DIRECTORATE FOR BIOLOGICAL SCIENCES (BIO) $972,410,000

Directorate for Biological Sciences (BIO)

(Dollars in Millions)

	FY 2022 Actual[1]	FY 2023 Estimate Base	Disaster Relief Supplemental Base	FY 2023 Estimate Total	FY 2024 Request	Change Over FY 2023 Base Total[2] Amount	Percent
Division of Molecular and Cellular Biology (MCB)	$156.74	$147.00	-	$147.00	$157.02	$10.02	6.8%
Division of Integrative Organismal Systems (IOS)	208.40	197.45	-	197.45	214.96	17.51	8.9%
Division of Environmental Biology (DEB)	180.10	169.81	-	169.81	188.55	18.74	11.0%
Division of Emerging Frontiers (EF)	89.17	108.97	25.25	134.22	183.96	49.74	37.1%
Division of Biological Infrastructure (DBI)	197.20	208.50	-	208.50	227.92	19.42	9.3%
Total	**$831.61**	**$831.73**	**$25.25**	**$856.98**	**$972.41**	**$115.43**	**13.5%**

[1] Excludes $43.53 million in American Rescue Plan supplemental funding.

[2] Captures both the FY 2023 Omnibus appropriation and the Disaster Relief Supplemental base.

About BIO

BIO supports fundamental research and infrastructure that promotes a unified understanding of all forms of life and at all scales, from molecules to populations of organisms, and species that underpin the functioning of the Nation's ecosystems, as well as across time and geographic diversity. It also supports the human capital necessary to enable this research. The knowledge gained advances fields from agriculture to climate change mitigation and conservation, biotechnology and biomedicine, and more. In the past decade, biology has been transformed by new technologies and has transformed other areas of science and engineering from computer and information sciences, engineering, and the mathematical and physical sciences. BIO seeks to capitalize on these advances to vastly improve our ability to understand life's deepest mysteries and enable new capabilities to modify organisms and ecosystems for societal benefit. Harnessing life's evolutionary innovations is the key to driving the Nation's bioeconomy, and BIO's support for foundational and translational research promotes economic prosperity, health, and security by addressing existing and future global challenges.

BIO's scientific investments align directly with Administration priorities, including biotechnology to promote the bioeconomy, environmental forecasting and mitigating the impacts of global warming on essential ecosystem services, predicting and preventing the emergence of infectious diseases, and increasing racial equity and diversity across the STEM enterprise. BIO investments in genomics, in cellular, organismal, and developmental biology, and in bioinformatics spur further development of capabilities in synthetic biology and enhance biotechnology beyond the current state-of-the-art. The accelerating power of this advanced biotechnology promises to sustain U.S. economic growth and innovation across multiple sectors including agriculture, biomanufacturing, pharmaceuticals, and other bioproducts. BIO investments in biotechnology also aid development of a circular bioeconomy that reduces carbon emissions and creates new sources of clean energy. BIO investments in ecology, evolution, and biodiversity, including support for the National Ecological Observatory Network (NEON), promote the development of dynamic, eco-forecasting models to predict climate change impacts at local, national, and even global scales. BIO investments in life's innovations will similarly focus on understanding the adaptive potential of species and ecosystems to respond to climate change stressors such as ocean acidification, sea level rise, droughts, flooding, fires, and other extreme events. Together, these investments are responsive to the national need to understand and develop solutions for the climate emergency. BIO will continue to invest in research on infectious disease emergence and transmission, contribute to the goal of preventing future pandemics, and fill

knowledge gaps concerning the spread and evolution of biothreats. BIO will build upon the foundational knowledge gained through Understanding Rules of Life (URoL) – of how key properties of living systems emerge from complex interactions – by focusing on Using the Rules of Life. This will support convergent, use-inspired research in biotechnology to address pressing societal challenges and grow and sustain a vibrant bioeconomy by creating new jobs and industries.

Biological questions often drive convergence research across multiple fields of science and technology and stimulate applications that enhance economic and national security, as well as societal well-being. Pursuits in the biological sciences to quantify living systems at all scales have propelled the frontiers of research in statistics, mathematics, and computer sciences to consider larger and more complex data sets that benefit from artificial intelligence (AI) and machine learning. Foundational research on microbes and their interactions with plants leverages these advances in data analytics using AI and advanced computing to fuel a revolution in agriculture. Similarly, collaborations between the biological and physical sciences have contributed to advances in biomaterials and other bio-inspired products, biological computing, and semiconductors, which exploit the extraordinary information density in genetic polymers, and neuro-technologies that power advances in neuroscience and cognition. Quantum biology, the application of quantum theory to biological systems, provides new insights into the power of photosynthesis for energy production as well as a fundamental understanding of vision, smell, magnetoreception, and other sensing systems. This research will enable bioinspired designs based on quantum energy production and sensing systems that will enhance American security.

Tackling bold questions in biology increasingly requires an integrated approach that leverages advances from multiple subdisciplines and incorporates cutting-edge methods, tools, and concepts. Such research is critical to inform solutions to societal challenges, including natural resource management, resilience to environmental change, and global food security. In FY 2024, BIO will invest in integrative, convergent, and team science; fundamental and use-inspired research aimed at addressing grand societal challenges; and in emerging industries, such as biotechnology, through existing core programs and a new effort focused on establishing BioFoundries. Special calls like Organismal Response to Climate Change (ORCC) and Biodiversity on a Changing Planet (BoCP), and programs aimed at addressing and overcoming the continuing challenge of integrating across subdisciplines and approaches, such as the Biology Integration Institutes (BII), will receive additional key funding. In FY 2024, BIO is also increasing its investment in synthesis centers, centers focused on integration and reuse of existing data to create new knowledge that will fuel advances in both basic and use inspired research across all scales of biological organization. BIO investments in these integration programs represent major funding opportunities to encourage cooperative research seeking a holistic understanding of how living systems function. These institute awards, and others across BIO, will result in highly collaborative, team-science endeavors, which also fosters diversity and inclusion in science.

BIO will continue supporting investments in building and broadening the biological sciences workforce through postdoctoral fellowships, Building Research Capacity of New Faculty in Biology (BRC-BIO), postbaccalaureate scholars (Research and Mentoring for Post baccalaureates in Biological Sciences (RaMP), and cultural change to ensure an inclusive environment that contributes to retention of these individuals (Leading Culture Change through Professional Societies of Biology (BIO-LEAPS). BIO currently provides 65 percent of the federal funding for basic research at academic institutions in the life sciences.

Major Investments

BIO Major Investments

(Dollars in Millions)

Area of Investment[1,2]	FY 2022 Actual	FY 2023 Estimate Base Total[3]	FY 2024 Request	Change over FY 2023 Estimate Base Total[3] Amount	Change over FY 2023 Estimate Base Total[3] Percent
Advanced Manufacturing	$7.16	$7.16	$7.16	-	-
Artificial Intelligence	20.00	20.00	20.00	-	-
BioFoundries	-	30.00	30.00	-	-
Biotechnology	118.00	148.00	176.88	28.88	19.5%
Climate: Clean Energy Technnology	50.00	55.00	74.50	19.50	35.5%
Climate: USGCRP	162.01	211.71	237.07	25.36	12.0%
Improving Undergraduate STEM Education	2.12	1.50	5.00	3.50	233.3%
Quantum Information Science	3.28	3.28	3.28	-	-

[1] Major investments may have funding overlap and thus should not be summed.

[2] This table reflects this directorate's support for selected areas of investment. In other directorate narratives, areas of investment displayed in this table may differ and thus should not be summed across narratives.

[3] Captures both the FY 2023 Omnibus appropriation and the Disaster Relief Supplemental base.

To learn more about cross-agency themes and initiatives supported by BIO, such as Advanced Manufacturing, Artificial Intelligence, Climate (Clean Energy Technology, USGCRP), Quantum Information Science, Improving Undergraduate STEM Education, National Nanotechnology Initiative, and NSF's Big Ideas, see individual narratives in the NSF-Wide Investments chapter.

- BioFoundries: The BioFoundries program supports collaborative teams of researchers and technology developers who will generate the technologies, instrumentation, workflow pipelines, and advanced computing that will enable the advancement of biology, biotechnology, bioengineering and biomanufacturing. As a steward of this agency-wide program, the FY 2024 request of $30 million is expected to support 2 or 3 new BioFoundry awards.

- Biotechnology: 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. For more information, see the Biotechnology narrative in the NSF-Wide Investments chapter.

Centers Programs

BIO Funding for Centers Programs

(Dollars in Millions)

	FY 2022 Actual	FY 2023 Estimate Base Total[1]	FY 2024 Request	Change over FY 2023 Estimate Base Total[1] Amount	Percent
Artificial Intelligence Research Institutes (Multiple)	-	$1.00	$1.00	-	-
Biology Integration Institutes (Multiple)	25.90	35.20	53.68	18.48	52.5%
Centers for Analysis & Synthesis (DBI)	1.50	2.50	6.50	4.00	160.0%
STC: Biology with X-ray Lasers (DBI)	3.32	-	-	-	N/A
STC: Center for Cellular Construction (DBI)	5.00	5.00	5.00	-	-
STC: Center for Research on Programmable Plant Systems (DBI)	5.00	5.00	5.00	-	-
Total	**$40.72**	**$48.70**	**$71.18**	**$22.48**	**46.2%**

[1] Captures both the FY 2023 Omnibus appropriation and the Disaster Relief Supplemental base.

For detailed information on individual centers programs, please see the Cross Theme Topics section of the NSF-Wide Investments chapter.

People Numbers and Funding Profiles

For Organization detail on the People Numbers and Funding Profile tables, please see the Summary Tables chapter.

BIO Major Facilities

BIO Funding for Major Facilities

(Dollars in Millions)

	FY 2022 Actual	FY 2023 Estimate Base Total[1]	FY 2024 Request	Change over FY 2023 Estimate Base Total[1] Amount	Percent
National Ecological Observatory Network (NEON)	$69.01	$71.71	$78.04	$6.33	8.8%

[1] Captures both the FY 2023 Omnibus appropriation and the Disaster Relief Supplemental base.

For detailed information on individual facilities, please see the Research Infrastructure section of the NSF-Wide Investments chapter.

DIVISION OF MOLECULAR AND CELLULAR BIOSCIENCES (MCB)

MCB Funding
(Dollars in Millions)

	FY 2022 Actual[1]	FY 2023 Estimate Base	FY 2024 Request	Change over FY 2023 Base Total[2] Amount	Percent
Total	**$156.74**	**$147.00**	**$157.02**	**$10.02**	**6.8%**
Research	145.71	145.00	154.02	9.02	6.2%
Education	9.71	1.00	2.00	1.00	100.0%
Infrastructure	1.32	1.00	1.00	-	-

[1] Does not capture funding provided by the American Rescue Plan supplemental appropriation.

[2] Captures both the FY 2023 Omnibus appropriation and the Disaster Relief Supplemental base.

MCB supports fundamental interdisciplinary research to uncover the basic principles that describe cellular function at the molecular level, including (a) how information content in cells is maintained and transmitted to the next generation and guides expression of cellular characteristics; (b) how material and energy are absorbed, transformed, and flow through biological system; and (c) how biological molecules assemble into complex structures and compartments with varied functions. In general, about 77 percent of the division portfolio is available to support new research grants. The remaining 23 percent supports research grants made in prior years.

DIVISION OF INTEGRATIVE ORGANISMAL SYSTEMS (IOS)

IOS Funding
(Dollars in Millions)

	FY 2022 Actual[1]	FY 2023 Estimate Base	FY 2024 Request	Change over FY 2023 Base Total[2] Amount	Percent
Total	**$208.40**	**$197.45**	**$214.96**	**$17.51**	**$0.09**
Research	178.60	183.65	200.16	16.51	9.0%
Education	12.43	3.80	4.80	1.00	26.3%
Infrastructure	17.37	10.00	10.00	-	-

[1] Does not capture funding provided by the American Rescue Plan supplemental appropriation.

[2] Captures both the FY 2023 Omnibus appropriation and the Disaster Relief Supplemental base.

IOS supports fundamental research and training focused on mechanistic analyses of the functional phenotypic characteristics of diverse organisms, prioritizing integrative research linking biological molecules to complex populations through understanding the processes that build and maintain diverse organisms in the contexts in which they function. In general, about 62 percent of the division portfolio is available to support new research grants. The remaining 38 percent supports research grants made in prior years.

DIVISION OF ENVIRONMENTAL BIOLOGY (DEB)

DEB Funding
(Dollars in Millions)

	FY 2022 Actual[1]	FY 2023 Estimate Base	FY 2024 Request	Change over FY 2023 Base Total[2] Amount	Change over FY 2023 Base Total[2] Percent
Total	**$180.10**	**$169.81**	**$188.55**	**$18.74**	**11.0%**
Research	168.18	168.31	186.05	17.74	10.5%
Education	9.83	1.50	2.50	1.00	66.7%
Infrastructure	2.09	-	-	-	N/A

[1] Does not capture funding provided by the American Rescue Plan supplemental appropriation.

[2] Captures both the FY 2023 Omnibus appropriation and the Disaster Relief Supplemental base.

DEB supports fundamental research on Earth's biodiversity and the ecological and evolutionary processes that explain the origin and maintenance of genetic variation in living systems, including its history and patterns of speciation and extinction. In general, about 72 percent of the division portfolio is available to support new research grants. The remaining 28 percent supports research grants made in prior years.

DIVISION OF EMERGING FRONTIERS (EF)

EF Funding
(Dollars in Millions)

	FY 2022 Actual[1]	FY 2023 Estimate Base	Disaster Relief Supplemental Base	FY 2023 Estimate Total	FY 2024 Request	Change over FY 2023 Base Total[2] Amount	Change over FY 2023 Base Total[2] Percent
Total	**$89.17**	**$108.97**	**$25.25**	**$134.22**	**$183.96**	**$49.74**	**$0.37**
Research	84.66	73.18	25.25	98.43	124.96	26.53	27.0%
Education	4.51	34.79	-	$34.79	58.00	23.21	66.7%
Infrastructure	-	1.00	-	$1.00	1.00	-	-

[1] Does not capture funding provided by the American Rescue Plan supplemental appropriation.

[2] Captures both the FY 2023 Omnibus appropriation and the Disaster Relief Supplemental base.

EF serves as an incubator for innovation and integration within the biological sciences. It supports research that transcends scientific disciplines and advances conceptual foundations across all levels of biological organization. Innovative research and infrastructure activities in BIO typically begin development in EF and then move to other BIO divisions to become part of the disciplinary knowledge base. In general, about 81 percent of the division portfolio is available to support new research grants. The remaining 19 percent supports research grants made in prior years.

DIVISION OF BIOLOGICAL INFRASTRUCTURE (DBI)

DBI Funding
(Dollars in Millions)

	FY 2022 Actual[1]	FY 2023 Estimate Base	FY 2024 Request	Change over FY 2023 Base Total[2] Amount	Percent
Total	**$197.20**	**$208.50**	**$227.92**	**$19.42**	**9.3%**
Research	48.96	60.60	77.13	16.53	27.3%
Education	31.76	25.50	29.00	3.50	13.7%
Infrastructure	116.48	122.40	121.79	-0.61	-0.5%

[1] Does not capture funding provided by the American Rescue Plan supplemental appropriation.

[2] Captures both the FY 2023 Omnibus appropriation and the Disaster Relief Supplemental base.

DBI empowers biological discovery by investing in the innovation and capacity-building of cutting-edge research infrastructure for fundamental biological science, which includes human capital, technologies, institutes and centers, and mid- to-large scale infrastructure. In general, about 22 percent of the division portfolio is available to support new research grants. The remaining 78 percent supports continuing grant increments and cooperative agreements for research infrastructures.