

DIRECTORATE FOR BIOLOGICAL SCIENCES (BIO)**\$704,950,000**
-\$78,790,000 / -10.1%**BIO Funding**
(Dollars in Millions)

	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual	
				Amount	Percent
Molecular and Cellular Biosciences (MCB)	\$144.70	-	\$130.89	-\$13.81	-9.5%
Integrative Organismal Systems (IOS)	194.38	-	175.84	-18.54	-9.5%
Environmental Biology (DEB)	153.60	-	150.26	-3.34	-2.2%
Biological Infrastructure (DBI)	180.79	-	158.07	-22.72	-12.6%
Emerging Frontiers (EF)	110.27	-	89.89	-20.38	-18.5%
Total	\$783.74	-	\$704.95	-\$78.79	-10.1%

About BIO

BIO supports fundamental research and infrastructure that promotes a unified understanding of life in all forms, from the biological molecules that are the machinery of living cells to the populations of organisms and species that underpin the functioning of the Nation’s ecosystems. In the past decade biology has been transformed by new tools to describe and manipulate genomes, new means of sensing processes at multiple biological scales simultaneously, and new computational and artificial intelligence (AI) approaches in bioinformatics and modeling to unveil the regulation of complex living systems. BIO seeks to capitalize on these advances to vastly improve our ability to understand life’s deepest mysteries, and to enable new capabilities to modify organisms and ecosystems for societal benefit and economic prosperity.

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. In this way, BIO programs directly support the Administration’s priorities in and the bioeconomy industries of the future. 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 environmental change at regional and continental scales. These investments support the Administration’s priority to advance Earth System Predictability, and address gaps in national security concerning the environmental spread and evolution of biothreats and engineered organisms.

Biological questions often drive convergence research in critical areas of science and technology and stimulate applications that enhance economic and societal well-being. Pursuits in the biological sciences to quantify living systems at all scales has propelled the frontiers of research in statistics and mathematical and computer sciences to consider larger and more complex data sets that benefit from 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 such as biological computing, taking advantage of the extraordinary information density in genetic polymers, and the development of neuro-technologies that are powering 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, olfaction,

magnetoreception, and other sensing systems. This research will enable bioinspired designs based on quantum energy production and sensing systems that will enhance American security.

As the lead directorate for the URoL Big Idea, BIO provides the stewardship support for URoL, an NSF-wide, convergence research funding opportunity addressing scientific and societal needs pertinent to the Administration's priorities in the bioeconomy. URoL is focused on elucidating the rules that govern the emergence of complex organismal traits and behaviors, such as robustness and adaptability, using a highly interdisciplinary approach that engages all the major disciplines represented across NSF's directorates and offices. URoL frames the essential challenges and opportunities associated with genotype to phenotype (structure to function) relationships. Through stewardship of URoL, BIO enables research that leads to a predictive understanding of biological systems at all scales. This knowledge is what drives advances in understanding the human body and improving health, enabling sustainable and efficient food production, and harnessing biological systems to enable bio-based manufacturing and new forms of energy production.

BIO also invests in Biology Integration Institutes (BII) to enable the discovery of underlying principles operating across all hierarchical levels of life, from biomolecules to organisms to ecosystems. Unlike URoL, BII provides institute-scale funding to address the critical need for integration within biology itself, both integration of approaches across scales that will enable biology to become a predictive science, and also cultural integration across the traditional sub-disciplines of biology that will propel significant advances in the life sciences. BII will provide support for research and training to promote this integrative biology through highly collaborative, team-science endeavors, which foster diversity and inclusion in science. This complements BIO's other investments in workforce development, including postdoctoral fellowships and research experiences for undergraduates.

BIO promotes other opportunities for convergence research and training through active participation and foundational investments in several Big Ideas beyond URoL. BIO participates in QL—contributing to more efficient and robust quantum technologies for solar energy harvesting, communication, and navigation as well as cutting edge DNA-based quantum computing. BIO will support basic research in this area primarily through established research programs in MCB and research resource programs in DBI. BIO is making strategic investments in HDR—from contributing to the mapping and understanding of the properties, structure, and functions of tens of thousands of molecules in cells, to collecting and analyzing data from leading facilities such as NEON, which provides data on environmental and land use change for the entire United States. BIO investments include CyVerse, Protein Data Bank, iDigBio, and Advancing Digitization of Biodiversity Collections. BIO participates in the NNA Big Idea through investments in environmental research and observational infrastructure in the Arctic, through the Long-Term Ecological Research program (LTER) and NEON. For more information about the Big Ideas, please see the narratives in the NSF-Wide Investments chapter.

BIO provides 67 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 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual	
				Amount	Percent
Advanced Manufacturing	\$4.50	-	\$7.16	\$2.66	59.1%
Artificial Intelligence	12.53	-	38.09	25.56	204.0%
Bioeconomy	90.00	-	96.00	6.00	6.7%
BRAIN	24.96	-	17.20	-7.76	-31.1%
IUSE	2.68	-	1.81	-0.87	-32.5%
NSF I-Corps™	1.00	-	1.00	-	-
Quantum Information Science	1.05	-	3.12	2.07	197.1%
NSF's Big Ideas					
<i>UROL Stewardship</i>	<i>30.00</i>	<i>-</i>	<i>30.00</i>	<i>-</i>	<i>-</i>

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

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

- **Advanced Manufacturing:** BIO will support Advanced Manufacturing in collaboration with ENG, by supporting basic research, infrastructure, and standards in synthetic biology. BIO will also support the development of new tools and new platform organisms to advance biotechnology that will enable new biomanufacturing capabilities. BIO will continue support for an Industry-Academia-NSF partnership (the Engineering Biology Research Consortium) that provides leadership and training to a network of practitioners that will sustain and grow the U.S. bioeconomy.
- **AI:** BIO, together with other NSF directorates and offices, will increase support for artificial intelligence. BIO's AI investments occur primarily in DBI through the Advances in Biological Informatics program, and center-scale investments that advance computational capacity in bioinformatics. AI methods such as machine learning, natural language processing, computer vision, and genetic algorithms are increasingly applied in biological research to solve problems such as genome sequence alignment, prediction of protein structure, reconstructing evolutionary relationships, predicting species range distributions, and extracting quantitative information from multi-media data sources.
- **Bioeconomy:** BIO will increase investments in support of the bioeconomy through research funding programs in synthetic biology, genomics, bioinformatics, and biotechnology, and training fellowships that help build the U.S. workforce in this area.
- **BRAIN:** BIO will continue to support the BRAIN Initiative through the Collaborative Research in Computational Neuroscience program and the Next Generation Networks for Neuroscience (NeuroNex) program which involves a partnership of NSF and funding agencies in Germany, United Kingdom, and Canada.
- **IUSE:** BIO will continue to support activities related to undergraduate biology education through Research Collaboration Networks—Undergraduate Biology Education. For more information regarding IUSE, see the NSF-Wide Investments chapter.
- **I-Corps™:** BIO will continue support for I-Corps™ nodes and teams that test the feasibility of commercial prototypes developed from NSF/BIO supported research. For more information on NSF I-Corps™, see the NSF-Wide Investments chapter.

- Quantum Information Science (QIS): BIO will continue to support QIS through investments in fundamental research in biophysics that seek to understand quantum phenomena within living systems and can inform applications in quantum information science.
- URoL: BIO will provide stewardship support for NSF URoL Big Idea initiative. URoL emphasizes multi-disciplinary, team science approaches to achieving a predictive understanding of how complex traits of an organism emerge from the interaction of its genetic makeup with the environment. Science outcomes from URoL advance biological theory that explains the complexity, diversity, and adaptability of living systems, inform applications in human health and agriculture, and expand the bioeconomy.

BIO Funding for Centers Programs and Facilities

BIO Funding for Centers Programs (Dollars in Millions)

	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual	
				Amount	Percent
Total	\$13.75	-	\$9.15	-\$4.60	-33.5%
Centers for Analysis and Synthesis (DBI)	0.05	-	-	-0.05	-100.0%
STC: Bio/computation Evolution in Action	3.70	-	-	-3.70	-100.0%
STC: Biology with X-ray Lasers (BioXFEL) (DBI)	5.00	-	4.15	-0.85	-17.0%
STC: Center for Cellular Construction (CCC) (DBI)	5.00	-	5.00	-	-

For additional information on NSF's centers programs, please see the NSF-Wide Investments chapter.

BIO Funding for Major Multi-User Facilities (Dollars in Millions)

	FY 2019 Actual ¹	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual	
				Amount	Percent
Total	\$70.40	-	\$65.00	-\$5.40	-7.7%
National Ecological Observatory Network (DBI)	70.40	-	65.00	-\$5.40	-7.7%

¹ Includes \$8.93 million for continuity of operations into FY 2020.

For information on continuity of operations funding, see the opening narrative of the Facilities chapter. For detailed information on individual facilities, please see the Facilities chapters.

Funding Profile

BIO Funding Profile			
	FY 2019 Actual Estimate	FY 2020 (TBD)	FY 2021 Estimate
Statistics for Competitive Awards:			
Number of Proposals	3,113	-	3,200
Number of New Awards	1,049	-	900
Funding Rate	34%	N/A	28%
Statistics for Research Grants:			
Number of Research Grant Proposals	2,458	-	2,500
Number of Research Grants	811	-	700
Funding Rate	33%	N/A	28%
Median Annualized Award Size	\$215,000	-	\$220,000
Average Annualized Award Size	\$262,945	-	\$270,000
Average Award Duration, in years	3.4	-	3.4

BIO supports investment in core research and education as well as research infrastructure. In FY 2021, BIO will invest \$9.15 million in research centers, accounting for 1.3 percent of the BIO budget. This total is down from FY 2019 Actual as two centers sunset and another is phasing down as planned. BIO's FY 2021 Request funds two Science and Technology Centers. O&M funding for BIO-supported facilities is 9.2 percent of BIO's FY 2021 Request.

Performance and Management

External Program Evaluations and Studies

- DBI funded an award to the National Academies of Science, Engineering and Medicine to produce a report entitled, "Biological Collections: Their Past, Present, and Future Contributions and Options for Sustaining Them."¹ This will inform how the division chooses to proceed at the end of the 10-year campaign on digitizing and maintaining collections through the Advancing Digitization of Biodiversity Collections and Collections in Support of Biological Research programs.
- In 2019, IOS received a consensus study report from the National Academies of Sciences, Engineering and Medicine entitled "Science Breakthroughs to Advance Food and Agricultural Research by 2030". This consensus study was co-funded by NSF, USDA/NIFA, DOE and the Supporters of Agricultural Research Foundation. The recommendations from this report will inform future investments in the plant sciences to produce the cross-disciplinary basic research to enable more efficient, resilient and sustainable agricultural systems crucial to the bioeconomy.

Workshops and Reports

- BIO supported the following workshops that have and continue to inform the planning of the directorate's research programs.
 - A workshop entitled "Workshop: Biology, Information, Communication and Coding Theory"² was funded in 2019 and will be held in January of 2020, to help inform future activities associated with the NSF Big Idea URoL.

¹ Biological Collections: Their Past, Present and Future Contributions and Options for Sustaining Them (Award 1827445); www.nsf.gov/awardsearch/showAward?AWD_ID=1827445&HistoricalAwards=false

² Workshop: Biology, Information, Communication and Coding Theory (Award 1945773); www.nsf.gov/awardsearch/showAward?AWD_ID=1945773&HistoricalAwards=false

- A workshop entitled “Trans-US Government expert meeting to examine synthetic biology roadmap”³ was held in October 2019. The workshop, which included attendees across academia, industry, and US government agencies, was convened to examine use cases in the field of synthetic biology and the most pressing basic research, technology, infrastructure, and workforce needs to advance the field. The results of the workshop helped inform the development of the work plan for the Interagency Synthetic Biology Working group as well as agency priorities in this area. A new Dear Colleague Letter in the area of plant synthetic biology, to be released in FY 2020 and supported by BIO and ENG at NSF, is one early outcome of this activity.
- A series of virtual and in-person workshops entitled “Reintegrating Biology Jumpstarts” were funded in 2019 and held throughout fall 2019 to engage the broader biological community in identifying: the exciting new research questions that could be addressed by combining approaches and perspectives from different sub-disciplines of biology; the key challenges and scientific gaps that must be addressed to answer these questions; and the physical infrastructure and workforce training needed. These workshops will inform research and training activities supported by Biology Integration Institutes.
- MCB supported multiple workshops that have and continue to inform the planning of the division’s research programs.
 - A Workshop series entitled “Finding your inner modeler: how computational biology can advance your research and how to get started” was initiated in FY 2017. The series of workshops were developed to promote the use of computational modeling by cell biologists. The third workshop in this series was funded in FY 2019. These workshops contribute to the continued enhancement of the quantitative/predictive portfolio of awards in MCB.⁴
 - A travel grant was awarded in 2019, titled “BIOROBOOST”, that provides travel support for US-based researchers attending workshops to develop standards in synthetic biology, to support US leaders in the development of experimental, data, and computational standards in the area of synthetic biology to work with European experts in the field to ensure common standards are developed to enable rapid development and commercialization of the field.
- IOS supported multiple workshops and meetings to inform the planning of the division’s research programs for FY 2021.
 - A workshop in FY 2018 “Breakthroughs 2030: A Strategy for Food and Agricultural Research” led to a National Academies of Sciences, Engineering and Medicine (NASEM) Breakthroughs 2030 report that helped guide the FY 2019 solicitation for plant genomics research in IOS.⁵ The workshop report on functional genomics is scheduled to be released in FY 2020.
 - In FY 2019, IOS commissioned a workshop from the NASEM on future directions in Functional Genomics. That workshop will be held February 10-12, 2020 at the NASEM in Washington, D.C. The workshop report is expected mid-year and will inform future investments in all IOS programs and NSF’s URoL Big Idea.
 - In spring of 2019, IOS held the first community visioning workshop for the organismal functional genomics community who discussed new areas of opportunity for non-traditional research organisms in functional genomics research. These discussions informed the recent addition of a track for research into complex multigenic traits to the Enabling Discovery Through Genomic Tools (EDGE) solicitation.
 - In late FY 2019, IOS held a community visioning workshop with the plant genomics research community. The plant genomics community discussed new areas for high impact plant sciences research. These discussions informed the creation of opportunities for synthetic plant biology

³ Trans-US Government expert meeting to examine synthetic biology roadmap (Award 1938199); www.nsf.gov/awardsearch/showAward?AWD_ID=1938199&HistoricalAwards=false

⁴ Stone, D. Haswell E. and Sztul, E., 2017. Finding your inner modeler: An NSF-sponsored workshop to introduce cell biologists to modeling/computational approaches. *Cellular Logistics*; 7: e1382669. <https://doi.org/10.1080/21592799.2017.1382669>

⁵ <http://nas-sites.org/dels/studies/agricultural-science-breakthroughs/>

research forthcoming in FY 2020. The “Interagency Strategic Plan for Microbiome Research FY 2018-2022”⁶ released in April 2018 continues to guide IOS investment into microbiomes, including microbial interactions with the environment, with animals and plants, and important ecosystem services such as soil stability, fertility, and sustainability.

- In March 2019, IOS received the workshop report from the “Rules of Life in the Context of Future Mathematical Sciences” workshop. This workshop brought together mathematicians and biologists to identify emerging research challenges in mathematical biology central to URoL. Increasing computational capacity in our communities is an important IOS goal and the opportunities and challenges identified in this report will focus IOS investments in mathematical biology and computation.
- DEB supported multiple workshops to inform the planning of the division’s research programs for FY 2021.
 - A 2019 workshop “Ecosystem Responses to Hurricanes Synthesis” provided valuable information on the broader implications of major catastrophic disturbances and the types of research that are likely to provide conceptual breakthroughs and a better understanding of the consequences of individual hurricanes.
 - Three virtual and two in-person international workshops in 2018 and 2019 discussed new procedures for enhancing the taxonomy and classification of uncultured microorganisms and improving the systematics of microbes.
 - “Workshop to stimulate research on microbial eukaryotic diversity” supported two workshops to identify priorities and coordinate research on the phylogenetics of microbial eukaryotes that will provide valuable information on investments for DEB on these poorly known organisms.
 - A 2020 workshop titled “Developing a vision for the future of systematics at the Society of Systematic Biologists conference” will discuss the challenges and opportunities in systematic biology and develop priorities for future biodiversity research.
 - Two workshops on “Genomics of Diseases in Wildlife” supported hands-on training on computationally extensive (“big data”) predictive analyses of animal pathogen outbreaks while also developing an inclusive and diverse research community including academic, governmental and private stakeholders.

Committees of Visitors (COVs)

- The DEB COV convened June 12-14, 2019, and reviewed division operations and the programmatic portfolio for the four-year period spanning FY 2015 – FY 2018. DEB is evaluating all the COV recommendations and working to include them in future planning activities.
- In 2020, a COV will review programs in DBI.
- There are no scheduled BIO COVs in 2021.

The Performance and Management chapter provides details regarding the periodic reviews of programs and portfolios of programs by external COVs and directorate Advisory Committees. Please see this chapter for additional information.

⁶ https://science.energy.gov/~media/ber/pdf/workshop%20reports/Interagency_Microbiome_Strategic_Plan_FY2018-2022.pdf

People Involved in BIO Activities

Number of People Involved in BIO Activities			
	FY 2019 Actual Estimate	FY 2020 (TBD)	FY 2021 Estimate
Senior Researchers	3,690	-	3,300
Other Professionals	1,338	-	1,200
Postdoctoral Associates	1,360	-	1,200
Graduate Students	2,716	-	2,400
Undergraduate Students	4,398	-	4,000
K-12 Teachers	-	-	-
K-12 Students	-	-	-
Total Number of People	13,502	-	12,100

DIVISION OF MOLECULAR AND CELLULAR BIOSCIENCES (MCB) **\$130,890,000**
-\$13,810,000 / -9.5%

MCB Funding
(Dollars in Millions)

	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual	
				Amount	Percent
Total	\$144.70	-	\$130.89	-\$13.81	-9.5%
Research	141.91	-	128.35	-13.56	-9.6%
Education	1.79	-	1.54	-0.25	-14.0%
Infrastructure	1.00	-	1.00	-	-
Center for High Energy X-ray Sciences	1.00	-	1.00	-	-

About MCB

MCB supports fundamental interdisciplinary research to uncover the basic principles that describe information content in cells and how: (a) it guides expression of cellular characteristics and is maintained and transmitted to the next generation, (b) material and energy are taken up, transformed, and flow through biological systems, and (c) biological molecules, which assemble into complex structures and compartments with varied functions, contribute to the processes required for life. Due to its interdisciplinary nature, MCB research contributes to NSF’s Big Ideas, URoL and QL.

Additionally, MCB supports convergence research at the molecular and cellular scales. This basic research at the interface of biological, mathematical, physical, and computer sciences and engineering provides the basis for a quantitative, predictive, theory driven understanding of molecular and cellular functions of biological systems across the tree of life. MCB supported research continues to leverage the latest advances across science and engineering, including single molecule imaging, artificial intelligence, and synthetic biology, and advances a clear mechanistic understanding of biological processes such as deoxyribonucleic acid (DNA) maintenance and repair, clustered regularly interspaced short palindromic repeats (CRISPR), and CRISPR-associated (Cas) genome editing. Advances in basic research enable the development of design rules for engineering molecules and cells, which contributes directly to biological innovations that advance the U.S. bioeconomy, medicine, agriculture, environmental sustainability, and biomanufacturing.

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

DIVISION OF INTEGRATIVE ORGANISMAL SYSTEMS (IOS)

\$175,840,000
-\$18,540,000 / -9.5%

IOS Funding
(Dollars in Millions)

	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual	
				Amount	Percent
Total	\$194.38	-	\$175.84	-\$18.54	-9.5%
Research	186.83	-	167.66	-19.17	-10.3%
Education	4.73	-	2.94	-1.79	-37.8%
Infrastructure	2.82	-	5.24	2.42	85.8%
Research Resources	2.82	-	5.24	2.42	85.8%

About IOS

IOS focuses on the organism and the key link between single biological molecules and complex populations. IOS programs support research and education aimed at integrating knowledge across different levels of biological organization, with the goal of understanding the processes that build and maintain organisms. More specifically, IOS activities focus on mechanistic analyses of how biological systems interact and function – spanning the nervous system, growth and development, behavior, and biochemical, biophysical, and physiological processes – and how these are integrated and result in stability of organisms living in dynamic environments. Such analysis is fundamental to understanding the principles that produce the vast diversity of life on Earth and the mechanisms that allow for biological adaptation to change.

IOS encourages interdisciplinary science and the development of new approaches through the Enabling Discovery through GENomic (EDGE) Tools program. Investments in research, including tools for high-throughput analysis of agriculturally-important plants, and support for the NSF-Simons Research Centers for Mathematics of Complex Biological Systems, are maintained as priorities. IOS will continue to leverage its activities across the spectrum of NSF basic science in conjunction with agricultural research supported by the U.S. Department of Agriculture’s National Institutes of Food and Agriculture. Funding research centered around plant biotic interactions, is an example of this partnership.

Results of IOS-supported research are fully consistent with the NSF Big URoL Idea. IOS’s contribution provides information to enable multi-scale biological integration to reveal emergent properties of organisms—spanning the gamut of biological diversity including microbes, plants, and animals. IOS science is highly relevant to societal needs for future food security and sustainability, understanding the healthy brain, and providing new knowledge on how organisms respond to environmental and social stressors.

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

DIVISION OF ENVIRONMENTAL BIOLOGY (DEB)

\$150,260,000
-\$3,340,000 / -2.2%

DEB Funding
(Dollars in Millions)

	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual	
				Amount	Percent
Total	\$153.60	-	\$150.26	-\$3.34	-2.2%
Research	151.09	-	148.32	-2.77	-1.8%
Education	2.51	-	1.94	-0.57	-22.7%

About DEB

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 can inform strategies to develop, use, and sustain biological resources, including natural, agricultural, and other managed ecosystems, and to forecast changes in species populations and ecosystems over time.

In addition to disciplinary programs in ecology, evolution and biodiversity, DEB provides support for long term ecological research (LTER), and for research addressing continental-scale questions in macrosystem biology. DEB programs encourage the use of data samples and other resources provided by the National Ecological Observatory Network (NEON) and other NSF infrastructure investments. DEB funded research provides the data, knowledge, and capability to advance models that can predict the spread of infectious diseases and of invasive species, and their impacts on wild, managed, and agricultural systems. Eco-forecasting models developed from biodiversity and ecological research are also used to predict environmental drivers of conflict, enhance our ability to strategically prepare for environmental threats, and field defense and mitigation capabilities that are resilient and adaptive.

In general, 80 percent of the DEB portfolio is available for new research grants, and 20 percent is available for continuing grants.

DIVISION OF BIOLOGICAL INFRASTRUCTURE (DBI)

\$158,070,000
-\$22,720,000 / -12.6%

DBI Funding
(Dollars in Millions)

	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual	
				Amount	Percent
Total	\$180.79	-	\$158.07	-\$22.72	-12.6%
Research	23.19	-	20.92	-2.27	-9.8%
Centers Funding (total)	13.75	-	9.15	-4.60	-33.5%
Centers for Analysis and Synthesis	0.05	-	-	-0.05	-100.0%
STC: Bio/computation Evolution in Action CONsortium (BEACON) ¹	3.70	-	-	-3.70	-100.0%
STC: Biology with X-ray Lasers (BioXFEL)	5.00	-	4.15	-0.85	-17.0%
STC: Center for Cellular Construction (CCC)	5.00	-	5.00	-	-
Education	28.54	-	18.28	-10.26	-35.9%
Infrastructure	129.06	-	118.87	-10.19	-7.9%
NEON ²	70.40	-	65.00	-5.40	-7.7%
NNCI	0.35	-	0.35	-	-
Research Resources	58.31	-	53.52	-4.79	-8.2%

For information on continuity of operations funding, see the opening narrative of the Facilities chapter.

¹STC BEACON will sunset as planned in FY 2020.

²FY 2019 Actual includes \$8.93 million for continuity of operations into FY 2020.

About DBI

DBI empowers biological discovery by supporting the development and enhancement of biological research resources, human capital, and facilities. 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 research experiences by participating in the NSF-wide IUSE and Research Experiences for Undergraduate Sites program. DBI also offers a multi-track postdoctoral research fellowships program with special emphasis on emerging areas of the biological sciences. Support for facilities, such as NEON, create opportunities to address targeted but deep biological questions that have major societal impact, particularly with respect to ecological forecasting. NEON is enabling the study of the biosphere and its response to environmental change at a continental scale. Additional infrastructure support will focus on developing capacity of the biological sciences research community through funding cyberinfrastructure and other tools necessary to address the NSF URoL Big Idea.

In general, about 27 percent of the DBI portfolio is available for new research grants. The remaining 73 percent supports research grants made in prior years and the research infrastructure needed by the biological sciences community.

DIVISION OF EMERGING FRONTIERS (EF)

\$89,890,000
-\$20,380,000 / -18.5%

EF Funding
(Dollars in Millions)

	FY 2019 Actual	FY 2020 (TBD)	FY 2021 Request	Change over FY 2019 Actual	
				Amount	Percent
Total	\$110.27	-	\$89.89	-\$20.38	-18.5%
Research	103.34	-	89.89	-13.45	-13.0%
Education	0.56	-	-	-0.56	-100.0%
Infrastructure	6.37	-	-	-6.37	-100.0%
NEON	3.53	-	-	-3.53	-100.0%
Research Resources	2.84	-	-	-2.84	-100.0%

About EF

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. For example, support for design and early construction of NEON originated within EF but moved to DBI once NEON operations were initiated. EF also facilitates the development and implementation of new forms of merit review and mechanisms to support transformative research and stimulate creativity.

EF also provides the support for BIO participation in national initiatives, NSF priority areas, and other interdisciplinary, cross-division, and cross-directorate programs. Hence, EF is the steward for investments in NSF's URoL Big Idea. In addition, EF will support innovative research and training that integrates across scales of biology, contributes to a re-unification of biology, and supports U.S. global competitiveness in the bioeconomy.

In general, 61 percent of the EF portfolio is available for new research grants, and 39 percent is available for continuing grants.

