



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 Research and Related Activities (R&RA), \$400.0 million for Major Research Equipment and Facilities Construction (MREFC), \$100.0 million for Education and Human Resources (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 Math and Science Partnership program, and \$15.0 million used solely for the Professional Science Master's Program.

The FY2012 request for the NSF totals \$7,767.0 million, a 13.0% increase (\$894.5 million) over the FY2011 enacted level of \$6,859.9 million. The FY2012 request provides support for seven major directorates and other programs and activity accounts. The R&RA account is proposed at \$6,253.5 million in the FY2012 request, 12.4% above the FY2011 level of \$5,563.9 million. R&RA funds research projects, research facilities, and education and training activities. R&RA is also 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.

On April 15, 2011, the President signed into law the Department of Defense and Full-Year Appropriations Act, 2011 (P.L. 112-10). The act provides, among other things, funding for the NSF through the Commerce, Justice, Science, and Related Agencies Act, 2011. The legislation provides a total of \$6,859.9 million for the NSF in FY2011, an approximate 1% reduction from 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 FY2012 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 FY2012 request for the NSF is \$7,767.0 million, a 13.2% increase (\$907.1 million) over the FY2010 level of \$6,859.9 million.⁴ Under President Barack Obama’s Strategy for American Innovation, the Administration has proposed doubling the federal investment in basic research over a period of 10 years relative to FY2006 levels. The FY2012 request will be an installment toward that doubling effort. NSF has identified several strategies in the FY2012 budget request, including expanding the scientific workforce and broadening participation from underrepresented groups and geographical regions; expanding and enhancing international partnerships and interagency

⁴ The FY2012 request for NSF does propose the termination or reduction of six programs—Deep Underground Science and Engineering Laboratory, Research Initiation Grants to Broaden Participation in Biology, Science of Learning Center, Synchrotron Radiation Center, National STEM Distributed Learning Program, and Graduate STEM Fellows in K-12 Education. For discussion please see Written testimony of Subra Suresh, Director, National Science Foundation, House Committee on Science, Space, and Technology, *The President’s Fiscal Year 2012 Budget Request for the National Science Foundation*, Hearing, 112th Congress, 1st Sess., March 11, 2011, p.7-8.

collaborations; promoting competitive markets that spur productive entrepreneurship; and maintaining 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. Transformative research is described by NSF as "... research that has the capacity to revolutionize existing fields, create new fields, cause paradigm shifts, support discovery, and lead to radically new technologies."⁵ Several reports have recommended that funds be allocated specifically for this type of research. Also included in the FY2012 budget request is \$998.2 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 FY2012 request provides support for seven major directorates and other programs and activity accounts. The Research and Related Activities (R&RA) account is funded at \$6,253.5 million in the FY2012 request, 12.4% above the FY2011 enacted level 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 FY2012 request for IA is \$275.0 million. The Office of Polar Programs (OPP), funded in the R&RA, is proposed at \$477.4 million in the FY2012 request.⁶ 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 FY2012 request of \$794.5 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 \$728.4 million in the FY2012 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.

⁵ National Science Board, *Enhancing Support of Transformative Research at the National Science Foundation*, NSB07-32, Arlington, VA, May 7, 2007, p. 1.

⁶ Proposed funding in the FY2012 request for OPP includes support for the ice-breaking research vessels the Laurence M. Gould and the Nathaniel B. Palmer, small fixed-wing aircrafts and helicopters, and icebreakers for ship escorts and channel breaking. NSF combines federal and civilian contract service providers for research support at the poles.

Education and Human Resources (EHR)

The FY2012 request of \$911.2 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.

Engineering (ENG)

The activities of the ENG, at \$908.3 million in the FY2012 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 FY2012 request of \$979.2 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 FY2012 request of \$1,432.7 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 \$301.1 million in FY2012, 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 \$224.7 million in the FY2012 request, a 91.8% increase above the FY2011 enacted level.⁷ 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 states that: “Modern and effective research infrastructure is critical to maintaining U.S. leadership in science and engineering. The future success of entire fields of research depends upon access to new generations of powerful research tools. Increasingly, these tools are large and complex, and have a significant information technology component.”⁸ NSF gives highest priority to ongoing projects, and second-highest priority 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 to shift the paradigm in scientific understanding.”⁹ In FY2012, NSF will support the following programs: National Ecological Observatory Network (NEON) \$87.9 million, Advanced Laser Interferometer Gravitational Wave Observatory (\$21.0 million); Atacama Large Millimeter Array (\$3.0 million); Advanced Technology Star Telescope (\$10.0 million); and the Ocean Observatories Initiative (\$102.8 million).

The FY2012 request for the Education and Human Resources (EHR) Directorate is \$911.2 million, \$50.2 million (5.8%) above the FY2010 level. 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 FY2012 request is as follows: research on learning in formal and informal settings (including precollege), \$264.1 million; undergraduate education, \$295.4 million; and graduate education, \$191.7 million. Priorities at the precollege level include research and evaluation on education in science and engineering (\$54.7 million), informal science education (\$68.1 million), project and program evaluation (\$22.0 million), and Discovery Research K-12 (\$99.2 million). Discovery Research is structured to encourage innovative thinking in K-12 science, technology, engineering, and mathematics education, and to develop tools for measuring learning impacts in a variety of forms.

According to NSF, its undergraduate level program is intended to address the needs of the 21st century while transforming undergraduate science and mathematics education. Priorities at the undergraduate level in FY2012 include the Robert Noyce Scholarship Program (\$45.0 million); Curriculum, Laboratory and Instructional Development (\$73.5 million); Advanced Technological Education (\$64.0 million); and the Math and Science Partnership program (MSP, \$48.2 million). The MSP is an interagency program and the NSF coordinates its MSP activities with the Department of Education and state-funded MSP sites. At the graduate level, NSF’s priorities are Integrative Graduate Education and Research Traineeship (IGERT) (\$30.2 million), Graduate

⁷For 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.

⁸ U.S. National Science Foundation, *National Science Foundation: FY2012 Budget Request to Congress*, Arlington VA, February 14, 2011, p. MREFC-1.

⁹*Ibid.*, p. MREFC-2.

Research Fellowships (\$134.6 million), and the Graduate STEM Fellows in K-12 Education (\$27.0 million).¹⁰

An additional priority in the EHR is to support a new comprehensive program to increase the participation of undergraduates at Historically Black Colleges and Universities, tribal colleges and universities, and Hispanic-serving institutions. The new program, Broadening Participation at the Core (BPAC), will build on and amplify 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.¹¹ BPAC is proposed at \$111.1 million in the FY2012 request.

Policy Issues

In September 2006, the NSF released the report, *Investing in America's Future- Strategic Plan FY2006-2011*.¹² 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 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.¹³ 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.

¹⁰ In the FY2012 budget request, NSF has proposed the eventual termination of the Graduate STEM Fellows in K-12 Education, citing that while the program has been effective in its goal, the agency plans to expand the graduate experiences through other programs. See Written testimony of Subra Suresh, Director, National Science Foundation, House Committee on Science, Space, and Technology, *The President's Fiscal Year 2012 Budget Request for the National Science Foundation*, p. 7, and Mervis, Jeffrey, "Outrage Greets NSF Decision to End STEM Fellows Program", *Science*, v. 331, March 4, 2011, p. 1127.

¹¹ The FY2011 request of the NSF also proposed a merger of the programs directed at underrepresented groups and diverse institutions. Report language and committee action in the appropriation process for FY2011 directed NSF to maintain the structure of those existing programs.

¹² National Science Foundation, *Investing in America's Future-Strategic Plan FY2006-2011*, NSF06-48, Arlington, VA, September 2006, 19 pp.

¹³ National Science Board, *Setting Priorities for Large Research Projects Supported by the National Science Foundation*, NSB05-77, Arlington, VA, September 2005, 31 pp.

In February 2008, NSF released its third annual *Facility Plan*.¹⁴ 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 were introduced during the 111th Congress to strengthen science and mathematics education. Concerns have been expressed 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 FY2012 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 FY2012 budget request.¹⁵ 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 (OIG). 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 OIG.

On October 18, 2010, Subra Suresh was sworn in as the 13th director of the NSF.¹⁶ He replaces Arden L. Bement, who had held the position since 2004.¹⁷ Suresh, a mechanical engineer and former dean of the school of engineering at the Massachusetts Institute of Technology, has conducted research in materials science and biology. Suresh indicated that some changes at NSF that may be necessary to make include the peer review system, a reevaluation of the requirement for a "broader impact" measure in grant proposals, and the loss of talent along the scientific and

¹⁴ 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.

¹⁵ See 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.

¹⁶ Suresh was confirmed by the Senate on September 30, 2010. The appointment is for a six-year term.

¹⁷ Bement resigned his position at NSF in May 2010 to become Director, Global Policy Research Institute, Purdue University.

technical pipeline.¹⁸ These issues and others are to be addressed in a climate of rising national debt concerns, budget constraints, and the changing political structure of a 112th Congress.¹⁹

On January 4, 2011, President Obama signed into law the America COMPETES Reauthorization Act, FY2010 (P.L. 111-358).²⁰ The law authorizes appropriations for the NSF from FY2011 through FY2013. Within the authorization levels, the R&RA is to receive the following: FY2011, \$5,974.8 million; FY2012, \$6,234.3 million; and FY2013, \$6,637.8 million. The EHR is authorized at the following levels: FY2011, \$937.9 million; FY2012, \$979.0 million; and FY2013, \$1,041.8 million. In addition, committee action denied the Administration's request to merge the programs directed at broadening participation in the sciences—Historically Black Colleges and Universities Undergraduate Program, Tribal Colleges and Universities Program, and Louis Stokes Alliances for Minority Participation. It was stated 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.”²¹

On April 15, 2011, President Obama signed into law the Department of Defense and Full-Year Appropriations Act, 2011 (P.L. 112-10). The act provides, among other things, funding for the NSF through the Commerce, Justice, Science, and Related Agencies. The act provides a total of \$6,859.9 million for the NSF, a 1% reduction from the FY2010 enacted level.²² Included in that total for NSF for FY2011 is \$5,563.9 million for R&RA; \$861.0 million for EHR; \$117.1 million for MREFC; \$4.5 million for the NSB; and \$14.0 million for the Office of Inspector General.

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¹⁸ Mervis, Jeffrey, “A World of Changes Prepares Subra Suresh to Tackle Change at NSF,” *Science*, v. 330, November 19, 2010, pp. 1034-1035.

¹⁹ See for example Young, Kerry, “GOP Aims Down, Not Up in Reversal of Budget Goals,” *Congressional Quarterly*, December 15, 2010, <http://www.cq.com/alertmatch/116816465>.

²⁰ For expanded discussion of the America COMPETES Reauthorization Act see CRS Report R41819, *Reauthorization of the America COMPETES Act: Selected Policy Provisions, Funding, and Implementation Issues*, by Heather B. Gonzalez.

²¹ Senate Committee on Appropriations, *Departments of Commerce and Justice, and Science, and Related Agencies Appropriations Bill, 2011*, 111th Sess., Report to accompany S. 3636, S.Rept. 111-229, July 22, 2010, p. 138.

²² The FY2011 level includes a 0.2% across-the-board rescission that has been applied to all non-defense programs. The Department of Defense and Full-Year Continuing Appropriations Act provides funding levels at the major account level. As of this writing, funding levels at the program level are not yet available. NSF has been directed to submit a plan with budgetary program levels to the House and Senate Committees on Appropriations within 60 days of the enactment of the continuing appropriation.