We affirm the resolution: In the United States, the benefits of the use of generative artificial intelligence in education outweigh the harms.

Definitions:

Generative AI: MIT in 2023 https://news.mit.edu/2023/explained-generative-ai-1109 defines:

Generative AI can be thought of as a machine-learning model that is **trained to create new data,** rather than making a prediction about a specific dataset. A generative AI system is **one that learns to generate more objects** that look like the data it was trained on.

Education: Cambridge https://dictionary.cambridge.org/us/dictionary/english/education defines: the process of teaching or learning, especially in a school or college, or the knowledge that you get from

C1: innovation

Research at universities is the catalyst for innovation

Bajraktari from the MIT Technology Review in **2024** [Ylli Bajraktari, Tom Mitchell, and Daniela Rus, "Three ways the US could help universities compete with tech companies on AI innovation", 04/19/2024, MIT Technology Review, https://www.technologyreview.com/2024/04/19/1091488/three-ways-the-us-could-help-universities-compete-with-tech-companies-on-ai-innovation/, Accessed 03/04/2025]

The ongoing revolution in artificial intelligence has the potential to dramatically improve our lives—from the way we work to what we do to stay healthy. Yet ensuring that America and other democracies can help shape **the trajectory of this technology requires** going beyond the tech development taking place at private companies. **Research at universities drove the AI advances** that laid the groundwork for the commercial boom we are experiencing today.

AI is the newest frontier for this research in over 14 universities

OpenAI 25 [OpenAI, "Introducing NextGenAI: A consortium to advance research and education with AI", 03/04/2025, OpenAI, https://openai.com/index/introducing-nextgenai/, Accessed 03/04/2025

Today, we're launching NextGenAI, a first-of-its-kind consortium with 15 leading research institutions dedicated to using AI **to accelerate** research **breakthroughs and transform education.** AI has the power to drive progress in research and education—but only when people have the right tools to harness it. That's why **OpenAI is committing $50M** in research grants, compute funding, and API access to support students, educators, and researchers advancing the frontiers of knowledge. Uniting institutions across the U.S. and abroad, NextGenAI aims to catalyze progress at a rate faster than any one institution would alone. This initiative is built not only to fuel the next generation of discoveries, but also to prepare the next generation to shape AI's future.

The Next Generation of AI Leaders NextGenAI's founding partners are **Caltech,** the California State University system, **Duke University, the University of Georgia, Harvard University, Howard University, Massachusetts Institute of Technology, the University of Michigan, the University of Mississippi, The Ohio State**

University, the University of Oxford, Sciences Po, Texas A&M University, as well as Boston Children's Hospital, the Boston Public Library, and OpenAI. Each institution is **using AI to tackle high-impact challenges, from revolutionizing healthcare to reimagining education**. Here are just a few examples of their groundbreaking work: Accelerating the next generation of research breakthroughs **The Ohio State University is leveraging AI to accelerate the fields of digital health, advanced therapeutics, manufacturing, energy, mobility, and agriculture, while educators are using AI to create advanced learning models. Harvard University and Boston Children's Hospital researchers are using OpenAI tools and NextGenAI funding to reduce the time it takes patients to find the right diagnosis, especially for rare orphan diseases, and improve AI alignment with human values in medical decision-making. Duke University scientists are using AI to pioneer metascience research, identifying the fields of science where AI can have the greatest benefit.** "Ohio State is at the forefront of a multidisciplinary approach to the benefits of AI, significantly impacting both research and education. We are excited to join Open AI and this elite research partnership, which **will enable us to drive even more groundbreaking discoveries and advancements in medicine, manufacturing, computing, and beyond.**" —Peter J. Mohler, Executive Vice President for Research, Innovation, and Knowledge, The Ohio State University Empowering the next generation to be AI-fluent **Texas A&M is using NextGenAI resources to fuel their Generative AI Literacy Initiative, providing hands-on training to enhance the responsible use of AI in academic settings.** MIT students and faculty will be able to use OpenAI's API and compute funding to train and fine-tune their own AI models and develop new applications. **Howard will use AI to develop curricula, experiment with new teaching methods, improve university operations, and give students hands-on AI experience to prepare them as future leaders.** "We look forward to collaborating with OpenAI, whose support will enable us to empower our students, researchers, and the broader academic community with cutting-edge knowledge and skills in the rapidly evolving field of generative artificial intelligence." —Dr. Robert H. Bishop, Vice Chancellor and Dean of the College of Engineering, Texas A&M University Imagining the future of AI-powered universities and libraries University of Oxford is leveraging AI for a broad research agenda, education, and university operations—its renowned Bodleian Library is digitizing rare texts and using OpenAI's API to transcribe them, **making centuries-old knowledge newly searchable by scholars worldwide.** University of Mississippi is exploring new ways to integrate AI into their core mission of education, research, and service, and **to advance AI-driven solutions that benefit their students, faculty, and the broader community.** Boston Public Library, America's first large free municipal public library, is digitizing public domain materials and using AI to make their information more accessible to patrons from all walks of life. "This new collaboration marks an exciting step forward, offering fresh opportunities to enrich our research, expand our AI capabilities, and foster skill development. By working together, we can learn from one another, advancing the frontiers of artificial intelligence, understanding its impact on education and unlocking its vast potential for the benefit of our university community and beyond."
—Anne Trefethen, Pro-Vice-Chancellor, Digital, University of Oxford Strengthening the Connection Between Academia & Industry NextGenAI reinforces the vital partnership between academia and industry, ensuring that AI's benefits extend to laboratories, libraries, hospitals, and classrooms worldwide. "The field of AI wouldn't be where it is today without decades of work in the academic community. Continued collaboration is essential to build AI that benefits everyone. NextGenAI will accelerate research progress and catalyze a new generation of institutions equipped to harness the transformative power of AI." —Brad Lightcap, Chief Operating Officer, OpenAI This initiative expands OpenAI's commitment to education, following the launch of ChatGPT Edu in May 2024, which enabled university-wide access to ChatGPT. NextGenAI complements this effort by providing institutions OpenAI's APIs and funding to drive critical innovation. NextGenAI is designed to support the scientist searching for a cure, the scholar uncovering new insights, and the student mastering AI for the world ahead. As we learn from this initiative, we'll explore opportunities to expand its reach and impact. We look forward to sharing updates as our partners drive progress—one breakthrough at a time.

It's specific to genAI

Amazon in 2024 [Amazon in 2024, "Amazon invests $110 million to support AI research at universities using Trainium chips", 11/12/2024, US About Amazon, https://www.aboutamazon.com/news/aws/amazon-trainium-investment-university-ai-research, Accessed 03/04/2025]

Amazon is announcing a $110 million investment for university-led research in generative AI. The program, known as **Build on Trainium, will provide compute hours that allow researchers the opportunity to build** new **AI architectures, machine learning (ML) libraries, and performance optimizations** for large-scale distributed AWS Trainium UltraClusters (collections of of AI accelerators that work together on complex computational tasks). AWS Trainium is the ML chip that AWS built for the purposes of deep learning training and inference. AI advances created through the Build on Trainium initiative will be open-sourced, so researchers and developers can continue to advance their innovations. 4 ways AWS is engineering infrastructure to power generative AI From networking innovations to changes in data center design, **AWS continues to optimize its infrastructure to support generative AI at scale. The program caters to a wide range of AI research,**

from algorithmic advancements to increase AI accelerator performance, all the way up to large distributed systems research. As part of Build on Trainium, AWS created a Trainium research ltraCluster with up to 40,000 Trainium chips, which are optimally designed for the unique workloads and computational structures of AI. As part of Build on Trainium, **AWS andleading AI**

student education. In addition, Amazon will conduct multiple rounds of Amazon Research Awards calls for proposals, with selected proposals receiving AWS Trainium credits, and access to the large Trainium UltraClusters for their research. A boost to computing power Developing frontier AI models and applications requires a lot of computing power, and many universities have had to slow down AI research due to budgetary constraints. A researcher might invent a new model architecture or a new performance optimization technique, but they may not be able to afford the high-performance computing resources required for a large-scale experiment. The Catalyst research group at Carnegie Mellon University (CMU) in Pittsburgh, Pennsylvania, is one of the research institutions participating in Build on Trainium. There, a large group of faculty and students are conducting research on ML systems, including developing new compiler optimizations for AI. "AWS's Build on Trainium initiative enables our faculty and students large-scale access to modern accelerators, like AWS Trainium, with an open programming model. It allows us to greatly expand our research on tensor program compilation, ML parallelization, and language model serving and tuning," said Todd C. Mowry, a professor of computer science at CMU. Funding to support AI experts of the future Since launching the AWS Inferentia chips in 2019, AWS has been a pioneer in building and scaling AI chips in the cloud. By opening those capabilities to academics, Build on Trainium will not only help broaden the pool of ideas, but also support the training of future AI experts. What you need to know about the AWS AI chips powering Amazon's partnership with Anthropic Anthropic will use our powerful, purpose-built AI chips to accelerate generative AI for our customers. "Trainium is beyond programmable—not only can you run a program, you get low-level access to tune features of the hardware itself," said Christopher Fletcher, an associate professor of computer science research at the University of California at Berkeley, and a participant in Build on Trainium. "The knobs of flexibility built into the architecture at every step make it a dream platform from a research perspective." These advancements are possible, in part, thanks to a new programming interface for AWS Trainium and Inferentia called the Neuron Kernel Interface (NKI). This interface gives direct access to the chip's instruction-set and allows researchers to build optimized compute kernels (core computational units) for new model operations, performance optimizations, and science innovations. "**AWS is really enabling unexpected innovation**," said Fletcher. "I walk across the lab and every project needs compute cluster resources for something different. The Build on Trainium resources will be immensely useful—from day-to-day work, to the deep research we do in the lab." Additional resources for grant recipients As part of the Build on Trainium program, researchers will be able to connect with others within the field to bring ideas to life. Grant recipients have access to AWS's extended technical education and enablement programs for Trainium. This is done in partnership with the growing Neuron Data Science community, a virtual organization led by Amazon's chip developer Annapurna, which bridges the AWS Technical Field Community (TFC), specialist teams, startups, AWS's Generative AI Innovation Center, and more. Your guide to free and low-cost AWS courses that can help you use generative AI More than 100 AWS trainings on AI/ML are available to everyone, with all levels of experience. AI advancements are moving quickly because developers anywhere in the world are able to access and deploy the software. **Researchers involved in Build on Trainium will publish papers on their work and will be asked to bring the code into the public sphere** via open-source machine learning software libraries. This collaborative research will become the foundation for the next round of advancements in AI.

This helps **agriculture.**

GenAI developed by universities allows farmers to adapt to climate challenges.

Saldana from Texas A&M in **2025** **Gabe Saldana, "Generative AI for decision-making in agricultural and natural resources production, management", 02/07/2025, Phys, https://phys.org/news/2025-02-generative-ai-decision-agricultural-natural.html#google_vignette, Accessed 03/04/2025**

An innovative resource designed to streamline and improve decision-making in agricultural and natural resources production and management is now available to a wide range of users—including policymakers, land and water managers, farmers, researchers and extension agents across the nation. **The Soil and Water Assessment Tool released was Virtual Extension Assistant, or SWAT VEXA, in late 2024 by Texas A&M AgriLife Research and IBM. It is a free, interactive, generative artificial intelligence, AI, assistant that provides custom, user-friendly insights**. By **addressing critical areas such as soil erosion, pollution control and disaster risk mitigation among many other scenarios, SWAT VEXA empowers users to make informed decisions across a host of scenarios. Decades of research and development Outputs from SWAT VEXA are based on big data sets of the Soil and Water Assessment Tool, SWAT. This advanced computer modeling system was developed over more than four decades by scientists at the Texas A&M** AgriLife Blackland Research Center at Temple along with the U.S. Department of Agriculture's Agricultural Research Service, USDA-ARS. Over the years, SWAT has become the international and U.S. standard for agriculture and natural resources decision-making at all geographical scales. "VEXA accelerates research, enhances reproducibility and empowers users to design innovative solutions for complex agricultural and hydrological challenges," said Raghavan Srinivasan, Ph.D., AgriLife Research distinguished professor and director of the Blackland Research Center at Temple. "With its ability to democratize

knowledge and fast-track decision-making, VEXA is set to drive significant advancements in SWAT model research, ultimately promoting ecosystem sustainability and effective resource management worldwide," Srinivasan said. Merging AI with proven technology The SWAT system was integrated with AI as part of a continuing collaboration between AgriLife Research and IBM through the technology company's IBM Sustainability Accelerator. SWAT VEXA also incorporates IBM's Deep Search AI, watsonx.ai and Granite model. Researchers say **the tool can advance agricultural and natural resource productivity and sustainability by enabling faster decision-making** for users worldwide. "Today, smallholder farmers need more than traditional advice," said Justina Nixon-Saintil, vice president and chief impact officer at IBM. "They need scientifically precise, data-driven insights. Solutions such as SWAT VEXA democratize access to critical environmental insights, enabling faster, more informed decision-making for communities facing agricultural challenges."

Driving global impact In addition to advancing agricultural and resource productivity, SWAT VEXA is expected to amplify the global impact of the IBM Sustainability Accelerator. To date, this program has **supported approximately 65,300 direct beneficiaries through efforts in sustainable agriculture initiatives.** By offering accessible, AI-powered insights, SWAT VEXA enables users to make data-informed decisions, ultimately promoting sustainability and resilience in agricultural systems worldwide.

U.S. agricultural innovation is how we feed the future.

Fain '23 [Irving; February 10; B.A. from Brown University, former analyst at Citi, founder and CEO of Bowery; Fortune, "A new agricultural revolution has started. Congress must invest now to secure the future of U.S. food,"

At a certain point, we have to wonder how much more the global food system can take. Historic flooding in Pakistan. Droughts across the American West. Russia's invasion of Ukraine. **The global food system and the supply chains** that have long allowed us to move food from where it is grown to where it **is needed have rarely been stretched so thin,** or so far. The consequences can be seen in the cost and availability of food in most parts of the world, including in the United States. Americans' growing demand for fresh produce will only accelerate our reliance on an increasingly fragile food system. However, the story of this decade doesn't have to be one of scarcity and strain. A different future is within reach: one of abundance, affordability, and sustainability. The U.S. has a Historic opportunity to shorten supply chains, safeguard long-term food security, and decrease the environmental costs of agriculture. Innovation can make this possible–but only if America invests in new farming technologies. Not only to feed ourselves but to reaffirm our role as the world's greatest exporter of both food and innovation. Unless you're in the industry, you might not know that agriculture is undergoing a quiet technological revolution. Drones, sensors, and satellite imaging systems help farms manage crops more effectively with more information and knowledge than ever before. Amid labor shortages, **farmers are looking to robotics and automation to fill the gap. Artificial intelligence is now used to monitor soil, control pests, and improve overall yield.** These and other advances are enabling the industry to rethink its most basic assumptions: how we grow, what we grow, and how we transport what we grow. For example, recent breakthroughs in artificial intelligence, computer vision, and sensor and control systems have allowed our company, Bowery, to grow fresh, local, pesticide-free in large-scale, smart indoor environments with crops stacked from floor to ceiling. This approach, powered by renewable energy, uses significantly less land and water. **It's a sustainable model that works irrespective of changing climate conditions or severe weather events. Vertical farms can be built just about anywhere.** But by putting them near the markets we serve, we can radically shorten the supply chain–decreasing disruptions and the environmental costs of long-haul shipping, and increasing the resilience of the food system overall. Many Americans have probably eaten vertically farmed products without realizing how differently they're grown. But vertical farming is only part of the broader transformation that the world must undertake.

With the global population projected to reach nearly 10 billion by 2050, and with the climate crisis worsening, we need to produce more food, more sustainably. This will require collective effort–and collective investment. Much like crops on a farm, a business requires the right inputs to grow. Great ideas, upfront capital, and a commitment at the state and local levels enable businesses to thrive. But for a cutting-edge industry to flourish and have a national and even global impact, the federal government has a key role to play as an accelerator of innovation.

Think of solar energy in the 1990s or electric vehicles in the early 2000s. The promise was evident. But these innovations could not have become the transformative, ubiquitous technologies they are today absent national investments in research and development, infrastructure, workforce training, and manufacturing–and without appropriate tax incentives.

Agriculture is poised to become the next great success story of sustainable innovation–as foreign governments increasingly recognize. For example, the Netherlands–the world's second-largest agricultural exporter–has invested in new growing technology and cell-based meat production. Small, land-poor states like Singapore and the UAE, as well as massive countries such as Russia and China, are working to build food systems that can withstand the changing climate and reduce their reliance on tumultuous trade relationships. The U.S. must do the same. The global challenges of climate change and food insecurity will accelerate the development of new farming technologies

everywhere humans live and eat. **America has an opportunity to lead this revolution and to spread the benefits around the world.** As a matter of foreign policy and economic policy, the new Congress must act.

Key to prevent poverty

Caldwell 08: 5-1-2008, "Food Price Crisis 101," Center for American Progress,

https://www.americanprogress.org/article/food-price-crisis-101/, accessed: 3-13-2022

The timing could not be worse for many of the world's hot spots and the United States' long-term national security. Rising prices and low stockpiles have fueled civil strife and political instability in urban areas of vitally strategic countries such as Egypt, Indonesia, Afghanistan, Somalia, Haiti, Pakistan, and India. At the precise moment when the United States has a narrow window of opportunity to contribute toward progress on the security, political, and economic fronts in key countries such as Pakistan and Afghanistan, the streets have erupted in food riots. Dramatic **increases in food prices disproportionately affect the poor** both in the United States and abroad. The purchasing power of families, food banks, and aid agencies erodes as prices rise, and they cannot keep pace with rising costs. Food banks and soup kitchens in the United States are reporting dwindling stocks and a 20 percent increase in visitors since April of last year. And **in developing countries,** where **60 to 80 percent of** a family's **income is spent on food, every 20 percent increase in food prices will push 100 million** more people **into the ranks of the poorest of the poor living on less than one dollar a day**

Food inflation in the United States is at its highest levels in 17 years. Enrollment in the nation's food stamp and nutrition programs has grown by 1.3 million to its highest levels ever. The U.S. Department of Agriculture estimates that the price of household food purchases will rise by 4 to 5 percent this year. Poor Americans spent almost 6 percent more of their income on food in 2006 than households with incomes above $70,000. Congress must use the Farm Bill and other legislation to provide additional funding to increase the budgets of the food stamp and nutrition programs so that they can serve more Americans in need.

C2: Alpha fold

One example in education is gen ai AlphaFold.

Koul '24 AlphaFold 3 - A Generative AI Model to predict 3D structure of biomolecules. Dr. Nimrita Koul Dr. Nimrita Koul ·6 min read · Jun 14, 2024

AlphaFold-3 (AF3) is the latest generative AI model in the series of AlphaFold models. It provides an accurate atomic-level view of the structure of biomolecular systems. AlphaFold3 can accurately predict not only the 3D structure of almost all the proteins, but also the interactions among DNA, RNA, and other small molecule ligands within our cells. It can also predict the structural impact of post-translational modifications and ions on these molecular systems.

Alpha Fold is key to research in education universities

Sharma et al. '24 @article{veo2024, title={Veo}, author={Abhishek Sharma and Adams Yu and Ali Razavi and Andeep Toor and Andrew Pierson and Ankush Gupta and Austin Waters and Aäron van den Oord and Daniel Tanis and Dumitru Erhan and Eric Lau and Eleni Shaw and Gabe Barth-Maron and Greg Shaw and Han Zhang and Henna Nandwani and Hernan

Moraldo and Hyunjik Kim and Irina Blok and Jakob Bauer and Jeff Donahue and Junyoung Chung and Kory Mathewson and Kurtis David and Lasse Espeholt and Marc van Zee and Matt McGill and Medhini Narasimhan and Miaosen Wang and Mikołaj Bińkowski and Mohammad Babaeizadeh and Mohammad Taghi Saffar and Nando de Freitas and Nick Pezzotti and Pieter-Jan Kindermans and Poorva Rane and Rachel Hornung and Robert Riachi and Ruben Villegas and Rui Qian and Sander Dieleman and Serena Zhang and Serkan Cabi and Shixin Luo and Shlomi Fruchter and Signe Nørly and Srivatsan Srinivasan and Tobias Pfaff and Tom Hume and Vikas Verma and Weizhe Hua and William Zhu and Xinchen Yan and Xinyu Wang and Yelin Kim and Yuqing Du and Yutian Chen}, url={https://deepmind.google/technologies/veo/}, year={2024} }

AlphaFold's impact

So far, AlphaFold has predicted over 200 million protein structures – nearly all catalogued proteins known to science. The AlphaFold Protein Structure Database makes this data freely available. So far, it has over two million users in 190 countries. That means it has already potentially saved millions of dollars and **hundreds of millions of years in research time.**

Meanwhile, AlphaFold Server predicts how proteins will interact with a broad spectrum of biomolecules, accelerating new research.

AlphaFold has already made a significant impact. We hope it will eventually help to transform our understanding of the biological world.

Alpha fold accelerates drug discovery and specific compound CDK 20 is cure to liver cancer.

Feng '23 From the journal: Chemical Science AlphaFold accelerates artificial intelligence powered drug discovery: efficient discovery of a novel CDK20 small molecule inhibitor† Check for updates Feng Ren,a Xiao Ding,a Min Zheng,a Mikhail Korzinkin,b Xin Cai,a Wei Zhu,a Alexey Mantsyzov,b Alex Aliper,b Vladimir Aladinskiy,b Zhongying Cao,a Shanshan Kong,a Xi Long,b Bonnie Hei Man Liu,b Yingtao Liu,a Vladimir Naumov,b Anastasia Shneyderman, ORCID logo b Ivan V. Ozerov,b Ju Wang,a Frank W. Pun,b Daniil A. Polykovskiy,b Chong Sun,c Michael Levitt,d Alán Aspuru-Guzik*c and Alex Zhavoronkov ORCID logo *ab Article type Edge Article Submitted 14 Oct 2022 Accepted 05 Jan 2023 First published 10 Jan 2023
https://pubs.rsc.org/en/content/articlelanding/2023/sc/d2sc05709c

The application of artificial intelligence (AI) has been considered a revolutionary change in drug discovery and development. In 2020, the AlphaFold computer program predicted protein structures for the whole human genome, which has been considered a remarkable breakthrough in both AI applications and structural biology. Despite the varying confidence levels, these predicted structures could still significantly contribute to structure-based drug design of novel targets, especially the ones with no or limited structural information. In this work, we successfully applied AlphaFold to our end-to-end AI-powered drug discovery engines, including a biocomputational platform PandaOmics and a generative chemistry platform Chemistry42. A novel hit molecule against a novel target without an experimental structure was identified, starting from target selection towards hit identification, in a cost- and time-efficient manner. PandaOmics provided the protein of interest for the treatment of **hepatocellular carcinoma (HCC)** and Chemistry42 generated the molecules based on the structure predicted by AlphaFold, and the selected molecules were synthesized and tested in biological assays. Through this approach, we identified a small molecule hit compound for cyclin-dependent kinase 20 (CDK20) with a binding constant Kd value of 9.2 ± 0.5 μM (n = 3) within 30 days from target selection and after only synthesizing 7 compounds. Based on the available data, a second round of AI-powered compound generation was conducted and through this, a more potent hit molecule, ISM042-2-048, was discovered with an average Kd value of 566.7 ± 256.2 nM (n = 3). Compound ISM042-2-048 also showed good CDK20 inhibitory activity with an IC50 value of 33.4 ± 22.6 nM (n = 3). In addition, ISM042-2-048 demonstrated selective anti-proliferation activity in an HCC cell line with CDK20 overexpression, Huh7, with an IC50 of 208.7 ± 3.3 nM, compared to a counter screen cell line HEK293 (IC50 = 1706.7 ± 670.0 nM). This work is the first demonstration of applying AlphaFold to the hit identification process in drug discovery.

CDK20 saves 30k people in the United States alone

ACS '25 Key Statistics About Liver Cancer American cancer society https://www.cancer.org/cancer/types/liver-cancer/about/what-is-key-statistics.html

The American Cancer Society's estimates for primary liver cancer and intrahepatic bile duct cancer in the United States for 2025 are:

- About 42,240 new cases (28,220 in men and 14,020 in women) will be diagnosed
- About 30,090 people (19,250 men and 10,840 women) will die of these cancers

Specifically cardio vascular disease (One example of 200 million). AlphaFold-predicted structures have been used to identify and visualize critical binding regions of PCSK9, such as the 370-385 region, which is crucial for its interaction with LDL receptors

D'Mello et. al '24 Engineering Plastic-Degrading Enzymes and PCSK9 Binders with Protein AI Tools A protein engineering toolkit for molecular design // Engineering enzymes to break down plastic with ProtGPT2, OmegaFold, TemStaPro // Designing drugs with RFDiffusion, ProteinMPNN, ColabFold TAHIR D'MELLO, BRONTË KOLAR, ANDKENNY WORKMAN OCT 18, 2024
https://blog.latch.bio/p/engineering-plastic-degrading-enzymes

Most recent advancements in deep learning based protein structure prediction tools have traditionally relied on evolutionary information from multiple sequence alignments (MSAs) to accurately predict structures. However, for enzymes designed to function outside of their native organisms—such as those aimed at degrading plastics in environmental or industrial settings—MSAs may not always be available or reliable due to a lack of evolutionary data and context.
OmegaFold addresses this challenge by accurately predicting high-resolution protein structures using only a single primary sequence, without the need for MSAs. It combines a protein language model, which makes predictions from single sequences, with a geometry-inspired transformer model trained on known protein structures. This approach allows OmegaFold to achieve similar prediction accuracy to AlphaFold2 and outperform RoseTTAFold, particularly in cases where evolutionary information is limited or noisy. [6]

For this flow, a Latch Workflow for OmegaFold was used to predict the 3D structures of the 1,000 enzyme sequences generated from the fine-tuned ProtGPT2 model.

This process converted the sequences into PDB files, providing initial structural models for further analysis.

Directory of generated PDB files on Latch Data
While this method is a valuable step in evaluating the potential of these enzymes, it is important to recognize the limitations: the accuracy of these structural predictions, particularly for entirely novel sequences, may not always be guaranteed. Therefore, further experimental prediction, validation and refinement are necessary.
To explore the potential of the generated enzyme sequences, we then used a range of computational tools to predict key properties and stability of protein sequences.

4. Thermostability Prediction with TemStaPro

We used a Latch Workflow for TemStaPro in bulk to predict the thermal stability of the generated enzyme sequences, estimating their stability across a range of temperature thresholds (40°C to 80°C).
The tool generated detailed TSV files with binary and raw predictions for each enzyme, providing insights into which enzymes may remain stable under conditions relevant to industrial and environmental applications.

TSV containing thermal stability predictions for generated enzymes on Latch Data
Predictions were made for mean thermal stability across the entire sequence, as well as per-residue predictions to pinpoint specific areas of instability within each enzyme. [7]
In future iterations of this process, these insights can guide sequence modifications to improve thermostability, either through rational design or further fine-tuning of ProtGPT2.

5. Aggregation Propensity with Aggrescan3D

To evaluate the aggregation tendencies of the 3D structures generated by OmegaFold, Aggrescan3D was used in bulk on all the PDB files through a Latch Workflow. [8]

Aggregation scores for protein 103 - red represents regions with high aggregation propensities while blue represents regions with low aggregation (high solubility) propensity

This tool identifies aggregation propensity by analyzing residue-level interactions and looking at the geometry of the protein surface. This is often overlooked by methods that just look at the sequence alone. The output provided an A3D score for each residue. As a quick summary measure for aggregation propensity of each generated enzyme, we used the median of the protein's residue A3D scores.
This information can highlight potential aggregation issues, guiding further structural optimization.

6. Electrostatic Potential and Hydrophobicity with PEP-Patch

Understanding the electrostatic and hydrophobic properties of enzymes is crucial for predicting their interactions with substrates and behavior in different environments.
PEP-Patch on Latch generates outputs to visualize and quantify these properties on the surface of the predicted enzyme structures. These insights help identify and prioritize surface features that are most likely to support efficient substrate interaction. [9]

Patches of electrostatic potential mapped out on protein 103 - red represents patches with a negative charge and blue represents regions with a positive charge

Patches representing hydrophobicity mapped out for protein 103 - red represents hydrophobic patches while blue represents hydrophilic patches
Future modifications can focus on enhancing these properties to increase the likelihood of effective plastic degradation in various environments.

7. Organize and Filter Results

To bring all the findings together, we used a Latch Pod to compile the results into a table in Latch Registry.
The table includes each generated sequence, dynamic links to structure files, and key predicted properties and files for thermostability values, aggregation scores, electrostatic and hydrophobic characteristics.
By organizing the data this way, we created a clear, centralized resource that makes it easier to analyze and select the most promising enzyme candidates for further refinement.
To narrow down the enzyme candidates, we applied filters to the table, focusing on those that were thermally stable at 40°C, had an aggregation propensity between -0.5 and 0.2—indicating an optimal balance of aggregation and stability—and were longer than 400 amino acids.
This filtering process helped to efficiently identify the most promising enzymes for further refinement and experimental testing, ensuring that only the best candidates move forward in the development cycle.

Designing De-Novo Binders for PCSK9

In this second flow, we turn to drug development and use our toolkit to build a protein binder. Our mock target is PCSK9, a protein involved in cardiovascular disease and of active interest in several modern drug programs. PCSK9 binds to LDL receptors (LDL-R) on liver cells, causing their degradation and reduces their ability to remove LDL cholesterol from the bloodstream. A PCSK9 binder prevents this interaction, allowing more LDL receptors to be recycled to the cell surface and potentially lowering blood cholesterol levels. [1]

Flow Anatomy

To arrive at candidate binders, we will start with scaffold design and end up generating 100 potential binder structures in the following steps:

1. **Use Pymol to identify the region of PCSK9 we want to bind**
2. **Diffuse 10 scaffolds near binding hotspots on PCSK9 with RFDiffusion**
3. **Use ProteinMPNN to generate 100 sequences for these scaffolds**
4. **Predict 3D protein structure for each sequence using ColabFold and explore the structure of the binders a complex with PCSK9**

1. Identifying the binding region

Let's take a look at PCSK9. We first navigate to the RCSB Protein Data Bank and download a PDB file of 2W2M, which stores the structure of a complex of PCSK9 bound to LDL-R. [7]

Opening this up in PyMol (a protein visualization tool) we see two chains representing PCSK9 (Chain A - *dark blue*, Chain P - *light blue*) and one representing LDL-R (Chain E - *gray*).

We will now highlight the binding regions on PCSK9 Chain A where LDL-R binds. Our hypothesis is that if we can design a binder to bind to these hotspot regions, we can prevent the interaction of PCSK9 and LDL-R.
From a literature search, we identified amino acids are critical hotspot residues in the 370-385 region of PCSK9 Chain A. [7]

- Asp374 (red)
- Thr377 (yellow)
- Phe379 (green)

Below, you can see these regions highlighted:

2. Designing a binder scaffold with RFDiffusion

Now that we've identified our target region and hotspots, RFDiffusion can be used to create a structure to scaffold this location. RFDiffusion is a protein design tool that uses diffusion models to generate novel protein structures. Using RFDiffusion, we can use the PCSK9 protein structure as a template and diffuse a structure around our hotspot region. This will serve as the backbone of our binder designs.
Using the 2W2M PDB file above as our input structure file, we can generate potential binder scaffolds on Latch using parameters in the RFDiffusion workflow to specify the regions of PCSK9 that we want to use.

These parameters launched a protein design workflow which created 10 potential binder structures, each up to 100 residues long, that were designed using Chain A (residues 370-395) of PCSK9 as a template. [8]
Let's take a look at one of structures generated by RFDiffusion: **PCSK9_binder_3.pdb**. Two chains were generated: 1) **Chain A**, in purple, is the diffused scaffold and 2) **Chain B**, in blue, is the region from PCSK9 that the scaffold was designed against. Essentially, **Chain A** is the generated binder structure.

Here, we can see how it aligns to the original PCSK9 A Chain, with and without hotspots annotated:

There are plenty of parameters that we didn't explore here from RFDiffusion that allow you to diffuse far more complex scaffolds than this. [9]

3. Sequence generation with ProteinMPNN

Now that we have binder structures, the next step is to generate an amino acid sequence sequence that folds to this backbone structure. ProteinMPNN is a powerful tool that does exactly this - given a backbone structure, it generates protein sequences.
We use the design from the previous section, **PCSK9_binder_3**, for the rest of this analysis. We feed the PDB file generated by RFDiffusion to ProteinMPNN on Latch and generate 100 sequences for the binder chain.
Within moments, we generate FASTA file containing 100 sequences that could plausibly fold to our binder.
ProteinMPNN also provides a series of metrics for each generated sequence. The **score**measures the model's confidence in the amino acids it chose for the designed parts of the protein, where lower is better. A low **global score** indicates that the complete protein sequence is more likely to be stable and functional [10] [11].

4. Predicting binder protein structure with ColabFold

The final step is to predict the structure of these generated sequences in a complex with the PCSK9 A Chain and inspect the interface between them. ColabFold combines the fast homology search of MMseqs2 with AlphaFold2 to predict the structure of protein structures and complexes [12]. It's worth noting that there are multiple structure prediction models with their own strengths. AlphaFold2 has shown to be one of the most accurate models for binder design, especially with its initial guess support [4], and has been used in conjunction with

Impact of PCSK9 research
https://pmc.ncbi.nlm.nih.gov/articles/PMC10626223/
Patients with established cardiovascular (CV) disorders continue to have greater mortality risks due to recurrent CV events. The most common cause of death globally is atherosclerotic cardiovascular disease (ASCVD) [1,2]. In 2016, 5.52 million individuals died of cerebrovascular disease, and ischemic heart disease caused mortality in 9.48 million, according to the Global Burden of Illness Study [1]. The primary and secondary prevention of CV disease can both be improved by lipid-lowering medications. Dyslipidemia, particularly high low-density lipoprotein cholesterol (LDL-C), is a significant risk factor for ASCVD [3,4]. Statins have long been considered the first-line treatment for reducing cholesterol and averting future CV problems [5,6]. According to the most recent US and European recommendations, proprotein convertase subtilisin/kexin type 9 (PCSK9) inhibitors combined with ezetimibe and statin drugs are implied in lowered CV risk in these individuals. Because PCSK9 promotes the breakdown of LDL receptors, LDL cannot be cleared from circulation. Thus, by modulating LDL receptor expression on the

hepatocytes' surface, modulators that inhibit PCSK9 may decrease LDL and, subsequently, significant CV events [7]. When used with statins, PCSK9 medications have been demonstrated to improve CV outcomes. According to ODYSSEY OUTCOMES research data, adding alirocumab to maximally tolerated statin therapy reduces the risk of CV events. When used with the maximum tolerable dose of statin treatment, evolocumab mitigated the risk of CV events in individuals with ASCVD [8]. Both PCSK9 inhibitors (evolocumab and alirocumab), having received FDA approval in 2015, have been approved for use in people with existing CV disease to reduce the risk of stroke, myocardial infarction, and coronary revascularization [5]. Alirocumab and evolocumab are often safe, according to a prior meta-analysis of 25 randomized, controlled studies. Evolocumab was shown to minimize the frequency of abnormal liver function, but alirocumab was found to increase the frequency of injection-site responses [5]. However, there is a dearth of information on PCSK9 inhibitors' impacts on CV outcomes. We aimed to conduct an updated meta-analysis to demonstrate the effectiveness of approved PCSK9 inhibitors on CV outcomes. Comprehending the efficiency of PCSK-9 inhibitors in lowering CV events such as heart attacks, strokes, and deaths from CV causes was the primary expected outcome.

Subpoint B: Pandemics

Not only did Gen AI help slow the spread of COVID it could prevent the outbreak of new strains

Higgins, Matthew K. "Can We AlphaFold Our Way out of the next Pandemic?" *Journal of Molecular Biology*, June **2021**, p. 167093, https://doi.org/10.1016/j.jmb.2021.167093.

With an infectious organism dominating the world stage, the developers of **Alphafold 2 were keen to play their part,** accurately predicting **novel structures of two proteins from SARS-CoV-2.**they highlighted this contribution, writing **"we've also seen signs that protein structure prediction** could be **useful in future pandemic response efforts"**.Knowledge of the structure of the SARS-CoV coronavirus spike protein allowed design of mutants which stabilise the spike in the pre-fusion conformation.[1] As this is the form of the spike found on virus particles, vaccine immunogens which elicit antibodies that target this conformation are likely to be most effective.[1] As the SARS-CoV-2 virus, which causes COVID-19, is closely related to SARS-CoV2, 3, 4 this insight was transferable to the new pandemic strain.[2] As a result, the Pfizer/BioNTech and Moderna vaccines, amongst others, include spike-stabilising mutations in their effective designs.[5] This is just one example of a broader field of 'reverse vaccinology', in which rational insight into the structures of pathogen surface proteins, and their complexes with neutralising monoclonal antibodies, guide design of improved vaccine immunogens. The current strengths of AlphaFold 2 appear to be in the prediction of structures of single proteins, both in cases where there is a similar structure to act as a template, and where there is not. As seen in the case of PfRH5, structures of single antigens can be used to guide design of improved vaccine immunogens

This is essential as pandemics killed 16 million lives globally.

UN 21

United Nations. "14.9 Million Excess Deaths Associated with the COVID-19 Pandemic in 2020 and 2021." *United Nations*, www.un.org/en/desa/149-million-excess-deaths-associated-covid-19-pandemic-2020-and-20 21

New estimates from the World Health Organization **(WHO) show** that the **full death toll** associated directly or indirectly **with the COVID-19** pandemic (described as "excess mortality") between 1 January 2020 and 31 December 2021 **was approximately** 14.9

million (range 13.3 million to **16.6 million).** "These sobering data not only point to the impact of the pandemic but also to the need for all countries to invest in more resilient health systems that can sustain essential health services during crises, including stronger health information systems," said Dr Tedros Adhanom Ghebreyesus, WHO Director-General.

We need these vaccinations not only in the event of another outbreak but to prevent death overall

Carter 21

Carter , Austin, et al. "Modeling the Impact of Vaccination for the Immunization Agenda 2030: Deaths Averted due to Vaccination against 14 Pathogens in 194 Countries from 2021-2030." *Papers.ssrn.com*, 20 Apr. 2021, papers.ssrn.com/sol3/papers.cfm?abstract_id=3830781 .

Overall, an estimated **51.0 million** (95% CI: 48.5 – 53.7) **deaths are expected to be averted due to vaccinations administered between the years 2021 and 2030.** With immunization coverage projected to increase over 2021-2030 an average of 5.1 million per year (4.9 – 5.4) deaths will be averted annually, with 4.4 million(3.6- 5.1) deaths be averted for the year 2021, gradually rising to 5.8 million(4.9-6.6) deaths averted in 2030.

Rebuttal

Inequality is decreasing

Bloomberg 23: https://news.slashdot.org/story/23/03/07/1958249/microsoft-google-backed-group-wants-to-boost-ai-education-in-low-income-schools

The group on Tuesday is announcing a national call for AI education with an expanded list of backers and partner schools at the South by Southwest EDU conference in Austin, Texas. So far, **aiEDU has reached 100,000 students and has relationship with districts representing 1.5 million low-income and underserved kids across the country.** The non-profit was founded in 2019, and Kotran thought it would take a few years before there was widespread demand from educators for these kinds of programs. "We were kind of wearing the T-shirt before the band was cool," he said. Instead the rapid increase in interest in generative AI with the popularity of programs like OpenAI's chatbot and Dall-E, its tool for digital images, has dramatically boosted demand, and the group could use more funding, he said.

This card goes against their claims because now 1.5 million underservred students get access to AI.

AI saves time and reduces workloads

(Mckinsey) Barshay 20 [Jill Barshay, "AI in education: Using ed tech to save teachers time and reduce workloads", January 27, 2020, Hechinger Report, https://hechingerreport.org/ai-in-education-reframing-ed-tech-to-save-teachers-time-and-reduce-workloads/, Accessed May 16, 2023]

So it was interesting to see **McKinsey & Co** , an elite consulting firm, reframe the argument for buying education technology away from computerized instruction to something more pedestrian: saving teachers time. A January 2020 report by the firm **estimated that** **between 20 and 40 percent of the** 50 **hours that a typical teacher currently works a week could be saved through existing automation technology**, often **enabled by** artificial intelligence (**AI**). **That adds up to 13 saved hours a week, hours of freedom that could help relieve teacher burnout. Those hours could also be reallocated so that teachers can do more of what teachers do best: interact with students.** “ Many of the attributes that make good teachers great are the very things that AI or other technology fails to emulate: inspiring students, building positive school and class climates, resolving conflicts, creating connection and belonging, seeing the world from the perspective of individual students, and mentoring and coaching students,” the McKinsey authors wrote. “These things represent the heart of a teacher’s work and cannot — and should not — be automated.” The McKinsey authors suggest that **existing tech**nology **can be used to** help teachers in several areas: **plan**ning **lessons, assess**ing **students**, **grad**ing **homework**, giving feedback **and [do] administrative paperwork**. **The consultants aren’t suggesting that computers can replace any of these tasks entirely but rather reduce the amount of time teachers have to spend on them. For example, they estimate that lesson preparation could be cut from almost 11 to six hours.** They calculate that **weekly grading could be cut in half from six to three hours.** And they say that **two hours a week of administrative paperwork could be trimmed.** The report is provocatively titled, “How artificial intelligence will impact K-12 teachers,” though many of the recommendations are for categories of software applications that don’t necessarily use sophisticated AI algorithms at all, such as sites where teachers can find curriculum materials posted by other teachers.

Gen ai in rural areas now

Veera Korhonen, research expert covering US social topis, 10-14-2024, "Global student AI usage for schoolwork 2024," Statista, https://www.statista.com/statistics/1498309/usage-of-ai-by-students-worldwide/, accessed 2-19-2025 //cy

Share of students using AI for schoolwork worldwide as of July 2024

During a global survey of students conducted in mid-2024, it was found that a whopping 86 percent said they were using artificial intelligence tools in their schoolwork. Almost a fourth of them used it on a daily basis.

“Rural Tech Project.” Rural Tech Project, www.ruraltechproject.com/ . 2025
The Rural Tech Project empowered educators with resources to create technology education programs that are customized for their students and local needs. This open innovation challenge used flexible delivery methods, including distance and blended learning, as well as competency-based education — a learning approach enabling students to master skills at their own pace — to provide high school students with advanced technology skills. By advancing technology skills development, rural communities can help their students prepare for rewarding career opportunities.

Ai in rural schools

Wright 15, Aubrey. “AI Goes Rural Brings Artificial Intelligence to Underserved Schools.” News - Indiana Public Media, 2015, indianapublicmedia.org/news/ai-goes-rural-brings-artificial-intelligence-to-local-underserved-schools.php . Accessed 8 Mar. 2025.
AI Goes Rural introduces students and teachers to artificial intelligence education in local rural middle schools. The project’s leaders provide rural schools with AI learning curriculum and professional development opportunities, associate professor and principal investigator Kyungbin Kwon said. “By introducing AI to the rural schools, we can bridge this gap and provide equal opportunities for students and even teachers to engage with emerging technologies,”

Generative AI is key to cost savings for K-12 schools, thereby freeing up funding for other priorities.

Applify 25, https://www.applify.co/research report/gen-ai-for-k12. Applify. (2024). ***Generative AI for K-12 education | Research Report by Applify*****. Applify.co. https://www.applify.co/research-report/gen-ai-for-k12 Applify is a software and IT company**

From cost efficiencies to job creation, its impact extends beyond classrooms, influencing educational budgets and the broader workforce. 10.1 Cost savings Generative AI offers schools a clear path to optimizing expenses while improving educational outcomes. Reduced development costs: Schools leveraging AI for tasks like curriculum design and resource creation report up to a 30% reduction in resource development costs, freeing up budgets for other priorities. Enhanced ROI: Adaptive learning tools powered by AI maximize return on investment by providing personalized education that improves student performance, retention, and satisfaction. This financial efficiency ensures that limited educational budgets can stretch further, creating a more sustainable and impactful learning environment.

AT: Cheating—Data

The best data shows no significant increase in cheating - turn, it actually helps

Lee et al. 24, *Associate Professor in the Graduate School of Education at Stanford University and is faculty lead for the Stanford Accelerator for Learning's initiative on AI and Education, **a senior lecturer and co-founder of Challenge Success at Stanford Graduate School of Education (*Victor R. Lee, **Denise Pope, Sarah Miles, Rosalía C. Zárate, 2024, "Cheating in the age of generative AI: A high school survey study of cheating behaviors before and after the release of ChatGPT," Computers and Education: Artificial Intelligence, Volume 7, December 2024, 100253, https://www.sciencedirect.com/science/article/pii/S2666920X24000560)

The public release of ChatGPT and other generative AI chatbot technologies has been accompanied by questions about how academic integrity and student cheating behaviors will be impacted. We analyzed anonymous survey data from three high schools to see if self-reported cheating numbers changed following the introduction of ChatGPT and similar technologies. This survey data set is unique in that data on cheating had been collected with this set of schools both before and after November 2022, when ChatGPT was publicly released and drew attention to these educational concerns. The results suggested that cheating behaviors remained relatively stable after the introduction of this current generation of generative AI chatbot technology. However, some changes in reported behaviors differed depending on the type of cheating (social cheating, AI-related cheating, etc.). Additional survey questions about high school students' AI chatbot usage and the perceived allowability of such technology revealed mixed opinions on the acceptability of using AI for various academic-related tasks. Most students did not think

that using a chatbot to produce an entire paper or complete an entire assignment should be allowable. However, there was support for using AI chatbots to help students to start on assignments and papers and to help explain new concepts to them.

They fundamentally misunderstand how AI works – it's a tool like calculators which still requires critical thinking to function.

Gibson 25 (Jen Gibson is an Instructional Coach, Instructional Technology Facilitator, and teacher at Capuchino High School, "From GPS to GPTs: Steering Students Toward AI Literacy", Krause Center for Innovation, https://krauseinnovationcenter.org/from-gps-to-gpts-steering-students-toward-ai-literacy/, 1-6-2025, DOA: 2-20-2025) //Bellaire MC

AI is like your GPS. You plug in the destination, **and it gives you directions. It's great at finding the fastest route**, avoiding traffic, and even letting you know when there's an In-N-Out Burger nearby. **But** here's the thing: **if you don't know where you're going in the first place,** the **GPS is useless.** And if the GPS tells you to turn into a lake (it happens!), you're the one who has to catch the mistake before things go off the rails. That's **AI**. It**'s a tool** that helps you get from point A to point B more efficiently. But it doesn't know why you're going there, and it won't tell you if the destination doesn't make sense. **It needs your critical thinking** and judgment **to steer it in the right direction.** Otherwise, you might end up at "Lake In-N-Out!"

GEN AI Climate Effects are Overblown and are actually being reduced by 1000 times by genai

Saenko 23 Saenko, K. (2023, May 25). ***A Computer Scientist Breaks Down Generative AI's Hefty Carbon Footprint.*** **Scientific American. https://www.scientificamerican.com/article/a-computer-scientist-breaks-down-generative-ais-hefty-carbon-footprint/**

In 2019, researchers found that creating a generative AI model called BERT with 110 million parameters consumed the energy of a round-trip transcontinental flight for one person. The number of parameters refers to the size of the model, with larger models generally being more skilled. Researchers estimated that creating the much larger GPT-3, which has 175 billion parameters, consumed 1,287 megawatt hours of electricity and generated 552 tons of carbon dioxide equivalent, the equivalent of 123 gasoline-powered passenger vehicles driven for one year. And that's just for getting the model ready to launch, before any consumers start using it.

Size is not the only predictor of carbon emissions. The open-access BLOOM model, developed by the BigScience project in France, is similar in size to GPT-3 but has a much lower carbon footprint, consuming 433 MWh of electricity in generating 30 tons of CO2eq. A study by Google found that for the same size, using a more efficient model architecture and processor and a greener data center can reduce the carbon footprint by 100 to 1,000 times.

I is hardly the biggest use of electricity

Cho 23

Cho, Renee. "AI's Growing Carbon Footprint." State of the Planet, June 9, 2023, https://news.climate.columbia.edu/2023/06/09/ais-growing-carbon-footprint/. Accessed February 14, 2025.

In 2021, global data center electricity use was about 0.9 to 1.3 percent of global electricity demand. One study estimated it could increase to 1.86 percent by 2030. As the capabilities and complexity of AI models rapidly increase over the next few years, their processing and energy consumption needs will too. One research company predicted that by 2028, there will be a four-fold improvement in computing performance, and a 50-fold increase in processing workloads due to increased use, more demanding queries, and more sophisticated models with many more parameters. It's estimated that the energy consumption of data centers on the