

**DIRECTORATE FOR BIOLOGICAL SCIENCES (BIO)****\$948,510,000**  
**+\$130,370,000 / 15.9%****BIO Funding**  
(Dollars in Millions)

	FY 2020	FY 2020	FY 2021	FY 2022	Change over	
	Actual <sup>1</sup>	CARES Act Actual	Estimate <sup>1</sup>	Request	FY 2021 Estimate Amount	Percent
Molecular and Cellular Biosciences (MCB)	\$153.54	-	\$155.64	\$170.74	\$15.10	9.7%
Integrative Organismal Systems (IOS)	204.05	-	206.98	227.07	20.09	9.7%
Environmental Biology (DEB)	171.31	-	178.86	196.22	17.36	9.7%
Biological Infrastructure (DBI)	181.85		167.08	204.89	37.81	22.6%
Emerging Frontiers (EF)	98.56	19.00	109.58	149.59	40.01	36.5%
<b>Total</b>	<b>\$809.31</b>	<b>\$19.00</b>	<b>\$818.14</b>	<b>\$948.51</b>	<b>\$130.37</b>	<b>15.9%</b>

<sup>1</sup> FY 2020 and FY 2021 funding is adjusted for comparability to reflect the movement of I-Corps™ to TIP in FY 2022. See the R&RA Overview for more details.

**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. The key to innovations that will drive the Nation’s bioeconomy is through discovery and harnessing of life’s evolutionary innovations. BIO’s support for foundational and translational research promotes economic prosperity, health, security, and well-being by addressing existing and future global challenges.

BIO's scientific investments align directly with Administration priorities, including biotechnology to promote the bioeconomy, forecasting and mitigating the impacts of global warming on essential ecosystem services, and predicting and preventing the emergence of infectious diseases. 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 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, and other extreme events. Together, these investments are responsive to the national need to understand and develop solutions for the climate emergency. BIO will also increase investments in research on infectious disease emergence and transmission, contribute to a goal of preventing future pandemics, and fill knowledge gaps concerning the spread and evolution of biothreats.

Biological questions often drive convergence research across multiple fields of science and technology and

stimulate applications that enhance economic and national security, and societal well-being. Pursuits in the biological sciences to quantify living systems at all scales have propelled the frontiers of research in statistics, 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 in biomaterial 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, 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, BIO is the steward of funds designated for NSF-wide investments for Big Idea: Understanding the Rules of Life (URoL). URoL is a convergence research funding opportunity addressing scientific and societal needs pertinent to advancing biotechnology and promoting 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 highly interdisciplinary approaches that engage 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, harnessing biological systems to mitigate the impacts of climate change, and to enable bio-based manufacturing and new forms of energy production. For more information about the Big Ideas, please see the narratives in the NSF-Wide Investments chapter.

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. BIO investments in Integrative Biology (IntBIO) and in Biology Integration Institutes (BII) represent major funding opportunities to encourage this type of synergistic research seeking a holistic understanding of how living systems function. BIO will increase support for these two programs to accelerate discovery of underlying principles operating across all hierarchical levels of life, from cells to organisms to ecosystems. Unlike URoL, BII provides institute-scale funding to address integration within biology itself, integration of research across scales of living systems, and cultural integration across the traditional sub-disciplines of biology that will propel significant advances in the life sciences. BII and IntBIO awards promote this integrative biology through highly collaborative, team-science endeavors, which also fosters diversity and inclusion in science. This complements BIO's other investments in workforce development, including postdoctoral fellowships, which will also be expanded to promote advanced training and integrative research on genomes, environment, and phenotypes.

There will be great emphasis placed on racial equity, as BIO continues to invest in activities to broaden participation, including INCLUDES and HBCU-EiR as well as new opportunities for mid-career scientists and researchers from groups underrepresented in STEM and with strong track records of prior accomplishment to pursue new transformative avenues of research. BIO will continue to utilize its Postdoctoral Research Fellowships in Biology program to support a diversity of young researchers, with a focus on broadening participation. BIO will increase investments in Research Experiences for Teachers (RET) to provide new opportunities to engage teachers and their classrooms in STEM, and support early engagement, creating inclusive learning environments. BIO is investing in new efforts to encourage professional societies to develop collaborative networks focused on advancing diversity, equity, and inclusion through an activity called LEAPS: Leading cultural change through Professional Societies.

BIO promotes other opportunities for convergence research and training through active participation and foundational investments in several Big Ideas beyond URoL. 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. BIO participates in Quantum Information Science (QIS)- related activities, 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 structure and function of tens of thousands of molecules in cells, to collecting and analyzing data from environmental observatories such as NEON, which provides open data on environmental and land use change for the entire United States. BIO’s investments in data and informatics include CyVerse for omics data, Protein Data Bank for structural biology, and iDigBio for biodiversity collections. BIO also provides support for the Environmental Data Initiative and will establish a new Center for Open Environmental Data Synthesis to advance modeling and forecasting capability for climate change impacts.

BIO provides 66 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 <sup>1,2</sup>	FY 2020 Actual	FY 2021 Estimate	FY 2022 Request	Change over FY 2021 Estimate	
				Amount	Percent
Advanced Manufacturing	\$8.48	\$7.16	\$17.16	\$10.00	139.7%
Artificial Intelligence	13.78	20.00	20.00	-	-
Biotechnology	110.00	110.00	130.00	20.00	18.2%
Climate: Clean Energy Technnology	18.00	45.00	59.28	14.28	31.7%
Climate: USGCRP	90.00	145.00	212.15	67.15	46.3%
Improving Undergraduate STEM Education	2.18	5.00	4.00	-1.00	-20.0%
Quantum Information Science	3.28	3.28	3.28	-	-
<b>NSF's Big Ideas</b>					
<i>URoL Stewardship</i>	<i>29.95</i>	<i>30.00</i>	<i>30.00</i>	<i>-</i>	<i>-</i>

<sup>1</sup> Major investments may have funding overlap and thus should not be summed.

<sup>2</sup> 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.

- **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. BIO will support an AI Institute to advance the use of AI methods such as machine

learning, natural language processing, computer vision, and genetic algorithms in biological research. AI contributes to solving 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.

- **Biotechnology:** BIO will increase investments in support of the bioeconomy through research funding programs in synthetic biology, genomics, bioinformatics, biotechnology, and training fellowships to help build the U.S. workforce in this area. BIO will support research to advance the ability to build cells and cell-like systems, explore novel concepts and enabling technologies to develop next-generation information storage and computing systems driven by biological principles, foundational research, and tool development in the growing field of plant synthetic biology, and interdisciplinary research to develop novel biological platforms that are capable of sensing and responding to infectious agents and other biothreats. These investments will be coordinated with programs established in the Directorate for Technology, Innovation, and Partnerships (TIP) to translate knowledge and tools into applications that promote the U.S. bioeconomy in public health, agriculture, energy, climate change, and security.
- **Clean Energy:** BIO supports research to advance clean energy biotechnologies and practices through fundamental research in areas such as systems and synthetic biology, plant genomics, and ecosystem sciences. This research seeks to streamline and scale the metabolic, energetic, and physiological potential of living organisms to produce non-petroleum sources of important chemicals/materials, plant biomass, feed stocks, and biofuels. Bioinspired design of complex biomaterials that can transform light into energy will also be supported. Investigations to assess the impact of fuel and/or bio-renewable chemical production on genome stability and phenotype of the production organisms are of interest, as are studies to assess environmental impacts of these technologies.
- **Climate change:** BIO will increase its support for research to understand the critical feedbacks between Earth's biota and the climate system, and to advance predictive models for how climate warming will impact critical U.S. ecosystems, including agricultural systems, forests, grasslands, freshwater, coastal and arctic systems, and human communities in both urban and rural regions, and Tribal Nations. In addition, BIO will increase support for research to understand the adaptive potential of species, ecosystems, and human society to respond to a warming climate and how this scales to impact regional ecosystems. Results will inform efforts to improve natural and human system resilience to climate change. BIO's support for this urgent challenge includes operations of NEON, the Nation's premier ecological observatory, and research programs such as LTER, Macro-system Biology, and Dynamics of Integrated Socio-Environmental Systems. These provide the foundational knowledge to advance eco-forecasting capability and guide efforts to mitigate the impact of climate warming on human health, and sectors of the bioeconomy such as agriculture, fisheries, and forestry.
- **IUSE:** BIO is committed to continuing investments to enhance and improve education in the nation. BIO supports the creation of networks of scientists, educators, and other stakeholders to advance and transform biology education. In pursuit of this goal, BIO will continue to support undergraduate biology education activities through Research Collaboration Networks in Undergraduate Biology Education to stay current with challenges, new technology, and trends. BIO places a high value on virtual learning, including virtual tutoring systems and virtual laboratories. For more information regarding IUSE, 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, which 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. URoL science advances biological theory that explains the complexity, diversity, and adaptability of living systems. BIO also will increase foundational investments that support the goals of URoL through its institute-scale program, Biology Integration Institutes, and its Integrative Biology program, which promotes ambitious, high-risk/high-reward collaborative research. A priority within these funding programs is

discovery of rules of life and advancing understanding of functional genomics, especially plant genomics, that can inform applications in agriculture, energy, and climate change mitigation.

- COVID-19: In response to the pandemic, BIO has reviewed and expanded existing programs in infectious disease research to better align with Administration priorities and national needs. BIO will enhance support for research to advance a predictive understanding of mechanisms mediating antagonistic or beneficial interactions among viruses, bacteria, plants, and animals. BIO will also increase investments in the Ecology and Evolution of Infectious Diseases (EEID) program, supporting research on the ecological, evolutionary, and social drivers that influence infectious diseases' transmission dynamics. BIO will launch a new funding opportunity, Predictive Intelligence for Pandemic Prevention (PIPP), which aims to forecast the emergence of infectious disease and prevent future pandemics. This new effort is being co-led by BIO and CISE but emphasizes interdisciplinary research that includes ENG and SBE.

### BIO Funding for Centers Programs and Major Facilities

#### BIO Funding for Centers Programs

(Dollars in Millions)

	FY 2020 Actual	FY 2021 Estimate	FY 2022 Request	Change over	
				FY 2021 Estimate Amount	Percent
Biology Integration Institutes	\$21.63	\$25.00	\$35.82	\$10.82	43.3%
Centers for Analysis & Synthesis	4.80	-	4.00	4.00	N/A
STC: Bio/computation Evolution in Action CONsortium (BEACON)	1.30	-	-	-	N/A
STC: Biology with X-ray Lasers (BioXFEL)	5.00	4.15	3.32	-0.83	-20.0%
STC: Center for Cellular Construction (CCC)	5.00	5.00	5.00	-	-
<b>Total</b>	<b>\$37.73</b>	<b>\$34.15</b>	<b>\$48.14</b>	<b>\$13.99</b>	<b>41.0%</b>

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

#### BIO Funding for Major Facilities

(Dollars in Millions)

	FY 2020 Actual	FY 2021 Estimate	FY 2022 Request	Change over	
				FY 2021 Estimate Amount	Percent
National Ecological Observatory Network (NEON) (DBI)	\$65.00	\$65.00	\$70.00	\$5.00	7.7%
<b>Total</b>	<b>\$65.00</b>	<b>\$65.00</b>	<b>\$70.00</b>	<b>\$5.00</b>	<b>7.7%</b>

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

**Funding Profile**

<b>BIO Funding Profile</b>				
	FY 2020			
	Actual	FY 2021	FY 2022	
	Estimate	Estimate	Estimate	
<b>Statistics for Competitive Awards:</b>				
Number of Proposals	3,785	3,200	3,300	
Number of New Awards	1,371	1,100	1,200	
Regular Appropriation	1,255	1,100	1,200	
CARES Act	116			
Funding Rate	36%	34%	36%	
<b>Statistics for Research Grants:</b>				
Number of Research Grant Proposals	3,063	2,600	2,700	
Number of Research Grants	1,116	900	1,000	
Regular Appropriation	1,001	900	1,000	
CARES Act	115			
Funding Rate	36%	35%	37%	
Median Annualized Award Size	\$200,000	\$210,000	\$220,000	
Average Annualized Award Size	\$242,781	\$260,000	\$270,000	
Average Award Duration, in years	3.0	3.2	3.4	

BIO supports investment in core research and education as well as research infrastructure. In FY 2022, BIO will invest \$48.14 million in research centers, accounting for 5.08 percent of the BIO budget, funding fourteen BIIs, a new Center for Analysis and Synthesis, and two Science and Technology Centers. O&M funding for BIO-supported facilities is 7.4 percent of BIO’s FY 2022 Request.

**Program Monitoring and Evaluation**

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

**People Involved in BIO Activities**

<b>Number of People Involved in BIO Activities</b>				
	FY 2020	FY 2020		
	Actual	CARES Act	FY 2021	FY 2022
	Estimate	Estimate	Estimate	Estimate
Senior Researchers	4,232	170	4,300	5,000
Other Professionals	1,341	46	1,400	1,600
Postdoctoral Associates	1,422	44	1,500	1,600
Graduate Students	2,765	79	2,800	3,000
Undergraduate Students <sup>1</sup>	4,578	30	5,000	5,800
<b>Total Number of People</b>	<b>14,338</b>	<b>369</b>	<b>15,000</b>	<b>17,000</b>

<sup>1</sup> The FY 2020 Actual for Undergraduates is adjusted downward from prior agency reported levels to correct an award reporting error.

**DIVISION OF MOLECULAR AND CELLULAR BIOSCIENCES (MCB)** **\$170,740,000**  
**+\$15,100,000 / 9.7%**

**MCB Funding**  
(Dollars in Millions)

	FY 2020 Actual	FY 2021 Estimate	FY 2022 Request	Change over	
				FY 2021 Amount	Estimate Percent
<b>Total</b>	<b>\$153.54</b>	<b>\$155.64</b>	<b>\$170.74</b>	<b>\$15.10</b>	<b>9.7%</b>
<b>Research</b>	<b>149.90</b>	<b>153.64</b>	<b>167.54</b>	<b>13.90</b>	<b>9.0%</b>
CAREER	21.81	37.36	37.36	-	-
<b>Education</b>	<b>1.64</b>	<b>1.00</b>	<b>2.20</b>	<b>1.20</b>	<b>120.0%</b>
<b>Infrastructure</b>	<b>2.00</b>	<b>1.00</b>	<b>1.00</b>	-	-
Midscale Research Infrastructure Programs	1.00	-	-	-	N/A
Center for High Energy X-ray Sciences (CHEXS)	1.00	1.00	1.00	-	-

**About MCB**

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 how it guides expression of cellular characteristics; (b) how material and energy are taken up, transformed, and flow through biological systems, and (c) how biological molecules assemble into complex structures and compartments with varied functions. MCB supported research uses tools of molecular biophysics, systems biology, and synthetic biology to probe these fundamental biological questions that address the essential processes required for life. Due to its interdisciplinary nature, MCB research contributes to NSF’s Big Ideas, URoL and QIS-related activities.

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 emerging industries, and advance the U.S. bioeconomy, medicine, agriculture, environmental sustainability, and biomanufacturing. MCB research has the potential to address challenges by providing biotechnology solutions to mitigate the impact of climate change; by expanding the molecular level understanding of virus replication; and by supporting the development platform technologies using the tools of synthetic biology necessary to rapidly detect (and treat) future threats from infectious organisms.

In general, about 80 percent of the MCB portfolio is available to support new research grants, and 20 percent is available for continuing grants.

**DIVISION OF INTEGRATIVE ORGANISMAL SYSTEMS (IOS)**

**\$227,070,000**  
**+\$20,090,000 / 9.7%**

**IOS Funding**  
(Dollars in Millions)

	FY 2020 Actual	FY 2021 Estimate	FY 2022 Request	Change over FY 2021 Estimate	
				Amount	Percent
<b>Total</b>	<b>\$204.05</b>	<b>\$206.98</b>	<b>\$227.07</b>	<b>\$20.09</b>	<b>9.7%</b>
<b>Research</b>	<b>195.36</b>	<b>198.18</b>	<b>216.67</b>	<b>18.49</b>	<b>9.3%</b>
CAREER	26.37	25.24	25.24	-	-
<b>Education</b>	<b>5.14</b>	<b>4.80</b>	<b>6.40</b>	<b>1.60</b>	<b>33.3%</b>
<b>Infrastructure</b>	<b>3.55</b>	<b>4.00</b>	<b>4.00</b>	-	-
Research Resources	3.55	4.00	4.00	-	-

**About IOS**

IOS supports fundamental research and training that focuses on the functional, phenotypic characteristics of diverse organisms. IOS prioritizes research aimed at integrating knowledge that links biological molecules and complex populations, with the goal of understanding the processes that build and maintain organisms. Specifically, IOS funded research focuses on mechanistic analyses of how biological systems interact and function – spanning the nervous system, organism growth and development, behavior, and genetic, genomic, 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 GENomics (EDGE) program which partners with NIH. 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 on plant biotic interactions and tools for high-throughput analysis of agriculturally important plants, are examples of this partnership. Previous investments in computational biology in neuroscience and support for the NSF-Simons Research Centers for Mathematics of Complex Biological Systems are maintained as priorities.

Results of IOS-supported research contribute to the NSF Big Idea: URoL IOS funded research 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 72 percent of the IOS portfolio is available for new research grants, and 28 percent is available for continuing grants.

**DIVISION OF ENVIRONMENTAL BIOLOGY (DEB)**

**\$196,220,000**  
**+\$17,360,000 / 9.7%**

**DEB Funding**  
(Dollars in Millions)

	FY 2020 Actual	FY 2021 Estimate	FY 2022 Request	Change over FY 2021 Estimate	
				Amount	Percent
<b>Total</b>	<b>\$171.31</b>	<b>\$178.86</b>	<b>\$196.22</b>	<b>\$17.36</b>	<b>9.7%</b>
<b>Research</b>	<b>165.85</b>	<b>176.16</b>	<b>192.52</b>	<b>16.36</b>	<b>9.3%</b>
CAREER	11.82	30.55	30.55	-	-
<b>Education</b>	<b>5.46</b>	<b>2.70</b>	<b>3.70</b>	<b>1.00</b>	<b>37.0%</b>

**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 responding to climate change and other anthropogenic disturbances.

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, 76 percent of the DEB portfolio is available for new research grants, and 24 percent is available for continuing grants.

**DIVISION OF BIOLOGICAL INFRASTRUCTURE (DBI)**

**\$204,890,000**  
**+\$37,810,000 / 22.6%**

**DBI Funding**  
(Dollars in Millions)

	FY 2020 Actual	FY 2021 Estimate	FY 2022 Request	Change over	
				FY 2021 Estimate Amount	Percent
<b>Total</b>	<b>\$181.85</b>	<b>\$167.08</b>	<b>\$204.89</b>	<b>\$37.81</b>	<b>22.6%</b>
<b>Research</b>	<b>44.20</b>	<b>33.91</b>	<b>56.29</b>	<b>22.38</b>	<b>66.0%</b>
CAREER	7.08	6.58	6.58	-	-
Centers Funding (total)	37.73	34.15	44.14	9.99	29.3%
Biology Integration Institutes	21.63	25.00	35.82	10.82	43.3%
Centers for Analysis & Synthesis	4.80	-	-	-	N/A
STC: Bio/computation Evolution in Action CONsortium (BEACON)	1.30	-	-	-	N/A
STC: Biology with X-ray Lasers (BioXFEL)	5.00	4.15	3.32	-0.83	-20.0%
STC: Center for Cellular Construction (CCC)	5.00	5.00	5.00	-	-
<b>Education</b>	<b>22.03</b>	<b>19.95</b>	<b>24.60</b>	<b>4.65</b>	<b>23.3%</b>
<b>Infrastructure</b>	<b>115.62</b>	<b>113.22</b>	<b>124.00</b>	<b>10.78</b>	<b>9.5%</b>
NEON	65.00	65.00	70.00	5.00	7.7%
NNCI	0.35	0.35	0.35	-	-
Research Resources	50.27	47.87	53.65	5.78	12.1%

**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; bioinformatics; biotechnology; 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 at the undergraduate level by participating in the NSF-wide IUSE program, and the Research Experiences for Undergraduate Sites program. In addition, DBI offers a multi-track postdoctoral research fellowships program with special emphasis on interdisciplinary research training, and on broadening participation in the biological sciences. DBI also provides sustained support for key facilities and other resources that enable researchers across the full breadth of biology to address targeted but deep questions. DBI supports the operation and maintenance of NEON, which is enabling study of the biosphere and its response to environmental change at a continental scale. NEON goals have major societal impact, particularly with respect to ecological forecasting. 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)**

**\$149,590,000**  
**+\$40,010,000 / 36.5%**

**EF Funding**  
(Dollars in Millions)

	FY 2020 Actual	FY 2021 Estimate	FY 2022 Request	Change over FY 2021 Estimate	
				Amount	Percent
<b>Total</b>	<b>\$98.56</b>	<b>\$109.58</b>	<b>\$149.59</b>	<b>\$40.01</b>	<b>36.5%</b>
<b>Research</b>	<b>87.52</b>	<b>109.58</b>	<b>149.59</b>	<b>40.01</b>	<b>36.5%</b>
Centers Funding (total)	-	-	4.00	4.00	N/A
Centers for Analysis & Synthesis	-	-	4.00	4.00	N/A
<b>Education</b>	<b>3.11</b>	-	-	-	<b>N/A</b>
<b>Infrastructure</b>	<b>7.93</b>	-	-	-	<b>N/A</b>
Research Resources	7.93	-	-	-	N/A

**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, 70 percent of the EF portfolio is available for new research grants, and 30 percent is available for continuing grants.

