

BIOLOGICAL SCIENCES (BIO)**\$738,160,000**
-\$4,060,000 / -0.5%**BIO Funding**
(Dollars in Millions)

	FY 2017 Actual	FY 2018 (TBD)	FY 2019 Request	Change over	
				FY 2017 Actual Amount	FY 2017 Actual Percent
Molecular and Cellular Biosciences (MCB)	\$137.02	-	\$137.69	\$0.67	0.5%
Integrative Organismal Systems (IOS)	215.63	-	184.97	-30.66	-14.2%
Environmental Biology (DEB)	145.42	-	146.16	0.74	0.5%
Biological Infrastructure (DBI)	130.35	-	175.14	44.79	34.4%
Emerging Frontiers (EF)	113.80	-	94.20	-19.60	-17.2%
Total	\$742.22	-	\$738.16	-\$4.06	-0.5%

About BIO

The Directorate for Biological Sciences (BIO) supports research that sheds light on the principles and mechanisms governing life across all scales and complexities, from individual biological molecules to ecosystems. This basic research enables discoveries that ultimately achieve significant downstream impact through collaboration with other scientific disciplines and application of science to improve quality of life. The span of investigation is reflected in a variety of specific interests, including Understanding the Rules of Life (URoL), the National Ecological Observation Network (NEON), and Understanding the Brain (UtB). A commitment to integrate research and education, broaden participation, and promote international partnerships is integral to all activities across the directorate.

In FY 2019, research that aligns with the comprehensive BIO framework, URoL, will continue. Gaining an understanding of the complex relationships between genotype and phenotype in plants, animals, and microbes across scales of size, time, and place is a grand challenge not easily achieved. Support for early investigators to ensure adequate numbers of researchers prepared to tackle these difficult and complex questions is critical to success and requires a long-term investment.

U.S. academic research in the biological sciences depends on NSF funding; BIO considers this role essential to the promotion of vibrant and innovative fundamental biological research at U.S. universities and colleges. Broad support for biology is necessary to produce knowledge relevant to national needs in food, health, energy, and environment. Additionally, support for biological research will continue a stream of economic innovations that contribute to American livelihoods, as demonstrated by progress in areas such as biofuels, biorenewable chemicals, and nanotechnology.

BIO increasingly supports projects that address comprehensive questions involving multiple types of data acquisition and levels of analysis. These projects are becoming larger and more collaborative both within the biological sciences and with other fundamental disciplines. Because of its broad mission, NSF is one of the few agencies where support for such integration across disciplines is possible.

FY 2019 priorities for BIO include:

- URoL: First introduced in FY 2017, support for URoL will continue in FY 2019, emphasizing research areas such as the genotype to phenotype challenge, plant- and animal-organismal interactions, and developing biological theory as a framework for the rules of life. Quantitative approaches that integrate the mathematical and physical sciences, computer science, and engineering to advance basic biological understanding will continue to be encouraged.

- NEON: With the construction of NEON scheduled to complete in fall 2018, BIO will assume responsibility for full operations and maintenance (O&M) and oversight funding, in FY 2019. NEON O&M funding is included in the budget for the Division of Biological Infrastructure (DBI). Support for NEON-science is a priority investment across BIO and designed to achieve the promise of this major new facility and its exciting capabilities. For more information on NEON, see the MREFC chapter.
- UtB, including the BRAIN Initiative: This cross-agency priority will continue in FY 2019. BIO funding for UtB, including the BRAIN Initiative, will support investments designed to enable the transformational research, engineering, infrastructure development, and training required to accomplish the overall multi-year goal and includes support for the Next Generation Networks for Neuroscience (NeuroNex) program. Additional information for UtB is available in the NSF-Wide Investments chapter.

BIO provides 69 percent of the federal funding for basic research at academic institutions in non-medical biology.

Major Investments

Area of Investment	FY 2017 Actual	FY 2018 (TBD)	FY 2019 Request	Change over FY 2017 Actual	
				Amount	Percent
CAREER	\$36.71	-	\$36.01	-\$0.70	-1.9%
IUSE	1.82	-	2.00	0.18	9.8%
NSF I-Corps™	1.00	-	1.00	0.00	0.1%
NSF Research Traineeship ¹	2.82	-	-	-2.82	-100.0%
Understanding the Brain	46.39	-	46.00	-0.39	-0.8%
<i>BRAIN Initiative</i>	<i>20.77</i>	<i>-</i>	<i>19.54</i>	<i>-1.23</i>	<i>-5.9%</i>
NSF's Big Ideas					
<i>NSF INCLUDES²</i>	<i>1.20</i>	<i>-</i>	<i>-</i>	<i>-1.20</i>	<i>-100.0%</i>
<i>Understanding the Rules of Life</i>	<i>-</i>	<i>-</i>	<i>30.00</i>	<i>30.00</i>	<i>N/A</i>

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

¹In FY 2019, NRT funding is provided through CISE and EHR.

²In FY 2019, NSF INCLUDES funding is provided through the EHR account.

BIO Funding for Centers Programs and Facilities

	FY 2017 Actual	FY 2018 (TBD)	FY 2019 Request	Change over FY 2017 Actual	
				Amount	Percent
Total	\$36.13	-	\$18.10	-\$18.03	-49.9%
Centers for Analysis & Synthesis (DBI)	15.80	-	4.40	-11.40	-72.2%
Nanoscale Science & Engineering Centers (DBI)	5.33	-	-	-5.33	-100.0%
STC: Bio/computational Evolution in Action CONsortium (BEACON) (DBI)	5.00	-	3.70	-1.30	-26.0%
STC: Biology with X-ray Lasers (BioXFEL) (DBI)	5.00	-	5.00	-	-
STC: Center for Cellular Construction (CCC) (DBI)	5.00	-	5.00	-	-

For detailed information on individual centers programs, please see the NSF-Wide Investments chapter.

BIO Funding for Facilities

(Dollars in Millions)

	FY 2017 Actual	FY 2018 (TBD)	FY 2019 Request	Change over	
				FY 2017 Amount	Actual Percent
Total	\$55.61	-	\$65.35	\$9.74	17.5%
National Ecological Observatory Network (NEON)	50.26	-	65.00	14.74	29.3%
Cornell High Energy Synchrotron Source (CHESS)	5.00	-	-	-5.00	-100.0%
National Nanotechnology Coordinated Infrastructure (NNCI)	0.35	-	0.35	-	-

For detailed information on individual facilities, please see the Facilities and the Major Research Equipment and Facilities Construction chapters.

Funding Profile

BIO Funding Profile

	FY 2017	FY 2018 (TBD)	FY 2019 Estimate
	Actual Estimate		
Statistics for Competitive Awards:			
Number of Proposals	5,010	-	5,200
Number of New Awards	1,147	-	1,100
Funding Rate	23%	-	21%
Statistics for Research Grants:			
Number of Research Grant Proposals	4,002	-	4,400
Number of Research Grants	829	-	800
Funding Rate	21%	-	18%
Median Annualized Award Size	\$196,229	-	\$196,200
Average Annualized Award Size	\$221,619	-	\$221,600
Average Award Duration, in years	3.2	-	3.2

People Involved in BIO Activities

Number of People Involved in BIO Activities

	FY 2017	FY 2018 (TBD)	FY 2019 Estimate
	Actual Estimate		
Senior Researchers	3,564	-	3,500
Other Professionals	1,399	-	1,300
Postdoctoral Associates	1,346	-	1,300
Graduate Students	2,662	-	2,500
Undergraduate Students	4,898	-	4,800
K-12 Teachers	-	-	-
K-12 Students	-	-	-
Total Number of People	13,869	-	13,400

Program Monitoring and Evaluations

Program Evaluations and Studies:

- In FY 2016, the Division of Environmental Biology (DEB) and the Division of Integrative Organismal Systems (IOS) contracted Abt Associates to conduct an external evaluation of the preliminary proposal review process. A report from Abt Associates was submitted in CY 2017 and made available on the NSF website¹. The report was instrumental in the decision to end the preliminary proposal review process and switch to a no-deadline, full proposal review system. In FY 2018, BIO issued a Dear Colleague Letter² to inform the community of this switch and it is being implemented in all BIO divisions beginning in CY 2018.
- In FY 2018, BIO will initiate an evaluation of the Macrosystems Biology and Early NEON Science program within the Division of Emerging Frontiers (EF). The evaluation will consider the program's portfolio of awards, the research community stakeholder input, as well as input from other NSF directorates. The results of this evaluation will inform solicitations to enhance the use of NEON data and infrastructure.
- In FY 2018, BIO will solicit external expert advice to inform the Rules of Life framework and, in part, the future of functional genomics in plants and animals.
- In early FY 2019, BIO is planning to implement an assessment of the NeuroNex program within EF. The results of this assessment will determine future program investments.
- In FY 2019, BIO will solicit advice on emerging areas of research using biological research collections, either vouchered biodiversity specimens or living stocks, and the collections' associated digitized data and metadata. The results of this assessment will determine future directorate investments.

Workshops and Reports:

- IOS research investments in FY 2019 will be informed, in part, by the 2015 NSF-sponsored workshop report "Unpacking the Phenotype (UP) Deciphering Genome to Phenome Relationships: Interdisciplinary Research at the Interface of the Biological and Mathematical Sciences"³. The report informs IOS's research interests related to the Rules of Life priority.
- The Division of Molecular and Cellular Biology (MCB) supported multiple workshops that have and continue to inform the planning of the division's research programs.
 - Workshops entitled "Finding your inner modeler: how computational biology can advance your research and how to get started" were initiated in FY 2017. The series of workshops were developed to promote the use of computational modeling by cell biologists. Over the next three years, MCB will track the impact of the workshops on the quality and number of modeling proposals submitted and funded by the division.
 - A workshop entitled "The Role of Crowdfunding in the STEM Ecosystem" was held in early FY 2018. The workshop was convened to examine the practice, benefits, challenges, and limitations of using crowdfunding to finance basic research in the fields of science, technology, engineering, and mathematics.

Committee of Visitors (COV):

- In 2018, COVs will review programs in IOS and MCB.
- In 2019, COVs will review programs in DEB.

¹www.nsf.gov/bio/pubs/reports/DEB_IOS_Review_Abt%20Final%20_report_Mar17.pdf

²www.nsf.gov/pubs/2018/nsf18011/nsf18011.jsp

³www.nsf.gov/mps/dms/documents/Deciphering_Genome-to-Phenome_Relationships.pdf

**DIVISION OF MOLECULAR AND CELLULAR
BIOSCIENCES (MCB)**

\$137,690,000
+\$670,000 / 0.5%

MCB Funding
(Dollars in Millions)

	FY 2017 Actual	FY 2018 (TBD)	FY 2019 Request	Change over	
				FY 2017 Actual Amount	Percent
Total	\$137.02	-	\$137.69	\$0.67	0.5%
Research	133.64	-	135.85	2.21	1.7%
CAREER	14.82	-	14.39	-0.43	-2.9%
Education	3.38	-	1.84	-1.54	-45.6%

MCB Summary

MCB supports fundamental interdisciplinary research to uncover the basic principles that describe how information content in cells guides expression of cellular characteristics and is maintained and transmitted to the next generation; how material and energy are taken up, transformed, and flow through biological systems; and how biological molecules, which assemble into complex structures and compartments with varied functions, contribute to the processes required for life. Research at the molecular and cellular scales provides the basis for understanding normal cell processes and healthy cell function. This understanding enables the development of design rules for engineering molecules and cells that contribute both to basic research and to applications in biomanufacturing, food security, environment, and healthcare.

In general, 67 percent of the MCB portfolio is available for new research grants and 33 percent is available for continuing grants.

DIVISION OF INTEGRATIVE ORGANISMAL SYSTEMS (IOS)

\$184,970,000
-\$30,660,000 / -14.2%

IOS Funding
(Dollars in Millions)

	FY 2017 Actual	FY 2018 (TBD)	FY 2019 Request	Change over	
				FY 2017 Amount	Actual Percent
Total	\$215.63	-	\$184.97	-\$30.66	-14.2%
Research	201.30	-	175.02	-26.28	-13.1%
CAREER	13.07	-	11.00	-2.07	-15.9%
Education	4.58	-	3.13	-1.45	-31.7%
Infrastructure	9.74	-	6.82	-2.92	-30.0%
Research Resources	9.74	-	6.82	-2.92	-30.0%

IOS Summary

IOS supports research at the level of organisms, the mid-scale of biological organization between molecular/cellular and populations/ecosystems. Research and education support is aimed at understanding the structure and function of plants, animals, and microorganisms as complex systems. Activities supported by IOS focus on neural, developmental, physiological, biomechanical, and behavioral processes that characterize organisms, and how these processes are integrated to result in the dynamic stability of whole organisms. Achieving such a systems-level understanding of organisms is fundamental to the overall understanding of the organizing principles and mechanisms behind the vast diversity of life on earth.

IOS encourages synthetic and interdisciplinary approaches and development of new tools through the Enabling Discovery through Genomic Tools (EDGE) program. These approaches span computational, mathematical, and organismal levels of inquiry and analysis. IOS-supported research affords new understanding of how a wide variety of plants, animals, microbes, and fungi respond and adapt to change to improve our understanding of the reciprocal interactions between the biological and physical worlds. Supported research includes comparative and evolutionary approaches to expose common patterns of developmental, neural, and physiological mechanisms underlying how organisms perceive and respond to their physical and social environment. Results of IOS-supported research will provide the information needed to enable multi-scale integration of these dynamic activities to reveal emergent properties at other biological, spatial and temporal scales. IOS-supported research is relevant to societal goals for food security, sustainability, understanding organismal responses to environmental and social stressors, and understanding the healthy brain.

In general, 38 percent of the IOS portfolio is available for new research grants and 62 percent is available for continuing grants.

DIVISION OF ENVIRONMENTAL BIOLOGY (DEB)

\$146,160,000
+\$740,000 / 0.5%

DEB Funding
(Dollars in Millions)

	FY 2017 Actual	FY 2018 (TBD)	FY 2019 Request	Change over	
				FY 2017 Actual Amount	Percent
Total	\$145.42	-	\$146.16	\$0.74	0.5%
Research	142.67	-	144.14	1.47	1.0%
CAREER	4.92	-	3.86	-1.06	-21.6%
Education	2.59	-	2.02	-0.57	-21.9%
Infrastructure	0.17	-	-	-0.17	-100.0%

DEB Summary

DEB supports fundamental research on Earth’s biodiversity and the ecological and evolutionary processes that explain the origin and maintenance of genetic variation in nature, including its history and patterns of speciation and extinction. DEB supported research also advances understanding of the functional importance of our natural biodiversity heritage to ecological and ecosystem processes occurring over short and long temporal and spatial scales. The discoveries from this research help the nation to wisely develop, use, and sustain its biological resources, including natural, agricultural, and other managed ecosystems, and to forecast changes in species populations and ecosystems over time.

DEB funded research provides the data, knowledge, and capability to predict the spread of infectious diseases and of invasive species, and their impacts on wild, managed, and agricultural systems. Models developed from biodiversity and ecological research are used to predict environmental drivers of conflict, enhance the nation’s ability to strategically prepare for environmental threats, and to field defense and mitigation capabilities that are resilient and adaptive.

In general, 67 percent of the DEB portfolio is available for new research grants. The remaining 33 percent supports continuing grants made in prior years.

DIVISION OF BIOLOGICAL INFRASTRUCTURE (DBI)

\$175,140,000
+\$44,790,000 / 34.4%

DBI Funding
(Dollars in Millions)

	FY 2017 Actual	FY 2018 (TBD)	FY 2019 Request	Change over FY 2017 Actual	
				Amount	Percent
Total	\$130.35	-	\$175.14	\$44.79	34.4%
Research	43.39	-	43.08	-0.31	-0.7%
CAREER	3.90	-	5.00	1.10	28.3%
Centers Funding (total)	36.13	-	18.10	-18.03	-49.9%
Centers for Analysis & Synthesis	15.80	-	4.40	-11.40	-72.2%
Nanoscale Science & Engineering Centers	5.33	-	-	-5.33	-100.0%
STC: Bio/computational Evolution in Action CONsortium (BEACON) (DBI)	5.00	-	3.70	-1.30	-26.0%
STC: Biology with X-ray Lasers (BioXFEL)	5.00	-	5.00	-	-
STC: Center for Cellular Construction (CCC)	5.00	-	5.00	-	-
Education	24.14	-	19.52	-4.62	-19.1%
Infrastructure	62.83	-	112.54	49.71	79.1%
NEON	-	-	65.00	65.00	N/A
CHES	5.00	-	-	-5.00	-100.0%
NNCI	0.35	-	0.35	-	-
Research Resources	57.48	-	47.19	-10.29	-17.9%

DBI Summary

DBI empowers biological discovery by supporting the development and enhancement of biological research resources, human capital, and facilities. In particular, DBI supports the development of, or improvements to research infrastructure, including cyberinfrastructure; instrumentation; and improvements to biological research collections, living stock collections, and field stations and marine labs. In addition, DBI supports the development of human capital through undergraduate, and postdoctoral research experiences. Support for facilities like NEON create opportunities to address targeted, but deep biological questions that have major societal impact particularly with respect to ecological forecasting.

In general, 30 percent of the DBI portfolio is available for new research grants and 70 percent funds continuing grants made in previous years.

DIVISION OF EMERGING FRONTIERS (EF)

\$94,200,000
-\$19,600,000 / -17.2%

EF Funding
(Dollars in Millions)

	FY 2017 Actual	FY 2018 (TBD)	FY 2019 Request	Change over	
				FY 2017 Actual Amount	Percent
Total	\$113.80	-	\$94.20	-\$19.60	-17.2%
Research	61.42	-	93.95	32.53	53.0%
CAREER	-	-	1.76	1.76	N/A
Big Idea: Understanding the Rules of Life	-	-	30.00	1.76	N/A
Education	2.12	-	0.25	-1.87	-88.2%
Infrastructure	50.26	-	-	-50.26	-100.0%
NEON	50.26	-	-	-50.26	-100.0%

EF Summary

EF identifies, incubates, and supports research areas and infrastructure that transcend scientific disciplines and/or advance conceptual foundations across all of biology. EF also facilitates the development and implementation of new forms of merit review and mechanisms to support transformative research and stimulate creativity (such as Ideas Labs). New programs and priority areas, especially those that are cross-cutting, typically begin development in EF and then move to other BIO divisions to become part of the disciplinary knowledge base. An example is NEON which transitioned from EF to DBI across FY 2017 and FY 2018. In FY 2019, EF is responsible for the financial stewardship of new investments in NSF's Big Idea, Understanding the Rules of Life. It will also provide support for cross-cutting activities that contribute to research that crosses spatial and temporal scales, as well as levels of biological organization.

In general, 29 percent of the EF portfolio is available for new research grants and 71 percent is available for continuing grants.

