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CRS Report for Congress

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 82.6% ($3,174.9 million) of NSF's FY2005 $3,844.2 million research and development (R&D) budget was awarded to U.S. colleges and universities.[1] Preliminary data reveal that for FY2005 the NSF provided approximately 60.3% 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. In addition, NSF provides more than 30% of the total federal support for science and mathematics education. This report will be updated periodically.

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.[2] Other federal agencies, in contrast, support mission-specific research (i.e., health, agriculture, defense).

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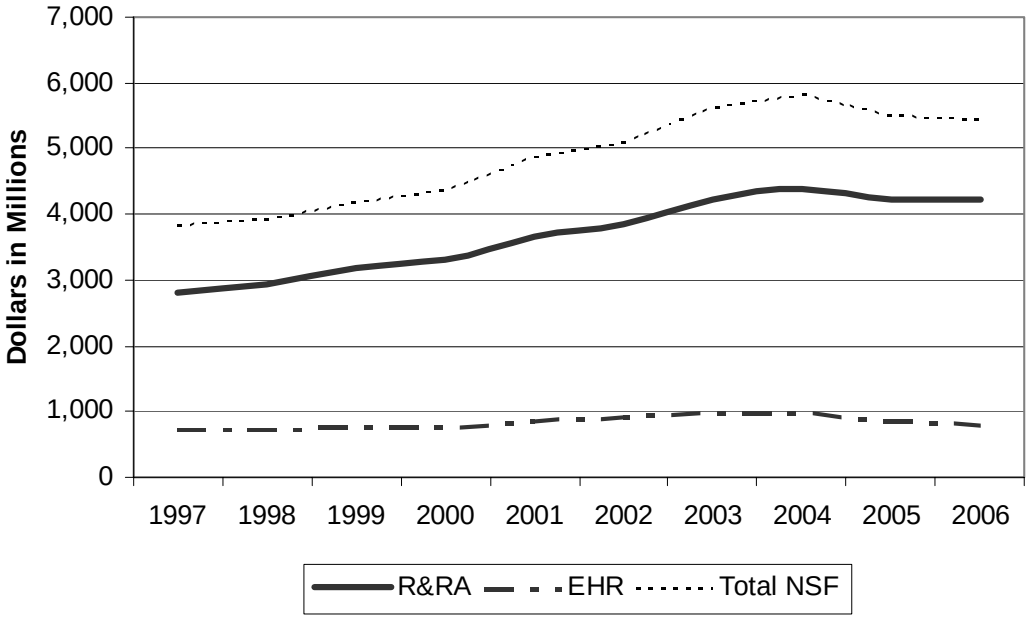
[1] National Science Foundation, *Federal Funds for Research and Development: Fiscal Years 2003- 2005*, Detailed Statistical Tables, NSF06-313, Arlington, VA, April 2006, Table 10.

[2] 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.

The NSF provides support for investigator-initiated, merit-reviewed, competitively selected awards, state-of-the-art tools, instrumentation and facilities. In FY2005, the agency received approximately 41,700 proposals for research, graduate and postdoctoral fellowships, and science, mathematics, and engineering projects, and made about 10,000 new funding awards. Support is provided to academic institutions, industrial laboratories, private research firms, and major research facilities and centers. 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.

Most of the research supported by the NSF is conducted at U.S. colleges and universities. Approximately 82.6% ($3,174.9 million) of NSF's estimated FY2005 $3,844.2 million research and development (R&D) budget was awarded to U.S. colleges and universities. Preliminary data reveal that in FY2005, NSF provided approximately 60.3% 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]

Figure 1. NSF R&D Support in FY2005 Constant Dollars, FY1997 - FY2006



Source: *National Science Foundation FY2007 Budget Request to Congress,* p.32

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[3] While the FY2005 R&D appropriation of $3,844.2 million for NSF was only 3.6% of the total federal R&D budget, the agency plays a significant role in maintaining the academic research enterprise. Preliminary FY2005 data reveal that the NSF provided 13.1% of all federally supported basic research and 13.5% of federal academic research. In addition, NSF was the second largest federal supporter of academic research in FY2005, eclipsed by the Department of Health and Human Services, which provided 67%. The Department of Defense, the third largest supporter of academic research, provided 6.6%. *Federal Funds for Research and Development: Fiscal Years 2003-2005,* Tables 10 and 29.

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.

Organization and Fiscal Year 2007 Request. The NSF has witnessed considerable growth during a period of constrained research budgets. When measured in current dollars, its total appropriation increased more than 69.2% in 10 years — FY1997, $3,298.8 million; FY2001, $4,459.9 million; and FY2006, $5,581.2 million. Even when inflation is taken into account, its growth increased (in constant FY2005 dollars) by 42% during this 10-year period. The FY2007 request for the NSF was $6,020 million, a 7.9% increase ($439 million) over the FY2006 level of $5,472.8 million. The President's American Competitiveness Initiative proposed to double the NSF budget over the next 10 years. The FY2007 request was to be the first installment toward that doubling effort. NSF planned an investment of approximately $640.0 million in programs targeted at those groups underrepresented in the science and engineering workforce. NSF asserts that international research partnerships are critical to the nation in maintaining a competitive edge, addressing global issues, and capitalizing on global economic opportunities. To address these particular needs, the FY2007 request proposed $40.6 million for the Office of International Science and Engineering. A first-year investment of $62.0 million was provided to address major challenges in polar research. Other FY2007 highlights included funding for the National Nanotechnology Initiative ($373.2 million), Climate Change Science Program ($205.3 million), homeland security ($384.2 million), and Networking and Information Technology Research and Development ($903.7 million).

Included in the FY2007 request was $4,666.0 million for Research and Related Activities (R&RA), a 7.7% increase ($334.5 million) over the FY2006 level of $4,331.5 million. R&RA funds research projects, research facilities, and education and training activities. The Administration proposed increased funding for the physical sciences in FY2007 — $248.5 million, a 6.6% increase over FY2006. 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 FY2007 request for IA was $131.4 million, a 4.2% decrease ($5.8 million) from the FY2006 level. The Office of Polar Programs (OPP), funded in the R&RA, was proposed at $438.1 million in the FY2007 request, 12.5% above FY2006. Significant increases in OPP for FY2007 were directed at the programs for arctic and antarctic sciences. In FY2006, responsibility for funding the costs of icebreakers that support scientific research in polar regions was transferred from the U.S. Coast Guard to NSF.[4] The NSF will continue to operate and maintain the three icebreakers.

The FY2007 request provided support for seven major directorates and other programs and activity accounts. 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

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[4] While the NSF does not own the ships, it is responsible for the operation, maintenance, and staffing of the vessels. NSF has been directed to pursue alternative sources of funding for the icebreaking fleet beyond 2006.

Sciences. Six of the seven directorates are in the R&RA. In addition to the directorates, the R&RA includes the OPP and IA. The seven major directorates are described below.

Biological Sciences (BIO). The FY2007 request of $607.9 million for the BIO Directorate supported 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 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, proposed at $526.7 million in FY2007, supported programs focused 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 emphasized are parallel processing, automation and robotics, large-scale integrated electronic systems, scientific computing, and networking.

Education and Human Resources (EHR). The FY2007 request of $816.2 million for EHR supported science, engineering, mathematics, and technology education. 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 $628.6 million in FY2007, were 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 FY2007 request of $744.9 million for the GEO Directorate provided support to 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 FY2007 request of $1,150.3 million for the MPS was 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 $213.8 million in FY2007, supported programs directed at developing basic scientific knowledge about human behavior, culture, interaction, and decisionmaking, and about social, political, and economic systems, organizations, and institutions. The SBE also has served 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 was funded at $240.5 million in the FY2007 request, a 26% increase over FY2006. The MREFC supports the acquisition and construction of major research facilities and equipment that extend the boundaries of science, engineering, and technology. First priority for funding is directed at ongoing projects, and second priority is given to new starts. Five ongoing projects and two new starts were scheduled for support in the FY2007 request — the Atacama Large Millimeter Array Construction ($47.9 million), EarthScope ($27.4 million), IceCube Neutrino Observatory ($28.7 million), National Ecological Observatory Network ($12 million), Scientific Ocean Drilling Vessel ($42.9 million), Alaskan Region Research Vessel ($56 million), and Ocean Observatories Initiative ($13.5 million).

The EHR was proposed at $816.2 million in FY2007, a 2.5% increase ($19.5 million) over FY2006. The EHR portfolio is focused on increasing the technological literacy of all citizens, preparing the next generation of science, engineering, and mathematics professionals, and closing the achievement gap in all scientific fields. Support at the educational levels was: precollege, $215 million; undergraduate, $196.8 million; and graduate, $160.6 million. The Math and Science Partnership Program (MSP) was funded at $46 million, 27.2% below FY2006. Support was directed at ongoing awards (no new partnerships were proposed), data collection, evaluation, and dissemination. Added support was given to programs directed at increasing the number of underrepresented minorities in science, mathematics, and engineering. These included the Historically Black Colleges and Universities Programs ($29.7 million), Tribal Colleges and Universities Program ($12.4 million), Louis Stokes Alliances for Minority Participation ($39.7 million), and Centers of Research Excellence in Science and Technology ($24.9 million). Funding for the Experimental Program to Stimulate Competitive Research (EPSCoR) was $100.0 million in the FY2007 request, a slight increase of $1.3 million over FY2006.

Policy Issues. 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. Appropriation language directed the NSF to improve its oversight of large projects by developing an implementation plan that included comprehensive guidelines and project oversight review. In September 2005, the NSB released its management report on the new guidelines for the development, review, and approval of major projects — *Setting Priorities for Large Research Facility Projects Supported by the National Science Foundation*.[5] The report describes facilities under construction and those being considered for future funding. Because of the changing nature of science and technology, NSF finds it necessary to have the flexibility of reconsidering facilities at the various stages of development. Also, the NSF states that it must be able to respond, effectively, to possible changes in interagency participation, international and cooperative agreements, or co-funding for major research facilities. NSF encourages project planning from disciplines and fields in which scientists and engineers have not traditionally partnered or collaborated. The report notes that while

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

some "concepts" may evolve into MREFC candidates, others may prove infeasible for major project support. The facility plan will be updated as needed.

Several pieces of competitiveness legislation were introduced during the 109th Congress that had as a key provision, funding and strengthening 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.[6] The Administration's *American Competitiveness Initiative* contends that there are several "gaps" in the educational system that need to be addressed in order to better prepare U.S. students for a workforce that is increasingly more scientifically and technically proficient.[7] 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, there were proposed cuts or level funding for several science education programs in NSF's FY2007 request. Also, there were reported efforts to shift support for some programs to the Department of Education. Overall, support for EHR has declined from $944.1 million in FY2004 to $816.2 million in the FY2007 request. Questions are being raised as to whether the NSF can address the "gaps" and effectively continue in its explicit mission and responsibility to improve science and mathematics education with the current level of funding.[8] In March 2006, the NSB approved a commission to prepare a national action plan for improving science and mathematics education. A report is expected in one year.

In September 2006, the NSF released the report, *Investing in America's Future-Strategic Plan FY2006-2011*.[9] NSF states that 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. In addition, NSF will continue to improve management excellence, with a focus on joining such areas as resource allocation, communication strategies, award management and oversight, and the core processes of merit review.

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[6] See for example National Center on Education and the Economy, *Tough Choices or Tough times, the Report fo the New Commission on the Skills of the American Workforce*, Executive Summary, January 2007, 26 pp.

[7] Office of Science and Technology Policy, Domestic Policy Council, *American Competitiveness Initiative - Leading the World In Innovation*, February 2006, Washington, DC, 23 pp.

[8] Mervis, Jeffrey, "National Science Foundation: Is the Education Directorate Headed for a Failing Grade?," *Science*, v. 311, February 24, 2006, pp. 1092-1093.

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