

BIOLOGICAL SCIENCES

\$607,850,000

The FY 2007 Budget Request for the Directorate for Biological Sciences (BIO) is \$607.85 million, an increase of \$31.16 million, or 5.4 percent, over the FY 2006 Current Plan of \$576.69 million.

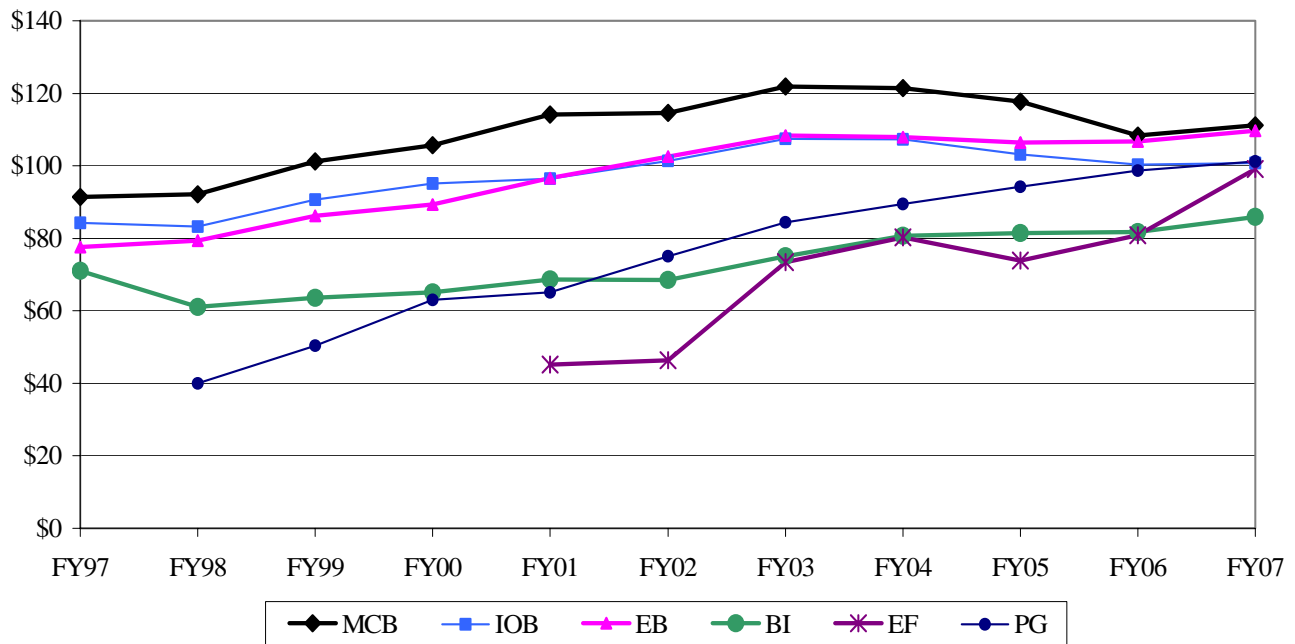
Biological Sciences Funding (Dollars in Millions)

	FY 2005	FY 2006	FY 2007	Change over	
	Actual	Current Plan	Request	FY 2006 Amount	FY 2006 Percent
Molecular and Cellular Biosciences (MCB)	\$117.74	\$108.27	\$111.22	\$2.95	2.7%
Integrative Organismal Biology (IOB)	103.12	100.39	100.74	0.35	0.3%
Environmental Biology (EB)	106.47	106.71	109.61	2.90	2.7%
Biological Infrastructure (BI)	81.41	81.80	85.90	4.10	5.0%
Emerging Frontiers (EF)	73.80	80.80	99.16	18.36	22.7%
Plant Genome (PG)	94.24	98.72	101.22	2.50	2.5%
Total, BIO	\$576.78	\$576.69	\$607.85	\$31.16	5.4%

Totals may not add due to rounding.

The Directorate for Biological Sciences (BIO) supports research, infrastructure, and education in the biological sciences at U.S. colleges, universities, non-profit research institutions, and other research and education organizations such as museums and independent field stations.

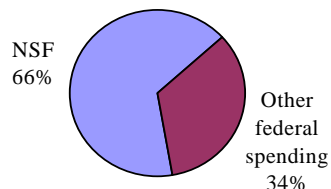
BIO Subactivity Funding (Dollars in Millions)



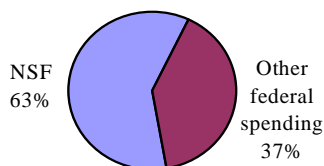
RELEVANCE

Advancing fundamental scientific discovery in all aspects of life – from molecules to whole ecosystems – is supported within NSF, where the ability to integrate the range of biological sub-disciplines is unique. Of the non-medical aspects of the biological sciences, BIO is the dominant federal supporter of basic research at academic institutions – providing 66 percent of all support. Issues of national importance related to the environment, economy, agriculture, and human welfare require an understanding of how living organisms function and interact with non-living systems. BIO-supported research enhances this understanding. NSF’s contribution to a broad array of the biological sciences is critically important – particularly in such areas as environmental biology and plant sciences.

Federal Support for Basic Research in Non-Medical Biological Sciences at Academic Institutions



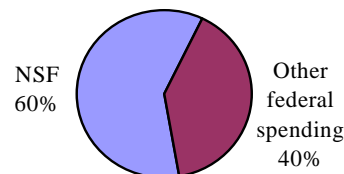
Federal Support for Basic Research in Environmental Biology at Academic Institutions



BIO support represents 63 percent of all federal funding for basic research in environmental biology. For example, the Assembling the Tree of Life program supports large teams of scientists working across institutions and disciplines to assemble a phylogeny, a genealogical map for all 1.7 million described species on Earth. Through its Long-Term Ecological Research program, BIO supports researchers creating well-designed and documented ecological experiments that can provide information needed for answering basic ecological questions. Additionally, BIO is the principal source of federal support for enhancing biological specimen collections and for modernizing facilities and equipment at biological field stations and marine laboratories.

BIO provides an estimated 60 percent of federal support for plant biology at academic institutions. The Plant Genome Research program supports projects that make significant contributions to our understanding of plant genome structure and function. Long-term benefits of this research include fundamental breakthroughs in our understanding of plant biology and practical applications to crop improvement and the development of novel, plant-based products. Since the program’s inception in FY 1998, accomplishments have included the sequencing of the whole genomes of rice and *Arabidopsis thaliana*; continued discovery of new genes involved in plant processes of economic value including disease resistance, stress tolerance, and floral development; and the establishment of several databases where plant genome data are presented in an integrated and cross-referenced form.

Federal Support for Basic Research in Plant Biology at Academic Institutions



Summary of Major Changes by Division

(Dollars in Millions)

BIO FY 2006 Current Plan	\$576.69
Molecular and Cellular Biosciences (MCB)	\$2.95
Support for microbial biology including observatories, analysis of living networks and complex interacting processes, integrated research in nanobiology, and plant biology will be emphasized.	
Integrative Organismal Biology (IOB)	\$0.35
Disciplinary and interdisciplinary research in the IOB core will increase by \$4.18 million, which includes an increase of \$0.35 million plus an additional \$3.83 million due to the transfer of responsibility for funding the Science and Technology Center for Behavioral Neuroscience from IOB to Emerging Frontiers.	
Environmental Biology (DEB)	\$2.90
Disciplinary and interdisciplinary research in the DEB core will increase by \$6.32 million, which includes an increase of \$2.90 million plus an additional \$3.42 million due to the transfer of responsibility for funding the National Center for Ecological Analysis and Synthesis from DEB to Emerging Frontiers.	
Biological Infrastructure (DBI)	\$4.10
Research Resources: An increase of \$2.55 million will enhance support for cyberinfrastructure in biology, including databases. Support for the multi-user instrumentation programs, put on hold in FY 2006, will continue to be deferred for FY 2007.	
Human Resources: An increase of \$1.55 million will be used to enhance support for programs that broaden participation and for NSF's K-12 education portfolio.	
Emerging Frontiers (EF)	\$18.36
Redirection of funds from other programs within EF will allow for increased support for the Frontiers in Integrative Biological Research (FIBR) program and initiation of a new program in theoretical biology. BIO will begin a collaboration with SBE on Biology and Society. Support for centers will be centralized within EF to foster collaboration and integration of research themes. As enormous amounts of genomic data, including data generated from plant research, have flooded cyberspace, the need for additional analysis and synthesis centers with a focus on genomics data will be considered within budgetary constraints. (+\$8.36 million)	
NEON: An increase will enhance R&D efforts in sensor development. (+\$6.0 million)	
Activities to broaden participation of individuals from underrepresented groups will be increased through programs such as Research Initiation Grants and Career Advancement Awards to Broaden Participation in the Biological Sciences (RIG/CAA). (+\$4.0 million)	
Plant Genome Research Program (PGR)	\$2.50
Genome-enabled plant biology research that takes advantage of cyberinfrastructure and the latest systems biology will receive the highest priority. Some support will also be	

provided for the BIO-wide Arabidopsis ‘2010’ project. The interagency maize genome-sequencing project begun in FY 2005 will continue.

Subtotal, Changes + \$31.16

BIO FY 2007 Request\$607.85

Summary of Major Changes by Directorate-wide Investments (Dollars in Millions)

BIO FY 2006 Current Plan\$576.69

Advancing the Frontier + \$18.06

Disciplinary and interdisciplinary research in core BIO programs will increase by \$12.82 million. The number of awards will increase by about 95; the funding rate, currently below the 20 percent level, will remain low at 18 percent. As part of this increase, support for Frontiers in Biological Research (FIBR), along with a program to foster development in theoretical biology will be increased by \$8.63 million. FIBR projects are multidisciplinary and address complex biological systems.

NSF has supported Long-Term Ecological Research (LTER) for over 20 years. Following the recommendations of a two-year strategic planning process, additional investments in cyberinfrastructure have been proposed to facilitate cross-site collaborations (+\$1.15 million).

Centers

Support for all BIO centers including Science & Technology Centers will be centralized within Emerging Frontiers, and funding will increase by \$4.09 million. The Center for Microbial Oceanography at the University of Hawaii was selected in the FY 2005 STC competition. Initial FY 2006 funding is through Integrative Activities; FY 2007 funding is through BIO.

Priority Areas

Biocomplexity in the Environment (BE) and Mathematical Sciences (MS) priority areas will continue their phase-downs, transferring \$22.10 million into base programs where these emphases will continue.

Broadening Participation in the S&E Enterprise + \$4.00

Research Initiation Grants and Career Advancement Awards (RIG/CAA) seek to promote the development and retention of scientists from underrepresented groups and to increase the numbers of such individuals that serve as role models for the scientific workforce of the future. Funding for RIG/CAA and programs with similar goals will increase by \$4.0 million.

Education and Workforce + \$0.55

BIO will increase support for the GK-12 program by \$550,000, for a total of \$1.69 million.

Facilities and Infrastructure

+\$6.00

R&D for NEON, a terrestrial research platform that will advance basic ecological understanding while contributing to the goals of the *US Strategic Plan for an Integrated Earth Observation System (IEOS)*, will increase by \$6.0 million for a total of \$11.94 million. Increased investments include sensor development and cyberinfrastructure, including test-beds for connectivity between field deployed instruments, are necessary to keep NEON project planning on schedule.

+\$2.55

Research Resources: An increase of \$2.55 million will enhance support for cyberinfrastructure, including databases, in biology.

Subtotal, Changes +\$31.16

BIO FY 2007 Request**\$607.85**

NSF-WIDE INVESTMENTS

BIO NSF-wide Investments

(Dollars in Millions)

	FY 2005 Actual	FY 2006		Change over FY 2006	
		Current Plan	FY 2007 Request	Amount	Percent
Biocomplexity in the Environment	\$39.86	\$30.43	\$9.43	-\$21.00	-69.0%
Climate Change Science Program	15.10	15.10	15.10	-	-
Cyberinfrastructure	77.00	84.00	90.50	6.50	7.7%
Human and Social Dynamics	0.50	0.50	0.50	-	-
International Polar Year	-	-	2.00	2.00	N/A
Mathematical Sciences	2.21	2.21	1.11	-1.10	-49.8%
National Nanotechnology Initiative	46.78	49.00	52.55	3.55	7.2%
Networking and Information Technology R&D	77.00	77.00	83.50	6.50	8.4%

In FY 2007, the BIO directorate will support research and education efforts related to broad, Foundation-wide investments in a number of areas, including NSF’s multidisciplinary priority areas and the Administration’s interagency R&D priorities.

Biocomplexity in the Environment: Funding will continue for environmental genomics, including a new activity in support of the International Polar Year (IPY) – Life in the Cold and Dark. Support for the Ecology of Infectious Diseases and Microbial Genome Sequencing research programs that contribute to Homeland Security R&D goals, while no longer components of BE, will be sustained at \$21.0 million and managed in the Emerging Frontiers subactivity.

Climate Change Science Program: A total of \$15.10 million will continue support for research to address key aspects of land use and land-cover change through studies on ecological rates of change and related loss of species diversity. This includes support for programs that specifically address terrestrial ecosystem response to climate change through experimental, modeling, and laboratory studies, including research in the Long Term Ecological Research (LTER) program.

Cyberinfrastructure: A total of \$90.5 million (+\$6.50 million) includes support for databases and informatics tools within BIO, including support for the Protein Data Bank (PDB), the international repository and primary source for information about the structure of biological macromolecules, and TAIR, The *Arabidopsis* Information Resource. Increased support in FY 2007 will focus on the cyberinfrastructure needs of long term ecological research, biological databases and other informatics tools, and test-beds for connectivity between field deployed instruments, including sensors and data collection necessary for the final deployment of NEON.

Human and Social Dynamics: A total of \$500,000 will be provided to support a focus on modeling human and social dynamics that are related to biological systems.

International Polar Year: As part of the International Polar Year (2007-2008), BIO will provide \$2.0 million to support research that addresses scientific challenges such as biological adaptation and ecosystem dynamics in polar environments using genomics tools. A new program activity, “Life in the Cold and Dark,” will be developed as part of the IPY.

Mathematical Sciences: As this priority area continues its phase-down, a total of \$1.11 million will continue support for interdisciplinary research training at the intersection of the mathematical and biological sciences. This program aims to transcend traditional boundaries in educating biological and mathematical scientists, so as to strengthen the nation’s research enterprise at this critical interface.

National Nanotechnology Initiative: A total of \$52.55 million (+\$3.55 million) will continue support for biosystems at the nanoscale, to support study of biologically-based systems that exhibit novel properties and potential applications. Potential applications are derived from exploiting functions of cellular organelles, devices for research in genomics, proteomics and cell biology, and nanoscale sensory systems. Special emphasis will be placed on research involving interdisciplinary research teams in FY 2007.

Networking and Information Technology R&D: A total of \$83.5 million (+\$6.50 million) will continue support for Human-Computer Interaction and Information Management (HCI&IM) to increase the benefit of computer technologies to biology; and for Software Design and Productivity (SDP) leading to fundamental advances in concepts, methods, techniques, and tools for software design.

QUALITY

BIO maximizes the quality of the R&D it supports through the use of a competitive, merit-based review process. The percent of research funds that were allocated to projects that undergo external merit review was 98 percent in FY 2005, the last year for which complete data exist.

To ensure the highest quality in processing and recommending proposals for awards, BIO convenes Committees of Visitors, which are composed of qualified external evaluators who review each program every three years. These experts assess the integrity and efficiency of the processes for proposal review and provide a retrospective assessment of the quality of NSF’s investments.

The Directorate for Biological Sciences also receives advice from the Advisory Committee for Biological Sciences (BIOAC) on such issues as: the mission, programs, and goals that can best serve the scientific community; how BIO can promote quality graduate and undergraduate education in the biological sciences; and priority investment areas in biological research. The BIOAC meets twice a year. Members

from academic institutions and industry represent a cross section of biology. The Committee is balanced with respect to gender, underrepresented minorities, and geographic regions.

PERFORMANCE

NSF's FY 2007 Budget Request is aligned to reflect funding levels associated with the Foundation's four strategic outcome goals and the ten investment categories highlighted in the FY 2003-2008 Strategic Plan. These categories were designed to better enable assessment of program performance and to facilitate budget and performance integration.

Biological Sciences By Strategic Outcome Goal and Investment Category (Dollars in Millions)

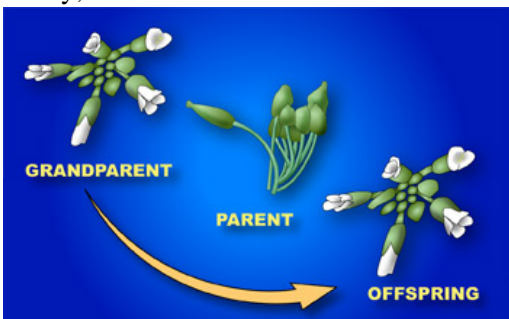
	FY 2006			Change over	
	FY 2005 Actual	Current Plan	FY 2007 Request	FY 2006 Amount	FY 2006 Percent
<i>Ideas</i>					
Fundamental Science and Engineering	400.85	383.30	397.27	13.97	3.6%
Centers Programs	11.07	10.22	14.31	4.09	40.0%
Capability Enhancement	-	-	-	-	N/A
	411.92	393.52	411.58	18.06	4.6%
<i>Tools</i>					
Facilities	7.18	7.13	13.13	6.00	84.2%
Infrastructure and Instrumentation	88.69	109.11	111.66	2.55	2.3%
Polar Tools, Facilities and Logistics	-	-	-	-	N/A
Federally-Funded R&D Centers	-	-	-	-	N/A
	95.87	116.24	124.79	8.55	7.4%
<i>People</i>					
Individuals	61.20	59.24	63.79	4.55	7.7%
Institutions	2.72	2.69	2.69	-	-
Collaborations	-	-	-	-	N/A
	63.92	61.93	66.48	4.55	7.3%
<i>Organizational Excellence</i>					
	5.07	5.00	5.00	-	-
Total, BIO	\$576.78	\$576.69	\$607.85	\$31.16	5.4%

Totals may not add due to rounding.

BIO will continue its commitment to education, training, and increasing diversity while emphasizing 21st Century Biology within all of its divisions and subactivities. The FY 2007 budget will slightly increase award size and continue to focus on multidisciplinary research activities, interagency partnerships, and international activities, with special attention given to broadening participation at all levels.

Recent Research Highlights

► **Reappearance of Missing Genetic Information Poses Exception to the Rule** For more than a century, the laws of inheritance dictated that genetic information contained in the nuclear genome is



Researchers discovered "missing" genetic information could reappear in later generations.

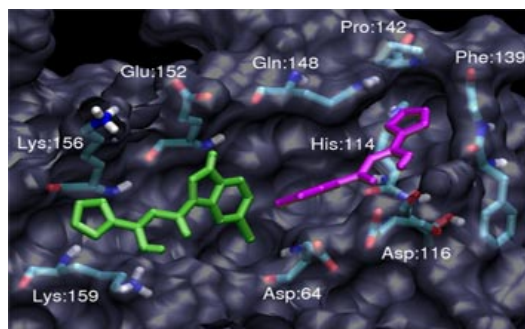
passed from one generation to the next in a predictable manner: from grandparents to parents to children. Recently, researchers at Purdue University have shown this cardinal rule is sometimes broken. By examining the genome of the model plant, *Arabidopsis thaliana*, they found genetic information absent in the parent would unexpectedly reappear in the genome of their offspring. They postulate that this "hidden" genetic information is maintained outside of the nuclear genome for numerous generations. Under certain circumstances these "hidden" sequences can be reincorporated and restore genomic sequences back to an ancestral state.

► **ORNIS: Five Million Birds in Your Computer** With over 70 million amateur and professional ornithologists, bird watching remains one of the most popular outdoor activities in the United States. ORNIS (ORNithological Information System), an NSF-sponsored information network developed at the University of Kansas, links together 33 ornithology collections from the U.S., Canada and Mexico into one "virtual" museum (<http://ornisnet.org/>) that allows users to extract information on nearly five million bird specimens. The information identifies places where living birds are found and habitats that might be suited for recolonization. ORNIS linked to similar information networks for other animal groups will create a biodiversity knowledge resource for tracking climate change and emerging diseases, like West Nile Virus.



ORNIS currently includes 33 North American bird collections, marked on this map with red dots.

► **Molecules in Motion: Computer Simulations Increase Understanding of Protein Structures.**



Andrew McCammon's work at the San Diego Supercomputer Center (SDSC) has been key in the design of a new class of drugs for the treatment of human immunodeficiency virus (HIV). McCammon and colleagues are harnessing the power of the supercomputer to understand the structure and function of molecules inside cells and to predict how the molecules might react to new drugs before any experiments are conducted in the laboratory. McCammon recently elucidated the structure of a crucial HIV protein allowing researchers at Merck Pharmaceutical Company to design new drugs targeting the

protein. The drugs are now entering human clinical trials.

► **Scientists Reveal Aerodynamics of Tiny Bird's Flight**

Hummingbirds are unique among birds for their ability to hover for long periods of time. Using a sophisticated digital imaging technique, researchers from Oregon State University, University of Portland and George Fox University have determined the aerodynamics of hummingbird flight. The team found that hummingbirds support 75 percent of their weight during the wing's down stroke and 25 percent on the up stroke. This contrasts with other birds, which use the down stroke to support 100 percent of their weight during slow flight and short-term hovering. The finding provides new insight into evolutionary trends that led to sustained hovering in birds and may provide engineers with a new model for future miniature autonomous flying vehicles.



Scientists used computer-aided digital imagery to analyze the aerodynamics of rufous hummingbird hovering.

► **Yellowstone Discovery Bodes Well for Finding Evidence of Life on Mars**



Researchers from the University of Colorado have discovered microbes in the pores of rocks in a highly acidic environment in Yellowstone's Norris Geyser Basin. The most abundant microbes identified by the team were a new species of mycobacterium, a group best known for causing tuberculosis and leprosy. The scientists also found that rock formation processes in the Norris Geyser Basin created fossil imprints of the organisms at various stages, leaving a record of development over time. They believe similar kinds of geothermal environments may have existed on Mars, where astrobiologists have intensified the search for past and present life forms in recent years. Thus, these bizarre microbes found in

Yellowstone can provide new clues about ancient life on Earth and help steer the hunt for evidence of life on Mars.

► **Arkansas University Recruits Minority Scientists for Environmental Research**

Mentorship is alive and well at Arkansas State University, where geochemist Robyn Hannigan has established a program to immerse minority and female students in the study of environmental science. The result has been a double success for science and education. The program, Research Internships in Science of the Environment (RISE), gives some students their first experience doing research. A Native American from a disadvantaged community, Hannigan knows from experience that science only appeals to many students after they have personally conducted hands-on research. With funding from NSF's Research Experiences for Undergraduates program, Hannigan designed RISE to increase diversity in the scientific workforce. Since 2001, RISE has supported the summer research projects of more than 30 undergraduate students. RISE participants work across disciplines to focus on the relationships between agricultural land use and ecological health. So far, Hannigan reports, more than 90 percent of graduates from the RISE program have gone on to pursue a doctorate.



Other Performance Indicators

The tables below show the change in the number of people benefiting from BIO funding along with trends in the award size, duration and number of awards.

Number of People Involved in BIO Activities

	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
Senior Researchers	3,554	3,554	3,800
Other Professionals	1,598	1,598	1,710
Postdoctorates	1,360	1,360	1,455
Graduate Students	2,066	2,066	2,210
Undergraduate Students	2,291	2,291	2,450
K-12 Teachers	20	20	25
Total Number of People	10,889	10,889	11,650

BIO Funding Profile

	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate
Statistics for Competitive Awards:			
Number	1,355	1,355	1,450
Funding Rate	21%	21%	22%
Statistics for Research Grants:			
Number of Research Grants	923	923	986
Funding Rate	17%	17%	18%
Median Annualized Award Size	\$140,000	\$140,000	\$147,000
Average Annualized Award Size	\$184,040	\$184,040	\$193,200
Average Award Duration, in years	3	3	3

MOLECULAR AND CELLULAR BIOSCIENCES

\$111,220,000

The FY 2007 Budget Request for the Division of Molecular and Cellular Biosciences (MCB) is \$111.22 million, an increase of \$2.95 million, or 2.73 percent, over the FY 2006 Current Plan of \$108.27 million.

Molecular and Cellular Biosciences Funding

(Dollars in Millions)

	FY 2005 Actual	FY 2006	FY 2007 Request	Change over	
		Current Plan		FY 2006	Amount
Molecular and Cellular Biology	\$117.74	\$108.27	\$111.22	\$2.95	2.7%
Major Components:					
Research & Education Projects	117.74	108.27	111.22	2.95	2.7%

About MCB:

MCB supports innovative research on the fundamental properties and dynamics of the molecular and cellular basis of life. This research advances our understanding of multi-scale, complex biological systems and their interactions with the physical world. Innovative ideas and insights from MCB investigators transform our understanding of the natural world, contribute to our economy through new applications in biotechnology, agriculture and the environment, and provide new insights that contribute to our ability to detect and defend against biological threats.

Transformative studies of complex biological questions increasingly require the tools of genomics, computer and information science, the physical sciences, and mathematics to achieve insights into the nature and function of the molecular machinery of the living cell, the mechanisms by which genetic information is transmitted and expressed, and the processes by which living cells are organized, communicate, and respond to environmental signals. MCB continues to forge partnerships with complementary disciplines to support research at these interfaces, to introduce new analytical and conceptual tools for biological research, and to provide unique education and training environments for the next generation of versatile biologists and scientifically literate citizens.

The Molecular and Cellular Biosciences Division is organized into three clusters: *Biomolecular Systems*, *Cellular Systems*, and *Genes and Genome Systems*. Multidisciplinary research is supported in each of these areas. *The Biomolecular Systems* cluster includes the scientific themes of molecular biochemistry, biophysics, and metabolic pathways and networks. The use of cutting-edge technologies is a priority to integrate theoretical, computational, and experimental approaches to study individual biological molecules and their functional complexes (representing paradigms for nanomachines). *The Cellular Systems* cluster supports research that addresses questions about how living cells are organized, how they communicate, and how they respond to internal and external signals. Areas supported include nanoscale studies of the structure, function, and assembly of cellular elements. Cellular mechanisms underlying immune-like defense mechanisms in plants and diverse animals, particularly lower vertebrates and invertebrates, are also a priority. *The Genes and Genome Systems* cluster supports studies of genomes and genetic mechanisms in all types of organisms. Areas of interest include genome organization, replication, recombination, repair, and vertical and lateral transmission of heritable information, as well as study of the processes that carry out and regulate expression of the information encoded in the genome.

In general, 40 percent of the MCB portfolio is available for new awards. The remaining 60 percent will fund awards made in previous years.

MCB priorities for FY 2007:

Integration of education and training and broadening participation in all aspects of molecular and cellular research. These priorities make available to the U.S. scientific enterprise the human and intellectual resources represented by all areas of the country, all types of institutions of higher education, and all facets of U.S. society, including those that until now have not been fully involved.

Research and education at the interface of biology and the physical sciences: In partnership with the Directorate for Mathematics and Physical Sciences, MCB will continue to support beginning investigators whose pioneering projects integrate research and education.

Living Networks and Complex Processes: There is growing appreciation that the functions of living cells cannot be understood as a collection of individual, linear processes, but only when viewed as interacting and interdependent networks. MCB will give priority to theoretical, computational, mathematical modeling and simulation approaches in all areas of the molecular and cellular biosciences. Formulating and testing physical and mathematical models of the structure and function of living networks of complex molecules, metabolic pathways, and other exquisitely regulated cellular processes represents one of the greatest theoretical and computational challenges facing biology in the 21st century. Cyberinfrastructure is indispensable for capturing and analyzing genome data to mathematically simulate complex networks of cellular signaling events.

Microbial Biology: MCB, through its core activities, encourages research on microbes at all levels of biological organization. New genomic and biochemical approaches are used to identify and characterize basic attributes of microbes, most of which are newly described. Understanding previously unknown microbes and their complex interactions with one another, with other organisms, and with the physical environment, is needed to develop integrated models. MCB supports this research through the microbial observatories and microbial interactions and processes efforts. These efforts contribute to “The Microbe Project,” a coordinated interagency effort.

Plant biology: Unsolicited research supported by MCB led to the discovery of the value of *Arabidopsis thaliana* as a model flowering plant. A high priority will be the continued support of broad-based plant biology research, particularly research enabled by the availability of the complete genome sequence of *Arabidopsis* and resources developed through the Arabidopsis 2010 project and the Plant Genome Research program.

Changes from FY 2006:

- Disciplinary and interdisciplinary research in the MCB core will increase by \$2.95 million. However, this increase is accompanied by a resumption of responsibility for microbial observatories and microbial interactions and processes research.

INTEGRATIVE ORGANISMAL BIOLOGY

\$100,740,000

The FY 2007 Budget Request for the Division of Integrative Organismal Biology (IOB) is \$100.74 million, an increase of \$0.35 million, or 0.3 percent, over the FY 2006 Current Plan of \$100.39 million.

Integrative Organismal Biology Funding

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006	
				Amount	Percent
Integrative Organismal Biology	\$103.12	\$100.39	\$100.74	\$0.35	0.3%
Major Components:					
Research & Education Projects Centers	99.17	96.56	100.74	4.18	4.3%
STC for Behavioral Neuroscience	3.95	3.83	-	-3.83	-100.0%

About IOB:

Biology, in the context of the organism, addresses questions that cannot be answered by focusing on the extremes of molecules or the environment. Richard Feynman, the oft-quoted recipient of the 1965 Nobel Prize in Physics, noted: *You can know the name of a bird in all the languages of the world, but when you're finished, you'll know absolutely nothing whatever about the bird.* Innovations in genomics, molecular biology, and computer science are now enabling advancement of the frontiers of knowledge on previously bewilderingly complex questions such as how does a bird fly, a heart beat, a flower bloom, or a sea urchin evolve. Research supported by IOB focuses on questions such as these, in order to understand the structure and function of organisms, with particular emphasis on the mechanisms by which organisms develop, behave, and respond to their environment.

Understanding organisms requires innovative integration of information across levels of analysis and stages of development, across phyla, environments, and evolutionary time. It can also require computational techniques and interdisciplinary perspectives from other areas of biology, the physical sciences, mathematics, engineering, social sciences and computer science. An underlying theme is the use of a wide diversity of organisms to identify unifying principles common to all organisms, and to understand the variety of adaptive mechanisms that have evolved in specific organisms.

The essence of organismal biology lies in the dynamics of living systems that cannot be described merely by enumerating their components. IOB researchers are now advancing the frontier of understanding complex, dynamic biological organisms in their native environments by building on investments in genome sequencing and projects that have accumulated in-depth knowledge of the molecular nature of biological systems. These innovative studies offer potential solutions to many critical national problems, such as energy production, carbon sequestration, and environmental cleanup. A better understanding of organismal biology will lead to improved diagnosis and treatment of disease, as well as better protection of people from environmental hazards. It will allow creation of novel biochemical processes and the modification of organisms to achieve predictable results. For example, organisms could be modified to serve as sensitive detectors for dangerous pathogens and toxins, or to create novel materials, catalysts, and drugs.

In general, 45 percent of the IOB portfolio is available for new awards. The remaining 55 percent will fund awards made in previous years.

IOB Priorities for FY 2007:

IOB will place highest priority on integrative studies that lead to a deeper understanding of the underlying principles, mechanisms, and processes that determine the behavior, development, physiology and adaptations of organisms. Studies that cross previously disparate scientific areas and that cross scales of organization from molecules to phenotypes and behavior will be highlighted. Highest priority will be placed on the following areas:

Integrative Developmental Biology: Developmental biologists have, for many years, focused their efforts to understand development by studying a few “model” organisms at the genetic, molecular and cellular levels. These efforts have led to a detailed understanding of underlying genetic mechanisms that control developmental events. Animal physiologists, by contrast, have employed a broad array of study systems, each selected for its unique suitability to address a specific physiological mechanism. But a deeper understanding of the development and function of living organisms will require integration of the approaches of each of these fields. This is not just an issue of filling in gaps that have been neglected (although these do exist), but more importantly of synthesizing the conceptual approaches, methodologies, and analytical tools of the two disciplines. Molecular-genetic approaches to development are well suited to uncovering details of cellular regulatory mechanisms, but they are typically not suited to elucidate mechanisms that operate at the level of tissues, organs and whole animals. Physiological approaches, by contrast, can elucidate higher-level regulatory mechanisms but are traditionally non-genetic. Both approaches are advanced by an increasingly powerful array of genomic techniques that provide outstanding opportunities to address important issues of long-standing interest to both physiologists and developmental biologists.

Genetic/Cellular Basis for Behavior: Behavior is the fundamental interface of an organism with its environment and with other individuals. While complex behaviors such as foraging, mate selection, or parental care are still poorly understood from a genetic point of view, advances in genetic tools, methods and databases, including those from whole-genome sequence projects, are providing unprecedented resources for genomic analyses of complex traits. These developments are providing new tools easily adopted for studying complex behavior, not only in model species but also in non-model organisms. The integration of the ability to identify the activity of individual genes active in specific neurons, with the ability to identify and examine neural networks in a variety of organisms will allow the focusing of research on the genetic/cellular basis for behavior. The ultimate goal is to understand the genetic basis of behavioral complexity and to develop an understanding of the principles underlying the genetic basis of behavioral diversity.

Changes from FY 2006:

- Disciplinary and interdisciplinary research in the IOB core will increase by \$4.18 million, which includes an increase of \$0.35 million plus an additional \$3.83 million due to the transfer of responsibility for funding the Behavioral Neuroscience Science and Technology Center to Emerging Frontiers. Additional IOB funds will increase support for the areas of Integrative Developmental Biology and Genetic/Cellular Basis for Behavior.

ENVIRONMENTAL BIOLOGY

\$109,610,000

The FY 2007 Budget Request for the Division of Environmental Biology (DEB) is \$109.61 million, an increase of \$2.90 million, or 2.72 percent, over the FY 2006 Current Plan of \$106.71 million.

Environmental Biology Funding

(Dollars in Millions)

	FY 2005 Actual	FY 2006		Change over FY 2006	
		Current Plan	FY 2007 Request	Amount	Percent
Environmental Biology	\$106.47	\$106.71	\$109.61	\$2.90	2.7%
Major Components:					
Research & Education Projects Centers Program	103.00	103.29	109.61	6.32	6.1%
National Center for Ecological Analysis and Synthesis	3.47	3.42	-	-3.42	-100.0%

About DEB:

The Division of Environmental Biology 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). Two fundamental theories define the frontiers of inquiry for environmental biology: the theory that all forms of life evolve by natural selection or genetic drift; and the theory that all life is connected to form functional ecosystems.

DEB will continue to balance disciplinary and transdisciplinary research needs; focus on science that NSF supports uniquely, or especially well; enhance ecological and evolutionary synthesis; and educate the next generation of environmental biologists while promoting full participation of all groups. Four clusters represent the major areas of scientific focus in DEB. Studies supported within and across these clusters accelerate the rate of discovery of new species, address the genealogical relationships of plants, animals, fungi, and microbes; elucidate the spatial and temporal dynamics of species interactions (e.g., competition, predation); discover the principles or rules by which species are assembled into functional communities and change through time; and determine the flux of energy and materials through ecosystems.

In addition, the Long-Term Ecological Research (LTER) program is a network of 26 comprehensive research sites located in areas broadly representative of the global range of natural, agricultural and urban ecosystems. A Network Office coordinates information and cross-site communication, as well as education, outreach and international activities, while promoting synthesis via an open access data policy. All LTER projects share common research themes that facilitate multi-site comparisons and encourage interdisciplinary activities.

In general, 45 percent of the DEB portfolio is available for new awards. The remaining 55 percent will fund awards made in previous years.

DEB priorities for FY 2007:

Advancing the Frontier: One of the grand challenges for environmental biology in the 21st century is to discover and comprehend the ecological and evolutionary mechanisms that maintain the structure and functioning of ecosystems, in light of anthropogenic and natural change. This requires a research enterprise that focuses an intellectual critical mass on a cascade of questions that connect our understanding of the biosphere to the services provided to humans by nature. In FY 2007, DEB will respond to this challenge by supporting: theory development that can be used to guide this research; projects that address the couplings of systems across different time and space scales; the dynamics of, and feedbacks between, human and natural systems; and the couplings of evolutionary and ecological mechanisms.

A second compelling challenge is to inventory the diversity of life on the planet, and to place this information in the context of a predictive understanding of the tree of life. In FY 2007, DEB will support an increased level of biodiversity inventory research, selecting projects that are cast within the theoretical framework of the tree of life.

Cyberinfrastructure: Special emphasis will be given to leveraging new cyberinfrastructure capabilities, developing partnerships with the informatics and computer sciences community, and bringing innovative analytical tools into the arsenal of environmental biologists. These investments arise from the initial support of the Information Technology Research program, and are particularly evident in the LTER network.

Education and Broadening Access: DEB will continue to place a premium on outstanding educational activities that are coupled to research projects. Support will emphasize broad career horizons, experiential learning, and preparing people to understand and apply information about the biological world in their daily lives. Support for CAREER grants, Doctoral Dissertation Improvement Grants, and Research Experiences for Undergraduates will be maintained. We will maintain funding for the LTER Schoolyard Science activity to enhance engagement of students in the primary and secondary schools.

Changes from FY 2006:

- Disciplinary and transdisciplinary research in the DEB core will increase by \$6.32 million. Of this amount, \$3.42 million comes from the transfer of responsibility for funding the National Center for Ecological Analysis and Synthesis to Emerging Frontiers.
- Support for the LTER Program will be increased by \$1.15 million to a total of \$19.61 million, in FY 2007. Additional funds will augment support for site-based integrated research and educational activities, cross-site collaborations, and continued development of cyberinfrastructure capabilities.

BIOLOGICAL INFRASTRUCTURE

\$85,900,000

The FY 2007 Budget Request for the Division of Biological Infrastructure (DBI) is \$85.90 million, an increase of \$4.10 million, or 5.01 percent, over the FY 2006 Current Plan of \$81.80 million.

Biological Infrastructure Funding

(Dollars in Millions)

	FY 2005 Actual	FY 2006 Current Plan	FY 2007 Request	Change over FY 2006	
				Amount	Percent
Research Resources	\$49.98	\$51.03	\$53.58	\$2.55	5.0%
Human Resources	\$31.43	\$30.77	\$32.32	\$1.55	5.0%
Biological Infrastructure	\$81.41	\$81.80	\$85.90	\$4.10	5.0%
Major Components:					
Research & Education Projects	74.23	74.66	78.76	4.10	5.5%
Facilities					
National Nanotechnology Infrastructure Network	0.40	0.40	0.40	-	-
National Ecological Observatories Network	5.98	5.94	5.94	-	-
Cornell High Energy Synchrotron Source	0.80	0.80	0.80	-	-

About DBI:

DBI’s responsibility is to build and develop innovative scientific infrastructure that empowers the biological research community to advance all fields of biology.

DBI is organized into two clusters. The Research Resources cluster supports development of research tools and resources, such as:

- Informatics tools – to provide power to mine all available information;
- Research resources – to develop database/knowledgebase biological resources to be mined for new insights and discoveries; and
- Instrumentation – to provide access to the latest instrumentation and to develop instrumentation with new capabilities.

In addition, this cluster supports planning for the proposed National Ecological Observatories Network, and research resource development for the BIO-wide *Arabidopsis* 2010 project. The Human Resources cluster supports education activities with the goal of training a new generation of scientists who are open to new and different approaches and ideas across all boundaries (“fearless scientists”).

In general, 52 percent of the DBI portfolio is available for new awards. The remaining 48 percent will fund awards made in previous years.

DBI Priorities for FY 2007:

Cyberinfrastructure has been an integral part of all DBI programs and will be a highest priority for FY 2007.

Research Resources

- Instrumentation Resources: DBI supports three instrumentation programs: (1) Instrument Development for Biological Research (IDBR); (2) Multi-User Equipment (MUE) for biological research; and (3) improvement of Field Stations and Marine Laboratories (FSML). IDBR and FSML will be maintained at FY 2006 levels. MUE was suspended in FY 2006
- Biological Databases and Informatics (BD&I): BD&I supports the design, development, implementation, and use of information resources and tools.
- Biological Research Collections (BRC): BRC supports natural history collections archived at museums, botanical gardens, field stations, and academic institutions that are widely used for biological research and education. DBI will place a priority on networking collection databases.
- Living Stock Collections (LSC): LSC supports repositories of research organisms, genetic stocks, seeds, cell lines and DNA clones that are associated with whole organisms in a collection.
- *Arabidopsis* 2010 Project: The *Arabidopsis* 2010 Project is a BIO-wide activity whose goal is to determine the function of all *Arabidopsis* genes by 2010. DBI supports 2010 projects that build community research resources, such as collections of full-length cDNA clones and a large collection of insertion mutants. Data and information from the *Arabidopsis* 2010 awards are deposited into The *Arabidopsis* Information Resources (TAIR).
- National Ecological Observatories Network (NEON): Implementation planning continues for NEON, a continental-scale research instrument consisting of geographically distributed infrastructure, networked via state-of-the-art communications.

Human Resources

- Postdoctoral Research Fellowships: In FY 2007, BIO will support Minority Postdoctoral Research Fellowships.
- Undergraduate Mentoring in Environmental Biology (UMEB): UMEB supports 5-year projects designed to engage undergraduates, especially from underrepresented groups, in year-round research and sustained mentoring activities. This program will not be offered in FY 2007.
- Cross-disciplinary Research at Undergraduate Institutions (C-RUI): This program for predominantly undergraduate institutions supports cross-disciplinary research. C-RUI is offered in alternate years from UMEB, and will be competed in FY 2007.
- Research Experience for Undergraduates (REU) sites: Support for REU sites continues to be a high priority. Broadening participation will continue to be a priority in FY 2007.

Changes from FY 2006:

- Research Resources will increase by \$2.55 million, of which \$780,000 will be used specifically to support cyberinfrastructure activities. The rest will support high priority activities identified above.
- Human Resources will increase by \$1.55 million. GK-12 will increase by \$550,000. The remainder will be used to support educational activities such as ROA, RET, and RAHSS supplements, and young investigators through CAREER awards.

EMERGING FRONTIERS

\$99,160,000

The FY 2007 Budget Request for the Emerging Frontiers (EF) Subactivity is \$99.16 million, an increase of \$18.36 million, or 22.72 percent, over the FY 2006 Current Plan of \$80.80 million.

Emerging Frontiers Funding

(Dollars in Millions)

	FY 2005	FY 2006	FY 2007	Change over	
	Actual	Current Plan	Request	FY 2006 Amount	FY 2006 Percent
Emerging Frontiers	\$73.80	\$80.80	\$99.16	\$18.36	22.7%
Major Components:					
Research & Education Projects	70.20	77.80	84.85	7.05	9.1%
Centers Programs					
National Evolutionary Synthesis Center	3.60	3.00	3.00	-	-
National Center for Ecological Analysis and Synthesis ¹	-	-	3.46	3.46	N/A
Center for Behavioral Neuroscience ²	-	-	3.85	3.85	N/A
Center for Microbial Oceanography	-	-	4.00	4.00	N/A

¹ Funded in prior years in DEB.

² Funded in prior years in IOB.

About EF:

Emerging Frontiers supports innovative research, education, and networking activities that are built upon and integrate advances in disciplinary research. By encouraging synergy among disciplines using project, network, and centers models, Emerging Frontiers catalyzes activities at the boundaries of disciplines. EF includes BIO-initiated multidisciplinary activities, centers, and programs that contribute to Homeland Security goals, such as Microbial Genome Sequencing and Ecology of Infectious Disease. R&D for world-class research facilities, as well as the NSF priority areas (Mathematical Sciences, Human and Social Dynamics, and Biocomplexity in the Environment), is part of EF. A high EF priority is support to broaden the participation of individuals and institutions traditionally underrepresented in biological research and networking activities, thereby ensuring that these groups participate more fully in the scientific enterprise.

In general, 65 percent of the EF portfolio is available for new awards; the remaining 35 percent funds awards made in previous years.

EF priorities for FY 2007:

Frontiers in Integrative Biological Research: FIBR continues support for research on major biological questions that are addressed using the creative application of a broad range of strategies and research tools from within and outside the biological sciences. FIBR projects encompass multiple levels of organization, time and space, and a range of organisms or processes. These projects also use combined experimental and theoretical analyses, and apply interdisciplinary approaches in a single, coherent effort.

Theoretical Biology: A new research activity focused on testing and refining extant biological theory as well as developing new theory and conceptual frameworks that span biological subdisciplines and link with non-biological areas. This activity takes advantage of the information explosion in all areas of biology from genomics to ecological systems and is enabled by new analytical, modeling, simulation and cyber tools.

Biology and Society: BIO will partner with SBE to support research on the interrelationships between biological discoveries and changes in social, behavioral and economic systems.

Centers: In addition to the National Center for Synthesis in Biological Evolution previously in the EF Subactivity, three additional centers will be located in EF starting in FY 2007. The National Center for Ecological Analysis and Synthesis will be transferred from the DEB Subactivity, the STC Center for Behavioral Neuroscience will be transferred from the IOB Subactivity, and the new STC Center in Microbial Oceanography will be located in EF. Centralizing the four BIO centers in EF will promote cross-center interaction and learning while facilitating the sharing of best practices between centers and NSF center managers. As enormous amounts of genomic data, including plant biology, have flooded cyberspace, the need for additional centers for analysis and synthesis within biology, with a focus on this genomics data, will be considered within budgetary constraints.

NEON (National Ecological Observatory Network): A world-class facility for environmental research, NEON will enable ecologists for the first time to test the theory that strong and weak forces link ecological processes across the continental US, Alaska, Hawaii, and Puerto Rico. In FY 2007, funds are requested for research and development of sensor arrays that have low power requirements and will form part of NEON's completely automated biogeochemistry and biodiversity measurement systems.

Broadening Participation: BIO will broaden the participation of individuals from groups traditionally underrepresented in the biological sciences by providing planning grants for early career researchers and by funding career advancement awards to mid-career researchers to promote their professional development and retention in the biological sciences. Other BIO activities to broaden participation will also be enhanced.

Biocomplexity in the Environment (BE): In FY 2007, BIO, SBE, GEO and OPP will partner for two BE activities: Environmental Genomics (EG), including Life in the Cold and Dark, an IPY activity, and Dynamics of Coupled Natural and Human Systems (CNH). EG builds on earlier BE activities and supports research that uses genomics to understand the complex biological processes that drive environmental systems. CNH continues to fund studies to understand the dynamic interactions and interdependencies between humans and the natural environment.

Changes from FY 2006:

- Redirection of funds from other programs within EF will allow for increased support for the Frontiers in Integrative Biological Research (FIBR) program and initiation of a new program in theoretical biology. BIO will begin a collaboration with SBE on Biology and Society. Support for centers will be centralized within EF to foster collaboration and integration of research themes. (+\$8.36 million)
- NEON: Support at \$6.0 million for sensor array research and development.
- Broadening Participation: Support for Research Initiation Grants and Career Advancement Awards (RIG/CAA), as well as other programs focused on broadening participation, will increase by \$4.0 million to a total of \$8.0 million.

PLANT GENOME RESEARCH

\$101,220,000

The FY 2007 Budget Request for the Plant Genome Research (PGR) Subactivity is \$101.22 million, an increase of \$2.50 million, or 2.53 percent, over the FY 2006 Current Plan of \$98.72 million.

Plant Genome Research Funding

(Dollars in Millions)

	FY 2005 Actual	FY 2006	FY 2007 Request	Change over	
		Current Plan		FY 2006 Amount	FY 2006 Percent
Plant Genome Research	\$94.24	\$98.72	\$101.22	\$2.50	2.5%
Major Components:					
Research & Education Projects	94.24	98.72	101.22	2.50	2.5%

About PGR:

The Plant Genome Research (PGR) subactivity was initiated in FY 1998, building upon an existing base of genome research supported throughout BIO. PGR supports projects that make significant contributions to our understanding of plant genome structure and function. Emphasis is placed on plants of economic importance. Long-term benefits of this research include fundamental breakthroughs in our understanding of plant biology, practical applications to crop improvement, and the development of novel, plant-based products.

The program was established as part of the National Plant Genome Initiative (NPGI). NSF plays a major role in the NPGI. Other participating agencies include USDA, DOE, NASA, USAID, and NIH. The NSF program follows the guidelines and objectives of the NPGI. PGR works closely with the other agencies in coordinating funding activities through the Interagency Working Group on Plant Genomes under the auspices of the National Science and Technology Council within OSTP. NSF, DOE and USDA often support joint activities, such as the Maize Genome Sequencing project and Gramene, an integrated database for cereals.

Plant biology is one of the areas for which BIO has major responsibilities, and PGR has had a major impact on plant biology research and education, thereby contributing to increased U.S. competitiveness in the development of a renewable resource-based economy of the future. Major PGR accomplishments to date include:

- Established the U.S. as the world leader in fundamental research in plant genomics;
- Transformed plant biology into a 21st century biology;
- Revitalized plant sciences at U.S. colleges and universities;
- Attracted a new generation of students to plant biology research;
- Provided an ability to address long-standing, complex questions in biology such as epigenetics, polyploidy, environmental stress tolerance, genome evolution, and cell wall synthesis; and
- Catalyzed large multinational collaborative plant genome research projects.

PGR currently supports the following specific activities:

- Development of plant genomics research resources and research tools including informatics tools
- Community databases in coordination with the USDA

- High throughput methods/techniques/technology for plant biology research
- Research translating findings from model systems to economically important plants
- Research addressing grand challenges in plant biology
- Whole genome sequencing of selected plant species
- Comparative plant genome sequencing
- Developing country collaboration in plant genomics
- Broadening participation
- Education, training, and outreach
- Participation in NSF-wide programs such as CAREER, IGERT, SGER, and support of workshops/conferences.

In general, 35 percent of the PGR portfolio is available for new awards. The remaining 65 percent will fund awards made in previous years.

PGR priorities for FY 2007:

Scientists have become increasingly able to answer long-standing major questions in plant biology because of the new tools and information resulting from PGR activities over the past 8 years. Genome-enabled plant biology research that takes full advantage of cyberinfrastructure and the latest systems biology approaches will be a high priority.

Continue Support for Maize Genome Sequencing: PGR will continue to support the interagency maize genome-sequencing project that began in FY 2005. Maize is the most economically important crop in the U.S. From a scientific standpoint, the maize genome, when completed, will become the most complex eukaryotic genome to be sequenced to date, including the human genome.

Continue Support for Comparative Plant Genome Sequencing: PGR will continue to support this new activity that began in FY 2006. The comparative plant genome sequencing program is aimed at developing sequence resources for comparative genomics studies..

Continue Support for Genome-enabled Plant Biology Research: Building on the knowledge and research resources/tools accumulated over the last eight years, scientists are poised to tackle grand challenges in plant biology.

Research Collaboration with Scientists in Developing Countries: PGR will continue to support research collaboration between U.S. scientists and scientists in developing countries with a focus on plant genomics and plant biotechnology. The activity began in FY 2004, and is coordinated with the Office of International Science and Engineering (OISE) at NSF, as well as USAID. The intent of this activity is to support collaborative research linking U.S. researchers with partners from developing countries to solve problems of mutual interest in agriculture, energy, and the environment. It will place U.S. and international researchers at the center of a global network of scientific excellence. To date, PGR has supported research collaborations with scientists from Bolivia, Brazil, India, Mexico, Nepal, Nigeria, Peru, Philippines, South Africa, and Sri Lanka.

Changes from FY 2006:

- PGR will increase by \$2.50 million. The increase will be used to support the BIO-wide *Arabidopsis* 2010 Projects.
- Another competition is planned for comparative plant genome sequencing in FY 2007.