Recent advances in artificial intelligence (AI) are revolutionizing biotechnology. This white paper, the second in a series of four AI-focused papers, provides a series of specific examples illustrating how AI is changing and advancing biotechnology today. The full potential impact of AI on biotechnology is far-reaching and touches fields including medicine, agriculture, and industrial production. Many of the following examples focus on health outcomes because the United States has historically made substantial investment in health, allowing for many different emerging technologies and interdisciplinary methods to find a starting place in health innovation.

Improved drug discovery

Drug manufacturers are using AI algorithms to digitally screen millions of chemical compounds for potential new drugs. Other AI models are identifying new drug targets in the body. The use of these models reduces the time and cost of the drug discovery process and has the potential to create more effective treatments.[1] The ATOM Alliance, a public-private partnership, used one such AI platform to rapidly improve an existing cancer therapeutic.[2] The first set of AI-designed drugs from different companies entered clinical trials over the past two years.[3]

More accurate medical diagnoses

Medical professionals are using AI-driven algorithms to analyze medical images such as MRIs, CTs, and X-Rays to more accurately detect and diagnose medical incidences such as aneurysms, cancer, and strokes.[4] The FDA has already approved nearly 700 AI-enabled medical devices in the United States.[5]

Autonomous biology labs

AI-powered robots, such as those at Emerald Cloud Labs,[6] are autonomously creating, analyzing, and validating the creation of biological components such as proteins and DNA. These new processes allow for a much larger range of experimentation and free up scientists to dedicate more time to original scientific creativity rather than repetitive experiments.[7]

Proteins to address food security

AI, in combination with synthetic biology, is opening new ways to produce food or to enhance the nutritional content of existing products. For example, the company Protera used AI to identify proteins that can be added to bread to increase its shelf-life and nutritional value.[8]

AI-enabled 21st century farming

Farmers can use AI-enabled equipment such as drones from Agro-Drone AI[9] or tractors from John Deere[10] to autonomously monitor and measure crop health or soil moisture. These new tools will help farmers optimize their water or nutrient use of their crops while reducing adverse environmental effects, and assist farmers in understanding what crop strains are thriving in a particular environment.

New countermeasures for pandemics

The next pandemic could be prevented and countered using AI-enabled tools: researchers from Harvard Medical School and the University of Oxford developed a tool that can predict outbreaks and future variants of concern for viruses such as SARS-CoV-2, HIV, and influenza.[11] Other algorithms, such as Lawrence Livermore National Laboratory's GUIDE program, are designed to rapidly develop and validate antibodies to counter public health threats.[12]

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1

Novel insights into health data

Researchers are using AI to clean, organize, and analyze the massive amounts of data generated in the healthcare system that would otherwise be too complicated for humans to assess. For example, researchers used a deep learning model to predict patient outcomes such as in-hospital mortality based on electronic health records.[13]

Optimized biofuel production

Researchers at Idaho National Laboratory are using data from biorefineries to train an AI algorithm to optimize biomass processing for energy production. These systems automatically respond and adjust to different biomass inputs so that refineries can use multiple different input sources to produce energy. Researchers at Idaho National Laboratory are planning to distribute these technologies to biorefineries around the United States.[14]

Generative AI for biology

Generative AI platforms like ChatGPT are known for producing information like text or images when trained on human language or imagery data. But generative AI platforms are also generating novel biological information, when they are trained on biological data. SalesForce Research's ProGen platform, for example, can generate entirely new proteins that do not exist in nature and exhibit a specifically desired function as determined by the researcher.[15]
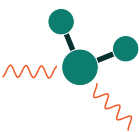
Enhanced sensors for biomanufacturing

Biomanufacturing companies are combining AI with existing tools to improve the efficiency of the production line. For example, researchers from the pharmaceutical company Boehringer Ingelheim coupled their spectroscopy equipment with AI algorithms to conduct real-time, in-line quality control measurements for biopharmaceutical production.[16]

Accurately predicting protein structures

Researchers are using publicly available AI programs such as AlphaFold and RoseTTAFold to predict the 3-D structure of proteins.[17] In addition to providing previously unknown information about basic cellular components, researchers can use protein structures to unlock information about protein function, which they can then use to develop treatments for cancer and other rare diseases.

Sources

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