



## THE ROLE OF PATHOLOGY IN DEVELOPING CRITICAL THINKING AND RESEARCH COMPETENCIES IN INDIAN MEDICAL GRADUATES: A CBME PERSPECTIVE

**Dr. Firoz Sheikh**

Associate Professor, Department of Pathology, Raipur Institute of Medical Science, Raipur, Chhattisgarh, India.

**Dr. Chandni Krishnani**

Associate Professor, Department of Pathology, Raipur Institute of Medical Science, Raipur, Chhattisgarh, India.

**ABSTRACT** Pathology occupies a central role in the Competency-Based Medical Education (CBME) framework by bridging foundational sciences with clinical practice and nurturing critical thinking, analytical reasoning, and research competencies among Indian Medical Graduates (IMGs). Through systematic exposure to diagnostic interpretation, clinicopathological correlation, and ethical reflection, Pathology develops students' abilities to integrate scientific understanding with clinical judgment. Its emphasis on analytical observation, differential diagnosis, and problem-solving through case-based and interdisciplinary learning fosters critical inquiry and decision-making skills fundamental to clinical reasoning. Early engagement in research activities, journal clubs, and quality assurance exercises enhances methodological rigor, ethical sensitivity, and evidence-based practice. Furthermore, incorporation of digital pathology, molecular diagnostics, and automation prepares learners for technology-driven healthcare environments. By promoting lifelong learning, ethical accountability, and interdisciplinary collaboration, Pathology strengthens professional identity formation and aligns with the NMC's expanded vision of IMGs as clinicians, communicators, researchers, and critical thinkers. Strengthening Pathology education through structured research exposure and technological integration is vital for cultivating future-ready doctors capable of addressing India's dynamic healthcare needs.

**KEYWORDS :** CBME, Critical thinking, Evidence-based medicine, Indian Medical Graduate, Pathology education, Research competency

### INTRODUCTION

The National Medical Commission (NMC), through its Graduate Medical Education Regulations (GMER) 2019, defined five core roles for Indian Medical Graduates (IMGs): Clinician, Leader and Member of the Health Care Team, Communicator, Lifelong Learner, and Professional (1). These roles aim to produce graduates who are clinically competent and equipped with interpersonal, ethical, and leadership skills essential for functioning effectively as "Doctors of first contact" (2).

In 2023, recognizing the growing importance of scientific inquiry and reflective practice, the NMC added two new roles - Researcher and Critical Thinker, emphasizing analytical reasoning, evidence-based decision-making, and problem-solving from early medical education (1,2). Together, these seven roles promote adaptable, reflective, and self-directed physicians capable of integrating knowledge and research into quality patient care.

Within this competency-based framework, Pathology in the Second MBBS holds a central, integrative position. As the bridge between pre-clinical and clinical sciences, it deepens understanding of disease at morphological, molecular, and biochemical levels while cultivating analytical reasoning, critical thinking, and clinicopathological correlation skills vital to all IMG roles. Training in pattern recognition, laboratory diagnostics, and clinicopathological exercises enhances diagnostic precision, ethical awareness, and scientific inquiry. Furthermore, early exposure to interdisciplinary learning and research promotes a systems-based understanding of health and disease, strengthening cognitive foundations and professional identity in alignment with CBME goals.

### 1. Pathology as a Catalyst for Critical Thinking

#### a. Development of Analytical Skills

Pathology, as a cornerstone of the Second MBBS curriculum, bridges pre-clinical knowledge with clinical application by fostering analytical acumen, observational precision, and diagnostic reasoning. Through systematic training in the examination of gross specimens, microscopic slides, and interpretation of laboratory investigations including hematology, biochemistry, and molecular diagnostics students learn to differentiate normal from abnormal tissue architecture, recognize cellular and morphological changes, and correlate these findings with clinical presentations.

This integration of physiological and biochemical principles into pathological interpretation promotes a holistic understanding of disease mechanisms while cultivating pattern recognition, attention to detail, and hypothesis-driven thinking skills fundamental to diagnostic accuracy and clinical reasoning. Moreover, Pathology sensitizes

students to the influence of social, cultural, and geographical diversity on disease prevalence and presentation. Endemic infections such as tuberculosis or regionally concentrated hemoglobinopathies like sickle cell anemia in tribal populations provide opportunities for learners to adapt diagnostic reasoning to local health landscapes, thereby preparing them for context-aware, personalized, and responsible medical practice an essential component of the "Critical Thinker" role.

#### b. Strengthening Diagnostic Reasoning

Pathology contributes significantly to clinical reasoning by training students to generate differential diagnoses based on tissue pathology, laboratory investigations, and disease pathophysiology. By understanding the evolution and progression of diseases from initiation to complications and correlating these processes with clinical symptoms and histological changes, students sharpen their ability to anticipate clinical outcomes and select appropriate investigations. This integration of basic and clinical sciences fosters a logical, evidence-based approach to diagnosis and management, thereby nurturing early diagnostic reasoning skills that are further refined during clinical training (4,5).

#### c. Enhancing Problem-Solving Abilities

Case-based learning, particularly through Clinicopathological Correlation (CPC) exercises in the Second MBBS, is essential for developing structured problem-solving and diagnostic reasoning. These sessions help students integrate data from histopathology, microbiology, radiology, pharmacology, and laboratory medicine to formulate differential diagnoses and clinical impressions.

By simulating real diagnostic challenges, CPCs encourage systems thinking, integrative learning, and teamwork while enhancing clinical judgment and innovation. This interdisciplinary format mirrors real medical practice, preparing students for multidisciplinary care by connecting disease mechanisms with therapeutic decisions. By guiding students to construct and justify their interpretations, CPCs build independence, decision-making clarity, confidence, and accountability which are core elements of lifelong analytical and ethical practice.

#### d. Promoting Interdisciplinary Collaboration

Pathology fosters teamwork and interprofessional collaboration by engaging students in multidisciplinary learning environments. Even at the Second MBBS level, students participate in joint seminars, interdisciplinary discussions, and group-based lab activities that integrate subjects like microbiology, pharmacology, and physiology. These interactions help students appreciate diverse perspectives in disease understanding and management.

As they progress, Pathology strengthens collaborative skills through involvement in tumor boards, multidisciplinary rounds, and interdepartmental case discussions with clinicians, radiologists, microbiologists, and other professionals. Such experiences promote mutual respect, shared decision-making, and effective communication which are core competencies for future healthcare leaders. By reflecting the collaborative dynamics of real-world practice, Pathology provides a framework for understanding how coordinated efforts improve patient outcomes and foster professional synergy across specialties (8).

### **e. Nurturing Ethical Sensibility**

Ethical reasoning is a core element of Pathology training, introducing students to professionalism, confidentiality, patient rights, and medical integrity. Activities such as specimen handling, histopathology reporting, autopsy participation, and student-led research engage learners with responsibilities tied to biological samples and sensitive information. Discussions on informed consent, specimen use, autopsy clearance, and data confidentiality foster respect for patient autonomy, while exposure to tissue banking, biobanking, and genetic testing highlights challenges of privacy, data ownership, and potential misuse. Ethical training in research covering consent procedures, data anonymization, plagiarism avoidance, and adherence to ethical protocols reinforces academic honesty and accountability. By engaging with these real-world scenarios, Pathology equips future physicians with the responsibility, respect, and integrity essential for modern medical and research practice.

## **2. Pathology as a Foundation for Research Competency**

### **a. Training in Research Methodology**

Pathology provides an ideal platform for introducing undergraduate medical students to structured research training, with the Second MBBS often serving as their first formal exposure to scientific inquiry. Under faculty mentorship, students engage in projects such as histopathology audits, disease prevalence studies, and clinicopathological correlation analyses, gaining experience in hypothesis formulation, study design, data collection, analysis, and interpretation within the context of disease mechanisms and diagnostic accuracy.

Alongside technical skills, learners are introduced to the regulatory and ethical foundations of research through mentorship and institutional ethics committees, where they appreciate the importance of informed consent, participant autonomy, and data confidentiality. Structured initiatives such as ICMR-STs reinforce protocol adherence and ethical compliance, instilling respect for biomedical ethics and accountability. This early exposure equips future physicians with essential research competencies while fostering responsible inquiry and professionalism in both academic and clinical settings.

### **b. Critical Appraisal and Evidence-Based Medicine**

Pathology plays a crucial role in developing students' ability to critically evaluate scientific literature, an essential skill for evidence-based medical practice. During Pathology practical sessions and journal clubs often introduced in the Second MBBS students learn foundational research competencies such as literature search strategies, data interpretation, and application of basic statistical methods. They are trained to assess the validity and reliability of research articles by examining study design, methodology, statistical analysis, and clinical relevance.

This structured exposure enables students to distinguish high-quality evidence from low-quality studies, fostering a habit of critical appraisal that supports rational clinical decision-making. By learning to integrate scientific evidence with clinical context at an early stage, students build a strong foundation for lifelong learning and adherence to evidence-based standards in future clinical practice (11).

### **c. Technological Proficiency in Modern Pathology**

Pathology offers early and meaningful exposure to emerging technologies that are transforming the landscape of modern diagnostics. Undergraduate training increasingly incorporates tools such as digital slide platforms, virtual microscopy, image analysis software, automated laboratory techniques, and laboratory information systems.

These technologies not only enhance student engagement and interactive learning but also build familiarity with the digital platforms that are becoming integral to contemporary medical diagnostics.

Exposure to such innovations during the Second MBBS allows students to appreciate the evolving role of technology in Pathology, including its applications in precision medicine, telepathology, and data-driven decision-making. By integrating these tools into routine teaching and practical sessions, Pathology equips students with the digital literacy and adaptability required for future clinical practice in an era of personalized and technology-enhanced healthcare (7,12).

### **d. Continuous Learning and Professional Growth**

Pathology fosters lifelong learning by immersing students in an ever-evolving body of medical knowledge. The curriculum incorporates emerging fields such as molecular diagnostics, immunopathology, cytogenetics, and cancer biology, encouraging students to stay updated with new scientific discoveries and clinical applications.

From the early MBBS years, participation in conferences, workshops, seminars, and journal clubs reinforces continuous learning. These activities deepen subject understanding and promote habits of critical reading, self-directed study, and professional growth. By emphasizing the importance of staying current with diagnostic and disease-related advances, Pathology helps shape lifelong learners committed to evidence-based and up-to-date clinical practice (2,10).

### **e. Understanding Quality Assurance and Standardization**

Pathology introduces Second MBBS students to the fundamentals of quality management in healthcare, emphasizing diagnostic accuracy, standardization, and patient safety. Through practical sessions, students learn key concepts such as quality control, standard operating procedures (SOPs), laboratory safety, and external quality assurance.

These experiences build an early understanding of the systematic processes behind reliable diagnostics and sound clinical decisions. By recognizing the value of protocol adherence, precise reporting, and error prevention, students develop a systems-based approach to healthcare. This foundation prepares them for future roles in clinical governance, audits, and accreditation while fostering a professional attitude grounded in safety, accountability, and continuous quality improvement which is the core of modern medical practice (13).

## **3. Broader Impacts of Pathology Training on Graduate Attributes**

Pathology develops competencies that extend beyond diagnostic accuracy, shaping well-rounded and future-ready medical professionals. In the Second MBBS, it provides the cognitive base for clinical learning by training students to correlate disease mechanisms with presentations and apply logical reasoning. Faculty-guided research, seminars, and journal clubs nurture curiosity, scientific rigor, and a research-oriented mindset, while exposure to specimen handling, confidentiality, and bioethics strengthens professionalism and ethics.

Pathology graduates gain versatile skills for diverse healthcare roles. They communicate disease mechanisms clearly, contribute to public health through disease trend analysis, and engage in translational research connecting laboratory findings with clinical practice. Their grounding in epidemiology and diagnostic data supports evidence-based policies and guidelines. Additionally, by sensitizing students to regional and sociocultural disease variations such as anemia from malnutrition or genetic disorders in consanguineous communities Pathology promotes socially responsive and equitable care.

By fostering independence, critical appraisal, and confident decision-making, Pathology equips learners to handle diagnostic uncertainty, engage meaningfully in clinical discussions, and embrace lifelong learning, producing ethical and analytical physicians ready for modern healthcare.

## **CONCLUSION**

Pathology, as a core discipline of the Second MBBS, occupies a central role in India's Competency-Based Medical Education (CBME) framework. By linking pre-clinical sciences with clinical practice, it trains students to correlate disease mechanisms with clinical findings and investigations, fostering critical thinking, diagnostic accuracy, and research literacy are key attributes of competent and ethical Indian Medical Graduates.

Beyond diagnostics, Pathology builds ethical reasoning, sociocultural awareness, and decision-making clarity while introducing research governance early in training. Through Clinicopathological Correlation exercises, research projects, and journal clubs, students develop

analytical reasoning, collaboration, and academic curiosity. Exposure to molecular diagnostics and digital pathology enhances evidence interpretation and integration into clinical decisions. These competencies prepare graduates to function as clinicians, researchers, communicators, and leaders. Strengthening Pathology education through research integration, ethical reflection, and technological innovation is vital to develop future-ready physicians equipped to meet India's evolving healthcare challenges.

**Disclosure:** The authors declare no conflict of interest. No funding was received for this study.

**Funding:** None

**Acknowledgments:** None

## REFERENCES

1. National Medical Commission. (2019). Graduate medical education regulations, 2019. New Delhi: NMC. Retrieved July 28, 2025, from <https://www.nmc.org.in>
2. National Medical Commission. (2023). Foundation course and electives guidelines, 2023. New Delhi: NMC. Retrieved July 28, 2025, from <https://www.nmc.org.in>
3. Dandekar, R. H., & Mahajan, P. B. (2020). Role of pathology in development of analytical and critical thinking in medical students: A narrative review. *Indian Journal of Pathology and Microbiology*, 63(4), 528–533. <https://doi.org/10.4103/IJPM.IJPM.480.19>
4. Harden, R. M. (2007). Outcome-based education: The future is today. *Medical Teacher*, 29(7), 625–629. <https://doi.org/10.1080/01421590701729930>
5. Muller, J. H., Jain, S., Loeser, H., & Irby, D. M. (2008). Lessons learned about integrating a medical school curriculum: Perceptions of students, faculty, and curriculum leaders. *Medical Education*, 42(8), 778–785. <https://doi.org/10.1111/j.1365-2923.2008.03110.x>
6. Majumder, M. A. A., Kumar, A., Krishnamurthy, K., et al. (2020). An integrative approach to medical education: Bridging the gap between basic science and clinical practice. *Advances in Medical Education and Practice*, 11, 711–716. <https://doi.org/10.2147/AMEPS253999>
7. Hanna, M. G., Reuter, V. E., Ardon, O., et al. (2020). Integrating pathology education with digital tools: Impact on learning and critical thinking. *Archives of Pathology & Laboratory Medicine*, 144(6), 660–666. <https://doi.org/10.5858/arpa.2019-0372-SA>
8. Burton, J. L., & Stephenson, T. J. (2001). Are histopathologists becoming mere technicians? The danger of underestimating the role of morphology in medical education. *Journal of Clinical Pathology*, 54(11), 817–820. <https://doi.org/10.1136/jcp.54.11.817>
9. Beauchamp, T. L., & Childress, J. F. (2013). *Principles of biomedical ethics* (7th ed.). Oxford University Press.
10. Patil, N. G., Lee, P., Yan, Y. H., et al. (2012). Redefining competencies through CBME: Needs in developing countries. *Medical Teacher*, 34(8), 620–622. <https://doi.org/10.3109/0142159X.2012.687121>
11. Sackett, D. L., Rosenberg, W. M., Gray, J. A., Haynes, R. B., & Richardson, W. S. (1996). Evidence based medicine: What it is and what it isn't. *BMJ*, 312(7023), 71–72. <https://doi.org/10.1136/bmj.312.7023.71>
12. Pritt, B., Tessmer-Tuck, J., & Vrana, J. (2021). Evolution of digital pathology and its impact on education. *Archives of Pathology & Laboratory Medicine*, 145(3), 313–320. <https://doi.org/10.5858/arpa.2020-0242-RA>
13. International Organization for Standardization. (2012). ISO 15189: Medical laboratories – Requirements for quality and competence. ISO.