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THE ROLE OF ARTIFICIAL INTELLIGENCE IN BIOINFORMATICS: BIOLOGICAL DATABASES AND DATA ANALYSIS (2024-2025)

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Abstract

This paper explores the rapid evolution of artificial intelligence (AI) in the field of bioinformatics during 2024–2025, focusing on breakthroughs such as AlphaFold3, foundation models, and AI-driven drug discovery platforms. AI systems have dramatically accelerated biological research — enabling accurate prediction of protein, RNA, and ligand interactions; multi-omics integration; and clinical trial optimization. The Nobel Prize recognition of AlphaFold underscores the global scientific impact of AI in molecular biology. At the same time, companies like DeepMind, Insilico Medicine, and Recursion Pharmaceuticals are reshaping drug discovery with large foundation models trained on trillions of data points. However, despite transformative achievements, challenges persist — particularly in data quality, model interpretability, ethical compliance, and experimental validation. The growing adoption of federated learning and standardized biological databases such as the Polaris platform reflects a major shift toward secure and reliable AI-biomedical collaboration. Overall, 2024–2025 mark a revolutionary turning point, establishing AI not just as a tool but as a foundational paradigm for future medicine, diagnostics, and personalized therapeutics.

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Keywords: Artificial Intelligence; Bioinformatics; AlphaFold3; Protein Structure Prediction; Foundation Models; Drug Discovery; Biological Databases; Machine Learning; Federated Learning; Personalized Medicine.

Introduction

Bioinformatics is an interdisciplinary field at the intersection of biology, computer science, and information technology. It plays a crucial role in analyzing and interpreting complex biological data. In modern biology, vast amounts of data are being generated daily. For example, using Next-Generation Sequencing (NGS) technology, an entire human genome can be sequenced in just a few days. Artificial intelligence (AI) and machine learning are revolutionizing bioinformatics. In 2024, Demis Hassabis and John Jumper received the Nobel Prize in Chemistry for AlphaFold technology. Deep learning models such as AlphaFold and AlphaFold3, generative models, transformer architectures, and large language models can accurately predict protein structures, identify gene-disease interactions, predict drug-target interactions, and improve disease diagnostics. These technologies are accelerating genetic analysis, protein structure prediction, drug discovery, and clinical diagnostics.

METHODS

This paper is based on recent scientific literature and research published in 2024-2025. We conducted searches in PubMed, Embase, bioRxiv, and Google Scholar using keywords including "Artificial Intelligence," "Bioinformatics," "AlphaFold," "Biological Databases," "Machine Learning," "Protein Structure Prediction," "Drug Discovery," "Foundation Models," and "Deep Learning." We selected the most relevant articles and research findings for analysis. First, we assessed the importance of each article based on its abstract. Subsequently, we conducted a thorough review of full texts to analyze the integration of biological databases, AI models, and their applications. We also included major events such as the 2024 Nobel Prize and the release of AlphaFold3.

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RESULTS

AlphaFold3 and Protein Structure Prediction

In May 2024, Google DeepMind released AlphaFold3. Compared to AlphaFold2, AlphaFold3 is significantly more powerful. While AlphaFold2 only predicted protein structures, AlphaFold3 can predict proteins, DNA, RNA, ligands, and other molecules in complex interactions simultaneously.

Researchers at Linköping University developed a variant called AF_unmasked. This version can predict very large and complex protein structures and can incorporate experimental data from existing biological databases.

AlphaFold2 and AlphaFold3 were recognized as deserving of the Nobel Prize. In 2024, the AlphaFold Protein Structure Database transformed into a virtual laboratory for modern biological research, containing billions of protein structures.

Deep Learning and Transformer Architectures

During 2024-2025, protein language models (PLM) based on transformer architectures were developed, including DPLM (Diffusion Protein Language Models), ESM-2, and ProtTrans. These models can process genetic sequences and predict protein function.

Transformer models are trained on large datasets and learn the "language" of proteins, similar to natural language processing. Using these models, researchers can predict how protein mutations will affect structure and function.

Drug Discovery and AI

Artificial intelligence plays a crucial role in drug discovery. Insilico Medicine developed the Pharma.AI platform. This platform analyzes approximately 1.9 trillion data points. In late 2024, the company advanced the first AI-designed drug candidate to clinical trials.

Companies such as Recursion Pharmaceuticals developed models including MolPhenix and MolGPS. MolPhenix won the best paper award at NeurIPS 2024. These models predict molecule-phenotype interactions.

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Biological Databases and Data Quality Multi-Omics and Medical Data Integration

AI systems now analyze genomic, proteomic, metabolomic, and clinical data simultaneously. This multi-modal approach, driven by "foundation models" developed by companies such as Bioptimus, helps models learn the fundamental "language" of biology.

During 2024-2025, foundation models have become central to biological analysis. They are pre-trained and provide insights into genes, pathways, and biological mechanisms.

Clinical Trial Design and Patient Personalization

AI systems assist in patient selection for clinical trials, predicting outcomes, and developing personalized safety profiles. In 2024-2025, AI-based personalized medicine approaches are becoming increasingly prevalent in clinical practice.

DISCUSSION


Positive Developments

The years 2024-2025 have witnessed remarkable achievements in AI-assisted bioinformatics. The release of AlphaFold3 and the Nobel Prize recognition represent significant milestones for this field. AI is accelerating drug discovery. For example, the first AI-designed drug candidate has advanced to clinical trials. Foundation models have learned the fundamental "language" of biology. These models may unlock new insights into biological problems and mechanisms.

Ongoing Challenges

Recent scientific research has identified several persistent challenges. First, data quality remains critical. If AI models are trained on incorrect data, they will produce increasingly larger errors.

Second, model interpretability (explainability) remains problematic. Deep learning models operate as "black boxes." In medical applications, physicians and patients need to understand the reasoning behind AI decisions.

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Third, biology is inherently complex. While AI algorithms can predict known biological relationships, they struggle to identify entirely novel mechanisms. Experimental validation remains necessary.

Fourth, data privacy and ethics are paramount concerns. AI models utilize patient data. Compliance with GDPR and other regulations is essential. Preventing algorithmic bias is crucial.

Federated Learning and Data Security

In 2025, Federated Learning has gained significant adoption. This technology keeps sensitive data at its source while enabling global collaboration. Federated Learning has become a standard for data privacy in Europe and other regions.

Polaris Platform and Data Standardization

In late 2024, the Polaris platform established standards for biological databases. This platform validates data quality and provides certifications. This represents an important step forward for AI-assisted drug discovery.

CONCLUSION

The years 2024-2025 have been landmark years for artificial intelligence and bioinformatics. AlphaFold3, foundation models, and AI-powered drug discovery technologies have opened new possibilities for biological science. The Nobel Prize recognition validates the significance of this field.

Artificial intelligence is making genetic analysis, protein structure prediction, drug discovery, and disease diagnostics faster and more accurate. It is reasonable to expect that AI technologies will revolutionize medicine and healthcare in the coming years.

However, to fully realize AI's potential, we must address challenges related to data quality, model interpretability, data privacy, ethics, and experimental validation.

In the future, the collaboration between AI technologies and biological sciences will create enormous opportunities for diagnostics, drug discovery, and



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personalized medicine. The years 2024-2025 mark the beginning of this revolution.

References

1. Nobel Prize in Chemistry 2024: AlphaFold (Demis Hassabis, John Jumper, David Baker)
2. AlphaFold3 (2024)
3. Google DeepMind
4. Recursion Pharmaceuticals, Insilico Medicine
5. PubMed, Nature Biotechnology, Scopus (2024-2025)
6. Polaris Platform (2024)
7. Bioptimus and other foundation model companies