Expanding the Frontiers of Biotechnology

Biodegradable plastics. Lifesaving vaccines. High-yield crop strains that are resistant to extreme temperatures. The U.S. National Science Foundation has helped make these and other advancements possible through decades of investments in biotechnology. Combining the power of engineering with the evolutionary knowledge of nature, biotechnology research stimulates the U.S. economy and helps to address growing challenges in health care, agriculture, manufacturing and energy. Today, NSF continues to support fundamental research to advance the bioindustries of the future and to accelerate new biotechnologies that will benefit science and society.

NSF invested over **$470 million** in Fiscal Year 2024 to support biotechnology researchers, infrastructure, and education.

NSF 75 YEARS OF DISCOVERY & INNOVATION

2025 marks the 75th anniversary of NSF. Throughout the year, the agency will host in-person and virtual activities to commemorate this significant milestone. For more information, visit: new.nsf.gov/75years

Seeding biotechnology breakthroughs

NSF has supported discoveries in biotechnology for decades by funding great ideas and working with other federal agencies, philanthropic organizations and industry to be on the cutting edge of biotechnology. In the 1980s, NSF invested in new fields in molecular biotechnology through the NSF Science and Technology Centers program and tissue engineering through the NSF Engineering Research Centers program. More recent investments have led to the development of new polymers, green fluorescent proteins and techniques that enabled the rapid sequencing and identification of SARS-CoV-2.

Today, many NSF programs carry on the legacy of these investments. For example, the NSF Molecular Foundations for Biotechnology and NSF Designing Synthetic Cells Beyond the Bounds of Evolution programs support researchers harnessing RNA to fight cancer and crop diseases and advancing DNA-based information storage. Three of NSF's 10 inaugural NSF Regional Innovation Engines power biotechnology ecosystems to drive regional economic growth, and the NSF BioFoundries enable researchers to rapidly design, create, test and streamline the development of tools and products to advance the bioeconomy. Additionally, the NSF Responsible Design, Development, and Deployment of Technologies program works to ensure the development of novel biotechnologies results in outcomes promoting the public's well-being and mitigating potential harm.

Polymerase chain reaction, a lab technique that powers today's biotechnology sector, traces its roots to NSF funding.

Training the biotechnology workforce

NSF invests in STEM education and training at every academic level across all STEM fields, and biotechnology is no exception. Example projects include:

With funding from the NSF Discovery Research PreK-12 program, the HudsonAlpha Institute for Biotechnology in Huntsville, Alabama provides 7-12th graders yearlong biotechnology training and career exploration, including advanced science education, skill building, authentic research experience, mentorship and networking.

Supported by the NSF Experiential Learning for Emerging and Novel Technologies program, Utah State University is leveraging its partnership with three leading biotechnology companies to lead an experiential learning program serving over 50 regionally-affiliated community colleges in the Intermountain West.

The InnovATE BIO National Biotechnology Center at Austin Community College, funded through the NSF Advanced Technological Education program, networks and collaborates with two- and four-year colleges and universities as well as high school affiliates to grow and empower the community of biotechnology educators.

Learn more at https://new.nsf.gov/focus-areas/biotechnology

Catalyzing research in established and emerging sectors

NSF supports cross-cutting advances in biology, chemistry, computing, engineering, geosciences, materials science, mathematics, physics and social and economic sciences to accelerate biotechnologies, drive innovation and foster economic growth. A few examples are highlighted below.

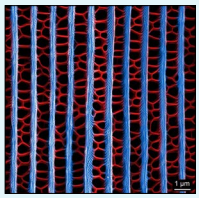
AI for biotechnology

The NSF Artificial Intelligence-driven RNA BioFoundry integrates cutting-edge AI for RNA design, synthesis and delivery.

Biocomputing

The NSF Emerging Frontiers in Research and Innovation: Biocomputing through EnGINeering Organoid Intelligence program supports the development of novel biological computing systems that emulate the flexibility, robustness and efficiency of cells and organs.

Biomanufacturing



Through a partnership with the Department of Energy, NSF provides support to researchers using design-build-test-learn capabilities at the DOE's Agile BioFoundry to develop testable prototypes based on the latest advances in synthetic engineering biology.

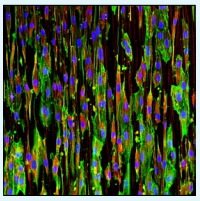
Biomedical technologies

Researchers at the NSF Engineering Research Center for Advanced Technologies for Preservation of Biological Systems transplanted rat kidneys which had been cryopreserved for up to 100 days, a process which could one day save thousands of human lives by enabling long-term organ storage.

Biophotonics and biosensing

The 2008 Nobel Prize in Chemistry was awarded to three NSF-funded researchers for their role in making the fluorescent protein GFP, first observed in jellyfish, usable as a tag to observe proteins and cells.

Cellular and biomechanical engineering



The NSF Advancing Cell-Free Systems Toward Increased Range of Use-Inspired Applications initiative supports research which leverages biomechanical processes in systems without cells to produce biomolecules for therapeutics, agriculture, climate resilience and more.

Plant & agricultural science

Through the NSF Convergence Accelerator Track J: Food & Nutrition Security, NSF is investing in new technologies that address the complex challenges in tackling food and nutrition insecurity from population growth, rising diet-related diseases and climate resilience.

Synthetic biology

Through research to understand how bacteria fight off viral infections, scientists supported by the NSF Systems and Synthetic Biology cluster developed CRISPR, the world's most power DNA editing tool.

Bringing biotechnology to market

New biotechnologies can lead to new industries, jobs and a stronger U.S. economy. NSF continues to support a broad portfolio of startups and small businesses focused on biological and biomedical technologies through the NSF Small Business Innovation Research and Small Business Technology Transfer programs. Businesses supported through this program are bioengineering disease-resistant crops, exploring new methods for vaccine delivery, recycling rare materials and creating bio-inspired sensors and instruments for U.S. industries. Additionally, the NSF Industry-University Cooperative Research Centers program supports several centers focused on biotechnology research of shared interest to industry and government partners.

Image credits from top: InnovATEBIO National Biotechnology Education Center; Ellen T. Showalter; GMGI-Labs - Joey Pheonix; Fred Zwicky/University of Illinois; Nanofiber Solutions; Stony Creek Colors

NSF is also working with other federal agencies, domestic and international partners to support initiatives that advance biotechnology and the bioeconomy.

- NSF has partnered with BioMADE, one of the Department of Defense's Manufacturing Innovation Institutes, to create opportunities for basic researchers to work alongside a more translationally focused research and development institute. Supported integrated projects include both an NSF component, covering basic research until proof of concept, as well as a BioMADE component to translate laboratory demonstrations to production-representative environments.
- NSF also collaborates with the Center for the Advancement of Science in Space International Space Station National Laboratory to conduct research on tissue engineering and mechanobiology in microgravity.