

2004 Guide to Programs



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NOTE: The following OMB & publication number information will appear on the electronic Guide to Programs on the Table of Contents page.

OMB 3145-0058

NSF 04-009 (Replaces NSF 03-009)

47.041 – Engineering Grants

47.049 – Mathematical and Physical Sciences

47.050 – Geosciences

47.070 – Computer and Information Science and Engineering

47.074 – Biological Sciences

47.075 – Social, Behavioral and Economic Sciences

47.076 – Education and Human Resources

47.078 – Office of Polar Programs

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Introduction

About the National Science Foundation

The National Science Foundation (NSF) is an independent Federal agency created by the National Science Foundation Act of 1950, as amended (42 U.S.C. 1861-75). The Act states that NSF shall consist of the National Science Board (NSB) and the Director and establishes NSF to, among other purposes, "promote the progress of science" and "advance the national health, prosperity, and welfare." The NSB establishes NSF's policies within the framework of applicable national policies as set forth by the President and Congress and, together with the Director, recommends and encourages the pursuit of national policies for the promotion of research and education in science and engineering.

From its first days, NSF has had a unique place in the Federal Government. It is responsible for the overall health of science and engineering across all disciplines. In contrast, other Federal agencies support research focused on specific missions such as health or defense. NSF is also committed to ensuring the Nation's supply of scientists, engineers, and science and engineering educators.

NSF funds research and education in most fields of science and engineering. It does this through grants to and cooperative agreements with more than 2,000 colleges, universities, K-12 school systems, businesses, informal science organizations, and other research institutions throughout the United States. NSF accounts for about one-fourth of all Federal support to academic institutions for basic research.

NSF receives approximately 30,000 - 35,000 proposals each year for research, education, and training projects, of which approximately 10,000 are funded. In addition, it receives several thousand applications for graduate and postdoctoral fellowships. NSF grants are typically awarded to universities, colleges, academic consortia, nonprofit institutions, and small businesses. NSF operates no laboratories itself, but it does support National Research Centers, user facilities, certain oceanographic vessels, and Antarctic research stations. It also supports cooperative research between universities and industry, U.S. participation in international scientific efforts, and educational activities at every academic level.

NSF is structured much like a university, with grants-funding divisions for the various disciplines and fields of science and engineering, and for science, technology, engineering, and mathematics education. NSF also uses a variety of management mechanisms to coordinate research in areas that cross traditional disciplinary boundaries. NSF is helped by advisers from the scientific community who serve on formal committees or as ad hoc reviewers of proposals. This advisory system, which focuses on both program directions and specific proposals, involves approximately 50,000 scientists and engineers each year. NSF staff members who are experts in a certain field or area make award recommendations; proposers get unattributed verbatim copies of peer reviews.

Grantees are wholly responsible for conducting their project activities and preparing the results for publication. Thus, NSF does not assume responsibility for such findings or their interpretation.

NSF welcomes proposals on behalf of all qualified scientists, engineers, and educators. It strongly encourages women, minorities, and persons with disabilities to participate fully in its programs. In accordance with Federal statutes and regulations and with NSF policies, no person on grounds of race, color, age, sex, national origin, or disability will be excluded from participation in any program or activity receiving financial assistance from NSF, or be denied the benefits of such a program or activity, or be subjected to discrimination under any such program or activity, although some programs may have special requirements that limit eligibility.

Facilitation Awards for Scientists and Engineers with Disabilities provide funding for special assistance or equipment to enable persons with disabilities to work on NSF-supported projects. See *Grant Proposal Guide (GPG)*, Chapter II, Section D.2. for instructions regarding preparation of these types of proposals.

NSF has Telephonic Device for the Deaf (TDD) and Federal Information Relay Service (FIRS) capabilities that enable individuals with hearing impairments to communicate with the Foundation about NSF programs, employment, or general information. TDD may be accessed at 703-292-5090; FIRS at 1-800-877-8339.

Deadlines and Target Dates

Many of the programs listed in the *Guide to Programs* have an established deadline or target date for the submission of proposals. Information about most of these dates can be found in the NSF *E-Bulletin*, an electronic publication available at <http://www.nsf.gov/home/ebulletin/>. Individual program announcements and solicitations also carry deadline and target date information, as do NSF division websites.

A list of all deadlines sorted by date and by program area is available at <http://www.nsf.gov/home/deadline/deadline.htm>.

Eligibility Requirements

Except where a program solicitation establishes more restrictive eligibility criteria, individuals and organizations in the following categories may submit proposals to NSF:

- **Universities and Colleges**—U.S. universities and 2- and 4-year colleges (including community colleges) acting on behalf of their faculty members.
- **Nonprofit, Nonacademic Organizations**—Independent museums, observatories, research laboratories, professional societies, and similar organizations in the United States that are directly associated with education or research activities.
- **For-Profit Organizations**—U.S. commercial organizations, especially small businesses with strong capabilities in scientific or engineering research and education. An unsolicited proposal from a commercial organization may be funded in cases where the project is of special concern from a national point of view; where special resources are available for the work; or where the proposed project is especially meritorious. NSF is interested in supporting projects that couple industrial research resources and perspectives with those of universities; therefore, it especially welcomes proposals for cooperative projects involving both universities and the private commercial sector.
- **State and Local Governments**—State educational offices or organizations and local school districts may submit proposals intended to broaden the impact, accelerate the pace, and increase the effectiveness of improvements in science, technology, engineering, and mathematics education at K–12 and postsecondary levels.
- **Unaffiliated Individuals**—Scientists, engineers, and educators in the United States and U.S. citizens may be eligible for support, provided that the individual is not employed by or affiliated with an organization, and
 - the proposed project is sufficiently meritorious and otherwise complies with the conditions of any applicable proposal-generating document;
 - the proposer has demonstrated the capability and has access to any necessary facilities to carry out the project; and
 - the proposer agrees to fiscal arrangements that, in the opinion of the NSF Grants Office, ensure responsible management of Federal funds.

Unaffiliated individuals should contact the appropriate program before they prepare a proposal for submission.

- **Foreign Organizations**—NSF rarely provides support to foreign organizations. NSF will consider proposals for cooperative projects involving U.S. and foreign organizations, provided support is requested only for the U.S. portion of the collaborative effort.
- **Other Federal Agencies**—NSF does not normally support research or education activities by scientists, engineers, or educators employed by Federal agencies or Federally Funded Research and Development Centers (FFRDC's). However, a scientist, engineer, or educator who has a joint appointment with a university and a Federal agency (such as a Veterans Administration Hospital) or with a university and an FFRDC may submit proposals through the university and may receive support if he or she is a bona fide faculty member of the university, although part of the salary may be provided by the Federal agency. In some unusual circumstances, other Federal agencies and FFRDC's may submit proposals directly to NSF. Preliminary inquiry should be made to the appropriate program before a proposal is prepared for submission.

To check on special requirements for a specific program, consult the applicable program solicitation or contact the program directly.

Who May Submit Proposals

Scientists, engineers, and educators usually initiate proposals that are officially submitted by their employing organization. It is recommended that the proposal be discussed with appropriate NSF program staff before formal submission.

Graduate students are not encouraged to submit research proposals, but they can arrange to serve as research assistants to faculty members. Some NSF divisions accept proposals for Doctoral Dissertation Research Grants, which should be submitted by a faculty member or thesis adviser on behalf of the graduate student. NSF also provides support specifically for women and minority scientists and engineers, scientists and engineers with disabilities, and faculty at primarily undergraduate academic institutions.

Merit Review Criteria for the Selection of Research and Education Projects

NSF Proposal Review Process

Reviews of proposals submitted to NSF are solicited from peers with expertise in the substantive area of the proposed research or education project. These reviewers are selected by program officers charged with the oversight of the review process. NSF invites the proposer to suggest at the time of submission, the names of appropriate or inappropriate reviewers. Care is taken to ensure that reviewers have no conflicts with the proposer. Special efforts are made to recruit reviewers from non-academic institutions, minority-serving institutions, or adjacent disciplines to what is principally addressed in the proposal.

The National Science Board approved revised criteria for evaluating proposals at its meeting on March 28, 1997 (see [NSB 97-72](#)). All NSF proposals are evaluated using the two merit review criteria. However, in some instances NSF will employ additional criteria--as necessary--to highlight the specific objectives of certain programs and activities.

On July 8, 2002, the NSF Director issued [Important Notice 127](#), "Implementation of new GPG Requirements Related to the Broader Impacts Criterion." This Important Notice reinforces the importance of addressing both criteria in the preparation and review of all proposals submitted to NSF. The Foundation continues to strengthen its internal processes to ensure that both of the merit review criteria are addressed when making funding decisions.

In an effort to increase compliance with these requirements, the January 2002 issuance of the *GPG* incorporated revised proposal preparation guidelines relating to the development of the Project Summary and Project Description. Chapter II of the *GPG* specifies that principal investigators (PIs) must address both merit review criteria in separate statements within the one-page Project Summary. This chapter also reiterates that broader impacts resulting from the proposed project must be addressed in the Project Description and described as an integral part of the narrative.

Effective October 1, 2002, NSF will return without review, proposals that do not separately address both merit review criteria within the Project Summary. It is believed that these changes to NSF proposal preparation and processing guidelines will more clearly articulate the importance of broader impacts to NSF-funded projects.

The two NSB-approved merit review criteria are listed below (see the *GPG*, Chapter III. A for further information). The criteria include considerations that help define them. These considerations are suggestions and not all will apply to any given proposal. While proposers must address both merit review criteria, reviewers will be asked to address only those considerations that are relevant to the proposal being considered and for which he/she is qualified to make judgments.

What is the intellectual merit of the proposed activity?

How important is the proposed activity to advancing knowledge and understanding within its own field or across different fields? How well qualified is the proposer (individual or team) to conduct the project? (If appropriate, the reviewer will comment on the quality of the prior work.) To what extent does the proposed activity suggest and explore creative and original concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?

What are the broader impacts of the proposed activity?

How well does the activity advance discovery and understanding while promoting teaching, training, and learning? How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)? To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships? Will the results be disseminated broadly to enhance scientific and technological understanding? What may be the benefits of the proposed activity to society?

NSF staff will give careful consideration to the following in making funding decisions:

Integration of Research and Education

One of the principal strategies in support of NSF's goals is to foster integration of research and education through the programs, projects, and activities it supports at academic and research institutions. These institutions provide abundant opportunities where individuals may concurrently assume responsibilities as researchers, educators, and students and where all can engage in joint efforts that infuse education with the excitement of discovery and enrich research through the diversity of learning perspectives.

Integrating Diversity into NSF Programs, Projects, and Activities

Broadening opportunities and enabling the participation of all citizens--women and men, underrepresented minorities, and persons with disabilities--is essential to the health and vitality of science and engineering. NSF is committed to this principle of diversity and deems it central to the programs, projects, and activities it considers and supports.

For More Information

The *Grant Proposal Guide (GPG)* provides guidance for the preparation and submission of proposals to NSF. The latest edition is available at <http://www.nsf.gov/cgi-bin/getpub?gpg>. Some NSF programs have program solicitations that modify the general provisions in the *GPG*. In such cases, the guidelines provided in the solicitation must be followed. It is recommended proposers contact NSF program personnel before preparing a proposal.

Effective October 1, 2000, all proposals to NSF must be submitted electronically via the NSF FastLane system (<http://www.fastlane.nsf.gov/fastlane.htm>). The *GPG* includes instructions on how to obtain an exception to the FastLane requirement for those who have difficulties with submission or cannot submit electronically to NSF.

Press Releases and Other Media Materials

As research results develop, NSF grantees should consider whether or not they might warrant National press interest. If so, the grantee should contact either the Media Section in NSF's Office of Legislative and Public Affairs, or the public affairs office of their home institution, to discuss the possibility of media coverage. Contact should be made far enough in advance of a formal announcement to allow sufficient time to develop an appropriate press strategy. Such a strategy may include a press release or news tip, video news release, press conference or briefing, or editorial (opinion) pieces. If unsure of the newsworthiness, contact NSF or the institution public affairs office. National media interviews should be granted only after advance coordination with a public affairs officer. The NSF Media Section can be reached at (703) 292-8070.



General Information

How to Use This Guide

The *Guide to Programs* is a compilation of funding opportunities offered by the National Science Foundation (NSF) for research and education in science, mathematics, engineering, and technology. The *Guide* includes broad, general descriptions of programs and activities for each NSF Directorate, as well as sources for more information. It also offers links to other information sources, including NSF Directorate home pages; to related publications such as program announcements and solicitations that contain additional proposal or eligibility information; and to the *E-Bulletin* for deadline and target date information.

E-Bulletin

The NSF *E-Bulletin* is a web-based document that announces current deadline and target dates for the submission of proposals to the Foundation. The *E-Bulletin* is updated daily on the NSF web site. Subscribers to NSF's Custom News Service (CNS) can receive, via email, a monthly edition of the *E-Bulletin* (see information on CNS below). Each edition covers a 4-month period that includes the current month and the following 3 months. A search form in the *E-Bulletin* lets you find deadlines and target dates for a selected period of time for each research area. For individuals who do not have web access, a print-on-demand monthly edition is available. The *E-Bulletin* can be accessed at <http://www.nsf.gov/home/ebulletin/>.

How to Obtain NSF Publications

NSF strongly encourages electronic dissemination of its documents and offers several ways of obtaining publications electronically.

- **Online Document System (ODS)**—Includes all forms and publications available electronically from NSF. The ODS lets you browse through NSF's electronic publications catalogue and offers a search capability that lets you search by document type, publication title, publication number, and keyword. The ODS home page is located at <http://www.nsf.gov/pubsys/ods/>. For a list of all current NSF documents available in electronic format, visit the ODS Index at <http://www.nsf.gov/pubsys/index.htm>.
- **Custom News Service (CNS)**—An e-mail and web-based alert service designed to allow quick and easy access to NSF news, publications, and information. CNS lets users create a personal profile in which they choose the types of information they are interested in, and notifies them via e-mail when new documents matching their profile are added to NSF's Online Document System. E-mails include links to the electronic location of each document and/or full text of short documents. A weekly e-mail alert listing all documents added the previous week is available under "Notification Preferences" when you set up or modify your profile.
To sign up for NSF's Custom News Service, visit <http://www.nsf.gov/home/cns/>. (*Note: You must have an e-mail address to use CNS.*)
- **Other Methods**—NSF also makes its publications available to users without web access. For information on other methods of obtaining NSF publications, see <http://www.nsf.gov/pubs/start.htm>, or call the NSF Information Center at 703-292-5111 (TDD: 703-292-5090; e-mail: info@nsf.gov).



Crosscutting Investment Strategies



This section contains a partial listing of cross-directorate programs sponsored by the National Science Foundation (NSF). Activities not mentioned here may appear elsewhere in this site. Refer to the appropriate directorate. All fields of science and engineering supported by NSF are eligible for consideration and support by these programs.

- [NSF Priority Areas](#)
- [Human Resource and Career Development](#)
- [Crosscutting Research, Instrumentation, and Partnering Programs](#)

For More Information

Visit the NSF Crosscutting Programs home page,
<http://www.nsf.gov/home/crssprgm>.



NSF CROSSCUTTING INVESTMENT STRATEGIES

NSF Priority Areas

The National Science Foundation's (NSF) investments in priority areas are focused on frontiers of knowledge, where discovery and innovation are likely to produce significant progress. NSF works with other government agencies to identify and support these multidisciplinary areas.

The priority areas that NSF has selected for significant investment during the next several years are:

1. Biocomplexity in the Environment
2. Information Technology Research
3. Nanoscale Science and Engineering
4. Mathematical Sciences
5. Human and Social Dynamics

The priority areas in this section address NSF's three strategic goals:

1. **People** – A diverse, internationally competitive and globally engaged workforce of scientists, engineers, and well-prepared citizens.
2. **Ideas** – Discovery at and across the frontier of science and engineering, and connections to its use in the service of society.
3. **Tools** – Broadly accessible, state-of-the-art, and shared research and educational tools.

1. Biocomplexity in the Environment

The environment is a subject of profound national importance and scientific interest, making it a strategic priority for NSF. The goals of NSF's investment in environmental research and education include enhancement of fundamental research in all relevant disciplines and in interdisciplinary and long-term research; creation of educational opportunities that build scientific and technological capacity; discovery of innovative methods that avoid environmental harm and inform the decision-making process; and support for advanced physical, technological, informational, and international infrastructure.

A centerpiece of NSF's Environmental Research and Education portfolio is the Biocomplexity in the Environment (BE) competition. Initiated in fiscal year (FY) 1999, this special competition promotes comprehensive, integrated investigations of environmental systems using advanced scientific and engineering methods.

Biocomplexity refers to the dynamic web of interrelationships that arise when living things at all levels--from molecular structures to genes to organisms to ecosystems--interact with their environment. Investigations of biocomplexity in the environment are intended to provide a more complete and synthetic understanding of natural processes, human behaviors and decisions in the natural world; and ways to use new technology effectively to observe the environment and sustain the diversity of life on Earth. By placing biocomplexity studies in an environmental context, the Biocomplexity in the Environment competition emphasizes research with the following characteristics: highly interdisciplinary; explicit consideration of nonhuman biota and humans; and focus on challenging systems with high potential for exhibiting nonlinear or highly coupled behavior.

Five interdisciplinary areas are emphasized again in FY 2004:

- **Dynamics of Coupled Natural and Human (CNH) Systems**—Emphasizes quantitative interdisciplinary analysis of relevant human and natural systems processes and the complex interactions among human and natural systems at diverse scales, with special emphasis given to studies of natural capital; landscapes and land use; and uncertainty, resilience, and vulnerability.
- **Coupled Biogeochemical Cycles (CBC)**—Focuses on the interrelation of biological, geochemical, geological, and physical processes at all temporal and spatial scales, with particular emphasis on understanding linkages between chemical and physical cycles and the influence of human and other biotic factors on those cycles.
- **Genome-Enabled Environmental Science and Engineering (GEN-EN)**—Encourages the use of genetic

and information technology approaches to gain novel insights into environmental questions and problems.

- **Instrumentation Development for Environmental Activities (IDEA)**—Supports the development of instrumentation and software that relies on and takes advantage of microelectronics, photonics, telemetry, robotics, sensing systems, modeling, data mining, and analysis techniques to bring recent laboratory instrumentation advances to bear on the full spectrum of environmental biocomplexity questions.
- **Materials Use: Science, Engineering, and Society (MUSES)**—Supports projects directed toward reducing adverse human impact on the total interactive system of resource use; designing and synthesizing new materials with environmentally benign impacts on biocomplex systems; and maximizing the efficient use of individual materials throughout their life cycles.

For More Information

See program solicitation NSF 03-597. Information is also available at the NSF Environmental Research and Education Web site, <http://www.nsf.gov/ere>.

2. Information Technology Research (ITR)

Sustained leadership in the United States in information technology requires an aggressive federal program to create new knowledge in a variety of areas. The U.S. economy's robust growth has resulted in part from new ideas that became the basis for new products. For example, NSF contributed greatly to the development of today's Internet. NSF's investments--in ideas, people, and tools--have benefited greatly from the application of information technology.

NSF faces two major challenges and opportunities with respect to information technology. The first challenge is to support the people, ideas, and tools that will create and advance knowledge in all areas of information science and engineering. Wholly new computational approaches are needed for problems arising from the science and engineering disciplines and the development of new learning technologies for use in education.

The second challenge is to upgrade the computational and computing infrastructures for all fields that NSF supports. Researchers and educators in many areas need to incorporate information technology and, in some cases, revolutionize their experimental and collaborative processes to attain new effectiveness and greater efficiency. In addition, the United States must address a range of access and workforce issues. Overcoming inequities will require innovative educational technologies, such as highly interactive computer science courseware that is both multicultural and multimedia.

NSF is the lead agency for a multiagency 5-year research initiative in information technology. Each agency participating in the initiative will define specific programs in keeping with that agency's mission. NSF is primarily responsible for basic research to advance knowledge and for education and workforce development activities. The multiyear Information Technology Research investment by NSF will lead to the following outcomes:

- Advancement of fundamental knowledge in techniques for computation, the representation of information, the manipulation and visualization of information, and the transmission and communication of information.
- Enhanced knowledge about how to design, build, and maintain large, complex software systems that are reliable, predictable, secure, and scalable.
- New knowledge about distributed and networked systems and interactions among component parts, as well as the interaction of systems with both individuals and cooperating groups of users. Such networks can empower a broadly distributed scientific community to participate fully in frontline research.
- Development of a significantly advanced high-end computing capability needed to solve myriad important science and engineering problems.
- Increased understanding of the societal, ethical, and workforce implications of the information revolution.
- A strong information technology workforce and a citizenry capable of using information technology effectively.

For More Information

Visit the ITR Web site, <http://www.itr.nsf.gov/>.

3. Nanoscale Science and Engineering

Nanoscale science and engineering promises to produce a dominant technology for the 21st century. Control of

matter at the nanoscale level underpins innovation in critical areas from information and medicine to manufacturing and the environment.

One nanometer (one billionth of a meter) is a unique point on the dimensional scale. Nanostructures are at the confluence of the smallest of human-made devices and the largest molecules of living systems. Biological cells such as red blood cells have diameters in the range of thousands of nanometers. Micro systems with nanoscale components are now approaching this same scale. This means we are now at the point of connecting machines to individual cells.

Sixteen federal agencies have joined together to promote advances in nanotechnology. NSF's nanoscale science and engineering program is a multiyear investment whose goals include the following:

- discovery of novel phenomena, material structures, processes, and tools;
- enhanced methods for the synthesis and processing of engineered, nanometer-scale building blocks for materials and system components;
- new device concepts and system architecture appropriate to the unique features and demands of nanoscale engineering;
- manufacturing and environmental processes at the nanoscale;
- development of a new generation of skilled workers who have the multidisciplinary perspective necessary for rapid progress in nanotechnology;
- increased understanding of societal, ethical, and workforce implications of nanoscience and nanotechnology; and
- convergence of nano-, bio-, information, and cognition-based technologies.



For More Information

See the latest program solicitation, available on the Nanoscale Science and Engineering Program Web site, <http://www.nsf.gov/nano/>.

4. Mathematical Sciences

Today's discoveries in science, engineering, and technology are inextricably intertwined with advances across the mathematical sciences, which provide both powerful tools for insight and a common language for science and engineering. Underlying recent progress in such areas as genomics, information technologies, and climate science are new mathematical and statistical tools that enable scientists and engineers to tackle a broad range of scientific and technological challenges long considered intractable. The goal of the Mathematical Sciences priority area is to advance frontiers in three interlinked areas:

- fundamental mathematical and statistical sciences;
- interdisciplinary research involving the mathematical sciences with science and engineering; and
- critical investments in mathematical sciences education.

Fundamental research themes cut across all areas of the mathematical and statistical sciences. To enhance research in these areas, NSF will provide support through focused research groups, individual investigator grants, and institute and postdoctoral training activities.

The success of the mathematical sciences in producing new analytical, statistical, and computational tools has increased the demand both for further development of new tools and for research teams capable of applying these techniques. A new cadre of researchers who are broadly trained is needed to tackle the increasingly complex *interdisciplinary research* topics that confront society. Three broad research themes have been identified for initial emphasis:

- **Mathematical and Statistical Challenges Posed by Large Data Sets**—Challenges arise in such areas as large genetic databases; the explosion of data from satellite observation systems, seismic networks, global oceanic and atmospheric observational networks, and large astronomical surveys; situations in which privacy and missing data are major concerns; massive data streams generated by automated physical science instruments; and data produced by modern engineering systems.
- **Managing and Modeling Uncertainty**—Predictions of phenomena, with measures of uncertainty, are critical for making decisions in areas from public policy to research. Challenges include improving methods for

assessing uncertainty and enhancing our ability to forecast extreme or singular events, thus increasing the safety and reliability of such systems as power grids, the Internet, and air traffic control. Other applications include forecasting the spread of an invasive species, predicting genetic change, evaluating the likelihood of complex climate change scenarios, and improving the utility of forecasts of market behavior.

- **Modeling Complex Nonlinear Systems**—Advances in mathematics are necessary for a fundamental understanding of the mechanisms underlying interacting complex systems and will be essential for further development of modern physical theories of the structure of the universe at the smallest and largest scales. Challenges include the analysis and prediction of emergent complex properties from social behaviors to brain function, and from communications networks to multi-scale business information systems.

NSF support in this area will encompass interdisciplinary focused research groups, interdisciplinary programs that link innovative training activities with research, and partnership activities with other federal agencies.

Education efforts will focus on innovative projects centered on these research agenda. Activities in this context will include teacher preparation and professional development, curriculum development, undergraduate research participation, and research on how mathematics is learned. Investments will include support for undergraduate and graduate education as well as postdoctoral training coupled with curriculum reform.

For More Information

A program announcement soliciting proposals in the mathematical sciences priority multidisciplinary area will be announced on the Division of Mathematical Sciences Web site, <http://www.nsf.gov/mps/dms/>.

5. Human and Social Dynamics

Uncertainty and change have become inescapable facts of life for people today. Economic, social, technological, and environmental change provide new opportunities as well as major challenges. Understanding the human and social dynamics of change in our contemporary world is essential for our nation's continued progress. Multi-scaled, multi-disciplinary approaches, many of which have been made possible by recently acquired knowledge and new technologies, can bring about this understanding.

To address contemporary problems and to advance fundamental knowledge and the welfare of the nation, the National Science Foundation will develop and apply these approaches through a new Human and Social Dynamics (HSD) priority area.

The goals of the HSD priority area are:

- to develop a comprehensive, multi-disciplinary approach to understanding human and social dynamics;
- to exploit the convergence in biology, engineering, information technology, and cognition to advance the understanding of behavior and performance at both the individual and social levels;
- to refine knowledge about decision making, risk, and uncertainty and to learn how to translate this knowledge into improved decision making;
- to develop the broad range of infrastructure needed to support transformative interdisciplinary research; and
- to create relevant large-scale data resources and advance methodological frontiers, such as agent-based modeling, complex network analysis, non-linear dynamics, computer-assisted qualitative analysis, multi-level, multi-scalar analysis, and measurement research and technologies.

HSD will be developed over the next five years, with the involvement of all of NSF's directorates. The Directorate for Social, Behavioral, and Economic Sciences along with the other research directorates and offices will run a special competition during fiscal year 2004 (FY 04). NSF expects that the scope of competitions and the level of funding will increase in later fiscal years.

Six broad areas will be emphasized and supported during the FY 04 competition pending availability of funds. These areas are:

- Agents of Change
- Enhancing Human Performance
- Decision Making and Risk
- Spatial Social Science

- Modeling Human and Social Dynamics
- Instrumentation and Data Resource Development

 **For More Information**

Further information about HSD is available on the Directorate for Social, Behavioral, and Economic Sciences Web site, <http://www.nsf.gov/sbe/>. Information on the HSD FY04 special competition will be posted there as well, once its available.



NSF CROSSCUTTING INVESTMENT STRATEGIES

Human Resource and Career Development

Among NSF's crosscutting investments are programs directed to the development of a diverse, internationally competitive, and globally engaged workforce of scientists, engineers, and well-prepared citizens. This section of the Guide highlights programs for human resource and career development that are supported as NSF-wide, as well as specific crosscutting programs of the Directorate for Education and Human Resources (EHR).

NSF sponsors a number of activities directed specifically at bringing members of underrepresented groups into the science and engineering education pipeline and preparing them for potential advancement to the highest levels of leadership. These activities are among those described in this section.

To locate programs that pertain specifically to underrepresented groups, see **Programs for Groups Underrepresented in Science and Engineering**.

One of the Foundation's goals is to promote a science and engineering workforce that is globally engaged. To help meet this goal, the Office of International Science and Engineering offers a variety of programs. For further information, visit the Office of International Science and Engineering Web site, <http://www.nsf.gov/sbe/int/>.

The programs and activities described in this section are organized in the following categories:

- [Programs at the Undergraduate Level](#)
- [Programs at the Graduate and Postdoctoral Level](#)
- [Specialized Programs](#)
- [Programs for Faculty and Institutional Development](#)
- [Programs for Groups Underrepresented in Science and Engineering](#)

For More Information

For further information about programs for human resource and career development, visit the NSF Crosscutting Programs home page, <http://www.nsf.gov/home/crssprgm>.

For further information about programs managed by the EHR Directorate, including programs for underrepresented groups, visit the following EHR Division home pages:

- Division of Human Resource Development, <http://www.ehr.nsf.gov/EHR/HRD>
- Division of Undergraduate Education, <http://www.ehr.nsf.gov/EHR/DUE>
- Division of Graduate Education, <http://www.ehr.nsf.gov/EHR/DGE/>

• **Programs at the Undergraduate Level**

Activities to enhance undergraduate education in science and engineering are supported throughout NSF. In particular, the **Division of Undergraduate Education (DUE)** in the EHR Directorate and some of the NSF disciplinary directorates support activities that improve science, mathematics, engineering, and technology undergraduate education for majors and non-majors in 2- and 4-year colleges and universities. In addition, the EHR Directorate's [Division of Human Resources](#) supports activities designed specifically to help increase the participation of underrepresented minorities. For information about these activities, see the EHR chapter in this Guide.

The NSF cross-directorate **Research Experiences for Undergraduates (REU) Program** supports active research participation by undergraduate students in science and engineering disciplines supported by NSF. REU projects

involve students in meaningful ways in ongoing research and education programs or in projects specially designed for the purpose. Two support mechanisms are offered: REU Supplements and REU Sites. REU Supplements may be included in proposals for new or renewal NSF grants or as supplements to ongoing NSF-funded projects. REU Sites are based on independent proposals to initiate and conduct undergraduate research and education projects for a number of students. REU Sites projects may be based within a single discipline or academic department or be based on interdisciplinary or multiple-department research opportunities with a strong intellectual focus. Proposals with an international dimension are welcomed. Undergraduate student participants supported with NSF funds in either Supplements or Sites must be citizens or permanent residents of the United States or its possessions.

For More Information

NSF program announcement [NSF 03-577](#), a list of contact people, a list of current REU Sites, and other guidance are available on the REU Web site, <http://www.nsf.gov/home/crssprgm/reu/start.htm>.

The **Undergraduate Mentoring in Environmental Biology (UMEB) Program** is designed to enable institutions to create innovative programs that will encourage undergraduate students, especially those from underrepresented groups, to pursue a career in environmental biology. UMEB supports projects designed to engage undergraduate students in year-round research activities and provide sustained mentoring support. Further information is available in Program Announcement [NSF 03-585](#).

• Programs at the Graduate and Postdoctoral Level

NSF is a major supporter of graduate and postdoctoral education in science and engineering. The majority of this support is embedded in awards to institutions through funds to support graduate research assistants and postdoctoral associates. NSF also supports fellowships and traineeships in the following programs:

Graduate Research Fellowships*

- **Graduate Research Fellowships***
- **Integrative Graduate Education and Research Traineeship (IGERT) Program***
- **NSF Graduate Teaching Fellows in K-12 Education***

***Note:** Graduate students supported as Fellows or Trainees in these programs must be citizens or permanent residents of the United States or its possessions.

- NSF is committed to the education of a science and engineering workforce drawn broadly from the Nation's talent pool. To increase diversity at the graduate level and beyond, NSF offers the **Alliances for Graduate Education and the Professoriate Program**.
- The Office of International Science and Engineering offers the **East Asia Summer Program** to provide U.S. graduate students with eight weeks in Chinese, Japanese, Korean, and Taiwanese research environments.

Postdoctoral Fellowships

In addition to supporting postdoctoral associates through NSF research awards to institutions, NSF offers a number of postdoctoral fellowship programs in specific disciplines.

 **For More Information**

A complete list of NSF postdoctoral fellowship programs, including contact names, brief program descriptions, links to program announcements, and other helpful information is available on the NSF FastLane System, https://www.fastlane.nsf.gov/jsp/homepage/postdoc_fel.jsp. The following table also lists current postdoctoral fellowship programs and contact information.

Fellowship	Contact
Minority Postdoctoral Research Fellowships in Biological, Social, Behavioral, and Economic Sciences (NSF 00-139)	BIO Minority Research Fellowships Biological Infrastructure National Science Foundation 4201 Wilson Blvd., Rm 615 Arlington, VA 22230 Tel: 703-292-8470 http://www.nsf.gov/bio/dbi/dbitraining.htm#pr_mi
	SBE Minority Research Fellowships Cross-Directorate Activities National Science Foundation 4201 Wilson Blvd., Rm 995 Arlington, VA 22230 Tel: 703-292-7279 http://www.nsf.gov/sbe/ses/cda/start.htm
In addition to the Minority Postdoctoral Research Fellowships and the Research Fellowships in Microbial Biology noted above, the BIO Directorate also offers postdoctoral research fellowships in selected areas of biology to provide opportunities for recent doctoral scientists to obtain additional training; gain research experience under the sponsorship of established scientists; and broaden their scientific horizons beyond their research experiences during their undergraduate or graduate training. See http://www.nsf.gov/bio/dbi/dbitraining.htm#pr for complete listing.	Postdoctoral Research Fellowships Biological Infrastructure National Science Foundation 4201 Wilson Blvd., Rm 615 Arlington, VA 22230 Tel: 703-292-8470 http://www.nsf.gov/bio/dbi/dbitraining.htm#pr
Postdoctoral Research Fellowships in Microbial Biology (NSF 99-142)	Postdoctoral Research Fellowships in Microbial Biology Biological Infrastructure National Science Foundation 4201 Wilson Blvd., Rm 615 Arlington, VA 22230 Tel: 703-292-8470 http://www.nsf.gov/bio/dbi/dbitraining.htm#pr_m

Fellowship	Contact
CISE Postdoctoral Research Associates in Experimental Computer Science (NSF 97-169)	Division of Experimental and Integrative Activities National Science Foundation 4201 Wilson Blvd., Rm 1160 Arlington, VA 22230 Tel: 703-292-8980 http://www.cise.nsf.gov/eia/index.html
Mathematical Sciences Postdoctoral Research Fellowships (with Research Instructorship option) (NSF 01-126)	Infrastructure Program Division of Mathematical Sciences National Science Foundation 4201 Wilson Blvd., Rm 1025 Arlington, VA 22230 Tel: 703-292-8870 e-mail: msprf@nsf.gov http://www.nsf.gov/mps/divisions/dms/start.htm
Mathematical Sciences University/Industry Postdoctoral Research Fellowships	
Graduate Student Industrial Fellowship	Dr. Donald Senich Division of Design, Manufacture, and Industrial Innovation
Postdoctoral Industrial Fellowship	National Science Foundation 4201 Wilson Blvd., Rm 527 Arlington, VA 22230 Tel: 703-292-7082
Ridge Interdisciplinary Global Experiments (RIDGE 2000) Postdoctoral Fellowships (NSF 02-011)	Division of Ocean Sciences National Science Foundation 4201 Wilson Blvd., Rm 725 Arlington, VA 22230 Tel: 703-292-8580 http://www.nsf.gov/pubs/2002/nsf02011/nsf02011.html
NSF Astronomy and Astrophysics Postdoctoral Fellowships (NSF 00-136)	Division of Astronomical Sciences National Science Foundation 4201 Wilson Blvd., Rm 1045 Arlington, VA 22230 Tel: 703-292-8820 e-mail: aapf@nsf.gov

Fellowship	Contact
MPS Distinguished International Postdoctoral Research Fellowships (NSF 01-154)	Division of Astronomical Sciences Rm 1045; Tel: 703-292-8820 Division of Chemistry Rm 1055; Tel: 703-292-8840 Division of Materials Research Rm 1065; Tel: 703-292-8810 Division of Mathematical Sciences Rm 1025; Tel: 703-292-8870 Division of Physics Rm 1015; Tel: 703-292-8890 National Science Foundation 4201 Wilson Blvd. Arlington, VA 22230
NSF-NATO Postdoctoral Fellowships in Science and Engineering (NSF 01-163)	NATO Postdoctoral Fellowship Program Division of Graduate Education National Science Foundation 4201 Wilson Blvd., Rm 907 Arlington, VA 22230 Tel: 703-292-8630 http://www.ehr.nsf.gov/dge/programs/nato
International Research Fellowships (NSF 02-149)	International Research Fellowship Program Office of International Science and Engineering National Science Foundation 4201 Wilson Blvd., Rm 935 Arlington, VA 22230 Tel: 703-292-8711 http://www.nsf.gov/sbe/int/int_postdocs.htm
Japan Society for the Promotion of Science (JSPS) Postdoctoral Awards for U.S. Researchers	JSPS Postdoctoral Awards Office of International Science and Engineering National Science Foundation 4201 Wilson Blvd., Rm 935 Arlington, VA 22230 Tel: 703-292-8704 e-mail: eapinfo@nsf.gov http://www.nsf.gov/sbe/int/int_postdocs.htm

• Specialized Programs

Some NSF programs approach human resource and career development by addressing these issues across several education levels. This approach is used in activities aimed at improving the recruitment and retention of women in careers in science and engineering and at realizing the potential for careers in science and engineering for persons with disabilities. Programs of this type include the following:

- Program for Gender Equity in Science, Mathematics, Engineering, and Technology
- Program for Persons with Disabilities

Facilitation Awards for Scientists and Engineers with Disabilities

The Facilitation Awards for Scientists and Engineers with Disabilities (FASSED) encourages scientists and engineers with disabilities—including investigators and other staff, postdoctoral associates, student research assistants, and awardees and honorable mention recipients for graduate fellowships—to participate in NSF programs. These awards enable physically disabled persons to facilitate their work by providing funds for special equipment or for the assistance needed in conjunction with NSF-supported projects. A request for special equipment or assistance may be included in a new proposal submitted to any NSF program or in a request for a supplement to an existing NSF grant. Information is available in program announcement [NSF 02-115](#).

• Programs for Faculty and Institutional Development

One of NSF's core strategies is the integration of research and education. This strategy is embodied in NSF's premier program for early career faculty and in its presidential awards component. NSF also supports faculty members from predominantly undergraduate institutions by supporting their substantial contributions to research and education. Special research and education opportunities are available for these faculty as well as for faculty who are underrepresented minorities. Opportunities are available from NSF through the following programs:

1. [Faculty Early Career Development](#)
2. [NSF Component of the Presidential Early Career Awards for Scientists and Engineers](#)
3. [Research in Undergraduate Institutions and Research Opportunity Awards](#)
4. [ADVANCE: Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers](#)
5. [Presidential Awards for Excellence in Science, Mathematics, and Engineering Mentoring](#)

To ensure a broad national base for research, NSF emphasizes developing the research capacity of faculty across a range of institutions, including not only the predominantly undergraduate institutions previously mentioned, but also institutions that have had low participation in NSF programs in the past. The **[Experimental Program to Stimulate Competitive Research \(EPSCoR\)](#)** is an example of this emphasis.

The following are three examples of specialized programs aimed at the enhancement of research and education in minority-serving institutions:

- **[Historically Black Colleges and Universities—Undergraduate Program](#)**
- **[Tribal Colleges and Universities Program](#)**
- **[Centers for Research Excellence in Science and Technology](#)**

1. Faculty Early Career Development (CAREER)

The CAREER Program is a Foundation-wide activity that offers the National Science Foundation's most prestigious awards for new faculty members. The CAREER Program recognizes and supports the early career-development activities of those teacher-scholars who are most likely to become the academic leaders of the 21st century. CAREER awardees will be selected on the basis of creative, career-development plans that effectively integrate research and education within the context of the mission of their organization. Such plans should build a firm foundation for a lifetime of integrated contributions to research and education. NSF encourages submission of CAREER proposals from new faculty members at all CAREER-eligible organizations and especially encourages women, members of underrepresented minority groups, and persons with disabilities to apply.



For More Information

Visit the CAREER Web site, <http://www.nsf.gov/home/crssprgm/career/start.htm>.

2. NSF Component of the Presidential Early Career Awards for Scientists and Engineers (PECASE)

Each year, NSF selects nominees for PECASE. Nominees are selected from among the most meritorious new awardees supported by the Faculty Early Career Development (CAREER) Program (see description of CAREER above). The PECASE Program recognizes outstanding scientists and engineers who early in their careers show exceptional potential for leadership at the frontiers of knowledge. This Presidential Award is the highest honor

bestowed by the U.S. Government on scientists and engineers who are beginning their independent careers.

 **For More Information**

Information about PECASE, including eligibility factors and other pertinent information, is available on the PECASE Web site, <http://www.nsf.gov/pecase/>.

3. Research in Undergraduate Institutions (RUI)

The Research in Undergraduate Institutions (RUI) activity supports research by faculty members from predominantly undergraduate institutions by funding (1) individual and collaborative research projects; (2) the purchase of shared-use research instrumentation; and (3) Research Opportunity Awards for work with NSF-supported investigators from other institutions (these three types of support are described below).

All NSF directorates participate in the RUI activity. RUI proposals are evaluated and funded by the NSF program in the disciplinary area of the proposed research. The objectives of RUI are to support high-quality research, strengthen the research environment in academic departments that are oriented primarily toward undergraduate instruction, and promote the integration of research and education.

The involvement of undergraduate students in a research-rich learning environment is an important feature of RUI. However, the primary purpose of RUI is to support faculty research, thereby maintaining the intellectual vibrancy of faculty members in the classroom and research community.

RUI provides the following types of support:

- **Individual-Investigator and Collaborative Faculty Research Projects**—Provides support through NSF research programs in response to proposals submitted by individual faculty members or by groups of collaborating investigators. RUI proposals differ from standard NSF proposals in that they include an RUI Impact Statement describing the expected effects of the proposed research on the research and education environment of the institution. Please note: the Directorate for Biological Sciences has special instructions for Collaborative Research at Undergraduate Institutions (C-RUI). See [NSF 03-514](#) for further details. *Please note:* the Directorate for Biological Sciences has special instructions for Collaborative Research at Undergraduate Institutions (C-RUI). See [NSF 03-514](#) for further details.
- **Shared Research Instrumentation and Tools**—Provides support for (1) the purchase or upgrade of instrumentation or equipment necessary to support research that will be conducted by several faculty members and (2) the development of new instrumentation.
- **Research Opportunity Awards (ROAs)**—Enable faculty members at predominantly undergraduate institutions to pursue research as visiting scientists with NSF-supported investigators at other institutions. ROAs are usually funded as supplements to ongoing NSF research grants. ROAs are intended to increase visitors' research capability and effectiveness; improve research and teaching at their home institution; and enhance the NSF-funded research of the host principal investigator.

 **For More Information**

For further information about the RUI activity, including guidelines for the preparation and submission of proposals, visit the RUI Web site, <http://www.ehr.nsf.gov/crssprgm/rui/start.shtm>.

Prospective applicants for RUI grants and principal investigators interested in hosting an ROA visiting researcher are urged to contact a program officer in the appropriate discipline.

4. ADVANCE: Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers

The ADVANCE Program seeks to improve the climate for women at academic institutions in the United States and facilitate the advancement of women to the highest ranks of academic leadership. The program seeks creative and sustainable approaches from women and men to meet these goals.

ADVANCE provides award opportunities for individuals and organizations through the following:

- **Fellows Awards**—Enable promising individuals to establish or re-establish full-time independent academic research and education careers in institutions of higher learning.
- **Institutional Transformation Awards**—Support academic institutional transformation to promote the increased participation and advancement of women scientists and engineers in academe.
- **Leadership Awards**—Recognize and encourage outstanding contributions of individuals, small groups, and organizations such as professional societies, with widespread impact on increasing the participation and advancement of women in academic science and engineering careers. These awards enable awardees to sustain, intensify, and initiate new activities designed to increase the participation and advancement of women scientists and engineers in academe.

Members of underrepresented minority groups and individuals with disabilities are encouraged to apply for an award. Proposals that address the participation and advancement of women from underrepresented minority groups are also encouraged.

 **For More Information**
Visit the ADVANCE Web site, <http://www.nsf.gov/home/crssprgm/advance/>.

5. Presidential Awards for Excellence in Science, Mathematics, and Engineering Mentoring (PAESMEM)

Administered by NSF on behalf of the White House, the PAESMEM Program seeks to identify outstanding mentoring efforts and programs that are designed to enhance the participation of groups traditionally underrepresented in science, mathematics, and engineering.

 **For More Information**
See program announcement [NSF 02-063](#); or visit the PAESMEM Web site, <http://www.ehr.nsf.gov/ehrd/paesmem.asp>.

• Programs for Groups Underrepresented in Science and Engineering

NSF has a number of special programs that address members of groups underrepresented in science and engineering. Activities are aimed at increasing the participation of underrepresented minorities; improving the recruitment and retention of women and girls in science and engineering careers; and ensuring that persons with disabilities have the opportunity to participate fully in NSF-supported projects. Such efforts include programs for students, faculty, and institutions designed to develop as fully as possible our Nation's talent pool.

The following is a list of these programs and activities, with reference to their accompanying publication, for further information.

Directorate for Biological Sciences (BIO):

- Minority Postdoctoral Research Fellowships and Supporting Activities ([NSF 00-139](#))
- Undergraduate Mentoring in Environmental Biology ([NSF 03-585](#))

Directorate for Computer and Information Science and Engineering (CISE):

- CISE Minority Institutions Infrastructure ([NSF 96-15](#))
- Information Technology Research ([NSF 02-168](#))
- CISE Research Resources ([NSF 01-100](#))

Division of Human Resource Development (HRD), Directorate for Education and Human Resources (EHR):

- Alliances for Graduate Education and the Professoriate ([NSF 01-138](#))
- Centers of Research Excellence in Science and Technology ([NSF 03-520](#))

- Tribal Colleges and Universities Program ([NSF 03-592](#))
- Historically Black Colleges and Universities Undergraduate Program ([NSF 03-594](#))
- Louis Stokes Alliances for Minority Participation ([NSF 01-140](#))
- Presidential Awards for Excellence in Science, Mathematics, and Engineering Mentoring ([NSF 01-54](#))
- Program for Gender Equity in Science, Mathematics, Engineering, and Technology ([NSF 01-6](#))
- Program for Persons with Disabilities ([NSF 01-67](#))

Directorate for Engineering (ENG):

- Biomedical Engineering and Research to Aid Persons with Disabilities ([NSF 03-560](#)). Direct inquiries to Dr. Gil Devey, Division of Bioengineering and Environmental Systems, National Science Foundation, 4201 Wilson Blvd., Rm. 565, Arlington, VA 22230; or contact by telephone, 703-292-8320.
- Supplemental Funding for Support of Women, Minorities, and Physically Disabled Engineering Research Assistants (see <http://www.eng.nsf.gov/eec/suppfund.htm>)

Directorate for Geosciences (GEO):

- Opportunities for Enhancing Diversity in the Geosciences ([NSF 02-104](#))

Directorate for Social, Behavioral, and Economic Sciences (SBE):

- Minority Postdoctoral Research Fellowships ([NSF 00-139](#))

Foundation-Wide Activities:

- Facilitation Awards for Scientists and Engineers with Disabilities ([NSF 02-115](#))
 - ADVANCE: Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers ([NSF 02-121](#))
 - Research Assistantships for Minority High School Students (see <http://www.nsf.gov/home/students/scholaid.htm>, for more information)
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NSF CROSSCUTTING INVESTMENT STRATEGIES

Crosscutting Research, Instrumentation, and Partnering Programs

The programs and activities described in this section are as follows:

1. Grant Opportunities for Academic Liaison with Industry
2. Partnerships for Innovation
3. Innovation and Organizational Change
4. Global Change Research Program
5. International Science and Engineering
6. Small Business Innovation Research Program and Small Business Technology Transfer Program
7. Small Grants for Exploratory Research
8. Science and Technology Centers: Integrative Partnerships
9. Major Research Instrumentation
10. Collaboratives to Integrate Research and Education
11. Science of Learning Centers

1. Grant Opportunities for Academic Liaison with Industry

The GOALI Program aims to synergize university/industry partnerships by making funds available to support these linkages. The program supports (a) faculty, postdoctoral fellows, and students to conduct research and gain experience in an industrial setting; (b) industry scientists and engineers to bring industrial perspective and integrative skills to academe; and (c) interdisciplinary university/industry teams to conduct long-term projects.

The program targets high-risk and high-gain research, with focus on fundamental topics that would not otherwise have been undertaken by industry; the development of innovative, collaborative university/industry educational programs; and the direct exchange of new knowledge between academe and industry. GOALI provides (a) funding for individuals such as faculty, postdoctoral fellows, and students to develop creative modes of collaborative interaction with industry through individual or small-group research projects; and (b) industry-based fellowships for graduate students and postdoctoral fellows. All NSF Directorates participate in the GOALI Program at this time.

For More Information

See program announcement [NSF 98-142](#); or visit the GOALI Web site, <http://www.nsf.gov/goali/>.

2. Partnerships for Innovation (PFI)

The PFI Program seeks to stimulate innovation by supporting partnerships among colleges and universities, State and local governments, the private sector, and other relevant organizations, thus emphasizing the productive connections between new knowledge created in the discovery process and learning and innovation.

For the purpose of this program, innovation explicitly extends to training and developing people and tools and creating organizational conditions necessary to foster the transformation of knowledge into products, processes, systems, and services that will fuel economic development, create wealth, and generate improvement in the national standard of living. Key factors in the innovation enterprise include creating and accessing new knowledge, a scientifically and technologically literate workforce, and infrastructure that will enable innovation. Concurrently, the PFI Program addresses NSF's strategic intention to broaden participation of people and institutions in NSF activities.

The goals of the PFI Program are

- to catalyze partnerships for innovation that will enable the transformation of knowledge created by the national research and education enterprise into innovations that create new wealth, build strong local, regional, and national economies; and 2) improve the national well-being;

- to broaden the participation of all types of academic institutions and of citizens in NSF activities to better meet the broad workforce needs of the national innovation enterprise; and
- to create enabling infrastructure necessary to foster and sustain innovation for the long term.

Examples of proposals that might be submitted to the PFI Program are those that include planning and/or implementation of new models for innovation; education and training activities that explicitly address the workforce needs of the innovation enterprise; and development and deployment of new tools or mechanisms that support the innovation infrastructure. They may seek to create an activity focusing on a critical level of innovation in a technological area in an industrial sector or in a geographic region. The outcomes for proposed activities should foster economic and/or societal well being that can be self-sustaining in the long term. The lead organization must be a degree-granting academic institution of higher learning. At a minimum, proposed partnerships must include private-sector organizations or State/local government entities.

For More Information

A complete list of awards made by the PFI Program including project descriptions, is available at <http://www.nsf.gov/od/lpa/news/press/00/pr0068.htm>. Further information is also available in program announcement [NSF 03-521](#); or on the PFI Web site, <http://www.nsf.gov/home/crssprgm/pfi/>.

3. Innovation and Organizational Change (IOC)

The IOC Program seeks to create and apply fundamental new knowledge with the aim of improving the effectiveness of the design, administration, and management of organizations, including industrial, educational, service, government, and nonprofit and voluntary organizations. The program encourages dissemination of knowledge gained from research to organizations and institutions that can design and implement improvements based on what has been learned.

The IOC Program places priority on investigator-initiated research that will advance our understanding of the fundamental processes and structures of organizations in a variety of institutional contexts. The program supports research that develops and tests theories, concepts, and methodologies related to organizational learning and redesign; strategic and cultural change; quality and process improvement; the genesis and management of innovation; new product and service development; and the organizational development and integration of new technologies. Projects that develop or build on research perspectives that cross-disciplinary lines are another priority. Perspective IOC research might draw on or include, but not be limited to, organizational behavior and theory, industrial engineering, industrial/organizational psychology, organizational sociology, public administration, and management science. Research methods span a broad variety of qualitative and quantitative methods including surveys, field studies, case studies simulation modeling, and organizational learning curves and social network analysis. Partner organizations to serve as data sources or testbeds may be drawn from all sectors including business, non-profits, governmental agencies, and educational institutions.

IOC is jointly sponsored by the following directorates: Engineering, Social, Behavioral, and Economic Sciences, and Education and Human Resources.

For More Information

Visit the IOC Program Web site, <http://www.nsf.gov/sbe/ses/ioc/start.htm>.

4. Global Change Research Programs (GCRPs)

NSF GCRPs support research and related activities that advance fundamental understanding of dynamic physical, biological, and socioeconomic systems as well as interactions among those systems. In addition to research on Earth system processes and the consequences of changes in those systems, NSF programs facilitate data acquisition and data management activities necessary for basic research on global change, promote the enhancement of modeling designed to improve representation of Earth system interactions, and develop advanced analytic methods to facilitate fundamental research. NSF also supports fundamental research on processes to identify and evaluate responses to changing global environmental conditions.

For More Information

A list of NSF-sponsored global change research programs and further information about each is available on the GCRP Web site, <http://www.nsf.gov/geo/egch/>.

5. International Science and Engineering

Support of international activities is an integral part of NSF's mission to promote the progress of U.S. science and engineering. In particular, NSF recognizes the importance of (1) enabling U.S. researchers and educators to advance their work through international collaboration and (2) helping ensure that future generations of U.S. scientists and engineers gain professional experience overseas early in their careers. Consistent with the international character of science and engineering, disciplinary programs throughout NSF offer support to U.S. scientists and engineers for the international aspects of their research when those aspects are judged to be important to the specific objectives of those activities.

The Office of International Science and Engineering (INT), administratively located in the Social, Behavioral, and Economic Sciences Directorate, expands and facilitates the international dimensions of NSF's mission by promoting new partnerships between U.S. scientists and engineers and their foreign colleagues, and new cooperative projects between established collaborators. Most programs are organized on a regional or country basis.

For More Information

Information and guidelines on proposal preparation for international programs and activities are available in program announcement [NSF 03-559](#); or visit the INT Web site, <http://www.nsf.gov/sbe/int>.

6. Small Business Innovation Research Program and Small Business Technology Transfer Program

Small Business Innovation Research (SBIR) Program

NSF encourages small businesses to submit high-quality proposals that focus on important science, engineering, and science/engineering education problems and opportunities and that will lead to significant commercial and public benefit. The SBIR Program is a government-wide program intended to stimulate technological innovation, use small-business concerns to meet federal research and development (R&D) needs, foster and encourage the participation of minority and disadvantaged persons in technological innovation, and increase the commercialization by the private sector of innovations resulting from Federal R&D.

SBIR uses a uniform three-phase process. Phase I is a 6-month effort designed to evaluate the feasibility of an idea based on its scientific and technical merit. Phase II builds on the feasibility study and leads to the development of a model or prototype. Phase III is the commercialization phase. Development of a partnership with another funding source is strongly encouraged and is one of the measures used in the evaluation of Phase II proposals. SBIR funds are not used for Phase III efforts.

SBIR is highly competitive and supports the Nation's small high-tech businesses, universities, and research institutions that are able to convert basic ideas and research into commercial products that will enhance the Nation's productivity and help maintain its competitive leadership in the global market.

The small business can partner with other businesses or nonprofit institutions such as academic or non-government laboratories. In Phase I, the partner's participation can be 33.3 percent; and in Phase II, up to 50 percent. Members of academic institutions can participate either through a subcontract to the small business or as consultants.

For More Information

Visit the SBIR Web site, <http://www.eng.nsf.gov/sbir/>.

Small Business Technology Transfer (STTR) Program

Also a government-wide program, STTR differs from SBIR in that it requires the small business to engage in cooperative research with nonprofit research institutions. STTR is also a three-phase process. Phase I is a 12-month effort that determines scientific, technical, and commercial merit and establishes concept feasibility and eligibility for Phase II. Phase II further develops the proposed idea while taking into consideration scientific, technical, and commercial merit; Phase I results; and other relevant information. Phase III involves the commercial application of the research funded in Phases I and II. STTR funds are not used for Phase III efforts.

STTR is highly competitive and supports the Nation's small high-tech businesses, universities, and research institutions that are able to convert basic ideas and research into commercial products that will enhance the Nation's productivity and help maintain its competitive leadership in the international marketplace.

The small business must partner with an academic institution or a federally funded research and development center, or other nonprofit institutions. In both Phase I and Phase II, the participation must amount to a minimum of 40 percent of the effort for the small-business concern and 30 percent of the effort for the nonprofit research institution. Members of the academic or research institution participate through a subcontract to the small business. Before starting Phase I, the partners need to enter into an agreement that covers rights to the technology involved in the proposal.

 **For More Information**
Visit the STTR Web site, <http://www.eng.nsf.gov/sbir/>.

7. Small Grants for Exploratory Research (SGER)

Proposals for small-scale, exploratory, high-risk research in the fields of science, engineering, and education normally supported by NSF may be submitted to individual programs. Such research is characterized as:

- preliminary work on untested and novel ideas;
- ventures into emerging research ideas;
- application of new knowledge or new approaches to “established” research topics;
- having a severe urgency with regard to the availability of or access to, data, facilities, or specialized equipment, including quick-response research on natural disasters and similar unanticipated events; or
- likely to catalyze rapid and innovative advances.

Investigators are strongly encouraged to contact the NSF program(s) most germane to the proposal topic before submitting an SGER proposal. This will facilitate determining whether the proposed work meets the guidelines described above; the availability of funds; and the appropriateness for SGER funding. The project description must be brief (two to five pages) and include clear statements as to why the proposed research meets the above criteria; the nature and significance of its potential impact on the field; and why an SGER grant would be a suitable means of supporting the work.

Biographical information is required for the PI and co-PI(s) only and should be provided in the standard NSF format. The box for “Small Grant for Exploratory Research” must be checked on the proposal Cover Sheet.

These proposals will be subject to internal NSF merit review only. SGERs are not renewable and continued funding may be requested only through the submission of a non-SGER proposal, subject to the full merit review. The maximum SGER award amount will not exceed \$200,000. The duration of an SGER project must not exceed two years.

At the discretion of the program officer, and with the concurrence of the division director, a small fraction of especially promising SGER awards may be extended for a period of six additional months and supplemented with up to \$50,000 in additional funding. Requests for extensions must be submitted at least 45 days prior to the expiration date of the initial award. A project report and outline of proposed research--not to exceed five pages--must be included.

8. Science and Technology Centers: Integrative Partnerships (STC)

The STC Program was established in 1987 to fund important basic research and education activities and to encourage technology transfer and innovative approaches to interdisciplinary activities. Since its inception, thirty-six comprehensive STCs have been established.

The STCs explore new areas and build bridges among disciplines, institutions, and other sectors. They offer the research community an effective mechanism to embark upon long-term scientific and technological research activities, explore better and more effective ways to educate students, and develop mechanisms to ensure the timely transition of research and education advances made into service in society.

For More Information

Write to the Office of Integrative Activities (OIA), National Science Foundation, 4201 Wilson Boulevard, Rm 1270, Arlington, VA 22230; or contact by telephone, 703-292-8040, or by e-mail, nsf_oia@nsf.gov; or visit the OIA home page at <http://www.nsf.gov/od/oia/start.htm>.

9. Major Research Instrumentation (MRI)

The MRI Program is designed to improve the condition of scientific and engineering (S&E) equipment used for research and research training in our Nation's academic institutions. The program works to improve the quality and expand the scope of research and research training in S&E and foster the integration of research and education by providing instrumentation for research-intensive learning environments.

The MRI Program assists in the acquisition or development by U.S. institutions of major research instrumentation that is generally too costly to support through other NSF programs. Maintenance and technical support associated with these instruments is also supported. Proposals may be for a single instrument, a large system of instruments, or multiple instruments that share a common research focus. Computer systems, clusters of advanced workstations, networks, and other information infrastructure components necessary for research are supported.

For More Information

Write to the Office of Integrative Activities (OIA), National Science Foundation, 4201 Wilson Boulevard, Rm 1270, Arlington, VA 22230; or contact by telephone, 703-292-8040, or by e-mail, nsf_oia@nsf.gov; or visit the OIA home page, <http://www.nsf.gov/od/oia/start.htm>.

10. Collaboratives to Integrate Research and Education (CIRE)

The CIRE activity was created to establish long-term research and education relationships between minority-serving institutions and NSF-supported facilities and centers. CIRE's long-term goal is to formally establish these developing relationships by negotiating formal institution-to-institution agreements for their continuation and support. Examples of the types of activities supported by CIRE are (1) the development of collaborative and mutually beneficial research and education projects that may include infrastructure enhancement at the minority-serving institution, if needed, to support the proposed collaborative activity; and (2) exchanges of faculty and students. It should be noted however, that CIRE is not a general infrastructure program for minority-serving institutions. Funds to support CIRE-like activities come from the cognizant research directorate. Therefore, communication should be made with the Office of the Assistant Director of the cognizant directorate.

For More Information

Write to the Office of Integrative Activities (OIA), National Science Foundation, 4201 Wilson Boulevard, Rm 1270, Arlington, VA 22230; or contact by telephone, 703-292-8040, or by e-mail, nsf_oia@nsf.gov; or visit the OIA home page, <http://www.nsf.gov/od/oia/start.htm>.

11. Science of Learning Centers

The Science of Learning Centers Program aims to understand what learning is and how it is affected at all levels, ranging from the digital to the societal. The science of learning emerges from the intersections of diverse disciplines across the biological, cognitive, computational, mathematical, physical, and social sciences, engineering, and education. Areas include psychological, social, and pedagogical aspects of learning; the biological basis of learning; machine learning; learning technologies; and mathematical analyses and modeling of all of these. This growing body of knowledge is extending our understanding of learning and connecting learning research to the scientific, technological, educational, and workforce challenges of our time.

 **For More Information**

Visit the SLC web site at <http://www.nsf.gov/home/crssprgm/slc/>.

The National Science Foundation
4201 Wilson Boulevard, Arlington, Virginia 22230, USA
Tel: 703-292-5111, FIRS: 800-877-8339 | TDD: 703-292-5090



Directorate for Biological Sciences (BIO)



The Directorate for Biological Sciences (BIO) promotes and advances scientific progress in biology, largely through grants to colleges, universities, and other institutions, especially in those areas where the National Science Foundation (NSF) has major responsibility. NSF is the Nation's principal supporter of fundamental academic research on plant biology, environmental biology, and biodiversity. It provides support for research to advance understanding of the underlying principles and mechanisms governing life. Research ranges from the study of the structure and dynamics of biological molecules, such as proteins and nucleic acids, to studies of

cells, organs, and organisms and to studies of populations and ecosystems. NSF encompasses processes that are internal to an organism and those that are external and includes temporal frameworks ranging from measurements in real time through individual life spans to the full scope of evolutionary time.

In addition to the research and infrastructure support mentioned in this chapter, the Directorate for Biological Sciences takes an active role in numerous crosscutting programs and activities. Support is provided for active research participation grants for high school students: Research Assistantships for Minority High School Students (see <http://www.nsf.gov/bio/progdes/nsf8939.htm>); for undergraduates: Research Experiences for Undergraduates (see <http://www.nsf.gov/home/crssprgm/reu/start.htm>) and Undergraduate Mentoring in Environmental Biology (see NSF 03-585); and for faculty from K-12: Research Experiences for Teachers (see NSF 02-090), and from predominantly undergraduate institutions: Research Opportunity Awards (see <http://www.nsf.gov/bio/progdes/roasupps.htm>).

Funds are also provided for the early development of academic faculty as both educators and researchers through programs such as Faculty Early Career Development (see <http://www.nsf.gov/bio/progdes/CAREER.htm>), research conferences, symposia, workshops, and—in selected areas—doctoral dissertation improvement grants (see <http://www.nsf.gov/bio/progdes/bioddig.htm>).

Funds are available through the ADVANCE program to increase the representation and advancement of women in academic science and engineering careers, thereby contributing to the development of a more diverse science and engineering workforce (see NSF 02-121 for more information).

Information on many of the programs listed here is available on the NSF Crosscutting Programs home page, <http://www.nsf.gov/home/crssprgm>. Information is also available by referring to the alphabetical listing of programs on the BIO Directorate Programs and Deadlines Web site, <http://www.nsf.gov/bio/programs.htm>; or visit the BIO Directorate home page, <http://www.nsf.gov/bio>.

The BIO Directorate supports proposals and activities through the following administrative units:

- [Division of Biological Infrastructure \(DBI\)](#)
- [Division of Environmental Biology \(DEB\)](#)
- [Division of Integrative Biology and Neuroscience \(IBN\)](#)
- [Division of Molecular and Cellular Biosciences \(MCB\)](#)
- [Plant Genome Research Program](#)
- [Emerging Frontiers \(EF\)—BIO's Virtual Division](#)

Eligibility Requirements for BIO Proposals

The most frequent recipients of support for basic scientific research in the biological sciences are academic institutions and nonprofit research organizations. In special circumstances, grants are awarded to other types of institutions and to individuals. In these cases, preliminary inquiry should be made to the appropriate program officer before a proposal is submitted. Support may be provided for projects involving a single scientist or a number of scientists. Awards are made for projects confined to a single disciplinary area and for those that cross or merge disciplinary interests.

Multiple Principal Investigator [PI] Proposals

Increasingly, many important research problems in science can be addressed best by a team of investigators, each bringing different perspectives to the activity. A team approach may result in the application of novel techniques to biological questions or a more comprehensive treatment of scientific problems, and may also provide innovative opportunities for the training of students.

The NSF Directorate for Biological Sciences encourages proposals from three or more investigators—who may come from more than one academic institution—for collaborative studies focused on a single problem. Such proposals will be evaluated through BIO's core programs, in addition to proposals from individual investigators, as part of the programs' portfolio of activities. Investigators interested in submitting a multi-PI proposal may contact the appropriate BIO program for further advice and guidance.

Submission of Proposals to the BIO Directorate

All proposals directed to NSF must be submitted through NSF's FastLane system. For details about this policy, see the latest NSF *Grant Proposal Guide* (see <http://www.nsf.gov/cgi-bin/getpub?gpg> for latest version). General information about FastLane is available at <http://www.fastlane.nsf.gov>.

Incoming proposals are assigned to program officers within the BIO Directorate for merit review and recommendation. Research with disease-related goals, including work on the etiology, diagnosis, or treatment of physical or mental disease, abnormality, or malfunction in human beings or animals, is normally not supported. Animal models of such conditions or the development and testing of drugs or other procedures for their treatment also are not eligible for support.

Research proposals to the BIO Directorate (not including proposals for conferences or workshops) cannot be duplicates of proposals to any other Federal agency for simultaneous consideration. The only exceptions to this rule are (1) when the proposers and program managers at relevant Federal agencies have previously agreed to joint review and possibly joint funding of the proposal and (2) proposals from PIs who are beginning investigators (individuals who have not been a PI or co-PI on a federally funded award with the exception of a doctoral dissertation, a postdoctoral fellowship, or research planning grants). For proposers who qualify under the latter, the box for "Beginning Investigator" must be checked on the proposal cover sheet.

Deadlines and Target Dates

In most cases the BIO Directorate has established deadlines and target dates for the submission of proposals. To confirm a date, refer to the electronic NSF *E-Bulletin*, <http://www.nsf.gov/home/ebulletin>; or visit the BIO Directorate home page, <http://www.nsf.gov/bio>; or contact the appropriate program director. The earliest possible effective date for an award is approximately 6 months after the target or deadline date. Unless there is a program solicitation stating otherwise, proposals must conform to all format requirements in the NSF *Grant Proposal Guide* (see <http://www.nsf.gov/cgi-bin/getpub?gpg> for latest version), with special attention paid to page limitations, font size, and appendix materials. Some programs or specific competitions have program announcements/solicitations that provide more details about the activities described in this guide.



DIRECTORATE FOR BIOLOGICAL SCIENCES

Division of Biological Infrastructure

The Division of Biological Infrastructure (DBI) supports activities that provide the infrastructure for contemporary research in biology.

DBI supports research through the following clusters:

- [Instrument-Related Activities](#)
- [Research Resources](#)
- [Training](#)

For More Information

Write to the Division of Biological Infrastructure, National Science Foundation, 4201 Wilson Boulevard, Room 615, Arlington, VA 22230; or contact the division by telephone, 703-292-8470; or visit the DBI home page, <http://www.nsf.gov/bio/dbi/start.htm>.

• Instrument-Related Activities Cluster

The Instrument-Related Activities Cluster is located within the Division of Biological Infrastructure and includes the following areas:

1. [Multi-User Biological Equipment and Instrumentation Resources](#)
2. [Instrument Development for Biological Research](#)
3. [Improvements in Facilities, Communications, and Equipment for Research at Biological Field Stations and Marine Laboratories](#)

This cluster also manages biology-related proposals submitted to the Major Research Instrumentation (MRI) Program. MRI is administered by the NSF Office of Integrative Activities (<http://www.nsf.gov/od/oia/start.htm>). See the *MRI Program Announcement (NSF 04-511)* for further details.

For More Information

Visit the cluster's Web site, http://www.nsf.gov/bio/dbi/dbi_instrument.htm.

1. Multi-User Biological Equipment and Instrumentation Resources

Provides cost-shared support for the acquisition of major items of specialized multi-user instrumentation, thereby providing access to state-of-the-art instruments. The instrumentation must be used in the conduct of research that falls within the purview of the BIO Directorate. The institution is required to share the capital cost.

- **Research at Undergraduate Institutions (RUI) Proposals for Multi-User Biological Equipment and Instrumentation Resources**—The Multi-User Biological Equipment and Instrumentation Resources Program (see program announcement [NSF 98-137](#)) accepts proposals through the RUI Program (see program announcement [NSF 00-144](#)). The Multi-User Biological Equipment Program requires that one of the principal investigators be actively receiving NSF funding for research. NSF recognizes that research in NSF-funded areas at RUI institutions is often supported by other sources. Therefore, for RUI institutions, the program makes an exception to the requirement for active NSF research funding provided that (1) the user group is conducting research in NSF-supported subject areas and (2) the user group is able to show adequate research support from other funding sources (such as private foundations or institutional research support) to support the proposed research activities.

2. Instrument Development for Biological Research

Supports the development of new instrumentation to increase the accuracy, range, or sensitivity of observations for BIO research fields, including development of concept and proof of concept for entirely new instruments; development of new instruments that will provide new capabilities or significantly extend currently achievable sensitivity or resolution; and development of improved or novel software for the operation of instruments or the analysis of data or images. For more information, see program announcement [NSF 98-119](#).

3. Improvements in Facilities, Communications, and Equipment for Research at Biological Field Stations and Marine Laboratories

Biological Field Stations and Marine Laboratories (FSMLs) are off-campus facilities for research and education conducted in the natural habitats of terrestrial, freshwater, and marine ecosystems. FSMLs support biological research and education by preserving access to study areas and organisms, providing facilities and equipment in close proximity to those study areas, and fostering an atmosphere of mutual scientific interest and collaboration in research and education. To fulfill these roles, FSMLs must offer modern laboratories and educational spaces, up-to-date equipment, appropriate personal accommodations for visiting scientists and students, and modern communications and data management systems for a broad array of users. In recognition of the importance of FSMLs in modern biology, NSF invites proposals that address these general goals of FSML improvement. For more information, see program guideline [NSF 02-040](#).

• Research Resources Cluster

The Research Resources Cluster is located within the Division of Biological Infrastructure and consists of the following:

1. [Biological Databases and Informatics](#)
2. [Support of Living Stock Collections](#)
3. [Biological Research Collections](#)

For More Information

Visit the cluster's Web site, <http://www.nsf.gov/bio/dbi/dbiresearch.htm>.

1. Biological Databases and Informatics (BDI)

Encourages support of new approaches to the management of biological knowledge that render the collection, maintenance, dissemination, and query of the data and information therein of greater use to the scientific community. For more information, see program announcement [NSF 02-058](#).

In addition to the BDI Initiative, the National Science Foundation and the National Institutes of Health signed a Memorandum of Understanding in fiscal year 2003 to participate in a new program, Tools for Collaborations that Involve Data Sharing. The program invites proposals to develop tools and techniques to harness the unprecedented volume of data generated by collaborations among researchers. Further information about the program is available at <http://www.nsf.gov/bio/progdes/nsfnihtools.htm>.

2. Support of Living Stock Collections

Supports repositories of research organisms, genetic stocks, and seeds, as well as cell lines and DNA clones that are associated with the whole organisms in the collection. The resources supported through this activity are considered essential for national or international scientific research in the biological sciences. Funds are also provided for curatorial databases and for linking the information associated with the collection to other information resources or scientific databases. Long-term support of a collection or repository will require the development and use of such databases. For more information, see program announcement and guidelines [NSF 97-80](#).

3. Biological Research Collections

Supports collection improvement; computerization of specimen-related data; research on curatorial and collection management techniques; and activities such as symposia and workshops to discuss subjects that enhance collections availability and utilization by the research community. For more information, see program announcement [NSF 03-566](#).

• Training Cluster

The Training Cluster is located within the Division of Biological Infrastructure and supports training-related activities. It consists of the following:

1. [Research Experiences for Undergraduates Sites](#)
2. [Undergraduate Mentoring in Environmental Biology](#)
3. [Collaborative Research at Undergraduate Institutions](#)
4. [Integrative Graduate Education and Research Training](#)
5. [Postdoctoral Research Fellowships](#)



For More Information

Visit the cluster's Web site, <http://www.nsf.gov/bio/dbi/dbitraining.htm>.

1. Research Experiences for Undergraduates (REU) Sites

This Foundation-wide program provides opportunities for undergraduate students to experience hands-on participation in research and related scholarly activities. BIO provides support to grantees who involve students in special training programs and ongoing research through the REU Sites and Supplements Program. For more information, see program announcement [NSF 03-577](#).

2. Undergraduate Mentoring in Environmental Biology (UMEB)

The UMEB Program is designed to enable institutions to create innovative programs that will encourage undergraduate students—especially those from underrepresented groups—to pursue a career in environmental biology. UMEB supports projects designed to engage undergraduate students in year-round research activities and to provide sustained mentoring support. For more information, see program announcement [NSF 03-585](#).

3. Collaborative Research at Undergraduate Institutions (C-RUI)

The C-RUI Program supports the collaboration of faculty across all science disciplines to engage in research activities that require the expertise of biologists (as well as nonbiologists) to solve biological problems requiring a multidisciplinary approach. Key elements in the program include the integration of research and teaching and the training of undergraduate students. The program is intended to build the research infrastructure at undergraduate institutions and to encourage multidisciplinary (e.g., biology and geoscience, biology and chemistry, biology and mathematics, biology and computer science) training of undergraduate students. It is the intention of the BIO Directorate to participate in this activity by continuing the C-RUI activity that began in fiscal year 1995. For more information, see program announcement [NSF 03-514](#).

4. Integrative Graduate Education and Research Training (IGERT)

The agency-wide IGERT Program was created by NSF to meet the need for a cadre of broadly prepared Ph.D.s with the technical, professional, and personal skills essential to address the varied career demands of the future. IGERT sponsors development of innovative, research-based graduate education and training programs in Ph.D.-granting institutions. The program supports projects that are based on multidisciplinary research themes and organized by diverse groups of investigators with appropriate research and teaching expertise. The use of a multidisciplinary research theme provides a framework for the integration of research and education activities and for collaborative efforts in training that span disciplinary areas. Thus, an IGERT project may involve investigators from one or more departments within a single institution or from more than one institution. The emphasis of the IGERT Program is on training graduate students; however, the program will support efforts that include undergraduate and/or postdoctoral training if such participation will strengthen the proposed training program.

For More Information

Information such as the IGERT program solicitation, answers to frequently asked questions about the program, detailed instructions on preparing and submitting IGERT preproposals or formal proposals, and the names of appropriate NSF staff are available on the IGERT Web site, <http://www.nsf.gov/home/crssprgm/igert/start.htm>.

5. Postdoctoral Research Fellowships

These fellowships are offered in select program areas to U.S. citizens, nationals, and lawfully admitted permanent resident aliens. Applicants choose a sponsoring scientist and present a research and training plan. These fellowships are awarded to individuals for research and training at any appropriate U.S. or foreign institution for 2 years, and require a change from the Ph.D. institution.

- The BIO Directorate offers postdoctoral research fellowships in selected areas of biology to provide opportunities for recent doctoral scientists to obtain additional training; gain research experience under the sponsorship of established scientists; and broaden their scientific horizons beyond their research experiences during their undergraduate or graduate training. These fellowships are further designed to assist new scientists to direct their research efforts across traditional disciplinary lines and to offer them unique research resources, sites, and facilities, including foreign locations. NSF postdoctoral fellowships are awarded to individuals, and applications are submitted directly by applicants to NSF. Fellows must affiliate with an appropriate research institution and are expected to devote themselves full time to fellowship activities for the duration of the fellowship. At the conclusion of the fellowship, a fellow who accepts a tenure-track appointment at a U.S. institution deemed eligible to receive NSF funds may apply for a research starter grant. This program seeks to encourage research and training at the postdoctoral level at the intersection of biology and the informational, computational, mathematical, and statistical sciences. Complete information, including deadline dates and program announcement numbers, is available at <http://www.nsf.gov/bio/dbi/dbitraining.htm#pr>.
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DIRECTORATE FOR BIOLOGICAL SCIENCES

Division of Environmental Biology

The Division of Environmental Biology (DEB) supports fundamental research on the origins, functions, relationships, interactions, and evolutionary history of populations, species, communities, and ecosystems. Scientific emphases include biodiversity, molecular genetic and genomic evolution, mesoscale ecology, conservation biology, global change, and restoration ecology.

DEB also supports computational biology research (including modeling); a network of long-term ecological research sites; doctoral dissertation research; research conferences and workshops; and a variety of other NSF-wide activities.

DEB supports research through the following clusters:

- [Systematic and Population Biology](#)
- [Ecological Studies](#)

For More Information

Write to the Division of Environmental Biology, National Science Foundation, 4201 Wilson Boulevard, Room 635, Arlington, VA 22230; or contact the division by telephone, 703-292-8480; or visit the DEB home page, <http://www.nsf.gov/bio/deb/start.htm>.

• Systematic And Population Biology Cluster

The Systematic and Population Biology Cluster of thematic areas is located within the Division of Environmental Biology and supports research on the patterns and causes of diversity within and among populations and species. Research projects in Systematic Biology and Biodiversity Surveys and Inventories may involve any group of organisms, including terrestrial, freshwater, and marine taxa, and may range in subject from microbes to multicellular plants, animals, and fungi. Studies of populations of any groups of organisms in terrestrial, wetland, or freshwater habitats are considered in Population Biology.

The cluster includes the following areas:

1. [Population Biology](#)
2. [Systematic Biology](#)
3. [Biodiversity Surveys and Inventories](#)

For More Information

Visit the cluster's Web site, <http://www.nsf.gov/bio/deb/debsysbio.htm>.

1. Population Biology

Focuses on measuring population properties and understanding processes that lead to variation within and between populations. Approaches include empirical and theoretical studies of population structure and dynamics, microevolution, organismal adaptation, geographical differentiation, natural hybridization and speciation, and processes that lead to macroevolutionary patterns of trait evolution. Research areas include:

- **Population Ecology**—Supports studies of single species from an ecological and evolutionary perspective, including life history and life cycle phenomena of terrestrial, freshwater, and wetland organisms; demography of age- and stage-structured populations; population dynamics, including linear, nonlinear, and stochastic approaches; and patterns of natural and sexual selection.
- **Evolutionary Genetics**—Supports studies of the causes and consequences of variation, change, selection,

and evolution of biochemical characteristics, RNA and DNA sequences, mobile elements, and genic organization and function; the evolution of genetic architecture; evolutionary genomics; and population and quantitative genetics.

- **Evolution of Phenotypes**—Supports studies of how the properties of genes (number, arrangement, and pattern) and their interactions, including epigenetics and development, determine evolutionary processes; and how micro- and macro-evolutionary processes explain the evolution of complex phenotypes.

Research that addresses aspects of ecology and evolutionary biology is also supported within other parts of the National Science Foundation. Studies that focus on organism-centered analyses of physiology, morphology, behavior, or development should be directed to the Division of Integrative Biology and Neuroscience (IBN) (see information on IBN elsewhere in the BIO chapter). Studies that focus on marine organisms should be directed to the Biological Oceanography Program in the Division of Ocean Sciences (see the Directorate for Geosciences chapter of this Guide). Studies that focus on interactions among species should be directed to Ecology in the Ecological Studies Cluster, elsewhere in the DEB section. Interdisciplinary studies are welcome.

2. Systematic Biology

Main focus areas include (1) taxonomic revisions and monographs to improve biological classifications and nomenclature (titles should be prefaced “REVSYS” and may be submitted to this or the Biodiversity Surveys and Inventories Program); (2) phylogenetic analyses that produce or test phylogenetic hypotheses or models and the use of phylogenies to elucidate comparative studies, including those of morphology development and molecular evolution; (3) studies that lead to better methods of taxonomic identification and practice or advances in classificatory theory; (4) understanding the patterns and processes of biological diversity at and above the level of species; and (5) theoretical and comparative empirical studies—such as those of morphology, paleontology, biogeography, sequence data or genomes—that contribute to knowledge or models of the origin, diversification, distribution, and extinction of species and clades, or that determine the tempo and mode of evolutionary change at higher levels. Also included is the Special Competitions for Partnerships for Enhancing Expertise in Taxonomy, the deadline dates for which are announced via special solicitation (see [NSF 00-140](#) for the latest program announcement and guidelines).

3. Biodiversity Surveys and Inventories (BS&I)

The main focus areas of the BS&I Program include collecting, identifying, vouchering, and describing the species-level diversity of all forms of life on Earth, from microbes to mammals, including expeditionary work to document biotic diversity in poorly known terrestrial, freshwater, and marine environments. Supported surveys may be primarily area-based (focusing on species inventory and new species discovery, plus in some cases ecological, biogeographic, and/or evolutionary hypothesis testing), primarily clade-based (continental-scale to global species inventory and discovery within a particular taxonomic group), or primarily guild-based (surveys that couple species inventory and discovery with macroecological, historical biogeographic, and/or macroevolutionary hypothesis testing). Beginning in 2003, the BS&I Program is partnering with the ALL Species Foundation and other parts of NSF to support planetary biodiversity inventories (PBI) of the worldwide, species-level diversity of entire major groups of organisms. Proposed taxonomic revisions and monographs that improve biological classifications and nomenclature should be prefaced “REVSYS” and may be submitted to this or the Systematic Biology Program.

• Ecological Studies Cluster

The Ecological Studies Cluster is located within the Division of Environmental Biology and supports research on natural and managed ecological systems, primarily in terrestrial, wetland, and freshwater habitats. Research areas include experimental, theoretical, and modeling studies on the structure and function of complex biotic/abiotic associations and the coupling of small-scale systems to each other and to large-scale systems. Projects are encouraged that develop conceptual and synthetic linkages, such as theoretical and modeling studies; that are conducted at one or more scales of ecological organization; and that synthesize empirical and theoretical findings into new ecological paradigms.

The cluster includes the following areas:

1. [Ecosystem Studies](#)
2. [Ecology](#)
3. [Long-Term Ecological Research](#)
4. [Long-Term Research in Environmental Biology](#)

 **For More Information**

Visit the cluster's Web site, <http://www.nsf.gov/bio/deb/debecological.htm>.

1. Ecosystem Studies

Supports mechanistic or empirical investigations of whole-system ecological processes and relationships in the following areas: biogeochemistry (such as studies of decomposition), global and regional elemental budgets, and biotic versus abiotic controls of nutrient cycles; primary productivity, particularly ecophysiology within an ecosystem framework; and landscape dynamics, with an emphasis on quantitative models of disturbances, ecosystem resilience, and successional patterns.

2. Ecology

Supports community ecology and population interactions in such areas as dynamics and processes within specific communities or habitats; food-Web structure and landscape patterns formed by community dynamics; paleoecology; and organismal interactions, such as mutualism, plant/animal interactions, competition, predation, coevolution, and chemical or evolutionary ecology.

3. Long-Term Ecological Research (LTER)

Supports investigations of whole ecosystems and their component organisms and processes at sites that represent major biomes. Projects are multidisciplinary and actively encourage collaborative research with nonecological investigators. The deadline for submission of proposals is announced only via special solicitations. Unsolicited proposals will not be accepted.

4. Long-Term Research in Environmental Biology (LTREB)

Supports smaller studies that focus on evolutionary or ecological phenomena and require long-term investigation. These awards are designed to provide funding to help maintain ongoing long-term research projects. LTREB awards are not a source of startup funds to initiate long-term research, nor does DEB envision that LTREB projects will be the main source of extramural support for investigators. For further information, visit the LTREB Web site at <http://www.nsf.gov/bio/progdes/ltreb.htm>.

**DIRECTORATE FOR BIOLOGICAL SCIENCES****Division of Integrative Biology and Neuroscience**

IBN supports research aimed at integrative understanding of living organisms—plants, animals, and microbes—as units of biological organization. Such research encompasses:

- the mechanisms by which plants, animals, and microbes develop, grow, reproduce, regulate their physiological activity, and respond to their environment;
- the integration of molecular, subcellular, cellular, and functional genomics approaches to understand the development, functioning, and behavior of organisms in both laboratory and natural settings;
- all aspects of the nervous system, including its structure, function, development, and integration with the physiological and behavioral systems affected by it;
- factors influencing the behavior of animals in the laboratory and field;
- whole-organism approaches to physiological ecology; and
- the form and function of organisms in view of their evolution and environmental interactions.

Synthetic and analytic approaches that address this integration often require advanced computational techniques and interdisciplinary perspectives involving other areas of biology, behavioral science, physical science, mathematics, engineering, and computer science. In addition, the development and use of a wide diversity of organisms as biological models are encouraged to assist both in identifying unifying principles common to all organisms and in documenting the variety of mechanisms that have evolved in specific organisms. Current scientific emphases include biotechnology, biomolecular materials, environmental biology, global change, biodiversity, molecular evolution, plant science, microbial biology, and computational biology, including modeling. Research projects generally include support for the education and training of future scientists.

The IBN Division also supports doctoral dissertation research; research conferences, workshops, and symposia; computational biology research; Undergraduate Mentoring in Environmental Biology; and a variety of NSF-wide activities.

The IBN Division supports research through the following clusters:

- Developmental Mechanisms
- Neuroscience
- Physiology and Ethology

 For More Information

Write to the Division of Integrative Biology and Neuroscience, National Science Foundation, 4201 Wilson Boulevard, Room 685, Arlington, VA 22230; or contact the division by telephone, 703-292-8420; or visit the IBN home page, <http://www.nsf.gov/bio/ibn/start.htm>.

• Developmental Mechanisms Cluster

The Developmental Mechanisms Cluster of thematic areas is located within the Division of Integrative Biology and Neuroscience (IBN) and supports research on the nature, control, and evolution of processes that comprise the life cycle of organisms. Approaches range from molecular genetics and genomic analysis of developmental processes to the experimental manipulation of whole organisms. Supported in this cluster is research on gametogenesis, fertilization embryogenesis, differentiation, pattern formation, morphogenesis, and areas of development specific to plants, animals, and/or microbes (e.g., self-incompatibility, seed and fruit development). Also supported are studies that explore the mechanisms of development in an evolutionary context.

 **For More Information**

Visit the cluster's Web site, <http://www.nsf.gov/bio/ibn/ibndevelop.htm>.

• Neuroscience Cluster

The Neuroscience Cluster of thematic areas is located within the Division of Integrative Biology and Neuroscience and supports research on all aspects of the nervous system structure, function, and development. Integrative approaches to basic research range from fundamental mechanisms of neuronal function at the molecular and cellular levels to adaptations of the brain for appropriate behavior in particular environments. A major focus is the development and use of a wide diversity of organisms as biological models for understanding fundamental principles of neuroscience. Multidisciplinary collaborative research projects are encouraged to apply different types of research techniques to single-focused problems in neuroscience.

Supported in this cluster is research on neural regulation of behavioral events, ranging from simple movements to complex adaptive and interactive responses; and studies that explore the computational functions of neurons, neural circuits, and nervous systems and encourage the development and testing of mathematical or computer models of neural systems. Also included is research on the development, regeneration, and aging of the nervous system, including aspects of cell lineage and determination; axonal navigation and cell migration; regulation of gene expression; neuronal morphogenesis; and neuron-glia interactions.

This cluster also supports research on understanding multifaceted relationships among the central nervous system, hormones, and behavior, especially in relation to environmental factors. This includes how the brain controls endocrine secretion and the effects of steroid and peptide hormones on the brain. Innovative approaches and techniques for exploring the cellular and molecular mechanisms of neuronal and glial cell function, including energy metabolism, ion and substrate transport, and synaptic mechanisms, are also supported. Included in this thematic area are studies of the mechanisms by which the nervous system acquires, encodes, and processes information about the environment, and research on neural processes at the molecular, cellular, systemic, and behavioral levels and psychophysical correlates of sensory neural processes.

 **For More Information**

Visit the cluster's Web site, <http://www.nsf.gov/bio/ibn/ibnneuro.htm>.

• Physiology And Ethology Cluster

The Physiology and Ethology Cluster of thematic areas is located within the Division of Integrative Biology and Neuroscience (IBN) and supports integrative studies of physiological functions at the genomic, cellular, systemic, and organismal levels, and animal behavior in both field and laboratory settings. Also considered are Long-Term Research in Environmental Biology (LTREB) proposals (for more information, see <http://www.nsf.gov/bio/progdes/ltreb.htm>).

The cluster supports research on the mechanism, development, function, and evolution of all animal behavior, including behavioral ecology and evolution; nonhuman learning and cognition; behavioral genetics; development of behavior; and behavioral physiology and motivation, including behavioral endocrinology, animal communication, and animal orientation. Also included are studies that address ecological or evolutionary questions in the areas of morphology, comparative physiology, physiological ecology, and biomechanics of plants, animals, protists, fungi, and bacteria, with emphasis on the study of whole organisms, living or extinct. These studies focus largely on how physiological or morphological mechanisms have evolved and how they may influence evolutionary pathways or interactions between organisms and their biotic or physiochemical environments. The cluster supports research on the basic physiological mechanisms at the molecular, cellular, tissue, organ, and whole animal level, with emphasis on the whole animal as an "integrated system." This includes studies of comparative physiology, functional morphology, endocrinology, epithelial transport, and biomechanics. Another focus is on understanding plants as "functional units" through the integration of genomic, molecular, biochemical, and biophysical approaches to studies of plant form and function. Examples include hormonal and environmental regulation of plant function, plant physiological interactions with pathogens, nitrogen-fixing organisms, mycorrhizae, and other beneficial or pathogenic organisms in the rhizosphere. The emphasis is on understanding the physiological and metabolic basis

of plant responses to such interactions.

 **For More Information**

Visit the cluster's Web site, <http://www.nsf.gov/bio/ibn/ibnphysio.htm>.



DIRECTORATE FOR BIOLOGICAL SCIENCES

Division of Molecular and Cellular Biosciences

The Division of Molecular and Cellular Biosciences (MCB) supports research and related activities that contribute to a fundamental understanding of life processes at the molecular, subcellular, and cellular levels.

Investigator-initiated research proposals are considered in the following clusters: Biomolecular Systems, Cellular Systems, and Genes and Genome Systems. Programs in MCB also support fundamental studies leading to technological innovation, proposals with substantial *computational components*, and multidisciplinary and small group research. MCB programs particularly encourage submission of proposals involving microbial biology, plant biology, theoretical and computational aspects of molecular and cellular studies, and molecular evolution. Genomic approaches are encouraged in all areas. The Division also coordinates a special BIO-wide competition for *Microbial Observatories and Microbial Interactions and Processes*. In addition, the Division supports a variety of NSF-wide activities including Biocomplexity in the Environment, Information Technology Research, Science and Technology at the Nanoscale, and Foundation-wide activities designed to promote integration of research and education, such as the Faculty Early Career Development (CAREER) and the Research in Undergraduate Institutions (RUI) Programs.

The MCB Division supports research through the following clusters:

- [Biomolecular Systems](#)
- [Cellular Systems](#)
- [Genes and Genome Systems](#)

 **For More Information**

Write to the Division of Molecular and Cellular Biosciences, National Science Foundation, 4201 Wilson Boulevard, Room 655, Arlington, VA 22230; or contact the division by telephone, 703-292-8440; or visit the MCB home page, <http://www.nsf.gov/bio/mcb/start.htm>.

• **Biomolecular Systems**

This cluster emphasizes the structure, function, dynamics, interactions, and interconversions of biological molecules. The context for such studies can range from investigations of individual macromolecules to the large-scale integration of metabolic and energetic processes. Research supported by this cluster includes development of cutting-edge technologies integrating theoretical, computational, and experimental approaches; the study of biological molecules and their functional complexes; mechanistic studies of the regulation and catalysis of enzymes and RNA; and higher-order characterization of the biochemical processes by which all organisms acquire, transform, and utilize energy from substrates. This cluster emphasizes the importance of multidisciplinary research carried out at the interfaces of biology, physics, chemistry, mathematics, computer science, and engineering.

The cluster includes the scientific themes of molecular biochemistry, molecular biophysics, and metabolic biochemistry.

 **For More Information**

Visit the cluster's Web site, <http://www.nsf.gov/bio/mcb/mcbbiomolec.htm>.

• **Cellular Systems**

This cluster supports research on the structure, function, and regulation of plant, animal, and microbial cells and their interactions with the environment and with one another. Areas supported include studies of the structure,

function, and assembly of cellular elements, such as the cytoskeleton, membranes, organelles, intracellular compartments, intranuclear structures, and extracellular matrix, including eukaryotic and prokaryotic cell walls and envelopes. In addition, support is provided for the study of intracellular and transmembrane signal transduction mechanisms and functions; and cell-cell signaling processes, including those that occur in biofilms. Research on cellular recognition and self-defense mechanisms is included. Research utilizing both traditional and innovative methodologies, multidisciplinary approaches, technique development, computation and modeling, and approaches that exploit genomic information is encouraged. Multidisciplinary approaches to the study of cellular systems, including research carried out at the interfaces of biology, physics, chemistry, mathematics, and computer science and engineering are also encouraged.

The cluster includes the scientific themes of cellular organization and signal transduction and cellular regulation.

The *Microbial Observatories and Microbial Interactions and Processes* competition is also housed in this cluster. This expanded activity supports integrative studies that explore novel microorganisms, their interactions in consortia and communities, and aspects of their physiology, biochemistry, and genomics in relationship to the processes that they carry out in their environments.

 **For More Information**

Visit the cluster's Web site, <http://www.nsf.gov/bio/mcb/mcbcell.htm>.

• Genes And Genome Systems

This cluster supports studies on genomes and genetic mechanisms in all organisms, whether prokaryote, eukaryote, phage, or virus. Proposals on the structure, maintenance, expression, transfer, and stability of genetic information in DNA, RNA, and proteins, and how those processes are regulated, are appropriate. Areas of interest include genome organization, molecular and cellular evolution, replication, recombination, repair, and vertical and lateral transmission of heritable information. Of equal interest are the processes that mediate and regulate gene expression, such as chromatin structure, epigenetic phenomena, transcription, RNA processing, editing and degradation, and translation. The use of innovative in vivo and/or in vitro approaches, including biochemical, physiological, genetic, genomic, and/or computational methods, is encouraged, as is research at the interfaces of biology, physics, chemistry, mathematics, and computer science and engineering.

This cluster includes the scientific themes of eukaryotic genetics, microbial genetics, and the biochemistry of gene expression.

 **For More Information**

Visit the cluster's Web site, <http://www.nsf.gov/bio/mcb/mcbgene.htm>.



DIRECTORATE FOR BIOLOGICAL SCIENCES

Plant Genome Research Program

The Plant Genome Research Program was initiated in fiscal year 1998. It is part of a National Plant Genome Initiative established by the Office of Science and Technology Policy. The long-term goal of this program is to understand the structure, organization, and function of plant genomes important to agriculture, the environment, energy, and health. The program initiates new collaborative research and infrastructure projects annually, and provides ongoing support for activities started in previous years via mechanisms such as virtual centers and young investigator, individual, and small group awards.

 **For More Information**

Further information including results of previous competitions is available at http://www.nsf.gov/bio/dbi/dbi_pgr.htm.



DIRECTORATE FOR BIOLOGICAL SCIENCES

Emerging Frontiers – Bio's Virtual Division

The Emerging Frontiers (EF) Virtual Division was proposed in fiscal year (FY) 2003 to serve as an incubator for 21st Century Biology. EF supports evolving multidisciplinary research opportunities and networking activities that arise from advances in disciplinary research. By encouraging synergy between disciplines, EF provides a mechanism by which new initiatives will be fostered—and subsequently integrated—into core programs.

EF focus in FY 2004 is on the following initiatives:

- [Frontiers in Integrative Biological Research \(FIBR\)](#)
- [Research Coordination Networks \(RCN\)](#)
- [Biocomplexity in the Environment \(BE\)](#)
- [Nanoscale Science & Engineering](#)
- [Information Technology Research \(ITR\)](#)
- [Mathematical Sciences](#)
- [Human Social Dynamics](#)

• [Frontiers in Integrative Biological Research \(FIBR\)](#)

Invites new ideas for integrative research on major biological questions from a multidisciplinary point of view. Relevant scientific questions will be those recognized both as major challenges in biology and as beyond the scope of traditional single investigator or small team approaches. For more information, see program solicitation [NSF 03-581](#).

• [Research Coordination Networks \(RCN\)](#)

Seeks to encourage and foster communications and collaborations among scientists with common goals and interests. RCN provides support for groups of investigators to communicate and coordinate their research efforts across disciplinary, organizational, institutional, and geographical boundaries. Networks are formed around a focal theme and can involve a broad research question, group of organisms, or particular technologies or approaches. For more information, see program announcement [NSF 00-56](#).

• [Biocomplexity in the Environment \(BE\)](#)

Emphasizes research on the dynamics that occur within biological systems and between these systems and the physical environment via five topical areas: (1) Dynamics of Coupled Natural and Human Systems (CNH); (2) Coupled Biogeochemical Cycles (CBC); (3) Genome-Enabled Environmental Science and Engineering (GEN-EN); (4) Instrumentation Development for Environmental Activities (IDEA); and (5) Materials Use: Science, Engineering, & Society (MUSES). Further information—including results of previous competitions—is available at <http://www.nsf.gov/geo/ere/ereweb/fund-biocomplex.cfm>. In addition to the five topical areas listed here, the BE portfolio in BIO includes the following three competitions:

1. **Assembling the Tree of Life (AToL)**—Supports multidisciplinary teams that conduct innovative and integrative projects to resolve phylogenetic relationships among significant groups of organisms and develop innovative data acquisition and analysis in phylogenetics and phyloinformatics, with the ultimate goal of reconstructing a framework phylogeny for all species on Earth. For more information, see program announcement [NSF 03-536](#).
2. **Ecology of Infectious Diseases (EID)**—A joint NSF-National Institutes of Health initiative that seeks to understand the ecological and biological mechanisms that govern relationships between human-induced environmental changes and the emergence and transmission of infectious diseases.

3. **Microbial Genome Sequencing Program**—A joint NSF-U.S. Department of Agriculture initiative that invites research proposals to support high-throughput sequencing of the genomes of microorganisms, including viruses, bacteria, archaea, fungi, oomycetes, protists, and agriculturally important nematodes (program announcement in progress).

- **Nanoscale Science & Engineering**

Research is focused on studying the structure and regulation of macromolecular machines and macromolecular complexes that are capable of self-replication and self-assembly. Further information, including results of previous competitions, is available at <http://www.nsf.gov/home/crssprgm/nano/start.htm>.

- **Information Technology Research (ITR)**

Broadly invites innovative fundamental research proposals that address the challenges that face IT or seek advances at the frontiers of science and engineering through the creative and innovative use and further development of IT. The ITR Program is interested in fostering visionary work that could lead to major advances in the future, new and unanticipated technologies, revolutionary applications, or new ways to perform important activities. Examples of BIO-relevant areas include algorithms for designing, managing, and linking primary biological databases; development of new tools for microbial genomics; development of innovative database structures (both hardware and software) that support distributed storage of very dense files of genetic sequence and genomic data; and development of real-time information networks linking researchers worldwide engaged in Tree of Life research. Further information, including results of previous competitions, is available at <http://www.itr.nsf.gov>.

- **Mathematical Sciences**

Supports interdisciplinary research involving mathematics, science, and engineering and focuses on mathematical and statistical challenges posed by large data sets, managing and modeling uncertainty, and modeling complex nonlinear systems.

- **Human Social Dynamics**

Focuses on research in behavior, cognition, development, and neuroscience. For more information, see program announcement [NSF 03-552](#).

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Directorate for Computer and Information Science and Engineering (CISE)



The National Science Foundation's (NSF's) Directorate for Computer and Information Science and Engineering (CISE) has three goals:

- to enable the United States to hold a position of world leadership in computing, communications, and information science and engineering;
- to promote understanding of the principles and uses of advanced computing, communications, and information systems in service to society; and
- to contribute to universal, transparent, and affordable participation in an information-based society.

To achieve these goals, the CISE Directorate supports investigator-initiated research in all areas of computer and information science and engineering; helps develop and maintain cutting-edge national computing and information infrastructure for science and engineering research and education in general; and contributes to the education and training of the next generation of computer scientists and engineers.

The research and education activities in which the CISE Directorate directs or participates in are organized into two crosscutting categories and four subdisciplinary divisions:

- [NSF Priority Areas](#)
- [CISE Emphases for FY 2004](#)
- [Division of Computing and Communication Foundations \(CCF\)](#)
- [Division of Computer and Network Systems \(CNS\)](#)
- [Division of Information and Intelligent Systems \(IIS\)](#)
- [Division of Shared Cyberinfrastructure \(SCI\)](#)

For More Information

Visit the CISE Directorate website, <http://www.cise.nsf.gov/>.



DIRECTORATE FOR COMPUTER AND INFORMATION SCIENCE AND ENGINEERING NSF Priority Areas

The CISE Directorate plays an active role in the following NSF-wide priority areas:

- Biocomplexity in the Environment
- Human and Social Dynamics
- Information Technology Research
- Mathematical Sciences
- Nanoscale Science and Engineering

Information Technology Research

CISE activities are core to NSF's efforts in information technology, including the priority area Information Technology Research (ITR). In fiscal year 2004 (FY 04), the ITR Program will focus on advancing current national priorities. A complete description of the program and details on proposal submission are available at http://www.cise.nsf.gov/funding/pgm_display.cfm?pub_id=11995.

For More Information

Further information about these priority areas and other NSF crosscutting programs can be found in chapter 1, "Crosscutting Investment Strategies" in this guide; or visit the NSF crosscutting programs home page, <http://www.nsf.gov/home/crssprgm>.



DIRECTORATE FOR COMPUTER AND INFORMATION SCIENCE AND ENGINEERING CISE Emphases for FY 2004

The CISE Directorate has identified a number of emphasis areas for advancing computer and information science and engineering in fiscal year 2004. They are:

1. Cyber Trust
2. Education & Workforce
3. Information Integration
4. Science of Design

1. Cyber Trust

Networked computers reside at the heart of systems on which people now rely, both in critical national infrastructures and in their homes, cars, and offices. Today, many of these systems are far too vulnerable to cyber attacks that can inhibit their function, corrupt important data, or expose private information. Cyber Trust promotes a vision of a society in which these systems are more predictable, more accountable, and less vulnerable to attack and abuse; are developed, configured, operated, and evaluated by a well-trained and diverse workforce; and are used by a public educated in their secure and ethical operation. Trustworthiness is a system property and economic, legal, social, and organizational factors--as well as technical ones--influence how systems are put together. Cyber Trust research aims to advance the science and technology of trustworthy system design and development and better understand the factors that will enable that technology to be incorporated in systems on which the public depends. Specific technical research and education topics may include but are not limited to: efforts addressing security and privacy needs of applications, including improved policy specification, accountability mechanisms, privacy assurance, and comprehensible user interfaces; research in systems software, including trustworthy operating system architectures and mechanisms and middleware for trustworthy software-controlled real-time systems; advances in the trustworthiness of networks at all scales, including affordable network security designs, secure collaboration and Grid computing mechanisms, denial of service prevention and avoidance, and improved accountability and network forensics; and research to establish a sound scientific foundation and technological basis for trustworthy computing, including means to specify and reason about the trustworthiness of individual components and combinations of trustworthy and untrustworthy components. Integrative research that addresses these technical areas in combination with social, organizational, economic, and legal influences on system design is also sought. For more information, see http://www.nsf.gov/pubsys/ods/getpub.cfm?ods_key=nsf04524.

2. Education & Workforce

Rapid advances in computing technology lead to the need to transfer research results into the classroom. Developing and making effective use of new research results requires a well educated and diverse computer and information science and engineering workforce that is representative of and able to interact with the entire populace. This emphasis involves all CISE divisions and supports projects that integrate research and education, study the causes of the current lack of diversity in the information technology workforce, and lead to a broadening of participation by all underrepresented groups in the CISE workforce. Specific activities include:

- **CISE Combined Research and Curriculum Development and Educational Innovation Program (CRCD/EI)**—Supports innovative activities in the computer and information science and engineering disciplines by encouraging the transfer of state-of-the-art research results into undergraduate and introductory graduate curricula; disseminating best practices in information technology (IT) education; investigating emerging areas; and implementing new IT programs. The CRCD/EI Program supports the design, development, testing, and dissemination of innovative approaches to increase the effectiveness of educational experiences. CRCD/EI projects may involve integrating research results into courses and curricula (the research may be ongoing or completed and may be drawn from any research activities in the computer and information sciences and engineering fields); planning and implementation of formal activities designed to publicize effective innovative programs and IT concepts through workshops, publication, and other dissemination mechanisms; and the creation of educational programs and tools that address cutting edge IT. The CRCD/EI Program places special emphasis on curricular approaches that address the recruitment and retention of women and underrepresented minorities in IT educational programs. For more information, see http://www.nsf.gov/pubsys/ods/getpub.cfm?ods_key=nsf04001.

- **Information Technology Workforce (ITWF)**—Since its inception in 2000, the Information Technology Workforce Program (ITWF) has supported basic research studies on the under representation of women and minorities in information technology (IT). ITWF is expanding its portfolio to include implementation and intervention projects that--based on research findings--seek to increase the numbers of women and underrepresented minority students and faculty in IT in the nation's colleges and universities. Implementation projects must incorporate rigorous programs of evaluation and dissemination. For more information, see <http://www.nsf.gov/pubsys/ods/getpub.cfm?nsf03609>.
- CISE also participates in a number of NSF-wide education and workforce programs, including:
 - Graduate Research Fellowships Program (see <http://www.nsf.gov/od/lpa/news/publicat/nsf04009/ehr/dge.htm#1>)
 - Graduate Teaching Fellows in K-12 Education (GK-12) (see <http://www.nsf.gov/od/lpa/news/publicat/nsf04009/ehr/dge.htm#2>)
 - Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers (ADVANCE) (see <http://www.nsf.gov/home/crssprgm/advance/>)
 - IGERT: Integrative Graduate Education and Research Traineeship Program (see <http://www.nsf.gov/od/lpa/news/publicat/nsf04009/ehr/dge.htm#3>)
 - REU: Research Experiences for Undergraduates (see <http://www.nsf.gov/home/crssprgm/reu/start.htm>)

3. Information Integration

Traditionally, an individual researcher developed hypotheses, designed experiments to test these hypotheses, collected observational data, and published results based on experiments. The data were often published in print to allow others to build upon or verify the results. In nearly every field of 21st century science and engineering, including all of the disciplines funded by NSF, research is now achieved by teams of researchers analyzing data sets that are far too large to publish in journals and sometimes collected independently by other scientists with different goals in mind. The goal of information integration research is to provide the necessary foundations to provide science and engineering researchers seamless access to a multitude of independently developed, heterogeneous data sources. Information integration seeks to maximally exploit available information to create new scientific knowledge. Effective information integration will also enhance public education by facilitating comprehensive access to distributed information resources. Topics may include, but are not limited to: integrating many different, disparate, and possibly distributed sources; supporting automated discovery of new data sources and information within them; integrating structured, semi-structured, text, image, video, time-series, 3D images, citations, graphs, and data streams; unifying data models and system descriptions; reconciling heterogeneous formats, schemas, and ontologies; web semantics; decentralized data-sharing; data-sharing on advanced cyberinfrastructure; and on-the-fly integration. For more information, see http://www.nsf.gov/pubsys/ods/getpub.cfm?ods_key=nsf04528.

4. Science of Design

Supports science and engineering research and education that develops the foundations of a Science of Design, leading to more effective development, evolution, and understanding of systems of large scale, scope, and complexity. The emphasis of this program is on software-intensive computing, information, and communication systems (ex, systems for which software is the principal means to conceptualize, define, model, analyze, develop, integrate, operate, control, and manage such systems). In other disciplines with a longer history than computing and software, there are scientifically discovered and validated facts, volumes of codified experience, and formalized, teachable principles. Analogous foundations are needed for a Science of Design for software-intensive systems. Research may address theories, models, principles, formalisms, empirical studies, and the nature and limits of design.

Proposals are expected to be crosscutting and topics may include, but are not limited to: design structures and composition techniques leading to robust and evolvable systems; representation of problem formulations and requirements for software-intensive systems, coupled with problem-solving and reasoning techniques to find designs that meet requirements; studies of designs, designers, and design methodology for software-intensive systems; design automation or computer-aided design for these systems; development and integration of design education into curriculum and training for computer scientists, software engineers, and systems engineers. (Note: A Science of Design solicitation is pending; please monitor <http://www.cise.nsf.gov/> for more information.)



DIRECTORATE FOR COMPUTER AND INFORMATION SCIENCE AND ENGINEERING

Division of Computing and Communication Foundations

The Division of Computing and Communication Foundations (CCF) supports research and education activities that explore the foundations of computing and communication devices and their usage. The CCF Division seeks advances in computing and communication theory; algorithms for computer and computational sciences; and architecture and design of computers and software. CCF-supported projects also investigate revolutionary computing paradigms based on emerging scientific ideas and integrate research and education activities to prepare future generations of computer science and engineering workers.

CCF is organized into three clusters, each of which represents and sponsors activities based on its foci.

1. [Emerging Models and Technologies for Computation Cluster](#)
2. [Formal and Mathematical Foundations Cluster](#)
3. [Foundations of Computing Artifacts and Processes Cluster](#)

For More Information

Write to the Division of Computing and Communications Foundations, National Science Foundation, 4201 Wilson Boulevard, Room 1145, Arlington, VA 22230; or contact the division by telephone, 703-292-8910; or visit the CCF home page, <http://www.cise.nsf.gov/div/index.cfm?div=ccf>.

1. Emerging Models and Technologies for Computation Cluster

This cluster seeks to explore computational models, techniques, and systems based on emerging and future technologies. Research and education projects are supported in computing systems based on nanotechnology, quantum computing and communication, and computational devices and architectures inspired by the processing of information in living matter. Sponsored projects examine concepts in new computing architecture, quantum, and biologically inspired computing, as well as micro- and nanosystems. Topical areas include computational algorithms and simulation techniques for nanoscale systems; design and architecture of systems based on molecular scale devices; quantum algorithms for computation, communication, and coding; realization of quantum computing; algorithms and computational modeling of biological processes; and computing models and systems for future technologies.

2. Formal and Mathematical Foundations Cluster

This cluster seeks to determine inherent limits of computation and communication and obtain optimal solutions within those limits. Sponsored projects examine information representation methods and computational techniques for advancing information technology and all scientific and engineering disciplines. Topical areas include models of computation; computational complexity; parallel and distributed computation; random and approximate algorithms; algorithmic algebra, geometry, topology, and logic; computational optimization; computational algorithms for high-end scientific and engineering applications; techniques for representing, coding and transmitting information; mobile communication; optical communication; signal processing systems; analysis of images, video, and multimedia information.

3. Foundations of Computing Artifacts and Processes Cluster

This cluster seeks to advance the science, formalisms, and methodologies for building computing and communication systems. Sponsored projects examine software engineering, programming language design and implementation, graphics and visualization systems, computer architecture, and design automation. Topical areas include software design methodologies; tools for software testing, analysis, and verification; semantics, design, and implementation of programming languages; microarchitecture; memory and I/O subsystems; application-specific architectures; performance metrics; VLSI electronic design; analysis, synthesis, and simulation algorithms; system-on-a-chip; and architecture and design for mixed or future media (e.g., nanotechnology).



DIRECTORATE FOR COMPUTER AND INFORMATION SCIENCE AND ENGINEERING

Division of Computer and Network Systems

The Division of Computer and Network Systems (CNS) supports research and education activities that invent new computing and networking technologies and explore new ways to make use of existing technologies. The CNS Division seeks to develop a better understanding of the fundamental properties of computer and network systems and create better abstractions and tools for designing, building, analyzing, and measuring future systems. The division also supports the computing infrastructure required for experimental computer science and coordinates cross-divisional activities that foster the integration of research, education, and workforce development.

The CNS Division is organized into three clusters, each of which is responsible for a related set of activities, as defined below:

- [Computer Systems Cluster](#)
- [Computing Research Infrastructure Cluster](#)
- [Network Systems Cluster](#)

For More Information

Write to the Division of Computer and Network Systems, National Science Foundation, 4201 Wilson Boulevard, Room 1160, Arlington, VA 22230; or contact the division by telephone, 703-292-8980; or visit the CNS home page, <http://www.cise.nsf.gov/div/index.cfm?div=cns>.

• [Computer Systems Cluster](#)

Future computing systems will be required to control a greater variety of computing, communication, storage, and external devices; support a broader range of increasingly demanding applications; and to manage hundreds of asynchronous activities correctly, securely, and reliably. The Computer Systems cluster supports research and education activities that address these requirements in a variety of systems, including distributed, mobile, and embedded systems; sensing and control systems; dynamically configured, multiple-component systems; parallel systems; and trusted systems.

Topical areas include new ways to organize systems (ex. peer to peer); software architectures that scale to handle thousands of components or a spectrum of heterogeneous components; ways to handle complex combinations of requirements, such as meeting real-time constraints and coordinating control in an embedded, failure-prone environment; methods that enable systems to detect problems and to take corrective action without human intervention; tools to analyze and predict the behavior of entire computing systems; techniques for developing complex, dynamically changing applications and for managing them at runtime; storage systems that are low-cost, scalable, and reliable; and operating systems and libraries for new technologies.

Specific sponsored activities include the following:

1. [Distributed Systems](#)
2. [Embedded and Hybrid Systems](#)
3. [Next Generation Software](#)

For More Information

Visit the cluster's Web page, http://www.cise.nsf.gov/div/cluster.cfm?div=cns&cluster_id=208.

1. [Distributed Systems](#)

Sponsors research and education on methodologies and designs of system software and runtime support for

distributed applications in order to achieve efficient, flexible, and robust computing in a parallel/multiprocessor/network execution environment. Focus is on novel concepts for design of distributed systems to capture the dynamic and open nature of the underlying system platforms. The program encompasses areas ranging from fundamental operating systems, cluster and grid computing, and middleware, to emerging pervasive agent/mobile systems and peer-to-peer web-based computing. Experimental designs and formal methods and analytical/simulation tools for such systems are also encouraged.

Topics of interest fall into two program components:

- Topics in the Distributed Systems component include system architectures for global-scale networked applications, programming paradigms for parallel and distributed systems, and mobile system architectures for pervasive and ubiquitous computing.
- Topics in the Operating Systems component include system architectures, run-time systems, and hardware impacts. Special emphasis is placed on operating system support for middleware and distributed applications and on creative system concepts brought forth from hardware innovations.

2. Embedded and Hybrid Systems

Supports research and education in scientific principles and technology to revolutionize the design and development of embedded systems for a broad range of applications. Software has enabled increasingly ambitious, often safety-critical systems such as transportation, manufacturing, medical devices and systems, environmental control, and energy management. These include distributed and coordinated embedded systems that demand high levels of autonomy, adaptability, and component integration, such as multi-modal sensing and control.

The goal of the program is to create and unify the foundations for managing interacting physical and computational systems, and to supply the technologies needed for building reliable software- and network-enabled embedded systems. Relevant research includes areas such as hybrid (discrete and continuous) modeling and control of physical systems; domain-specific design, programming, and software synthesis approaches for embedded systems; verification and analysis technology for checking and certifying correct operation of embedded systems; real-time open systems, middleware, and virtual machine strategies for embedded systems; dynamic scheduling that accommodates both hard and soft real-time processes; and program composition approaches for synthesizing software while preserving essential properties.

3. Next Generation Software (NGS)

Fosters multidisciplinary group and single investigator software research. The overall thrusts of NGS are research and development for new software technologies integrated across the systems architectural layers; supporting the design and operation cycle of applications and computing and communications systems; and delivering quality of service (QoS). Topics of interest fall into two program components:

- Technology for Performance Engineered Systems (TPES) component, supports research and education leading to the development of performance frameworks for modeling, measurement, analysis, evaluation, and prediction of performance of complex computing and communications systems; and of the applications executing on such systems.
- Complex Application Design and Support Systems (CADSS) component, supports research on novel software for the development and run-time support of complex applications executing on complex computing platforms; CADSS-fostered technology breaks down traditional barriers in existing software components in the application development, support and runtime layers, and leverages technology for performance engineered systems-developed technology for delivering QoS.

• Computing Research Infrastructure Cluster

An important component of experimental computing is building prototypes and test beds, and this requires having an experimental infrastructure. The Computing Research Infrastructure cluster provides support for the acquisition, enhancement, and operation of experimental facilities for all CISE research and education areas. Supported facilities range from instrumentation needed by a few projects, to major experimental facilities for an entire department. Support is also provided to enhance the computational and human infrastructure in minority-serving institutions and to support the equipment needs of collaborative, distributed research projects. An emphasis is to expand support to include a wider range of infrastructure needs, research projects, and institutions. Topical areas

include:

1. [CISE Research Infrastructure](#)
2. [CISE Research Resources](#)
3. [Minority Institutions Infrastructure](#)

For More Information

Visit the cluster's Web page, http://www.cise.nsf.gov/div/cluster.cfm?div=cns&cluster_id=920.

1. CISE Research Infrastructure

Provides support to aid in the establishment, enhancement, and operation of major experimental facilities that are planned for the support all the research areas in the CISE Directorate. The program may also assist activities for integration of research and education. The program recognizes the emergence of research groups requiring strengthening of experimental facilities in a variety of environments—those solely within a single academic department; those drawing from several departments in a single institution; and those spanning several different institutions. This program supports the areas of research supported by the CISE Directorate that are described in this *Guide to Programs*.

2. CISE Research Resources

Increases the capability and capacity to carry out basic research in information technology at U.S. institutions. The program supports the acquisition and development of advanced resources for research and integrated research and education activities. Resources may include research equipment, instrumentation, software, data repositories, or services. Resources supported under this program are those generally not supported by other programs due to cost, complexity, level of shared use, or other reasons. Three elements comprise this program: CISE instrumentation, collaborative research resources, and distributed research resources.

3. Minority Institutions Infrastructure

Provides awards to aid efforts that might significantly expand the numbers of minority students attracted to and retained in computer and information science and engineering disciplines. Eligible institutions must be minority institutions as defined by significant percentages of minority students. The program considers a variety of activities including research programs involving minority students, curriculum development projects, mentoring, and outreach. Both 1-year planning grants and continuing grants of up to 5 years in duration are awarded.

• Network Systems Cluster

In the future, networks are likely to exhibit unpredictable, complex behavior and dynamics. They are likely to span a broad range of technologies and bandwidths—from wireless sensors to a high-performance core—and to carry increasingly large amounts of increasingly demanding traffic. The Network Systems cluster supports a range of research and education activities in network systems, including networking research, new technologies, and networking research test beds. Topical areas include rethinking the architecture of the core of the network to accommodate orders of magnitude increases in traffic; sensor networks that are self-diagnosing, self-healing, and self-organizing; overlay networks that seek to build a rich layer of support for application-level functionality on top of the current IP infrastructure; extensible networks that provide a framework by which new services and applications can be added dynamically; adaptable networks that detect and respond to threats; and wireless networking systems that support more users, have higher bandwidth, require less power, have longer range, and integrate seamlessly with wired networks.

For More Information

For information on specific CNS-sponsored activities, visit the cluster's Web page, http://www.cise.nsf.gov/div/cluster.cfm?div=cns&cluster_id=207.



DIRECTORATE FOR COMPUTER AND INFORMATION SCIENCE AND ENGINEERING

Division of Information and Intelligent Systems

The Division of Information and Intelligent Systems (IIS) supports research and education that will increase the capabilities of human beings and machines to create, discover, and reason with knowledge by advancing the ability to represent, collect, store, organize, locate, visualize, and communicate information. The division contributes to interdisciplinary research on how observational data leads to discovery in the sciences and engineering.

The IIS Division is divided into three clusters, each of which supports a specific set of related activities, as defined below:

1. [Data, Inference and Understanding Cluster](#)
2. [Science and Engineering Informatics Cluster](#)
3. [Systems in Context Cluster](#)

For More Information

Write to the Division of Computer and Network Systems, National Science Foundation, 4201 Wilson Boulevard, Room 1115, Arlington, VA 22230; or contact the division by telephone, 703-292-8930; or visit the CNS home page, <http://www.cise.nsf.gov/div/index.cfm?div=iis>.

• Data, Inference And Understanding Cluster

The Data, Inference and Understanding cluster supports basic computer science research and education with the goal of creating general purpose systems for representing, storing, and accessing data, information, and knowledge. It also supports research and education in automated methods of drawing conclusions from data and knowledge. Topical areas include:

1. [Artificial Intelligence and Cognitive Science](#)
2. [Computer Vision](#)
3. [Human Language and Communication](#)
4. [Information and Data Management](#)

For More Information

Visit the cluster's Web page, http://www.cise.nsf.gov/div/cluster.cfm?div=iis&cluster_id=3948.

1. Artificial Intelligence and Cognitive Science

Supports research and related education activities that are fundamental to the development of computer systems capable of performing a broad variety of intelligent tasks and to the development of computational models of intelligent behavior across the spectrum of human intelligence. Examples of performance-oriented topics include intelligent agents, planning, automated reasoning, machine learning, case-based reasoning, knowledge representation methodologies, and architectures for combining intelligent tasks such as perception, reasoning, planning, learning, and action. Examples of cognitive-oriented topics include analogical reasoning, concept formation and evolution, argumentation, integration of knowledge from diverse sources and experience, knowledge acquisition by human learners, manipulation and development of taxonomies and classification systems, collaborative behavior, and adaptation and learning.

2. Computer Vision

Supports research and education activities to develop novel ideas into projects that have the potential to lead to advanced visual perception and intelligent systems. The emphasis is on image representation and interpretation for

systems designed to infer properties of the environment from imaging data, and advanced vision systems providing cognitive abilities. Research topics include recognition, classification, and identification of objects, people, events, and activities; scene understanding, including algorithms for the geometric and photometric description of objects from visual data; methods for grouping, comparing, matching, indexing, and retrieving visual data; and 2D and 3D video.

3. Human Language and Communication

Supports research and related education activities fundamental to the development of computer systems capable of analyzing, understanding, and generating language, speech, and other forms of communication that humans use naturally across a wide variety of situations. The program's ultimate objective is to transform the human-computer communication experience so that users can address a computer at any time and any place at least as effectively as if they were addressing another person.

4. Information and Data Management

Supports research and education fundamental to the design, implementation, development, management, and use of databases, information retrieval, and knowledge-based systems. Topics include design methodologies, data, metadata, information, knowledge and process/event modeling, information access and interaction, knowledge discovery and visualization, and systems architecture and implementation. Research areas span web-based systems, novel data types, efficient data gathering and storage/archival, information and data organization and management, including security/privacy issues, information flow, dynamic/evolutionary systems, change maintenance, and information life-cycle management, interoperability in heterogeneous systems, highly scalable, data-intensive, and distributed/mobile information systems, and performance and quality of service issues.

• Science And Engineering Informatics Cluster

The Science and Engineering Informatics cluster supports research and education focused on advances in information technology that address problems in specific sciences and engineering domains such as biology, geology, or chemistry. Characteristics of the research and education activities within the cluster include integrative, focused on tools and analysis, supportive of the data infrastructure across all fields of science and engineering, and focused on a significant computer science problem that is a barrier to achieving a domain challenge.

The cluster sponsors projects through the following activities:

1. Collaborative Research in Computational Neuroscience
2. Science and Engineering Information Integration and Informatics

For More Information

Visit the cluster's Web page, http://www.cise.nsf.gov/div/cluster.cfm?div=iis&cluster_id=3945.

1. Collaborative Research in Computational Neuroscience

Seeks to enhance our understanding of nervous system function by providing analytical and modeling tools that describe, traverse, and integrate different levels of information. The most exciting and difficult challenge facing neuroscientists is to understand the functions of complex neurobiological systems. Computational approaches are needed in the study of neuroscience as the requirement for comprehensive analysis and interpretation of complex data sets becomes increasingly important. Collaborations among computer scientists, engineers, mathematicians, statisticians, theoreticians, and experimental neuroscientists are imperative to advance our understanding of the nervous system and mechanisms underlying brain disorders. Computational understanding of the nervous system may also have a significant impact on the theory and design of engineered systems.

2. Science and Engineering Information Integration and Informatics

Focuses information technology research on addressing problems that will enable scientific discovery via analysis of large data sets or information resources. This component sponsors collaboration between computer scientists

and engineers and scientists and engineers from other domains to address significant, real requirements of an application. Topics include science and engineering data models and systems; analysis of science databases and information resources; analysis of scientific and engineering images; and construction of shared resource environments. This component is among the CISE Emphases for fiscal year 2004 (for a complete description, see [CISE Emphases for Fiscal Year 2004](#), elsewhere in the CISE section).

• Systems In Context Cluster

The Systems in Context cluster supports research and education on the interaction between information, computation, and communication systems and users, organizations, government agencies, the scientific community, and the external environment. Research results provide requirements for the design and construction of future systems so that more system deployments are successful by design. The result of the integration of research and education ensures that future generations of researchers and educators are well prepared to support new discovery over the long run. Topical areas include:

1. [Digital Government](#)
2. [Digital Society and Technologies](#)
3. [Human-Computer Interaction](#)
4. [Robotics](#)
5. [Universal Access](#)



For More Information

Visit the cluster's Web page, http://www.cise.nsf.gov/div/cluster.cfm?div=iis&cluster_id=3947.

1. Digital Government

Government, on a large scale, is a collector and provider of data and information; a provider of information-based services; and a user of information technologies. The Digital Government Program has two goals that reflect the importance of information technology on the conduct and services of government: (1) projects will support computer and information science research on the application of information/computer technologies to government missions, in partnership with government agencies; and (2) projects will support multidisciplinary research on the design and use of information technologies in democratic processes; the impact of information technologies on government institutions; and the interaction between citizens and government. Digital government research and education may be conducted in government contexts, such as environmental management; electronic rule making; long-term archiving of digital objects; urban and land-use planning; social services; criminal justice and law enforcement; crisis management and emergency response; public transportation; public records and libraries; and the collection, maintenance, and confidentiality of government statistics.

2. Digital Society and Technologies

The future and well being of the nation depend on the effective integration of information technologies (IT) into its various enterprises and social fabric. ITs are designed, used, and have consequences in a number of social, economic, legal, ethical, and cultural contexts. With the rise of unprecedented new technologies (ex., smart homes, shop-bots, pedagogical agents, wearable computers, personal robots, multi-agent systems, sensors, grids, knowledge environments) and their increasing ubiquity in our social and economic lives, large-scale social, economic, and scientific transformations are predicted. In order to make progress and advance science, scientists and scholars need to work across disciplinary boundaries to develop new interdisciplinary knowledge at the interstices of computer and information sciences and the social, behavioral and economic sciences. Areas of interest include but are not limited to, universal participation in a digital society; collaborative intelligence; management of knowledge intensive enterprises; knowledge environments for science and engineering; and enterprise transformation.

3. Human-Computer Interaction (HCI)

Supports research and education fundamental to the design of systems that mediate between computers and humans, and that lead to the creation of tomorrow's exciting new user interface software and technology. The program's ultimate objective is to transform the human-computer interaction experience so the computer is no longer a distracting focus of attention, but instead is an invisible tool that empowers the individual user and

facilitates natural and productive human-human collaboration. HCI research topics include but are not limited to, development and formal experimental evaluation of foundational models and theories; augmented cognition and novel uses of computer technologies in education; multi-media and multi-modal interfaces in which combinations of text, graphics, gesture, movement, touch, sound, etc. are used by people and machines to communicate with one another; intelligent interfaces; information visualization; virtual and augmented reality; immersive environments; wearable, mobile, and ubiquitous computing; and new I/O devices.

4. Robotics

Provides opportunities to develop novel ideas into projects that have the potential to lead to advanced, intelligent robotic systems. The Robotics Program supports fundamental research and related education activities in robotics (ex., machines with sensing, intelligence, mobility). The emphasis is on systems operating in unstructured environments with a high level of uncertainty; interaction and cooperation of humans and robots; and advanced robotic sensory systems. Topics include but are not limited to, theoretical, algorithmic, experimental, and hardware issues in robotics; robotics for unstructured environments; personal robots with an emphasis on human-centered end use; novel and advanced approaches to sensing, perception, and actuation; representation, reasoning, and planning for complex physical tasks; robots to extend human capabilities into unknown and hazardous environments; communication and task sharing between humans and machines, and among machines; and intelligent control architecture for robotic systems.

5. Universal Access (UA)

Supports fundamental research and related education activities in computer science that advance computer systems technology so that all people can possess the skills needed to fully harness the power of computing. The program's mission is to empower people with disabilities, young children, seniors, and members of other underrepresented groups, so that they are able to participate fully in the new information society. UA research topics derive from all aspects of human-computer interaction, but topics of special interest include development of new models, architectures, and programming languages that emphasize interface speed and usability by all; definition of semantic structures for multimedia information to support cross-modal I/O; development of specific solutions to address the special needs of communities such as those enumerated above; and experimental studies to evaluate the success of attempts to provide access in all its varied forms.

For More Information

Write to the Division of Information and Intelligent Systems, National Science Foundation, 4201 Wilson Boulevard, Room 1115, Arlington, VA 22230; or contact the division by telephone, 703-292-8930; or visit the IIS home page, <http://www.cise.nsf.gov/div/index.cfm?div=iis>.



DIRECTORATE FOR COMPUTER AND INFORMATION SCIENCE AND ENGINEERING

Division of Shared Cyberinfrastructure

The Division of Shared Cyberinfrastructure (SCI) supports the design, development, and deployment of a set of interconnected computational engines, data repositories, digital libraries, sensors and field-specific instruments known as cyberinfrastructure. Such resources are widely shared across multiple scientific and engineering domains and enable the creation of shared digital knowledge environments where researchers and educators create and promulgate new knowledge across distance, time, and fields of expertise. Some of the areas of activity include:

- **High-Performance Computational Infrastructure**—The SCI Division supports the acquisition, operation, and upgrade of national infrastructure in support of high-end computation for the academic research community. These resources may include supercomputers, high-capacity mass-storage systems, system software suites and programming environments, productivity software libraries and tools, large-scale data repositories, and the experts and support staff that create and maintain the facilities.
- **Advanced Networking Technologies and Infrastructure**—The SCI Division supports networks of various research and granularity—from high-speed backbone networks that connect high-performance computational resources and high-end instrumentation sites, to wireless networks that connect embedded sensor nodes in remote scientific field sites. SCI fosters deployment of networks and development and fielding of networking technologies that enhance cyberinfrastructure. Some of the key areas include end-to-end networking protocols; performance monitoring tools and measurement infrastructure; wireless networks; strategic international collaborations; and testbeds to support trial deployment.
- **Advanced Services and Cybertools**—There is a need for development and SCI supports development of an array of software tools and services that hide the implementation complexities and heterogeneity while offering clean logical interfaces to users. These tools and services include information management systems and data services; scalable interactive visualization tools; middleware service building blocks for high-end computational resources; and networked instrumentations and sensors.

In each of the above areas, the SCI Division stresses fielding, testing, and ongoing support of advanced technologies beyond basic proof-of-concept demonstrations. SCI collaborates with all NSF Directorates and Offices to ensure that the advancement of cyberinfrastructure will meet the demands of tomorrow's science and engineering communities.

For More Information

For a list of programs supported by the SCI Division and further information about them, visit the SCI home page, <http://www.cise.nsf.gov/div/index.cfm?div=sci>; or write to the Division of Shared Cyberinfrastructure, National Science Foundation, 4201 Wilson Boulevard, Room 1122, Arlington, VA 22230; or contact the division by telephone, 703-292-8970.



Directorate for Education and Human Resources (EHR)



NSF's Directorate for Education and Human Resources (EHR) provides national leadership in the effort to improve science, technology, engineering, and mathematics (STEM) education at all levels, from pre-Kindergarten to grade 12, and undergraduate through graduate.

The EHR Directorate supports programs and activities through the following:

- Math and Science Partnership (MSP)
- Division of Elementary, Secondary, and Informal Education (ESIE)
- Division of Graduate Education (DGE)
- Division of Human Resource Development (HRD)
- Division of Research, Evaluation, and Communication (REC)
- Division of Undergraduate Education (DUE)
- Experimental Program to Stimulate Competitive Research (EPSCoR)

 **For More Information**

Visit the EHR Directorate home page, <http://www.ehr.nsf.gov/>.



DIRECTORATE FOR EDUCATION AND HUMAN RESOURCES
Math and Science Partnership

The underlying philosophy of NSF's Math and Science Partnership (MSP) is that collaborations of school systems, higher education, and other partners will increase the capacity of preK-12 educational systems to provide requisites for learning to high standards in science and mathematics. NSF developed the MSP in conjunction with the President's "No Child Left Behind" education initiative. The MSP seeks to ensure the future strength of the Nation by supporting the preparation of the next generation of scientists, engineers, science and math educators, and a science-literate citizenry.

The strategic focus of the MSP is to engage the Nation's higher education institutions; local, regional, and State school districts; and other partners in preK-12 reform by calling for a significant commitment by colleges and universities to improving the quality of science and mathematics instruction in schools and by investing in the recruitment, preparation, and professional development of highly competent science and mathematics teachers. MSP, as a major national effort, is an investment intended to serve all students so that learning outcomes can no longer be predicted based on race/ethnicity, socioeconomic status, gender, or disability.

MSP will support the development, implementation, and sustainability of exemplary partnerships to improve student outcomes in high-quality mathematics and science by all students in all preK-12 levels. The partnerships will be expected to contribute to increases in student achievement across the board, as well as reductions in achievement gaps in mathematics and science education among diverse student populations differentiated by race/ethnicity, socioeconomic status, gender, or disability.

 **For More Information**

Further information, including the MSP program announcement and information for prospective proposers is available at <http://www.ehr.nsf.gov/msp/>.

**DIRECTORATE FOR EDUCATION AND HUMAN RESOURCES****Division of Elementary, Secondary, and Informal Education**

Science, mathematics, and technology (SMT) education—pre-kindergarten through grade 12 (preK-12)—lays the foundation of knowledge and skills needed by future researchers, educators, and technologists; students pursuing postsecondary education in other disciplines; and individuals directly entering the technological workforce. The Division of Elementary, Secondary, and Informal Education (ESIE) supports the National Science Foundation's mission of providing leadership and promoting development of the infrastructure and resources needed to strengthen preK-12 SMT education throughout the United States.

ESIE's comprehensive and coherent research-based program portfolio strengthens the Nation's capacity to support high-quality SMT education. Innovative instructional materials and student assessments, as well as new models for teacher education, contribute to SMT classroom environments that enable all students to achieve their full potential. Moreover, ESIE's informal learning opportunities via media, exhibit, and community-based projects increase scientific and technological literacy, as well as develop lifelong learning skills that benefit students of all ages. All ESIE programs work together, adding to a knowledge base that informs practice and forging partnerships that leverage the expertise and resources of other major education stakeholders, including higher education, state and local education agencies, school districts, informal science education institutions, professional societies, and industry.

ESIE supports the following programs:

1. [Centers for Learning and Teaching](#)
2. [Teacher Professional Continuum](#)
3. [Presidential Awards for Excellence in Mathematics and Science Teaching](#)
4. [Instructional Materials Development](#)
5. [Informal Science Education](#)
6. [Communicating Research to Public Audiences](#)
7. [Information Technology Experiences for Students and Teachers](#)
8. [Advanced Technological Education](#)

 **For More Information**

Write to the Division of Elementary, Secondary, and Informal Education, National Science Foundation, 4201 Wilson Boulevard, Room 885, Arlington, VA 22230; or contact the division by telephone, 703-292-8620; or by e-mail, ehr-esi-info@nsf.gov; or visit the ESIE home page, <http://www.ehr.nsf.gov/ehr/esie>.

1. Centers for Learning and Teaching (CLT)

The Centers for Learning and Teaching Program is a comprehensive, research-based effort that addresses critical issues and national needs of the science, mathematics, and technology (SMT) instructional workforce across the entire spectrum of formal and informal education. Each center has a specific research focus, but all offer rich environments that meld education research, high-quality teacher education, and innovations in instructional practices. Centers consist of a doctoral degree-awarding university and one or more school districts, plus partnering organizations.

CLT program goals are:

- to renew and diversify the cadre of national leaders in science, technology, engineering, and mathematics (STEM) education through doctoral, postdoctoral, and internship programs for the broad array of professionals who educate and support the instructional workforce;
- to increase significantly the numbers of K-12 STEM educators in schools and informal settings; and
- to provide substantive opportunities for research into the nature of learning, strategies of teaching, policies of educational reform, and outcomes of standards-based reform.

Eligibility Requirements for CLT

The CLT program has special eligibility requirements beyond the standard NSF requirements. For more information, see program solicitation [NSF 03-522](#).

2. Teacher Professional Continuum (TPC)

The TPC program is managed jointly by ESIE and the Division of Undergraduate Education. TPC addresses the full continuum of teacher education (grades K-12) from recruitment and preparation, through enhancement, retention, and life-long learning of science, mathematics, and technology (SMT) teachers. TPC supports four categories of projects: (1) *Research Studies* to identify effective strategies for educating teachers; developing supportive structures and environments that sustain SMT educators; and impacting teaching practice through teacher learning; (2) *Research and Development of Educational Models and Systems* to evaluate overall effectiveness of models and systems to be studied, as well as how relationships among various components influence effectiveness; (3) *Professional Resources Development* that are grounded in recent advances in research on teaching and learning; and (4) *Conferences and Symposia* that focus on planning and dissemination of research findings, issues, innovations, and action plans.

The goals of the TPC Program are:

- to improve the quality and coherence of the learning experiences that prepare and enhance SMT teachers;
- to develop innovative curriculums, materials, tools, ideas, and information resources for the professional development of SMT teachers and administrators;
- to research, develop, and identify models, organizational structures, and systems that support the teacher professional continuum;
- to use scientifically based studies to research teacher learning throughout the teacher professional continuum and its impact on teaching practice;
- to advance the knowledge base on the preparation, enhancement, and retention of SMT teachers, and on the strategies that strengthen and diversify the SMT teaching profession; and
- to disseminate this knowledge and research, as well as innovative models and resources, to a national audience.

Eligibility Requirements for TPC

The TPC Program has special eligibility requirements beyond the standard NSF requirements. For more information, see program solicitation [NSF 03-534](#).

3. Presidential Awards for Excellence in Mathematics and Science Teaching (PAEMST)

Administered on behalf of the White House, the PAEMST Program recognizes teachers who incorporate creativity into their classroom teaching and demonstrate leadership in the education community. Beginning in 2003, the competition will alternate each year between teachers of grades 7-12 and teachers of grades K-6. In 2003, teachers of grades 7-12 mathematics and science in each State and the four U.S. jurisdictions are eligible for nomination. Teachers of grades K-6 will be eligible for Presidential Awards in 2004. Awardees receive a \$10,000 cash award and a special citation from the President, and are honored in Recognition Week ceremonies in Washington, D.C.

Eligibility Requirements for PAEMST

The PAEMST Program has special eligibility requirements beyond the standard NSF requirements. For complete information, visit the PAEMST Web site, https://www.ehr.nsf.gov/pres_awards/.

4. Instructional Materials Development (IMD)

The IMD Program supports development of rigorous single- and multiyear curriculums in science, mathematics, and technology (SMT); supplementary instructional materials; and assessments to guide instruction and evaluate student learning. IMD's student-based materials are generally accompanied by materials for teachers,

administrators, and parents/caregivers. The three categories of IMD projects include: (1) *Instructional Materials* for Students that include embedded assessments, enhance classroom instruction, and reflect SMT education standards developed by national professional organizations; (2) *Assessments* (including creation of tools for assessing student learning) that are tied to nationally developed standards and assist in the implementation of new assessments; and (3) *Applied Research* that provides evidence of the effectiveness of instructional materials and feedback for future program development. IMD projects are national in scope and significance; are grounded in recent research in teaching and learning; and have the potential to make a noticeable impact on the nationwide market for instructional materials.

Eligibility Requirements for IMD

The IMD Program has special eligibility requirements beyond the standard NSF requirements. For more information, see program solicitation [NSF 03-524](#).

5. Informal Science Education (ISE)

The Informal Science Education (ISE) Program is designed to increase public interest in, understanding of, and engagement with science, technology, engineering, and mathematics (STEM). All ISE projects have the informal learner (from young child to senior citizen) as their primary audience, presume voluntary participation, and are not related to formal school activities or curricula. The outcome of ISE projects is an informed citizenry that has access to the ideas of science and engineering, and an understanding of their role in enhancing quality of life and the health, prosperity, welfare, and security of the Nation. Categories of projects include media (television, radio, film); exhibits (museums, science centers, aquariums, zoos, libraries, other informal learning institutions); and community and youth-based programs.

ISE Program goals are:

- to engage the interest of children and adults in STEM disciplines so they will develop scientific and technological literacy, mathematical competence, problem-solving skills, and the desire to learn;
- to bring together individuals and organizations from the informal and formal education communities, as well as from the private and public sectors, with the objective of strengthening STEM education in all settings; and
- to develop and implement innovative strategies that support development of a socially responsible and informed public, and demonstrate promise of increasing participation of all citizens in continued learning and careers in STEM disciplines.

Eligibility Requirements for ISE

The ISE Program has special eligibility requirements beyond the standard NSF requirements. For more information, see program solicitation and guidelines [NSF 03-511](#).

6. Communicating Research to Public Audiences (CRPA)

CRPA grants are a special category of projects supported under the Informal Science Education (ISE) Program. These grants, with funding levels up to \$75,000, provide an opportunity for principal investigators (PIs) of awards from any NSF directorate or the Office of Polar Programs to communicate, in nontechnical terms, research results, research in progress, or research methods to a broad and diverse audience. Grants can be used for any activity that falls within the definition of an informal science education activity (e.g., media presentations, exhibits, youth-based activities) in order to disseminate research results, research in progress, or research methods.

Eligibility Requirements for CRPA

The CRPA Program has special eligibility requirements beyond the standard NSF requirements. For more information, see program solicitation and guidelines [NSF 03-509](#).

7. Information Technology Experiences for Students and Teachers (ITEST)

The ITEST Program seeks to increase opportunities for students (grades 7-12) and teachers to learn about, experience, and use information technologies within the context of science, technology, engineering, and mathematics (STEM) disciplines, including information technology courses. Two categories of projects are (1) *Youth-Based projects*, which create innovative models for engaging students in meaningful, intensive learning experiences, building the skills and knowledge needed to advance their studies so they can function and contribute in a technologically rich society and (2) *Comprehensive Projects for Students and Teachers*, which are designed to infuse information technologies into STEM courses, giving teachers opportunities to put into practice what they have learned via summer laboratory experiences with students in grades 7-12.

Eligibility Requirements for ITEST


The ITEST Program has special eligibility requirements beyond the standard NSF requirements. For more information, see program solicitation and guidelines [NSF 02-147](#).

8. Advanced Technological Education (ATE)

The ATE Program is managed jointly by DUE and the Division of Elementary, Secondary, and Informal Education. The program promotes improvement in the education of technicians in science- and engineering-related fields at the undergraduate and secondary school levels. It particularly targets two-year colleges and encourages collaboration among 2-year colleges, 4-year colleges, universities, secondary schools, business, industry, and Government. Proposals are solicited in the following three tracks:

- **Projects**—Activities may include the adaptation of exemplary educational materials, courses, and curriculums in new educational settings; preparation and professional development of college faculty and secondary school teachers; development of educational materials, courses, curriculums, and laboratories; internships and field experiences for students and educators; evaluation and broad dissemination of exemplary educational materials, curricula, and pedagogical practices designed by previously funded ATE centers and projects; and research on effective practices in technician education.
- **Centers**—Centers are comprehensive national or regional resources that provide models and leadership for other projects and act as clearinghouses for educational materials and methods. National Centers of Excellence engage in the full range of activities described above for projects. Regional centers for manufacturing or information technology education pursue comprehensive approaches that focus on reforming academic programs, departments, and systems to produce a highly qualified workforce to meet industry's needs within a particular geographic region. Resource centers constitute a highly visible source of materials, ideas, contacts, and mentoring in particular fields of technological education.
- **Articulation Partnerships**—Focus on enhancing either of two important educational pathways for students between 2-year colleges and 4-year colleges and universities. One type of Articulation Partnership focuses on strengthening science, technology, and mathematics preparation of prospective K–12 teachers enrolled in preprofessional programs at 2-year colleges. The other type of partnership targets 2-year college programs for students to continue their education in 4-year science, technology, engineering, and mathematics programs, especially programs that have a strong technological basis.

Proposals in all three tracks must show evidence of a coherent vision of technological education—a vision that recognizes the needs of the modern workplace, the needs of students as lifelong learners, and the need for articulation of educational programs at different levels. Whenever feasible, projects are expected to utilize and innovatively build from successful educational materials, courses, curriculums, and methods that have been developed through other ATE grants, as well as other exemplary resources that can be adapted to technological education.

 **For More Information**
Visit the ATE Program Web site,
<http://www.ehr.nsf.gov/EHR/DUE/programs/ate/>.



DIRECTORATE FOR EDUCATION AND HUMAN RESOURCES

Division of Graduate Education

NSF provides support to individual graduate students, postdoctoral fellows, and institutions to improve graduate and postdoctoral education and to promote strength, diversity, and vitality in the science and engineering workforce. The Division of Graduate Education (DGE) provides the Foundation's focus to promote strong and innovative graduate education that will develop the Nation's future leadership in all the science, technology, engineering, and mathematics (STEM) fields supported by NSF.

DGE manages the following programs, maintaining close connections with programs funded through other NSF directorates:

1. [Graduate Research Fellowships \(GRF\)](#)
2. [Graduate Teaching Fellowships in K–12 Education \(GK–12\)](#)
3. [Integrative Graduate Education and Research Traineeships \(IGERT\)](#)
4. [NSF-NATO Postdoctoral Fellowships in Science and Engineering \(NATO\)](#)
5. [Travel Grants for NATO Advanced Study Institutes \(ASI\)](#)

For More Information

Write to the Division of Graduate Education, National Science Foundation, 4201 Wilson Boulevard, Room 907, Arlington, VA 22230; or contact DGE by telephone, 703-292-8630; or by e-mail, graded@nsf.gov. For information such as program announcements and application guidelines for the programs in this division, visit the DGE home page, <http://www.ehr.nsf.gov/ehr/dge/>. The DGE home page also provides links to graduate and postdoctoral programs managed by other NSF Directorates.

1. Graduate Research Fellowships (GRF)

GRFs promote the strength and diversity of the Nation's science and engineering base and offer recognition and 3 years of support for advanced study to approximately 900 outstanding graduate students annually in all fields of science, mathematics, and engineering supported by NSF. To be eligible for this nationwide merit competition, an individual must be a citizen, national, or permanent resident of the United States and be at or near the beginning of graduate study.

For More Information

Visit the GRF Program Web site, <http://www.nsf.gov/grfp>.

2. Graduate Teaching Fellowships in K–12 Education (GK–12)

In order to strengthen K–12 science and mathematics education, provide pedagogical training and experience for graduate students, and enhance links between K–12 and higher education levels, NSF initiated the GK–12 Program in 1999. GK–12 projects support graduate and advanced undergraduate science, mathematics, engineering, and technology (STEM) students as content resources for K–12 teachers. These fellows assist teachers in the science and mathematics content of their teaching; demonstrate key science and mathematics concepts; and gain the pedagogical skills necessary at all education levels. The program links the acknowledged excellence of U.S. graduate education with the excitement and critical needs of K–12 learning and teaching, and promotes interest in teaching and learning practices among graduate-level institutions.

Only academic institutions that grant master's or doctoral degrees in STEM fields may submit proposals. GK–12 fellows are selected by awardee institutions and must be (1) citizens, nationals, or permanent residents of the United States and (2) graduate students enrolled in STEM programs or advanced undergraduate STEM majors who have demonstrated a strong proficiency in mathematics and science.

 **For More Information**

Visit the GK–12 Program Web site, <http://www.nsf.gov/home/crssprgm/gk12>.

3. Integrative Graduate Education and Research Traineeships (IGERT)

NSF places high priority on the preparation of Ph.D.s who are equipped with the multidisciplinary background and the technical, professional, and personal skills essential to address the career demands of the future. To meet these needs, NSF created IGERT, an agency-wide graduate education program. Unlike graduate fellowships, for which individuals apply, IGERT considers only proposals from institutions that offer doctoral degrees.

The primary goal of the IGERT Program is to enable the development of innovative graduate education activities that are research-based and that will produce scientists and engineers who are well prepared for a broad spectrum of career opportunities. IGERT integrates research and education with emphasis on experimentation to yield a variety of new models for a paradigm shift in graduate education. Projects supported should incorporate the following features:

- a comprehensive, doctorate-level multidisciplinary research theme that serves as the foundation for graduate education activities;
- activities that integrate the multidisciplinary research theme with innovative educational opportunities, including training in the responsible conduct of research and interactions between students and faculty;
- an educational environment that exposes students to state-of-the-art research instrumentation and methodologies;
- an institutional strategy and operational plan for student recruitment, with special consideration for efforts aimed at members of groups underrepresented in science and engineering, to ensure preparation of a diverse science and engineering workforce; and
- a well-defined strategy for assessment of project performance.

 **For More Information**

Visit the IGERT Program Web site, <http://www.nsf.gov/igert>.

4. NSF-NATO Postdoctoral Fellowships in Science and Engineering (Including Special Fellowship Opportunities for Scientists from NATO Partner Countries)

At the request of the U.S. Department of State, NSF administers a program of NATO postdoctoral fellowships to promote closer collaboration among scientists and engineers of member and NATO partner countries. Approximately 25 awards are made each year to U.S. institutions on behalf of scientists and engineers from NATO partner countries to enable them to conduct research at institutions in the United States.

Eligibility Requirements for NSF-NATO Fellowships

Scientists and engineers from NATO partner countries who are within 5 years of their doctoral degree are eligible to be nominated by a scientific advisor at a U.S. institution.

 **For More Information**

Send an inquiry via e-mail to nsf-nato@nsf.gov; or visit the program's Web site, <http://www.ehr.nsf.gov/dge/programs/nato>.

5. Travel Grants for NATO Advanced Study Institutes (ASI)

NSF awards travel grants of \$1,000 each to enable U.S. science and engineering graduate students and junior postdoctorates to attend NATO Advanced Study Institutes held in NATO member or partner countries of Europe. These 2- to 3-week instructional courses, which are conducted by noted scientists and engineers, are scheduled throughout the year, although the majority of them are held during the summer.

Eligibility Requirements for NATO Advanced Study Institutes

The director of a NATO Advanced Study Institute may nominate a U.S. citizen, national, or permanent resident who is a graduate student or who has received a Ph.D. within the past 3 years and has been accepted at a NATO institute.

For More Information

Send an inquiry via e-mail to nato-asi@nsf.gov; or visit the program's Web site, <http://www.ehr.nsf.gov/dge/programs/asi>.



DIRECTORATE FOR EDUCATION AND HUMAN RESOURCES

Division of Human Resource Development

The Division of Human Resource Development (HRD), located in the Directorate for Education and Human Resources, serves as a focal point for NSF's agency-wide commitment to enhance the quality and excellence of science, technology, engineering, and mathematics (STEM) education and research by broadening the participation of underrepresented groups and institutions. HRD's programs aim to increase the participation and advancement of minority-serving institutions, women and girls, and persons with disabilities at every level of science and engineering enterprises including underrepresented minorities. By doing so, these programs contribute to the development of a diverse, internationally competitive, and globally engaged workforce of scientists, engineers, and well-prepared citizens.

In order to maximize the preparation of a well-trained scientific and instructional workforce for the new millennium, HRD programs focus strongly on partnerships and collaborations, and are aligned with their respective target populations:

- Minorities and Minority-Serving Institutions
- Women and Girls
- Persons with Disabilities
- Crosscutting Initiatives

All HRD programs seek to encourage access to and equity within STEM education. Thematically, these goals are realized via:

- education research and demonstration;
- enhancement of institutional education capacity;
- enhancement of institutional research capacity;
- large-scale implementation; and
- recognition and dissemination.

For More Information

Write to the Division of Human Resource Development, National Science Foundation, 4201 Wilson Boulevard, Room 815, Arlington, VA 22230; or contact the division by telephone, 703-292-8640; or by fax, 703-292-9018; or visit the HRD home page, <http://www.ehr.nsf.gov/hrd>.

HRD Programs According to Theme and Population

	Minorities and Minority-Serving Institutions	Women And Girls	Persons with Disabilities
Education Research and Demonstration		PGE	PPD
Enhancement of Institutional Education Capacity	HBCU-UP, TCUP	PGE	PPD
Enhancement of Institutional Research Capacity	CREST		
Large-scale Implementation	LSAMP, AGEP		
Recognition and Dissemination	PAESMEM	PAESMEM, PGE	PAESMEM, PPD

• Minorities And Minority Serving Institutions

Minority groups underrepresented in science, technology, engineering, and mathematics (STEM) disciplines include American Indians/Alaskan Natives (Native Americans), African Americans, Hispanic Americans, and Native Pacific Islanders. The Division of Human Resource Development (HRD) supports efforts that are focused on two major objectives: (1) supporting student activities and (2) strengthening the research capabilities of minority institutions. HRD programs represent a coherent effort to stimulate organizational and institutional change; markedly improve the quality of education opportunities available to minority and other students; and increase the quality and quantity of students pursuing degrees in STEM disciplines.

HRD programs that specifically support minorities and minority-serving institutions are:

1. Alliances for Graduate Education and the Professoriate (AGEP)
2. Centers of Research Excellence in Science and Technology (CREST)
3. Historically Black Colleges and Universities–Undergraduate Program (HBCU-UP)
4. Louis Stokes Alliances for Minority Participation (LSAMP)
5. Tribal Colleges and Universities Program (TCUP)

For More Information

Write to the Division of Human Resource Development, National Science Foundation, 4201 Wilson Boulevard, Room 815, Arlington, VA 22230; or contact by telephone, 703-292-8640; or by fax, 703-292-9018; or visit the HRD home page, <http://www.ehr.nsf.gov/hrd>.

1. Alliances for Graduate Education and the Professoriate (AGEP)

The AGEP Program seeks to significantly increase the number of American Indian/Alaskan Native (Native American), African American, Hispanic American, and Native Pacific Islander students receiving doctoral degrees in science, technology, engineering, and mathematics (STEM) fields customarily supported by NSF. The lack of role models and mentors in the professoriate constitutes a significant barrier to producing minority STEM doctoral graduates. NSF is particularly interested in increasing the number of minorities who will enter the professoriate in these disciplines.

Specific objectives of AGEP are to (1) develop and implement innovative models for recruiting, mentoring, and retaining minority students in STEM doctoral programs and (2) develop effective strategies for identifying and supporting underrepresented minorities who want to pursue academic careers.

The AGEP Program also supports a research effort to identify major factors that promote the successful transition of minority students from (1) undergraduate through graduate study; (2) course-taking in the early years of the graduate experience to independent research required for completion of a dissertation; and (3) the academic environment to the STEM workplace. To accomplish this, the research component will be informed by a portfolio of federal and private efforts in this arena in order to identify factors underlying exemplary as well as unsuccessful efforts.

Eligibility Requirements for AGEP

Alliances that consist of STEM doctoral degree-granting institutions are eligible to apply to the program. One institution must be designated as the lead institution for the project. Institutions in the United States and its territories that have documented success in graduating minority students at the Ph.D. level are strongly encouraged to participate. Alliances are encouraged to establish partnerships with minority-serving undergraduate institutions to enhance recruitment efforts, where appropriate.

 **For More Information**
Visit the HBCU-UP Web site, <http://www.ehr.nsf.gov/EHR/HRD/agep.asp>.

2. Centers of Research Excellence in Science and Technology (CREST)

NSF recognizes that academic institutions with significant minority student enrollments play a vital role in conducting the research that contributes to our knowledge base in all disciplines and in educating minority students who go on to careers in science, technology, engineering, and mathematics (STEM) fields.

The CREST Program makes substantial resources available to upgrade the capabilities of the most research-productive minority institutions. The program develops outstanding research centers through the integration of education and research. In addition, it serves to promote the production of new knowledge; increase the research productivity of individual faculty; and expand a diverse student presence in STEM disciplines. CREST projects enhance the effectiveness of related science and engineering activities within the project's area of research focus.

Eligibility Requirements for CREST

Institutions eligible to participate in CREST Research Infrastructure Improvement (RII) awards must have the following:

- Enrollments of 50 percent or more members of minority groups underrepresented in advanced levels of science and engineering (e.g., Alaskan Natives [Eskimo or Aleut], American Indian, African American, Native Pacific Islanders [Polynesian or Micronesian], Hispanic or Latino);
- Graduate programs in NSF-supported fields of science or engineering;
- Demonstrated strengths in NSF-supported fields, as evidenced by an existing or developing capacity to offer doctoral degrees in one or more science and engineering disciplines;
- A willingness and capacity to serve as a resource center in one or more research thrust areas;
- A demonstrated commitment and track record in enrolling and graduating minority scientists and engineers; and
- Strong collaborations in the proposed field of research.

 **For More Information**
Visit the CREST Web site, <http://www.ehr.nsf.gov/EHR/HRD/crest.asp>.

3. Historically Black Colleges and Universities – Undergraduate Program (HBCU-UP)

HBCU-UP seeks to enhance the quality of undergraduate science, technology, engineering, and mathematics (STEM) education at Historically Black Colleges and Universities as a means to broaden participation in the Nation's STEM workforce. The program provides support for the implementation of comprehensive institutional strategies to strengthen STEM teaching and learning in ways that will improve the access and retention of underrepresented groups in STEM. Typical project implementation strategies include STEM course and curricular

reform and enhancement; faculty professional development; supervised research and other active learning experiences for STEM undergraduates; student support; scientific instrumentation to improve STEM instruction; and other activities that meet institutional needs.

Eligibility Requirements

Historically Black Colleges and Universities that currently offer associate, baccalaureate, or graduate degrees in STEM fields are eligible.

 **For More Information**
Visit the HBCU-UP Web site, <http://www.ehr.nsf.gov/EHR/HRD/hbcu.asp>.

4. Louis Stokes Alliances for Minority Participation (LSAMP)

The LSAMP Program is designed to develop the comprehensive strategies necessary to strengthen the preparation and increase the number of minority students who successfully complete baccalaureates in science, technology, engineering, and mathematics (STEM) fields. This objective facilitates the long-term goal of increasing the production of doctorates in STEM fields, with an emphasis on entry into faculty positions.

The LSAMP Program requires each awardee to establish meaningful partnerships among academic institutions and encourages the inclusion of government agencies and laboratories, industry, and professional organizations. It is expected that successful partnerships will enable the development of approaches tailored to the institutional setting for achievement of program goals in STEM undergraduate education. Activities supported include student enrichment such as collaborative learning, skill development, and mentoring; academic enrichment, such as curricular and instructional improvement; and direct student support, such as summer activities.

Eligibility Requirements

With justification, nonprofit organizations may serve as members of the partnership. Academic institutions with a track record of educating underrepresented minority students in STEM disciplines are eligible to apply to the LSAMP Program.

 **For More Information**
Visit the LSAMP Web site, <http://www.ehr.nsf.gov/EHR/HRD/amp.asp>.

5. Tribal Colleges and Universities Program (TCUP)

TCUP provides awards to enhance the quality of science, technology, engineering, and mathematics (STEM) instruction and outreach programs, with an emphasis on the leveraged use of information technologies at Tribal Colleges and Universities, Alaskan Native-serving institutions, and Hawaiian Native-serving institutions. Support is available for the implementation of comprehensive institutional approaches to strengthen STEM teaching and learning in ways that improve access to, retention within, and graduation from STEM programs, particularly those that have a strong technological foundation. Through this program, assistance is provided to eligible institutions in their efforts to bridge the “digital divide” and prepare students for careers in information technology, science, mathematics, and engineering fields.

Proposed activities should be the result of careful analysis of institutional needs, address institutional and NSF goals, and have the potential to result in significant, sustainable improvement in STEM program offerings.

Typical TCUP project implementation strategies include curriculum enhancement, faculty professional development, undergraduate research and community service, academic enrichment, infusion of technology to enhance STEM instruction, collaborations, and other activities that meet institutional and community needs.

Eligibility Requirements for TCUP

Organizations that are eligible include Tribal Colleges and Universities, Alaskan Native-serving institutions, and Native Hawaiian-serving institutions.

For More Information

Visit the TCUP Web site, <http://www.ehr.nsf.gov/EHR/HRD/tcup.asp>.

• Women and Girls

Gender Diversity in Science, Technology, Engineering, and Mathematics Education (GDSE)

All of the divisions within NSF's Directorate for Education and Human Resources encourage projects that will increase the participation of women and girls in science, technology, engineering, and mathematics (STEM) fields. Because women are underrepresented in many disciplines, HRD supports research on focused interventions that are directed toward increasing the number of fully participating women in the mainstream of the Nation's scientific and technological enterprises. GDSE specifically supports the following activities:

- **Research**—This area seeks to enhance the multidisciplinary understanding of gender differences in human learning—behavioral, cognitive, affective, and social aspects—through sociopsychological, ethnographic, statistical, anthropological, economic, and organizational studies. The efforts in this area provide a research foundation for educational approaches, curriculum materials, and technological tools that are already developed or can be developed in the future. Emphasis is also placed on bridging research and educational practice in settings such as classrooms, informal learning sites, and technological learning environments. Results of PGE research projects should be cumulative, reproducible, sustainable, and scalable, supporting sustained improvement in educational practice.
- **Demonstration or "Model" Projects**—This area employs evaluation methods to determine the effectiveness of new learning tools, pedagogies, professional development, or student programs and services. Demonstration projects apply research findings about girls' learning preferences in the design of new curriculum materials, services, pedagogy, or instructor development programs. Successful or "model" projects may be institutionalized and replicated. Teacher and faculty development demonstrations test new ways to integrate the understanding and awareness of gender-inclusive practices into preservice and in-service programs and into professional standards and policies. It is anticipated that participants in demonstration projects will directly benefit from the learning experience and assimilate new behaviors.
- **Information Dissemination Activities**—This area of GDSE supports projects focusing on the dissemination of research results or strategies for reducing the barriers for women and girls in STEM fields. Supported activities include media (e.g., videotapes and brochures), conferences, teleconferences, symposia, and workshops that bring together experts to discuss issues, projects, policies, and research related to the participation and achievement of women and girls in STEM. Dissemination projects take exemplary models and materials to a significant national audience.

For More Information

Visit the GDSE Web site, <http://www.ehr.nsf.gov/EHR/HRD/pge.asp>.

• Persons With Disabilities

Research in Disabilities Education (RDE)

The Research in Disabilities Education (RDE) Program supports efforts to increase the participation and achievement of persons with disabilities in science, technology, engineering, and mathematics (STEM) education and careers. Meritorious projects from diverse institutions are supported via RDE demonstration, enrichment, and information dissemination (RDE-DEI) standard grants. Promising research efforts may then be developed further via continuing grants under the focused-research initiatives (RDE-FRI) program track. Finally, broadly applicable methods and products are disseminated for widespread use, commercialization, or inclusion in the activities of

program-sponsored Regional Alliances for persons with disabilities in STEM education (RDE-RAD). RDE Alliances serve to inform the public, government, and industry about proven good practices in the classroom; promote broader awareness of disabilities issues; and define specific areas of accessibility and human learning in need of further attention by educators and the research community.



For More Information

Visit the RDE Program Web site, <http://www.ehr.nsf.gov/EHR/HRD/rde.asp>.

• **Crosscutting Initiatives**

Presidential Awards for Excellence in Science, Mathematics, and Engineering Mentoring (PAESMEM)

The White House established the PAESMEM Program to recognize the importance of role models and mentors in the academic, professional, and personal development of students underrepresented in science, technology, engineering, and mathematics (STEM) fields. PAESMEM identifies outstanding mentors and mentoring programs that enhance the experiences of underrepresented students in the sciences, mathematics, and engineering. At the individual and institutional levels, PAESMEM awardees have been exemplary in their demonstration of the idea that the Nation must fully develop its human resources in STEM disciplines through the support of increased access by, and inclusion of, diverse populations.

Nominees, both individual and institutional, must have served as mentors or facilitated mentoring services for at least 5 years. Awards are made to (1) individuals who have demonstrated outstanding and sustained mentoring and effective guidance to a significant number of students at the K–12, undergraduate, or graduate level of education and (2) institutions that have, through their programming, enabled a substantial number of students from groups traditionally underrepresented in science, mathematics, and engineering to pursue and complete relevant degree programs successfully. At the postsecondary level, these efforts must show that students have completed either a baccalaureate, masters, or doctoral degree.



For More Information

Visit the PAESMEM Web site at:
<http://www.ehr.nsf.gov/EHR/HRD/paesmem.asp>.

**DIRECTORATE FOR EDUCATION AND HUMAN RESOURCES****Division of Research, Evaluation, and Communication**

The Division of Research, Evaluation, and Communication (REC) seeks to:

- advance research on science, technology, engineering, and mathematics (STEM) education and improve evaluative research on STEM education programs;
- increase the capacity of the field to conduct high-quality, innovative, useful, and credible STEM education evaluation or research studies; and
- increase the capacity of STEM education researchers and STEM education program evaluators to communicate the results of their research.

The REC Division supports the following programs and activities:

1. Research on Learning and Education (ROLE)
2. Evaluative Research and Evaluation Capacity Building (EREC)
3. Crosscutting Programs and Activities
4. Technical Assistance Contracts for Assessment, Evaluation, and Communication of EHR's Programs and Activities

 For More Information

Write to the Division of Research, Evaluation, and Communication (REC), National Science Foundation, 4201 Wilson Boulevard, Room 855, Arlington, VA 22230; or contact the division by telephone, 703-292-8650; or by e-mail, REC@nsf.gov; or visit the REC home page, <http://www.ehr.nsf.gov/EHR/REC>.

1. Research on Learning and Education (ROLE)

The ROLE Program supports research across a continuum that includes (1) the biological basis of human learning; (2) behavioral, cognitive, affective, and social aspects of human learning; (3) science, technology, engineering, and mathematics (STEM) learning in formal and informal educational settings; and (4) changing educational systems to improve STEM learning. ROLE aims to advance the knowledge base within and across the intersections of these multidisciplinary areas.

 For More Information

See the ROLE/EREC (Evaluative Research and Evaluation Capacity Building) joint program solicitation, [NSF 03-542](#); or visit the ROLE Web site, <http://www.ehr.nsf.gov/rec/programs/research>.

2. Evaluative Research and Evaluation Capacity Building (EREC)

The EREC Program supports projects that offer unique approaches to evaluation practice in the generation of knowledge for the science, technology, engineering, and mathematics (STEM) education community, and for broad policymaking within research and education enterprises. EREC also supports projects to increase the capacity of the field to conduct high-quality, innovative, useful, and credible STEM education evaluation studies.

 For More Information

See the EREC/ROLE (Research on Learning and Education) joint program solicitation, [NSF 03-542](#); or visit the EREC Web site, <http://www.ehr.nsf.gov/rec/programs/evaluation>.

3. Crosscutting Programs and Activities

REC participates in several of NSF's crosscutting activities, including interdisciplinary programs, programs that are supported by multiple NSF Directorates, international activities, and programs jointly supported by NSF and other federal agencies. The primary REC crosscutting activities are listed alphabetically below.

- **Faculty Early Career Development (CAREER)**—The CAREER Program recognizes and supports the early career development activities of those teacher-scholars who are most likely to become the academic leaders of the 21st century. CAREER proposals are welcome in the research areas identified in the unified EREC-ROLE program announcement, available through the NSF Online Document System at <http://www.nsf.gov/pubsys/ods/getpub.cfm?nsf03542>. CAREER proposals may also address the research questions or areas of interest identified by other EHR Divisions and programs. Frequently asked questions about CAREER can be found at <http://www.nsf.gov/pubs/2003/nsf03031/nsf03031.htm>. For more information, visit the CAREER Program Web site, <http://www.nsf.gov/home/crssprgm/career/start.htm>.
- **Information Technology Research (ITR)**—Information technology (IT) today is an essential ingredient in research, technology, education, and other societal endeavors. REC's share of the multi-NSF Directorate/multi-federal agency Information Technology Research (ITR) Initiative focuses on support for basic research to advance knowledge for education and workforce development. For more information, visit the ITR Initiative Web site, <http://www.itr.nsf.gov>.
- **Interagency Education Research Initiative (IERI)**—The goal of IERI—supported jointly by the Institute of Education Sciences, the National Science Foundation (represented by REC), and the National Institute of Child Health and Human Development—is to support scientific research that investigates the effectiveness of educational interventions in reading, mathematics, and the sciences as they are implemented in varied school settings with diverse student populations. For more information, see NSF's IERI program solicitation at <http://www.nsf.gov/pubs/2004/nsf04553/nsf04553.htm>; or visit the Department of Education's Web site, <http://www.ed.gov/about/offices/list/ies/index.html>.
- **Small Business Innovation Research (SBIR)**—SBIR is government-wide program intended to stimulate technological innovation; use small-business concerns to meet federal research and development (R&D) needs; foster and encourage the participation of minority and disadvantaged persons in technological innovation; and increase the commercialization by the private sector of innovations resulting from federal R&D. The primary objective of the NSF SBIR Program is to increase incentive and opportunity for small firms to undertake cutting-edge, high-risk, high-quality scientific, engineering, or science/engineering education research that would have a high potential economic payoff if the research is successful. For more information, visit the SBIR Program Web site, <http://www.eng.nsf.gov/sbir>.

4. Technical Assistance Contracts for Assessment, Evaluation and Communication of EHR's Programs and Activities

REC funds contracts that analyze the development, implementation, and impact of programming across the EHR Directorate and coordinates with other federal agencies engaged in similar science, technology, engineering, and mathematics education program or project evaluation. The Directory of Evaluation Contractors Home Page lists contact information for current prime and subcontractors and is available on the Evaluation and Communication Program Web site, <http://www.ehr.nsf.gov/rec/programs/evaluation>.

Contracted activities include program assessment, improvement, accountability, and generation and systematization of knowledge to benefit NSF. NSF's Contracts Branch is responsible for planning, solicitation, negotiation, award, and administration of all such contracts. Interested outside organizations, including for-profit businesses, universities, and other nonprofits and professional associations, should monitor monthly postings to the NSF's Contracting Opportunities page.



For More Information

Visit the NSF's Contracting Opportunities Web site,
<http://www.nsf.gov/home/about/contracting/index.cfm>.



DIRECTORATE FOR EDUCATION AND HUMAN RESOURCES

Division of Undergraduate Education

The Division of Undergraduate Education (DUE) serves as the focal point for NSF's efforts in undergraduate education. DUE's mission is to promote excellence in undergraduate science, technology, engineering, and mathematics (STEM) education for all students, including STEM majors, prospective teachers of grades preK through 12 (preK-12), students preparing for the technical workplace, and students in their role as citizens.

The Division accomplishes its mission by doing the following:

- Providing leadership to (1) promote cutting-edge efforts, risk-taking, and continuous innovation in the development of new practices and ideas; (2) shape national priorities to further educational innovation and research; and (3) direct efforts to increase the diversity of STEM communities.
- Supporting curriculum development that stimulates research on learning; leads to exemplary materials and strategies for education; incorporates model assessment programs and practices; effects broad dissemination of effective pedagogy and materials; and enables long-term sustainability of effective activities.
- Preparing the workforce by promoting technological, quantitative, and scientific literacy; supporting an increase in diversity, size, and quality of the next generation of STEM professionals who enter the workforce with 2- or 4-year degrees or who continue their studies in graduate and professional schools; investing in the Nation's future K-12 teacher workforce; and funding research to evaluate and improve workforce initiatives.
- Fostering connections by facilitating communication across disciplinary boundaries, across all educational levels (from K-12 through graduate school), and between academia, industry, and professional societies; encouraging faculty to combine teaching and discipline-based research; and collaborating with research communities and with NSF research directorates.

DUE supports the following programs and activities:

1. [Advanced Technological Education](#)
2. [Computer Science, Engineering, and Mathematics Scholarships](#)
3. [Course, Curriculum, and Laboratory Improvement \(which includes the Assessment of Student Achievement\)](#)
4. [Federal Cyber Service: Scholarship for Service](#)
5. [NSF Director's Award for Distinguished Teaching Scholars](#)
6. [National Science, Technology, Engineering, and Mathematics Education Digital Library](#)
7. [Robert Noyce Scholarship Program](#)
8. [Science, Technology, Engineering, and Mathematics Talent Expansion Program](#)
9. [Teacher Professional Continuum](#)

For More Information

Write to the Division of Undergraduate Education, National Science Foundation, 4201 Wilson Boulevard, Room 835, Arlington, VA 22230; or contact the division by telephone, 703-292-8670; or by e-mail, undergrad@nsf.gov; or visit the DUE home page, <http://www.ehr.nsf.gov/EHR/DUE/>.

1. Advanced Technological Education (ATE)

The ATE Program is managed jointly by DUE and the Division of Elementary, Secondary, and Informal Education. The program promotes improvement in the education of technicians in science- and engineering-related fields at the undergraduate and secondary school levels. It particularly targets 2-year colleges and encourages collaboration among 2-year colleges, 4-year colleges, universities, secondary schools, business, industry, and government. Proposals are solicited in the following three tracks:

- **Projects**—Activities may include the adaptation of exemplary educational materials, courses, and curriculums in new educational settings; the preparation and professional development of college faculty and secondary school teachers; development of educational materials, courses, curriculums, and laboratories; internships and field experiences for students and educators; the evaluation and broad

dissemination of exemplary educational materials, curricula, and pedagogical practices designed by previously funded ATE centers and projects, and research on effective practices in technician education.

- **Centers**—Centers are comprehensive national or regional resources that provide models and leadership for other projects and act as clearinghouses for educational materials and methods. National Centers of Excellence engage in the full range of activities described above for projects. Regional centers for manufacturing or information technology education pursue comprehensive approaches that focus on reforming academic programs, departments, and systems to produce a highly qualified workforce to meet industry's needs within a particular geographic region. Resources Centers constitute a highly visible source of materials, ideas, contacts, and mentoring in a particular field of technological education.
- **Articulation Partnerships**—Focus on enhancing either of two important educational pathways for students between 2-year colleges and 4-year colleges and universities. One type of Articulation Partnership focuses on strengthening the science, technology, and mathematics preparation of prospective K–12 teachers who are enrolled in preprofessional programs at 2-year colleges. The other type of partnership targets 2-year college programs for students to continue their education in 4-year science, technology, engineering, and mathematics programs, especially programs that have a strong technological basis.

Proposals in all three tracks must show evidence of a coherent vision of technological education—a vision that recognizes the needs of the modern workplace, the needs of students as lifelong learners, and the need for articulation of educational programs at different levels. Whenever feasible, projects are expected to utilize and innovatively build from successful educational materials, courses, curriculums, and methods that have been developed through other ATE grants, as well as other exemplary resources that can be adapted to technological education.

For More Information

Visit the ATE Program Web site, <http://www.ehr.nsf.gov/EHR/DUE/programs/ate>.

2. Computer Science, Engineering, and Mathematics Scholarships (CSEMS)

The CSEMS Program provides institutions with funds to support scholarships for talented but financially disadvantaged students in computer science, computer technology, engineering, engineering technology, or mathematics degree programs. Through support from this program, grantee institutions establish scholarships that promote full-time enrollment and completion of degrees in higher education in the above fields. NSF established the program in accordance with the American Competitiveness and Workforce Improvement Act of 1998 (Public Law 105-277). The Act reflects the Nation's need to increase substantially the number of graduates from associate, baccalaureate, and graduate degree programs in these fields. The goals of this program are to:

- improve education for students in the stated disciplines;
- increase retention of students to degree completion;
- improve professional development, employment, and further higher education placement of participating students; and
- strengthen partnerships between institutions of higher education and related employment sectors.

The eligibility criteria for a CSEMS scholarship recipient include the following:

- status as a U.S. citizen, national, refugee alien, or permanent resident alien at the time of application;
- full-time enrollment in a computer science, computer technology, engineering, engineering technology, or mathematics degree program at the associate, baccalaureate, or graduate level;
- demonstration of academic potential or ability; and
- demonstration of financial need, defined for undergraduates as financial eligibility under U.S. Department of Education rules for federal financial aid, and defined for graduate students as eligibility for Graduate Assistance in Areas of National Need.

CSEMS proposers must be institutions of higher education that grant degrees in computer science, computer technology, engineering, engineering technology, or mathematics.


For More Information

Visit the CSEMS Program Web site, <http://www.ehr.nsf.gov/EHR/DUE/programs/csems>.

3. Course, Curriculum, and Laboratory Improvement (CCLI)

The CCLI Program seeks to improve the quality of science, technology, engineering, and mathematics (STEM) education for all students, based on research concerning the needs and opportunities that exist and effective ways to address them. It targets activities affecting learning environments, course content, curriculums, and educational practices, with the aim of contributing to the relevant research base. The program invites proposals to improve undergraduate STEM education in a broad spectrum of institutions, including 2-year colleges, 4-year colleges, and universities. Projects may involve a single institution, a collaborative effort among several institutions, or a collaboration with business and industry partners. The program has four tracks:

- **Educational Materials Development (CCLI-EMD)** projects are expected to produce innovative materials that incorporate effective educational practices to improve student learning of STEM. Projects to develop textbooks, software, or laboratory materials for commercial distribution are appropriate. Two types of EMD projects will be supported: (1) those that intend to demonstrate the scientific and educational feasibility of an idea—a "proof of concept" or prototype and (2) those that are based on prior experience with a prototype that intend to fully develop and test the product or practice. Such materials are expected to be disseminated nationally for adoption and adaptation.
- **National Dissemination (CCLI-ND)** projects are expected to provide faculty with professional development opportunities to enable them to introduce new content into undergraduate courses and laboratories and to explore effective educational practices to improve the effectiveness of their teaching. Projects should be designed to offer workshops, short courses, or similar activities on a national scale in single or multiple disciplines.
- **Adaptation and Implementation (CCLI-A&I)** projects are expected to result in improved education in STEM at academic institutions through adaptation and implementation of exemplary materials, laboratory experiences, and/or educational practices that have been developed and tested at other institutions. Proposals may request funds in any budget category supported by NSF or may request funds to purchase only instrumentation.
- **Assessment of Student Achievement (CCLI-ASA)** projects are expected to develop and disseminate assessment practices, materials (tools), and measures to guide efforts that improve the effectiveness of courses, curriculums, programs of study, and academic institutions in promoting student learning in STEM. This program track also promotes the full integration of assessment with these educational efforts. Three types of ASA projects will be supported: (1) New Development—developing new assessment materials (tools) and practices for use in single or multiple undergraduate disciplines; (2) Adaptation—adapting assessment materials and practices that have proven effective for one setting or audience for use in a new setting, or with a different audience; and (3) Dissemination—spreading the use of effective assessment practices through workshops or web-based materials that are thoroughly documented with detailed instructions.

 **For More Information**
Visit the CCLI Program Web site,
<http://www.ehr.nsf.gov/EHR/DUE/programs/ccli>.

4. Federal Cyber Service: Scholarship for Service (SFS)

The SFS Program seeks to increase the number of qualified students entering the fields of information assurance and computer security and increase the capacity of higher education enterprise in the United States in order to continue producing professionals in these fields. The program consists of the following tracks:

- **Scholarship Track** provides funding to colleges and universities to award scholarships in information assurance and computer security fields. Scholarship recipients will become part of the Federal Cyber Service of information technology specialists who ensure the protection of the U.S. Government's information infrastructure. After their 2-year scholarships, the recipients will be required to work for a federal agency for 2 years as their Federal Cyber Service commitment.
- **Capacity Building Track** seeks to increase the national capacity for producing trained information assurance professionals by providing support to colleges and universities interested in building programs, individually or in partnership.

 **For More Information**
Visit the SFS Program Web site, <http://www.ehr.nsf.gov/EHR/DUE/programs/sfs>.

5. NSF Director's Award for Distinguished Teaching Scholars (DTS)

The purpose of the DTS Program is to recognize and reward individuals who have contributed significantly to the scholarship of their discipline and to the education of students in science, technology, engineering, and mathematics (STEM), and who exemplify the ability to engage productively in both research and education. DTS is part of NSF's efforts to foster an academic culture that values a scholarly approach to both research and education. The Director's Award is the highest honor bestowed by the NSF for excellence in both teaching and research in STEM fields, or in educational research related to these disciplines.

For More Information

Visit the DTS Program Web site, <http://www.ehr.nsf.gov/EHR/DUE/programs/dts>.

6. National Science, Technology, Engineering, and Mathematics Education Digital Library (NSDL)

The goal of the NSDL Program is to support the creation and development of a national digital library for science, technology, engineering, and mathematics (STEM) education. The resulting virtual facility--learning environments and resources network for STEM education--is intended to meet the needs of students and teachers at all levels, including K-12, undergraduate, graduate, and lifelong learning, in both individual and collaborative settings. The NSDL Program builds on work supported under the multiagency Digital Libraries Initiative (see <http://www.dli2.nsf.gov>) and represents a synergistic collaboration of research and education efforts.

The NSDL Program is currently supporting a Core Integration effort that coordinates and manages the digital library's holdings and services. To complement and further expand this Core Integration capacity, the NSDL Program accepts proposals in the following tracks:

- **Collections** projects are expected to aggregate and manage a subset of the library's content within a coherent theme or specialty.
- **Services** projects are expected to develop services that will support users, collection providers, and the Core Integration effort, as well as enhance the impact, efficiency, and value of the library.
- **Targeted Research** projects are expected to explore specific topics that have immediate applicability to one of the other two tracks, or the Core Integration effort discussed above.

For More Information

Visit the NSDL Program Web site,
<http://www.ehr.nsf.gov/EHR/DUE/programs/nsdl>.

7. Robert Noyce Scholarship Program

The Robert Noyce Scholarship Program seeks to increase the number of K-12 teachers with strong science, technology, engineering, and mathematics (STEM) content knowledge by encouraging talented STEM undergraduates and STEM professionals to pursue teaching careers in elementary and secondary schools. The program provides funding to institutions of higher education to provide scholarships, stipends, and programmatic support for STEM majors and STEM professionals to enter and complete teacher credentialing programs. Scholarship recipients are required to complete two years of teaching in a high need school district for each year of scholarship or stipend support.


For More Information

For specific information on eligibility, visit the Noyce Program Web site,
<http://www.ehr.nsf.gov/EHR/DUE/programs/noyce/>.

8. Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP)

STEP seeks to increase the number of students (U.S. citizens or permanent residents) pursuing and receiving associate or baccalaureate degrees in established or emerging fields within science, technology, engineering, and

mathematics (STEM). The program is open to institutions of higher education in the United States and its territories and to consortia of such institutions, offering either associate degrees or baccalaureate degrees in STEM fields. Type 1 proposals are solicited that provide for full implementation efforts at academic institutions. Type 2 proposals are solicited that provide for educational research projects on associate or baccalaureate degree attainment in STEM.

 **For More Information**
Visit the STEP Program Web site,
<http://www.ehr.nsf.gov/EHR/DUE/programs/step>.

9. Teacher Professional Continuum (TPC)

The TPC Program is managed jointly by ESIE and the Division of Undergraduate Education. TPC addresses the full continuum of teacher education (grades K–12) from recruitment and preparation through enhancement, retention, and lifelong learning of SMT teachers. TPC supports four categories of projects: (1) Research Studies—identify effective strategies for educating teachers, develop supportive structures and environments that sustain SMT educators, and impact teaching practice through teacher learning; (2) Research and Development of Educational Models and Systems—evaluate overall effectiveness of models and systems to be studied, as well as how relationships among various components influence effectiveness; (3) Professional Resources Development that are grounded in recent advances in research on teaching and learning; and (4) Conferences and Symposia—focus on planning and dissemination of research findings, issues, innovations, and action plans.

TPC Program goals are to:

- improve the quality and coherence of the learning experiences that prepare and enhance SMT teachers;
- develop innovative curricula, materials, tools, ideas, and information resources for the professional development of SMT teachers and administrators;
- research, develop, and identify models, organizational structures, and systems that support the teacher professional continuum;
- use scientifically-based studies to research teacher learning throughout the teacher professional continuum and its impact on teaching practice;
- advance the knowledge base on the preparation, enhancement, and retention of SMT teachers, and on the strategies that strengthen and diversify the SMT teaching profession; and
- disseminate this knowledge and research--as well as innovative models and resources--to a national audience.

Eligibility Requirements for TPC

The TPC Program has special eligibility requirements beyond the standard NSF requirements. For more information, see program solicitation [NSF 03-534](#).



DIRECTORATE FOR EDUCATION AND HUMAN RESOURCES

Experimental Program to Stimulate Competitive Research

The Experimental Program to Stimulate Competitive Research (EPSCoR) is a joint program of the National Science Foundation (NSF) and several U.S. States and territories. The program promotes the development of States' science and technology (S&T) resources through partnerships involving a State's universities, industry, and government, and the federal research and development (R&D) enterprise. EPSCoR's goal is to maximize the potential inherent in State S&T resources and use those resources as a foundation for economic growth.

 **For More Information**

A full array of information about the program and its requirements and participants is available on the EPSCoR Web site, <http://www.ehr.nsf.gov/epscor>. Information may also be obtained by writing to the EPSCoR Office, Room 875, National Science Foundation, 4201 Wilson Boulevard, Arlington, VA 22230; or contact by telephone, 703-292-8683.

The National Science Foundation
4201 Wilson Boulevard, Arlington, Virginia 22230, USA
Tel: 703-292-5111, FIRS: 800-877-8339 | TDD: 703-292-5090



Directorate for Engineering (ENG)



The Directorate for Engineering (ENG) supports engineering research and education in a competitive environment that emphasizes innovation, creativity, and excellence. This support benefits the Nation by creating the human resources and knowledge that spur technological innovation and economic growth in an increasingly swift, complex, and interconnected world. A significant portion of ENG's funds is invested in investigator-initiated research. Although the research supported by ENG is fundamental in nature, much of it is focused on societal needs. Over the long term, ENG investments contribute to innovation that enables the creation of valuable new

products and services and new and more productive enterprises that enhance the Nation's future economic strength, security, and quality of life.

ENG's investment and partnerships with academe, federal agencies, and private industry as well as collaboration with other National Science Foundation (NSF) directorates in the emerging technologies of microsystems and nanotechnology, information technology, and biotechnology enable significant advances in health care, manufacturing, education, and the service industry. For example, awards made by the Grant Opportunities for Academic Liaison with Industry (GOALI) Program, which receives strong ENG support, bring university and industry collaborators together at the conceptual phase of a research and education endeavor. Strengthening these intellectual connections increases the value of engineering education and fundamental research to the private sector and opens exciting new areas of research.

Overall, NSF provides about 36 percent of the total Federal support for fundamental engineering research at universities and colleges in the United States.

The Directorate for Engineering supports programs and activities through the following:

- [Crosscutting Programs and Activities](#)
- [Division of Bioengineering and Environmental Systems \(BES\)](#)
- [Division of Chemical and Transport Systems \(CTS\)](#)
- [Division of Civil and Mechanical Systems \(CMS\)](#)
- [Division of Design, Manufacture, and Industrial Innovation \(DMII\)](#)
- [Division of Electrical and Communications Systems \(ECS\)](#)
- [Division of Engineering Education and Centers \(EEC\)](#)

For More Information

Visit the ENG Directorate home page, <http://www.eng.nsf.gov/>.



DIRECTORATE FOR ENGINEERING

Crosscutting Programs and Activities

NSF-Wide Activities

In addition to the programs and activities mentioned in this section, the Directorate for Engineering (ENG) takes an active role in the following NSF-wide programs and activities: Nanoscale Science and Engineering, Biocomplexity in the Environment, Information Technology Research, Mathematical Sciences, and Human and Social Dynamics priority areas. Faculty Early Career Development (CAREER) Program, Research Experiences for Undergraduates (REU), Integrative Graduate Education and Research Training (IGERT), Graduate Fellowships (e.g., Graduate Research Fellowships, GK-12 Teaching Fellowships), Grant Opportunities for Academic Liaison with Industry (GOALI), Major Research Instrumentation (MRI), undergraduate activities, the ADVANCE program to increase the participation of women in the scientific and engineering workforce, minority programs, Small Business Innovation Research (SBIR), Small Business Technology Transfer Research (STTR), and programs for persons with disabilities.

For More Information

Visit the NSF Crosscutting Programs home page,
<http://www.nsf.gov/home/crssprgm/>.

Engineering-Wide Activities

The ENG Directorate also has programs that are available across all of its divisions. The Materials Use: Science, Engineering, and Society (MUSES) component of Biocomplexity in the Environment is an important ENG-wide activity. Another emphasis is in Sensing and Sensor Technology. For information about ENG's education programs, see the Division of Engineering Education and Centers (EEC) section of this Guide; or visit the EEC home page, <http://www.eng.nsf.gov/eec>.



DIRECTORATE FOR ENGINEERING

Division of Bioengineering and Environmental Systems

The Division of Bioengineering and Environmental Systems (BES) supports research that

- expands the knowledge base of bioengineering at scales ranging from proteins and cells to organ systems, large bioreactors, and biomanufacturing systems, including mathematical models, devices, and instrumentation systems. BES is particularly interested in postgenomic engineering, metabolic engineering, and tissue engineering. BES continues its strong interest in upstream and downstream processing of proteins and other biochemicals (see the Biochemical Engineering and Biotechnology Program for more information).
- applies engineering principles to the models and tools used in understanding living systems, and to products for human health care. BES supports the development of prototypes for new and improved devices and software for persons with disabilities. Emphasis is placed on basic engineering research that will contribute to better and more efficient health care delivery and that will aid people with disabilities. Current areas of interest include biomedical photonics and sensing (see the Biomedical Engineering Program for more information).
- improves our ability to apply engineering principles to avoid and correct problems that impair the usefulness of land, air, and water. Current interest areas include environmental remediation, especially with respect to understanding the fate and transport of surface and groundwater pollutants; novel processes for waste treatment; industrial ecology; and technologies for avoiding pollution (see the Environmental Engineering and Technology Program for more information).

The BES Division supports the following programs and activities:

1. [Biochemical Engineering and Biotechnology](#)
2. [Biomedical Engineering and Research to Aid Persons with Disabilities](#)
3. [Environmental Engineering and Technology](#)

 **For More Information**

Write to the Division of Bioengineering and Environmental Systems, National Science Foundation, 4201 Wilson Boulevard, Room 565, Arlington, VA 22230; or contact the division by telephone, 703-292-8320; or by fax, 703-292-9098; or visit the BES home page, <http://www.eng.nsf.gov/bes>.

1. Biochemical Engineering and Biotechnology

Supports research that links the expertise of engineering with that of the life sciences to provide a fundamental basis for economical manufacturing of substances of biological origin. Engineers and small groups of engineers and scientists are encouraged to apply for support. Synergy among the various disciplines in these types of projects is a very important evaluation criterion. Current areas of interest include the following:

- **Postgenomic Engineering**—Quantitative methods for predicting the phenotypic behavior of proteins, pathways, and cells from genomic data.
- **Metabolic Engineering**—Methods for understanding and beneficially altering the chemical pathways of living systems.
- **Tissue Engineering**—Development of polymeric scaffolding, imbedding of cells, cell-to-cell communications, tissue biomechanics, and so forth.
- **Bioprocessing**—Novel bioreactors and processing systems and controls; major changes in downstream isolation and purification.

2. Biomedical Engineering and Research to Aid Persons with Disabilities

Supports fundamental engineering research that has the potential to contribute to improved health care and

reduced of health care costs. Other areas of interest include models and tools for understanding biological systems; fundamental improvements in deriving information from cells, tissues, organs, and organ systems; extraction of useful information from complex biomedical signals; new approaches to the design of structures and materials for eventual medical use; and new methods of controlling living systems. The program is also directed toward the characterization, restoration, and substitution of normal functions in humans. The research could lead to the development of new technologies or to the novel application of existing technologies rather than to product development. Also supported are undergraduate engineering design projects, especially those that provide prototype "custom-designed" devices or software for persons with mental or physical disabilities. New areas of research interest include biomedical photonics and sensors.

3. Environmental Engineering and Technology

Supports sustainable developmental research, the goal of which is to reduce the adverse effects on land, fresh and salt water, and air that are brought on by the solid, liquid, and gaseous discharges that result from human activity, causing deterioration of those resources. The program also supports innovative research in the areas of biological, chemical, and physical processes that are used alone or as components of engineered systems to restore the usefulness of polluted land, water, and air resources. Emphasis is on engineering principles that underlie pollution avoidance, and pollution treatment and repair. Improved sensors, innovative production processes, waste reduction and recycling, and industrial ecology are important to this program. Research may be directed toward improving the cost-effectiveness of pollution avoidance as well as developing new principles for pollution avoidance technologies. The program places particular emphasis on engineering principles that underlie pollution avoidance.



DIRECTORATE FOR ENGINEERING

Division of Chemical and Transport Systems

Technologies and processes for transforming materials and energy are critical to improve living standards, prolong life, and protect the natural environment. The Division of Chemical and Transport Systems (CTS) supports research that contributes to the knowledge base important for the design and control of a large number of industrial processes. Relevant areas of application include production of chemicals, pharmaceuticals, petroleum and petrochemicals; synthetic and natural materials such as polymers and electronic materials; energy; and waste treatment. CTS support is directed to fundamental engineering principles involving mathematical models of macro and molecular systems and experimental techniques. Emphasis is on projects that have the potential for innovation and broad application in areas related to environmental preservation, materials development, and chemical and thermal processing. Increased emphasis is being placed on formation of nanostructured functional materials, environmentally benign chemical and materials processing, the development of sustainable and more efficient energy systems, and effective integration of research and education.

The CTS Division supports four general thematic areas through the following programs:

1. Chemical Reaction Processes
2. Interfacial, Transport, and Separation Processes
3. Fluid and Particle Processes
4. Thermal Systems

 For More Information

Write to the Division of Chemical and Transport Systems, National Science Foundation, 4201 Wilson Boulevard, Room 525, Arlington, VA 22230; or contact the division by telephone, 703-292-8371; or by fax, 703-292-9054; or visit the CTS home page, <http://www.eng.nsf.gov/cts>.

1. Chemical Reaction Processes

This program consists of two components: (1) Kinetics, Catalysis, and Molecular Processes (KCMP) and (2) Process and Reaction Engineering (PRE). Activities supported through the components include research on the rates and mechanisms of important classes of chemical reactions and on the quantitative description of chemical reactors and processes.

- **Kinetics, Catalysis, and Molecular Processes (KCMP)**—Supports the study of reactions at the molecular scale. Topics of interest include fundamental theories, novel modeling, and simulation approaches to reactive molecular processes; molecular modeling to relate atomistic-level phenomena to plant-scale design; single-molecule mechanisms and characterization; combinatorial catalysis and combinatorial chemistry; automated parallel synthesis and high-throughput screening; catalytic and materials process informatics; catalysis in medicine and life processes; reactions in nanoenvironments; large-scale kinetics databases and intelligent data management; distributed and collaborative reactive process characterization; bioinspired reactive process design; nanofabricated reactive processes; nanophase control in reactive processes; electrochemical and photochemical processes; environmentally sustainable and abundant feedstocks; wasteless pathways and pollution prevention; low-temperature chemical processes; and single-step processing.
- **Process and Reaction Engineering (PRE)**—Generally deals with reactors, macroscopic reaction systems, and chemical-processing plants. Topics of interest include design and optimization of complex chemical processes including scheduling and supply-chain modeling; dynamic modeling and control of processes; combined reaction and separation; sensors for process and quality control; reactive processing of polymers, ceramics, and thin films; global integration of chemical processes within the service economy; interactions between chemical reactions and transport processes in reactive systems; and the use of information technology in the design of complex chemical reactors.

2. Interfacial, Transport, and Separation Processes

Activities supported through the components in this program support research in areas related to interfacial phenomena and mass transport, separation science, and phase-equilibrium thermodynamics. The two components of the program are (1) Interfacial, Transport, and Thermodynamics (ITT) and (2) Separation and Purification Processes (SPP).

- **Interfacial, Transport, and Thermodynamics (ITT)**—Major focus areas include advanced materials processing and environmentally benign processing. ITT provides support for fundamental approaches and theories that deal with the thermodynamics of complex fluids and transport phenomena at interfaces of synthetic and biological systems, and the processing of nanoscale materials and thin films. The ITT Program also supports research aimed at minimizing hazardous products in chemical and materials manufacturing, with a focus on environmentally friendly coatings, alternate reactions, and processing media.
- **Separation and Purification Processes (SPP)**—Major focus areas include the development of functional materials as effective mass-separation agents, high-performance computing and modeling applied to separation processes, and novel strategies that combine several phenomena to accomplish effective separations. The SPP Program supports basic research that involves novel membranes and adsorbents; modeling and computations applied over a range of scales, from a molecular level to macroscale analysis of separation processes; and separations utilizing combined effects of controlled hydrodynamics, adsorption phenomena, electrical or magnetic fields, and chemical reactions.

3. Fluid and Particle Processes

Consists of two components (1) Fluid Dynamics and Hydraulics (FDH) and (2) Particulate and Multiphase Processes (PMP). Activities supported through these components include fundamental research on mechanisms and phenomena that govern single- and multiphase fluid flow; particle formation and transport, various multiphase processes; synthesis and processing of nanostructured materials, and fluid and solid system interactions.

- **Fluid Dynamics and Hydraulics (FDH)**—Supports basic research on fluid dynamics, both computational and experimental. Major areas of interest include turbulence, flow in complex geometries, stability and transition in polymer processing, and flow in nanostructures, with applications to design and control machines and processes. The program also strives to increase the understanding and predictive capabilities of flows in rivers and coastal areas for environmental and commercial applications.
- **Particulate and Multiphase Processes (PMP)**—Funds research on topics related to multiphase and dispersed systems. Areas of interest include not only multiphase flows but also the synthesis and processing of nanoparticles. In addition to experimental studies, the program supports work on molecular and mesoscale modeling of particle formation and materials synthesis. Hierarchical simulation techniques that will lead to insights of engineering relevance and nonintrusive measurement techniques are supported, as is research on innovative uses of particles in new processes and technologies.

4. Thermal Systems

This program consists of two components (1) Thermal Transport and Thermal Processes (TTP) and (2) Combustion and Plasma Systems (CPS). Priorities in both programs include projects related to environmental quality and energy efficiency as well as new manufacturing techniques.

- **Thermal Transport and Thermal Processes (TTP)**—Supports projects that seek a basic understanding of heat transfer, particularly at the micro- and nanoscale levels, and that apply heat and mass transfer principles to technologically-related fields. Areas in need of basic heat-transfer research include photon and phonon transport in thin films, laser/radiation interactions with liquid and solid phases, macroscopic transport with microstructure formation during solidification, flow and heat transport in porous media, microjet cooling for electronic equipment; phase-change materials, non-isothermal rheology, and crystal growth. Examples of technologically related fields are manufacturing, laser processing and machining, welding, gas turbines, heating and ventilation systems, biotechnology, and cryogenics.
- **Combustion and Plasma Systems (CPS)**—Supports research on the fundamental, physical, and chemical processes involved in combustion. A primary objective is to address major problems such as the formation of pollutants in combustion, energy-conversion inefficiencies, and fire hazards. The program supports fundamental science and engineering studies that underlie the application of plasma technology in situations such as chemical conversions, materials refining, and energy recovery. Projects supported by CPS apply combustion or plasma processing to such areas as production of fine powders or thin films, waste

destruction, sterilization, and surface modification. Major topics covered include flame chemistry, incineration, internal combustion engines, pollutant formation from combustion, models of combustion or plasma systems, diagnostics for combustion and plasmas, plasma chemistry and physics, and combustion synthesis. CPS also supports computational efforts in both theory and simulation, and experimental studies on real engineering systems or laboratory models, diagnostic techniques, and real-time monitoring of processes.

**DIRECTORATE FOR ENGINEERING****Division of Civil and Mechanical Systems**

The Division of Civil and Mechanical Systems (CMS) supports research that contributes to the knowledge base and intellectual growth in the areas of infrastructure construction and management, geotechnology, structures, dynamics and control, mechanics and materials, sensing for civil and mechanical systems, and the reduction of risks induced by earthquakes and other natural and technological hazards.

The CMS Division encourages cross-disciplinary partnerships at the intersections of traditional disciplines. These partnerships promote discoveries using technologies such as autoadaptive systems, nanotechnology, and information technology to enable revolutionary advances in the Nation's civil and mechanical systems.

The CMS Division supports the following research programs:

1. Dynamic System Modeling, Sensing, and Control (DSMSC)
2. Geotechnical and Geohazards Systems (GGS)
3. Infrastructure and Information Systems (IIS)
4. Solid Mechanics and Materials Engineering (SMME)
5. Structural Systems and Engineering (SSE)
6. George E. Brown Jr. Network for Earthquake Engineering Simulation (NEES)

 For More Information

Write to the Division of Civil and Mechanical Systems, National Science Foundation, 4201 Wilson Boulevard, Room 545, Arlington, VA 22230; or contact the division by telephone, 703-292-8360; or by fax, 703-292-9053; or visit the CMS home page, <http://www.eng.nsf.gov/cms>.

1. Dynamic System Modeling, Sensing, and Control (DSMSC)

Supports research on the fundamental engineering concepts and mathematical theories for modeling, analysis, simulation, and control of complex nonlinear dynamic systems, including the study of new control methods, acoustics, vibrations, and kinematics relationships. DSMSC invests in research on information technology as related to smart and autoadaptive civil and mechanical systems, including the study of new technologies for sensing and acquiring information; multiple and intelligent system functionality; integration of sensors, actuators, controllers, and power sources; and modeling, synthesis, simulation, and prototyping of intelligent systems and their components.

2. Geotechnical and Geohazards Systems (GGS)

Seeks to advance the fundamental engineering and related knowledge for geostructures—foundations, slopes, excavations, soil and rock improvement technologies, and reinforcement systems; geohazards mitigation; constitutive modeling and verification; remediation and containment of geo-environmental contamination; transferability of laboratory results to field scale; and nondestructive and in situ evaluation. GGS support is given for research that will increase the geotechnical and geohazards knowledge necessary to mitigate the impacts of natural and technological hazards in both constructed and natural environments. A broad spectrum of research is supported, including the use of data from laboratory and field experiments to develop and validate innovative designs and methodologies; the application of new sensing and information technologies to the simulation of complex phenomena; and the collection of data from catastrophic events including deployment of rapid-response reconnaissance.

3. Infrastructure and Information Systems (IIS)

Supports research to develop new science bases necessary for developing and deploying advanced information systems and technologies required to sustain the Nation's infrastructure. IIS research affects infrastructure system design, construction, maintenance, and operation and control. It includes networking technology, Internet-based

data systems, voice and data communications technologies, and geographical information systems-based multimedia global infrastructure information systems. The IIS Program is also interested in systems and network approaches to infrastructure management and life-cycle engineering, integrated systems behavior and network simulation, hazard preparedness and response, societal and economic impacts, decision theory, intelligent systems and engineering (life-cycle design), and conceptual and theoretical bases of scalable enterprise for civil systems construction and management.

4. Solid Mechanics and Materials Engineering (SMME)

Links the expertise of analytical, computational, and experimental solid mechanics and biomechanics with materials and surface engineering to understand, characterize, analyze, design, and control the mechanical properties and performance of materials and devices. SMME supports research on the deformation, fracture, fatigue, friction, wear, and corrosion of all types of materials, including composites, nanostructured materials, construction materials, and coatings and surface modification for service under extreme conditions. The program also supports experimental and analytical investigations and simulation modeling of material microstructures and their connections to nano-, meso-, and macroscale structural behavior.

5. Structural Systems and Engineering (SSE)

Emphasizes new discoveries in the design, construction, repair, rehabilitation, upgrade, and maintenance of structural materials and systems. SSE supports research that will advance the knowledge base on the application of advanced polymer materials and high-performance steel and concrete materials, durability of construction materials, soil structure interaction, safety and reliability of bridges and other structures including applications of condition assessment to structural systems, and integrated building systems. Also of interest is research that will lead to improved understanding of the impact of extreme events on the performance of the constructed environment and on interactions between natural and constructed environments.

6. NSF George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES)

Funded under the NSF Major Research Equipment and Facilities Construction Account, NEES is authorized for a construction period of 5 years through September 30, 2004, for a total NSF contribution of \$81.8 million. The goal of NEES is to provide a national networked collaboratory of geographically distributed shared-use, next-generation experimental research equipment sites. The sites will be equipped with teleobservation and teleoperation capabilities that will transform the environment for earthquake engineering research and education through collaborative and integrated experimentation, computation, theory, database, and model-based simulation. The goal is to improve the seismic design and performance of U.S. civil and mechanical infrastructure systems. When the construction is completed, the NEES consortium will operate the NEES collaboratory through the year 2014.

The NEES collaboratory will include 15 to 20 equipment sites (shake tables, centrifuges, tsunami wave basin, large-scale laboratory experimentation systems, and field experimentation and monitoring installations) networked together through a high performance Internet. In addition to providing access for telepresence at the NEES equipment sites, the network will use cutting-edge tools to link high performance computational and data storage facilities, including a curated repository for experimental and analytical earthquake engineering and related data. The network will also provide distributed physical and numerical simulation capabilities and resources for visualization of experimental and computed data. For further information, visit the program's Web site, <http://www.eng.nsf.gov/nees>.

**DIRECTORATE FOR ENGINEERING****Division of Design, Manufacture, and Industrial Innovation**

The Division of Design, Manufacture, and Industrial Innovation (DMII) supports fundamental academic research in design, manufacturing, and industrial engineering. DMII also manages crosscutting industrial innovation programs that encompass major components of NSF.

Technological advances, increasing global competition, and the Internet have combined to make today's manufacturing activities increasingly integrative, such that the distinction between "manufacturing" and "service" has become blurred. The mission of the Engineering Design and Manufacture research programs is to address this rapidly changing environment; the challenge it poses to the Nation's economic well-being; the expanding opportunities of the emerging service sector; and the need for an educated technical workforce for the manufacturing and service enterprises of the future.

To address this mission, DMII identifies and supports fundamental research on issues that span the areas supported within the Engineering Directorate—from design to manufacturing to service. These areas include size scales from the "nano" environment that will drive tomorrow's manufacturing processes to the "macro" or global enterprise scale that defines the production systems of the traditional manufacturing sector and extends into the growing service sector of the future. DMII-funded research includes an emphasis on environmentally benign manufacturing and a sustainable industrial economy, and seeks to address those fundamental issues that will deepen our understanding of the processes and systems that comprise modern design, manufacturing, and service enterprises and benefit society. The Division maintains a commitment to the integration of research and education and the education of a diverse engineering workforce that will be responsive to the needs of industrial and service enterprises.

The DMII Division's academic research programs are grouped into the following two clusters:

- Engineering Decision Systems
- Manufacturing Process and Equipment Systems

The former focuses on the mathematical aspects of design, service, and enterprise systems; the latter addresses the physical aspects of materials and manufacturing processes.

- Industrial Innovation Programs

DMII's Industrial Innovation Programs support small business and organizational innovation research as well as programs that seek collaboration with industry. These programs are crosscutting and span all areas supported by the Engineering Directorate and many other parts of NSF.

 For More Information

Write to the Division of Design, Manufacture, and Industrial Innovation, National Science Foundation, 4201 Wilson Boulevard, Room 550, Arlington, VA 22230; or visit the DMII home page, <http://www.eng.nsf.gov/dmii>; or contact by telephone, 703-292-8330; or by fax, 703-292-9056. Personal visits are also welcome.

• Engineering Decision Systems Cluster

The Engineering Decision Systems Cluster provides funding for fundamental research on theory and methods that guide and support decisions about the design and operation of products and enterprise systems. The programs are distinguished by their focus on methods that:

- are founded in mathematics, statistics, decision sciences, economics, and information technology, as opposed to the natural and social sciences; and

- address the prescriptive derivation of preferred choice, as opposed to descriptive characterization of scientific and engineering phenomena.

Much of the research is computational and/or exploits capabilities of the Internet but development of commercial software or networks is not supported. Similarly, incorporation of the research into educational programs is encouraged, but supported projects must have significant research content.

The cluster consists of the following programs:

1. Engineering Design
2. Operations Research
3. Manufacturing Enterprise Systems
4. Service Enterprise Engineering

For More Information

Visit the Engineering Decision Systems Cluster Web site,
<http://www.eng.nsf.gov/dmii/Message/EDS/eds.htm>.

1. Engineering Design (ED)

Focuses on fundamental theory and general-purpose tools for conceptualization and description of engineered products and systems, including analysis of alternatives and selection of preferred choices. The program embraces a holistic view of design that recognizes that choices are best made in a total-system, life-cycle context. ED does not support the design of specific products or systems, but instead seeks novel advances in generic design theory and methodology.

2. Operations Research (OR)

Is concerned with generic tools for modeling and optimization of engineering design, manufacturing, and service enterprise operations. Emphasis is on improving basic analytical and computational techniques, especially where their potential for impact on relevant engineering and operations management problems is apparent.

3. Manufacturing Enterprise Systems (MES)

Addresses research that is focused on design, planning, and control of operations in manufacturing enterprises, including the associated procurement and distribution supply chains. Contributions should extend the range of analytical and computational techniques applicable to these enterprise operations and advance novel models that offer policy insight or the prospect of implementable solutions. Research in MES is typically performed with the guidance or collaboration of appropriate industrial partners.

4. Service Enterprise Engineering (SEE)

Addresses engineering issues particular to the service sector. Contributions should extend the range of analytical and computational techniques addressed to service enterprise operations and advance novel models offering policy insight or the prospect of implementable solutions. However, the measurement and conceptualization of service processes as engineered systems may themselves represent a contribution in some applications. Research in SEE is typically performed with the guidance or collaboration of appropriate industrial partners.

• Manufacturing Processes And Equipment Systems Cluster

The manufacturing enterprise requires the integration of appropriate scientific, engineering, and mathematics disciplines with design objectives within a systems framework where the desired outcome is a viable product or service. Product realization, integrated product and process development (IPPD), and concurrent engineering are all aspects of the manufacturing enterprise. The drivers for the manufacturing enterprise are the economic, energy, and environmental issues that define viability in terms of cost, delivery, and performance. The major developments in manufacturing during the past 30 years include computer-integrated manufacturing; automation in robotics and

flexible manufacturing systems for lean and agile manufacturing; artificial intelligence and Internet-based systems for distributed manufacturing; quality assurance; net shape processes; additive, layered, and beam processing, including solid freeform fabrication and surface modification; and open-architecture manufacturing systems. However, research is needed in order to make macro-, meso-, micro-, and nanomanufacturing more productive, predictable, efficient, economical, environmentally benign, and globally competitive.

The goals of the Manufacturing Processes and Equipment Systems Cluster are:

- to support research that will advance our understanding of the manufacturing processes, machine tools, and systems within the broad scope of unit manufacturing processes; and
- to bring about manufacturing innovations that have an impact on the economy and society.

The cluster emphasizes research that employs a blend of analytical, computational, and experimental efforts to address three key research issues: predictability, producibility, and productivity. These issues are key to enhancing performance, efficiency, quality, and the reduction/elimination of adverse environmental effects in manufacturing to make U.S. industries globally competitive.

There are three program elements under this cluster:

1. Manufacturing Machines and Equipment (MME)
2. Materials Processing and Manufacturing (MPM)
3. Nanomanufacturing (NM)

For More Information

Visit the Manufacturing Processes and Equipment Systems Cluster Web site,
<http://www.eng.nsf.gov/dmii/Message/MPES/mpes.htm>.

1. Manufacturing Machines and Equipment (MME)

Focuses on generating the fundamental knowledge for building next-generation machines and equipment and their applications for materials processing, parts manufacture, assembly, inspection, and other operations. It supports theoretical and experimental research in mechanism, surface integrity, monitoring and control, metrology, part fixturing, environmental effects, performance, and productivity improvements related to micro-, meso-, and macromachining processes and manufacturing equipment.

2. Materials Processing and Manufacturing (MPM)

Supports the innovation of novel manufacturing processes and methodologies for making useful products from new and recycled materials through the understanding and control of the behavior of materials during processing. Typical research activities include the net shape processing of metals, ceramics, polymers, and composite materials. The program does not support research in the processing of semiconductor materials such as Si and GaAs.

3. Nanomanufacturing (NM)

Supports innovative, fundamental research in the science and technology of nanostructured materials, components, and systems leading to potential breakthroughs in the manufacturability of new industrial products or enabling useful services and new applications. Emphasis is on theoretical and experimental research that addresses the underlying necessities for predictability, producibility, and productivity in manufacturing at the nanoscale.

• Industrial Innovation Programs

The Industrial Innovation Programs address innovation opportunities for small businesses, as well as academic research on the innovation process itself. These programs provide opportunities for academic research to link with the industrial sector and include:

1. Small Business Innovation Research (SBIR)

2. [Small Business Technology Transfer \(STTR\)](#)
3. [Grant Opportunities for Academic Liaison with Industry \(GOALI\)](#)
4. [Innovation and Organizational Change \(IOC\)](#)

 **For More Information**

Visit the DMII home page, <http://www.eng.nsf.gov/dmii>.

1. Small Business Innovation Research (SBIR)

Offers opportunities and incentives for creative small businesses that are involved in science, engineering, education, or technology to conduct innovative, high-risk research on important scientific and technical problems. Research supported by the SBIR Program should have significant potential for commercialization and public benefit. This three-phase program offers incentives for converting federally supported research carried out in Phases I and II into commercial application in Phase III, which is funded by private capital.

2. Small Business Technology Transfer (STTR)

Links entrepreneurs with the academic research community and encourages commercialization of government-funded research by the private sector. Proposals submitted to the STTR Program must have small-business principal investigators, but up to 60 percent of STTR funding may be used to support university subcontracts necessary to assist in the commercialization of research products by the small business firm. STTR is a three-phase program that offers incentives for converting research done in Phases I and II to commercial application in Phase III, which is funded by private capital. The difference between SBIR and STTR is in the requirements for partnership of the small business sector with the academic community.

3. Grant Opportunities for Academic Liaison with Industry (GOALI)

This initiative aims to encourage industry/university partnerships by making funds available for the support of an eclectic mix of industry/university linkages. Specifically, GOALI provides support (1) to conduct research and gain experience with production processes in an industrial setting; (2) for industry scientists and engineers to bring industry's perspective and integrative skills to academe; and (3) for interdisciplinary industry/university teams to conduct long-term projects. GOALI supports faculty, postdoctoral fellows, and students in developing creative modes of collaborative interaction with industry through individual or small-group projects, and supports industry-based fellowships for graduate students and postdoctoral fellows. GOALI targets high-risk, high-gain research that focuses on fundamental topics that would not have been undertaken by industry, and supports the development of innovative, collaborative, industry/university educational programs and the direct transfer of new knowledge between academe and industry.

4. Innovation and Organizational Change (IOC)

Seeks to create and apply fundamental new knowledge with the aim of improving the effectiveness of the design, administration, and management of organizations, including industrial, educational, service, government, and nonprofit and voluntary organizations. The program encourages dissemination of knowledge gained from research to organizations and institutions that can design and implement improvements based on what has been learned. The Directorates for Engineering; Social, Behavioral, and Economic Sciences; and Education and Human Resources jointly support IOC. The program places a priority on investigator-initiated research that advances our understanding of the fundamental processes and structures of organizations in a variety of institutional contexts. Prospective IOC research might draw on or include organizational behavior and theory, industrial engineering, industrial/organizational psychology, organizational sociology, and public administration and management science. Proposers should work with partner organizations in business, nonprofits, governmental agencies, and educational institutions.

**DIRECTORATE FOR ENGINEERING****Division of Electrical and Communications Systems**

The Division of Electrical and Communications Systems (ECS) addresses the fundamental research issues underlying device technologies and the engineering systems principles of complex systems and applications. ECS also seeks to ensure the education of a diverse workforce prepared to support the continued rapid development of these technologies as drivers of the global economy. The research and education supported by ECS are fundamental to developing synergy between macro-, micro- and nanotechnology, biotechnology, and information technology in support of homeland security and the emerging new industries and economy of the 21st century.

The study of microelectronic, spin electronic, organoelectronic, nanoelectronic, micromagnetic, photonic, optoelectric, and microelectromechanical devices and their integration into circuits and microsystems is rapidly expanding in technical scope and application. New generations of integrated microsystems incorporate microchip technology with mechanical, biological, chemical, and optical sensors, actuators, and signal processing devices to achieve new functionality. Trends toward smaller devices raise new research challenges to fabricate molecular-based nanoscale structures and understand quantum principles, which dominate their behavior. Modern computing and communications systems are based on these devices. Wireless methods of telemetry to extract data from these new devices are equally important in order to realize local and global networks of sensors and other devices for analysis, interpretation, and extrapolation.

Research on the design and analysis of systems and the convergence of control, communications, and computation forms the basis for new research on data-rich complex dynamical systems. These systems, which learn new functions and adapt to changing environments, are especially important for advanced applications. The integration of device research and systems principles has broad applications in telecommunications, wireless networks, security, and efficiency of power system grids, thus enabling technologies for alternate energy sources such as space solar power, environment, transportation, biomedicine, nanomanufacturing, and other areas.

ECS supports integrative research through opportunities that encourage innovative and collaborative systems-oriented research. ECS also provides support for specialized resources and infrastructure—such as the National Nanofabrication User Networks—that facilitate research and education activities as well as the development of a strong and diverse engineering workforce.

The ECS Division supports the following programs and activities:

1. [Electronics, Photonics, and Device Technologies \(EPDT\)](#)
2. [Control, Networks, and Computational Intelligence \(CNCI\)](#)
3. [Integrative Systems \(IS\)](#)
4. [Resources and Infrastructure](#)

 **For More Information**

Write to the Division of Electrical and Communications Systems, National Science Foundation, 4201 Wilson Boulevard, Room 675, Arlington, VA 22230; or contact the division by telephone, 703-292-8339; or by fax, 703-292-9147; or visit the ECS home page, <http://www.eng.nsf.gov/ecs>.

1. Electronics, Photonics, and Device Technologies (EPDT)

Seeks to improve the fundamental understanding of devices and components based on the principles of electronics, photonics, electromagnetics, electro-optics, electromechanics, and related physical phenomena. Additionally, seeks to enable the design of integrated microsystems that define new capabilities and applications; experimental and theoretical studies of nanoscale electronic, spintronic, and photonic devices and principles; use of nanotechnology for device fabrication; and related topics in quantum and molecular engineering and quantum computing are of particular current interest. Answers and alternative strategies to the challenges identified for conventional silicon electrodes at the nanoscale are needed for both fabrication and metrology. Adaptive and reconfigurable devices and low-power/low-noise electronics are used in novel network architectures and advanced communications systems. Microsensors and microactuators, MEMS, RF MEMS, and bioMEMS are used in diverse areas ranging from industry and defense applications to biology and medicine. New answers are needed for wireless applications involving RF ICs, smart antennas, reconfigurable antennas, wireless sensors and devices,

and wireless systems on a chip. Also needed are new methods for the modeling, design, and characterization of electromagnetic materials and devices. The program invites proposals for research that can lead to high performance of macro-, micro- and nanoscale devices, components, and materials; advanced methods of design, modeling, and simulation of devices and components; and improved techniques for processing, fabrication, and manufacturing.

2. Control, Networks, and Computational Intelligence (CNCI)

Supports creative research underlying the analysis and design of intelligent engineering systems and networks for control, communications, and computation. The program invites proposals for research that can lead to improved methods for analysis, design, optimization, reliability, robustness, and evaluation of complex systems. Distributed systems and networks occur in telecommunications; power, energy, and transportation systems; and agile and adaptive sensor networks that will be needed to monitor and protect our critical infrastructure, as well as the emerging cyberinfrastructure. Hybrid systems incorporate both continuous and symbolic knowledge representation and are of increasing interest in the study of networks, manufacturing, and transportation systems. Adaptive, learning, and self-organizing principles offer potential for improved performance of systems with unknown models and changing characteristics, especially in biomedical and environmental applications. Biologically inspired methods and algorithms, including neural networks, evolutionary computation, behavioral architectures, and intelligent agents for engineering applications are also of interest. High-performance and domain-specific computation as well as quantum computing are applied to the development of simulation, design, and decision tools for engineering applications.

3. Integrative Systems (IS)

Stimulates innovative research in areas that integrate device concepts and systems principles to aid in the development of new technologies and new research directions. Proposals are sought that address fundamental research issues associated with the analysis and design of such integrative systems. Areas of opportunity are announced on the ECS Division home page. In addition, researchers are welcome to propose potential topics of interest and are encouraged to discuss them with a program director. An example of an integrated microsystem is a miniature implantable device that combines sensors, actuators, and computational algorithms and microcircuits for biomedical applications ranging from drug delivery to microsurgery. A second example is a wireless network of handheld or wearable computing devices that incorporates microsystem transmitters, receivers, antennas, and sensors and constitutes a complex distributed network with high bandwidth and high information-transfer requirements. Design of power grids and systems that are reliable, efficient, and environmentally benign is yet another example. Such integrative systems offer new challenges in basic research and promise for future applications. Proposals for integrative systems research may involve collaborative research among investigators to capture the breadth of expertise needed for such multidisciplinary but integrative research.

4. Human Resources and Infrastructure

In partnership with other NSF directorates and government agencies, ECS provides state-of-the-art user facilities for micro- and nanofabrication and metrology tools with the establishment of the National Nanotechnology Infrastructure Network (NNIN). The NNIN provides access to all faculty and students for research and educational use at moderate costs. ECS also offers faculty and student researchers in optoelectronics access to precommercial devices and systems through the Photonics Technology Access Program (PTAP). NSF's Science and Technology Centers (STCs), Engineering Research Centers (ERCs), Industry/University Cooperative Research Centers (IUCRC), and Integrative Graduate Education and Research Traineeships (IGERT), Graduate Research Fellowships (GRF), and GK-12 Fellowship Programs affect overlap and supplement research areas of the electrical and communications community. Researchers and educators are encouraged to build linkages with these programs. ECS also seeks to enhance academic infrastructure through supplemental and special program opportunities such as the Grant Opportunities for Academic Liaison with Industry (GOALI) and Major Research Instrumentation (MRI) Programs, and through the international collaborations described in the overview of the Engineering Directorate. In addition, ECS encourages the participation in the development of cross-disciplinary group awards. Programs such as Centers for Learning and Teaching, Bridges between Engineering Education, Faculty Early Career Development (CAREER), and Nanotechnology Undergraduate Education offer many opportunities to infuse the latest research developments into the electrical engineering curriculum. Current principal investigators are encouraged to apply for supplemental grants via programs such as Research Experience for Undergraduates (REU), Research Experience for Teachers (RET), and underrepresented precollege students as research assistants on engineering grants.

**DIRECTORATE FOR ENGINEERING****Division of Engineering Education and Centers**

The Division of Engineering Education and Centers (EEC) supports centers that collaborate with industry to integrate research, education, and projects to promote innovations in engineering education and engage a diverse body of students in engineering research. These efforts integrate new knowledge across disciplines, accelerate technology development, and improve the capabilities and diversity of engineering graduates entering the technical workforce.

EEC's centers promote partnerships among researchers in different disciplines and between industry and universities. They focus on integrated engineered systems and produce technological innovations that strengthen the competitive position of industry. Their graduates are well-rounded, professionally oriented engineers with a global outlook, experience in technological innovation, and the ability to assume leadership roles in industry, academe, and government.

The educational innovation projects of EEC range from small-scale efforts that integrate research into curricula at the course level to the development and implementation of large-scale models for engineering curriculum reform. These efforts have infused knowledge of emerging technology into curriculums across the country and have provided models for systemic reform of engineering curriculum that have included freshman-year experience with design and product development. All efforts promote the diversity of the engineering workforce.

The EEC Division supports the following programs and activities:

1. Engineering Research Centers (ERCs)
2. Industry/University Cooperative Research Centers (I/UCRCs)
3. Engineering Education Programs
4. Grants for Department-Level Reform of Engineering Education
5. Supplemental Funding for Support of Women, Minorities, and Physically Disabled Engineering Research Assistants

 For More Information

Write to the Division of Engineering Education and Centers, National Science Foundation, 4201 Wilson Boulevard, Room 585, Arlington, VA 22230; or contact the division by telephone, 703-292-8380; or by fax, 703-292-9051; or visit the EEC home page, <http://www.eng.nsf.gov/eec>.

1. Engineering Research Centers (ERCs)

Provide an integrated environment for academe and industry to focus on next-generation advances in complex engineered systems, with synergy among engineering, science, and industrial practices. ERCs integrate research and education at both the graduate and undergraduate levels and produce curriculum innovations derived from the engineering systems research focus of the ERC. ERCs build partnerships with industry, develop shared infrastructure, and increase the capacity of engineering and science graduates to contribute to U.S. competitiveness. They are supported for up to 10 years to promote the long-term perspective in engineering research and education that is required to produce new technologies and innovative products and services.

2. Industry/University Cooperative Research Centers (I/UCRCs)

Develop long-term partnerships among industry, academe, and government. The centers are university-based and catalyzed by a small investment from NSF but are primarily supported by industry members. I/UCRCs are led by faculty who have a strong desire to work with industry and who want to pursue fundamental research agendas recommended by industrial advisory boards. Center research projects are conducted primarily by graduate students; the program thus develops students who know how to conduct industrially relevant research and communicate their findings effectively.

3. Engineering Education Programs

Stimulates innovation and reform in engineering education to produce graduates who are better able to serve the evolving needs of the new century. A high priority is developing high-quality engineering curriculums that will attract and retain increased numbers of engineering students, especially women, underrepresented minorities, and people with disabilities. The Engineering Education Programs support the implementation of new approaches to educate engineers and encourage outstanding students—particularly from underrepresented groups—to enter the field. The programs build on successful innovations from the NSF Engineering Education Coalitions and other new concepts for the reform and improvement of engineering education, and seek to involve research-active scholars more actively in education innovation.

EEC supports programs through which new faculty can learn from successful scholars and practitioners in such areas as learning theories, course and curriculum design, test construction and evaluation, multimedia technologies, student mentoring, diversity, and leadership.

4. Grants for Department-Level Reform of Undergraduate Engineering Education

Supports departmental and larger units to reformulate, streamline, and update engineering and engineering technology degree programs; develop new curriculums for emerging engineering disciplines; and meet the emerging workforce and educational needs of U.S. industry. These efforts should increase the relevance of undergraduate engineering curriculum to modern engineering practice and induce an increased proportion of students who enroll to complete engineering degree programs. These goals can be accomplished by introducing modern learning strategies, expanding both the disciplinary breadth and the range of problems and problem-solving techniques to which engineering students are exposed; incorporating new laboratories and research experiences; and effectively integrating the powerful software tools used in engineering practice.

5. Supplemental Funding for Support of Women, Minorities, and Physically Disabled Engineering Research Assistants

Provides supplemental funding to include women, underrepresented minorities, and physically disabled undergraduate or high school students as research assistants on NSF-funded projects. Supplemental funding of up to \$5,000, including indirect costs, may be requested for each student added to the project. Funds provided by this program are limited to two students per grant. Up to 10 percent of this amount may be used for supplies and services. The support may be used for a summer, a quarter, or an academic year.

If necessary, funds in excess of \$5,000 may be requested to provide special equipment or modify existing equipment, or to provide other services specifically for the purpose of enabling a physically disabled person (or persons) to participate. The equipment must be directly related to the research work, such as a prosthetic device to manipulate a specific piece of equipment, not for general assistance such as wheelchairs or ramps.



Directorate for Geosciences (GEO)



Research in the Directorate for Geosciences (GEO) seeks to advance the state of knowledge about the Earth, including its atmosphere, continents, oceans, interior, and Sun, and the processes that modify and link them together.

The Directorate for Geosciences supports programs and activities through the following:

- [Crosscutting Programs and Activities](#)
- [Education and Outreach Activities](#)
- [Division of Atmospheric Sciences \(ATM\)](#)
- [Division of Earth Sciences \(EAR\)](#)
- [Division of Ocean Sciences \(OCE\)](#)

 **For More Information**

Visit the GEO Directorate home page, <http://www.geo.nsf.gov/>.

**DIRECTORATE FOR GEOSCIENCES****Crosscutting Programs and Activities**

In addition to the programs mentioned in the other sections, the Directorate for Geosciences supports crosscutting programs and activities that include:

- [Biogeosciences](#)
- [Collaborations in Mathematical Geosciences \(CMG\)](#)
- [Earth System History \(ESH\)](#)
- [Ecology of Infectious Diseases \(EID\)](#)
- [Integrated Carbon Cycle Research \(ICCR\)](#)
- [Water Cycle Research \(WCR\)](#)
- [Other Programs and Activities](#)

• Biogeosciences

As part of the Directorate for Geosciences' fundamental goal—"to advance the scientific understanding of the integrated Earth systems through supporting high-quality research" (*NSF Geosciences Beyond 2000*, NSF 00-27; <http://www.geo.nsf.gov/adgeo/geo2000.htm>)—a new program has been initiated to develop research in the biogeosciences more fully. The Biogeosciences Initiative evolves from a wealth of recent planning between the Directorate and the scientific community, as well as from planning activities within the Atmospheric Sciences (ATM), Earth Sciences (EAR), and Ocean Sciences (OCE) Divisions in NSF's GEO Directorate. Biogeosciences explores how organisms influence—and are influenced by—the Earth's environment. The emergence of this field is characterized by conceptual and technological advances, opening new avenues of research and the development of shared methods, paradigms, and vocabulary that are bridging disciplinary differences.

 **For More Information**

Contact Dr. Rachael Craig, Directorate for Geosciences, by telephone, 703-292-8233; or by e-mail, rcraig@nsf.gov.

• Collaborations in Mathematical Geosciences (CMG)

The CMG Program is jointly funded by the Divisions of Atmospheric Sciences (ATM), Earth Sciences (EAR), and Ocean Sciences (OCE) (in NSF's GEO Directorate) and by the Division of Mathematical Sciences (DMS) (in NSF's MPS Directorate). The goals of the CMG activity are (a) to enable collaborative research at the intersection of mathematical sciences and geosciences and (b) to encourage cross-disciplinary education through summer graduate training activities. Research topics under (a) should fall within one of the following two broad themes: (1) mathematical and statistical modeling of large complex geosystems or (2) representing uncertainty in geosystems. Research projects supported under this activity should be essentially collaborative in nature. Research groups should include at least one mathematical scientist and at least one geoscientist. Projects under category (a) should be of 3 to 4 years in duration. It is not the intent of this activity to provide general support for infrastructure. Projects under category (b) are not restricted to topics (1) and (2).

 **For More Information**

Contact Dr. Stephen Meacham, Directorate for Geosciences, by telephone, 703-292-8527; or by e-mail, smeacham@nsf.gov.

• Earth System History (ESH)

The ESH competition is a coordinated paleoscience research initiative of the U.S. Global Change Research Program (USGCRP) that is jointly supported by the NSF Directorate for Geosciences' Divisions of Atmospheric Sciences (ATM), Earth Sciences (EAR), and Ocean Sciences (OCE); by NSF's Office of Polar Programs (OPP); and by the National Oceanic and Atmospheric Administration's (NOAA) Office of Global Programs. The goals of the ESH competition are (1) to encourage innovative research on the natural variability of the Earth's climate system from records preserved in geobiologic archives and (2) to provide a comprehensive understanding of Earth's changing climate with regard to forcing mechanisms, interactions, and feedbacks.

For More Information

Contact Dr. David Verardo, Directorate for Geosciences, by telephone, 703-292-8527; or by e-mail, dverardo@nsf.gov.

• Ecology of Infectious Diseases (EID)

The EID Program is jointly funded by the NSF Directorates for Biological Sciences and Geosciences, the National Institutes of Health, and the National Institute of General Medical Sciences. The EID program encourages development of predictive models and discovery of principles for relationships between anthropogenic environmental change and transmission of infectious agents. To that end, research should focus on understanding the ecological determinants of transmission by vectors or abiotic agents, the population dynamics of reservoir species, and transmission to humans and other hosts. Proposals may focus on terrestrial, freshwater, or marine systems and organisms.

For More Information

Contact Dr. Samuel Scheiner, Directorate for Biological Sciences, by telephone, 703-292-8481; or by e-mail, ssscheine@nsf.gov.

• Integrated Carbon Cycle Research (ICCR)

The ICCR Program reflects the Directorate for Geosciences' commitment to a national effort aimed at significantly increasing our understanding of the processes that regulate the transport and transformation of carbon within and among the terrestrial, oceanic, and atmospheric environments of the Earth. The program solicits innovative proposals from U.S. academic institutions to conduct basic research in the scientific aspects of the global carbon cycle, including studies of the chemical, biological, ecological, and physical processes driving carbon distribution; transformation; and transport within and between terrestrial, atmospheric, and oceanic environments.

For More Information

Contact Dr. Rachael Craig, Directorate for Geosciences, by telephone, 703-292-8233; or by e-mail, rcraig@nsf.gov.

• Water Cycle Research (WCR)

The WCR Program encompasses research that contributes to an enhanced understanding of water cycle processes. The U.S. Global Change Research Program (USGCRP) has placed high priority on research into the water cycle. Specific recommendations are detailed in *A Plan for a New Science Initiative on the Global Water Cycle* (USGCRP, 2001, <http://www.usgcrp.gov/usgcrp/ProgramElements/water.htm>). Federal agencies other than NSF bear primary responsibility for developing and maintaining an observational infrastructure required for the day-

to-day assessment of water distribution, movement, and quality. The water cycle research envisioned for support by NSF focuses on fundamental processes and interactions to which NSF can contribute basic understanding that complements the other activities in the total federal program.

 **For More Information**

Contact Dr. L. Douglas James, Directorate for Geosciences, by telephone, 703-292-8549; or by e-mail, ldjames@nsf.gov.

• **Other Programs and Activities**

The Directorate for Geosciences also participates in the following Foundation-wide programs and activities:

- Biocomplexity in the Environment (BE)
- Environmental Research and Education (ERE)
- Experimental Program to Stimulate Competitive Research (EPSCoR)
- Graduate Teaching Fellows in K-12 Education (GK-12)
- Grant Opportunities for Academic Liaison with Industry (GOALI)
- Human and Social Dynamics (HSD)
- Major Research Instrumentation (MRI)
- Partnerships for Innovation (PFI)
- Nanoscale Science and Engineering (NSE)

 **For More Information**

Visit the NSF Crosscutting Programs home page,
<http://www.nsf.gov/home/crssprgm/start.htm>.



DIRECTORATE FOR GEOSCIENCES

Education and Outreach Activities

In addition to the discipline-specific education and outreach activities supported by the Directorate for Geosciences, the Directorate participates in the multiagency Globe Program. Globe is a developing international effort that links scientists and schoolchildren through a global information network. It is designed to promote general science literacy related to environmental and global change issues.

For More Information

Visit the Globe Program Web site, <http://www.globe.gov>. For information about Globe activities within NSF, contact the Globe program director in the Directorate for Geosciences by telephone, 703-292-7858; or by e-mail, globe@nsf.gov; or visit the GEO Directorate home page, <http://www.geo.nsf.gov>; or the Education and Human Resources Directorate home page, <http://www.ehr.nsf.gov>. Additional information about programs in the EHR Directorate can also be found in the EHR section of this Guide.

Geosciences Education Program

The Geosciences Education Program supports education activities that integrate geoscience research and education, as well as lead to improvement in the quality of geoscience education. A program announcement is released annually and proposals at all education levels are encouraged. Abstracts of previous awards are available at <http://www.geo.nsf.gov/adgeo/education.htm>.

For More Information

See program announcement NSF 03-515; or contact the program by e-mail, geod@nsf.gov; or visit the GEO Directorate home page, <http://www.geo.nsf.gov/>.

Digital Library for Earth System Education

The Directorate for Geosciences supports the development of a well-organized, high-quality digital library of educational materials for learner access to data describing the Earth system. These are the raw materials needed to implement discovery-based pedagogies that research indicates are most effective for learning the methods and content of science. The Digital Library for Earth System Education (DLESE) Program provides the structure and services needed to transform the plethora of exciting Earth materials and data available on the Web into a community resource with the potential to transform Earth system education.

For More Information

Contact Dr. Michael Mayhew by e-mail, mmayhew@nsf.gov; or visit the GEO Directorate home page, <http://www.geo.nsf.gov>.

Opportunities for Enhancing Diversity in the Geosciences (OEDG)

The OEDG Program is part of the Directorate for Geosciences' effort to broaden the participation of groups traditionally underrepresented in the geosciences, including women, minorities, and persons with disabilities. For further information about OEDG—implemented in fiscal year (FY) 2001—see the FY 2002 program announcement

NSF 02-104. Future announcements will be issued biennially.

 **For More Information**

Contact the program by e-mail, geo_diversity@nsf.gov; or visit the GEO Directorate home page, <http://www.geo.nsf.gov/geo/diversity>.

Other Programs and Activities

In addition to the programs and activities mentioned here, the GEO Directorate participates in the following NSF-wide education and outreach activities:

- Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers (ADVANCE)
- Math and Science Partnership (MSP)
- Faculty Early Career Development (CAREER)
- Integrative Graduate Education and Research Training (IGERT)
- Presidential Early Career Awards for Scientists and Engineers (PECASE)
- Program for Persons with Disabilities (PPD)
- Research Experiences for Teachers (RET)
- Research Experiences for Undergraduates (REU)
- Research in Undergraduate Institutions and Research Opportunity Awards (RUI/ROA)

 **For More Information**

Visit the NSF Crosscutting Programs home page, <http://www.nsf.gov/home/crsspgrm/start.htm>.



DIRECTORATE FOR GEOSCIENCES

Division of Atmospheric Sciences

The Division of Atmospheric Sciences (ATM) supports research to increase understanding of the behavior of Earth's atmosphere and its interactions with the Sun. Included are studies of the physics, chemistry, and dynamics of Earth's upper and lower atmospheres and its space environment; research on climate processes and variations; and studies to understand the natural global cycles of gases and particles in Earth's atmosphere. NSF also provides support for participation by the U.S. scientific community in international scientific research endeavors, such as the World Climate Research Program.

The ATM Division supports the following programs and activities:

- [Lower Atmosphere Research](#)
- [Upper Atmosphere Research](#)
- [Centers and Facilities](#)

Submission of Proposals to ATM

Proposals may be submitted at any time during the year for all programs in the ATM Division except special programs such as Earth System History (ESH); Coupling, Energetics, and Dynamics of Atmospheric Regions (CEDAR); and Geospace Environmental Modeling (GEM). Proposals submitted to ATM that request the allocation of observation and computing facilities must also be submitted to the appropriate facility manager. (For more information, see Lower Atmospheric Observing Facilities or National Center for Atmospheric Research under the Centers and Facilities section.) Proposals should be submitted to the appropriate NSF program and should follow the guidelines printed in the NSF Grant Proposal Guide (see <http://www.nsf.gov/cgi-bin/getpub?gpg> for latest version). For projects that propose the use of lower atmospheric observing facilities or computing resources, a facility request also is required. A facility request should be sent to the manager of each facility where the proposed work would take place. Procedures for requesting the use of a facility are established by the institution managing the facility. It is important for institutions submitting a request to seek advice from the Lower Atmospheric Observing Facilities manager at NSF. Those submitting facility requests requiring more than \$500,000 in deployment costs are required to submit a preproposal to NSF 4 months before the actual deadline for submission of proposals.

Any questions on the use of computing resources should be directed to the Director, Scientific Computing Division (SCD), National Center for Atmospheric Research (NCAR), P.O. Box 3000, Boulder, CO 80307; or visit the SCD Web site, <http://www.scd.ucar.edu>.

For More Information

Write to the Division of Atmospheric Sciences, National Science Foundation, 4201 Wilson Boulevard, Room 775, Arlington, VA 22230; or contact the division by telephone, 703-292-8520; or visit the ATM Division home page, <http://www.geo.nsf.gov/atm>.

• Lower Atmosphere Research

The following programs make up the Lower Atmosphere Research Section. For complete information, visit the Lower Atmosphere Research Section Web site, <http://www.geo.nsf.gov/atm/lower.htm>.

1. [Atmospheric Chemistry](#)
2. [Climate Dynamics](#)
3. [Large-Scale Dynamic Meteorology](#)
4. [Mesoscale Dynamic Meteorology](#)
5. [Paleoclimate](#)
6. [Physical Meteorology](#)

1. Atmospheric Chemistry

Supports research to measure and model the concentration and distribution of gases and aerosols in the lower and middle atmosphere. The program also supports research on chemical reactions among atmospheric species, the sources and sinks of important trace gases and aerosols, aqueous-phase atmospheric chemistry, the transport of gases and aerosols throughout the atmosphere, and improved methods for measuring the concentrations of trace species and their fluxes into and out of the atmosphere.

2. Climate Dynamics

Supports research on the processes that govern climate and the causes of climate variability and change, methods to predict climate variations, the assembly and analysis of modern climatic data, and the development and use of climate models to diagnose and simulate climate and its variations and changes.

3. Large-Scale Dynamic Meteorology

Supports basic research to improve the understanding and prediction of atmospheric motion on scales from synoptic to planetary. Research topics include general circulation of the troposphere and stratosphere, synoptic-scale weather phenomena, atmospheric predictability, data assimilation, and parameterization of physical processes and numerical methods for use in large-scale models.

4. Mesoscale Dynamic Meteorology

Supports research on all aspects of mesoscale meteorological phenomena, including studies of the morphological, thermodynamic, and kinematic structure of mesoscale systems; the development of mesoscale systems and precipitation processes; and the energy transfer between scales.

5. Paleoclimate

Supports research on the natural evolution of Earth's climate with the goal of providing a baseline for present variability and future trends through improved understanding of the physical, chemical, and biological processes that influence climate over the long term.

6. Physical Meteorology

Supports basic research on the physics of the atmosphere, with emphasis on cloud and precipitation physics; the transfer of solar and terrestrial radiation; atmospheric measurements, including active and passive remote sensing; and atmospheric electricity and acoustics. The program also supports research in micrometeorology, particularly turbulence, boundary-layer processes, and wave phenomena.

• Upper Atmosphere Research

The following programs make up the Upper Atmosphere Research Section. For complete information, visit the Upper Atmosphere Research Section Web site, <http://www.geo.nsf.gov/atm/upper.htm>.

1. [Aeronomy](#)
2. [Magnetospheric Physics](#)
3. [Solar-Terrestrial](#)

1. Aeronomy

Supports research on upper and middle atmosphere phenomena of ionization, recombination, chemical reaction, photoemission, and transport; the transport of energy, momentum, and mass in the mesosphere/thermosphere/ionosphere system, including the processes involved and the coupling of this global system to the stratosphere below and magnetosphere above; and the plasma physics of phenomena manifested in

the coupled ionosphere/magnetosphere system, including the effects of high-power radio wave modification.

2. Magnetospheric Physics

Supports research on the magnetized plasma envelope of the outer atmosphere, including energization by solar wind; the origin of geomagnetic storms and substorms; the population by solar and ionospheric sources; the origin of electric fields; the coupling among the magnetosphere, ionosphere, and atmosphere; and waves and instabilities in the natural plasma. Also supported are ground-based observational programs at high latitudes. Theoretical research programs may include numerical simulations using a variety of magnetohydrodynamics, hybrid, and particle codes. The analysis of data from all sources, whether ground-based or from spacecraft, is also supported.

3. Solar-Terrestrial

Supports research on the processes by which energy in diverse forms is generated by the Sun, transported to the Earth, and ultimately deposited in the terrestrial environment. Major topics include helioseismology, the solar dynamo, the activity cycle, the magnetic flux emergence, solar flares and activity, coronal mass ejections, solar wind heating, interactions with cosmic rays, and solar wind/magnetosphere boundary problems. Studies on terrestrial influences include solar spectral irradiance changes, solar “constant” changes and climatic impacts; C14 and Sun/climate connections; and solar activity and its effects on the terrestrial environment of various time scales.

• Centers And Facilities

1. [Lower Atmospheric Observing Facilities \(LAOF\)](#)
2. [Upper Atmospheric Facilities \(UAF\)](#)
3. [National Center for Atmospheric Research \(NCAR\)](#)
4. [UNIDATA](#)

1. Lower Atmospheric Observing Facilities (LAOF)

The LAOF Program supports multiuser national research facilities that offer educational opportunities and serve the observational needs of the atmospheric science research community. These facilities include the following:

- **Aircraft**—Located at the National Center for Atmospheric Research (NCAR) is a four-engine Lockheed EC-130Q Hercules; at the University of Wyoming, a Beech King Air; and at the South Dakota School of Mines and Technology, an armored T-28. These aircraft can be equipped with sensors to measure meteorological and chemical state parameters. A variety of instruments can be selected for a particular project, or users may supply specialized instrumentation.
- **Radar**—NCAR operates an airborne X-band—a dual-beam, rapid-conical-scanning, multiple-frequency radar—and a transportable multiparameter S/X-band Doppler radar. Colorado State University (CSU) operates a transportable CSU S-band radar that provides two complete transmit and receive channels.
- **Other Facilities**—NCAR operates surface-observing systems that measure surface fluxes of trace chemical species, water vapor, sensible heat, and momentum. NCAR also operates a network of surface meteorology stations that measure wind, temperature, humidity, pressure, solar radiation, and precipitation.

NCAR also provides a number of systems that measure the vertical profile of temperature, moisture, pressure, and winds in the troposphere.

Eligibility Requirements for LAOF Proposals

LAOF are available on a competitive basis to all qualified scientists. Use of LAOF is based on the scientific merit of the research proposed, the capabilities of the facilities to carry out the proposed observations, and the availability of the facility during the requested time.

For More Information

Write to the following or visit the corresponding home pages:

- Division Director, Atmospheric Technology Division, National Center for Atmospheric Research, P.O. Box 3000, Boulder, CO 80307-3000; or visit the ATD Web site, <http://www.atd.ucar.edu>.
- Facility Manager, Wyoming King Air, Department of Atmospheric Science, P.O. Box 3038, University Station, Laramie, WY 82071; or visit the department's facilities Web site, <http://flights.uwyo.edu/>.
- Facility Manager, T-28, Institute of Atmospheric Sciences (IAS), South Dakota School of Mines and Technology, Rapid City, SD 57701; or visit the IAS research aircraft Web site, <http://www.ias.sdsmt.edu/institute/t28/index.htm>.
- Facility Manager, CSU-CHILL Radar, Department of Atmospheric Sciences, Colorado State University, Fort Collins, CO 80523; or visit the CSU-CHILL Web site, <http://chill.colostate.edu>.

2. Upper Atmospheric Facilities (UAF)

NSF supports four large incoherent-scatter radar multiuser facilities located along a longitudinal chain from Greenland to Peru. Each facility is also equipped with powerful optical diagnostic instruments. In response to a need for more understanding of global-scale thermospheric and ionospheric problems, these facilities have been upgraded and realigned into a chain extending from the edge of the polar cap to the magnetic equator.

The major goal of the UAF Program is to promote basic research on the structure and dynamics of the Earth's upper atmosphere. Research is supported through the following activities:

- **Sondrestrom Research Facility**—Located in Sondre Stromfjord, Greenland, this facility is operated by SRI International under cooperative agreement with NSF. The facility allows observations on the edge of the polar cap, the cusp, and the northern part of the auroral oval.
- **Millstone Hill Radar**—Located near Boston, Massachusetts, and operated by the Massachusetts Institute of Technology under a cooperative agreement with NSF, this facility is south of the auroral oval in a region where significant midlatitude phenomena are observed. The radar provides observations of high-altitude regions from almost directly above the radar in Sondre Stromfjord to almost directly above the next radar in the chain at Arecibo, Puerto Rico.
- **Arecibo Observatory**—Located in Arecibo, Puerto Rico, this observatory is operated by Cornell University's National Astronomy and Ionosphere Center under cooperative agreement with NSF. At Arecibo's latitude, scientists have obtained evidence of particle precipitation in the atmosphere, composition changes in the atmosphere after magnetic storms, gravity waves propagating from the auroral region, and the penetration of magnetospheric electric fields.
- **Jicamarca Radio Observatory**—Located at the magnetic equator in Jicamarca, Peru, this observatory is owned by the Instituto Geofisico de Peru. Through a cooperative agreement with Cornell University, NSF acts as the principal sponsor of the facility, which provides a subcontract to the Institute.

For More Information

Write to the following addresses or visit the corresponding home pages:

- Director, Sondrestrom Research Facility, Radio Physics Laboratory, SRI International, Menlo Park, CA 94025; or visit the facility Web site, <http://isr.sri.com>.
- Director, Millstone Hill Radar, MIT, Haystack Observatory, Westford, MA 01886; or visit the facility Web site, <http://hyperion.haystack.edu>.
- Director, NAIC for Arecibo Observatory, Cornell University, Ithaca, NY 14853; or visit the NAIC Web site, <http://www.naic.edu>.
- Jicamarca Radio Observatory Project, Department of Electrical Engineering, Cornell University, Ithaca, NY 14853; or visit the observatory Web site, <http://jicamarca.ece.cornell.edu/>.

3. National Center for Atmospheric Research (NCAR)

The National Center for Atmospheric Research (NCAR) in Boulder, Colorado, is a focal point for research in the field of atmospheric and related sciences.

NCAR is supported by NSF and managed under a cooperative agreement between NSF and the University Corporation for Atmospheric Research, a nonprofit consortium of North American universities with graduate programs in atmospheric sciences.

The facilities at NCAR serve the entire atmospheric sciences research community and part of the ocean science community. Facilities include a computing and data center that provides supercomputer resources and services for the development and production of large models and for archiving, manipulating, and visualizing large data sets. For information on other NCAR facilities, see Lower Atmospheric Observing Facilities elsewhere in this section.

NCAR's scientific research programs focus on subjects such as large-scale atmospheric and ocean dynamics; global and regional atmospheric chemistry; the variable nature of the Sun and the physics of the corona; the physics of clouds, thunderstorms, and precipitation formation and their interactions and effects on larger scale weather; and human society's impact on and response to global environmental change. NCAR also provides fellowships for visiting scientists to conduct research and interact with NCAR scientists.

The Scientific Computing Division (SCD) is part of NCAR. SCD's goal is to enable the best atmospheric research in the world by providing and advancing high-performance computing technologies. SCD offers computing, research data sets, data storage, networking, and data analysis tools to advance NCAR's scientific research agenda.

For More Information

For further information about the Scientific Computing Division (SCD), write to the Division Director, Scientific Computing Division, National Center for Atmospheric Research, P.O. Box 3000, Boulder, CO 80307-3000; or visit the SCD home page, <http://www.scd.ucar.edu>.

For further information about NCAR in general, write to the Director, National Center for Atmospheric Research, P.O. Box 3000, Boulder, CO 80307; or visit the NCAR home page, <http://www.ncar.ucar.edu>.

Eligibility Requirements for NCAR Proposals

Support for facilities and visiting scientists is provided on a competitive basis to qualified scientists according to scientific merit, the availability of facility time, and the level of resources.

4. UNIDATA

UNIDATA is a national program to help universities access, analyze, and display a wide range of atmospheric data on their own computers, often in real time. The program is managed by UCAR and is supported by NSF's Division of Atmospheric Sciences. UNIDATA serves a broad community, including teaching and research professionals in weather forecasting, climate studies, atmospheric analysis and modeling, and related disciplines.

For More Information

Visit the UNIDATA home page, <http://www.unidata.ucar.edu>.



DIRECTORATE FOR GEOSCIENCES

Division of Earth Sciences

The Division of Earth Sciences (EAR) supports research and education in most areas of the solid-Earth and surficial-terrestrial sciences. Emphasis is on the support of basic research aimed at improving our understanding of the Earth's structure, composition, natural processes, evolution, paleobiology, and interactions with the Earth's biosphere, atmosphere, and hydrosphere. In addition, EAR provides support for instrumental and observational infrastructure and encourages innovative educational activities in the earth sciences.

The research programs and activities in the EAR Division are organized into two areas:

- Core Research
- Special Emphasis

Core Research programs support research in the following areas: the solid Earth, with emphasis on our understanding of the Earth's dynamic behavior and structure; surficial-terrestrial research, which deals with processes related to the Earth's environmental envelope and near-surface phenomena; and instrumentation and facilities and education, which focuses on the development and acquisition of instrumentation for the research community and educational aspects of the earth sciences.

Special Emphasis areas include research directed toward special scientific opportunities that accommodate the changing needs of the scientific community. This research is often interdisciplinary or multidisciplinary in character or focuses on newly emerging areas of the earth sciences.

For More Information

Write to the Division of Earth Sciences, National Science Foundation, 4201 Wilson Boulevard, Room 785, Arlington, VA 22230; or contact by telephone, 703-292-8550; or visit the EAR Division home page, <http://www.geo.nsf.gov/ear>.

• Core Research Support Programs

The Division of Earth Sciences (EAR) supports fundamental research through programmatic discipline, as well as interdisciplinary and multidisciplinary proposals that may involve one or more disciplines. Especially welcome are proposals for research in newly emerging areas of science that may not fit easily into one of the program categories.

The following programs make up the Core Research Support in the EAR Division. The titles of these programs indicate in general terms the subject matter covered by each and should be taken in the broadest sense and not necessarily restricted to their specified discipline of science.

1. Continental Dynamics
2. Education and Human Resources
3. Geology and Paleontology
4. Geophysics
5. Hydrologic Sciences
6. Instrumentation and Facilities
7. Petrology and Geochemistry
8. Tectonics

1. Continental Dynamics

Supports multidisciplinary research that will result in a better understanding of the processes that govern the origin, structure, composition, and dynamic evolution of the continents and continental building blocks. This program is especially geared toward projects whose scope and complexity require a cooperative or multi-institutional approach and multiyear planning and execution. The program is intended to fund only relatively large projects that do not fit

easily within other EAR programs and that offer broad support for major sections of the earth sciences community. The program also funds research as part of the International Continental Scientific Drilling Program.

 **For More Information**

Contact the program by telephone, 703-292-8559; or visit the EAR Division home page, <http://www.geo.nsf.gov/ear>.

2. Education and Human Resources

Coordinates the division's efforts to improve earth science education for U.S. citizens and provides a liaison between the earth sciences research community and NSF's Directorate for Education and Human Resources. The program supports EAR's participation in NSF-wide programs such as Research Experiences for Undergraduates Sites.

 **For More Information**

Contact the program by telephone, 703-292-8557; or visit the EAR Division home page, <http://www.geo.nsf.gov/ear>.

3. Geology and Paleontology

Supports studies directed toward a better understanding of physical, chemical, geological, and biological processes at or near the Earth's surface and the landforms, sediments, fossils, low-temperature fluids, and sedimentary rocks that they produce. Areas of research may include paleontology, paleoecology, stratigraphy, paleoclimatology, geomorphology, glacial geology, sedimentology, soil genesis, sedimentary petrology, diagenesis, and organic geochemistry and biogeochemical cycles.

 **For More Information**

Contact the program by telephone, 703-292-8551; or visit the EAR Division home page, <http://www.geo.nsf.gov/ear>.

4. Geophysics

Supports laboratory, field, theoretical, and computational studies related to the composition, structure, and processes of the Earth's interior. Topics include studies in seismicity and seismic wave propagation; the nature and occurrence of earthquakes; and the Earth's magnetic, gravitational, and electrical fields and its internal temperature distribution. Support also is provided for geophysical studies of active deformation, including global-positioning-system-based geodesy and fundamental laboratory studies of properties and behavior of earth materials in support of geophysical observation and theory.

 **For More Information**

Contact the program by telephone, 703-292-8556; or visit the EAR Division home page, <http://www.geo.nsf.gov/ear>.

5. Hydrologic Sciences

Supports basic research dealing with the Earth's hydrologic cycle and the role of water on and near the continental surfaces of the Earth. The program views hydrologic sciences as a geoscience interactive on a wide range of space and time scales with ocean, atmospheric, and solid earth sciences as well as plant and animal sciences. Supported projects may involve water in the form of precipitation, lakes, streams, and groundwater, and interactions with landforms, soils, the atmosphere, the biosphere, and the Earth's crust. The program encourages integrated studies of water balance and fluxes among the various reservoirs.

 **For More Information**

Contact the program by telephone, 703-292-8549; or visit the EAR Division home page, <http://www.geo.nsf.gov/ear>.

6. Instrumentation and Facilities

Supports the acquisition or upgrade of equipment required for research, the development of new instrumentation and techniques that extend current research capabilities in the earth sciences, the operation of multiuser regional or national facilities that provide access to complex and expensive instrument or database systems for a significant segment of the earth sciences research community, and the funding of research technicians.

 **For More Information**

Contact the program by telephone, 703-292-8558; or visit the EAR Division home page, <http://www.geo.nsf.gov/ear>.

7. Petrology and Geochemistry

Supports research on igneous, metamorphic, and hydrothermal processes that occur within the Earth and other planetary bodies and on the minerals, rocks, fluids, and ore deposits resulting from these processes. Included are studies in mineralogy, crystallography, petrology, volcanology, geochemistry, and economic geology. Supported research includes field, laboratory, theoretical, and computational studies.

 **For More Information**

Contact the program by telephone, 703-292-8554; or visit the EAR Division home page, <http://www.geo.nsf.gov/ear>.

8. Tectonics

Involves studies in structural geology, tectonics, geochronology, petrology, paleomagnetism, and other fields related to understanding the tectonic history of the lithosphere through time. Supported research includes field, laboratory, and theoretical studies of the processes and kinematics accompanying deformation at plate boundaries and in plate interiors.

 **For More Information**

Contact the program by telephone, 703-292-8552; or visit the EAR Division home page, <http://www.geo.nsf.gov/ear>.

• Special Emphasis Areas

Certain research areas within the Division of Earth Sciences may be selected for emphasis on the basis of special scientific opportunities. Frequently, these opportunities are related to areas of national priority such as the environment, the U.S. Global Change Research Program, and the National Earthquake Hazard Reduction Program.

For More Information

The following is a list of Special Emphasis Areas in the EAR Division. Further information on any of the programs can be found in the corresponding program announcement (if available), or on the EAR Division home page, <http://www.geo.nsf.gov/ear>.

- Cooperative Studies of the Earth's Deep Interior (CSEDI) ([NSF 95-155](#))
- Earth System History ([NSF 02-191](#))
- Fundamental Earthquake Studies of the National Earthquake Hazard Reduction Program (NEHRP) ([NSF 92-93](#))
- Water and Energy: Atmospheric, Vegetative, and Earth (WEAVE) Interactions (This program does not have a program announcement. Please refer to the program's Web page for further information, http://www.nsf.gov/geo/egch/gc_weave.html.)

In addition, the Division of Earth Sciences has initiated the EarthScope Program under NSF's Major Research Equipment and Facility Construction (MREFC) support. EarthScope is a scientific infrastructure initiative for new observational facilities that will address fundamental questions about the evolution of continents and the processes responsible for earthquakes and volcanic eruptions. The integrated observing systems that will comprise the EarthScope facility include USArray—maps in 3-D the Earth's interior by means of seismic and magnetotelluric systems; Plate Boundary Observatory (PBO)—monitors the distortion of the Earth's surface by means of geodetic systems; and the San Andreas Fault Observatory at Depth (SAFOD)—defines the conditions and physics of an active plate boundary fault at depth. All data from the EarthScope facility will be openly available in real time to maximize participation from the scientific community and to provide ongoing educational outreach to students and the public. For EarthScope science and education support, see program solicitation [NSF 03-567](#). For general information, see the EarthScope home page, <http://www.earthscope.org>.



DIRECTORATE FOR GEOSCIENCES

Division of Ocean Sciences

The Division of Ocean Sciences (OCE) supports basic research and education to further understanding of all aspects of the global oceans and their interactions with the Earth and the atmosphere. OCE also supports the operation, acquisition, construction, and conversion of major shared-use oceanographic facilities needed to carry out oceanographic-related research programs.

OCE supports research through the following sections:

- [Ocean Section](#)
- [Marine Geosciences Section](#)
- [Integrative Programs Section](#)

At any given time, certain research areas within the OCE Division may be selected for emphasis on the basis of special scientific opportunities. Further information on global change research programs and other focused programs is available via the appropriate links on the OCE Division home page, <http://www.geo.nsf.gov/oce>.

For More Information

For further information, including deadline and target dates, extended program descriptions, and publications, write to the Division of Ocean Sciences, National Science Foundation, 4201 Wilson Boulevard, Room 725, Arlington, VA 22230; or contact the division by telephone, 703-292-8580; or visit the OCE Division home page, <http://www.geo.nsf.gov/oce>.

• Ocean Section

The Ocean Section of the Division of Ocean Sciences funds projects dealing with the disciplinary sciences of biological, chemical, and physical processes in the ocean. The section is composed of the following programs:

1. [Biological Oceanography](#)
2. [Chemical Oceanography](#)
3. [Physical Oceanography](#)

In addition to these regular programs, there are occasional announcements of opportunity to participate in global change research programs and other initiatives.

For More Information

Write to the Ocean Section, Division of Ocean Sciences, National Science Foundation, 4201 Wilson Boulevard, Room 725, Arlington, VA 22230; or contact the division by telephone, 703-292-8582; or visit the OCE Division home page, <http://www.geo.nsf.gov/oce>.

1. Biological Oceanography

Supports research on ocean productivity; the distribution, abundance, physiology, and life history of pelagic, coastal, and deep-sea marine organisms and their interactions with environments; structures of pelagic and benthic food chains; primary and secondary production; interactions between deep-sea biological processes and the ocean ecosystem; the specialization of deep-sea organisms; the ecology of the Great Lakes and factors regulating productivity; and marine biotechnology.

2. Chemical Oceanography

Supports research on physical and chemical properties of seawater, including kinetic and thermodynamic equilibria of chemical species and compounds in seawater; fluxes between sea floor sediments, their interstitial waters and overlying seawater; fates of materials deposited on the sea floor; alterations and interactions of material moving through the ocean; interactions and interdependencies between chemical processes and marine organisms; air/sea exchanges of manmade and naturally mobilized chemicals; and chemical properties of the ocean surface.

3. Physical Oceanography

Supports research on the description, analysis, and modeling of oceanic circulation and transport; the effects of circulation on energy and momentum transport; physical circulation processes, eddy generation, and turbulent mixing on continental shelves; mixing processes and circulation in estuaries; wind-generated tides and surface and internal waves; small-scale transport processes such as diffusion, conduction, convection, and three-dimensional turbulence; and physical properties of seawater and circulation and mixing processes in lakes.

• Marine Geosciences Section

The Marine Geosciences Section supports research on processes that occur on and below the sea floor and at the water/sediment/rock interface. The section also supports facilities dedicated to such research. The section is composed of the following programs:

1. [Marine Geology and Geophysics](#)
2. [Ocean Drilling Program](#)

For More Information

Write to the Marine Geosciences Section, Division of Ocean Sciences, National Science Foundation, 4201 Wilson Boulevard, Room 725, Arlington, VA 22230; or contact the program by telephone, 703-292-8581; or visit the OCE Division home page, <http://www.geo.nsf.gov/oce>.

1. Marine Geology and Geophysics

Supports research on the structure of continental margins, oceanic rise systems, and deep-sea sedimentary basins; the evolution of ocean basins; processes controlling exchanges of heat and chemical elements between seawater and oceanic rocks; tectonic and volcanic activity at midocean ridges; chemical and mineralogic variations in marine sediments; the deposition, erosion, and distribution of marine sediments; geologic and oceanographic processes controlling sedimentary systems; past oceanic circulation patterns and climates; the evolution of microfossil groups; paleoenvironmental controls on fossil groups and sediment types; and interactions of continental and oceanic geologic processes.

2. Ocean Drilling Program (ODP)

Explores, on a global scale, the Earth's crust beneath the ocean in order to learn more about the composition, structure, and history of the submerged portion of the Earth's surface. The drilling process involves collecting and logging geologic samples from the floor of deep ocean basins through rotary coring and hydraulic piston coring. The logs and samples of the cores are available to qualified scientists throughout the world for research projects.

- **ODP Operations**—The drilling program has taken samples at various sites, including the North Atlantic Ocean, Norwegian Sea, Mediterranean Sea, southern and equatorial Atlantic Ocean, Pacific Ocean off the west coast of South America, Weddell Sea off Antarctica, Indian Ocean, and western and equatorial Pacific Ocean.

The general contractor for the overall management and operation of the ODP is Joint Oceanographic Institutions, Inc. (JOI), a consortium of major U.S. oceanographic institutions. The drilling operations are managed by Texas A&M University; logging is managed by the Lamont-Doherty Earth Observatory at Columbia University.

- **U.S. Science Support**—NSF provides funding for the participation and drilling-related research performed

by U.S. scientists. Activities include investigations of potential drilling regions, especially by means of regional geophysical field studies; the feasibility and initial development of downhole instruments and techniques; and downhole geophysical and geochemical experiments. In addition, NSF will consider proposals for studies that lead to a long-range definition of future drilling objectives. To be considered for support, proposed projects should be clearly relevant to the drilling plans of the international drilling community and focus on predrilling or drilling-concurrent activities. Postcruise studies should generally be submitted through other appropriate NSF programs in the areas of ocean and earth sciences and polar programs.

Additional support for U.S. scientists may be obtained through the JOI-U.S. Science Advisory Committee (JOI-USSAC). This NSF-sponsored program consists of planning activities such as workshops to define concepts and develop problem-related drilling programs, including U.S. participation in Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES); support for U.S. scientists participating on the drill ship; and support for necessary follow up studies related to initial publication of drilling results. Requests for proposals may be issued for other surveys, regional and topical syntheses of existing data, or the development of down-hole tools and instrumentation as these tasks are identified.

Other Pertinent Information

Proposals for drilling specific sites should be submitted to the JOIDES Planning Committee Chairman, c/o Joint Oceanographic Institutions, Inc., 1755 Massachusetts Avenue, NW., Suite 800, Washington, DC 20036; or contact by telephone, 202-232-3900.

Applications for scientific participation aboard a ship should be submitted to the Manager of Science Operations, Ocean Drilling Program, Texas A&M University, College Station, TX 77843-3469. Appropriate support may be provided by JOI-USSAC.

Submit requests for data and samples of core material to the Curator, Ocean Drilling Program, Texas A&M University, College Station, TX 77843-3469; or visit the ODP home page, <http://www-odp.tamu.edu/curation>.

For information on logs and the logging program, write to the Borehole Research Group, Lamont-Doherty Earth Observatory, Palisades, NY 10964; or visit the group's home page, <http://www.oceandrilling.org>.

Proposals for planning activities and workshops may be submitted to the JOI-USSAC Chairman, c/o Joint Oceanographic Institutions, Inc., 1755 Massachusetts Avenue, NW., Suite 800, Washington, DC 20036.

• Integrative Programs Section

The Integrative Programs Section supports the activities and facilities necessary to enable or support NSF-funded research and training of oceanographers across disciplines. Examples of research and training support include technology development and dedicated educational activities. Facilities supported include ships, submersibles, large shipboard equipment, and shared-use instruments to collect and analyze data. The University-National Oceanographic Laboratory System (UNOLS) schedules these facilities and expeditionary programs.

1. Oceanographic Facilities
 - Ship Operations
 - Oceanographic Instrumentation
 - Oceanographic Technical Services
 - Shipboard Scientific Acquisitions and Upgrades
2. Oceanographic Technology and Interdisciplinary Coordination
3. Ocean Education Program

Special Proposal Submission Requirements

Proposals for field programs that require the use of University-National Oceanographic Laboratory Systems (UNOLS) ships in the following calendar year must be submitted by the February 15 target date. For example, proposals requesting ship time in the calendar year 2004 must be submitted by February 15, 2003. For further information, including the UNOLS Shiptime Request Form, visit the UNOLS Web site, <http://www.unols.org/scheduling.html>.

 **For More Information**

Write to the Integrative Programs Section, Division of Ocean Sciences, National Science Foundation, 4201 Wilson Boulevard, Room 725, Arlington, VA 22230; or contact the section by telephone, 703-292-8583; or visit the OCE Division home page, <http://www.geo.nsf.gov/oce>.

1. Oceanographic Facilities (Ship Operations, Oceanographic Instrumentation, Technical Services, and Shipboard Scientific Acquisitions and Upgrades)

Support for major oceanographic facilities is concentrated at institutions that have substantial research programs in oceanography and also support the research projects of other institutions. Before submitting a proposal for support in these areas, institutions should seek advice from the relevant program officer. Specific instructions on how to submit proposals can be found in the publication *Division of Ocean Sciences (OCE): Proposal Submission Deadlines for Research Ship Operations, Instrumentation and Equipment, and Technical Services Support (NSF 00-39)*.

2. Oceanographic Technology and Interdisciplinary Coordination

Supports a wide range of multidisciplinary activities that broadly seek to develop, transfer, or apply instrumentation and technologies that will benefit research programs supported by NSF, and enhance the conduct of basic ocean sciences research. Instrumentation and technology projects supported by this program must be broadly usable and be of benefit to more than just one particular research project. The scope of projects varies from short-term feasibility studies to the development, construction, and at-sea testing of a prototype to demonstrate that useful and applicable data can be obtained using it. If ocean research is to be undertaken, joint consideration with the relevant research program may be conducted for the instrument development phase of the project. In addition, the Interdisciplinary Coordination Program area supports a limited number of research approaches that cross the four basic ocean science subdisciplines (physics, chemistry, biology, and geology and geophysics).

3. Ocean Education Program

Provides support for programs—many of them agency-wide—emphasizing educational opportunities at all levels. The Division of Ocean Sciences has recently initiated a new program to establish a network of coordinated centers that will facilitate collaborations and communications between ocean science researchers and educators. These Centers for Ocean Science Education Excellence (COSEE) will foster the integration of ocean research into high-quality educational materials, allow ocean researchers to gain a better understanding of educational organizations and pedagogy, provide educators with an enhanced capacity to understand and deliver high-quality educational programs in the ocean sciences, and provide material to the public that will promote a deeper understanding of the ocean and its influence on each person's quality of life and our national prosperity.



Directorate for Mathematical and Physical Sciences (MPS)



The programs in the Directorate for Mathematical and Physical Sciences (MPS) are designed to increase the knowledge base in mathematical and physical sciences, improve the quality of education in mathematical and physical sciences in graduate and undergraduate activities, increase the rate at which advances in mathematical and physical sciences are translated into advances in science and technology on a broad spectrum and into societal benefits, and increase the diversity of people and approaches in mathematical and physical sciences.

To help the programs in MPS meet these goals, the Directorate encourages collaboration with other NSF Directorates and with other agencies and industrial organizations. MPS also encourages communication among the divisions and across Directorate boundaries to ensure effective support of research and education projects in emerging fields that cut across those lines.

MPS is an active participant in the following interagency and intra-agency programs that focus on interdisciplinary areas of importance to the Nation: Information Technology Research (ITR), Biocomplexity in the Environment (BE), Nanoscale Science and Engineering, Mathematical Sciences and their connections to other disciplines, and Human and Social Dynamics. In addition, MPS works with other agencies to optimize opportunities for advancing the mathematical and physical sciences through shared infrastructure and support for research and education. Researchers and educators interested in exploring opportunities in these areas should contact the program most closely related to their own interests to learn more about submitting proposals.

The MPS Directorate supports programs and activities through the following:

- [Office of Multidisciplinary Activities \(OMA\)](#)
- [Division of Astronomical Sciences \(AST\)](#)
- [Division of Mathematical Sciences \(DMS\)](#)
- [Division of Physics \(PHY\)](#)
- [Division of Chemistry \(CHE\)](#)
- [Division of Materials Research \(DMR\)](#)

For More Information

Visit the MPS Directorate home page, <http://www.nsf.gov/home/mps>.



DIRECTORATE FOR MATHEMATICAL AND PHYSICAL SCIENCES

Office of Multidisciplinary Activities

The Office of Multidisciplinary Activities (OMA) facilitates and supports opportunities in research and education that cross the traditional disciplinary boundaries. OMA works in partnership with the five MPS Divisions—Astronomical Sciences, Chemistry, Materials Research, Mathematical Sciences, and Physics—to respond more effectively to the excellence and creativity of the MPS communities, particularly to proposals that, because of their subject, scope, or multi-investigator or multidisciplinary nature, did not readily fit the existing MPS program structure.

OMA provides a focal point in the Directorate for partnerships (e.g., with other agencies, industry, national laboratories, State and local governments, and international organizations), seeds crosscutting research in areas of particular promise, and supports innovative experiments in education that could lead to new paradigms in graduate and undergraduate education in the mathematical and physical sciences, particularly in multidisciplinary settings.

OMA is open to creative ideas from all segments of the MPS community, ranging from individual investigators to centers. It especially encourages initiatives by multi-investigator, multidisciplinary teams pursuing problems on a scale that exceeds the capacity of individual investigators. OMA is particularly receptive to projects incorporating education and research training experiences that contribute to a diverse, high-quality workforce with technical and professional skills, career path flexibility, and an appetite for lifelong learning appropriate to the dynamic global science and technology enterprise of the 21st century.

In addition to encouraging creative proposals from the community, OMA works with MPS Divisions to identify areas of research and education that are seen as particularly timely and promising. Three areas of emphasis for fiscal year 2004 are the development of next-generation instrumentation to enable fundamental advances within disciplines and across disciplinary boundaries; innovations in education, particularly at the graduate and undergraduate levels, that broaden the backgrounds and strengthen the technical, professional, and personal skills of graduates; and research at the interface between MPS disciplines and the biological sciences, where there are extraordinary opportunities for mathematical and physical scientists to use their expertise in addressing significant research and instrumentation challenges in the biosciences and biomedical-related sciences.

In partnership with the MPS Divisions, OMA coordinates three MPS-wide activities that integrate research and education:

1. Research Experiences for Teachers (RET)


Utilize the extensive network of Research Experiences for Undergraduates (REU) Sites as a platform for providing in-service and preservice K–12 teachers with discovery-based learning experiences in the MPS disciplines that they can incorporate into their classroom activities.

2. MPS Distinguished International Postdoctoral Research Fellowships (MPS-DRF)

Enable postdoctoral investigators in MPS disciplines to carry out research at the world's leading facilities and laboratories. A primary objective of the MPS-DRF activity is to provide talented, recent doctoral recipients in the mathematical and physical sciences with an effective means of establishing international collaborations in the early stages of their careers, thereby facilitating and enhancing connections between the U.S. science and engineering community and its international counterparts (see program announcement [NSF 01-154](#)).

3. MPS Internships in Public Science Education (MPS-IPSE)

Are intended to bring together the expertise of the scientific research community traditionally supported by the MPS Directorate with that of the public science education community, in partnership, to communicate the most recent scientific advances to the public. The IPSE activity provides support for undergraduate and graduate students and for K–12 teachers to work in conjunction with MPS research scientists and with professionals at science centers and museums on projects in public science education (see program announcement [NSF 02-064](#)).

 **For More Information**

Write to the Head, Office of Multidisciplinary Activities, Directorate for Mathematical and Physical Sciences, 4201 Wilson Boulevard, Room 1005, Arlington, VA 22230; or contact the office by telephone, 703-292-8803.



DIRECTORATE FOR MATHEMATICAL AND PHYSICAL SCIENCES

Division of Astronomical Sciences

The NSF is the lead Federal agency for the support of ground-based astronomy. Funding is provided through grants, contracts, and cooperative agreements awarded in response to unsolicited, investigator-initiated proposals.

Program areas in the Division of Astronomical Sciences (AST), supported primarily through individual investigator awards, include planetary astronomy, stellar astronomy and astrophysics, galactic astronomy, extragalactic astronomy, and cosmology. A broad base of observational, theoretical, and laboratory research is aimed at understanding the states of matter and physical processes in the Solar System, our Milky Way galaxy, and the universe. Funding is also available for advanced technologies and instrumentation, university radio telescope facilities, and a variety of special programs.

AST supports the development and operation of five National Astronomy Centers: the Gemini Observatory, National Optical Astronomy Observatory (NOAO), National Solar Observatory (NSO), National Radio Astronomy Observatory (NRAO), and National Astronomy and Ionosphere Center (NAIC). The Gemini Observatory is an international partnership that operates two 8-meter optical/infrared telescopes. The astronomy centers are equipped with radio, optical, infrared, and special telescopes that are made available to the scientific community on a competitive basis. Staff members at the centers give technical assistance to visiting scientists, conduct research on their own, and develop advanced instrumentation. AST currently supports the construction of the Atacama Large Millimeter Array (ALMA). The Electromagnetic Spectrum Management Unit is responsible for ensuring that the scientific community has access to the radio spectrum for research purposes.

AST support for astronomy and astrophysics research is provided through two categories:

- [Grants Programs](#)
- [Facilities](#)

For More Information

Write to the Division of Astronomical Sciences, National Science Foundation, 4201 Wilson Boulevard, Room 1045, Arlington, VA 22230; or contact the division by telephone, 703-292-8820; or visit the AST home page, <http://www.nsf.gov/mps/divisions/ast>. Further information about deadlines for proposal submission is available at http://www.nsf.gov/mps/divisions/ast/news/c_deadlines.htm.

• Grants Programs

The category Grants Programs consists of the following:

1. [Advanced Technologies and Instrumentation \(ATI\)](#)
2. [Astronomy and Astrophysics Research Grants \(AAG\)](#)
3. [Education and Special Programs \(ESP\)](#)
4. [Electromagnetic Spectrum Management \(ESM\)](#)

1. Advanced Technologies and Instrumentation (ATI)

Supports the development and construction of state-of-the-art detectors and instruments for the visible, infrared, and radio regions of the spectrum, including interferometric imaging instrumentation and adaptive optics; and the application of new hardware and software technology and innovative techniques in astronomical research. Instrumentation projects should be driven by scientific considerations and clearly articulated scientific goals. Proposals to the ATI Program should include a brief task implementation plan with milestones, schedules, and costs.

The ATI program director also handles proposals for astronomical instrumentation submitted to the NSF-wide Major Research Instrumentation (MRI) Program.

2. Astronomy and Astrophysics Research Grants (AAG)

Provide individual investigator research grants in the following themes:

- **Planetary Astronomy (PLA)**—Theoretical and observational studies of the detailed structure and composition of the surfaces, interiors, and atmospheres of the planets and satellites in the Solar System; the nature of small bodies (asteroids and comets); the interplanetary medium; and the origin and development of the Solar System phenomena.
- **Stellar Astronomy and Astrophysics (SAA)**—Theoretical and observational studies of the structure and activity of the Sun and other stars; the physical properties and composition of all types of single and multiple stars; extra-Solar System planet formation and detection; star formation and stellar evolution; stellar nucleosynthesis; and the properties of atoms and molecules of relevance to stellar astronomy.
- **Galactic Astronomy (GAL)**—Theoretical and observational studies of the more distant universe. Research topics include galaxy formation, evolution, and interaction; active galaxies; quasars; large-scale structure; and all areas of cosmology.
- **Extragalactic Astronomy and Cosmology (EXC)**—Theoretical and observational studies of the more distant universe. Research topics include galaxy formation, evolution, and interaction; active galaxies; quasars; large-scale structure; and all areas of cosmology.

3. Education and Special Programs (ESP)

The ESP activity in the AST Division administers all Foundation-wide (crosscutting) programs as well as programs that cross disciplinary lines in astronomy, or that have significant educational components. Programs include the following: Faculty Early Career Development (CAREER)—supports the early career-development activities of teacher-scholars; NSF Astronomy and Astrophysics Postdoctoral Fellowships (AAPF)—the only postdoctoral program for astronomers that combines research and education; Research Experiences for Undergraduates (REU) Sites and Supplements—support a large number of research opportunities for undergraduates; Research in Undergraduate Institutions (RUI)—scope of program is similar to regular research grants but supports faculty members at predominantly undergraduate institutions; Research Opportunity Awards (ROA)—a supplement available for active research awards to involve faculty from non-research institutions; Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers (ADVANCE)—offers different options for increasing the participation of women in the scientific and engineering workforce; MPS Internships in Public Science Education (MPS-IPSE)—strives to bring science research results from MPS disciplines to the public by funding interns; and MPS Distinguished International Postdoctoral Research Fellowships (MPS-DRF)—fellowships to conduct research at leading institutions outside the United States.

For More Information

Further information, including full descriptions of these and other NSF-wide programs, can be found on the NSF Crosscutting Programs home page, <http://www.nsf.gov/home/crssprgm>; or on the AST Division home page, <http://www.nsf.gov/mps/divisions/ast>.

4. Electromagnetic Spectrum Management (ESM)

The objective of ESM is to ensure access by the scientific community to portions of the radio spectrum needed for research purposes. ESM does this by representing the interests of NSF and the scientific community in the field of telecommunications management and regulation. This involves in particular (1) the establishment of national radio regulations and operating procedures and technical standards under those regulations related to the use of the allocated frequency bands, by representing the NSF on the Interdepartment Radio Advisory Committee (IRAC) and its subcommittees and ad hoc committees and (2) the establishment of international radio regulations by providing input into U.S. Government preparations for World Radiocommunications Conferences through the Radio Conference Subcommittee (RCS), and serving as technical advisor to U.S. delegations to World Radiocommunication Conferences, when appropriate.

• Facilities

The Facilities category supports astronomical facilities and instrumentation that are available on a competitive basis to qualified scientists from all over the world. Telescope time is assigned after judgment of research proposals on the basis of scientific merit, the capability of the instruments to do the work, and the availability of the telescope during the requested time. The Division of Astronomical Sciences supports the following facilities:

1. [Atacama Large Millimeter Array \(ALMA\)](#)
2. [Gemini Observatory](#)
3. [National Astronomy and Ionosphere Center \(NAIC\)](#)
4. [National Optical Astronomy Observatory \(NOAO\)](#)
 - [Kitt Peak National Observatory \(KPNO\)](#)
 - [Cerro Tololo Inter-American Observatory \(CTIO\)](#)
 - [NOAO Gemini Science Center \(NGSC\)](#)
5. [National Radio Astronomy Observatory \(NRAO\)](#)
6. [National Solar Observatory \(NSO\)](#)
7. [University Radio Observatories \(UROs\)](#)

1. Atacama Large Millimeter Array (ALMA)

Originally referred to as the Millimeter Array (MMA), this project was conceived as an aperture-synthesis radio telescope operating in the wavelength range from 3 to 0.4 mm. ALMA will be the world's most sensitive, highest resolution millimeter-wavelength telescope. It will combine an angular resolution comparable to that of the Hubble Space Telescope with the sensitivity of a single antenna nearly 100 meters in diameter. The array will provide a testing ground for theories of star birth and stellar evolution, galaxy formation and evolution, and the evolution of the universe itself. It will reveal the inner workings of the central black hole “engines” that power quasars, and will make possible a search for planets around hundreds of nearby stars.

The interferometer will be located at 5000 m altitude near San Pedro de Atacama, Chile (the so-called Llano de Chajnantor area). The goal of the U.S.—European ALMA partnership is an array consisting of 64 antennas 12 meters in diameter. The U.S. side of the project is led by Associated Universities, Inc./National Radio Astronomy Observatory. Europe is an equal partner in ALMA, with funding and execution of the project carried out through the European Southern Observatory (ESO). Canada has proposed to join the U.S. side of the ALMA partnership and Japan remains interested in the possibility of joining the project at a later date. NSF provides funding for the U.S. participation. After several years of detailed design and development, construction activities began in fiscal year 2002. Construction is expected to take 9 years.

For More Information

Visit the Atacama Large Millimeter Array web page,
<http://www.alma.aoc.nrao.edu/>.

2. Gemini Observatory

An international partnership involving the United States, the United Kingdom, Canada, Australia, Chile, Brazil, and Argentina. The observatory operates two 8-meter telescopes: one in the Northern Hemisphere on Mauna Kea, Hawaii, and one in the Southern Hemisphere on Cerro Pachon, Chile. The twin telescopes are infrared-optimized, have superb image quality, and provide unprecedented optical and infrared coverage of the northern and southern skies for astronomical research.

These telescopes provide astronomers from the partnership countries with world-class observing facilities. Observing time is assigned on the basis of scientific merit. NSF acts as the executive agency for the partnership, and the Association of Universities for Research in Astronomy, Inc. (AURA)—a consortium of 37 U.S. and international university, educational, and nonprofit institutions—manages the Gemini Observatory.

For More Information

Visit the Gemini Observatory home page, <http://www.gemini.edu>.

3. National Astronomy and Ionosphere Center (NAIC)

A visitor-oriented national research center supported by NSF that focuses on radio and radar astronomy and atmospheric sciences. NAIC's headquarters in Ithaca, New York, are operated and managed for NSF by Cornell University. Its principal observing facilities are 19 kilometers south of the city of Arecibo, Puerto Rico. NAIC provides telescope users with a wide range of instrumentation for research and observation. The center has a permanent staff of scientists, engineers, and technicians who are available to help visiting investigators with their observation programs.

NAIC's principal astronomical research instrument is a 305-meter fixed spherical radio/radar telescope, the world's largest single radio wavelength reflector. Its frequency capabilities range from 25 megahertz to 10 gigahertz. Transmitters include an S-band (2,380-megahertz) radar system for planetary studies and a 430-megahertz radar system for aeronomy studies.

For More Information

Write to the Director, National Astronomy and Ionosphere Center, Cornell University, Ithaca, NY 14853; or visit the NAIC home page, <http://www.naic.edu>.

4. National Optical Astronomy Observatory (NOAO)

A national center for research in ground-based optical and infrared astronomy, supported by NSF. The NOAO staff of astronomers, engineers, and various support personnel are available to assist qualified visiting scientists in their use of the facilities, including large optical telescopes, observing instrumentation, and data analysis equipment.

Headquartered in Tucson, Arizona, NOAO is operated and managed by the Association of Universities for Research in Astronomy, Inc. (AURA). NOAO is composed of the following observatories:

- **Kitt Peak National Observatory (KPNO)**—The observing facilities of KPNO are on Kitt Peak, a 2,089-meter mountain 90 kilometers southwest of Tucson, Arizona. KPNO includes the 3.5-meter WIYN telescope, the 4-meter Mayall telescope, a 2.1-meter general-purpose reflector, and the WIYN 0.9-meter imaging telescope. Numerous other telescopes operated by universities and private consortia are also tenants on Kitt Peak.
- **Cerro Tololo Inter-American Observatory (CTIO)**—Qualified scientists are provided with telescopes and related facilities for astronomical research in the Southern Hemisphere. CTIO has offices, laboratories, and living quarters in the coastal city of La Serena, Chile, 482 kilometers north of Santiago. The observing facilities are on Cerro Tololo, a 2,194-meter mountain on the western slopes of the Andes, 64 kilometers inland from La Serena. CTIO operates the 4-meter Blanco telescope—a near twin to the 4-meter Mayall at Kitt Peak; a general-purpose 1.5-meter reflector; and 1.3-meter and 0.9-meter imaging telescopes. The 1-meter-class telescopes are operated in a consortium with a number of U.S. universities and nonprofit institutions—the SMARTS Consortium. In addition, a new-technology 4-meter telescope—the Southern Observatory for Astrophysical Research (SOAR)—is nearing completion on nearby Cerro Pachon.
- **NOAO Gemini Science Center (NGSC)**—NGSC serves as the gateway to the international Gemini Observatory for the U.S. astronomical community and also represents the U.S. scientific, technical, and instrumentation interests in the international community of the Gemini Project. In addition, NOAO administers the following programs:
 - *Telescope System Instrumentation Program (TSIP)*—Provides funds for construction of major research instrumentation at private observatories in return for community access to the largest private observing facilities.
 - *NOAO Public Affairs and Educational Outreach Program (PAEO)*—Provides access to the science and scientists of NOAO for the K-12 and college-level communities. Programs include outreach and educational resources for families, students, and teachers, from kindergarten through the postgraduate level. The NOAO Visitor Centers on Kitt Peak and Cerro Tololo offer a variety of tours, Web pages, and volunteer opportunities as well as nightly observing programs.
 - NOAO scientists and engineers are actively involved in technology development aimed at the next generation of very large, ground-based telescopes, including the Large Synoptic Survey Telescope and the Giant Segmented Mirror Telescope.

 **For More Information**

Write to the Director, National Optical Astronomy Observatories, 950 N. Cherry Avenue, Tucson, AZ 85719; or visit the NOAO home page, <http://www.noao.edu>.

5. National Radio Astronomy Observatory (NRAO)

Offers the use of radio astronomy facilities through a competitive proposal process. The staff at NRAO help visiting scientists use the large radio antennas, receivers, and other equipment required to detect, measure, and identify radio waves from astronomical objects. The NRAO facilities include the following:

- The 100-meter **Robert C. Byrd Green Bank Telescope (GBT)**, located in Green Bank, West Virginia, was dedicated in August 2000 and is now being commissioned. This telescope will eventually cover a frequency range of 100 MHz to 100 GHz. The telescope is presently being used for scientific observations at frequencies between 250 MHz and 50 GHz.
- The **Very Large Array (VLA)**, located west of Socorro, New Mexico, consists of 27 antennas and conducts aperture synthesis observations of cosmic radio sources at high angular resolution. The VLA covers a frequency range spanning large portions of the 73 MHz to 50 GHz range. Significant upgrades to the VLA are underway and will improve the array's sensitivity and spectral agility.
- The **Very Long Baseline Array (VLBA)** is a transcontinental network of ten 25-meter antennas that operate at individual frequency bands ranging between 330 MHz and 43 GHz. VLBA antennas are located at ten separate sites—eight in the continental United States, one in St Croix, and one in Hawaii. The VLBA is used to study cosmic radio sources at unprecedented angular resolution.

NRAO actively supports student research at all of its facilities, and telescopes and scientists are available to support research at the undergraduate, graduate, and postgraduate levels. The Green Bank and VLA sites include recently expanded visitor facilities that are the foundation of education and public outreach activities at NRAO. The NRAO headquarters are located in Charlottesville, Virginia, on the grounds of the University of Virginia.

 **For More Information**

Write to the Director, National Radio Astronomy Observatory, Edgemont Road, Charlottesville, VA 22903; or visit the NRAO home page, <http://www.nrao.edu>.

6. National Solar Observatory (NSO)

Makes available to qualified scientists the world's largest collection of optical and infrared solar telescopes and auxiliary instrumentation for observation of the solar photosphere, chromosphere, and corona.

NSO has observing facilities atop Kitt Peak, Arizona, and Sacramento Peak, New Mexico (NSO/SP). Kitt Peak telescopes include the 1.5-meter McMath-Pierce Solar Telescope (the world's largest solar research instrument) and a solar vacuum telescope/magnetograph. The McMath complex is designed primarily for solar observations but is also used for planetary and stellar observations and for laboratory high-resolution spectroscopy. The principal instrument of NSO/SP is the 0.76-meter Dunn Solar Telescope, a vacuum tower telescope equipped with adaptive optics to produce the world's best spatial resolution for solar studies. Also available are spectrographs and the Advanced Stokes Polarimeter. The Evans Solar Facility is a 40-centimeter aperture coronagraph with spectrographs and a coronal photometer. NSO operates the Global Oscillation Network Group (GONG), a worldwide network of six solar telescopes for helioseismology, and the GONG Data Center in Tucson, Arizona. NSO is leading the design effort for a new 4-meter Advanced Technology Solar Telescope (ATST).

NSO also maintains the National Solar Observatory Digital Library, which provides free public access to an archive of major NSO data sets. These include the Kitt Peak Vacuum Telescope magnetograms and spectroheliograms; the Fourier Transform Spectrometer transformed spectra; the Sacramento Peak Evans Facility spectroheliograms and coronal scans; and solar activity indices. NSO's educational outreach activities include a variety of programs for undergraduate and graduate students and science educators.

 **For More Information**

Write to the Director, National Solar Observatory, Box 62, Sunspot, NM 88349; or visit the NSO home page, <http://www.nso.edu>.

7. University Radio Observatories (UROs)

NSF-supported UROs serve as centers for focused scientific research and technical development in radio astronomy through the collaborative involvement of faculty, research engineers, and students. The emphasis of the program is to maintain a presence for radio astronomy in the university environment for the purpose of fostering innovation and training upcoming generations of students in the field. UROs also provide research opportunities of scope and risk not typically available at the national centers.

The URO program provides funding for telescope operations and for equipment development at existing facilities, and may support construction of new facilities. It also provides partial or full salary support for research faculty, engineers, and technicians; partial summer salaries for teaching faculty; and stipend support for both graduate and undergraduate students.

URO awards are for 3-year intervals and are renewable. UROs fully supported by NSF provide the general astronomical community with access to between one-third and one-half of all telescope observing time. UROs also develop and maintain a strong program of student education and training in radio astronomy and conduct public outreach activities appropriate to the location and nature of the facility.



DIRECTORATE FOR MATHEMATICAL AND PHYSICAL SCIENCES

Division of Mathematical Sciences

The Division of Mathematical Sciences (DMS) supports a wide range of projects aimed at developing and exploring the properties and applications of mathematical structures. Most of these projects are awarded to single investigators or small groups of investigators working with graduate students and postdoctoral researchers. Programs such as Mathematical Sciences Infrastructure handle activities that fall outside this mode.

DMS programs and activities are organized within the following:

- [Disciplinary Programs](#)
- [Infrastructure Programs and Other Activities](#)

Proposals for General Conferences, Workshops, Symposia, Special Years, and Related Activities in DMS

Proposals for general conferences, workshops, symposia, special years, and related activities should be submitted to the appropriate disciplinary program. Proposals should be submitted 1 year before the start of the activity. Contact the division for information on proposal requirements or see program solicitation [NSF 00-109](#).

Specific Types of Grants Supported by DMS

In addition to the usual types of research grants awarded to principal investigators and institutions, DMS supports the following:

- **University/Industry Cooperative Research**—DMS feels it is important to provide more opportunities to conduct research and training in an industrial environment and for industrial scientists to return periodically to academia. To facilitate research and training, the division provides Mathematical Sciences University/Industry Postdoctoral Research Fellowships, Senior Research Fellowships, and Industry-Based Graduate Research Assistantships and Cooperative Fellowships in the Mathematical Sciences.
- **Interdisciplinary Grants**—These grants enable faculty members to expand their skills and knowledge into areas beyond their disciplinary expertise, to subsequently apply that knowledge to their research, and to enrich the educational experiences and career options for students. These grants support interdisciplinary experiences at the principal investigator's (PI's) institution (outside the PI's department) or at academic, financial, or industrial institutions in a nonmathematical science environment.

For More Information

Write to the Division of Mathematical Sciences, National Science Foundation, 4201 Wilson Boulevard, Room 1025, Arlington, VA 22230; or contact the division by telephone, 703-292-8870; or visit the DMS home page, <http://www.nsf.gov/mps/divisions/dms>.

• [Disciplinary Programs](#)

The Division of Mathematical Sciences supports the following disciplinary programs:

1. [Algebra, Number Theory, and Combinatorics](#)
2. [Analysis](#)
3. [Applied Mathematics](#)
4. [Computational Mathematics](#)
5. [Geometric Analysis](#)
6. [Statistics](#)
7. [Probability](#)
8. [Topology](#)
9. [Foundations](#)

 **For More Information**

Write to the Division of Mathematical Sciences, National Science Foundation, 4201 Wilson Boulevard, Room 1025, Arlington, VA 22230; or contact the division by telephone, 703-292-8870; or visit the DMS home page, <http://www.nsf.gov/mps/divisions/dms>.

1. Algebra, Number Theory, and Combinatorics

Supports research in algebra, including algebraic structures, general algebra, and linear algebra; number theory, including algebraic and analytic number theory, quadratic forms, and automorphic forms; and combinatorics, graph theory, and algebraic geometry.

2. Analysis

Supports research on properties and behavior of solutions of differential equations; variational methods; approximations and special functions; analysis in several complex variables and singular integrals; harmonic analysis and wavelet theory; Kleinian groups and theory of functions of one complex variable; real analysis; Banach spaces, Banach algebras, and function algebras; Lie groups and their representations; harmonic analysis; ergodic theory and dynamical systems; some aspects of mathematical physics such as Schroedinger operators and quantum field theory; and operators and algebras of operators on Hilbert space.

3. Applied Mathematics

Supports research in any area of mathematics except probability or statistics. Research is expected to be motivated by or have an effect on problems arising in science and engineering, although intrinsic mathematical merit is the most important factor. Areas of interest include partial differential equations that model natural phenomena or that arise from problems in science and engineering, continuum mechanics, reaction-diffusion and wave propagation, dynamical systems, asymptotic methods, numerical analysis, variational methods, control theory, optimization theory, inverse problems, mathematics of biological or geological sciences, and mathematical physics.

4. Computational Mathematics

Supports research in algorithms, numerical and symbolic methods, and research in all areas of the mathematical sciences in which computation plays a central and essential role. The prominence of computation in the research is a key distinction between Applied and Computational Mathematics. Proposals from interdisciplinary teams to develop critical mathematical and computational techniques from modeling and algorithm development through implementation are encouraged. Also encouraged are proposals for innovative computational methods within the mathematical sciences.

5. Geometric Analysis

Supports research on differential geometry and its relation to partial differential equations and variational principles; aspects of global analysis, including the differential geometry of complex manifolds and geometric Lie group theory; geometric methods in modern mathematical physics; and geometry of convex sets, integral geometry, and related geometric topics.

6. Statistics

Supports research for developing and improving statistical theory and methods that are used for the collection, exploration, analysis, and interpretation of data to enable discovery and advancement in virtually all areas of science and engineering. Subfields include parametric and nonparametric inference, multivariate analysis, Bayesian analysis, experimental design, robust statistical methods, time series analysis, spatial analysis, and resampling methods.

7. Probability

Supports research on the theory and applications of probability. Subfields include discrete probability, stochastic processes, limit theory, interacting particle systems, stochastic differential and partial differential equations, and Markov processes. Research in probability, which involves applications to other areas of science and engineering, is especially encouraged.

8. Topology

Supports research on algebraic topology, including homotopy theory, ordinary and extraordinary homology and cohomology, cobordism theory, and K-theory; topological manifolds and cell complexes, fiberings, knots, and links; differential topology and actions of groups of transformations; geometric group theory; and general topology and continua theory.

9. Foundations

Supports research in mathematical logic, including proof theory, recursion theory and model theory, foundations of set theory, and infinitary combinatorics.

• Infrastructure Programs and Other Activities

In addition to support in the disciplinary programs, the Division of Mathematical Sciences (DMS) offers activities that differ from the usual type of research projects. A few examples of these programs are included here. For additional programs and further information, visit the DMS home page, <http://www.nsf.gov/mps/divisions/dms>.

Other programs of interest that the Division of Mathematical Sciences is involved with include:

1. [Mathematical Sciences Research Institutes and Other Activities](#)
2. [Focused Research Groups](#)
3. [Enhancing the Mathematical Sciences Workforce in the 21st Century \(EMSW21\)](#)

For More Information

Write to the Division of Mathematical Sciences, National Science Foundation, 4201 Wilson Boulevard, Room 1025, Arlington, VA 22230; or contact the division by telephone, 703-292-8870; or visit the DMS home page, <http://www.nsf.gov/mps/divisions/dms>.

1. Mathematical Sciences Research Institutes and Other Activities

The Division of Mathematical Sciences (DMS) currently funds seven awards given to different mathematical sciences research institutes. These projects stimulate research in all of the mathematical sciences through thematic and residential programs, workshops, and access to distinctive resources. All of the institutes offer visiting opportunities for researchers in every stage of their career, and most offer postdoctoral fellowships for one or more years, with mentoring provided by outstanding scientists. Many of these centers involve new researchers, graduate students, and undergraduates through tutorials related to current programs, mathematical research experiences based on industrial or other problems, and summer schools. Interested parties are encouraged to contact the institutes directly for information on current and future programs, visiting opportunities, and other activities. The seven institutes and their Web sites are:

American Institute of Mathematics

AIM Research Conference Center
360 Portage Ave
Palo Alto, CA 94306-2244
Web address: <http://www.aimath.org>

Institute for Advanced Study

School of Mathematics
1 Einstein Drive
Princeton, NJ 08540
E-mail address: math@math.ias.edu
Web address: <http://www.math.ias.edu>

Institute for Mathematics and its Applications

University of Minnesota
400 Lind Hall, 207 Church Street SE
Minneapolis, MN 55455-0436
Web address: <http://www.ima.umn.edu>

Institute for Pure and Applied Mathematics

IPAM Building
460 Portola Plaza
Box 957121
Los Angeles, CA 90095-7121 (it's important to include the entire 9-digit Zip Code)
E-mail: ipam@ucla.edu
Web address: <http://www.ipam.ucla.edu>

Mathematical Biosciences Institute

The Ohio State University
231 W. 18th Avenue
Columbus, OH 43210
Tel: 614-292-3648
Web address: <http://mbi.osu.edu>

Mathematical Sciences Research Institute

17 Gauss Way
Berkeley, CA 94720-5070
E-mail: inquiries@msri.org
Web address: <http://www.msri.org>

Statistical and Applied Mathematical Sciences Institute

19 T. W. Alexander Drive
P.O. Box 14006
Research Triangle Park, NC 27709-4006
Tel: 919-685-9350 FAX: 919-685-9360
E-mail: info@samsi.info
Web address: <http://www.samsi.info>

In addition to these institutes, DMS contributes to the support of the Banff International Research Station for Mathematical Innovation and Discovery in Banff, Alberta, a joint venture between Canada and the United States (visit the station's Web site at <http://www.pims.math.ca/birs>). This site is an international center for workshops, team research, and summer schools for mathematical sciences and mathematical challenges in science and industry.

- **Regional Conferences**—Operated by the conference board of the mathematical sciences, these conferences feature a principal speaker who gives 10 1-hour talks on a particular subject during a weeklong session.
- **Scientific Computing Research Environments in the Mathematical Sciences**—Offers moderate grants for computing equipment that will benefit groups of outstanding researchers who are highly productive but whose work has been seriously impeded by the lack of computing facilities.
- **Undergraduate Activities**—Awards are made in conjunction with NSF-wide undergraduate efforts, including Research Experiences for Undergraduates (REU), cooperative activities with the Directorate for Education and Human Resources (EHR), and other related activities. For more information on REU, visit the NSF Crosscutting Programs home page, <http://www.nsf.gov/home/crssprgm>. Further information about EHR programs and activities can be found in the EHR section in this Guide.
- **Mathematical Sciences Postdoctoral Research Fellowships**—Fellowships will be awarded to between 30 and 35 new fellows in 2004. Tenure provides a research instructorship option.

Eligibility Requirements for the Mathematical Sciences Postdoctoral Research Fellowships

Each applicant will be required to submit a research plan for the tenure period requested. The fellowships are not intended to support the preparation of prior research results for publication or the writing of textbooks.

To be eligible for one of these fellowships, an individual must (1) be a citizen, national, or lawfully admitted permanent resident alien of the United States as of January 1, 2004; (2) have earned by the beginning of his or her fellowship tenure a doctoral degree in one of the mathematical sciences listed above, or have research training and experience equivalent to that represented by a Ph.D. in one of those fields; and (3) have held the doctorate for no more than 2 years as of January 1, 2004.

2. Focused Research Groups

The mathematical sciences thrive on sharing ideas and information from various scientific fields and disciplines. Certain research needs can only be met appropriately through the use of investigative teams. The Focused Research Groups (FRG) Program supports these teams, thereby allowing groups of researchers to respond to the scientific needs of pressing importance, take advantage of current scientific opportunities, and prepare the ground for anticipated developments in the mathematical sciences. In addition to mathematical scientists, groups may include researchers from other scientific and engineering disciplines. FRG projects are highly focused scientifically, timely, limited to 3 years' duration, and substantial in both scope and impact. Projects supported through FRG are essentially collaborative in nature, their success dependent on the interaction of a group of researchers.

3. Enhancing the Mathematical Sciences Workforce in the 21st Century (EMSW21)

The long-range goal of the EMSW21 Program is to increase the number of U.S. citizens, nationals, and permanent residents who are well prepared for and want to pursue careers in the mathematical sciences and in other NSF supported disciplines. EMSW21 builds on the Vertical Integration of Research and Education (VIGRE) Program and now includes a broadened VIGRE activity, an additional component for Research Training Groups in the Mathematical Sciences (RTG), and an additional component for Mentoring through Critical Transition Points in the Mathematical Sciences (MCTP).

- The **Grants for Vertical Integration of Research and Education (VIGRE)** component focuses on enhancing the educational experience of all students and postdoctoral associates in a department (or departments). Broad faculty commitment and a team approach to enhancing learning are necessary for the success of this program. A principal element of VIGRE is the increase in interaction among undergraduates, graduate students, postdoctoral associates, and faculty members. Integrating research and education for graduate students and postdoctoral associates, involving undergraduates in substantial learning by discovery, and developing a team approach are keys to successful VIGRE projects. These goals can be accomplished in many ways, and proposers should develop creative approaches that suit their circumstances.
- The **Research Training Groups in the Mathematical Sciences (RTG)** component provides groups of researchers who have related research goals in the mathematical sciences with funds to foster research-based training and education. Although the groups may include researchers and students from different departments and institutions, the research-based training and education activities must be based in the mathematical sciences. The RTGs are expected to vary in size, scope, proposed activities, and plans for organization, participation, and operation.
- The **Mentoring Through Critical Transition Points in the Mathematical Sciences (MCTP)** component provides a system of mentoring that focuses on points of transition critical for success in a mathematical science career path—from undergraduate studies to the early years in a tenure track position. The program may be a comprehensive department effort or a more focused endeavor involving a few faculty mentors and aimed toward a specific transition point or group of points. However, department-wide programs that include components for undergraduates, graduates, and postdoctorates, may be more appropriate for the VIGRE component. Successful proposals will be those that provide ways to increase the number and the quality of training of U.S. citizens, nationals, or permanent residents entering the scientific workforce with strong mathematical training, including the number of degrees awarded in the mathematical sciences.



DIRECTORATE FOR MATHEMATICAL AND PHYSICAL SCIENCES

Division of Physics

The Division of Physics (PHY) supports a wide range of activities in the different subfields of physics. The primary mode of funding is to individual investigators or small groups. The division also funds the operation of two large-scale accelerator facilities (the Cornell Electron Storage Ring and the Michigan State University National Superconducting Cyclotron Laboratory); the Laser Interferometer Gravitational Wave Observatory; several smaller-scale accelerators; a number of centers in atomic, molecular, and optical physics and in theoretical physics; and a new program of Physics Frontiers Centers.

The research activities in the Physics Division are inextricably linked to education, and support about 800 graduate students who are fully engaged in research. Some of these activities involve substantial numbers of undergraduate students as well, especially the summer activities that are centered around the Research Experiences for Undergraduates (REU) Program. The division now supports approximately 50 REU Sites. Research activities at 4-year colleges are supported through the Research at Undergraduate Institutions (RUI) Program. The division also supports Research Experiences for Teachers through grants to provide grade K–12 science teachers with research training opportunities. In addition, the division offers significant training opportunities for young people through its support of about 500 postdoctoral positions. The division also supports outreach activities coupled to research that are intended to convey the excitement of physics to students in grades K–12 and to help educate the public at large in forefront science.

PHY supports the following programs and activities:

1. Atomic, Molecular, Optical, and Plasma Physics
2. Biological Physics
3. Elementary Particle Physics
4. Gravitational Physics
5. Nuclear Physics
6. Particle and Nuclear Astrophysics
7. Theoretical Physics
8. Education and Interdisciplinary Research
9. Physics at the Information Frontier
10. Physics Frontiers Centers (PFCs)

 **For More Information**

Write to the Division of Physics, National Science Foundation, 4201 Wilson Boulevard, Room 1015, Arlington, VA 22230; or contact the division by telephone, 703-292-8890; or visit the PHY home page, <http://www.nsf.gov/mps/divisions/phy>.

1. Atomic, Molecular, Optical, and Plasma Physics

In Atomic and Molecular Physics, research is supported in areas such as quantum control, cooling and trapping of atoms and ions, low-temperature collision dynamics, the collective behavior of atoms in weakly interacting gases (Bose-Einstein condensates), precision measurements of fundamental constants, and the effects of electron correlation on structure and dynamics. In Optical Physics, support is provided in areas such as nonlinear response of isolated atoms to intense, ultrashort electromagnetic fields; the atom/cavity interaction at high fields; and quantum properties of the electromagnetic field. In basic Plasma Physics, support focuses on the study of the behavior of plasmas in confined magnetic structures and in laser plasma interactions.

Several centers and one user facility are supported. The Joint Institute for Laboratory Astrophysics (JILA) at the University of Colorado is supported jointly with the National Institute of Standards and Technology. JILA conducts leading-edge research in many aspects of atomic, molecular, and optical physics. The Center for Ultracold Atoms, a joint MIT-Harvard University activity, conducts research in the area of Bose-Einstein condensates and coherent atom sources. The Large Aperture Plasma Device at UCLA is supported jointly with the Department of Energy as a user facility for the study of plasma waves.

2. Biological Physics

Supports projects in which the analytical and experimental tools of physics are applied to the study of problems that originate in the living world. Both experimental and theoretical projects will be considered, although the main focus of the program is the experimental area. Of particular interest are projects in which new experimental approaches are brought to bear on a well-identified problem. These approaches should, at the same time, have the potential for broad applicability to a set of similar problems, thereby adding to the set of tools the scientist has for addressing biological problems in general. While the problems under study must be important to advancing understanding of the living world in a meaningful way, particular emphasis will be placed on those projects in which the lessons learned from the application serve to foster new concepts and ideas that expand the intellectual basis of physics. The program funds individual investigators, although collaborative proposals between physicists and biologists are welcome.

3. Elementary Particle Physics

Supports research on the properties and interactions of elementary particles, the most fundamental building blocks of matter, at the frontiers of energy and sensitivity. Research includes the exploration of quarks and leptons and interactions among these elementary constituents. The program supports university groups working at major accelerator laboratories, including those operated by the Department of Energy, and university groups involved in the construction of detectors for the Large Hadron Collider at the European Organization for Nuclear Research (CERN).

The program supports the Cornell Electron Storage Ring (CESR), which produces electron and positron colliding beams that allow detailed studies by university groups of b-meson physics and upsilon physics, and facilitates an aggressive program of synchrotron radiation research at the Cornell High-Energy Synchrotron Source, which is operated by the Division of Materials Research. CESR is among the highest luminosity electron-positron colliders in the world in this energy range. CESR also maintains a vigorous program of accelerator research and development.

4. Gravitational Physics

Emphasizes the theory of strong gravitational fields and their application to astrophysics and cosmology, computer simulations of strong gravitational fields, gravitational radiation, and construction of a quantum theory of gravity. The program oversees the management of the construction, commissioning, and operation of the Laser Interferometer Gravity Wave Observatory (LIGO) and provides support for LIGO users and other experimental investigations in gravitational physics and related areas.

5. Nuclear Physics

Supports research on the properties and behavior of nuclei and nuclear matter under extreme conditions; the quark-gluon basis for the structure and dynamics of nuclear matter (which is now given in terms of mesons and nucleons); phase transitions of nuclear matter from normal nuclear density and temperature to the predicted high-temperature quark-gluon plasma; and basic interactions and fundamental symmetries. This research involves many probes, including intermediate-energy to multi-GeV electrons and photons; intermediate-energy light ions; low-energy to relativistic heavy ions, including radioactive beams; and non-accelerator-based studies. Other important components of the program include accelerator physics, interdisciplinary efforts, and applications to other fields.

The program supports university user groups executing experiments at a large number of laboratories in the United States and abroad, and a national user facility—the National Superconducting Cyclotron Laboratory, a superconducting, heavy-ion cyclotron facility at Michigan State University. The program also supports smaller accelerator facilities, such as those at Florida State University, the University of Notre Dame, and the State University of New York at Stony Brook.

6. Particle and Nuclear Astrophysics

Supports university groups conducting research in particle and nuclear astrophysics. Activities supported currently include high-energy cosmic ray studies, solar and high-energy neutrino astrophysics, the study of gamma ray bursts, and searches for dark matter. Under construction are the Auger, HiRes, STACEE, and Milagro cosmic ray/gamma ray detectors, the Borexino solar neutrino detector, the Amanda II high-energy neutrino detector, and

the CDMS II and DRIFT dark matter detectors. Support also is provided for accelerator-based nuclear astrophysics studies of stellar process, nucleosynthesis, and processes related to cosmology and the early universe.

7. Theoretical Physics

Supports the development of qualitative and quantitative understanding of fundamental physical systems, ranging from the most elementary constituents of matter through nuclei and atoms to astrophysical objects. This includes formulating new approaches for theoretical, computational, and experimental research that explore the fundamental laws of physics and the behavior of physical systems; formulating quantitative hypotheses; exploring and analyzing the implications of such hypotheses computationally; and in some cases, interpreting the results of experiments. Support is given for research in the following areas: elementary particle physics; nuclear physics; atomic, molecular, optical, and plasma physics; astrophysics and cosmology; and a broad spectrum of topics in mathematical physics, computational physics, nonlinear dynamics, chaos, and statistical physics. The effort also includes a considerable number of interdisciplinary grants.

In addition, the program supports infrastructure activities such as the Institute for Theoretical Physics at the University of California at Santa Barbara, the Harvard-Smithsonian Institute for Theoretical Atomic, Molecular, and Optical Physics, and the Aspen Center for Physics. These activities include both short- and long-term visitor programs, workshops, and research involving the participation of external scientists from universities, national laboratories, and industry, as well as graduate students and postdoctoral fellows.

8. Education and Interdisciplinary Research

Supports activities in conjunction with NSF-wide programs such as Faculty Early Career Development (CAREER), Research Experiences for Undergraduates (REU), and programs aimed at women, minorities, and persons with disabilities. Further information about all of these programs and activities is available in the Crosscutting Investment Strategies section in this Guide.

The program also supports activities that seek to improve the education and training of physics students—both undergraduate and graduate—such as curriculum development for upper-level physics courses and activities that are not included in specific programs elsewhere within NSF. Also supported is research at the interface between physics and other disciplines—including medical physics and computation—and extending to emerging areas. Broadening activities related to research at the interface with other fields, possibly not normally associated with physics, also may be considered.

9. Physics at the Information Frontier

Provides support for physics proposals in three subareas: computational physics, information intensive physics, and quantum information and revolutionary computing. Computational physics focuses on computational problems in physics requiring significant long-term code development and/or a medium to large collaborative effort involving physicists or physicists interacting with applied mathematicians and computer scientists. Information intensive physics seeks proposals to (1) develop rapid, secure, and efficient access to physics data stores rising from Petabytes (today) to Exabytes (in 10 years) via heterogeneous and distributed computing resources and networks of varying capability and reliability and (2) to develop internally consistent approaches to the usage of common resources required in the multiple collaborations and serving virtual science organizations on a global scale. Quantum information and revolutionary computing supports proposals that explore applications of quantum mechanics to new computing paradigms for physics or that foster interactions between the physical, mathematical, and computer scientists who push the frontiers of quantum physics.

10. Physics Frontiers Centers (PFCs)

Support university-based centers and large groups in cases where this mode of research is required to make transformational advances in the most promising research areas. Proposals will be considered in areas within the purview of the Division of Physics, broadly interpreted—for example, atomic, molecular, optical, plasma, elementary particle, nuclear, astro, gravitational, interdisciplinary, and emerging areas of physics. Interdisciplinary physics is taken here to mean research at the interface between physics and other disciplines—for example, biophysics, quantum information science, and mathematical physics. The purpose of the PFC Program is to enable major advances at the intellectual frontiers of physics by providing needed resources not usually available to individual investigators or small groups. PFCs make it possible to address major challenges that require combinations of

talents, skills, and/or disciplines; specialized infrastructure; large collaborations; or centers/institutes that catalyze rapid advances on the most promising research topics. Proposals are received only in response to a program solicitation. The next solicitation will be released in fiscal year 2004.



DIRECTORATE FOR MATHEMATICAL AND PHYSICAL SCIENCES

Division of Chemistry

The Division of Chemistry (CHE) supports research and the development of research infrastructure in the principal subdisciplines of chemistry. The field of chemistry is very diverse, and NSF support for chemistry research goes beyond the CHE Division. Other NSF divisions supporting chemistry research include Astronomical Sciences, Atmospheric Sciences, Molecular and Cellular Biosciences, Chemical and Transport Systems, Earth Sciences, Advanced Computational Research, Physics, and Materials Research. Support for the development of infrastructure in chemistry is also provided by appropriate divisions in the Directorates for Education and Human Resources (EHR) and Biosciences (BIO) through the Division of Biological Infrastructure.

Molecular science plays a central role in many areas of science and engineering. Because of this, much of the research supported by the CHE Division will also further the advancement of research in other disciplines, such as biology and chemical engineering, and in various multidisciplinary or interdisciplinary areas, such as environmental science and materials science.

CHE supports the following programs and activities:

1. Analytical and Surface Chemistry
2. Inorganic, Bioinorganic, and Organometallic Chemistry
3. Organic Chemical Dynamics
4. Organic Synthesis
5. Experimental Physical Chemistry
6. Theoretical and Computational Chemistry
7. Office of Special Projects
8. Chemistry Research Instrumentation and Facilities

 **For More Information**

Write to the Division of Chemistry, National Science Foundation, 4201 Wilson Boulevard, Room 1055, Arlington, VA 22230; or contact the division by telephone, 703-292-8840; or visit the CHE home page, <http://www.nsf.gov/mps/divisions/che>.

1. Analytical and Surface Chemistry

Supports fundamental chemical research directed toward the characterization and analysis of all forms of matter. Studies of elemental and molecular composition and of the microstructure of both bulk and surface domains are included. The program supports projects that develop the fundamentals of measurement science, new sensors and new instruments, and innovative approaches to data processing and interpretation.

Investigations designed to probe the chemical structure and reactivity of the interface between different forms of matter also are supported. The program is linked to several other chemistry research programs within NSF, including Solid State Chemistry (Materials Research Division, MPS Directorate); Biochemistry and Biophysics (Molecular and Cellular Biosciences Division, BIO Directorate); and Chemical Reaction Processes and Interfacial, Transport, and Separation Processes (Chemical and Transport Systems Division, ENG Directorate).

2. Inorganic, Bioinorganic, and Organometallic Chemistry

Supports research on the synthesis, properties, and reaction mechanisms of molecules composed of metals, metalloids, and nonmetals with elements covering the entire periodic table. Included are fundamental studies that underscore (1) bioinorganic reactions, (2) homogeneous catalysis and organometallic reactions, (3) photochemical and charge transfer processes, and (4) studies aimed at the rational synthesis of new inorganic molecular substances, self-assemblies, and nano-sized materials with predictable chemical, physical, and biological properties. Objectives are to provide the basis for understanding (1) the function of metal ions in biological systems, (2) the behavior of new inorganic materials and new industrial catalysts, and (3) the systematic chemistry and

behavior of most of the elements and compounds in the environment. The program has links to other programs within NSF that support chemistry research, including Solid State Chemistry and Polymers (Materials Research Division, MPS Directorate); Chemical Reaction Processes (Chemical and Transport Systems Division, ENG Directorate); Biochemistry and Biophysics (Molecular and Cellular Biosciences Division, BIO Directorate); and Geochemistry (Earth Sciences Division, GEO Directorate).

3. Organic Chemical Dynamics

Supports research that will advance the knowledge of carbon-based molecules, metallo-organic systems, and organized molecular assemblies. Experimental, computational, and theoretical projects that illuminate chemical structures, reactivity, and properties and that provide organic mechanistic, structural, and kinetic foundations for the understanding of biological processes are all considered. The program has links to other programs within NSF that support chemistry research, including Solid State Chemistry and Polymers (Materials Research Division, MPS Directorate); Chemical Reaction Processes (Chemical and Transport Systems Division, ENG Directorate); Biochemistry and Biophysics (Molecular and Cellular Biosciences Division, BIO Directorate); and Atmospheric Chemistry (Atmospheric Sciences Division, GEO Directorate).

4. Organic Synthesis

Supports research on the synthesis of carbon-based molecules, organometallic systems, and organized molecular assemblies. Research includes the development of new reagents and methods for organic synthesis and characterization, and the investigation of natural products and new organic materials. Such research provides the basis for designed syntheses of new materials and natural products important to the chemical and pharmaceutical industries. The research has links to other programs within NSF that support chemistry research, including Biochemistry (Molecular and Cellular Biosciences Division, BIO Directorate) and Polymers (Materials Research Division, MPS Directorate).

5. Experimental Physical Chemistry

Supports experimental research directed at understanding the physical properties of chemical systems at a molecular level. Chemical systems include solids, liquids, interfaces, clusters, and isolated molecules or ions in gas or condensed phases. Chemical properties of interest include solute/solvent interactions in liquids and in clusters; chemical dynamics of bimolecular and unimolecular chemical processes; time-resolved internal energy redistribution; and molecular structure and the shape of the ground and excited electronic-state potential energy surfaces. Experimental methodologies include frequency domain and time domain spectroscopic techniques covering the entire range of the electromagnetic spectrum; time-resolved dynamical studies, including state-selected and mass-selected systems; reactive scattering; and single-molecule studies.

The program has links to other programs within NSF that support chemistry research, including Atomic, Molecular, and Optical Physics (Physics Division, MPS Directorate); Biophysics (Molecular and Cellular Biosciences Division, BIO Directorate); Atmospheric Chemistry (Atmospheric Sciences Division, GEO Directorate); Galactic Astronomy (Astronomical Sciences Division, MPS Directorate); Chemical and Transport Systems (ENG Directorate); and various programs in the Materials Research Division (MPS Directorate).

6. Theoretical and Computational Chemistry

Supports theoretical and computational research in areas of electronic structure, statistical mechanics, computer simulations, and chemical dynamics. The program also supports some areas of experimental thermodynamics and condensed phase dynamics of chemical systems that rely heavily on theoretical interpretation of experimental data. Areas of application span the full range of chemical systems, from small molecules to macromolecules, and degrees of aggregation from clusters to macroscopic systems. The goal of projects supported in this program is to provide a molecular-level interpretation for chemical properties and reactivity. The program has links to other programs within NSF that support chemistry research, including Atomic, Molecular, and Optical Physics (Physics Division, MPS Directorate); Materials Theory (Materials Research Division, MPS Directorate); Biophysics (Molecular and Cellular Biosciences Division, BIO Directorate); and Advanced Computational Research (Advanced Computational Infrastructure and Research Division, CISE Directorate).

7. Office of Special Projects

Supports or coordinates the support for most of the infrastructure programs and activities in which the CHE Division is involved. Examples include the Research Experiences for Undergraduates and the Faculty Early Career Development Programs, pilots for undergraduate research centers, and a postdoctoral discovery corps, as well as various special-purpose grants in education, outreach, diversity, and graduate training. The office also coordinates the division's involvement in large-scale projects, such as the Environmental Molecular Science Institutes and the Science and Technology Centers. The office manages the Collaborative Research in Chemistry Program, whose purpose is to enable groups of researchers to respond to recognized scientific needs; take advantage of current scientific opportunities; or prepare the groundwork for anticipated and significant scientific developments in chemistry, broadly defined. Further information on the research centers and groups supported by the CHE Division is available at http://www.nsf.gov/mps/divisions/che/about/c_facilities.htm.

8. Chemistry Research Instrumentation and Facilities (CRIF)

Supports the purchase or upgrade of departmental multiuser instrumentation, instrumentation development, and chemistry research facilities. The first of these topics focuses on departmental development and is intended to facilitate research by grantees and potential grantees that are being supported by the CHE Division. Instrumentation development is intended to implement, test, and introduce new concepts for chemical measurement to be used on a wider scale. Chemistry research facilities provide unique, state-of-the-art instrumentation and expertise to users from the chemical sciences community. Only a few facilities are supported at any time. Individuals interested in submitting a facilities proposal must first contact the appropriate staff person in the CHE Division. CRIF interfaces with the following cross-directorate programs and activities: Major Research Instrumentation, Small Business Innovation Research, Small Business Technology Transfer, and instrumentation programs in the Materials Research Division (MPS Directorate), the Division of Undergraduate Education (EHR Directorate), the Office of Cross-Disciplinary Activities (CISE Directorate), and the Division of Biological Infrastructure (BIO Directorate). For a description of the facilities currently supported by the CHE Division, see http://www.nsf.gov/mps/divisions/che/about/c_facilities.htm.



DIRECTORATE FOR MATHEMATICAL AND PHYSICAL SCIENCES

Division of Materials Research

The Division of Materials Research (DMR) supports a wide range of programs that address fundamental phenomena in condensed matter and functional materials, including synthesis and processing, structure and composition, properties and performance, and materials education. DMR provides support for research and education carried out by individual investigators, groups, and centers; for instrumentation; and for national user facilities. Grants for proposed projects may be for individual investigators or groups in a single discipline, target a specific program or project, be interdisciplinary, or require partnerships that cross the boundaries of traditional programs. DMR has interest in projects that advance the field of materials research and materials education through its core programs and through the NSF-wide priority areas and other activities of importance to the broader goals of NSF. DMR staff facilitate the co-review and co-funding of highly meritorious proposals within a program and across programs, divisions, or directorate boundaries as appropriate.

DMR-supported programs and activities are organized in two categories:

- [DMR Programs](#)
- [Other DMR Activities of Interest](#)

For More Information

For information about awards and abstracts, target and deadline dates for proposal submission, and DMR programs and activities, visit the DMR home page, <http://www.nsf.gov/mps/divisions/dmr>; or contact DMR by telephone, 703-292-8810; or write to the Division of Materials Research, National Science Foundation, 4201 Wilson Boulevard, Room 1065, Arlington, VA 22230.

• [DMR Programs](#)

Programs in the category DMR Programs support materials research and education ranging from investigations in condensed matter physics and solid state chemistry to basic research on functional materials, including metals, ceramics, polymers, biomaterials, and electronic, photonic, and magnetic materials. DMR supports projects that lead to the discovery and understanding of materials and condensed matter phenomena and the basis for their translation into technological applications. The division especially encourages projects that lead to the discovery of new phenomena, the creation of novel materials, and advances in understanding and control of materials behavior and processing. Discoveries often emerge from a creative interplay among theory, experiment, computer-based modeling and simulation, and the development of new instruments.

The following programs comprise the Division of Materials Research (DMR):

1. [Metals](#)
2. [Ceramics](#)
3. [Electronic Materials](#)
4. [Materials Theory](#)
5. [Condensed Matter Physics](#)
6. [Solid-State Chemistry](#)
7. [Polymers](#)
8. [Materials Research Science and Engineering Centers](#)
9. [Instrumentation for Materials Research](#)
10. [Office of Special Programs](#)
11. [National Facilities](#)

For More Information

For information about awards and abstracts, target dates and deadlines for proposal submission, or DMR programs and activities, visit the DMR home page, <http://www.nsf.gov/mps/divisions/dmr>; or contact DMR by telephone, 703-292-8810; or write to the Division of Materials Research, National Science Foundation, 4201 Wilson Boulevard, Room 1065, Arlington, VA 22230.

1. Metals

Supports research to increase understanding and predictive capabilities for relating synthesis, processing, alloy chemistry, and microstructure of metals to their physical and structural properties and performance in various applications and environments. Metals research encompasses the broad areas of physical and mechanical metallurgy. Topics supported include phase transformations and equilibria; morphology; solidification; surface modification, structure, and properties; interfaces and grain boundary structure; nanostructures; corrosion and oxidation; defects; deformation and fracture; and welding and joining.

2. Ceramics

Supports research investigating the characteristics of ceramic materials as they relate to the complex interplay among processing, development, and manipulation of microstructure, and properties and their ultimate performance in various applications and environments. The materials studied include oxides, carbides, nitrides, and other ceramics, including diamond and carbon-based materials. The microstructures investigated range from crystalline, polycrystalline, and amorphous to composite and nanostructured. Potential uses include, but are not limited to, electronic and electrical, electrochemical, structural, optical/photonic, and biological/medical applications.

3. Electronic Materials

Supports research that investigates the fundamental phenomena associated with the synthesis and processing of electronic and photonic materials. The objective is to increase fundamental understanding and develop predictive capabilities for relating synthesis, processing, and microstructure of these materials to their properties and performance in various applications and environments. Topics supported include basic processes and mechanisms associated with nucleation and growth of thin films; nanostructure definition and etching processes; bulk crystal growth; and the interrelationship among experimental conditions, phenomena, and properties.

4. Materials Theory

Supports theoretical and complementary computational research in the topical areas represented in DMR programs, including condensed matter physics, polymers, solid-state chemistry, metals, electronic materials, and ceramics. Materials Theory is the primary source of funding at NSF for condensed matter theory. The program supports fundamental research that advances conceptual, analytical, and computational techniques for materials research. A broad spectrum of research is supported using electronic structure methods, many-body theory, statistical mechanics, and Monte Carlo and molecular dynamics simulations, along with other techniques, many of which involve advanced scientific computing. Emphasis is on approaches that begin at the smallest appropriate length scale—electronic, atomic, molecular, nano-, micro-, and mesoscale—required to yield fundamental insight into material properties, processes, and behavior and to reveal new materials phenomena. Areas of recent interest include strongly correlated electron systems; low-dimensional systems; quantum magnetism; nonequilibrium phenomena, including pattern formation, microstructural evolution, and fracture; high-temperature superconductivity; nanostructured materials and mesoscale phenomena; quantum coherence and its control; and soft condensed matter, including systems of biological interest.

5. Condensed Matter Physics

Supports fundamental, experimental, and combined experiment and theory projects on the physics of solid, liquid, and amorphous systems. Phenomena of interest include phase transitions; localization; electronic, magnetic, and lattice structure; superconductivity; elementary excitations, including electronic, magnetic, plasma, and lattice; transport, magnetic, and optical properties; and nonlinear dynamics. Low-temperature physics is represented by research on quantum fluids and solids as well as two-dimensional electron systems. Soft condensed matter research includes partially ordered fluids, colloid physics, and hybrid media involving biological molecules.

Characterization and analysis of new materials by novel methods and research on condensed matter under extreme conditions—such as low temperatures, high pressures, and high magnetic fields—are of interest. Development of new experimental techniques to carry out proposed projects is encouraged.

6. Solid-State Chemistry

Supports basic research that includes understanding the atomic and molecular basis for synthesis, structure-composition-property relationships, and the processing of materials. The program is largely multidisciplinary with strong components of chemistry, physics, biology, and materials science. Special attention is given to the creation of new classes of materials exhibiting new phenomena and discovering specific materials with superior properties. Current research areas include innovative synthetic routes to new materials; characterization of materials displaying new phenomena or superior behavior; the relationships among structure, composition, and properties such as chemisorption, cooperative-assembly, transport, and reactivity; and materials preparation, processing, and optimization by chemical means. The current materials emphasis is on hybrid materials, complex materials, bio-inspired and environmental materials, and advanced materials optimization and processing.

7. Polymers

Supports basic research and education on the materials aspects of polymer science that are largely experimental and multidisciplinary, with strong components of chemistry, physics, and materials science. The program addresses synthesis, structure, morphology, processing, characterization, and structure-property relationships of polymers at the molecular level, with particular focus on new materials or materials with superior properties. The polymers studied are principally synthetic, but there is also an interest in biopolymers.

8. Materials Research Science and Engineering Centers (MRSECs)

Support interdisciplinary materials research and education while addressing fundamental problems in science and engineering that are important to society. MRSECs require outstanding research quality and intellectual breadth, provide support for research infrastructure and flexibility in responding to new opportunities, and strongly emphasize the integration of research and education. These centers foster active collaboration between universities and other sectors, including industry, and they constitute a national network of university-based centers in materials research. MRSECs address problems of a scope or complexity requiring the advantages of scale and interdisciplinary interaction provided by a campus-based research center. DMR expects that there will be an open competition for new MRSECs in fiscal year 2005. For more information about the MRSECs, including links to the research and education activities of each center, visit the MRSEC home page, <http://www.mrsec.org>.

9. Instrumentation for Materials Research

Supports the development and acquisition of state-of-the-art tools to carry out advanced materials research. The program supports major shared instruments essential to investigators conducting research that spans two or more disciplinary areas within DMR or more than one NSF division; and instrumentation required by one or more investigators conducting research in a single disciplinary area within DMR that has a total cost of approximately \$100,000 or more. The program strongly encourages submission of proposals for the development of new instruments that have the potential to solve important materials problems, proposals that will significantly advance measurement capabilities, and proposals that could lead to new discoveries. The program typically has only one deadline per year. For more information about current program guidelines and deadlines, visit the DMR home page, <http://www.nsf.gov/mps/divisions/dmr>. The program also coordinates the review for the NSF-wide Major Research Instrumentation (MRI) Program for DMR.

10. Office of Special Programs

Coordinates DMR-related international activities and DMR participation in many of the NSF-wide programs involving education, human resource, and career development. Programs include Research Experiences for Undergraduates (REU) and Research Experiences for Teachers (RET), Opportunities for International Cooperation in Materials Research, International Materials Institutes (IMI), Partnerships for Research and Education in Materials (PREM), Presidential Early Career Awards for Scientists and Engineers (PECASE), Faculty Early Career Development (CAREER), Research at Undergraduate Institutions (RUI), and Research Opportunity Awards (ROA).

11. National Facilities

Supports the operation of national user facilities—research facilities with specialized instrumentation available to the scientific research community in general and the materials research community in particular. These facilities provide unique research capabilities that can be located at only a few highly specialized laboratories in the Nation. They include facilities and resources for research using high magnetic fields, ultraviolet and x-ray synchrotron radiation, neutron scattering, and nanofabrication. For more information, please contact the facilities directly at the addresses listed below.

Center for High-Resolution Neutron Scattering

National Institute of Standards and Technology
NIST Center for Neutron Research
100 Bureau Drive, MS 8562
Gaithersburg, MD 20899-8562
Telephone: 301-975-6242
Web address: <http://www.ncnr.nist.gov/programs/CHRNS>

ChemMatCARS

Building 434D
Advanced Photon Source
Argonne National Laboratory
9700 South Cass Avenue
Argonne, IL 60439
Telephone: 630-252-0464
Web address: http://www.aps.anl.gov/aps/frame_beamtime.html
(Click “Beamline Directory,” go to 15-ID and click “CARS.”)

Cornell High-Energy Synchrotron Source

200 L. Wilson Laboratory
Cornell University
Ithaca, NY 14853
Telephone: 607-255-7163
Web Address: <http://www.chess.cornell.edu>

National High Magnetic Field Laboratory (operated by Florida State University, the University of Florida, and Los

Alamos National Laboratory)
Florida State University
1800 E. Paul Dirac Drive
Tallahassee, FL 32310-3706
Telephone: 850-644-0311
Web address: <http://www.magnet.fsu.edu>

Synchrotron Radiation Center

University of Wisconsin at Madison
3731 Schneider Drive
Stoughton, WI 53589-3097
Telephone: 608-877-2000
Web address: <http://www.src.wisc.edu>

National Nanofabrication Users Network

Web address: <http://www.nnun.org>
(Participating institutions: Cornell University, Howard University, the Pennsylvania State University, Stanford University, and University of California at Santa Barbara)
The NNUN will be replaced in January 2004 with a broader National Nanotechnology Infrastructure Network with enhanced capabilities.

• Other DMR Activities Of Interest

The Division of Materials Research (DMR) participates in and supports a broad range of crosscutting research and interdisciplinary activities, complementary international activities, and NSF-wide programs that develop human resources and underrepresented minorities. DMR has a significant interest in the NSF-wide priority area of

Nanoscale Science and Engineering. DMR has interest in projects that benefit the materials community and that address the NSF-wide priority area of Information Technology Research, and potential interest in projects that address Biocomplexity in the Environment. DMR participates in NSF-wide programs such as Small Business Innovation Research (SBIR), Small Grants for Exploratory Research (SGER), Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers (ADVANCE), Integrative Graduate Education and Research Traineeship (IGERT), Information Technology Workforce (ITR), and Minority Research Planning Grants and Career Advancement Awards. DMR primarily provides individual and group support; however, faculty may form a small collaborative group to apply for funding as a Focused Research Group (FRG) to address problems having broader scope than traditional individual investigator grants. The international and human resource activities are coordinated primarily through the DMR Office of Special Programs. A few activities are described briefly in this section.

1. [Focused Research Groups \(FRGs\)](#)
2. [Research Experiences for Undergraduates \(REU\) and Research Experiences for Teachers \(RET\)](#)
3. [Materials Research and Education Awards](#)
4. [Opportunities for International Cooperation in Materials Research](#)
5. [International Materials Institutes \(IMI\)](#)
6. [Grant Opportunities for Academic Liaison with Industry \(GOALI\)](#)
7. [Partnerships for Research and Education in Materials \(PREM\)](#)

For More Information

Detailed descriptions of these and other NSF-wide programs are available on the NSF Crosscutting Programs home page, <http://www.nsf.gov/home/crssprgm>; or the DMR home page, <http://www.nsf.gov/mps/divisions/dmr>.

1. Focused Research Groups (FRGs)

These are materials research projects that generally are smaller than centers (e.g., Materials Research Science and Engineering Centers) and address problems that require an interactive approach involving three or more investigators. This is not a new program and there is no specific announcement or call for FRG proposals. FRG proposals are handled by individual investigator program directors in the Division of Materials Research, and are reviewed and co-reviewed by DMR and other NSF program staff as appropriate, recognizing the collaborative interdisciplinary aspects of such proposals. A list of FRGs currently supported by DMR is available on the DMR home page, <http://www.nsf.gov/mps/divisions/dmr/research/start.htm>.

2. Research Experiences for Undergraduates (REU) and Research Experiences for Teachers (RET)

DMR supports more than 70 REU Sites, as well as REU supplements for undergraduate participation in research. REU awards are made in conjunction with the NSF-wide REU Program, and REU Sites are coordinated through the Office of Special Programs. To foster participation by precollege science teachers in materials research, DMR also supports awards for RET in conjunction with the MPS Office of Multidisciplinary Activities. For more information on REU, visit the NSF Crosscutting Programs home page, <http://www.nsf.gov/home/crssprgm>. A list of DMR-supported REU Sites is available on the DMR home page, <http://www.nsf.gov/mps/divisions/dmr/research/start.htm>.

3. Materials Research and Education Awards

DMR supports innovative approaches to materials education at the undergraduate and graduate levels. Awards are made annually through open competition. For more information on this DMR activity see http://www.nsf.gov/mps/divisions/dmr/research/c_mre.htm; or contact the Office of Special Programs.

4. Opportunities for International Cooperation in Materials Research

DMR supports a growing number of activities that enhance international cooperation in materials research. Examples include supplementary support for existing grants, international workshops, and awards for cooperative research projects and related activities. In many cases, these activities are coordinated and co-funded with the Office of International Science and Engineering and other NSF offices, including the Directorate for Engineering and the MPS Office for Multidisciplinary Activities. Proposals can usually be submitted to the appropriate disciplinary program. In some cases, they are evaluated through a special competition coordinated through the Office of Special Programs. For example, cooperative activities with Europe—in partnership with the European

Community or with funding agencies in European countries—respectively are described in more detail in program announcements [NSF 03-565](#) and [NSF 02-135](#); and cooperative activities with the Americas—in partnership with funding agencies in countries in the Americas—are described in Dear Colleague Letter [NSF 02-141](#). For more information, see <http://www.nsf.gov/mps/divisions/dmr/research/start.htm>.

5. International Materials Institutes (IMI)

DMR aims to establish International Materials Institutes that will enhance international collaboration between U.S. researchers and educators and their counterparts in specific regions of the world such as Africa, the Americas, Asia, Europe, or the Pacific region. These institutes will advance fundamental materials research by coordinating international projects that involve condensed matter and materials physics; solid state and materials chemistry; and the design, synthesis, characterization, and processing of materials to meet global and regional needs. The institutes must be university-based and provide a research environment that will attract leading scientists and engineers. This may be accomplished for example, by supporting research in selected thematic areas by networking with other universities, centers, and national facilities. An important aspect of the IMI's activities will be to integrate materials research with education. For more information, see program solicitation [NSF 03-593](#), or contact the Office of Special Programs. A new competition is expected in fiscal year 2004.

6. Grant Opportunities for Academic Liaison with Industry (GOALI)

DMR supports a wide range of GOALI awards in the area of materials. GOALI aims to catalyze university-industry partnerships by making funds available to support an eclectic mix of industry-university linkages. Special interest is focused on affording the opportunity for (1) faculty, postdoctoral fellows, and students to conduct research and gain experience with production processes in an industrial setting; (2) industrial scientists and engineers to bring industry's perspective and integrative skills to academe; and (3) interdisciplinary university-industry teams to conduct long-term projects. The initiative targets high-risk/high-gain research with a focus on fundamental topics that would not be undertaken by industry, new approaches to solving generic problems, development of innovative collaborative industry-university educational programs, and direct transfer of new knowledge between academe and industry. For more information, visit the GOALI home page, <http://www.nsf.gov/home/crssprgm/goali/start.htm>.

7. Partnerships for Research and Education in Materials (PREM)

Enhances diversity in materials research and education by stimulating the development of formal, long-term, collaborative research and education partnerships between minority-serving institutions and DMR-supported groups, centers, and facilities. For more information on PREM, see program solicitation [NSF 03-564](#) or contact the Office of Special Programs.



Office of Polar Programs (OPP)



The Earth's polar regions offer compelling scientific opportunities, but their isolation and extreme climate challenge the pursuit of these opportunities.

The National Science Foundation (NSF) supports Arctic and Antarctic research and education, both to improve understanding of the regions and their relationship with global processes and to seize opportunities presented by the regions as research platforms. Support is provided for investigations in a range of scientific disciplines in the physical, biological, and social sciences. This range and the unique aspects of

polar regions provide opportunities to advance discovery while promoting teaching, training, and learning.

In addition to providing individual grants to scientists and educators at U.S. institutions, NSF funds contractor-provided operational support to field and laboratory science in Antarctica, the Southern Ocean, and the Arctic.

Most NSF funding for polar research and education comes from these sources:

- Antarctic Sciences (Office of Polar Programs (OPP))
- Arctic Sciences (Office of Polar Programs (OPP))
- Educational Activities* (Education and Human Resources Directorate)
- Crosscutting Programs (Foundation-wide)

**Although these areas of NSF do not generally offer polar-specific programs, they do consider and support polar proposals.*

For More Information

Refer to the appropriate program announcement for definitive information about research areas, field support, and proposal preparation.

- Antarctic Research ([NSF 03-551](#))
- Arctic Research Opportunities ([NSF 03-574](#))

Other information sources are the Office of Polar Programs home page (<http://www.nsf.gov/od/opp/>), which describes research areas and operational support; and the OPP Advisory Committee web page (http://www.nsf.gov/od/opp/opp_advisory/oaccrit2.htm), which discusses the NSF broader impacts merit review criterion.



OFFICE OF POLAR PROGRAMS Antarctic Sciences

United States Antarctic Program

The United States Antarctic Program (USAP) in the Office of Polar Programs (OPP) encompasses U.S. Government-sponsored activities in the region roughly south of 60° south latitude. NSF funds and manages this national program, which centers on scientific research and includes operational support provided by contractors and the military. The program supports the range of U.S. Antarctic interests including adherence to the Antarctic Treaty.

Research supported by the program has two thrusts:

1. to understand the Earth and its systems, with emphasis on Antarctica's (and the Southern Ocean's) influence on and response to these systems; and
2. to utilize Antarctica as a research site by supporting studies made possible by the region's unusual and extreme conditions.

The program supports research that is *best* carried out in the Antarctic or that can be carried out *only* in the Antarctic. Research and education proposals that *will* not require fieldwork, or proposals that *will* require the use of samples already in U.S. depositories, are also welcome.

Non-United States Facilities—International Cooperation

NSF encourages scientists from the United States to participate in cooperative research programs and activities sponsored by or involving other Antarctic Treaty nations. Scientists interested in submitting a proposal for such a program are strongly encouraged to contact an OPP program manager first, to allow NSF time to coordinate the operational support needs with the other participating country or countries.

Eligibility

In addition to the categories stated in the section "Eligibility Requirements," other federal agencies may coordinate their research needs within the framework of NSF-supported Antarctic logistics.

Persons selected to work in the Antarctic must pass physical and dental examinations whose standards are specified by USAP. Prospective winterers must pass a psychological examination as well.

Defining Operational Needs

If a proposed project involves fieldwork, the proposer must also include the "Operational Requirements Worksheets" (<http://polarice.usap.gov/index.htm>) in portable document file (pdf) format in their FastLane proposal. Proposals submitted without a "pdf" file of these worksheets will be considered incomplete. The worksheets must be completed by the first Wednesday in June of the year preceding the fieldwork. For example, a proposal received on 2 June 2004 normally will be considered for projects involving fieldwork that will take place in the Antarctic beginning in the 2005–2006 austral summer.

Instructions on how to submit the worksheets are available in the *Antarctic Research* program announcement (<http://www.nsf.gov/pubsys/ods/getpub.cfm?nsf03551>). Funding programs offered by areas of NSF other than the Office of Polar Programs, may have different deadlines or target dates. However, the Operational Requirements Worksheets must still be completed by the same deadline (first Wednesday in June) as proposals submitted to the Office of Polar Programs. Be sure and include copies of the worksheets in the FastLane proposal to NSF, as instructed in the *Antarctic Research* program announcement.

For multiyear proposals, include the worksheets in the original proposal to NSF, even if fieldwork is proposed for a later year.

Antarctic Sciences

The Office of Polar Programs funds Antarctic research through these programs:

1. Antarctic Aeronomy and Astrophysics

- **Aeronomy and Space Physics**—Supports unique studies of Earth's ionosphere, magnetosphere, and solar-terrestrial relationships. Year-round station-based research is possible in Antarctica because of its physically stable location at high geomagnetic latitudes, which range from 53°S at Palmer Station to 79°S at McMurdo Station. Automatic platforms provide year-round support for low-powered autonomous instruments at sites on the ice sheet. Research objectives include improving understanding of Earth's upper atmosphere and near-space environment; investigating coupling between the magnetosphere and ionosphere, and investigating solar-terrestrial effects on neutral atmosphere.
- **Astronomy and Astrophysics**—Because of its location at the Earth's spin axis on the 2.8-kilometer-thick East Antarctic Ice Sheet, South Pole Station is well situated for long, continuous astronomical and astrophysical observations. The high elevation of the station (2,835 meters), dry atmosphere, extremely low air turbulence and temperature, isolation from radio noise, and long periods of clear weather provide superior observing astronomical conditions. In addition, a crystal-clear (at depths 1.5 - 2.5 km) ice allows almost ideal detection of Cherenkov's emission caused propagating cosmic neutrinos.
- **Long-Duration Ballooning**—In cooperation with the National Aeronautics and Space Administration, NSF has developed the capability to launch balloon science payloads from McMurdo Station. These payloads may weigh more than a ton and can reach altitudes of approximately 40 kilometers. The balloons then circle once or twice over the Antarctic during a 10- to 30-day period. This capability can be used by several disciplines and may serve as a low-cost substitute for space flights.

2. Antarctic Biology and Medicine

- **Marine Biology/Biological Oceanography**—The oceans around Antarctica make up one of the world's more productive marine regions. Research objectives are to understand the structure and function of the Antarctic marine ecosystems; to determine the adaptations of organisms; and to acquire more knowledge of their distribution, abundance, and dynamics. The focus is on ship- and shore-based studies that stress trophodynamics, including detailed investigations at all trophic levels. Topics of interest include interdisciplinary studies of carbon and nutrient cycling, krill, ice-edge ecosystems, and low-temperature adaptations.
- **Medical Research**—Biomedical studies can be directed toward physiological and psychological attributes and adaptations of people in small, isolated groups.
- **Terrestrial and Freshwater Biology**—Biota of terrestrial and freshwater Antarctica, and particularly their adaptation to the extreme environment, are of interest. The simplicity of these ecosystems provides opportunities for analysis that is more difficult and sometimes impossible in the complex systems of the lower latitudes. The primary research objective is to understand the effects of the physical environment on the biota and adaptations of organisms, and to gain further knowledge of their distribution, abundance, and dynamics.

3. Antarctic Geology and Geophysics

- **Marine Geology and Geophysics**—The seafloor around Antarctica is complex and presents fundamental problems in marine geology and geophysics. Its sediments provide detailed records of change over time in the size of the Antarctic ice sheet, as well as clues to other geological and tectonic processes that have affected the continent. Research objectives are to interpret geological and glacial history and to understand geological processes from studies of the continental margins and the adjacent oceanic crust.
- **Terrestrial Geology and Geophysics**—Antarctica represents about 9 percent of the Earth's continental crust and has been in a near-polar position for more than 100 million years. Reconnaissance has increased understanding of the geology of the continent and has provided evidence in support of plate tectonics models and the Gondwana supercontinent. Focused projects now contribute to solving regionally and

globally significant geologic problems such as geophysical investigations of the sub-ice bedrock. Objectives are to explain the geology and the geological evolution of Antarctica; to understand the relationship of Antarctica to global geodynamic systems; and to exploit unique aspects of Antarctica to address fundamental problems in geology and geophysics.

4. Antarctic Glaciology

The world's largest ice sheet covers 98 percent of the Antarctic continent and is up to 4.8 kilometers thick, comprising 90 percent of the world's ice and storing information about climate and atmospheric constituents and their variation over time. Objectives of this program are 1) to determine the dynamics of the ice sheet; 2) to understand the climatic record stored in the layers of firn and ice; 3) to determine the history of glacial advance and retreat through the study of glacial/geologic deposits; and 4) to determine the present dynamic status of the ice sheet and its relationship to glacial and climatic history.

5. Antarctic Ocean and Climate Systems

- **Atmospheric Sciences**—Antarctica interacts strongly with regional and global weather and climate. Far removed from pollution sources, it is an important monitoring and research area for world background levels of natural and anthropogenic atmospheric constituents. Conditions in Antarctica reflect global atmospheric changes on many scales. Research objectives are to improve understanding of the physical processes of the atmosphere; determine the relationship between events and conditions in the Antarctic atmosphere and global events; and assess the region's role in past and present global climate.
- **Physical and Chemical Oceanography**—The Southern Ocean has a central role in world ocean circulation. Large-scale heat exchange and ice formation at the ocean surface overturn the water column and mix trace constituents, making the Southern Ocean the site of global-scale deep-ocean ventilation and one of two primary sources (the other being the Arctic) of the world's intermediate and deep-water masses. Huge annual changes in the extent of sea ice—between 4 and 20 million square kilometers—also influence energy transfer. The Antarctic Circumpolar Current—the world's largest ocean current—has a primary role in ocean circulation. Research objectives are to determine the dynamics of formation and distribution of water masses, currents, and sea ice; investigate the relationships among oceanic and atmospheric circulation systems and the physical bases for biotic productivity; and investigate interactions between the Southern Ocean and climate processes.

6. Antarctic Operational Support

The U.S. Antarctic Program provides operational and laboratory support in Antarctica. Operational support includes the following: a year-round inland research station at the South Pole (90°S.); two year-round coastal research stations with extensive laboratory and computing capabilities—one at McMurdo Station (78°S.) on Ross Island and one at Palmer Station (64°S.) on Anvers Island in the Antarctic Peninsula region; summer field camps for research, as required; the ice-capable research ship *Laurence M. Gould*, 70.1 meters in length; the icebreaking research ship *Nathaniel B. Palmer*, 94 meters in length; ski-equipped LC-130 airplanes (for heavy-lift transport); other airplanes; helicopters; a Coast Guard icebreaker for channel breaking at McMurdo as well as research support; over-snow vehicles; and automated, unmanned weather and geophysical observatories. Occasionally, vessels from the U.S. academic fleet and from the Ocean Drilling Program support Antarctic research. NSF-supported research by U.S. scientists also can be carried out as an international collaboration with other national antarctic programs and aboard non-U.S. research ships.

For instructions on how to request Antarctic operational support in a proposal, see the *Antarctic Research* program announcement ([NSF 03-551](#)).



OFFICE OF POLAR PROGRAMS Arctic Sciences

Arctic Research Program

NSF's Arctic Research Program seeks to gain a better understanding of the Arctic's biological, geological, chemical, and sociocultural processes, and the interactions of ocean, land, atmosphere, life, and human systems in the Arctic and with global systems. Arctic research is supported by the Office of Polar Programs (OPP) and by other NSF disciplinary programs. The program is structured to allow coordination across NSF disciplines when appropriate, enable joint review and funding of Arctic proposals, and provide mutual support of projects with high logistics costs.

NSF is one of 12 Federal agencies that sponsor or conduct Arctic science, engineering, and related activities. As mandated by the Arctic Research and Policy Act of 1984, planning for Federal interagency research is coordinated through the Interagency Arctic Research Policy Committee, chaired by NSF.

Further information on other agency programs is presented in the U.S. Arctic Research Plan and its biennial revisions.

The Arctic is the homeland of native peoples and attention must be given to all aspects of research and education that may affect their lives. For further information in this regard, see the interagency statement "Principles for the Conduct of Research in the Arctic" (<http://www.nsf.gov/od/opp/arctic/conduct.htm>). All Arctic research grantees are expected to abide by these guidelines. Additional information can also be found in the *Arctic Research Opportunities* program announcement (NSF 03-574).

Submission of Proposals

Submit proposals for field projects (including projects requiring an oceanic research vessel) by 15 February of the year preceding fieldwork.

A minimum of 9 months advance notice is required for research vessels needing clearance for Russian waters.

For fieldwork in Greenland, fill out the Danish Polar Center application form (<http://www.dpc.dk/Guide>) and include it in "Supplementary Docs" in your FastLane proposal.

Arctic Sciences

The Office of Polar Programs funds arctic research through these programs:

1. Arctic Natural Sciences Program

Provides core support for disciplinary research in the following areas:

- **Atmospheric Sciences**—Research focuses on stratospheric and tropospheric processes, climate, and meteorology. Research on past climates and atmospheric gases preserved in snow and ice is encouraged. The program also supports research on atmosphere-sea and atmosphere-ice interactions. In upper atmosphere and space physics, research interests include auroral studies, atmospheric dynamics and chemistry, and magnetosphere-ionosphere coupling.
- **Biological Sciences**—Research emphasis is on understanding the adaptation of organisms; freshwater, marine, and terrestrial biology; organismal biology; ecology; microbiology; ecosystem structure and

processes; and the consequences of ultraviolet radiation.

- **Earth Sciences**—Research includes all subdisciplines of terrestrial and marine geology and geophysics. Of greatest interest is a better understanding of Arctic geological processes that are important for improving our ability to interpret the geologic record of environmental change in the polar regions. Also of interest is better understanding and reconstruction of the plate tectonic history of the Arctic Ocean.
- **Glaciology**—Research can focus on the history and dynamics of all naturally occurring forms of snow and ice including seasonal snow, glaciers, and the Greenland ice sheet. The program also supports mass balance modeling, glacial geology, and remote sensing studies of ice sheets.
- **Ocean Sciences**—Research to expand the knowledge about the structure of the Arctic Ocean and adjacent seas; their physical and biological interactions with the global hydrosphere; and the formation and persistence of sea-ice cover.

2. Arctic System Science (ARCSS)

The Arctic comprises a tightly coupled system of air, ice, ocean, land, and people. The Arctic System Science (ARCSS) program supports interdisciplinary research on arctic physical, geological, chemical, biological, and socio-cultural processes that relate to global change. The purpose is to advance the scientific basis for predicting change on a time scale from seasons to centuries. Research is thematic rather than disciplinary in nature and is organized around the following broad questions.

- How do human activities interact with changes in the Arctic to affect the sustainability of ecosystems and societies?
- What are the limits of arctic system predictability?
- How will changes in arctic cycles and feedbacks affect arctic and global systems?

These questions emphasize concepts fundamental to research on arctic change, including predictability, sustainability, and feedbacks. Global change proposals that focus on the arctic system are also welcome from individual investigators or small groups of investigators.

ARCSS supports studies that predict and analyze the consequences of environmental variability and global change. To achieve this, ARCSS supports a Synthesis, Integration and Modeling Studies (SIMS) effort. A successful ARCSS proposal normally will connect directly to some suite of existing ARCSS-funded projects; fill a gap in understanding of the arctic system; connect parts of the arctic system; help explain the range of states for the arctic system; and focus on explaining cause and effect.

3. Arctic Social Sciences

Encompasses all areas of social science supported by NSF, including anthropology, archaeology, economics, geography, linguistics, political science, psychology, sociology, and related subjects. The following are areas of particular interest: rapid social change including the processes and consequences of social, economic, and cultural change; community viability including issues relating to community and cultural vitality and survival; and human/environmental interactions including issues related to subsistence and sustainable development.

The program encourages projects that: include indigenous peoples; are circumpolar or comparative; integrate social and natural sciences; involve collaborations between researchers and those living in the Arctic; include traditional knowledge; and form connections among disciplines, regions, researchers, communities, and students, including those at grades K–12 level and undergraduate and graduate programs.

Projects Involving Research with Human Subjects -- must ensure that the subjects are protected from research risks in conformance with the Common Rule (*Federal Policy for the Protection of Human Subjects*, 45 CFR §690). All projects involving human subjects must either (1) have approval from the organization's Institutional Review Board (IRB) before issuance of an NSF award or (2) identify the applicable subsection exempting the proposal from IRB review, as established in section 101(b) of the Common Rule. The box for "Human Subjects" should be checked on the proposal Cover Sheet with the IRB approval date (if available) or exemption subsection from the Common Rule identified in the space provided.

4. Arctic Research and Education

The integration of research with outreach and education is important to OPP. Investigators are encouraged to

include these activities in their research proposals in accordance with the broader impacts review criterion.

Some education and outreach activities may develop during the course of a research grant that's already been implemented. They may even warrant a separate proposal. The Arctic Research and Education program supports these activities in concert with funded research grants and agreements through supplemental requests and as separate proposal requests to support new ventures in arctic research and education. Proposals submitted to this program may include formal or informal education or outreach for students K-12 or higher, or to the broader public. Most commonly, these awards are made as supplements to research grants or small grants. The Arctic Research and Education program seeks to collaborate with other Directorates at NSF to promote the integration of research and education.

5. Arctic Research and Policy

OPP supports the management of Arctic data and information. The objective is to make data and information resources more readily available to researchers. Proposals to integrate data and information management are encouraged. Further information is available at the National Information Services Corporation home page, <http://www.nisc.com/request/bibltrial.asp>.

6. Arctic Research Support and Logistics

Supports the logistics components of field research projects and a variety of activities considered to be research support—most notably, long-term observations. The program was created to improve access and safety in the Arctic for scientists. It supports field components of research funded by the Arctic Sciences Section, other Directorates at NSF, and occasionally other Federal agencies. Support includes but is not limited to, providing transportation, food, and shelter while conducting field work; user and day-rate fees at field camps; salaries of staff hired specifically for field work; and activities such as travel to coordinate projects with permitting agencies and Native peoples. For more information, visit the "Arctic Research Support and Logistics" web page, <http://www.nsf.gov/od/opp/arctic/suplog.htm>. Access to logistics from this program is through the regular proposal process.

The program supports collection, management, and dissemination of data in the service of the broad arctic research community. Examples include the establishment or maintenance of long-term observations; the support of aspects of collecting underway data from ships; the acquisition of satellite and airborne imaging and mapping data; and the production and dissemination of user-friendly data products. The program works with several organizations to meet the needs of arctic field research as described in the Arctic Research Opportunities program announcement, [NSF 03-574](#).



OFFICE OF POLAR PROGRAMS Crosscutting Programs

Because the Office of Polar Programs supports research in several disciplines, a number of NSF-supported programs that cross traditional disciplinary boundaries will be of interest to investigators planning polar research and education projects. These crosscutting programs offer significant additional opportunities for support. OPP strongly urges investigators considering polar research to examine the programs before submitting proposals.

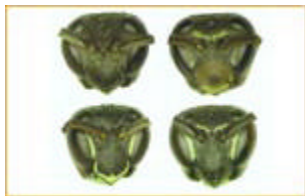
For More Information

Visit the NSF Crosscutting Programs home page,
<http://www.nsf.gov/home/crssprgm/>.

The National Science Foundation
4201 Wilson Boulevard, Arlington, Virginia 22230, USA
Tel: 703-292-5111, FIRS: 800-877-8339 | TDD: 703-292-5090



Directorate for Social, Behavioral, and Economic Sciences (SBE)



The goals of the Directorate for Social, Behavioral, and Economic Sciences (SBE) are (1) to support the development of basic scientific knowledge of human behavior, social interaction, and decision-making and about social and economic systems, organizations, and institutions; (2) to collect, analyze, and publish data on the status of the Nation's science and engineering, human, institutional, and financial resources; and (3) to advance the U.S. science and engineering enterprise by promoting international partnerships and by enhancing the work of U.S. researchers through cooperative activities with foreign scientists and engineers and their facilities and institutions.

The Directorate for Social, Behavioral, and Economic Sciences supports programs and activities through the following:

- [Crosscutting Programs and Activities](#)
- [Division of Behavioral and Cognitive Sciences \(BCS\)](#)
- [Division of Social and Economic Sciences \(SES\)](#)
- [Division of Science Resources Statistics \(SRS\)](#)
- [Office of International Science and Engineering \(INT\)](#)

For More Information

Visit the SBE Directorate home page, <http://www.nsf.gov/sbe>.



DIRECTORATE FOR SOCIAL, BEHAVIORAL, AND ECONOMIC SCIENCES Crosscutting Programs and Activities

In addition to supporting the programs and activities within the Directorate for Social, Behavioral, and Economic Sciences (SBE), SBE also takes an active role in the following crosscutting programs and activities:

Priority Areas

- Biocomplexity in the Environment
- Nanoscale Science and Engineering
- Mathematical Sciences
- Human and Social Dynamics

National Science and Technology Council Crosscuts

- Networking and Information Technology Research and Development (NITRD)
- U.S. Global Change Research
- Climate Change Research Initiative

For More Information

Visit the NSF Crosscutting Programs home page,
<http://www.nsf.gov/home/crssprgm/>.



DIRECTORATE FOR SOCIAL, BEHAVIORAL, AND ECONOMIC SCIENCES

Division of Behavioral and Cognitive Sciences

Research support is available in the Division of Behavioral and Cognitive Sciences (BCS) through the following clusters of programs:

- [Anthropological and Geographic Sciences Cluster](#)
- [Cognitive, Psychological, and Language Sciences Cluster](#)

Submission of Proposals to the BCS Division

All programs in the BCS Division consider proposals for research projects, conferences, and workshops. Some programs also consider proposals for doctoral dissertation improvement, the acquisition of specialized research and computing equipment, and large-scale data collection.

BCS conducts special initiatives and competitions on a number of topics, such as cognitive neuroscience, children's research, human origins, and environmental, social, and behavioral sciences. In addition, BCS participates in a number of Foundation-wide crosscutting activities, such as Integrative Graduate Education and Research Traineeship (IGERT) and Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers (ADVANCE).

For More Information

Write to the responsible program director, Division of Behavioral and Cognitive Sciences, National Science Foundation, 4201 Wilson Boulevard, Room 995, Arlington, VA 22230; or contact by telephone, 703-292-8740; or visit the BCS home page, <http://www.nsf.gov/sbe/bcs/start.htm>.

• Anthropological And Geographic Sciences Cluster

This cluster of programs is within the Division of Behavioral and Cognitive Sciences (BCS) and is composed of the following:

1. [Archaeology and Archaeometry](#)
2. [Cultural Anthropology](#)
3. [Geography and Regional Science](#)
4. [Physical Anthropology](#)

For More Information

Visit the BCS Division home page, <http://www.nsf.gov/sbe/bcs/start.htm>.

1. Archaeology and Archaeometry

Supports archaeological research that contributes to an anthropological understanding of the past. Both fieldwork and non-fieldwork are eligible for support. Through a special archaeometry competition, the program offers support for laboratories that provide data of anthropological significance and also for the development of new techniques.

2. Cultural Anthropology

Supports basic research on the causes and consequences of crosscultural and intracultural variation as such research broadens or refines anthropological theory. In an effort to enhance the quality of students' field research in graduate programs, the program offers various awards for the support of field training and collaborative research of students and faculty. Scholars' Awards in Methodological Training for Cultural Anthropologists are offered for senior

researchers who wish to upgrade their research skills by learning a particular analytical technique.

3. Geography and Regional Science

Supports basic research on the causes and consequences of geographical differences in economic, social, cultural, and physical phenomena, including interactions among places and regions and interrelations between human activities and the natural environment. Projects on a variety of domestic and overseas topics that will enhance geographical theory, geographical methods, and their applications qualify for support.

4. Physical Anthropology

Supports basic research in areas that relate to human evolution and contemporary human variation. Research areas supported by the program include human genetic variation, human adaptation, human osteology, human origins, human paleontology, primate functional anatomy, and primate behavior.

• Cognitive, Psychological, and Language Sciences Cluster

This cluster of programs is within the Division of Behavioral and Cognitive Sciences (BCS) and is composed of the following:

1. Developmental and Learning Sciences
2. Perception, Action, and Cognition
3. Linguistics
4. Social Psychology
5. Cognitive Neuroscience

For More Information

Visit the BCS Division home page, <http://www.nsf.gov/sbe/bcs/start.htm>.

1. Developmental and Learning Sciences

Supports research on cognitive, social, and biological processes related to child and adolescent learning in formal and informal settings. Priorities are to support research on learning and development that incorporates multidisciplinary, multimethod, microgenetic, and longitudinal approaches; develops new methods and theories; examines transfer of knowledge from one domain to another; assesses peer relations, family interactions, social identities, and motivation; examines the impact of family, school, and community resources; assesses adolescents' preparation for entry into the workforce; and investigates the role of culture in children's learning and development.

2. Perception, Action, and Cognition

Supports research on cognition, perception, and action, including the development of these capacities. Emphasis is on research strongly grounded in theory. Research topics include vision, audition, haptics, attention, memory, reasoning, written and spoken discourse, motor control, and developmental issues in all topic areas. The program encompasses a wide range of theoretical perspectives, such as symbolic computation, connectionism, ecological, nonlinear dynamics, and complex systems, and a variety of methodologies including both experimental studies and modeling. Research involving acquired or developmental deficits is appropriate if the results speak to basic issues of cognition, perception, or action.

3. Linguistics

Supports theoretically informed research on human language. The program encompasses a wide range of theoretical perspectives and a variety of methods, including experimental studies and computational modeling. Research topics include the properties of individual languages and of language in general; language acquisition; the cognitive processes involved in the use of language; social and cultural factors in language use; language variation and change; acoustic, articulatory, and perceptual study of speech; and the neurological bases of language. Program awards have also supported the development of lexicons, corpora, databases, and other

resources for the language sciences. In addition to regular research proposals, the program accepts proposals for doctoral dissertation research; conferences, workshops, and symposia; group travel to international conferences; and Small Grants for Exploratory Research.

4. Social Psychology

Supports research on human social behavior, including cultural influences and lifespan social development. Research topics include aggression; altruism; attitude formation and change; attitudes and behavior; attributional processes; emotion; environmental psychology; group decision-making, performance, and process; intergroup relations; interpersonal attraction and relations; nonverbal communication; person perception; personality processes; prejudice; the self; social comparison; social cognition; social influence; and stereotyping.

5. Cognitive Neuroscience

Supports neuroscientific research on cognitive, perceptual, linguistic, developmental, affective, and social processes, including developmental and computational modeling approaches. Priorities of the program are to support collaborative research and to enhance training at all levels of professional development.



DIRECTORATE FOR SOCIAL, BEHAVIORAL, AND ECONOMIC SCIENCES

Division of Social and Economic Sciences

Research support is available in the Division of Social and Economic Sciences (SES) through the following clusters of programs:

- [Economic, Decision, and Management Sciences Cluster](#)
- [Methods, Cross-Directorate, and Science and Society Cluster](#)
- [Social and Political Sciences Cluster](#)

Submission of Proposals to the SES Division

All programs in the SES Division consider proposals for research projects, conferences, and workshops. Some programs also consider proposals for doctoral dissertation improvement, the acquisition of specialized research and computing equipment, and large-scale data collection. Some programs participate in jointly sponsored competitions with programs in other directorates.

For More Information

Write to the responsible program director, Division of Social and Economic Sciences, National Science Foundation, 4201 Wilson Boulevard, Room 995, Arlington, VA 22230; or contact by telephone, 703-292-8760; or visit the SES home page, <http://www.nsf.gov/sbe/ses/start.htm>.

• Economic, Decision, and Management Sciences Cluster

This cluster of programs is within the Division of Social and Economic Sciences (SES) and consists of the following:

1. [Decision, Risk, and Management Science](#)
2. [Economics](#)
3. [Innovation and Organizational Change \(IOC\)](#)

For More Information

Visit the SES Division home page, <http://www.nsf.gov/sbe/ses/start.htm>.

1. Decision, Risk, and Management Science

Supports scientific research directed at increasing the understanding and effectiveness of decision-making by individuals, groups, organizations, and society. Disciplinary and interdisciplinary research, doctoral dissertation research, and workshops are funded in the areas of judgment and decision-making; decision analysis and decision aids; risk analysis, perception, and communication; societal and public policy decision-making; and management science and organizational design. The program also supports small grants for exploratory research that are time-critical, such as decision-making in response to extreme events. Funded research must have implications in an operational or applied context, be grounded in theory, be based on empirical observation or subject to empirical validation, and be generalizable.

2. Economics

Supports basic scientific research designed to improve understanding of the processes and institutions of the U.S. economy and of the world system of which it is a part. The program supports empirical and theoretical research as well as conferences in almost every subfield of economics, including econometrics, mathematical economics, labor economics, macroeconomics, industrial organization, international economics, public finance, and economic history. The program also supports interdisciplinary research and conferences that strengthen the connection

between economics and other disciplines, including the other social sciences, statistics, mathematics, the behavioral sciences, and engineering.

3. Innovation and Organizational Change (IOC)

Seeks to create and apply fundamental new knowledge with the aim of improving the effectiveness of the design, administration, and management of organizations, including industrial, educational, service, government, and nonprofit organizations. The IOC Program places a priority on investigator-initiated research that develops and tests theories and methodologies related to organizational learning and redesign, quality and process improvement, the management of innovation, and the organizational development and integration of new technologies. Projects that develop or build upon cross-disciplinary research perspectives are another priority. Perspective IOC research draws on but is not limited to, organizational behavior and theory, industrial engineering, organizational sociology, public administration, and management science.

IOC is jointly sponsored by the Directorates for Engineering, Social, Behavioral, and Economic Sciences, and Education and Human Resources.

• Methods, Cross-Directorate, And Science And Society Cluster

This cluster of programs is within the Division of Social and Economic Sciences (SES) and is composed of the following:

1. Cross-Directorate Activities
2. Methodology, Measurement, and Statistics
3. Science and Technology Studies
4. Societal Dimensions of Engineering, Science, and Technology (SDEST): Ethics and Values Studies, Research on Science and Technology

For More Information

Visit the SES Division home page, <http://www.nsf.gov/sbe/ses/start.htm>.

1. Cross-Directorate Activities

Administers and provides information about various cross-directorate programs in which the Social, Behavioral, and Economic Sciences Directorate participates. The program administers the Research Experiences for Undergraduates (REU) Sites, Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers (ADVANCE) Fellows, and Minority Postdoctoral Research Fellowships for the social and behavioral sciences. In addition, the program coordinates the Faculty Early Career Development (CAREER), Presidential Early Career Awards for Scientists and Engineers (PECASE), Research in Undergraduate Institutions (RUI), Integrative Graduate Education and Research Traineeships (IGERT), and GK-12 NSF Graduate Teaching Fellows in K-12 Education Programs for the social and behavioral sciences. The program also supports special studies, analyses, and workshops on issues affecting social and behavioral science disciplines—including issues that span organizational boundaries and division priorities—and activities that address needs in education and human resources, as well as the creation of a diverse social and behavioral science personnel pool. In addition, for the social and behavioral sciences, the program officers for Cross-Directorate Activities can provide information about special opportunities NSF offers for educational initiatives.

For More Information

For a complete description of these programs, see Chapter 1, Crosscutting Investment Strategies, in this Guide; or see the NSF Crosscutting Programs home page, <http://www.nsf.gov/home/crssprgm/start.htm>; or the SES Division home page, <http://www.nsf.gov/sbe/ses/cda>.

2. Methodology, Measurement, and Statistics

Supports fundamental research on the development, application, and extension of formal models and methodologies for social and behavioral research, including methods for improving measurement, and research on

statistical methodology or statistical modeling that has direct implications for one or more of the social and behavioral sciences. Also supported are research on methodological aspects of new or existing procedures for data collection; research to evaluate or compare existing databases and data collection procedures; the collection of unique databases with cross-disciplinary implications, especially when paired with developments in measurement or methodology; and the methodological infrastructure of social and behavioral research.

3. Science and Technology Studies

Supports historical, philosophical, cognitive, and social research regarding the character and development of science and technology; the nature of theory and evidence in different fields; and the social and intellectual construction of science and technology. Support is also given to research that examines the relationship among science, government, and other social institutions and groups, and processes of scientific innovation and change.

4. Societal Dimensions of Engineering, Science, and Technology (SDEST): Ethics and Values Studies, Research on Science and Technology

Includes the components Ethics and Values Studies (EVS) and Research on Science and Technology (RST). SDEST considers proposals that examine questions that arise in the interactions of engineering, science, technology, and society. The EVS component supports examinations of the ethical and value dimensions in those interactions. The RST component supports research on social and strategic choices that influence knowledge production and innovation and their effects.

• Social And Political Sciences Cluster

This cluster of programs is within the Division of Social and Economic Sciences (SES) and consists of the following:

1. [Law and Social Science](#)
2. [Political Science](#)
3. [Sociology](#)

For More Information

Visit the SES Division home page, <http://www.nsf.gov/sbe/ses/start.htm>.

1. Law and Social Science

Supports social science studies of law and lawlike systems of rule, institutions, processes, and behavior. These studies may include research designed to enhance the scientific understanding of the impact of law; human behavior and interaction as they relate to law; the dynamics of legal decision-making; and the nature, source, and consequence of variation and change in legal institutions. The primary consideration is that the research show promise of advancing the scientific understanding of law and legal process. Within this framework, the program has an “open window” for diverse theoretical perspectives, methods, and contexts for study.

2. Political Science

Supports scientific research that advances knowledge and understanding of citizenship, government, and politics. Research proposals are expected to be theoretically motivated, conceptually clear, methodologically rigorous, and empirically oriented. Substantive areas for research proposals include American government and politics, comparative government and politics, international relations, political behavior, political economy, and political institutions. In recent years, program awards have supported research projects on bargaining processes; campaigns and elections, electoral choice, and electoral systems; citizen support in emerging and established democracies; democratization, political change, and regime transitions; domestic and international conflict; international political economy; party activism; political psychology and political tolerance. On occasion, program awards also have supported research experiences for undergraduate students, methodological advances in political science, and infrastructural improvements through conference activities.

3. Sociology

Supports scientific research on all forms of human social organization—societies, institutions, groups, and demography. The program encourages theoretically focused empirical investigations of social processes and social structures. It welcomes research that will build connections with other disciplines. Recent awards supported by the program include research on assimilation, crime and delinquency, democratization, education, family, gender, group processes, migration and immigration, organizations and organizational behavior, race and ethnic relations, religion, science and technology, social networks, social movements, stratification and mobility, voluntary organizations, and work and labor markets. The program also promotes doctoral research through dissertation improvement.



DIRECTORATE FOR SOCIAL, BEHAVIORAL, AND ECONOMIC SCIENCES

Division of Science Resources Statistics

The Division of Science Resources Statistics (SRS) provides statistical data, quantitative analysis, and indicators on the science and engineering enterprise: education, workforce, research and development funding, and research facilities. This information enables policymakers, researchers, and the public to better understand our Nation's science, engineering, and technology enterprise. SRS contracts for most of the data collection activities and some of the analyses it supports. It also purchases or obtains data from other government agencies and private sources.

The SRS Division encourages proposals for research, workshops, and methodological studies that will lead to the development of new or improved science and technology (S&T) indicators; to strengthening methodologies to improve surveys of S&T data; and to an improved understanding of the S&T enterprise in the United States and globally. SRS also invites new approaches to the presentation of indicators that will increase the understanding of S&T issues and permit more sophisticated techniques of statistical analysis and electronic display. SRS encourages proposals that will analyze SRS data separately or in conjunction with those from other sources, but does not limit the work to only analysis of the data it collects. A new area of interest is the improvement of methodologies used in collecting, analyzing, and disseminating statistical data through surveys, censuses, and administrative records.

Proposal Submission

The SRS Division welcomes the submission of proposals to its programs in the topic areas mentioned in this Guide. For specific information and instructions on proposal submission, see the program announcement *Grants for the Analysis of Science and Technology Resources (NSF 02-165)*. Proposals are due in mid-September. Awards are made in March of the following year.

SRS Documents

Using data from its surveys, the SRS Division produces numerous reports on important topics in science, engineering, and technology. The following are examples of widely referenced SRS publication series:

- *Science and Engineering Indicators*
- *Women, Minorities, and Persons with Disabilities in Science and Engineering*
- *National Patterns of R&D Resources*
- *Science and Engineering Research Facilities*
- *Science and Engineering Doctorate Awards*

Also available are Special Reports, InfoBriefs, and Working Papers on topics related to the science, engineering, and technology enterprise. Data products such as microdata files may be made available to the research community under license. To help acquaint customers with SRS products and databases, the division has an extensive Web site presenting its full collection of reports, public-use microfiles, and online data systems.

For More Information

Visit the SRS home page, <http://www.nsf.gov/sbe/srs>; or contact the division by telephone, 703-292-8774.



DIRECTORATE FOR SOCIAL, BEHAVIORAL, AND ECONOMIC SCIENCES

Office of International Science and Engineering

Science and engineering are, and always will be, international enterprises critical to U.S. competitiveness and security. The National Science Foundation (NSF) plays a unique role in leading the worldwide efforts of the American science, engineering, and education communities. The Office of International Science and Engineering (INT) serves as the focal point for the agency's international science and engineering activities. The office works in close partnership with NSF Directorates on international research collaborations and training opportunities. It also manages its own programs that include support for U.S. scientists, engineers, and students (undergraduates, graduate students, and postdoctoral researchers) involved in international projects.

Submission of Proposals to the Office of International Science and Engineering (INT)

Depending on the nature of a proposed project, a grant proposal may be submitted to INT directly or to the appropriate disciplinary division. International supplements to existing grants from the Foundation's research and education directorates also may be requested. Principal investigators who are considering applying for an INT supplement should discuss the scope and timeframe of their proposed activity with both the cognizant program manager in the disciplinary research division and the appropriate (normally, geographically based) program manager in INT.

INT typically supports the international costs of the U.S. participants in an activity. Further detailed information such as special considerations and funding provisions for certain geographical regions or countries can be found on the INT home page, <http://www.nsf.gov/sbe/int/start.htm>, where instructions and guidelines for each program initiative are provided.

Information is also available in the following program announcements: *International Opportunities for Scientists and Engineers* (NSF 03-559), *International Research Fellowship Program* (NSF 02-149), *East Asia Summer Institutes for U.S. Graduate Students* (NSF 02-174), and *Pan-American Advanced Studies Institutes Program* (NSF 03-506).

INT participates in a number of NSF crosscutting programs, encouraging international cooperative activities, especially in the Program for Integrative Graduate Education and Research Traineeship (IGERT) and the Program for Research Experiences for Undergraduates (REU). Further information about these programs can be found on the NSF Crosscutting Programs Web site, <http://www.nsf.gov/home/crssprgm/>.

Eligibility Requirements for the Office of International Science and Engineering

Eligible for consideration are proposals submitted by U.S. scientists and engineers for international activities in all fields of science and engineering normally supported by NSF. A U.S. institution should submit the proposal. Two exceptions to this procedure are the International Research Fellow Awards and the East Asia Summer Institutes for U.S. Graduate Students Program, which accept applications directly from individuals who are U.S. citizens or permanent residents. Proposals submitted to INT normally compete in one of five regional groupings. Proposals for International Research Fellow Awards are in a separate competition.

 **For More Information**

For information about the agency's international programs, write to the Office of International Science and Engineering, National Science Foundation, 4201 Wilson Boulevard, Suite 935, Arlington, VA 22230; or contact the INT office by telephone, 703-292-8710; or e-mail, intpubs@nsf.gov. Information, including a current staff directory, is also available on the INT home page, <http://www.nsf.gov/sbe/int/start.htm>.

Specific geographic or transregional affairs phone and e-mail contacts are:

Africa, Near East, and South Asia (ANESA)

703-292-8707; anesainfo@nsf.gov

Americas

703-292-8706; amerinfo@nsf.gov

Central and Eastern Europe (CEE)

703-292-8703; ceeinfo@nsf.gov

East Asia and Pacific Region (EAP)

703-292-8704; eapinfo@nsf.gov

Western Europe (WE)

703-292-8702; weinfo@nsf.gov

Trans-regional Affairs

703-292-8711

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