, GIT, RT, effusion, miscellaneous fluids, biopsy and autopsy specimens.

6. Quality control and recent advances in cytology ,Image analysis, Insitu hybridization.

7. Structural and molecular organization of chromosomes

Identification of human chromosomes

Karyotyping

Blood culture and bone marrow culture

Banding techniques

Lyon's Hypothesis, Sex chromatin, heterochromatin, euchromatin

Autoradiography of human chromosomes

Chromosomal abnormalities

HISTOPATHOLOGY

1. Organisation of Histology Laboratory
2. Histological equipments
3. Reception and recording of tissue specimen
4. Tissue processing and Microtome including frozen sections
5. Theory of staining
6. Preparation and quality control of all routine and special stains used in Histopathology
7. All staining techniques and their interpretation
8. Immunohistochemistry
9. Molecular markers of malignant neoplasms
10. Molecular techniques
11. Immunofluorescent techniques
12. Enzyme histochemistry
13. Museum techniques
14. Autopsy Techniques
15. Automation in Histological Techniques

5.ADVANCED CLINICAL MICROBIOLOGY

1. Automation in microbiology- Stand alone and system automation
2. Laboratory safety, Types of safety hoods- classification, international standards and Quality control of Microbiological laboratory
3. Drugs and delivery system- efflux mechanisms
4. Ethical issues in vaccination- failures of vaccination, government policies and legal issues
5. Recent advances
6. Application of new diagnostic methods
7. Recent immunological techniques in the identification of microbial infections
8. Molecular diagnostics in clinical microbiology
9. Egg inoculation techniques in virology
10. Emerging microbial diseases
11. Antigenic variations
12. Accidental infections.
13. Epidemiological studies
14. Analysis of mycotoxins in food and human samples; study of other microbial toxins in the same

6.ORGAN SPECIFIC METABOLISM AND CLINICAL TOXICOLOGY

1. Heart- cardiac energy, metabolism in health and diseases
2. Understanding correlation of cardiac metabolism at the molecular level- transcriptional and translational changes
3. CNS- neurons, chemical changes, drug effects and monitoring of treatment.
4. Bone and bone marrow- metabolism and cytological changes, stem cell research
5. Reproductive system (male& female)– reproductive health, hormonal actions and other metabolic pathways, infertility and contraceptives.
6. Xenobiotics
7. Clinical toxicology-screening procedure for the detection of drugs, pharmacology and analysis of specific drugs and toxic agents. Drugs of abuse.
8. Autopsy samples, chemical analysis
9. Tissue poisoning, analysis of pesticide poisoning samples

RECOMMENDED BOOKS

BIOCHEMISTRY

1. 1.Biochemistry by Geoffrey L Zubay, Fourth Edition, 1998
2. Fundamentals of Biochemistry by Donald Voet, Judith Voet and Pratt, second edition,
3. 1995
4. Biochemistry – Lubert Stryer
5. Harper’s Biochemistry by Murray et al. Appleton and Lange Publishers, 27h edition,2006
6. 5.Principles of Biochemistry by Lehninger, Nelson and Cox, fourth edition, W H Freeman And Company, New York, USA, 2005
7. Textbook of Biochemistry by West and Todd, Fourth Edition, 1966
8. Text book of clinical chemistry - Teitz
9. Varley’s Practical Clinical Biochemistry by Alan H Gowenlock, published by
- 10.CBS
- 11.Publishers and distributors, India Sixth Edition
- 12.Practical Biochemistry – Wilson & Walker
- 13.Clinical chemistry – Marshal
- 14.Clinical Biochemistry Principle and Practice – Praful B Godkar
- 15.Lecture notes on Clinical chemistry – L.G.Whitby
- 16.Clinical Chemistry – Kaplan
- 17.Clinical chemistry in diagnosis and treatment – Philip D Mayne
- 18.Clinical Chemistry – Michael L Bishop
- 19.NMS Biochemistry
- 20.Immunology: Janis Kuby fourth edition, W H Freeman Company, USA (2000)
- 21.Essential Immunology: Ivan Roitt (Blackwell Science Publishers, UK, 1997)
- 22.A Hand Book of Practical Immunology: GP Talwar (Vikas Publishing House, 1983)
- 23.Principles of Statistics.
- 24.21.Fundamentals of Biostatistics:Veer Bala Rastogi
- 25.22.Methods in Biostatistics for medical students & research works: B. K Mahajan

MICROBIOLOGY

1. Topley & Wilsons – Microbiology & Microbial Infections – 9th Edition
2. Leslie Collier, Albert Balows, Max Sussman – Volume I, II, III, IV, V
3. Mandell, Douglas & Bennetts
4. Principle & Practice of Infectious Diseases – Volume I, II – IVth Edn
5. Colour atlas of & text book of Diagnosis Microbiology – IVth Edn
6. Felmer W. Koneman
7. Bailey & Scott's Diagnostic Microbiology – 12th Edn
8. Jawetz Melnick & Adelberg's Medical Microbiology
9. Medical Microbiology – Minna Plafair Roitt

PATHOLOGY

1. 1.Theory and practice of histological Techniques John.D.Bancroft
2. Hand book of histopathological Techniques. CFA Culling
3. Practical haematology. Davie & Lewis
4. Wintrob's Practical haematology
5. Lynch's Medical Laboratory Technology
6. Haematology Charles E David
7. Diagnostic Cytology Koss. Volume I & II
8. de Gruy's Clinical Haematology
9. Atlas of Haematology.
10. Henry's Clinical Diagnosis&Management by Laboratory method.
11. Basic Histopathology – Stevens.
12. Practical Cytology – Astarita.
13. Atlas of Haematology – Mc Donald-Paul Anderson.
14. Recent Advances in Haematology – Choudhary.
15. Hand book of Medical Laboratory Technology – Robert H. Carman
16. Compendium of Transfusion Medicine.- Dr.R.N. Makroo
17. Immunology – Kuby.
18. Cytogenetics by Yunis..