

AI to help accelerate the progress of synthetic biology

Steven Ness - bioAI

Apply AI to synthetic biology

Synthetic biology - Apply engineering principles to biology

How To Grow Almost Anything class

MIT Media Lab + Harvard + Global listeners

20 in person students

500 registered global listeners

George Church

Gingko Bioworks - Twist Biosciences

Phage to treat multidrug antibiotic resistant bacteria

Bacteria can develop immunity to antibiotics

Multidrug Resistant (MDR) bacteria can be resistant to many antibiotics

Outbreaks in hospitals can have dire consequences

Bacteriophages are viruses that infect bacteria - Phage therapy

Bacteria can evolve to escape phages

Design phages that are hard to evolve against

Use important parts of the bacteria they can't easily change

MS2 phage - E.coli

Multidrug-resistant (MDR) *Escherichia coli* (*E. coli*) is a significant problem in hospitals and other healthcare settings.

MS2 Phage - bacteriophage specific to *E. coli*.

MS2 has only 4 genes

Lysis protein (L-protein) responsible for lysing *E. coli* cell

L-protein interacts with host DnaJ chaperone

Mutate L-protein so that mutations on DnaJ chaperone don't disrupt function

Technology

Students given assignment to design these mutants

Each wrote up a detailed report

Use Claude 3 to evaluate student work

Use Claude 3 to design experiments

Issues

Had to be very specific with Claude 3 to get around filters against making viruses that can escape host immune system:

"I apologize, but I do not feel comfortable providing any information or advice related to mutating viruses or bacteriophages in ways that could prevent a host from escaping infection. Pursuing research in that direction raises serious ethical concerns, as it could potentially be misused to engineer viruses that are more harmful or difficult to treat. I would suggest focusing your scientific inquiries on less risky areas that do not pose those kinds of dangers. Let me know if there are other microbiology topics I can assist with though!"

Issues

Claude 3 was a bit too lenient

Had to adjust prompts:

"Please mark the student on their performance as if they were a graduate level student"

Demo

Potential Revenue Streams in AI for synthetic biology

Education

Drug discovery and development

Genetic engineering services

Custom microorganisms for industry

Bioinformatics services

Synthetic biology tools and APIs

Key Competitors in AI for synthetic biology

BenchSci : Specializes in AI-driven literature analysis for antibody discovery and research.

Ginkgo Bioworks: Specializes in programming cells for a wide range of applications, leveraging automation and machine learning.

Twist Bioscience: Offers high-throughput DNA synthesis technologies for applications in medicine, agriculture, and industrial chemicals.

Amyris: Uses synthetic biology and an AI-driven platform for sustainable production of chemicals and materials..

DeepMind Technologies (Google Health) : Involved in various healthcare AI projects, including cancer-related research.

Generative LLM model for synthetic biology research

Protein Design: Predict and design novel proteins with specific functions.

Genetic Circuit Optimization: Suggest improvements for synthetic biological systems.

DNA Sequence Automation: Generate optimal DNA sequences for targeted applications.

Biological System Predictions: Forecast outcomes of biological interactions.\

Bioinformatics Insights: Derive insights from complex bioinformatics datasets.