

**DIRECTORATE FOR BIOLOGICAL SCIENCES (BIO)****\$794,490,000**  
**+\$79,950,000 / 11.2%****BIO Funding**  
(Dollars in Millions)

	FY 2010 Omnibus Actual	FY 2010 ARRA Actual	FY 2010 Enacted/ Annualized FY 2011 CR	FY 2012 Request	Change Over FY 2010 Enacted Amount	Percent
Molecular & Cellular Biosciences (MCB)	\$125.90	-	\$125.59	\$145.72	\$20.13	16.0%
Integrative Organismal Systems (IOS)	216.32	-	216.25	231.65	15.40	7.1%
Environmental Biology (DEB)	142.50	-	142.55	156.40	13.85	9.7%
Biological Infrastructure (DBI)	127.19	0.35	126.86	135.95	9.09	7.2%
Emerging Frontiers (EF)	102.85	-	103.29	124.77	21.48	20.8%
<b>Total, BIO</b>	<b>\$714.77</b>	<b>\$0.35</b>	<b>\$714.54</b>	<b>\$794.49</b>	<b>\$79.95</b>	<b>11.2%</b>

Totals may not add due to rounding.

**About BIO**

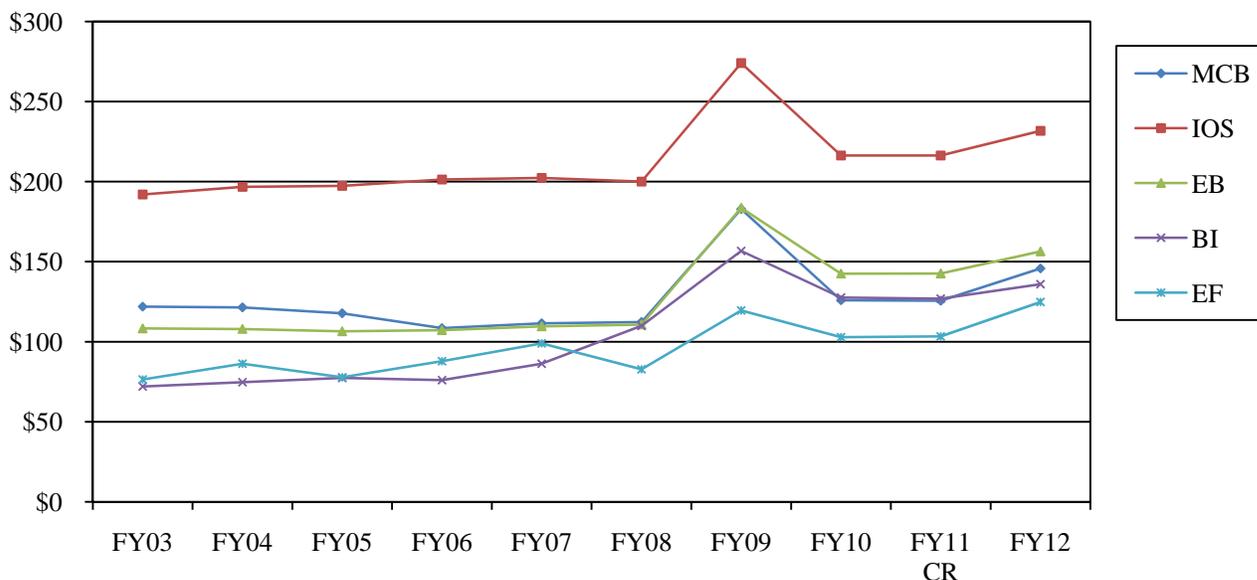
BIO's mission is to enable discoveries for understanding life. Through investments in innovative and transformative research, BIO advances the frontiers of knowledge in the life sciences by increasing our understanding of complex living systems. BIO-supported projects also provide the theory, data, and other research resources that advance research in other science and engineering fields. These fields are adapting and employing principles and processes derived from biological systems to answer fundamental questions, develop practical applications, and solve problems.

Issues of national importance related to the environment, economy, agriculture, and human welfare require an understanding of how complex living systems function and interact with each other and with non-living systems. Research supported by BIO enhances this understanding. As the physical, computational, mathematical, and engineering fields increasingly use living systems to address their major questions, NSF's robust investment in the non-medical biological sciences becomes increasingly relevant to tackling these multidisciplinary challenges.

Biological concepts are integral to wide-ranging areas of science essential to human welfare and the bio-economy, including national priorities such as climate science, biotechnology, and bioengineering. Over the last 3.5 billion years, living organisms have evolved mechanisms for efficiently using energy, producing an endless array of novel compounds, and storing information in a highly compact, adaptable format. Fundamental biological research makes these innovations available to inform the next generation of nano-, bio-, and information technologies. For example, research funded through a BIO CAREER award recently showed that simple and efficient algorithms can be developed using insights derived from discoveries about how a nervous system develops. BIO's investment portfolio includes projects on understanding the changing dynamics of the biosphere, research on the fundamental characteristics of biological energy systems, and efforts to broaden participation and develop the next generation of biological researchers.

BIO provides about 68 percent of federal funding for non-medical, basic research at academic institutions in the life sciences, including environmental biology, a research area critical for addressing questions related to climate science.

**BIO Subactivity Funding**  
(Dollars in Millions)



**FY 2012 Summary by Division**

- Across all BIO divisions, the FY 2012 Request reflects enhanced support for Science, Engineering, and Education for Sustainability (SEES), including a priority investment in clean energy and support for the Research at The Interface of the Biological, Mathematical, and Physical Sciences (BioMaPS) program. In addition, MCB, IOS, DEB, and DBI support the CAREER program.
- MCB’s FY 2012 requested increase of \$20.13 million, or 16.0 percent, reflects enhanced support for fundamental research to understand the dynamics and complexity of living systems at the biochemical, molecular, and cellular level. Within this increase, MCB will contribute to advanced manufacturing research via BioMaPS and the National Nanotechnology Initiative. MCB will also participate in the BioMaPS and SEES activities by supporting fundamental research on the components and processes that comprise and control biological systems at the nano to cellular scales. These interdisciplinary efforts will result in accelerated understanding of biological systems, leading to innovations in manufacturing in such areas as renewable fuels, bio-based materials, bio-imaging, and bio-inspired sensors.
- IOS’s FY 2012 requested increase of \$15.40 million, or 7.1 percent, is aimed at fundamental research on organisms as complex integrated systems, and their interactions with their social and physical environments especially as they adapt to climate variability and other environmental factors. IOS also maintains its commitment to support for fundamental plant genome research. The activities of the Plant Genome Research Program (PGRP) support genome-scale research to accelerate discoveries about basic plant biology, as well as downstream applications of societal benefit such as crop improvement, new sources of bio-based energy, and development of novel bio-based materials. IOS will also participate in BioMaPS and SEES by supporting research on novel energy capture and transduction systems.

- DEB’s FY 2012 requested increase of \$13.85 million, or 9.7 percent, will provide support for research on complex ecological and evolutionary dynamics to improve our ability to understand the reciprocal interactions between living systems and the environment, and inform essential considerations of environmental sustainability. The increase also reflects the Administration’s focus on climate science research and support for the NSF-wide investment in SEES, including programs that enhance our understanding of the diversity of life on Earth and basic research and related activities that enhance fundamental understanding of the complex interactions within and among natural and human systems, with special emphasis placed on the coupling between human and natural systems.
- DBI’s FY 2012 requested increase of \$9.09 million, or 7.2 percent, empowers biological discovery by supporting the development and enhancement of biological research resources, human capital, and centers. It also reflects funding for the new NSF investment, Cyberinfrastructure Framework for 21<sup>st</sup> Century Science and Engineering (CIF21). Within this increase, DBI will contribute to clean energy research via support for the SEES Sustainability Research Networks, which link together networks of researchers exploring the intersection of environmental, energy, and economic understanding needed for long term sustainability.
- EF’s FY 2012 requested increase of \$21.48 million, or 20.8 percent, enhances support for developing priorities. In FY 2012, these are: focused activities within SEES; oversight and management of NEON, including the start of NEON operations; and coordination of cross-directorate innovation activities. It also reflects support for NSF’s CIF21 investment. EF will also contribute to clean energy and advanced manufacturing research through support for BioMaPS.

## Major Investments

### BIO Major Investments

(Dollars in Millions)

Area of Investment	FY 2010	FY 2010	FY 2012 Request	Change Over	
	Omnibus Actual	Enacted/ Annualized FY 2011 CR		FY 2010 Enacted	Percent
SEES Portfolio	\$121.00	\$121.00	\$146.00	\$25.00	20.7%
Clean Energy	28.20	28.20	55.10	26.90	95.4%
CAREER	30.60	29.06	33.01	3.95	13.6%
BioMaPS	-	-	32.57	32.57	N/A
Advanced Manufacturing	-	-	10.00	10.00	N/A
CIF21	-	-	6.00	6.00	N/A

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

- BIO will participate in SEES by funding activities that will generate discoveries, advances, and capabilities in climate and energy science, engineering, and education to inform societal decisions needed for future environmental and economic sustainability and sustainable human well-being. Increased funding will be directed across all BIO divisions, reflecting a broad portfolio of support for Sustainability Research Networks, research on Sustainable Energy Pathways, Postdoctoral Fellowships in Sustainable Solutions, Dynamics of Coupled Natural Systems and the Dimensions of Biodiversity program.

- BIO will support Foundation-wide clean energy activities by funding research projects and Sustainability Research Networks that increase fundamental knowledge about how organisms capture and convert energy, which can form the basis to: imagine, invent, and deploy novel energy systems; explore alternative energy sources and technologies that can sustain a high quality of life on Earth; and investigate novel pathways for human energy futures built on a comprehensive understanding of risks and stressors related to environmental, biospheric, and societal responses associated with new energy pathways. Funding is split between MCB, IOS, EF, and DBI for this priority in FY 2012.
- BIO supports the CAREER program, an Administration priority. BIO's CAREER awards support young investigators who exemplify the role of teacher-scholars through outstanding research, excellent education, and the integration of education and research within the context of the mission of their organizations.
- In FY 2012, BIO will support the BioMaPS program, which seeks to integrate research at the intersections of the biological, mathematical and physical sciences, and engineering in order to discover, understand, and harness new knowledge to improve the human condition and our ability to adapt to a changing world. Research foci include discovering new physical, chemical, and mathematical principles driven by biological interactions; applying chemical and engineering principals to design and construct novel molecular and cellular systems for more efficient computational devices, complex circuits and networks, and new biomaterials; and developing novel nano-scale technologies that sense, collect, measure, and analyze information in real time. Enhanced support spans all BIO divisions.
- In FY 2012, BIO will support NSF's advanced manufacturing activities through funding in IOS, MCB, and EF. A portion of the new investment will be through BioMaPS. These interdisciplinary efforts will result in accelerated understanding of biological systems, leading to innovations in manufacturing in areas such as bio-based materials and bio-inspired sensors.
- BIO's funding for the new NSF-wide investment, Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21), will support each of the new programmatic components of CIF21: data enabled science, community research networks, new computational infrastructure, and access and connections to cyberinfrastructure facilities. FY 2012 funding will be split between EF and DBI.

## Summary and Funding Profile

BIO supports investment in research and education as well as research infrastructure through support for centers and research resources such as databases and collections. BIO supports one major facility, the National Ecological Observatory Network (NEON), which begins construction in FY 2011; operations will commence late in FY 2012.

In FY 2012, the number of research grant proposals is expected to increase by approximately 20 percent compared to FY 2010 Enacted. BIO expects to award approximately 1,130 research grants in FY 2012. Average annualized award size will increase to reflect increasing costs of research, while duration will be held level with the FY 2010 Enacted.

In FY 2012, funding for Centers represents 5.3 percent of the BIO portfolio. Centers funding will increase with both the establishment in FY 2010 of a new Science and Technology Center (STC), the Bio/computational Evolution in Action Consortium, also known as the BEACON Center for the Study of Evolution, as well as increased support for a new environmental synthesis center to be established in FY 2011.

Funding for facilities, including initiating support for the maintenance and operations of NEON, represents 3.1 percent of the BIO portfolio in FY 2012.

### BIO Funding Profile

	FY 2010 Actual Estimate	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Estimate
<b>Statistics for Competitive Awards:</b>			
Number of Proposals	8,060	7,150	8,580
Number of New Awards	1,557	1,370	1,557
Regular Appropriation	1,477	1,370	1,557
ARRA	80		
Funding Rate	19%	19%	18%
<b>Statistics for Research Grants:</b>			
Number of Research Grant Proposals	6,690	6,080	7,359
Number of Research Grants	1,130	930	1,130
Regular Appropriation	1,129	930	1,130
ARRA	1		
Funding Rate	17%	15%	15%
Median Annualized Award Size	\$171,723	\$165,500	\$192,330
Average Annualized Award Size	\$221,637	\$206,500	\$248,233
Average Award Duration, in years	3.1	3.1	3.1

**BIO Funding for Centers Programs and Facilities**

**BIO Funding for Centers Programs**  
(Dollars in Millions)

	FY 2010	FY 2010	FY 2012 Request	Change Over	
	Omnibus Actual	Enacted/ Annualized FY 2011 CR		FY 2010 Enacted Amount	Percent
<b>Centers Programs</b>	\$33.63	\$33.62	\$41.71	\$8.09	24.1%
<i>Centers for Analysis &amp; Synthesis</i>	22.52	22.52	25.61	3.09	13.7%
<i>Nano Centers</i>	5.11	5.10	5.10	-	-
<i>Science &amp; Technology Centers</i>	4.00	4.00	9.00	5.00	125.0%
<i>Science of Learning Centers</i>	2.00	2.00	2.00	-	-

No FY 2010 obligations for centers were made with funds provided by the ARRA.

Detailed information on individual centers can be found in the NSF-Wide Investments chapter.

**Centers Programs**

- Funding for the Centers for Analysis and Synthesis increases by \$3.09 million over the FY 2010 Enacted level, to a total of \$25.61 million. The program will support four centers in FY 2012, two of which are supported jointly with the Directorate for Mathematical and Physical Sciences (MPS). The increased support includes annual increments and a planned ramp up for the new environmental synthesis center that will be established in FY 2011.
- In addition to the Science and Technology Center for Microbial Oceanography: Research and Education (C-MORE), BIO will support the BEACON Center for the Study of Evolution in Action. BEACON is a consortium of universities led by Michigan State University, with partner institutions of North Carolina A&T State University, the University of Idaho, the University of Texas at Austin, and the University of Washington. BEACON’s mission is to illuminate the power of evolution in action to advance science and technology, benefit society, and unite biologists, computer scientists, and engineers in joint study.

**BIO Funding for Facilities**  
(Dollars in Millions)

	FY 2010	FY 2010	FY 2012 Request	Change Over	
	Omnibus Actual	Enacted/ Annualized FY 2011 CR		FY 2010 Enacted Amount	Percent
<b>Facilities</b>	\$34.71	\$25.80	\$23.28	-\$2.52	-9.8%
<i>Nanofabrication (NNIN)</i>	0.35	0.35	0.35	-	-
<i>National Ecological Observatory Network (NEON)</i>	34.36	25.45	22.93	-\$2.52	-9.9%

No FY 2010 obligations for facilities were made with funds provided by the ARRA.

For detailed information on individual facilities, please see the Facilities chapter.

**Facilities**

- Construction on NEON begins in FY 2011, with funding from the Major Research Equipment and Facilities (MREFC) account. In FY 2012, NEON operations will begin for the first NEON domain, the calibration and validation laboratory, and the data center.

**Program Evaluation and Performance Improvement**

The Performance Information 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.

In FY 2010, BIO held two COVs: one for DBI, and one for the Plant Genome Research Program within IOS. In FY 2011, BIO will hold COV reviews for IOS and MCB. All BIO divisions are responding to and implementing recommendations from recent COVs. The BIO Advisory Committee (BIO AC) met twice in 2010, in April and October. The second meeting was held at NEON headquarters in Boulder, CO, and included a site review of facilities and discussions with scientific staff. FY 2012 COVs are planned for DEB and EF.

A recent workshop and two recently released reports have been of interest with respect to programmatic portfolio development. The workshop, held on January 6 and 7, 2011, “Research Frontiers in Bioinspired Energy: Molecular-level Learning from Natural Systems,” was sponsored by NSF and the Department of Energy (DOE), and was jointly organized by the National Academies of Science (NAS) Boards on Life Sciences and Chemical Sciences and Technology. Its focus was to explore the molecular-level frontiers of energy processes in nature. BIO’s senior management is reviewing the recommendations from the Presidential Commission for the Study of Bioethics report, *NEW DIRECTIONS: The Ethics of Synthetic Biology and Emerging Technologies*, as well as the NAS workshop report, *Implementing the New Biology: Decadal Challenges Linking Food, Energy, and the Environment*. These reports will also be evaluated at the spring 2011 BIO AC meeting for potential implementation of recommendations and incorporation into future fiscal year program planning. In addition, the 2010 NAS report, *Research at the Intersection of the Physical and Life Science*, has informed the development of the BioMaPS program in FY 2012.

In FY 2010, BIO initiated a Science and Technology Policy Institute (STPI) study to assess the scientific, technological, economic and societal impacts of NSF/BIO’s investments in plant biology research. Final results from this study are expected during FY 2011.

**Number of People Involved in BIO Activities**

	FY 2010 Actual Estimate	FY 2010 ARRA Estimate	FY 2010 Enacted/ Annualized FY 2011 CR Estimate	FY 2012 Estimate
Senior Researchers	5,791	452	4,547	4,530
Other Professionals	1,727	60	1,838	1,830
Postdoctorates	1,474	4	1,561	1,550
Graduate Students	2,947	9	3,123	3,330
Undergraduate Students	4,641	38	3,995	4,290
<b>Total Number of People</b>	<b>16,580</b>	<b>563</b>	<b>15,064</b>	<b>15,530</b>



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

**\$145,720,000  
+\$20,130,000 / 16.0%**

**MCB Funding**  
(Dollars in Millions)

	FY 2010		FY 2012 Request	Change Over	
	FY 2010 Omnibus Actual	Enacted/ Annualized FY 2011 CR		FY 2010 Enacted Amount	Percent
	<b>MCB Funding</b>	<b>\$125.90</b>		<b>\$125.59</b>	<b>\$145.72</b>
<b>Research</b>	<b>124.78</b>	<b>124.89</b>	<b>145.02</b>	<b>20.13</b>	<b>16.1%</b>
<i>CAREER</i>	14.12	14.06	15.86	1.80	12.8%
<b>Education</b>	<b>1.12</b>	<b>0.70</b>	<b>0.70</b>	-	-

MCB supports fundamental research and educational activities that promote understanding of complex living systems at the molecular, subcellular, and cellular levels. Research supported by MCB typically combines integrated theoretical and experimental approaches with technologies derived from biological, physical, mathematical, computational, and engineering sciences. Projects are particularly encouraged in emerging areas such as single molecule or single cell studies, RNA biology, and synthetic biology. The MCB research portfolio also emphasizes projects aimed at understanding and predicting the molecular and cellular foundation of adaptation to environmental change. MCB continues to forge partnerships to support research that intersects biology and fields such as physical sciences and engineering, to introduce new analytical and conceptual tools for biological research, and to provide unique education and training opportunities for the next generation of researchers, scientific educators, and scientifically literate citizens.

In general, 44 percent of the MCB portfolio is available for new research grants. The remaining 56 percent funds continuing grants made in previous years.

**FY 2012 Summary**

**Research**

- Maintaining the health of its disciplinary knowledge base is one of BIO's top priorities, which is reflected in requested increases for all divisions. Increased support for basic biological research will yield insights that can be used to produce the next generation of nano-, bio-, and information technologies (+\$2.87 million to a total of \$144.60 million).
  - The blueprint for the form and function of an organism lies in its DNA and in the way that DNA is expressed as it interacts with its environment. MCB will support research to link the distinctive properties of organisms – from form to physiology to behavior – to the selective expression of their genetic information.
  - As with all BIO divisions, MCB will support BioMaPS in partnership with the Engineering and Mathematical and Physical Sciences Directorates (+\$5.40 million to a total of \$5.40 million).
- MCB will contribute \$5.0 million to advanced manufacturing research via BioMaPS and the National Nanotechnology Initiative by supporting fundamental research on the components and processes that comprise and control biological systems at the nano to cellular scales.
  - Synthetic Biology employs an unconventional approach to understanding living systems by using chemical and engineering principles to design and construct (or reconstruct) functional molecular and cellular systems. MCB will encourage support of interdisciplinary research

- employing Synthetic Biology approaches to advance our understanding of living systems and to enhance the quality of life on Earth.
- MCB will also contribute \$5.0 million to clean energy research through the BioMaPS and SEES activities to support research on novel processes used by living organisms to capture and transduce energy.
    - MCB will prioritize research of societal importance, particularly related to energy, environment, and the diversity of life on Earth. Fundamental knowledge about how organisms capture and convert energy will help us develop sources of clean energy. For example, research funded by MCB has provided the basis for engineering of a nanoscale biocatalyst that uses light energy to generate hydrogen, a clean energy source. In addition, understanding the molecular and cellular basis for the adaptation of organisms to their environment is essential to understanding the central role of the diversity of life on Earth in adapting to or bringing about environmental change.
  - MCB will increase support for CAREER (+\$1.80 million to a total of \$15.92 million) in accordance with Administration priorities.

**Education**

- All BIO divisions include support for Research Experiences for Teachers (RET) and Research Experiences for Undergraduates (REU) activities.

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

**\$231,650,000**  
**+\$15,400,000 / 7.1%**

**IOS Funding**

(Dollars in Millions)

	FY 2010		FY 2012 Request	Change Over FY 2010 Enacted	
	FY 2010 Omnibus Actual	Enacted/ Annualized FY 2011 CR		Amount	Percent
<b>IOS Funding</b>	<b>\$216.32</b>	<b>\$216.25</b>	<b>\$231.65</b>	<b>\$15.40</b>	<b>7.1%</b>
<b>Research</b>	<b>172.04</b>	<b>170.25</b>	<b>185.65</b>	<b>15.40</b>	<b>9.0%</b>
<i>CAREER</i>	7.83	7.00	8.00	1.00	14.3%
<b>Education</b>	<b>8.81</b>	<b>6.00</b>	<b>6.00</b>	-	-
<b>Infrastructure</b>	<b>35.47</b>	<b>40.00</b>	<b>40.00</b>	-	-

IOS supports research and education aimed at understanding the diversity of plants, animals, and microorganisms as complex systems interacting with their environments. Reaching a systems level understanding of organisms will require a new emphasis on interdisciplinary approaches and development of new tools. These approaches span computational, molecular, cellular, individual organism and population levels of inquiry. Many activities supported by IOS focus on biological processes that affect organismal development, structure, performance, and interactions under varying environmental conditions. IOS-supported research focuses on investigating organismal performance in an environmental context, which is significant for understanding reciprocal interactions between living systems and the environment.

The activities of the Plant Genome Research Program (PGRP) support genome-scale research to accelerate discoveries about basic plant biology as well as downstream applications of potential societal benefit such as crop improvement, development of new sources of bio-based energy, development of sources of novel bio-based materials, and adaptation to global climate variability.

The Basic Research to Enable Agricultural Development (BREAD) Program will continue support for basic research to test innovative, early-concept approaches and technologies for sustainable, science-based solution to problems of agriculture in developing countries. BREAD in FY 2012 is supported by NSF (\$6.0 million) and the Bill & Melinda Gates Foundation (\$6.0 million) through funding provided to NSF.

In general, 55 percent of the IOS portfolio is available for new research grants. The remaining 45 percent funds continuing grants made in previous years.

**FY 2012 Summary**

**Research**

- Maintaining the health of its disciplinary knowledge base is one of BIO's top priorities, which is reflected in requested increases for all divisions. In IOS (+\$4.95 million to a total of \$185.95 million) there is an emphasis on cross-disciplinary, integrated approaches, from the genome to the organism, to understanding complex living systems, especially as they interact with, and adapt to, a changing environment. Enabling research at the interfaces of organismal biology, environmental biology, and molecular and cellular biology, to address major questions in organismal biology and climate science, will be a priority. These studies are expected to extend the understanding of organismal structure and

function at all scales, from the individual to populations. For example, research funded by IOS has shown that tree resins collected by honey bees to fight microbes in the hive aids their immune systems. Local differences in the availability of resin producing trees and genetic behavioral differences in how much resin is collected provide insight into the interaction between these economically important pollinators and their environment at multiple scales.

- New genomic technologies and computational tools are critical to gaining a mechanistic understanding of such diverse processes as plant development and animal development from elaboration of the nervous system to behavior processes. IOS will support development of critical tools and resources to enable a systems-level understanding of these processes.
- IOS will continue to support basic research with the potential to yield societal benefits, in such areas as bio-inspired materials, industrial raw materials and new sources of energy. Ongoing genome-scale research within PGRP and BREAD will continue to accelerate basic discoveries with potential downstream applications.
- IOS will support BioMaPS, especially in areas relevant to bio-inspired design (+\$4.39 million to a total of \$4.39 million in IOS).
- IOS will contribute \$5.0 million to clean energy research through BioMaPS and SEES to support research on novel energy capture and transduction systems.
- Responding to the national priority of supporting young investigators, IOS support for CAREER increases (+\$1.0 million to a total of \$8.00 million).

### **Education**

- All BIO divisions include support for Research Experiences for Teachers (RET) and Research Experiences for Undergraduates (REU) activities.

### **Infrastructure**

- Within infrastructure, the IOS Request includes investments in research resources essential to the plant genome research program.

**DIVISION OF ENVIRONMENTAL BIOLOGY (DEB)**

**\$156,400,000**  
**+\$13,850,000 / 9.7%**

**DEB Funding**  
(Dollars in Millions)

	FY 2010		FY 2012 Request	Change Over	
	FY 2010 Omnibus Actual	Enacted/ Annualized FY 2011 CR		FY 2010 Enacted Amount	Percent
	<b>DEB Funding</b>	<b>\$142.50</b>		<b>\$142.55</b>	<b>\$156.40</b>
<b>Research</b>	<b>139.15</b>	<b>140.55</b>	<b>154.40</b>	<b>13.85</b>	<b>9.9%</b>
<i>CAREER</i>	4.92	4.50	5.14	0.64	14.2%
<b>Education</b>	<b>3.35</b>	<b>2.00</b>	<b>2.00</b>	-	-

DEB supports catalytic and transformative research to inventory life on earth, to discover life’s origins and evolutionary history, and to understand the dynamics of ecological systems. Ecological systems, in turn, provide goods and services upon which human health and welfare depend (e.g., breathable air, potable water, food and fiber, crop pollination, disease control). Long-term DEB research is critical to understanding the feedbacks between natural and human systems. Scientific foci in DEB address the process of evolution; describe the genealogical relationships of all life; elucidate the spatial and temporal interactions of species interactions that lead functional communities; and determine the flux of energy and materials through ecosystems. This theoretical and empirical research in ecology, evolution, and the diversity of life is enhanced by dynamic interactions with the fields of genomics, computer science, and mathematics.

In general, 51 percent of the DEB portfolio is available for new research grants. The remaining 49 percent funds continuing grants made in previous years.

**FY 2012 Summary**

**Research**

- Maintaining the health of its disciplinary knowledge base is one of BIO’s top priorities, which is reflected in requested increases for all divisions. Support increases in DEB (+\$3.26 million to a total of \$153.05 million) for fundamental research on ecological and evolutionary patterns and processes at all spatial and temporal scales in the context of climate science and other environmental factors.
- BioMaPS (+\$3.39 million to a total of \$3.39 million) supports interdisciplinary research at the intersection of the life and physical sciences, such as theories underlying the interactions at various levels of biological organization, from gene to population to ecosystem.
- Funding for SEES (+\$5.0 million to a total of \$5.0 million) supports the Dimensions of Biodiversity program and the Dynamics of Coupled Natural and Human Systems.
  - The Dimensions of Biodiversity program will use integrative, innovative approaches to transform how we describe and understand the role and scope of life on Earth. Previous research funded by DEB has demonstrated that species losses in ecosystems due to fragmentation of natural habitats can result in increases in the transmission of infectious diseases such as West Nile virus, Lyme disease, and Hantavirus. Supporting studies to elucidate the functional role of biological diversity, a major knowledge gap, is a central focus of the Dimensions program.
- Responding to the national priority of supporting young investigators, DEB support for CAREER increases (+\$640,000 to a total of \$5.14 million).

- DEB supports research for which long-term data are critical to address some of our most pressing environmental challenges. Increased support for the Long Term Ecological Research (LTER) program will cover planned annual increments for LTER sites (+\$1.5 million to a total of \$23.11 million).

**Education**

- All BIO divisions include support for Research Experiences for Teachers (RET) and Research Experiences for Undergraduates (REU) activities.

**DIVISION OF BIOLOGICAL INFRASTRUCTURE (DBI)**

**\$135,950,000**  
**+\$9,090,000 / 7.2%**

**DBI Funding**  
(Dollars in Millions)

	FY 2010		FY 2010	FY 2012	Change Over	
	Omnibus Actual	ARRA Actual	Enacted/ Annualized FY 2011 CR		FY 2010	Enacted
				Request	Amount	Percent
<b>DBI Funding</b>	<b>\$127.19</b>	<b>\$0.35</b>	<b>\$126.86</b>	<b>\$135.95</b>	<b>\$9.09</b>	<b>7.2%</b>
<b>Research</b>	<b>41.68</b>		<b>40.80</b>	<b>58.35</b>	<b>17.55</b>	<b>43.0%</b>
<i>CAREER</i>	3.72	-	3.50	4.01	0.51	14.6%
<i>Centers Funding (total)</i>	33.63	-	33.62	41.71	8.09	24.1%
<i>Natl. Ctr for Ecol. Analysis &amp; Synthesis</i>	3.70	-			-	N/A
<i>Natl. Environmental Synthesis Center</i>		-	3.70	6.00	2.30	62.2%
<i>Natl. Evolutionary Synthesis Center</i>	5.50	-	5.50	5.35	-0.15	-2.7%
<i>Natl. Institute for Math and Bio Synthesis</i>	2.35	-	2.35	2.35	-	-
<i>iPlant</i>	10.97	-	10.97	11.91	0.94	8.6%
<i>Cntrs. for Enviro. Implications of Nanotech.</i>	5.11	-	5.10	5.10	-	-
<i>STC: Microbial Oceanography: Res. &amp; Ed.</i>	4.00	-	4.00	4.00	-	-
<i>STC: BEACON</i>		-		5.00	5.00	N/A
<i>SLC: Temporal Dynamics of Learning</i>	2.00	-	2.00	2.00	-	-
<b>Education</b>	<b>27.77</b>	<b>0.35</b>	<b>26.06</b>	<b>17.60</b>	<b>-8.46</b>	<b>-32.5%</b>
<b>Infrastructure</b>	<b>57.74</b>		<b>60.00</b>	<b>60.00</b>		
<i>NNIN</i>	0.35	-	0.35	0.35	-	-
<i>Research Resources</i>	57.39	-	56.75	56.75	-	-

DBI empowers biological discovery by supporting the development and enhancement of biological research resources, human capital, and centers. In particular, DBI supports the development of, or improvements to, research infrastructure, including instruments, software, and databases; and the improvements to biological research collections, living stock collections, and field stations and marine labs. In addition, DBI funds the development of human capital through support of undergraduate, graduate, and postdoctoral research experiences. Support of center and center-like activities creates opportunities to address targeted but deep biological questions that have major societal impact.

DBI supports research resources that include the development of research tools, acquisition of instrumentation, and infrastructure improvements; human resource activities; and centers. Approximately 45 percent of the DBI budget is available for new awards each year, with approximately 36 percent available for new research grants. Approximately 30 percent supports Centers, while the remainder is distributed through grants for various DBI and BIO priorities and continuing funds for grants made in previous years.

**FY 2012 Summary**

**Research**

- DBI will support BioMaPS (+\$4.39 million to a total of \$4.39 million), focusing on areas such as bio-inspired information technologies and nano-scale bio-sensors.

- BIO will be actively involved in all aspects of the new CIF21 investment, as its components are important to advancement across all of the biological sciences. Support will focus on Data-Enabled Science, but will also be directed to Community Research Networks and Access and Connections to Cyberinfrastructure Facilities (+\$3.0 million to a total of \$3.0 million).
- CAREER funding in DBI increases by \$510,000 to a total of \$4.01 million in FY 2012. This increase is consistent with DBI's emphasis on supporting early career researchers.
- The Research Improvement Grants (RIG) program will end in DBI (-\$2.0 million), as the program did not receive the increased numbers of proposals from underrepresented groups, as was intended. RIG will be absorbed and supported across the other BIO divisions.
- DBI contributes \$5.0 million to clean energy research through support for SEES Sustainability Research Networks to link together networks of researchers exploring the intersection of environmental-energy and economic understanding needed for long term sustainability.

### **Centers**

- As planned, FY 2010 was the final year of funding for the National Center for Ecological Analysis and Synthesis. Support for the new environmental synthesis center that will be established in FY 2011 increases to a total of \$6.0 million in FY 2012. The center will stimulate research, education, and outreach at the interface of the biological, geological, and social sciences, and foster synthetic, collaborative, cross-disciplinary efforts.
- Small adjustments are provided for the National Evolutionary Synthesis Center (-\$150,000 to a total of \$5.35 million) and iPlant (+\$940,000 to a total of \$11.91 million) as part of existing cooperative agreement annual increments.
- BIO will initiate support (+\$5.0 million) for a new STC, the BEACON Center for the Study of Evolution in Action. BEACON unites biologists, computer scientists and engineers in joint study.

### **Education**

- Support for a number of BIO programs, Undergraduate Research Mentoring (URM) and Interdisciplinary Training for Undergraduates in Biological and Mathematical Sciences (UBM) will be eliminated (-\$4.10 million), and support is decreased for IGERT (-\$3.25 million to a total of \$3.25 million). Funding from these reductions will be used to support new biology undergraduate education activities resulting from the recommendations of the "Vision and Change: A Call to Action" conference and report: [http://visionandchange.org/files/2010/03/VC\\_report.pdf](http://visionandchange.org/files/2010/03/VC_report.pdf). In addition, some new activities will be developed by partnering with the Education and Human Resources Directorate (EHR) on new pilot programs aimed at improving undergraduate STEM education.
- ADVANCE increases (+\$70,000 to a total of \$2.57 million) in accordance with NSF priorities.

### **Infrastructure**

- DBI investments in infrastructure further advances in all areas of biological research as well as databases, resources, and tools for the entire biology community. For example, historically the amount of animal vocalization and associated species data has been limited, due to the enormous human effort and cost required for field collecting. DBI has funded the development of permanent and portable recording devices and accompanying software to automate species identification, which has made major contributions to the spatial and temporal coverage of animal biodiversity data. These technological advances have allowed for improved collection of biodiversity data that is aiding land managers in assessing ecosystem health and making informed conservation decisions.

**DIVISION OF EMERGING FRONTIERS (EF)**

**\$124,770,000**  
**+\$21,480,000 / 20.8%**

**EF Funding**  
(Dollars in Millions)

	FY 2010		FY 2012 Request	Change Over	
	FY 2010 Omnibus Actual	FY 2010 Enacted/ Annualized FY 2011 CR		FY 2010 Enacted	Percent
<b>EF Funding</b>	<b>\$102.85</b>	<b>\$103.29</b>	<b>\$124.77</b>	<b>\$21.48</b>	<b>20.8%</b>
<b>Research</b>	<b>58.52</b>	<b>66.94</b>	<b>76.94</b>	<b>10.00</b>	<b>14.9%</b>
<b>Education</b>	<b>9.97</b>	<b>10.90</b>	<b>14.90</b>	<b>4.00</b>	<b>36.7%</b>
<b>Infrastructure</b>	<b>34.36</b>	<b>35.45</b>	<b>32.93</b>	<b>-2.52</b>	<b>-7.1%</b>
<i>NEON</i>	<i>34.36</i>	<i>25.45</i>	<i>22.93</i>	<i>-2.52</i>	<i>-9.9%</i>

EF identifies, incubates, and supports infrastructure and research areas that transcend scientific disciplines and/or advance the conceptual foundations of biology. For example, research supported by EF found that cockroaches scrambling over rough terrain do not change the neural signals to their leg muscles; instead, control is built into the mechanics of their legs that requires no active adjustments from a brain. This ability to self-stabilize like an extraordinary passive suspension system was predicted by project mathematicians and built into a robot to improve maneuverability. Using a novel model approach, this research team “rewrote” the neural code from the spinal cord to the leg muscles in running cockroaches to tease apart the complex neural and muscular networks, information which was used to revise the mathematical models that were applied to the robot. This fundamental research to understand how animals control legged locomotion is advancing the design of the first search-and-rescue robot that has performance truly comparable to animals.

Typically, developing programs and priority areas begin in EF and then shift to other BIO divisions to become part of the disciplinary knowledge base. Examples include the Assembling the Tree of Life and Ecology of Infectious Diseases programs. Supporting biological research that crosses scales of organization and involves multiple disciplines continues to be a high priority, and is particularly relevant for research questions related to global change. EF also facilitates the development and implementation of new forms of merit review and mechanisms to support transformative research and stimulate creativity. These goals are accomplished by promoting cultural change within and across scientific disciplines to increase and strengthen multidisciplinary collaborations, encourage curiosity and exploration through novel mechanisms and investments, and facilitate support of research areas relevant to all of biology by targeted co-funding throughout the directorate.

In general, 90 percent of the EF portfolio is available for new research grants. The remaining 10 percent funds continuing grants made in previous years.

**FY 2012 Summary**

**Research**

- The Advancing Theory in Biology program (-\$5.0 million) and the Life in Transition focus (-\$10.0 million), after development and growth in EF, now shift to be supported as a mainstream activity across all other BIO divisions.
- The CDI program will end in BIO (-\$1.0 million) as support refocuses on CIF21.
- Investment increases include:

- Active involvement in all aspects of the new CIF21 emphasis, as components are important to advancement across all of the biological sciences. Support will focus on Data-Enabled Science, but will also be directed to Community Research Networks and Access and Connections to Cyberinfrastructure Facilities (+\$3.0 million to a total of \$3.0 million)
- EF will support SEES (+\$5.0 million to a total of \$5.0 million) through sustainability research networks and the Dimensions of Biodiversity program, which is designed to provide an enhanced and integrated understanding of the key natural variation and function of life on Earth, across genetic, taxonomic, and functional dimensions.
- Continued funding (\$10.0 million total) will be provided for an activity in support of digitization of scientific information associated with biological specimens held in U.S. research collections. This program was begun in FY 2009 with funding from ARRA. A strategic plan developed by the community and released in FY 2010 will guide investments in FY 2012.
- Continued support of research activities relevant to NEON, including macrosystems biology, as construction continues on NEON.
- EF contributes \$5.0 million to clean energy research via BioMaPS, by supporting research on novel processes used by living organisms to capture and transduce energy.
- EF contributes \$10.0 million to advanced manufacturing research via BioMaPS, by supporting research that aims to understand the components and processes that comprise and control biological systems from the nano to cellular scales.

#### **Education**

- In FY 2012, BIO is focusing on support for new biology undergraduate education activities, including selected Transforming Undergraduate Biology Education (TUBE) activities with well-developed metrics (+\$4.0 million to a total of \$14.90 million). This is based on the recommendations of the 2009 “Vision and Change: A Call to Action” conference and report ([http://visionandchange.org/files/2010/03/VC\\_report.pdf](http://visionandchange.org/files/2010/03/VC_report.pdf)). In addition, some new activities will be developed, including partnering with EHR on new pilot programs aimed at improving undergraduate STEM education.

#### **Infrastructure**

- In FY 2012, management and operations funding for NEON will commence, assuming a construction start by July 2011. The request for \$22.93 million will enable operations of the first two domains constructed, including related management and technical support, seasonal biological sampling, and domain facility costs. Project planning costs conclude as the NEON project transitions into construction and operations.