

AI-Powered Biotechnology: How Artificial Intelligence Is Revolutionizing Drug Discovery and Personalized Medicine

Nauraiz Ali Abid^{*1}, Manahil Khalid¹, Shaiza Tanveer¹, Asma Farooq¹ and Aamna Usman Ansari¹

1. University Institute of Biochemistry and Biotechnology, Pir Meher Ali Shah, Arid Agriculture University, Rawalpindi, Pakistan

*Corresponding Author: nauraizhusain@gmail.com

ABSTRACT

The fusion of biotechnology and AI is redefining the field of modern medicinal techniques, revolutionizing how diseases are examined, drugs are made, and personalized treatments are established. The ability of AI to analyze large-scale and complicated biological data allows scientists to discover mechanisms that were hidden through traditional methods. AI and machine learning analyze biological datasets, target identification, and screen for biological designs and drug target mechanisms in drug discovery, which opens the road for faster and more accurate medicinal therapeutics. On the other hand, AI is also revolutionizing the fusion of AI and Genomics for personalized treatments, which helps in disease prediction, health risks, treatment responses to individuals, and patients' specific drug requirements, which automatically turns the healthcare system to the next level of precision from traditional methods. However, there are some ethical concerns as well, such as privacy being a big concern, algorithm bias, or regulatory challenges. In this article, we discuss the overall convergence of AI and Biotechnology, the future trends, and Personalized Medicine.

Keywords: Biotechnology, Artificial Intelligence, Drugs, Drug Discovery, Genomics

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Introduction

Think of a world where the medicine/drug is designed in a few days rather than years, and medical treatments are unique to every patient according to their genetic make-up. This is not a dream of the future - it has become a big reality in terms of the potential combination of Artificial intelligence and Biotechnology. Artificial intelligence is the development of computer systems that are able to perform various tasks that specifically require human intelligence. From drug discovery to personalized medicine, AI has transformed the world.

The combination of AI with Biotechnology has proven a landmark study in medical research and development of drugs, which includes personalized treatments, drug discoveries, bioprocessing, biomolecular engineering, genome editing, CRISPR technology, biogenomics, metabolomics, and AI-enabled robotics in biotechnology. This leads to mitigating scientific research and global challenges and offers an environmentally responsible approach. Recent research in this comprehensive analysis includes personalized medicines, energy access, and drug discoveries even faster than before [1]. AI is directly revolutionizing drug discovery and personalized medicines.

When Artificial Intelligence Meets Biology

AI, biological data, genomics, and AI evaluation of complex biological data. Current innovations in Genomics have strengthened our capability to explore deeper into the complex mechanisms of diseases. The number of specific genetic variations is vast, and their effects are particularly small and specific [2]. The incorporation of multi-omics research with AI has the capability to fundamentally alter our understanding of biological systems. Multi-omics analysis has a lot of potential to change with the integration of AI and data processing techniques. AI can accelerate the discovery of new biomarkers and therapeutic solutions as well as the development of personalized medicines by evaluating and incorporating immense, complicated data sets. The domain of multi-omics has moved from studying one type of biological data at a time to linking different types of data for more understanding. This change has been powered by the developments of large-scale data processing and bioinformatics. In early stages, scientists diagnosed diseases by viewing genomics and transcriptomics to understand the causes and how genes are governed, but AI has remarkably changed the way of thinking and made it easy and fast [3].

Nowadays, multimodal AI is playing a crucial role in biotechnology, like in drug development, precision medicine, and diagnostic purposes. The global market was worth \$233.46 billion in 2024 and is continuing to grow. By 2030, more than half of drugs may involve AI in their production [13].

The Drug Discovery Process

AI-based target identification, screening, drug design, prediction, faster and cheaper drug development.

Development of new drugs is an expensive and time-consuming process. A variety of biological experiments at molecular, organ, cellular, and whole animal levels are used to define the activity and selectivity of the drug. AI

in drug design can be used to create and enhance the capability of molecular structures of promise. As DSP-1181 is the first ever drug created by AI that enters clinical trials, it is responsible for the treatment of OCD, a severe anxiety disorder [4]. AI tools can analyze Genomics, health records, and real-world evidence to identify specific disorder groups, predict trial results, and monitor safety issues [5]. Diseases such as Alzheimer's, cancer, and genetic disorders are on the front-line of benefiting from these advancements in computational technologies. With the power of AI and machine learning, scientists can predict drugs' effectiveness more accurately and accuracy by reducing the time and cost of the drugs [6].

Medicine Designed for You

Precision medicine, genomics, and selecting treatments according to individual patients. Precision medicine has become a concept that indicates the new era of medicine. According to WHO, the responsible, clear, and well-considered use of traditional medicine is "the sum of the medical knowledge and skills based on theories and experiences through novel cultures". The main examples of traditional medicine are the use of herbal treatments/medicines in China or the practical experience of Ayurveda in India. While traditional medicines are based on historical practices, modern medications rely on scientific research and evidence. It involves the most effective methods and scientific research for patients' treatments, likely precision medicine. It combines doctors' experience with trustworthy scientific research of the medicine to provide more effective patient treatment [7].

Modern medicine progressively implements genomic technologies, so doctors can better diagnose and prescribe medicines according to patients' genetic information. These technologies can see a person's DNA, proteins, genomic activities, and metabolic rate to describe a clear picture of a patient's health. To make it practical (precision medicine), physicians or healthcare systems need to develop tools such as family histories, health risk assessment, and clinical systems. Then it is combined with genomic data to identify a person's individual health risks and helps better treatment decisions. As genomic technologies are developing rapidly, access to personal information is changing how a person can understand and decide about their own health [8].

Finding the Right Drug—and the Right Dose

Pharmacogenomics and AI-assisted prediction of treatment response and personalized drug dosages. Current advancements in pharmacogenomics, CRISPR gene editing, and AI technologies are revolutionizing precision medicine by making treatments more precise for individual patients. AI-based tools can help scientists discover biomarker which improves drug development and dosage. Pharmacogenomics identifies genetic differences that affect how a person adapts to the medicine, its potency, and its side effects. CRISPR gene editing helps in editing the false genes and modifies the gene by correcting the harmful genetic mutations. Together, these techniques have the power to make precision medicine more accurate and effective [9]. AI is the best tool for drug discovery as it connects genomic

information with pharmacokinetics and examines a large amount of biomedical information. These technologies help scientists to identify impactful patterns and information from complex genetic data. These technologies make drug discovery faster and even cheaper [10].

A Future Built on Predictive Biology

AI has growing potential in Biotechnology, medicine, agriculture, and other biological industries. In agriculture, AI helps to enhance food security by supporting farmers in climate change challenges, crop diseases, and soil health. And enhance the production of food quality and quantity. In medicine, diagnostics, precision medicine, robotics, disease prediction and prevention, epidemiology, and treatments that best help patients. It supports technologies like CRISPR, gene editing, drug design, and identifying genetic diseases helps to improve drug design for individual like the disease is detected at an early stage. AI technology and algorithms are continuously growing with more precision, and their applications are expected to expand more, making healthcare more effective, safe, efficient, and personalized [14].

The Challenges Behind the Revolution

Precision medicine depends on molecular and genetic information to guide the path of diagnosis and treatments that can significantly benefit from the analytical technology of AI, which makes the process faster and more economical. Applications like robotic surgeries and natural language processing (NLP) to examine medical records are therefore improving healthcare. However, ethical issues and patient safety should have proper laws [11]. Ethical issues may include the safety of patients' privacy, cybersecurity threats, explainability of AI tools, and navigating regulatory frameworks [12]. Cooperation between scientists, technology experts, healthcare workers, and policymakers is crucial to use AI properly in medicine and biotechnology [11].

The main challenges in AI and Biotechnology are large and high-quality data sets and data augmentation. AI models should be easy and clear to understand so scientists can trust and use them easily. These challenges need solutions to make AI models reliable and accurate in biology research [13].

Conclusion

AI is becoming an emerging driver in biotechnology and modern medicine. By collaborating with AI, genetic and molecular biology and pharmaceutical scientists can examine complex biological systems and view datasets that were difficult to visualize before. AI is helping healthcare

move towards a more precise and safe approach. In the future, AI will be able to design a drug according to an individual's own genetic make-up with more precision. Evolving techniques such as multi-omics analysis, digital twins, AI-based tools, and trials can reshape further how diseases are diagnosed and their treatments. However, it has some ethical concerns, such as accuracy, privacy, and algorithm bias. AI cannot replace humans, and it should not be rather, it should strengthen their ability to inspire decisions. Ultimately, the greatest promise of AI-biotechnology lies in turning vast biological information into medical treatments. The future may not be about just treating diseases but also predicting harmful genetic diseases, prevention, and their possible treatments.

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