



U.S. National Science Foundation: An Overview

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Summary

The National Science Foundation (NSF) was created by the National Science Foundation Act of 1950, as amended (P.L.81-507). The NSF has the broad mission of supporting science and engineering in general and funding basic research across many disciplines. The agency provides support for investigator-initiated, merit-reviewed, competitively selected awards, state-of-the-art tools, and instrumentation and facilities. The majority of the research supported by the NSF is conducted at U.S. colleges and universities. Approximately 82.7% (\$3,320.5 million) of NSF's FY2007 \$4,049.4 million research and development (R&D) budget was awarded to U.S. colleges and universities.

On February 17, 2009, President Barack Obama signed into law the American Recovery and Reinvestment Act (ARRA), 2009, P.L. 111-5 (H.R. 1). The legislation provided slightly more than \$3.0 billion for the NSF—\$2.5 billion for R&RA, \$400.0 million for MREFC, \$100.0 million for EHR, and \$2.0 million for the Office of Inspector General. Language in the conference agreement directed that within the R&RA, \$300.0 million be available solely for the Major Research Instrumentation program. Additional conference language directed that of the total provided to EHR, \$60.0 million be directed to the Robert Noyce Program, \$25.0 million be directed to the MSP, and \$15.0 million used solely for the Professional Science Master's Program.

The FY2011 request for the NSF totals \$7,424.4 million, an 8.0% increase (\$551.9 million) over the FY2010 estimate of \$6,872.5 million. The FY2011 request provides support for seven major directorates and other programs and activity accounts. The Research and Related Activities (R&RA) account is funded at \$6,018.8 million in the FY2011 request, 8.2% above the FY2010 estimate of \$5,563.9 million. R&RA funds research projects, research facilities, and education and training activities. R&RA includes Integrative Activities (IA), and is a source of funding for the acquisition and development of research instrumentation at U.S. colleges and universities, disaster research teams, Partnerships for Innovation, and the Science and Technology Policy Institute. The FY2011 request for IA is \$295.9 million. The Office of Polar Programs, funded in the R&RA, is proposed at \$528.0 million in the FY2011 request.

On July 22, 2010, the Senate Committee on Appropriations approved S. 3636, Commerce, Justice, and Science Appropriations Bill, FY2011 (S.Rept. 111-229). The Senate bill requests a total of \$7,353.4 million for the NSF in FY2011, approximately \$71.0 million below the Administration's FY2011 request and \$480.9 million above the FY2010 estimate. Included in the support for NSF is \$5,967.2 million for the R&RA, \$51.6 million below the President's FY2011 request and \$403.3 million above the FY2010 level.

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Background

The NSF's primary responsibility is to maintain the health and vitality of the U.S. academic science and engineering enterprise. In addition to ensuring the nation's supply of scientific and engineering personnel, the NSF promotes academic basic research and science and engineering education across many disciplines.¹ Other federal agencies, in contrast, support mission-specific research (i.e., health, agriculture, defense).

The NSF provides support for investigator-initiated, merit-reviewed, competitively selected awards, state-of-the-art tools, instrumentation and facilities. NSF receives approximately 44,400 proposals for research, graduate and postdoctoral fellowships, and science, mathematics, and engineering projects annually, and makes about 11,500 new funding awards. Support is provided to academic institutions, industrial laboratories, private research firms, and major research facilities and centers. In addition, annual awards are made for professional and service contracts. While NSF does not operate any laboratories, it does support Antarctic research stations, selected oceanographic vessels, and national research centers. Additionally, NSF supports university-industry relationships and U.S. participation in international scientific ventures.

The majority of the research supported by the NSF is conducted at U.S. colleges and universities. Approximately 81.9% (\$3,569.1 million) of NSF's estimated FY2008 \$4,357.7 million research and development (R&D) budget was awarded to U.S. colleges and universities.² Preliminary data reveal that in FY2008, NSF provided approximately 62.4% of all federally funded **basic** research conducted at the nation's colleges and universities, with the exclusion of biomedical research sponsored by the National Institutes of Health.³

The NSF is an independent agency in the executive branch and under the leadership of a presidentially appointed Director and a National Science Board (NSB) composed of 24 scientists, engineers, and university and industry officials involved in research and education. The NSB and the Director make policy for the NSF.

¹ The NSF does not provide funding for research in clinical medicine, commerce, social work, or the arts and humanities. However, its investments in basic research contribute to scientific advances in drug delivery, regenerative medicine, and the design and manufacturing of pharmaceuticals.

² National Science Foundation, *Federal Funds for Research and Development: Fiscal Years 2006-2008*, Detailed Statistical Tables, NSF10-303, Arlington, VA, October 2009, Table 10.

³ While the FY2008 R&D appropriation of \$4,049.4 million for NSF was only 3.9% of the total federal R&D budget, the agency plays a significant role in maintaining the academic research enterprise. Preliminary FY2008 data reveal that the NSF provided 14.3% of all federally supported basic research and 15.7% of federal academic research. In addition, NSF was the second largest federal supporter of academic research in FY2008, eclipsed by the Department of Health and Human Services, which provided 70.0%. The Department of Defense, the third largest supporter of academic research, provided 6.3%. *Federal Funds for Research and Development: Fiscal Years 2006-2008*, Tables 10 and 59.

**Figure I. NSF R&D Support in FY2010 Constant Dollars
FY2001-FY2010**



Source: National Science Foundation FY2011 Budget Request to Congress, Summary Tables -14. (R&RA—Research and Related Activities, and EHR—Education and Human Resources).

Organization and FY2011 Request

The NSF has witnessed growth during a period of constrained research budgets. When measured in current dollars, its total appropriation increased approximately 65.4% in 10 years—FY2001, \$4,459.9 million; FY2005, \$5,480.8 million; and FY2010, \$6,872.5 million. Even when inflation is taken into account, its growth increased 25.7% during this 10-year period. The FY2011 request for the NSF is \$7,424.4 million, an 8.0% increase (\$551.9 million) over the FY2010 estimate of \$6,872.5 million. Under President Barack Obama’s Plan for Science and Innovation, the Administration has proposed doubling the federal investment in basic research over a period of 10 years relative to FY2006 levels. The FY2011 request will be an installment toward that doubling effort. NSF has identified several strategies in the FY2011 budget request: to expand the scientific workforce and broaden the participation from underrepresented groups and geographical regions; to increase three-fold the number of new Graduate Research Fellowships awarded annually; to expand and enhance international partnerships and interagency collaborations; to perform effectively with the highest standards of accountability; to meet the National Innovation Strategy goals of supporting next-generation information technology and secure cyber space; and to maintain a portfolio of basic, high-risk, and transformative research across all disciplines. NSF contends that in the global environment of science and engineering, support for transformative, high-risk, high-reward research is critical to U.S. competitiveness. Arden L. Bement, Director, NSF, describes transformative research as “a range of endeavors, which promise extraordinary outcomes; such as, revolutionizing entire disciplines, creating entirely new fields, or disrupting

accepted theories and perspective.”⁴ Also included in the FY2011 budget request is \$766.0 million for a portfolio of programs entitled Science, Engineering, and Education for Sustainability. Support for these programs will provide integrated methods to expand U.S. energy independence, reduce energy use and carbon intensity, and improve environmental management, all while simultaneously promoting economic growth.

The FY2011 request provides support for seven major directorates and other programs and activity accounts. The Research and Related Activities (R&RA) account is funded at \$6,018.8 million in the FY2011 request, 8.2% above the FY2010 estimate of \$5,563.9 million. R&RA funds research projects, research facilities, and education and training activities. R&RA includes Integrative Activities (IA), and is a source of funding for the acquisition and development of research instrumentation at U.S. colleges and universities, disaster research teams, Partnerships for Innovation, and the Science and Technology Policy Institute. The FY2011 request for IA is \$295.9 million. The Office of Polar Programs (OPP), funded in the R&RA, is proposed at \$528.0 million in the FY2011 request. The directorates are the Biological Sciences; Computer and Information Science and Engineering; Education and Human Resources; Engineering; Geosciences; Mathematical and Physical Sciences; and Social, Behavioral, and Economic Sciences. Six of the seven directorates are in the R&RA account. The seven major directorates are described below.

Biological Sciences (BIO)

The FY2011 request of \$767.8 million for the BIO Directorate supports programs structured to improve scientific understanding of biological phenomena, ranging from the study of fundamental molecules of living organisms to the complexity of biological systems. Types of support to be provided include research workshops, symposia, conferences, the improvement of research collections, purchase of scientific equipment, and operation of research facilities.

Computer and Information Science and Engineering (CISE)

The CISE Directorate is proposed at \$684.5 million in the FY2011 request. Programs in CISE focus on the fundamental understanding of computing and information processing, and the use of state-of-the-art computational techniques in scientific and engineering research. Currently, areas of research emphasis include parallel processing, automation and robotics, large-scale integrated electronic systems, scientific computing, and networking.

Education and Human Resources (EHR)

The FY2011 request of \$892.0 million for EHR supports science, engineering, mathematics, and technology education at all educational levels. People receiving funding from the EHR include senior researchers, postdoctoral associates, graduate and undergraduate students, and teachers and students at the precollege level. Additional support is provided to individuals through informal science activities.

⁴ Bement, Jr., Arden L., Director, National Science Foundation, “Transformative Research: The Artistry and Alchemy of the 21st Century,” remarks, Texas Academy of Medicine, Engineering and Science Fourth Annual Conference, Austin, Texas, January 4, 2007. http://www.nsf.gov/news/speeches/bement/07/alb070104_texas.jsp.

Engineering (ENG)

The activities of the ENG, at \$825.7 million in the FY2011 request, are directed at enhancing the long-term economic strength and security of the nation by fostering innovation and excellence in engineering education and research. The ENG is focused on integrating education and research in interdisciplinary areas such as information and communication technologies, biotechnology, and environmental research.

Geosciences (GEO)

The FY2011 request of \$955.3 million for the GEO Directorate is to support programs that promote knowledge and discussions concerning earth, including the sun, atmosphere, continents, oceans, and interior, and the linkages among them. One of the objectives of the GEO is to expand the knowledge of the biological, chemical, geological, and physical processes in the ocean, and at its boundaries, with the atmosphere and the earth's crust.

Mathematical and Physical Sciences (MPS)

The FY2011 request of \$1,409.9 million for the MPS is to fund programs designed to increase the knowledge base in the relevant sciences; improve the quality of educational programs, with emphasis at the undergraduate level; improve the rate at which research efforts are translated into societal benefits; and increase the diversity of approaches and individuals in the mathematical and physical sciences.

Social, Behavioral, and Economic Sciences (SBE)

The SBE Directorate, proposed at \$268.8 million in FY2011, is to support programs directed at developing basic scientific knowledge about human behavior, culture, interaction, and decision making, and about social, political, and economic systems, organizations, and institutions. The SBE serves as the nation's primary data source on science and engineering human, institutional, and financial resources.

Other Program Activities and Accounts

The Major Research Equipment and Facilities Construction (MREFC) account is funded at \$165.2 million in the FY2011 request, a 40.8% increase above the FY2010 estimate.⁵ The MREFC supports the acquisition and construction of major research facilities and equipment that extend the boundaries of science, engineering, and technology. According to NSF, it is the primary federal agency providing support for "forefront instrumentation and facilities for the academic research and education communities." NSF's first priority for funding is for ongoing projects. Second priority is given to projects that have been approved by the National Science Board for new starts. To qualify for support, NSF requires MREFC projects to have "the potential

⁵ The American Recovery and Reinvestment Act, FY2009, provided an additional \$400.0 million for the MREFC in FY2009. For expanded discussion of the MREFC account see CRS Report RS21267, *U.S. National Science Foundation: Major Research Equipment and Facility Construction*, by Christine M. Matthews.

to shift the paradigm in scientific understanding and/or infrastructure technology.” In FY2011 NSF anticipates construction of the National Ecological Observatory Network (NEON) at a cost of \$20.0 million. The NEON will compile data on the effects of climate changes, land use changes, invasive species on natural resources, and biodiversity. The data from NEON will have local, regional, and national uses. In addition to the support of NEON, NSF will continue its support of four ongoing construction projects: Advanced Laser Interferometer Gravitational Wave Observatory (\$23.6 million), Atacama Large Millimeter Array (\$13.9 million), Advanced Technology Solar Telescope (\$17.0 million), and the Ocean Observatories Initiative (\$90.7 million).

The FY2011 request for the EHR Directorate is \$892.0 million, \$19.2 million (2.2%) above the FY2010 estimate. The EHR portfolio is focused on, among other things, increasing the technological literacy of all citizens; preparing the next generation of science, engineering, and mathematics professionals; and closing the achievement gap of underrepresented groups in all scientific fields. Support at the various educational levels in the FY2011 request is as follows: research on learning in formal and informal settings (including precollege), \$247.9 million; undergraduate, \$290.0 million; and graduate, \$185.3 million. The Math and Science Partnership Program (MSP), an interagency program, is proposed at \$58.2 million in the FY2011 request. The MSP in NSF coordinates activities with the Department of Education and its state-funded MSP sites. NSF’s priorities in the EHR include Discovery Research K-12 (\$118.5 million), Integrative Graduate Education and Research Traineeship (\$29.5 million), Graduate Research Fellowships (\$107.6 million), and the Graduate Teaching Fellows in K-12 Education (\$48.2 million). An additional priority in the EHR will support a new comprehensive program to increase the participation of undergraduates at Historically Black Colleges and Universities, at Tribal colleges and universities, and at Hispanic-serving institutions. This new program, Comprehensive Broadening Participation of Undergraduates in STEM, will build on and realign the existing NSF programs that are directed at strengthening and expanding the participation of underrepresented groups and diverse institutions in the scientific and engineering enterprise. The Comprehensive Broadening Participation of Undergraduates in STEM is proposed at \$103.1 million in the FY2011 request.

Policy Issues

In September 2006, the NSF released the report, *Investing in America’s Future- Strategic Plan FY2006-2011*.⁶ The report addresses the accelerating pace of scientific discoveries that are occurring in a more competitive international environment. The *Strategic Plan* lists several investment priorities that are targeted for increased emphasis or funding over the next five years. The investments include furthering U.S. economic competitiveness; promoting transformational, multidisciplinary research; improving K-12 teaching and learning in science and mathematics; developing a comprehensive, integrated cyberinfrastructure; and strengthening the nation’s collaborative advantage through unique networks and innovative partnerships.

There has been considerable debate in the academic and scientific community and in Congress about the management and oversight of major projects selected for construction and the need for prioritization of potential projects funded in the MREFC account. One continuing question has focused on the process for including major projects in the upcoming budget cycle. In a

⁶ National Science Foundation, *Investing in America’s Future-Strategic Plan FY2006-2011*, NSF06-48, Arlington, VA, September 2006, 19 pp.

management report on major projects, NSF contends that because of the changing nature of science and technology, it is necessary to have the flexibility of reconsidering facilities at the various stages of development.⁷ In addition, NSF asserts that it must be able to respond, effectively, to possible changes in interagency participation, international and cooperative agreements, or co-funding for major facilities. NSF maintains that while some “concepts” may evolve into major research projects, others may prove infeasible for project support.

In February 2008, NSF released its third annual *Facility Plan*.⁸ The *2008 Facility Plan* covers readiness stage projects through those projects that are in the process of completion. The *Facility Plan* describes NSF’s goals and strategies for incorporating the existing approaches and practices into a system for selecting, managing, and overseeing large facility projects to make certain that a large facility is both constructed properly and is the appropriate facility to build. All projects seeking funding in the MREFC move through a “progressive sequence of increasingly detailed development and assessment steps” in order to be considered for construction support.

Several pieces of competitiveness legislation have been introduced in the 111th Congress to strengthen science and mathematics education. There are concerns about the nation’s continued ability to compete in world markets and to produce a scientific and technical workforce that would ensure economic prosperity and military capability. A priority of the NSF is to advance the productivity of research for students and teachers and to increase the number of U.S. students pursuing scientific and technical disciplines. However, the FY2011 request proposed reductions for some science education programs. The America COMPETES Act authorized increased funding for selected science and mathematics education programs, and the establishment of some new programs. Several of these programs did not receive the authorized level of funding in the FY2010 budget request.⁹ Support for EHR has declined from \$944.1 million in FY2004 to \$892.0 million in the FY2011 request. Questions are being raised as to whether the NSF can effectively continue in its explicit mission and responsibility to improve science and mathematics education.

On February 17, 2009, President Obama signed into law P.L. 111-5, the American Recovery and Reinvestment Act, 2009 (H.R. 1). The legislation provided approximately \$3.0 billion in additional appropriation funding for NSF in FY2009—\$2.5 billion for R&RA, \$400.0 million for MREFC, \$100.0 million for EHR, and \$2.0 million for the Office of Inspector General. Language in the conference agreement directs that within the R&RA, \$300.0 million be available solely for the Major Research Instrumentation program. Additional conference language directs that of the total provided to EHR, \$60.0 million be directed to the Robert Noyce Program, \$25.0 million be directed to the MSP, and \$15.0 million used solely for the Professional Science Master’s Program. The House-passed version of H.R. 1 had provided similar funding levels for the selected directorates and programs. The Senate-passed version of the legislation, however, would have provided slightly more than \$1.2 billion for the NSF—\$1.0 billion for R&RA, \$150.0 million for MREFC, \$50.0 million for EHR, and \$2.0 million for the Office of Inspector General.

On July 22, 2010, the Senate Committee on Appropriations approved S. 3636, Commerce, Justice, and Science Appropriations Bill, FY2011 (S.Rept. 111-229). The Senate bill requests a

⁷ National Science Board, *Setting Priorities for Large Research Projects Supported by the National Science Foundation*, NSB05-77, Arlington, VA, September 2005, 31 pp.

⁸ National Science Foundation, *2008 Facility Plan*, NSF08-24, Arlington, VA, February 2008, 44 pp. Note: The *2009 Facility Plan* is currently in its final review.

⁹ See CRS Report RL34396, *The America COMPETES Act and the FY2009 Budget*, by Deborah D. Stine.

total of \$7,353.4 million for the NSF in FY2011, approximately \$71.0 million below the Administration's FY2011 request and \$480.9 million above the FY2010 estimate.¹⁰ Included in the support for NSF is \$5,967.2 million for the R&RA, \$51.6 million below the President's FY2011 request and \$403.3 above the FY2010 level. Within the R&RA, \$144.6 million is provided for cybersecurity research, with \$55.0 million being directed at the Comprehensive National Cybersecurity Initiative. EPSCoR is to be funded at \$157.4 million, a 7.0% increase over the FY2010 level. The Committee report proposes transferring \$54.0 million to the Coast Guard for operation and maintenance of the polar icebreakers.¹¹ The Senate Committee will also provide \$155.2 million for MREFC (\$10.0 million below the request and \$37.9 million above the FY2010 level) and \$892.0 million for the EHR (an amount level with the request and \$19.2 million above FY2010). The Committee denies the Administration's request to merge the programs directed at broadening participation in the sciences—Historically Black Colleges and Universities Undergraduate Program (HBCU-UP), Tribal Colleges and Universities Program (T-CUP), and Louis Stokes Alliances for Minority Participation (LSAMP). The report states that: “These three programs each have different purposes and engage students and colleges and universities in a different manner. One size will not fit all.”¹² The report directs NSF to maintain the structure of these programs and to fund HBCU-UP at \$32.0 million, T-CUP at \$14.0 million, and LSAMP at \$44.8 million in FY2011.¹³

H.R. 5116, the America COMPETES Reauthorization Act, FY2010 passed the House on May 28, 2010 (H.Rept. 111-478).¹⁴ The bill authorizes appropriations for the NSF for the next five years in the following amounts: FY2011, \$7,481.0 million; FY2012, \$8,127.0 million; FY2013, \$8,764.0 million; FY2014, \$9,436.0 million; and FY2015, \$10,161.0 million. Within those authorization levels, the R&RA is to receive the following: FY2011, \$6,020.0 million, FY2012, \$6,496.0 million; FY2013, \$7,009.0 million; FY2014, \$7,562.0 million; and FY2015, \$8,160.0 million. Language in the report directs that a minimum of 5.0% of the research budget be directed toward high-risk, high-reward, potentially transformative basic research. Language is also included that states that prior to any realignment of the Broadening Participation Program, NSF should develop a plan clarifying the objectives of the proposed changes, detailing how the separate programs would contribute to increasing the number of individuals from underrepresented groups.

¹⁰ The FY2010 level has been adjusted reflecting the Coast Guard transfer.

¹¹ Report language in the Senate Committee report cautioned NSF that for FY2012, no funds would be considered for the operation and the maintenance of the icebreakers Polar Sea and Polar Star. (Although security needs in the Arctic have increased, both of these heavy icebreakers are currently out of service.) Such funding for operation and maintenance would have to be sought and included in the Coast Guard's budget request. An updated Memorandum of Agreement between the Coast Guard and the NSF must be submitted to the Senate Committee by December 31, 2010.

¹² Senate Committee on Appropriations, *Departments of Commerce and Justice, and Science, and Related Agencies Appropriations Bill, 2011*, 111th Congress, 2nd Sess., Report to accompany S. 3636, S.Rept. 111-229, July 22, 2010, p. 138.

¹³ See for example Mervis, Jeffrey, “NSF Misfires on Plan to Revamp Minority Programs,” *Science*, v. 329, July 23, 2010, p. 376.

¹⁴ On May 18, 2010, H.R. 5116 was reintroduced as H.R. 5325. H.R. 5325 was considered under suspension of the rules but failed to get the necessary two-thirds vote. H.R. 5325 was moved to unfinished business. For an expanded discussion of the America COMPETES Act, see for example CRS Report R41231, *America COMPETES Reauthorization Act of 2010 (H.R. 5116) and the America COMPETES Act (P.L. 110-69): Selected Policy Issues*, coordinated by Heather B. Gonzalez.

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