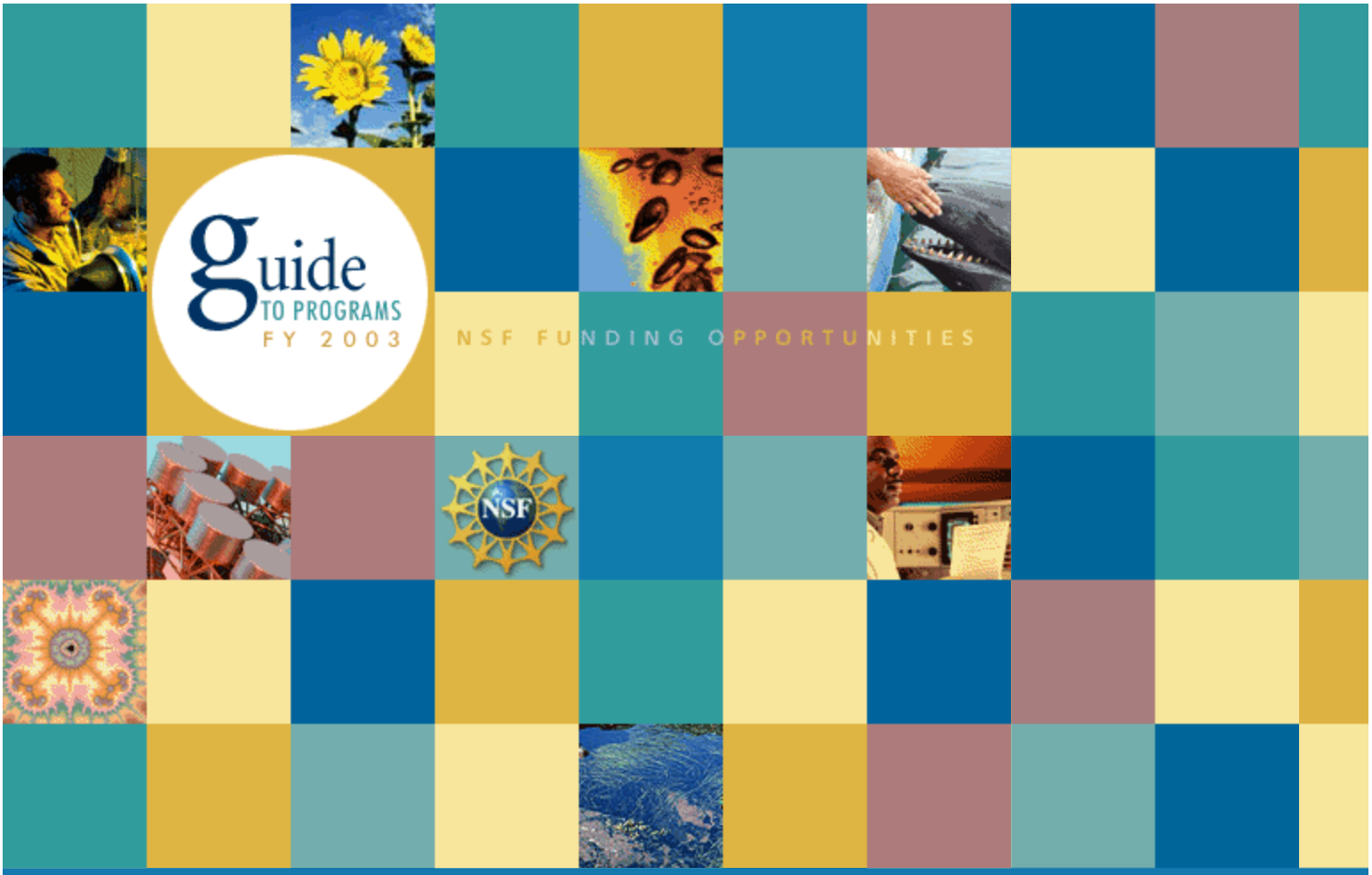

guide TO PROGRAMS FY 2003

NSF FUNDING OPPORTUNITIES

TABLE OF CONTENTS

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 03-009 (Replaces NSF 02-03)

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

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*, 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 this *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

Funding decisions on proposals are made largely through the process of merit review, in which expert evaluation by external peer reviewers contributes to recommendations by NSF program managers. NSF receives more than 170,000 external reviews each year from approximately 50,000 scientists and engineers.

The NSB approved revised criteria for evaluating proposals at its meeting on March 28, 1997 (NSB 97-72)-reducing the criteria from four to two. The criteria are designed to be useful and relevant across NSF's many different programs, but NSF will employ special criteria as required to highlight the specific objectives of certain programs and activities. In evaluating a proposal, reviewers are requested to provide

detailed, substantive comments for *each* criterion, addressing the proposal's strengths and weaknesses with respect to relevant questions on which the reviewer feels competent to pass judgment. Suggested questions are listed under each criterion, all of which may not be appropriate for a given proposal. The reviewer also can identify and comment on additional relevant questions. A summary statement accompanying the proposal should be prepared by the reviewer to explain the relative importance of each of the criteria in the summary rating and the extent to which the proposal actually meets both merit review criteria.

On July 8, 2002, the NSF Director issued Important Notice 127, Implementation of new *Grant Proposal Guide (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.

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's proposal preparation and processing guidelines, will more clearly articulate the importance of broader impacts to NSF-funded projects.

The two merit review criteria are as follows:

> **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 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)? 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? Examples illustrating activities likely to demonstrate broader impacts are available electronically at http://www.nsf.gov/pubs/2002/nsf022/bicexamples.pdf. Principal investigators should pay special attention to the following elements in their proposal, as well as to other questions relevant to broader impacts of the proposed activity, to provide reviewers with the information necessary to respond fully to both of the NSF merit review criteria. NSF staff will give these elements careful consideration 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 in which 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 learner 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. Contact with NSF program personnel before a proposal is prepared is encouraged.

Effective October 1, 2000, all proposals to NSF must be submitted electronically via the NSF FastLane system (http://www.fastlane.nsf.gov/). 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.

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

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/.

- **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/, or call the NSF Information Center at 703-292-5111 (TDD: 703-292-5090; e-mail: info@nsf.gov).

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

NSF 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. Workforce for the 21st Century
4. Nanoscale Science and Engineering
5. Mathematical Sciences
6. 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 this area include enhancement of fundamental environmental 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 will be emphasized again in FY 2003:

- **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
The current program solicitation is NSF 02-167. Information is also available at the NSF Environmental Research and Education web site, http://www.nsf.gov/ere/. Additional information on anticipated multidisciplinary BE-related activities in microbial genome sequencing, carbon and water cycling, social adaptation to hazards, and geomicrobiology will be posted on the web site.

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 at http://www.itr.nsf.gov/ .

3. Workforce for the 21st Century

Continued U.S. leadership in the global economy is dependent on the availability of a diverse science, technology, engineering, and mathematics (STEM) workforce. As technological advances radically change workplace environments, the workforce at large will require new skills, including higher education degrees of problem solving ability, quantitative computer and communications literacy, and increased competencies in STEM. This priority area focuses on generating the base of knowledge that will support effective research-based pedagogies that will address these higher order skills, advancing curriculum and faculty development, integrating research and education programs, and embedding diversity throughout.

Fiscal year 2003 areas of emphasis include:

- **Workforce Research**—Investments in determining the experiences and strategies that are most effective in attracting and retaining students in careers that require competence in STEM.
- **Learning Tools**—Research, development, and testing of information technology-based tools that facilitate learning across many levels of formal and informal education for both individuals and groups. New communication and information technologies show promise to enhance the delivery of education and offer the possibility of providing truly learner-centered, independent learning environments over an entire lifetime and at any convenient place and time.
- **Creating Connections**—Activities create connections across levels of formal education and workforce development and provide mechanisms to bridge gaps between educational layers.
- **Centers for Learning and Teaching (CLT)**—Activities that link K-12 and higher education to

provide lifelong learning opportunities for the instructional workforce in contexts supported by information technology tools and by research on learning, science, and mathematics. CLTs will address the need to increase the quality of research on learning and teaching, to develop the next generation of science and mathematics education specialists, and to strengthen the competencies of the preK-12 instructional workforce.

4. 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 magical 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 has the largest investment. 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/.

5. 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. NSF has proposed a priority area in the Mathematical Sciences that will begin in fiscal year 2003. The goal of this 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, 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/.

6. 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. This priority area seeks to (1) better understand the causes and ramifications of change; (2) increase our collective ability to anticipate the complex consequences of change; (3) better understand the dynamics of behavior and the human mind; (4) better understand the cognitive and social structures that create and define change; and (5) help people and organizations better manage profound or rapid change.

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. To prepare for the full development of HSD, the Directorate for Social, Behavioral, and Economic Sciences will conduct three special competitions during fiscal year 2003 (FY 03). NSF expects that a broader range of competitions will be conducted in later fiscal years.

Three interdisciplinary areas will be emphasized and supported during the FY 03 competition pending availability of funds. These areas are:

- Climate Change Research Initiative—Decision Making Under Uncertainty (DMUU);
- Enhancing Human Performance (EHP); and
- Empirical Implications of Theoretical Models (EITM).

For More Information
Further information about HSD and the HSD FY 03 special competition is available on the Directorate for Social, Behavioral, and Economic Sciences web site, http://www.nsf.gov/sbe/hsd/.

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 EHR offers focused programs for the education of technologists, primarily through community colleges, and for the education of future teachers. On a broader scale, DUE supports course, curriculum, and laboratory improvement aimed at all undergraduate students, both nonmajors and majors, in science and engineering. In addition, some of NSF's disciplinary directorates offer programs in support of course development. Information on these can be found in the directorate sections of this Guide.

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 undergraduate level, NSF offers the **Louis Stokes Alliances for Minority Participation Program**.

To provide opportunities for participation in research, NSF supports the **Research Experiences for Undergraduates (REU) Program**.

The 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 02-136, 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/.

• 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

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/sbe/ses/cda/ • SBE Minority Research Fellowships Cross-Directorate Activities National Science Foundation 4201 Wilson Blvd., Rm 995 Arlington, VA 22230 Tel: 703-292-8763 http://www.nsf.gov/sbe/ses/ip/
Postdoctoral Research Fellowships in Interdisciplinary Informatics: Bridging Biology with the Mathematical Sciences (program announcement in progress)	Postdoctoral Research Fellowships in Biological Informatics 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

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
CISE Postdoctoral Research Associates in Experimental Computer Science (NSF 97-169) **(NOTE: A revised announcement is expected to be released in FY 03)**	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/
Mathematical Sciences Postdoctoral Research Fellowships (with Research Instructorship option) (NSF 01-126) **Mathematical Sciences University/Industry Postdoctoral Research Fellowships**	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/
Graduate Student Industrial Fellowship **Postdoctoral Industrial Fellowship**	Dr. Donald Senich Division of Design, Manufacture, and Industrial Innovation National Science Foundation 4201 Wilson Blvd., Rm 527 Arlington, VA 22230 Tel: 703-292-8330
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	Division of Astronomical Sciences National Science Foundation

Postdoctoral Fellowships (NSF 00-136)	4201 Wilson Blvd., Rm 1045 Arlington, VA 22230 Tel: 703-292-8820 e-mail: aapf@nsf.gov
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/fellows/
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: NSFJinfo@nsf.gov http://www.nsf.gov/sbe/int/

• 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 (FASED) 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. Minority Research Planning Grants and Career Advancement Awards
5. ADVANCE: Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers
6. 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 Faculty Early Career Development (CAREER) Program is an NSF-wide activity that supports junior faculty within the context of their overall career development. It combines in a single program research

support and education of the highest quality. CAREER emphasizes the importance NSF places on the early development of academic careers dedicated to stimulating the discovery process in which the excitement of research is enhanced by inspired teaching and enthusiastic learning.

For More Information
Visit the CAREER web site, http://www.nsf.gov/home/crssprgm/career/.

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

Each year, NSF selects up to 20 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 02-020 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. Minority Research Planning Grants and Career Advancement Awards

These awards are part of NSF's overall effort to give members of minority groups that are underrepresented in science and engineering greater access to science and engineering research and education support.

- **Minority Research Planning Grants (MRPGs)**—Enable principal investigators (PIs) who have not had prior independent Federal research support to develop competitive research projects by supporting preliminary studies and similar activities. These are one-time awards of up to $18,000 for a maximum of 18 months.
- **Minority Career Advancement Awards (MCAAs)**—Support activities that can expand the research career potential of promising applicants. These awards are limited to approximately $50,000 for 12 months and in general are one-time nonrenewable grants.

For More Information
The submission deadline date varies with each program. For additional information, contact the appropriate discipline. Information is also available in program announcement NSF 94-147.

5. 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/.

6. 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/ehr/hrd/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 (among minorities, these groups include American Indians/Alaska Natives [Native Americans], Blacks [African Americans], Hispanics, and Pacific Islanders); 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)

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 00-53)
- Centers of Research Excellence in Science and Technology (NSF 98-19)
- Tribal Colleges and Universities Program (NSF 02-019)
- Historically Black Colleges and Universities Undergraduate Program (NSF 00-131)
- 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 01-12). 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 01-36)

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

- Minority Postdoctoral Research Fellowships (NSF 00-139)

Foundation-Wide Activities:

- Minority Research Planning Grants and Career Advancement Awards (NSF 94-147). All inquiries should be directed to the appropriate disciplinary program officer.
- 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 (NSF 89-39)

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

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

The Grant Opportunities for Academic Liaison with Industry (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 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 02-060. The PFI web site can be found at http://www.ehr.nsf.gov/pfi/.

3. Innovation and Organizational Change (IOC)

The IOC Program seeks to improve the performance of industrial, educational, service, health care, government, and other organizations and institutions through the support of research on theories, concepts, and methodologies of innovation and organizational change. To foster innovation and manage change, we need to understand effective approaches to organizational learning and redesign; strategic and cultural change; quality and process improvement; innovation; new product and service development; and the development and integration of new technologies. The program supports research using theory combined with empirical validation to clarify effective approaches to organizational learning and redesign; strategic and cultural change; quality and process improvement; innovation; new product and service development; and the development and integration of new technologies.

IOC is jointly sponsored by the Directorates for Social, Behavioral, and Economic Sciences; Engineering; and Education and Human Resources.

For More Information
Visit the program's web site at http://www.nsf.gov/sbe/ses/ioc/.

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 at 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. Most programs in the international programs office are organized on a regional or country basis. Prospective applicants should also consider international opportunities supported by other parts of NSF and elsewhere.

For More Information
Information and guidelines on proposal preparation for international programs and activities are available in program announcement NSF 00-138; or visit the INT web site at 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 international marketplace.

The small business can partner with other businesses or nonprofit institutions such as academic or 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 institution or as consultants.

For More Information
Visit the SBIR web site at 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 a federally funded research and development center, university, or nonprofit institution. 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 research institution. Members of the academic or research institution participate through a subcontract to the institution. Before starting Phase I, the partners make an agreement that covers rights to the technology involved in the proposal.

  For More Information
  Visit the STTR web site at 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 expertise or new approaches to "established" research topics;
- having a severe urgency with regard to availability of, or access to data, facilities or specialized equipment, including quick-response research on natural disasters and similar unanticipated events; or
- efforts of similar character 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 and availability and appropriateness for SGER funding, or whether the work is more appropriate for submission as a fully reviewed proposal. The project description must be brief (two to five pages) and include clear statements as to why the proposed research should be considered particularly exploratory and high risk, 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.

Brief biographical information is required for the PI and co-PI(s) only, and must list no more than five significant publications or other research products. 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. Renewed funding of SGER awards may be requested only through submission of a non-SGER proposal that will be subject to full merit review. The maximum SGER award amount will not exceed $100,000. Although the maximum award amount is $100,000, the award amount usually will be substantially less than a given program's average award amount. The project's duration will normally be one year, but may be up to 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. The SGER award extensions will be possible for awards of two-year initial duration as well as for those of shorter initial duration. Requests for extensions must be submitted one to two months before 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/.

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/ .

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/.

DIRECTORATE FOR BIOLOGICAL SCIENCES

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/) and Undergraduate Mentoring in Environmental Biology (see http://www.nsf.gov/bio/progdes/nsf02090.htm); and for faculty from K-12: Research Experiences for Teachers (see http://www.nsf.gov/bio/progdes/nsf02090.htm), 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).

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

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.

Multi-Investigator Proposals in the BIO Directorate

Increasingly, many important research problems in science can best be addressed by groups of investigators. A group approach may result in a more comprehensive treatment of many scientific problems and also may provide innovative opportunities for training students.

The need for increased attention to research and training in biology by multiple principal investigators (PIs) has been identified by several workshops, such as the "NSF/BIO Workshop on Impact of Emerging Technologies on the Biological Sciences," and by advisory committees such as the NSF Biological Sciences Advisory Committee. In response to these recommendations, the BIO Directorate encourages proposals from three or more investigators, who may come from more than one academic institution, intending collaborative studies focused on a single problem. The directorate will evaluate these proposals in addition to proposals received from individual PI's as part of the portfolio of activities within the existing budget. As is the case for proposals from individual investigators, multi-PI proposals may provide for the training of students and may also involve industrial collaborations if appropriate. Investigators interested in submitting a multi-PI proposal should contact the cognizant BIO staff 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's divisions 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 Biological Sciences 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 doctoral dissertation, 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/.

• 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 Equipment and Instrumentation Resources for Biological Sciences
2. Instrument Development for Biological Research
3. Improvements in Facilities, Communications, and Equipment 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/). See the MRI Program Announcement (NSF 01-171) for further details.

For More Information
Visit the cluster's web site, http://www.nsf.gov/bio/dbi/dbi_instrument.htm.

1. Multi-User Equipment and Instrumentation Resources for Biological Sciences

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 Equipment and Instrumentation Resources for Biological Sciences**—The Multi-User Equipment and Instrumentation Resources for Biological Sciences Program (see program announcement NSF

98-137) accepts proposals through the RUI Program (see program announcement NSF 00-144). The Multi-User 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.

- **Joint NSF/NIH Multi-User Instrumentation Activity**—Offers support for the purchase of a single instrument with a total purchase cost exceeding $500,000. Proposals that would normally be eligible for submission to both the National Institutes of Health (NIH) and NSF may be submitted to NIH for joint funding with NSF. Proposers must include the necessary NSF documentation, as summarized in program announcement NSF 98-137. Proposals will be evaluated by the agencies in a special review group that will be convened by NIH as a special NIH study section, with NSF participation. A program announcement for shared instrumentation grants will be published in the January issue of the *NIH Guide for Grants and Contracts*. There is one annual deadline date (usually in the last week of March) for receipt of applications.

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 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 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. FSML's 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 guidelines 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

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.

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

Provides support for collection improvement, collection computerization, research on curatorial and collection management techniques, and community-based development activities. Supplements are also provided to underwrite the involvement of undergraduate and high school students in collection-based research. For more information, see program announcement NSF 02-117.

• 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. Collaborative Research at Undergraduate Institutions
3. Integrative Graduate Education and Research Training
4. Postdoctoral Research Fellowships, including
    - Minority Postdoctoral Research Fellowships
    - Postdoctoral Research Fellowships in Interdisciplinary Informatics: Bridging Biology with the Mathematical and Physical Sciences
    - Postdoctoral Research Fellowships in Microbial Biology

For More Information
Visit the cluster's web site, http://www.nsf.gov/bio/dbi/dbitraining.htm.

1. Research Experiences for Undergraduates (REU) Sites

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 Program. For more information, see program announcement NSF 02-136.

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

The overall goals of C-RUI have now been incorporated into the NSF-wide program Research at Undergraduate Institutions (RUI) (see program announcement NSF 00-144). 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 and continued in fiscal years 1997, 1999, and 2001. We would like to assure the biology community of BIO's commitment to C-RUI activities and encourage qualified investigators at undergraduate institutions to apply for collaborative research funding. BIO further encourages applicants whose research would especially benefit from forging a collaboration with their colleagues across traditional disciplinary lines and, in doing so, offer their students exposure to a multidisciplinary research environment.

3. 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.-degree-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 the training of 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 an IGERT preproposal or formal proposal, and the names of the appropriate NSF staff are available on the IGERT web site, http://www.nsf.gov/home/crssprgm/igert/.

4. 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 the applicant to NSF. Fellows must affiliate with an appropriate research institution and are expected to devote themselves full

time to the 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. Specific activities are described below. Complete information including deadline dates and program announcement numbers, is available at http://www.nsf.gov/bio/dbi/dbitraining.htm#pr.

- **Minority Postdoctoral Research Fellowships**—Seek to prepare minority scientists who are within 4 years of receipt of their doctoral degrees for leadership positions in academe and industry. The term "minority," as used here, refers to those racial or ethnic groups that are significantly underrepresented at advanced levels of science and engineering in the United States. They include American Indians or Alaska Natives (Native Americans), Blacks (African Americans), Hispanics, and Pacific Islanders. Tenure at a foreign institution can be followed by an additional third year of support at a U.S. institution. Fellows are invited to an annual meeting at NSF and are eligible to apply for research starter grants. Minority graduate students within 18 months of their doctoral degrees are eligible for travel awards to visit prospective sponsors before they prepare a fellowship application.
- **Postdoctoral Research Fellowships in Interdisciplinary Informatics: Bridging Biology with the Mathematical and Physical Sciences**—Seek to increase the number of (a) junior scientists with doctoral degrees in the mathematical, chemical, and physical sciences who will pursue postdoctoral training with scientists in biology; and (b) junior scientists with doctoral degrees in the biological sciences who will pursue postdoctoral training with sponsors in the mathematical, chemical, and physical sciences. The intent of this cross-training program is to prepare junior scientists so that they are able to establish research programs in areas connecting the mathematical and physical sciences with biology and informatics.
- **Postdoctoral Research Fellowships in Microbial Biology**—Support training and research on the basic biology of protozoan, microalgal, fungal, archaeal, bacterial, and viral species that are not generally considered to be model organisms, such as E. coli, Saccharomyces cerevesiae, or tobacco mosaic virus (TMV). The use of model organisms in comparative studies with non-model organisms is not excluded. Studies of the interactions of these microbes with each other and with plants and animals (e.g., symbiosis) may also be supported. Applicants are reminded that BIO does not support research with disease-related goals, including the etiology, diagnosis, or treatment of physical or mental disease, abnormality, or malfunction in human beings or animals. Animal or plant models of such conditions or the development or testing of drugs or other procedures for their treatment are also not eligible for support.

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; Undergraduate Mentoring in Environmental Biology; and a variety of other NSF-wide activities.

DEB supports research through the following clusters:

- Systematic and Population Biology
- Ecological Studies

In addition to the areas supported by these clusters, DEB encourages studies of earth's species and their interrelationships through directorate-wide activities. For example, the Tree of Life Program (see program solicitation NSF 02-074) 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. The Ecology of Infectious Diseases Initiative--a joint NSF-NIH initiative--seeks to understand the ecological and biological mechanisms that govern relationships between human-induced environmental changes and the emergence and transmission of infectious diseases.

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/.

• 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 Biotic 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. Biotic 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 measures of 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) phylogenetic analyses that produce or test phylogenetic hypotheses or models and the use of derived phylogenies to elucidate patterns of structural, developmental, or molecular evolution; (2) studies that lead to improved classifications, better methods of taxonomic identification, contributions to classificatory theory, and nomenclature reform (included here are the Special Competitions for Partnerships for Enhancing Expertise in Taxonomy, the deadline dates for which are announced via special solicitation) (see program announcement and guidelines NSF 00-140); (3) understanding of processes that underlie the origin and maintenance of taxonomic diversity; and (4) theoretical and empirical studies of biogeographical, coevolutionary, and paleobiological patterns to develop models of the origin, diversification, distribution, and extinction of species and evolutionary lineages, and determine the tempo and mode of evolutionary change.

3. Biotic Surveys and Inventories

Main focus areas include collecting and recording the diversity of life on Earth. Permanent, well-curated collections and computerized databases are strongly encouraged as products of the program's support. For more information, see program announcement NSF 01-150.

• 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

Research supported includes 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 non-ecological investigators. The deadline date 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 that require long-term investigation. These awards are designed to provide funding to help maintain an ongoing long-term research project. 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

The Division of Integrative Biology and Neuroscience (IBN) supports research aimed at understanding the living organism-plant, animal, microbe-as a unit of biological organization. Such research encompasses

- the mechanisms by which plants and animals 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/.

• 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 those 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 either plants or animals (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 to 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 (IBN) and Neuroscience 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 environment. 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 contributing to a fundamental understanding of life processes at the molecular, subcellular, and cellular levels.

Investigator-initiated research proposals are considered in the following general areas: biomolecular structure and function, biomolecular processes, cell biology, and genetics. Clusters in the MCB Division also support fundamental studies leading to technological innovation, proposals with substantial computational components, and multidisciplinary and small-group research. The division particularly encourages submission of proposals involving microbial biology, plant biology, theoretical/computational aspects of molecular and cellular studies, molecular evolution, and biomolecular materials. Genomics approaches are encouraged in all areas. MCB supports a variety of NSF-wide activities such as Biocomplexity in the Environment (BE), and activities designed to promote the integration of research and education, such as Faculty Early Career Development (CAREER) and Research at Undergraduate Institutions (RUI). Also considered are proposals for limited support of special meetings and workshops and the Undergraduate Mentoring in Environmental Biology (UMEB) activity. UMEB is intended to provide support for talented students to gain research experience in areas of biological science related to the environment and to foster an enriched and culturally diverse research and educational environment.

The MCB Division supports research through the following clusters:

- Biomolecular Structure and Function
- Biomolecular Processes
- Cell Biology
- Genetics

In addition to the areas supported by these clusters, the division encourages the discovery of novel microorganisms, microbial consortia, communities, activities, and other novel properties and the study of their roles in diverse environments through the directorate-wide Microbial Observatories Program competition (see program solicitation NSF 02-118). More broadly, the division emphasizes the exploration of all aspects of microbial biology including microbial physiology, genomics/genics, and communities.

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/.

• Biomolecular Structure And Function Cluster

The Biomolecular Structure and Function Cluster of thematic areas is located within the Division of Molecular and Cellular Biosciences (MCB) and supports research aimed at understanding the structure

and function of biological macromolecules, including proteins, nucleic acids, polysaccharides, and lipid assemblies. The research supported by this cluster encompasses a broad range of topics and techniques. The cluster encourages multidisciplinary and innovative efforts between biology and physics, chemistry, mathematics, and computer sciences.

The cluster includes the following areas:

1. Molecular Biochemistry
2. Molecular Biophysics

For More Information
Visit the cluster's web site, http://www.nsf.gov/bio/mcb/mcbstructure.htm.

1. Molecular Biochemistry

Emphasizes structure-function relationships in biological macromolecules and supramolecular structures such as multienzyme complexes, membranes, and viruses. Other areas of emphasis include the mechanisms of regulation and catalysis by enzymes and RNA; biochemical reactions involved in bioenergetic processes and photosynthesis; key biochemical processes involved in synthesis and folding of proteins; and the synthesis of other biomolecular materials. Typically, a combination of experimental techniques is used in an integrated manner to explore the functions and mechanisms of the actions of biomolecules.

2. Molecular Biophysics

Emphasizes research at the interfaces of biology, physics, chemistry, mathematics, and computer science, with focus on the development of new and cutting edge technologies that integrate theoretical, computational, and experimental approaches to the characterization of the structure, dynamics, interactions, and functions of biological macromolecules.

• Biomolecular Processes Cluster

The Biomolecular Processes Cluster of thematic areas is located within the Division of Molecular and Cellular Biosciences and supports research on molecular mechanisms by which genetic and metabolic processes occur in plant, animal, and microbial organisms. These processes and related regulatory features are the primary areas of emphasis.

The cluster includes the following areas:

1. Biochemistry of Gene Expression
2. Metabolic Biochemistry

For More Information
Visit the cluster's web site, http://www.nsf.gov/bio/mcb/mcbprocess.htm.

1. Biochemistry of Gene Expression

Emphasizes research using biochemical and molecular biological methods to investigate mechanisms for the replication, expression, transfer, and stability of genetic information, both DNA and RNA. These studies involve primarily in vitro biochemical approaches, including genomics. Gene expression

mechanisms are a major focus and include transcription and processing of mRNA regulatory features, including chromatin architecture, RNA stability, and translational mechanisms. Other areas of study include DNA replication, mutation, and repair.

2. Metabolic Biochemistry

Emphasizes research on many aspects of the dynamic activities of cells, including characterization of the biochemical pathways and other processes by which all organisms acquire, transform, and utilize energy from substrates and synthesize new small molecules and macromolecular cell components. Major topics of interest include the diversity of primary and secondary metabolism and mechanisms of metabolic regulation, in response to both internal and external signals. Also of interest are biotransformations of environmentally significant compounds; manipulations of metabolism with practical applications; quantitative and temporal aspects of metabolism; integration and subcellular organization of metabolic processes; and the use of new methods and technologies and approaches, including genomics, to conduct studies of metabolic pathways and networks.

• Cell Biology Cluster

The Cell Biology Cluster of thematic areas is located within the Division of Molecular and Cellular Biosciences (MCB) and supports research on the structure, function, and regulation of plant, animal, and microbial cells. Research that will utilize both traditional and innovative methodologies and encourage multidisciplinary approaches, technique development, modeling, and approaches that exploit genomic information is encouraged.

The cluster includes the following areas:

1. Cellular Organization
2. Signal Transduction and Cellular Regulation

For More Information
Visit the cluster's web site, http://www.nsf.gov/bio/mcb/mcbcell.htm.

1. Cellular Organization

Supports studies of the structure, function, and assembly of cellular elements, such as the cytoskeleton, membranes, organelles, intracellular compartments, intranuclear structures, and extracellular matrix, including cell walls. This encompasses structural and dynamic aspects of cellular and intracellular motility, meiosis and mitosis, and cell shape and polarity, including the mechanisms of endocytosis, exocytosis, and intracellular trafficking of membranes and macromolecules.

2. Signal Transduction and Cellular Regulation

Supports the study of intracellular and transmembrane signal transduction mechanisms and functions. These include signal reception; ion channels; second messenger and/or signaling cascades and their interactions; cellular mechanisms of recognition and defense; and the regulation of cell cycle progression.

• Genetics Cluster

The Genetics Cluster is located within the Division of Molecular and Cellular Biosciences (MCB) and supports a wide range of studies directed toward answering significant questions of organization, recombination, function, regulation of function, and transmission of heritable information in all organisms, from viruses and micro-organisms to plants and animals. Specific areas include mechanisms of gene regulation, chromosome structure and replication, epigenetic phenomena, DNA repair and recombination, sex determination, genetic interactions between genomes, and molecular evolution and genomics.

The cluster includes the following areas:

1. Eukaryotic Genetics
2. Microbial Genetics

For More Information
Visit the cluster's web site, http://www.nsf.gov/bio/mcb/mcbgenetics.htm.

1. Eukaryotic Genetics

Emphasizes genetic studies of eukaryotic organisms. Studies of both organelle and nuclear genomes are included, as are studies of viruses of these organisms and parasitic or symbiotic interactions at the genetic level. Epigenetic phenomena, molecular evolution, and genomics are also areas of interest.

2. Microbial Genetics

Emphasizes genetic studies of eubacteria and archaebacteria. Also included are studies of the genetics of bacterial viruses and other infectious agents of bacteria. Investigations of microbial interactions with other organisms are also considered if the emphasis of the study is on the microbe. Studies on molecular evolution of microbial genes and on genomics are also considered.

DIRECTORATE FOR BIOLOGICAL SCIENCES

Plant Genome Research Program

The Plant Genome Research Program was initiated in fiscal year (FY) 1998. It is part of a national plant genome research 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. In FYs 1998-2002, the program held separate competitions. The program initiates new collaborative research and infrastructure projects annually, as well as provides ongoing support for activities started in previous competitions.

For More Information

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

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 COMPUTER AND INFORMATION SCIENCE AND ENGINEERING

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 research and education in general; and contributes to the education and training of the next generation of computer scientists and engineers.

CISE activities are core to NSF's efforts in information technology, including the Information Technology Research Program. The directorate's activities in fiscal year 2003 (FY 03) encompass broad, thematic, large-scale, and long-term basic computer science research, emphasizing software, human-computer interaction, information management, scalable information infrastructure, high-end computing, and the economic and social implications of information technology. Support will be provided for individual investigator and group research projects and for a limited number of information technology research centers. Complete descriptions of the program and details on proposal submission will be available on the CISE Directorate home page in FY 03.

The CISE Directorate supports programs and activities through the following:

- Crosscutting Programs and Activities
- Division of Computer-Communications Research (C-CR)
- Division of Information and Intelligent Systems (IIS)
- Division of Advanced Computational Infrastructure and Research (ACIR)
- Division of Advanced Networking Infrastructure and Research (ANIR)
- Division of Experimental and Integrative Activities (EIA)

CISE is inherently multidisciplinary, and the directorate strongly encourages collaboration with all NSF-supported disciplines. Several CISE programs--such as Research Infrastructure, Instrumentation, and Educational Innovations--encompass all fields of computer and information science and engineering and are managed on a cross-divisional basis.

In addition to supporting research, the CISE Directorate provides the general scientific community with access to advanced computing and networking capabilities. Programs such as Partnerships for Advanced Computational Infrastructure give qualified users access to extremely powerful computing resources, train users, and develop the software required for effective use. Networking activities offer and build a national infrastructure for computer and human interaction as well as communication for research and education. In addition, the directorate supports distributed research resources and systems for research and education, and educational development through various activities such as educational infrastructure and educational supplements.

For More Information
Visit the CISE Directorate home page, http://www.cise.nsf.gov/.

Crosscutting Programs and Activities

In addition to the programs mentioned in this section, the CISE Directorate takes an active role in the following crosscutting programs and activities:

- Information Technology Research
- Biocomplexity in the Environment
- Workforce for the 21st Century
- Nanoscale Science and Engineering
- Mathematical Sciences

For More Information
Visit the NSF Crosscutting Programs home page, http://www.nsf.gov/home/crssprgm/.

DIRECTORATE FOR COMPUTER AND INFORMATION SCIENCE AND ENGINEERING

Division of Computer-Communications Research

The Division of Computer-Communications Research (C-CR) supports research on the principles, key concepts, and fundamental knowledge underlying information technology products, processes, and services. Specifically, C-CR engages in basic analytical and engineering research required to develop and use computer and communication systems. C-CR seeks to determine inherent limitations of computation and to obtain the best possible solutions within those limits. C-CR advances the theory, analysis, design, construction, and utilization of computing and networking hardware and software. It is concerned with issues of efficiency, reliability, security, and trustworthiness of computers, computation, and communication.

The C-CR Division supports the following programs and activities:

1. Communication Research
2. Computer Systems Architecture
3. Design Automation for Micro- and Nanosystems
4. Graphics and Symbolic, and Geometric Computation
5. Distributed Systems and Compilers
6. Signal Processing Systems
7. Software Engineering and Languages
8. Theory of Computing
9. Embedded and Hybrid Systems
10. Trusted Computing

For More Information

Write to the Division of Computer-Communications Research, National Science Foundation, 4201 Wilson Boulevard, Room 1145, Arlington, VA 22230; or contact the division by telephone, 703-292-8910; or visit the C-CR home page, http://www.cise.nsf.gov/div/ccr/index.html.

1. Communication Research

Supports research on all aspects of communications science and technology in order to facilitate the efficient representation and transmission of information at scales that approach the theoretical limits. This includes efficient representation of information sources; computationally efficient retrieval of information; modern modulation and coding techniques that exploit the temporal and spatial redundancy of channels; power-aware techniques; resource allocation algorithms working across network layers; and physical layer security methods. Mobile wireless network applications, optical communication technologies, multimedia information sources, and quantum information processing possibilities are all motivating new communication techniques of interest to the program. Also of interest are interdisciplinary projects, particularly at the interface between communications and other CISE programs in which new perspectives can contribute to communications issues.

2. Computer Systems Architecture

Supports basic research on new computing systems and architecture. Focus is on new architecture ideas and concepts that will form the basis for solving computing problems likely to arise in the future. Broadly speaking, this covers design, implementation, and evaluation of novel computing structures and technologies, as well as theoretical and small-scale experimental studies and assessment of fault tolerance and performance. Also supported is research on system software when intimately connected to the architecture or hardware. Currently, special attention is being given to the following research areas:

- **Emerging Architectures**—Molecular and nano architectures and quantum and optical computing systems.
- **Hardware/Software Co-Design**—Reconfigurable architectures, co-simulation, synthesis, low power design, and embedded systems.
- **Microarchitecture**—Compiler-architecture interaction, out-of-order execution, very large instruction word (VLIW), instruction and data pre-fetching and prediction, speculation, superscalar processing, multithreading, embedded processor design, and lower power architectures.
- **Metrics and Parallelism**—Performance evaluation of single processor and multiprocessor architectures, analytical modeling, new measurement and simulation techniques, co-simulation, and benchmarks for scientific and commercial system architectures.
- **Systems**—Latency reduction, interconnection networks, active networks, shared memory multiprocessors, workstation clusters, quality of service, fault-tolerance and reliability, and real-time communication.
- **Memory**—New memory architectures, bandwidth, latency reduction, data prefetching and forwarding techniques, cache coherence and synchronization, memory hierarchy management, processor-in-memory, active memory, and memory management problems.
- **Input/Output (I/O)**—Disk organization, scheduling, data stream management, low overhead protection, latency reduction, active disk, and high performance I/O design.

3. Design Automation for Micro- and Nano-Systems

Very large-scale integration (VLSI) design methodologies are exceptionally challenged by the rapid advances in deep submicron, mechanical (MEMS), optical, nano, and quantum computing media. The program supports basic research underlying the science and methodologies for designing integrated systems comprised of micro systems in traditional silicon VLSI technology, in MEMS technologies, and in computing media of the future. Since new computing technologies are not expected to replace silicon in the foreseeable future, research must continue on silicon VLSI design as well as design in new technologies. The program has three segments:

- **Design in Future Computing Media**—As with VLSI, giant strides may occur when the design process is separated from the development of the underlying medium. Enhancing the dialogue between the silicon design community and non-silicon technologists may stimulate crossover activities between electronic design automation (EDA) design researchers and micro-/nano-/molecular technology researchers.
- **Traditional VLSI Electronic Design**—Emphasis is on the basic science involved in designing next generation VLSI chips. Design media are deep submicron technologies. Research covers all phases of the design cycle for integrated circuits and systems, from conception to testing. The three basic segments here are system design, physical design, and testing.
- **Design for Mixed Technologies**—Includes optical, mechanical (MEMS), and mixed signal (analog-electrical) technologies within a microsystem. The technology has matured to the point that many different microsensor and microactuator devices can be fabricated in the same process, and a design science needs to be developed.

4. Graphics and Symbolic and Geometric Computation

Supports fundamental research in areas where advanced algorithmic and computational techniques are coupled with mathematical methods of analysis. The specific program areas include computer graphics, computational geometry and topology, symbolic and algebraic computation, computational logic and automated deduction, computationally oriented numerical analysis, and mathematical optimization. The program encourages the integration of numeric, symbolic, geometric, and graphic techniques into problem-solving environments to support computational science and engineering. The program also supports advanced computational techniques aimed at modeling and simulation of physical processes; the design and construction of high-quality mathematical computing software for scientific research; and experimental implementation when it is an integral part of the research. Innovative applications of advanced computational and graphic techniques in science and engineering applications, manufacturing and design, proof support systems, and prototypic and design verification are also welcome.

5. Distributed Systems and Compilers

Sponsors research 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. Work that extends and integrates operating system, compiler, and network technologies is emphasized. The program encompasses areas that range from fundamental operating systems and compilers, 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.

6. Signal Processing Systems

Supports fundamental research in the areas of digital signal processing, analog signal processing, and supporting hardware and software systems. This includes one-dimensional digital signal processing (1-D DSP), including (adaptive) filtering and equalization and time-frequency representations; statistical signal and array processing; image and multi-dimensional digital signal processing, including image analysis, filtering, restoration and enhancement, image and video coding, and vector quantization; and analog signal processing, including analog-to-digital conversion and analog circuits and filters.

Special attention is currently given to antenna array processing with application in wireless communications systems, especially cellular telephony, personal communications systems, and wireless local area networks; signal compression for reduced data rate with applications in wireless communications systems; scalable/progressive/multi-resolution approaches in signal decomposition, compression, and other signal processing techniques to support content analysis; data quality validation; and manufacturing applications (e.g., nondestructive test and evaluation), computed tomography, and synthetic aperture radar (SAR). Other topics of special interest are signal authentication and distributed signal processing for sensor networks.

7. Software Engineering and Languages

Supports the fundamental research underlying the development and evolution of quality software-based systems. Projects may study or develop methods, processes, tools, or environments, taking a conceptual, experimental, or developmental approach, or may represent innovative work in the theory and design of programming languages, language semantics, and programming environments. Specific research topics include domain-specific languages for specification and design; constructive approaches to software design and evolution; issues of software modularity and composition; enhancement of confidence and quality; automating stages of software development; distributed and

network environment issues, including distributed development and software security; and formal foundations for all aspects of software engineering and programming languages. Experimental approaches to concept validation are strongly encouraged as a necessary adjunct to conceptually motivated research. Projects contributing to an experimental research infrastructure by providing access to testbeds, software development data, or repositories of software project artifacts will be considered.

8. Theory of Computing

Supports fundamental research in three areas:

- **Core Theory**—Includes computational complexity, cryptography, interactive computation, computational learning, parallel and distributed computation, computation on random data, online computation, and reasoning about knowledge.
- **Fundamental Algorithms**—Includes developing combinatorial, approximation, parallel, online, numerical, geometric, and graph algorithms that transcend application domains.
- **Application-Specific Theory**—Support is provided for developing models and techniques for solving problems that arise in areas of science and engineering such as molecular biology, communications networks, and computational linguistics. Of particular interest are theoretical developments that have potential impact on experimental or applied areas of computer science research. Investigators are encouraged to pursue strategies that mix theory with experimentation.

Additional areas supported by the program are: applied algorithms; computational learning theory; computational biology; graph-theoretic algorithms; distributed and parallel systems; structural and algebraic complexity; foundations of computing and logic; security and cryptography; algorithmic building blocks for parallel systems; theory of information, digital libraries, and communication; quantum complexity; and algorithms.

9. Embedded and Hybrid Systems

Supports research 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, adaptivity, and component integration, such as multi-modal sensing and control. Embedded systems combine interacting elements, spatial, and physical properties, and the continuous dynamics of the system to be monitored or controlled; the timing and synchrony properties and resource demands of software that controls the system; and the characteristics and services of the computational platform, both systems software and hardware.

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. The program draws on control theory, modeling, software generation, real time software systems, and formal methods. 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.

10. Trusted Computing

Seeks to establish a sound scientific foundation and technological basis for managing privacy and security in a world linked through computing and communication technology. This research is necessary to build the secure and reliable systems required for a highly interconnected, information technology enabled society. The program supports innovative research in all aspects of secure reliable information systems, including methods for assessing the trustworthiness of systems. Some specific areas in which research is needed are:

- **Component Technologies**—Specification, design, development, testing, and verification of methods needed to ensure that specified properties are met. Ideally, such technologies should be flexible so they can be applied in accordance with the degree of trustworthiness required and the resources available. Methods are needed to identify the components that will provide a good basis on which to construct trustworthy systems.
- **Composition Methods**—Assembling components into subsystems and systems with known and quantifiable trustworthiness; identifying and minimizing the security assumptions made in a given security design; and exploiting the existence of large numbers of untrustworthy computing platforms in order to effectively create secure or trustworthy multiparty computations.
- Methods for maintaining trustworthiness as systems adapt and evolve.
- Methods for improving human understanding of critical system behavior and control.
- Methods for assessing tradeoffs in trustworthy system design, for example, between security and performance.
- Techniques for modeling, analyzing, and predicting trust properties of systems and components.

DIRECTORATE FOR COMPUTER AND INFORMATION SCIENCE AND ENGINEERING

Division of Information and Intelligent Systems

The Division of Information and Intelligent Systems (IIS) supports research that will improve the ability to generate, organize, locate, communicate, and store knowledge using new technologies. IIS recognizes that high-quality content and its accessibility and usability are important benefits provided by new technologies and are complementary to bandwidth and disk space. IIS fundamental research foci include universal access; human language technology; knowledge modeling; scientific collaboratories; robotics; computer vision; data mining; database access technology; human-computer interaction; and embedded intelligent systems. IIS also supports interdisciplinary and interagency activities such as the Digital Libraries and STIMULATE (Speech, Text, Image, and Multimedia Advanced Technology Effort) Initiatives.

The IIS Division supports the following programs and activities:

1. Digital Society and Technologies
2. Human-Computer Interaction
3. Information and Data Management
4. Knowledge and Cognitive Systems
5. Robotics and Human Augmentation
6. Special Projects
7. Universal Access

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/iis/index.html.

1. Digital Society and Technologies

Supports research fundamental to the development of new knowledge about the complex processes of adaptation and interchange between society and new information technologies. New theories, models, and technologies are encouraged, as well as empirical maps of the landscape of social and economic change. Research topics include universal participation in a digital society; large-scale social technologies for science, education, and work collaboration and learning; ethical principles in technical design; information privacy and intellectual property in a digital age; and technologies for independence throughout life.

2. Human-Computer Interaction

Supports research fundamental to the design of systems that mediate between computers and humans. Topics include universal access; visualization; animation and simulation; interactive computing; human language technology, including speech recognition and natural language understanding; posture- and sound-based interfaces; virtual reality; and multimedia environments.

3. Information and Data Management

Supports research fundamental to the design, implementation, development, management, and use of databases; information retrieval; and knowledge-based systems. Topics include data, metadata, information, and knowledge process modeling; information access and interaction; knowledge discovery, data mining, and visualization; and system architecture and implementation. Research areas span web-based systems, multimedia systems, scientific databases, geographic information systems, digital libraries, and other intelligent information systems; efficient data gathering and storage/archival; information organization, information flow management, and security/privacy issues; evolutionary systems, change maintenance, and information life-cycle management; heterogeneous systems; and highly scalable, data-intensive, and distributed/mobile information systems.

4. Knowledge and Cognitive Systems

Supports research fundamental to the development of machines that behave intelligently. This can be in conjunction with humans (computer-aided machine intelligence) or alone (autonomous intelligent agents). Some of the research involves knowledge representation in machines and studies of cognitive processes, which may be modeled on what we know of human or animal cognition, or which may use approaches different from those in humans and animals. Cognitive activities of interest include multiple types of machine learning, planning, reasoning, decision making, sensory cognition, and linguistic cognition, or combinations of these in intelligent agents. Fundamental research in these areas may have as a goal, for example, the application of integrated design and manufacturing; network management; medical diagnosis; data mining; or intelligent tutoring.

5. Robotics and Human Augmentation

Supports research fundamental to the design of machines and systems that implement some characteristics of intelligence and are capable of performing tasks that require generation of mechanical motion. Research topics include theoretical, algorithmic, experimental, and hardware issues on macro-, micro-, and nanoscale, with an emphasis on intelligent sensing and unstructured environments; personal robotics with an emphasis on its human-centered end-use; robotic applications such as systems for surgery, undersea, space, and agriculture; complex sensing, perception, and action; understanding and processing of visual data; representation, reasoning, and planning for complex physical tasks involving temporal and spatial relationships; communication and task sharing between humans and machines and among machines; and cooperation among geographically separated robotics resources.

6. Special Projects

Supports research, workshops, and other interdisciplinary activities focusing on computing, communications, and the development and use of digital content in a variety of scholarly, social, and work contexts. Special Projects is the managing program for the Digital Libraries Initiative and is global in scope, promoting international collaboration across a wide range of topics related to the expansion of the capabilities and use of the Internet.

7. Universal Access

Aims primarily to support research fundamental to empowering people with disabilities so that they are able to participate fully in the emerging information society. The program also seeks to advance computer technology so that all people can possess the skills needed to fully harness the power of

computing. Focus is on topics such as the development of new models, architectures, and languages that emphasize interface speed and usability by all; the definition of semantic structures for multimedia information to support cross-modal input/output; the development of specific solutions to address the special needs of large disabled communities; and experimental studies to evaluate the success of attempts to provide access in all its varied forms. The word "access" implies the ability to find, manipulate, and use information in an efficient and comprehensive manner.

DIRECTORATE FOR COMPUTER AND INFORMATION SCIENCE AND ENGINEERING

Division of Advanced Computational Infrastructure and Research

The Division of Advanced Computational Infrastructure and Research (ACIR) provides access to and support of high-end computing infrastructure and research for the national scientific community through its programs.

The ACIR Division supports the following programs and activities:

1. Advanced Computational Research
2. Advanced Computational Infrastructure
3. Terascale Computing System

For More Information

Write to the Division of Advanced Computational Infrastructure and Research, National Science Foundation, 4201 Wilson Boulevard, Room 1122, Arlington, VA 22230; or contact the division by telephone, 703-292-8970; or visit the ACIR home page, http://www.cise.nsf.gov/div/acir/index.html.

1. Advanced Computational Research (ACR)

Supports a range of enabling technologies needed to advance the state of the art in high performance computing and brings advanced computing and simulation capabilities to bear on fundamental problems throughout science and engineering. Technologies of particular interest include (1) software environments and tools; (2) visualization and data management; and (3) high-performance algorithms. For details on each of the three focus areas or for specific program information, see program announcement NSF 98-168. In addition, ACR serves as the lead program for the Scientific Frontiers area of the multidisciplinary Information Technology Research Program.

2. Advanced Computational Infrastructure (ACI)

Provides the resources and technical expertise to meet the continuously expanding need for high-end computation and information technologies required by the U.S. academic community. The ACI Program supports two partnerships, each consisting of a leading-edge site and a significant number of partners. The two leading-edge sites maintain a variety of high-end computer systems. Together with Partners who support smaller versions of these and other computers and experimental systems, they constitute a geographically distributed computing environment that is connected via high-speed networks. PACI sites also participate in the development, application, and testing of the necessary software, tools, and algorithms that contribute to the expansion of this "national grid" of interconnected, high-performance computing systems.

The activities of the partnerships focus on the following: accessibility to a diverse set of advanced and mid-range computer engines, data storage systems, and experimental machine architectures; enabling technologies-through the development of software tools for parallel computation and software for use on the partnerships' widely distributed and architecturally diverse machines and data sources, thus

enabling effective use of the partnerships' very large distributed systems; application technologies-engage groups in high-end applications to develop and optimize their discipline-specific codes and software infrastructures, making them available to the program as a whole and to researchers in other areas; education outreach and training-build a growing awareness and understanding of how to use high performance computing and communications resources and broaden the base of participation to help ensure the Nation's continued world leadership in computational science and engineering.

3. Terascale Computing System

Provides multi-teraflop computing systems in support of science and engineering research in the United States. NSF bears special responsibility for this national program that is available for use by the national computational community. Two systems have been awarded in the past two years and enhancements of these systems will be put in place in fiscal year (FY) 2003 to create an Extensible Terascale Facility (ETF). In FY 2003, a solicitation will be issued for integrating new sites and facilities into the ETF. For further information, see program announcement NSF 02-116.

DIRECTORATE FOR COMPUTER AND INFORMATION SCIENCE AND ENGINEERING

Division of Advanced Networking Infrastructure and Research

The Division of Advanced Networking Infrastructure and Research (ANIR) is concerned with Networking Research (ANR) and Networking Infrastructure (ANI).

The ANIR Division supports research within the following sections:

- Advanced Networking Research
- Advanced Networking Infrastructure

For More Information
Write to the Division of Advanced Networking Infrastructure and Research, National Science Foundation, 4201 Wilson Boulevard, Room 1175, Arlington, VA 22230; or contact the division by telephone, 703-292-8950; or visit the ANIR home page, http://www.cise.nsf.gov/div/anir/index.html.

• Advanced Networking Research

The Advanced Networking Infrastructure section seeks to further fundamental research in networking and build on the base of information required to enable the field to maintain and strengthen the momentum it has demonstrated with the success of the Internet.

The section includes the following programs:

1. Networking Research
2. Special Projects

For further information about these programs, refer to the applicable program announcement.

1. Networking Research Program

Focuses on the fundamental science and technology needed to facilitate the efficient high-speed transfer of information through networks and distributed systems. Projects funded range from network design and performance evaluation to middleware and software frameworks in support of applications running on top of networks and distributed systems. Projects may also address how networked and distributed systems interact with underlying communications technology and with other related disciplines. Research areas include high-speed, optical, wireless, and mobile networks; traffic control; resource management; quality of service; protocols; multicast; network security, design, and management; performance evaluation; network architectures; network systems; object-oriented frameworks for networks; agent-based networks; multimedia applications; and multiple-access platforms. For specific program information, see program announcement NSF 02-123.

2. Special Projects Program

Differs from the Networking Research Program in that it supports larger and more multidisciplinary projects, specialized hardware and software, and networks for networking systems research. Projects supported by this program focus on networking issues and may include work from other disciplines of computer science and engineering, such as distributed systems, communications, operating systems, databases, software, signal processing, control theory, and devices. Theoretical research activities that address networking issues require small teams of researchers. Experimental research that demonstrates proof of concept for novel networking ideas may range in scope from laboratory experimentation to national collaborations. For specific program information, see program announcement NSF 98-120.

• Advanced Networking Infrastructure

The Advanced Networking Infrastructure section seeks to stimulate and contribute to, as well as make available for the research and education communities, the very latest in high-performance networking capability in both the national and international arenas. The activity seeks to enable the use of novel and advanced research applications across all disciplines of science and engineering; coordinate interactions with networking and other disciplines of science; and promote the analysis, improvement, and evolution of the Internet. The focus has shifted from backbone networks to middleware and network services, networked applications, and networking for new participants.

Programs within this section include the following:

1. Network Centric Middleware Services
2. High Performance Network Connections for Science and Engineering Research
3. Strategic Technologies for the Internet

For further information about these programs, refer to the applicable program announcement.

1. Network Centric Middleware Services Program

Enables those entities that compose the advanced network community, including research universities, government agencies, and industrial units, to collaborate in assembling known and needed pieces of Network Centric Middleware Services. Middleware refers to the software that is common to multiple applications and builds on the network transport services to enable ready development of new applications and network services. By producing a working software distribution, this program will assemble the known pieces and highlight places where new knowledge is needed. Research is also supported on issues relating to this area to accomplish the above goals. For specific program information, see program announcement NSF 02-028.

2. High Performance Network Connections for Science and Engineering Research Program

Seeks to provide high performance network connection support for institutions of higher education that are not currently connected to an advanced network, and encourages additional U.S. institutions to establish such a high performance Internet connection when such a connection is required to advance an area of scientific research. For example, researchers at an institution that is not yet connected may wish to collaborate on a research project that requires high performance networking with investigators at other institutions. For specific program information, see program announcement NSF 01-73

3. Strategic Technologies for the Internet Program

Improves the operational or functional capabilities of the Internet and enables related collateral efforts for the benefit of the research and education communities. Areas of support include but are not limited to complex network monitoring, problem detection, and resolution mechanisms; development of automated and advanced network tools, networked applications tools, or network-based middleware; creation of usable and widely deployable networking applications that promote collaborative research and information sharing; and innovative access network technologies. For specific program information, see program announcement NSF 01-90.

DIRECTORATE FOR COMPUTER AND INFORMATION SCIENCE AND ENGINEERING

Division of Experimental and Integrative Activities

The Division of Experimental and Integrative Activities (EIA) facilitates new ventures and the evolution of CISE-related disciplines, and encourages activities that cross traditional boundaries. Specifically, EIA promotes new and typically multidisciplinary research initiatives, builds capacity in terms of people and facilities, and assesses the impact of information technology (IT) research, education, and technology on society. EIA includes four primary areas: multidisciplinary research; instrumentation and infrastructure; education, human resources, and workforce; and special projects such as conferences, symposia, studies, travel grants, and international activities. Multidisciplinary research includes research that crosses disciplinary boundaries within the CISE Directorate and projects that have a core of CISE research and application outside of CISE areas. EIA provides instrumentation and infrastructure (such as high performance computers, robots, and visualization devices) for group investigations and enables multi-investigator research. EIA promotes the uses of technology to improve learning; the transfer of research advances into college and graduate level curriculum; and projects that increase the participation of underrepresented groups in education and careers in IT. EIA also supports workshops, symposia, studies, travel, and international activities related to areas and issues of interest to CISE and its grantees.

The EIA Division supports the following programs and activities:

1. Multidisciplinary Research
    - Biological Information Technology and Systems
    - Digital Government
    - Joint NSF/NIH Initiative to Support Collaborative Research in Computational Neuroscience (CRCNS)
    - Next Generation Software
    - Quantum and Biologically Inspired Computing
2. Instrumentation and Infrastructure
    - CISE Research Resources
    - CISE Research Infrastructure
    - CISE Minority Institutions Infrastructure
    - Major Research Instrumentation [Cross-Directorate Program]
3. Education and Workforce
    - CISE Educational Innovation
    - CISE Postdoctoral Research Associates
    - Combined Research-Curriculum Development
    - Information Technology Workforce
    - Integrative Graduate Education and Research Training [Cross-Directorate Program]
    - Research Experiences for Undergraduates [Cross-Directorate Program]
    - Special Projects Related to Education and Workforce
4. Special Projects
    - Conferences, Workshops, Symposia, Studies, and Travel
    - NSF-CONACyT Collaborative Research Opportunities
    - NSF-CNPq Collaborative Research Opportunities

For More Information
Write to the Division of Experimental and Integrative Activities, National Science Foundation, 4201 Wilson Boulevard, Room 1160, Arlington, VA 22230; or contact the division by telephone, 703-292-8980; or visit the EIA home page, http://www.cise.nsf.gov/div/eia/index.html.

1. Multidisciplinary Research

- **Biological Information Technology and Systems**—Supports high-risk/high-return research at the interface of biology and information technology. Biological systems have enormous capabilities as powerful and agile control systems for robotic and regulatory systems and for pattern recognition, adaptability, information storage, retrieval and processing, sensor fusion, and other information-handling tasks. Biology often performs orders of magnitude better than systems based on today's silicon device technologies. Determining what needs to be and what can be learned about information processing in biological systems should lead to important new information systems (algorithms, software, and systems) and technologies (computer platforms, sensors, robotic devices, etc.). The initial phase of this program will focus on developing computational models and theories for the information-processing mechanisms encountered in biological systems that will lead to new information technology systems and hardware platforms. While these new information technology systems will not necessarily or exclusively be implemented in biological matter, the program will emphasize hybrid (bio-silical) systems, particularly as a means for experimenting with and validating new theories of biological information technologies and systems.
- **Digital Government**—Aims to build a research domain of problems that intersect the traditional CISE research communities with the mid- to long-term research, development, and experimental deployment needs of the federal information service communities. It accomplishes this by supporting projects that innovatively, effectively, and broadly address potential improvement of agency, interagency, and intergovernmental operations as well as government-citizen interaction. The Federal Government is a major user of information technologies, a collector and maintainer of very large data sets, and a provider of critical, often unique information services to individuals, States, businesses, and other customers. Still, most federal agencies are struggling with the creation of a strategic vision and an operational philosophy for information technologies. For specific program information, see program announcement NSF 99-103.
- **Joint NSF/NIH Initiative to Support Collaborative Research in Computational Neuroscience (CRCNS)—**The most exciting and difficult challenge facing neuroscientists is how to understand the functions of complex neurobiological systems. Computational neuroscience provides a theoretical foundation and a set of technological approaches that may enhance our understanding of nervous system function by providing analytical and modeling tools that describe, traverse, and integrate different levels of organization, spanning vast temporal and spatial scales. 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, cognitive scientists, engineers, theoreticians, and neurobiologists are imperative for us to advance our understanding of the nervous system. The participating NSF Directorates and Institutes of the National Institutes of Health (NIH) will support interdisciplinary research that focuses on integrating computational models and methods with neuroscience.
- **Next Generation Software (NGS)**—The overall thrusts of NGS are the research and development of new software technologies integrated across a system's architectural layers; support for the design and operation cycle of applications, computing, and communications systems; and delivering quality of service (QoS). NGS fosters multidisciplinary software research under two components: Technology for Performance Engineered Systems (TPES) and Complex Application Design and Support Systems (CADSS).

- **Quantum and Biologically Inspired Computing**—Supports interdisciplinary research to improve the fundamental capabilities of computer science by incorporating insights from either biological systems or quantum foundations or both. In order to achieve this improvement, there must be fundamental research on the unification of information science across the disciplines--computer science, physics, biology, and engineering. Expanding research efforts in interdisciplinary areas at the interface of information science and technology with the fields of biology, chemistry, engineering, physics, and computer science will lead to better understanding in all areas of science. This will increase the ability to develop future information technologies that are very critical to the economy and society at the national and international level. Priority is given to group proposals that represent multiple disciplines, although single-investigator proposals that are cross disciplinary are also considered.

2. Instrumentation and Infrastructure

- **CISE Research Infrastructure (CISE-RI)**—Provides support for the establishment, enhancement, and operation of major experimental facilities for all CISE research areas. Projects supported usually involve several individual projects with synergy among their research activities. Ph.D. degree-granting departments in disciplines pertaining to the CISE Directorate and partnerships with at least one partner in a CISE-related discipline are eligible. Outreach to underrepresented groups is also encouraged by the program.
- **CISE Research Resources (CISE-RR)**—Designed to increase 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/education activities. Resources may include research equipment, instrumentation, software, data repositories, or services. Resources supported under this program include those not generally supported by other programs due to cost, complexity, level of shared use, or other reasons. CISE-RR consists of the following three elements: CISE instrumentation; collaborative research resources; and distributed research resources.
- **CISE Minority Institutions Infrastructure (CISE-MII)**—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. Significant matching for the latter (usually 25 percent) is expected.
- **Major Research Instrumentation (MRI)**—Supports projects with one primary research focus whose infrastructure requirement is too costly for other programs to support. All institutions are eligible, with a limit of two proposals from each institution per year. Matching at the 30 percent level is expected.

3. Education and Workforce

- **CISE Educational Innovation**—Supports innovative education activities at the undergraduate level in computer and information science and engineering whose research results are incorporated into undergraduate curricula. Projects that are supported are expected to show promise as national models of excellence by acting as prototypes for use by a broader segment of the CISE community. Proposals may address a variety of educational activities, including the development of courses, instructional technologies, software, and other educational materials. A related program--in cooperation with the Engineering Directorate, the Combined Research and Curriculum Development (CRCD) Program--supports multidisciplinary projects in upper-level undergraduate and introductory graduate-level curricula (see information on CRCD elsewhere in this section).

- **CISE Postdoctoral Research Associates**—Aims to increase the expertise in experimental computer science and engineering by providing opportunities to work in established laboratories performing experimental research in computer science and engineering. Through these awards, recent Ph.D.s are able to broaden their knowledge and experience and prepare for significant research careers on the frontiers of experimental computer science.
- **Combined Research-Curriculum Development (CRCD)**—Jointly supported by the CISE and Engineering (ENG) Directorates, CRCD seeks to incorporate into upper-level undergraduate/graduate engineering curricula, information about exciting research advances that have taken place in important technological areas. A major goal of the program is to encourage faculty researchers to place renewed value on quality education and curriculum innovation in the context that education and research are of equal value and act as complementary parts of an integrated whole. A CRCD-supported project should focus on a topic of importance to industry and to the Nation, as well as be an area of research supported by both the CISE and ENG directorates. In addition, each CRCD project contains five major components: research, curriculum development, a team of participants (faculty and students), project evaluation plans, and cost sharing of at least 25 percent.
- **Information Technology Workforce**—Advances in information technology (IT) have dramatically transformed the way in which our entire society lives, works, learns, communicates, and does business. In particular, the conduct of science and engineering has been profoundly altered so that it is possible today to work on problems in these areas at unprecedented levels of speed, precision, and detail. In education, IT has the potential to make the highest levels of learning, information, and analysis available in the remotest corners of earth. To enhance the positive effects of these transformations, our research programs must be expanded considerably and the supply of high quality, trained personnel must be substantially increased. The National Science Foundation wishes to fund innovative, high-payoff research that explores new science, engineering, and education areas in IT.
- **Integrative Graduate Education and Research Training (IGERT)**—Seeks to enable the development of innovative, research-based graduate education and training activities that will produce a diverse group of new scientists and engineers who are well prepared for a broad spectrum of career opportunities. Projects supported must be based on a multidisciplinary research theme and organized around a diverse group of investigators from Ph.D.-granting institutions in the United States who have appropriate research and teaching interests and expertise.
- **Research Experiences for Undergraduates (REU)**—A Foundation-wide effort that provides undergraduate students with the opportunity to participate in hands-on research and related scholarly activities. Active research experience is one of the most effective techniques for attracting talented undergraduates to and retaining them in careers in mathematics, science, and engineering. The REU Program is designed to help meet this need. REU has two components: one supports sites for several students; the other supplements awards to existing research grants for one or two students.
- **Special Projects Related to Education and Workforce**—Supports activities to expand opportunities for women, minorities, and persons with disabilities in computer and information science and engineering. Potential proposers are strongly encouraged to contact a program director to discuss their project ideas before submitting a proposal.

4. Special Projects

- **Conferences, Workshops, Symposia, Studies, and Travel**—Supports special workshops, symposia, analytical studies, and travel grants of interest to the CISE Directorate. Potential proposers are strongly encouraged to contact a program director to discuss their project ideas before submitting a proposal.
- **NSF-CONACyT Collaborative Research Opportunities**—Jointly supported between NSF and the Consejo Nacional de Ciencia y Tecnologia (CONACyT) (National Council of Science and Technology Research) of Mexico, supports efforts in international cooperative research and

research infrastructure in computer science, information systems, computer engineering, and engineering research, including environment and manufacturing, civil, chemical, electrical, mechanical, and biomedical systems. Proposals from Mexican researchers and research institutions are selected and administered by CONACyT and are subject to the regulations of the program for the Support of Science in Mexico.

- **NSF-CNPq Collaborative Research Opportunities**—Jointly supported between NSF and CNPq-Conselho Nacional de Desenvolvimento Cientifico e Tecnologico da Pesquisas (National Council of Scientific and Technological Research) of Brazil, supports new efforts in international cooperative research in any CISE-related area where the efforts are likely to produce positive, complementary, and synergistic effects. The program seeks to advance science and engineering knowledge in areas of interest to the CISE Directorate through joint research efforts by investigators who have complementary talents and interests. The initiative capitalizes on the international character of modern scientific research and the ability to conduct collaborative research from a distance through the support of computer network infrastructures.

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 EDUCATION AND HUMAN RESOURCES

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 Educational System Reform (ESR)
- 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 Math and Science Partnership 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 the 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/mathandsciencepp.asp.

DIRECTORATE FOR EDUCATION AND HUMAN RESOURCES

Division of Educational System Reform

The Division of Educational System Reform (ESR) manages a portfolio of programs that encourage and facilitate coordinated approaches to systemic, standards-based reform of science, mathematics, and technology (SMT) education.

Systemic reform relies on partnerships to identify needs, articulate visions, and develop goals, strategies, and activities for improvement of targeted areas. Although each systemic initiative is unique in its approach, all must begin as a collaborative effort among individuals and organizations that are committed to requiring high expectations for all students through challenging educational opportunities. Systemic initiatives catalyze change and cultivate coordination within cities, states, rural areas, school systems, and other organizations involved with education. They result in a comprehensive impact on curricula (inclusive of content, instruction, and assessment), policy, professional development, convergence of intellectual and fiscal resources, broad-based stakeholder support, and student performance.

The ESR Division supports improvement in K-12 SMT education through 84 active projects, supported by the following programs:

1. Urban Systemic Program
2. Rural Systemic Initiatives

Note: There will be no competitions for either the Urban Systemic Program or the Rural Systemic Initiatives in fiscal year 2003.

For More Information

Write to the Division of Educational System Reform, National Science Foundation, 4201 Wilson Boulevard, Room 875, Arlington, VA 22230; or contact by telephone, 703-292-8690; or visit the ESR home page, http://www.ehr.nsf.gov/ehr/esr/.

DIRECTORATE FOR EDUCATION AND HUMAN RESOURCES

Division of Elementary, Secondary, and Informal Education

Science, mathematics, and technology (SMT) education, preK through grade 12 (preK-12), lays the foundation of knowledge and skills needed by future researchers, educators, and technologists; students pursuing post-secondary 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 improve preK-12 SMT education throughout the United States.

ESIE's comprehensive and coherent research-based program portfolio develops the nation's capacity to support high quality SMT education. Innovative instructional materials and student assessments as well as new models for the delivery of teacher professional development, 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 programs increase scientific and technological literacy, as well as develop life-long learning skills that benefit students of all ages. All ESIE programs contribute to development of a knowledge base that informs practice and partnerships that leverage expertise and other resources of major education stakeholders nationwide, including higher education, state and local education agencies, school districts, informal science education institutions, and industry.

ESIE supports the following programs:

1. Teacher Enhancement
2. Centers for Learning and Teaching
3. Instructional Materials Development
4. Informal Science Education
5. Information Technology Experiences for Students and Teachers
6. Presidential Awards for Excellence in Mathematics and Science Teaching
7. 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 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. Teacher Enhancement (TE)

The TE Program develops models for strengthening the teacher workforce by expanding and deepening understanding of content, pedagogy, and instructional technologies; by heightening awareness and deepening understanding of the diverse learning needs of students; by grounding continued professional development in the context of school structure and organization; and by developing a cadre of teachers and administrators who can effectively lead the reform of SMT education.

Eligibility Requirements for TE

The TE Program has special eligibility requirements beyond the standard NSF requirements. For more information, see program solicitation and guidelines NSF 01-60.

2. Centers for Learning and Teaching (CLT)

The CLT's address critical issues and national needs of the science, technology, engineering, and mathematics (STEM) instructional workforce through meaningful partnerships among educational stakeholders, especially Ph.D.-granting institutions, school systems, and informal education organizations. Its goals are to rebuild and diversify the national infrastructure for STEM education; enhance the content knowledge and instructional skills of K-16 STEM educators; and provide substantial opportunities for research into the nature of learning and teaching.

Eligibility Requirements for CLT

The CLT Program has special eligibility requirements beyond the standard NSF requirements. For more information, see program solicitation NSF 02-038.

3. Instructional Materials Development (IMD)

The IMD Program develops high quality, research-based instructional and assessment materials for students that enhance knowledge, thinking skills, and problem-solving abilities of all students, as well as incorporate recent advances in disciplinary content, research on teaching and learning, and instructional technologies. IMD materials are intended to be implemented nationwide and address learning in diverse settings.

Eligibility Requirements for IMD

The IMD Program has special eligibility requirements beyond the standard NSF requirements. For more information, see program solicitation and guidelines NSF 02-067.

4. Informal Science Education (ISE)

The ISE Program provides stimulating experiences for SMT learning outside of formal classroom environments through media, exhibits, and community-based programming. Its goals are to increase the understanding of and participation in SMT disciplines by individuals of all ages; establish linkages between informal and formal education; and stimulate parents and others to support their children's SMT learning endeavors and become informed proponents for high-quality, universally available SMT education.

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 01-60.

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

The ITEST Program seeks to increase the opportunities for students and teachers to learn about, experience, and use information technologies within the context of STEM, including information technology (IT) courses. It responds directly to concern about shortages of technology workers in the United States and builds on the earlier NSF program for youth titled After School Centers for Exploration and New Discovery (ASCEND). Supported projects are intended to provide opportunities for both middle- and high-school students, for their teachers to build the skills and knowledge needed to advance their study, and to function and contribute in a technologically rich society.

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.

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

The PAEMST Program, which was established in 1983 by The White House and managed by NSF, identifies outstanding science and mathematics teachers--in kindergarten through 12th grade--in each state and four U.S. jurisdictions. It is the nation's highest honor for K-12 science and mathematics teachers.

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/.

7. Advanced Technological Education (ATE)

The ESIE Division and the Division of Undergraduate Education jointly manage the ATE Program. ATE 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 three major tracks:

- **Projects**—Activities may include the design and implementation of new courses, laboratories, and educational materials; the adaptation and implementation of exemplary curricula and programs in new educational settings; the preparation and professional development of college faculty and secondary school teachers; internships and field experience for students, faculty, and teachers; or national conferences, workshops, and similar activities that focus on issues in technological education.
- **Centers**—ATE 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.
- **Articulation Partnerships**—These projects 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 SMT preparation of prospective K-12 teachers who are enrolled in preprofessional programs at 2-year colleges. The other type of

Articulation Partnership targets 2-year college programs for students to continue their education in 4-year STEM 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; of students as lifelong learners; and for articulation of educational programs at different levels.

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 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 homepage 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 three 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

Oak Ridge Associated Universities (ORAU) manages the annual application and review process for the NSF Graduate Research Fellowship Program. Write to ORAU at NSF Graduate Research Fellowship Program, P.O. Box 3010, Oak Ridge, TN 37831-3010; or contact ORAU by telephone, 865-353-0905 (toll-free); or by e-mail, nsfgrfp@orau.gov.

Individuals are expected to apply through FastLane at http://www.fastlane.nsf.gov/. Application forms and instructions are also available on the GRF 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 activity 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 (a) be citizens, nationals, or permanent residents of the United States; and (b) be 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)

The 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 operation 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 a 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 five 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 postdocs 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 underrepresented minorities and minority-serving institutions, women and girls, and persons with disabilities at every level of the science and engineering enterprise. 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 by phone, 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 those students who are 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

Program for Gender Equity in Science, Technology, Engineering, and Mathematics (PGE)

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 women as full participants in the mainstream of the Nation's scientific and technological enterprise. PGE 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 socio-psychological, 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 PGE 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 PGE web site, http://www.ehr.nsf.gov/ehr/hrd/pge.asp.

• Persons With Disabilities

Program for Persons with Disabilities (PPD)

PPD is dedicated to increasing the number of people with disabilities employed in the nation's science, engineering, mathematics, and technology workforce. To accomplish this, PPD supports projects designed to:

- bring about needed changes in academic and professional climates;\
- increase awareness and recognition of the needs and capabilities of students with disabilities;
- promote accessibility and appropriateness of instructional materials, media, and educational technologies; and
- increase availability of student enrichment resources, including mentoring activities.

PPD investments help alter the factors that prevent persons with disabilities from accessing STEM education opportunities and subsequent workforce participation.

For More Information
Visit the PPD web site at http://www.ehr.nsf.gov/ehr/hrd/ppd.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 the 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) provides a research-based foundation for teaching and learning in science, technology, engineering, and mathematics (STEM), using the results of research in technology utilization, content, pedagogy, assessment, and policy-oriented studies and indicators. The REC Division supports projects that investigate the learning process and integrate research with educational practices, including those that provide the groundwork for the effective use of technology. The division provides support for NSF's participation in the Interagency Education Research Initiative (IERI); various international comparative studies such as the Third International Mathematics and Science Study (TIMSS); and the EHR Directorate's participation in the agency-wide Faculty Early Career Development Program (see the CAREER home page, http://www.nsf.gov/home/crssprgm/career/). Through periodic program evaluations, REC activities also analyze the development, implementation, and impact of science and mathematics programming across the EHR Directorate.

The REC Division supports the following programs and activities:

1. Research on Learning and Education
2. Interagency Education Research Initiative
3. Evaluation

For More Information

Write to the Division of Research, Evaluation, and Communication, 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 is a comprehensive education research program sponsored by the REC Division that supports the knowledge base that undergirds improvement in math and science instruction; provides more efficient use of educational technologies; and develops a more effective math and science instructional workforce. The ROLE Program supports research in several domains, including basic research in neural and cognitive sciences; teaching, learning, and institutional change processes; exploratory development of new instructional approaches; materials and implementation models whose impact can be systematically evaluated; studies of systemic factors in implementing educational innovations; policy studies; and collaborative research and development proposals on new and evolving information technologies.

2. Interagency Education Research Initiative (IERI)

The REC Division sponsors NSF's participation in the Interagency Education Research Initiative IERI. IERI is a joint program of the U.S. Department of Education, the National Institutes for Child Health and Development (NICHD), and the NSF. The initiative supports research in the adaptation and scaling-up of proven K-12 science, mathematics, and reading interventions.

3. Evaluation

The Evaluation Program provides support for the assessment of NSF education and training programs and coordinates the evaluation of similar initiatives in other federal agencies. The overall purpose of this assessment is program improvement, accountability, and a generation of new knowledge for the education community at large. Evaluations are usually supported through competitively awarded contracts to outside organizations. Additionally, the program solicits proposals for evaluative studies of NSF or other national science and mathematics programs of interest. The program accepts proposals for the development of innovative techniques, approaches, and methodologies for the general improvement of education evaluation.

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. Whether preparing students to participate as citizens in a technological society; enter the workforce with 2- or 4-year degrees; continue their formal education in graduate school; or further their education in response to new career goals or workplace expectations, undergraduate education provides the critical link between the Nation's secondary schools and a society increasingly dependent on science and technology.

DUE's programs and leadership efforts aim to strengthen the vitality of undergraduate science, technology, engineering, and mathematics (STEM) education for all students, including STEM majors, prospective teachers of grades preK through 12, students preparing for the technical workplace, and students in their role as citizens in society at large.

Proposals submitted to programs in DUE are encouraged to incorporate as appropriate, features that address one or more of the following four themes that have been targeted for special emphasis: (1) teacher preparation, (2) professional development for faculty, (3) increasing diversity within STEM fields, and (4) integrating technology in education. Although the activities described below are expected to constitute the majority of projects supported through DUE, proposals that address other mechanisms for improving undergraduate STEM education will be considered.

DUE supports the following programs and activities:

1. Advanced Technological Education
2. Assessment of Student Achievement in Undergraduate Education
3. Computer Science, Engineering, and Mathematics Scholarships
4. Course, Curriculum, and Laboratory Improvement
5. Federal Cyber Service: Scholarship for Service
6. NSF Director's Award for Distinguished Teaching Scholars
7. National Science, Technology, Engineering, and Mathematics Education Digital Library
8. Noyce Scholarships
9. Science, Technology, Engineering, and Mathematics Talent Expansion Program
10. Science, Technology, Engineering, and Mathematics Teacher Preparation

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 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 development of educational materials, courses, curricula, and laboratories; the preparation and professional development of college faculty and secondary school teachers; internships and field experiences for students and educators; and the dissemination of exemplary educational materials, curricula, and pedagogical practices designed by previously funded ATE centers and projects.
- **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.
- **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, curricula, 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. Assessment of Student Achievement (ASA) in Undergraduate Education

The ASA Program supports the development and dissemination of assessment practices, materials (tools), and measures to guide efforts that improve the effectiveness of courses, curricula, programs of study, and academic institutions in promoting student learning in science, technology, engineering, and mathematics (STEM). ASA seeks to support the use of assessment practices by STEM faculty, STEM departments, and institutional administrators seeking to measure student achievement in courses, curricula, programs of study, and the cumulative undergraduate experience embodying some STEM learning.

To help ensure that project results will effectively serve the STEM community, at least one investigator (principal investigator or co-principal investigator) in a project must be a STEM faculty member.

Projects can focus on one or more of the following broad areas:

- Development of new and adapting extant assessment materials that can be used to improve STEM courses and curricula in order to achieve explicit learning objectives;
- Development of methods to assess student achievement resulting from a group of courses that constitute a minor or major field of study;

- Assessment of the impact on student achievement of interdisciplinary learning experiences, student teams, co-curricular activities (e.g., service learning), increased laboratory and field experiences, and other forms of learning enrichment; and
- Development of indicators of student learning within certain domains, and measures of institutional program quality.

For More Information
Visit the ASA Program web site, http://www.ehr.nsf.gov/ehr/due/programs/asa/.

3. 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:

- show status as a U.S. citizen, national, refugee alien, or permanent resident alien at the time of application;
- be enrolled full-time in a computer science, computer technology, engineering, engineering technology, or mathematics degree program at the associate, baccalaureate, or graduate level;
- demonstrate academic potential or ability; and
- demonstrate 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/csems.htm.

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

The CCLI Program supports projects that are expected to improve undergraduate science, technology, engineering, and mathematics (STEM) education by increasing the availability and use of high-quality educational materials and the employment of effective pedagogical strategies. Proposals that address all levels of undergraduate education are encouraged. Proposals to improve introductory level courses, curricula, and laboratories are especially welcome.

The CCLI 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 CCLI Program has three major tracks:

- **Educational Materials Development Track**—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 projects will be supported: (1) those that intend to demonstrate the scientific and educational feasibility of an idea, a "proof of concept," or a prototype and (2) those that are based on prior experience with a prototype that intend to fully develop the product or practice. Such materials are expected to be disseminated nationally for adoption and adaptation.
- **Adaptation and Implementation Track**—Projects are expected to result in improved education in STEM at academic institutions through the adaptation and implementation of exemplary materials, laboratory experiences, and educational practices that have been developed and tested at other institutions. Proposers may request funds in any category normally supported by NSF, or funds for the purchase of instrumentation only. Matching is required on equipment and instrumentation but not on non-instrumentation items. The program invites proposals for projects that enable a group of faculty to explore strategies for overcoming identified challenges and barriers to curricular reform.
- **National Dissemination Track**—Projects are expected to provide faculty with professional development opportunities that will enable them to introduce new content into undergraduate courses and laboratories and explore effective educational practices. Projects should be designed to offer workshops, short courses, or similar activities on a national scale in single or multiple disciplines.

For More Information
Visit the CCLI Program web site,
http://www.ehr.nsf.gov/ehr/due/programs/ccli/.

5. 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 to continue producing professionals in these fields. The program consists of the following scholarship and capacity-building tracks:

- **Scholarship**—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**—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/.

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

The purpose of the DTS Program is to recognize individuals who have demonstrated excellence and promise for future success in both scientific research and the education of undergraduates in science, technology, engineering, and mathematics (STEM). The program promotes the continued and expanded efforts of individuals with a history of impact on both (a) the research in a STEM discipline or on STEM educational research and (b) the STEM education of undergraduates, including those who are not STEM majors. 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/.

7. 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: 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/.

8. Noyce Scholarships

The Noyce Program provides funding for colleges and universities to award scholarships designed to recruit and prepare K-12 mathematics and science teachers. Institutions are expected to provide the programming and support to enable scholarship recipients to become successful elementary or secondary teachers. Scholarships may be designated for juniors or seniors, or career-changing professionals in STEM fields seeking to become K-12 teachers.

For More Information
For specific information on eligibility, visit the Noyce Program web site, http://www.ehr.nsf.gov/ehr/due/programs/noyce/.

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

The STEP Program 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 associates degrees or baccalaureate degrees in science, technology, engineering, and mathematics (STEM).

For More Information
Visit the STEP Program web site, http://www.ehr.nsf.gov/ehr/due/programs/step/.

10. Science, Technology, Engineering, and Mathematics Teacher Preparation (STEMTP)

The STEMTP Program supports efforts to develop exemplary science and mathematics preK-12 teacher preparation models through partnerships involving science, mathematics, engineering, technology, and education faculty at 2- and 4-year institutions of higher education and local school districts. The goals of the program are:

- to increase significantly the number of preK-12 teachers who are certified and well qualified to teach mathematics and science; and
- to improve the quality of preservice education, induction, and continued professional growth in mathematics and science for preK-12 teachers.

Projects must address local needs for increased numbers of teachers who are well qualified to teach mathematics and science by providing strategies for recruiting and retaining teachers in the workforce. The STEMTP Program offers the following two areas of focus:

- **Baccalaureate and 5-Year Programs**—Projects are expected to include strategies for ensuring that preservice students acquire STEM content and pedagogical knowledge and skills for successful teaching.
- **Alternative Pathways to Teaching**—Projects are expected to design and implement alternative credentialing programs for STEM professionals and recent STEM graduates in order to facilitate their entry into the teaching profession.

For More Information
Visit the STEMTP Program web site, http://www.ehr.nsf.gov/ehr/due/programs/stemtp/.

DIRECTORATE FOR EDUCATION AND HUMAN RESOURCES

Experimental Program to Stimulate Competitive Research

The Experimental Program to Stimulate Competitive Research (EPSCoR) increases the research and development (R&D) competitiveness of 21 States and the Commonwealth of Puerto Rico. The States are Alabama, Alaska, Arkansas, Hawaii, Idaho, Kansas, Kentucky, Louisiana, Maine, Mississippi, Montana, Nebraska, New Mexico, Nevada, North Dakota, Oklahoma, South Carolina, South Dakota, Vermont, West Virginia, and Wyoming.

EPSCoR offers two types of funding to improve research and development competitiveness in eligible jurisdictions. They are:

1. **EPSCoR Research Infrastructure Improvement Awards**—These grants provide up to $9 million for 36 months to support infrastructure improvements in science and technology areas selected by the state's EPSCoR governing committee as being important to the state's future R&D competitiveness and economic development. A 50 percent non-federal match, up to $4.5 million, is required.
2. **EPSCoR Co-funding**—This investment provides partial support for proposals that have undergone merit review and are at or near the cutoff for funding by regular programs and special initiatives throughout NSF.

EPSCoR Outreach

EPSCoR outreach investment provides financial support for visits by NSF staff to acquaint EPSCoR researchers and their institutions with NSF priorities, programs, and policies, as well as acquaint NSF staff more fully with the R&D resources residing in EPSCoR jurisdictions. Procedures for institutional outreach visits are located on the EPSCoR web site.

For More Information

Write to EPSCoR, Directorate for Education and Human Resources, National Science Foundation, 4201 Wilson Boulevard, Room 875, Arlington, VA 22230; or contact the program by telephone, 703-292-8683; or by e-mail, jhoehn@nsf.gov; or visit the EPSCoR home page, http://www.ehr.nsf.gov/epscor/.

DIRECTORATE FOR ENGINEERING

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, the 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/.

Crosscutting Programs and Activities

NSF-Wide Activities

In addition to the programs and activities mentioned in this section, the Directorate for Engineering (ENG) also takes an active role in the following NSF-wide programs and activities: Nanoscale Science and Engineering, Biocomplexity in the Environment, Information Technology Research, Workforce for the 21st Century, 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. These include the Combined Research-Curriculum Development Program and supplemental support for underrepresented research assistants on engineering grants. 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 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; technologies for avoiding pollution; and technology to limit fouling of the ocean (see the Environmental Engineering Program, below, 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

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 within the program include the following:

- **Post-Genomic 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 to the reduction 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. Emphasis is on the advancement of fundamental engineering knowledge rather than on product development. 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

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 the 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 improving the living standards and prolonging life as well as protecting the natural environment. The Division of Chemical and Transport Systems (CTS) supports research that contributes to the knowledge base important for 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, and energy, as well as 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, 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 and 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; bio-inspired 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 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 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 non-intrusive measurement techniques are supported, as well as 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 like 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
2. Geotechnical and Geohazards Systems
3. Infrastructure and Information Systems
4. Solid Mechanics and Materials Engineering
5. Structural Systems and Engineering
6. National Science Foundation (NSF) George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES)

The CMS Division also manages the Network for Earthquake Engineering Simulation (NEES) Program, a project funded within the Major Research Equipment and Facilities Construction Account that began construction in fiscal year 2000 and is expected to continue through 2004. For further information, visit the program's web site, http://www.eng.nsf.gov/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 (GHS)

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. GHS 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 and 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. National Science Foundation (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 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.

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. We welcome personal visits as well.

• 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/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, 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 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
2. Materials Processing and Manufacturing
3. Nanomanufacturing

For More Information
Visit the Manufacturing Processes and Equipment Systems Cluster web site, http://www.eng.nsf.gov/dmii/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 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. The GOALI Initiative targets high-risk and 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 improve the performance of industry, education, service, health care, government, and other organizations and institutions through the support of research on theories, concepts, and methodologies of innovation and organizational change. The Directorates for Engineering; Social, Behavioral, and Economic Sciences; and Education and Human Resources jointly support IOC. The program supports research that combines theory with empirical validation to understand effective approaches to organizational learning and redesign, strategic and cultural change, quality and process improvement, innovation, new product and service development, and development and integration of new technologies. Proposers should work with partner organizations in industry, education, health care, government, or service.

DIRECTORATE FOR ENGINEERING

Division of Electrical and Communications Systems

The Division of Electrical and Communications Systems (ECS) addresses the fundamental research issues underlying both the 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 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.

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 whose themes 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
2. Control, Networks, and Computational Intelligence
3. Integrative Systems
4. Human 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, electrooptics, 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. Adaptive and reconfigurable devices and low-power/low-noise electronics are used in novel network architectures and advanced communications systems. Microsensors and microactuators are used in diverse areas ranging from industry and defense applications to biology and medicine. The program invites proposals for research that can lead to high performance of 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 and energy, and transportation systems. 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 is 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 incorporate microsystem transmitters, receivers, antennas, and sensors and constitute 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 in order to capture a breadth of expertise.

4. Human Resources and Infrastructure

In partnership with other NSF directorates and government agencies, provides nationwide research and education resources, including the National Nanofabrication Users Network. NSF's Science and Technology Centers (STCs), Engineering Research Centers (ERCs), Industry/University Cooperative

Research Centers (I/UCRC), and Integrative Graduate Education and Research Traineeship (IGERT) Programs affect many of the research areas of the electrical and communications systems community. Researchers and educators are encouraged to build linkages with these facilities and to fully utilize the infrastructure. The ECS Division 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, the ECS Division encourages the participation in the development of cross-disciplinary group awards. The Combined Research-Curriculum Development (CRCD) Program offers an opportunity to infuse the latest research developments into the electrical engineering curriculum. Current principal investigators are encouraged to apply for supplemental grants via programs like Research Experience for Undergraduates (REU), Research Experience for Teachers, 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 and 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
2. Industry/University Cooperative Research Centers
3. Engineering Education
4. Combined Research-Curriculum Development
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 practice. 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 curricula that will attract and retain increased numbers of engineering students, especially women, underrepresented minorities, and people with disabilities. The Engineering Education Program supports the implementation of new approaches to educate engineers and encourage outstanding students-particularly from underrepresented groups-to enter the field. The program builds on successful innovations from the NSF Engineering Education Coalitions and other new concepts for the reform and improvement of engineering education, and seeks to involve research-active scholars more actively in education innovation.

The EEC Division participates in NSF's Workforce for the 21st Century priority area, building on successes and experiences in the systemic reform of education in grades K-12. EEC also 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. Combined Research-Curriculum Development Program

Curriculum Development Program-Supports curriculum development projects that integrate new state-of-the-art research advances in emerging technological areas into upper-level undergraduate and introductory graduate engineering and computer and information science curricula.

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, additional 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, and not for general assistance such as wheelchairs or ramps.

DIRECTORATE FOR GEOSCIENCES

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 this section, the Directorate for Geosciences takes an active role in the following crosscutting programs and activities:

- Environment and Global Change, Including the Regional Institutes for Global Change Research
- Information Technology Research
- Biocomplexity in the Environment
- Nanoscale Science and Engineering
- Workforce for the 21st Century
- Experimental Program to Stimulate Competitive Research (EPSCoR)
- Earth System History (ESH)
- Graduate Teaching Fellows in K-12 Education (GK-12)
- Grant Opportunities for Academic Liaison with Industry (GOALI)
- Integrated Carbon Cycle Research
- Major Research Instrumentation (MRI)
- Opportunities for Research Collaborations between Mathematical Sciences and Geosciences (CMG)
- Partnerships for Innovation (PFI)
- Science and Technology Centers (STCs): Integrative Partnerships
- Water Cycle Research

For More Information
Visit the NSF Crosscutting Programs home page, http://www.nsf.gov/home/crssprgm/.

Education and Outreach Activities

Global Learning and Observations to Benefit the Environment

In addition to the discipline-specific education and outreach activities supported by the Directorate for Geosciences, the directorate participates in the multiagency Global Learning and Observations to Benefit the Environment (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 (EHR) 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 program announcement is issued annually. The intent of the program is to support geoscience education activities that integrate geoscience research and education and lead to improvements in the quality of geoscience education. 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
Contact Ms. Jewel Prendeville by e-mail, jprendev@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 and 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 A. Mayhew by email, mmayhew@nsf.gov; or visit the GEO Directorate home page, http://www.geo.nsf.gov/.

Opportunities for Enhancing Diversity in the Geosciences

The Opportunities for Enhancing Diversity in the Geosciences (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 Ms. Jewel Prendeville by e-mail, jprendev@nsf.gov; or visit the GEO Directorate home page, http://www.geo.nsf.gov/geo/diversity/. Suggestions and comments related to this new effort can be sent to geo_diversity@nsf.gov.

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)
- Minority Research Planning Grants and Minority Career Advancement Awards (MRPG/MCAA)
- Presidential Early Career Awards for Scientists and Engineers (PECASE)
- Program for Persons with Disabilities (PPD)
- 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/crssprgm/.

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 contact 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 in excess of $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/, located on the NCAR home page.

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 the 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 the 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
2. Upper Atmospheric Facilities
3. National Center for Atmospheric Research
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), 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, MA, 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 mid-latitude 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://jro.ece.cornell.edu/overview.html.

3. National Center for Atmospheric Research

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 datasets, 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 Support Programs
- Special Emphasis Areas

The Core Research section supports 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.

The Special Emphasis section includes research directed toward special scientific opportunities or that accommodates 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, paleomagnetics, 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 listed can be found in the corresponding program announcement listed (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 00-11)
- 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.geo.nsf.gov/cgi-bin/showprog.pl?id=63&div=ear.)

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 seafloor sediments, their interstitial waters, and overlying seawater; fates of materials deposited on the seafloor; 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 seafloor 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 mid-ocean 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 of 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, and the development of downhole tools and instrumentation as these tasks are identified.

Other Pertinent Information Regarding ODP

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. Educational Opportunities

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 website, 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. Educational Opportunities

Provides support for programs, many of them agency-wide, emphasizing educational opportunities at all levels.

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 MATHEMATICAL AND PHYSICAL SCIENCES

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 a number of interagency and intra-agency programs that focus on interdisciplinary areas of importance to the national interest. These programs include advanced materials and processing; biotechnology; environment and global change; high-performance computing and communications; advanced manufacturing technologies; civil infrastructure systems; and science, mathematics, engineering, and technology 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

In 1995, the Office of Multidisciplinary Activities (OMA) was established in the Directorate for Mathematical and Physical Sciences and charged with facilitating and supporting opportunities in research and education that cross 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 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 2003 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)

Utilizes 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 01-39).

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 facilities, and a variety of special programs.

AST supports the development and operation of four National Astronomy Centers: National Optical Astronomy Observatory (NOAO), National Solar Observatory (NSO), National Radio Astronomy Observatory (NRAO), and National Astronomy and Ionosphere Center (NAIC). AST also provides the U.S. share of funding for the operation of the Gemini Observatory, an international partnership that has 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 at the centers give technical assistance to visiting scientists, conduct research of their own, and develop advanced instrumentation. 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:

- Research Projects and Instrumentation
- 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.

• Research Projects And Instrumentation

The Research Projects and Instrumentation category consists of the following astronomy and astrophysics grant programs:

1. Extragalactic Astronomy and Cosmology
2. Galactic Astronomy
3. Planetary Astronomy
4. Stellar Astronomy and Astrophysics
5. Education, Human Resources, and Special Programs

6. Electromagnetic Spectrum Management
7. Advanced Technologies and Instrumentation
8. University Radio Observatories

1. Extragalactic Astronomy and Cosmology (EXC)

Theoretical and observational studies of extragalactic objects-ranging from nearby galaxies to the most distant quasars-and their relevance to galactic evolution and cosmology.

2. Galactic Astronomy (GAL)

Theoretical and observational studies on the structure and evolution of the Milky Way galaxy and nearby galaxies. Research may focus on the stellar populations in these galaxies; the characteristics of star clusters; the interstellar medium; and the properties of atoms and molecular constituents of the interstellar medium.

3. Planetary Astronomy (PLA)

Theoretical and observational studies of the detailed structure and composition of planetary surfaces, interiors, atmospheres, and satellites; the nature of small bodies (asteroids and comets); and the origin and development of the solar system.

4. Stellar Astronomy and Astrophysics (SAA)

Theoretical and observational studies of the structure and activity of the Sun and other stars; the physical properties of all types of stars; all aspects of star formation and stellar evolution; stellar nucleosynthesis; and the properties of atoms and molecules of relevance to stellar astronomy.

5. Education, Human Resources, and Special Programs

Coordinates research support in special areas and educational and outreach programs that are related to astronomy. Programs include Research Experiences for Undergraduates (REU) Sites and Supplements, Faculty Early Career Development (CAREER), Presidential Early Career Awards for Scientists and Engineers (PECASE), Research at Undergraduate Institutions (RUI), Research Opportunity Awards (ROA), NSF Astronomy and Astrophysics Postdoctoral Fellowships (AAPF), and programs for underrepresented minorities. Additional information on NSF-wide programs can be found on the NSF Crosscutting Programs home page, http://www.nsf.gov/home/crssprgm/.

6. Electromagnetic Spectrum Management

Ensures the access of the scientific community to portions of the radio spectrum that are needed for research purposes. With other government agencies, coordinates the use of the radio spectrum for research purposes and obtains spectrum support for NSF radio communication systems, when required.

7. Advanced Technologies and Instrumentation

Supports the development and construction of state-of-the-art detectors and instruments for the visible, infrared, and radio regions of the spectrum; interferometric imaging instrumentation; adaptive optics; and

the application of new hardware and software technology and innovative techniques in astronomical research. Proposals should clearly identify the astronomical measurement objectives that will be enabled and include a brief task implementation plan with milestones, schedules, and costs.

8. University Radio Observatories

Supports university-based observatories as centers for focused and innovative scientific and technical achievement, emphasizing the training of young radio astronomers. Fosters hands-on involvement of students in instrument building and telescope operations to help maintain the future health of U.S. radio astronomy.

• Facilities

The Facilities section 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 Astronomical Sciences Division supports the following facilities:

1. Gemini Observatory
2. National Astronomy and Ionosphere Center
3. National Optical Astronomy Observatory
    - Kitt Peak National Observatory
    - Cerro Tololo Inter-American Observatory
    - U.S. Gemini Program
4. National Radio Astronomy Observatory
5. National Solar Observatory

1. Gemini Observatory

An international partnership involving the United States, the United Kingdom, Canada, Australia, Chile, Brazil, and Argentina. The project involves the construction and operation of 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. Scientific operations began on Gemini North in 2000 and on Gemini South in summer 2001.

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.-a consortium of 20 major universities-manages the Gemini Observatory.

For More Information
Visit the Gemini Observatory home page, http://www.gemini.edu/.

2. National Astronomy and Ionosphere Center (NAIC)

A visitor-oriented national research center, supported by NSF and focusing 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/.

3. National Optical Astronomy Observatory (NOAO)

A national center for research in ground-based optical and infrared astronomy, supported by NSF. It has large optical telescopes, observing instrumentation, and data analysis equipment. The NOAO staff of astronomers, engineers, and various support personnel are available to assist qualified visiting scientists in their use of the facilities.

NOAO, whose headquarters are in Tucson, Arizona, 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, and a 2.1-meter general-purpose reflector. Numerous other telescopes operated by universities or private consortia are also tenants on Kitt Peak. A full complement of state-of-the-art spectroscopic and imaging instrumentation is available for use on these telescopes.
- **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, which is a near twin to the 4-meter Mayall at Kitt Peak, and a general-purpose 1.5-meter reflector. These telescopes are equipped with instruments similar to those at KPNO. Several other telescopes operated by U.S. universities are also located on Cerro Tololo. A new technology 4-meter telescope (Southern Observatory for Astrophysical Research-SOAR) is under construction on nearby Cerro Pachon.
- **The U.S. Gemini Program (USGP)** at NOAO serves as the gateway to the International Gemini Observatory for the U.S. astronomical community and represents the U.S. scientific, technical, and instrumentation interests in the international community of the Gemini Project.

For More Information
Write to the Director, National Optical Astronomy Observatories, P.O. Box 26732, Tucson, AZ 85726; or visit the NOAO home page, http://www.noao.edu/noao.html.

4. National Radio Astronomy Observatory (NRAO)

Offers the use of radio astronomy facilities to qualified scientists. The staff at NRAO helps visiting scientists use the large radio antennas, receivers, and other equipment needed to detect, measure, and identify radio waves from astronomical objects.

NRAO headquarters are in Charlottesville, VA. Observing sites are in Green Bank, West Virginia; a site 80 kilometers west of Socorro, New Mexico; and 10 other sites in the continental United States and on the islands of Hawaii and St. Croix, U.S. Virgin Islands. The St. Croix site includes individual antennas of the Very-Long-Baseline Array (VLBA). NRAO is supported under the terms of a cooperative agreement between NSF and Associated Universities, Inc. (AUI), the organization responsible for the operation and management of the observatory.

The new 100-meter Robert C. Byrd Green Bank Telescope, dedicated in August 2000, is now being commissioned and has begun limited scientific use. The Very Large Array (VLA) telescope, located west of Socorro, New Mexico, consists of 27 antennas and carries out aperture synthesis observations of faint radio sources at high angular resolution. The VLBA is a transcontinental network of 10 25-meter antennas that operate at frequencies ranging from 330 MHz to 43 GHz. It carries out ultra-high-resolution studies of extragalactic and galactic sources and allows users to observe both continuum and spectral line emission.

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/.

5. 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, 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. The NSO also 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).

For More Information
Visit the NSO home page, http://www.nso.edu/; or write to the Director, National Solar Observatory, Box 62, Sunspot, NM 88349.

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 those 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
- Other Programs of Interest

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 both 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**—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; algebraic geometry; quadratic forms and automorphic forms; and combinatorics and graph theory.

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. National Radio Astronomy Observatory (NRAO)

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.

5. Geometric Analysis

Supports research on differential geometry and its relation to partial differential equation 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, discrete and combinatorial 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 and the foundations of mathematics, including proof theory, recursion theory, model theory, set theory, and infinitary combinatorics.

• Other Programs Of Interest

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. Grants for Vertical Integration of Research and Education
4. Cross-Disciplinary Interaction

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, Palo Alto, CA; see http://www.aimath.org/;
- Institute for Advanced Study, School of Mathematics, Princeton, NJ; see http://www.math.ias.edu/;
- Institute for Mathematics and its Applications, Minneapolis, MN; see http://www.ima.umn.edu/;
- Institute for Pure and Applied Mathematics, Los Angeles, CA; see http://www.ipam.ucla.edu/;
- Mathematical Biosciences Institute, Columbus, OH; see http://mbi.osu.edu/;
- Mathematical Sciences Research Institute, Berkeley, CA; see http://www.msri.org/; and
- Statistical and Applied Mathematical Sciences Institute, Research Triangle Park, NC; see 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 website 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 one-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 25 and 30 new fellows in 2003. 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, 2003; (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, 2003.

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. Grants for Vertical Integration of Research and Education (VIGRE)

The long-range goal of the VIGRE activity in DMS is to increase the number of U.S. citizens, nationals, and permanent residents who are well prepared to pursue careers in the mathematical sciences. VIGRE is designed to stimulate innovative educational projects that

- integrate research with educational activities;
- enhance interaction among undergraduates, graduate students, postdoctoral associates, and faculty members;
- broaden the educational experiences of its students and postdoctoral associates to prepare them for a wide range of career opportunities; and
- motivate more students to pursue an education in the mathematical sciences.

VIGRE provides funds for institutions with Ph.D.-granting departments in the mathematical sciences to support postdoctoral associate positions with enhanced opportunities for research, graduate research traineeships, and research experiences for undergraduates. The program focuses on the effectiveness of the educational experience of students and postdoctoral associates in preparing them to become successful researchers, communicators, and mentors.

4. Cross-Disciplinary Interaction

A number of areas in science and engineering have problems of great mathematical and statistical complexity or obscurity that are creating a demand for mathematical and statistical cooperation. The

depth of the problems being raised often exceeds that of the training of the scientists and engineers currently in mathematical and statistical theory. To progress in solving these problems, mathematical scientists must be sought to work in tandem with other scientists. At the same time, the problems posed often stimulate interesting, new, and deep mathematical and statistical questions that deserve attention. DMS hopes to foster interactions that require the participants to go well beyond their respective areas of expertise, to nurture young talent in the interdisciplinary mode of research, and to involve underrepresented groups whenever possible.

The following are some of the exciting research opportunities:

- In the area of biosciences and biocomplexity, striking advances in biology, computer science, and the mathematical sciences are creating opportunities to collaborate on research work in fields such as molecular biology, neuroscience, and ecosystems, and offer challenging computational and analytical problems. Biological sciences interaction may extend significantly into the core areas of mathematics, such as topology, operator algebra, probability, and nonlinear dynamical systems, as well as the more traditional areas of applied mathematics and statistics.
- Other opportunities include research in the areas of high-performance computing and communications; research in information technology; mathematical and statistical aspects of materials behavior and theoretical continuum mechanics; geosciences; advanced manufacturing technologies; mathematical sciences related to biotechnology; and mathematical, statistical, and computational aspects of global change research. Research in the area of materials includes interaction of thermal and mechanical effects; nanoscale science, phase transition, and formation of microstructures and crystals; foundations of nonlinear elasticity and electromagnetic materials; composite materials; and related mathematical questions such as control, optimization, and studies of differential equations arising in these contexts. Research opportunities in advanced manufacturing particularly emphasize simulation, modeling, and analysis of manufacturing processes and devices; applications for manufacturing of deterministic and stochastic quality control; and optimization. Mathematical science research related to biocomplexity, bioprocessing and bioconversion, bioelectronics and bionetworks, agricultural applications, and marine biotechnology is especially encouraged.
- Environmental research supports the critical development of modeling, analysis, simulation, and prediction in the context of the total Earth system. A particular emphasis is placed on analytical and computational methods for stochastic and deterministic partial differential equations and statistical techniques that encompass the full range of temporal and spatial scales. There also are opportunities in environmental technology, including pollution prevention, monitoring, and remediation. Researchers should be aware of the implications of their efforts toward such activities.

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 Gravity 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. Elementary Particle Physics
3. Gravitational Physics
4. Nuclear Physics
5. Particle and Nuclear Astrophysics
6. Theoretical Physics
7. Education and Interdisciplinary Research
8. Physics Frontiers Centers

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. 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 the 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.

3. Gravitational Physics

Emphasizes the theory of strong gravitational fields and their application to astrophysics and cosmology, computer simulations of strong and gravitational fields, and 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.

4. Nuclear Physics

Supports research on 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.

5. Particle and Nuclear Astrophysics

Supports university groups conducting research in particle and nuclear astrophysics. Current supported activities are 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.

6. 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.

7. 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. The program supports research at the interface between physics and other disciplines, with particular emphasis on biological physics, but 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.

8. 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. No solicitation will be released in fiscal year 2003.

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. Similarly, support for the development of infrastructure in chemistry also is 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. Chemistry of Materials
8. Office of Special Projects
9. 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. Chemistry of Materials

Supports chemistry aspects of research problems related to the design, synthesis, and characterization of advanced materials. Emphasis is on projects that take a chemistry-based molecular or supramolecular approach to materials synthesis and performance from an experimental, theoretical, and computational perspective. Current research areas include the synthesis of new molecular organic, inorganic, and organometallic precursors to polymeric, ceramic, electronic, photonic, magnetic, and biomolecular materials; chemical reactivity of polymeric, microporous, and other solid substrates; chemistry of thin films and interfaces as applied to materials performance; synthesis of new molecular nanoscopic materials with novel or improved properties; research on catalysts and reactive molecular intermediates for materials synthesis; the molecular basis of materials properties and performance, such as nonlinear optical activity, conductivity, magnetism, and liquid crystalline behavior; molecular switching and electronics; and supramolecular self-assembly. The activity is strongly linked to several programs in the Materials Research Division (MPS Directorate) and in the ENG and BIO Directorates.

8. 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, Faculty Early Career Development, and Research Sites for Educators in Chemistry, 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.

9. 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 materials, materials synthesis and processing, structure and composition, properties and performance, and materials education. DMR supports individual investigators, groups, centers, national facilities, and instrumentation. Individual investigator and group proposals do not have to be confined or targeted to a specific program; division staff work to facilitate the co-review and co-funding of highly meritorious proposals across program, division, or directorate boundaries as appropriate.

DMR-supported programs and activities are organized into the following categories:

- DMR Programs
- Other DMR Activities of Interest

For More Information

For lists of awards and abstracts, target and deadline dates for proposal submission, or further information about 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

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. National Facilities

For More Information

For lists of awards and their abstracts, target dates and deadlines for proposal submission, or more information about 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 involving advanced scientific computing. Emphasis is on approaches that begin at the smallest appropriate length scale, such as 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; 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)

Supports 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.

For More Information
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 (1) major shared instruments essential to investigators conducting research that spans two or more disciplinary areas within DMR, or more than one NSF division, and (2) 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. For more information, see program announcement NSF 01-05.

10. National Facilities

Supports the operation of National User Facilities, which are 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, small-angle 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
Reactor Radiation Division
Gaithersburg, MD 20899
Telephone: 301-975-6242
Web address: http://rrdjazz.nist.gov/

Cornell High-Energy Synchrotron Source
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 32306-4005
Telephone: 850-644-0311 or 850-644-0850
Web address: http://www.magnet.fsu.edu/

Synchrotron Radiation Center
University of Wisconsin at Madison
3731 Schneider Drive
Stoughton, WI 53589-2200
Telephone: 608-877-2000
Web address: http://www.src.wisc.edu/

National Nanofabrication Users Network
Web address: http://www.nnun.org/

• Other DMR Activities Of Interest

The Division of Materials Research (DMR) also supports complementary activities that cut across programmatic lines in many cases. These include awards for Research Experiences for Undergraduates Sites and Supplements, Presidential Early Career Awards for Scientists and Engineers, Faculty Early Career Development, Research at Undergraduate Institutions, Research Opportunity Awards, support for underrepresented minorities, international activities, awards in materials education, and awards for faculty groups addressing problems with broader scope than traditional individual investigator grants. In addition, DMR activities are intrinsic to NSF-wide areas of focus such as nanoscale science and engineering. Some of these activities are described briefly in this section. They include:

1. Focused Research Groups
2. Research Experiences for Undergraduates and Research Experiences for Teachers
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)

For More Information
For more detailed descriptions of these programs, visit the NSF Crosscutting Programs home page, http://www.nsf.gov/home/crssprgm/, or the DMR home page at http://www.nsf.gov/mps/divisions/dmr/.

1. Focused Research Groups (FRGs)

These are materials research projects that generally are smaller than centers (MRSECs) 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 among 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/.

2. Research Experiences for Undergraduates (REU) and Research Experiences for Teachers (RET)

DMR supports more than 60 REU Sites, as well as REU supplements for undergraduate participation in research awards. Awards are made in conjunction with the NSF-wide REU Program. 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/.

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. Current awards are listed on the DMR web page, http://www.nsf.gov/mps/divisions/dmr/research/edawards.doc.

4. Opportunities for International Cooperation in Materials Research

DMR supports a growing number of activities to 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 Division of International Programs and other NSF units, 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. A specific example is the program for cooperative activities with Europe, in partnership with the European Community, described in more detail in program announcement NSF 01-105.

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 involving 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 02-096.

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

DMR supports a wide range of GOALI awards in materials. The GOALI Initiative aims to synergize 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. This initiative targets high-risk/high-gain research with a focus on fundamental topics that would not have been 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, see the GOALI Initiative homepage at http://www.nsf.gov/home/crssprgm/goali/.

OFFICE OF POLAR PROGRAMS

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.

Foundation funding for polar research and education comes from the following sources:

- Antarctic Sciences (Office of Polar Programs)
- Arctic Sciences (Office of Polar Programs)
- Educational Activities* (Education and Human Resources Directorate)
- Crosscutting Programs (Foundation-wide)

**Note: Although these areas of NSF do not generally offer polar-specific programs, they can consider and support polar proposals.*

For More Information

Visit the Office of Polar Programs (OPP) home page, http://www.nsf.gov/od/opp/; or visit the OPP Advisory Committee web page to read about ongoing issues regarding OPP and the NSF merit review criterion 2 (broader impacts), http://www.nsf.gov/od/opp/opp_advisory/oaccrit2.htm; or the NSF home page, http://www.nsf.gov/. Further information on the NSF Merit Review Criteria is also available in the Introduction section of this Guide.

United States Antarctic Program

The United States Antarctic Program (USAP) 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.

USAP-supported research has two thrusts:

- to understand the Earth and its systems, with emphasis on Antarctica's influence on and response to these systems; and
- to utilize Antarctica as a research site by supporting studies made possible by the unusual and extreme conditions on the continent and in the surrounding ocean.

USAP supports research that is *best* carried out in the Antarctic, or that can be carried out *only* in the Antarctic.

The Office of Polar Programs Antarctic research support is available through the following programs:

1. Antarctic Aeronomy and Astrophysics
2. Antarctic Biology and Medicine
3. Antarctic Geology and Geophysics
4. Antarctic Glaciology
5. Antarctic Ocean and Climate Systems
6. Antarctic Operational Support

Non-U.S. Facilities–International Cooperation

NSF encourages scientists from the United States to participate in cooperative research programs and activities sponsored by and/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 Requirements for USAP

U.S. academic institutions and academically oriented, nonprofit organizations may submit proposals for research support. Industrial firms and state and local agencies may be eligible. Other federal agencies may coordinate their research needs within the framework of NSF-supported Antarctic logistics.

NSF encourages proposals from everyone, including women, minorities, and persons with disabilities,

as well as proposals for research that includes undergraduates as stated in the guidelines established by NSF programs such as Research Experiences for Undergraduates.

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.

Deadlines and Target Dates for USAP

The annual deadline for receipt of proposals for the U.S. Antarctic Program (Office of Polar Programs) is June 1.

Crosscutting programs and education programs may have different deadlines.

An "Operational Requirements Worksheet" (available at http://esp.polar.org/) is required if the proposed project will involve fieldwork in the Antarctic. This includes the use of NSF-funded ice-capable Antarctic research ships. The worksheets have a deadline of June 1, 2003, for projects that would take place in the Antarctic beginning in the 2004-2005 austral summer.

To confirm a deadline date, refer to the NSF E-Bulletin (http://www.nsf.gov/home/ebulletin/); or the OPP home page, http://www.nsf.gov/od/opp/; or the appropriate program office.

Literature

Although NSF program announcements and guidelines remain the primary starting point for individuals interested in applying for NSF support, additional resources are available that can also provide valuable information. A range of literature referencing research priorities for the Antarctic is available on the OPP home page, http://www.nsf.gov/od/opp/. Contact the source indicated.

In addition, the following are also available:

- Publications containing research recommendations, available from the National Academy of Sciences (NAS). Write to the Polar Research Board, 500 5th Street, N.W., TNA-751, Washington, DC 20011; or contact by telephone, 202-334-3479; or visit the NAS home page, http://www.nas.edu/.
- *Antarctic Bibliography*, in cooperation with NSF is published by the American Geological Institute (AGI) under cooperative agreement OPP 99-09727. You can search the Antarctic database at http://www.coldregions.org/. Under a cooperative agreement between AGI and the National Information Services Corporation (NISC), the *Antarctic Bibliography* (and other polar bibliographies) is collectively available online at the NISC home page, http://www.nisc.com/, and also on CD-ROM.
- The U.S. Geological Survey (USGS) in a joint program with NSF, has Antarctic reconnaissance and geologic maps of portions of Antarctica at various scales; maps of the entire continent; an extensive collection of Antarctic aerial photographs; current and historical handheld photography; and other materials. For more information, visit the USGS United States Antarctic Resource Center web site, http://usarc.usgs.gov/.
- Ice cores, seabed cores, terrestrial sedimentary cores, dredged rocks, biotic specimens, meteorites, and seafloor photographs are available for study. For more information, refer to the *Antarctic Research Program Announcement* (NSF 02-086).
- NSF's Antarctic Artists and Writers Program supports documentation of America's Antarctic heritage by providing field access (but not funds) to painters, poets, photographers, authors, educational specialists, and representatives of related genres. For complete information about this program, including details on eligibility criteria, visit the Antarctic Artists and Writers Program web site, http://www.nsf.gov/od/opp/.

For More Information

For further information, including the areas of research supported by USAP; material to help proposers evaluate the potential environmental impact of their projects; and descriptions of operational needs in Antarctica, refer to the *Antarctic Research Program Announcement* (NSF 02-086).

For questions regarding field operations and logistics to Antarctica, contact the Polar Research Support Section at 703-292-8032; or visit the Raytheon Polar Services Company web site, http://www.polar.org/.

Research and education proposals that will not require fieldwork or that will use samples already in U.S. depositories are welcome.

For further information, contact the Office of Polar Programs, National Science Foundation, 4201 Wilson Boulevard, Room 755, Arlington, VA 22230; or visit the OPP home page, http://www.nsf.gov/od/opp/. Specialists are available in each of the science areas discussed in this section, as well as in logistics, field camps, research ships, laboratory support, waste management, environmental protection, safety, and Antarctic Conservation Act permits.

1. Antarctic Aeronomy and Astrophysics

Supports research projects in the following areas:

- **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 effective sky temperature, isolation from noise, and long periods of clear weather provide superior observing conditions.
- **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 weigh more than a ton and can reach altitudes of approximately 40 kilometers. The balloons then drift once or twice over the South Pole during a 10- to 30-day period. This capability can be used by several disciplines and in some cases can serve as a low-cost substitute for space flight.
- **Upper Atmosphere Physics**—Supports unique studies of the Earth's magnetosphere and ionosphere and of Sun/Earth relationships. Year-round station-based research is possible in Antarctica because of its physically stable location at high geomagnetic latitudes, which range from 53° south at Palmer Station to 79° south at McMurdo Station. Automatic Geophysical Observatories provide year-round support for low-powered autonomous instruments at several remote sites on the ice sheet. Research objectives include improving the understanding of Earth's upper atmosphere and near-space environment; investigating coupling among the neutral atmosphere, the ionosphere, and the magnetosphere; and investigating solar terrestrial effects.

2. Antarctic Biology and Medicine

Supports research projects in the following areas:

- **Marine Biology/Biological Oceanography**—Supports research on the oceans around Antarctica, which 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 and to determine the adaptations of organisms and acquire more knowledge of their distribution, abundance, and dynamics. The major focus is on ship- and shore-based studies that stress trophodynamics, including detailed investigations at all trophic levels. Topics of particular interest include interdisciplinary studies of carbon and nutrient cycling, krill, ice-edge ecosystems, and low-temperature adaptations.
- **Medical Research**—Biomedical studies are directed toward physiological and psychological attributes and adaptations of people in small, isolated groups.
- **Terrestrial and Freshwater Biology**—Biota of terrestrial and freshwater Antarctica, particularly their adaptation to the extreme environment, are of particular 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

Supports research projects in the following areas:

- **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 changes 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 studies have led to increased understanding of many general aspects of the geology of the continent, and major evidence has developed in support of plate tectonics models and of the Gondwana supercontinent. Antarctic geology has entered an era in which focused projects can contribute to solving regionally and globally significant geologic problems. Geophysical investigations of the sub-ice bedrock have become a prominent part of the program. Aerogeophysical research involving acquisition of such data as surface elevation, ice thickness, and magnetic and gravity data, can be supported as self-contained projects. Satellite imagery also is contributing to research in these areas. Over-snow seismic capabilities are anticipated for the future. Overall objectives of the program are to explain the geology and 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

Supports studies of the world's largest ice sheet. The ice sheet, which covers 97 percent of the Antarctic continent and is up to 4.8 kilometers thick, comprises 90 percent of the world's ice and is a storehouse of information about climate and atmospheric constituents and their variation over time. The program's objectives are to determine the dynamics of the ice sheet, understand the climatic record stored in the layers of firn and ice, determine the history of glacial advance and retreat through the study of glacial/geologic deposits, and determine the present dynamic status of the ice sheet and its relationship to glacial and climatic history.

5. Antarctic Ocean and Climate Systems

Supports research projects in the following areas:

- **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. The primary 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 asses the region's role in past and present global climate.
- **Physical and Chemical Oceanography**—Supports research on the Southern Ocean, which 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 changes in the extent of sea ice, which varies annually 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 general oceanic 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

In addition to funding research, USAP 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-strengthened 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 can also be carried out as an international collaboration aboard non-U.S. research ships.

Air transport between New Zealand and McMurdo Station is provided several times per week in the austral summer, which runs from early October to the end of February. From McMurdo, a logistics hub, research groups can access other sites, including the station at the South Pole. Several flights are made in August between New Zealand and McMurdo that provide an opportunity for late winter access. The summer camps are closed between February and October, and winter research is limited to the immediate environs of the stations, where residents are isolated for as long as 8 months. Consideration is being given to lengthening the operating season at and near McMurdo. Proposals that would take advantage of this change are welcome.

Palmer Station, on Anvers Island in the Antarctic Peninsula region, relies mainly on the ship *Laurence M. Gould* for transport of people and materials to and from Punta Arenas, Chile, at the southern tip of South America. The ship makes several trips a year and supports onboard research. The *Gould* supports onboard research in marine biology, oceanography, and geophysics in the Antarctic Peninsula region and can support science in other areas of the Southern Ocean.

U.S. Antarctic stations, ships, and some field camps provide voice and data communications (including Internet access) to locations outside Antarctica. For instructions on how to request Antarctic operational support in a proposal, see the *Antarctic Research Program Announcement* (NSF 02-086).

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.

The United States Arctic Research and Policy Act of 1984 defines the Arctic as all areas north of the Arctic Circle and all U.S. territory north and west of the boundary formed by the Porcupine, Yukon, and Kuskokwim Rivers; all contiguous seas including the Arctic Ocean and the Beaufort, Bering, and Chukchi Seas; and the Aleutian chain. Field projects falling outside these boundaries but directly related to Arctic science and engineering conditions or issues, such as laboratory and theoretical studies, are appropriate.

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 potentially affect their lives. For more information, see the interagency statement "Principles for the Conduct of Research in the Arctic," available at http://www.nsf.gov/od/opp/arctic/conduct.htm. All Arctic research grantees are expected to abide by these guidelines. See also *Arctic Research Opportunities* (NSF 00-96).

The Arctic Research Program is composed of the following:

1. Arctic Natural Sciences
2. Arctic Social Sciences
3. Arctic System Science
4. Other Arctic Support

Target Dates for Arctic Research

The target dates for the Arctic Natural Sciences, Arctic Social Sciences, and Arctic System Science Programs are February 15 and August 8. Proposals for workshops, Small Grants for Exploratory Research, or dissertation improvement grants can be submitted at any time. Further information about these types of grants is available in the NSF *Grant Proposal Guide* (see http://www.nsf.gov/cgi-bin/getpub?gpg for the latest version).

Submission of Proposals for Arctic Research

Submit proposals for field projects (including projects requiring an oceanic research vessel) by February 15 of the year preceding fieldwork.

A minimum of 9 month's advance notice is required for research vessels needing clearance for Russian waters.

For fieldwork in Greenland, fill out the Danish Polar Center application form (see http://www.dpc.dk/Guide) and put it in Supplementary Docs in the FastLane proposal submitted to OPP.

For More Information
Further information about any of the Arctic programs and activities mentioned in this section is available in the publication, *Arctic Research Program Opportunities* (NSF 00-96). Additional information can also be obtained by contacting the Office of Polar Programs, National Science Foundation, 4201 Wilson Boulevard, Room 755, Arlington, VA 22230; or by visiting the OPP home page, http://www.nsf.gov/od/opp/.

1. Arctic Natural Sciences

Supports research in glaciology; atmospheric, biological, earth, and ocean sciences; and contaminants. The program provides core support for disciplinary research in the Arctic and coordinates its support of Arctic research with the Directorates for Geosciences and Biological Sciences. Areas of special interest include marine and terrestrial ecosystems, atmospheric chemistry, exploration of the Arctic Ocean, and Arctic geological and glaciological processes. The program supports research in the following areas:

- **Atmospheric Sciences**—Focuses on stratospheric and tropospheric processes; Arctic climate and meteorology; research on past climates and atmospheric gases, as preserved in snow and ice cores; and research on atmosphere/sea and atmosphere/ice interactions. In the area of upper atmospheric and space physics, research interests include auroral studies, atmospheric dynamics and chemistry, and magnetosphere-ionosphere coupling. Conjugate studies are considered jointly with the Antarctic Aeronomy and Astrophysics Program.
- **Biological Sciences**—Supports projects that emphasize understanding the adaptation of organisms to the Arctic environment. Biological studies in the Arctic include research on freshwater, marine, and terrestrial biology; organismal adaptation to the Arctic environment; ecology; ecosystem structure and processes; and the biological consequences of ultraviolet radiation.
- **Earth Sciences**—Supports research in all subdisciplines of terrestrial and marine geology and geophysics, with special emphasis on understanding geological processes important to the Arctic regions and geologic history dominated by those processes.
- **Glaciology**—Supports glaciological research, which is concerned with the history and dynamics of all naturally occurring forms of snow and ice, including seasonal snow, glaciers, and the Greenland ice sheet. The Arctic Natural Sciences Program also includes ice dynamics, modeling, glacial geology, and remote-sensing studies of ice sheets. OPP is the focal point for glaciological research within NSF.
- **Ocean Sciences**—Seeks to develop knowledge of the structure of the Arctic Ocean and adjacent seas, their physical and biological interactions with the global hydrosphere, and the

formation and persistence of the Arctic sea/ice cover. Special interest areas include the distribution of life in high-latitude oceans; low-temperature life processes; the formation, movement, and mixing of Arctic water masses; the growth and decay of sea ice; the exchange of salt and heat with the Atlantic Ocean and the Bering Sea; geographical anomalies; sedimentary history; and the role of the Arctic Ocean and adjacent seas in the global climate. Proposals concerned with the interdependencies of chemical and physical processes and marine organisms and productivity are encouraged.

- **Contaminants**—Supports research on the physical, chemical, and biological processes that sequester and disperse contaminants in Arctic natural systems and on the socioeconomic impacts of and human response to such contaminants. Quantification of these processes for a variety of contaminants-including heavy metals, radionuclides, persistent organic pollutants (e.g., pesticides, industrial chemicals), hydrocarbons, ozone (and precursors), and aerosols derived from various parts of the Arctic and other U.S., European, and former Soviet Union sites-is fundamental to appreciating and mitigating their impact on human physical and socioeconomic systems.

2. Arctic Social Sciences

Encompasses all social sciences supported by NSF, including anthropology, archaeology, economics, geography, linguistics, political science, psychology, sociology, and related subjects. Unsolicited proposals in any of these social sciences are welcome. Areas of particular interest include rapid social change, including the processes and consequences of social, economic, and cultural change; community viability, including issues related to community and cultural vitality and survival; and human/environment 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; or form connections among disciplines, regions, researchers, communities, and students, including those in grades K-12 and undergraduate and graduate programs.

The Arctic Social Sciences Program considers joint review and funding with other programs within OPP and within other NSF directorates when appropriate. Special funding opportunities may also be available through NSF's Environment and Global Change activities (for more information, see the Crosscutting Investment Strategies section of this Guide) or the Arctic System Science Program (see program description elsewhere in this section).

Projects Involving Human Subjects

Projects involving research with human subjects must ensure that 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.

3. Arctic System Science (ARCSS)

The overall goals of the ARCSS Program are to understand the physical, geological, chemical, biological, and sociocultural processes of the Arctic system that interact with the total Earth system and thus contribute to or are influenced by global change; to advance the scientific basis for predicting

environmental change on a seasonal-to-centuries time scale; and to formulate policy options in response to the anticipated impacts of global change on humans and societal support systems. To achieve these goals, ARCSS places strong emphasis on four scientific thrusts: (1) to understand global and regional impacts of the Arctic climate system and its variability; (2) to determine the role of the Arctic in global biogeochemical cycling; (3) to identify global change impacts on the structure and stability of Arctic ecosystems; and (4) to establish links between environmental change and human activity.

Most of the available support in ARCSS is directed toward large integrated research projects that are proposed and implemented in response to scientific plans developed by the science community through Science Steering Committees for each component of ARCSS. However, global change proposals from individual investigators or small groups of investigators are also welcome.

ARCSS includes a component on Human Dimensions of the Arctic System (HARC) (see program announcement NSF 99-61). The science plan for HARC is available on the Arctic Research Consortium of the United States (ARCUS) home page, http://www.arcus.org/; and on the OPP home page, http://www.nsf.gov/od/opp/. These sites should be consulted for new developments. In all these components, proposals for new and different research topics are encouraged.

ARCSS also supports the integration of research results across components within the program and with any other Arctic research program through a Synthesis, Integration, and Modeling Studies (SIMS) effort. Science plans approved by each Science Steering Committee, as well as examples of projects supported within each component and SIMS, are accessible on either the web site maintained by the ARCSS Data Coordination Center at the University of Colorado National Snow and Ice Data Center, http://arcss.colorado.edu/, or the ARCUS home page.

The Arctic system consists of physical, biological, and cultural factors that may respond to global change. Some models that predict the climatic response to global change show greater change in the Arctic than in any other region. The predicted climatology, however, may not consider the largely unknown interannual variability in the Arctic. The presence of cultural institutions in a region subject to possibly large perturbations makes it important that scientists better understand interactions of the global and Arctic systems. Therefore, the research supported in ARCSS extends beyond purely observational studies to studies that predict and analyze the consequences of global change that are important to wise stewardship of renewable resources and development of policy options for resource managers and residents.

In order to focus on the Arctic system at a scale that incorporates the multiple environmental feedback mechanisms involved, large interdisciplinary projects that integrate major elements of the system will be supported. For more information on how a research proposal might best fit the programs and themes of ARCSS, contact a program manager.

4. Other Arctic Support

The following additional NSF programs and activities also offer research support in the Arctic Research Program.

- **Arctic Research Support and Logistics (RSL)**—The RSL Program has been established in OPP to address all field program requirements. The primary means of accessing this support is through the regular proposal process. Investigators should be able to justify the field support in the context of their proposal and are encouraged to consider the following in particular: increased mobility to and within the Arctic; increased safety potential of satellite-based global phone networks; use of field staff trained and experienced in field (and boat) safety and first aid; increased interaction with local communities; and use of equipment improved for use during fieldwork in Arctic conditions.

Support for grantees from the RSL Program includes food and shelter during the course of the fieldwork; user- and day-rate fees; salaries of staff hired specifically for fieldwork; and the steps necessary to coordinate projects with permitting agencies and native peoples.

A brief section within the proposal and in the budget explanation should outline the field plan and associated costs. If a third party (e.g., VECO, see below) is going to provide support, then those costs do not need to be included in the proposal budget.

The program manager from the program supporting the research, in consultation with the manager of the program, will determine the level of support that can be provided by RSL. In some cases, OPP may determine that several unrelated proposals can derive significant cost benefits from a centrally managed resource. If so, NSF's Arctic Support Contractor (VECO Polar Resources) or another entity will be responsible for coordinating the support with the principal investigators, consistent with the agreements between the investigators and their program managers. Work also can be proposed as a large coordinated activity, supported at some level by the science team or a support contractor.

The Barrow Arctic Science Consortium supports work at most sites on Alaska's North Slope. The Institute of Arctic Biology at the University of Alaska supports work at Toolik Field Station (see http://www.uaf.edu/toolik/). The contractor manages support at most other Arctic sites including use of military airlift, support to and within Greenland, and support in Arctic Alaska. The contractor can provide additional information and can coordinate with other nations' logistics providers, such as Canada's Polar Continental Shelf Program.

Investigators are encouraged to discuss support options with the Arctic contractor, VECO Polar Resources (http://www.veco.com/vpr/), before they prepare proposals. All work should be described in the proposal.

- **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.

OFFICE OF POLAR PROGRAMS

Crosscutting Programs

The Office of Polar Programs supports research in several disciplines, thus, 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

The goals of the Directorate for Social, Behavioral, and Economic Sciences (SBE) are to develop basic scientific knowledge of human social behavior, interaction, and decision making, and of social and economic systems, organizations, and institutions; to collect, analyze, and publish data on the status of the Nation's science and engineering human, institutional, and financial resources; and 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

- Information Technology Research
- Biocomplexity in the Environment
- Workforce for the 21st Century
- 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; environmental, social, and behavioral sciences; and integrative graduate education and research training.

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/.

• 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/.

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 Ethnographic Research Training Awards. 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 its 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. Human Cognition and Perception
3. Linguistics
4. Social Psychology
5. Cognitive Neuroscience

For More Information
Visit the BCS Division home page, http://www.nsf.gov/sbe/bcs/.

1. Developmental and Learning Sciences

Supports research on cognitive, social, and biological processes related to children 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. Human Cognition and Perception

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 life-span social development. Research topics include aggression; altruism; attitude formation and change; attitudes and behavior; attributional processes; emotion; environmental psychology; group decisionmaking, 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.

For More Information
Write to the responsible program director, Division of Social and Economic Sciences, National Science Foundation, 4201 Wilson Boulevard, Room 99, Arlington, VA 22230; or contact by telephone, 703-292-8760; or visit the SES home page, http://www.nsf.gov/sbe/ses/.

• 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

For More Information
Visit the SES Division home page, http://www.nsf.gov/sbe/ses/.

1. Decision, Risk, and Management Science

Supports scientific research directed at increasing the understanding and effectiveness of decisionmaking by individuals, groups, organizations, and society. Disciplinary and interdisciplinary research, doctoral dissertation research, and workshops are funded in the areas of judgment and decisionmaking; decision analysis and decision aids; risk analysis, perception, and communication; societal and public policy decisionmaking; and management science and organizational design. The program also supports small grants for exploratory research that are time-critical, such as decisionmaking 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. The program conducts a special joint NSF/private-sector initiative, through which NSF funding is matched by contributions from private firms, to conduct basic research that is firmly grounded in real and practical contexts.

2. Economics

Supports basic scientific research designed to improve the 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 improve the performance of industrial, educational, service, health care, government, and other organizations and institutions. Proposers work in partnership with organizations in these areas to perform research on theories, concepts, and methodologies of innovation and organizational change. The program supports research using theory combined with empirical validation to understand effective approaches to organizational learning and redesign, strategic change, and cultural change; quality and process improvement; innovation and change management; new product and service development; and the development and integration of new technologies.

Three NSF directorates jointly support the program: Social and Economic Sciences; Engineering; and Education and Human Resources. The IOC Program supersedes and extends the scope of two previous NSF programs: Management of Technological Innovation (MOTI) and Transformations to Quality Organizations (TQO).

• 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: Ethics and Values Studies, Research on Science and Technology

For More Information
Visit the SES Division home page, http://www.nsf.gov/sbe/ses/.

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, ADVANCE Fellows, Minority Postdoctoral Research Fellowships, and Major Research Instrumentation programs for the social and behavioral sciences. In

addition, the program coordinates the Faculty Early Career Development, Presidential Early Career Awards for Scientists and Engineers, Research in Undergraduate Institutions, Research Opportunity Awards, Integrative Graduate Education and Research Traineeships, GK-12 NSF Graduate Teaching Fellows in K-12 Education, and Small Business Innovation Research 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. The program supports 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/; 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: 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/.

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 shows 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 policy-makers, researchers, and the public to better understand our Nation's science, engineering, and technology enterprise. SRS contracts for most of the data collection activities it supports and some of the analyses. 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.

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 website 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

Research and education in science and engineering benefit immensely from international cooperation. The Office of International Science and Engineering (INT) enables and encourages U.S. scientists, engineers, and their institutions to avail themselves of opportunities to enhance their research and education programs through international cooperation. NSF also provides opportunities for future generations of U.S. scientists and engineers to gain the experience and outlook they will need to function productively in an international research and education environment. INT programs support the participation of scientists, engineers, and students (undergraduates, graduate students, and postdoctoral researchers) involved in international cooperative activities.

The Office of International Science and Engineering is organized into five geographic regions:

- Africa, Near East, and South Asia
- The Americas
- Central and Eastern Europe
- East Asia and the Pacific
- Western Europe

Submission of Proposals to the Office of International Science and Engineering (INT)

INT works closely with the disciplinary research divisions of NSF. Depending on the circumstance, a proposal may be submitted to INT or to the appropriate disciplinary division, or supplements to existing grants 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 costs of the U.S. participants in the 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/, where instructions and guidelines for each program initiative are given. Information is also available in the following program announcements: *International Opportunities for Scientists and Engineers* (NSF 00-138); *International Research Fellowship Program* (NSF 02-149); *Summer Programs in Japan, Korea and Taiwan* (NSF 02-174); and *Pan-American Advanced Studies Institutes Program* (NSF 01-48).

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). All of these can be found in http://www.nsf.gov/home/crssprgm/.

Eligibility Requirements for the Office of International Science and Engineering

Proposals from U.S. scientists and engineers for international activities are eligible for consideration in all fields of science and engineering supported by NSF. Normally a proposal must be submitted by a

U.S. institution, with the exception of International Research Fellow awards and the Japan, Korea, and Taiwan Summer programs, which accept applications 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

Contact the relevant program office listed below, or write to the Office of International Science and Engineering, National Science Foundation, 4201 Wilson Boulevard, Suite 935, Arlington, VA 22230; or contact INT by telephone, 800-437-7408; or by e-mail, intpubs@nsf.gov. Information is also available on the INT home page, http://www.nsf.gov/sbe/int/.

International Research Fellow Awards
(worldwide) 703-292-8711

Africa, Near East, and South Asia
703-292-8707

The Americas
703-292-8706

Central and Eastern Europe
703-292-8703

East Asia and the Pacific
703-292-8704

Western Europe
703-292-8702