

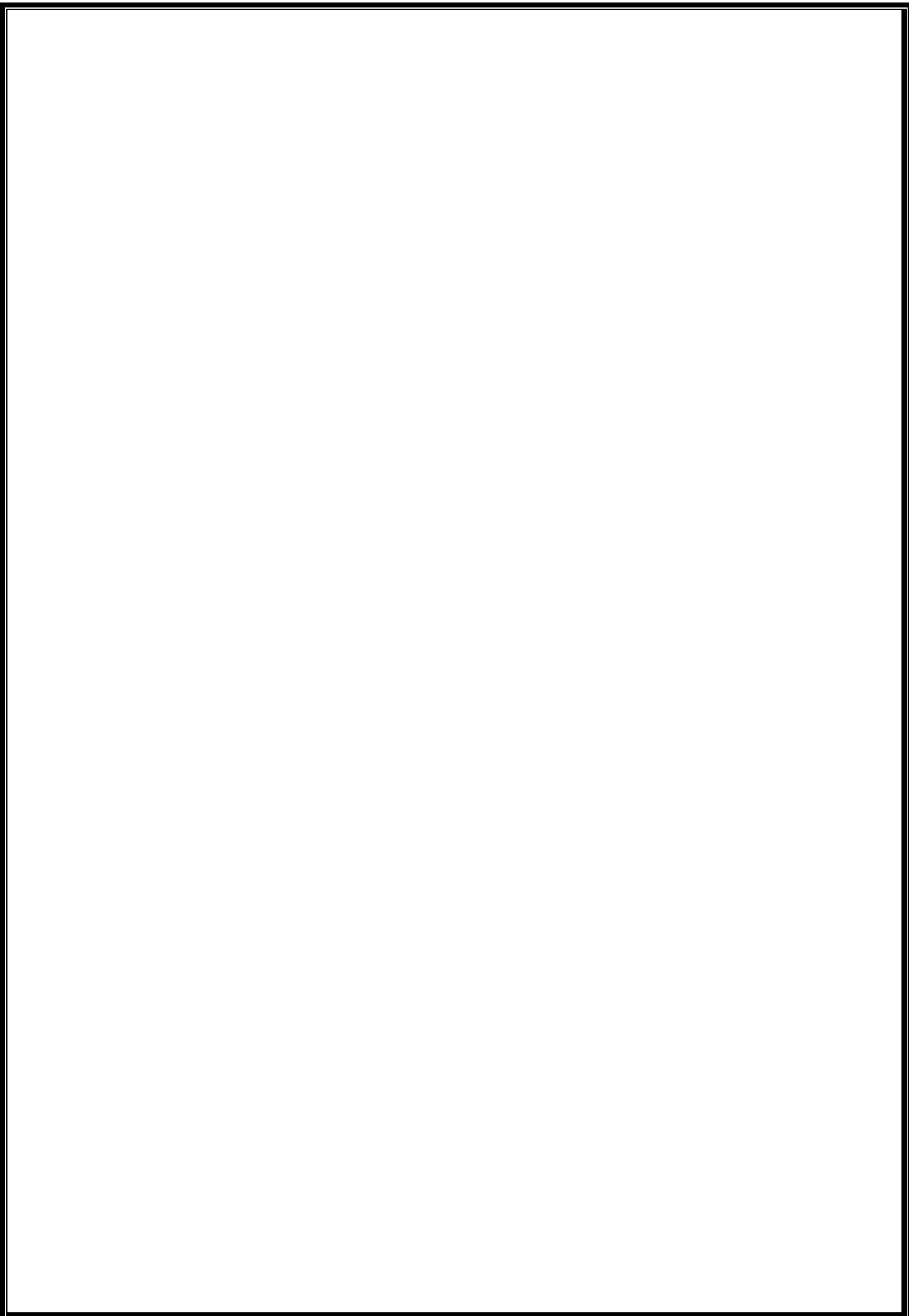
Ministry of Health and Family Welfare

Allied Health Section 2015-16



Model Curriculum Handbook
**MEDICAL LABORATORY
SCIENCE**





Model Curriculum Handbook

MEDICAL LABORATORY SCIENCE



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Ministry of Health and Family Welfare
Allied Health Section

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CONTRIBUTORS TO DRAFTING AND REVIEW (MEDICAL LABORATORY SCIENCE TASKFORCE-MoHFW)

1. Dr. A.K Mukhopadhyay, All India Institute of Medical Science (AIIMS), New Delhi
2. Mr. M V G Thampi, Amrita Centre for Allied Health Science, Amrita University, Kochi
3. Dr. Ameeta Joshi, Grant Medical College, Mumbai
4. Dr. Harish Belgode, Jawaharlal Institute of Postgraduate Medical Education and Research (JIPMER), Puducherry
5. (Hony) Brig. Dr. Arvind Lal, Dr Lal Path Labs, New Delhi
6. Dr. Arvind Rajwanshi, Post Graduate Institute of Medical Education and Research(PGIMER), Chandigarh
7. Dr. Pankaj Kaul, Post Graduate Institute of Medical Education and Research(PGIMER), Chandigarh
8. Dr. Murlidhar K. Katti, SreeChitraTirunal Institute for Medical Science and Technology (SCTIMST), Trivandrum
9. Dr. Abhijit Chaudhary, Sri Venkateswara Institute of Medical Science (SVIMS), Tirupati
10. Dr. A.K. Mandal, VardamanMahavir Medical College & Safdarjung Hospital, Delhi
11. Dr. Shahajahan Maulana. Mumbai
12. Mr. Kaptan Singh Sehrawat, Technical Officer-MLS, Kalawati Saran Children's Hospital, Ministry of Health & Family Welfare, New Delhi
13. Dr. Ashvinder Raina, Post Graduate Institute of Medical Education and Research(PGIMER), Chandigarh
14. Dr. Anand Singh Dangi, Rohtak, Haryana
15. Dr Sunil Sharma, Indian Spinal Injuries Centre, New Delhi
16. Dr Usha Baveja, Medanta the Medicity, New Delhi
17. Dr Malkit Singh, Post Graduate Institute of Medical Education and Research (PGIMER), Chandigarh.....Taskgroup Chairperson

NATIONAL CURRICULA REVIEW COMMITTEE

1. Mr. Ali R. Rizvi, Joint Secretary (in-charge Human Resource), Ministry of Health & Family Welfare (MoHFW)- Chairman
2. Prof. Sanjay Srivastava, DDG(ME), MoHFW
3. Mr. B. S Murthy, Director (AHS), MoHFW
4. Dr. Arun Kr. Agarwal, Ex-Dean, MAMC
5. Dr. B.V. Adkoli, Educationalist, Ex-AIIMS
6. Dr. Bipin Batra, Executive Director, NBE
7. Dr. Subhash Salunke, Senior Advisor, PHFI
8. Dr. T K Jena, Professor, School of Health Sciences, IGNOU
9. Dr. Zenab Zaidi, Director, Health Sector Skill Council
10. Ms. Kavita Narayan, Director, NIAHS TSU

Project Director – Ms. Kavita Narayan

Moderator – Ms. Shivangini Kar Dave

Content Organizer– Mr. Ashish Arora (Former) and Ms. Tanu Sri Sahu

List of Abbreviations

AED	Automated external defibrillator
AHPs	Allied Healthcare Professionals
AIDS	Acquired Immuno Deficiency Disease
BLS	Basic life support
BMLS	Bachelors in Medical Laboratory Science
CATS	Credit Accumulation and Transfer System
CBC	Complete Blood Count
CBCS	Choice-Based Credit System
CBD	Case-based discussion
CEX	Case Evaluation Exercise
CMP	Comprehensive Metabolic Panel
CPR	Cardiopulmonary Resuscitation
CPU	Central Processing Unit
CSF	Cerebrospinal fluid
DMLS	Diploma in Medical Laboratory Science
DOPs	Direct observation of procedures
ECTS	European Credit Transfer System
HIS	Hospital Information System
HOD	Head of Department
HSSC	Healthcare Sector Skill Council
LFT	Liver Function Tests
LIS	Laboratory Information System
MLS	Medical laboratory scientist
MMLS	Masters in Medical Laboratory Science MT: Medical Technologist
NAAC	National Assessment and Accreditation Council
NCRC	National Curricula Review Committee
NIAHS	National Initiative for Allied Health Science
NSDA	National Skills Development Agency
NSQF	National Skills Qualification Framework
OSCE	Objective Structured Clinical Examination
OSLER	Objective Structured Long Examination Record
OSPE	Objective Structured Clinical Examination
RFT	Renal Function Tests
SDL	Self-Directed Learning TFT: Thyroid Function Test
UGC	University Grants Commission
UHC	Universal Health Coverage
WWW	World Wide Web

Chapter 1

Introduction to the Handbook

Chapter 1: Introduction to the Handbook

The report 'From Paramedics to Allied Health Professionals: Landscaping the Journey and Way Forward' that was published in 2012, marked the variance in education and training practices for the allied health courses offered by institutions across the country. This prompted the Ministry of Health and Family Welfare to envisage the creation of national guidelines for education and career pathways of allied health professionals, with a structured curriculum based on skills and competencies. Thus, this handbook has been designed to familiarize universities, colleges, healthcare providers as well as educators offering allied health courses with these national standards.

Individually, created for different professional groups of allied health, this handbook aims to reduce the variation in education by comprising of a standardized curriculum, career pathways, nomenclature and other details for each profession. The change from a purely didactic approach will create better skilled professionals and improve the quality of overall patient care. In the absence of a national standard-setting authority, this handbook can also guide the thousands of young adults who choose healthcare as a profession – not as doctors or nurses but to play several other critical roles – on the appropriate course of action to enable them to be skilled allied health professionals of the future.

Who is an Allied Health Professional?

The Ministry of Health and Family Welfare, accepted in its entirety the definition of an allied health professional based on the afore-mentioned report, though the same has evolved after multiple consultations and the recommended definition is now as follows-

*'Allied health professionals (AHPs) includes individuals involved with the delivery of health or healthcare related services, with qualification and competence in therapeutic, diagnostic, curative, preventive and/or rehabilitative interventions. They work in multidisciplinary health teams in varied healthcare settings including doctors (physicians and specialist), nurses and public health officials to promote, protect, treat and/or manage a person(s) physical, mental, social, emotional, environmental health and holistic well-being.'*¹

Since the past few years, many professional groups have been interacting and seeking guidance on all those who would qualify under the purview of “allied health professionals”. In the healthcare system, statutory bodies exist for clinicians, nurses, pharmacists and dental practitioners; but a regulatory structure for around 50 professions is absent in India. Currently, the Government is considering these professions (as listed Annex-1) under the ambit of the allied health system. However, this is subject to changes and modifications over time, particularly considering how quickly new technologies and new clinical avenues are expanding globally, creating newer cadres of such professionals.

Scope and need for allied health professionals in the Indian healthcare system

The quality of medical care has improved tremendously in the last few decades due to the advances in technology, thus creating fresh challenges in the field of healthcare. It is now widely recognized that health service delivery is a team effort involving both clinicians and non-clinicians, and is not the sole duty of physicians and nurses.¹ Professionals that can competently handle sophisticated machinery and advanced protocols are now in high demand. In fact, diagnosis is

now so dependent on technology, that allied health professionals (AHPs) are vital to successful treatment delivery.

Effective delivery of healthcare services depends largely on the nature of education, training and appropriate orientation towards community health of all categories of health personnel, and their capacity to function as an integrated team. For instance in the UK, more than 84,000 AHPs, with a range of skills and expertise, play key roles within the National Health Service, working autonomously, in multi-professional teams in various settings. All of them are first-contact practitioners and work across a wide range of locations and sectors within acute, primary and community care. Australia's health system is managed not just by their doctors and nurses, but also by the 90,000 university-trained, autonomous AHPs vital to the system.^{2,3}

As the Indian government aims for Universal Health Coverage, the lack of skilled human resource may prove to be the biggest impediment in its path to achieve targeted goals. The benefits of having AHPs in the healthcare system are still unexplored in India. Although an enormous amount of evidence suggests that the benefits of AHPs range from improving access to healthcare services to significant reduction in the cost of care, though the Indian healthcare system still revolves around the doctor-centric approach. The privatization of healthcare has also led to an ever-increasing out-of-pocket expenditure by the population. However, many examples assert the need of skilled allied health professionals in the system, such as in the case of stroke survivors, it is the support of AHPs that significantly enhance their rehabilitation and long term treatment ensures return to normal life. AHPs also play a significant role to care for patients who struggle mentally and emotionally in the current challenging environment and require mental health support; and help them return to well-being.² Children with communication difficulties, the elderly, cancer patients, patients with long term conditions such as diabetes people with vision problems and amputees; the list of people and potential patients who benefit from AHPs is indefinite.

Thus, the breadth and scope of the allied health practice varies from one end to another, including areas of work listed below:

- Across the age span of human development from neonate to old age;
- With patients having complex and challenging problems resulting from systemic illnesses such as in the case of diabetes, cardiac abnormalities/conditions and elderly care to name a few;
- Towards health promotion and disease prevention, as well as assessment, management and evaluation of interventions and protocols for treatment;
- In a broad range of settings from a patient's home to community, primary care centers, to tertiary care settings; and
- With an understanding of the healthcare issues associated with diverse socio-economies and cultural norms within the society.

Learning goals and objectives for allied health professionals

The handbook has been designed with a focus on performance-based outcomes pertaining to different levels. The learning goals and objectives of the undergraduate and graduate education program will be based on the performance expectations. They will be articulated as learning goals (why we teach this) and learning objectives (what the students will learn). Using the framework,

students will learn to integrate their knowledge, skills and abilities in a hands-on manner in a professional healthcare setting. These learning goals are divided into nine key areas, though the degree of required involvement may differ across various levels of qualification and professional cadres:

1. Clinical care
2. Communication
3. Membership of a multidisciplinary health team
4. Ethics and accountability at all levels (clinical, professional, personal and social)
5. Commitment to professional excellence
6. Leadership and mentorship
7. Social accountability and responsibility
8. Scientific attitude and scholarship (only at higher level- PhD)
9. Lifelong learning

1. Clinical Care⁴

Using a patient/family-centered approach and best evidence, each student will organize and implement the prescribed preventive, investigative and management plans; and will offer appropriate follow-up services. Program objectives should enable the students to:

- Apply the principles of basic science and evidence-based practice
- Use relevant investigations as needed
- Identify the indications for basic procedures and perform them in an appropriate manner
- Provide care to patients – efficiently and in a cost-effective way – in a range of settings, and maintain foremost the interests of individual patients
- Identify the influence of biological, psychosocial, economic, and spiritual factors on patients' well-being and act in an appropriate manner
- Incorporate strategies for health promotion and disease prevention with their patients

2. Communication^{4,5}

The student will learn how to communicate with patients/clients, care-givers, other health professionals and other members of the community effectively and appropriately. Communication is a fundamental requirement in the provision of health care services. Program objectives should enable the students to:

- Provide sufficient information to ensure that the patient/client can participate as actively as possible and respond appropriately to the information
- Clearly discuss the diagnosis and options with the patient, and negotiate appropriate treatment plans in a sensitive manner that is in the patient's and society's best interests
- Explain the proposed healthcare service – its nature, purpose, possible positive and adverse consequences, its limitations, and reasonable alternatives wherever they exist
- Use effective communication skills to gather data and share information including attentive listening, open-ended inquiry, empathy and clarification to ensure understanding
- Appropriately communicate with, and provide relevant information to, other stakeholders including members of the healthcare team

- Use communication effectively and flexibly in a manner that is appropriate for the reader or listener
- Explore and consider the influence that the patient's ideas, beliefs and expectations have during interactions with them, along with varying factors such as age, ethnicity, culture and socioeconomic background
- Develop efficient techniques for all forms of written and verbal communication including accurate and timely record keeping
- Assess their own communication skills, develop self-awareness and be able to improve their relationships with others
- Possess skills to counsel for lifestyle changes and advocate health promotion

3. Membership of a multidisciplinary health team⁶

The student will put a high value on effective communication within the team, including transparency about aims, decisions, uncertainty and mistakes. Team-based health care is the provision of health services to individuals, families, and/or their communities by at least two health providers who work collaboratively to accomplish shared goals within and across settings to achieve coordinated, high quality care. Program objectives will aim at making the students being able to:

- Recognize, clearly articulate, understand and support shared goals in the team that reflect patient and family priorities
- Possess distinct roles within the team; to have clear expectations for each member's functions, responsibilities, and accountabilities, which in turn optimizes the team's efficiency and makes it possible for them to use division of labor advantageously, and accomplish more than the sum of its parts
- Develop mutual trust within the team to create strong norms of reciprocity and greater opportunities for shared achievement
- Communicate effectively so that the team prioritizes and continuously refines its communication channels creating an environment of general and specific understanding
- Recognize measurable processes and outcomes, so that the individual and team can agree on and implement reliable and timely feedback on successes and failures in both the team's functioning and the achievement of their goals. These can then be used to track and improve performance immediately and over time.

4. Ethics and accountability

Students will understand core concepts of clinical ethics and law so that they may apply these to their practice as healthcare service providers. Program objectives should enable the students to:

- Describe and apply the basic concepts of clinical ethics to actual cases and situations
- Recognize the need to make health care resources available to patients fairly, equitably and without bias, discrimination or undue influence
- Demonstrate an understanding and application of basic legal concepts to the practice
- Employ professional accountability for the initiation, maintenance and termination of patient-provider relationships

- Demonstrate respect for each patient's individual rights of autonomy, privacy, and confidentiality

5. Commitment to professional excellence⁷

The student will execute professionalism to reflect in his/her thought and action a range of attributes and characteristics that include technical competence, appearance, image, confidence level, empathy, compassion, understanding, patience, manners, verbal and non-verbal communication, an anti-discriminatory and non-judgmental attitude, and appropriate physical contact to ensure safe, effective and expected delivery of healthcare. Program objectives will aim at making the students being able to:

- Demonstrate distinctive, meritorious and high quality practice that leads to excellence and that depicts commitment to competence, standards, ethical principles and values, within the legal boundaries of practice
- Demonstrate the quality of being answerable for all actions and omissions to all, including service users, peers, employers, standard-setting/regulatory bodies or oneself
- Demonstrate humanity in the course of everyday practice by virtue of having respect (and dignity), compassion, empathy, honour and integrity
- Ensure that self-interest does not influence actions or omissions, and demonstrate regards for service-users and colleagues

6. Leadership and mentorship⁸

The student must take on a leadership role where needed in order to ensure clinical productivity and patient satisfaction. They must be able to respond in an autonomous and confident manner to planned and uncertain situations, and should be able to manage themselves and others effectively. They must create and maximize opportunities for the improvement of the health seeking experience and delivery of healthcare services. Program objectives should enable the students to:

- Act as agents of change and be leaders in quality improvement and service development, so that they contribute and enhance people's wellbeing and their healthcare experience
- Systematically evaluate care; ensure the use of these findings to help improve people's experience and care outcomes, and to shape clinical treatment protocols and services
- Identify priorities and effectively manage time and resources to ensure the maintenance or enhancement of the quality of care
- Recognize and be self-aware of the effect their own values, principles and assumptions may have on their practice. They must take charge of their own personal and professional development and should learn from experience (through supervision, feedback, reflection and evaluation)
- Facilitate themselves and others in the development of their competence, by using a range of professional and personal development skills
- Work independently and in teams. They must be able to take a leadership role to coordinate, delegate and supervise care safely, manage risk and remain accountable for the care given; actively involve and respect others' contributions to integrated person-centered care; yet work in an effective manner across professional and agency boundaries. They must know when and how to communicate with patients and refer them to other professionals and agencies, to respect the choices of service users and

others, to promote shared decision-making, to deliver positive outcomes, and to coordinate smooth and effective transition within and between services and agencies.

7. Social Accountability and Responsibility⁹

The students will recognize that allied health professionals need to be advocates within the health care system, to judiciously manage resources and to acknowledge their social accountability.¹⁰ They have a mandate to serve the community, region and the nation and will hence direct all research and service activities towards addressing their priority health concerns. Program objectives should enable the students to:

- Demonstrate knowledge of the determinants of health at local, regional and national levels and respond to the population needs
- Establish and promote innovative practice patterns by providing evidence-based care and testing new models of practice that will translate the results of research into practice, and thus meet individual and community needs in a more effective manner
- Develop a shared vision of an evolving and sustainable health care system for the future by working in collaboration with and reinforcing partnerships with other stakeholders, including academic health centres, governments, communities and other relevant professional and non-professional organizations
- Advocate for the services and resources needed for optimal patient care

8. Scientific attitude and Scholarship¹⁰

The student will utilize sound scientific and/or scholarly principles during interactions with patients and peers, educational endeavors, research activities and in all other aspects of their professional lives. Program objectives should enable the students to:

- Engage in ongoing self-assessment and structure their continuing professional education to address the specific needs of the population
- Conduct evidence-based practices by applying principles of scientific methods
- Take responsibility for their educational experiences
- Acquire basic skills such as presentation skills, giving feedback, patient education and the design and dissemination of research knowledge; for their application to teaching encounters

9. Lifelong learning¹¹

The student should be committed to continuous improvement in skills and knowledge while harnessing modern tools and technology. Program objectives will aim at making the students being able to:

- Perform objective self-assessments of their knowledge and skills; learn and refine existing skills; and acquire new skills
- Apply newly gained knowledge or skills to patient care
- Enhance their personal and professional growth and learning by constant introspection and utilizing experiences
- Search (including through electronic means), and critically evaluate medical literature to enable its application to patient care
- Develop a research question and be familiar with basic, clinical and translational research in its application to patient care

- Identify and select an appropriate, professionally rewarding and personally fulfilling career pathway

Introduction of new elements in allied health education

Competency-based curriculum

A significant skill gap has been observed in the professionals offering healthcare services irrespective of the hierarchy and level of responsibility in the healthcare settings. The large variation in the quality of services is due to the diverse methodologies opted for healthcare education and the difference in expectations from a graduate after completion of a course and at work. What one is expected 'to perform' at work is assumed to be learned during the course, however, the course design focuses on what one is expected 'to know'. The competency-based curriculum thus connects the dots between the 'know what' and 'do how'.

The efficiency and effectiveness of any educational programme largely depends on the curriculum design that is being followed. With emerging medical and scientific knowledge, educators have realized that learning is no more limited to memorizing specific lists of facts and data; in fact, by the time the professional aims to practice in the healthcare setting, the acquired knowledge may stand outdated. Thus, competency-based education is the answer; a curricular concept designed to provide the skills that professionals need. A competency-based program is a mix of skills and competencies based on individual or population needs (such as clinical knowledge, patient care, or communication approaches), which is then developed to teach relevant content across a range of courses and settings. While the traditional system of education focuses on objectives, content, teacher-centric approach and summative evaluation; competency-based education has a focus on competencies, outcomes, performance and accomplishments. In such a case, teaching activities are learner-centered, and evaluation is continuous and formative in structure. The competency-based credentials depend on the demonstration of a defined set of competencies which enables a professional to achieve targeted goals. Competency frameworks comprise of a clearly articulated statement of a person's abilities on the completion of the credential, which allows students, employers, and other stakeholders to set their expectations appropriately.¹²¹³

Considering the need of the present and future healthcare delivery system, the curriculum design depicted in this handbook thus will be based on skills and competencies.

Promoting self-directed learning of the professionals

The shift in the focus from traditional to competency-based education has made it pertinent that the learning processes may also be revisited for suitable changes. It is a known fact that learning is no more restricted to the boundaries of a classroom or the lessons taught by a teacher. The new tools and technologies have widened the platform and introduced innovative modes of how students can learn and gain skills and knowledge. One of the innovative approaches is learner-centric and follows the concept of **self-directed learning**.

Self-directed learning, in its broadest meaning, describes a process in which individuals take the initiative with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying resources for learning, choosing and implementing learning strategies and evaluating learning outcomes (Knowles, 1975).¹⁴

In self-directed learning, learners themselves take the initiative to use resources rather than simply reacting to transmissions from resources, which helps them learn more in a better way.¹⁵ Lifelong,

self-directed learning (SDL) has been identified as an important ability for medical graduates (Harvey, 2003)¹⁶ and so is applicable to other health professionals including AHPs. It has been proven through many studies worldwide that the self-directed method is better than the teacher-centric method of learning. Teacher-directed learning makes learners more dependent and the orientation to learning becomes subject-centred. If a teacher provides the learning material, the student is usually satisfied with the available material, whereas if a student is asked to work on the same assignment, he or she invariably has to explore extensive resources on the subject.¹⁵

Thus the handbook promotes self-directed learning, apart from the usual classroom teaching and opens the platform for students who wish to engage in lifelong learning.

Credit hours vs traditional system

Recently the National Assessment and Accreditation Council (NAAC) and the University Grants Commission (UGC) have highlighted the need for the development of a Choice-Based Credit System (CBCS), at par with global standards and the adoption of an effective grading system to measure a learner's performance.¹⁷ All the major higher education providers across the globe are operating a system of credits. The European Credit Transfer System (ECTS), the 'National Qualifications Framework' in Australia, the Pan-Canadian Protocol on the Transferability of University Credits, the Credit Accumulation and Transfer System (CATS) in the UK as well as the systems operating in the US, Japan, etc. are examples of these. Globally, a need now exists for the use of a fully convertible credit-based system that can be accepted at other universities. It has now become imperative to offer flexible curricular choices and provide learners mobility due to the popularity of initiatives such as 'twinning programmes', 'joint degrees' and 'study abroad' programmes.¹⁸

In order to ensure global acceptability of the graduates, the current curriculum structure is divided into smaller sections with focus on hours of studying which can be converted into credit hours as per the international norms followed by various other countries.

Integrated structure of the curriculum

Vertical integration, in its truest sense, is the interweaving of teaching clinical skills and knowledge into the basic science years and, reinforcing and continuing to teach the applications of basic science concepts during the clinical years. (Many efforts called 'vertical integration' include only the first half of the process).

Horizontal integration is the identification of concepts or skills, especially those that are clinically relevant, that cut across (for example, the basic sciences), and then putting these to use as an integrated focus for presentations, clinical examples, and course materials. e.g. Integration of some of the basic science courses around organ systems, e.g., human anatomy, physiology, pathology; or incorporating ethics, legal issues, finance, political issues, humanities, culture and computer skills into different aspects of a course like the Clinical Continuum.

The aim of an integrated curriculum is to lead students to a level of scientific fluency that is beyond mere fact and concept acquisition, by the use of a common language of medical science, with which they can begin to think creatively about medical problems.¹⁹

This innovative new curriculum has been structured in a way such that it facilitates horizontal and vertical integration between disciplines; and bridges the gaps between both theory & practice, and between hospital-based practice and community practice. The amount of time devoted to basic and laboratory sciences (integrated with their clinical relevance) would be the maximum in the first year, progressively decreasing in the second and third year of the training, making clinical exposure and learning more dominant.¹¹ However it may differ from course to course depending on the professional group.

Introduction of foundation course in the curriculum

The foundation course for allied health professions is an immersive programme designed to impart the required knowledge, skills and confidence for seamless transition to the second semester of a professional allied health course. Post admission, the foundation course is designed for a period of 6 months to prepare a student to study the respective allied healthcourse effectively and to understand the basics of healthcare system. This aims to orient the student to the national health system and the basics of public health, medical ethics, medical terminologies, communication skills, basic life support, computer learning, infection prevention and control, environmental issues and disaster management, as well as orientation to the community with focus on issues such as gender sensitivity, disability, human rights, civil rights, etc. However, the course is flexible in terms of the required numbers of hours for each subject of the foundation course and its appropriate placement across various semesters.

Learning methodologies

With a focus on self-directed learning, the curriculum will include a foundation course that focuses on communication, basic clinical skills and professionalism; and will incorporate clinical training from the first year itself. It is recommended that the primary care level should have sufficient clinical exposure integrated with the learning of basic and laboratory sciences. There should also be an emphasis on the introduction of case scenarios for classroom discussion/case-based learning.

Healthcare education and training is the backbone of an efficient healthcare system and India's education infrastructure is yet to gain from the ongoing international technological revolution. The report '*From Paramedics to Allied Health: Landscaping the Journey and way ahead*', indicates that teaching and learning of clinical skills occur at the patient's bedside or other clinical areas such as laboratories, augmented by didactic teaching in classrooms and lecture theatres. In addition to keeping up with the pace of technological advancement, there has been a paradigm shift to outcome-based education with the adoption of effective assessment patterns. However, the demand for demonstration of competence in institutions where it is currently limited needs to be promoted. The report also mentions some of the allied health schools in India that have instituted clinical skill centres, laboratories and high-fidelity simulation laboratories to enhance the practice and training allied health students and professionals. The report reiterates the fact that simulation is the replication of part or all of a clinical encounter through the use of mannequins, computer-assisted resources and simulated patients. The use of simulators addresses many issues such as suboptimal use of resources and equipment, by adequately training the manpower on newer technologies, limitations for imparting practical training in real-life scenarios, and ineffective skills

assessment methods among others.¹ The table mentioned below lists various modes of teaching and learning opportunities that harness advanced tools and technologies.

Table 1 Clinical learning opportunities imparted through the use of advanced techniques^{1,20}

Teaching modality	Learning opportunity examples
Patients	Teach and assess in selected clinical scenarios
	Practice soft skills
	Practice physical examination
	Receive feedback on performance
Mannequins	Perform acquired techniques
	Practice basic procedural skills
	Apply basic science understanding to clinical problem solving
Simulators	Practice teamwork and leadership
	Perform cardiac and pulmonary care skills
	Apply basic science understanding to clinical problem solving
Task under trainers	Preparation of the patient, slides, etc.

Assessment methods

Traditional assessment of students consists of the yearly system of assessments. In most institutions, assessments consist of internal and external assessments, and a theory examination at the end of the year or semester. This basically assesses knowledge instead of assessing skills or competencies. In competency-based training, the evaluation of the students is based on the performance of the skills as per their competencies. Hence, all the three attributes – knowledge, skills, and attitudes – are assessed as required for the particular competency.

Several new methods and tools are now readily accessible, the use of which requires special training. Some of these are given below:

- Objective Structured Clinical Examination(OSCE), Objective Structured Practical Examination (OSPE), Objective Structured Long Examination Record(OSLER)
- Mini Case Evaluation Exercise(CEX)
- Case-based discussion(CBD)
- Direct observation of procedures(DOPs)
- Portfolio
- Multi-source feedback
- Patient satisfaction questionnaire

An objective structured clinical examination (OSCE) is used these days in a number of allied health courses, e.g. Optometry, Physiotherapy and Radiography. It tests the performance and competence in communication, clinical examination, and medical procedures/prescriptions. In physiotherapy, orthotics, and occupational therapy, it tests exercise prescription, joint mobilization/manipulation techniques; and in radiography it tests radiographic positioning, radiographic image evaluation, and interpretation of results. The basic essential elements consist

of functional analysis of the occupational roles, translation of these roles (“competencies”) into outcomes, and assessment of trainees' progress in these outcomes on the basis of demonstrated performance. Progress is defined solely by the competencies achieved and not the underlying processes or time served in formal educational settings. Most methods use predetermined, agreed assessment criteria (such as observation check-lists or rating scales for scoring) to emphasize on frequent assessment of learning outcomes. Hence, it is imperative for teachers to be aware of these developments and they should suitably adopt them in the allied health education system.²¹

Chapter 2

Methodology of Curriculum Development

Chapter 2: Methodology of curriculum development

With the release of the report ‘From Paramedics to Allied Health: Landscaping the journey and the way ahead’, the Ministry of Health and Family Welfare prioritized the key recommendations and concerns raised by various allied health professionals groups and experts as indicated in the report. One of the major recommendations in the report was the need for standardization of curriculum and pedagogic requirements for the major allied health professional courses.

The MoHFW has identified 12 priority professional streams in the phase-I for the purpose of standardization. The expertise of over 50 leading public and private allied health educational institutions for 12 different disciplines has been sought as part of this exercise. Additionally, international experts from Canada, Sweden, USA and UK are also being roped in, to arrive at a comprehensive and globally acceptable set of educational standards based on a skills and competencies approach. The opinions were sought from experts for all the courses, though curricula for the following two professions were not redesigned as they fall under the ambit of an existing regulatory body –the Rehabilitation Council of India governed by the Ministry of Social Justice and Empowerment –

- Audiology and Speech Pathology
- Orthotics and Prosthetics

The National Skills Development Agency has also developed the National Skills Qualification Framework (NSQF). Under the aegis of the NSDA, the Healthcare Sector Skill Council (HSSC) has undertaken a similar process for a few entry level allied health courses (Certificate and Diploma level). The focus of the Ministry of Health and Family Welfare is thus to preempt duplication of efforts and arrive at a comprehensive set of minimum standards for the allied health professions but for higher level professional qualifications. This would ensure that the key considerations and obligations of both the public and the private sector are adequately addressed.

In view of the above, the Ministry of Health and Family Welfare instituted 12 National Curricula Redesign Taskforce groups comprising of academicians and professionals from the best institutes and colleges across the country. These people served as subject experts and redesigned the curricula based on a standardized framework developed by the NIAHS TSU (National Initiative for Allied Health Sciences-Technical Support Unit), which is the technical arm supporting this project. The final curriculum has been reviewed and approved by the National Curricula Review Committee (NCRC), (constituted by the MoHFW), that consists of experts with versatile and immense experience in their respective streams, to assess the applicability of the curricula drafted in view of the healthcare system as a whole.

Steps undertaken in the curricula review process –

1. Curricula were sought from various States and institutions across the country in response to which the NIAHS TSU reviewed:
 - a. 118 curricula of allied health courses (different levels and different professions) from 10 states across the country;
 - b. 133 curricula of various allied health courses collected during phase-I of the NIAHS project.

2. Literature review –a comprehensive literature review was undertaken resulting in a detailed curriculum of the allied health courses, which included competency and skills-based models followed nationally as well as internationally, methodologies of curriculum development, assessment protocols, and many such aspects of curriculum development. The literature review helped the TSU to develop a reference document that comprised of a standard framework for a competency-based curriculum to be followed for the curricula review and redesign. A detailed mapping of all the resources was undertaken and shared with the taskgroup experts via email.
3. Constitution of the National Curricula Redesign Taskforces for various professional groups – Specific taskforces were then instituted comprising of technical as well as subject experts who were engaged in the process of redesigning the curriculum.
4. Constitution of the National Curricula Review Committee (NCRC) – The NCRC (comprising of experts with versatile and immense experience in their respective domains) was then constituted for final review and approval on the curriculum drafted by the taskforce and NIAHS TSU.
5. National Curricula Redesign Taskforce Consultations– a series of consultations were conducted with subject experts including both regional and national taskgroup experts to develop a ‘skill and competency’ framework for education and career pathways. The consultations were facilitated by the NIAHS TSU members and were led by the chairpersons of the respective groups. Post this, the draft version and recommendations were compiled by the TSU members and sent to the experts for final review and consent.
6. Local consultations – These were also conducted in different hospitals and other healthcare settings to get suggestions, feedback and ideas from the subject experts for their respective curricula.
7. Response draft – Comments and suggestions were received on the draft and a response draft curriculum was prepared, which was then re-circulated for final consent and validation by the taskgroup experts.
8. Submission and approval of draft curriculum – The final draft of the curriculum handbook was then submitted by the taskforce chairman to the National Curricula Review Committee for approval and final sign-off.
9. Public opinion – The handbook was uploaded to seek public opinion from national and international experts, students, faculty, and practitioners of the respective professional groups.
10. Final approval by the NCRC – The comments and suggestions of the public were then reviewed and considered for possible modifications by the taskforce groups. The final approval and sign off for the overall structure was then sought from NCRC.
11. Dissemination – The final handbook (guidelines) is disseminated by the Ministry of Health and Family Welfare for further adoption and incorporation by institutes/universities as applicable to ensure standardization.

Chapter 3

Background of the profession

Chapter 3: Background of the profession

Statement of Philosophy– Why this profession holds so much importance?

Medical Laboratory Professionals work in all areas of a clinical laboratory including blood banking, clinical bio-chemistry, haematology, immunology, histopathology and medical microbiology. They perform a full range of laboratory tests – from simple prenatal blood tests, to more complex tests to uncover diseases such as HIV/AIDS, diabetes, and cancer. They are also responsible for confirming the accuracy of test results, and reporting laboratory findings. The information obtained from a Medical Laboratory Scientist helps the physician influence the medical treatment a patient will receive. Medical Laboratory Scientists operate complex electronic equipment, computers and precision instruments costing millions of dollars.

Medical Laboratory Professionals analyze human fluid samples using techniques available to the clinical laboratory, such as manual white blood cell differentials, bone marrow counts, analysis via microscopy, and advanced analytical equipment. They help physicians in choosing the correct laboratory tests and ensure proper collection methods. They receive patient specimens, analyze and interpret them, and report results.

Medical Laboratory Professionals must recognize anomalies in their test results and know how to correct problems with the instrumentation. They monitor, screen, and troubleshoot analyzers featuring the latest technology available in the market. They perform equipment validations, calibrations, quality controls, “STAT” or run-by-run assessment, statistical control of observed data, and recording of normal operations. To maintain the integrity of the laboratory process, medical laboratory scientists recognize factors that could introduce error and reject contaminated or substandard specimens, as well as investigate discrepant results.

Common tests performed by Medical Laboratory Professionals are complete blood count (CBC), comprehensive metabolic panel (CMP), electrolyte panel, liver function tests (LFT), renal function tests (RFT), thyroid function test (TFT), urinalysis, coagulation profile, lipid profile, blood type, semen analysis (for fertility and post-vasectomy studies), serological studies and routine cultures. In some facilities that have few phlebotomists, or none at all, (such as in rural areas) Medical Laboratory Professionals may perform phlebotomy on patients, as this skill is part of their clinical training.

The practical experience required to obtain a Bachelor's degree in Medical Laboratory Science gives these professionals a unique understanding of the inter-relationship between microbiological and chemical testing and the resulting clinical manifestations in clinical, scientific and industrial settings.

About Medical Laboratory Science

Medical laboratory science is the branch of science which deals with all the clinical laboratory investigations on clinical samples for laboratory diagnosis of various diseases. Blood, tissue and body fluids are analyzed and examined for various types of foreign organisms and abnormalities. This information is then used by the medical team to make decisions regarding a patient's medical care. 85% of all medical decisions are based on the results of clinical laboratory investigation reports.

Medical Laboratory Science is an important subject in the field of Medicine. In each system of Medicine, diagnosis of disease is a primary step because no treatment is possible without a proper diagnosis. It is the Medical Laboratory Technocrat, who performs this important task by various scientific tools and techniques.

In today's modern world of technology, the diagnosis, treatment & prognosis of various diseases depends upon the results of investigations carried out in a clinical laboratory. Thus, these professionals play a key role in the field of health care. Medical Laboratory Science has played a significant role in the advancement in the field of Medicine, especially in past few decades. As modern medicine becomes more of a team effort, the Medical Laboratory Scientist/Technologist is an important member and integral part of the Medical team.

Scope of practice

- Collection and receiving of specimens (infectious samples i.e. blood, urine, stool, sputum, pus, semen, tissues and body fluids) for various biochemical, pathological, microbiological, haematological and blood bank investigations, etc.
- To perform and validate various investigations for the purpose of differential diagnosis
- Calibration and standardization of glassware's and other laboratory equipment
- Standardization and selection of test analytical procedures
- Maintenance of supplies of laboratory reagents / diagnostic kits
- Evaluation of reagents and diagnostic kit for diagnostic suitability
- Maintenance of quality control for reliability of laboratory reports
- Preparation of chemical and biological reagents
- Supervision, organization of work and personnel management
- Maintenance of records and preparation of statistics
- They look for bacteria, parasites, and other microorganisms; analyze the biochemical content of fluids; match blood for transfusions; and test for drug levels in the blood to show how a patient is responding to treatment
- Technologists also prepare specimens for examination, count cells, and look for abnormal cells in blood and body fluids
- They use automated equipment and computerized instruments capable of performing a number of tests simultaneously, as well as microscopes, cell counters, and other sophisticated laboratory equipment
- Then they analyze the results and relay them to physicians
- With increasing automation and the use of computer technology, the work of Technologists has become less hands-on and more analytical
- The complexity of tests performed, the level of judgment needed, and the amount of responsibility workers assume depend largely on the amount of education and experience they possess
- They make cultures of body fluid and tissue samples, to determine the presence of bacteria, fungi, parasites, viruses or other microorganisms
- Clinical laboratory technologists analyze samples for chemical content or a chemical reaction and determine concentrations of compounds such as blood glucose and cholesterol, enzymes and hormones levels

- They also type and cross match blood samples for transfusions. Clinical laboratory staff evaluate test results, develop and modify procedures, and establish and monitor programs, to ensure the accuracy of tests. Senior technologists supervise junior laboratory technologists.
- Medical Laboratory Tech. staffs in small laboratories perform many types of tests, whereas those in large laboratories generally specialize
- Laboratory Technology staff prepare specimens and analyze the chemical, hormonal and enzyme contents of body fluids
- They also examine and identify bacteria and other microorganisms
- In blood bank or Immuno-Haematology, technologists collect, type and cross match blood and prepare its components for transfusions. They also analyze the blood for safe and infection free transfusion (Like HIV, Hepatitis, Syphilis, TPHA, Malaria Parasite etc.)
- In Immunology, technologists examine elements of the human immune system and its response to foreign bodies
- In Molecular Biology, technologists perform complex protein and nucleic acid testing on human cell samples

Table 2: Career Pathway and Nomenclature for Medical Laboratory Professionals

Levels	Nomenclature in various sectors			Qualification and experience
	Clinical	Academic	Industry/ Management	
Level 4	Medical Laboratory Technologist	NA	NA	<ul style="list-style-type: none"> • BMLS – 4 year course (3.5 years + 6 months internship) OR • Diploma MLS (2 years + 6 months internship) + 2 years' experience

Levels	Nomenclature in various sectors			Qualification and experience
	Clinical	Academic	Industry/ Management	
Level 5	<ul style="list-style-type: none"> • Technical Officer (MLS) • Senior Technical Officer (MLS) • Chief Technical Officer 	NA	NA	<ul style="list-style-type: none"> • BMLS – 4 year course (3.5 years + 6 months internship) + 5 years’ experience at level 4 OR • Diploma MLS (2 years + 6 months Internship) + 5 years’ experience at level 4 <p>Further promotion suggested after every 5 years in a horizontal manner.</p> <ol style="list-style-type: none"> 1. From level 4, the professional will be promoted to Technical Officer, then Sr. Technical Officer followed by Chief Technical Officer after 5 years on previous level. (Cadre already functional in Central Hospitals/Institutions under MoHFW) 2. The person will be eligible for Level 6 only if he/she increases his/her qualification to MMLS.
Level 6	Medical Laboratory Scientist (Grade-B)	Clinical Laboratory Demonstrator	Deputy Technical Manager	<ul style="list-style-type: none"> • MMLS with respective specialization. (similar Scientist Cadre already exist in ICMR/DHR under MoHFW) <p><i>(25% vacancies should be filled from existing eligible staff, fulfilling desired qualification criteria without any age bar)</i></p>
Level 7	Medical Laboratory Scientist (Grade C)	Assistant Professor	Technical Manager	<ul style="list-style-type: none"> • For Medical Lab. Scientist Grade-C/ Technical Manager: MMLS with 3 years of experience at Level 6 • For Academics: MMLS in respective specialization with 3 years of experience at Level 6 as Clinical Laboratory Demonstrator
Level 8	Medical Laboratory Scientist (Grade D)	Associate Professor	Deputy Quality Manager	<ul style="list-style-type: none"> • For Medical Lab. Scientist Grade-D/Deputy Quality Manager: MMLS with 3 years of experience at Level 7 • For Academics: MMLS in respective specialization with 3 years of experience at Level 7 as Asst. Professor <p style="text-align: center;">OR</p> <p>Ph.D. with MMLS in the respective specialization</p>

Levels	Nomenclature in various sectors			Qualification and experience
	Clinical	Academic	Industry/ Management	
Level 9	Medical Laboratory Scientist (Grade E)	Additional Professor	Quality Manager	<ul style="list-style-type: none"> • For Medical Laboratory Scientist (Grade E)/ Quality Manager: MMLS with 3 years of experience at Level 8 • For Academics: Ph.D. with MMLS and 3 years of experience at Level 8 as Assoc. Professor in respective specialization.
Level 10	<ul style="list-style-type: none"> • Medical Laboratory Scientist (Grade F) • Medical Laboratory Scientist (Grade G) • Medical Laboratory Scientist (Grade H) 	Professor / Principal	Director Laboratory Services/ HOD	<ul style="list-style-type: none"> • For Medical Laboratory Scientist(Grade F,G,H)/Director – Laboratory Services/HOD: MMLS with 3 year of experience at Level 9 / • For Academics: Ph.D. with MMLS and 3 years of experience at Level 9 as Professor in respective specialization. (Promotion after every 4 years as FCS scheme“Flexible Complementing Scheme” of ICMR)

IMPORTANT NOTES:

1. **Diploma MLT, B.Sc. MLT and M.Sc. MLT completed before implementation of this scheme shall be considered at par with the current scheme of Diploma MLS, Bachelors MLS and Masters MLS respectively, irrespective of their course duration for concerned level.**
2. **Existing in-service Medical Laboratory staff should be considered at par in the present scheme at their respective levels.**
3. ***Diploma should be phased out in the future and the minimum required qualification should be BMLS 4 year course (3.5 years + 6 months internship).**

Definition of Medical Laboratory Science

“A medical laboratory professional (also referred to as a Medical Laboratory Technologist, a Clinical Laboratory Scientist or Clinical Laboratory Technologist) is a healthcare professional who performs chemical, hematological, immunologic, microscopic and microbiological diagnostic analyses on body fluids such as blood, urine, sputum, stool, cerebrospinal fluid (CSF), peritoneal fluid, pericardial fluid, and synovial fluid, as well as other specimens. Medical laboratory scientists work in clinical laboratories at hospitals, reference laboratories, biotechnology laboratories and non-clinical industrial labs.”

Education of the medical laboratory professional

When developing any education programme, it is necessary that programme planning should be outcome-based and should meet local and national manpower requirements. It should also provide personal satisfaction and career potential for the professionals with supporting pathway in the development of the profession. One of the major changes is the shift from a focus based on traditional theoretical knowledge, to skills-and competencies-based education and training. Optimal education/training requires that the student is able to integrate knowledge, skills and attitude in order to be able to perform a professional act adequately in a given situation.

Thus, the following curriculum is prescriptive, aims to focus on a skills- and competencies-based approach for learning and is designed accordingly to standardize the content across the nation.

Entry requirements

- Candidates should have passed 10 + 2 with biology or vocational course in MLS/MLT at 10+2 level
- Minimum percentage of marks: 50% aggregate
- Separate entrance exam should be incorporated for these students who want to pursue allied health course

Course duration

It is recommended that any programme developed from this curriculum should have the following minimum duration for students to qualify as entry level professionals in laboratory Science –

- 2.5 year programme (including 6 months of internship) – Diploma level
- 4 year programme (including 6 months of internship) – Bachelors’ degree level
- 2 year programme (including dissertation)- Masters’ degree level
- Ph.D. programme (including thesis)

The emphasis initially should be on the academic content establishing a strong scientific basis and in the last six months on the application of theory to clinical/reflective practice. In the Bachelors' degree programme, six months shall be devoted to clinical practice, on a continuum of rotation from theory to practice over the programme. The aim of the 4 year degree programme is to enable the development of the laboratory professional as a key member of the healthcare system. With the change in disease dynamics and multifold increase in cases needing medical laboratory science for the purpose of diagnosis, it is imperative that a well-structured programme of postgraduate education is also encouraged so as to enhance research capacity within the country to widen the scope of clinical practice for the profession and to produce well trained teaching faculty from within the profession. Thus, a **Master's degree programme** is recommended with minimum of two years of education including dissertation/thesis, to specialize in the field of Medical Laboratory Science. Postgraduate students can contribute significantly in research and academics.

Ph.D. also plays a significant role in the academic system of Medical Laboratory Science; however the curriculum has not indicated any prescriptive guidelines for that level apart from mapping it on the career and qualification map. The same needs to be promoted, for strengthening the Faculty development and significant contribution of Med. Lab. Professionals in the field of Research and development.

Teaching faculty and infrastructure

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

Teaching areas should facilitate different teaching methods. Where students share didactic lectures with other disciplines (e.g. diagnostic radiographers, nurses) large lecture theatres may be appropriate, but smaller teaching areas should also be provided for tutorial and problem/case-based learning approaches. In all venues where students are placed the health and safety standards must be adhered to.

It is recommended that a faculty and student ratio of 1:10 is to be followed for the Post graduate programmes and 1:25 for the under graduate programmes.

Job availability

As per ILO documentation, employers worldwide are looking for job applicants who not only have technical skills that can be applied in the workplace, but who also can communicate effectively, including with customers; can work in teams, with good interpersonal skills; can solve problems; have good ICT skills; are willing and able to learn; and are flexible in their approach to work.²³ Graduates can expect to be employed in hospitals and private laboratories. A career in research, following the completion of a higher degree such as a Ph. D., is an option chosen by some graduates. Graduates are eligible for employment overseas where their qualifications, training and experience are highly regarded. Graduates have good employment prospects, and will enter a field in which the demand for professionals has increased in recent years and will keep on increasing due to chronic emerging conditions.

Chapter 4

Model Curriculum of Medical Laboratory Science Courses

Chapter 4: Model Curriculum

Background

Various qualifications in medical laboratory science can be accomplished with a course duration ranging from 2.5 years of Diploma (inclusive of 6 months of internship), 4 years of Bachelor's degree (BMLS) (inclusive of 6 months of internship) and 2 years of Master's program (inclusive of Research Project/Dissertations) and Ph.D.

The aim of the recommended curricula is to produce professionals who are technically and clinically competent and are well versed with importance of quality assurance in MLS. They should understand the theoretical basis for evidence-based practice and be effective members of the multidisciplinary team. They should always be prepared to participate in or initiate research into practice. They should be able to work according to registration requirements of the respective country/ state.

All aspects of Medical laboratory Science have been considered in the development of this curriculum together with the identification of the roles expected for different levels of medical laboratory professionals based on their qualification and experience. The need for connecting the dots between the education and employment practices has been the road map for devising this curriculum.

The National Curriculum Taskforce on Medical Laboratory Science has successfully designed the career and qualification map indicating the growth opportunities for a professional in the career pathway based on the level as indicated in the National Skills Qualification Framework (NSQF). The career pathway indicates level 4 as the entry level after the completion of a minimum 2.5 years of Diploma level programme including 6 months internship in medical laboratory science (Diploma in Medical Laboratory Science) and level 5 as the entry level after completion of a minimum 4 years of Baccalaureate level programme including 6 months internship in medical laboratory science (Bachelor in Medical Laboratory Science – BMLS). The components of the programmes starting from diploma and above have been detailed out in the coming chapters.

A foundation course has also been designed to bring all the students at the same level of understanding with respect to basic healthcare related norms before the start of a career in a healthcare professional course. The foundation course is mandatory for all the allied health professional courses and for both entry level courses – diploma as well as degree. If a diploma holder has completed the foundation course and is willing to pursue the degree course, the candidate will directly get entry for next semester, however a pre-qualifier skill test will have to be satisfactorily completed, if not, then the candidate will have to undergo the first semester of foundation course again.

4.1 Diploma in Medical Laboratory Science (DMLS)

Diploma in Medical Laboratory Science (DMLS)

Introduction:

Learning objectives:

1. To have theoretical and practical knowledge about principles, procedures, interpretation and preparation of reagents for routine clinical laboratory investigations performed for laboratory diagnosis of various human diseases, so that after completion of the course the candidate may be able to perform routine clinical laboratory investigations in any clinical laboratory.
2. To have theoretical and practical know-how in advanced newer techniques so that trained personnel can apply these wherever facilities exist.

Expectation from the future Diploma holder in providing patient care:

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

1. Perform routine clinical laboratory testing
2. Make specimen-oriented decisions on predetermined criteria including working knowledge of critical values
3. Communicate with other members of the healthcare team, alongwith customers and patients in an effective manner
4. Process information and ensure quality control as appropriate to routine laboratories
5. Train students in routine laboratory procedure
6. Upgrade knowledge and skills in a changing healthcare scenario

Eligibility for admission:

Selection procedure:

1. Candidate should have passed 10 + 2 with biology or vocational course in MLS/MLT at 10+2 level
2. Minimum percentage of marks: 50% aggregate.
3. Separate entrance exam should be incorporated for students who wish to pursue allied health courses

Provision of Lateral Entry:

No provision of lateral entry is needed at Diploma level, as this is the basic entry level for professionals

Duration of the course:

4 semesters/ 2 Years + six months internship

Minimum of 720 hours of internship should be completed by the candidate to be awarded a Diploma

Total number of hours – 2896 for the total course

Medium of instruction:

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

Attendance:

A candidate has to secure minimum -

- 75% attendance in theoretical
- 80% in skills training (practical) to be able to appear for the final examination

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

Model Curriculum Outline

First Semester– Foundation Course

Subject Code	Course Titles	Hours per week			Marks			CR
		L	T	P	Internal	External	Total	
DMLS-101	Introduction to National Healthcare Delivery System in India	1	-	-	15	35	50	1
DMLS-102	Basic computers and information Science	2	-	-	15	35	50	2
DMLS-103	Communication and soft skills	2	-	-	15	35	50	2
DMLS-104	Medical Terminology, Record keeping (including anatomical terms) and Orientation to Medical Laboratory Science (MLS)	2	-	-	15	35	50	2
DMLS-105	Medical Law and Ethics	2	-	-	15	35	50	2
DMLS-106	Introduction to Quality and Patient safety (including Basic emergency care and life support skills, Infection prevention and control, Biomedical waste management, Disaster management and Antibiotic resistance)	2	1	-	15	35	50	2
DMLS-107	Professionalism and values	1	-	-	15	35	50	1
DMLS-108	Environmental Science	1	-	-	15	35	50	1
DMLS-109	Principals of Management with special reference to Medical Laboratory Science (MLS) management	2	1	-	15	35	50	2
DMLS-110	Community orientation and clinical visit	1	-	-	15	35	50	1
DMLS-111	Basic computers and information Science - Practical	-	-	4	15	35	50	2
DMLS-112	Communication and soft skills – Practical	-	-	2	15	35	50	2
DMLS-113	Medical Terminology, Record keeping (including anatomical terms) and Orientation to Medical Laboratory Science (MLS) – Practical	-	-	2	15	35	50	2
DMLS-114	Introduction to Quality and Patient safety- Practical	-	-	4	15	35	50	2
DMLS-115	Environmental Science – Practical	-	-	2	15	35	50	1
DMLS-116	Principals of Management with special reference to Medical Laboratory Science (MLS) management-Practical	-	-	2	15	35	50	1
TOTAL		16	2	16	240	560	800	26
Total Hours in Semester		544						

NOTE:

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

- Teaching resources should be made available at every institute for all basic subjects
- Considering four months per semester as working months, total contact hour hours per semester shall be 544 (Five hundred and forty four)

Second Semester

S No.	Course Name	Hours per week			Marks			CR
		L	T	P	Internal	External	Total	
DMLS-201	Human Anatomy & Physiology	4	-	-	30	70	100	4
DMLS-202	Basics of Medical Microbiology	4	-	-	30	70	100	4
DMLS-203	Basics of Haematology	4	-	-	30	70	100	4
DMLS-204	Basics of Clinical Biochemistry	4	-	-	30	70	100	4
DMLS-205	Human Anatomy & Physiology -Practical	-	-	4	30	70	100	2
DMLS-206	Basics of Medical Microbiology -Practical	-	-	4	30	70	100	2
DMLS-207	Basics of Haematology-Practical	-	-	4	30	70	100	2
DMLS-208	Basics of Clinical Biochemistry -Practical	-	-	4	30	70	100	2
	Guest Lecture/Tutorial/visit to any medical research/ Medical institution	-	2	-	-	-	-	2
TOTAL		16	2	16	300	700	1000	26
Total Hours in Semester		544						

NOTE:

- Abbreviations: L - Lecture, T - Tutorials and P – Practical
- Considering four months per semester as working months, total contact hour hours per semester shall be 544 (Five hundred and forty four)

Third Semester

S No.	Course Name	Hours per week			Marks			CR
		L	T	P	Internal	External	Total	
DMLS-301	Applied Bacteriology, Mycology and Basic Immunology	4	-	-	30	70	100	4
DMLS-302	Applied Haematology	4	-	-	30	70	100	4
DMLS-303	Applied Clinical Biochemistry-I	4	-	-	30	70	100	4
DMLS-304	Histopathology	4	-	-	30	70	100	4
DMLS-305	Applied Bacteriology, Mycology and Basic Immunology -Practical	-	-	4	30	70	100	2
DMLS-306	Applied Haematology-Practical	-	-	4	30	70	100	2
DMLS-307	Applied Clinical Biochemistry-I—Practical	-	-	4	30	70	100	2
DMLS-308	Histopathology -Practical	-	-	4	30	70	100	2
	Guest Lecture/Tutorial/visit to any medical research/ Medical institution	-	2	-	-	-	-	2
TOTAL		16	2	16	300	700	1000	26
Total Hours in Semester		544						

NOTE:

- Abbreviations: L - Lecture, T - Tutorials and P – Practical
- Considering four months per semester as working months, total contact hour hours per semester shall be 544 (Five hundred and forty four)

Fourth Semester

S No.	Course Name	Hours per week			Marks			CR
		L	T	P	Internal	External	Total	
DMLS-401	Medical Parasitology & Virology	4	-	-	30	70	100	4
DMLS-402	Immuno-Haematology/ Blood Banking	4	-	-	30	70	100	4
DMLS-403	Applied Biochemistry-II	4	-	-	30	70	100	4
DMLS-404	Immuno-Pathology and Cytopathology	4	-	-	30	70	100	4
DMLS-405	Medical Parasitology & Virology –Practical	-	-	4	30	70	100	2
DMLS-406	Immuno-Haematology/ Blood Banking-Practical	-	-	4	30	70	100	2
DMLS-407	Applied Biochemistry-II—Practical	-	-	4	30	70	100	2
DMLS-408	Immuno-Pathology and Cytopathology - Practical	-	-	4	30	70	100	2
	Guest Lecture/Tutorial/visit to any medical research/ Medical institution	-	2	-	-	-	-	2
TOTAL		16	2	16	300	700	1000	26
Total Hours in Semester		544						

NOTE:

1. Abbreviations: L - Lecture, T - Tutorials and P – Practical
2. Considering four months per semester as working months, total contact hour hours per semester shall be 544 (Five hundred and forty four)

Fifth Semester

Subject Code	Course Titles	Hours per week			Marks			CR
		L	T	P	Internal	External	Total	
DMLS-501	MLS Internship	-	-	720	50	150	200	26
	Total	-	-	720	50	150	200	26

NOTE:

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

INTERNSHIP – After completion of four semesters of Diploma MLS, the candidates shall undergo six months' internship in a Government recognized hospital/Institution completing minimum of 720 hours training, as partial fulfillment for the award of Diploma in MLS as per government norms

First Semester – Foundation course

DMLS-101: Introduction to National Healthcare Delivery System in India

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

1. Introduction to healthcare delivery system
 - a. Healthcare delivery system in India at primary, secondary and tertiary care
 - b. Community participation in healthcare delivery system

- c. Health system in developed countries.
- d. Private Sector
- e. National Health Mission
- f. National Health Policy
- g. Issues in Health Care Delivery System in India
2. National Health Programmes – Background objectives, action plan, targets, operations, achievements and constraints in various National Health Programmes.
3. Introduction to AYUSH system of medicine
 - a. Introduction to Ayurveda
 - b. Yoga and Naturopathy
 - c. Unani
 - d. Siddha
 - e. Homeopathy
 - f. Need for integration of various systems of medicine
4. Health scenario of India – past, present and future. Public health in India (epidemiology and demography)
5. Demography & Vital Statistics
 - a. Demography – its concept
 - b. Vital events of life & its impact on demography
 - c. Significance and recording of vital statistics
 - d. Census & its impact on health policy
6. Epidemiology
 - a. Principles of epidemiology
 - b. Natural history of disease
 - c. Methods of epidemiological studies
 - d. Epidemiology of communicable & non-communicable diseases, disease transmission, host defense immunizing agents, cold chain, immunization, disease monitoring and surveillance.

DMLS-102: Basic computers and information science

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

1. Introduction to computers: Introduction, characteristics of computers, block diagram of computers, generations of computers, computer languages
2. Input output devices: Input devices(keyboard, point and draw devices, data scanning devices, digitizer, electronic card reader, voice recognition devices, vision-input devices), output devices(monitors, pointers, plotters, screen image projector, voice response systems)
3. Processor and memory: Central Processing Unit (CPU), main memory
4. Storage Devices: Sequential and direct access devices, magnetic tape, magnetic disk, optical disk, mass storage devices
5. Introduction of windows: History, features, desktop, taskbar, icons on the desktop, operation with folder, creating shortcuts, operation with windows (opening, closing, moving, resizing, minimizing and maximizing, etc.)
6. Introduction to MS-Word: Introduction, components of a word window, creating, opening and inserting files, editing a document file, page setting and formatting the text,

- saving the document, spell checking, printing the document file, creating and editing of table, mail merge
7. Introduction to Excel: Introduction, about worksheet, entering information, saving workbooks and formatting, printing the worksheet, creating graphs
 8. Introduction to PowerPoint: Introduction, creating and manipulating presentation, views, formatting and enhancing text, slide with graphs
 9. Introduction of Operating System: Introduction, operating system concepts, types of operating system
 10. Computer networks: Introduction, types of network (LAN, MAN, WAN, Internet, Intranet), network topologies (star, ring, bus, mesh, tree, hybrid), components of network
 11. Internet and its Applications: Definition, brief history, basic services (E-Mail, File Transfer Protocol, telnet, the World Wide Web (WWW)), www browsers, use of the internet
 12. Application of Computers in clinical settings

Suggested Readings:

1. Information technology by Anshuman Sharma (Lakhanpal Publisher)
2. Computer Fundamentals (Concepts. Systems and applications) by P. K. Sinha (University of Tokyo, Japan) BPB Publications

DMLS-103: Communication and soft skills

Rationale: Emphasizing on building basic language skills, this course introduces elements of communication skills using topics like business communication, public speaking, health communication, etc.

Major topics to be covered under Communication course²⁸ –

1. Basic language skills: Grammar and Usage
2. Business communication skills: With focus on speaking - conversations, discussions, dialogues, short presentations, pronunciation
3. Teaching the different methods of writing (like letters, e-mails, reports, case studies, basic compositions, journals, collecting and reporting patient data, etc.) with a focus on paragraph form and organization
4. Basic concepts & principles of good communication
5. Special characteristics of health communication
6. Types & process of communication
7. Barriers of communication & how to overcome them

DMLS-104: Medical Terminology, Record keeping (including anatomical terms) and Orientation to Medical Laboratory Science (MLS)

Rationale: This subject introduces the elements of medical terminology. Emphasis is placed on building familiarity with medical words through knowledge of roots, prefixes and suffixes. Topics include: origin, word building, abbreviations and symbols, terminology related to the human anatomy, reading medical orders and reports, and terminology specific to the student's field of study. Spelling is critical and will be counted when grading tests. The students will be oriented to the role of a medical laboratory professional in the healthcare system, and the scope, purpose and career opportunities in the field of medical laboratory science.

Topics to be covered under the subject are as follows:

Medical Terminology, Record keeping

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

Orientation to Medical Laboratory Science (MLS)

1. Medical Lab Science – Introduction
2. Career opportunities in MLS
3. Role of a Medical lab. professional in Health care system
4. Common laboratory associated hazards and biosafety measures including radiation hazards
5. Subject specific role of a Medical lab. professional:
 - a. Microbiology
 - Role of microbes in human health
 - Overview of the role of Medical Laboratory Professionals in Medical Microbiology
 - Bio-safety in Microbiology
 - b. Haematology
 - Introduction to Haematological diseases
 - Overview of the role of Medical lab. professional in Haematology
 - Bio-safety in Haematology
 - c. Histopathology
 - Introduction to Tumor pathology
 - Overview of the role of Medical lab. professional in Histopathology
 - Bio-safety in Histopathology
 - d. Biochemistry
 - Introduction to metabolic disorders
 - Overview of the role of Medical lab. professional in Clinical Biochemistry
 - Bio-safety in Clinical Biochemistry

Suggested reading: An introduction to Med. Lab. Technology by F.J. Baker & R.E. Silverton, Pb. London Butterworth and Co. Ltd.

DMLS-105: Medical Law and Ethics

Rationale: Legal and ethical considerations are firmly believed to be an integral part of medical practice in planning patient care. Advances in medical Science, growing sophistication of the modern society's legal framework, increasing awareness of human rights and changing moral principles of the community at large, now result in frequent occurrences of healthcare professionals being caught in dilemmas over aspects arising from daily practice.²⁷

Medical ethics has developed into a well based discipline which acts as a "bridge" between theoretical bioethics and the bedside. The goal is "to improve the quality of patient care by identifying, analyzing, and attempting to resolve the ethical problems that arise in practice".²⁷ Physicians are bound by, not just moral obligations, but also by laws and official regulations that form the legal framework to regulate medical practice. Hence, it is now a universal consensus that legal and ethical considerations are inherent and inseparable parts of good medical practice across the whole spectrum. Few of the important and relevant topics that need to focus on are as follows:

1. Medical ethics - Definition - Goal - Scope
2. Introduction to Code of conduct
3. Basic principles of medical ethics – Confidentiality
4. Malpractice and negligence - Rational and irrational drug therapy
5. Autonomy and informed consent - Right of patients
6. Care of the terminally ill- Euthanasia
7. Organ transplantation
8. Medico legal aspects of medical records – Medico legal case and type- Records and document related to MLC - ownership of medical records - Confidentiality Privilege communication - Release of medical information - Unauthorized disclosure - retention of medical records - other various aspects.
9. Professional Indemnity insurance policy
10. Development of standardized protocol to avoid near miss or sentinel events
11. Obtaining an informed consent.
12. Ethics in the profession of Medical Laboratory Science

Suggested readings:

1. Medical Law and Ethics by Bonnie F Fremgen
2. Medical Law and Ethics by Herring
3. Medical Laboratories Management- Cost effective methods by Sangeeta Sharma, Rachna Agarwal, Sujata Chaturvedi and Rajiv Thakur

DMLS-106: Introduction to Quality and Patient safety (including Basic emergency care and life support skills, Infection prevention and control, Bio-medical waste management, Disaster management and Antibiotic resistance)

Rationale: The subject will introduce the students to understand the basic concepts of quality in health Care and develop skills to implement sustainable quality assurance program in the health system. It will sensitize students in basic emergency care, Infection prevention & control with knowledge of Bio-medical waste management and Antibiotic resistance.

- 1. Quality assurance and management -**
 - a. Concepts of Quality of Care
 - b. Quality Improvement Approaches
 - c. Standards and Norms
 - d. Quality Improvement Tools
 - e. Introduction to NABH guidelines
- 2. Basics of emergency care and life support skills -** Basic life support (BLS) is the foundation for saving lives following cardiac arrest. Fundamental aspects of BLS include

immediate recognition of sudden cardiac arrest (SCA) and activation of the emergency response system, early cardiopulmonary resuscitation (CPR), and rapid defibrillation with an automated external defibrillator (AED). Initial recognition and response to heart attack and stroke are also considered part of BLS. The student is also expected to learn about basic emergency care including first aid and triage. Topics to be covered under the subject are as follows:

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

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

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

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

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

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

5. Antibiotic Resistance-

- a. History of Antibiotics
- b. How Resistance Happens and Spreads
- c. Types of resistance- Intrinsic, Acquired, Passive
- d. Trends in Drug Resistance
- e. Actions to Fight Resistance
- f. Bacterial persistence
- g. Antibiotic sensitivity

- h. Consequences of antibiotic resistance
 - i. Antimicrobial Stewardship- Barriers and opportunities, Tools and models in hospitals
- 6. Disaster preparedness and management-** The objective of this section will be to provide knowledge on the principles of on-site disaster management. Concepts to be taught should include-
- a. Fundamentals of emergency management,
 - b. Psychological impact management,
 - c. Resource management,
 - d. Preparedness and risk reduction,
 - e. Key response functions (including public health, logistics and governance, recovery, rehabilitation and reconstruction), information management, incident command and institutional mechanisms.

DMLS-107: Professionalism and Values

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

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

Suggested Readings

1. R. R. Gaur, R Sangal, GP Bagaria, 2009, a Foundation Course in Value Education.
2. E.F. Schumacher, 1973, Small is Beautiful: A study of Economics as if people mattered, Blond & Briggs, Britain.
3. A. Nagraj, 1998, JeevanVidyaekParichay, Divya Path Sansthan, Amarkantak.
4. P.L. Dhar, R.R.Gaur, 1990, Science and Humanism, Common wealth Publishers.
5. A.N. Tripathy, 2003, Human Values, New Age International Publishers
6. E G Seebauer& Robert L. Berry, 2000, Fundamentals of Ethics for Scientists & Engineers, Oxford University Press
7. B. P. Banerjee, 2005, Foundations of Ethics and Management, Excel Books.

DMLS-108: Environmental Science

Rationale: The student will be made aware of our environment in general, Natural Resources, Ecosystems, Environmental Pollution, and Social issues related to environment, Human Population and the Environment and understanding the Hospital Environment.

1. Introduction: Definition and scope and importance of multidisciplinary nature of environment. Need for public awareness.
2. Natural Resources: Natural Resources and associated problems, use and over exploitation, case studies of forest resources and water resources.

3. Ecosystems: Concept of Ecosystem, Structure, interrelationship, producers, consumers and decomposers, ecological pyramids-biodiversity and importance. Hotspots of biodiversity
4. Environmental Pollution: Definition, Causes, effects and control measures of air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards
 - 4.1 Solid waste management: Causes, effects and control measure of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies.
 - 4.2 Social blemishes and the Environment From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, water shed management Resettlement and rehabilitation of people; its pros and concerns.
 - 4.3 Case studies, Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.
 - 4.4 Case studies, Wasteland reclamation.
 - 4.5 Consumerism and waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act. Water (Prevention and control of pollution) Act. Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation Public awareness.
 - 4.6 Human Population and the Environment, Population growth, variation among nations. Population explosion–Family Welfare Programme. Environment and human health, Human Rights, Value Education, HIV/AIDS. Women and child Welfare. Role of Information Technology in Environment and human health. Case studies.
5. Understanding the Hospital Environment
6. Understanding the environment in the following clinical laboratories:
 - 6.1 Microbiology
 - 6.2 Biochemistry
 - 6.3 Histopathology
 - 6.4 Haematology
7. Clinical laboratory hazards to the environment from the following and means to prevent:
 - 7.1 Infectious material
 - 7.2 Toxic Chemicals
 - 7.3 Radioactive Material
 - 7.4 Other miscellaneous wastes

Suggested Readings

1. Agarwal, K. C. 2001 Environment Biology, Nidi Publ. Ltd. Bikaner.
2. Jadhav, H &Bhosale, V.M. 1995. Environment Protection and Laws. Himalaya Pub House, Delhi 284 p.
3. Rao M. N. &Datta A.K. 1987. Waste water treatment. Oxford & IBH Publ. Co. Pvt. Ltd. 345 p.
4. Daniel D. Chiras 2010. Environmental Science. 1st Indian Edition, Jones and Bartlett India Pvt. Ltd. 4262/3, Ansar Road, Daryaganj, New Delhi.
5. Principle of Environment Science by Cunningham, W.P.
6. Essentials of Environment Science by Joseph.
7. Environment Pollution Control Engineering By Rao, C.S.

8. Perspectives in Environmental Studies by Kaushik, A.
9. Elements of Environment Science & Engg. By Meenakshi.
10. Elements of environment Engg. by Duggal.

DMLS-109: Principals of Management with special reference to Medical Laboratory Science (MLS) Management

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

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

Medical Laboratory Science Management

Rationale: The students will be made aware of the basic ethics, good lab practices including awareness/ safety in a clinical lab. In addition they will be made to understand Sample accountability, Quality Management system, biomedical waste management, Calibration and Validation of Clinical Laboratory instruments, Laboratory Information system (LIS), Hospital Information system (HIS) and financial Management.

1. Ethical Principles and standards for a clinical laboratory professional
 - 1.1. Duty to the patient
 - 1.2. Duty to colleagues and other professionals
 - 1.3. Duty to the society
2. Good Laboratory Practice (GLP) Regulations and Accreditation
 - 2.1. Introduction to Basics of GLP and Accreditation
 - 2.2. Aims of GLP and Accreditation
 - 2.3. Advantages of Accreditation
 - 2.4. Brief knowledge about National and International Agencies for clinical laboratory accreditation
3. Awareness / Safety in a clinical laboratory
 - 3.1. General safety precautions
 - 3.2. HIV: pre- and Post-exposure guidelines
 - 3.3. Hepatitis B & C: pre- and Post-exposure guidelines
 - 3.4. Drug Resistant Tuberculosis
4. Patient management for clinical samples collection, transportation and preservation, sample accountability
 - 4.1. Purpose of accountability
 - 4.2. Methods of accountability
5. Sample analysis
 - 5.1. Introduction
 - 5.2. Factors affecting sample analysis
6. Reporting results: Awareness about the following;
 - 6.1. Basic format of a test report

- 6.2. Reported reference range
- 6.3. Clinical Alerts
- 6.4. Abnormal results
- 6.5. Turnaround time
- 6.6. Results from referral laboratories
- 6.7. Release of examination results
- 6.8. Alteration in reports
7. Quality Management system
 - 7.1. Introduction
 - 7.2. Quality assurance
 - 7.3. Quality control system
 - 7.4. Internal and External quality control
8. Biomedical waste management in a clinical laboratory
9. Introduction and importance of calibration and Validation of Clinical Laboratory instruments
10. Introduction to Laboratory Information system (LIS), Hospital Information system (HIS) and financial management
11. Ethics in Medical laboratory Practice
 - 11.1. Understanding the term 'Ethics'
 - 11.2. Ethics in relation to the following:
 - 11.2.1. Pre-Examination procedures
 - 11.2.2. Examination procedures
 - 11.2.3. Reporting of results
 - 11.2.4. Preserving medical records
 - 11.2.5. Access to Medical laboratory Records
12. Inventory Control

Suggested reading: Medical Laboratories Management- Cost effective methods by Sangeeta Sharma, Rachna Agarwal, Sujata Chaturvedi and Rajiv Thakur

DMLS-110: Community Orientation and Clinical Visit

Rationale: The objective of this particular section of the foundation course is to sensitize potential learners with essential knowledge; this will lay a sound foundation for their learning across the under-graduate program and across their career. Innovative teaching methods should be used to ensure the attention of a student and make them more receptive such as group activities, interactive fora, role plays, and clinical bed-side demonstrations.²⁹

1. The community orientation and clinical visit will include visit to the entire chain of healthcare delivery system -Sub centre, PHC, CHC, SDH, DH and Medical College, private hospitals, dispensaries and clinics.
2. The student will also be briefed regarding governance at village level including interaction and group discussion with village panchayat and front line health workers.
3. Clinical visit to their respective professional department within the hospital.

DMLS-111: Basic computers and Information Science-Practical

Practical on fundamentals of computers -

1. Demonstration of basic hard ware of the computers and laptops
2. Learning to use MS office: MS word, MS PowerPoint, MS Excel.
3. To install different software.

4. Data entry efficiency

DMLS-112: Communication and Soft Skills-Practical

1. Précis writing and comprehension of simple passages from a prescribed text book. The passage should be atleast 100 words and students should answer a few questions based on it.
2. To practice all forms of communication i.e. drafting reports, agendas, notes, précis writing, telegrams, circulars, presentations, press releases, telephonic communication, along with practice on writing resumes and applications for employment.

DMLS-113: Medical Terminology, Record keeping (including anatomical terms) and Orientation to Medical Laboratory Science (MLS)-Practical

1. General discussion/Sensitization on career opportunities and role of MLS in Hospital Care
2. Visit to Central Sterile Supply Department (CSSD)
3. Visit to incinerator complex
4. Visit to Immunization section
5. Visit to working Microbiology, Haematology, Biochemistry and Histopathology laboratories

DMLS-114: Introduction to Quality and Patient safety (including Basic emergency care and life support skills, Infection prevention and control, Biomedical waste management, Disaster management and Antibiotic resistance)-Practical

1. Biomedical waste management:
 - 1.1. Types of the waste generated
 - 1.2. Segregation
 - 1.3. Treatment
 - 1.4. Disposal

Suggested readings:

1. Text book of Preventive Medicine by Par and Park for infection prevention and control
2. Text book of Microbiology by Ananthanaryanan for Antibiotic Resistance

DMLS-115: Environmental Science-Practical

1. Any Activity related to public awareness about the environment:
 - 1.1. Preparation of Charts/Models
 - 1.2. Visit to any effluent treatment plant
 - 1.3. Seeding a plant/s and take care of it/them.
2. Preparation of models/charts in relation to natural resources of drinking water.
3. Preparation of Models of Ecosystem on biodiversity.
4. Effects of environmental pollution on humans through poster presentation.
5. Any Activity related to wild life preservation.
6. Visit to any hospital/ clinical laboratory and understanding the environment therein.
7. Visit to an incinerator.
8. Any activity related to biomedical waste management in a hospital or clinical laboratory

DMLS-116: Principals of Management with special reference to Medical Laboratory Science (MLS) Management: Practical

1. Clinical sample collection e.g.
 - 1.1. Blood
 - 1.2. Urine
 - 1.3. Stool
 - 1.4. Saliva
 - 1.5. Sputum
 - 1.6. Semen analysis
2. Sample accountability
 - 2.1. Labeling of sample
 - 2.2. Making entries in Laboratory records
3. Reporting results
 - 3.1. Basic format of a test report
 - 3.2. Release of examination results
 - 3.3. Alteration in reports
4. Quality Management system
 - 4.1. Quality assurance
 - 4.2. Internal and External quality control
 - 4.3. Quality improvement
5. Biomedical waste management in a clinical laboratory - Disposal of used samples, reagents and other biomedical waste
6. Calibration of Clinical Laboratory instruments
7. Ethics in Medical laboratory Practice in relation to the following (Role models will be displayed while working in a clinical laboratory during):
 - 7.1. Pre-Examination procedures
 - 7.2. Examination procedures
 - 7.3. Reporting of results
 - 7.4. Preserving medical records
 - 7.5. Access to Medical laboratory Records

Second Semester

DMLS-201: Anatomy and Physiology

Rationale: The students are supposed to have basic knowledge of structure of human body, its anatomical parts and physiological functions.

1. Introduction to human body, its anatomy and physiology
2. Elementary tissues of body and their classification along with brief description.
3. Digestive System:
 - 3.1. Organs of digestion, histology of the digestive organs (stomach, small intestine, liver, pancreas), Process of digestion
 - 3.2. Absorption and assimilation of food
4. Respiratory System
 - 4.1. Organs of respiration and their histology (lungs and trachea)
 - 4.2. Respiration (Definition and Mechanism)
5. The skin (Structure and functions)

6. The excretory system
 - 6.1. Organs of excretion (kidneys, ureter, bladder)
 - 6.2. Histology of kidney and its functions
 - 6.3. Formation of urine and its composition
 - 6.4. Structure of nephron
7. Circulatory system
 - 7.1. Composition and functions of blood
 - 7.2. The heart anatomy and physiology
 - 7.3. The chambers of heart, various vessels and valves
 - 7.4. Circulation of blood
 - 7.5. The blood pressure
 - 7.6. Arteries and veins
 - 7.7. Lymph and lymphatic system
8. Nervous System
 - 8.1. Central nervous system (Brain and Spinal cord)
 - 8.2. Peripheral nervous system (cranial and spinal nerves)
 - 8.3. The reflex action and reflex arc
 - 8.4. The transmission of nerve impulse
 - 8.5. The sense organs (eye, ear, tongue and nose); structure and functions
9. Muscular System
 - 9.1. Brief description of skeletal, smooth and cardiac muscles
 - 9.2. Muscular contraction
 - 9.3. Muscle Fatigue
 - 9.4. Some important muscles of body
10. Skeletal System
 - 10.1. The skeleton, important bones and their brief description
 - 10.2. Articulation of Bones - joints
11. Endocrine System
 - 11.1. Short description of various endocrine glands and their functions
12. Reproductive System
 - 12.1. Male and female reproductive system
 - 12.2. Histology of Gonads
 - 12.3. The ovarian cycle and ovulation
 - 12.4. Fertilization
 - 12.5. Fertility control

Suggested Readings:

1. Anatomy & Physiology by Ross and Wilson
2. Anatomy and Physiology: Understanding the Human Body by Clark
3. Anatomy and Physiology for nurses by Evelyn Pearce
4. Anatomy and Physiology for nurses by Sears
5. Anatomy and Physiology for nurses by Pearson
6. Anatomy and Physiology by N Murgesh

DMLS-202: Basic of Medical Microbiology

Rationale: The candidates undergoing training in medical laboratory technology will learn the techniques of collection of samples, their processing and identification of various pathogens like bacteria, parasites, viruses using different techniques. In addition, the candidates are given training in the use of standard safety measures while handling infective materials. The basic knowledge of different diseases caused by various micro-organisms is also imparted. The training is aimed at making the students competent to isolate and identify the causative micro-organisms.

Theory

1. Introduction to Microbiology: Definition, history, relationship of microorganisms to man, safety in a microbiology laboratory.
2. Morphology of Bacteria: Anatomy of a bacterial cell including spores, flagella and capsules
3. Growth and Nutrition of Bacteria: A typical growth curve and bacterial nutrition
4. Classification of micro-organisms with special reference to bacteria – general classification, biological classification
5. Sterilization: Definition, sterilization by dry heat, moist heat (below, at and above 1000C) Autoclave, its structure and functioning, autoclave controls and sterilization indicators, sterilization by radiation and filtration
6. Antiseptics and Disinfectants: Definitions, types, properties and uses of disinfectants and antiseptics, In-use test
7. Microscopy: Structure and working of simple and compound microscope. Principles of dark field, fluorescent, phase contrast and electron microscope
8. Staining Techniques: Methods of smear preparation, fixation, simple stains, grams stain, AFB staining, Albert's stain, Neisser's stain, staining of spores, capsules
9. Culture Media: Definition, Purpose, classification of culture media. Liquid and solid media, defined and synthetic media, routine laboratory media (Basal, enriched, selective, enrichment, indicator, transport and storage or preservation)
10. Bacterial Culture: Inoculation of culture media, aerobic and anaerobic culture, isolation of pure cultures and disposal of cultures
11. Morphological and biochemical identification of bacteria by:
 - 11.1. Microscopic morphology
 - 11.2. Colony characteristics
 - 11.3. Biochemicals
 - 11.3.1. Carbohydrate Utilization test
 - 11.3.2. Catalase, oxidase, urease, coagulase
 - 11.3.3. Indole, citrate, MR, VP, TSIA, Nitrate Reduction
 - 11.3.4. Motility
12. Morphological, cultural, biochemical characteristics and laboratory diagnosis of:
 - 12.1. Staphylococci and Micrococci
 - 12.2. Streptococci and pneumococci
 - 12.3. Coryne bacterium diphtheria
 - 12.4. Enterobactereaceae-I (E.Coli, Klebsiella, Enterobacter)
 - 12.5. Enterobactereaceae-II (Salmonella, Shigella, Proteus)
 - 12.6. Pseudomonas
 - 12.7. Vibrio Cholerae
 - 12.8. Neisseria

- 12.9. Mycobacteria
- 12.10. Clostridia
- 12.11. Treponema pallidum

Suggested readings:

- 1. Practical Medical Microbiology by Mackie and Mac. Cartney Volume 1 and 2
- 2. Text book of Microbiology by Ananthanarayanan
- 3. Medical Microbiology by Paniker & Satish Gupte
- 4. Medical laboratory Technology vol. I, II, III by Mukherjee
- 5. District Laboratory Practice in tropical countries Vol II Microbiology by Monica Cheesbrough
- 6. Text book of Microbiology by Prescott

DMLS-203: Basics of Haematology

Rationale: The training in this subject is imparted to enable the students to carry out routine clinical laboratory investigation (blood, urine etc.). They should be able to provide technical help for selected sophisticated hematological techniques with adequate knowledge of various principles. The training in laboratory safety is also provided

- 1. Introduction to Haematology
- 2. Apparatus and Instruments: Parts, functions principles and working of compound microscope, centrifuge, water bath and cell counter
- 3. Cleaning of Glass Ware: General and volumetric apparatus cleaning
- 4. Introduction to Blood
 - 4.1. Erythropoiesis, Leucopoiesis, formation of platelets (Thrombopoiesis)
 - 4.2. Definition, composition and functions of blood
- 5. Anticoagulants: Definition and various types along with their mode of action, merits and demerits of each
- 6. Collection of Blood;
 - 6.1. Collection of blood; venous and capillary
 - 6.2. Various equipment used for collection of blood samples
- 7. Romanowsky Stains
 - 7.1. Preparation and theory
 - 7.2. Choice of slide and spreader and preparation of blood film.
 - 7.3. Characteristics of good film preparation.
- 8. Haemoglobinometry
 - 8.1. Types of Hemoglobin and its function
 - 8.2. Various methods of estimation
 - 8.3. Formation of Hemoglobin and its breakdown
- 9. Differential Leucocyte Counting: Blood Cell Morphology in Health and Disease
- 10. Preparation of Blood Smear
 - 10.1. For malarial parasite (thick and thin smear)
 - 10.2. Study of life cycle of malarial parasite and its laboratory diagnosis
- 11. Haemo-cytometry
 - 11.1. Various counting chambers (Neubauer, Burker, Fuch-Rosenthal)
 - 11.2. Methods of counting of RBC, WBC and platelets
 - 11.3. Errors involved

12. Physiological Variation in the Normal Values of Tests (HB, TLC, DLC, PCV/ESR, Platelets Etc.)
13. Routine Examination of Urine (Microscopic, Macroscopic and Chemical)

Suggested reading:

1. Text book of Medical Laboratory Technology by Paraful B. Godkar
2. Medical laboratory Technology by K.L. Mukherjee Volume-I
3. Haematology for students Practitioners by RamnikSood
4. Hand book of Medical Laboratory Technology (IInd edition) by V.H. Talib
5. Haematology (International edition) Emmanuel C. BesaHarwal Publisher
6. Practical Haematology by J.B. Dacie
7. Practical Haematology (8th edition) by Sir John
8. Clinical Haematology by Christopher A. Ludlam
9. Clinical Diagnosis & Management by Laboratory methods (20th edition) by John Bernard Henary
10. Medical Laboratory Technology Methods & Interpretation (5th edition) by RamnikSood
11. Atlas of Haematology (5th edition) by G.A. McDonald
12. A Manual of Laboratory & Diagnostic Tests (6th edition) by Frances Fischbach
13. Haematology (Patho-physiological basis for clinical practice) by Stephen M. Robinson

DMLS-204: Basics of Clinical Biochemistry

Rationale: The candidates are imparted basic training of theoretical and practical in the field of Clinical biochemistry. They are taught the technique of collection of clinical samples and their processing along with recording of data. The students will also be given the basic knowledge of chemistry and metabolism of various metabolites which are routinely estimated in different diseases so that a clear understanding of the different tests is obtained, in addition to basic training in safety measures, quality control and automation.

THEORY

1. Introduction to Biochemistry
 - 1.1. Definition
 - 1.2. Importance of bio-chemistry
 - 1.3. SI units and their use
 - 1.4. Volumetric apparatus and their calibration
2. Cleaning of Laboratory Glass Ware
 - 2.1. Cleaning and care of glass-ware
 - 2.2. Different cleaning agents (soaps detergents, chromic acid)
 - 2.3. Methods of cleaning
3. Important Instruments: Principle working and care of:
 - 3.1. Balance (Analytical, electrical/electronic)
 - 3.2. Centrifuge
 - 3.3. Colorimeter
 - 3.4. Spectrophotometer
 - 3.5. Flame photometer
4. Blood Chemistry
 - 4.1. Composition of blood and its functions
 - 4.2. Use of various anticoagulants

- 4.3. Separation of serum and plasma
- 4.4. Process of sterilizing blood collecting equipment
- 4.5. Different protein precipitation agents
- 4.6. Preparation of Protein Free Filtrate (PFF) and uses
5. Collection and Preservation of Biological Specimens:
 - 5.1. Blood - Sputum
 - 5.2. Body fluids - Stool

Suggested readings:

1. Text book of Medical Laboratory Technology by P. B. Godker
2. Medical Laboratory Technology by KL Mukherjee volume III
3. Practical Clinical Biochemistry by Harold Varley
4. Principal of Biochemistry by M. A. Siddiqi
5. Instrumental Analysis by Chatwal Anand
6. Text book of Medical Biochemistry by ChaterjeeShinde

DMLS-205: Anatomy and physiology – Practical

1. Demonstration of various parts of body
2. Demonstration of tissues of body
3. Demonstration of parts of digestive system
4. Demonstration of parts of respiratory system
5. Demonstration of parts of skin
6. Demonstration of parts of excretory system
7. Demonstration of various parts of circulatory system (Demonstration from models)
8. Examination of blood film for various blood cells from stained slides
9. Blood pressure estimation
10. Demonstration of various parts of nervous system (brain and spinal cord)(Model)
11. Structure of eye and ear (demonstration from models)
12. Demonstration of reflex action
13. Demonstration of structural differences between skeletal, smooth and cardiac muscles (permanent mounts)
14. Demonstration of various bones and joints
15. Demonstration of various parts of reproductive system (Male and female from models and charts)

Note: Demonstrations can be done with the help of models, charts and histological slides

DMLS-206 Basic of Medical Microbiology - Practical

1. Demonstration of safety rules in a microbiology laboratory
2. Preparation of cleaning agents and techniques of cleaning glassware
3. Preparation of material for sterilization in an autoclave and hot air oven
4. Sterilization by an autoclave and hot air oven
5. Sterilization by filtration
6. In-use test
7. Handling and care of different types of microscopes

8. Staining techniques: Gram's stain, Z.N stain, Albert's stain, Spore and capsule staining
9. To demonstrate the instruments used to seed culture media
10. To learn techniques for Inoculation of bacteria on culture media
11. Demonstration of motility
12. Preparation of culture media
13. Aerobic and anaerobic culture methods
14. To isolate specific bacteria from a mixture of organisms.
 - 14.1. Preparing media for different biochemical and
 - 14.2. Inoculations and incubation biochemical,
 - 14.3. Reporting bio-chemicals
15. Testing antimicrobial susceptibility of bacteria by Stoke's disc diffusion method
16. To prepare the reagent and demonstrate following biochemical tests with positive and negative control bacteria:
 - 16.1. Catalase
 - 16.2. Coagulase
 - 16.3. Indole
 - 16.4. Methyl Red (MR)
 - 16.5. VogesProskauer (VP)
 - 16.6. Urease
 - 16.7. Citrate
 - 16.8. Oxidase
 - 16.9. TSIA
 - 16.10. Nitrate reduction
 - 16.11. Carbohydrate fermentation
 - 16.12. Demonstration and motility
17. Demonstration of Morphological and Biochemical identification of bacteria
 - 17.1. Staphylococcus
 - 17.2. Streptococcus & Pneumococcus
 - 17.3. Corynebacterium
 - 17.4. Escherichia coli
 - 17.5. Klebsiella
 - 17.6. Citrobacter
 - 17.7. Enterobacter
 - 17.8. Proteus
 - 17.9. Salmonella
 - 17.10. Shigella
 - 17.11. Vibrio cholera
 - 17.12. Pseudomonas

DMLS-207: Basics of Haematology- Practical

1. Parts of microscope; its functioning and care
2. Parts of centrifuge; its functioning and care
3. Cleaning and drying of glassware
4. Preparation of various anticoagulants
5. Collection of venous and capillary blood

6. Cleaning of glass-syringes and its sterilization
7. Preparation of the stains and other reagents
8. Preparation of peripheral blood film (PBF)
9. Staining of PBF
10. Hemoglobin estimation methods (Sahli's, Oxyhaemoglobin, and Cyanmethaemoglobin)
11. Differential leukocyte count (DLC)
12. Recognition and staining of various types of blood cells (normal and abnormal)
13. Preparation of thick and thin blood smear for malarial parasite (Leishman/Giemsa/JSB)
14. RBC counting
15. WBC counting
16. Platelet counting
17. Routine Examination of urine

DMLS-208: Basics of Clinical Biochemistry - Practical

1. Cleaning of glass ware
2. Sterilization of glass ware
3. Standardization of glass ware
4. Handling and Maintenance of each instrument
5. Preparation of various anticoagulants and specimen collection bottle
6. Collection of blood
7. Separation of serum and plasma
8. Preparation of different protein precipitating agents, PFF preparation

Third Semester

DMLS-301: Applied Bacteriology, Mycology & Basic Immunology

Rationale: The candidates undergoing training in medical laboratory technology will learn the applications of bacteriology, Mycology and basics of immunology in a clinical laboratory. In addition the candidates are given training about the laboratory strategies of sample processing for lab diagnosis of various bacterial and fungal infections. The training is aimed at making the students competent to isolate and identify the causative micro-organisms from clinical samples.

1. Laboratory Diagnosis of Infectious Diseases
 - 1.1. Septicemia and bacteremia
 - 1.2. Respiratory tract infections
 - 1.3. Wound and skin infections
 - 1.4. Urinary tract infections
 - 1.5. Genital tract infections
 - 1.6. Meningitis
 - 1.7. Gastro intestinal infections
 - 1.8. Enteric fever
2. Bacteriological examination of water, milk and air
3. Nosocomial Infections
 - 3.1. Introduction
 - 3.2. Common types of Nosocomial infections
 - 3.3. Sources of infections

- 3.4. Surveillance (Bacteriological) and control of Nosocomial infections
4. General characteristics of medically important fungi
5. Culture media for fungi
 - 5.1. SDA (Saboraud's Dextrose Agar)
 - 5.2. CMA (Corn Meal Agar)
 - 5.3. RSA (Rice starch Agar)
6. Direct microscopy in Mycology
 - 6.1. KOH preparation
 - 6.2. LCB (Lactophenol Cotton Blue)
7. Cultivation of Fungi
 - 7.1. Candida
 - 7.2. Dermatophytes
 - 7.3. Penicillium
 - 7.4. Aspergillus
8. Immunity (Innate and Acquired)
9. Antigens (Definition, types and properties)
10. Antibodies (Definition, types and properties)
11. Antigen – Antibody reactions (Principles and applications of agglutination, precipitation and flocculation reactions)
12. Serological tests-I (Principles & procedure)
 - 12.1. Widal Test
 - 12.2. Rose Waller Test
 - 12.3. ASO and CRP
 - 12.4. VDRL

Suggested Readings:

1. Practical Medical Microbiology by Mackie and MacCartney Volume 1 and 2
2. Text book of Microbiology by Ananthanarayanan
3. Medical Microbiology by Paniker & Satish Gupte
4. Medical laboratory Technology vol. I ,II, III by Mukherjee
5. District Laboratory Practice in tropical countries Vol. II Microbiology by Monica Cheesbrough
6. Medical Mycology by Dr. JagdishChander

DMLS-302: Applied Haematology

Rationale: The training in this subject is imparted to enable the students to carry out routine clinical laboratory investigation (blood, urine etc.). They should be able to provide technical help for selected sophisticated hematological techniques with adequate knowledge of various principles. The training in laboratory safety is also provided.

1. Erythrocyte Sedimentation Rate (ESR)
 - 1.1. Introduction
 - 1.2. Various methods of estimation
 - 1.3. Factors on which ESR and PCV depends
 - 1.4. Interpretation
2. Various colour indices; their brief description
3. Absolute eosinophil counting

- 3.1. Introduction
- 3.2. Various methods
- 3.3. Clinical importance
4. Reticulocyte counting
 - 4.1. Introduction
 - 4.2. Various methods of counting
 - 4.3. Clinical importance
5. LE cell phenomenon
 - 5.1. Theory of formation of LE cell, its differentiation from tart cell
 - 5.2. Preparation and staining of smear and its examination
 - 5.3. Clinical importance
6. Anaemias
 - 6.1. Definition and types of anemia; factor causing anemia
 - 6.2. Plasma hemoglobin and fetal hemoglobin estimation
 - 6.3. Laboratory diagnosis of hemolytic anemia
7. Red cell fragility test
 - 7.1. Principle and setting up the test
 - 7.2. Clinical importance
8. Coagulation
 - 8.1. Theories
 - 8.2. Coagulation defects
 - 8.3. Principles and methods of Prothrombin Time (PT), Prothrombin Time Index (PTI), Prothrombin Time with Kaolin (PTTK) – Bleeding Time (BT) Clotting Time (CT), and Clot Retraction Test
9. Bone-marrow examination
 - 9.1. Structure and function of bone-marrow
 - 9.2. Collection of bone-marrow
 - 9.3. Preparation, staining and examination of bone-marrow smears
 - 9.4. Significance of bone-marrow examination
10. Leukemia's- Classification (FAB)
11. Automation in haematology
12. Quality control in haematology

Suggested reading:

1. Text book of Medical Laboratory Technology by Paraful B. Godkar
2. Medical laboratory Technology by KL Mukherjee Volume-I
3. Haematology for students Practitioners by RamnikSood
4. Hand book of Medical Laboratory Technology (IInd edition) by V.H. Talib
5. Haematology (International edition) Emmanuel C. BesaHarwal Publisher
6. Practical Haematology by J.B. Dacie
7. Practical Haematology (8th edition) by Sir John
8. Clinical Haematology by Christopher A. Ludlam
9. Clinical Diagnosis & Management by Laboratory methods (20th edition) by John Bernard Henary
10. Medical Laboratory Technology Methods & Interpretation (5th edition) by RamnikSood
11. Atlas of Haematology (5th edition) by G.A. McDonald

DMLS-303: Applied Clinical Biochemistry-I

Rationale: The candidates are imparted basic training (both theoretical and practical) in the field of clinical biochemistry. They are made to learn the technique of collection of clinical samples and their processing along with recording of data. The student will also obtain the basic knowledge of chemistry and metabolism of various metabolites which are routinely estimated in different diseases so that a clear understanding of the different tests is obtained. The students are also given basic training in safety measures, quality control and automation.

1. Blood sugar estimation and G.T.T
 - 1.1. Principle and methods of estimation
 - 1.2. Normal and abnormal values
 - 1.3. True and apparent sugar
 - 1.4. Metabolism of sugar
 - 1.5. Precautionary measures
 - 1.6. Renal threshold
 - 1.7. Importance and performance of GTT
 - 1.8. Clinical importance of blood sugar and GTT
2. Serum urea
 - 2.1. Formation and excretion of urea
 - 2.2. Principles and procedures of different methods of urea estimation
 - 2.3. Normal and abnormal levels
 - 2.4. Clinical importance
3. Plasma and serum proteins
 - 3.1. Definition
 - 3.2. Formation of plasma proteins
 - 3.3. Different methods of estimation including principles and procedures
 - 3.4. Normal and abnormal values
 - 3.5. Clinical importance
4. Serum cholesterol
 - 4.1. Formation and estimation of cholesterol
 - 4.2. Various methods of estimation including principles and procedures
 - 4.3. Normal and abnormal values
 - 4.4. Clinical importance
5. Serum bilirubin
 - 5.1. Formation and excretion of bilirubin
 - 5.2. Metabolism of bile pigments
 - 5.3. Conjugated and unconjugated bilirubin
 - 5.4. Principles and procedures of serum bilirubin estimation
 - 5.5. Normal and abnormal values
 - 5.6. Clinical importance
6. Inorganic phosphorus
 - 6.1. Principles and procedures of estimation
 - 6.2. Normal and abnormal values
 - 6.3. Clinical importance
7. Creatinine estimation

- 7.1. Principles and procedures of estimation
- 7.2. Normal and abnormal/ values
- 7.3. Clinical importance
8. Serum calcium
 - 8.1. Principles and procedures estimation
 - 8.2. Normal and abnormal values
 - 8.3. Clinical importance
9. Uric acid estimation
 - 9.1. Principles and procedures estimation
 - 9.2. Normal and abnormal values
 - 9.3. Clinical importance
10. Electrolytes and trace elements
 - 10.1. Functions of electrolytes like Na⁺, K⁺ and Cl⁻. Other essential trace elements like Ca²⁺, Fe²⁺ etc. Metabolism of these ions
 - 10.2. Principles and procedures of estimation
 - 10.3. Normal and abnormal values
11. Clinical importance of radioisotopes. Their brief description and use.
12. Quality control in clinical bio-chemistry

Suggested readings:

1. Text book of Medical Laboratory Technology by P. B. Godker
2. Medical Laboratory Technology by K.L. Mukherjee volume III
3. Practical Clinical Biochemistry by Harold Varley
4. Principal of Biochemistry by M. A. Siddiqi
5. Instrumental Analysis by ChatwalAnand
6. Text book of Medical Biochemistry by ChaterjeeShinde

DMLS-304: Histopathology

Rationale: The training is aimed at preparing the students to prepare tissue sections of various types (paraffin/frozen) and stain them. Candidates will be able to provide special stains for detailed information. Candidates should be able to display specimens for museum and help in performing autopsies.

1. Definitions, sources and types of histological specimen (Biopsy), histological preservations.
2. Labeling, fixation, properties, classification and composition of fixatives
3. Paraffin embedding, dehydration, clearing, impregnation and casting
4. Cutting of Tissue Sections Care and use of microtomes, microtome knives: honing and stropping techniques, attachment of block to block holder, trimming, section cutting, errors in sectioning and remedies, collection of sections to slide from tissue floatation bath
5. Principles and staining techniques of ;
 - 5.1. Routine - Haemotoxylin and Eosin
 - 5.2. Special
 - 5.2.1. Reticulin
 - 5.2.2. PAS

- 5.2.3. Iron
- 5.2.4. PTAH
- 5.2.5. AFB
- 5.2.6. Calcium
- 5.2.7. Fat (Lipid)
- 6. Decalcification of bones
 - 6.1. Process of decalcification and methods
 - 6.2. Reagents used for decalcification
- 7. Bone cutting without decalcification
- 8. Frozen sections
 - 8.1. Freezing microtome and cryostat- its care and uses
 - 8.2. Technique of cutting frozen section
 - 8.3. Principles of special stains used and their preparation
- 9. Preparation of museum specimen
 - 9.1. Care of Museum specimen
 - 9.2. Preparation of fixatives and mounting solutions
 - 9.3. Mounting and after care of mounted specimen
 - 9.4. Cataloguing of museum specimen
- 10. Cataloguing of slides and blocks, dispatch of reports, maintenance of records.
- 11. Autopsy
 - 11.1. Care of instruments
 - 11.2. Preparation and performance of autopsy in brief

Suggested reading:

1. An introduction to Med. Lab. Technology by F.J. Baker & R.E. Silvertown, Pb. London Butterworth and Co. Ltd.
2. Handbook of Histopathological Techniques by C.F.A Culling
3. Medical Lab. Technology by Lynch
4. Theory & Practice of Histological Techniques by Johan D Bancroft & Gamble
5. Handbook of Histopathological & Histochemical Techniques by CFA Culling

DMLS-305: Applied Bacteriology, Mycology & Basic Immunology - Practical

1. Processing and identification of pure bacterial culture
2. Processing of following clinical samples for culture and identification of pathogens:
 - 2.1. Blood
 - 2.2. Throat swab
 - 2.3. Sputum
 - 2.4. PUS.
 - 2.5. Urine
 - 2.6. Stool
 - 2.7. C.S.F. and other body fluids
3. Processing of water, milk, food and air samples for bacteriological examination
4. To prepare different culture media used in mycology
5. Staining techniques
 - 5.1. KOH Preparation
 - 5.2. LCB

- 5.3. India Ink preparation
6. To observe characteristics of common laboratory contaminants (Fungal)
7. Collection and processing of samples for diagnosis of fungal infections
 - 7.1. Skin
 - 7.2. Nail
 - 7.3. Hair
 - 7.4. Body fluids and secretions
8. To perform;
 - 8.1. Widal test
 - 8.2. VDRL test
 - 8.3. Rose Waller
 - 8.4. ASO and CRP
9. Antimicrobial susceptibility testing
10. To perform antibiotic susceptibility testing of clinical isolates by using
 - 10.1. Stokes method and
 - 10.2. Kirby-Bauer method
11. Collection, transportation and processing of water and air
12. To learn 'How to dispose of bacterial cultures

DMLS-306: Applied Haematology - Practical

1. ESR estimations (Wintrobe and Westergreen)
2. PCV (Wintrobe and capillary)
3. Absolute Eosinophil counting
4. Reticulocyte counting
5. Red cell fragility test
6. Plasma haemoglobin estimation
7. Fetal haemoglobin test
8. Examination of colorindices
9. Bleeding time and clotting time, PT, PTI, PTTK
10. Clot retraction test
11. Examination of Bone-marrow (from stained slide)
12. Demonstration of LE Cell Smear and its examination (from stained slide)
13. Recognition of various types of blast cells and leukemia (from stained slide)

DMLS-307: Applied Clinical Biochemistry-I - Practical

1. Estimation of blood Sugar (Folin-Wu method, enzyme methods etc.)
2. Performance of GTT
3. Serum Urea estimation
4. Plasma and serum protein estimation
5. Serum cholesterol estimation
6. Estimation of electrolyte level (Na⁺, K⁺ and Cl⁻ by flame photometer and kit methods)
7. Preparation all types of reagents
8. Estimation of Serum bilirubin
9. Estimation of Phosphorous
10. Estimation of Serum calcium

11. Estimation of Serum creatinine
12. Estimation of Serum uric acid

DMLS-308: Histopathology - Practical

1. Receiving specimen, labeling and cataloguing
2. Preparation of fixatives, fixing of specimen
3. Dehydrating, making solution of various reagents, clearing, impregnation and casting
4. Embedding and cutting of sections
5. Preparation of stains
6. Routine (H & E) and special staining
7. Preparation of various reagents
8. Decalcification
9. Demonstrating of cataloguing of slides blocks
10. Demonstration of dispatching reports and maintenance of records
11. Demonstration of freezing microtone
12. Examination of stained frozen section slides
13. Preparation of museum fixatives

Fourth Semester

DMLS-401: Medical Parasitology and Virology

Rationale: The candidates undergoing training medical laboratory technology are made to learn the techniques of collection of samples, their processing and identification of various parasitic and viral pathogens, using different procedures with special reference to their habitat, morphology, life cycle and their isolation for diagnostic purpose.

1. Introduction to Medical Parasitology
2. General characteristics of protozoa and helminthes
3. Collection, transport, processing and preservation of samples for routine parasitological investigations
4. Morphology, life cycle and lab-diagnosis of Giardia and Entamoeba
5. Morphology, Life cycle and lab-diagnosis of Roundworms and Hookworms
6. Morphology, life cycle and lab-diagnosis of T. solium and T. saginata
7. Morphology, life cycle and lab-diagnosis of malarial parasite with special reference to P.vivax and P. falciparum
8. Laboratory diagnosis of hydrated cyst and cysti-cercosis
9. Concentration techniques for demonstration of Ova and cysts (principles and applications)
10. Introduction to medical virology
11. Classification of viruses
12. Classification of medically important viruses (Rabies, Polio, HIV, Influenza)
13. Collection, transportation and storage of samples for viral diagnosis
14. Processing of samples for viral diagnosis (Egg inoculation and tissue culture)

Suggested Readings:

1. Practical Medical Microbiology by Mackie and MacCartney Volume 1 and 2
2. Text book of Microbiology by Ananthanarayanan
3. Medical Microbiology by Paniker & Satish Gupte
4. Medical laboratory Technology vol. I, II, III by Mukherjee
5. District Laboratory Practice in tropical countries Vol II Microbiology by Monica Cheesbrough
6. Parasitology in relation to Clinical Medicine by K.D. Chhatterjee
7. Medical Entomology by A.K. Hati Pub. Allied Book Agency

DMLS-402: Immuno-Haematology/Blood Banking

Rationale: The candidates are taught the skill of blood collection from donors and preventive measures against communicable diseases. They should be able to perform different investigations, preservation and interpretation.

1. Historical introduction to blood grouping
2. Antigen and antibodies – role in blood grouping
3. Blood collection, preservation of blood in blood bank, anticoagulants used in blood banking
4. Preparation of donor, criteria of an ideal blood donor, history of donor.
5. ABO grouping and its subgroups
6. Rh grouping
7. Cleaning and care of glassware in blood banking
8. Cross matching - major and minor cross matching, preparation of working antiglobulin, serum, principle and importance of cross matching
9. Preparation and preservation of various blood components for transfusion
10. Coomb's test - preparation of antisera, principle, types and importance of Coomb's test
11. Transfusion reactions - brief introduction
12. Screening of blood for
 - 12.1. AIDS
 - 12.2. Hepatitis
 - 12.3. Syphilis

Suggested readings:

1. Introduction to Medical Laboratory Technology – FJ Baker
2. Medical Laboratory Technology (Volume I & II) by Kanai, L Mukherjee, Swarajit Ghosh
3. Lynch's Medical Lab. Technology by Stanley S. Raphael
4. Practical Haematology by JB Dacie
5. Transfusion Science by Overfield, Hamer
6. Mollison's Blood Transfusion in Clinical Medicine, 12th Edition by Harvey G. Klein

DMLS-403: Applied Clinical Biochemistry- II

Rationale: The candidates are imparted specialized training of theory and practical in the field of clinical biochemistry. The candidates are made to learn special biochemical investigations e.g. LFT, RFT, Electrophoresis chromatography and automation in Clinical Biochemistry etc.

1. SGOT and SGPT
 - 1.1. Principles and procedures of estimation

- 1.2. Normal and abnormal values
- 1.3. Clinical importance
2. ALP and ACP (Alkaline and Acid Phosphatase)
 - 2.1. Principles and procedures of estimation Normal and abnormal values
 - 2.2. Clinical importance
3. Serum amylase
 - 3.1. Principles and procedures of estimation
 - 3.2. Normal and abnormal values
 - 3.3. Clinical importance
4. Renal Functions Test (RFT)
 - 4.1. Functions of kidney
 - 4.2. Renal clearance tests
 - 4.3. Clinical importance
5. Urine analysis
 - 5.1. Normal composition of urine and its properties
 - 5.2. Clinical importance of urine analysis
 - 5.3. Presence of abnormal constituents like protein, sugar, bile salts and bile pigments
 - 5.4. Quantitative estimation for protein and sugar
 - 5.5. Identification of sugar
 - 5.6. Detailed discussion on glycosuria and albuminuria
 - 5.7. Ketone bodies
6. Stool Chemistry
 - 6.1. Physical characteristics and chemical composition of stool
 - 6.2. Significance of presence of blood and excess fat in stool
 - 6.3. Occult blood – Detection
7. Renal calculi
 - 7.1. Formation, composition and properties of renal calculi
 - 7.2. Principle of procedure for identifying types of renal calculi
8. Cerebro-spinal fluid
 - 8.1. Composition and functions of CSF
 - 8.2. Methods of determination of sugar, chloride, and proteins in CSF
 - 8.3. Normal and abnormal levels
9. Biological fluids: Formation and composition of different biological fluids like peritoneal, pleural, synovial, ascetic fluids
10. Blood gases: Different blood gases and their functions, principles and procedure of determination of CO₂ combining power and oxygen saturation
11. Electrophoresis
 - 11.1. Theory
 - 11.2. Principle and procedure of paper, gel electrophoresis, method of elution
12. Chromatography
 - 12.1. Theory of chromatographic separation between stationary and mobile phases
 - 12.2. Different chromatographic methods like paper, column and thin layer chromatography.
 - 12.3. Method of separation
13. Automation in biochemistry

Suggested readings:

1. Practical Clinical Biochemistry by Harold Varley
2. Text book of Medical Laboratory Technology by P. B. Godker
3. Medical Laboratory Technology by Mukherjee
4. Principal of Biochemistry by M. A. Siddiqi

DMLS-404: Immunopathology and Cytopathology

Rationale: The candidates are imparted basic training of theoretical and practical in the field of Immunopathology. The candidates are made to learn the technique of collection of clinical samples and their processing along with recording of data. The student will also obtain the basic knowledge of Immunity and the cells involved, which are routinely estimated in different diseases so that a clear understanding of the different tests is obtained. The students are also given basic training in safety measures quality control and automation. In addition the training in Cytology is aimed at preparing the students for preparing exfoliate smears/sections of various types and stain them. Candidate will able to provide special stain for detailed information. Candidate should be able to collect exfoliate cytology smears, carry out routine and special staining procedures.

[A] Immunopathology

1. Cells and organs of the immune system.
2. Antigens, antibodies and humeral immune response.
3. Allergy
4. Rheumatological diseases and investigations.
5. Infection and the immune system.
6. Cancer Immunology.
7. Tissue typing for kidney transplant.

Suggested Readings:

1. Immunology by Ivan Roitt, Jonathan Brostoff and David Male
2. Medical Immunology by Daniel P Stites
3. Basic & Clinical Immunology by P. Daniel Fudenberg. H. Hugh and Stites

[B] Cytopathology

1. Exfoliative cytology
 - 1.1. Preparation of vaginal and cervical smears
 - 1.2. PAP smears and its fixation
 - 1.3. Preparation of PAP stains, cell blocks
 - 1.4. Staining techniques (PAP, H&E and Giemsa)
 - 1.5. Interpretation of results
 - 1.6. Various body fluid processing like Urine, Sputum, Fluids (Pleural, Pericardial and Peritoneal), CSF etc.
2. Aspiration Cytology principles, indications & utility of the technique with special emphasis on role of cytotechnologist in FNAC clinics
3. Barr body analysis

Suggested readings:

1. Introduction to Medical Laboratory Technology – F.J. Baker

2. Medical Laboratory Technology (Volume I & II) by Kanai, L. Mukherjee, Swarajit Ghosh
3. Lynch's Medical Lab. Technology by Stanley S. Raphael

DMLS-405: Medical Parasitology and Virology - Practical

1. Routine stool examination for detection of intestinal parasites with concentration methods:
 - 1.1. Saline preparation
 - 1.2. Iodine preparation
 - 1.3. Floatation method
 - 1.4. Centrifugation method
 - 1.5. Formal ether method
 - 1.6. Zinc sulphate method
2. Identification of adult worms from models/slides
 - 2.1. Tapeworm segments
 - 2.2. Ascaris
 - 2.3. Hookworms
 - 2.4. Pinworms
3. Malarial parasite:
 - 3.1. Preparation of thin and thick blood smears
 - 3.2. Staining of smears
 - 3.3. Examination of smears for malarial parasites (*P. vivax* and *P. falciparum*)
 - 3.4. Demonstration of various stages of life cycle of malarial parasites from stained slides
4. To demonstrate structure of viruses and their multiplication from charts etc.
5. To perform Giemsa's stain, Sella's stain.
6. Demonstration of fertilized hen egg
7. Demonstration of various inoculation routes in fertilized hen egg

DMLS-406: Immuno-Haematology/Blood Banking - Practical

1. Demonstration of equipment/material for blood collection
2. Cleaning of glassware
3. ABO and Rh grouping
4. Cross match - Major and Minor
5. Preparation of ACD and CPO anticoagulants

DMLS-407: Applied Clinical Biochemistry- II -Practical

1. Various methods employed for:
 - 1.1. Renal clearances tests
 - 1.2. SGOT estimation
 - 1.3. SGPT estimation
 - 1.4. ALP estimation
 - 1.5. ACP estimation
2. Analysis of urine for sugar and proteins (Qualitative and quantitative)
3. Occult blood test using stool specimen
4. Qualitative analysis of renal calculi
5. Estimation of sugar proteins, chlorides in CSF
6. Serum amylase estimation

7. Titration for acidity determination and qualitative analysis of gastric juice
8. Demonstration of electrophoresis and chromatography
8. Preparation of buffers strips, gels, column etc.

DMLS-408: Immunopathology and Cytopathology - Practical

1. Cell separation by density gradient
2. ELISA
3. Serum electrophoresis
4. Immuno-electrophoresis
5. Pregnancy test for HCGH
6. PAP staining and interpretation of results
7. To perform Papnicolaou's stain on cervical smear
8. To process samples using cytospin
9. To perform Guard's staining for demonstration sex chromatin (Barr bodies on a buccal smear)
10. Liquid based Cytology : Principle and Preparation

Fifth Semester

Internship:

The internship will be for a span of 6 months/ 1 semester. This will include 6 hours of practice a day, totaling to 720 hours during internship semester. As a part of this, the students will maintain a work logbook which will be duly endorsed by the supervisor or trainer. At the end of internship the candidate shall submit the work log book along with certificate from the training institute. Finally the training of candidate shall be evaluated by the internal and external examiners deputed by University/Board in the form of practical / viva examination.

The internship time period provides the students the opportunity to continue to develop confidence and increased skill in clinical delivery of services. Students will demonstrate competence in beginning and intermediate procedures. Students will observe the advanced and specialized procedures. The student will complete the clinical training by practicing all the skills learned in classroom and clinical instruction. The students are expected to work for minimum 6 hours per day and this may be more depending on the need and the healthcare setting.

Skills based outcomes and monitorable indicators for Medical Laboratory Technologists

Skills based outcomes and monitorable indicators for DMLS:

1. Demonstrate professional interpersonal, oral, and written communications skills sufficient to serve the needs of patients and the public including an awareness of how diversity may affect the communication process.
2. Perform pre-analytical, analytical, and post-analytical processes:
 - 2.1. Demonstrate ability to understand investigation/test requisition.
 - 2.2. Collecting the relevant clinical samples alongwith complete and accurate documentation with proper safety measures in relation to sample accountability.
 - 2.3. To transport the samples with precautionary measures to the relevant lab section.
 - 2.4. Demonstrate the ability to prepare clinical sample for processing.

- 2.5. To demonstrate the knowledge of accurate sample processing for the required routine lab investigation.
- 2.6. Perform routine clinical laboratory tests in Clinical chemistry, Hematology/haemostasis, Immunology, Immunopathology, Immunohaematology, Microbiology, Histopathology, Cytopathology, body fluid analysis, and laboratory operations.
- 2.7. Ability to record and report the test results/data.
3. Apply basic scientific principles in learning new techniques/procedures; demonstrate application of principles and methodologies
4. Utilize computer technology applications to interact with computerized instruments and laboratory information systems.
5. Demonstrate adequate knowledge of computer software as it applies to document production, spreadsheets, and presentations.
6. Demonstrate professional behavior with co-team mates.
7. Demonstrate sensitivity and compassion towards patients.

4.2 Bachelor's in Medical Laboratory Science (BMLS)

Bachelors in Medical Laboratory Science

Introduction

Objectives/aim of the course:

1. Proficiently perform a full range of clinical 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

Expectation from the future graduate in providing patient care:

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

1. Perform routine clinical laboratory testing.
2. Make specimen-oriented decisions 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 procedures.
5. Train students in routine 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 able to extrapolate data acquired
9. Should be able to working on automated machine

Eligibility for admission

Selection procedure

1. Candidate should have passed 10 + 2 with Biology or vocational course in MLS/MLT.
2. Minimum percentage of marks: 50% aggregate.
3. Separate entrance exam should be incorporated for these students who want to pursue allied health course.

Provision of Lateral Entry:

Students who have successfully completed DMLS and would like to pursue BMLS can directly enter into the second year or 3rd Semester, subject to availability of vacancy on merit of entrance test.

Duration of the course

Duration of the course: Total 4 Years(8 semesters or 4528 hours) with 3.5 Years didactic and practical (3808 hours) + 6 months (720 hours) internship after successful completion of all the 7 semesters of BMLS.

Medium of instruction

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

Provision of internship & project

Six months of internship should be mandatory in a Government recognized Hospital/Institution as partial fulfillment for the award of Bachelor in MLS Degree to candidates, as per government norms.

Minimum 720 hours of internship should be completed by the candidate to be awarded the degree.

Attendance

A candidate has to secure minimum-

- 1) 75% attendance in theoretical
- 2) 80% in Skills training (practical) 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. Students must attain a cumulative score of at least 50% marks in both theory and practical for each individual subject and internal assessment separately.

Model Curriculum Outline

First Semester – Foundation Course

Subject Code	Course Titles	Hours per week			Marks			CR
		L	T	P	Internal	External	Total	
BMLS-101	Introduction to National Healthcare Delivery System in India	2	-	-	15	35	50	1
BMLS-102	Basic computers and information Science	2	-	-	15	35	50	2
BMLS-103	Communication and soft skills	2	-	-	15	35	50	2
BMLS-104	Medical Terminology, Record keeping (including anatomical terms) and Orientation to Medical Laboratory Science (MLS)	2	-	-	15	35	50	2
BMLS-105	Medical Law and Ethics	2	-	-	15	35	50	2
BMLS-106	Introduction to Quality and Patient safety (including Basic emergency care and life support skills, Infection prevention and control, Biomedical waste management, Disaster management and Antibiotic resistance)	3	1	-	15	35	50	2
BMLS-107	Professionalism and values	1	-	-	15	35	50	1
BMLS-108	Environmental Science	1	-	-	15	35	50	1
BMLS-109	Principals of Management with special reference to Medical Laboratory Science (MLS) management	2	1	-	15	35	50	2
BMLS-110	Community orientation and clinical visit	1	-	-	15	35	50	1
BMLS-111	Basic computers and information Science - Practical	-	-	4	15	35	50	2
BMLS-112	Communication and soft skills – Practical	-	-	2	15	35	50	1

Subject Code	Course Titles	Hours per week			Marks			CR
		L	T	P	Internal	External	Total	
BMLS-114	Introduction to Quality and Patient safety (including Basic emergency care and life support skills, Infection prevention and control, Biomedical waste management, Disaster management and Antibiotic resistance) - Practical	-	-	4	15	35	50	2
BMLS-115	Environmental Science – Practical	-	-	2	15	35	50	1
BMLS-116	Principals of Management with special reference to Medical Laboratory Science (MLS) management-Practical	-	-	2	15	35	50	1
Total		16	2	16	240	560	800	26
Total Hours in Semester		544						

NOTE:

1. Abbreviations: L - Lecture, T - Tutorials and P – Practical
2. Considering four months per semester as working months, total contact hour hours per semester shall be 544 (Five hundred and forty four)
3. Teaching resources should be made available at every institute for all basic subjects

Second Semester

Subject Code	Course Titles	Hours per week			Marks			CR
		L	T	P	Internal	External	Total	
BMLS-202	Basic Haematology	4	-	-	30	70	100	4
BMLS-203	Basic Clinical Biochemistry	4	-	-	30	70	100	4
BMLS-204	Human Anatomy and Physiology	4	-	-	30	70	100	4
BMLS-205	General Clinical Microbiology – (Practical)	-	-	4	30	70	100	2
BMLS-206	Basic Haematology – (Practical)	-	-	4	30	70	100	2
BMLS-207	Basic Clinical Biochemistry – (Practical)	-	-	4	30	70	100	2
BMLS-208	Human Anatomy and Physiology – (Practical)	-	-	4	30	70	100	2
	Guest Lecture/Tutorial/Seminar/visit to any medical research institution or reputed clinical laboratory	-	2	-	-	-	-	2
Total		16	2	16	240	560	800	26
Total Hours in Semester		544						

NOTE:

1. Abbreviations: L - Lecture, T - Tutorials and P – Practical
2. Considering four months per semester as working months, total contact hour hours per semester shall be 544 (Five hundred and forty four)

Third Semester

Subject Code	Course Titles	Hours per week			Marks			CR
		L	T	P	Internal	External	Total	
BMLS-301	Systematic Bacteriology	4	-	-	30	70	100	4
BMLS-302	Basics of Haematological diseases	4	-	-	30	70	100	4
BMLS-303	Biochemical metabolism	4	-	-	30	70	100	4
BMLS-304	Fundamentals of Histology	4	-	-	30	70	100	4
BMLS-305	Systematic Bacteriology– (Practical)	-	-	4	30	70	100	2
BMLS-306	Basics of Hematological diseases – (Practical)	-	-	4	30	70	100	2
BMLS-307	Biochemical metabolism – (Practical)	-	-	4	30	70	100	2
BMLS-308	Fundamentals of Histology – (Practical)	-	-	4	30	70	100	2
	Guest Lecture/Tutorial/Seminar/visit to any medical research institution or reputed clinical laboratory	-	2	-	-	-	-	2
Total		16	2	16	240	560	800	26
Total Hours in Semester		544						

NOTE:

1. Abbreviations: L - Lecture, T - Tutorials and P – Practical
2. Considering four months per semester as working months, total contact hour hours per semester shall be 544 (Five hundred and forty four)

Fourth Semester

Subject Code	Course Titles	Hours per week			Marks			CR
		L	T	P	Internal	External	Total	
BMLS-401	Applied Bacteriology	4	-	-	30	70	100	4
BMLS-402	Applied Haematology – I	4	-	-	30	70	100	4
BMLS-403	Analytical Clinical Biochemistry	4	-	-	30	70	100	4
BMLS-404	Applied Histopathology – I	4	-	-	30	70	100	4
BMLS-405	Applied Bacteriology– (Practical)	-	-	4	30	70	100	2
BMLS-406	Applied Haematology - I – (Practical)	-	-	4	30	70	100	2
BMLS-407	Analytical Clinical Biochemistry – (Practical)	-	-	4	30	70	100	2
BMLS-408	Applied Histopathology - I – (Practical)	-	-	4	30	70	100	2
	Guest Lecture/Tutorial/Seminar/visit to any medical research institution or reputed clinical laboratory	-	2	-	-	-	-	2
Total		16	2	16	240	560	800	26
Total Hours in Semester		544						

NOTE:

1. Abbreviations: L - Lecture, T - Tutorials and P – Practical
2. Considering four months per semester as working months, total contact hour hours per semester shall be 544 (Five hundred and forty four)

Fifth Semester

Subject Code	Course Titles	Hours per week			Marks			CR
		L	T	P	Internal	External	Total	
BMLS-501	Immunology & Bacterial serology	4	-	-	30	70	100	4
BMLS-502	Applied Haematology – II	4	-	-	30	70	100	4
BMLS-503	Applied Clinical Biochemistry – I	4	-	-	30	70	100	4
BMLS-504	Applied Histopathology - II	4	-	-	30	70	100	4
BMLS-505	Immunology & Bacterial serology – (Practical)	-	-	4	30	70	100	2
BMLS-506	Applied Haematology - II – (Practical)	-	-	4	30	70	100	2
BMLS-507	Applied Clinical Biochemistry – I- (Practical)	-	-	4	30	70	100	2
BMLS-508	Applied Histopathology-II – (Practical)	-	-	4	30	70	100	2
	Guest Lecture/Tutorial/Seminar/visit to any medical research institution or reputed clinical laboratory	-	2	-	-	-	-	2
Total		16	2	16	240	560	800	26
Total Hours in Semester		544						

NOTE:

1. Abbreviations: L - Lecture, T - Tutorials and P – Practical
2. Considering four months per semester as working months, total contact hour hours per semester shall be 544 (Five hundred and forty four)

Sixth Semester

Subject Code	Course Titles	Hours per week			Marks			CR
		L	T	P	Internal	External	Total	
BMLS-601	Medical Parasitology & Entomology	4	-	-	30	70	100	4
BMLS-602	Advanced Haematology	4	-	-	30	70	100	4
BMLS-603	Applied Clinical Biochemistry – II	4	-	-	30	70	100	4
BMLS-604	Cytopathology	4	-	-	30	70	100	4
BMLS-605	Medical Parasitology & Entomology - (Practical)	-	-	4	30	70	100	2
BMLS-606	Advanced Haematology - (Practical)	-	-	4	30	70	100	2
BMLS-607	Applied Clinical Biochemistry – II-- (Practical)	-	-	4	30	70	100	2
BMLS-608	Cytopathology - (Practical)	-	-	4	30	70	100	2
	Guest Lecture/Tutorial/Seminar/visit to any medical research institution or reputed clinical laboratory	-	2	-	-	-	-	2
Total		16	2	16	240	560	800	26
Total Hours in Semester		544						

NOTE:

1. Abbreviations: L - Lecture, T - Tutorials and P – Practical
2. Considering four months per semester as working months, total contact hour hours per semester shall be 544 (Five hundred and forty four)

Seventh Semester

Subject Code	Course Titles	Hours per week			Marks			CR
		L	T	P	Internal	External	Total	
BMLS-701	Medical Mycology and Virology	4	-	-	30	70	100	4
BMLS-702	Blood Banking & Genetics	4	-	-	30	70	100	4
BMLS-703	Immunopathology & Molecular Biology	4	-	-	30	70	100	4
BMLS-704	Research methodology and Biostatistics	4	-	-	30	70	100	4
BMLS-705	Medical Mycology and Virology - (Practical)	-	-	4	30	70	100	2
BMLS-706	Blood Banking & Genetics- (Practical)	-	-	4	30	70	100	2
BMLS-707	Immunopathology & Molecular Biology - (Practical)	-	-	4	30	70	100	2
BMLS-708	Research methodology and Biostatistics - (Practical)	-	-	4	30	70	100	2
	Guest Lecture/Tutorial/Seminar/visit to any medical research institution or reputed clinical laboratory	-	2	-	-	-	-	2
Total		16	2	16	240	560	800	26
Total Hours in Semester		544						

NOTE:

1. Abbreviations: L - Lecture, T - Tutorials and P – Practical
2. Considering four months per semester as working months, total contact hour hours per semester shall be 544 (Five hundred and forty four)

Eighth Semester

Subject Code	Course Titles	Hours per week			Marks			CR
		L	T	P	Internal	External	Total	
BMLS-801	MLS Internship	-	-	720	50	150	200	26
Total		-	-	720	50	150	200	26

NOTE:

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

INTERNSHIP – After completion of seven semesters of Bachelor MLS the candidates shall undergo six months internship in a Government recognized hospital/Institution as partial fulfillment for the award of Bachelor in MLS as per government norms.

BMLS-101: Introduction to National Healthcare Delivery System in India

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

1. Introduction to healthcare delivery system
 - 1.1. Healthcare delivery system in India at primary, secondary and tertiary care
 - 1.2. Community participation in healthcare delivery system
 - 1.3. Health system in developed countries.
 - 1.4. Private Sector
 - 1.5. National Health Mission
 - 1.6. National Health Policy
 - 1.7. Issues in Health Care Delivery System in India
2. National Health Programme- Background objectives, action plan, targets, operations, achievements and constraints in various National Health Programme.
3. Introduction to AYUSH system of medicine
 - 3.1. Introduction to Ayurveda.
 - 3.2. Yoga and Naturopathy
 - 3.3. Unani
 - 3.4. Siddha
 - 3.5. Homeopathy
 - 3.6. Need for integration of various system of medicine
4. Health scenario of India – past, present and future, Public health – India (epidemiology and demography)
5. Demography & Vital Statistics-
 - 5.1. Demography – its concept
 - 5.2. Vital events of life & its impact on demography
 - 5.3. Significance and recording of vital statistics
 - 5.4. Census & its impact on health policy
6. Epidemiology
 - 6.1. Principles of Epidemiology
 - 6.2. Natural History of disease
 - 6.3. Methods of Epidemiological studies
 - 6.4. Epidemiology of communicable & non-communicable diseases, disease transmission, host defense immunizing agents, cold chain, immunization, disease monitoring and surveillance.

BMLS-102: Basic computers and information science

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

1. Introduction to computer: Introduction, characteristics of computer, block diagram of computer, generations of computer, computer languages.
2. Input output devices: Input devices(keyboard, point and draw devices, data scanning devices, digitizer, electronic card reader, voice recognition devices, vision-input devices), output devices(monitors, pointers, plotters, screen image projector, voice response systems).
3. Processor and memory: The Central Processing Unit (CPU), main memory.
4. Storage Devices: Sequential and direct access devices, magnetic tape, magnetic disk, optical disk, mass storage devices.
5. Introduction of windows: History, features, desktop, taskbar, icons on the desktop, operation with folder, creating shortcuts, operation with windows (opening, closing, moving, resizing, minimizing and maximizing, etc.).
6. Introduction to MS-Word: introduction, components of a word window, creating, opening and inserting files, editing a document file, page setting and formatting the text, saving the document, spell checking, printing the document file, creating and editing of table, mail merge.
7. Introduction to Excel: introduction, about worksheet, entering information, saving workbooks and formatting, printing the worksheet, creating graphs.
8. Introduction to power-point: introduction, creating and manipulating presentation, views, formatting and enhancing text, slide with graphs.
9. Introduction of Operating System: introduction, operating system concepts, types of operating system
10. Computer networks: introduction, types of network (LAN, MAN, WAN, Internet, Intranet), network topologies (star, ring, bus, mesh, tree, hybrid), components of network.
11. Internet and its Applications: definition, brief history, basic services (E-Mail, File Transfer Protocol, telnet, the World Wide Web (WWW)), www browsers, use of the internet.
12. Application of Computers in clinical settings.

Suggested Readings:

1. Information technology by Anshuman Sharma (Lakhanpal Publisher)
2. Computer Fundamentals (Concepts. Systems and applications) by P. K. Sinha (University of Tokyo, Japan) BPB Publications

BMLS-103: Communication and soft skills

Rationale: The students will be able to appreciate communication skills as these are important to everyone - they are how we give and receive information and convey our ideas and opinions with those around us.

Soft skills is a term often associated with a person's "EQ" (Emotional Intelligence Quotient), which is the cluster of personality traits that characterize one's relationships with other people. These skills can include social graces, communication abilities, language skills, personal habits, cognitive or emotional empathy, and leadership traits.

A person's soft skill EQ is an important part of their individual contribution to the success of an organization. Organizations which deal with customers face-to-face are generally more successful

if they train their staff to use these skills. Screening or training for personal habits or traits such as dependability and conscientiousness can yield significant return on investment for an organization. For this reason, soft skills are increasingly sought out by employers in addition to standard qualifications.

Topics taught in this module include:

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

Soft Skills - with important sub-elements:

1. Communication Styles
2. Team work
3. Leadership Skills
4. Effective & Excellent Customer Service
5. Decision Making & Problem Solving
6. Managing Time and Pressures
7. Self-Management & Attitude

Suggested readings:

1. Effective Communication and Soft Skills by Nitin Bhatnagar Pearson Education India, 2011
2. Communication N Soft Skills Paperback – 2014 by Niraj Kumar, Chetan Srivastava

BMLS-104: Medical Terminology, Record keeping (including anatomical terms) and Orientation to Medical Laboratory Science (MLS)

Rationale: This subject introduces the elements of medical terminology. Emphasis is placed on building familiarity with medical words through knowledge of roots, prefixes, and suffixes. Topics include: origin, word building, abbreviations and symbols, terminology related to the human anatomy, reading medical orders and reports, and terminology specific to the student's field of study. Spelling is critical and will be counted when grading tests. The students will be oriented to the role of medical laboratory professional in healthcare system, scope, purpose, career opportunities in Medical Laboratory science. They will also be introduced to healthcare system and public health in India.

Topics to be covered under the subject are as follows:

Medical Terminology, Record keeping

1. Derivation of medical terms.

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

Orientation to Medical Laboratory Science (MLS)

1. Medical Lab Science – Introduction
2. Career opportunities in MLS
3. Role of a Medical lab. professional in Health care system
4. Common laboratory associated hazards and biosafety measures including radiation hazards
5. Subject specific role of a Medical lab. professional:
6. Microbiology
 - 6.1. Role of microbes in human health
 - 6.2. Overview of the role of Medical Laboratory Professional in Medical Microbiology
 - 6.3. Bio-safety in Microbiology
7. Haematology
 - 7.1. Introduction to Haematological diseases
 - 7.2. Overview of the role of Medical lab. professional in Haematology
 - 7.3. Bio-safety in Haematology
8. Histopathology
 - 8.1. Introduction to Tumor pathology
 - 8.2. Overview of the role of Medical lab. professional in Histopathology
 - 8.3. Bio-safety in Histopathology
9. Biochemistry
 - 9.1. Introduction to metabolic disorders
 - 9.2. Overview of the role of Medical lab. professional in Clinical Biochemistry
 - 9.3. Bio-safety in Clinical Biochemistry

Suggested readings:

1. An Introduction to Medical Lab Technology by F J Baker and Silverton
2. Medical Laboratories Management- Cost effective methods by Sangeeta Sharma, Rachna Agarwal, Sujata Chaturvedi and Rajiv Thakur

BMLS-105: Medical Law and Ethics

Rationale: Legal and ethical considerations are firmly believed to be an integral part of medical practice in planning patient care. Advances in medical science, growing sophistication of the modern society's legal framework, increasing awareness of human rights and changing moral

principles of the community at large, now result in frequent occurrences of healthcare professionals being caught in dilemmas over aspects arising from daily practice.

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

1. Medical ethics - Definition - Goal - Scope
2. Introduction to Code of conduct
3. Basic principles of medical ethics – Confidentiality
4. Malpractice and negligence - Rational and irrational drug therapy
5. Autonomy and informed consent - Right of patients
6. Care of the terminally ill- Euthanasia
7. Organ transplantation
8. Medico legal aspects of medical records – Medico legal case and type- Records and document related to MLC - ownership of medical records - Confidentiality Privilege communication - Release of medical information - Unauthorized disclosure - retention of medical records - other various aspects.
9. Professional Indemnity insurance policy
10. Development of standardized protocol to avoid near miss or sentinel events
11. Obtaining an informed consent.
12. Ethics in the profession of Medical Laboratory Science

Suggested readings:

1. Medical Law and Ethics by Bonnie F Fremgen
2. Medical Law and Ethics by Jonathan Herring

BMLS-106: Introduction to Quality and Patient safety (including Basic emergency care and life support skills, Infection prevention and control, Biomedical waste management, Disaster management and Antibiotic resistance)

Rationale: The subject will introduce the students to the basic concepts of quality in health care and develop skills to implement sustainable quality assurance program in the health system. It will sensitize them in basic emergency care, infection prevention & control with knowledge of bio-medical waste management and antibiotic resistance.

1. Quality assurance and management - The objective of the subject is to help students understand the basic concepts of quality in health care and develop skills to implement sustainable quality assurance program in the health system.
 - 1.1 Concepts of Quality of Care
 - 1.2 Quality Improvement Approaches
 - 1.3 Standards and Norms

- 1.4 Quality Improvement Tools
- 1.5 Introduction to NABH guidelines

2. Basics of emergency care and life support skills – Basic life support (BLS) is the foundation for saving lives following cardiac arrest. Fundamental aspects of BLS include immediate recognition of sudden cardiac arrest (SCA) and activation of the emergency response system, early cardiopulmonary resuscitation (CPR), and rapid defibrillation with an automated external defibrillator (AED). Initial recognition and response to heart attack and stroke are also considered part of BLS. The student is also expected to learn about basic emergency care including first aid and triage. Topics to be covered under the subject are as follows:
 - 2.1 Vital signs and primary assessment
 - 2.2 Basic emergency care – first aid and triage
 - 2.3 Ventilations including use of bag-valve-masks (BVMs)
 - 2.4 Choking, rescue breathing methods
 - 2.5 One- and Two-rescuer CPR
 - 2.6 Using an AED (Automated external defibrillator).
 - 2.7 Managing an emergency including moving a patientAt the end of this topic, the students should be able to perform the maneuvers in a simulation lab and test their skills focusing on airway management and chest compressions. At the end of the foundation course, each student should be able to perform and execute/operate on the above mentioned modalities.
3. Bio medical waste management and environment safety – The aim of this section will be to help prevent harm to workers, property, the environment and the general public. Topics to be covered under the subject are as follows:
 - 3.1 Definition of Biomedical Waste
 - 3.2 Waste minimization
 - 3.3 BMW – Segregation, collection, transportation, treatment and disposal (including color coding)
 - 3.4 Liquid BMW, Radioactive waste, Metals / Chemicals / Drug waste
 - 3.5 BMW Management & methods of disinfection
 - 3.6 Modern Technology for handling BMW
 - 3.7 Use of Personal protective equipment (PPE)
 - 3.8 Monitoring & controlling of cross infection (Protective devices)
4. Infection prevention and control – The objective of this section will be to provide a broad understanding of the core subject areas of infection prevention and control and to equip AHPs with the fundamental skills required to reduce the incidence of hospital acquired infections and improve health outcomes. Concepts taught should include –
 - 4.1 Evidence-based infection control principles and practices [such as Sterilization, Disinfection, Effective hand hygiene and use of Personal Protective Equipment (PPE)],
 - 4.2 Prevention & control of common healthcare associated infections,
 - 4.3 Components of an effective infection control program, and
 - 4.4 Guidelines (NABH and JCI) for Hospital Infection Control
5. Antibiotic Resistance-
 - 5.1 History of antibiotics
 - 5.2 How resistance happens and spreads
 - 5.3 Types of resistance- intrinsic, acquired, passive
 - 5.4 Trends in drug resistance
 - 5.5 Actions to fight resistance

- 5.6 Bacterial persistence
 - 5.7 Antibiotic sensitivity
 - 5.8 Consequences of antibiotic resistance
 - 5.9 Antimicrobial Stewardship – Barriers and opportunities, tools and models in hospitals
6. Disaster preparedness and management – The objective of this section will be to provide knowledge on the principles of on-site disaster management. Concepts to be taught should include-
 - 6.1 Fundamentals of emergency management,
 - 6.2 Psychological impact management,
 - 6.3 Resource management,
 - 6.4 Preparedness and risk reduction,
 - 6.5 Key response functions (including public health, logistics and governance, recovery, rehabilitation and reconstruction), information management, incident command and institutional mechanisms.

Suggested readings:

1. The Essentials of Patient Safety by Charles Vincent
2. Laboratory quality control and patient safety by De Gruyter

BMLS-107: Professionalism and Values

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

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

Suggested Readings

1. R. R. Gaur, R. Sangal, G.P. Bagaria, 2009, a Foundation Course in Value Education.
2. E.F. Schumacher, 1973, Small is Beautiful: A study of Economics as if people mattered, Blond & Briggs, Britain.
3. A. Nagraj, 1998, Jeevan VidyaekParichay, Divya Path Sansthan, Amarkantak.
4. P.L.Dhar, R.R.Gaur, 1990, Science and Humanism, Common wealth Publishers.
5. A.N. Tripathy, 2003, Human Values, New Age International Publishers
6. E G Seebauer& Robert L. Berry, 2000, Fundamentals of Ethics for Scientists & Engineers, Oxford University Press
7. B. P. Banerjee, 2005, Foundations of Ethics and Management, Excel Books.

BMLS-108: Environmental Science

Rationale:

The student will be made aware of the environment in general, natural resources, ecosystems, environmental pollution, and social issues related to environment, human population and the environment and understanding the hospital environment.

1. Introduction: Definition and scope and importance of multidisciplinary nature of environment. Need for public awareness.
2. Natural Resources: Natural Resources and associated problems, use and over exploitation, case studies of forest resources and water resources.
3. Ecosystems: Concept of Ecosystem, Structure, interrelationship, producers, consumers and decomposers, ecological pyramids-biodiversity and importance. Hotspots of biodiversity
4. Environmental Pollution:- Definition, Causes, effects and control measures of air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards
 - 4.1 Solid waste management: Causes, effects and control measure of urban and industrial wastes. Role of an individual in prevention of pollution. Pollution case studies.
 - 4.2 Disaster management: Floods, earthquake, cyclone and landslides.
5. Social blemishes and the Environment From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, water shed management Resettlement and rehabilitation of people; its pros and concerns.
 - 5.1 Case studies. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.
 - 5.2 Case studies, Wasteland reclamation.
 - 5.3 Consumerism and waste products. Environment Protection Act, Air (Prevention and Control of Pollution) Act. Water (Prevention and control of pollution) Act. Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation Public awareness.
 - 5.4 Human Population and the Environment, Population growth, variation among nations. Population explosion–Family Welfare Programme. Environment and human health, Human Rights, Value Education, HIV/AIDS. Women and child Welfare. Role of Information Technology in Environment and human health. Case studies.
6. Understanding the Hospital Environment
7. Understanding the environment in the following clinical laboratories:
 - 7.1 Microbiology
 - 7.2 Biochemistry
 - 7.3 Histopathology
 - 7.4 Haematology
8. Clinical laboratory hazards to the environment from the following and means to prevent:
 - 8.1 Infectious material
 - 8.2 Toxic Chemicals
 - 8.3 Radioactive Material
 - 8.4 Other miscellaneous wastes

Suggested Readings

1. Agarwal, K. C. 2001 Environment Biology, Nidi Publ. Ltd. Bikaner.
2. Jadhav, H &Bhosale, V.M. 1995. Environment Protection and Laws. Himalaya Pub House, Delhi 284 p.
3. Rao M. N. &Datta A.K. 1987. Waste water treatment. Oxford & IBH Publ. Co. Pvt. Ltd. 345 p.
4. Daniel D. Chiras 2010. Environmental Science. 1st Indian Edition, Jones and Bartlett India Pvt. Ltd. 4262/3, Ansar Road, Daryaganj, New Delhi.
5. Principle of Environment Science by Cunningham, W.P.
6. Essentials of Environment Science by Joseph.
7. Environment Pollution Control Engineering By Rao, C.S.

8. Perspectives in Environmental Studies by Kaushik, A.
9. Elements of Environment Science & Eng. By Meenakshi.
10. Elements of environment Eng. by Duggal.

BMLS-109: Principals of Management with special reference to Medical Laboratory Science (MLS) Management:

The course is intended to provide knowledge about the basic principles of Management listed below, in addition to MLS management:

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

Medical Laboratory Science Management

Rationale:

The students will be made aware of the basic ethics, good lab practices including awareness/safety in a clinical lab. In addition they will understand sample accountability, quality management system, biomedical waste management, calibration and validation of clinical laboratory instruments, Laboratory Information system (LIS), Hospital Information system (HIS) and financial management.

1. Ethical Principles and standards for a clinical laboratory professional
 - 1.1 Duty to the patient
 - 1.2 Duty to colleagues and other professionals
 - 1.3 Duty to the society
2. Good Laboratory Practice (GLP) Regulations and Accreditation
 - 2.1 Introduction to Basics of GLP and Accreditation
 - 2.2 Aims of GLP and Accreditation
 - 2.3 Advantages of Accreditation
 - 2.4 Brief knowledge about National and International Agencies for clinical laboratory accreditation
3. Awareness / Safety in a clinical laboratory
 - 3.1 General safety precautions
 - 3.2 HIV: pre- and post-exposure guidelines
 - 3.3 Hepatitis B & C: pre- and post-exposure guidelines
 - 3.4 Drug Resistant Tuberculosis
4. Patient management for clinical samples collection, transportation and preservation
5. Sample accountability
 - 5.1 Purpose of accountability
 - 5.2 Methods of accountability
6. Sample analysis
 - 6.1 Introduction
 - 6.2 Factors affecting sample analysis
7. Reporting results

- 7.1 Basic format of a test report
- 7.2 Reported reference range
- 7.3 Clinical Alerts
- 7.4 Abnormal results
- 7.5 Turnaround time
- 7.6 Results from referral laboratories
- 7.7 Release of examination results
- 7.8 Alteration in reports
- 8. Quality Management system
 - 8.1 Introduction
 - 8.2 Quality assurance
 - 8.3 Quality control system
 - 8.4 Internal and External quality control
- 9. Biomedical waste management in a clinical laboratory
- 10. Introduction and importance of calibration and Validation of Clinical Laboratory instruments
- 11. Laboratory Information system (LIS), Hospital Information system (HIS) and financial Management
 - 11.1 Introduction
 - 11.2 Functions of a laboratory management system
 - 11.3 Standards for laboratory management system
 - 11.4 Introduction and awareness of financial management in a clinical laboratory
- 12. Ethics in Medical laboratory Practice
 - 12.1 Understanding the term 'Ethics'
 - 12.2 Ethics in relation to the following:
 - 12.2.1 Pre-Examination procedures
 - 12.2.2 Examination procedures
 - 12.2.3 Reporting of results
 - 12.3 Preserving medical records
 - 12.4 Access to Medical laboratory Records
- 13. Procurement of equipment and Inventory Control
 - 13.1 Audit in a Medical Laboratory
 - 13.2 Introduction and Importance
 - 13.3 Responsibility
 - 13.4 Planning
 - 13.5 Horizontal, Vertical and Test audit
 - 13.6 Frequency of audit
 - 13.7 Documentation

Suggested readings:

1. Medical Laboratories Management- Cost effective methods by Sangeeta Sharma, Rachna Agarwal, Sujata Chaturvedi and Rajiv Thakur

BMLS-110: Community Orientation and Clinical Visit

The objective of this particular section of the foundation course is to sensitize potential learners with essential knowledge; this will lay a sound foundation for their learning across the undergraduate program and across their career. Innovative teaching methods should be used to ensure the students' attention and make them more receptive, such as group activities, interactive fora, role plays and clinical bed-side demonstrations.²⁹

1. The community orientation and clinical visit will include visit to the entire chain of the healthcare delivery system – Sub centre, PHC, CHC, SDH, DH and Medical College, private hospitals, dispensaries and clinics.
2. The student will also be briefed regarding governance at village level including interaction and group discussion with village panchayat and front line health workers.
3. Clinical visit to their respective professional department within the hospital.

BMLS-111: Basic computers and Information Science-Practical

Practical on fundamentals of computers -

1. Demonstration of basic hardware of the computers and laptops
2. Learning to use MS office: MS word, MS PowerPoint, MS Excel
3. To install different software
4. Data entry efficiency

BMLS-112: Communication and Soft Skills-Practical

1. Précis writing and simple passage from a prescribed text books. Atleast 100 words should be chosen and few questions from the passage may be said to answer.
2. To practice all forms communication i.e. drafting report, agenda notes, précis writing, telegram, circular, representations, press, release, telephonic communication, practice of writing resume and writing application of employment.

BMLS-113: Medical Terminology, Record keeping (including anatomical terms) and Orientation to Medical Laboratory Science (MLS)-Practical

1. General discussion on Medical Terminology and understanding basics of various diseases.
2. Coding
3. Assembling of patient files
4. Sensitization on career opportunities and role of MLS in Hospital Care
5. Visit to working;
 - 5.1 Microbiology
 - 5.2 Haematology
 - 5.3 Biochemistry and
 - 5.4 Histopathology laboratories

BMLS-114: Introduction to Quality and Patient safety (including Basic emergency care and life support skills, Infection prevention and control, Biomedical waste management, Disaster management and Antibiotic resistance)-Practical

Quality and Patient safety:

1. Discussion on Concepts of Quality of Care
2. Approaches to Quality Improvement
3. Quality Improvement Tools
4. Discussion on NABH guidelines and its exercises

Basics of emergency care and life support skills:

1. Vital signs and primary assessment
2. Basic emergency care – first aid and triage
3. Ventilations including use of bag-valve-masks (BVMs)
4. Choking, rescue breathing methods

5. One- and Two-rescuer CPR
6. Using an AED (Automated external defibrillator).
7. Managing an emergency including moving a patient

Students should perform the maneuvers in simulation lab and to test their skills with focus on airways management and chest compressions.

Bio medical waste management and environment safety-

1. Visit to Central Sterile Supply Department (CSSD)
2. Visit to incinerator complex
3. Visit to Immunization section
4. Discussion on Biomedical Waste,
5. Demonstration of Types of waste generated from Health Care Facility
6. Discussion on waste minimization
7. Poster presentation of BMW – Segregation, collection, transportation, treatment and disposal (including color coding)
8. Discussion on Liquid BMW, Radioactive waste, Metals / Chemicals / Drug waste
9. Visit to Central Sterile Supply Department for demonstration of BMW Management & methods of disinfection
10. Modern Technology for handling BMW e.g. Incenerator, Shredder etc.
11. Demonstration of proper use of Personal protective equipment (PPE)
12. Demonstration of monitoring & controlling of cross infection (Protective devices)

Infection prevention and control:

1. Demonstration of evidence-based infection control principles and practices [such as Sterilization, Disinfection, Effective hand hygiene and use of Personal Protective Equipment (PPE)],
2. Discussion on prevention & control of common healthcare associated infections,
3. Preparing Charts & Posters of Components of an effective infection control program, and
4. Guidelines (NABH and JCI) for Hospital Infection Control

Antibiotic Resistance-

1. Discussion on various types of Antibiotics
2. Demonstration of how Resistance Happens and Spreads
3. Discussion on types of resistance- Intrinsic, Acquired, Passive
4. Antibiotic sensitivity testing
5. Display of Consequences of antibiotic resistance
6. Demonstration of Antimicrobial Barriers and opportunities, Tools and models in hospitals

Disaster preparedness and management:

1. Discussion on fundamentals of emergency management,
2. Management psychological impact
3. Discussion on;
 - 3.1 Resource management,
 - 3.2 Preparedness and risk reduction,

BMLS-115: Environmental Science-Practical

1. Any Activity related to the public awareness about the environment:
 - 1.1 Preparation of Charts/Models
 - 1.2 Visit to any effluent treatment plant

- 1.3 Seeding a plant/s and take care of it/them.
2. Preparation of models/charts in relation to natural resources of drinking water.
3. Preparation of Models of Ecosystem on biodiversity.
4. Effects of environmental pollution on humans through poster presentation.
5. Any Activity related to wild life preservation.
6. Visit to any hospital/ clinical laboratory and understanding the environment therein.
7. Any activity related biomedical waste management in a hospital or clinical laboratory

BMLS-116: Principals of Management with special reference to Medical Laboratory Science (MLS) Management: Practical

1. Clinical sample collection e.g.
 - 1.1 Blood
 - 1.2 Urine
 - 1.3 Stool
 - 1.4 Saliva
 - 1.5 Sputum
 - 1.6 Semen analysis
2. Sample accountability
 - 2.1 Labeling of sample
 - 2.2 Making entries in Laboratory records
3. Reporting results
 - 3.1 Basic format of a test report
 - 3.2 Release of examination results
 - 3.3 Alteration in reports
4. Quality Management system
 - 4.1 Quality assurance
 - 4.2 Internal and External quality control
 - 4.3 Quality improvement
5. Biomedical waste management in a clinical laboratory - Disposal of used samples, reagents and other biomedical waste
6. Calibration and Validation of Clinical Laboratory instruments
7. Ethics in medical laboratory practice in relation to the following:
 - 7.1 Pre-Examination procedures
 - 7.2 Examination procedures
 - 7.3 Reporting of results
 - 7.4 Preserving medical records
 - 7.5 Access to medical laboratory records
8. Audit in a Medical Laboratory -Documentation

Second Semester

BMLS-201: General Medical Microbiology

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

1. Introduction to Medical Microbiology:
 - 1.1 Definition

- 1.2 History
- 1.3 Host - Microbe relationship
2. Safety measures in Clinical Microbiology
3. Glassware used in Clinical Microbiology Laboratory:
 - 3.1 Introduction
 - 3.2 Care and handling of glassware
 - 3.3 Cleaning of glassware
 - 3.4 Equipment used in clinical Microbiology Laboratory:
 - 3.4.1 Introduction
 - 3.4.2 Care and maintenance including calibration
4. Microscopy
 - 4.1 Introduction and history
 - 4.2 Types, principle and operation mechanism of following microscopes
 - 4.2.1 Light microscope
 - 4.2.2 DGI
 - 4.2.3 Fluorescent
 - 4.2.4 Phase contrast
 - 4.2.5 Electron microscope: Transmission/ Scanning
5. Sterilization:
 - 5.1 Definition
 - 5.2 Types and principles of sterilization methods
 - 5.2.1 Heat (dry heat, moist heat with special Reference to autoclave)
 - 5.2.2 Radiation
 - 5.2.3 Filtration
 - 5.2.4 Efficiency testing to various sterilizers
6. Antiseptics and disinfectants:
 - 6.1 Definition.
 - 6.2 Types and properties
 - 6.3 Mode of action - Uses of various disinfectants
 - 6.4 Precautions while using the disinfectants - Qualities of a good disinfectant
 - 6.5 Testing efficiency of various disinfectants
7. Biomedical waste management in a Medical Microbiology laboratory:
 - 7.1 Types of the waste generated – Segregation – Treatment – Disposal
8. General characteristics & classification of Microbes: (Bacteria & fungi)
 - 8.1 Classification of microbes with special reference to prokaryotes & eukaryotes
 - 8.2 Morphological classification of bacteria
 - 8.3 Bacterial anatomy (Bacterial cell structures)
9. Growth and Nutrition of Microbes:
 - 9.1 General nutritional & other requirements of the bacteria
 - 9.2 Classification of bacteria on the basis of their nutritional requirements
 - 9.3 Physical conditions required for growth.
 - 9.4 Normal growth cycle of bacteria (growth curve)
 - 9.5 Types of microbial cultures: Synchronous, Static, continuous culture.
10. Culture media:
 - 10.1 Introduction
 - 10.2 Classification of culture media (Example & Uses) solid media, liquid media, semisolid, Media, routine/synthetic/defined media, basal media, enriched, enrichment, Selective differential media, sugar fermentation media, transport media, preservation media and anaerobic culture media
 - 10.3 Quality control in culture media
 - 10.4 Automation in culture media preparation

11. Aerobic & anaerobic culture methods:
 - 11.1 Concepts
 - 11.2 Methods Used for aerobic cultures
 - 11.3 Methods used for anaerobic cultures
12. Introductions to Immunology
 - 12.1 Immunity
 - 12.2 Antigens and Antibodies
13. Care & handling of laboratory animals:
 - 13.1 Introduction
 - 13.2 General care & handling
 - 13.3 Ethics & legality in use of laboratory animals

Suggested Readings

1. Practical Medical Microbiology by Mackie and McCartney
2. Text book of Microbiology by Ananthanarayan
3. Medical Microbiology by Panikar & Satish Gupte
4. Medical laboratory Technology vol. I, II, III by Mukherjee
5. District Laboratory Practice in tropical countries Vol II Microbiology by Monica Cheesbrough
6. Text book of Microbiology by Prescott

BMLS-202: Basic Haematology

Rationale: Students will be made aware of the composition of blood and methods of estimating different components of blood. Students will learn the basic concepts of Haematology & routine clinical investigations of Haematology laboratory.

1. Introduction to Haematology
 - 1.1 Definition
 - 1.2 Importance
 - 1.3 Important equipment used
2. Laboratory organization and safety measures in Haematology Laboratory
3. Introduction to blood, its composition, function and normal cellular components
4. Anticoagulants: types, mode of action and preference of anticoagulants for different hematological studies
5. Collection and preservation of blood sample for various hematological investigations
6. Formation of cellular components of blood (Haemopoiesis)
 - 6.1 Erythropoiesis
 - 6.2 Leucopoiesis
 - 6.3 Thrombopoiesis
7. Hemoglobin: definition, types, structure, synthesis and degradation
8. Morphology of normal blood cells
9. Normal Hemostasis & physiological properties of coagulation factors
10. Radioactivity: definition, half-life, physical decay and units
11. Urine analysis
12. Quality assurance in Haematology
 - 12.1 Internal and external quality control including reference preparation
 - 12.2 Routine quality assurance protocol
 - 12.3 Statistical analysis i.e. Standard deviation, Co-efficient of variation, accuracy and precision

Suggested Readings

1. Text book of Medical Laboratory Technology by Praful B. Godkar
2. Medical laboratory Technology by K.L. Mukherjee Volume-I
3. Practical Haematology by J.B. Dacie
4. Clinical Diagnosis & Management by Laboratory methods (20th edition) by John Bernard Henry
5. Atlas of Haematology (5th edition) by G.A. McDonald
6. De Gruchy's Clinical Haematology in Medical Practice

BMLS-203 Basic Clinical Biochemistry

Rationale: The main objective of the subject is to impart the knowledge of apparatus, units, equipment, and volumetric analysis in the laboratory of clinical Biochemistry.

1. Introduction to Medical lab. Technology
 - 1.1 Role of Medical lab Technologist
 - 1.2 Ethics and responsibility
 - 1.3 Safety measures
 - 1.4 First aid
2. Cleaning and care of general laboratory glass ware and equipment
 - 2.1 Steps involved in cleaning soda lime glass
 - 2.2 Steps involved in cleaning borosil glass
 - 2.3 Preparation of chromic acid solution
 - 2.4 Storage
3. Distilled water
 - 3.1 Method of preparation of distilled water
 - 3.2 Type of water distillation plants
 - 3.3 Storage of distilled water
4. Units of Measurement.
 - 4.1 S.I unit and CGS units
 - 4.2 Conversion
 - 4.3 Strength, molecular weight, equivalent weight
 - 4.4 Normality, Molarity, Molality
 - 4.5 Numerical
5. Calibration of volumetric apparatus
 - 5.1 Flask
 - 5.2 Pipettes
 - 5.3 Burettes
 - 5.4 Cylinders
6. Analytical balance
 - 6.1 Principle
 - 6.2 Working
 - 6.3 Maintenance
7. Concept of pH
 - 7.1 Definition
 - 7.2 Henderson Hassel batch equation
 - 7.3 Pka value
 - 7.4 pH indicator
 - 7.5 Methods of measurement of pH
 - 7.5.1 pH paper
 - 7.5.2 pH meter
 - 7.5.3 Principle, working, maintenance and calibration of pH meter

8. Volumetric analysis
 - 8.1 Normal and molar solutions
 - 8.2 Standard solutions
 - 8.3 Preparation of reagents
 - 8.4 Storage of chemicals
9. Osmosis
 - 9.1 Definition
 - 9.2 Types of osmosis
 - 9.3 Factors affecting osmotic pressure
 - 9.4 Vant Hoff's equation
 - 9.5 Applications of osmosis
 - 9.6 Dialysis

Suggested Readings

1. Text book of Medical Laboratory Technology by P. B. Godker
2. Medical Laboratory Technology by K.L. Mukherjee volume III
3. Practical Clinical Biochemistry by Harold Varley
4. Principal of Biochemistry by M. A. Siddiqi
5. Instrumental Analysis by Chatwal Anand
6. Text book of Medical Biochemistry by Chatterjee, Shinde
7. Principal of Biochemistry by Lehninger
8. Biochemistry by Voet&Voet
9. Biochemistry by Stryer

BMLS-204: Human Anatomy and Physiology

Rationale: Students will be able to learn the terminology of the subject and basic knowledge of cells, tissues, blood and to understand anatomy and physiology of human body. This subject will develop an understanding of the structure and function of organs and organ systems in normal human body.

1. Introduction to human Anatomy and Physiology
2. Cell and cell organelles
 - 2.1 Structure and classification
 - 2.2 Function
 - 2.3 Cell division (Mitosis and Meiosis)
3. Tissues
 - 3.1 Definition
 - 3.2 Classification with structure and Functions
 - 3.2.1 Epithelial tissues
 - 3.2.2 Connective tissues
 - 3.2.3 Muscular tissues
 - 3.2.4 Nervous tissue
4. Blood
 - 4.1 Composition
 - 4.2 Function of blood
5. Muscular skeletal system
 - 5.1 Introduction
 - 5.2 Classification
 - 5.3 Structure and function of skeletal system, muscles and joints
 - 5.4 Various movements of body

6. Respiratory system
 - 6.1 Introduction
 - 6.2 Structure
 - 6.3 Function
 - 6.4 Mechanism of breathing and respiration
 - 6.5 Various terms involved in respiratory System
 - 6.5.1 Vital capacity
 - 6.5.2 Total Volume
 - 6.5.3 Reserve volume
 - 6.5.4 Total lung capacity
7. Cardiovascular system
 - 7.1 Anatomy and physiology of heart
 - 7.2 Blood circulation
 - 7.3 Arteries and veins
 - 7.4 Conductive system of heart
 - 7.5 Cardiac cycle
 - 7.6 Introduction to ECG
8. Lymphatic system
 - 8.1 Introduction
 - 8.2 Structure and function
 - 8.2.1 Lymph nodes
 - 8.2.2 Spleen
 - 8.2.3 Thymus gland, Tonsils
9. Structure and function of sense organ
 - 9.1 Eye
 - 9.2 Ear
 - 9.3 Nose
 - 9.4 Tongue
10. Body fluids and their significance: Important terms, types of body fluid, total body water, avenues by which water leaves and enters body, general principles for fluid balance, cardinal principle, How body fluids maintain Homeostasis, Electrolytes & ions Function of electrolytes, How electrolyte imbalance leads to fluid imbalance
11. Digestive system: Organization; accessory organs; structure & function (Mouth, Tongue, Teeth, Esophagus, Pharynx, Stomach, Intestine, Rectum, Anus); Digestive glands; physiology of digestion of carbohydrates, lipids & proteins
12. Liver: structure and function
13. Urinary system: Main parts, Structure & function of kidney, structure of nephron, physiology of excretion & urine formation, urine, additional excretory organs
14. Genital system: Structure of male and female reproductive system, Gametogenesis in male & female, menstrual cycle. Placenta and extra embryonic membranes.
15. Nervous system: Parts, function & structure; brain, spinal cord, spinal & cranial nerves; all & none principle, role of neurotransmitters in transmission of nerve impulse
16. Endocrine system: Endocrine & exocrine glands, their location, structure & functions

Suggested readings:

1. Anatomy & Physiology- Ross and Wilson
2. Anatomy and Physiology: Understanding the Human Body by Clark
3. Anatomy and Physiology for nurses by Evelyn Pearce
4. Anatomy and Physiology for nurses by Sears
5. Anatomy and Physiology for nurses by Pearson
6. Anatomy and Physiology by N Murgesh

BMLS-205: General Medical Microbiology – Practical

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

BMLS-206 Basic Haematology – Practical

1. Preparation of various anticoagulants :
 - 1.1 EDTA
 - 1.2 Sodium Citrate,
 - 1.3 Oxalate with Fluoride
2. Collection of blood sample for various Lab Investigations
3. Familiarization and working of routine Haematology Lab. Instruments
 - 3.1 Microscopes
 - 3.2 Haemocytometers
 - 3.3 Colorimeter
 - 3.4 Spectrophotometer
 - 3.5 Glass pipettes & Auto pipettes
 - 3.6 Glassware
 - 3.7 Sahli's Apparatus
4. Identification of Normal blood cells
5. Urine Analysis:
 - 5.1 Routine biochemistry of Urine for:
 - 5.1.1 pH
 - 5.1.2 Specific Gravity
 - 5.1.3 Glucose
 - 5.1.4 Ketones
 - 5.1.5 Bilirubin
 - 5.1.6 Albumin
 - 5.2 Microscopic Examination of Urine

BMLS-207: Basic Clinical Biochemistry – Practical

1. Cleaning of the laboratory glass ware (Volumetric and non-volumetric)
2. Preparation of distilled water

3. Principle, working and maintenance of pH meter.
4. To prepare 0.1 N NaOH solution.
5. To prepare 0.2N HCl solution.
6. To prepare 0.1 molar H₂SO₄
7. To prepare 0.2 Molar Sodium carbonate solution.
8. Demonstration of osmosis and dialysis.

BMLS-208: Human Anatomy & Physiology – Practical

1. Demonstration of various parts of body
2. Demonstration of tissues of body
3. Demonstration of parts of digestive system
4. Demonstration of parts of respiratory system
5. Demonstration of parts of skin
6. Demonstration of parts of excretory system
7. Demonstration of various parts of circulatory system (Demonstration from models)
8. Examination of blood film for various blood cells from stained slides
9. Blood pressure estimation
10. Demonstration of various parts of nervous system (brain and spinal cord)(Model)
11. Structure of eye and ear (demonstration from models)
12. Demonstration of reflex action
13. Demonstration of structural differences between skeletal, smooth and cardiac muscles (permanent mounts)
14. Demonstration of various bones and joints
15. Demonstration of various parts of reproductive system (Male and female from models and charts)
16. To study circulatory system from charts and transverse section (TS) of artery and vein from permanent slides.
17. To study digestive system from charts and TS of liver, spleen and pancreas from permanent slides.
18. Study of Urinary system (charts)
19. Study of Genital system (male & female) from charts and TS of testis and ovary from permanent slides.
20. To study nervous system (From models / charts)
21. To study various body fluids.

Note: Demonstrations can be done with the help of models, charts and histological slides

Third Semester

BMLS-301: Systematic Bacteriology

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

1. Bacterial culture
 - 1.1 Instruments used to seed culture media
 - 1.2 Culture procedures – seeding a plate
2. Staining techniques in bacteriology
 - 2.1 Significance of staining in bacteriology

- 2.2 Principle, Reagent preparation, procedures and interpretation of the following
 - 2.2.1 Simple staining
 - 2.2.2 Negative staining
 - 2.2.3 Gram stain
 - 2.2.4 Albert's stain
 - 2.2.5 Neisser's stain
 - 2.2.6 Ziehl –Neelsen staining
 - 2.2.7 Capsule staining
 - 2.2.8 Flagella staining
 - 2.2.9 Spore staining
 - 2.2.10 Fontana stain for spirochetes
3. Principle, procedures and interpretation of the following biochemical tests for identification of different bacteria.
 - 3.1 Catalase
 - 3.2 Coagulase
 - 3.3 Indole
 - 3.4 Methyl Red
 - 3.5 VogesProskauer
 - 3.6 Urease
 - 3.7 Citrate
 - 3.8 Oxidase
 - 3.9 TSIA
 - 3.10 Nitrate reduction
 - 3.11 Carbohydrate fermentation
 - 3.12 Huger and Leifson
 - 3.13 Bile solubility
 - 3.14 H₂S production
 - 3.15 Demonstration of motility
 - 3.16 Decarboxylases
 - 3.17 CAMP
 - 3.18 Hippurate hydrolysis
 - 3.19 Nagler's reaction
 - 3.20 Cholera-red reaction
4. Definition, Classification, Various characteristics (morphological, cultural and biochemical), pathogenesis and laboratory diagnosis of the following bacteria
 - 4.1 Staphylococcus
 - 4.2 Streptococcus
 - 4.3 Pneumococcus
 - 4.4 Neisseria gonorrhoea and Neisseria meningitidis
 - 4.5 Haemophilis
 - 4.6 Corynebacterium
 - 4.7 Enterobacteriaceae: Escherichia coli, Klebsiella, Citrobacter, Enterobacter, Proteus, Salmonella, Shigella, Yersinia enterocolitica and Yersinia pestis
 - 4.8 Vibrio, Aeromonas and Plesiomonas
 - 4.9 Clostridia of wound infection
 - 4.10 Mycobacterium tuberculosis complex, Atypical Mycobacteria and M. leprae
 - 4.11 Spirochetes – Treponema, Borrelia and leptospira
 - 4.12 Bordetella and brucella
 - 4.13 Mycoplasma and Ureaplasma
 - 4.14 Rickettsia
 - 4.15 Chlamydia

- 4.16 Actinomyces
- 4.17 Pseudomonas and Burkholderia
- 4.18 Brief introduction about non sporing anaerobic cocci and bacilli

Suggested Readings:

1. Practical Medical Microbiology by Mackie & McCartney Volume 1 and 2
2. Text book of Microbiology by Ananthanarayanan
3. Medical Microbiology by Paniker & Satish Gupte
4. Medical laboratory Technology Vol. I, II, III by Mukherjee

BMLS-302: Basics of Hematological Diseases

Rationale: The students will be made aware of various diseases like anemia, quantitative disorders of Leucocytes, morphological alterations in blood cells, bleeding disorders.

1. Anemia
 - 1.1 Introduction
 - 1.2 Classification
 - 1.2.1 Microcytic hypochromic anemia
 - 1.2.2 Macrocytic anemia
 - 1.2.3 Normocytic normochromic anemia
2. Quantitative disorders of Leukocytes Cause and significance
 - 2.1 Granulocytic and Monocytic Disorders
 - 2.2 Lymphocytic Disorders
3. Morphologic Alterations in Neutrophils
 - 3.1 Toxic granulation
 - 3.2 Cytoplasmic vacuoles
 - 3.3 Döhle bodies
 - 3.4 May–Hegglin anomaly
 - 3.5 Alder–Reilly anomaly
 - 3.6 Pelger–Huët anomaly
 - 3.7 Chédiak–Higashi syndrome
4. Bleeding disorders
 - 4.1 Introduction Causes of bleeding disorders
 - 4.2 Vascular defect
 - 4.2.1 Platelet defect
 - 4.2.2 Factor deficiency
 - 4.2.3 Inhibitors
 - 4.2.4 Hyper fibrinolysis
 - 4.3 Types of bleeding disorders
 - 4.3.1 Inherited bleeding disorders
 - 4.3.2 Acquired bleeding disorders
5. Thrombosis
 - 5.1 Introduction
 - 5.2 Causes of thrombosis
6. Monitoring of Anticoagulants
 - 6.1 Oral anticoagulants by INR
 - 6.2 Heparin

Suggested Readings

1. Textbook of Medical Laboratory Technology by Praful B. Godkar

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

BMLS-303: Biochemical Metabolism

Rationale: This subject shall give information about all the major metabolic pathways occurring in our body. The students will learn the details about metabolism of carbohydrates, proteins, lipids, nucleic acids, enzymes & the deficiency diseases related to them.

1. Carbohydrate Metabolism
 - 1.1 Introduction, Importance and Classification
 - 1.2 Digestion and Absorption
 - 1.3 Metabolism: - Glycolysis, Citric acid cycle, Gluconeogenesis, Glycogenolysis, Glycogenesis
 - 1.4 Disorders of carbohydrate metabolism.
2. Protein Metabolism
 - 2.1 Introduction, Importance and classification
 - 2.2 Important properties of proteins
 - 2.3 Digestion & absorption of Proteins
 - 2.4 Protein synthesis
 - 2.5 Metabolism of proteins
 - 2.6 Disorders of protein metabolism and Urea Cycle
3. Lipid
 - 3.1 Introduction & Classification
 - 3.2 Digestion & absorption of fats
 - 3.3 Lipoproteins
 - 3.4 Fatty acid biosynthesis & fatty acid oxidation
4. Nucleic Acid
 - 4.1 Introduction
 - 4.2 Functions of Nucleic acid
 - 4.3 Functions of energy carriers
5. Enzymes
 - 5.1 Introductions, Importance & Classifications
 - 5.2 Properties of enzymes
 - 5.3 Mechanism of enzyme action
 - 5.4 Factors affecting enzyme action
 - 5.5 Enzyme kinetics & enzyme inhibitors

Suggested Readings

1. Practical Clinical Biochemistry by Harold Varley
2. Text book of Medical Laboratory Technology by P. B. Godker
3. Medical Laboratory Technology by Mukherjee
4. Principal of Biochemistry by M. A. Siddiqi
5. Instrumental Analysis by Chatwal Anand
6. Text book of Medical Biochemistry by Chatterjee, Shinde
7. Principal of Biochemistry by Lehninger

8. Biochemistry by Voet&Voet
9. Biochemistry by Stryer

BMLS-304: Fundamentals of Histology

Rationale: The student will study diseases associated with different body organs and systems.

Topics include:

1. Alimentary System: Diseases of mouth, Diseases of Esophagus- Esophageal varices.
2. Digestive System: Gastritis, Peptic ulceration, Appendicitis microbial diseases, food poisoning, hernia, Intestinal obstructions & mal absorption.
3. Accessory Digestive glands: Salivary glands- mumps
 - 3.1 Liver – hepatitis, liver failure, cirrhosis.
 - 3.2 Pancreas- pancreatitis.
 - 3.3 Gall Bladder- Gall stones, jaundice and cardiovascular diseases.
4. Circulatory System: Diseases of Blood vessels- Atheroma, Arteriosclerosis, heart block. Disorders of Blood Pressure-Hyper & Hypotension.
5. Respiratory System: Upper respiratory tract infection, Bronchi, Asthma, Pneumonia, Lung abscess, Tuberculosis, Lung Collapse.
6. Urinary System: Glomerulonephritis, Nephrotic syndrome, renal failure, renal calculi, Urinary obstruction, Urinary tract infection.
7. Reproductive system: Sexually transmitted diseases, Pelvic inflammatory disease, disorder of cervix (CIN), Disease of ovaries, ectopic pregnancy, prostatitis, Infertility
8. Nervous System: Neuronal damage, ICP, Cerebral Infarction, head injury, Alzheimer’s disease, dementia.
9. Endocrine System:
 - 9.1 Pituitary: Hyper & Hypo secretions
 - 9.2 Thyroid: Goiter
 - 9.3 Adrenal: Cushing Syndrome, Addison Disease
 - 9.4 Pancreas: Diabetes
10. Sense Organs:
 - 10.1 Ear: Otitis
 - 10.2 Eye: Cataract

Suggested readings

1. Anatomy & Physiology – Ross and Wilson
2. Human Anatomy and Physiology by Pearce
3. Di Fiore’s Atlas of Histology
4. Medical Laboratory Technology by KL Mukherjee-Volume III
5. Text book of Pathology by Robbins

BMLS-305: Systematic Bacteriology – Practical

1. To demonstrate the instruments used to seed culture media
2. To learn techniques for Inoculation of bacteria on culture media
3. To isolate specific bacteria from a mixture of organisms.
4. To demonstrate simple staining (Methylene blue)
5. To prepare India ink preparation to demonstrate negative staining.
6. Bacterial identification: To demonstrate reagent preparation, procedure and interpretation for
 - 6.1 Gram stain

- 6.2 Albert stain
- 6.3 Neisser's staining
- 6.4 Z-N staining
- 6.5 Capsule staining
- 6.6 Demonstration of flagella by staining methods
- 6.7 Spore staining
- 6.8 To demonstrate spirochetes by Fontana staining procedure
- 7. To prepare the reagent and demonstrate following biochemical tests with positive and negative control bacteria:
 - 7.1 Catalase
 - 7.2 Coagulase
 - 7.3 Indole
 - 7.4 Methyl Red (MR)
 - 7.5 VogesProskauer (VP)
 - 7.6 Urease
 - 7.7 Citrate
 - 7.8 Oxidase
 - 7.9 TSIA
 - 7.10 Nitrate reduction
 - 7.11 Carbohydrate fermentation
 - 7.12 Huger and Leifson
 - 7.13 Bile solubility
 - 7.14 H₂S production
 - 7.15 Demonstration and motility
 - 7.16 Decarboxylases
 - 7.17 CAMP
 - 7.18 Hippurate hydrolysis
 - 7.19 Nagler's reaction
- 8. To demonstrate various characteristics (morphological, cultural and biochemical) of bacteria commonly isolated from clinical samples i.e.
 - 8.1 Staphylococcus
 - 8.2 Streptococcus
 - 8.3 Corynebacterium
 - 8.4 Escherichia coli
 - 8.5 Klebsiella
 - 8.6 Citrobacter
 - 8.7 Enterobacter
 - 8.8 Proteus
 - 8.9 Salmonella
 - 8.10 Shigella
 - 8.11 Vibrio cholera
 - 8.12 Mycobacterium tuberculosis
 - 8.13 Pseudomonas

BMLS-306: Basics of Haematological Diseases – Practical

1. Parts of microscope; its functioning and care
2. Parts of centrifuge; its functioning and care
3. Cleaning and drying of glassware
4. Preparation of various anticoagulants
5. Collection of venous and capillary blood
6. Cleaning of glass-syringes and its sterilization

7. Preparation of the stains and other reagents
8. Preparation of peripheral blood film (PBF)
9. Staining of PBF
10. Haemoglobin estimation methods (Sahli's, Oxyhaemoglobin, and cyanmethaemoglobin)
11. Differential leukocyte count (DLC)
12. Recognition and staining of various types of blood cells (normal and abnormal)
13. Preparation of thick and thin blood smear for malarial parasite (Leishman/Giemsa/JSB)
14. RBC counting
15. WBC counting
16. Platelet counting
17. Routine Examination of urine

BMLS-307: Biochemical Metabolism – Practical

1. To determine the presence of carbohydrates by Molisch test.
2. To determine the presence of reducing sugar by Fehling solutions
3. To determine the presence of reducing sugar by Benedicts method.
4. To determine starch by Iodine test.
5. Determination of Glucose in serum & plasma
6. Estimates of blood Glucose by Folin& Wu method
7. Determination of Urea in serum, plasma & urine.
8. Determination of Creatinine in serum or plasma
9. Determination of serum Albumin
10. Determination of Cholesterol in serum or plasma

BMLS-308 Fundamentals of Histology – Practical

1. To study squamous cell from cheek cells (Buccal mucosa)
2. To study stained slide preparation from organs of digestive system
3. Study of stained slides of liver, pancreas, gall bladder
4. Study of various types of microscope and draw diagram in practical notebook
5. To study stained slide preparation from organs of circulatory system
6. To study stained slide preparation from organs of Respiratory system
7. To study stained slide preparation from organs of Nervous system
8. To study stained slide preparation from organs of Urinary system
9. To study stained slide preparation from organs of Endocrine system

Fourth Semester

BMLS-401 Applied Bacteriology

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

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

- 1.2 Upper Respiratory tract infections
- 1.3 Lower respiratory tract infections
- 1.4 Wound, skin, and deep sepsis
- 1.5 Urinary tract infections
- 1.6 Genital Tract infections
- 1.7 Meningitis
- 1.8 Gastro intestinal infections
- 1.9 Enteric fever
- 1.10 Tuberculosis (Pulmonary and Extra-pulmonary)
- 1.11 Pyrexia of unknown origin
2. Antibiotic susceptibility testing in bacteriology
 - 2.1 Definition of antibiotics
 - 2.2 Culture medium used for Antibiotic susceptibility testing
 - 2.3 Preparation and standardization of inoculum
 - 2.4 Control bacterial strains
 - 2.5 Choice of antibiotics
 - 2.6 MIC and MBC: Concepts and methods for determination
 - 2.7 Various methods of Antibiotic susceptibility testing with special reference to Stokes and Kirby-Bauer method
3. Basics of Nucleic acid techniques in diagnostic microbiology with special reference to Polymerase chain reaction (PCR)
4. Automation in bacterial culture detection and antimicrobial susceptibility testing: Principles and importance.
5. Bacteriological examination of water, milk, food and air
 - 5.1 Examination of water
 - 5.1.1 Collection and transportation of water sample
 - 5.1.2 Presumptive coliform count
 - 5.1.3 Eijkman test
 - 5.1.4 Introduction and importance of other bacteria considered as indicators of fecal contamination
 - 5.1.5 Membrane filtration tests
 - 5.1.6 Interpretation of results
 - 5.2 Examination of Milk and milk products
 - 5.2.1 Basic Concepts regarding gradation of milk
 - 5.2.2 Various tests for Bacteriological examination of milk
 - 5.3 Examination of food articles
 - 5.3.1 Basic Concepts regarding classification of food like frozen food, canned food, raw food, cooked food etc.
 - 5.3.2 Various tests for Bacteriological examination with special reference to food poisoning bacteria
 - 5.4 Examination of Air
 - 5.4.1 Significance of air bacteriology in healthcare facilities
 - 5.4.2 Settle plate method
 - 5.4.3 Types of air sampling instruments
 - 5.4.4 Collection processing and reporting of an air sample
6. Sterility testing of I/v fluids
 - 6.1 Collection, transportation and processing of I/v fluids for bacterial contamination
 - 6.2 Recording the result and interpretation
7. Nosocomial Infection:
 - 7.1 Introduction, sources and types of nosocomial infections.
 - 7.2 Surveillance of hospital environment for microbial load.

- 7.3 Role of microbiology laboratory in control of nosocomial infections
- 8. Epidemiological markers:
 - 8.1 Introduction
 - 8.2 Types
 - 8.3 Serotyping
 - 8.4 Phage typing and
 - 8.5 Bacteriocin typing
- 9. Preservation methods for microbes
 - 9.1 Basic concepts of preservation of microbes
 - 9.2 Why do we need to preserve bacteria?
 - 9.3 Principle and procedures of various short term and long term preservation methods with special reference to Lyophilization

Suggested Readings:

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

BMLS-402: Applied Haematology-I

Rationale: The students will be made aware of the methods of estimating different components of blood. Students will learn the basic concepts of staining and coagulation in Haematology laboratory.

1. Haemoglobinometry: Different methods to measure Haemoglobin with merits and demerits
2. Haemocytometry: Introduction, Principle, Reagent preparation, procedure, errors involved and means to minimize errors.
 - 2.1 RBC Count,
 - 2.2 Total leucocytes count (TLC)
 - 2.3 Platelet Count.
 - 2.4 Absolute Eosinophil count
3. Principle mechanism and different methods with merit and demerits for the measuring Erythrocyte Sedimentation Rate (ESR) and its significance
4. Different methods with merit and demerits for packed cell volume/Haematocrit value
5. Preparation of blood films
 - 5.1 Types, Methods of preparation (Thick and thin smear/film) and utility
6. Staining techniques in Haematology (Romanowsky's stains): Principle, composition, preparation of staining reagents and procedure of the following
 - 6.1 Giemsa's stain
 - 6.2 Leishman's stain
 - 6.3 Wright's stain
 - 6.4 Field's stain
 - 6.5 JSB stain.
7. Differential leucocytes count (DLC)

8. Normal and absolute values in Haematology
9. Physiological variations in Hb, PCV, TLC and Platelets
10. Macroscopic and microscopic examination of seminal fluid
11. Examination of CSF and other body fluids for cytology i.e. pleural, peritoneal and synovial fluid etc.
12. Preparation of Reagents for coagulation studies:
 - 12.1 M/40 Calcium chloride
 - 12.2 Brain Thromboplastin
 - 12.3 Cephalin
 - 12.4 Adsorbed Plasma
13. Screening Tests for coagulation Studies and their significance

Suggested Readings:

1. Textbook of Medical Laboratory Technology by Praful B. Godkar
2. Medical Laboratory Technology by K.L. Mukherjee Volume-I
3. Practical Haematology by J.B. Dacie
4. Clinical Diagnosis & Management by Laboratory methods (20th edition) by John Bernard Henry
5. Atlas of Haematology by G.A. McDonald
6. De Gruy's Clinical Haematology in medical practice

BMLS-403: Analytical Clinical Biochemistry

Rationale

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

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

4. Electrophoresis:
 - 4.1 Introduction
 - 4.2 Principle
 - 4.2.1 Instrumentation
 - 4.2.2 Applications
 - 4.3 Types of electrophoresis
 - 4.3.1 Paper electrophoresis
 - 4.3.2 Gel electrophoresis

Suggested readings

1. Practical Clinical Biochemistry by Harold Varley
2. Text book of Medical Laboratory Technology by P. B. Godker
3. Medical Laboratory Technology by Mukherjee
4. Principal of Biochemistry by M. A. Siddiqi
5. Instrumental Analysis by Chatwal Anand
6. Text book of Medical Biochemistry by Chatterjee, Shinde
7. Principal of Biochemistry by Lehninger
8. Biochemistry by Voet&Voet
9. Biochemistry by Stryer

BMLS-404: Applied Histopathology-I

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

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

- 10.3 Processors
- 10.4 Embedding:
 - 10.4.1 Definition
 - 10.4.2 Various types of embedding media
- 11. Section Cutting
 - 11.1 Introduction regarding equipment used for sectioning
 - 11.2 Microtome Knives, Sharpening of Microtome Knives, Honing, Stropping, various types of microtome and their applications
 - 11.3 Freezing Microtome and various types of Cryostats.
 - 11.4 Faults in paraffin section cutting with reason and remedy, spreading the sections and attachment or mounting of sections to glass slides.
- 12. Staining, Impregnation and Mountants
 - 12.1 Theory of Staining, Classifications of Dyes, Principles of Dye Chemistry
 - 12.2 Stains and Dyes and their uses
 - 12.3 Types of Stains, Chemical Staining Action, Mordants and Accentuators, Metachromasia
 - 12.4 Use of Controls in Staining Procedures
 - 12.5 Preparation of Stains, solvents, aniline water and buffers etc.
 - 12.6 Commonly used mountants in histotechnology lab
 - 12.7 General Staining Procedures for Paraffin Infiltrated and Embedded tissue
 - 12.8 Nuclear Stains and Cytoplasmic stains
 - 12.9 Equipment and Procedure for manual Staining and Automatic Staining Technique
 - 12.10 Mounting of Cover Slips, Labeling and Cataloguing the Slides
- 13. Routine Staining Procedures
 - 13.1 Haematoxylin and Eosin Staining, various types of Haematoxylin 13.2 Mallory's Phosphotungstic Acid Haematoxylin (PTAH)

Suggested Readings

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

BMLS-405: Applied Clinical Bacteriology – Practical

1. Inoculation of different culture media
2. Isolation of pure cultures
3. Processing of following clinical samples for culture and identification of bacterial pathogens:
 - 3.1 Blood
 - 3.2 Throat swab
 - 3.3 Sputum
 - 3.4 Pus
 - 3.5 Urine
 - 3.6 Stool for Salmonella, Shigella and Vibrio cholerae
 - 3.7 C.S.F. and other body fluids
4. Demonstration of PCR
5. Demonstration of automation in bacterial culture detection and antimicrobial susceptibility testing
6. Antimicrobial susceptibility testing
 - 6.1 Introduction and terms used

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

BMLS-406: Applied Haematology-I – Practical

1. Hb Estimation
 - 1.1 Sahli's method
 - 1.2 Cyanmethaemoglobin method
 - 1.3 Oxyhaemoglobin method
2. Total leukocyte count
3. Platelet count
4. Absolute Eosinophil count
5. Preparation of smear and staining with Giemsa and Leishman stain.
6. ESR (Wintrobe and Westergren method)
7. Packed cell volume (Macro & Micro)
8. Cytological examination of CSF and other body fluids
9. Physical and Microscopic examination of seminal fluid including sperm count
10. Perform normal DLC
11. Preparation of M/40 Calcium chloride
 - 11.1 Brain thromboplastin and standardization
 - 11.2 Cephalin
 - 11.3 Adsorbed plasma
12. Perform BT, CT, Hess test, PT and APTT

BMLS-407: Analytical Clinical Biochemistry- Practical

1. To demonstrate the principle, working & maintenance of spectrophotometer.
2. To demonstrate the principle, working & maintenance of colorimeter.
3. To demonstrate the principle, working & maintenance of flame photometer.
4. To demonstrate the principle, procedure of paper chromatography.
5. To demonstrate the principle & procedure of Gas chromatography.
6. To demonstrate the principle & demonstration of TLC.
7. To demonstrate the principle & procedure of column chromatography.
8. To demonstrate the principle & procedure of Electrophoresis.

BMLS-408: Applied Histopathology-I - Practical

1. Demonstration of instruments used for dissection
2. Use of antiseptics, disinfectants and insecticides in a tissue culture processing laboratory

3. Reception and labeling of histological specimens
4. Preparation of various fixatives
 - 4.1 Helly's fluid
 - 4.2 Zenker's fluid
 - 4.3 Bouin's fluid
 - 4.4 Corney's fluid
 - 4.5 10% Neutral formalin
 - 4.6 Formal saline
 - 4.7 Formal acetic acid
 - 4.8 Pereyn's fluid
5. Testing of melting point of paraffin wax and perform embedding of given tissue in paraffin block
6. To process a bone for decalcification
7. To prepare ascending and descending grades of alcohol from absolute alcohol
8. Processing of tissue by manual and automated processor method
9. To demonstrate various part and types of microtome
10. To learn sharpening of microtome knife (Honing and stropping technique), and types of disposable blades in use (High and Low Profile).
11. To perform section cutting (Rough and Fine)
12. To practice attachment of tissue sections to glass slides
13. To learn using tissue floatation bath and drying of sections in oven (60-65C)
14. To perform & practice the Haematoxylin and Eosin staining technique
15. To perform & practice the Mallory's Phospho tungstic Acid Haematoxylin (PTAH)
16. To learn mounting of stained smears

Fifth Semester

BMLS-501: Immunology and Bacterial Serology

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

1. History and introduction to immunology
2. Immunity
 - 2.1 Innate
 - 2.2 Acquired immunity
 - 2.3 Basic concepts about their mechanisms
3. Definition, types of antigens and determinants of antigenicity
4. Definition, types, structure and properties of immunoglobulin
5. Antigen-Antibody reactions
 - 5.1 Definition
 - 5.2 Classification
 - 5.3 General features and mechanisms
 - 5.4 Applications of various antigen antibody reactions
6. Principle, procedure and applications of under mentioned in Medical Microbiology:
 - 6.1 Complement fixation test
 - 6.2 Immuno- fluorescence
 - 6.3 ELISA
 - 6.4 SDS-PAGE
 - 6.5 Western blotting
7. Principle, procedure and interpretation of various serological tests:

- 7.1 Widal
- 7.2 VDRL
- 7.3 ASO
- 7.4 CRP
- 7.5 Brucella tube agglutination
- 7.6 Rose-Waaler
- 8. Complement system:
 - 8.1 Definition
 - 8.2 Basic concepts about its components
 - 8.3 Complement activation pathways
- 9. Immune response:
 - 9.1 Introduction
 - 9.2 Basic concepts of Humoral and Cellular immune responses
- 10. Hypersensitivity:
 - 10.1 Definition
 - 10.2 Types of hypersensitivity reactions
- 11. Basic concepts of autoimmunity and brief knowledge about autoimmune diseases
- 12. Automation in diagnostic serology
- 13. Vaccines:
 - 13.1 Definition
 - 13.2 Types
 - 13.3 Vaccination schedule
 - 13.4 Brief knowledge about 'Extended programme of immunization' (EPI) in India

Suggested Readings:

1. Practical Medical Microbiology by Mackie & McCartney Volume 1 and 2
2. Text book of Microbiology by Ananthanarayanan
3. Medical Microbiology by Paniker & Satish Gupte
4. Medical laboratory Technology Vol. I, II, III by Mukherjee
5. Medical Laboratory manual for tropical countries Vol II Microbiology by Monica Cheesbrough
6. Immunology by Riot
7. Basic & Clinical Immunology by P. Daniel Fudenberg. H. Hugh and Stites

BMLS-502: Applied Haematology-II

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

1. Safety precautions in Haematology
2. Basic concepts of automation in Haematology with special reference to:
 - 2.1 Blood cell counter
 - 2.2 Coagulometer
3. Bone marrow examination
 - 3.1 Composition and functions
 - 3.2 Aspiration of bone marrow (Adults and children)
 - 3.3 Processing of aspirated bone marrow (Preparation & staining of smear)

- 3.4 Brief knowledge about examination of aspirated bone marrow (differential cell counts and cellular ratios)
- 3.5 Processing and staining of trephine biopsy specimens
4. Red cell anomalies
 - 4.1 Morphological changes such as variation in size shape & staining character.
5. Reticulocytes: Definition, different methods to count, Absolute reticulocyte count and IRF (Immature reticulocyte fraction) and significance of reticulocytes.
6. Lupus Erythematosus (L.E) cell phenomenon.
 - 6.1 Definition of L.E. cell.
 - 6.2 Demonstration of L.E. cell by various methods.
 - 6.3 Clinical significance.
7. Correction studies for Factor deficiency
8. Quantitative assay of coagulation factors
 - 8.1 Principle
 - 8.2 Procedure
9. Screening of inhibitors
 - 9.1 Inhibitors against coagulation factors
 - 9.2 APLA
10. Karyotyping: Chromosomal studies in hematological disorders (PBLC and Bone marrow)
11. Cyto-chemical staining: Principles, method and significance
12. Biomedical waste management in Haematology laboratory (Other than Radioactive material)

Suggested Readings

1. Text book of Medical Laboratory Technology by Paraful B. Godkar
2. Medical laboratory Technology by KL Mukherjee Volume-I
3. Practical Haematology by JB Dacie
4. Clinical Diagnosis & Management by Laboratory methods (20th edition) by John Bernard Henary
5. Atlas of Haematology (5th edition) by G.A. McDonald
6. De Gruchy's clinical Haematology in medical practice

BMLS-503: Applied Clinical Biochemistry–I

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

1. Hazards & safety measures in clinical Biochemistry laboratory
2. Quality control and quality assurance in a clinical biochemistry laboratory
3. Laboratory organization, management and maintenance of records
4. Principles of assay procedures, Normal range in blood, Serum, Plasma and Urine and reference values for:
 - 4.1 Glucose
 - 4.2 Proteins
 - 4.3 Urea
 - 4.4 Uric acid
 - 4.5 Creatinine
 - 4.6 Bilirubin
 - 4.7 Lipids
5. Principles, procedures for estimation & assessment of the following including errors involved and their corrections

- 5.1 Sodium, Potassium and Chloride, Iodine
- 5.2 Calcium, Phosphorous and Phosphates
6. Instruments for detection of Radioactivity
7. Applications of Radioisotopes in clinical biochemistry.
8. Enzyme linked immune sorbent assay

Suggested Readings

1. Text book of Medical Laboratory Technology by P.B. Godkar.
2. Medical Laboratory Science, Theory & Practical by A. Kolhatkar.
3. Practical Clinical Biochemistry by Harold Varley.
4. Biochemistry, U. Satyanarayan& U. Chakrapani.
5. Text book of Medical Biochemistry by Chatterjee&Shinde.
6. Principal of Biochemistry by Lehninger
7. Biochemistry by Voet&Voet
8. Biochemistry by Stryer

BMLS-504: Applied Histopathology-II

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

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

Suggested Readings

1. Handbook of Histopathological Techniques by C F A Culling
2. Medical Lab technology by Lynch
3. An Introduction to Medical Lab Technology by F J Baker and Silverton

4. Bancroft's Theory and Practice of Histopathological Techniques by John D Bancroft

BMLS-505: Immunology and Bacterial Serology – Practical

1. Collection of blood sample by vein puncture, separation and preservation of serum
2. Performing Haemolysin titration for Rose-Waaler test
3. Preparation of Phosphate buffers, Verinol buffer, ASO buffer, Richardson's buffer, Buffers of different pH and Molarity, Tris buffer, Standardization of cell concentration by Spectrophotometer
4. Performance of Serological tests i.e.
 - 4.1 Widal,
 - 4.2 Brucella Tube Agglutination,
 - 4.3 VDRL (including Antigen Preparation),
 - 4.4 ASO (Anti-Streptolysin 'O')
 - 4.5 C-Reactive Protein (Latex agglutination)
 - 4.6 Rheumatoid factor (RF) Latex agglutination
 - 4.7 Rose Waaler test,
5. Demonstration of antigen/antibody determination by Immuno fluorescence (IF), Immunodiffusion, precipitation in Agarose gel (Ouchterlony), CCIEP, ELISA, SDS - PAGE and Western blotting.

BMLS-506: Applied Haematology-II – Practical

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

BMLS-507: Applied Clinical Biochemistry–I - Practical

1. Estimation of Glucose in Urine and in Blood.
2. Estimation of Protein in Urine and Blood.
3. Estimation of Urea in blood.
4. Estimation of uric acid in blood.
5. Estimation of serum Bilirubin
6. Estimation of Total Cholesterol in blood.
7. Estimation of HDL Cholesterol.
8. Estimation of LDL Cholesterol.
9. Estimation of TG
10. Estimation of Creatinine in Blood
11. Estimation of serum calcium, Inorganic phosphate

12. To measure electrolytes Sodium, Potassium & Chloride.

BMLS-508: Applied Histopathology-II - Practical

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

Sixth Semester

BMLS-601: Medical Parasitology and Entomology

Rationale

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

1. Introduction to Medical Parasitology with respect to terms used in Parasitology.
2. Protozoology/ Protozoal parasites:
 - 2.1 General characteristics of protozoa.
 - 2.2 Geographical distribution, Habitat, Morphology, life cycle, Mode of infection and laboratory diagnosis of Entamoeba sp.
 - 2.3 Geographical distribution, Habitat, Morphology, life cycle, Mode of infection and laboratory diagnosis of Intestinal and vaginal flagellates i.e. Giardia, Trichomonas sp.
 - 2.4 Geographical distribution, Habitat, Morphology, life cycle, Mode of infection and laboratory diagnosis of blood and tissue flagellates i.e. Plasmodium and Toxoplasma sp.
3. Helminthology/ Helminthic parasites:
 - 3.1 General characteristics of Cestodes, Trematodes and Nematodes
 - 3.2 Geographical distribution, Habitat, Morphology, life cycle, Mode of infection and laboratory diagnosis of :

- 3.2.1 *Taeniasolium* and *saginata*
- 3.2.2 *Echinococcusgranulosus*
- 3.2.3 *Hymenolepis nana*
- 3.2.4 *Schistosoma haematobium* and *mansoni*
- 3.2.5 *Fasciola hepatica* and *buski*
- 3.2.6 *Trichuristrichura*
- 3.2.7 *Trichinellaspirales*
- 3.2.8 *Strongyloidesstercoralis*
- 3.2.9 *Ancylostomaduodenale*
- 3.2.10 *Enterobiusvermicularis*
- 3.2.11 *Ascarislumbricoides*
- 3.2.12 *Wuchereriabancrofti*
- 3.2.13 *Dracunculusmedinensis*
4. Diagnostic procedures:
 - 4.1 Examination of Stool for parasites
 - 4.1.1 For intestinal protozoal infections
 - 4.1.2 General rules for microscopic examination of stool samples
 - 4.1.3 Collection of stool samples
 - 4.1.4 Preparation of material for unstained and stained preparations
 - 4.1.5 Staining methods i.e. Iodine staining and permanent staining
 - 4.1.6 For Helminthic infections
 - 4.1.6.1 Introduction, direct smear preparation and examination
 - 4.1.6.2 Concentration techniques i.e. Flotation and sedimentation techniques
 - 4.1.6.3 Egg counting techniques
 - 4.1.7 Examination of blood for parasites
 - 4.1.7.1 Preparation of thin and thick blood film
 - 4.1.7.2 Leishman staining
 - 4.1.7.3 Examination of thick and thin smear
 - 4.1.7.4 Field's stain
 - 4.1.7.5 JSB stain
 5. Examination of blood film for Malarial parasite and *Microfilariae*
 6. Collection, Transport, processing and preservation of samples for routine parasitological investigations
 7. Morphology, life cycle and lab-diagnosis of *Giardia* and *Entamoeba*
 8. Morphology, life cycle and lab-diagnosis of Roundworms and Hookworms
 9. Morphology, life cycle and lab-diagnosis of *T. solium* and *T. saginata*
 10. Morphology, life cycle and lab-diagnosis of Malarial parasite with special reference to *P.vivax* and *P. falciparum*
 11. Laboratory diagnosis of hydated cyst and cysticercosis
 12. Concentration techniques for demonstration of Ova and Cysts (Principles and applications)

Suggested Readings

1. Parasitology in relation to Clinical Medicine by K D Chhatterjee
2. Medical Entomology by A.K. Hati, Pub. Allied Book Agency
3. Medical Parasitology by D.R. Arora
4. Clinical Parasitology by Paul Chester Beaver

BMLS-602: Advanced Haematology

Rationale

The students will be made aware of different anemia, Leukemia, chromosomal studies, bleeding disorders and radiation hazards

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

Suggested Readings

1. Text book of Medical Laboratory Technology by Paraful B. Godkar
2. Medical laboratory Technology by KL Mukherjee Volume-I
3. Practical Haematology by JB Dacie
4. Clinical Diagnosis & Management by Laboratory methods (20th edition) by John Bernard Henary
5. Atlas of Haematology (5th edition) by G.A. McDonald
6. De Gruchy's clinical Haematology in medical practice
7. Postgraduate Haematology by Hoffbrand

BMLS-603: Applied Clinical Biochemistry- II

Rationale:

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

1. Automation in clinical biochemistry
2. Method of estimation and assessment for:
 - 2.1 Glucose tolerance test
 - 2.2 Insulin tolerance test
 - 2.3 Xylose excretion test.
3. Gastric analysis.
4. Clearance test for renal function.
5. Qualitative test for:
 - 5.1 Urobilinogens
 - 5.2 Barbiturates

- 5.3 T3, T4 and TSH
- 5.4 Ketosteroids
- 6. Enzymes:
 - 6.1 Principles
 - 6.2 Clinical significance and
 - 6.3 Procedures for estimation
 - 6.3.1 Acid phosphatase
 - 6.3.2 Alkaline phosphatase
 - 6.3.3 Lactate dehydrogenase
 - 6.3.4 Aspartate transaminase
 - 6.3.5 Alanine transaminase
 - 6.3.6 Creatine phosphokinase
- 7. Qualitative analysis of Renal calculi.
- 8. Chemical examination of Cerebrospinal fluid.
- 9. Brief knowledge about rapid techniques in clinical biochemistry

Suggested Readings

1. Text book of Medical Laboratory Technology by P.B. Godkar.
2. Medical Laboratory Science, Theory & Practical by A. Kolhatkar.
3. Practical Clinical Biochemistry by Harold Varley.
4. Biochemistry, U. Satyanarayan & U. Chakrapani.
5. Text book of Medical Biochemistry by Chaterjee & Shinde.
6. Principal of Biochemistry by Lehninger
7. Biochemistry by Voet & Voet
8. Biochemistry by Stryer

BMLS-604: Cytopathology

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

1. Cryostat sectioning, its applications in diagnostic cytopathology
2. Enzyme Cytochemistry:
 - 2.1 Diagnostic applications
 - 2.2 Demonstration of Phosphatases, Dehydrogenases, Oxidases & Peroxidases
3. Vital staining for Sex Chromatin
4. Aspiration cytology:
 - 4.1 Principle
 - 4.2 Indications & utility of the technique with special emphasis on role of cytotechnologist in FNAC clinics
5. Exfoliative cytology (Papanicolaou technique for the staining of cervical smears)
 - 5.1 Cervical cytology
 - 5.2 Fluid Cytology
 - 5.2.1 Urine
 - 5.2.2 CSF
 - 5.2.3 Body Fluids (Pleural, Pericardial, Ascitic)
6. Automation in cytology
7. Liquid based cytology: Principles and preparation, Cytocentrifuge, molecular cytology, Cell Block and Immune-cytochemistry

Suggested Readings

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

BMLS-605: Medical Parasitology and Entomology – Practical

1. Routine stool examination for detection of intestinal parasites with concentration methods:
 - 1.1 Saline preparation
 - 1.2 Iodine preparation
 - 1.3 Floatation method
 - 1.4 Centrifugation method
 - 1.5 Formal ether method
 - 1.6 Zinc sulphate method
2. Identification of adult worms from models/slides:
 - 2.1 Tapeworm
 - 2.2 Tapeworm segments
 - 2.3 Ascaris (Round worm)
 - 2.4 Hookworms
 - 2.5 Pinworms
3. Malarial parasite:
 - 3.1 Preparation of thin and thick smears
 - 3.2 Staining of smears
 - 3.3 Examination of smears for malarial parasites (*P. vivax* and *P. falciparum*)

BMLS-606: Advanced Haematology – Practical

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

BMLS-607: Applied Clinical Biochemistry-II – Practical

1. Estimation of Glucose tolerance test (GTT).
2. Estimation of Insulin tolerance test (ITT).
3. Determination of Uric acid in Urine.
4. Determination of Creatinine clearance.

5. Determination of Urea clearance.
6. Determination of Serum acid phosphatase.
7. Determination of Serum Alkaline phosphatase.
8. Determination of Serum Lactate dehydrogenase.
9. Determination of T3, T4 and TSH

BMLS-608: Cytopathology – Practical

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

Seventh Semester

BMLS-701 Virology and Mycology

Rationale

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

Virology:

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

Mycology:

1. Introduction to Medical Mycology
2. Basic concepts about superficial and deep Mycoses
3. Taxonomy and classification and general characteristics of various medically important fungi
4. Normal fungal flora
5. Morphological, cultural characteristics of common fungal laboratory contaminants
6. Culture media used in mycology
7. Direct microscopy in Medical mycology laboratory
8. Processing of clinical samples for diagnosis of fungal infections i.e. Skin, nail, hair, pus, sputum, CSF and other body fluids
9. Techniques used for isolation and identification of medically important fungi

10. Methods for identification of yeasts and moulds
11. Dimorphism in fungi
12. Antifungal susceptibility tests
13. Preservation of fungal cultures
14. Routine myco-serological tests and skin tests

Suggested Readings

1. Practical Medical Microbiology by Mackie & MacCartney Volume 1 and 2
2. Text book of Microbiology by Ananthanarayanan
3. Medical Microbiology by Panikar & Satish Gupte
4. Medical laboratory Technology Vol. I, II, III by Mukherjee
5. Medical Laboratory manual for tropical countries Vol. II Microbiology by Monica Cheesbrough
6. Medical Mycology by Dr. Jagdish Chander

BMLS-702: Blood Banking and Genetics

Rationale: Blood banking will make students learn about blood grouping & blood transfusion. The students will learn about the concept of blood grouping, compatibility testing in blood transfusion & screening of donated blood for various infectious diseases. Genetics will make students learn about Fundamentals of Heredity. The students will learn about the concept of inheritance in various genetic diseases.

Blood Banking

1. Introduction to Blood Banking
2. History and discovery of various blood group systems
3. ABO blood group system
4. Rh and other major blood group system
5. Sources of error in blood grouping and their elimination.
6. ABO grouping: Forward and reverse grouping. Causes of discrimination between forward and reverse grouping
7. Rh grouping
8. Compatibility test in blood transfusion
 - 8.1 Collection of blood for cross matching from a blood bag
 - 8.2 Major cross matching
 - 8.3 Minor cross matching
 - 8.4 Use of enzymes in blood bank specially Papain
9. Complications and hazards of blood transfusion
10. Laboratory investigations of transfusion reactions and mismatched blood transfusion.
11. Precautions while procurement and storage of grouping antisera
12. Various anticoagulants used to collect blood for transfusion purposes
13. Selection of donor and procedure for collection of blood from a healthy donor
14. Preparation of various fractions of blood for transfusion and therapeutic purposes such as:
 - 14.1 Packed red cells, washed red cells and FROZEN Red cells
 - 14.2 Platelet Rich Plasma (PRP), Platelet concentrate and frozen platelets.
 - 14.3 Fresh plasma (FP), Fresh Frozen Plasma (FFP) and cryoprecipitate
15. Brief introduction of blood substitute/artificial blood
16. Haemopheresis: pertaining to Leucocytes, platelets and plasma.

17. Quality control in blood bank

Genetics

1. Continuity of life-heredity, variation;
2. Mendel's laws of inheritance,
3. Chromosomal basis of inheritance; other patterns of inheritance- incomplete dominance, multi parallelism, quantitative inheritance.
4. Chromosomes - bacterial cell and eukaryotic cell; parallelism between genes and chromosomes; genome, linkage and crossing over; gene mapping; recombination;
5. Molecular genetics: DNA as a genetic material- its structure and replication; structure of RNA and its role in protein synthesis, Vectors, plasmids
6. Human Genetics
7. Microbial genetics

Suggested readings

1. Practical Haematology by J.B. Dacie
2. Transfusion Science by Overfield, Hamer
3. Medical Laboratory Technology by K.L. Mukherjee Volume-I
4. Mollison's Blood Transfusion in Clinical Medicine, 12th Edition by Harvey G. Klein
5. Genes by Benjamin Lewin
6. Genetics by B.D. Singh
7. Principals of Genetics by Gardner
8. Instant Notes on Genetics by PC Winter, GI Hickey and HL Fletcher

BMLS-703: Immunopathology & Molecular Biology

Rationale: The students will learn how to analyze various clinical patients' samples, for estimation of different components which are the cause of the immune disease or are the diagnostic/prognostic markers. This subject gives information about various clinically important cells of immune system, lymphoid organs, antigen, antibody, Ag-Ab. reactions, transplant immunology etc. & automation techniques. Molecular biology concerns the molecular basis of biological activity between biomolecules in the various systems of a cell, including the interactions between DNA, RNA and proteins and their biosynthesis, as well as the regulation of these interactions. A basic introduction of molecular biology and its techniques like PCR, RTPCR etc. will also be rendered to sensitize students to take up future molecular biology challenges.

1. Introduction to Immunology
2. Cells of the immune system
3. Types and Mechanisms of immune response
4. Lymphoid organs of the Immune system
5. MHC I & II
6. HLA Typing & Cross matching
7. Transplant Immunology
8. Hypersensitivity: Definition, Types, Mechanisms
9. Autoimmunity
10. Immune tolerance : Basic concepts
11. Introduction to Molecular Biology
12. Relationship of Mol. Biology with other Science
13. Molecular Biology Techniques : Principle, Reagents used, procedure and applications in Medical diagnostics
 - 13.1 Polymerase Chain Reaction and its advanced versions

- 13.2 Gel electrophoresis
- 13.3 Western blotting
- 14. Chemical composition of DNA
 - 14.1 DNA replication
 - 14.2 DNA damage and repair
 - 14.3 Regulation of prokaryotic and eukaryotic gene expression
 - 14.4 Cell Cycle

Suggested Readings

1. Immunology by Ivan Roitt, Jonathaan Brostoff and David Male
2. Immunology by Kuby
3. Medical Immunology by Daniel P Stites
4. Basic & Clinical Immunology by P. Daniel Fudenberg, H. Hugh and Stites
5. Elements of Biotechnology by PK Gupta
6. Watson Molecular Biology of Gene
7. Advanced Molecular Biology by R Twyman
8. Principal of Biochemistry by Lehninger

BMLS-704: Research Methodology and Biostatistics

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

Research Methodology:

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

Biostatistics:

1. Need of biostatistics
2. What is biostatistics: beyond definition
3. Understanding of data in biostatistics
4. How & where to get relevant data
5. Relation between data & variables
6. Type of variables: defining data set
7. Collection of relevant data: sampling methods
8. Construction of study: population, sample, normality and its beyond (not design of study, perhaps)
9. Summarizing data on the pretext of underlined study
10. Understanding of statistical analysis (not methods)

Suggested readings

1. Statistical Methods by S.P. Gupta
2. Methods in biostatistics for medical students by B.K.Mahajan
3. RPG Biostatistics by HimanshuTyagi

BMLS-705: Virology and Mycology – Practical

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

BMLS-706: Blood Banking and Genetics – Practical

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

BMLS-707: Immunopathology & Molecular Biology – Practicals

1. Peripheral blood mononuclear cell (PBMC) isolation by gradient centrifugation
2. T and B cell separation
3. Immunofluorescence
 - 3.1 Anti- Nuclear Antibody (ANA)
 - 3.2 Anti- Neutrophil Cytoplasmic Antibody (ANCA)
4. AIDS Immunology and Pathogenesis (AIP)

5. Thyroid Microsomal antigen (TMA)- Agglutination reactions
6. Electrophoresis
7. Gel diffusion
8. Nephelometry
9. HLA
 - 9.1 Typing Serology & Cross match
 - 9.2 Molecular Typing
10. Nitro blue Tetrazolium Chloride Test (NBT)
11. FACS for CD4 and CD8
12. ELISA for lab. diagnosis of AIDS
13. Polymerase Chain Reaction and its advanced versions
14. Gel electrophoresis
15. Western blotting
16. Isolation of DNA and RNA
17. Estimation of DNA and RNA
18. Determination of molecular weight and quantification of DNA using agarose gel electrophoresis

BMLS-708 Research Methodology and Biostatistics – Practical

1. To practice problems on various biostatistics tools.

Eighth Semester

BMLS-801 Internship:

The internship will span 6 months/ 1 semester. This will include 6 hours of practice a day, totaling to 720 hours during internship semester. As a part of this, the students will maintain a work logbook which will be duly endorsed by the supervisor or trainer. At the end of internship the candidate shall submit the work log book along with certificate from the training institute. Finally the training of candidate shall be evaluated by the internal and external examiners deputed by University/Board in the form of practical / viva examination.

The internship time period provides the students the opportunity to continue to develop confidence and increased skill in clinical delivery of services. Students will demonstrate competence in beginning and intermediate procedures. Students will observe the advanced and specialized procedures. The student will complete the clinical training by practicing all the skills learned in classroom and clinical instruction. The students are expected to work for minimum 6 hours per day and this may be more depending on the need and the healthcare setting.

Skills based outcomes and monitorable indicators for Medical Laboratory Scientist

1. Demonstrate professional interpersonal, oral, and written communications skills sufficient to serve the needs of patients and the public including an awareness of how diversity may affect the communication process.
2. Perform pre-analytical, analytical, and post-analytical processes:
 - 2.1 Demonstrate ability to understand investigation/test requisition.
 - 2.2 Collecting the relevant clinical samples along with complete and accurate documentation with proper safety measures in relation to sample accountability.
 - 2.3 To transport the samples with precautionary measures to the relevant lab section.
 - 2.4 Demonstrate the ability to prepare clinical sample for processing.

- 2.5 To demonstrate the knowledge of accurate sample processing for the required lab investigation. Perform routine clinical laboratory tests in clinical chemistry, hematology/haemostasis, immunology, immunohaematology, microbiology, Histopathology, Cytopathology, body fluid analysis, and laboratory operations.
- 2.6 Perform mathematical calculations related to all areas of the clinical laboratory
- 2.7 Ability to record the test results/data.
- 2.8 To demonstrate the ability to interpret the test reports and its documentation in lab records.
- 2.9 Demonstrate ability to release the report to the right person in minimum turn-around-time (TAT).
3. Perform problem solving and troubleshooting techniques for laboratory methodologies
Correlate laboratory test results with patient diagnosis and treatment.
4. To follow basic quality assessment protocol of clinical laboratory.
5. Demonstrate routine laboratory techniques sufficient to orient new employees within the clinical laboratory.
6. Apply basic scientific principles in learning new techniques/procedures; demonstrate application of principles and methodologies.
7. Utilize computer technology applications to interact with computerized instruments and laboratory information systems.
8. Demonstrate adequate knowledge of computer software as it applies to document production, spreadsheets, and presentations.
9. Demonstrate professional behavior with co-team mates.
10. Demonstrate sensitivity and compassion towards patients.

4.3 Masters in Medical Laboratory Science

Background

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

All aspects of Medical Laboratory Science needs to be considered in the development of this curriculum together with the identification of the roles expected for different levels of medical laboratory professionals based on their specialization and experience.

The discipline of Medical Laboratory Science comprises broadly of Histopathology, Medical Microbiology, Clinical Biochemistry and Haematology and Total Quality Management or Lab Management subjects. It is proposed that the Masters in Medical Laboratory Science shall be offered in above said specializations i.e.

1. Masters in Medical Laboratory Science – Clinical Biochemistry
2. Masters in Medical Laboratory Science – Medical Microbiology
3. Masters in Medical Laboratory Science – Pathology
4. Masters in Medical Laboratory Science – Haematology and Blood Banking
5. Masters in Medical Laboratory Science – Total Quality Management

Masters in Medical Laboratory Science – Clinical Biochemistry

Introduction

Objectives/aim of the course:

1. Proficiently supervise and perform full range of clinical Biochemistry 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)

Expectation from the future Postgraduate in providing patient care, teaching and research

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

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

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 pursue Masters in MLS.

Provision of Lateral Entry: 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 MLS 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.

Model Curriculum Outline

First Semester

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 and twelve)

Second Semester

Course Code	Course Title	Hours			Marks		Total Marks	Credit
		L	T	P	Internal	External		
MMLSB-201	Principles of Biochemistry	4	1	-	50	100	150	5
MMLSB-202	Enzymes & Metabolism –II	4	1	-	50	100	150	5
MMLSB-203	Vitamins, Hormones, General Physiology and Nutrition	4	-	-	50	100	150	4
MMLSB-204	Molecular Biology and Bioinformatics	4	-	-	50	100	150	4

Course Code	Course Title	Hours			Marks		Total Marks	Credit
		L	T	P	Internal	External		
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 and 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 basic subjects
3. Considering four months per semester as working months, total contact hour hours per semester shall be 512 (Five hundred and twelve)

Third Semester

Course Code	Course Title	Hours			Marks		Total Marks	Credit
		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 Tests	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 Tests(Practical)	-	-	2	50	100	150	1
MMLSB-308	Advanced Clinical Biochemistry	-	-	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

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
5. Faculty development in Medical Laboratory Science (MLS)

Expectation from the future Postgraduate in providing patient care, teaching and research

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
10. Should be capable of teaching, proposing/executing research project

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 pursue Masters in MLS.

Provision of Lateral Entry: 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 MLS 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 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 basic subjects
3. Considering four months per semester as working months, total contact hour hours per semester shall be 512 (Five hundred and twelve)

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:

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)

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

Masters in Medical Laboratory Science – 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
5. Faculty development in Medical Laboratory Science (MLS)

Expectation from the future Postgraduate in providing patient care, teaching and research

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 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 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 pursue Masters in MLS.

Provision of Lateral Entry: 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 MLS 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 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 basic subjects
3. Considering four months per semester as working months, total contact hour hours per semester shall be 512 (Five hundred and twelve)

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 basic subjects
3. Considering four months per semester as working months, total contact hour hours per semester shall be 512 (Five hundred and twelve)

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 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		
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

Masters in Medical Laboratory Science – Haematology and Blood Banking

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)

Expectation from the future Postgraduate in providing patient care, teaching and research

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 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 pursue Masters in MLS.

Provision of Lateral Entry: 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 Masters in MLS 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	Principles of Coagulation	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	Principles of Coagulation(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 basic subjects
3. Considering four months per semester as working months, total contact hour hours per semester shall be 512 (Five hundred and twelve)

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

Course Code	Course Title	Hours			Marks		Total Marks	Credits
		L	T	P	Internal	External		
MMLSH-202	Applied Coagulation	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	Applied Coagulation(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 basic subjects
3. Considering four months per semester as working months, total contact hour hours per semester shall be 512 (Five hundred and twelve)

Third Semester

Course Code	Course Title	Hours			Marks		Total Marks	Credits
		L	T	P	Internal	External		
MMLSH-301	Blood Banking and Immuno-Haematology	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 Immuno-Haematology (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 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		

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

Masters in Medical Laboratory Science – Total Quality Management (TQM)

Introduction

Objectives/Aim of the Programme:

MMLS in TQM is a breakthrough futuristic programme designed to provide students with advanced skills and knowledge required to organize, manage and regulate complex Clinical Laboratory Management System. Total Quality Management (TQM) is a comprehensive and structured approach to organizational management that seeks to improve the quality of products process and services through ongoing refinements in response to continuous feedback. Programme covers every aspect of Lab Management i.e. General Laboratory Management & Technical Quality Management as per International Laboratory Quality Standards. Further MMLS-TQM is designed to create a specific cadre of Laboratory Quality Managers/Laboratory Directors with following objectives-

1. To improve and sustain quality of Laboratory Services and manage various Standard Operating procedures (SOPS) and protocols.
2. To apply various management techniques to enhance the clinical laboratory standards and reliability with the perspective of management, patient safety and society as a whole
3. Manage information to enable effective, timely, accurate, and cost-effective reporting of laboratory-generated information to patients and clinicians
4. To teach under graduate and PG students of MLS and develop/guide research projects
5. To coordinate with all Clinical Laboratory Departments for quality policies and planning in Clinical Lab Services.
6. Faculty development in Medical Laboratory Sciences (MLS)
7. To Develop and evaluate test systems and interpretive algorithms.
8. To be a nodal person for quality planning, policy making and performance of Clinical Laboratory functioning.

Expectation from the future Postgraduate in providing Laboratory Quality Management Services, Patient Care, teaching and research in Clinical Laboratory Services

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

1. Establish system for assuring quality of laboratory services and manage various Standard Operating procedures (SOPS) and protocols.
2. apply various management techniques to enhance the laboratory standards and reliability with the perspective of management, patient safety and society as a whole

3. Manage information to enable effective, timely, accurate, and cost-effective reporting of laboratory-generated information to patients and clinicians
4. Teach under graduate and PG students of MLS and develop/guide research projects
5. Coordinate with all Clinical Laboratory Departments for quality policies and planning in Clinical Lab Services.
6. Faculty development in Medical Laboratory Sciences (MLS)
7. To Develop and evaluate test systems and interpretive algorithms as per applied quality tools and Techniques.
8. Should know the logical interpretation of clinical lab investigations.
9. Should be capable to extrapolate data acquired
10. Should be capable of applying statistical methods
11. Should be capable of teaching, proposing/executing research project

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 pursue Masters in MLS.

Provision of Lateral Entry: 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 MLS 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 Marks	CR
		L	T	P	Internal	External		
MMLS-TQM 101	Introduction to Total Quality Management (TQM) and its importance in Health Care System	5	-	-	50	100	150	5
MMLS-TQM 102	Principles of Total Quality Management	5	-	-	50	100	150	6
MMLS-TQM 103	Organizational framework of Clinical Laboratories	5	-	-	50	100	150	6
MMLS-TQM 104	Research Methodology and Biostatistics	5	-	-	50	100	150	5
MMLS-TQM 105	Introduction to Total Quality Management (TQM) and its importance in Health Care System– Practical	-	-	2	50	100	150	1
MMLS-TQM 106	Principles of Total Quality Management - Practical	-	-	4	50	100	150	1
MMLS-TQM 107	Organizational framework of clinical laboratories - Practical	-	-	2	50	100	150	1
MMLS-TQM 108	Research Methodology and Biostatistics	-	-	4	50	100	150	1
Total		20	0	12	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

Second Semester

Course Code	Course Title	Hours			Marks		Total Marks	Credits
		L	T	P	Internal	External		
MMLS-TQM-201	Quality System and its Essential Elements	5	-	-	50	100	150	5
MMLS-TQM-202	Fundamentals of TQM in Clinical Lab Service: National	5	-	-	50	100	150	5
MMLS-TQM-203	Applied Statistics Tools & Techniques in TQM	5	-	-	50	100	150	6
MMLS-TQM-204	Introduction and applications of ISO-9001:2000	5	-	-	50	100	150	6
MMLS-TQM-205	Quality System and its Essential Elements –Practical	-	-	2	50	100	150	1
MMLS-TQM-206	Fundamentals of TQM in Clinical Lab Service: National and International Quality Standard –Practical	-	-	4	50	100	150	1
MMLS-TQM-207	Applied Statistics Tools & Techniques in TQM –Practical	-	-	2	50	100	150	1

Course Code	Course Title	Hours			Marks		Total Marks	Credits
		L	T	P	Internal	External		
MMLS-TQM-208	Introduction and applications of ISO 9001:2000 -Practical	-	-	4	50	100	150	1
Total		20	0	12	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

Third Semester

Course Code	Course Title	Hours			Marks		Total Marks	Credit
		L	T	P	Internal	External		
MMLS-TQM-301	Laboratory Operational Management	5	-	-	50	100	150	6
MMLS-TQM-302	Introduction and applications of ISO 15189	5	-	-	50	100	150	6
MMLS-TQM-303	Pre-Analytical, analytical and Post-analytical phase Quality Management	5	-	-	50	100	150	6
MMLS-TQM-304	Clinical Laboratory Audit	5	-	-	50	100	150	4
MMLS-TQM-305	Laboratory Operational Management –Practical	-	-	2	50	100	150	1
MMLS-TQM-306	Introduction and applications of ISO15189 –Practical	-	-	4	50	100	150	1
MMLS-TQM-307	Pre-Analytical, analytical and Post-analytical phase Quality Management –Practical	-	-	2	50	100	150	1
MMLS-TQM-308	Clinical Laboratory Audit – Practical	-	-	4	50	100	150	1
Total		20	0	12	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

Fourth Semester

Course Code	Course Title	Hours	Marks		Total Marks	Credits
			Internal	External		
MMLS-TQM-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

4.4 Doctorate in Medical Laboratory Science (Ph.D)

Doctorate in Medical Laboratory Science

Background

Ph.D. plays a significant role in the academic system of Medical Laboratory Science; however the curriculum has not indicated any prescriptive guidelines for that level apart from mapping it on the career and qualification map. The same needs to be encouraged, for strengthening the Faculty development and significant contribution of Med. Lab. Professionals in the field of Research and Development.

Doctorate degree (Ph.D.) in Medical laboratory Science presently exists in the following disciplines;

1. Clinical Biochemistry
2. Clinical Bacteriology
3. Virology
4. Mycology
5. Parasitology
6. Immunology and Immunopathology
7. Histopathology
8. Cytopathology
9. Molecular Biology
10. Haematology
11. Blood Banking
12. Total Quality Management

All related disciplines of Medical Laboratory Science need to be considered for Ph.D. in the development of this curriculum together with the identification of the roles expected for different levels of Medical Laboratory Professionals based on their specialization and experience.

Chapter 5

Job description

Chapter 5: Job Description for all levels

Nature, job, duties, responsibilities and requisite competencies of medical laboratory professionals

Overview of Medical Laboratory Science & Technology

A branch of Medical science and technology deals with- collection, receiving, processing, performing and analysis of various biological samples of Blood, Urine Stool, Cerebrospinal fluid (CSF), synovial fluid and PUS, and other body fluids etc., for timely delivery of qualitative laboratory results for an early and accurate diagnosis and treatment of the diseases. Medical Laboratory science and its application have key role in present health care system as nowadays; more than 70% of medical decisions are based on clinical lab investigations. This branch of science is known by various names worldwide as- Medical Laboratory Science & Technology-MLT, Clinical Laboratory Science-CLS, Biomedical Laboratory science-BLS and Laboratory Medicine etc.

Introduction of Medical Laboratory Professionals:

Medical Laboratory Professionals play indispensable role in diagnosis and treatment of diseases. They perform the duties of collecting, receiving, and performing of the various Pathological, Biochemical, Bacteriological, Virological, Molecular, Biological Experimental and blood banks investigations in various contagious body fluids under more than 30 different clinical Laboratory divisions/ Departments.

They have to deal with various sophisticated scientific machines and also various manual tools and techniques for diagnosis, treatment, prevention and monitoring of diseases. As diagnosis of diseases is the primary step to cure, they play a crucial role in the early and accurate diagnosis and treatment of diseases other matters connected with pure and applied research, experimental development of products in teaching, training, quality testing, and quality control etc. in all relevant fields of Laboratory Medicine.

Besides they also perform many other important tasks in functioning of Laboratory Services like laboratory management and supervision at various levels, quality assurance in testing, lab storage of chemical, reagents and kits, inventory stock management, Biomedical hazards and lab safety, Biomedical waste management as per standard procedure and regulations. They require a sound professional knowledge, continuing education, expertise and independent judgment capabilities even in odd hour emergency duties. Medical Laboratory Professionals form an integral part of the medical profession from basic health care to super specialty care in health care system in every established and recognized system of medicine. Duties and responsibilities of medical laboratory technical staff is highly specialized, sophisticated and very sensitive. Clinical laboratory personnel need good analytical judgment and the ability to work independently in odd hours/night duties. Close attention to detail is essential, because small differences or changes in test results or numerical readouts can be crucial for patient care. Manual dexterity and normal color vision are highly desirable. With the widespread use of automated laboratory equipment, computer skills are important. In addition, Medical Laboratory technical staff in particular is expected to be good at problem solving.

Designation wise General Nature of Job, Duties, and Responsibilities & Desired Competencies of all posts are as under-

Level 4 - Junior Medical Lab. Technologist-(Jr. MLT)*

General Description of the Post: Jr. Medical Lab Technologist (Jr. MLT) is proposed as an entry level technical post of the Lab Cadre. He/She is an integral member of health care system and is responsible and accountable for professional act & practices according to scope of his/her practices as well as per the Laws and Regulations governing the profession, if any. He/She has to coordinate and participate in a variety of routine technical tasks such as sample collection & receiving, performance and analysis of routine laboratory investigations to obtain data for use in the diagnosis and treatment of disease.

*Present entry level post in central Government Hospitals proposed to be upgraded & merged with Medical Laboratory Technologist after implementing of BMLS as minimum entry qualification in lab cadre

General Nature of Job, Duties, Responsibilities & Desired Competencies:

1. **Sample receiving:** Identification, receiving and registering of various biological samples received from all sample collection units (Phlebotomy sections) according to standard operating procedures.
2. **Sample handling & accessioning:**
 - Ensures relevant required information is on the requisition form received with the test request.
 - Verifies specimen suitability including adequate amount/volume and integrity. Registered specimens into laboratory information system i.e. register/computerized system.
 - Complies with existing guidelines for specimen collection, retention, storage and disposal.
 - Takes corrective action when errors in pre-analytical phase are identified.
3. **Preservation & transportation of samples:** Delivery of specimens to sample processing area in a safe and timely manner taking into account priority and specimen stability. Preserve and transport various biological samples to different divisions of lab as per standard operating procedures, if required.
4. **Sample processing for testing:**
 - Check the specimen received for testing against requisition form for name, requisition number and test to be performed.
 - Prepare specimen for analysis i.e. centrifuging, aliquoting, preserving.
 - Priorities analyses in system, e.g. stat, urgent, routine sample stability.
 - Prepares and uses calibrators, standards, quality control materials.
 - Preparation of glasswares and other desire material for sample analysis.
 - Arrange specimen reagents and solutions for testing.
 - Register and process sample for investigations by operating various auto-analyzers and for manual system & microscopic examinations.
5. **Sample testing:** Perform all the routine investigations in various departments/divisions of laboratories i.e. Haematology Biochemistry, Clinical Pathology, Histopathology, Microbiology and Blood Banks under the supervision of Senior Laboratory Professionals.
6. **Analysis and Reporting of results:** Under supervision of senior medical laboratory professionals, an incumbent of this class performs routine tests and may give reports of routine tests as and when required for the speedy treatment of the patients.

7. **Assist senior lab technical staff.** In addition to lab technical procedures, they have to assist other senior technical staff in various specialized work of laboratories in all departments/divisions.
8. Should apply principles of standard precautions in lab & use personal protective equipments e.g. gloves mask gown etc.
9. **Sterilization and autoclaving** of various laboratory materials.
10. **Records keeping** of lab results and other records.
11. Cleaning and maintenance of various sophisticated medical laboratory-testing instruments like semi-auto analyzers and fully auto analyzers.
12. Look after of Bio-medical hazards and Bio-medical waste management at work place.
13. Supervision of subordinate auxiliary staff (MTS) in laboratory.
14. Any other duty including emergency or Shift duties independently round 'o'clock assigned by the Head of the department.

Desirable Competencies

1. Proper knowledge of theory and practices and Practical skill of all diagnostic tools, techniques and procedures as per standard procedures and his/her scope of practices and a patient friendly communication skill.
2. Competent to take proper analytical decisions independently even in odd hour duties and managerial abilities as per given scope of practices.
3. Knowledge of Computer
4. Assisting in phlebotomy procedure with nursing /assigned personnel.

Level 4 - Medical Laboratory Technologist

General Description of the Post: Medical Laboratory Technologist (MLT) is an integral member of health care system and is responsible and accountable for professional act & practices according to standards of practice as well as Laws and Regulations governing the profession, if any. He /She has to Coordinate and participate in a variety of lab technical work in various departments/divisions.

In addition to the routine duties and responsibilities of the Jr. Medical Technologist, the Medical Lab. Technologist will also perform the following specialized work as per their place of posting –

Should know the correct phlebotomy procedure

In Clinical Pathology and Haematology-

Heamogram-

- Should be able to perform Hb, TLC, DLC, ESR, platelets count and indices, Peripheral smear staining-for RBC morphology, DLC and parasites e.g. Malarial parasite microfilaria etc.
- They have to identify staining problems and to initiate corrective action and
- Should be able to run Heamatology analyzers.

Coagulation studies- Proper collection, storage and analysis, use of auto-analyzers, **Should be able to do**

- Iron profile,
- Hb Electrophoresis, Hb HPLC,
- Flow cytometry, use and maintenance light Microscope.
- Semen analysis- Making of smear, PAP, Staining and microscopic examinations.

Quality Assurance-

- Perform Calibration of auto-analysers through various calibrators. Recognizes when results of patient analyses are outside expected findings and responds appropriately. Investigates unusual findings prior to reporting.
- Communicates information regarding laboratory analyses to clients in an appropriate manner.
- Ensures that laboratory results are accurately documented and retained in accordance with existing legislation.
- Maintains appropriate documentation, e.g., document laboratory reporting errors and corrective measures taken.
- Recognizes malfunctions in equipment/ instruments and initiates appropriate corrective action.

In Blood Banks:

- Should be able to perform blood grouping by tube/ gel card method and cross match
- Direct & indirect coombs test
- Antibody screening & identification
- Tests for transfusion transmitted infections by ELISA/ appropriate method.
- Making blood components
- Performing Apheresis
- Ensures proper storage and quality of blood products Also evaluates the appropriateness of blood product for patient clinical condition.
- QC of all tests and ,
- Record maintenance
- Also screening of donor before blood donation.
- Giving reports with his or her own signature for the treatment of patient.
- Able to recognize and investigates the adverse effects of transfusion according to established protocol & initiates follow-up action.
- Should have patient friendly communication skill.

In Clinical Biochemistry- They perform kidney function Test to rule out various Kidney diseases, Liver function Tests to rule out various liver disease, various type of Diabetes monitoring tests (in Blood and urine), ketoacidosis, Iron profile, Cardiac Enzymes, Lipid profile for preventing cardiac arrest, various hormonal assay, like Thyroid, FSH, LH, Prolactin, Cortisol, Testosterone and other function test, etc., for controlling and rule out of diseases.

- Blood gas analysis ,Serum electrolytes
- Giving reports with his or her own signature for the treatment of patient in emergency.
- Should have knowledge of autoanalysers, Chemiluminescence
- To run quality assurance programme

In Histo-cyto Pathology-

- Receiving samples from operation theatre like gall bladder, uterus, intestine, stones, other body organs or tissues and deferent types of body fluids etc.

- Participating in grossing, embedding, and section cutting, processing for slide making, mounting,
- Making of buffered formalin
- Frozen sectioning
- Special stains –AFB Lepra,PAS, mucicarmine, Silver methamine, VG, Reticulin PTAH etc. Providing data concerned for reporting of results to pathologist,
- Maintains records of slides and reports,
- Operating & maintaining common lab equipments
- Prepares blood ,body fluids and other clinical specimens for microscopy
- Running of Cytospin and,
- Also act as museum curator in histopathology lab. Work including preparing surgical specimens for display, helping in photo-micrographic work, indexing surgical specimens, maintaining and furnishing the museum. Compiling statistical data etc.]

Immunology

- Applies principles of immunology to detection of antigens & antibodies
- Able to perform ELISA, FISH
- Immunohistochemistry

In Clinical Microbiology- various hazardous specimens receiving and keeping them in appropriate temperatures, making deferent types of agar (media for bacterial growth). Sterilization of various equipments used in testing, making culture and sensitivity for specimen, Participating in the reporting and identification of deferent type of infections (bacterial growth), Micros- coping examination where-ever it is applicable, to rule out various type of infectious diseases like Septicemia, Meningitis, Tuberculosis, Typhoid, Cholera, Leprosy, etc. Also doing tests based on antigens antibody reaction, ELISA, to rule out HIV, HbsAg, HCV, various STD Causative organisms, TORCH, and many IgM, IgG antibodies, Dengue serology etc. Giving reports with his or her own signature for the treatment of patient. Coordinate the preparation and quality assurance of culture media, chemicals, reagents, stains and solutions as appropriate. Evaluate collected laboratory data and prepare reports assessing accuracy, completeness, timeliness, progress, adverse trend and appropriate recommendation or conclusions. Maintain sufficient inventory of material supplies and equipment for performance of duties; clean and maintain standard laboratory equipments. Participate in the development of new medical procedure and techniques.

Teaching- Assists in training teachings of UG/PG Medical Students. Utilize various laboratory and hospital information system and software. Maintenance of departmental records. Participation in the development and implementation of clinical evaluation. Provide technical guidance and instruction to DMLT students, interns and MD students. Participate in the lab. Inspection and work with inspectors as needed, and look after of Bio-medical hazards and Bio-medical waste management at work place. **Supervise the work of Junior Technical Staff** of Group ‘C’&‘D’ in his own section.

Any other department duty including emergency or Shift duties independently round ‘o’clock assigned by the Head of the department.

Desirable Competencies

Proper knowledge of theory and practices and Practical skill of all diagnostic tools, techniques and procedures as per standard procedures and his/her scope of practices and a patient

friendly communication skill. Competent to take proper analytical decision independently even in odd hour duties and managerial abilities as per given scope of practices. **Knowledge of Computer**

Level 5 - Technical Officer (MLS)

General Description of the Post: Technical Officer (MLT) is an integral member of health care system and is responsible and accountable for professional act & practices according to standards of practice as well as Laws and Regulations governing the profession, if any. He /She has to Coordinate and participate in a variety of specialized lab work and will be the technical in-charge of their Lab division/section under a particular department of lab.

Job, Duties, Responsibilities:

In addition to all the duties handled by the Medical Laboratory Technologist (MLT), the Technical Officer (MLT) will perform the following duties: -

- 1) Act as person in charge (PIC) of a division of a laboratory department as well as a resource person as per guideline determined by laboratory management system. Monitor Quality Control, Quality assurance, safety and Infection Control practices to assure compliance with internal and external regulations.
- 2) Supervise in specimen collection area: He/She is responsible and accountable for functioning pre-analytical area of patient identification, specimen labeling and collection verification, or instructing patient or other healthcare providers in collection and preservation techniques for serum, blood, urine, sputum, stool, scraping, directed donations, or other biological specimens for analysis.
- 3) Supervised in operating and maintenance of different types of instrument: and equipment used in Medical testing Laboratories e.g. semi-auto analyzers and fully auto analyzer based (*FlowCytometry, HPLC, Chemoluminescence, Radio-immunoassay, Immunophenotyping etc.*)
- 4) Processing and analysis of samples for highly special investigations.
- 5) Maintenance of laboratory manuals, SOPs and supervision of maintenance and upkeep of laboratories.
- 6) Monitor workflow, assessment of staffing levels and reassignment as needed. Follow up to ensure work is completed.
- 7) Participation in the development and implementation of clinical evaluation.
- 8) Utilize various laboratory and hospital information system and software. Maintenance of departmental records.
- 9) Provide advance problem solving, troubleshooting, and interpretation/consultation. Verification of specimen quality and test results.
- 10) Any other duty as assigned by the Head of the department.
- 11) Preparation and standardization of reagents of specialized test.
- 12) To assist the senior staff in the supervising the work of Technical staff in different divisions/sections of the department. Vigilance against misuse of laboratory materials, equipments or reagents.
- 13) Provide advance problem solving, troubleshooting, and interpretation/ consultation. Verification of specimen quality and test results.
- 14) Monitor workflow, assessment of staffing levels and reassignment as needed. Follow up to ensure work is completed.
- 15) Communicate and coordinates with patient, family and other medical personnel as necessary to obtain information for laboratory records, explain procedures, clarify orders and communicate status.
- 16) Any other duty including posting in Emergency duties as assigned by the Head of the department.

Level 5 - Senior Technical Officer (MLS)

General Description of the Post: Sr. Technical Officer (MLT) is a supervisory post responsible and accountable for professional act & practices according to standards of practice as well as Laws and Regulations governing the profession, if any. He /She has to Coordinate and participate in a variety of specialized lab work and will be the overall technical in-charge of their department of lab for assisting head of the department for various managerial function of the laboratory.

In addition to all the duties handled by the Technical officer (MLT), STO will also perform the following duties: -

- 1) To Work as a Technical In-charge in particular Department of Lab.
- 2) To maintain the inventory and assist the Head of the department in procurement of Lab. Department requirements and correspondence regarding maintenance, repair and upkeep of equipments.
- 3) Assist the Head of the Department for maintenance of leave records, posting of staff etc.
- 4) To ensure punctuality and regularity of all staff posted under him or her.
- 5) To assist the Head of Department in the supervising the work of Technical staff in different divisions/sections of the department. Vigilance against misuse of laboratory materials, equipments or reagents.
- 6) Interact with doctors, nurses and health unit coordinators (HUC) and other health providers when answering questions or providing other information about a patient results.
- 7) To ensure safety against theft and pilferage in the laboratories.
- 8) Supervision in the lab. Inspection and work with inspectors as needed and Supervision of Bio-medical hazards and Bio-medical waste management at work place.
- 9) To work as an In-charge of Departmental store for storage of chemical and reagents.
- 10) To coordinate and manage the supply of reagent and chemical for lab departments supply of chemical kits and chemicals.
- 11) Maintenance of laboratory manuals and supervision of maintenance and upkeep of laboratories.
- 12) Any other duty including posting in Emergency duties as assigned by the Head of the department.

Level 5 - Chief Technical Officer (MLS)

General Description of the Post: Chief Technical Officer (MLT) is a supervisory post for technical supervision and coordination of all laboratory services of different departments in a hospital/institutions, an integral member of health care system and is responsible and accountable for professional act & practices according to standards of practice as well as Laws and Regulations governing the profession, if any. He /She has to Coordinate and participate in a variety of specialized lab work and will be the overall technical in-charge of their department of lab for assisting head of the department for various managerial function of the laboratory.

- 1) The Post of Chief Technical Officer (MLT) is created as Group A post of Lab Technical Cadre for total quality management and a nodal post for coordination of different division/ departments of Lab in a hospital.
- 2) He/ She will be the overall technical in-charge of laboratory services in hospital and will be responsible for quality assurance programmes and implementation of other policy decisions of authorities related to lab services.
- 3) Total quality Management and Quality assurance is an emerging area and are the present challenges of laboratory services so highly qualified lab professionals are required for qualitative lab services to work as a quality manager of laboratories.

- 4) Post is proposed for highly qualified lab professionals with master professional degree or PhD. in relevant stream of Lab sciences.
- 5) He will be a resource person for various academic activities/scientific activities-seminar/conferences of lab departments in a hospital.
- 6) Responsible for Maintaining quality policy and Procedures.
- 7) Responsible for implementation of all policy decision of management for smooth functioning of lab departments.

Level 6 - Job responsibilities of Medical Laboratory Scientist (Grade B)/ Clinical Laboratory Demonstrator

For Non-Teaching: Performs tasks, duties and/or complex tests in all areas of the laboratory assigned (Haematology, Immuno-Haematology, Immunology, Bacteriology, Microscopy, routine Chemistry, Therapeutic drug monitoring) according to established laboratory protocols and procedures.

- Processes specimens for advanced/special investigations utilizing protocols and scientific knowledge.
- Calibrates, standardize and maintains instruments as per established procedures.
- Performs quality control, preventive maintenance, troubleshooting protocols to ensure proper functioning of instruments, reagents, procedures.
- Validates and report results of tests performed.
- To ensure delivering patients reports as per prescribed Turn Around Time (TAT)
- Orientation and teaching students and new employees.
- Researches and develops new procedures as assigned.
- Follows established safety practices including biohazards, exposure control plan (blood-borne pathogens), infection control to include universal precautions, employee right to know (hazardous chemicals), and chemical hygiene standard.
- Promotes effective working relationships and works effectively as part of a department / unit /team inter and intra departmentally to facilitate the department/unit's ability to meet its goals and objectives.
- Attends all in service education required as per hospital policy.
- Demonstrates respect and regard for the dignity of all patients, families, visitors and fellow employees to ensure a professional, responsible and courteous environment.
- To supervise and allocate responsibilities to level 4 and level 5.

For Teaching Institutes only

- Teaching & training Undergraduate Medical Laboratory Science students including Interns/ and short term trainees, so as to achieve the Educational Objectives i.e. to develop their knowledge, skills & attitude.
- To assist the Asstt., Assoc., Add. Professors / Professors / Heads of the department to do periodic evaluation / assessment through examination/to conduct examination/to maintain attendance & academic (including Internship) record of individual Undergraduate, Interns & short term trainees for the minimum period as per Govt. rules.
- To organize/participate in teaching programmes like Lectures /Tutorials/Group Discussions Demonstrations/ Practical and other academic activities like Seminars / Symposia / Panel Discussions/Workshops/Guest Lectures/Conferences/Continuing

Medical Education Programmes etc. and to maintain a Departmental Library for students as well as teaching staff.

- To conduct Research Projects and contribute to medical knowledge by scientific paper publications in indexed journals & their presentation at various local / state / international Conferences.
- To work on various Students' Welfare-related Committees like "Anti-Ragging Committee" and to enforce discipline among medical students.

Level 6 - Job responsibilities of Deputy Technical Manager:

- To ensure the implementation of QMS parameters in routine service of the laboratory. These are as follows:
- To keep Technical Manager updated regarding annual maintenance calendar of laboratory equipment particularly about calibration due date and AMC/CMC etc.
- To maintain their laboratory equipment in working condition
- If any equipment goes out of order then to arrange alternative and its repair as soon as possible and to record the relevant data regarding its down time.
- To maintain consumable inventory record
- To ensure First-in and first-out policy in consumables
- To maintain proper stock of consumables
- To observe and record daily NCRs if any, to report it to respective SIC and to ensure CAPA is taken and recorded.
- To maintain all other data relevant to QMS on formats approved by Quality management To ensure daily housekeeping of their respective sections and record data. In case of any problem, to contact incharge Housekeeping.

Level 7-Job responsibilities of Medical laboratory Scientist (Grade C)/Assistant Professor

For Non-Teaching

In addition to level 6 responsibilities, level 7 (MLS Gr. C) will perform as under:

- To ensure implementation of internal quality control and quality assurance programmes.
- Ensures tasks, duties and/or complex tests in all areas of the laboratory as mentioned at level 6, according to established laboratory protocols and procedures.
- Ensures processing of specimens for advanced/special investigations utilizing protocols and scientific knowledge.
- Ensures Calibration, standardization and maintenance of instruments as per established procedures.
- Validates and cross checks report results of tests performed.
- To ensure release of patient reports as per prescribed Turn Around Time (TAT)
- Orientation and teaching students and new employees.
- Researches and develops new procedures.
- Ensures established safety practices and chemical hygiene standard.
- Ensures unit's ability to meet its goals and objectives.
- Attends all in service education required as per hospital policy.
- Responsible to maintain courteous environment.
- To supervise and allocate responsibilities to level 6.

- To ensure implementation of quality control and quality assurance procedures as per requirements including calibration of instrument.

For Teaching Institutes only

- Teaching & training Undergraduate Medical Laboratory Science students including Interns/ and short term trainees, so as to achieve the Educational Objectives i.e. to develop their knowledge, skills & attitude.
- To assist the Assoc., Add. Professors / Professors / heads of the department to do periodic evaluation / assessment through examination/to conduct examination/to maintain attendance & academic (including Internship) record of individual Undergraduate, Interns & Postgraduate student for the minimum period as per Govt. rules.
- To work on the College Council , Undergraduate & Postgraduate Academic Committees , Medical Education Teaching Technology Cell , Library Committee of the College and to organize / participate in teaching programmes like Lectures / Tutorials/Group Discussions Demonstrations/ Practical and other academic activities like Seminars / Symposia / Panel Discussions / Workshops / Guest Lectures / Conferences / Continuing Medical Education Programmes etc. and to maintain a Departmental Library for students as well as teaching staff.
- If Eligible for Examiner-ship, To participate in conduct of academic and practical Examinations as an External Examiner/ undertake any task on “Inspection Committee” for inspection of institutes in other States / Universities / National Board / “Local Inquiry Committee” under the Dean /Principal availing the facility of Special Leave .
- To conduct Research Projects and contribute to medical knowledge by scientific paper publications in indexed journals & their presentation at various local / state / international Conferences.
- To work on various Students’ Welfare-related Committees like “Anti-Ragging Committee” and to enforce discipline among medical students.

For Teaching Institutes and Hospitals

In addition to the teaching as mentioned above Assistant Professor shall perform as under:

- To perform all such duties to ensure continued enhancement in the quality of patient care through efficient Health care delivery system.
- To assist the associate professors/professors/heads of the department in Complete management of a full-time Unit in such a way that there is no “Medical Negligence” in patient care service as a result of breach / violation / infringement of any Act / code of professional ethics which brings disgrace to the reputation of the Institute / Hospital.
- It is binding to attend to emergency calls as and when required even beyond duty hours.
- To provide the laboratory records as and when required by the administration.
- To suggest / recommend use of certain managerial tools / techniques / skills to upgrade the quality of patient care services.
- To ensure implementation of quality control and quality assurance procedures as per requirements including calibration of instrument.

Administrative Responsibilities: In addition to the teaching and hospital services as mentioned above Assistant Professor shall perform as under:

- To assist the HOD/Professor, Assistant Prof. shall perform all such duties to ensure continued enhancement in the quality of performance of teaching as well as non-teaching staff of the department.
- Planning, proposing, processing the proposals, procuring & maintaining plant & machinery, equipment & instruments, Furniture & Fixtures (Dead Stock) and to maintain record of all such items in the custody of the Department.
- To work on various Hospital Committees like Local Tender Committee, Theatre Committee, Hospital Infection Control Committee, Grievance Committee, Sexual Harassment Committee etc.
- To exercise authority in Administrative control of the Department:
- To recommend or refuse any kind of Leave (Casual Leave/Special Leave /Earned Leave) to any staff member of the Dept. as per rules or punctuality in respect of a defaulting employee.
- To serve a memorandum to the undisciplined employee giving him / her a chance to improve.
- To organize / conduct / encourage “Core Competency Development Programmes” for Faculty Development; also training programmes for other non-teaching staff of the Dept.
- Whenever ordered by the higher authorities, to conduct “Preliminary Inquiry” into a particular untoward incidence or in respect of a particular employee and to submit report in time as per the rules.

Level 7 - Job responsibilities of Technical Manager:

Technical Manager shall supervise the responsibilities of Deputy Technical manager, take corrective and preventive action as and when required and will report to Deputy Quality Manager.

Level 8- Job responsibilities of Medical Laboratory Scientist (Grade D)/Associate Professor For Non-Teaching

In addition to supervisory responsibilities of level 7, level 8 (MLS Gr. D) will perform as under:

- To ensure implementation of external quality control procedures as per WHO/ International accreditation norms.
- Sorting of anomalies and Discrepancies if any in Validation and cross checking report results of tests performed.
- Ensures orientation and training of students/ new recruits.
- Participation in Research and development.
- Attend all in service refresher courses/ Workshops.
- To supervise and allocate responsibilities to level 7.

For Teaching Institutes only

To perform all such duties to ensure continued improvement in the quality of Medical Education & Research.

- Teaching & training Undergraduate students including Interns/ Postgraduate students so as to achieve the Educational Objectives i.e. to develop their knowledge, skills & attitude.
- To do periodic evaluation / assessment through examination/to conduct examination/to maintain attendance & academic (including Internship) record of individual Undergraduate & Postgraduate student for the minimum period as per Govt. rules.
- To work on the College Council , Undergraduate & Postgraduate Academic Committees , Medical Education , Library Committee , to organize / participate in teaching programmes

like Lectures / Tutorials/Group Discussions Demonstrations/ Practical and other academic activities like Seminars / Symposia / Panel Discussions / Workshops / Guest Lectures / Conferences / Continuing Medical Education Programmes etc. and to maintain a

- Departmental Library for students as well as teaching staff.
- To participate in conduct academic Examinations of other State Health Universities / National Board as an External Examiner with the permission / under the direction of the Dean availing the facility of Special leave.
- To undertake any task entrusted by AHP Board like working on “Inspection Committee” for inspection of Colleges in other States with the permission of the Principal/Dean/Director.
- To undertake any other task entrusted by University/ Institute like working on “Local Inquiry Committee” for inspection of Colleges.
- To conduct Research Projects – clinical research, and contribute to medical knowledge by scientific paper publications in indexed journals & their presentation at various local / state / international Conferences.
- To work on various Research-related Committees like Ethics Committee , Research Society of the institute
- To work on various Students’ Welfare-related Committees like “Anti-Ragging Committee” and to enforce discipline among medical students.

For Teaching Institutes/ Hospitals

In addition to the teaching as mentioned above Associate Professor shall perform as under:

- To perform all such duties to ensure continued enhancement in the quality of patient care through efficient Health care delivery system.
- In Complete management of a Full-time Unit in such a way that there is no “Negligence” in patient care service as a result of breach / violation / infringement of any Act / Code of professional ethics which brings disgrace to the reputation of the Institute / Hospital.
- It is binding to attend to Emergency calls as and when required even beyond duty hours.
- To provide the laboratory records as and when required by the Administration.
- To suggest / recommend use of certain managerial tools / techniques / skills to upgrade the quality of patient care services.
- To ensure implementation of quality control and quality assurance procedures as per requirements including calibration of instrument.
- Supervise the Work of Assistant Professors, Students

Administrative Responsibilities: In addition to the teaching and hospital services as mentioned above Associate Professor shall perform as under:

- To assist the head of the department perform all such duties to ensure continued enhancement in the quality of performance of teaching as well as non-teaching staff of the Department.
- Planning, proposing, processing the proposals, procuring & to supervise maintenance of equipment & instruments.
- To work on various Hospital/Institute Committees like Local Tender Committee, Hospital Infection Control Committee, Grievance Committee, Sexual Harassment Committee etc.
- To exercise authority in Administrative control of the Department:
- To maintain ‘Personal Files’ of all teaching as well as non-teaching staff of the Dept.

- To recommend or refuse any kind of Leave (Casual Leave/Special Leave/Earned Leave to any staff member of the Dept. as per rules in that regard.
- To maintain Muster Roll of teaching as well as non-teaching staff of the Department; to conduct periodic audit of the timings of arrival / departure of the staff; to mark any Sanctioned Leave or Absence Without Leave (AWL) – which is Unauthorized Absence – of the employee as the case may be and to report to the Competent Leave sanctioning Authority i.e. Dean, any irregularity in attendance or punctuality in respect of a defaulting employee.
- To serve a memorandum to the undisciplined employee giving him / her a chance to improve.
- To write annual ‘Confidential Report’ (Performance Appraisal /Work Audit) of the employees working in the Dept. as well as your own “Self-Appraisal / Assessment” as per the guiding principles in that regard; to inform the erring member about the adverse remarks, if any, immediately through a memorandum.
- To organize / conduct / encourage “Core Competency Development Programmes” for Faculty Development; also training programmes for other non-teaching staff of the Dept.
- Whenever ordered by the higher authorities , to conduct “Preliminary Inquiry” into a particular untoward incidence or in respect of a particular employee and to submit report in time as per the rules in that regard.

Level 8 - Job responsibilities of Deputy Quality Manager:

Deputy Quality Manager shall supervise the responsibilities of Technical manager, ensure corrective and preventive action as and when required and will report to Quality Manager. Some specific responsibilities of Deputy Quality Manager shall be as follows:

- To ensure timely calibration, preventive maintenance of equipment and check daily user maintenance of equipment.
- To promote policies for adopting alternative measures in case of equipment breakdown or runs out of calibration.
- To look after document control under supervision of Quality manager.
- Monitoring the house keeping activity to check the compliance of universal safety precautions.
- To plan and co-ordinate internal quality audits every six months and submit a periodic report to QM.
- To establish policies and procedures for control of laboratory documents as per quality system for documentation.
- To assist DQM-1 in document control
- To ensure competency evaluation, training and retraining of the personnel if the corrective action results in change of policies or procedures.

Level 9 - Job responsibilities of Medical Laboratory Scientist (Grade E)/Additional Professor

For Non-Teaching

In addition to level 8 responsibilities, level 9 (MLS Gr. E) will perform as under:

- Sorting of anomalies and Discrepancies if any in Breakdown of Instruments and Maintenance Contracts.
- Ensures overall performance of Laboratory as per Good Laboratory Practice (GLP).

- Attend and organize various in-service Workshops and up gradation required from time to time.
- To direct and allocate responsibilities to staff through level 8.
- To undertake any task entrusted by AHP Board like working on “Inspection Committee” for Laboratories in other Institutes/Hospitals with the permission of the Principal/Dean /Director or any other competent authority.
- Participation and to ensure Research and development i.e. Research Projects & their presentation at various National/ international Conferences and its publication and to participate in various “Research committees.”
- To undertake any other task entrusted by University/ Institute like working on “Local Inquiry Committee”, “Ethics Committee”, and “Staff Welfare-related Committees” and to enforce discipline among departmental staff.

For Teaching Institutes only

- To perform all such duties to ensure continued improvement in the quality of Medical Education & Research.
- Teaching & training Undergraduate students including Interns/ Postgraduate students so as to achieve the Educational Objectives i.e. to develop their knowledge, skills & attitude.
- To do periodic evaluation / assessment through examination/to conduct examination/to maintain attendance & academic (including Internship) record of individual Undergraduate & Postgraduate student for the minimum period as per Govt. rules.
- To work on the College Council , Undergraduate & Postgraduate Academic Committees , Medical Education , Library Committee , to organize / participate in teaching programmes like Lectures / Tutorials/Group Discussions Demonstrations/ practical and other academic activities like Seminars / Symposia / Panel Discussions / Workshops / Guest Lectures / Conferences / Continuing Medical Education Programmes etc. and to maintain a
- Departmental Library for students as well as teaching staff.
- To participate in conduct academic Examinations of other State Health Universities / National Board as an External Examiner with the permission / under the direction of the Dean availing the facility of Special leave.
- To undertake any task entrusted by AHP Board like working on “Inspection Committee” for inspection of Colleges in other States with the permission of the Principal/Dean/Director.
- To undertake any other task entrusted by University/ Institute like working on “Local Inquiry Committee” for inspection of Colleges.
- To conduct Research Projects – clinical research, and contribute to medical knowledge by scientific paper publications in indexed journals & their presentation at various local / state / international Conferences.
- To work on various Research-related Committees like Ethics Committee, Research Society of the institute.
- To work on various Students’ Welfare-related Committees like “Anti-Ragging Committee” and to enforce discipline among medical students.

For Teaching Institutes/ Hospitals

In addition to teaching, as mentioned above, Professor shall perform as under:

- To perform all such duties to ensure continued enhancement in the quality of patient care through efficient Health care delivery system.

- In Complete management of a Full-time Unit in such a way that there is no “Negligence” in patient care service as a result of breach / violation / infringement of any Act / Code of professional ethics which brings disgrace to the reputation of the Institute / Hospital.
- It is binding to attend to Emergency calls as and when required even beyond duty hours.
- To provide the laboratory records as and when required by the Administration.
- To suggest / recommend use of certain managerial tools / techniques / skills to upgrade the quality of patient care services.
- To ensure implementation of quality control and quality assurance procedures as per requirements including calibration of instrument.
- Supervise the Work of Assistant Professors, Students

Administrative Responsibilities: In addition to the teaching and hospital services as mentioned above Professor shall perform as under:

- To assist the head of the department perform all such duties to ensure continued enhancement in the quality of performance of teaching as well as non-teaching staff of the Department.
- Planning, proposing, processing the proposals, procuring & to supervise maintenance of equipment & instruments.
- To work on various Hospital/Institute Committees like Local Tender Committee, Hospital Infection Control Committee, Grievance Committee, Sexual Harassment Committee etc.
- To exercise authority in Administrative control of the Department :
- To maintain ‘Personal Files’ of all teaching as well as non-teaching staff of the Dept.
- To recommend or refuse any kind of Leave (Casual Leave/Special Leave/Earned Leave to any staff member of the Dept. as per rules in that regard.
- To maintain Muster Roll of teaching as well as non-teaching staff of the Department; to conduct periodic audit of the timings of arrival / departure of the staff; to mark any Sanctioned Leave or Absence Without Leave (AWL) – which is Unauthorized Absence – of the employee as the case may be and to report to the Competent Leave sanctioning Authority i.e. Dean, any irregularity in attendance or punctuality in respect of a defaulting employee.
- To serve a memorandum to the undisciplined employee giving him / her a chance to improve.
- To write annual ‘Confidential Report’ (Performance Appraisal / Work Audit) of the employees working in the Dept. as well as your own “Self-Appraisal / Assessment” as per the guiding principles in that regard; to inform the erring member about the adverse remarks, if any, immediately through a memorandum.
- To organize / conduct / encourage “Core Competency Development Programmes” for Faculty Development; also training programmes for other non-teaching staff of the Dept.
- Whenever ordered by the higher authorities, to conduct “Preliminary Inquiry” into a particular untoward incidence or in respect of a particular employee and to submit report in time as per the rules in that regard.

Level 9 - Job responsibilities of Quality Manager:

Quality Manager shall supervise the responsibilities of Deputy Quality Manager and shall be responsible for implementation of total quality management system in Medical Laboratory Services

and will report to Laboratory Director/HOD. Some specific responsibilities of Quality Manager shall be as follows:

- Ensuring that processes needed for the quality management system are established, implemented, and maintained;
- Communicating Management's commitment for the development and implementation of the QMS and their importance of meeting patients/clinicians requirements as well as statutory and regulatory requirements to the staff.
- Reporting to laboratory management, at the level at which decisions are made on laboratory policy, objectives, and resources, on the performance of the quality management system and any need for improvement;
- Ensuring the promotion of awareness of users' needs and requirements throughout the laboratory organization.
- Ensure that the integrity of management system is maintained when changes to the management system are planned and implemented
- Implement Good Laboratory Practice (GLP) by providing instructions and training as needed, develops work plan and procedures and requires that these be followed in all day to day operations of the laboratory
- To ensure client confidentiality.
- Preparation and review of scope for accreditation
- Preparation and review of quality manual for accreditation
- To prepare the format of SOPs
- To ensure continued accreditation of the laboratory
- Formulating new procedures as may be necessary; to review or approve the review of the existing procedures followed by their update and amendment
- To co-ordinate with SICs for EQAS and Inter-laboratory comparisons
- Application to and in general co-ordination with NABL
- To arrange and prepare for Management Review Meetings (MRMs)
- Attests, by signature, to the validity of all laboratory tests and reports or maintain a list of approved or authorized signatories of the laboratory.
- To ensure completion of corrective actions on Non-conformities raised during internal and/or external audits. To ensure the review and periodical compliance of these corrective actions.
- To document client complaints and address them in MRM and seek opinion for repetition of the same.
- To ensure and coordinate with HOD, the training, supervision, evaluation and recording the assessment.
- To establish policies and procedures for control of laboratory documents as per quality system for documentation.
- To ensure competency evaluation, training and retraining of the personnel if the corrective action results in change of policies or procedures.

Level 10 - Job responsibilities of Medical Laboratory Scientist (Grade F, G and H)/ Director Professor/Principal/ HOD/Director Laboratory Services

- **Overall operation and administration-** Take responsibility for overall operation and administration of lab, including employment of personnel competent to perform test procedures, record.

- **Definition/retention of others' duties-** If desired, delegate / Specify / reapportion, in writing responsibilities, authorities and duties of each consultant/Medical Laboratory Scientist and person engaged in any phase of testing.
- **Licensure and accreditation** - Assure compliance with applicable regulations.
- Personnel Management & Authorization
- Identify which examinations and procedures each individual is authorized to perform.
- Training & Competency Assessment
- Ensure all personnel have appropriate education, experience and training for type & complexity of services, in order to perform testing reliably and report accurate results.
- Supervision
- Ensure on-site supervision of high complexity testing. Identify supervision required for specimen processing, test performance or result reporting. Identify supervisory or director review required prior to reporting patient test results.
- Adequate and Appropriate Staffing
- Employ sufficient/appropriate personnel with education, training, and experience to provide consultation, supervise and perform tests, and report test results.
- Monitoring Competency
- Ensure policies and procedures for monitoring individuals to assure competency and to assure identification of needs for remedial training or continuing education.
- Facilities & Safety
- Ensure physical and environmental conditions are appropriate and provide a safe environment in which employees are protected from physical, chemical, and biological hazards.
- Quality Management System
- Ensure that all the services of the laboratory are as per Quality Management system which includes: Quality control, Quality assurance, Quality improvement, proficiency testing etc. etc.
- Interaction with others
- Relate and function effectively with accrediting regulatory agencies, administrative officials, medical community, medical device industry, and patient population.
- Strategic Planning
- Perform planning for setting goals and developing and allocating resources appropriate to Institute/hospital/laboratory environment i.e. Operational Management + Financial Management + Administrative Management.
- Administration and Management
- Provide effective and efficient administration, including budget planning and control with responsible financial management. Define, implement, and monitor standards of performance in cost-effectiveness of lab services.
- Research and Development
- Plan and direct research and development appropriate to the facility.
- Education
- Ensure proper planning and implementation of teaching system for Medical laboratory students/staff, and participate in educational programs of the institution.

List of Allied Health Professionals

1. Anesthesia assistants and technologist
2. Behavioral therapist
3. Biomedical engineers and technologist
4. Biostatisticians (non-medical)
5. Cardiovascular technologist
6. Clinical social worker
7. Counselor- Integrated behavioral health counselors, Palliative counselors, mental health support workers etc.
8. Critical care/ICU technologist
9. Dialysis therapy technologist
10. Dietitian
11. ECG technologist
12. ECHO technologist
13. EEG/END technologist
14. Emergency medical technologist (Paramedic)
15. EMG technologist
16. Endoscopy technologist
17. Environmental health specialists (non-medical)
18. Epidemiologists (non-medical)
19. Forensic technologist
20. Geriatric aide
21. Health educators (disease counselors, diabetes educators, lactation consultants etc.)
22. Health management information system managers (Medical records)
23. Home health aide
24. Hospital managers
25. Kinesiotherapist
26. Medical Laboratory Professionals
 - a) Medical Laboratory Technologist (Graduate in MLS)
 - b) Medical Laboratory Scientist (Master & Doctorate in MLS)
27. Medical assistant
28. Medical dosimetrist
29. Medical illustrator
30. Medical physicist
31. Medical secretaries
32. Medical transcriptionist
33. Neuro lab technologist
34. Neurophysiologist
35. Nuclear medicine technologist
36. Nutritionist
37. Occupational therapist
38. Oncology care assistant
39. Ophthalmic assistants
40. Optometrist
41. OT technologist

42. Perfusionist
43. Phlebotomist
44. Physician associates and assistants
45. Physiotherapist
46. Podiatry assistants
47. Pulmonary function (PFT) technologist
48. Radiologic /Imaging technologist (including Medical Sonography, Radiographer, MRI,CT, Mammography technologists)
49. Radiotherapy technologist
50. Respiratory therapist
51. Sanitary health inspectors
52. Sleep lab technologist
53. Sterilization aide (CSSD technician)
54. Urology technologist

References:

- ¹Narayan, K Kar, S Gupta, N. From 'Paramedics' to 'Allied Health Professionals': Landscaping the Journey and Way Forward. Public Health Foundation of India: New Delhi, India, 2012.
- ² Allied Health Professions Federation. AHPs involvement in health and social care 2011. Available from: http://www.ahpf.org.uk/files/ahpf_gov_briefing_v7_09-05-11.pdf.
- ³ Narayan. K. How many doctors it takes to fix India's healthcare glitches? Deccan Herald [Internet]. 2014. Available from: <http://www.deccanherald.com/content/381371/how-many-doctors-takes-fix.html>.
- ⁴ Introduction to clerkship 1999. Available from: https://umanitoba.ca/faculties/medicine/media/mission_goals_object_class_2011.pdf.
- ⁵ Standards of practice for ACT Allied Health Professionals 2005. Available from: <http://health.act.gov.au/c/health?a=dlpubpoldoc&document=863>.
- ⁶ Pamela Mitchell et al. Core principles and values of effective team based healthcare 2012. Available from: <https://www.nationalahec.org/pdfs/VSRT-Team-Based-Care-Principles-values.pdf>.
- ⁷ Professionalism in nursing, midwifery and the allied health professions in Scotland. Scottish Government, 2012 978-1-78045-925-7.
- ⁸ Nursing & Midwifery Council .Standards for competence for registered nurses. Available from: <http://www.nmc-uk.org/Documents/Standards/Standards%20for%20competence.pdf>.
- ⁹ Social Accountability- A vision for Canadian medical schools Available from: https://www.afmc.ca/fmec/pdf/sa_vision_canadian_medical_schools_en.pdf.
- ¹⁰ University of Manitoba. Faculty of medicine teaching handbook 2004. Available from: umanitoba.ca/faculties/medicine/media/teaching_handbook04.doc.
- ¹¹ Medical Council of India. Vision 2015. Published March 2011. Available from: http://www.mciindia.org/tools/announcement/MCI_booklet.pdf.
- ¹² Sherwin J. Competency-Based Medical Education Takes Shape 2011. Available from: https://www.aamc.org/newsroom/reporter/april11/184286/competency-based_medical_education.html.
- ¹³ Bushway D, Everhart D. Investing in Quality Competency-Based Education 2014. Available from: <http://www.educause.edu/ero/article/investing-quality-competency-based-education>.
- ¹⁴ Brookfield, S. D. Self-Directed Learning In: YMCA George Williams College ICE301 Lifelong learning Unit 1 Approaching lifelong learning. London: YMCA George Williams College; 1994.
- ¹⁵ Ramnarayan K, Hande S. Thoughts on Self-Directed Learning in Medical Schools: Making Students More Responsible 2005. Available from: <http://education.jhu.edu/PD/newhorizons/lifelonglearning/higher-education/medical-schools/>.
- ¹⁶ Harvey, B. J., Rothman, A. I., Frecker, R.C. Effect of an undergraduate medical curriculum on students' self-directed learning. Academic Medicine. 2003; 78(12): 1259-65.
- ¹⁷ Credit-Based-Grading-System for Assessment of Students. Available from: http://www.presiuniv.ac.in/web/exam_assessment.php.
- ¹⁸ Manual on semester based, credit and grading system Mumbai: University of Mumbai 2011. Available from: http://www.mu.ac.in/1_Manual_SCGS_Arts_09-06-2011.pdf.
- ¹⁹ Vertical Integration 2015. Available from: <http://www.mcw.edu/Medical-School/Curriculum/Traditional-Curriculum/Vertical-Integration.htm>.
- ²⁰ Baker D, Day R, Salas E. Teamwork as an essential component of high reliability organisations. Health Services Research. 2006; 41(4):1576-98.
- ²¹ Srinivas, D.K. Adkoli, B.V. Faculty Development in Medical Education in India: The Need of the Day. Al Ameen J Med Sci (2009)2 (1):6-13. Available at: <http://www.alameenmedical.org/ajms/ArticlePDFs/AJMS3.6-13.pdf>

ADDITIONAL REFERENCES FOR THE TECHNICAL CONTENT DRAWN FROM THE FOLLOWING:

22. Objective structured clinical examination 2010. Available from: http://en.wikipedia.org/wiki/Objective_structured_clinical_examination
23. Enhancing youth employability: the importance of core work skills. Skills for employment: policy brief [Internet]. 2013. Available from: http://www.ilo.org/wcmsp5/groups/public/---ed_emp/--ifp_skills/documents/publication/wcms_234467.pdf
24. Diploma in Medical Laboratory Technology [internet] [cited 2014 Sep 20]. Available from: <http://web.tnmgrmu.ac.in/syllabus/alliedhealth/dmltsyllabus.pdf>
25. Diploma in Medical Laboratory Technology [internet] [cited 2014 Sep 18]. Available from: http://www.iaseuniversity.org.in/syllabus/de_syl/DMLT.pdf.

26. Fremgen B, Frucht S. Medical Terminology: A Living Language: Pearson Education, Inc. Available from: http://www.ogeecheetech.edu/docs/d_Programs/AlliedHealth/Syllabi/ALHS1090.pdf
27. Kong-lung H. Law and ethics in medical practice: An Overview. 2003; 8. Available from: www.fmshk.org/article/746.pdf.
28. Texas Intensive English Program2014. Available from: <https://www.tiep.edu/intensive-programs/>.
29. Mittal R, Mahajan R, Mittal N. Foundation programme: A student's perspective. International Journal of Applied and Basic Medical Research. 2013; 3(1):52-4. Epub 10.4103/2229-516X.112241.
30. Curriculum for Medical Laboratory Technology. Available from: Directorate General of Health Services.
31. Regulations & curriculum for Bachelor of Science degree courses in allied health science [internet] [cited 2014 Sep 25]. Available from: <http://www.rguhs.ac.in/cdc/alliedhealth/bmlt.pdf>
32. Syllabus for Bachelor of Science degree courses [internet] [cited 2014 Sep 25]. Available from: http://de.nimsuniversity.org/wp-content/uploads/2012/12/BMLT_SYLLABUS.pdf?51550b
33. Detailed syllabus for distance education under graduate degree program Bachelor of Science – medical laboratory technology (bmlt) [internet] [cited 2014 Sep 22]. Available from: http://www.iaseuniversity.org.in/syllabus/de_syl/BMLT.pdf
34. Curriculum for medical laboratory technology course [internet] [cited 2014 Sep 24]. Available from: <https://www.drexelmed.edu/Home/AbouttheCollege/DepartmentsCentersandInstitutes/ClinicalDepts/PathologyandLaboratoryMedicine.aspx>
35. University of Pune Three Year B. Sc. Degree Course in MICROBIOLOGY Syllabus [internet]. [Cited 2014 Sep 15]. Available from:http://www.unipune.ac.in/Syllabi_PDF/revised_2013/sci/18_F.Y.B.Sc.%20Microbiology.pdf
36. Amity Institute of Virology and Immunology Curriculum [internet] [cited 2014 Sep 21]. Available from: <http://www.amity.edu/aivi/Curriculum.asp>
37. www.jfmti.com
38. www.pgimer.edu.in
39. www.ibms.org
40. www.ifbls.org
41. www.lpu.inLovely Professional University, Phagwara, Punjab
42. Indian Confederation of Medical Laboratory Science (ICMLS) weblink
43. International Committee for Standardization & Augmentation of Clinical Lab Professions (InCoSALP)
44. Rajasthan University of Health Science-website
45. <https://www.ptu.ac.in/>Punjab Technical University, Kapurthala, Punjab

DETAILS OF INVOLVED/RESPONSIBLE OFFICERS AT THE MINISTRY OF HEALTH AND FAMILY WELFARE (MOHFW)

1. Mr. Arun Singhal, Joint Secretary (Human Resource)
2. Mr Ali R.Rizvi, Joint Secretary (Human Resource)- Former
3. Mr B. Sriramachandra Murthy, Director (Allied Health Section)
4. Mr Satish Kumar, Under Secretary (Allied Health Section)

National Initiative for Allied Health Sciences – Technical Support Unit (NIAHS – TSU)

1. Ms Kavita Narayan, *FACHE*, Director, NIAHS-TSU at MoHFW, GoI
2. Ms Shivangini Kar Dave , Project Lead Coordinator
3. Ms Natasha D'Lima, Program Coordinator
4. Ms Namita Gupta, Consultant
5. Mr Sutirtha Mazumder, Senior Research Assistant
6. Mr Ashish Arora, Senior Research Assistant (former)
7. Ms Tanu Sri Sahu, Senior Research Assistant
8. Mr Akhilendra Trivedi, Senior Research Assistant
9. Mr Vivek Bhatnagar, Senior Research Assistant
10. Mr Anirooddha Mukherjee, Research Assistant

For additional details or queries, please contact:

1. Mr Uttam Sengupta, SO (AHS),
Room 539 – A,
Nirman Bhavan, New Delhi 110001.
Phone: 23061182, Email: ahssection@gmail.com
2. NIAHS TSU,
Facilitation Centre, Near Gate No 5,
Nirman Bhavan, New Delhi 110001.
Phone: 011-23061751, Email: ahpsforindia@gmail.com

MINISTRY OF HEALTH AND FAMILY WELFARE
National Initiative for Allied Health Sciences (NIAHS)
Technical Support Unit (NIAHS – TSU)
Nirman Bhawan, New Delhi 110001.