BIOTECHNOLOGY

Biotechnology Funding
(Dollars in Millions)

	FY 2021 Actual	FY 2022 (TBD)	FY 2023 Request
BIO	$110.00	-	$130.00
CISE	6.92	-	6.00
EDU[1]	14.41	-	9.00
ENG	86.77	-	101.50
GEO	10.00	-	10.00
MPS	91.88	-	52.20
SBE	2.04	-	1.50
OPP	1.60	-	2.00
IA	1.00	-	1.00
TIP[2]	11.84	-	69.06
Total	**$336.47**	**-**	**$382.26**

[1] Formerly known as Directorate for Education and Human Resources (EHR).

[2] FY 2021 funding for TIP is shown for comparability across fiscal years.

Overview

Since the first genetic engineering experiments over 50 years ago, the U.S. has become a world leader in biotechnology with resulting products of biotechnology contributing over $900 billion in economic activity, approximately 5 percent of the U.S. GDP, in recent years[1]. Biotechnology comprises the data, tools, research infrastructure, workforce capacity, and innovation that enable the discovery, utilization, and reprogramming of living organisms, their constituent components, and their biologically related processes. Advances in biotechnology areas include genome sequencing, editing, and synthesis; synthetic and engineered biology; chemical biology and chemical genetics; imaging and biosensing; and computational methods including artificial intelligence and biomolecule structure prediction. This also include bio-related approaches from engineering, mathematics, physical sciences, and computational sciences, which are spurring rapid development of capabilities in biotechnology that drive innovation for the U.S. bioeconomy. These capabilities also provide solutions to societal challenges such as climate change and infectious disease and provide the foundational and use-inspired research that will lead to the creation of goods and services that contribute to the agriculture, health, security, manufacturing, energy, and environmental sectors of the United States.

NSF has long supported the breadth of fundamental research that catalyzes the development of biotechnology. Current investments—from programs in almost every directorate—include research and infrastructure encompassing studies across scales; from the molecular, to the organism and ecosystem, and from basic and fundamental to use-inspired, carried out by individual investigators, teams, and multi-institutional centers. NSF also invests in educational programs to prepare and enable a workforce to support U.S. needs in biotechnology, and NSF funds research on the ethical, social, legal, economic, and environmental consequences of synthetic biology and other biotechnologies that contribute to public understanding and socially responsible use. These

[1] Public and Private Funding Opportunities to Advance a Circular US Bioeconomy and Maintain U.S. Biotechnology Competitiveness, Interim Report of Schmidt Futures Bioeconomy Task Force, 2021.

investments enable biotechnology innovations that not only address societal problems, such as climate change, food security, and clean energy, but also promote development of a robust supply chain of biologically derived materials needed to ensure U.S. resilience to global interruptions. Biotechnology promises to enable new modes of computation, including for information storage, retrieval, and processing; foods and feedstocks that will provide raw materials for new bioindustries; new organs and organisms engineered for multiple purposes, technologies capable of sensing emerging infectious agents; self-healing materials for sustainable infrastructure; and other heretofore unimagined products, processes and technologies inspired by, or developed with, living systems. Biotechnology advances will enable novel predictive tools and platform technologies to empower the U.S. to react rapidly to new and emerging biological threats, to address economic and societal challenges, and to respond with solutions for unanticipated challenges.

NSF has responded to reports from the Office of Science and Technology Policy (OSTP)[2], the National Academies[3], and the Government Accountability Office[4] to lead and coordinate interagency activities to promote synthetic biology and to develop next-generation tools to advance biotechnology. New NSF investments in FY 2022 aimed at biotechnology innovation include programs for: Accelerating Innovations in Biomanufacturing Approaches through Collaboration between NSF and the DOE Bioenergy Technologies Office-funded Agile BioFoundry; Semiconductor Synthetic Biology Circuits for Communication and Information Storage; EFRI: Engineering Living Systems; EFRI: Brain-inspired Dynamics for Engineering Energy-Efficient Circuits and Artificial Intelligence; and new tracks on Sustainable Materials for Global Challenges and Food and Nutrition Security in the FY 2022 Convergence Accelerator solicitation. These programs build on programs initiated in FY 2021, e.g., Designing Synthetic Cells Beyond the Bounds of Evolution; Sentinel Cells for Surveillance and Response to Emergent Infectious Diseases; and Molecular Foundations for Biotechnology, and prior-year investments, e.g., Enabling Discovery Through Genomics; Future Manufacturing; Materials Innovation Platforms; Plant Synthetic Biology; and Reproducible Cells and Organoids via Directed-Differentiation Encoding. They also build on FY 2021 investments at the intersection of biotechnology and artificial intelligence and quantum sciences through the National Artificial Intelligence Research Institutes and Quantum Leap Challenge Institutes programs. Together, these new investments complement core programs in research, infrastructure, workforce development and translation that advance U.S. competitiveness and leadership in biotechnology and the bioeconomy.

Goals

1. *Fundamental Research:* Support foundational and use-inspired research in science and engineering that will fuel innovations in biotechnology.
2. *Computing and Physical Infrastructure:* Develop the computing and physical infrastructure necessary to generate fundamental knowledge and advance accompanying biotechnology.
3. *Proof-of-Concept Advances:* Deliver proof-of-concept processes, devices, bio-based robots (biobots), applications, tools, and systems that integrate fundamental engineering and translational research to exploit emerging biotechnological advances for scientific and societal

[2]https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/national_bioeconomy_blueprint_april_2012.pdf

[3]www.nationalacademies.org/our-work/safeguarding-the-bioeconomy-finding-strategies-for-understanding-evaluating-and-protecting-the-bioeconomy-while-sustaining-innovation-and-growth

[4]www.gao.gov/products/gao-18-656

benefit.

4. *Education and Workforce Development:* Empower the full spectrum of U.S. talent to build the capacity to achieve the above goals and to generate the biotechnology-literate workers who will implement the results of these breakthroughs.

FY 2023 Investments

Fundamental Research

NSF will continue its support in the discovery of fundamental biological principles and the development of biotechnologies and other tools that permit measurement and use-inspired manipulation and design of living systems and their components. New interdisciplinary partnerships across the agency will motivate bio-inspired design and stimulate use-inspired solutions, including through the NSF Big Idea, Understanding the Rules of Life.

Computing and Physical Infrastructure

NSF will continue to invest in bioinformatics, computational biology, and artificial intelligence to support biotechnology. A new synthesis center in molecular and cellular biosciences will enable data synthesis and reuse for biological understanding and biotechnology design, and NSF will leverage distributed networks of biofoundries and regional mid-scale facilities–to support growth of U.S. biotechnology innovation.

Proof-of-Concept Development

Sustained support for synthetic and engineering biology as a pillar of biotechnology will accelerate the design-build-test-learn cycle and leverage bio-inspired design to develop bio-machines, biobots, and biomanufacturing technologies to address many of today's challenges. New investments in regional innovation will expand participation within the bioeconomy and accelerate the translation of biotechnology to solve societal problems.

Education and Workforce Development

To prepare a diverse biotechnological workforce, NSF will invest through programs such as the Advanced Technological Education program at two-year institutions, sites and supplements for Research Experiences for Undergraduates and Research Experiences for Teachers, and the NSF Research Traineeship Program that prepares graduate students to conduct research in convergent areas and acquire skills that allow them to succeed in diverse employment settings. NSF will also support training at the postdoctoral and early-career level through fellowships and participation in the NSF Innovation Corps (I-Corps™) program, to enable scientists and engineers to further the societal benefits of their work.