Review Article

Training for laboratory medicine in India

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ABSTRACT

Laboratory medicine education is crucial in India for enhancing accurate diagnoses, improving clinical decision-making, and ensuring quality patient care, especially in the face of a growing demand for skilled professionals to detect complex diseases like cancer and infectious illnesses. It provides hands-on skills for laboratory technologists, fosters interdisciplinary collaboration among healthcare providers, and helps bridge the existing gap in diagnostic healthcare services, particularly in rural and underserved areas. This education is vital for making laboratory services accessible, affordable, and reliable, ultimately reducing errors, improving health outcomes, and supporting the overall development of India's healthcare system. This review summarizes the recognized available options, for medical and non-medical professionals, in laboratory medicine, from undergraduate to postgraduate level. Career prospects of the course as well as the major institutions offering the course in India are also summarized.

Keywords: India; Training; Laboratory Medicine

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Introduction

India offers various levels of training in Laboratory Medicine, catering to different career aspirations and academic backgrounds. Laboratory Medicine training is important for improving diagnostic accuracy and patient care. Training in laboratory medicine equips physicians and technologists to interpret diagnostic results accurately, leading to more informed and effective patient management. It also provides the skills to conduct tests for a wide range of conditions, including infections, chronic diseases, blood disorders, and organ function issues. In addition, a strong foundation in laboratory medicine helps minimize pre-analytical, analytical, and post-analytical errors, thereby improving patient safety.

Laboratory medicine also addresses Healthcare System Needs. Many remote and small hospitals in India lack qualified personnel. Laboratory medicine education, particularly at the postgraduate level, creates a workforce capable of managing diagnostic facilities in these underserved areas. By developing accessible, affordable, and quality-assured laboratory services, education in this field makes timely and reliable diagnosis available to a larger population. Furthermore, the increasing complexity of diseases necessitates a larger number of skilled medical laboratory professionals, a demand that can be met through enhanced and improved training programs.

Laboratory medicine also enhances skills and collaboration. Hands-on training in laboratory medicine develops essential competencies, including sample collection, processing, and the interpretation of results. In addition, the discipline promotes teamwork and collaboration between various healthcare professionals, such as clinicians, pathologists, and laboratory technologists, which is vital for effective patient care. Education often incorporates problem-based learning through case studies, which helps students develop analytical and problem-solving skills.

Laboratory medicine education

A variety of undergraduate and postgraduate courses are available for both medical and non-medical professionals in India.

Diploma and bachelor's degrees

- Diploma in Medical Laboratory Technology (DMLT): This is typically a 2-year diploma course after completing the 12th standard (Science stream). It provides foundational knowledge and practical skills in basic laboratory techniques like microbiology, pathology, and hematology.
- Bachelor of Science in Medical Laboratory Technology (BMLT/BSc MLT): This is a 3-year undergraduate degree program requiring completion of 12th standard (Science stream with Physics, Chemistry, and Biology). It offers a more in-depth curriculum covering a wider range of lab techniques, biomedical research, and clinical skills.

Postgraduate degrees

- MD Pathology: A postgraduate medical degree (Doctor of Medicine) that requires an MBBS degree as a prerequisite. The program duration is usually 3 years, focusing on diagnosing diseases by examining tissues, blood, and body fluids.
- MD Laboratory Medicine: This is another postgraduate level course (3 years duration) for doctors after completing their MBBS. It focuses on advanced diagnostic procedures, laboratory management, and patient follow-up, covering aspects of pathology, biochemistry, microbiology, immunology, and molecular biology.

Super specialization

- DM (Clinical Immunology and Rheumatology): This is a 3-year super-specialization course focusing on diagnosing and managing immunological and rheumatic diseases. Eligibility requires holding an MD degree in General Medicine or MD in Pediatrics, along with qualifying for the NEET SS (Super Specialty) entrance examination.

Other DM options: Specializations like Neuropathology and Immunology can be pursued as super-specializations after an MD Pathology.

MD/PhD Programs

Other training and certifications

- Fellowships: Various national institutes offer specialized fellowships in areas like neuropathology, nephropathology, molecular hematology, hematopathology, cytopathology, and oncopathology. These fellowships are often competitive, involving entrance exams and interviews.
- Post Doctoral Fellowships: Programs like the Post Doctoral Fellowship in Laboratory Immunology and Molecular Laboratory Hematology are available for those with MDs in Pathology, Microbiology, or Biochemistry.
- PhD Programs: PhD in Biochemistry (Clinical Biochemistry) and Microbiology (Clinical Microbiology) are available to postgraduates in biological sciences or medical graduates/postgraduates. Eligibility usually requires a Master's degree with a minimum of 55% aggregate marks and selection is based on an entrance examination and interview.

DMLT (Diploma in Medical Laboratory Technology)

DMLT is a 2-year paramedical course in India that trains students to work as laboratory technicians (1-11). They perform diagnostic tests on various body fluids to help doctors detect, diagnose, and treat diseases.

Course details

Eligibility: The primary requirement is to pass the 10+2 examination, typically in the science stream

(Physics, Chemistry, and Biology), with a minimum of 45–50% aggregate marks.

Duration: 2 years, often divided into four semesters. Some universities may offer a 3-year diploma.

Syllabus: The curriculum covers a wide range of subjects, including Anatomy and Physiology, Biochemistry, Microbiology, Pathology (including Hematology, Histology, and Cytology), Blood Banking

Admission process: Admission is generally based on merit from the 10+2 marks, though some colleges may conduct an entrance exam.

Job opportunities: Hospitals and clinics: Government and private healthcare facilities, diagnostic and pathology labs: Standalone laboratories, blood banks: For blood collection and testing, research and development (R&D) centres: Both government and private, pharmaceutical companies: in quality control and research departments, and public health programs and NGOs

Starting salary: Averages between ₹2.5 and ₹4 LPA for freshers.

Career advancement: Graduates can pursue a Bachelor's in Medical Laboratory Technology (BMLT or B.Sc. MLT) for advanced roles and specialization.

Institutes offering DMLT programs include:

- Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh
- Christian Medical College (CMC), Vellore
- Sanjay Gandhi Postgraduate Institute of Medical Sciences (SGPGIMS), Lucknow
- Delhi Pharmaceutical Sciences and Research University (DPSRU), New Delhi
- Institute of Public Health and Hygiene, New Delhi
- State-specific colleges: For example, medical colleges in Thiruvananthapuram, Kozhikode, and Kottayam offer DMLT programs in Kerala.

BSc MLT (BSc in Medical Laboratory Technology)

A BSc in Medical Laboratory Technology (MLT) in India is a 3- to 4-year undergraduate program that trains students in diagnostic lab techniques (16-20). Admissions are based on merit or entrance exams, and graduates find careers in hospitals, diagnostic labs, and research centers.

Course details

Duration: 3 years (6 semesters), with some institutions including an additional 6–12 months of mandatory internship.

Eligibility: Pass Class 12 in the science stream (Physics, Chemistry, and Biology) from a recognized board, with at least 50% aggregate marks. Some colleges also accept Mathematics.

Admission: Primarily based on Class 12 merit, though some top institutions require entrance exams like the Common University Entrance Test (CUET).

Syllabus: The curriculum is a mix of theoretical knowledge and hands-on practical training.

First year: Human Anatomy, Physiology, Biochemistry, Microbiology, and General Pathology.

Second year: Clinical Biochemistry, Clinical Hematology, Immunology and Serology, and Systemic Microbiology.

Third year: Histopathology, Cytology, Clinical Endocrinology, Parasitology, Virology, and Medical Ethics.

Career scope: Graduates can work in government and private hospitals, diagnostic labs, blood banks, research institutions, and pharmaceutical companies.

Salary expectations: Salaries vary widely based on experience, sector (government vs. private), and location. For freshers (0–2 years): Annual salaries typically range from ₹2.5 to ₹4 Lakhs. For mid-level professionals (3–7 years): Annual salaries can increase to ₹4 to ₹6.5 Lakhs. For senior-level professionals (8+ years): With advanced degrees or specializations, earnings can rise to ₹8 Lakhs or more per annum.

Higher studies: After completing a BSc MLT, it is possible to pursue higher education in one of the following areas.

- Master of Science (MSc) in MLT: Specializations include Microbiology, Clinical Biochemistry, and Hematology.
- PG Diploma courses: Options are available in fields such as Clinical Research.
- Ph.D. in Laboratory Medicine: For those interested in advanced research and academia.

MD Laboratory Medicine

MD in Laboratory Medicine is a three-year postgraduate course in India focused on laboratory diagnostics after completing an MBBS degree (21-37). This specialization aims to train doctors in performing state-of-the-art diagnostic procedures, managing laboratory operations, and ensuring quality control. The curriculum covers a wide range of laboratory-based diagnostics, including biochemistry, hematology, microbiology, immunology, endocrinology, and molecular diagnostics. Graduates are trained as "laboratory physicians of first contact" capable of optimizing test selection, operation, and interpretation to provide comprehensive and high-quality reports to clinicians and patients.

Eligibility: Candidates must have an MBBS degree from an MCI-recognized university. One year of compulsory rotating internship completion is required. Also, permanent registration with a State Medical Council is mandatory.

Admission Process: Admission is primarily based on the National Eligibility cum Entrance Test (NEET PG) scores, followed by counselling conducted by central or state authorities.

Fees: The average annual course fee can range from ₹40,000 to ₹10 Lakh, varying across colleges.

Employment Opportunities: Graduates can find opportunities in various settings, including government

hospitals and institutions (e.g., Registrar, Senior Resident, Demonstrator), private sector hospitals and diagnostic centers (e.g., Consultant, Resident Doctor, Specialist) and academic positions (teaching and research).

Potential Salary: The average salary for MD Laboratory Medicine postgraduates ranges from ₹10 Lakh to ₹40 Lakh per annum.

Further Studies: MD Laboratory Medicine serves as a feeder qualification for super-specialty courses recognized by the National Medical Commission (NMC).

Institutions offering MD in Laboratory Medicine

- Currently, the MD in Laboratory Medicine program is primarily offered by AIIMS, New Delhi.
- Other medical colleges across India are expected to introduce the course in the future, subject to fulfilling the requirements set by the NMC.

MD/PhD Program

MD-PhD programs in India are offered at leading institutions like AIIMS Delhi, NIMHANS, SRIHER, and the Indian Institute of Science (IISc) to train integrated clinician-scientists. The Indian Council of Medical Research (ICMR) supports select MD/MS-PhD programs, while the Department of Health Research (DHR) is also expanding integrated MD-PhD offerings for medical graduates. These programs combine clinical training with in-depth research, fostering future leaders in biomedical research.

Key Institutions & Programs

AIIMS (All India Institute of Medical Sciences), Delhi: Offers advanced training and research opportunities, including the MD-PhD program. Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh: Known for its extensive medical research and doctoral programs. Christian Medical College (CMC), Vellore: One of India›s most respected medical colleges, with strong research departments offering PhD opportunities. Banaras Hindu University (BHU), Varanasi: The Institute of Medical Sciences (IMS-BHU) offers PhD programs with interdisciplinary research options. Jawaharlal Institute of Postgraduate Medical Education & Research (JIPMER), Puducherry: A leading institute for advanced medical research and education. National Institute of Mental Health and Neurosciences (NIMHANS), Bengaluru: A hub for neuroscience research and training, which has participated in the ICMR MD-PhD scheme. SRIHER **(Sri Ramachandra Institute of Higher Education and Research), Chennai:** Offers an MD-PhD dual degree program for postgraduates entering through the NEET. KGMU (King George's Medical University), Lucknow: A partner institution for the ICMR-supported MD/MS-PhD program.

Integrated MD-PhD programs

Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Thiruvananthapuram: This Institute of National Importance offers an integrated program for its first-year residents. Candidates must enroll in the PhD program within six months of joining their regular MD/DM/MCh course. Tata IISc Graduate Medical School, Bengaluru: A new initiative focusing on translational research. The program trains students to apply modern fields like AI and nanoengineering to healthcare, aiming to produce physician-scientists.

How to Apply

National Level Entrance Exam: Medical graduates are selected for these programs through national-level entrance tests, such as NEET for some programs.

Institutional Application: After being admitted to an MD/MS program at a participating institution, interested candidates can apply for the PhD component.

DHR/ICMR Support: The Department of Health Research (DHR) and the Indian Council of Medical Research (ICMR) offer financial support and identify Institutions of National Importance (INIs) to host and expand these dual degree programs.

Career Path

Clinician-Scientists: Graduates from these programs become well-trained research scientists and clinicians dedicated to advancing medicine.

Impactful Research: They can lead efforts in biomedical research, contributing to India's self-sufficiency in healthcare.

Interdisciplinary Work: These programs encourage combining medical expertise with areas like biotechnology, data science, and artificial intelligence.

Fellowships in laboratory medicine in India

Several institutions in India offer specialized fellowships in various branches of laboratory medicine, focusing on advanced diagnostic techniques and laboratory management. These fellowships, typically lasting 1-2 years, are suitable for graduates with an MD or DNB in Biochemistry, Pathology or equivalent qualifications (38-51). Here are some notable institutions and fellowship programs:

National Institutes

- NIMHANS, Bengaluru: Offers a Neuropathology fellowship.
- SGPGI, Lucknow: Offers a popular Nephropathology fellowship.
- AIIMS (various locations including New Delhi, Jodhpur, Bhubaneswar, Rishikesh):
  - Post-Doctoral Fellowship in Onco Pathology (Jodhpur).
  - Post-Doctoral Fellowship in Renal Pathology (Jodhpur).
  - Offers DM courses in Clinical Hematology, Hematopathology, and Pediatric Hemato-Oncology

through the INI-SS entrance examination.

- PGI, Chandigarh:
  - Post-Doctoral Fellowship in Laboratory Immunology and Molecular Laboratory Hematology.
  - Certificate Course in Immunopathology.
  - Offers DM in Clinical Hematology.

Other institutions

- CMC, Vellore: Offers fellowships in Hematopathology, Laboratory Medicine, Cytogenetics, and Molecular Hematology. The course duration is 2 years, with a monthly stipend and accommodation provided.
- Tata Memorial Hospital (TMH), Mumbai: Offers fellowships in Hematopathology, Cytopathology, and Oncopathology.
- Kidwai Memorial Institute of Oncology, Bengaluru: Offers an Oncopathology fellowship.
- Amrita Institute of Medical Sciences, Kochi: Offers a Fellowship in Gastrointestinal and Liver Pathology.
- Institute of Liver and Biliary Sciences (ILBS), New Delhi: Offers a Post-Doctoral Certificate Course in Hepatopathology.
- Sri Shankara Cancer Hospital and Research Centre (SSCHRC), Bengaluru: Offers a Fellowship in Tumor Pathology.
- Bharati Vidyapeeth University Medical College, Pune:
  - Fellowship in Diagnostic Haematology, focusing on training in the management and medical supervision of a high-volume hematology laboratory, evaluation of peripheral blood smears, bone marrow and lymph node biopsies, and related procedures.
  - Fellowship in Clinical Microbiology and Antimicrobial Stewardship, a one-year post-MD/MS program in clinical microbiology and antimicrobial stewardship.
- RPIHE Foundation: Offers a Fellowship in Clinical Biochemistry (duration: 1 year, offline/online), with eligibility criteria of MBBS/BAMS/BUMS/BHMS/ BDS/BPT/ MSc Medical/MS/MD/PhD/DSc.
- FNB courses in laboratory medicine are also available in Delhi.
- Admission to these programs often involves entrance exams and interviews.
- While fellowships offer valuable specialized knowledge and skills, their impact on career progression and salary may vary, especially in private medical colleges.
- The Medical Council of India (MCI) does not count fellowships as experience.
- Postdoctoral research fellowships, such as the ICMR-PDF Scheme, also provide opportunities for MD/MS holders to conduct research in areas like basic science, communicable and non-communicable diseases, and reproductive health. These are typically 2-year fellowships with a consolidated amount of ₹65,000/- per month plus HRA and NPA as applicable, along with an annual contingency grant of ₹3,00,000/-.
- ICMR also offers international fellowships for Indian biomedical scientists to receive specialized training abroad for shorter durations (15 days to 3 months).

MIBCB (Membership of Indian Board of Clinical Biochemistry)

It is a degree awarded by the Indian Board of Clinical Biochemistry (IBCB), which is constituted under the Association of Clinical Biochemists of India (ACBI) (52). The course offering this degree is also recognized by the Quality Council of India. The MIBCB program aims to provide a professional course in clinical biochemistry, similar to how professional bodies in the UK award higher education degrees like MRCP and FRCPath. The aim of the course is to impart training to graduates, to render them proficient to perform the medical biochemical techniques, interpret the results of various tests, supervise the medical biochemistry laboratories, identify biochemical diagnostic agents or tests useful in diagnosis and monitoring response to therapy and interpret the clinical significance of biochemical lab test results.

The duration of the course shall be 3 years. The total course is divided into 6 modules (or semesters), each of 6 months' duration. Each module is comprised of 5 topics; thus, the whole course will have 30 topics. At the end of each module (semester), there will be an examination on the 5 topics of that module. The course will be mainly through correspondence. Further, there will be direct contact classes.

Although there are lots of Universities and Colleges in India, imparting MSc degrees in Biochemistry, a specialized course in Clinical Biochemistry is still lacking. There are few courses run by selected medical colleges, giving MD degree for MBBS graduates and MSc degree of Medical Biochemistry for Science graduates. However, seats for this course are very limited. A course on Clinical Biochemistry is not available anywhere in India.

Those who pass the examination will be able to man and supervise the activities of the clinical laboratories. At the moment, the availability of seats to various MSc / MD courses in the universities is limited, and that too the speciality of clinical biochemistry is not emphasized. The number of positions available in the clinical laboratories in the country far exceeds the availability of suitably qualified persons.

Conflict of Interests

The Authors declare that they have no conflict of Interests.

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