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AI-Powered Biotechnology: Unlocking New Possibilities in Drug Discovery

BIOS4YOU
AR 2.0

BIO-INSPIRED STEM TOPICS FOR ENGAGING YOUNG GENERATIONS
THANKS TO THE USE OF AUGMENTED REALITY

Project Number: 2023-1-DE03-KA220-SCH-000126516

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Image 1. AI-Powered Biotechnology: Unlocking New Possibilities in Drug Discovery.

General topic of the learning path	Artificial Intelligence in Biotechnology
Specific name of the learning unit	AI-Powered Biotechnology: Unlocking New Possibilities in Drug Discovery
Age of the target users	14-18 years
Requirements for the learner	1. Basic understanding of environmental science concepts (e.g.,ecosystem, climate). Basic literacy and numeracy skills. Basic ICT skills. 2. Access to a computer or tablet with internet connectivity. 3. Willingness to engage with digital tools (AR apps, CoSpaces Edu). 4. No prior coding or AR development experience required, as CoBlocks is beginner-friendly.
Description of the learning unit	This learning unit provides a comprehensive introduction to artificial Intelligence in biotechnology and more specifically to new possibilities in drug discovery. It is divided into three sections: "Explore" introduces foundational concepts of climate change, ecosystems, and restoration. "Execute" delves into bio-inspiration, showcasing how natural processes inspire solutions and how Augmented Reality (AR) can visualize these

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	processes and impacts, supported by real-world examples and practical activities. "Enhance" justifies the pedagogical benefits of AR, offering examples of useful AR applications and practical integration strategies. The unit culminates in a hands-on exercise where students use a gamified AR experience in Delightex to strengthen their understanding and engagement with the topic.
Subject: Parties involved	Digital Literacy/Computer Science, Art & Design, Social Studies, Mathematics , Language Arts
Keywords	Artificial Intelligence (AI) Biotechnology, Drug Discovery, Machine Learning (ML), Deep Learning, Target Identification, Virtual Screening, Clinical Trials Optimization, Drug Repurposing Bio-inspiration, Digital Literacy, Augmented Reality (AR), Gamification.
Key qualifications, skills and knowledge that can be acquired	Skills: ● **Critical Thinking:** Analyzing large datasets to identify patterns and make predictions in a scientific context. ● **Problem-Solving:** Applying bio-inspired concepts to drug discovery challenges, such as matching drug candidates to targets. ● **Digital Literacy:** Navigating and utilizing AR applications. ● **Scientific Inquiry:** Interpreting data and observing natural processes (virtual or real). ● **Communication:** Explaining complex concepts and presenting ideas. Knowledge: ● Understanding of core principles of biotechnology and artificial intelligence (AI), including Machine Learning (ML) and Deep Learning. ● Understanding how AI is integrated into various stages of drug development, from target

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	identification and virtual screening to clinical trials and drug repurposing. ● Recognising bio-inspired solutions derived from nature. ● Understanding the potential and applications of Augmented Reality in Bio-sciences and Health Sciences.
Resources and didactic aids used	Resources: ● Textbooks/Scientific articles ● Case studies ● Internet resources ● Free AR platforms (Delightex) ● AR-compatible devices (smartphones/tablets)
Assessment criteria and evaluation	● **Participation:** Engagement in discussions and activities throughout the unit. ● **Activity Completion:** Execution of practical AR exercise ● **Concept Map/Mind Map:** Creation of a visual representation linking climate change, ecosystems, restoration methods, and bio-inspired solutions.

Introduction

Traditional drug discovery paradigms, characterized by laborious experimental procedures, high attrition rates, and extensive timelines, are being fundamentally reshaped by advanced computational methodologies. This module will elucidate how AI algorithms, through their capacity for rapid data analysis, pattern recognition, and predictive modeling, are optimizing various stages of drug development, thereby enhancing efficiency, precision, and cost-effectiveness. Upon completion of this unit, learners will possess a comprehensive understanding of the synergistic relationship between AI and biotechnology and its implications for the future of therapeutic innovation.

1. Explore – Foundations of AI in Biotechnology

1.1 What is Biotechnology?

Biotechnology is a field of biology that involves using living systems and organisms to develop or make products, or "any technological application that uses biological

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systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use" (Convention on Biological Diversity, 1992). From ancient practices like brewing and baking to modern genetic engineering and vaccine production, biotechnology has a long history of harnessing biological processes for human benefit.

1.2 What is Artificial Intelligence (AI)?

Artificial Intelligence (AI) refers to the development of computer systems that can perform tasks that typically require human intelligence. These tasks include learning, reasoning, problem-solving, perception, and understanding language. A key subset of AI is **Machine Learning (ML)**, where algorithms learn from data without being explicitly programmed. **Deep Learning**, a more advanced form of ML, uses complex neural networks to process vast amounts of data, mimicking the human brain's structure.

1.3 How AI powers Biotechnology?

The integration of AI and biotechnology, often referred to as AI-powered biotechnology, marks a paradigm shift in life sciences. AI's ability to analyze massive, complex datasets, identify patterns, and make predictions is revolutionizing various biotechnological applications, from genome sequencing to personalized medicine (Asad & Zulfiqar, 2024).

1.4 Is AI in Drug Discovery a Game Changer?

Drug discovery is a prime example of where AI is making a significant impact. Traditionally, this process is resource-intensive, time-consuming, and has a high failure rate. AI is transforming each stage, offering improvements in efficiency, cost reduction, and success rates (Pușcașu et al., 2025). Here’s how AI is accelerating drug discovery:

- **Faster Target Identification:** AI rapidly analyzes biological data (genomics, proteomics) to quickly pinpoint disease-relevant therapeutic targets, shortening the initial discovery phase.
- **Accelerated Virtual Screening:** AI-powered computational models rapidly screen billions of chemical compounds virtually, predicting which are likely to bind to a specific disease target. This greatly speeds up identifying potential drug candidates compared to physical testing (Marins et al., 2024).
- **Efficient Drug Design:** AI, including generative AI, designs novel molecular structures from scratch, optimizing them for desired biological activities and refining existing drug candidates to improve efficacy and safety.

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- **Improved ADMET Prediction:** AI models accurately predict a drug's Absorption, Distribution, Metabolism, Excretion, and Toxicity (ADMET) early on. This allows researchers to quickly filter out harmful or ineffective compounds, preventing costly failures in later stages.
- **Optimized Clinical Trials:** AI analyzes patient data to efficiently identify suitable trial participants and design more targeted protocols. It also predicts responses and monitors outcomes in real-time, leading to faster recruitment, shorter trial durations, and higher success rates.
- **Rapid Drug Repurposing:** AI algorithms quickly identify new therapeutic uses for existing drugs by analyzing vast datasets of approved medications and disease information, accelerating treatment availability.

2. Execute – The Role of Augmented Reality in AI Powered Biotechnology

2.1 Specific features and types of AR Tools

An AR application for this purpose would be more than just a visualization tool; it would be a dynamic platform for discovery, design, and problem-solving. Key features and tools could include:

- **3D Model Visualization:** Allowing students to interact with 3D models of molecules, atoms, proteins and antibodies.
- **Interactive "What If" Scenarios:** Users could manipulate drug variables (e.g.,toxicity) and see the AR-projected impact on molecules.
- **Simulations:** Placing students virtually within different settings to observe the impact of various variables on drug discovery (e.g., seeing how a protein reacts to a drug).

2.2 Real studies and practical exercises

A video study involving 18 pre-service secondary teachers from the Zurich University of Teacher Education has been conducted. In this exploratory research, the molecular browser tool Molegram-Scientist was utilized in a cooperative learning module with the AR-headset HoloLens. The analysis indicates that the learning tasks were completed with concentration, even though AR-headsets were new and could therefore be distracting. The usability has proven to be acceptable. Intuitive methods for interaction, such as moving around in the classroom or collaborating with other users, were utilized extensively. Overall, the findings suggest that AR-technology appears to be appropriate for collaborative learning modules and warrants further exploration (Furrer et al., 2023).

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3. Enhance – AR for Deeper Learning and Engagement

3.1 Examples of Useful AR Apps and Tools

Various AR tools can significantly enhance the learning experience for ecosystem restoration by providing immersive and interactive ways to explore complex environmental concepts. Here is an example:

Delightex (CoSpaces Edu):

Delightex allows users to create interactive 3D virtual worlds and then experience them in augmented reality or virtual reality. It features a drag-and-drop interface and a visual block-based coding language (CoBlocks), making it highly accessible for students and teachers with no prior coding experience. It offers a free version with core functionalities. Students can design and build their own virtual ecosystems, simulate environmental changes, and visualize restoration efforts. Its creative freedom empowers students to become content creators, not just consumers.

3.2 Practical Suggestions for Integration into the Learning Experience

Integrating these AR tools into the curriculum can profoundly strengthen students' connection to ecosystem restoration and support more effective knowledge building:

Exercise: AI Drug Matchmaker AR App

In The AI Drug Matchmaker AR App students explore a simplified drug discovery process through an interactive Delightx scene. They guide a virtual “AI” that uses basic coding logic to identify the correct drug molecule to bind with a disease target. As students test different molecules, the app visually demonstrates molecular interactions in 3D, showing how correct matches form stable bindings and how incorrect choices fail. By the end of the exercise, students gain a hands-on understanding of molecular interactions, drug targeting, and the role of AI in drug discovery, connecting abstract biological and chemical concepts with interactive, visual, and practical learning.

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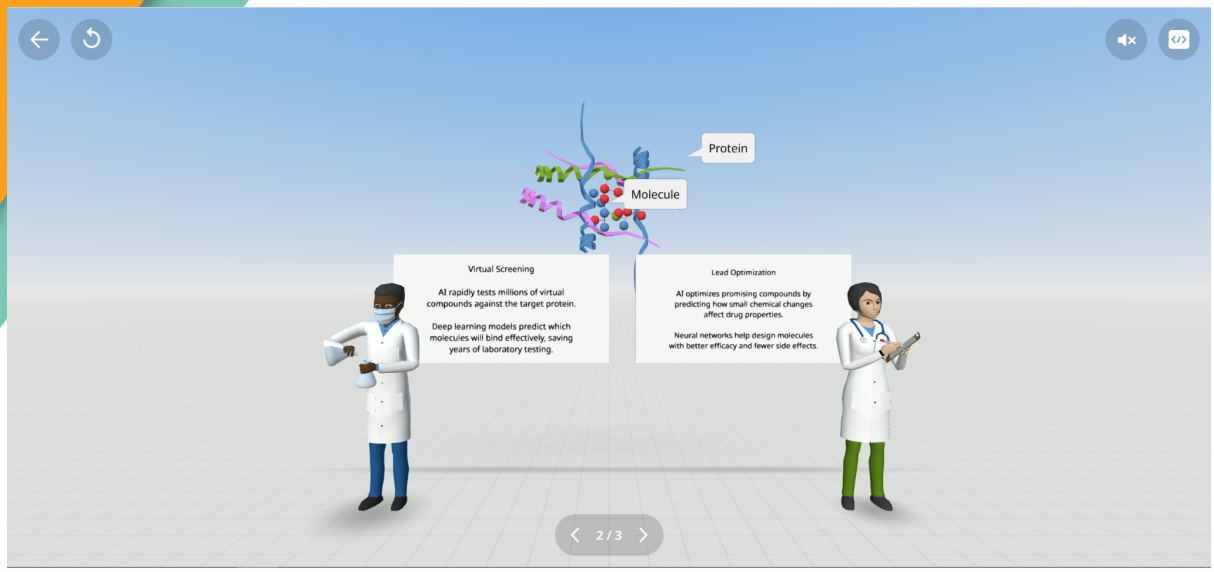

Image 2. AI Drug Matchmaker AR App

By thoughtfully integrating AR into the curriculum, educators can create dynamic, immersive learning experiences that not only strengthen students' connection to ecosystem restoration but also empower them with the knowledge and tools to become active participants in environmental stewardship.

Conclusion

This learning unit has provided a comprehensive overview of how Artificial Intelligence is revolutionizing biotechnology, with a specific focus on its profound impact on drug discovery. We've explored the foundational concepts of AI and biotechnology, delved into the practical applications of AI in accelerating drug development, and seen how the principles of bio-inspiration continue to guide innovation. Furthermore, we've highlighted the transformative potential of Augmented Reality (AR) as a powerful educational tool, capable of making complex molecular concepts accessible, interactive, and highly engaging for learners.

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Phase	Description
Explore	- Research and Discovery: Introduce students to the principles of molecular biology, drug discovery, and AI-assisted prediction. Explain how drugs interact with disease targets and the basics of molecular binding.
	- Content Development: Provide engaging visuals, short readings, and animations showing molecular structures, disease targets, and AI decision-making logic.
	- Needs Analysis: Assess students' prior knowledge of chemistry, biology, and computational thinking to tailor AR activities and quiz questions.
Execute	- Curriculum Implementation: Connect theoretical concepts of molecular interactions, drug targeting, and AI logic to practical AR exercises. Students learn how different molecules can bind (or fail to bind) to disease targets and how AI algorithms help predict correct matches.
	- Interactive Exercises: Using the AR app "The AI Drug Matchmaker", students guide a virtual AI to select appropriate drug molecules for specific disease targets. Real-time 3D visualizations show molecular interactions and stability of bindings.
	- Feedback Collection: Students reflect on AI choices, discuss outcomes with peers or teachers, and compare different strategies for effective drug design.
Enhance	- AR Integration: The AR app visualizes molecular binding interactions in 3D, making abstract biochemical processes tangible and interactive.
	- Interactive Learning:
	Gamified Content: -
	AR-Based Assessments: Replace traditional tests with interactive evaluations where students demonstrate understanding of molecular interactions, drug discovery principles, and AI-assisted prediction processes.

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