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Teaching With AI In The Life Sciences: A Review Of Methods, Risks And Responsible Practice

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Abstract

Artificial Intelligence (AI) is reshaping educational practices in the life sciences through adaptive systems, virtual laboratories, generative content tools, and data-driven feedback mechanisms. This review critically synthesizes literature from 2015–2025 to evaluate how AI is transforming teaching and learning in the life sciences. It identifies key teaching methods, summarizes empirical evidence of learning outcomes, and assesses the ethical, technical, and institutional risks involved. Responsible integration practices centered on ethical literacy, transparency, faculty training, and equitable access are discussed as essential to sustainable adoption. The review concludes with recommendations for aligning AI innovation with pedagogical and ethical standards to ensure that technology enhances rather than replaces the human elements of scientific education.

1. Introduction

The convergence of Artificial Intelligence (AI) and life-science education marks a transformative period for teaching and research. Life-science disciplines—including molecular biology, biotechnology, and medical education—are increasingly dependent on large-scale data analytics, predictive modeling, and computational inference (Kolachalama & Garg, 2022; Shaw et al., 2025). As AI-driven methods become embedded in laboratory simulations, diagnostics, and research workflows, educators face the dual challenge of fostering both technical proficiency and ethical literacy. This review evaluates the landscape of AI-enhanced education in the life sciences, examining pedagogical methods, risks, and responsible practices within a structured IMRaD framework.

2. Materials and Methods

This review followed a systematic narrative approach to synthesize literature from 2015– 2025 focusing on AI in life-science education. Databases searched included Scopus, Web of Science, PubMed, and ERIC using combinations of keywords such as 'artificial intelligence', 'life sciences education', 'biotechnology teaching', 'adaptive learning systems', and 'AI ethics in education'. Peer-reviewed journal articles, systematic reviews, and major policy documents (e.g., UNESCO, OECD) were included. Studies were screened for relevance to pedagogical design, risk assessment, or responsible integration. Thematic synthesis was applied across methodological, ethical, and institutional dimensions.

3. Results

3.1 AI-Enhanced Teaching Methods

AI-enhanced pedagogies in the life sciences include adaptive tutoring systems, virtual simulations, natural language processing (NLP)-based feedback tools, and generative AI for instructional design. Adaptive learning platforms employ reinforcement learning and Bayesian inference to tailor instruction to individual learner trajectories (Lin et al., 2023; Chevalère et al., 2023). Virtual laboratories enable repeated, risk-free experimentation, improving conceptual understanding and procedural skills (Dodevska et al., 2025; Carroll et al., 2025). NLP-driven tools automate feedback on lab reports and conceptual explanations, providing timely formative assessment (Shi et al., 2024). Generative AI models, particularly large language models (LLMs), have expanded educational possibilities through automated content creation, interactive tutoring, and personalized support (Lee et al., 2024; Monib, 2024). However, evidence on long-term knowledge retention and ethical judgment development remains limited.

3.2 Risks and Challenges

The adoption of AI in life-sciences education introduces several ethical and operational risks. Data privacy breaches, algorithmic bias, and misinformation from generative
systems are recurrent concerns (Morley et al., 2020; Liu, 2023). Inadequate instructor preparedness can also result in misuse or over-reliance on AI scaffolds (Bond, 2024). Academic integrity challenges have intensified with the availability of LLMs, necessitating new assessment strategies such as oral evaluations and project-based verification (Balalle, 2025). Furthermore, inequitable access to AI infrastructure may widen global educational disparities (Muthupoltotage & Gardner, 2025). These risks require comprehensive governance, faculty capacity building, and inclusion-focused policy frameworks.

4. Discussion

The findings affirm that AI tools can significantly enhance engagement, conceptual understanding, and procedural competence in the life sciences. However, sustainable adoption depends on embedding ethics and critical reasoning into every stage of learning design. Faculty readiness is a key determinant of effective use; institutions must provide structured professional development in data ethics, model interpretability, and AI literacy (Philippakos et al., 2025; Chiu, 2025). Ethical education should not be treated as a peripheral module but as an integrated practice that informs data governance, fairness auditing, and transparency (Gajjar et al., 2025; Georgieva & Stuart, 2025). Equitable access to AI tools and multilingual resources also remains essential for global parity (UNESCO, 2025).

Future research must address longitudinal impacts of AI interventions on cognitive and ethical learning outcomes. Development of validated, domain-specific AI literacy instruments—such as the AI Competency Objective Scale (AICOS)—is critical for measuring educational effectiveness (Markus et al., 2025). Moreover, empirical studies should adopt cross-disciplinary and multi-institutional designs to assess how AI literacy translates into research competence and professional readiness (Bećirović et al., 2025; Zha et al., 2025).

5. Conclusion and Recommendations

Integrating AI into life-sciences education offers transformative pedagogical potential but also raises ethical, technical, and equity concerns. Responsible adoption requires alignment between technological innovation and human-centered pedagogy. Institutions should: (1) embed AI ethics and data governance into curricula; (2) invest in continuous faculty training; (3) enforce transparency in AI tool usage; and (4) ensure equitable access to infrastructure and resources. Ongoing research, interdisciplinary collaboration, and evidence-based policymaking are vital to ensure AI enhances rather than displaces the human essence of education (Papaneophytou et al., 2025; Wiese, 2025).

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