SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH
(A Deemed to be University Declared under Section 3 of UGC Act, 1956)
Comprising Sri Devaraj Urs Medical College
[Constituent Unit of Sri Devaraj Urs Educational Trust for Backward Classes (Regd.)]
TAMAKA, KOLAR-563103, KARNATAKA, INDIA
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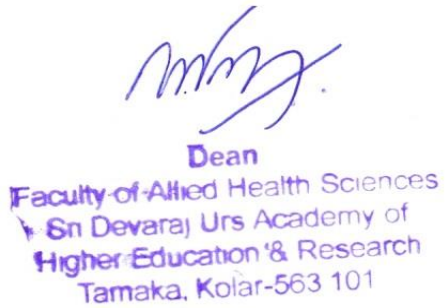
(With effect from 2015-16 batches)

Post Graduate Curriculum for Master of Science in Medical Laboratory Technology – Hematology and Blood Transfusion)



Approved as per BOM-25-2013, (Resolution No XXV-04(c)/13) Dated-19/06/2013

REGULATIONS GOVERNING

MASTER OF SCIENCE

MEDICAL LABORATORY TECHNOLOGY IN
CLINICAL HAEMATOLOGY & BLOOD TRANSFUSION
UNDER FACULTY OF ALLIED HEALTH SCIENCES

SYLLABUS/CURRICULUM
2015 – 16

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION & RESEARCH
(A Deemed To be University)

Declared under Section 3of UGC Act, 1956, MHRD GOI No.F.9-36/2006-U.3(A)dt.25th May 2007
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SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION & RESEARCH
Comprising Sri Devaraj Urs Medical College
(A-Deemed-To-Be-University)
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Ph:08152-243244, 210604, 210605, Fax:08152-243008, E-mail: registrar@sduu.ac.in/office@sduu.ac.in, website: www.sduu.ac.in

No: SDUAHER/KLR/ADMN/ 4274 / 2014-15 Date: 10.12.2013

NOTIFICATION

Sub: Regulations and Curriculum for M.Sc. Medical Laboratory Technology program.

Ref: 1. Proceedings of the 3rd meeting of Curriculum Development Committee held on 16.03.2013
2. Proceedings of the 9th meeting of BOS Allied Health Sciences Held on 08.04.2013.
3. Proceedings of 10th meeting of BOS Allied Health Sciences Held on 09.10.2013.
4. Proceedings of the 14th meeting of Academic Council held on 20.05.2013.
5. Proceedings of 25th meeting of Board of Management held on 19.06.2013.

Sri Devaraj Urs Academy of Higher Education and Research was declared as Deemed to be University under Section 3 of UGC Act, 1956, MHRD GOI No.F.9-36/2006-U.3(A), Dated 25th May 2007. In accordance with the resolutions of the Curriculum Development Committee, Board of Studies of Allied Health Sciences and Academic Council held as above, decided to approve Regulations and Curriculum for the M.Sc. in Medical Laboratory Technology (Clinical Biochemistry, Clinical Microbiology and Immunology and Hematology and Blood Transfusion) programs offered under the Department of Allied Health Sciences.

In exercise of the power conferred on the University under Section 6of MoA rules as per UGC regulations – 2010, the university is pleased to notify the Regulations and Curriculum for students admitted to M.Sc. MLT program offered under the department of Allied Health Sciences from the academic year 2014-15.

By Order,

Sd/-
Registrar

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH

VISION

"UNIVERSITY OF EXCELLENCE - KNOWLEDGE FOR POSTERITY"

MISSION

- To be a global center of excellence for Teaching, Training and Research in the field of Higher Education.
- To inculcate scientific temper, research attitude and social accountability amongst faculty and students.
- To promote with value based education for the overall personality development and leadership qualities to serve the humanity.

OBJECTIVES

- To provide need based infrastructure and facilities to students to become responsible professionals with social commitment and accountability.
- To implement effectively innovative programs in teaching learning and evaluation.
- To impart scientific and socio cultural temperament among students to forge National identity and needs.
- To provide instruction and training in basic and advanced branches of learning.
- To provide facilities for research for the advancement and dissemination of knowledge.
- To undertake extra mural studies, consultancy, extension programs and field outreach services for the development of society.
- To collaborate with other Universities, Institutions of excellence and Research Organizations within the country and outside for the purpose of teaching, training and research.
- To undertake need based activities for the betterment of socially and educationally backward society.

MASTER OF SCIENCE (M.Sc.) MEDICAL LABORATORY TECHNOLOGY CLINICAL HAEMATOLOGY & BLOOD TRANSFUSION

GOAL AND PROGRAM OBJECTIVE

The goal and objective of the M.Sc Medical Laboratory Technology program are to create qualified and competent technical personnel in the field of medical laboratory technologies to support the health care system in the country.

STUDENT LEARNING OUTCOMES

Graduates will have cognitive psychomotor and affective skills required to accomplish the roles and responsibilities of medical Laboratory technologists.

Graduates will have clinical exposure to learn more about laboratory diagnosis and management.

Graduates will have technical skills and shall be able to provide reliable results with assertion and confidence in performing laboratory tasks.

Graduates will have appropriate professional communication skills, attitudes and ethics expected of medical laboratory technologists.

Graduates will integrate the roles and services of laboratory technicians with the roles and services of other health care professionals in patient care.

2.0 Regulations Governing M.Sc. Medical Laboratory Technology Clinical Haematology & Blood Transfusion program

1. TITLE OF THE COURSE

Master of Science degree in Medical Laboratory Technology in Clinical Haematology & Blood Transfusion program abbreviated as M.Sc. MLT- CHBT

2. DURATION OF THE COURSE

The duration of the Master's Degree in Medical Laboratory technology including submission of project work on the topic registered shall be for a period of two years (consists of four semesters) from the commencement of the academic term.

3. ELIGIBILITY FOR ADMISSION

The students who have passed B.Sc. Medical Laboratory Technology (MLT) Course from Institutions affiliated to RGUHS/other recognised Universities/ considered equivalent by SDUAHER are eligible to this course.

Note: Candidates passing B.Sc. MLT degree through Correspondence shall not be eligible

4. SELECTION CRITERIA

Seat Selection shall be based on the University conducted entrance examination. The merit in the qualifying examination followed interview by the selection committee.

Note: The candidate has to choose the branch of his /her choice during the time of seat selection. No change of branch will be permitted once he /she get admitted.

5. ELIGIBILITY CERTIFICATE

No candidate shall be admitted for the MSc MLT course unless the candidate has obtained and produced the eligibility certificate issued by the university.

The original Marks cards of all the university examinations passed. Migration certificate. Certificate of conduct, Transfer certificate. Proof of SC/ST or category-I as the case may be. A candidate who has been admitted to post-graduate course should register his/her name in the university within a week time after paying the prescribed fee.

Note: Candidates should obtain the eligibility certificate before the last date for admission as notified by The university.

6. MEDIUM OF INSTRUCTION

English shall be the medium of instruction for the subjects of study as well as for the Examination.

7. COURSE OF STUDY

The course shall be pursued on full time basis. There are three branches in M.Sc MLT course. However, both study and examination of main and subsidiary subjects in first year (first and second semester) shall be common to all the three branches/specialities.

In the second year (third and fourth semester) the student shall study subject of his/ her chosen branch during admission.

Note: Students shall be posted to clinical/department/clinical laboratories as per the university direction.

8. ATTENDANCE

Every candidate should have attended at least 75% of the total number of classes conducted in a semester from the date of commencement of the semester to the last working day as notified by university in each of the subjects prescribed for that year, separately, in theory and practical. Only such candidates are eligible to appear for the University examinations in their first attempt.

A candidate lacking the prescribed percentage of attendance in any subject either in Theory or Practical in the first appearance will not be eligible to appear for the University Examination in that particular subject. The course shall be pursued on full time basis.

Note: No candidate shall join any other course of study or appear for any other examination conducted by this university or any other university in India or abroad during the period of study.

First year (1st and 2nd semester) subjects for study, teaching hours, and distribution of marks. Second year (3rd and 4th semester) of M.Sc. MLT program are shown in following Tables.

Table - I Distribution of Teaching Hours in First Year [1st semester] M.Sc. MLT

SL. No.	Mani Subjects	Theory Hours	Practical hours	Total
1	**Biochemistry - I** **Paper title**: Clinical Biochemistry, Biomedical Techniques and Laboratory Management	50	50	100
	Section A: Clinical Biochemistry	25	50	
	Section B: Biomedical Techniques and Laboratory Management	25		
2	**Microbiology – I** **Paper title:** Clinical Microbiology & Immunology	50	50	100
	Section A : Clinical Microbiology	25	50	
	Section B : Immunology	25		
3	**Hematology & Blood Transfusion–I** **Paper title:** Hematology, Clinical Pathology & Immunopathology	50	50	100
	Section A : Hematology	25	50	
	Section B : Clinical Pathology and Immunopathology	25		
	Subsidiary subject:			
	a. Research methodology	20		20
		170	150	320

Note: Main and Subsidiary subjects are common in I year for all the three branches

Table – I (a) Distribution of Teaching Hours in First Year [2nd semester] M.Sc. MLT

SL. No.	Mani Subjects	Theory Hours	Practical hours	Total
1	**Biochemistry - I** **Paper title:** Clinical Biochemistry, Biomedical Techniques and Laboratory Management	50	50	100
	Section A: Clinical Biochemistry	25	50	
	Section B: Biomedical Techniques and Laboratory Management	25		
2	**Microbiology – II** **Paper title:** Clinical Microbiology & Molecular Biology	50	50	100
	Section A : Clinical Microbiology	25	50	
	Section B : Molecular Biology	25		
3	**Hematology & Blood Transfusion–II** **Paper title:** Hematology, Clinical Pathology & Medical Genetics	50	50	100
	Section A : Hematology	25	50	
	Section B : Clinical Pathology & Medical Genetics	25		
	Subsidiary subject:			
	a. Biostatics	20		20
		170	150	320

Note: Main and Subsidiary subjects are common in I year for all the three branches.

Table- I (b) Distribution of marks for First semester M.Sc. MLT

Paper	Code	Subject	Theory marks			Practical marks				Grand total
		FIRST SEMESTER	Theory	IA	Sub total	Practical	IA	Viva voce	Sub total	
I	A010	**Biochemistry - I** **Paper title:** Clinical Biochemistry, Biomedical Techniques and Laboratory Management	100	20	120	40	10	30	80	200
		Section A: Clinical Biochemistry	50							
		Section B: Biomedical Techniques and Laboratory Management	50							
II	A020	**Microbiology – I** **Paper title:** Clinical Microbiology & Immunology	100	20	120	40	10	30	80	200
		Section A : Clinical Microbiology	50							
		Section B : Immunology	50							
III	A030	**Hematology & Blood Transfusion–I** **Paper title:** Hematology, Clinical Pathology & Immunopathology	100	20	120	40	10	30	80	200
		Section A : Hematology	50							
		Section B: Clinical Pathology and Immunopathology	50							
		Grand Total	300	60		120	30	90		600

Table- I (c) Distribution of marks for second semester M.Sc. MLT

Paper	Code	Subject	Theory marks			Practical marks				Grand total
		SECOND SEMESTER	Theory	IA	Sub total	Practical	IA	Viva voce	Sub total	
I	B010	**Biochemistry - II** **Paper title**: Clinical Biochemistry, Biomedical Techniques and Laboratory Management	100	20	120	40	10	30	80	200
		Section A: Clinical Biochemistry	50							
		Section B: Biomedical Techniques and Laboratory Management	50							
II	B020	**Microbiology – II** **Paper title:** Clinical Microbiology & Molecular Biology	100	20	120	40	10	30	80	200
		Section A : Clinical Microbiology	50							
		Section B : Molecular Biology	50							
III	B030	**Hematology & Blood Transfusion–II** **Paper title:** Hematology, Clinical Pathology &Medical Genetics	100	20	120	40	10	30	80	200
		Section A : Hematology	50							
		Section B: Clinical Pathology & Medical Genetics	50							
		Grand Total	300	60		120	30	90		600

[3rd semester] as per the selection of branch in M.Sc MLT

BRANCH (Clinical Haematology & Blood Transfusion)

Table IV (a) Distribution of teaching hours -3rd semester Clinical Haematology & Blood Transfusion

Paper-	Subject	Theory No. of hours	Practical 2hours/class	Total
I	**Pathology:** **Paper title:** Clinical Haematology	80	80	160
II	**Pathology:** **Paper title:** Blood Transfusion	80	80	160
	Total	160	160	320

Table IV (b) Distribution of marks- 3rd semester Clinical Haematology & Blood Transfusion

Paper	Code	Subject	Theory marks			Practical marks				Grand total
			Theory	IA	Sub total	Practical	IA	Viva voce	Sub total	
I	C010	**Pathology:** **Paper title:** Clinical Hematology	100	20	120	40	10	30	80	200
II	C020	**Pathology:** **Paper title:** Blood Transfusion	100	20	120	40	10	30	80	200
III		**Project work**	80					20		100
			Grand Total							500

Table- IV (c) Distribution of teaching hours & marks in Second year [4th semester] as per the selection of branch in M.Sc MLT

BRANCH (Clinical Haematology & Blood Transfusion)

Table IV(d) Distribution of teaching hours -4th semester **Clinical Haematology & Blood Transfusion**

paper	Subject	Theory No. of hours	Practical 2hours/class	Total
I	**Pathology:** Haematology	80	80	160
II	**Pathology:** Blood Transfusion	80	80	160
	Total	160	160	320

Table IV (e) Distribution of marks -4th semester Clinical Haematology & Blood Transfusion

Paper	Code	Subject	Theory marks			Practical marks				Grand total
			Theory	IA	Sub total	Practical	IA	Viva voce	Sub total	
01	**D010**	**Pathology:** Hematology	100	20	120	40	10	30	80	200
02	**D020**	**Pathology:** Blood Transfusion	100	20	120	40	10	30	80	200
		Project work	80					20		100
			Grand Total							500

9. MONITORING PROGRESS OF STUDIES

WORK DIARY/RECORD BOOK

Every candidate shall attend symposia, seminars, conferences, journal review meetings & lectures during each semester as prescribed by the department and not absent him/her from work without valid reasons. Every candidate shall maintain a work diary and record of his/her participation in the training Program. Special mention may be made of the presentations by the candidate as well as details of laboratory work conducted by the candidate. The work diary and record shall be scrutinized and certified by the concerned faculty members.

INTERNAL ASSESSMENT (IA)

Institutions running the course shall conduct two tests each in every semester for Internal Assessment as per the University prescribed calendar of events. The marks obtained in these tests will be considered for internal assessment. Average of the two marks will be computed for internal assessment and shall be sent to the university as per the notification issued by Registrar (Evaluation) before each university examination. Records and marks obtained in tests will be maintained by the college and made available to the university. Marks of periodic tests shall be displayed on the notice board by the principals without fail.

Note: If a candidate is absent for the test due to genuine and satisfactory reason, such a candidate may be given a re-test within a fortnight.

The distribution of marks for internal assessment for subjects of study in first year and second year are shown in Tables III and IV respectively.

Distribution of Internal Assessment marks (Subject Wise)

Course: M.Sc MLT (I &II semester)

SL. No.	Subject	Theory/ paper	Practical / paper
01	Biochemistry I& II Paper title: Clinical biochemistry, Biomedical technique & Laboratory management	20	10
02	Microbiology I Paper title: Clinical microbiology and immunology Microbiology II Paper title: Clinical microbiology and Molecular biology	20	10
03	Hematology & Blood Transfusion I Paper title: Hematology, clinical pathology& immunopathology Hematology & Blood Transfusion II Paper title: Hematology, clinical pathology & Medical Genetics	20	10

Branches: M.Sc MLT in Clinical Biochemistry/ Clinical Microbiology/ Haematology & Blood Transfusion

SL. No.	Subject	Theory/ paper	Practical / paper
03	**Hematology and blood transfusion (Pathology)** Hematology & Blood Transfusion 3rd and 4th semesters		
	Paper-I Hematology	20	10
	Paper-II B lood transfusion	20	10

Note:

a) students must secure at least 50% of total marks fixed for Internal Assessment for a particular subject in order to be eligible to appear in University examination in that subject

b) Internal Assessment marks will be added to the marks obtained in the University Examination.

NOTE: A student must secure at least 50% of total marks fixed for internal assessment for a particular subject in order to be eligible to appear in university examination in that subject. The internal assessment marks **will be added** to the marks obtained in the university examination for declaration of pass.

10. PROJECT WORK

Each candidate pursuing M.Sc. MLT Course in the selected specialisation is required to carry out dissertation work on a selected topic in the area of specialisation under the guidance of a recognized post graduate teacher after successful completion of first year of

the course (1st & 2nd semester).The candidate has to commence the project work during the third semester and should complete the same in the fourth semester. The completed project should be submitted to University one month prior to the fourth semester University examination through Head of the department duly certified by the Guide.

The project work is aimed to kindle the research instincts among the students. The work should comprise adequate exposure to various research methodologies and techniques. Which includes identification of problem, formulation of hypothesis, search and review of literature, getting acquainted with recent advances, collection of data, interpretation of results and drawing conclusions.

University shall arrange for evaluation of the project work both internally and externally and shall have to obtain 50% of the total marks allotted for the project work including viva voce[80marks for project and 20marks for viva voce]

The University shall arrange for review of synopsis and if found suitable shall register the dissertation topic. No change in the dissertation topic or guide shall be made without prior approval of the University.

The project report shall have the following components.

- Introduction
- Aims or objectives of study
- Review of literature
- Materials and methods
- Results
- Discussion
- Conclusion
- Summary
- References
- Tables
- Annexure

The written text of project work shall not be less than 50 pages and shall not exceed 100 pages excluding references, tables, questionnaires and other annexure. It should be neatly

typed in double line spacing on one side of paper (A4 size, 8.27" x 11.69") and bound properly. A declaration by the candidate to the effect that the work was done by him/her and a certificate of bonafide on the research work from the have to be affixed in the beginning of the project report. Five copies of project report should be submitted to the

University through proper channel along with a soft copy (CD) one month before the final examinations.

11. GUIDE

The eligibility academic qualification and teaching experience required for recognition as Guides by the SDUAHER are:

a) ELIGIBILITY TO BE A GUIDE

Shall be a full time teacher in the college or institution where he or she is working..

b) Academic qualification and teaching/professional experience for each M.Sc. MLT-Haematology & Blood Transfusion

1. M.D. or Ph.D. in Pathology and three years teaching/professional experience after post-graduation in a teaching in medical institution or in a laboratory approved by RGUHS,
   or
2. M.Sc. MLT in Haematology & Blood Transfusion with five years of teaching/professional experience after the postgraduate qualification in a teaching in medical institution or laboratory approved by RGUHS.

c) Age*:* The age of guide shall not exceed 65 years.

d) STUDENT: GUIDE RATIO

5:1. As a guide or co-guide shall supervise dissertation work of not more than five students per academic year.

12. SCHEDULE OF EXAMINATION

a. The University conducts four semester examinations during course period. Each year consists of two semesters, each semester consists of Ninety working days. Examination should get over during the period of six months of a semester.

The number of examiners for practical and viva-voce shall be two, comprising of one internal and one external examiner appointed by the university.

b. A candidate shall not be admitted to the practical examinations for the first time unless he/she produces the practical record book certified by the Head of the Department.

d. A failed candidate needs to appear for both theory and practical examination in the failed subject/s only in the subsequent examination.

13. SCHEME OF EXAMINATION:

University examination:

There shall be four University semester examinations, two at the end of first year and the other two the end of second year respectively.

First Year MSc MLT

Both the main and subsidiary subjects for M.Sc. MLT course shall be common for all the three branches.

Eligibility to appear in university examination

A candidate shall be eligible to appear for first year M.Sc. MLT examination at the end of each semester in the Academic year from the commencement of the course. He/she should have satisfactorily completed the prescribed course fulfilment with prescribed attendance.

Written examination: Written examination shall consist of three theory papers each of three hours duration. Each paper shall carry 100 marks.

Practical examination: There shall be one practical examination at the end of each semester in first year and second year subjects. Each practical examination carries 100 marks.

Viva- voce : - This shall aim at assessing depth of knowledge, logical reasoning, confidence and oral communication skills. Both internal and external examiners shall conduct the viva-voce. Total marks shall be 30. The particulars of subjects for examination and distribution of marks are shown in the Table –V.

Second year M.Sc MLT[3rd & 4th semester]

Examination in II year (3rd & 4th semester) shall be held separately for each branch. A candidate will appear only in the branch chosen by him/her at the time of admission.

Eligibility: To be eligible to appear in the II year examination (3rd & 4th semester) a candidate shall have Completed first year of study (1st & 2nd semester) and passed in all the subjects of I year.

Written examination : Written examination shall consists of two theory papers. Each paper shall be of three hours duration. Each paper shall carry 100 marks.

Practical examination: There shall be one practical examination in each of the branches . The marks for each practical examination shall be 40 marks.

The duration of practicals from 9.00 a.m. to 5.00 p.m. with a lunch break of one

hour in between for each of the branches is as follows:

M.Sc. MLT Clinical Biochemistry II Practical - 2 days

(Viva- voce : This shall aim at assessing depth of knowledge, logical reasoning, confidence & oral communication skills. Total marks shall be 30. Presentation of dissertation and discussion on it be done during the viva-voce . No marks shall be awarded to the presentation of dissertation. Both internal and external examiners shall conduct the practical and viva- voce examination. The particulars of subjects for examination and distribution of marks are shown in the Table. III (b) & (e), IV (b) &(e)

15. CARRY OVER

A Candidate who has admitted to postgraduate programs under the faculty of Allied health and basic sciences shall be permitted to carry over the backlog subject till the completion of duration of the programme.

However she/ he shall be declared passed in the programme only after successfully passing all the subject/ courses of all semesters of the post graduate programme

16 DECLARATION OF DISTINCTION:

A candidate securing aggregate marks of 75% or more in the first attempt shall be declared as passed with distinction. Distinction will not be awarded for candidates passing the examination with more than one attempt.

17. MAXIMUM DURATION FOR COMPLETION OF COURSE

The maximum duration of the programme shall be four years from the date of admission

The candidate failing to complete the course within four years from the date of admission will be declared unfit to continue and will be discharged from the programme.

18. ELIGIBILITY FOR AWARD OF DEGREE

A candidate shall have passed in all the subjects of first year (1st and 2nd semester) and second year (3rd and 4th semesters) to be eligible for award of degree.

MINIMUM REQUIREMENT OF FACULTY AND INFRASTRUCTURE FOR M.SC. MLT COURSE

1. Basic Infrastructure to all three specialities:

1. Institute should have its own Hospital with full-fledged central diagnostic laboratory centre to fulfil the minimum work load criteria for each of the subject speciality is here under.

Basic Laboratories:

1. clinical biochemistry, clinical microbiology and clinical pathology laboratories with area of 800sq.ft each

2. One lab for Immunopathology 10x10 sqft with power back -up

3. One class room with capacity for 30 students measuring 500sq.ft.

4. One ICT enabled departmental Seminar room measuring 250sq.ft for each specialty with compulsory.

Other infrastructure criteria- Principals room, student's common room, staffroom, Library, office room, Store room, preparation room etc will be as per minimum criteria. Norms of B.Sc MLT course.

II. Infrastructure subject wise: Biochemistry

a. Laboratory equipments

1. Chemical Balance/single Pan Balance 2. Colorimeter 3. Spectrophotometer 4. Flame Photometer/ ISE Electrolyte analyser 5. pH meter 6. Chromatography instruments 7. Electrophoresis unit 8. Semi auto analyser/ 9. Auto analyser 10. Chemiluminescence / Drug and Hormone analyser (optional) 11. Blood gas analyser 12. Refrigerator

Apart from the above mentioned equipements ,necessary glass ware, kits, chemicals, as per the syllabus requirements should be made available in adequate quantity.

b. Minumum work load criteria for conducting M.Sc MLT.in Clinical Biochemistry.100 different bio-chemical tests per day [Routine and special tests]

Man power requirement for clinical biochemistry / Microbiology and Immunology/ Haematology and Blood transfusion

Sl No	Posts	requirement
01	Professor	01
02	Assoc professor	01
03	Asst professor	01
04	lecturer	02
05	tutors	02
06	Technical staff	03

Staff requirement for each department

Teaching staff: Should actively involve in teaching the particular subject: Qualification: 1. MD in respective subject

1. MSc -only Medical Microbiology/Medical Biochemistry degree acceptable) with 3 years' experience after MSc. 2. D.C.P - 2 years' experience 3. Bio-technologist - MSc in Biotechnology

Teaching staff requirement for each speciality

1.) Professor – 1, 2.) Associate Professor (1 - 5yrs teaching experience), 3. Assistant Professor (1- 3yrs teaching experience) 4. Lecturer – 2, 5). Tutors - 2 MBBS, MSc. Technical staff - senior technician – 1, Junior technician – 2 and a Peon - 1

SYLLABUS

I. BIOCHEMISTRY – I (First semester)

Paper Title: Clinical biochemistry, biochemical technique and Laboratory management (50 hours)

SECTION A : CLINICAL BIOCHEMISTRY (25 hours)

1. CARBOHYDRATES

General description of carbohydrates

Chemistry: classification, stereoisomers, monosaccharides, disaccharides and polysaccharides.

Chemical properties of carbohydrates. Glucose metabolism, Metabolic fate of glucose, Regulation of blood glucose homeostasis.

Hyperglycaemias: Diabetes mellitus, laboratory findings in type 1 and type 2 DM, gestational DM.

Diagnostic and monitoring criteria for DM. The role of laboratory in differential diagnosis of patients with glucose metabolism alteration

a) Methods of glucose measurement
b) Glucose Tolerance test
c) Glycosylated Hemoglobin
d) Ketones
e) Microalbuminuria
f) Islets antibodies and insulin testing

2. PROTEINS

Chemistry of proteins/plasma proteins in health and disease. Total protein abnormalities (hypo and hyper proteinemia) methods of protein analysis (total protein), electrophoresis, capillary electrophoresis isoelectro focussing, immunochemical methods,

Non protein nitrogen substances: biochemistry, clinical application, analytical methods, pathophysiology of a) urea b) uric acid c) creatinine d) ammonia

3. LIPIDS (10hours)

Chemistry of lipids [fatty acids/TAG/phospholipids/ cholesterol). General lipoprotein structure, types, formation and clinical significance of chylomicrons/VLDL/IDL/LDL/HDL/lipoprotein X

Diagnosis of lipid disorders

Lipid lipoprotein analysis:[lipid profile]: a) total lipids b) cholesterol c)TAG d)HDL e)LDL f)phospholipids g) fatty acid

4. ENZYMES (05 hours)

Definition and general properties, classification and nomenclature

Enzyme kinetics; mechanism, factors influencing enzyme activity, measurement of enzyme activity, calculation of enzyme activity, measurement of enzyme mass.

Enzymes of clinical significance: creatine kinase LDH /ALT/AST /ALP/ACP/GGT/amylase/lipase

5. NUCLEIC ACIDS (05 hours)

Nucleotides and analouges, Nucleotides functions, structural details of DNA and types. RNA and classification. Isolation and Purification of DNA.

PRACTICALS- CLINICAL BIOCHEMISTRY **(50 hours)**

Laboratory safety and regulations

Safety awareness for clinical laboratory personnel

Estimation of blood glucose by Ortho toludine method

Estimation of blood glucose by GOD – POD method.

Estimation of protein by Biuret method, Lowry, UV method

Estimation of serum creatinine by Jaffe's method

Estimation of urea in blood sample by urease

Estimation of Total cholesterol by CHOD/POD method

Estimation of Triglycerides by GOP/PA method

Estimation of HDL Cholesterol by precipitation method

Section B: BIOMEDICAL TECHNIQUES AND LABORATORY MANAGEMENT (25 hours)

BIOMEDICAL TECHNIQUES

(15 hours)

METHODS OF QUALITATIVE ANALYSIS OF BIOMOLECULES:

Principles, experimental procedures and application of chromatography –

paper, thin-layer, ion exchange, affinity, gel filtration, gas-liquid and HPLC. Principles, procedures and application of Electrophoresis – paper, polyacrylamide gel, agarose gel, capillary and cellulose acetate.

Centrifugation techniques:

Principle and technique of preparative and analytical centrifugation, differential

centrifugation, density gradient centrifugation, ultra-centrifuge and its application.

Quantitative methods:

Principles and applications of Photometry, Spectrophotometry, flurometry, ion selective

procedures, flame photometry, atomic absorption spectrometry. Ion selective electrodes and their

applications in Medicine.

Isotopes: Detection and measurement of radioactive isotopes, application of isotopes in research and clinical bio-chemistry.

PRACTICALS UNDER BIOMEDICAL TECHNIQUES

Chromatography: paper, thin layer, ion exchange, gel chromatography, demonstration of HPLC and GLC

Electrophoresis; slide gel, PAGE, Agarose, SDS-PAGE demonstration

LABORATORY MANAGEMENT SYSTEM (10 HOURS)

Cost-analysis (tests and instruments)

Preparation of operating budgets; general aspects of financial management of laboratories

justification of providing new services or rejecting existing ones; lease and purchase

decision analysis; delegation of budget responsibilities, work load statistics.

Laboratory design

Designing laboratories for different types and sizes of institutions: selection of equipment and

systems for the laboratory, concepts of workstation consolidation,workflow concepts in laboratory automation (sample transportation systems, modular robotics).

Laboratory safety:

Fire, chemical, radiation and infection control (body substance precautions), hazardous waste

and transport of hazardous materials

Training of technical staff:

Familiarity is needed with the syllabi of various training programs; knowledge of the teaching requirements and level of knowledge technical staff; understanding of qualifications of technologists trained in other countries

Maintenance of records:

Procedure manuals, ward manuals, quality control programs, patient data retrieval.

Personnel management:

Personnel policy manual; job descriptions; labour, supervision relations; conducting job interviews;

motivation, recognizing job distress syndrome; delegation to a laboratory manager.

Hospital organization;

interactions between the laboratory service and the rest of the hospital. Professional ethics.

Quality assurance; total quality management; development and monitoring of performance indicators.

Note: Laboratory Management has field work

II SEMESTER

BIOCHEMISTRY-II

Paper Title: Clinical biochemistry, biomedical technique and Laboratory management (50 hours)

Section A- Clinical Biochemistry

Clinical Significance: Principle of Estimation

Formation and detoxification of bilirubin, types, differential diagnosis of jaundice, bile salts and bile pigments. Method of detection.

Quantification of bilirubin by Mally evlyn method, jenddrassrk and Gorf method direct spectrophotometry method.

Estimation of Alkaline phosphatase and Acid phosphatase by kings method

Assay of SGOT and SGPT by Reitman and Frankel method

Gastric juice analysis

Insulin tolerance test

Xylose absorption test

Analysis of calculi

Composition and function of CSF , clinical significance of fluid analysis, estimation of sugar and protein in CSF

Urine chemistry

Physical and chemical examination of urine sample, qualitative tests for inorganic ingradients, common qualitative and quantitative tests for urine, clearance tests

Automation in urine chemistry

Electrolytes

Sodium, potassium, chloride, total and ionised calcium, phosphorous magnesium, blood gas and pH, carboxy haemoglobin, carbon monoxide, methaemoglobin, oxygen saturation.

Blood collection procedure and theory of anticoagulation.

Biomedical wastes, types, potential risks and their safe management.

II semester
Section A : Clinical biochemistry practical

Estimation of SGOT in blood sample by kinetic method

Estimation of SGPT in blood sample by kinetic method

Estimation of alkaline phosphatase in blood sample by kinetic method

Estimation of acid phosphatase in blood sample by kinetic method

Estimation of bilirubin in blood sample by kinetic method

Estimation of Na+, K+ & Ca++ by electrode analyser

Estimation of common parameters in urine through use of strips

Estimation of T3, T4 and TSH by ELISA method.

Section B

Biomedical techniques and laboratory management (25 hours)

Biomedical techniques (15 hours)

	Cell Fractionation, Biochemical activities of different fractions, marker enzymes
Bioenergetics and Biological oxidation	Concept of free energy change, high energy compounds, ATP generation, redox potential Internal Assesmentl, Electron transport chain, oxidative phosphorylation, inhibitors, Uncouplers, ionophores.
	Purificationofenzymes fromcells, characterization and critera Internal Assesment of purity, purification of proteins.
	Bio-Medical waste: Types, potential risks and their safe management.

PRACTICALS on Boiomedical Techniques

1. Photometry,
2. spectrophotometry,
3. atomic absorption spectrophotometry

4. Cell fractionation -methods

LABORATORY MANAGEMENT (10 hours)

Public relations; hospital and community

Basic clinical epidemiology

Laboratory Data Processing:

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

Use of computers in quality control and management; use of computers for calculating analytical results (eg. non-linear functions).

General aspects of system design; central vs. stand-alone systems, host computers and equipment interfaces.

Laboratory information systems LIS), Hospital information systems (HIS).

Personal computer use: word processing, spreadsheets, graphics, statistics, presentations, email, internet. Security of data storage and transmission.

Data base structures and data mining.

Appropriate access control to patient information

Note: Laboratory Management has field work

Reference Books:

1. Biochemistry – Strayer H.Gerjmetal-W.H. Freeman and company New York 5th edn 2002.
2. Lehnineger's Principles of Biochemistry – Lininger. A.L., Nelson. D.L., Eral-C.B.S. Publishers & distributors, New Delhi 3rd edition.
3. Harper Illustrated Biochemistry – Murray R.K. Grannar, D.K. Mayes-P.A. Eral 26th edtion, McGraw HIll. 2003.
4. Medical Biochemistry – N.V. Bhagavan -Academic Press 4th edition 2002.
5. Text Book of Biochemistry – A.S. Saini, C.B.S Publishers and distributors 2nd edition.
6. Teitz fundamentals of Clinical Chemistry – Burtis. C.A. Ashoowd E. R. – Har Court (India) Ltd 5th edition 2001.
7. Varley's Practical Clinical Biochemistry – Gowenlock and Bell William Heinemann, 6th edition 1992.
8. Text Book of Biochemistry with Clinical Correlations – Devlin T.M. Wiley Liss, New York 5th Edition 2002.
9. Clinical Physiology of Acid-Base balance and Electrolyte disorders – Rose. B.D – Mcgraw-Hill International edition New York 4th edition 1994.
10. Methods in Bio-Statistics for Medical students – Mahajan. B.K. Jaypee brothers Medical Publishers, New Delhi.
11. Manual of Practical Biochemistry for M.B.B.S –S.K.Gupta, Veena Singh Ghalaut- Arya publishing Company, New Delhi.
12. Clinical Chemistry – Theory analysis and Correlation – Kalpan. L.A. and pesse. A.G- C.V. Moslay and Company St. Louis, M.O. 2nd edition 1989.
13. Principles of Biochemistry – CBS Publishers – Lehninger, Nelson, Cox.

SCHEME OF EXAMINATION OF BIOCHEMISTRY

Theory: - Their shall be one paper of 3 hrs duration, carrying 100 marks each in semester

PAPER I:-Biochemistry-I

Title: Clinical Biochemistry, Biomedical Techniques and Laboratory management

Sec A: - Clinical Biochemistry -50 marks

Sec B: - Biomedical Techniques and Laboratory Management -50 marks

Type of questions and distribution of marks for each section carrying 50 marks in theory subjects

Section A and section B			
Type of questions	No of questions	Marks for each questions	Total
Long Essay	01	20	20

Short Essay	05	06	30

PRACTICAL EXAMINATION **Max Marks: 70**

Experiments (40 marks) , Viva voce 30 (marks)

1. Identification of Unknown Carbohydrate,
   Protein or NPN - 15 Marks

   2. Practicals: A - 15 Marks

   Procedures involving Chromatography or Electrophoresis to be given for seperation and identification of aminoacids or carbohydrates.

   Practicals: B - 10 Marks

   Estimation of Glucose, Total protein, Creatinine, Urea, Cholesterol (any one)

   VIVA-VOCE----30 Marks
   The Viva Voce exam will carry 30 marks and both the internal and external examiners will conduct the examination

Note: each theory paper for 100 marks, Theory internal assessment 20 marks, viva voce 30 marks, practicals 40 marks, & practical internal assessment 10 marks. Thus each subject is for 200 marks

3.1 SYLLABUS

MICROBIOLOGY - I (FIRST SEMESTER)

Paper Title: Clinical Microbiology & Immunology (50 hours)

Section A: Clinical Microbiology
Section B: Immunology

SECTION A: CLINICAL MICROBIOLOGY (25 hours)

General aspects:
The investigation of biological samples in infectious diseases is different from the other branches in that it requires general knowledge of pathogenic agents (bacteria or viruses) and of host reaction.

Definition of infection and infectious disease:
natural bacteriological ecosystem. Pathogenicity of bacteria and viruses. General pidemiology of infection and infectious diseases. Sterilization & Disinfection Culture media and preparation Bacteriology of Milk, Water and Air

Diagnostic procedures:
Specimen selection and collection (blood, urine, sputum, faeces, others).
Specimen processing: smears, staining, cultures including cell cultures, susceptibility testing, antigen detection. Preservation of cultures Usual techniques for microbe and virus identification (including principal differential characteristics).
Molecular biology techniques for characterization of microbes and viral agents. Bacteriological and viral serology.

Bacterias:
Succinct description of responsible bacterial and viruses in bacteriological and viral

syndromes or diseases (including principal differential characteristics).

Bacterial: Neisseria gonorrhoeae and N. meningitidis, Staphylococcus aureus, Coagulase Negative Staphylococcus, Streptococcus pyogenes (especially S. agalactiae and S. pneumonia), Escherichia coli, Salmonella, Shigella and other Enterobacteriaceae,
Vibrio cholerae, Pseudomonas aeruginosa Haemophilus influenzae, Clostridium perfringens, C. tetani, Bacteroides spp, Lister monocytogenes, Legionella, Mycobacterium tuberculosis and others, Treponema pallidum,

Chlamydia, Mycoplasma, etc.Corynebacterium diphtheriae, Bacillus anthracis, B.cereus, Non sporing Anaerobes, Bordetella, Brucella, Yersinia, Actinomyces, Pasteurella, Franciesella,

Section A clinical microbiology practicals (25 hours)

Collection of clinical materials like blood, urine, stool, sputum, swabs, CSF etc.

Procedure of techniques of sputum for AFB.

Procedure of skin clipping of Leprae Bacilli

Identification of organisms with Biochemical reactions of common organism like - Staphylococus, E.coli - Klebsiella, shigella, Salmonella, Proteus, Pseudomonas

Antibiotic Sensitivity tests

Preservation of stock culture

Bacteriology of water

SECTION B: IMMUNOLOGY (25 hours)

BASIC IMMUNOLOGY

Characteristics of the Immune system:

Define CD antigens.
Define primary and secondary lymphoid tissues.
Define mucosal-associated lymphoid tissues.
oral
nasopharyngeal
gut-associated
reproductive
Describe blood-lymph circulation and lymphatics.
Organization of lymph nodes
Explain hematopoietic cell distribution in lymph nodes.
Provide examples and locations of lymph nodes in head and neck.

Innate and Adaptive Immunity:
Define concepts of specificity and memory.
Describe basic properties of innate immune cells.
Describe basic properties of adaptive immune cells.

Physiochemical Properties of innate immunity:
Physiological barriers
Anatomical barriers

Phagocytic/endocytic barriers
Inflammatory barriers

Adaptive Immunity:
Define humoral immunity.
Define cell-mediated immunity.
Define T cells, T cell subsets, B cells, and plasma cells.

Antigens and Immunogens :
Define antigen and immunogen.
Define relative antigenicity of macromolecules.
Define and give example of antigenic determinants and epitopes.
List types of antigens with examples.
Define 'Hapten' and explain how they function in the immune system

Immunoglobulins (Igs)/ Antibodies (Abs):
source from B cells and plasma cells
B cell/antibody/specificity relationship
Describe structure of immunoglobulins:
Molecular components of Igs
heavy and light chains
variable and constant regions
Define allotype, isotype, idiotype.

Classification of immunoglobulins:
Explain differences based on heavy and light chains.
Describe functional properties of Ig classes.
Describe evidence for number of antigenic determinants recognized by Igs.

T cells:
Describe classification of T cells (Th1, Th2, αβ and γδ T cells).
Compare and contrast molecular and cellular features of T cell receptor (TCR) to B cells receptor (Ig molecule).
Describe development of T cells in the thymus.
Describe the genes' rearrangement in TCR development.
T cell-associated molecule - the TCR complex
CD3 molecules
T cell signaling by CD3
Define αβ and γδ T cells, including
tissue distribution
differential functions of αβ and γδ T cell.

The Complement system:
Define the complement system and describe when and how it is used.
Provide step-by-step examples of how complement works:
the classical complement pathway
the alternate complement pathway
List representative infectious agents and products that activate complement.
Describe biological effects mediated by complement.
Describe the effects of complement on the immune system.

Describe the significance of complement at oral mucosal surfaces.

Antigen Processing and Presentation:
Describe use as a function of T cell activation.
Describe cells involved in antigen processing and presentation.

The Major Histocompatibility complex (MHC):
Describe gene nomenclature for MHC antigens.
List the numbers of human MHC genes.
Explain the tissue distribution of MHC antigens.
Describe the structure of MHC Class-I and Class-II molecules.
Describe, with examples, how peptide antigens are processed.

Cell-Mediated Immunity (CMI):
Describe the cells involved in CMI and the role played in the immune response.
Describe the mechanisms of tissue cell destruction by T cells.
Describe concept of 'Memory T Cell'.
Define Natural Killer (NK) cell.
Define 'Super Antigen' and give examples in disease.
Bio-Medical waste: Types, potential risks and their safe management.

Section B: PRACTICALS On Immunology **(25 hours)**

VDRL Tests

Brucella Agglutination test

Weil felix test (Demonstration only)

Paul Bunnel test (Demonstration only)

RA test

CRP test

TPHA

ELISA

ASLO

WIDAL

3.1 SYLLABUS

Microbiology-II (Second semester)

Paper Title: Clinical Microbiology & Molecular biology (50 hours)

Section A: Clinical Microbiology
Section B: Molecular Biology

SECTION A: CLINICAL MICROBIOLOGY (25 hours)

Viruses:
Viruses: herpes (herpes simplex, herpes varicellae, cytomegalovirus, Epstein Barr virus); hepatitis A, B, C, D, E; human immunodeficiency virus; enteroviruses (poliovirus); rubella, mumps, measles, parvovirus B19, RSV, myxovirus, rhinovirus, coronavirus, adenovirus, rotavirus, papillomavirus, rabies, Arboviruses, Poxviruses, Oncogenic Viruses,etc

Antibiotics and antiviral agents:
Basic knowledge of antibiotics and antimicrobial therapy.
Antibiotic and antiviral sensitivity test.
Antibiotic and antiviral resistant mechanisms

Medical Parasitology & Mycology:
Epidemiology, main clinical signs, basis for biological diagnosis (including a succinct description of parasites and fungi without biochemical characteristics),treatment. Amoebiasis: Entamoeba histolytica. Giardsis, cryptosporidiosis and uro-genital richomoniases.Malaria.Toxoplasmosis. Intestinal, hepatic and urinary helminthiasis:

strongyloidiasis, ancylostomiasis, enterobiasis, ascariasis, schistosomiasis (Schistosoma mansoni and S haematobium), fascioliasis (Fasciola hepatica) and taeniasis (Taenia saginata). Fungal infections (Candida albicans, Cryptococcus neoformans, etc.).
Aspergillus infections (Aspergillus fumigatus). Dermatophyte infections (Microsporum canis, Epidermophyton floccosum, Trichophyton rubrum, Trichophyton mentagrophytes). Leishmaniosis. Echinococcosis. Pneumocystosis. Filariasis. Leptospirosis

Bio-medical waste:

Usual techniques for parasite and fungus identification Immunological and molecular diagnosis of parasitic and mycological disease mycological diseases. Bio-Medical waste Types, potential risks and their safe management.

Section A: PRACTICALS on clinical microbiology (25 hours)

Parasitology - collection, preservation and transportation of faecal material for examination of parasites. Concentration techniques of stool for ova and cyst. Wet preparation of faecal sample for ova and cyst. Identification of ova and cyst in stool sample.

Collection of specimen for fungal examination like skin scrapings, swabs, CSF.

Fungal examination by wet preparation

Fungal culture

ELISA HIV & HBsAg test

Western blot test

Incubation of fertile eggs and inoculation by various routes. (Demonstration only)

Section B: MOLECULAR BIOLOGY (second semester)

DNA: the support of Hereditary information
Structure, types, coiling and supercoiling, topoisomerases, replication, satellite DNA. 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.

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.

Mutation spontaneous, induced, point mutation and silent mutation, frameshift mutation, physical and chemical mutagents, molecular basis, site directed mutagenesis, significance mutagenesis, DNA repair, isolating mutants, Ames test.

Recombinant DNA technology: Necessaryelements – enzymes and vectors – plasmids, cosmids, bacteriophages, vectors, expression vectors, construction of rDNA and cloning strategies – various methods, genomic libraries (e.g. using phage vectors), cDNA libraries, introduction of rDNA into host – methods, restriction maps and sequencing

Genetics in medicine:
Hemoglobin and hemoglobinopathies, phenylketonuria, alkaptonuria, homocystinuria, Lesch-Nyhan syndrome, genetics of cancer, Down's syndrome, Di-George syndrome, Kleinfelters syndrome, Turner's syndrome, hermaphroditism, cystic

Fibrosis, haemophilia , prenataldiagnosisofgeneticdiseases, application of recombinant DNA Technology in medicine – PCR, RFLP, DNA finger printing, therapeutic proteins, vaccines, antibodies, transgenic organisms, gene therapy, human genome project.

Section B : PRACTICALS on Molecular Biology (25 hours)

PCR- Side Directed Mutagenesis
DNA Isoltation and purification
DNA Cloning,
Bacteriall Transformation and Fusion
Protein Purification
Plasmid Analysis by Restriction Digestion
Protein Gel Electrophoresis
DNA Gel Electrophoresis

References:

1. Text book of Microbiology by Ananthnarayan, 6 th Edition, Orient Longman

2. Diagnostic Microbiology by Bailey & Scott 11th Edition; Mosby

Medical Microbiology by Greenwood & Slack 16th Edition; Churchill Livinstone

3. The Short Textbook of Medical Microbiology by Satish Gupte 8th Edition; Jaypee

4. Text book of Medical Parasitology by Panikar 5th Edition; Jaypee

5. Colour Atlas and Textbook of Diagnostic Microbiology by Koneman 5th Edition,

Williams Wilkins

6. District Laboratory in Tropical Countries, Monica Cheesbrough 1st Edition, Cambridge

7. Mackie & Maccarteney Practical Medical Microbiology 14th Edition; Churchill Livingstone

8. Essential Immunology, Roitts & Delves 10th Edition; Blackwel Science

SCHEME OF EXAMINATION OF MICROBIOLOGY

Theory: - Their shall be one paper of 3 hrs duration, carrying 100 marks each in semester

PAPER I:-Microbiology-I

Title: Clinical Microbiology, Immunology & Molecular Biology

Sec A: - Clinical Microbiology -50 marks

Sec B: - Immunology & Molecular Biology -50 marks

Type of questions and distribution of marks for each section carrying 50 marks in theory subjects

Section A and section B

Type of questions	No of questions	Marks for each questions	Total
Long Essay	01	20	20
Short Essay	05	06	30

PRACTICAL EXAMINATION **Max Marks: 70**

Experiments (40 marks) , Viva voce 30 (marks)

Identification of Bacterial culture, spotters, stool examination, acid fast stain, albert's stain, serology exercise, mycology exercise

VIVA-VOCE----30 Marks

The Viva Voce exam will carry 30 marks and both the internal and external examiners will conduct the examination

Note: each theory paper for 100 marks, Theory internal assessment 20 marks, viva voce 30 marks, practicals 40 marks, & practical internal assessment 10 marks. Thus each subject is for 200 marks

3.1 SYLLABUS

HAEMATOLOGY AND BLOOD TRANSFUSION -I (FIRST SEMESTER)

Paper Title: Haematology, Clinical Pathology and Immunopathology (50 hours)

Section A Haematology, (25 hours)

Haemotopoesis:
Origin, development, function and fate of blood cells.

Erythropoiesis:
Origin, development of RBCs, biosynthesis of Hb, control of Erythropoiesis
Disorder's of Red blood cells, Erythrocyte Indices, Red cell inclusion bodies
Anaemia, definition, Pathophysiology, classification - morphologic and Etiologic classification and clinical features. Investigations in a case of anaemia.

Morphologic: Microcytic hypochromic anaemia, macrocytic anaemia.

Haemolytic anaemias: Definition, classifiction, clinical features
Investigations to establish a case of haemolytic anaemia.

Tests done:
Peripheral smear – specific morphologic abnormalities
Reticulocyte count Corrected reticulocyte count Reticulocyte production index
Osmotic fragility test
Coomb's test
Sickling phenomenon
Kleihauer acid Elution test

Alkali denaturation test
Ham's test, Sucrose lysis Test
Electrophoresis – HbF & Hb A2 estimation
Test for G6PD deficiency
Aplastic anemia. Pancytopenia, Anemia due to abnormal globin synthesis
Polycythaemia.

Disorders of white Blood cells:
Leucocytosis, Leukopenia, Leukaemoid reaction, Myelodysplastic syndrome(MDS) .

Leukaemias: Definition ,Etiology ,Clinical features

Classification:
[French American British- FAB classification] Lab Investigations Cytochemistry of Acute leukaemias

Chronic myeloid leukaemia:
clinical presentation. Investigations. Philadelphia chromosome.
Leucocyte Alkaline Phosphatase [LAP score.]Chronic lymphocytic leukaemia

Plasma cell disorders:
classification Plasma cell myeloma – definition ,clinical features, investigations.

Myelo Proliferative disorders:
general features ,classification – investigations
Lympho Proliferative disorders:
general features, classification , Investigations

Lipid Storage Disorders
Haemoparasites
Bone marrow examination

Section A: **PRACTICALS on** Haematology (25 hours)

Blood collection. Anticoagulants used in Hematology
Red cell indices
E.S.R., PCV, Platelet count, Absolute Eosinophil count
Reticulocyte count
Stains used in Hematology
Preparation of blood film
Preparation of Leishman's stain, Giemsa stain and MGG stain
Peripheral smear staining by leishman's stain. Interpretation of
peripheral smear. Differential count.
Microcytic hypochromic anemia –
Investigations including serum Iron & TIBC
Macrocytic anemia - Investigations including B12 & folate assay,

schilling test

Hemolytic anemia – General Lab investigations

Hemolytic anemia - Special Tests.
Osmotic fragility test
Alkali denaturation test
Sickling test
Hb electrophoresis
Investigations of G6PD deficiency
Autoimmune hemolytic anemia investigations
Coomb's test

Blood Parasites

Bone marrow – preparation of bone marrow smears , Trephine biopsy smears
Staining of B.M Aspiration Smears. Demonstration of Iron stain

Leukemia Interpretation of Peripheral smear in Leukemia.

Cytochemical stains –Demonstration

Section B CLINICAL PATHOLOGY & IMMUNOPATHOLOGY (25 hours)
Clinical Pathology (10 hours)

Collection, transport, preservation and processing of various clinical specimens
Urine examination, Physical, chemical and microscopic. Urine analysis by Strip method
Test for haemosiderin pigment.
Renal function tests.
Stool examination – collection of specimen of faces

Macroscopic (Naked eye) inspection:
Concentration method ,Flotation method .
Microscopic examination
Chemical examination

Strip method:
Test for Occult blood – Benzidine Test Sputum examination – collection of specimen
Physical examination
Microscopic – Gram's stain, Ziehl Neelsen stain for AFB
Chemical examination

PRACTICAL on **Clinical Pathology** (10 Hours)

Urine examination, Physical, chemical and microscopic. Urine examination by Strip method

Urine Test for haemosiderin pigment. [Demonstration]

Stool examination –
i. Macroscopic examination
ii. Concentration method ,Flotation method .
iii. Microscopic examination
iv. Benzidine Test- for occult blood

Sputum examination - Macroscopic, Microscopic and AFB
Staining

IMMUNOPATHOLOGY (15 hours)
Mechanism of Ab- mediated inactivation:
direct and indirect
Eg. Diabetes mellitus, thyroid diseases, pernicious anemia, polyendocrinopathy, infertility, haemophilia, myasthenia gravis, anti-idiotypes and diseases.

Immune deficiency disorders

Immunohaematologic diseases:
transfusion reactions, erythroblastosis foetails, warm-antibody disesases, cold antibody diseases, drug and hemolytic diseases, agranulocytosis, thrombocytopenic purpura, immune suppression cytotoxic antibodies in vitro.

Immune comples reactions:
arthus reaction, serum sickness, evaluation of circulating immune complexes.

Atopic anaphyllactic reactions:
reaginic antibody, anaphylaxis, atopic allery –factors involved, asthma, hay fever, food allergy, insect allergy, atopiceczma, delayed hypersensitivity reactions, contact dematitis, viral infectionss, graft-host relationship in pregnancy.

Autoallergiiic diseases:
encephalomyelitis, multiple sclerosis, oorchitis, thyroiditis, sjogren's syndrome.

PRACTICAL on Immunopathology (15 HOURS)

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Serological tests [Screening &diagnostic] used in different pathological conditions.
Delayed type hypersensitivity testing
Detection of tumor markers.
Histocompatibility testing.
Blood grouping &cross matching.
Coomb's Test - Direct & Indirect.
Setting up of Immuno histochemistry lab.

SECOND SEMESTER
Haematology and Blood Transfusion –II

Paper Title: Haematology, Clinical pathology and Medical Genetics(50 hours)

Section A Haematology (25 hours)

Haemorrhagic disorders:

Definition – Pathogenisis,Clinical fearture ,Classification. - vascular disorders, Platelet disorders, coagulation disorders, Fibrionolysis.

Normal haemostasis .

Investigation of heamorrhagic 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]

Coagulation Factor assay. Factor VIII: C Inhibitor Study.

Disseminated Intravascular Coagulation [DIC]-Definition ,Pathophysiology, Clinical Feartures and Laboratory Investigations.

Fibrinogen assay

Thrombotic disorders:

Classification, Pathogenisis, Clinical Feartures and Laboratory

Investigations. Antiphospholipd Syndrome.

Automation in Haematology

Organization & quality control in the laboratory

Cleaning of glassware

Biomedical waste management

Section A: PRACTICAL on Haematology (25 hours)

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

Urea Solubility Test for Factor XIII- Demonstration

Fibrinogen assay - - Demonstration

Thrombotic work up - Demonstration

Investigation for Antiphospholipid Antibody- Demonstration

Automation in hematology - demonstration

Cleaning of glassware

Bio-medical waste management – demonstration.

Organization and quality control in the laboratory

Preparation of Stains, Reagents, Diluting fluids.

Recommended Books -Haematology and Clinical Pathology

1. Clinical Haematology illustrted - Colour Atls Victor Hoffbrand, John E Peth't
2. Parasitology - K.D.Chatterjee
3. Practical Haematolgoy - 9th edition Dacie 7 Lewis
4. Haematology -6th edition - Williams
5. Wintrobe clinical haematology Vol- I - 10th edition
6. Windtrobe clinical haematology Vol- II -10th edition
7. Lynch's Medical Lab - Technology Latest edition
8. Clinical Diagnosis & Management - Todd & Sanford 19th edition 1996
9. Medical Laboratory Technology by Sood 5th edition, Jaypee Brothers 1999
10. Clinical Haematology in Medical Practice - G.C. Degruchy - 5th edition

Section B **Clinical Pathology & Medical Genetics** (12 hours)

Clinical Pathology

Gastric analysis:

Indications ,contra indication. Method of collection. Fasting gastric juice – Macroscopic and microscopic examination.

i Fractional test meal
ii. Augumented Histamin test
iii. Hollander's test
Cerebrospinal fluid analysis
Method of obtaining CSF, indications, contra indications.

Examination of CSF :

i. Physical examinatio
ii. Biochemical examination
iii. Microscopic examination
a. Cytological examination
b. Bacteriological examination

Body fluids:

Microscopic examination of Pleural, Pericardial, synovial, ascitic and peritonial fluid.

Pregnancy Test- Method ,interpretation.

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

PRACTICAL on Clinical Pathology (12 hours)

Examination of Cerebrospinal fluid [CSF] and body fluids.
Pregnancy Test
Examination of Semen.

MEDICAL GENETICS (13 hours)

The history and impact of Genetics in Medicine

Gregor mendel and the laws of inheritance:

The chromosome basis of inheritance Origin of Medical Genetics Classification of Genetic disease The impact of Genetic disease Major new developments

The Chromosome varInternal Assesmenttion and sex determination An overview of chromosome number, chromosome composition and sex determination in humans.
Methods of chromosome analysis. Molecular cytogenetics. Chromosome abnormalities.

Human genetic diseases:

Genetic disorders with classical MendelInternal Assesmentn inheritance. Autosomal recessive inheritance. Patterns of autosomal dominant inheritance. X-linked inheritance.
Patterns of pseudo-autosomal inheritance. A typical pattern of inheritance.
Biochemical genetics:

The inborn errors of metabolism. Disorders of amino acid metabolism. Urea cycle disorders. Disorders of carbohydrate metabolisms. Disorders of steroid metabolism.
Disorders of lipid metabolism. Lysosomal storage disorders. Disorders of urine /pyrimidine metabolism. Organic acid disorders. Disorders of copper metabolism.
Peroxidase disorders.

Human Genome project, treatment of genetic disease and gene therapy:

Human genome project Treatment of genetic disease Gene therapy.
Genetics & society.

PRACTICAL On Medical Genetics (13 hours)

Study of Karyotypes I

Normal karyotyping in Humans – male (46, XY) and
female (46, XX), G banded metaphase plates.

Study of Karyotypes II
Abnormal karyptypes – Down syndrome (Autosomal),
Turner syndrome and Klinefelter syndrome (Sex
chromosome)
Sex chromatin

Buccal semear study and staining methods for Barr bodies
Blood smear study of drumsticks in neutrophils

SCHEME OF EXAMINATION OF PATHOLOGY

Theory: - Their shall be one paper of 3 hrs duration, carrying 100 marks each in semester

PAPER I:-Pathology-I
Title: Haematology & Blood Transfusion

Sec A: - Haematology & Clinical Pathology -50 marks
Sec B: - Immunopathology & Medical Genetics -50 marks
Type of questions and distribution of marks for each section carrying 50 marks in theory subjects

Section A and section B			
Type of questions	No of questions	Marks	Total
Long Essay	01	20	20
Short Essay	05	06	30

PRACTICAL EXAMINATION **Max Marks: 70**

Experiments (40 marks) , Viva voce 30 marks) Spotters, Staining and reporting the Peripheral smear, Special test -(Any two to be performed) RBC / WBC Count, eticulocyte count, Absolute Eosinophil Count, ESR or PCV, Osmotic Fragility Test, Sickling test,

Blood Transfusion preliminary tests
Blood grouping and typing including Dn test (Compulsory) Any one of the following, Cross – Matching –Coomb's Test - Direct &

Indirect, Clinical Pathology a. Urine Examination (Compulsory)
Physical, Microscopic, Chemical
Any two of the following
Sugar & Ketone Bodies, Protein & Blood, Bilirubin / Bile salt / Bile pigment,
Stool Examination
Microscopic, Macroscopic, Special Tests

VIVA-VOCE----30 Marks
The Viva Voce exam will carry 30 marks and both the internal and external examiners will conduct the examination
Note: each theory paper for 100 marks, Theory internal assessment 20 marks, viva voce 30 marks, practicals 40 marks, & practical internal assessment 10 marks. Thus each subject is for 200 marks

SUBSIDARY SUBJECTS IN FIRST YEAR (I &II SEM) (40 hours)

Syllabus For M.Sc MLT Subsidiary subject

Paper-1 Research methodology and biostatistics(100marks)

Section A Research Methodology 50 marks

Research hypothesis/Research question

- What is a research question?
- Refining research question-SMART –Specific Measurable Attainable Relevant Time constraint
- PICO model-Definition of Population, Intervention, Comparison and Outcomes

Review of literature

- Need for Review of Literature
- Performing electronic literature search (Pubmed, EMBASE, Ind Med, Cochrane)
- Medical journals/text books
- Use of Boolean operators, keywords and filters
- Bibliography (reference writing styles)
- Systematic review and Meta-analysis

Study designs for Biomedical Research

- Pilot study

a. Observations(analytical-case control cohort, descriptive-cross sectional)

b. Experimental (Randomized clinical trials(RCT) and Non RCT) Preclinical studies, Clinical trials:

- Nuremberg code, Declaration of Helsinki, Belmont principles
- Phases of clinical trials (Blinding, Randomization)
- International Conference on Harmonization (ICH)-Good clinical practice (GCP), Good laboratory practice (GLP)

Protocol writing & Informed consent from

References:

1. Biomedical Research, Jagadeesh G, Sreekant Murthy, Gupta YK, Amitabh Prakash, Lippincott Williams & Wilkins 2010
2. Biostatistics: A foundation for analysis ion health sciences. Wayne W Daniel. 2008
3. Basic Epidemiology. Bonita R, Beaglehole and Kjellstrom T, 2nd Edition. 2007
4. Ethical Guidelines for biomedical research on human subjects. ICMR New Delhi 2006
5. Statistical Methods in Medical Research, Armitage P, Berry G, Matthews JNS. 4th Edition.2001
6. Guidelines for use of Laboratory Animals in Medical Colleges, ICMR New Delhi 2001

SECTION B: BIO-STATISTICS

Educational research, questionnaire design, reliability, validity

Sampling and sample size calculation

- Different types of sampling (like cluster, stratified, purposive)
- Methods of estimating sample size
- Data-variables, scales

Data Analysis:

Choosing a statistical test-descriptive and inferential

- Parametric tests
- Non parametric tests
- Post hoc tests
- Correlation and Regression
- Data interpretation
- Use of SPSS and other statistical packages

Research proposal writing/grant writing for extramural funds

Scientific communication

- Paper presentation at conference
- How to write good scientific paper?

- Structure of scientific paper, Abstract, Title, Introduction, Methods, Results, Discussion (IMARD)

Critical appraisal of article in journal

Thesis writing

Evidence Based Medicine

Ethical issues in research

- Institutional Animal Ethics Committee
- Institutional Ethics Committee/Institutional Review Board
- Research Misconduct
- Plagiarism
- Authorship guidelines
- Conflict of interest
- Acknowledgement

References :

1. Lwanga SK Cho-Yook Tye (Editors). Teaching Health Statistics, Twenty lessons and seminar outlines, World Health Organization, Geneva
2. Mahajan BK, Methods in Biostatistics for medical students and research workers. 6th Edition, Jaypee Brothers medical Publishers, New Delhi, 1997.
3. Sundr Rao PSS and Richard J. Introduction of Biostatistics; A Manual for students in Health sciences. Prentic-Hall of India Pvt. Ltd, New Delhi.
4. N.S.M. Rao : Elements of Health statistics

Assignments

1. Collection and tabulation of data
2. Graphical representation of data
3. Correlation and regression analysis
4. Student's 't' test
5. Chi-square test
6. ANOVA

THIRD SEMESTER

BRANCH: HAEMATOLOGY AND BLOOD TRANSFUSION

4.1 SYLLABUS

Pathology (Third semester)

Haematology and Blood Transfusion

Paper I Hematology

General aspects:

Blood cell formation,Sites of haemopoiesis. Development of blood cells. Morphology and Regulation of heaemopoiesis.

Red cells: Basic aspects of anaemia definition, patho physiology ,classification and clinical features.Investigation of a case of anaemia in general.

Microcytic hypochromic anaemias: Sideroblastic anemia Anaemia of chronic infection Thalassaemia. Iron deiciency anaemia – Iron metabolism , causes of iron deficiency, clinical features, laboratory investigations.

Macrocytic Anaemias: Megaloblastic Non megaloblastic Megaloblastic anaemia – Etiology, clinical features, laboratory investigation. Pernicious anaemia.

Normocytic normochromic anaemia: Anaemia in systemic disorders Acute blood loss, Renal failure Liver disorders etc.

Disorders of Haemoglobin: Structure of Hb and Synthesis Normal and Abnormal haemoglobins Hamoglobinopathies

Haemolytic anaemia:

Definition, pathogenesis, classification, clinical features, Extrinsic factors & Intrinsic factors –investigation

Laboratory investigations to establish a case of haemolytic anaemia.

1. Peripheral smear – specific morphologic abnormalities

2. Special tests

a) Osmotic fragility test
b) Sickling test
c) Kleihaure acid elution test
d) Alkali denaturation test
e) Ham's test ,
f) Sucrose lysis test
g) Coomb's test
h) Electrophoresis – HbF, HbA2 estimation
i) Tests for G6PD deficeiency

3. Hemolytic disease of new born – causes and investigations

Aplastic anaemia:

Pancytopenia.

Clinical Polycythaemia- classification features, laboratory investigation:

Leucocyte disorders Leukaemoid reaction – type of leukaemoid and diagnosis. Myelodysplastic syndrome [MDS] Definition, clinical features, peripheral smear and Bone marrow findings.

Leukaemias: Definition, –French- American-British [FAB] and World Health Organization- classification of acute leukaemias Diagnostic criteria , Cytochemical staining and Immunophenotyping Chronic Leukaemias:

classification, Diagnostic criteria .

Myeloproliferative disorders –
classification ,Clinical features, laboratory investigations.
Chronic myeloid leukaemia in detail.
Lymphoproliferative disorders.- Chronic
lymphocytic leukaemia in detail.
Plasma cell disorders – classification.
Plasma cell myeloma – definition. Clinical
features, laboratory investigations.

PRACTICAL

Paper 1 Hematology

1. Staining and Interpretation of Peripheral smears.

2. Microcytic hypochromic anaemia- Peripheral smear, bone marrow Examination , Serum iron. Serum Total iron bindng capacity [TIBC] Percentsaturation, Serumferritin, bone marrow. Ironstain .

3. Macrocytic Anaemia- Peripheral smear, bone marrow. Examination, Vit B12 assay, Folate assay,Schilling Test.
4. Plasma Hb Estimation
5. Haemolytic Work up Peripheral smear – spceific morphologic abnormalities Special tests Osmotic fragility test Sickling test Kleihauer acid elution test) Alkali denaturation test Ham's test, Sucrose lysis test Coomb's test Electrophoresis – HbF, HbA2 estimation Tests for G-6PD deficiency

6. Leukaemias:
   i. Myeloperoxidase
   ii. Periodic Acid Phosphatase [PAS]
   iii. Sudan Black
   iv. Esterase, Non specific esterse
   v. Leucocyte alkaline Phsophatase

Immuno Cytochemical Staining.

Plasma cell Disorders : Serum Protein Electrophoresis Urine Electrophoresis

Paper 2 Blood Transfusion

Introduction to Immuno Haematology:

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 occuring in the stored blood
6. Blood group systems – antigen – antibody reaction ,ABO system- Forward grouping reverse group
7. Rh system Inheritence& nomenclature R h grouping – Rh antigen and antibodies DuVariant 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
10. Blood components – Indications preparation of blood components

PRACTICAL
Paper 2 Blood Transfusion

Blood grouping – ABo grouping, Forward grouping (slide & tube method)
Reverse grouping – preparation of pooled A, B & O cells Grading of Reaction. Other methods of grouping. AB0 antibody titration, Cold antibody titration.
Rh grouping & Rh typing (slide & tube method)

Du Testing Rh – antibody titration
Antiglobulin Testing Direct and Indirect
Preparation of Coomb's Control Cells.
Compatibility Testing
Selection of blood
Crossmatching Technique – Major, Minor, Saline, Albumin, Coomb's
Emergency –Cross matches
Blood Collection
Donor selection Blood collection [Phlebotomy] Post donation Care
Preservation and Storage of blood
Preparation and Storage of blood Components
Packed Cells ,Fresh Frozen plasma [FFP], Platelet
Concentrate, Cryoprecipitate Component transfusion – selection of blood group

FOURTH SEMESTER

BRANCH: HAEMATOLOGY AND BLOOD TRANSFUSION

4.1 SYLLABUS

Pathology (Fourth semester). Specialisation -Haematology and Blood Transfusion

Paper –I Hematology

Haemorrhagic disorders:

Definition: Pathogenesis, clinical features, Classification: a. Primary hemostasis, b. secondary hemostasis – causes and investigations of both. Fibrinolysis.

Platelet disorders:

Quantitative – Thrombocytopenia – Idiopathic thromobcytopenic purpura (ITP) Classification, clinical featrues, diagnosis and bone marrow findings in ITP. Qualitative platelet disorders. Thromobcytosis – Definition , Etiology,. Lab Investigations

Coagulation disorders:

Inherited -Haemophilia A and B, von Willebrand's disease, Acquired: Vit. K deficiency, Liver disease, DIC Investigation of Haemorrhagic disorders. Tests of vascular and platelet function -Bleeding time, Clot retraction , Patelet count. Platelet aggregation studies. Bone marrow examination.

Tests for coagulation disorders: Screening tests- First line tests -Prothrombin time (PT), Activated partial thromboplastin time (APTT) Thrombin time (TT) Second line tests – Mixing experiments. Coagulation factory assay. Urea solubility tests for Factor XIII. Factor VIII inhibitor study. Fibrinogen assay. Disseminated intravascular coagulation- Definition, Pathogenesis, laboratory investigations

Thrombotic disorders:

Classification - Inherited and Acquired. Clinical features, Investigation of thrombotic disorders:

Tests:

i. Protein C

ii Protein S,

iii. AT-III

iv Factor V leiden

Antiphospholipid antibody syndrome: Defintion clinical feature laboratory investigation.

B.M.Examination-

Aspiration and Trephin biopsy staining

Automation in haematology

Molecular genetics in hematology

Cleaning of glass ware

Organization and quality control in the laboratory

Bio medical waste management .

PRACTICALS
Paper 1 Hematology

Investigation of Haemorrhagic disorders Test of vascular and platelet function – Bleeding time, Clot retraction, Platelet count. Platelet aggregation studies. Bone marrow

Tests for coagulation disordrs:

Screening tests – First line tests- Prothrombin time (PT),

Activated partial thromboplastin time(APTT), Thrombin

time(TT), INR.

Second line tests – Mixing experiments.

Coagulation factor assay

Urea solubility tests for Factor XIII

Factor VIII inhibitor study

Fibrinogen assay

Thrombotic Work-up

Tests: i. Protein C

ii. Protein S

iii. AT-III

iv. Factor V leiden

Antiphospholipid Antibody –work up

Bone marrow examination – Preparation of B.M
Aspiration and Trephine biopsy smears staining

Organisation and quality control in the laboratory

Cleaning of glass ware

Bio Medical waste management

Preparation of Reagents, Diluting fluids, Stains – Leishman's stain Geimsa stain
M.G.G stain

Paper 2 Blood Transfusion

Autologous transfusion

1. Transfusion transmitted disease
2. Haemolytic disease of the new born and exchange transfusion
3. Transfusion Therapy
4. Transfusion in Special Situations-Auto immune haemolytic anaemia
5.Transfusion reactions and investigation of transfusion reaction
6.Transfusion transmitted infections
7. Immunomodulation and graft versus host reactions .
8. Haemapheresis-Definition ,Types of pheresis ,Machines and Techniques.
9. Tissue banking
10.Cord blood banking
11. Stem cell processing, storage and transplantation
12..Disposal of wastes and biologically hazardous substance in the blood bank 13.Medico legal aspects of blood transfusion 14.Technical advances and future trends in blood banking
15.Paternity testing Orientation of a routine blood bank
16. Quality Assurance - General condition
Equipment

Reagents

Donor processing

17.Drugs control regulation and Blood Bank

PRACTICAL

Paper 2 Blood Transfusion

1 Cross matching in Special Situations
2 Exchange transfusion –selection of blood group
3 Autoimmune haemolytic anaemia
4 Investigation of Blood-Transfusion reaction
5 Testing for transfusion Transmitted Diseases
Elisa-HIV, HBsAg ,HCV
VDRL Test
Malaria
6 Quality control – Methods
Reagents
Test methods
Products
Documents
Equipment
7 Apheresis procedure-Types of pheresis, Machines and Techniques.
Biomedical Waste management -
Record keeping – to be observed
Documentation

Books Recommend for Blood Transfusion

1. Technical manual - 12th edition - AABB

2. The Clinical use of Blood Handbook WHO
3. ABO Rh system - Ortho diagnostics
4. Compatibility testing - Ortho diagnostics
5. Compendium of transfusion medicine Fr. R. N. Makroo. Ed. 1999
6. Bl ood transfusion in Clinical Medicine - Mollision - 5th edition
7. Blood group Serology, Theory, Techniques, Practical application - K.E.Boorman, B.E Dodd, P. J.Lincoln - 5th edition
8. Technical Manual 12th edition AABB.
9. Rossi's Principles of Transfusion Medicine 3rd Edition 2002 Toby L.Simon ,Walter H Dzik,Edward L.Snuder , Christopher P. Stowell Ronald G.Strauss 3 rd edition Lippincott Willams and Wilkins.