COURSECURRICULUM

For

Masters in Medical Laboratory Sciences

(MMLS)

(*w.e.f.* Academic Session 2021-22)

Erstwhile M.Sc.-MLT(Master of Science in Medical Lab Techniques)

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कुलपति
अटल बिहारी बाजपेयी चिकित्सा विश्वविद्यालय
उत्तर प्रदेश, लखनऊ

Background

The specialization of Master's in Medical Laboratory Sciences (MMLS) deals with the all the modern laboratories techniques.

Master 's degree in Medical laboratory science can be accomplished with course duration of 2 years (4 semester) inclusive of Research Project/Dissertations in fourth semester.

The discipline of Medical Laboratory Techniques comprises broadly of Clinical Biochemistry, Pathology, Haematology and Blood Banking and Medical Microbiology.

It is proposed that the Master's in Medical Laboratory Sciences (MMLS) shall be offered in above said specializations i.e.

1. Master's in Medical Laboratory Sciences (MMLS)– **Clinical Biochemistry**

2.Master's in Medical Laboratory Sciences (MMLS)– **Pathology**

3.Master's in Medical Laboratory Sciences (MMLS)– **Haematology and Blood Banking**

4.Master's in Medical Laboratory Sciences (MMLS)– **Medical Microbiology**

1. **HUMAN RESOURCES REQUIRMENT FOR COMMENCING B. Sc. M.L.S. DEGREE PROGRAM**

Teaching faculty: Teacher student ratio must be 1:10 (Teacher: student)

Non-teaching staff: office clerical staff (Lower divisional clerk, upper divisional clerk, office superintendent), library staff, computer operator, lab. assistant, Driver, guards, peon, housekeeping staff (sweeper) etc.

Pay scale of teaching and non-teaching staff: As per latest UGC norms.

Duration of course: Total duration of B.Sc. Medical Laboratory Techniques (B. Sc. M.L.S.) course will be 04 years (7 semester) followed by compulsory 6 months' rotatory internship.

Teaching faculty and staff:

The importance of providing an adequate learning environment for student's needs be emphasized. Both the physical infrastructure and the teaching staff must be adequate.

2. **ACADEMIC QUALIFICATIONS, TEACHING EXPERIENCE AND OTHER ELIGIBILITY REQUIREMENT FOR APPOINTMENT OF FOR B.M.L.S. COURSE**

1. **Assistant Professor:**

A Master degree with minimum of 55% marks (or an equivalent grade in a point-scale, wherever the grading system is followed) at the Master degree (M.Sc. M.L.T./M.Sc. M.L.S./M.Sc. Pathology/M.Sc. Microbiology/M.Sc. Biochemistry, relevant/allied subject from an Indian University, or an equivalent degree from an accredited foreign university) shall be the essential qualification for direct recruitment of faculty.

2. **Associate Professor:**

i. Essential:A good academic record, Master degree with at least 55% marks (or an equivalent grade in a point-scale, wherever the grading system is followed) in (M. Sc. M.L.T./M.Sc. M.L.S/M.Sc. Pathology/M.Sc. Microbiology/M.Sc. Biochemistry, relevant/allied subject from an Indian University, or an equivalent degree from an accredited foreign university).

ii. A minimum of eight years of experience of teaching and / or research in an academic/research position equivalent to that of Assistant Professor in a University, College or Accredited ResearchInstitution/Industry with a minimum of three publications in the peer-reviewed or UGC-listed journals.

Desirable:Ph.D. Degree in the concerned/allied/relevant disciplines.

3. **Professor:**

A.

Essential: An eminent scholar havingMaster degree (M.Sc. M.L.T./M.Sc. M.L.S/M.Sc. Pathology/M.Sc. Microbiology/M.Sc. Biochemistry, relevant/allied subject from an Indian University, or an equivalent degree from an accredited foreign university) and minimum of ten years of teaching experience in university/college as Assistant Professor/Associate Professor/Professor, and / or research experience at equivalent level at the University/National Level Institutions.

Desirable: Ph.D. degree in the concerned/allied/relevant discipline, and published work of high quality, actively engaged in research with evidence of published work with, a minimum of 05 research publications in the peer-reviewed or UGC-listed journals.

B.

An outstanding professional, having Ph.D. Degree in the concerned/allied/relevant disciplines, from any academic institutions (not included in A above) / industry, who has made significant

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contribution to the knowledge in the concerned/allied/relevant discipline, supported by documentary evidence provided he/she has ten years' experience.

4. College Principal /Dean:

A.

Essential:

Master degree (M.Sc. M.L.T./M.Sc. M.L.S/M.Sc. Pathology/M.Sc. Microbiology/M.Sc. Biochemistry, relevant/allied subject from an Indian University, or an equivalent degree from an accredited foreign university) with total ten years of experience teaching/research in Universities, Colleges and other institutions of higher education. Senior most professor shell be designated as principle/Dean.

Desirable:

Higher qualification like Ph.D.degreein M.Sc.M.L.T./M.Sc. M.L.S/ Pathology/ Microbiology/ Biochemistry, relevant/allied subject from an IndianUniversity, or an equivalent degree from an accredited foreign university). A minimum of 10 research publications in high slandered peer-reviewed or UGC-listed journals.

B. Tenure

i) A College Principal shall/Dean be appointed for a period of five years, extendable for another term of fiveyears on the basis of performance assessment by a Committee appointed by the University, constitutedas per these regulations.

ii) After the completion of his/her term as Principal, the incumbent shall join back his/her parent organization with the designation as Professor and in the grade of the professor.

5. Vice Principal

An existing senior faculty member may be designated as Vice-Principal by the Governing Body of the College on the recommendation of the principal, for a tenure of two years, who can be assigned specific activities, in addition to his/her existing responsibilities. During the absence of the principal, for any reason, the vice -principal shall exercise the powers of the principal.

3. DEPARTMENT-WISE AND YEAR-WISE FACULTY REQUIREMENT

Teaching staff (fulltime):

It is recommended that a faculty and student ratio of 1:3 is to be followed for the post graduate (M.M.L.S.) programs and 1:10 for the under graduate programs (B.M.L.S.).

Required teaching staff year wise bachelor course (B. Sc. M.L.S.) for 60 intakes

(Proposed by Uttar Pradesh State Allied and Healthcare Council)

For bachelor course year wise	Principal/Dean	Professor	Associate Professor	Assistant Professor
First & second year	01	01	03	06
Third year		01	02	04
Total (18)	01	02	05	10

Required teaching staff year wise master course (M.M.L.S.) for 15 intakes specialization (Proposed by Uttar Pradesh State Allied and Healthcare Council)

For bachelor course year wise	Professor	Associate Professor	Assistant Professor
First year	01	02	04
Second year	01	02	04
Total (14)	02	04	08

Technical staff (Proposed by Uttar Pradesh State Allied and Healthcare Council)

Technical staff	Lab. Technician	Lab. assistant
For B. Sc. M.L.S.	03	03
For M.Sc. M.L.S.	02	02

Administrative staff for B.M.L.S. and M.M.L.S.

(Proposed by Uttar Pradesh State Allied and Healthcare Council)

Administrative staff	**Number of staff**
Administrative officer	01
Office superintendent	01
PA to principal/Dean	01
Accountant/cashier	01

Ancillary staff for B.M.L.S. and M.M.L.S.

(Proposed by Uttar Pradesh State Allied and Healthcare Council)

Ancillary staff	**Number of staff**
Upper divisional clerk	02
Lower divisional clerk	02
Record clerk	01
Librarian	01
Lab attendant	03
Library attendant	02
Steno typist Hindi	01
Steno typist English	01
Office attendant	02
Audio-visual technician	01
Class room attendant	04
Peon	02
Security guard	02
Driver	01
Housekeeping staff (sweeper)	05

4. ACADEMIC FACILITES:

A. Infrastructure required:

(Proposed by Uttar Pradesh StateMedical Faculty Lucknow)

The importance of providing an adequate learning environment for students needs be emphasized. Both the physical infrastructure and the teaching staff must be adequate.

Total land and building area required:

Depending on the location of college/institute land area requirement will be as given below-

Land area required	Building/covered area	Hospital requirement
For urban area 4000 sq meter or 43040 sq ft while for rural area 8000 sq meter or 86080 sq ft is required. The land should be in the name of society. In case of more than one course there must be additional 2000 sq meter area required for each course.	There must be 1000 sq meter or 10760 sq ft Building/covered area. In case of more than one course there must be additional 200 sq meter Building/covered area will be required for each course.	The Institution should be in the vicinity of a functional medical college (100 bed) or University and has an attached hospital for purpose of practical exposure and internships of the students.

Planning and layout:

(Proposed by Uttar Pradesh State Allied and Healthcare Council)

Administrative block- 1700 sq.ft			
Space required for	Area required per unit up to 50 intakes	No of units required	Total required build-up area in sq.ft.
Principal office	300sq.ft	1	300sq.ft
Main administrative office	500sq.ft	1	500sq.ft
Reception	200sq.ft	1	200sq.ft
Wash room	200sq.ft	1	200sq.ft
Others	500sq.ft	1	500sq.ft
Faculty office – 1600sq. ft.			
Professor's office	150sq.ft	4	600sq.ft
Associate Professor's office	100sq.ft	4	400sq.ft
Assistant Professor's office	75sq.ft	8	600sq.ft

Academic block			
Class room (with LCD projector, audio-visual aids)	750sq.ft	2	1500sq.ft
Conference room with LCD projector, audio-visual aids)	300sq.ft	2	600sq.ft
Laboratory	500sq.ft	3	1500sq.ft
Library (20 students)	1200sq.ft	1	600sq.ft
Computer room with high-speed internet	300sq.ft	1	300sq.ft
Seminar room withA.V. aids	300sq.ft	1	300sq.ft
Store room	200sq.ft	1	200sq.ft
Auditorium/multipurpose hall	1500sq.ft	1	1500sq.ft
Museum	500sq.ft	1	500sq.ft
Students common room for girls	1000sq.ft	1	1000sq.ft
Students common room for boys	250sq.ft	1	250sq.ft
Wash room female	200sq.ft	1	200sq.ft
Wash room male	200sq.ft	1	200sq.ft
Electricity Power generator	20KVA 10KVA		
Water cooler	25L	2	4500sqft
Telephone/PCO		1	
Vehicle Parking		1	
Canteen/cafeteria		1	
Microbiology laboratory	1200sq.ft	1	1200sq.ft
Biochemistry laboratory	1200sq.ft	1	1200sq.ft
Laboratory for histopathology and cytology	1200sq.ft	1	1200sq.ft
Recreational area	1000sq.ft.	1	1000sq.ft.
Hostels for girls	mandatory	Separate/shared with medical college	
Hostels for girls	mandatory	Separate/shared with medical college	

B. Hospital requirement:

The Institution/college should be in the vicinity of a functional medical college (100 bed) or University. Institution/college should have its own hospital/attached hospital for purpose of practical exposure and internships of the students. Institution shall have to satisfy themselves

that satisfactory infrastructure facilities ofPathology Laboratory exist in the Institute/Hospital where the internship training has to beundertaken.

SPORTS FACILITIES:
Outdoor and Indoor facilities for sports should be available for the students to lead a balanced life style and to enhance leadership skills. The Institution must have adequate Sports, Cultural, Gymnasium and Yoga infrastructure facilities for overall development of students. Sports activities such as basketball court, cricket, football, athletics, kabaddi and indoor playground for table tennis, badminton, chess, carom, etc. Separate gymnasium for boys and girls should be provided in the hostel.

Wi Fi Setup
The campus should be well equipped with a Next Generation Network (NGN) Wi Fi facility.

CCTV Setup in Campus
CCTV should be installed in campus and in hostel.

5. RULES & REGULATION FOR ADMISSION:

(As mentioned in University prospectus)

1. Admission to B.Sc. Medical Laboratory Sciences (B. Sc. M.L.S.) course in the Paramedical Colleges, which are affiliated to the University will be made on the basis of final Merit List (Average of Combined Percentage of High School and Intermediate (10+2) (PCB) with English qualifying examinations.
2. Minimum age for admission is 17 years on or before 31st December of respective year.
3. Minimum qualifications for admission will be as per latest National Commission for Allied and Healthcare Professionals regulations.
   a) Candidates should have passed High School (10th) and Intermediate (10+2) qualifying examination from U.P. Board, CBSE Board, ISC/ICSE Board and other only.
   b) Passed High School (Marks percentage of ALL Subjects will be required).
   c) Candidates with Science who have passed qualifying 12th Standard examination (10+2) and must have obtained a minimum of 50% marks in Physics, Chemistry and Biology (PCB) taken together from any recognized board
   d) Candidates from State Open School recognized by State Government and National Institute of Open School (NIOS) recognized by central government having Science subjects are also eligible
   e) 5% of total marks in core subjects (PCB) in (10+2) is relaxed for SC/ST candidates. It should be 45% instead of 50% as stated above.
   f) Color blind candidates are eligible provided that color corrective contact lens and spectacles are worn by such candidates.
   g) The selection of candidate will be subject to medical fitness. No selected candidate will be permitted to join the course unless declared medically fit by the Medical Board appointed by the University. The decision of the Medical Board shall be final.

4. **Reservation Policy:** Reservation of seats will be as per the State Govt. under the reservation policy and within the sanctioned number of seats and not above it.

a. Any change in reservation policy will be followed as per the Uttar Pradesh State government directives.

b. Reservation for disability (PH): 5% Horizontal reservation will be considered for disabled candidates with a disability of loco-motor to the tune of 40% to 50% of the lower extremity and other eligibility criteria with regard to qualification will be same as prescribed for Unreserved (UR) category candidates. (The Gazette of India No. 275 dated 05th July 2021). NOTE: A committee will be formed consisting of medical officer authorized by Medical Board of State Government and a nursing expert in the panel which may decide whether the candidate have the disability of loco-motor to the tune of 40% to 50%.

c. Caste certificate issued by ONLY the competent authority (Tehsildar) of Uttar Pradesh Government are acceptable.

d. EWSs quota of 10% is admissible provided a valid certificate is furnished which has been issued by competent authority (Tehsildar) of Uttar Pradesh Government.

e. The candidate has to ascertain his own eligibility based on the criteria above, otherwise his/her claim for reservation will not be considered.

f. If the information furnished by the applicant is found incorrect at this stage or at a later stage the applicant's candidature or the applicant's admission to B.M.L.S. course shall stand cancelled.

g. The decision of the Vice-Chancellor shall be final in the matter of selection of candidates for admission to the course and no appeal shall be entertained on this subject.

Masters in Medical Laboratory Science (MMLS) – Clinical Biochemistry

Introduction

Learning Objectives:

1. Knowledge to supervise and perform full range of clinical Biochemistry laboratory tests.

2. Knowledge to develop and evaluate test systems and interpretive algorithms.

3. Manage information to enable effective, timely, accurate, and cost-effective reporting of laboratory-generated information

4. Knowledge to teach under graduate students and develop/guide research projects.

5. Understand case base learning.

Program Specific Outcomes (PSOs):

At the end of the course the student should be able to:

1. Development of knowledge on innovative practices in medical and health care system.
2. Perform/supervise routine Clinical Biochemistry laboratory testing.

3. Practice and use of various techniques relating to clinical biochemistry laboratory analyses.

4. Provide Medical laboratory services in all types of clinical laboratories from Primary healthcare laboratory to Tertiary health care institution in the fields of Bacteriology, Immunology, Mycology, Parasitology and Virology.

5. Communicate with other members of healthcare team, customers and patients in an effective manner.

6. Train students in routine/special laboratory procedure.

7. Should know the logical interpretation of clinical lab investigations.

8. Should be capable of supervise / guide the staff working on automated instruments.

Eligibility for Admission:

Selection Procedure

1. Candidate should have passed Bachelor in Medical Laboratory Science (BMLS).

2. Minimum percentage of marks: 55% aggregate.

3. Separate entrance exam should be incorporated for these students who want to purse Masters in Medical Laboratory Science.

Provision of Lateral Entry: There should be no provision for lateral entry at Masters level.

Duration of the course:

Total 2 Years (4 semesters or 2048 hours) with 1.5 Years didactic and practical (1536 hours) + 6 months (512 hours) Research project/Dissertation.

Medium of instruction: English shall be the medium of instruction for all the subjects of study and for examination of the course.

Provision of dissertation & project: Six months of dissertation should be mandatory as partial fulfillment for the award of Masters in Medical Laboratory Science Degree.

Attendance: A candidate has to secure minimum- 1. 75% attendance in theory &practical training for qualifying to appear for the final examination. No relaxation, whatsoever, will be permissible to this rule under any ground including indisposition etc.

Assessment: Assessments should be completed by the academic staff, based on the compilation of the student 's theoretical & clinical performance throughout the training Programme. To achieve this, all assessment forms and feedback should be included and evaluated. Student must attain cumulative score of at least 50% marks in both theory and practical for each individual subject and internal assessment separately.

Medium of instruction:
English shall be the medium of instruction in the class and in the University examination

Attendance to appear in the university examination:
The permission to appear in annual examination shall be granted to such candidate only whohave fulfilled the condition of 75% attendance in each subject separately in theory and practical as per the university rule.

Outline:First Sem.

Course Code	Course Title	Hours			Marks		Total Marks	Credit
		L	T	P	Internal	External		
MMLSB-101	General Biochemistry	4	1	-	50	100	150	5
MMLSB-102	Enzymes & Metabolism–I	4	1	-	50	100	150	5
MMLSB-103	Medical Laboratory Management	4	-	-	50	100	150	4
MMLSB-104	Research Methodology & Bio-Statistics	4	-	-	50	100	150	4
MMLSB-105	General Biochemistry(Practical)	-	-	5	50	100	150	3
MMLSB-106	Enzymes & Metabolism –I (Practical)	-	-	5	50	100	150	3
MMLSB-107	Medical Laboratory Management (Practical)	-	-	2	50	100	150	1
MMLSB-108	Research Methodology & Bio- Statistics- (Practical)	-	-	2	50	100	150	1
Total		16	2	14	400	800	1200	26
Total Hours in Semester		512						

NOTE:

1. **Abbreviations: L - Lecture, T - Tutorials and P -Practical**
2. **Teaching resources should be made available at every institute for all basic subjects**
3. **Considering four months per semester as working months, total contact hour hours per semester shall be 512 (Five hundred andtwelve)**

Second Semester

Course Code	Course Title	Hours			Marks		Total Marks	Credits
		L	T	P	Internal	External		
MMLSB-201	Principles of Biochemistry	4	1	-	50	100	150	5
MMLSB-202	Enzymes and Metabolism-II	4	1	-	50	100	150	5
MMLSB-203	Vitamin, Hormones, General Physiology & Nutrition	4	-	-	50	100	150	4
MMLSB-204	Molecular Biology and Bioinformatics	4	-	-	50	100	150	4
MMLSB-205	Principles of Biochemistry (Practical)	-	-	5	50	100	150	3
MMLSB-206	Enzymes & Metabolism – II (Practical)	-	-	5	50	100	150	3
MMLSB-207	Vitamins, Hormones, General Physiology & Nutrition (Practical)	-	-	2	50	100	150	1
MMLSB-208	Molecular Biology and Bioinformatics (Practical)	-	-	2	50	100	150	1
Total		16	2	14	400	800	1200	26
Total Hours in Semester		512						

NOTE:

1. **Abbreviations: L - Lecture, T - Tutorials and P -Practical**
2. **Teaching resources should be made available at every institute for all basicsubjects**
3. **Considering four months per semester as working months, total contact hour hours per semester shall be 512 (Five hundred andtwelve)**

Third Semester

Course Code	Course Title	Hours			Marks		Total Marks	Credits
		L	T	P	Internal	External		
MMLSB-301	Applied Clinical Biochemistry	4	1	-	50	100	150	5
MMLSB-302	Immunology	4	1	-	50	100	150	5
MMLSB-303	Organ Function Test	4	-	-	50	100	150	4
MMLSB-304	Advanced Clinical Biochemistry	4	-	-	50	100	150	4
MMLSB-305	Applied Clinical Biochemistry (Practical)	-	-	5	50	100	150	3
MMLSB-306	Immunology (Practical)	-	-	5	50	100	150	3
MMLSB-307	Organ Function Test (Practical)	-	-	2	50	100	150	1
MMLSB-308	Advanced Clinical Biochemistry (Practical)	-	-	2	50	100	150	1
Total		16	2	14	400	800	1200	26
Total Hours in Semester		512						

NOTE:

1. **Abbreviations: L - Lecture, T - Tutorials and P -Practical**
2. **Teaching resources should be made available at every institute for all basic subjects**
3. **Considering four months per semester as working months, total contact hour hours per semester shall be 512 (Five hundred and twelve**

Fourth Semester

Course Code	Course Title	Hours	Marks		Total Marks	Credits
			Internal	External		
MMLSB-401	Dissertation/Project	Submission within five Months	150	250	400	26
Total Hours in Semester		512				

NOTE:

1. **Abbreviations: L - Lecture, T - Tutorials and P –Practical**

Course Code MML.SB-101	M.M.L.S. First Semester GENERAL BIOCHEMISTRY	L-4 T-1 P-0 C-5
Course Content:		
Unit-1	**History & scope of Biochemistry.** **Chemistry of living things**: Cell, cell composition intracellular organelles, Architecture and functions, chemical bonding, water and its properties	
Unit-2	**General Biochemistry of Carbohydrates:** Definition, biological importance, Classification, Isomerism & Properties of Monosaccharides, Disaccharides Polysaccharides & Digestion and absorption	
Unit-3	**General Biochemistry of proteins:** Definition, biological importance, Classification peptides and polypeptides, Properties, Structural Organization-Primary, Secondary, Tertiary & Quaternary, Ramachandran plot, Plasma Proteins, digestion and absorption	
Unit-4	**General Biochemistry of lipids:** Introduction, definition, classification, biological importance, digestion and absorption. Ketones bodies Fatty acids: Essential and non-essential fatty acids, saturated and unsaturated fatty acids, Cholesterol, Prostaglandins, Lipoproteins in the blood composition & their functions in brief	
Unit-5	**General Biochemistry of Amino Acids:** Definition, biological importance, Classification Properties. Essential and non-essential amino acids	
	1. Lehninger's Principle of Biochemistry by David L. Nelson and Michael M. Cox. W. H. Freeman; 6th edition 2. Text book of Biochemistry, D M Vasudevan, Jaypee Publishers 3. Fundamentals of Biochemistry by Voet and Voet, John Wiley and sons NY. 4. Biochemistry by L. Stryer, W.H. Freeman and Co.	

Course Code MMLSB-102	M.M.L.S. First Semester ENZYMES METABOLISM -I	L-4 T-1 P-0 C-5
Course Content:		
Unit-1:	**Introduction to Enzymes:** Nomenclature, Classification and Characteristics of enzymes, Enzyme specificity, Cofactors, Co-enzyme and Prosthetic group, activators, inhibitors, active site, metalloenzymes,	
Unit-2:	**Mechanism of Enzyme Action:** Nature of active site, identification of functional groups at active site, enzyme substrate complex, Factors responsible for catalytic efficiency of enzymes:	
Unit-3:	**Enzyme Kinetics:** Michaelis Menten equation. Derivation of Michaelis Menten equation and determination of Km and Vmax values,	
Unit-4:	**Enzyme Inhibition** Enzyme inhibition: reversible and irreversible inhibition, Kinetics of competitive, uncompetitive and non-competitive inhibition, Reversible inhibition - competitive,	
Unit-5:	**Clinical Enzymology:** Clinical enzymology - Enzymes as thrombolytic agents, anti-inflammatory agents, digestive aids. Therapeutic use of asparaginase, streptokinase. Enzymes and isoenzymes in diagnosis, Principles of diagnostic enzymology, clinical significance of ALT, AST, ALP, GGT, CPK, CK-MB, LDH, Amylase, Lipase, ACP, Cholinesterase	
	1. T Palmer P L Bonner Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, Horwood Publishing, Chichester, UK 2. Price NC and Stevens L Fundamentals of Enzymology, 3rd Edition, Oxford University Press Inc., New York 3. Lehninger's Principle of Biochemistry by David L. Nelson and Michael M. Cox. W. H. Freeman; 6th edition	

Course Code MML.SB-103	M.M.L.S. First Semester MEDICAL LABORATORY MANAGEMENT	L-4 T-0 P-0 C-4
Course Content:		
Unit-1:	**Preparation of operating budgets:** General aspects of financial management of laboratories. **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 **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).	
Unit-2:	**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.	
Unit-3	**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. **Public relations:** hospital and community.	
Unit-4	**Basic clinical epidemiology** **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) **Use of computers in quality control and management:** Use of computers for calculating analytical results (eg. non-linear functions).	
Unit-5	**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, data-base, graphics, statistics, presentations, email, internet. Security of data storage and transmission. Data base structures and data mining. Appropriate access control to patient information.	
	1. Laboratory Management Quality in LaboratoryDiagnosis **by** Candis A. Kinkus, 2. Clinical Laboratory Management by	

Course Code MML.SB-104	M.M.L.S. First Semester **Research Methodology & Bio-statistics**	L-4 T-0 P-0 C-4
Course Content:		
Unit-1	**Research Methodology** – Definition of research, Characteristics of research, Steps involved in research process, Types of Research methods and methodology, Research Design, Variables & Lifecycle of Research	
Unit-2	**Statistics, data, population, samples, parameters; Representation of Data**: Tabular, Graphical, Measures of central tendency, Arithmetic mean, mode, median; Measures of dispersion, Range, mean deviation, variation, standard deviation, Standard error, Chi-square test	
Unit-3	**Introduction and significance of Student's t-distribution**: test for single mean, difference of means and paired t- test, F-distribution, one-way and two-way analysis of variance (ANOVA). Small sample test based on t-test, Z- test and F test; Confidence Interval; Distribution-free test	
Unit-4	**Introduction to philosophy**: definition, nature and scope, concept, branches. Ethics: definition, moral philosophy, nature of moral judgments and reactions. Ethics with respect to science and research Intellectual honesty and research integrity. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP). Redundant publications: duplicate and overlapping publications, salami slicing. Selective reporting and misrepresentation of data. Report Writing: meaning and significance of report writing, types of report, steps in writing report, layout of the research report	
Unit-5	**Publication ethics**: definition, introduction and importance. Conflicts of interest, Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types ,Violation of publication ethics, authorship and contributor ship, Identification of publication misconduct, complaints and appeals, Predatory publishers and journals	
Textbook	Cooper, "Business Research Methods", Tata McGraw Hill, New Delhi.	
Reference Book	Fowler, F.J. Survey Research Methods. New Delhi, Sage, 1993 Goode, W.J and Hatt, P.K. Methods in Social Science Research. New Delhi, McGraw Hill, 1986 Leddy, Paul. D Practical Research: Planning Design. London, Clive Bingley. 1980	

Course Code MML.SB-105	M.M.L.S. First Semester GENERAL BIOCHEMISTRY (PRACTICAL)	L-0 T-0 P-2 C-1
Course Content:		
1	Preparation of buffers and determination of pH	
2	Deproteinization of blood sample	
3	Preparation of solution and reagents	
4	To identify carbohydrates in given solution by various methods.	
5	To determine protein by Biuret method.	
6	Urine sugar determination by Benedict's method.	
7	Protein by heat and acetic method	
8	Bile salt, Bile pigments and Urobilinogen determination	
9	Determination of Ketone bodies	
10	Preparation of hemolysate	
11	Determination of protein in given sample by Lowry method/Bradford method	
12	Determination of acid value, saponification and iodine number of lipid samples.	

Course Code MML.SB-106	M.M.L.S. First Semester ENZYMES METABOLISM-I (PRACTICAL)	L-0 T-0 P-5 C-3
Course Content:		
1	To perform estimation of ALT & AST	
2	To perform estimation of ALP	
3	To perform estimation of GGT	
4	To perform estimation of CPK	
5	To perform estimation of CPK-MB	
6	To perform estimation of LDH	
7	To perform estimation of Amylase	
8	To perform estimation of AC	
9	To determine glucose conc. By GOD-POD method.	
10	Estimation of blood urea.	
11	To determine HbA1C by ion exchange method.	
12	To determine protein conc. by Biuret method.	
13	To determine Urea by DAM/ urease method.	
14	To determine creatinine by alkaline picrate method.	
15	To determine total cholesterol by CHOD-POD method.	
16	To determine triglyceride method	
17	To determine HDL-Cholesterol.	
18	Estimation of serum creatinine	

Course Code MML.SB-107	M.M.L.S. First Semester MEDICAL LABORATORY MANAGEMENT (PRACTICAL)	L-0 T-0 P-5 C-3
Course Content:		
1	**Sample accountability** A. Labelling of sample B. Making entries in Laboratory records	
2	**Reporting results** A. Basic Format of a test report B. Release of examination results C. Alterations in reports	
3	**Calibration and Validation of Clinical Laboratory instruments**	
4	**Ethics in medical laboratory practice in relation to the following:** A. Pre-Examination procedures B. Examination procedures - Reporting of Results C. Preserving Medical Records	

Course Code MML.SB-108	M.M.L.S. First Semester Research Methodology & Bio-statistics (PRACTICAL)	L-0 T-0 P-2 C-1
Course Content:		
1	Uses of LATEX	
2	Uses of MS Excel	
3	Uses of MS Word	
4	Uses of MS Power Point	
5	Uses of SPSS	
6	Uses of Web Technology	

Course Code MML.SB-201	M.M.L.S. Second Semester Principles of Biochemistry	L-4 T-1 P-0 C-5
Course Content:		
Unit-1	**Electrophoresis: -Definition, General Methodology**Factors affecting migration of charged particles Proteins separation by gel Electrophoresis, Isoelectric Focusing. Protein purification and Evaluation – total protein, total activity , specific activity , yield , purification level ,Blot Techniques- Southern & Northern Techniques Ultracentrifugation , valuable for separating Biomolecules and Determining their masses	
Unit-2	**Spectrophotometry:-** Protein Mass Determination by Mass Spectrometry, Protein Purification, Immunological techniques For Protein Investigation , Antibodies to Specific Proteins , Enzyme Linked Immune sorbent assay	
Unit-3	**Radio Isotopes:** Detection and measurement of radioactive isotopes, application of isotopes in research and clinical bio-chemistry, Radioactive emissions, radiation-matter interaction, radiation dose.	
Unit-4	**Fluorimeter:** Principles, Factors Affecting Fluorescence Fluorescent Markers – Visualiz	
Unit-5	**Reflectance Photometry** Introduction & Applications Flame Photometry,Immunochemical Techniques	
	1. Principles and Techniques of Biochemistry and Molecular Biology by Wilson/Walker 2. Basic Techniques in Biochemistry and Molecular Biology by Ahmad Sarafaraz 3. Analytical Techniques in Biochemistry and Molecular Biology by by RajanKatoch 4. Basic Techniques in Biochemistry, Microbiology and Molecular Biology by**Aakanchha Jain** 5. Total quality management by Dough Hutchinson	

Course Code MML.SB-202	M.M.L.S. Second Semester ENZYME & METABOLISM-II	L-4 T-1 P-0 C-5
Course Content:		
Unit-1	**Interrelationship in Metabolism** Metabolic interrelationship between adipose tissue, liver & extra hepatic tissues, Clinical Importance, Key Junction Glucose – 6 – Phosphate, Pyruvate & Acetyl-Co-A, Unique metabolic profile of various organs	
Unit-2	**Electron Transport & Oxidative Phosphorylation** Components of Electron Transport Chain, Respiratory Chain Energy Coupling hypothesis, Proton- Gradient generation, Mechanism of ATP synthesis, Uncoupling of Oxidative Phosphorylation	
Unit-3	**Glycogen Storage Diseases & Galactosuria**: Introduction, Different types of Diseases, Pompe's Disease, Cori's Disease, McArdle's Disease, Andersen's Disease, Hers' Disease Taruis Disease ,Galactosuria	
Unit-4	**Intrinsic Disorders of Red Cells, Haemoglobin and Porphyrins Sphingolipidases:** a) Disorders of Red Cells, HaemolyticAnemia,Sickle Cell Anemia,Thalassaemia b) Disorders of Hemoglobin, Haemoglobinuria, Other Haemoglobinuriapathies c) Disorders of Porphyrins,Introduction,Porphyria: Definition and types,Acute Intermittent Porphyria	
Unit-5	**Gout & Genetic Defects in Urate Metabolism:** Introduction, Types of Gout,Primary,Secondary Treatment , X-Linked Disorder	
	1. Kuby Immunology 8Ed (Pb 2019) by PUNT J, FREEMAN 2. Cellular and Molecular Immunology by Abbas 3. Clinical Immunology & Serology: A Laboratory Perspective by Linda E. Miller	

Course Code MML.SB-203	M.M.L.S. Second Semester VITAMINS, HORMONES, GENERAL PHYSIOLOGY & NUTRITION	L-4 T-0 P-0 C-4
Course Content:		
Unit-1:	**Chemistry and functions of Vitamins and Hormones.** Digestion and Absorption of food.Digestion of Carbohydrates, Proteins, Lipids, Nucleic Acid. Absorption of Monosaccharide, amino acid, dipeptide and tripeptides, electrolyte Vitamins and Water.	
Unit-2:	**Respiration,** Lung volume and capacities, Internal and external respiration, Transport of oxygen and carbon dioxide **Muscle contraction ,** Sliding filament contractions , The contraction cycle , Excitation-contraction coupling	
Unit-3	**Nutrition in Health and Disease:** Balanced DietRegulations of food intake and energy storage. Disorder of nutrition-Malnutrition, malabsorption, obesity, starvation, deficiency diseases.	
Unit-4	**Minerals & Their Role in Nutrition:** Common mineral salts – Source, function and importance, Trace mineral salts - Source, function and importance	
Unit-5	**Hormones:** Classification and their mode of action. **Detoxification:**Pathways of metabolism. Drug Biotransformation.	
	Physiology, Endocrine Hormones - StatPearls - NCBI Bookshelf https://www.ncbi.nlm.nih.gov › books › NBK538498	

Course Code MML.SB-204	M.M.L.S. Second Semester MOLECULAR BIOLOGY AND BIOINFORMATICS	L-4 T-0 P-0 C-4
Course Content:		
Unit-1	Nucleic acids: Nucleotides, Nucleosides, Nitrogen bases DNA – structure, types, coiling and supercoiling, topoisomerases, replication, Satellite DNA. Organization 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, regulation in eukaryotes and gene amplification Mutation: spontaneous, induced,	
Unit-3	Recombinant DNA Technology: necessary elements – enzymes and their properties, DNA ligase, DNA ligase, DNA modifying enzymes, cloning vectors plasmids	
Unit-4	Genetics in Medicine: Haemoglobin and haemoglobinopathies, phenylketonuria, alkaptonuria, homocystinuria, Lesch-Nyhan syndrome, genetics of cancer, Down's syndrome, Di-george syndrome, Klinefelter's	
Unit-5	Bioinformatics databases - Nucleotide sequence databases, Primary nucleotide sequence databases-EMBL, GeneBank, DDBJ; Secondary nucleotide sequence databases; Protein databases- UniProt, Protein Data Bank.	
Reference Book	Fowler, F.J. Survey Research Methods. New Delhi, Sage, 1993 Goode, W.J and Hatt, P.K. Methods in Social Science Research. New Delhi, McGraw Hill, 1986 Leddy, Paul. D Practical Research: Planning Design. London, Clive Bingley. 1980	

Course Code MML.SB-205	M.M.L.S. Second Semester PRINCIPLES OF BIOCHEMISTRY (PRACTICAL)	L-0 T-0 P-2 C-1
Course Content:		
1.	Chromatography: paper, thin layer, gel, ion-exchange, demonstration of HPLC and GLC	
2.	Photometry, spectrophotometry.	
3.	Electrophoresis: slide gel, PAGE, Agarose gel, Native, SDS PAGE of Blood Sample.	
4.	Cell fractionation – methods	
5.	Estimation of Inorganic phosphorous	
6.	Estimation of Serum Calcium	
7.	Estimation of Sodium	
8.	Estimation of Potassium	
9.	Estimation of Haemoglobin	
10.	Identification of Sugars in fruit juices by using Thin layer Chromatography	
11.	Interpretation and correlation of various biochemical parameters with different clinical conditions.	

Course Code MML.SB-206	M.M.L.S. Second Semester ENZYMES & METABOLISM-II(PRACTICAL)	L-0 T-0 P-5 C-3
Course Content:		
1.	**To determine total serum iron**	
2.	**To determine total protein bound iron**	
3.	**To determine total serum folic acid**	
4.	**To determine G-6-PD**	
5.	**To perform Hb Electrophoresis**	
6.	**To determine serum uric acid**	
7.	**To determine RA factor**	
8.	**To determine serum lipid profile**	

Course Code MML.SB-207	MMLS Second Semester VITAMINS, HORMONES, GENERAL PHYSIOLOGY AND NUTRITION (PRACTICAL)	L-0 T-0 P-2 C-1
Course Content:		
1.	Determination of bicarbonate	
2.	Estimation of total and differential proteins	
3.	Estimation of Electrolytes	
4.	Estimation of hormones	
5.	To determine Vitamin D3	
6.	To determine Vitamin B12	
7.	To determine serum Calcium	

Course Code MML.SB-208	M.M.L.S. SecondSemester MOLECULAR BIOLOGY AND BIOINFOMATICS(PRACTICAL)	L-0 T-0 P-2 C-1
Course Content:		
1.	Isolation of DNA	
2.	Separation of DNA by Agarose gel electrophoresis	
3.	To perform of PCR.	
4.	HIV test by Western Blotting	
5.	To perform karyotyping	
6.	To perform of PCR mycobacterium pathogen	
7.	To perform of PCR HIV	
8.	Separation of Nucleic acid	

Course Code MML.SB-301	MMLS Third Semester APPLIED CLINICAL BIOCHEMISTRY	L-4 T-1 P-0 C-5
Course Content:		
Unit-1	Biological materials- Methods of estimation, normal range in blood serum, plasma and Urine of Glucose, Proteins, Urea, Uric acid, Creatinine, Cholesterol, Quality control & standardization. Enzymes-Methods of estimation, normal range in tissues and clinical conditions leading to abnormal levels of: SGOT, SGPT, Alkaline phosphatase, Acid phosphatase, Amylase, CPK.	
Unit-2	Mineral-Methods of estimation, principles of assay, normal range in tissues and clinical conditions leading to abnormal levels of : Na, K, Ca, CI, O2, CO2, P, iodine, Nitrogen, Zn, Mg, Li.	
Unit-3	Hormones-Methods of estimation, principles of assay, normal range in tissues and clinical conditions leading to abnormal levels of: Androgens, Pregnonediol, estrogens, corticosteroids, catecholamine, thyroid, prolactin, growth hormones. FSH, LH, testosterone, β-HCG.	
Unit-4	Vitamins-Methods of estimation, principles of assay, normal range in tissues and clinical conditions leading to abnormal levels of: Vitamin A, thiamine, Niacin, Pyridoxine, Ascorbic acid, Vitamin D3	
Unit-5	Immunological Techniques-Equipment, reagents and principles of measurement, Significant molecules that can be detected, sensitivity, sources of error of RIA and ELISA, immunofixation, immunochemistry, turbimetry, and immunohistochemistry.	
	1. Williams Textbook of Endocrinology 2. Greenspan's Basic and Clinical Endocrinology by David G. Gardner 3. Endocrinology by Hadley 4. Tietz Textbook of Clinical Chemistry and Molecular Diagnostics	

Course Code MML.SB-302	M.M.L.S. Third Semester IMMUNOLOGY	L-4 T-1 P-0 C-5
Course Content:		
Unit-1	Introduction, History of immunology, Innate immune system-properties and mechanism, nonspecific defence system, inflammation. Adaptive immune system-properties and mechanism, cells involved, MHC and its role	
Unit-2	Cells and organs of the immune system. Haematopoiesis, Cells of the immune system: Lymphoid cells, mononuclear phagocytes, granulocytic cells. Primary lymphoid organ: Thymus , Bone marrow, Lymphatic system Describe blood-lymph circulation and lymphatics	
Unit-3	B- cell and T- cell responses. Antigens: Antigenicity, Factors influencing Immunogenicity, Epitopes, Hapten. Immunoglobulins / Antibodies: Structure and function, antibody mediated effector functions, Antibody classes and their biological role, Antigenic determinants on Igs (allotype, isotype, idiotype), Hybridoma technology and Mab and its applications, Antibody diversity.	
Unit-4	T-lymphocyte: Classification (Th1, Th2, αβ and γδ T cells) Markers of T-cell-MHC, CD3, CD4, TCR 3. Compare and contrast molecular and cellular features of T cell receptor (TCR) to B cells receptor (Ig molecule)	
Unit-5	Development of T cell and B-cell: Generation, Maturation, Activation, Proliferation and Differentiation. Complement system	
References	https://pdfprof.com/EN/PDF_Documents_Doc.php?q=7PDF141289-immunology+books+by+indian+authors+	

Course Code MML.SB-303	MMLSThird Semester ORGAN FUNCTION TEST	L-4 T-0 P-0 C-4
Course Content:		
Unit-1:	**Cardiac Function:** Definitions of Acute coronary syndrome, angina, coronary artery disease ischemia, myocardial infarction, plague, atherosclerosis, factors promoting atherosclerosis,Events leading to an acute myocardial infarction, hypercoagulable state Cardiac markers, symbolism and embolism	
Unit-2:	**Liver Function:** Macroscopic and microscopic anatomy of hepatic system. Define hepatic lobule, portal triad, jaundice, viral and chronic hepatitis, cirrhosis, cholestasis, cholecystitis, Major functions of liver Enzymes synthesized by liver, their functions and clinical significance. Three specific patters of liver cell injury, its causes and symptoms	
Unit-3	**Gastric, pancreatic and intestinal function:** Define-Ulcer, cystic fibrosis, steatorrhea, acid peptic diseases. Three phases of digestion. Structure and function of stomach, intestinal tract and pancreas Function and clinical significance of intrinsic factor Hormones and enzymes synthesized in the GI tract, their functions and clinical significance	
Unit-4	**Thyroid and salivary gland functions:** Anatomy of Benign and malignant tumors. Define-Follicle, colloid, thyroglobulin, reverse T3, goitre, Structure and function of thyroid gland. Synthesis, regulation and metabolism of thyroid hormones. Effects of increased and decreased concentrations of thyroid hormones on TSH levels Laboratory tests to assess thyroid gland function.	
Unit-5	**Lung function:**Anatomy of the lung lobule air way obstruction diseases, constricting diseases, interstitial diseases, Bronchial asthma, chronic bronchitis emphysema, Pneumonia, TB, tumors of lung and pleura, plural cavity.	
	1. https://www.academia.edu/50623901/Organ_Function_Tests_Sowbhagya_Lakshmi_and_TV_Sowmya_eds_ 2. https://www.thepharmacystudy.com/human-anatomy-and-physiology-books-pdf/	

Course Code MML.SB-304	MMLS Second Semester ADVANCED CLINICAL BIOCHEMISTRY	L-4 T-0 P-0 C-4
Course Content:		
Unit-1	Metabolism of carbohydrates, Major metabolic pathways, importance. Blood sugar regulation (Hormonal). Abnormalities , Diabetes mellitus, GTT Glycated-Hemoglobin.	
Unit-2	Metabolism of Lipids. Beta oxidation, Ketogenesis, Ketosis. Adipose tissue Lipoprotein metabolism in health and disease, Chylomicrons, VLDL, IDL, LDL and HDL. Atherosclerosis and cholesterol metabolism. Fatty liver, Fatty acid synthesis	
Unit-3	Immunological Techniques-Equipment, reagents and principles of measurement, Significant molecules that can be detected, sensitivity, sources of error of RIA and ELISA, immunofixation, immunochemistry, turbimetry, and immunohistochemistry.	
Unit-4	Mineral-Methods of estimation, principles of assay, normal range in tissues and clinical conditions leading to abnormal levels of : Na, K, Ca, CI, O2, CO2, P, lodine, Nitrogen, Zn, Mg, Li.	
Unit-5	Tumour markers : CEA, AFP (α-β proteins), Serum Urine and Hb electrophoresis	
Textbook	1. http://med-mu.com/wp-content/uploads/2018/06/DM-Vasudevan-Textbook-of-Biochemistry-For-Medical-Students-6th-Edition.pdf	

Course Code MML.SB-305	MMLSThird Semester APPLIED CLINICAL BIOCHEMISTRY (PRACTICAL)	L-0 T-0 P-5 C-3
Course Content:		
1.	Estimation of T3	
2.	Estimation of T4	
3.	Estimation of TSH	
4.	Estimation of FSH	
5.	Estimation of LH	
6.	Estimation of hCG	

Course Code MML.SB-306	M.Sc. MLT Third Semester IMMUNOLOGY (PRACTICAL)	L-0 T-0 P-5 C-3
Course Content:		
1.	To perform Gram staining	
2.	To perform Acid fast staining (ZeihlNeelsen staining)	
3.	Biochemical test to differentiate between Staphylococcusand Streptococcus	
4.	Preparation of Media, nutrient agar, MacConkey agar,blood agar, chocolate agar, Robertson cooked meat medium, Muller Hilton agar	
5.	Culture methods of bacteria- Streaking method, Spreading method, Dilution method	
6.	To perform WIDAL and Typhoid test.	
7.	To perform AFB staining and MTB IgG & IgM.	

Course Code MML.SB-307	MMLS Third Semester ORGAN FUNCTION TEST (PRACTICAL)	L-0 T-0 P-2 C-1
Course Content:		
1.	Collection, Transport and Processing of specimens.	
2.	Cardiac Function: Lipid Profile	
3.	Renal function, Urea, Creatinine and uric acid.	
4.	Liver Function, total protein, Bilirubin, SGOT & SGPT.	
5.	Serum amylase, serum lipase and serum insulin.	
6.	T3, T4 & TSH Estimation.	

Course Code MML.SB-308	MMLSThird Semester ADVANCED CLINICAL BIOCHEMISTRY (PRACTICAL)	L-0 T-0 P-2 C-1
Course Content:		
1.	Determination of Electrolytes.	
2.	Determination of amylase.	
3.	Determination LH, FSH and Prolactin.	
4.	Determination of Progesterone, estrogens	
5.	Determination of GH	
6.	Immunological techniques like ELISA.	

Master of Medical Laboratory Sciences (MMLS)–Pathology

Introduction

Objectives/aim of the course:

1. Proficiently supervise and perform full range of Clinical Pathology laboratory tests.
2. Develop and evaluate test systems and interpretive algorithms.
3. Manage information to enable effective, timely, accurate, and cost-effective reporting of laboratory-generated information
4. To teach under graduate students and develop/guide research projects

Learning objectives & Programme specific outcome (PSOs)

At the end of the course the student should be able to:

1. Supervise/Perform routine Clinical Pathology laboratory testing.
2. Make specimen oriented decision on predetermined criteria including working knowledge of critical values.
3. Communicate with other members of healthcare team, customers and patients in an effective manner.
4. Process information and ensure quality control as appropriate to routine laboratory.
5. Train students in routine/special laboratory procedure.
6. Upgrade knowledge and skills in a changing healthcare scenario.
7. Should know the logical interpretation of clinical lab investigations.
8. Should be capable of supervise / guide the staff working on automated machine
9. Should be capable of teaching, proposing/executing research project

Eligibility for admissionSelection procedure

1. Candidate should have passed Bachelor in Medical Laboratory Science (BMLS).
2. Minimum percentage of marks: 55% aggregate.
3. Separate entrance exam should be incorporated for these students who want to purse Master of Medical Laboratory Science (MMLS).

ProvisionofLateralEntry: There should be no provision for lateral entry at Masters Level.

Duration of the course

Duration of the course: Total 2 Years (4 semesters or 2048 hours) with 1.5 Years didactic and practical (1536 hours) + 6 months (512 hours) Research project/Dissertation.

Medium of instruction

English shall be the medium of instruction for all the subjects of study and for examination of the course.

Provision of dissertation & project

Six months of dissertation should be mandatory as partial fulfillment for the award of Masters in Medical Laboratory Sciences.

Attendance: A candidate has to secure minimum- 1. 75% attendance in theory &practical training for qualifying to appear for the final examination. No relaxation, whatsoever, will be permissible to this rule under any ground including indisposition etc.

Assessment: Assessments should be completed by the academic staff, based on the compilation of the student 's theoretical & clinical performance throughout the training Programme. To achieve this, all assessment forms and feedback should be included and evaluated. Student must attain cumulative score of at least 50% marks in both theory and practical for each individual subject and internal assessment separately.

First Semester:

Course Code	Course Title	Hours			Marks		Total Marks	Credit
		L	T	P	Internal	External		
MMLSP-101	General Histology	4	1	-	50	100	150	5
MMLSP-102	Applied Histology	4	1	-	50	100	150	5
MMLSP-103	Medical Laboratory Management	4	-	-	50	100	150	4
MMLSP-104	Research Methodology & Bio-Statistics	4	-	-	50	100	150	4
MMLSP-105	General Histology (Practical)	-	-	5	50	100	150	3
MMLSP-106	Applied Histology(Practical)	-	-	5	50	100	150	3
MMLSP-107	Medical Laboratory Management(Practical)	-	-	2	50	100	150	1
MMLSP-108	Research Methodology & Bio- Statistics (Practical)	-	-	2	50	100	150	1
Total		16	2	14	400	800	1200	26
Total Hours in Semester		512						

NOTE:

1. **Abbreviations: L - Lecture, T - Tutorials and P -Practical**
2. **Teaching resources should be made available at every institute for all basicsubjects**
3. **Considering four months per semester as working months, total contact hour hours per semester shall be 512 (Five hundred andtwelve)**

Second Semester

Course Code	Course Title	Hours	Marks		Total Marks	Credits		
		L	T	P	Internal	External		
MMLSP-201	Histopathology	4	1	-	50	100	150	5
MMLSP-202	Cytopathology	4	1	-	50	100	150	5
MMLSP-203	Principles of Immunology	4	-	-	50	100	150	4
MMLSP-204	Molecular Biology and Bioinformatics	4	-	-	50	100	150	4
MMLSP-205	Histopathology (Practical)	-	-	5	50	100	150	3
MMLSP-206	Cytopathology (Practical)	-	-	5	50	100	150	3
MMLSP-207	Principles of Immunology (Practical)	-	-	2	50	100	150	1
MMLSP-208	Molecular Biology and Bioinformatics (Practical)	-	-	2	50	100	150	1
Total		16	2	14	400	800	1200	26
Total Hours in Semester		512						

NOTE:

1. **Abbreviations: L - Lecture, T - Tutorials and P -Practical**
2. **Teaching resources should be made available at every institute for all basicsubjects**
3. **Considering four months per semester as working months, total contact hour hours per semester shall be 512 (Five hundred andtwelve)**

Third Semester

Course Code	Course Title	Hours			Marks		Total Marks	Credits
		L	T	P	Internal	External		
MMLSP-301	Applied Histopathology	4	1	-	50	100	150	5
MMLSP-302	Applied Cytopathology	4	1	-	50	100	150	5
MMLSP-303	Applied Immunopathology	4	-	-	50	100	150	4
MMLSP-304	Advanced Histopathology	4	-	-	50	100	150	4
MMLSP-305	Applied Histopathology (Practical)	-	-	5	50	100	150	3
MMLSP-306	Applied Cytopathology (Practical)	-	-	5	50	100	150	3
MMLSP-307	Applied Immunopathology(Practical)	-	-	2	50	100	150	1
MMLSP-308	Advanced Histopathology (Practical)	-	-	2	50	100	150	1
Total		16	2	14	400	800	1200	26
Total Hours in Semester		512						

NOTE:

1. **Abbreviations: L - Lecture, T - Tutorials and P -Practical**
2. **Teaching resources should be made available at every institute for all basicsubjects**
3. **Considering four months per semester as working months, total contact hour hours per semester shall be 512 (Five hundred andtwelve)**

Fourth Semester

Course Code	Course Title	Hours	Marks		Total Marks	Credits
			Internal	External		
MMLSP-401	Dissertation/Project	Submission within five Months	150	250	400	26
Total Hours in Semester		512				

NOTE:

1. **Abbreviations: L - Lecture, T - Tutorials and P –Practical**

Course Code MMLSP-101	MMLS First Semester GENERAL HISTOLOGY	L-4 T-1 P-0 C-5
Course Content:		
Unit-1	Cells, Different components of a cell and description of its functions Anatomy of cell membrane Epithelium Types of epithelium and their anatomical location, Connective Tissue and its function	
Unit-2	Blood, Bone Marrow & Lymphatic System, Muscle & Skin (Integumentary System), Eye and Ear, Cartilage and Bone: Histological appearance of cartilage 8. Histological appearance of bone	
Unit-3	Endocrine System, Nervous System Histological features of peripheral nerve and spinal cord	
Unit-4	Respiratory System, Cardiovascular System, Digestive System	
Unit-5	Female Reproductive System & Male Reproductive System, Urinary System	
Textbook	Medical Histology by Prof. Laiq Hussain.	
Reference Book	1. Gray's Anatomy by Prof. Susan Standring 39th Ed., Elsevier. 2. Anatomy & Physiology, Ross & Wilson 3. Human Anatomy, B D Chaurasia	

Course Code MMLSP-102	MMLS First Semester APPLIED HISTOLOGY	L-4 T-1 P-0 C-5
Course Content:		
Unit-1:	Microscopy: general concept of microscopy, Numerical apertures, magnification, Principle, working of various microscopes like: Light, compound, phase contrast, fluorescence.	
Unit-2:	Electron microscope: Principle & working of TEM & SEM	
Unit-3:	Staining: Introduction, A general theory of staining, Some dyestuff properties, Acidic & Basic Dye, Progressive & Regressive Staining	
Unit-4:	Cell: Cell division & Cell Signaling. Abnormal cell Benign & Malignant tumor	
Unit-5:	Various methods of preparation of tissue sections, Reception, Recording, Labeling, transportation & Storage of tissue specimens.	
Textbook	Text Book of Histopathology & Histotechniques, C FA Culling	
Reference Book	Gray's Anatomy by Prof. Susan Standring 39th Ed., Elsevier. Anatomy & Physiology, Ross & Wilson Human Anatomy, B D Chaurasia	

Course Code MMLSP-103	MMLS First Semester MEDICAL LABORATORY MANAGEMENT	L-4 T-0 P-0 C-4
Course Content:		
Unit-1:	**Preparation of operating budgets:** General aspects of financial management of laboratories. **Cost-analysis (tests and instruments);** justification of **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,	
Unit-2:	**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; **Maintenance of records:** Procedure manuals, ward manuals, quality control programs, patient data retrieval.	
Unit-3	**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. **Public relations:** hospital and community.	
Unit-4	**Basic clinical epidemiology** **Laboratory Data Processing** General principles of methods for reduction of data into forms suitable for electronic data handling systems **Use of computers in quality control and management:** Use of computers for calculating analytical results (eg. non-linear functions).	
Unit-5	**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, data-base, graphics, statistics, presentations, email, internet.	
	3. Laboratory Management Quality in LaboratoryDiagnosis **by** Candis A. Kinkus, 4. Clinical Laboratory Management by	

Course Code MMLSP-104	MMLS First Semester RESEARCH METHODOLOGY & BIOSTATISTICS	L-4 T-0 P-0 C-4
Course Content:		
Unit-1	**Research Methodology** – Definition of research, Characteristics of research, Steps involved in research process, Types of Research methods and methodology, Research Design, Variables & Lifecycle of Research	
Unit-2	**Statistics, data, population, samples, parameters; Representation of Data**: Tabular, Graphical, Measures of central tendency, Arithmetic mean, mode, median; Measures of dispersion, Range, mean deviation, variation, standard deviation, Standard error, Chi-square test	
Unit-3	**Introduction and significance of Student's t-distribution**: test for single mean, difference of means and paired t- test, F-distribution, one-way and two-way analysis of variance (ANOVA). Small sample test based on t-test, Z- test and F test; Confidence Interval; Distribution-free test	
Unit-4	**Introduction to philosophy**: definition, nature and scope, concept, branches. Ethics: definition, moral philosophy, nature of moral judgments and reactions. Ethics with respect to science and research Intellectual honesty and research integrity. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP). Redundant publications: duplicate and overlapping publications, salami slicing.	
Unit-5	**Publication ethics**: definition, introduction and importance. Conflicts of interest, Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types ,Violation of publication ethics, authorship and contributor ship, Identification of publication misconduct, complaints and appeals, Predatory publishers and journals	
Reference Book	Fowler, F.J. Survey Research Methods. New Delhi, Sage, 1993 Goode, W.J and Hatt, P.K. Methods in Social Science Research. New Delhi, McGraw Hill, 1986 Leddy, Paul. D Practical Research: Planning Design. London, Clive Bingley. 1980	

Course Code MMLSP-105	MMLS First Semester GENERAL HISTOLOGY(Practical)	L-0 T-0 P-5 C-3
Course Content:		
1	Identification of connective tissue, cartilage and bone under microscope.	
2	Identification of muscle tissues under microscope	
3	Identification of nerve under microscope	
4	Identification of lymphoid tissue under microscope	
5	Identification of blood vessel under microscope	
6	Identification of skin under microscope	

Course Code MMLSP-106	MMLS First Semester APPLIED HISTOLOGY(Practical)	L-0 T-0 P-5 C-3
Course Content:		
1	Demonstration of a compound microscope	
2	Staining of smear by a simple histological staining	
3	Identification of a cell under compound microscope	
4	Identification of a tumour cell under compound microscope	
5	Identification of interphase nucleus under compound microscope	

Course Code MMLSP-107	MMLS First Semester MEDICAL LABORATORY MANAGEMENT (Practical)	L-0 T-0 P-2 C-1
Course Content:		
1	**Sample accountability** C. Labelling of sample D. Making entries in Laboratory records	
2	**Reporting results** D. Basic Format of a test report E. Release of examination results F. Alterations in reports	
3	**Calibration and Validation of Clinical Laboratory instruments**	
4	**Ethics in medical laboratory practice in relation to the following:** D. Pre-Examination procedures E. Examination procedures - Reporting of Results F. Preserving Medical Records	

Course Code MMLSP-108	MMLS First Semester RESEARCH METHODOLOGY & BIOSTATISTICS(Practical)	L-0 T-0 P-2 C-1
Course Content:		
1	Uses of LATEX	
2	Uses of MS Excel	
3	Uses of MS Word	
4	Uses of MS Power Point	
5	Uses of SPSS	
6	Uses of Web Technology	

Second Semester

Course Code MMLSP-201	MMLS Second Semester HISTOPATHOLOGY	L-4 T-1 P-0 C-5
Course Content:		
Unit-1	Introduction to Histopathology Laboratory, Quality management, Risk management, Control of chemicals hazardous to health and the environment, Control of physical hazards from equipment, Hazards and handling of common histological chemicals, Laboratory requirements, Safety measures in histotechnology lab.	
Unit-2	Equipments and instruments used in histology, Histopathological techniques, Method of examination of tissues and cells	
Unit-3	Tissue and its types, Location and function, Grossing of tissues, whole mount, sections, & smears	
Unit-4	Fixation and Fixatives Introduction, Theoretical aspects of fixation, Main factors involved in fixation, Practical aspects of fixation, Dehydration, Decalcification & decalcification methods, Clearing.	
Unit-5	Staining of the connective tissue, Staining of the section for reticulin by silver nitrate method, Staining of the section for elastic fibers, Staining and identification of the various types of carbohydrates, Staining and identification of amyloids, Staining of the sections for hemosiderin, Staining of the section for calcium and Its Practical Implications,	
Reference Book	1. Wheater's Basic Histopathology: A Color Atlas and Text (Wheater's Histology and Pathology) 2. Text Book of Histopathology &Histotechniques, C FA Culling	

Course Code MMLSP-202	MMLS Second Semester CYTOPATHOLOGY	L-4 T-1 P-0 C-5
Course Content:		
Unit-1	Living matter - characteristics. Cell definition and general concepts. Main principles of the cell theory. Chemical composition, cell organization & morphology of the cell. Classification and general characteristics of the cellular structures.	
Unit-2	Buffer preparation, Benign & Malignant cells, Various type of cytological sample: Cell suspension, Preparation of various types of cytological smears.	
Unit-3	Introduction to Cytopathology Laboratory, Control of chemicals & of physical hazards hazardous to health and the environment, Hazards and handling of common cytological chemicals, Laboratory requirements, Safety measures in histotechnology lab.	
Unit-4	Instruments and equipment's used in cytology Fixation and Fixatives used in cytology, Adhesive and mounting media, Cell block and cytospin technique,	
Unit-5	Cytology &Ctopathogy: Types of Cytopathology, Aspiration & Exfoliative cytology, Patient preparation & Sample collection FNAC.	
Reference Book	1. Cytopathology, Bibbo 2. Diagnostic Cytology, Naib	

Course Code MMLSP-203	MMLS Second Semester PRINCIPLES OF IMMUNOLOGY	L-4 T-0 P-0 C-4
Course Content:		
Unit-1:	History & Overview of Immunology; Immunity, types of immunity- innate and acquired. Organs of immune system, Primary and Secondary lymphoid organs. Cells of Immune system.	
Unit-2:	Antigens and immunogenicity- antigen, immunogen, haptens, super antigen, tolerates, epitopes, paratopes. antigenicity and immunogenicity. Basis of antigen specificity. MHC – types and importance- distribution and function.	
Unit-3	Immunoglobulin- structure, types, distribution, biological and chemical properties - Theories of antibody production- its regulation and diversity. Monoclonal and polyclonal antibodies. Complement system – mode of activation- Classical, Alternate and Lectin pathways, biological functions.	
Unit-4	Antigen recognition – TCR, BCR, MHC restriction, lymphocyte activation, clonal proliferation and differentiation. Physiology of immune response – various phases of HI,	
Unit-5	Hypersensitivity – types and mechanisms, Autoimmunity, Tumour and Transplantation immunology. Immune regulation mechanisms – brief account on immunoinduction, Immunosuppression,	
Reference Book	1. Roitts, Essential Immunology 13th edition, Ivan M. Roitt, J. Brostoff and D. K. Male, Gower Medical Publishing, London, 2001. 2. Encyclopedia of Immunology 2nd edition, Peter J. Delves and Ivan M. Roitt; Academic Press, 1998.	

Course Code MML.SB-204	MMLS Second Semester MOLECULAR BIOLOGY AND BIOINFORMATICS	L-4 T-0 P-0 C-4
Course Content:		
Unit-1	Nucleic acids: Nucleotides, Nucleosides, Nitrogen bases DNA – structure, types, coiling and supercoiling, topoisomerases, replication, Satellite DNA. Organization 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, regulation in eukaryotes and gene amplification Mutation: spontaneous, induced, point mutation and silent mutation, frame-shift mutation, physical and chemical mutagens, molecular basis, site directed mutagenesis,	
Unit-3	Recombinant DNA Technology: necessary elements – enzymes and their properties, DNA ligase, 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),	
Unit-4	Genetics in Medicine: Haemoglobin and haemoglobinopathies, phenylketonuria, alkaptonuria, homocystinuria, Lesch-Nyhan syndrome, genetics of cancer, Down's syndrome, Di-george syndrome, Klinefelter's syndrome, Turner's syndrome, hermaphroditism, cystic fibrosis, haemophilia, prenatal diagnosis of genetic diseases, application of recombinant DNA technology in medicine – PCR	
Unit-5	Bioinformatics databases - Nucleotide sequence databases, Primary nucleotide sequence databases-EMBL, GeneBank, DDBJ; Secondary nucleotide sequence databases; Protein databases- UniProt, Protein Data Bank. Sequence Analysis-Basic concepts, Alignment of pairs of sequence: - Homologous, Analogue, Orhtologous, paralogous, Xenologous (Need for sequence alignment, Local and Global alignment, Scoring matrices- PAM and BLOSUM matrices.	
Reference Book	1. Fowler, F.J. Survey Research Methods. New Delhi, Sage, 1993 2. Goode, W.J and Hatt, P.K. Methods in Social Science Research. New Delhi, McGraw Hill, 1986 3. Leddy, Paul. D Practical Research: Planning Design. London, Clive Bingley. 1980	

Course Code MMLSP-205	MMLS Second Semester Histopathology (Practical)	L-0 T-0 P-5 C-3
Course Content:		
1.	Gross examination and fixation of the specimen	
2.	Fixation of a freshly removed tissue.	
3.	Dehydrate the tissue specimen using increasing concentration of alcohol.	
4.	Decalcification of the calcified tissue	
5.	Staining of a reticulin by silver nitrate method	
6.	Staining of a tissue rich with carbohydrates content	

Course Code MMLSP-206	MMLS Second Semester Cytopathology (Practical)	L-0 T-0 P-5 C-3
Course Content:		
1.	Preparation of a cell suspension	
2.	Preparation of various cytological smear	
3.	Demonstration & working of cytospin	
4.	Perform the cell block cytology	
5.	Fix a cytological smear by an fixative.	
6.	FNAC: aspiration, smear preparation and staining	

Course Code MMLSP-207	MMLS Second Semester Principles of Immunology (Practical)	L-0 T-0 P-2 C-1
Course Content:		
1.	Preparation of 5% red cell suspension	
2.	To perform ABO blood group (Forward)	
3.	To perform ABO blood group (Reverse)	
4.	To perform RA test	
5.	To perform widal test	

Course Code MMLSP-208	MMLS Second Semester MOLECULAR BIOLOGY AND BIOINFOMATICS(PRACTICAL)	L-0 T-0 P-2 C-1
Course Content:		
9.	Isolation of DNA	
10.	Separation of DNA by Agarose gel electrophoresis	
11.	To perform of PCR.	
12.	HIV test by Western Blotting	
13.	To perform karyotyping	
14.	To perform of PCR mycobacterium pathogen	
15.	To perform of PCR HIV	
16.	Separation of Nucleic acid	

Third Semester

Course Code MMLSP-301	**MMLS Third Semester APPLIED HISTOPATHOLOGY**	**L-4 T-1 P-0 C-5**
Course Content:		
Unit-1	Tissue processing by manual methods: Principles of tissue processing, Paraffin wax, Impregnation & Casting & Embedding, L-Shaped mould, Embedding media &Parafinization.	
Unit-2	Microtome, its type and working, various type of microtome, Microtome knives, its type and knife sharpening, Section cutting, fault and remedies, Section adhesive	
Unit-3	Cryostat, frozen sections of fresh, fixed and unfixed tissue, freeze drying, rapid frozen sections and staining for emergency diagnosis, Deparafinization procedure & Staining.	
Unit-4	The Hematoxylin and Eosin, Introduction, Alum Hematoxylin, Iron Hematoxylin, Tungsten Hematoxylin, Molybdenum Hematoxylin, Lead Hematoxylin, Hematoxylin without a mordant, Quality control in routine H & E staining, Staining H & E for photomicrography,	
Unit-5	mounting and mounting media, advantages & disadvantages, refractive index & Microscopy of tissue	
Reference Book	1. Wheater's Basic Histopathology: A Color Atlas and Text (Wheater's Histology and Pathology) 2. Text Book of Histopathology &Histotechniques, C FA Culling	

Course Code MMLSP-302	MMLS Third Semester APPLIED CYTOPATHOLOGY	L-4 T-1 P-0 C-5
Course Content:		
Unit-1	Staining such as PAP, Diff-quick, MGG, H&E, Shorr staining, significance of PAP-HPV, Destaining and restaining of slides, Cover slipping	
Unit-2	Biomarkers &Tumor marker, Hormonal Cytology & Sex chromatin demonstration	
Unit-3	Body fluids & Normal cell in various body fluids, Sample collection & pathological condition related to various body fluids like: Sputum, urine, BAL fluid, CSF, Synovial fluid, Pleural, peritoneal and pericardial fluid.	
Unit-4	Body fluids & Abnormal cell in various body fluids, processing & cytology of various body fluids like: Sputum, urine, BAL fluid, CSF, Synovial fluid, Pleural, peritoneal and pericardial fluid.	
Unit-5	Introduction of Immunocytochemistry, different markers and its applications, Automation in cytology, Liquid based preparation & automated screening device	
Textbook	1. Diagnostic Cytology, Koss& Koss	
Reference Book	1. Cytopathology, Bibbo 2. Diagnostic Cytology, Naib	

Course Code MMLSP-303	MMLS Third Semester APPLIED IMMUNOPATHOLOGY	L-4 T-0 P-0 C-4
Course Content:		
Unit-1:	Classes of Pathogens, Structure-function correlation, Host-pathogen interaction, immunity to pathogens, immune evasion strategies, organization of lymphoid organs, TLRs and Innate Immunity,	
Unit-2:	Cells of the Innate Immune system and their functions, B cells, T cells, macrophages, Dendritic cells, Neutrophils, mast cells, B-Cell development and maturation, B-Cell Receptor, B-cell activation, Effectors function, T cell development and T cell responses. Classes of Immunoglobulins- IgA, IgG, IgD, IgM and IgE. Biological properties of Immunoglobulins,	
Unit-3	Immunotherapy, Vaccines and adjuvant, limitations of vaccination, antibodies in therapy, immunoconjugates - specific drug targeting, immuno-toxins; Sera and Immunoglobulins; Immunosuppressant's and transplantation; Condition for blood transfusion. Basic principle followed for blood transfusion.	
Unit-4	Cancer Immunology and Hematological Malignancy, autoimmunity, allergy, inflammation, infections and immunological aspects of cancer, Tumor immunology: Oncogene and cancer induction,	
Unit-5	Cell type specific assays: For B cells, T cells, Neutrophils; mast cells, Dendritic cells, Monocytes-macrophages; Cell proliferation assay; Apoptosis assay; Oxidative burst assay; Cytokine assay; Colony forming unit assay; Gene expression assays; Immuno-labeled microscopy;	
Textbook	Kuby Immunology 8th edition, by Jenni Punt, Sharon A. Stranford, Patricia P. Jones and Judith A. Owen, W. H. Freeman and Company, New York. 2019.	
Reference Book	Janeway's Immunobiology 7th edition, K. Murphy, Garland Science, 2007. Essentials of Clinical Immunology 6th edition, Chapel H and Halbey M, ELBS, 2014. Manual of Clinical Laboratory Immunology 3rd, Noel R. Rose, Herman Friedman and John L. Fahey, American Society for Microbiology, 1992.	

Course Code MMLSP-304	MMLS Second Semester ADVANCED HISTOPATHOLOGY	L-4 T-0 P-0 C-4
Course Content:		
Unit-1	Automated tissue processing: Components, Principles, Parts & Working with Automated tissue processing. Other automation in cytology.	
Unit-2	Museum Techniques: Fixation, preparation, mounting, labeling& storage of specimen for museum techniques. Maintenance of color transparency in museum techniques	
Unit-3	Flow Cytometry, Chemiluminescent assay &Immuno Chemistry Technique,	
Unit-4	Immunohistochemistry: principle, types, applications, antigen retrieval, APAAP, Quality control in histopathology	
Unit-5	Microwaves, Micro-Incineration, Autoradiography, Microphography& its implementation in histopathology.	
Textbook	1. Histopathology &Histotechniques, Bancroft	
Reference Book	1. Wheater's Basic Histopathology: A Color Atlas and Text (Wheater's Histology and Pathology) 2. Text Book of Histopathology &Histotechniques, C FA Culling	

Course Code MMLSP-305	MMLS Third Semester Applied Histopathology (Practical)	L-0 T-0 P-5 C-3
Course Content:		
1.	Tissue processing by manual method	
2.	Tissue processing by automatic tissue processor	
3.	Processing of histology tissue for paraffin embedding	
4.	Study of microtome and sharpening of the microtome knife	
5.	Section cutting of paraffin wax embedding tissue and to fix the sections of the slides	
6.	Staining of tissue section by using Hematoxylin and eosin staining method	

Course Code MMLSP-306	MMLS Third Semester Applied Cytopathology (Practical)	L-0 T-0 P-5 C-3
Course Content:		
1.	Staining of cells by using papanicolaou staining method	
2.	Staining of cell using crystal violet staining	
3.	Staining of cells by using MGG staining method	
4.	Staining of cells by using Diff Quick staining method	
5.	Staining of cells by using Shorr staining method	
6.	Perform the demonstration of Barr body.	

Course Code MMLSP-307	MMLS Third Semester Applied Immunopathology (Practical)	L-0 T-0 P-2 C-1
Course Content:		
1.	To perform radial Immunodiffusion test	
2.	To perform immune precipitation method.	
3.	Introduction of Allergy panel	
4.	Demonstration of Montoux test	
5.	To perform ELISA test.	

Course Code MMLSP-308	MMLS Third Semester Advanced Histopathology (Practical)	L-0 T-0 P-2 C-1
Course Content:		
1.	Demonstration of Automated tissue processing	
2.	Mount a tissue specimen for a museum.	
3.	Perform Immunohistochemistry	
4.	Demonstration of flowcytometry	
5.	Demonstration of Chemiluminescent assay	

Master of Medical Laboratory Sciences (MMLS)–HaematologyandBloodBanking

Introduction

Objectives/aim of the course:

1. Proficiently supervise and perform full range of Haematological and Immuno-haematological laboratory tests.
2. Develop and evaluate test systems and interpretive algorithms.
3. Manage information to enable effective, timely, accurate, and cost-effective reporting of laboratory-generated information
4. To teach under graduate students and develop/guide research projects
5. Faculty development in Medical Laboratory Science (MLS)

Learning objective and Programme specific outcome (PsO):

At the end of the course the student should be able to:

1. Supervise/Perform routine Haematological and Immuno-haematological laboratory testing.
2. Make specimen oriented decision on predetermined criteria including working knowledge of critical values.
3. Communicate with other members of healthcare team, customers and patients in an effective manner.
4. Process information and ensure quality control as appropriate to routine laboratory.
5. Train students in routine/special laboratory procedure.
6. Upgrade knowledge and skills in a changing healthcare scenario.
7. Should know the logical interpretation of clinical lab investigations.
8. Should be capable to extrapolate data acquired
9. Should be capable of supervise / guide the staff working on automated machine
10. Should be capable of teaching, proposing/executing research project

Eligibility for admissionSelection procedure

1. Candidate should have passed Bachelor in Medical Laboratory Science (BMLS).
2. Minimum percentage of marks: 55% aggregate.
3. Separate entrance exam should be incorporated for these students who want to purse Master in Medical Laboratory Sciences (MMLS).

ProvisionofLateralEntry: There should be no provision for lateral entry at Masters Level.

Duration of the course

Duration of the course: Total 2 Years (4 semesters or 2048 hours) with 1.5 Years didactic and practical (1536 hours) + 6 months (512 hours) Research project/Dissertation.

Medium of instruction

English shall be the medium of instruction for all the subjects of study and for examination of the course.

Provision of dissertation & project

6 months of dissertation should be mandatory as partial fulfillment for the award of Master's Degree.

Attendance

A candidate has to secure minimum-

1. 75% attendance in theoretical
2. 80% in practical training for qualifying to appear for the final examination.

No relaxation, whatsoever, will be permissible to this rule under any ground including indisposition etc.

Assessment:

Assessments should be completed by the academic staff, based on the compilation of the student 's theoretical & clinical performance throughout the training Programme. To achieve this, all assessment forms and feedback should be included and evaluated. Student must attain cumulative score of at least 50% marks in both theory and practical for each individual subject and internal assessment separately.

Curriculum Outline

First Semester

Course Code	Course Title	Hours			Marks		Total Mark	Credits
		L	T	P	Internal	External		
MMLSH-101	Fundamentals of Haematology	4	1	-	50	100	150	5
MMLSH-102	General Pathology	4	1	-	50	100	150	5
MMLSH-103	Medical Laboratory Management	4	-	-	50	100	150	4
MMLSH-104	Research Methodology & Bio-Statistics	4	-	-	50	100	150	4
MMLSH-105	Fundamentals of Haematology (Practical)	-	-	5	50	100	150	3
MMLSH-106	General Pathology (Practical)	-	-	5	50	100	150	3
MMLSH-107	Medical Laboratory Management (Practical)	-	-	2	50	100	150	1
MMLSH-108	Research Methodology & Bio-Statistics (Practical)	-	-	2	50	100	150	1
Total		16	2	14	400	800	1200	26
Total Hours in Semester		512						

NOTE:

1. **Abbreviations: L - Lecture, T - Tutorials and P -Practical**
2. **Teaching resources should be made available at every institute for all basicsubjects**
3. **Considering four months per semester as working months, total contact hour hours per semester shall be 512 (Five hundred andtwelve)**

Second Semester

Course Code	Course Title	Hours			Marks		Total Marks	Credits
		L	T	P	Internal	External		
MMLSH -201	Applied Haematology-I	4	1	-	50	100	150	5
MMLSH-202	Clinical Pathology	4	1	-	50	100	150	5
MMLSH-203	Principles of Immunology	4	-	-	50	100	150	4
MMLSH-204	Molecular Biology and Bioinformatics	4	-	-	50	100	150	4
MMLSH-205	Applied Haematology-I (Practical)	-	-	5	50	100	150	3
MMLSH-206	Clinical Pathology (Practical)	-	-	5	50	100	150	3
MMLSH-207	Principles of Immunology (Practical)	-	-	2	50	100	150	1
MMLSH-208	Molecular Biology and Bioinformatics (Practical)	-	-	2	50	100	150	1
Total		16	2	14	400	800	1200	26
Total Hours in Semester		512						

NOTE:

1. **Abbreviations: L - Lecture, T - Tutorials and P -Practical**
2. **Teaching resources should be made available at every institute for all basicsubjects**
3. **Considering four months per semester as working months, total contact hour hours per semester shall be 512 (Five hundred andtwelve)**

Third Semester

Course Code	Course Title	Hours			Marks		Total Marks	Credits
		L	T	P	Internal	External		
MMLSH-301	Blood Banking and Immunohematology	4	1	-	50	100	150	5
MMLSH-302	Cytogenetics and Molecular Genetics	4	1	-	50	100	150	5
MMLSH-303	Applied Immunopathology	4	-	-	50	100	150	4
MMLSH-304	Automation and Quality Assurance	4	-	-	50	100	150	4
MMLSH-305	Blood Banking and Immunohematology(Practical)	-	-	5	50	100	150	3
MMLSH-306	Cytogenetics and Molecular Genetics (Practical)	-	-	5	50	100	150	3
MMLSH-307	Applied Immunopathology (Practical)	-	-	2	50	100	150	1
MMLSH-308	Automation and Quality Assurance (Practical)	-	-	2	50	100	150	1
Total		16	2	14	400	800	1200	26
Total Hours in Semester		512						

NOTE:

1. **Abbreviations: L - Lecture, T - Tutorials and P -Practical**
2. **Teaching resources should be made available at every institute for all basicsubjects**
3. **Considering four months per semester as working months, total contact hour hours per semester shall be 512 (Five hundred and twelve**

Fourth Semester

Course Code	Course Title	Hours	Marks		Total Marks	Credits
			Internal	External		
MMLSH-401	Dissertation/Project	Submission within five Months	150	250	400	26
Total Hours in Semester		512				

NOTE:

1. **Abbreviations:** **L - Lecture, T - Tutorials and P –Practical**

Course Code MMLSH -101	MMLS First Semester FUNDAMENTALS OF HAEMATOLOGY	L-4 T-1 P-0 C-5
Course Content:		
Unit-1	Blood: its composition, function and formation, Hematopoiesis and hematopoietic growth factors, Haematopoietic microenvironment tissue such as bone marrow, spleen, liver, thymus, lymph nodes, Red and yellow haematopoietic marrow, Mechanism of haemopoiesis, erythropoiesis, leucopoiesis (Granulopoiesis, monopoiesis, lymphopoiesis) and thrombopoiesis, role of haemopoietic growth factors, clinical use of growth factors, morphology of all blood cells.	
Unit-2	RBC, stages of erythropoiesis, Structure and function of erythrocytes, Metabolic pathways in the red cell, EMP pathway (Anaerobic glycolysis), Rapaport-lueberingshunt ,HMP (PPP), Methaemoglobin reductase pathway, Haemoglobin , function, structure, types, variants of haemoglobin, acquired abnormal hemoglobins, Heme synthesis, Intravascular & extravascular hemolysis.	
Unit-3	Leucocytes, its type, morphology and function, Maturation and developmental stages of Neutrophil, Eosinophil, Basophil, Monocytes and Lymphocytes.	
Unit-4	Platelets, its maturation and developmental stages, functions of platelets, platelets structure, Role of platelets in haemostasis, platelet function test, Fibrinolytic system.	
Unit-5	Anticoagulants, mechanism of action, advantages and disadvantages, effect of storage on blood cell, Blood collection method, Vaccutainer, its type, uses and advantages, Haemoglobin by various methods, total, absolute and differential count, general blood picture, PCV/Hematocrit, ESR, Red cell indices, Platelet count, Reticulocyte count, Complete blood count determination by automated method and significance of each parameter, Principles, uses, care & maintenance and applications of cell counter, Coagulometer, ESR analyzer.	
	1. Mukherjee .L.K(2017), Medical Laboratory Technology,Vol.1-3,3rd edition, Tata McgrawHill 2. SoodRamnik,(2015), Text book of Medical Laboratory Technology,2nd edition, JaypeePublications 3. Wintrobe'sClinicalHaematology,(2014),13thedition,LippincottWilliams& Wilkins 4. De Gruchy's Clinical Haematology in Medical Practice,(2012),Sixth edition, WileyPublications 5. Dacie&LewisPracticalHaematology,(2011),11thedition,ElsevierPublications	

Course Code MMLSH-102	MMLS First Semester General Pathology	L-4 T-1 P-0 C-5
Course Content:		
Unit-1:	Normal cell structure and functions, Cell injury and adaptation, Ischemic and hypoxic cell injury, Types of adaptations, hypertrophy, hyperplasia, atrophy, metaplasia, necrosis and apoptosis, Inflammation, acute and chronic inflammation and its mechanism, Phagocytosis.	
Unit-2:	Introduction to repair and regeneration, fibrosis, wound healing. Introduction to edema, hyperemia, hemorrhage, hemostasis, thrombosis, embolism, infarction and shock.	
Unit-3:	Introduction and classification of neoplasia, neomenclature of neoplasms, characteristics of benign and malignant tumors, Metastasis, molecular basis of cancer, etiology of cancer, laboratory diagnosis for cancer.	
Unit-4:	Environmental pollution, injury by chemical and physical agents, protein energy malnutrition, defincincy diseases of vitamins and minerals, nutritional excess and imbalances. Role and effect of metals (zinc, iron and calcium) and their deficiency diseases.	
Unit-5:	Etiology and pathophysiology of diabetes, artheriosclerosis, myocardial infarction, respiratory diseases (COPD), Parkinson disease, Infectious diseases –pathogenesis and overview of modes of infections, prevention and control with suitable examples like TB, Dengue, Malaria, Typhoid, Chickenguniya, Swine flu, Bird flu, AIDS and Hepatitis.	
	1. Harshmohan (2017), Textbook of Pathology,7th edition, Jaypee Publications 2. Robbins,(2012), Text book of Pathology, 3rd edition, Elsevier Publication	

Course Code MMLSH-103	MMLS First Semester MEDICAL LABORATORY MANAGEMENT	L-4 T-0 P-0 C-4
Course Content:		
Unit-1:	**Preparation of operating budgets:** General aspects of financial management of laboratories. **Cost-analysis (tests and instruments);** justification of providing new services or rejecting existing ones; lease and purchase decision analysis; **Laboratory design:** Designing laboratories for different types and sizes of institutions: selection of equipment and systems for the laboratory, concepts of workstation consolidation,	
Unit-2:	**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; **Maintenance of records:** Procedure manuals, ward manuals, quality control programs, patient data retrieval.	
Unit-3	**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. **Public relations:** hospital and community.	
Unit-4	**Basic clinical epidemiology** **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), **Use of computers in quality control and management:** Use of computers for calculating analytical results (eg. non-linear functions).	
Unit-5	**General aspects of system design:** Central vs. stand-alone systems, host computers and equipment interfaces. Laboratory information systems (LIS), Hospital information systems (HIS). Appropriate access control to patient information.	
Reference	1. Laboratory Management Quality in LaboratoryDiagnosis **by** Candis A. Kinkus, 2. Clinical Laboratory Management by	

Course Code MMLSH-104	MMLS First Semester **RESEARCH METHODOLOGY & BIOSTATISTICS**	L-4 T-0 P-0 C-4
Course Content:		
Unit-1	**Research Methodology** – Definition of research, Characteristics of research, Steps involved in research process, Types of Research methods and methodology, Research Design, Variables & Lifecycle of Research	
Unit-2	**Statistics, data, population, samples, parameters; Representation of Data**: Tabular, Graphical, Measures of central tendency, Arithmetic mean, mode, median; Measures of dispersion, Range, mean deviation, variation, standard deviation, Standard error, Chi-square test	
Unit-3	**Introduction and significance of Student's t-distribution**: test for single mean, difference of means and paired t- test, F-distribution, one-way and two-way analysis of variance (ANOVA). Small sample test based on t-test, Z- test and F test; Confidence Interval; Distribution-free test	
Unit-4	**Introduction to philosophy**: definition, nature and scope, concept, branches. Ethics: definition, moral philosophy, nature of moral judgments and reactions. Ethics with respect to science and research Intellectual honesty and research integrity. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP). Redundant	
Unit-5	**Publication ethics**: definition, introduction and importance. Conflicts of interest, Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types	
Textbook	Cooper, "Business Research Methods", Tata McGraw Hill, New Delhi.	
Reference Book	Fowler, F.J. Survey Research Methods. New Delhi, Sage, 1993 Goode, W.J and Hatt, P.K. Methods in Social Science Research. New Delhi, McGraw Hill, 1986 Leddy, Paul. D Practical Research: Planning Design. London, Clive Bingley. 1980	

Course Code MMLSH-105	MMLS First Semester Fundamentals of Haematology (Practical)	L-0 T-0 P-5 C-3
Course Content:		
1.	Determination of haemoglobin by various methods.	
2.	Determination of Total RBC count.	
3.	Determination of PCV.	
4.	Red cell indices/Absolute values.	
5.	General blood picture.	
6.	Preparation & staining of thick and thin blood smear.	
7.	Determination of TLC and DLC.	
8.	Absolute eosinophil count.	
9.	Demonstration of toxic granulation of neutrophil.	
10.	To perform reticulocyte count.	
11.	ESR estimation.	
12.	Determination of total platelet count.	

Course Code MMLSH-106	MMLS First Semester General Pathology (Practical)	L-0 T-0 P-5 C-3
Course Content:		
1.	Basic steps for drawing a blood specimen by vein puncture, skin puncture and arterial puncture.	
2.	Determination of leukemic cell by flow cytometry.	
3.	Determination of Widal test .	
4.	Determination of coagulation profile.	
5.	Identification of normal and cancer cells.	
6.	To demonstrate malarial slide.	
7.	To perform special staining for cancer slides.	

Course Code MMLSH-107	MMLS First Semester Medical laboratory management(Practical)	L-0 T-0 P-2 C-1
Course Content:		
1	**Sample accountability** E. Labelling of sample F. Making entries in Laboratory records	
2	**Reporting results** G. Basic Format of a test report H. Release of examination results I. Alterations in reports	
3	**Calibration and Validation of Clinical Laboratory instruments**	
4	**Ethics in medical laboratory practice in relation to the following:** G. Pre-Examination procedures H. Examination procedures - Reporting of Results I. Preserving Medical Records	

Course Code MMLSH-108	MMLS First Semester Research Methodology & Bio-statistics (PRACTICAL)	L-0 T-0 P-2 C-1
Course Content:		
1	Uses of LATEX	
2	Uses of MS Excel	
3	Uses of MS Word	
4	Uses of MS Power Point	
5	Uses of SPSS	
6	Uses of Web Technology	

Second Semester

Course Code MMLSH-201	MMLS Second Semester APPLIED HAEMATOLOGY- I	L-4 T-1 P-0 C-5
Course Content:		
Unit-1	Complete blood count and interpretation of histograms, Disorder of Red cell-Anemia-Definition, Various classifications of Anemia and adaptive mechanism in Anemia, clinical significance of anemia, Lab investigations and management of Anemia, Iron Deficiency Anemia, Metabolism of iron, pathogenesis,	
Unit-2	Hereditary disorders of Haemoglobin structures and synthesis. Structural variants of haemoglobin, pathophysiology of structural haemoglobin variants, sickle cell Anemia with lab diagnosis,Thalassemia, definition, types of thalassemia including Alpha, Beta thalassemia, pathophysiology and lab diagnosis, HemolyticAnemia-	
Unit-3	Disorder of White Blood Cells: Neutrophilia, Luekemoid reaction, neutropenia, morphologic abnormalities of neutrophils, functional abnormalities of neutrophils, reactive eosinophilic and hyper eosinophilic syndrome, lymphocytosis, infectious mono neucleosis, lymphocytopenia.	
Unit-4	Hemostatic mechanism and its disorders, primary and secondary hemostasis, role of platelets in hemostasis, role of coagulation factors, coagulation inhibitory system, coagulation pathways-intrinsic and extrinsic, fibrinolytic system	
Unit-5	LE cells, its demonstration and significance and SLE. Hemoparasites and their identification: Malaria, Trypanosomes, Leishmania and Filaria.	
	1. Godkar.B.Praful,(2016)TextbookofMLT,3rd edition,BhalaniPublications 2. Ochei J & Kolhatkar A(2000),Medical Laboratory Science: Theory & Practice, 3rd edition,McgrawHillEducation 3. Mukherjee .L.K(2017), Medical Laboratory Technology,Vol.1-3,3rd edition, Tata McgrawHill 4. SoodRamnik,(2015), Text book of Medical Laboratory Technology,2nd edition, JaypeePublications	

Course Code MMLSH-202	MMLS Second Semester CLINICAL PATHOLOGY	L-4 T-1 P-0 C-5
Course Content:		
Unit-1	Fetal and neonatal physiology and pediatricdiseases : Growth and functional development of the fetus, adjustment of the infant to extrauterine life, special functional problem in the neonate, problems of prematurity,	
Unit-2	Cervical cancer, uterine and ovarian cancers, gestational trophoblastic neoplasia. Sexually transmitted diseases – syphilis, gonorrhoea, trichomoniasis, human papilloma virus infection.	
Unit-3	Polycythemia vera: history, epidemiology, clinical feature, blood and lab findings, bone marrow study, cytogenetic and pathogenesis, Myelofibrosis: History and pathogenesis, clinical features, lab finding and diagnosis Chronic lymphocytic leukemia: Etiology, clinical findings, lab findings and staging,	
Unit-4	WBC disorders: Leukamoid reaction, myelodysplastic syndrome (MDS) – definition, clinical features, peripheral smear and bone marrow findings Leukemias : definition, classification – FAB and WHO of acute leukemias, diagnostic criteria, cytochemicalstaining and immunophenotyping,	
Unit-5	Collection, transport, preservation and processing of various clinical specimens, Urine examination – physical, chemical and microscopic examination of urine, Body fluids: CSF – specimen collection, normal composition and clinical significance,	
	1. Medical Lab Technology by KL. Mukherjee, 2. Practical Haematology.Dacie& Lewis, 11th edition 3. De gruchy's Clinical Hematology in Medical Practice 4. https://www.hematology.org/education 5. https://www.vet.cornell.edu/animal-health-diagnostic-center/laboratories/clinical	

Course Code MMLSH-203	MMLS Second Semester PRINCIPLES OF IMMUNOLOGY	L-4 T-0 P-0 C-4
Course Content:		
Unit-1:	History & Overview of Immunology; Immunity, types of immunity- innate and acquired. Organs of immune system, Primary and Secondary lymphoid organs. Cells of Immune system.	
Unit-2:	Antigens and immunogenicity- antigen, immunogen, haptens, super antigen, tolerates, epitopes, paratopes. antigenicity and immunogenicity.	
Unit-3	Immunoglobulin- structure, types, distribution, biological and chemical properties - Theories of antibody production- its regulation and diversity. Monoclonal and polyclonal antibodies.	
Unit-4	Antigen recognition – TCR, BCR, MHC restriction, lymphocyte activation, clonal proliferation and differentiation. Physiology of immune response – various phases of HI, CMI – cell mediated cytotoxicity, DTH response.	
Unit-5	Hypersensitivity – types and mechanisms, Autoimmunity, Tumour and Transplantation immunology. Immune regulation mechanisms – brief account on immunoinduction, Immunosuppression, immunotolerance, immunopotentiation. Role of cytokines, lymphokines and chemokines.	
Reference Book	3. Roitts, Essential Immunology 13th edition, Ivan M. Roitt, J. Brostoff and D. K. Male, Gower Medical Publishing, London, 2001. 4. Encyclopedia of Immunology 2nd edition, Peter J. Delves and Ivan M. Roitt; Academic Press, 1998. 5. Clinical Immunology 1 st edition, Pravash Sen Gupta, Oxford University Press, 2003.	

Course Code MMLSH-204	MMLS Second Semester MOLECULAR BIOLOGY AND BIOINFORMATICS	L-4 T-0 P-0 C-4
Course Content:		
Unit-1	Nucleic acids: Nucleotides, Nucleosides, Nitrogen bases DNA – structure, types, coiling and supercoiling, topoisomerases, replication, Satellite DNA. Organization of prokaryotic and eukaryotic genome, Chromosomes- structure, number, sex chromosomes, human karyotype,	
Unit-2	Transcription and Translation: Factors involved, RNA processing, types of RNA, genetic code, regulation in eukaryotes and gene amplification Mutation: spontaneous, induced, point mutation and silent mutation, frame-shift mutation, physical and chemical mutagens, molecular basis, site	
Unit-3	Recombinant DNA Technology: necessary elements – enzymes and their properties, DNA ligase, DNA ligase, DNA modifying enzymes, cloning vectors plasmids, cosmids, bacteriophages, shuttle vectors, expression vectors,	
Unit-4	Genetics in Medicine: Haemoglobin and haemoglobinopathies, phenylketonuria, alkaptonuria, homocystinuria, Lesch-Nyhan syndrome, genetics of cancer, Down's syndrome, Di-george syndrome, Klinefelter's syndrome,	
Unit-5	Bioinformatics databases - Nucleotide sequence databases, Primary nucleotide sequence databases-EMBL, GeneBank, DDBJ; Secondary nucleotide sequence databases; Protein databases- UniProt, Protein Data Bank.	
Textbook	1. **Concepts of Genetics, 12th Edition - Pearson** 2. Clinical Chemistry, Teitz 3. Fundamentals of Bioinformatics by Harisha S. 4. Molecular Biology by David Clark 5. Molecular Biology by N Arumugam	
Reference Book	4. Fowler, F.J. Survey Research Methods. New Delhi, Sage, 1993 5. Goode, W.J and Hatt, P.K. Methods in Social Science Research. New Delhi, McGraw Hill, 1986 6. Leddy, Paul. D Practical Research: Planning Design. London, Clive Bingley. 1980	

Course Code MMLSP-205	MMLS Second Semester Applied Haematology I (Practical)	L-0 T-0 P-5 C-3
Course Content:		
1.	Staining of bone marrow.	
2.	To perform sickling test.	
3.	To determine fetal haemoglobin.	
4.	To perform osmotic fragility test.	
5.	To perform schilling test.	
6.	To perform auto hemolysis test.	
7.	To perform Iron profile.	
8.	Haemoglobin electrophoresis.	

Course Code MMLSH-206	MMLS Second Semester Clinical Pathology (Practical)	L-0 T-0 P-5 C-3
Course Content:		
1.	Coomb's test (direct and indirect)	
2.	Urine : microscopic examination and automation in urine analysis	
3.	Reticulocyte count: preparation, staining examination and corrected retic count.	
4.	Semen analysis: microscopic examination and methylene blue staining for morphology.	
5.	Pregnancy test.	
6.	Body fluid analysis (CSF, pleural and peritoneal/ascetic fluid)- physical, chemical and microscopic examination.	
7.	Staining of bone marrow.	
8.	Demonstration of leukemic slides.	

Course Code MMLSP-207	MMLS Second Semester Principles of Immunology (Practical)	L-0 T-0 P-2 C-1
Course Content:		
1.	Preparation of 5% red cell suspension	
2.	To perform ABO blood group (Forward)	
3.	To perform ABO blood group (Reverse)	
4.	To perform RA test	
5.	To perform widal test	

Course Code MMLSP-208	MMLS Second Semester Molecular biology and bioinformatics (Practical)	L-0 T-0 P-2 C-1
Course Content:		
1.	Isolation of DNA	
2.	Separation of DNA by Agarose gel electrophoresis	
3.	To perform of PCR.	
4.	HIV test by Western Blotting	
5.	To perform karyotyping	
6.	To perform of PCR mycobacterium pathogen	
7.	To perform of PCR HIV	
8.	Separation of Nucleic acid	

Third Semester

Course Code MMLSH-301	MMLS Third Semester BLOOD BANKING AND IMMUNOHAEMATOLOGY	L-4 T-1 P-0 C-5
Course Content:		
Unit-1	History of transfusion medicine, Basic introduction of antigen, antibody, Blood group systems, ABO & Rh system, Bombay blood group, antigen and antibody of ABO system, direct and reverse grouping, slide and tube method, discrepancies in ABO grouping and their solution,.	
Unit-2	Rare blood group system and their importance. Lewis, MNSs, KELL, DUFFY, KIDD, Lutheran etc. Blood donor, its types, donor selection, blood collection, post donation care, adverse donor reactions, processing of donor blood, transfusion transmitted infectious markers and their identification,	
Unit-3	Blood components, preparation of various components, principles of centrifugation, indications of various components, PRBCs, leucodepleted RBCs, platelets concentrate, PRP, PPP, FFP, cryoprecipitate, granulocyte concentrate. Hemapheresis, indications of hemapheresis, apheresis machines	
Unit-4	Compatibility testing, major & minor cross match, Coomb's cross match, solid phase and gel technology, immediate spin technique, compatibility testing in emergencies, Antiglobulin Test,	
Unit-5	Antibody screening and identification methods, preparation and preservation of cell panels Hemolytic disease of new born, causes, classification and laboratory investigations on new born, Blood transfusion reactions and its type, prevention and control of transfusion reactions	
	1. Godkar.B.Praful,(2016)TextbookofMLT,3rd edition,BhalaniPublications. 2. Ochei J & Kolhatkar A(2000),Medical Laboratory Science: Theory & Practice, 3rd edition,McgrawHillEducation. 3. Mukherjee .L.K(2017), Medical Laboratory Technology,Vol.1-3,3rd edition, Tata McgrawHill.	

Course Code MMLSH-302	MMLS Third Semester CYTOGENETICS & MOLECULAR GENETICS	L-4 T-1 P-0 C-5
Course Content:		
Unit-1	Methods of preparation of fluids for microscopic examination: Preparation of direct or sediment smears, Cytocentrifuge preparation, Preparation with membrane filters, Preparation cell blocks, Processing of haemorrhagic fluids, Methods of preparation of cell suspensions.	
Unit-2	Chromosome structure and morphology, chromosomal abnormalities, numerical and structural abnormalities cytogenetic nomenclature ,Technique of processing of cytologic samples for electron microscopic examination,	
Unit-3	DNA replication and gene expression – Enzyme involved in DNA replication. Synthesis of RNA, types of RNA, function of RNA. Polymerase chain reaction, various types, principle and applications.	
Unit-4	Blotting Techniques, it's Principle, types, applications. Molecular diagnosis of sickle cell anaemia, Leukemia, Thalassemia, Chromatography, its principle, types and applications.	
Unit-5	Purification and separation of nucleic acids, Extraction and Purification of nucleic acids, Detection and Quantitation of Nucleic acids, Gel Electrophoresis, Nucleic acid Hybridization :Principle and application – preparation of nucleic acid probes ,principle of Nucleic acid hybridization, microarrays, ELISA and RIA.	
	1. Wintrobe's Clinical Hematology, (2014), 13th edition, Lippincott Williams & Wilkins 2. De Gruchy's Clinical Haematology in Medical Practice, (2012), Sixth edition, Wiley Publications 3. Dacie& Lewis Practical hematology, (2011), 11th edition, Elsevier Publications 4. RN Makroo, (2009), Compendium of Transfusion medicine, 2nd edition, Career Publications 5. Teitz, (2007), Fundamentals of Clinical Chemistry, 6th edition, Elsevier Publications 6. Henry's Clinical Diagnosis and Management by Laboratory Methods, (2011), 22nd edition, Elsevier	

Course Code MMLSH-303	MMLS Third Semester APPLIED IMMUNOPATHOLOGY	L-4 T-0 P-0 C-4
Course Content:		
Unit-1:	Classes of Pathogens, Structure-function correlation, Host-pathogen interaction, immunity to pathogens, immune evasion strategies, organization of lymphoid organs, TLRs and Innate Immunity, Triggering of immune response, kinetics of immune response, Organ-specific immune response, Immunogens and antigens.	
Unit-2:	Cells of the Innate Immune system and their functions, B cells, T cells, macrophages, Dendritic cells, Neutrophils, mast cells, B-Cell development and maturation, B-Cell Receptor, B-cell activation, Effectors function, T cell development and T cell responses.	
Unit-3	Immunotherapy, Vaccines and adjuvant, limitations of vaccination, antibodies in therapy, immunoconjugates - specific drug targeting, immuno-toxins; Sera and Immunoglobulins; Immunosuppressant's and transplantation; Immuno- suppressants and autoimmunity. Transplantation immunology,	
Unit-4	Cancer Immunology and Hematological Malignancy, autoimmunity, allergy, inflammation, infections and immunological aspects of cancer, Tumor immunology: Oncogene and cancer induction, Tumor antigens, Immune response to tumors, relation between tumor and nature of immune response	
Unit-5	Cell type specific assays: For B cells, T cells, Neutrophils; mast cells, Dendritic cells, Monocytes-macrophages; Cell proliferation assay; Apoptosis assay; Oxidative burst assay; Cytokine assay; Colony forming unit assay; Gene expression assays;	
Reference Book	Janeway's Immunobiology 7th edition, K. Murphy, Garland Science, 2007. Essentials of Clinical Immunology 6th edition, Chapel H and Halbey M, ELBS, 2014.	

Course Code MMLSH-304	MMLS Third Semester AUTOMATION AND QUALITY ASSURANCE	L-4 T-0 P-0 C-4
Course Content:		
Unit-1	Quality Assurance and Quality Management concepts: Definition and concept of Quality control, Quality assurance.	
Unit-2	Equipment's selection, purchase specifications, maintenance, purchase specifications and maintenance of stores for raw materials.	
Unit-3	General Provisions, Organization and Personnel, Facilities, Equipment, Testing Facilities Operation, Test and Control Articles, Protocol for Conduct of a Nonclinical Laboratory Study, Records and Reports, Disqualification of Testing Facilities	
Unit-4	Complaints and evaluation of complaints, Handling of return good, recalling and waste disposal.Qualification of UV-Visible spectrophotometer, General principles of Analytical method Validation.	
Unit-5	Introduction, definition and general principles of calibration, qualification and validation, importance and scope of validation, types of validation, validation master plan. Calibration of pH meter,	

Course Code MMLSH-305	MMLS Third Semester Blood Banking & Immunohaematology(Practical)	L-0 T-0 P-5 C-3
Course Content:		
1.	Demonstration of apparatus and equipment's used in blood banking.	
2.	Prepare different percent of cell suspension.	
3.	To perform ABO & Rh blood grouping by slide and tube method.	
4.	To perform forward and reverse grouping.	
5.	To perform cross match.	
6.	To perform coomb's test.	
7.	To perform Rh titre.	
8.	To perform transfusion transmissible marker.	
9.	Preparation of various blood components and their quality control.	

Course Code MMLSH-306	MMLS Third Semester Cytogenetics &Molecular Diagnosis Practical	L-0 T-0 P-5 C-3
Course Content:		
1.	Isolation of DNA.	
2.	Separation of DNA by Agarose gel electrophoresis.	
3.	Demonstration of PCR.	
4.	To perform Karyotyping.	
5.	Separation of RNA	
6.	Sothern and western blot techniques.	

Course Code MMLSH-307	MMLS Third Semester Applied Immunopathology (Practical)	L-0 T-0 P-2 C-1
Course Content:		
1.	To perform radial Immunodiffusion test	
2.	To perform immune precipitation method.	
3.	Introduction of Allergy panel	
4.	Demonstration of Montoux test	
5.	To perform ELISA test.	

Course Code MMLSH-308	MMLS Third Semester Automation & Quality Assurance (Practical)	L-0 T-0 P-2 C-1
Course Content:		
1.	To perform standardization of instruments.	
2.	To perform calibration of Ph Meter.	
3.	To perform calibration of spectrophotometer.	
4.	To make report for different tests.	

Master in Medical Laboratory Sciences (MMLS)-MedicalMicrobiology

Introduction

Objectives/aim of the course:

1. Proficiently supervise and perform full range of clinical laboratory investigations related to Medical Microbiology hence provide Medical laboratory services in all types of clinical laboratories from Primary healthcare laboratory to Tertiary health care institution in the fields of Bacteriology, Immunology, Mycology, Parasitology and Virology.
2. Develop and evaluate test systems and interpretive algorithms.
3. Manage information to enable effective, timely, accurate, and cost-effective reporting of laboratory-generated information
4. To teach under graduate students and develop/guide research projects

Learning Objective and Programme Specific outcome (PSO):

At the end of the course the student should be able to:

1. To provide Medical laboratory services in all types of clinical laboratories from primary healthcare laboratory to tertiary health care institution in the fields of Bacteriology, Immunology, Mycology, Parasitology and Virology.
2. Make specimen-oriented decision on predetermined criteria including working knowledge of critical values.
3. Communicate with other members of healthcare team, customers and patients in an effective manner.
4. Process information and ensure quality control as appropriate to routine laboratory.
5. Train students in routine/special laboratory procedure.
6. Upgrade knowledge and skills in a changing healthcare scenario.
7. Should know the logical interpretation of clinical lab investigations.
8. Should be capable to extrapolate data acquired
9. Should be capable of supervise / guide the staff working on automated machine

Eligibility for admission

Selection procedure

1. Candidate should have passed B. Sc. Medical Laboratory Sciences (BMLS).
2. Minimum percentage of marks: 55% aggregate.
3. Separate entrance exam may be incorporated for these students who want to purse Master's in Medical Laboratory Sciences (MMLS).

ProvisionofLateralEntry: There should be no provision for lateral entry at Masters level.

Duration of the course

Duration of the course: Total 2 Years (4 semesters or 2048 hours) with 1.5 Years didactic and practical (1536 hours) + 6 months (512 hours) Research project/Dissertation.

Medium of instruction

English shall be the medium of instruction for all the subjects of study and for examination of the course.

Provision of dissertation & project

Six months of dissertation should be mandatory as partial fulfillment for the award of Master's in Medical Laboratory Sciences (MMLS).

Attendance

A candidate has to secure minimum-

1. 75% attendance in theoretical
2. 80% in practical training for qualifying to appear for the final examination.

No relaxation, whatsoever, will be permissible to this rule under any ground including indisposition etc.

Assessment:

Assessments should be completed by the academic staff, based on the compilation of the student's theoretical & clinical performance throughout the training Programme. To achieve this, all assessment forms and feedback should be included and evaluated. Student must attain cumulative score of at least 50% marks in both theory and practical for each individual subject and internal assessment separately.

Curriculum Outline

First Semester

Course Code	Course Title	Hours			Marks		Total Marks	Credit
		L	T	P	Internal	External		
MMLSM-101	Basic Medical Microbiology	4	1	-	50	100	150	5
MMLSM-102	Systematic Bacteriology	4	1	-	50	100	150	5
MMLSM-103	Medical Laboratory Management	4	-	-	50	100	150	4
MMLSM-104	Research Methodology & Biostatistics	4	-	-	50	100	150	4
MMLSM-105	Basic Medical Microbiology (Practical)	-	-	5	50	100	150	3
MMLSM-106	Systematic Bacteriology (Practical)	-	-	5	50	100	150	3
MMLSM-107	Medical Laboratory Management (Practical)	-	-	2	50	100	150	1
MMLSM-108	Research Methodology & Biostatistics (Practical)	-	-	2	50	100	150	1
Total		16	2	14	400	800	1200	26
Total Hours in Semester		512						

NOTE:

1. **Abbreviations: L - Lecture, T - Tutorials and P -Practical**
2. **Teaching resources should be made available at every institute for all basicsubjects**
3. **Considering four months per semester as working months, total contact hour hours per semester shall be 512 (Five hundred andtwelve)**

Second Semester

Course Code	Course Title	Hours			Marks		Total Marks	Credits
		L	T	P	Internal	External		
MMLSM-201	Applied Bacteriology-I	4	1	-	50	100	150	5
MMLSM-202	Immunology and Bacterial Serology	4	1	-	50	100	150	5
MMLSM-203	Medical Parasitology & Entomology	4	-	-	50	100	150	4
MMLSM-204	Molecular Biology and Bioinformatics	4	-	-	50	100	150	4
MMLSM-205	Applied Bacteriology-I (Practical)	-	-	5	50	100	150	3
MMLSM-206	Immunology and Bacterial Serology (Practical)	-	-	5	50	100	150	3
MMLSM-207	Medical Parasitology & Entomology (Practical)	-	-	2	50	100	150	1
MMLSM-208	Molecular Biology and Bioinformatics (Practical)	-	-	2	50	100	150	1
Total		16	2	14	400	800	1200	26
Total Hours in Semester		512						

NOTE:

4. **Abbreviations: L - Lecture, T - Tutorials and P -Practical**
5. **Teaching resources should be made available at every institute for all basicsubjects**
6. **Considering four months per semester as working months, total contact hour hours per semester shall be 512 (Five hundred andtwelve)**

Third Semester

Course Code	Course Title	Hours			Marks		Total Marks	Credits
		L	T	P	Internal	External		
MMLSM-301	Applied Bacteriology-II	4	1	-	50	100	150	5
MMLSM-302	Advances in Medical Microbiology	4	1	-	50	100	150	5
MMLSM-303	Medical Mycology	4	-	-	50	100	150	4
MMLSM-304	Medical Virology	4	-	-	50	100	150	4
MMLSM-305	Applied Bacteriology-II (Practical)	-	-	5	50	100	150	3
MMLSM-306	Advances in Medical Microbiology (Practical)	-	-	5	50	100	150	3
MMLSM-307	Medical Mycology (Practical)	-	-	2	50	100	150	1
MMLSM-308	Medical Virology (Practical)	-	-	2	50	100	150	1
Total		16	2	14	400	800	1200	26
Total Hours in Semester		512						

Fourth Semester

Course Code	Course Title	Hours	Marks		Total Marks	Credits
			Internal	External		
MMLSM-401	Dissertation/Project	Submission within five Months	150	250	400	26
Total Hours in Semester		512				

NOTE:

1. **Abbreviations:** **L - Lecture, T - Tutorials and P –Practical**

Course Code MMLSM-101	MMLS First Semester Basic Medical Microbiology	L-4 T-1 P-0 C-5
Course Content:		
Unit-1	**Organization of clinical microbiology laboratory** Introduction, Clinical microbiology laboratory set-up, Laboratory management, Laboratory safety, First aid measures, Waste management	
Unit-2	**Introduction and history of microbiology** Discovery of microorganisms, Contributions of Robert Koch, Antony Van Leeuwenhoek, Louis Pasteur, Bordet, Paul Ehrlich, Alexander Fleming, Elie Metchnikoff, John Needham, John Tyndall, Joseph Lister and Karls Landsteiner, Scope of medical microbiology	
Unit-3	**Microscope and other tools of medical microbiology** Types of microscopes- Bright field microscope Using a bright field microscope, microscopic resolution Dark field microscope, Phase- Contrast microscope Fluorescence microscope, Electron microscope (SEM and TEM), High performance optical microscopy Care and maintenance of the microscope Balances, Hot plate and magnetic stirrer, centrifuge, hot air oven, autoclave, incubator, spectrophotometer, pH meter, water distillation plant	
Unit-4	**Classification of microorganisms** Introduction to classification, morphological classification, classification based on oxygen requirement, nutritional requirement, pH requirements, Gram's Positive and Gram's negative bacteria **Microbial growth:** Bacterial growth curve, Batch culture, fed batch culture, continuous culture, factors influencing microbial growth, Microbial metabolism and energy production	
Unit-5	**Interactions between human and microbes** Introduction, Defences of the body, Acute reaction to infection, Markers of cytokines response, complement system, pathogenic properties of bacteria, Virulence factors,Safety measures used in microbiology laboratory	
SuggestedReadings	1. PracticalMedicalMicrobiologybyMackieandMcCartney 2. Microbiology For Medical Sciences by Bhagat Singh &Renu Singh 2.TextbookofMicrobiologybyAnanthanarayan 3.MedicalMicrobiologybyPanikar&SatishGupte 4.MedicallaboratoryTechnologyvol.I,II,IIIbyMukherjee 5.DistrictLaboratoryPracticeintropicalcountriesVolIIIMicrobiologybyMonicaCheesbrough 6.TextbookofMicrobiologybyPrescott	

Course Code MMLSM-102	**MMLS First Semester Systematic Bacteriology**	**L -4 T -1 P -0 C -5**
Course Content:		
Unit-1	Biosafety in clinical microbiology laboratory including universal containment, personal protective equipment for biological agent, Isolation precautions including standard precautions and transmission-based precautions	
Unit-2	Principles and methods of sterilization physical and chemical methods, pasteurization, disinfection, factors affecting effectiveness of disinfectant, preservation of microorganisms and lyophilization	
Unit-3	**Gram-positive cocci** of medical importance including Staphylococcus, Streptococcus, Micrococcus, anaerobic cocci etc. **Gram-negative cocci** of medical importance including *Neisseriameningitidis*,*Neisseria gonorrhoeae,* Moraxella etc.	
Unit-4	**Gram-positive bacilli** of medical importance including Lactobacillus, Corynebacterium,Bacillus, Clostridium, Listeria, Actinomyces and Nocardia etc	
Unit-5	**Gram-negative enteric bacilli**of medical importance including *Escherichia coli, Klebsiella pneumoniae,* Salmonella, Proteus, Shigella, *Vibrio cholerae,*Campylobacter etc. **Gram negative non-entericbacilli**of medical importance including Brucella, Bordetella,Francisella, Haemophilus, Pseudomonas, Legionella and Yersinia	
SuggestedReadings	1. PracticalMedicalMicrobiologybyMackieandMcCartney 2. Microbiology For Medical Sciences by Bhagat Singh &Renu Singh 3. TextbookofMicrobiologybyAnanthanarayan 4. MedicalMicrobiologybyPanikar&SatishGupte 5. MedicallaboratoryTechnologyvol.I,II,IIIbyMukherjee 6. DistrictLaboratoryPracticeintropicalcountriesVolIIMicrobiologybyMonicaCheesbrough 7. TextbookofMicrobiologybyPrescott Elements of Medical Microbiology, 4th ed, Rajesh Bhatia and Rattan Lal Ichhpujani	

Course Code MMLSM-103	MMLS First Semester Medical Laboratory Management	L -4 T -0 P -0 C -4
Course Content:		
Unit-1	**Quality control in medical microbiology lab** Introduction, Elements of the service, Guidance to users, Delivery of specimens, Request forms, Reception of specimens, Safety in the reception area, Work sections of the laboratory, Choice of tests, Reading of results, Wording of reports, Issue of reports, Computerization of reports, The laboratory manual, Training and Safety precautions in medical microbiology laboratory	
Unit-2	**Quality assurance** Quality control and monitoring, Assessment, Internal quality Assessment and External quality assessment, assurance, audit,Quality control of materials, In-house produced culture media, Commercial media and bases, Equipment, Organization of quality control, Duties of the QC officer.	
Unit-3	**Computers in medical microbiology** Objectives and functional requirements, hardware and software, types of computer systems, computers linked to equipment's, main laboratory system, computers in use, pre-analytical phase and analytical phase, data entry, worksheets, coding lists, post -analytical phase.	
Unit-4	**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). **Safety in Microbiology Laboratory** Fire, chemical, radiation and infection control, hazardous waste and transport of hazardous materials	
Unit-5	**Training of technical staff** Familiarity 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; labor, supervision relations; conducting job interviews; motivation, recognizing job distress syndrome; delegation to a laboratory manager.	
Unit-6	**Hospital organization** Interactions between the laboratory service and the rest of the hospital **Disposal of Laboratory/Hospital Waste** Definition, classification of laboratory/hospital waste, methods of laboratory/hospital waste disposal (Non-infectious waste, Infectious waste disposal, etc.)	
Suggestedreadings	1. MedicalLaboratoriesManagement-CosteffectivemethodsbySangeetaSharma,RachnaAgarwal,SujataChaturvediandRajivThakur 2. PracticalMedicalMicrobiologybyMackieandMcCartney 3. Microbiology For Medical Sciences by Bhagat Singh &Renu Singh 4. MedicallaboratoryTechnologyvol.I,II,IIIbyMukherjee	

Course Code MMLSM-104	MMLS First Semester Research Methodology & Biostatistics	L-4 T-0 P-0 C-4
Course Content:		
Unit-1	**Research Methodology** Definition of research, Characteristics of research, Steps involved in research process, Types of Research methods and methodology, Research Design, Variables & Lifecycle of Research	
Unit-2	**Statistics, data, population, samples, parameters; Representation of Data**: Tabular, Graphical, Measures of central tendency, Arithmetic mean, mode, median; Measures of dispersion, Range, mean deviation, variation, standard deviation, Standard error, Chi-square test	
Unit-3	**Introduction and significance of Student's t-distribution**: Test for single mean, difference of means and paired t- test, F-distribution, one-way and two-way analysis of variance (ANOVA). Small sample test based on t-test, Z- test and F test; Confidence Interval; Distribution-free test	
Unit-4	**Introduction to philosophy**: definition, nature and scope, concept, branches. Ethics: definition, moral philosophy, nature of moral judgments and reactions. Ethics with respect to science and research Intellectual honesty and research integrity. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP). Redundant publications: duplicate and overlapping publications, salami slicing. Selective reporting and misrepresentation of data. Report Writing: meaning and significance of report writing, types of report, steps in writing report, layout of the research report	
Unit-5	**Publication ethics**: Definition, introduction and importance. Conflicts of interest, Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types,Violation of publication ethics, authorship and contributor ship, Identification of publication misconduct, complaints and appeals, Predatory publishers and journals	
Suggestedreadings	Cooper, "Business Research Methods", Tata McGraw Hill, New Delhi.	
	Fowler, F.J. Survey Research Methods. New Delhi, Sage, 1993 Goode, W.J and Hatt, P.K. Methods in Social Science Research. New Delhi, McGraw Hill, 1986 Leddy, Paul. D Practical Research: Planning Design. London, Clive Bingley. 1980	

Course Code MMLSM-105	MMLS First Semester Basic Medical Microbiology Practical	L-0 T-0 P-5 C-3
Course Content:		
1.	Identification of different types of culture media	
2.	Procedure for collection and testing of sputum for AFB.	
3.	Preparation of stains and staining procedures	
4.	Methods for isolation of pure culture	
5.	Preservation of stock culture.	
6.	Biochemical tests for identification of bacteria	
7.	Microscopic examination of bacterial isolates	
8.	Gram's staining of bacteria	
9.	Different types of staining methods for fungi	
10.	Procedure to perform antibiotic sensitivity test.	

Course Code MMLSM-106	MMLS First Semester Systematic Bacteriology Practical	L-0 T-0 P-5 C-3
Course Content:		
1.	Universal containers and swabs used in medical microbiology	
2.	Preparation of blood agar for bacteria	
3.	Preparation of selective culture media for bacteria	
4.	Isolation and identification of *E. coli* from clinical specimen	
5.	Isolation and identification of Salmonella from clinical specimen	
6.	Isolation and identification of Klebsiella from clinical specimen	
7.	Isolation and identification of Shigella from clinical specimen	
8.	Isolation and identification of *Staphylococcus aureus* from clinical specimen	
9.	Isolation and identification of Streptococci from clinical specimen	
10.	Study of bacterial growth curve	
11.	Demonstration of bacterial enzymes and toxins	
12.	To perform antibiotic sensitivity test for bacteria using antibiotic disc	

Course Code MMLSM-107	MMLS First Semester Medical Laboratory Management Practical	L-0 T-0 P-2 C-1
Course Content:		
1.	Preparation of lab design for medical microbiology	
2.	To study safety measures used in medical microbiology lab	
3.	Isolation and identification of microbes from hospital wards and OPD	
4.	Methods for disposal of infectious laboratory waste	
5.	To prepare request form of microbiology specimen	
6.	To prepare report for microbiology	
7.	Computerization of report for microbiology	
8.	Preservation of stock culture	

Course Code MMLSM-108	MMLS First Semester Research Methodology & Biostatistics Practical	L-0 T-0 P-2 C-1
Course Content:		
1.	Uses of LATEX	
2.	Uses of MS Excel	
3.	Uses of MS Word	
4.	Uses of MS Power Point	
5.	Uses of SPSS	
6.	Uses of Web Technology	

Second semester

Course Code MMLSM-201	MMLS Second Semester Applied Bacteriology-I	L-4 T-1 P-0 C-5
Course Content:		
Unit-1	**Applied bacteriology:** Introduction, recent advances in bacteriology, Collection and transport of specimen for microbiology, Different techniques for isolation and identification of bacteria,PCR, electrophoresis etc.	
Unit-2	**Recent techniques** used for isolation and identification of pathogens from Clinical specimen, air, water and food, rapid biochemical test detection kits, pathogen detection based on lateral flow assay.	
Unit-3	**Infections** caused by *Mycobacterium tuberculosis* and *Mycobacterium leprae,* rapid method for detection of Mycobacterium Infections caused by Rickettsia Infections caused by Chlamydia	
Unit-4	**Bacterial metabolism**, Introduction, production of bacterial enzymes, toxins antimicrobials and bacteriocins and other virulence factors, Antibiotic sensitivity test for bacteria.	
Unit-5	**Antimicrobial agents**, types and classification, mechanisms of drug resistance, Microbial genetics and bacteriophages Molecular genetics relevant tomedical microbiology	
Suggestedreadings	1. PracticalMedicalMicrobiologybyMackieandMcCartney 2. Microbiology For Medical Sciences by Bhagat Singh &Renu Singh 3. TextbookofMicrobiologybyAnanthanarayan 4. MedicalMicrobiologybyPanikar&SatishGupte 5. MedicallaboratoryTechnologyvol.I,II,IIIbyMukherjee 6. TextbookofMicrobiologybyPrescott 7. Elements of Medical Microbiology, 4th ed, Rajesh Bhatia and Rattan Lal Ichhpujani	

Course Code MMLSM-202	MMLS Second Semester Immunology and Bacterial Serology	L-4 T-1 P-0 C-5
Course Content:		
Unit-1	**Introduction and scope of immunity** **Antigens**Definition, properties and types ofantigen, Factors influencing immunogenicity, Chemical nature of immunogens, T-Independent antigens and T-Dependentantigens, Hapten-carrier conjugates, Antigenic determinants, Determinants recognized by B-cells, T- cells and superantigens	
Unit-2	**Immunoglobulins/antibodies** Properties and structure of antibodies/immunoglobulins, Electrophoretic mobility, Types of Immunoglobulins, Immunoglobulin-G (IgG), Types of Light Chains and Subclasses of IgG, Immunoglobulin-M (IgM), Immunoglobulin-A (IgA), Immunoglobulin D (IgD), Immunoglobulin E (IgE)	
Unit-3	**Types of immunity**-Cell mediated (innate /non-specific) immunity, **Anatomical barriers to infections** Mechanical barriers, chemical barriers and biological barriers **Humoral barriers to infections** Complement system, Coagulation system, Lactoferrin and transferring,Interferons, Lysozyme and Interleukin-1 **Cellular barriers to infections** Neutrophils, Macrophages, Natural killer (NK) cells and Eosinophils	
Unit-4	**Acquired (specific/ humoral) immunity** Primary and secondary responses, Fate of antigen in tissues, Production of antibodies, B-cell biology, **B-cell activation,** T-dependent antigen triggering T-independent antigen triggering	
Unit-5	**Antigen-antibody reactions-** **1. Agglutination** a.Qualitative agglutination test b. Quantitative agglutination test c. Applications of agglutination tests **2. Hemagglutination test** **3. Coomb's Test (Antiglobulin Test)** a. Direct Coomb's Test b. Indirect Coomb's Test **4. Hemagglutination Inhibition** **Precipitation** 1. Radial Immunodiffusion 2. Immunoelectrophoresis 3. Countercurrent electrophoresis	

	Enzyme linked immunosorbent assay (ELISA) direct and indirectRadioimmunoassay (RIA) Fluorescence immunoassay (FIA) a. Direct Immunofluorescence b. Indirect Immunofluorescence c. Flow Cytometry Complement fixation test	
Unit-6	**Normal microflora of human body** Microflora of Skin, Oral cavity, Gastrointestinal tract Microflora of other body regions including Respiratory tract, Urogenital tract, Eye and External year **Hypersensitivity reactions and its types** **Vaccines and immunotherapy**	
Suggestedreadings	1. PracticalMedicalMicrobiologybyMackieandMcCartney 2. Microbiology For Medical Sciences by Bhagat Singh &Renu Singh 3. TextbookofMicrobiologybyAnanthanarayan 4. MedicalMicrobiologybyPanikar&SatishGupte 5. MedicallaboratoryTechnologyvol.I,II,IIIbyMukherjee 6. DistrictLaboratoryPracticeintropicalcountriesVolIIMicrobiologybyMonicaCheesbrough 7. TextbookofMicrobiologybyPrescott 8. Elements of Medical Microbiology, 4th ed, Rajesh Bhatia and Rattan Lal Ichhpujani	

Course Code MMLSM-203	MMLS Second Semester Medical Parasitology & Entomology	L-4 T-0 P-0 C-4
Course Content:		
Unit-1	**General characters and classifications of parasites** Nature and types of parasitism, Host, types of hosts, parasite types of parasites, vectors, types of parasitism etc.	
Unit-2	**Protozoan parasites of medical importance:** Morphology, life cycle, disease and diagnosis of Entamoeba, Free living Amoeba, Giardia, Trichomonas, Leishmania, Trypanosoma, Toxoplasma, Sarcocystis, Cryptosporidium, Microsporidium, Cyclospora, Isospora, Babesia, Balantidium etc	
Unit-3	**Helminthic parasite of medical importance** Morphology, life cycle, disease and diagnosis of a. **Cestodes –** *T. solium, T. saginata, E. granulosus,* Diphyllobothrium, Dipylidium, Multiceps etc. b. **Trematodes –** *S. haematobium & F. hepatica, Fasciolopsis, Gastrodiscoides, Paragonimus,* Clonorchis *etc.* c. **Nematodes-** Life cycle, Morphology, disease & lab diagnosis of *Ascaris lumbricoides*(roundworm) *Enterobius vermicularis* (Thread worm) *Ancylostoma duodenale* (Hook worm) **Tissue Nematodes:** *W. Bancrofti* - Life cycle, Morphology, Disease & Lab Diagnosis	
Unit-4	**Entomology** Common arthropod vectors viz. mosquito, sand fly, ticks, mire, cyclops, louse and myasis.	
Unit-5	**Common anti-parasitic agents**	
SuggestedReadings	ParasitologyinrelationtoClinicalMedicinebyKDChhatterjee 2.MedicalEntomologybyA.K.Hati,Pub.AlliedBookAgency 3.MedicalParasitologybyD.R.Arora 4.ClinicalParasitologybyPaulChesterBeaver	

Course Code MMLSM-204	MMLS Second Semester Molecular Biology and Bioinformatics	L-4 T-0 P-0 C-4
Course Content:	**A- MOLECULAR BIOLOGY**	
Unit-1	**Gene: Structure, replication, and expression** DNA as a genetic material, flow of genetic information, structure and replication of DNA, structure of gene, transcription, translation, genetic code, Organization 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	**Microbial genetics: mechanism of genetic variation** Mutations (types and effects), detection of mutation, DNA repair, genetic variability, bacterial plasmids, transposable elements, bacterial conjugation, transformation and transduction. **Regulation of gene expression** Levels of regulation (regulation of transcription initiation, transcription elongation), regulation of translation, post translation regulation etc.	
Unit-3	**Recombinant DNA technology** Development of Recombinant DNA, cloning vectors, applications of recombinant DNA technology **Genetics in Medicine:** Haemoglobin and haemoglobinopathies, phenylketonuria, alkaptonuria, homocystinuria, Lesch-Nyhan syndrome, genetics of cancer, Down's syndrome, Di-george syndrome, Klinefelter's 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, transgenic organisms, gene therapy, human genome project.	

	B- BIOINFORMATICS	
Unit-4	**Bioinformatics databases–** Nucleotide sequence databases, Primary nucleotide sequence databases-EMBL, GeneBank, DDBJ; Secondary nucleotide sequence databases; Protein databases- UniProt, Protein Data Bank. **Sequence Analysis-** Basic concepts, Alignment of pairs of sequence: - Homologous, Analogue, Orhtologous, paralogous, Xenologous (Need for sequence alignment, Local and Global alignment, Scoring matrices- PAM and BLOSUM matrices	
Unit-5	**Pairwise sequence alignments:** BLAST, Multiple sequence alignments (MSA) BLAST: - Nucleotide BLAST, Protein BLAST, PSI-BLAST, Analysis of BLAST results, E Value, sensitivity and specificity of BLAST, FASTA Structure analysis tools and software	
Suggested readings:	1. Concepts of Genetics, 12th Edition - Pearson 2. Clinical Chemistry, Teitz 3. Fundamentals of Bioinformatics by Harisha S. 4. Molecular Biology by David Clark 5. Molecular Biology by N Arumugam 6. A text book of Bioinformatics by Sharma, Munjal, Shankar	

Course Code MMLSM-205	MMLS Second Semester Applied Bacteriology-IPractical	L-0 T-0 P-5 C-3
Course Content:		
1.	Methods for isolation of pure culture of bacteria	
2.	Different containers used for collection of specimens for microbiology tests	
3.	Preparation of selective culture media for isolation of bacteria	
4.	Preparation of differential culture media for isolation of bacteria	
5.	Different biochemical tests for identification of bacteria	
6.	Isolation and identification of bacillus from clinical specimen	
7.	Isolation and identification of *Mycobacterium tuberculosis* from sputum	
8.	Isolation and identification of Proteus from clinical specimen	
9.	Cultivation of anaerobic bacteria	
10.	To perform antibiotic sensitivity test.	
11.	Isolation of microorganism form air, milk and water	

Course Code MMLSM-206	MMLS Second Semester Immunology and Bacterial Serology Practical	L-0 T-0 P-5 C-3
Course Content:		
1.	Collection of blood for serological tests	
2.	To perform Venereal disease research laboratory (VDRL) test	
3.	To perform Brucella Agglutination test	
4.	To Demonstrate Weil felix test (Demonstration only)	
5.	To Demonstrate Paul Bunnel test (Demonstration only)	
6.	To perform rheumatoid arthritis (RA) test	
7.	To perform C-reactive protein (CRP) test	
8.	To perform Treponema pallidum hemagglutination assay (TPHA) test	
9.	To perform Anti-streptolysin O antibody (ASLO) test	
10.	To perform Widal test for enteric fever	
11.	To perform venereal disease research laboratory (VDRL) test	
12.	To perform pregnancy test	
13.	To perform ELISA for HIV	
14.	To perform ELISA for HBsAg test	
15.	To Demonstrate Western blot test (Demonstration Only)	

Course Code MMLSM-207	MMLS Second Semester Medical Parasitology & Entomology IPractical	L-0 T-0 P-2 C-1
Course Content:		
1.	Methods for collection, preservation of fecal material for examination of parasites	
2.	Methods for transportation of fecal material	
3.	Concentration techniques of stool for ova and cyst	
4.	Wet preparation of fecal sample for ova and cyst	
5.	Method for identification of ova and cyst in stool sample	
6.	Identification of different ova & cysts in stool samples	
7.	Identification of different stage of Plasmodium in blood films	
8.	Differentiation of cyst and trophozoite	

Course Code MMLSM-208	MMLS Second Semester Molecular Biology and Bioinformatics Practical	L-0 T-0 P-2 C-1
Course Content:		
1.	Methods for extraction of genetic material from bacteria	
2.	Principal and use of polymerase chain reaction (PCR)	
3.	Principal and use of reverse transcriptase polymerase chain reaction (RT-PCR)	
4.	Amplification of DNA through PCR	
5.	Separation of DNA by Agarose gel electrophoresis	
6.	To perform bacterial conjugation	
7.	To perform Hybridization of DNA	
8.	To perform Extraction of viral RNA	
9.	Use of RT-PCR for detection of viral RNA	
10.	To perform of PCR mycobacterium pathogen	

Course Code MMLSM-301	MMLS Third Semester Applied Bacteriology-II	L-4 T-1 P-0 C-5
Course Content:		
Unit-1	**Microbial pathogenicity and epidemiology:** Pathogenicity, Epidemiology of disease transmission, Reservoirs of infection, Mode of disease transmission, Control of epidemic disease	
Unit-2	**Antimicrobial prophylaxis**Introduction to chemotherapy, types and classification of antibiotics, mode of action of antibiotic, production of antibiotics	
Unit-3	**Vaccines,** types of vaccines, methods of preparation and route of administration, cold chain	
Unit-4	**Routes of disease transmission**Introduction, methods of disease transmission including air, water, food, vectors etc.Prevention of hospital-acquired infections	
Unit-5	**Causes, symptoms and treatment of various bacterial infections of:** Respiratory tract infections Urinary tract infections Infection of circulatory system Infection of nervous system Central nervous system infections Congenital infections Gastrointestinal infections Infections of skin, mouth, eye, ear, and nose **Opportunistic infections** causes and prevention, sexually transmitted diseases **Human and Animal ethics involved in microbiology work**	
Suggestedreadings	1. PracticalMedicalMicrobiologybyMackieandMcCartney 2. Microbiology For Medical Sciences by Bhagat Singh &Renu Singh 3. TextbookofMicrobiologybyAnanthanarayan 4. MedicalMicrobiologybyPanikar&SatishGupte 5. MedicallaboratoryTechnologyvol.I,II,IIIbyMukherjee 6. DistrictLaboratoryPracticeintropicalcountriesVolIIMicrobiologybyMonicaCheesbrough 7. TextbookofMicrobiologybyPrescott 8. Elements of Medical Microbiology, 4th ed, Rajesh Bhatia and Rattan Lal Ichhpujani	

Course Code MMLSM-302	MMLS Third Semester Advances in Medical Microbiology	L-4 T-1 P-0 C-5
Course Content:		
Unit-1	**Automation in Medical Microbiology** – Introduction, definition, types and use of autoanalyzer's in microbiology, Principle & Applications, Latest trends in Automation: use of biochips, Lab on a chip (LoC) **Nano sensors advantages and disadvantages** Gold nanoparticle based lateral flow assay	
Unit-2	**Introduction, principle and recent advancement in rapid detection:** 1. Component steps in fully automated analyzers 2. Mini Vidasanalyzers 3. Auto analyzers based on immunoassay techniques, Micro particle enzyme immunoassay (MEIA) 4. BD Phoenix™ M50 Automated Microbiology System 5. Immulite automated immunoassay analyzers	
Unit-3	**Polymerase chain reaction (PCR),** Real Time Polymerase chain reaction (RT-PCR) principle and applications. **Lateral flow assay for point of care testing (POCT) of bacterial and viral disease** **Accreditations of microbiology laboratory**	
Unit-4	Automated blood culture systems for the detection of pathogens from blood specimens Chromogenic media as rapid culture-based tests an alternative to molecular testing Improving efficiency and patient care via real-time communication	
Unit-5	**Advances in antibiotic susceptibility testing** Use of combi-disc fordetermination of antimicrobial resistance, Epsilometer test (E- test) an 'exponential gradient' method for determination of antimicrobial resistance	
Suggestedreadings	1. PracticalMedicalMicrobiologybyMackieandMcCartney 2. Microbiology For Medical Sciences by Bhagat Singh &Renu Singh 3. TextbookofMicrobiologybyAnanthanarayan 4. MedicalMicrobiologybyPanikar&SatishGupte 5. MedicallaboratoryTechnologyvol.I,II,IIIbyMukherjee 6. DistrictLaboratoryPracticeintropicalcountriesVolIIMicrobiologybyMonicaCheesbrough 7. TextbookofMicrobiologybyPrescott 8. Elements of Medical Microbiology, 4th ed, Rajesh Bhatia and Rattan Lal Ichhpujani	

Course Code MMLSM-303	MMLS Third Semester Medical Mycology	L-4 T-0 P-0 C-4
Course Content:		
Unit-1	**General characteristics** and classification of pathogenic fungi Morphology and reproduction of fungi Isolation and identification of fungi	
Unit-2	**Fungal pathogens associated with cutaneous infections** Morphology culture characters and infectionscaused by Epidermophyton species, Microsporum species and Trichophyton species	
Unit-3	**Fungal pathogens associated with subcutaneous infections** Morphology culture characters and infectionscaused by:*Actinomaduramadurae,* Cladosporium *Madurella grisea* Phialophora and *Sporothrixschenckii*	
Unit-4	**Fungal pathogens associated with systemic infections** Morphology culture characters and infectionscaused by:*Blastomyces dermatitidis* *Coccidioides immitis* *Histoplasma capsulatum and Paracoccidioides brasiliensis*	
Unit-5	**Fungal pathogens associated with opportunistic infections** Morphology culture characters and infectionscaused by: *Aspergillus fumigatus* *Candida albicans* *Cryptococcus neoformans* *Pneumocystis carinii*and Rhizopus species **Antifungal agents and *in-vitro* susceptibility testing**	
Suggestedreadings	1. PracticalMedicalMicrobiologybyMackieandMcCartney 2. Microbiology For Medical Sciences by Bhagat Singh &Renu Singh 3. TextbookofMicrobiologybyAnanthanarayan 4. MedicalMicrobiologybyPanikar&SatishGupte 5. MedicallaboratoryTechnologyvol.I,II,IIIbyMukherjee 6. Elements of Medical Microbiology, 4th ed, Rajesh Bhatia and Rattan Lal Ichhpujani	

Course Code MMLSM-304	MMLS Third Semester Medical Virology	L-4 T-0 P-0 C-4
Course Content:		
Unit-1	**General characteristics** and classification of viruses Morphology and structure of viruses Isolation and identification of viruses, cultivation of viruses	
Unit-2	**Non-Enveloped DNA Viruses** Morphology, Replication, Transmission, Pathogenesis, Clinical Significance, Laboratory Identification, Prevention and Control of:Adenoviruses and Papillomavirus (Papovaviridae and Parvoviridae)	
Unit-3	**Enveloped DNA Viruses** Morphology, Replication, Transmission, Pathogenesis, Clinical Significance, Laboratory Identification, Prevention and Control of:**Herpes Viruses,** Herpes Simplex Virus (HSV), Varicella-Zoster Virus (also known as Herpes Zoster Virus, Human Herpes Virus-3), Human Cytomegalovirus, Epstein-Barr Virus **Poxviruses,** Poxviridae, Molluscum Contagiosum Virus (MCV) **Hepatitis Viruses** Hepatitis -B Virus, Hepatitis -C Virus and Hepatitis D Virus (Delta Agent)	
Unit-4	**Viruses with Positive RNA Strand** Morphology, Replication, Transmission, Pathogenesis, Clinical Significance, Laboratory Identification, Prevention and Control of: Picornaviruses, Togaviruses, Flavivirus and Caliciviruses **Retroviruses and Immunodeficiency Diseases** Human immunodeficiency virus (HIV)	
Unit-5	**Viruses with Negative RNA Strand** Morphology, Replication, Transmission, Pathogenesis, Clinical Significance, Laboratory Identification, Prevention and Control of: Rhabdovirus (Rabies Virus), Orthomyxoviruses (Influenza Viruses) and Paramyxovirus	
Unit-6	**Coronaviruses (CoVs), COVID-19** **Viriods and prions** **Vaccines and antiviral drugs**	
Suggestedreadings	1. PracticalMedicalMicrobiologybyMackieandMcCartney 2. Microbiology For Medical Sciences by Bhagat Singh &Renu Singh 3. TextbookofMicrobiologybyAnanthanarayan 4. MedicalMicrobiologybyPanikar&SatishGupte 5. MedicallaboratoryTechnologyvol.I,II,IIIbyMukherjee 6. DistrictLaboratoryPracticeintropicalcountriesVolIIMicrobiologybyMonicaCheesbrough 7. TextbookofMicrobiologybyPrescott	

Course Code MMLSM-305	MMLS Third Semester Applied Bacteriology-II Practical	L-0 T-0 P-5 C-3
Course Content:		
1.	Collection of clinical materials like blood, urine, stool, sputum, swabs, CSF etc.	
2.	Isolation and identification of microorganisms from blood	
3.	Isolation and identification of microorganisms from urine.	
4.	Isolation and identification of microorganisms from sputum.	
5.	Isolation and identification of microorganisms from CSF	
6.	Isolation and identification of microorganisms from throat swabs.	
7.	Isolation and identification of microorganisms from stool.	
8.	Isolation and identification of microorganisms from ear	
9.	Isolation and identification of microorganisms from nose	
10.	Isolation and identification of microorganisms from eye	
11.	To perform antimicrobial sensitivity test on bacterial isolates	
12.	Isolation and identification of microorganisms from different food material	
13.	Isolation and identification of microorganisms from water	
14.	Isolation and identification of microorganisms from air	

Course Code MMLSM-306	MMLS Third Semester Advances in Medical Microbiology Practical	L-0 T-0 P-5 C-3
Course Content:		
1.	Use of advanced instruments used for rapid identification of microorganisms	
2.	Microchip based detection pf pathogenic bacteria	
3.	Lateral flow assay for point of care testing (POCT) of viral disease	
4.	Identification of Mycobacterium using PCR	
5.	Identification of HIV using RT- PCR	
6.	Identification of COVID-19 using RT-PCR	
7.	Use of chromogenic culture media for detection of pathogenic bacteria	
8.	Detection of pathogens from blood specimens using automated blood culture method	

Course Code MMLSM-307	MMLS Third Semester Medical Mycology Practical	L-0 T-0 P-2 C-1
Course Content:		
1.	Preparation of fungal culture media	
2.	Cultivation of fungi on solid culture media	
3.	Morphological identification of fungi on solid media	
4.	Staining of fungi for microscopic examination	
5.	Examination of fungi by wet mount	
6.	Different methods for isolation of fungi from clinical specimen	
7.	Isolation and identification of fungi from skin	
8.	Isolation and identification of fungi from swabs	
9.	Isolation and identification of fungi from exudates	
10.	Isolation and identification of fungi from air	
11.	Isolation and identification of fungi mucormycosis	
12.	Differentiation of Epidermophyton, Microsporium and Trichophyton	
13.	Isolation and identification of candida albicans	
14.	Microscopic examination of fungi showing morphology, width and branching of septa	

Course Code MMLSM-308	MMLS Third Semester Medical VirologyPractical	L-0 T-0 P-2 C-1
Course Content:		
1.	Collection of throat swabs for isolation of viruses	
2.	Packing of throat swabs for transportation	
3.	Different methods for cultivation of viruses	
4.	Rapid methods of identification of viruses	
5.	Identification of HIV using lateral flow assay	
6.	Identification of HIV using RT-PCR	
7.	Identification of HBsAg using lateral flow assay	
8.	Identification of Hepatitis virus using lateral flow assay	
9.	Identification of COVID-19 using lateral flow assay	
10.	Identification of COVID-19 using RT-PCR	
11.	Methods for extraction of RNA from COVID-19	
12.	Methods for in-vitro cultivation of viruses	
13.	Different containment levels of biosafety lab.	
14.	Use of personal protective equipment (PPE) kit	

कुलपति
अटल बिहारी वाजपेयी चिकित्सा विश्वविद्यालय
उत्तर प्रदेश, लखनऊ