

DIRECTORATE FOR BIOLOGICAL SCIENCES (BIO)

\$767,810,000
+\$53,270,000 / 7.5%

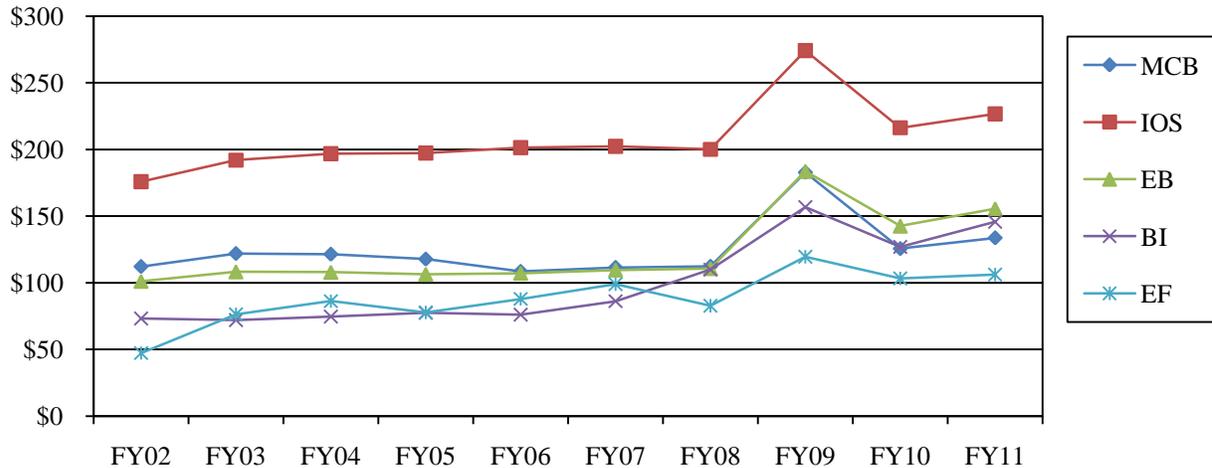
BIO Funding
(Dollars in Millions)

	FY 2009	FY 2009	FY 2010	FY 2011	Change Over	
	Omnibus	ARRA			FY 2010 Estimate	FY 2011 Request
	Actual	Actual	Estimate	Request	Amount	Percent
Molecular & Cellular Biosciences (MCB)	\$121.28	\$61.53	\$125.59	\$133.69	\$8.10	6.4%
Integrative Organismal Systems (IOS)	212.34	61.71	216.25	226.70	10.45	4.8%
Environmental Biology (DEB)	120.37	63.23	142.55	155.59	13.04	9.1%
Biological Infrastructure (DBI)	117.95	38.74	126.86	145.63	18.77	14.8%
Emerging Frontiers (EF)	84.68	34.80	103.29	106.20	2.91	2.8%
Total, BIO	\$656.62	\$260.00	\$714.54	\$767.81	\$53.27	7.5%
Research	502.57	230.56	520.64	577.84	57.20	11.0%
Education	36.01	18.45	45.66	52.45	6.79	14.9%
Infrastructure	107.20	10.99	135.45	123.23	-12.22	-9.0%
Stewardship	10.84	-	12.79	14.29	1.50	11.7%

Totals may not add due to rounding.

The mission of BIO is to enable discoveries for understanding life. Through its 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 theoretical basis for advancing the growing body of research being done by other science and engineering fields that involves applying biological principles or employing biological systems or processes.

BIO Subactivity Funding
(Dollars in Millions)



BIO in Context

BIO provides about 68 percent of federal funding for non-medical, basic research at academic institutions in the life sciences including environmental biology, a critical research area needed to answer questions related to climate change. 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 non-living systems. Research supported by BIO enhances this understanding. As the physical, computational, mathematical, and engineering fields increasingly use living systems to address major questions in their areas, 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 change science, biotechnology and bioengineering. BIO supported research has been responsible for a wide range of critical breakthroughs essential to the Nation's prosperity, economic competitiveness, and quality of life. 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 is working to make this 3.5 billion years of biological innovation available to inform the next generation of nano-, bio-, and information technologies. BIO's investments focus on understanding the changing dynamics of the biosphere, research on the fundamental characteristics of biological energy systems, and efforts to enhance education and broaden participation. An example is the Basic Research to Enable Agricultural Development (BREAD) program begun in partnership with the Bill and Melinda Gates Foundation. This program supports basic research to test innovative hypotheses and novel approaches and technologies for sustainable, science-based solutions to problems of agriculture in developing countries.

To identify new opportunities and challenges for transformative research, the directorate supports numerous workshops, conferences, and projects each year. In addition, other reports, workshops, and conferences influence the direction of science supported within the biological sciences as well as the development of new programs and activities. Examples of these are:

- Reports by the National Research Council of the National Academies:
 - *Restructuring Federal Climate Research to Meet the Challenges of Climate Change (2009)*;
 - *A New Biology for the 21st Century: Ensuring the United States Leads the Coming Biology Revolution (2009)*; and
 - *Research at the Intersection of the Physical and Life Sciences (2009)*.
- *Transitions and Tipping Points in Complex Environmental Systems (2009)*, a report by the NSF Advisory Committee for Environmental Research and Education.
- *National Plant Genome Initiative: 2009 – 2013 (2009)*, National Science and Technology Council (NSTC), Committee on Science, Interagency Working Group on Plant Genomes.
- *Preliminary Findings from the NSF Survey of Object-Based Scientific Collections (December 2008)*, Science and Technology Policy Institute (STPI).
- *Scientific Collections: Mission-Critical Infrastructure for Federal Science Agencies (2009)*, NSTC, Committee on Science, Interagency Working Group on Scientific Collections.
- Workshops such as:
 - *Future Directions in Biodiversity and Systematics Research (3 workshops): May, September, and October 2009*;
 - *Enabling Biodiversity Research: The Roles of Information and Support Networks: December 2009*;
 - *Conference on Water-Ecosystem Services, Drought and Environmental Justice: November 2009*;
 - *Tools for 21st Century Biology: March 2009*;
 - *Opportunities and Challenges in the Emerging Field of Synthetic Biology: July 2009*;
 - *Exploring Science Needs for Predicting Organismal Responses to Rapid Directional Environmental Change: November 2008*; and
 - *Variable Atmosphere Laboratory (VAL): Extremely Large-scale "Growth Chambers" for Physiological Studies: August 2009*.

Factors Influencing the Allocation Across Divisions and Major Programs

Sustaining core funding, implementing Administration priorities such as climate change research, supporting cutting edge transformative research, developing new scientific areas, and broader support for students and new faculty are the principal factors that influence allocations across divisions.

Specific factors include:

- Developing new scientific areas and implementing Administration priorities – new emphases are reflected in FY 2011 allocations across divisions.
 - Science, Engineering, and Education for Sustainability (SEES): +\$5.0 million (to a total of \$126.0 million) to increase efforts in integrating NSF’s climate and energy science. Activities to receive enhanced funding in FY 2011 include Coupled Natural and Human Systems and support for a new center for environmental synthesis. Activities begun in FY 2010 as part of the climate research investment (Ocean Acidification, Water, Modeling, and Dimensions of Biodiversity) will continue. Increased support for SEES is focused in the Division of Environmental Biology (DEB); other climate research activities are supported across all divisions.
 - U.S. Global Change Research Program (+\$8.0 million, to a total of \$89.0 million): BIO will increase support for core research to ensure support for a broad research portfolio related to climate change and the biological drivers of change.
 - Bio-economy: \$20.0 million total to leverage core investments in the biological sciences in order to acquire knowledge that can contribute to new or improved products and services for the “bio-economy” – e.g. the discovery, development and use of biological products and processes that boost productivity of agriculture and industrial processes. Support will be focused within the Molecular and Cellular Biosciences (MCB) and Integrative Organismal Systems (IOS) divisions.
 - Intersection of the Biological Sciences and Physical Sciences: Two recent reports from the National Academies of Science highlighted exciting research opportunities at the intersection of the biological and physical sciences (*Research at the Intersection of the Physical and Life Sciences* and *A New Biology for the 21st Century: Ensuring the United States Leads the Coming Biology Revolution*). BIO will invest \$5.6 million total to work in partnership with the Directorate for Mathematical and Physical Sciences (MPS) to identify and support potentially transformative research projects that explore this interdisciplinary interface. Support is focused across all BIO divisions.
- Cyber-enabled Discovery & Innovation: +\$2.0 million (to a total of \$3.0 million) to increase investment in the existing program. The Division of Biological Infrastructure (DBI) will increase support for Cyber-enabled Discovery and Innovation (CDI) to enable revolutionary biological discoveries through the innovative use of advances in computational concepts, methods, models, algorithms, and tools. Investments will be focused on multidisciplinary activities that, through computational thinking, promise radical, paradigm-changing research findings and on transformative research that leads to productive intellectual partnerships involving U.S. and international investigators from academe, industry and/or other types of organizations. Support is focused in DBI.
- The “Vision and Change” conference emphasized new approaches to transform undergraduate biology education (www.visionandchange.org). An increase of \$5.0 million (to a total of \$15.9 million) is focused in DBI.
 - Beginning in FY 2010, BIO began investment in a new activity to transform undergraduate biology education. New activities will be carefully baselined and assessment metrics developed to allow for evaluation of all new programs. Guided by recommendations stemming from the 2009 “Vision and Change” conference and building on investments initiated in FY 2010, BIO

will increase support for the Research Coordination Networks – Undergraduate Biology Education (RCN-UBE) program, collaborate with Education and Human Resources (EHR) in supporting a new STEM Talent Expansion Program (STEP) Center, and invest in faculty development activities. All new programs will be informed by baselining assessment activities conducted in FY 2010, and appropriately rigorous evaluations will guide program evolution.

- Multiple programs are being reduced within BIO (ADVANCE, IGERT, and GK-12) in order to target investments on these new undergraduate programmatic activities.
- NEON: With the FY 2011 MREFC funding request to begin NEON construction, the project emphasis begins to shift from project planning to construction. New programs such as macrosystems biology and multi-scale modeling will continue to support foundational research activities by the community of potential NEON users. Support is focused in Emerging Frontiers (EF).
- Digitization: A total of \$10.0 million will continue support for efforts to digitize and network U.S. specimen-based research collections. These collections provide proper validation of species including a wealth of ancillary data such as DNA samples and environment/habitat information. These data provide the baseline from which to begin further biodiversity studies and provide critical information about the existing gaps in our knowledge of life on Earth. Filling these gaps is crucial to a complete understanding of the biodiversity of the planet, both in space and time, and the history of climate change. Support is focused in EF.
- Innovation: Support is sustained in all divisions (\$2.0 million in each) and in EF (\$8.0 million to leverage division investments) to allow for a continuing emphasis on innovation, interdisciplinary research, and transformation.

BIO Funding for Centers and Facilities**BIO Funding for Centers and Facilities**

(Dollars in Millions)

	FY 2009	FY 2009	FY 2010	FY 2011	Change Over	
	Omnibus	ARRA			FY 2010 Estimate	FY 2011 Request
	Actual	Actual	Estimate	Request	Amount	Percent
Centers	\$30.83	-	\$33.62	\$34.15	0.53	1.6%
<i>National Center for Ecological Analysis & Synthesis</i>	3.71	-	3.70	-	-3.70	-100.0%
<i>Environmental Synthesis Center</i>	-	-	-	4.00	4.00	N/A
<i>National Evolutionary Synthesis Center</i>	2.55	-	5.50	5.32	-0.18	-3.3%
<i>National Institute for Math & Bio Synthesis</i>	1.85	-	2.35	2.35	-	-
<i>iPlant (formerly Plant Science Cyber Collaborative)</i>	9.11	-	10.97	11.38	0.41	3.7%
<i>Centers for Environmental Implications of Nanotech.</i>	5.10	-	5.10	5.10	-	-
<i>STC: Behavioral Neuroscience</i>	2.51	-	-	-	-	N/A
<i>STC: Microbial Oceanography: Research & Ed.</i>	4.00	-	4.00	4.00	-	-
<i>SLC: Temporal Dynamics of Learning</i>	2.00	-	2.00	2.00	-	-
Facilities	\$13.61	-	\$25.80	\$15.35	-\$10.45	-40.5%
<i>Nanofabrication (NNIN)</i>	0.35	-	0.35	0.35	-	-
<i>National Ecological Observatory Network (NEON)</i>	13.26	-	25.45	15.00	-10.45	-41.1%

Detailed information on individual Centers can be found in the NSF-Wide Investments chapter. For further detail about individual facilities, please see the Facilities chapter.

Centers

- FY 2010 will be the final year of funding for the National Center for Ecological Analysis and Synthesis (NCEAS). However, given the success of NCEAS in demonstrating the value of synthetic approaches in advancing ecology and the role of ecological synthesis in addressing societal issues, support will be provided in FY 2011 for a new environmental synthesis center to stimulate research, education, and outreach at the interface of the biological, geological, and social sciences. This new center will foster synthetic, collaborative, cross-disciplinary efforts to understand the complex interactions among ecological populations, communities and ecosystems, the geophysical environment, and human actions and decisions that underlie global environmental change.
- A small increase is provided for iPlant (formerly Plant Science Cyber Collaborative) as part of the existing cooperative agreement for an annual increment.

Facilities

- BIO requests \$15.0 million to finalize the baseline design of the National Ecological Observatory Network (NEON) prior to beginning construction in late FY 2011. The FY 2011 MREFC request includes funding to begin NEON construction. The Final Design Review (November 2009) determined that NEON was ready to begin construction. Both the preliminary design review (PDR) in June 2009 and the final design review (FDR) in November 2009 included recommendations for finalizing the design. R&RA funds in the FY 2010 current plan and as part of the FY 2011 request will be used to finalize prototyping for the cyberinfrastructure, Fundamental Sentinel Unit (FSU), and Fundamental Instrument Unit (FIU), three major components of the NEON design. The prototyping will be completed early in FY 2011, and remaining FY 2011 funds will support the project team until the beginning of construction. An operations review is scheduled for April 2010. During FY 2010, BIO will document existing intra-agency, inter-agency, and international collaborations and

agreements directly related to NEON, and will develop new collaborations as it coordinates with the other Federal agencies funding relevant ecological observation networks.

BIO Administration Priority Programs and NSF Investments

BIO Administration Priority Programs and NSF Investments

(Dollars in Millions)

	FY 2009	FY 2009	FY 2010 Estimate	FY 2011 Request	Change Over		
	Omnibus	ARRA			FY 2010 Estimate	FY 2010 Estimate	Percent
	Actual	Actual			Amount	Percent	
Faculty Early Career Development (CAREER)	\$24.52	\$38.04	\$29.06	\$31.11	\$2.05	7.1%	
Graduate Research Fellowships (GRF)	-	7.11	-	6.87	6.87	N/A	
Climate Change Education Program (CCE)	-	-	1.50	1.50	-	N/A	
Science, Engineering, and Education for Sustainability (SEES)	N/A	N/A	121.00	126.00	5.00	4.1%	

BIO's FY 2011 budget will continue and expand support in key NSF programs for students, early-career researchers, and the next generation of environmentally engaged scientists and engineers. The budget also encourages potentially transformative research and supports critical priorities in a new investment framework – Science, Engineering, and Education for Sustainability (SEES). The goal of SEES is to integrate NSF's efforts in climate and energy science and engineering research to enable discoveries that can inform societal actions aimed at achieving a sustainable Earth.

In support of Administration priorities and other NSF investments, BIO activities include:

- CAREER: BIO will increase its investment in CAREER by \$2.05 million within MCB, IOS, DBI, and DEB.
- Graduate Research Fellowship program (GRF): BIO will provide new funding totaling \$6.87 million for graduate research fellowships in FY 2011.
- Climate Change Education (CCE): BIO will provide a total of \$1.5 million to support CCE in order to prepare a scientific and technical workforce to engage in climate change and energy R&D; identify approaches to develop more effective instructional materials about climate change; engage the general public with climate change issues; and establish models for teaching and learning. CCE will promote partnerships among K-12 education, higher education, the private sector, and related non-profit organizations, in formal and informal settings, as well as relevant education and/or climate-related policymakers.
- Science, Engineering, and Education for Sustainability (SEES): In FY 2011, BIO will invest \$126.0 million (+\$5.0 million) in the SEES portfolio to integrate efforts in climate and energy science and engineering. BIO will support projects that include modeling the interaction of biological, physical and human systems; fundamental research on living systems to achieve predictive understanding of how they drive and respond to environmental change; environmental observatories and long term projects; and research on sustainable adaptation and mitigation strategies for both natural and human systems in a changing climate.

For more information on Administration priorities and NSF investments, please refer to the Overview and NSF-Wide Investments sections.

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 2009, BIO held two COVs – one in June 2009 for the Division of Environmental Biology and the second in September 2009 for Emerging Frontiers. The Directorate for Biological Sciences Advisory Committee (BIO AC) met twice in FY 2009: April and September 2009.

In FY 2010, BIO COV reviews will take place for the Division of Biological Infrastructure and for the Plant Genome Research Program within the Division of Integrative Organismal Systems. All BIO divisions are responding to and implementing recommendations from recent COVs.

Two reports from the National Academies of Science were recently released: *Research at the Intersection of the Physical and Life Sciences* and *A New Biology for the 21st Century: Ensuring the United States Leads the Coming Biology Revolution*. Report recommendations are under review by directorate senior management and will also be evaluated at the Spring BIO AC meeting for implementation of recommendations and incorporation into future fiscal year program planning.

The “Vision and Change” conference emphasized new approaches to transform undergraduate biology education. The recommendations from that conference provided the basis for new programmatic activities requested in the FY 2010 and FY 2011 budgets. Beginning in FY 2010, baselining activities will occur for all recommended new programs. This will determine the data collection and evaluation methodologies necessary for assessment of the effectiveness for all programs implemented with the FY 2011 request.

Number of People Involved in BIO Activities

	FY 2009 Estimate	FY 2009 ARRA Estimate	FY 2010 Estimate	FY 2011 Estimate
Senior Researchers	4,439	1,538	4,547	4,800
Other Professionals	1,533	490	1,838	1,880
Postdoctorates	1,377	516	1,561	1,670
Graduate Students	2,800	1,812	3,123	3,520
Undergraduate Students	4,067	2,017	3,995	4,290
Total Number of People	14,216	6,373	15,064	16,160

BIO Funding Profile

	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate
Statistics for Competitive Awards:			
Number of Proposals	6,574	7,150	7,690
Number of New Awards	1,823	1,370	1,475
Regular Appropriation	1,261	1,370	1,475
ARRA	562	-	-
Funding Rate	27.7%	19.2%	19.2%
Statistics for Research Grants:			
Number of Research Grant Proposals	5,590	6,080	6,540
Number of Research Grants	1,316	930	1,000
Regular Appropriation	858	930	1,000
ARRA	458	-	-
Funding Rate	23.5%	15.3%	15.3%
Median Annualized Award Size	160,001	165,500	167,000
Average Annualized Award Size	199,695	206,500	208,500
Average Award Duration, in years	3.1	3.1	3.1

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

\$133,690,000
+\$8,100,000 / 6.4%

MCB Funding						
(Dollars in Millions)						
	FY 2009	FY 2009			Change Over	
	Omnibus	ARRA	FY 2010	FY 2011	FY 2010 Estimate	
	Actual	Actual	Estimate	Request	Amount	Percent
MCB	\$121.28	\$61.53	\$125.59	\$133.69	\$8.10	6.4%
Research	121.28	61.53	125.59	133.69	8.10	6.4%

MCB supports fundamental research to understand the dynamics and complexity of living systems at the biochemical, molecular, and cellular level. Priorities include projects that address the organization, function, and regulation of genes and genomes, the structure and properties of biomolecules, supramolecular complexes, and subcellular systems, as well as the genetic and metabolic complexity of living systems. MCB research often integrates theory and experimentation in an iterative way and increasingly utilizes tools and technologies derived from biological, physical, mathematical, computational, and engineering sciences. Genome-wide or metagenomics approaches are encouraged when applied to specific questions of interest to the division.

In general, 40 percent of the MCB portfolio is available for new research grants. The remaining 60 percent funds continuing grants made in previous years.

Factors Influencing the Allocation Across MCB Programs

- Foundational research in molecular and cellular biology that will inspire high impact technologies and the production of novel materials remains a priority. Multidisciplinary studies in many MCB areas have the potential to spawn new, and support emerging, technologies such as synthetic biology, which will promote the development of a vibrant economy based on biologically-based industries of the future (\$8.0 million total in FY 2011).
- MCB will support innovative projects that address the biochemical, molecular, and cellular underpinnings of climate change. Knowledge about adaptation and feedbacks is critical to inform predictions and construct simulation models about the impact of climate change on living organisms. To address one area of this research, MCB will invest in understanding the molecular basis of the biological drivers and effects of ocean acidification.
- MCB will expand knowledge of energy capture and conversion through increased investments in potentially transformative research in these areas. The capture and conversion of solar energy on Earth is largely mediated by photosynthetic organisms, and fundamental information about these processes will inform our ability to provide sustainable sources of energy and food for the future.
- The division will also support molecular studies that take a systems-level approach to understanding the diversity of biological networks, to define, assemble, and characterize the interaction of intracellular components, including genes, proteins, and metabolites. High throughput technologies now allow surveying the components and the systems properties of living organisms at a scale unprecedented in the history of biology. These surveys provide a broad view of the operation of living systems and guidance for focusing on controlling events. Understanding the complexity of molecular systems that provide the basis for organismal properties and responses will be encouraged in the core programs in MCB.

- All BIO divisions will work in partnership with MPS to identify and support potentially transformative research projects that explore the interdisciplinary interface between physical and life sciences (\$5.6 million total in BIO).

DIVISION OF INTEGRATIVE ORGANISMAL SYSTEMS (IOS)

\$226,700,000
+\$10,450,000 / 4.8%

IOS Funding

(Dollars in Millions)

	FY 2009		FY 2010 Estimate	FY 2011 Request	Change Over FY 2010 Estimate	
	Omnibus Actual	ARRA Actual			Amount	Percent
IOS Funding	\$212.34	\$61.71	\$216.25	\$226.70	\$10.45	4.8%
IOS Project Support	111.12	61.71	113.86	121.31	7.45	6.5%
Plant Genome Research Program	101.22	-	102.39	105.39	3.00	2.9%
Research	175.99	61.71	179.36	189.81	10.45	5.8%
Infrastructure	36.35	-	36.89	36.89	-	-

IOS supports research and education aimed at understanding the diversity of plants, animals, and microorganisms as complex systems. 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, 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 understanding organismal performance in an environmental context, which is significant for understanding reciprocal interactions between the biosphere and drivers of global climate change. The activities of the Plant Genome Research Program contribute to a systems level understanding of plants of economic importance and plant processes of potential economic value.

In general, 47 percent of the IOS portfolio is available for new research grants. The remaining 53 percent funds continuing grants made in previous years. In general, 48 percent of the Plant Genome Research Program portfolio is available for new research grants. The remaining 52 percent funds continuing grants made in previous years.

Factors Influencing the Allocation Across IOS Programs

- Strengthening core program activities through IOS project support is a high priority, especially through support of emerging areas integrating tools and resources, developing new computational and modeling approaches, and taking increasing advantage of data integration. There is an emphasis on cross-disciplinary, integrated approaches to understand organisms as complex systems, especially as they relate to identification of novel biological materials and processes of potential economic importance that could stimulate the foundation of new biologically-based industries (\$12.0 million total in FY 2011).
- IOS will give priority to projects that lead to a greater understanding of the mechanisms and principles that allow organisms to survive, adapt to, and transform their environment, since this knowledge enhances our ability to predict organisms’ responses to climate and environmental change and suggests potential strategies for adaptation and mitigation. As part of these activities, IOS will invest in understanding organismal responses to, and feedback on, ocean acidification.
- The Plant Genome Research Program (PGRP) increases by \$3.0 million (to a total of \$105.39 million) to support genome-scale research to accelerate basic discoveries of potential application in crop improvement, development of new sources of bio-based energy, development of sources of bio-based materials, and adaptation to global climate change. Guided by recommendations in the National Plant Genome Initiative strategic plan (*National Plant Genome Initiative: 2009 – 2013*,

National Science and Technology Council (NSTC), Committee on Science, Interagency Working Group on Plant Genomes), PGRP will focus funding on basic research while capitalizing on previous investments in infrastructure to enable this new level of analysis and integration leading to a “systems” understanding of plants. The Basic Research to Enable Agricultural Development (BREAD) Program will continue support for basic research to test innovative hypotheses, approaches, and technologies for sustainable, science-based solutions to problems of agriculture in developing countries. BREAD in FY 2011 is supported by NSF (\$6.0 million) and the Bill & Melinda Gates Foundation (\$6.0 million) through funding provided to NSF.

- All BIO divisions will work in partnership with MPS to identify and support potentially transformative research projects that explore the interdisciplinary interface between physical and life sciences (\$5.6 million total in BIO).

DIVISION OF ENVIRONMENTAL BIOLOGY (DEB)

\$155,590,000
+\$13,040,000 / 9.1%

DEB Funding						
(Dollars in Millions)						
	FY 2009	FY 2009			Change Over	
	Omnibus	ARRA	FY 2010	FY 2011	FY 2010 Estimate	
	Actual	Actual	Estimate	Request	Amount	Percent
DEB	\$120.37	\$63.23	\$142.55	\$155.59	\$13.04	9.1%
Research	120.37	63.23	142.55	155.59	13.04	9.1%

DEB supported research on complex ecological and evolutionary dynamics improves our ability to understand and mitigate environmental change, and informs essential considerations of environmental sustainability. 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 dynamics of species interactions that govern the assembly of functional communities; and determine the flux of energy and materials through ecosystems. This theoretical and empirical research in ecology, evolution, and biodiversity is enhanced by dynamic interactions with the fields of genomics, computer science, and mathematics.

In general, 48 percent of the DEB portfolio is available for new research grants. The remaining 52 percent funds continuing grants made in previous years.

Factors Influencing the Allocation Across DEB Programs

- Strengthening core program activities is a high priority, especially through increasing investments in the long-term research necessary to identify warning signs of abrupt, potentially irreversible changes or tipping points in natural and coupled human-natural systems; in multi-scale modeling efforts to advance understanding of processes that occur across diverse spatial (local-regional-global) and temporal scales, and in infusing evolutionary dynamics and historical perspectives into studies of the dynamics of complex environmental systems.
- DEB investments, focusing on the priorities as identified under the Science, Engineering, and Education for Sustainability (SEES), will integrate efforts in fundamental environmental biology with research in climate and energy science (\$5.0 million total). A key focus will be to understand the scope and role of biodiversity in adaptation and ecosystem sustainability. Cross-disciplinary research that integrates genetic, taxonomic, and functional aspects of biodiversity is the core of a new activity begun in FY 2010 – Dimensions of Biodiversity – to define the dimensions of biodiversity and their consequences for ecosystem services and human well-being. Influences of, and feedbacks to, climate change are included in the activity. In addition, increased DEB investments (\$6.0 million total) in the Dynamics of Coupled Natural and Human Systems program will improve our understanding of the basic feedbacks between socio-economic, ecological and evolutionary, and geophysical systems that influence global change and human well-being.
- All BIO divisions will work in partnership with MPS to identify and support potentially transformative research projects that explore the interdisciplinary interface between physical and life sciences (\$5.6 million total in BIO).

DIVISION OF BIOLOGICAL INFRASTRUCTURE (DBI)

\$145,630,000
+\$18,770,000 / 14.8%

DBI Funding

(Dollars in Millions)

	FY 2009	FY 2009	FY 2010 Estimate	FY 2011 Request	Change Over	
	Omnibus Actual	ARRA Actual			FY 2010 Estimate	FY 2011 Request
DBI	\$117.95	\$38.74	\$126.86	\$145.63	\$18.77	14.8%
Research	30.83	9.20	33.62	34.15	0.53	1.6%
<i>National Center for Ecological Analysis & Synthesis</i>	3.71	-	3.70	-	-3.70	-100.0%
<i>Environmental Synthesis Center</i>	-	-	-	4.00	4.00	N/A
<i>National Evolutionary Synthesis Center</i>	2.55	-	5.50	5.32	-0.18	-3.3%
<i>National Institute for Math & Bio Synthesis</i>	1.85	-	2.35	2.35	-	-
<i>iPlant (formerly Plant Science Cyber Collaborative)</i>	9.11	-	10.97	11.38	0.41	3.7%
<i>Centers for Environmental Implications of Nanotech</i>	5.10	-	5.10	5.10	-	-
<i>STC: Behavioral Neuroscience</i>	2.51	-	-	-	-	N/A
<i>STC: Microbial Oceanography: Research & Ed</i>	4.00	-	4.00	4.00	-	-
<i>SLC: Temporal Dynamics of Learning</i>	2.00	-	2.00	2.00	-	-
Education ¹	31.90	18.45	33.30	50.99	17.69	53.1%
Infrastructure	53.08	11.09	57.10	55.33	-1.77	-3.1%

¹Funds for Transforming Undergraduate Biology Education (TUBE) activities are shifting from EF to DBI in FY 2011.

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 improvements to biological research collections, living stock collections, and field stations and marine labs. These investments underpin advances in all areas of biological research as well as databases, resources and tools for the entire biology community. DBI also supports the development of human capital through support of undergraduate, graduate, and postdoctoral research experiences. DBI is leading BIO efforts both to transform undergraduate biology education based on the recommendations of the “Vision and Change” Conference of July 2009 and to prepare the climate change research workforce (Climate Change Education). 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 36 percent of the DBI budget is available for new awards each year, with approximately 20 percent available for new research grants. Approximately 29 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.

Factors Influencing the Allocation Across DBI Programs

- Undergraduate biology education activities initiated in EF are being integrated with the rest of BIO’s education portfolio in DBI; thus, the EF funds for these activities are transferred to DBI in FY 2011. Focus will be on transforming undergraduate biological education by integrating education and research experiences that involve experiential, hands-on exposure to science to build a diverse citizenry well-prepared to understand and apply information about the biological world in their daily lives. Guided by recommendations stemming from the 2009 “Vision and Change” conference and building on investments initiated in FY 2010, DBI will increase support for the Research

Coordination Networks – Undergraduate Biology Education (RCN-UBE) program, collaborate with EHR to support a new STEP Center, and invest in faculty development activities. New undergraduate biology education programs will be informed by baselining assessment activities conducted in FY 2010 (+\$5.0 million, to a total of \$15.9 million).

- DBI will refocus investments in human capital activities and decrease funding for ADVANCE, GK-12, and IGERT in order to increase funding for Transforming Undergraduate Biology Education (TUBE) activities. Support will be provided in FY 2011 (\$4.0 million total) for a new Environmental Synthesis Center to stimulate research, education, and outreach at the interface of the biological, geological and social sciences. It will foster efforts to understand and predict the complex interactions among ecological populations, communities and ecosystems, the geophysical environment, and human actions and decisions that underlie global environmental change. The center will also play a pivotal role in generating the knowledge base for adaptive responses to environmental change.
- DBI will increase support for Cyber-enabled Discovery and Innovation (CDI) in order to enable revolutionary biological discoveries through the innovative use of advances in computational concepts, methods, models, algorithms, and tools. Investments will be focused on multidisciplinary activities that promise radical, paradigm-changing research findings and on transformative research that leads to productive intellectual partnerships involving U.S. and international investigators from academe, industry, and/or other types of organizations (+\$2.0 million, to a total of \$3.0 million).
- All BIO divisions will work in partnership with MPS to identify and support potentially transformative research projects that explore the interdisciplinary interface between physical and life sciences (\$5.6 million total in BIO).
- Increasing support for BIO-related instrumentation from the Major Research Instrumentation (MRI) program and a new emphasis on human resources has led to a slight decrease in funding available for research resources/infrastructure programs in DBI (-\$1.77 million, to a total of \$55.33 million).

DIVISION OF EMERGING FRONTIERS (EF)

\$106,200,000
+\$2,910,000 / 2.8%

EF Funding

(Dollars in Millions)

	FY 2009		FY 2010 Estimate	FY 2011 Request	Change Over	
	Omnibus	ARRA			FY 2010 Estimate	
	Actual	Actual			Amount	Percent
EF	\$84.68	\$34.80	\$103.29	\$106.20	\$2.91	2.8%
Research	71.42	23.80	56.94	81.20	24.26	42.6%
Education ¹	-	-	10.90	-	-10.90	-100.0%
Infrastructure	13.26	11.00	35.45	25.00	-10.45	-29.5%
<i>National Ecological Observatory Network</i>	<i>13.26</i>	<i>-</i>	<i>25.45</i>	<i>15.00</i>	<i>-10.45</i>	<i>-41.1%</i>

¹Funds for Transforming Undergraduate Biology Education (TUBE) activities are shifting from EF to DBI in FY 2011.

EF identifies, incubates, and supports infrastructure and research areas that transcend scientific disciplines and/or advance the conceptual foundations of biology. Typically, developing programs and priority areas begin in EF and then shift to other BIO divisions as core research. Examples include the Assembling the Tree of Life and Ecology of Infectious Diseases programs, as well as Transforming Undergraduate Biology Education programs in FY 2011. 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, by encouraging curiosity and exploration through novel mechanisms and investments, and by facilitating 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 is used primarily to fund continuing grants made in previous years.

Factors Influencing the Allocation Across EF Programs

- The Transforming Undergraduate Biology Education (TUBE) activities, initiated and incubated in EF, are being integrated with the rest of BIO's education portfolio in DBI; thus, the EF funds for these activities are transferred to DBI in FY 2011 (-\$10.9 million).
- Support will continue in EF for efforts to digitize and network U.S. specimen-based research collections. These collections and data provide critical information about existing gaps in our knowledge of life on earth. Filling these gaps is crucial to a complete understanding of the biodiversity of the planet, both in space and time, and the history of climate change (\$10.0 million total).
- To facilitate the support of transformative research, and to encourage development of innovative forms of merit review, EF will maintain an innovation fund of \$8.0 million total to co-fund activities in other BIO divisions that use innovative mechanisms for identifying and reviewing exceptionally novel and high impact research projects.
- As construction of NEON begins, EF will focus on supporting research activities relevant to NEON, including macrosystems biology and multi-scale modeling (total of \$10 million).

