

## REVOLUTIONISING THE FUTURE OF BIOLOGY EDUCATION: OPPORTUNITIES AND CHALLENGES OF ARTIFICIAL INTELLIGENCE.

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### **Abstract**

*The paper focused on how the application of Artificial intelligence could transform and shape Biology education in the future, looking into its uses, prospects and challenges. The research used a literature review approach: collecting, analysing and synthesising information from various relevant written sources. The results show that AI is already here to stay and is being used to imitate human thought patterns to bring about a revolution in several fields including Biology. Artificial Intelligence, among other things, offers tools for personalized learning, interactive simulations, and advanced data analysis. It can personalize the learning experience, automate tasks, and provide access to complex biological concepts through visualisation and simulations. However, despite its numerous advantages and opportunities, its use poses several risks which include; over-dependence, fabrication and loss of social interface. AI must be regulated with clear guidelines, particularly in biology education, to avoid the risk of it being abused. Challenges identified include: lack of skilled personnel, the preference for traditional teaching methods, lack of data. poor awareness and huge financial implications amongst others. Notwithstanding, Biology education stands to be a whole new experience with the right application of Artificial Intelligence.*

**Keywords:** Artificial Intelligence, Biology Education, Transform, Future.

### **Introduction**

The advent of the 21st century has brought about significant advancements in various fields, with Artificial Intelligence (AI) being one of the most transformative technologies of our time (Dwivedi et al. 2021). In recent years, Artificial Intelligence (AI) has seamlessly integrated into various sectors of human life, including healthcare, finance, and entertainment. However, one of the most significant, yet often overlooked, impacts of AI is in the field of education (Tuhin, 2025). The potential of AI to transform how we learn, teach, and assess is profound. From personalized learning experiences to the automation of administrative tasks, AI promises to not only improve the quality of education but also make it more accessible and equitable (Luna, 2024; Puntillo, 2024). AI holds numerous possibilities in store for the future of biology education. It has the capacity to make biology education more accessible, appealing and personalised to students' needs as well as to make teaching and learning more efficient and dynamic (Taliat, 2025; Ugwoti, et al., 2023; Luna, 2024). AI can play an important role in facilitating the visualization of complex biological concepts, providing adaptive learning experiences tailored to students' individual abilities, and offering virtual laboratories that allow biological experiments without the limitations of physical facilities (Telambanua, 2025; Taliat, 2025). On the other hand, AI has the potential to be misused, creating false content and eroding academic authenticity, if proper restrictions and guidelines are not put in place (Gergersen, 2024; Copeland,

2024; Luna, 2024). Challenges in its implementation, such as limited infrastructure, lack of teacher training, and high implementation costs, are still major obstacles (Tuhin, 2025; Ugwoti, et al., 2023) There needs to be more attention to aspects of training, infrastructure, and education policies to support the application of this technology.

This paper offers a focused literature review on AI's role in transforming biology education with focus on its applications, prospects and potential challenges. The paper aims to guide stakeholders towards harnessing the potential of AI to transform biology education. It accentuates the importance of funding, training, and strong control measures to mitigate potential challenges.

## **Methodology**

**Research Approach:** This research uses a literature review approach, which is a research method that is carried out by collecting, analysing, and synthesising information from various relevant written sources (Adlini et al., 2022). The data sources used include scientific journals, books, conference proceedings, research reports, and other documents related to artificial intelligence (AI) and biology education.

**Research Steps:** This included identifying the Topic and Scope; Determining the main topic, namely: Transforming the future of biology education: Opportunities and Challenges of artificial intelligence. The scope of research was limited to the uses of AI in biology education, its benefits and drawbacks.

**Search and Data Collection:** Academic databases such as Google were used to search for relevant articles, journals, and research reports. Keywords used in the searches included: Artificial Intelligence in Education, AI in Biology, Benefits and Challenges of AI.

**Data Analysis:** This process included conducting a content analysis of the literature that had been collected. Examining the utilisation of AI in biology education. Exploring the benefits of AI in biology and assessing the implementation and challenges of AI adoption in biology education.

**Synthesis of Findings:** The results of analysis from various sources were integrated to provide a comprehensive picture of how Artificial Intelligence could transform biology education, pin-pointing potential benefits, limitations, challenges and proffering probable solutions.

## **Literature Review**

### **The Benefits of Artificial Intelligence in Biology Education**

Biology is a vast field of study, which has a lot of complex material and various abstract concepts. It often involves detailed accounts and concepts of the anatomy, physiology and interactions of living organisms and their environments. AI offers several advanced innovations that can transform Biology education. (Lasaiba, 2023; Tuhin, 2025).

AI can analyze a biology student's performance and adjust the difficulty and pace of lessons to suit individual needs, ensuring that each student learns at their optimal level (Taliat, 2025). It provides a personalized learning experience; with adaptive learning platforms and intelligent tutoring systems. These systems provide personalized guidance, feedback, and support, helping biology students understand challenging concepts and track their progress (Teachflow, 2023; DigiTechie, 2024). AI can give

targeted feedback which identifies areas where biology students struggle and provide specific feedback and suggestions for improvement (Plus AI, 2024).

AI-powered Virtual Reality (VR) and Augmented Reality (AR) tools can create immersive simulations of biological processes, allowing students to explore complex systems like cells or ecosystems in a dynamic and interactive way (Ugwuotì et al, 2023). AI thus provides the biology student enhanced visualization and engagement. AI also can generate detailed 3D models of biological structures like organs, tissues and various cells, offering a more in-depth understanding of their form and function (Telambanua, 2025; Taliat, 2025). AI-driven interactive simulations can demonstrate the effects of environmental changes and genetic mutations, helping biology students grasp complex biological cycles and principles (Ugwuotì et al., 2023; Plus AI, 2024; Bitesize Bio, 2025).

Another benefit of AI in biology education is its efficient data analysis and exploration capabilities. AI can analyze large biological datasets, identify patterns, and generate visualizations, enabling students to explore complex information and draw conclusions (Teachflow, 2023; Luna, 2024). AI can automate repetitive tasks like data entry and image analysis, freeing up biology students and researchers to focus on more complex aspects of their work (Bitesize Bio, 2025).

AI is being used in drug discovery and research. It can assist in identifying potential drug candidates and predicting their effectiveness, accelerating the drug discovery process (Bitesize Bio, 2025). AI-powered tools can help biology students and researchers develop scientific skills by encouraging them to think critically and by presenting them with complex problems and challenging them to find solutions (Teachflow, 2023). AI can be used to simulate real-world scenarios, allowing biology students practice problem-solving skills in a safe and controlled environment (Teachflow, 2023). Data analysis and interpretation are simplified with AI-powered tools which can help biology students develop essential data analysis skills by enabling them to work with large datasets and extract meaningful insights (Taliat, 2025).

Artificial intelligence is already being used in biology education, even though it is constantly evolving. Puntillo, (2024) highlighted several practical AI tools biology teachers may use in the classroom which include: *Top Hat*, *Education Copilot* as well as *ChatGPT*, which is a virtual smart teacher assistant for course and lesson plan creation; *Dreambox*, *Smart Sparrow* or *Knewton* useful for differentiated learning; *Gradescope* which is an auto-grading AI tool. *Exact Path* is a tool used to pinpoint knowledge gaps, while *ExamSoft*, *R. Test* or *ClassPoint* are utilised for test preparation. *Zapier* is used for administrative and task automation; *Z Squirrel AI* is a tool for personalised virtual tutoring. To provide student feedback, *Turnitin Feedback Studio* is used; while adaptable universal access tools include *Briana* and *Ai-Live Captioning*. Research by Ugwuotì et al. (2023), found that AI tools have the potential to supplement and enhance traditional teaching methods.

### **Shortcomings of Using AI in Biology Education**

In spite of being a very beneficial technology, AI also has its challenges, limitations and probabilities for abuse in biology education. It goes without saying that one of the obvious disadvantages of AI is the tendency of biologists to become over-reliant on

this technology (Luna, 2024; DigiTechie, 2024). AI has an unlimited number of uses. It can perform in seconds what could take lengthy and tasking days to do. From writing degree thesis's and composing essays, to summarising passages and completing difficult homework. Just as calculators, computers and smartphones have made our lives easier, there is the attendant risk of lack of critical thinking, laziness and losing the effort, diligence and determination required by biology students to succeed academically (Tuhin, 2024; Dwivedi, et al., 2021).

Since AI simply depends on the data it has been programmed with to make complex calculations to create accurate content, they are prone to producing responses that are factually inappropriate, absurd and even harmful. This could trigger misinformation and wrong beliefs in the classroom. A typical scenario of garbage in, garbage out. Biology teachers therefore need to be able to identify erroneous content (Luna, 2024; Puntillo, 2024).

AI is an effective but generally solitary, individualised education that isolates the students as they interact with a virtual assistant instead of with their classmates and teachers. This could hamper the social skills of biology students (Tuhin, 2025; Ugwoti et al., 2023)

Luna (2024); Tuhin (2025) and Taliat (2025) observed that the rise of AI has made ensuring academic genuineness very challenging. Since this new technology is not regulated and there are no clear guidelines on the limitations for its use, including in education, biology students, like others, may abuse its use to submit work that is AI generated as their own. AI generated content is not yet sufficiently detected accurately and reliably by current technologies compounding the problem of plagiarism and lack of academic integrity (Luna, 2025; Teachflow, 2023).

High costs could make AI technology and tools unavailable to the vast majority of teachers and students, particularly in developing countries, where there are bound to be disparities between those of disadvantaged socioeconomic backgrounds and those that have access to AI. In addition, while AI can provide great benefits, the hardware and software needed to support this technology are still expensive, especially for schools on a budget. Research by (Spector et al., 2008) highlighted the challenge of high cost of equipment as one of the main barriers to technology adoption in education.

Research by (Salas-Pilco et al., 2022) found that training for teachers is one of the important factors in ensuring the successful application of technology in the classroom. Trained teachers can effectively harness AI to design more engaging learning experiences for biology students. As the application of AI in the educational sector advances and evolves, students and teachers utilising it shall be far ahead of the others thus widening educational inequalities (Obidiebube, et al., WEF, 2024)

## **Discussion**

Artificial Intelligence (AI) is increasingly being used to simplify life, due to its ability to perform complex intellectual and repetitive processes. AI systems identify their environment, deal with what they identify, solve problems and act to help make our daily lives easier. (Sachdeva, 2024). Educational institutions across the world are beginning to harness the potential of AI to evolve and move education beyond the

walls of traditional classrooms. Its possibilities are being tested in all kinds of educational scenarios (Mubarik, 2024; Fitri, & Dilia, 2024). AI has the capacity to transform the way biology is taught and learnt in the future. Its ability to personalize the learning experience, bridges the gap between the slow and fast learners in large classrooms. It would obviously be an indispensable tool to Biology Researchers and Teachers; saving prized time that otherwise would have been used to grade, plan lesson notes and analyze data. AI's ability to simulate virtual reality and provide 3D models would transform biology in the future. saving teachers extensive explanations and inadequate improvisations. Virtual laboratories would allow biological experiments without the limitations of physical facilities and constraints of limited finance for reagents, models and specimens. Biology practical classes and lectures would become a whole new exciting experience to look forward to. The traditional biology lesson, in which the teacher spends time drawing specimens, and endless diagrams of complex physiological cycles and unheard-of organisms, on the chalkboard, would be a thing of the past.

Biology researchers and students exposed to and trained in the practical applications of AI, would also be better equipped to face an employment market with growing demands for advanced technological knowledge and know-how. AI is changing the nature of work, with many jobs being automated and new ones being created (Frey & Osborne, 2017). Biology students who are aware of AI's impact on the job market can prepare themselves for the changing demands of the workforce and develop skills that are complementary to AI.

Unfortunately, despite the growing importance of AI, research suggests that many students lack a comprehensive understanding of AI concepts and applications (Zhang et al., 2020).

It goes without saying, that the future of biology education transformed by AI, it is not all rosy. The tendency for students and teachers alike to become over reliant on this fascinating technology poses a challenge as opined by Dwivedi, et al. (2021). Undetected plagiarism of research thesis's, assignments, projects and much more, stand to hamper genuine academic research in biology and lead to widespread abuse. The lack of data, infrastructure, skilled and trained personnel, as well as the lack of awareness and general preference for the traditional methods of imparting knowledge in biology education, could all set back the any projections for the glorious future of AI in Biology education (Tuhin, 2025; Telaumbanua Telaumbanua, 2025; Ugwoti, et al., 2024;. More attention needs to be paid to creating awareness, training, infrastructure, and education policies to support the widespread application AI in biology education (Obidiebube, et al., 2025; Tuhin, 2025). The challenges notwithstanding, the application of AI in biology education has great potential to transform how it is taught and learnt in the future.

## **Conclusion**

AI is transforming biology education by offering tools for personalized learning, enhanced visualizations, and efficient data analysis. AI-powered systems can adapt to individual learning styles, provide customized feedback, and create interactive simulations, making complex biological concepts more accessible and engaging for students. However, its benefits come with prospective challenges in its

implementation, such as limited infrastructure, lack of teacher training, and high implementation costs which could constitute major obstacles. The risk of bias, misinformation and abuse need to be limited by proper guidelines and regulations.

However, the future of biology education, with the correct application of artificial intelligence and the requirements to make it work holds a lot of promise.

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