



Guide TO Programs

FY2000

**NSF FUNDING
OPPORTUNITIES**

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 USC 1861-75). The idea of such a Foundation was an outgrowth of the important contributions made by science and technology during World War II. Its aim is to promote and advance progress in science and engineering in the United States. From those 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. The Foundation 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 and cooperative agreements to more than 2,000 colleges, universities, K-12 school systems, businesses, informal science organizations, and other research institutions throughout the United States. The Foundation accounts for about one-fourth of Federal support to academic institutions for basic research.

NSF receives approximately 30,000 proposals each year for research, education, and training projects, of which approximately 10,000 are funded. In addition, the Foundation receives several thousand applications for graduate and postdoctoral fellowships. NSF grants are typically awarded to universities, colleges, academic consortia, nonprofit institutions and small businesses. The agency operates no laboratories itself but does support National Research Centers, user facilities, certain oceanographic vessels, and Antarctic research stations. The Foundation also supports cooperative research between universities and industry, US 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, math, engineering, and technology education. NSF also uses a variety of management mechanisms to coordinate research in areas that cross traditional disciplinary boundaries. The Foundation is helped by advisors 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; applicants get unattributed verbatim copies of peer reviews.

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

NSF welcomes proposals on behalf of all qualified scientists, engineers, and educators. The Foundation strongly encourages women, minorities, and persons

with disabilities to participate fully in its programs. In accordance with Federal statutes, regulations, and NSF policies, no person on grounds of race, color, age, sex, national origin, or disability shall be excluded from participation in, be denied the benefits of, or be subjected to, discrimination under any program or activity receiving financial assistance from NSF, 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.

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) 306-0090, FIRS at (800) 877-8339.

Deadlines and Target Dates

Many of the programs listed in this Guide have an established deadline or target date for the submission of proposals. To confirm a date, refer to the program's Web site on the NSF home page (<http://www.nsf.gov/>) or to the NSF E-Bulletin, a Web-based document that lists the latest deadline and target dates for NSF programs. The E-Bulletin can be accessed directly at <http://www.nsf.gov/home/ebulletin/>.

Eligibility Requirements

There are certain eligibility requirements that apply to all grants available from NSF. In some cases, additional requirements also apply for grants within specific Directorates, departments, and programs. To check on special requirements for a specific program, consult the applicable program announcement or contact the program directly. For general eligibility and other information on NSF proposal submission, refer to the NSF *Grant Proposal Guide* (NSF 00-2) at <http://www.nsf.gov/pubs/2000/nsf002/start.htm>.

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 prior to formal submission.

Graduate students are not encouraged to submit research proposals but 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 advisor 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.

Categories of Proposers

Unless 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 two- and four-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 science or engineering research or education. An unsolicited proposal from a commercial organization may be supported if the project is of special concern from a national point of view; special resources are available to perform the work; or the proposed project is especially meritorious. NSF is particularly interested in supporting projects that couple industrial research resources and perspectives with those of universities. Thus, proposals for cooperative projects involving both universities and the private commercial sector are especially welcome.
- **State and Local Governments**—State education offices, organizations, and local school districts may submit proposals that are intended to broaden the impact, accelerate the pace, and increase the effectiveness of improvements in science, mathematics, and engineering education in grades K to 12 and at the post-secondary levels.
- **Unaffiliated Individuals**—Scientists, engineers, and educators in the United States as well as U.S. citizens may be eligible for support provided that (a) they are not employed by or affiliated with an organization; and (b) 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; 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 prior to preparing a proposal for submission.

- **Foreign Organizations**—NSF rarely provides support to foreign organizations. However, 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 (FFRDCs). A scientist, engineer, or educator however, who has a joint appointment with a university and a Federal agency (such as a Veterans Administration Hospital, or with a university and a FFRDC) may submit a proposal through the university and may receive support if they are a bona fide faculty member of the university, although part of their salary may be provided by the Federal agency. There are some unusual circumstances that may allow other Federal agencies and FFRDCs to submit a proposal directly to NSF. Preliminary inquiry should be made to the appropriate program before preparing a proposal for submission.

Merit Review Criteria for the Selection of Research and Education Projects

NSF receives nearly 30,000 new proposals for funding per year and awards about one-third of them. Funding decisions 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 general criteria for reviewing proposals were revised, effective October 1, 1997. Under the new criteria, reviewers are asked to address two questions regarding every proposal: (1) what is the intellectual merit of the proposed activity; and (2) what are the broader impacts of the proposed activity.

Proposals will continue to be rated on a five-category system, from "excellent" to "poor." The reviewer is asked to state the relative importance of each of the criteria to his or her overall proposal rating. The two criteria need not be weighted equally but their relative weight should depend upon any additional published guidance provided by NSF for a particular program, and the reviewer's judgment of the relative importance of each of the criteria to the proposed work.

For each of the criteria, the review form suggests several questions to be considered, as follows:

Criterion 1: 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?

Criterion 2: What are the broader impacts of the proposed activity?

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

Principal Investigators should address the following elements in their proposal to provide reviewers with the information necessary to respond fully to both of the above-described NSF merit review criteria. NSF staff will give these factors 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 where individuals may concurrently assume responsibilities as researchers, educators, and students and where all can engage in joint efforts that infuse education with the excitement of discovery and enrich research through the diversity of learner perspectives.

Integrating Diversity into NSF Programs, Projects, and Activities

Broadening opportunities and enabling the participation of all citizens--women and men; underrepresented minorities; 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

For further information on proposal submission and the grants process at NSF, refer to the NSF *Grant Proposal Guide* (NSF 00-2) at <http://www.nsf.gov/pubs/2000/nsf002/start.htm>.

GENERAL INFORMATION

How to Use This Guide

The *Guide to Programs* is a compilation of funding opportunities offered by the National Science Foundation for research and education in science, mathematics, engineering, and technology. The Guide includes broad, general descriptions of programs and research areas for each NSF Directorate as well as sources for more information. The Guide offers links to other information sources, including NSF Directorate home pages, related publications like program announcements and solicitations,

that contain additional proposal or eligibility requirements. The Guide also offers links to the E-Bulletin, where changes and updates to NSF's fiscal year 1999 programs are posted throughout the year.

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 National Science Foundation. The E-Bulletin is available in a daily and monthly edition. Subscribers to NSF's Custom News Service (CNS) can request monthly notification each time a new E-Bulletin is available (see information on CNS elsewhere in this section). Each edition covers a four-month period that includes the current month and the following three months. A search engine on the E-Bulletin allows you to request deadlines and target dates for a selected period of time. For individuals who do not have Web access, a print-on-demand monthly edition is available.

The E-Bulletin can be accessed directly at <http://www.nsf.gov/home/ebulletin/>.

How to Obtain NSF Publications

NSF strongly encourages electronic dissemination of its documents and has several ways of obtaining publications in this manner, which are described below. Unless otherwise indicated, publications with an NSF number are available free of charge. The first two digits of the publication number indicate the year of publication. When requesting a publication, be sure to include the NSF publication number and title, your name, and your complete mailing address.

- **Online Document System (ODS)** -- Includes all NSF publications and forms that are available in electronic format. Most of these documents are available in more than one format. The ODS search capability allows you to search by

document type, publication title, form number, or keyword. For a list of current NSF documents available in electronic format, visit the ODS Index at <http://www.nsf.gov/pubsys/index.htm>.

- **By E-Mail** -- If you are unable to download documents from the Web, you can receive many NSF publications electronically via e-mail by sending a request to an automated mailserver at getpub@nsf.gov. For a list of all documents available from GetPub, including file formats and sizes, send an e-mail to the same address and type the words "get index" in the body of the message. To retrieve a list of all GetPub commands and usage tips, type the word "help" in the body of the message.
- **By Web**, fill in and submit the electronic form located at <http://www.nsf.gov/home/orderpub.htm>.
- **By telephone**, call the NSF Publications Clearinghouse at (301) 947-2722.
- **By mail**, send your request and the applicable NSF publication number to NSF Publications Clearinghouse, P.O. Box 218, Jessup, MD 20794-0218.

If you would like to be notified when new publications become available, you can sign up for the NSF Custom News Service at <http://www.nsf.gov/home/cns/>.

CROSSCUTTING INVESTMENT STRATEGIES

This chapter contains a partial listing of cross-directorate programs sponsored by NSF. Activities not mentioned here might appear elsewhere in this publication. Refer to the appropriate directorate.

- **NSF Priority Multidisciplinary Areas**
- **Human Resource and Career Development**
- **Other Crosscutting Programs and Activities**

NSF PRIORITY MULTIDISCIPLINARY AREAS

The priority multidisciplinary areas in this section reflect the Foundation's three strategic goals:

- (1) Ideas - Discovery at and across the frontier of science and engineering, connected to learning, innovation, and service of society.
- (2) People - A diverse, internationally competitive and globally engaged workforce of scientists, engineers and well-prepared citizens.
- (3) Tools - Broadly accessible, state-of-the-art and shared research and education tools.

NSF's investments in Ideas, People, and Tools work in concert to support the agency's mission to maintain U.S. leadership in all aspects of science and engineering research and education.

NSF's priority multidisciplinary areas are

- **Information Technology**
- **Biocomplexity in the Environment**
- **Twenty-First Century Workforce**
- **Nanoscale Science and Engineering**

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Information Technology

Sustained U.S. leadership in information technology requires an aggressive Federal program to create new knowledge in a variety of areas. The U.S. economy's robust growth is in part due to new ideas that become the basis for new products. For example, NSF contributed greatly to the development of today's Internet. NSF's investments – in People, Ideas, and Tools– have benefited greatly from the application of information technology. NSF itself has a strongly vested interest in furthering research in information technology as rapidly and as effectively as possible.

NSF faces two major challenges and opportunities with respect to information technology. One is to support the people, ideas, and tools that will create and advance knowledge in all areas of information science and engineering. This includes the creation of wholly new computation approaches to problems arising from the science and engineering disciplines and the development of new learning technologies for use in education.

The second challenge is to support upgrading 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. Finally, the United States must address a range of access and workforce issues. The digital divide won't disappear on its own. Overcoming inequity will require innovative educational technologies such as highly interactive computer science courseware, that is multilingual, multicultural, and multimedia.

NSF is the lead agency for a multiagency five-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 Initiative 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.
- 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

Further information about Information Technology is available at <http://www.itr.nsf.gov/>.

Biocomplexity in the Environment

The environment is a subject of profound national importance and of scientific interest; hence, it is a strategic priority for NSF. In fact, the significance of environmental studies was recently affirmed by the National Science Board in its report *Environmental Science and Engineering for the 21st Century: The Role of the National Science Foundation* (NSB 00-22). The goals of NSF's increasing investment in this area are to enhance environmental research in all relevant disciplines, including interdisciplinary and long-term research; create educational opportunities that enhance scientific and technological capacity; enable an increased portfolio of scientific assessments; and support enhanced physical, technological, and information infrastructure.

As an initial step, NSF has begun intensive study of biocomplexity in the environment. Biocomplexity refers to phenomena that result from dynamic interactions among biological, physical, and social components of the Earth's diverse systems.

Studying biocomplexity will provide a more complete understanding of natural processes; the effects of human actions on the natural world; and ways to use new technology effectively. A strategic multiyear investment by NSF will lead to the following outcomes:

- More comprehensive understanding of environmental systems, including the processes that mediate energy and material flows among systems over space and time; the relationship among genetic information, biodiversity, and the functioning of ecosystems; and the social and economic factors affecting the environment.
- Development of new theories, mathematical methods, and computational strategies for modeling complex systems. This may improve the capability to forecast environmental changes and their impacts, including long-term climatic change, earthquakes, floods, land-use changes, and introductions of non-native species.
- Development of advanced technologies and approaches, including functional genomics and other genetic and nano/molecular level capabilities.
- Utilization of biocomplexity-inspired design strategies for discovery of new materials, sensors, process engineering, and other technologies, especially those that are environmentally beneficial.
- Improved platforms for research, such as networked observational systems, physical and digital natural history collections, and digital libraries.

For More Information

Further information about Biocomplexity in the Environment is available at <http://www.nsf.gov/home/crssprgm/be/>.

Twenty-First Century Workforce

U.S. leadership in the concept-based, innovation-led global economy of the next century will depend on success in building and sustaining a competent and diverse scientific, mathematics, engineering, and technology (SMET) workforce, drawing on all elements of the Nation's rich human resources.

The SMET education continuum reaches from pre-kindergarten through elementary and secondary to undergraduate, graduate, and continuing professional education. The level, quality, and accessibility of SMET education depends upon the following: understanding the nature of learning; strategically enabling an improved science- and technology-based educational enterprise; and building an infrastructure to broaden participation of all members of our society.

Across the Foundation, organizations will provide disciplinary and interdisciplinary support for educational linkages to the research community as well as and new tools and models for K-12, undergraduate, and graduate education. These activities will recognize the importance of the SMET content of educational programs for K-12 students and for the instructional workforce.

A National Digital Library for SMET Education will provide ready access to the highest quality educational materials, pedagogy, and research on learning, and will enhance the quality of graduate, undergraduate, K-12, and public science education.

The outcome of NSF's sustained investment in research, education, training, and human resource programs will be:

- Enhanced knowledge about how humans learn.
- Enhanced practices throughout the SMET educational enterprise, especially at the K-12 level, leading to improved teacher performance and student achievement.
- A more inclusive and globally engaged SMET enterprise that fully reflects the strength of America's diverse population.

Nanoscale Science and Engineering

Nanoscale science and engineering promise to yield a dominant technology of the 21st century. Control of matter at the nanoscale 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 large molecules of living systems. Biological cells like red blood cells, have diameters in the range of thousands of nanometers. Microelectrical mechanical systems are now approaching this same scale. This means we are now at the point of connecting machines to individual cells.

A multiyear investment by NSF in nanoscale science and engineering will lead to the following outcomes:

- Discovery of novel phenomena, 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.
- Development of a new generation of skilled workers who have the multidisciplinary perspective necessary for rapid progress in nanotechnology.

For More Information

Further information about Nanoscale Science and Engineering is available at <http://www.nsf.gov/home/crssprgm/nano/start.htm>.

HUMAN RESOURCE AND CAREER DEVELOPMENT

NSF sponsors a number of activities directed specifically at bringing underrepresented group members into the science and engineering education pipeline. These activities help to engage underrepresented populations in science and technology and to prepare them for potential advancement to the highest levels of leadership. Retaining these students in the education enterprise and preparing them to make lifelong contributions in the sciences and engineering can help to make great strides in advancing the Nation's knowledge base. The cross-directorate programs described in this section are designed to help nurture a diverse talent pool into a successive cadre of versatile, well-prepared scientists, engineers, technicians, and "knowledge workers." In addition to these programs, many NSF directorates offer programs that target underrepresented groups. Also included in this section are programs that target undergraduate and graduate students and faculty.

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

- **Minority Programs (Includes Undergraduate, Graduate, and Postdoctoral programs for underrepresented minority groups)**
- **Women's Programs**
- **Support for Persons with Disabilities**
- **Undergraduate and Graduate Activities**

For More Information

For further information on these and other related programs, visit the Division of Human Resource Development home page (located within the Education and Human Resources Directorate), <http://www.ehr.nsf.gov/EHR/HRD/default.asp>.

MINORITY PROGRAMS

NSF has a number of special programs that target members of minority groups that are underrepresented in science and engineering. These groups include American Indians or Alaskan Natives (Native Americans), Blacks (African Americans), Hispanics, and Pacific Islanders. Such efforts include programs for students, faculty, and institutions.

(1) Historically Black Colleges and Universities--Undergraduate Program

(2) Louis Stokes Alliances for Minority Participation

- (3) Model Institutions for Excellence**
- (4) Research Opportunities for Minority Students and College Faculty**
- (5) Presidential Awards for Excellence in Science, Mathematics, and Engineering Mentoring**
- (6) Alliances for Graduate Education and the Professoriate**
- (7) Centers of Research Excellence in Science and Technology**
- (8) Minority Postdoctoral Research Fellowships and Graduate Student Travel Awards in the Biological, Social, Behavioral, and Economic Sciences**
- (9) Minority Research Planning Grants and Career Advancement Awards**

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(1) Historically Black Colleges and Universities--Undergraduate Program

The Historically Black Colleges and Universities--Undergraduate Program (HBCU-UP) targets historically black colleges and universities (HBCUs) to initiate a plan of action to address the underrepresentation of minorities in the baccalaureate, and promote interest in pursuing careers in science, engineering, and mathematics disciplines, including the professoriate. HBCU institutions are particularly important in their provision of role models and mentors and in their demonstrated effectiveness in retaining and graduating minority students.

For More Information

Further information about HBCU-UP is available in the program announcement NSF 99-73; or on the Division of Human Resource Development (part of the Education and Human Resources Directorate) home page, <http://www.ehr.nsf.gov/ehr/hrd/>.

(2) Louis Stokes Alliances for Minority Participation

The Louis Stokes Alliances for Minority Participation (LSAMP) Program is a multidisciplinary undergraduate program designed to increase substantially the quantity and quality of students, including those currently underrepresented in science and engineering fields, who are receiving baccalaureate degrees in science, mathematics, engineering, and technology (SMET). Subsequently, the

program aims to increase the number of these students who are entering graduate schools to attain a doctorate in SMET fields normally supported by NSF. LSAMP also encourages the formation of coalitions among leaders throughout academia, government, industry, and other organizations. The program will maximize the potential for making significant positive impact on the participation of minority and other populations in SMET fields over the next decade.

For More Information

Further information about LSAMP is available in the program announcement NSF 98-19; or on the Division of Human Resource Development (part of the Education and Human Resources Directorate) home page, <http://www.ehr.nsf.gov/ehr/hrd/>.

(3) Model Institutions for Excellence

The Model Institutions for Excellence (MIE) program is a joint venture between the National Science Foundation, the National Aeronautics and Space Administration, and the U.S. Departments of Agriculture and Interior. The MIE Program aims to increase the number and quality of underrepresented minorities in science, engineering, and mathematics (SEM) education in the nation's higher education institutions and particularly targets institutions that have a history of awarding SEM degrees to African Americans, Hispanics, and Native Americans. The program provides funds and technical assistance to help improve institution facilities and provide technical support.

MIE-awarded schools will concentrate on recruiting and retaining SEM students; pay special attention to counseling and academic enrichment; offer research opportunities; and will encourage students to attend graduate school. The success of these institutions will serve as models for high-quality SEM education that can be replicated at colleges and universities nationwide.

For More Information

For further information, write to the Office of Integrative Activities (OIA), National Science Foundation, 4201 Wilson Boulevard, Room 1270, Arlington, VA 22230; or contact by telephone, (703) 306-1040; or by e-mail, nsf_oia@nsf.gov; or visit the OIA home page, <http://www.nsf.gov/od/oia/start.htm>.

(4) Research Opportunities for Minority Students and College Faculty

NSF offers several activities that encourage talented and promising minority students and college faculty to participate in ongoing research. All of these activities are achieved through supplements to existing NSF-supported research

projects. NSF encourages principal investigators who receive NSF support to include minority students in their projects as research assistants.

For More Information

- For undergraduate students, the Research Experiences for Undergraduates Program. For further information on student-focused programs, see the publication *Research Experiences for Undergraduates* (NSF 96-102).
- For college faculty, Research Opportunity Awards, a component of the Research in Undergraduate Institutions Program. Research Opportunity Awards for faculty are described in full in the publication *Research in Undergraduate Institutions* (NSF 94-79).

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

The Presidential Awards for Excellence in Science, Mathematics and Engineering Mentoring (PAESMEM) was established by the White House through the National Science and Technology Council and the Office of Science and Technology Policy. It is 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 (SME). The awardees will serve as exemplars to their colleagues and will be leaders in the national effort to more fully develop the Nation's human resources in SME.

For More Information

Further information about PAESMEM is available in the brochure NSF 00-41; or on the Division of Human Resource Development (part of the Education and Human Resources Directorate) home page, <http://www.ehr.nsf.gov/ehr/hrd/>.

(6) Alliances for Graduate Education and the Professoriate

The Alliances for Graduate Education and the Professoriate (AGEP) is intended to increase significantly the number of underrepresented minority students receiving doctoral degrees in the sciences (physical and life science disciplines), mathematics, and engineering (SME). NSF is particularly interested in increasing the number of minorities who will enter the professoriate in these disciplines. To accomplish its goals, AGEP provides support for alliances of doctoral granting institutions and is designed to develop institutional partnerships that will implement comprehensive strategies to remove barriers to minority success at the graduate level. NSF promotes synergy among AGEP projects and

with other funded programs to maximize the opportunities for developing infrastructure at the graduate level that is sustainable after the NSF funding period.

For More Information

Further information about AGEF is available in the brochure NSF 00-53; or on the Division of Human Resource Development (part of the Education and Human Resources Directorate) home page, <http://www.ehr.nsf.gov/ehr/hrd/>.

(7) Centers of Research Excellence in Science and Technology

The Centers of Research Excellence in Science and Technology (CREST) Program (formerly known as the Minority Research Centers of Excellence Program) seeks to develop outstanding research centers that will produce new knowledge as well as increase the number of underrepresented minorities with Ph.D.s in science, mathematics, engineering, and technology (SMET). CREST accomplishes this goal by integrating research with education, thus making substantial resources available to upgrade research and education capabilities at the most productive minority institutions. Additionally, the program enables faculty at these institutions to cooperate with other science and engineering (S&E) centers of excellence to increase the effectiveness of related S&E activities; and builds bridges for minority student career development through alliances with business, government laboratories, and other universities.

For More Information

Further information about CREST is available in the program announcement NSF 98-19; or on the Division of Human Resource Development (part of the Education and Human Resources Directorate) home page, <http://www.ehr.nsf.gov/ehr/hrd/>.

(8) Minority Postdoctoral Research Fellowships and Graduate Student Travel Awards in the Biological, Social, Behavioral, and Economic Sciences

These are one-time fellowship and travel awards available to recent Ph.D.s or to those about to earn a doctoral degree in an eligible field. Travel awards facilitate a visit to the potential host institution to discuss details of a postdoctoral appointment with the proposed mentor. Fellowships are portable and provide stipend and other support for up to 3 years of additional research training at a U.S. or foreign institution chosen by the fellow.

For More Information

For further information, see the program announcement *Minority Postdoctoral Research Fellowships and Supporting Activities* (NSF 94-133); or visit the BIO Directorate home page, <http://www.nsf.gov/bio/>; or write to one of the following:

--In the Biological Sciences Directorate, write to BIO Minority Research Fellowships, Biological Infrastructure, National Science Foundation, 4201 Wilson Boulevard, Rm. 615, Arlington, VA 22230; or contact by telephone, (703) 306-1469.

--In the Social, Behavioral, and Economic Sciences, write to SBE Minority Research Fellowships, Cross-Directorate Activities, SBER, Rm. 995, National Science Foundation, 4201 Wilson Boulevard, Arlington, VA 22230; or contact by telephone, (703) 306-1733.

(9) 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 scientific research support. The goal of these programs is to increase the number of minority faculty in mainstream research.

- **Minority Research Planning Grants (MRPGs)**—Are one-time, limited awards for preliminary studies and other activities to facilitate the development of more competitive NSF proposals. The awardee is expected to submit a proposal to one of NSF's research programs or to the Faculty Early Career Development (CAREER) Program after completion of the planning grant (further information on CAREER is available elsewhere in this section).
- **Minority Career Advancement Awards (MCAAs)**—Are geared toward expanding opportunities for minority researchers to advance their careers. MCAAs are particularly appropriate for independent investigators whose careers are still evolving and for experienced researchers who are changing research direction or who have had a significant research career interruption. For example, an investigator may wish to acquire new skills in an area that will expand his or her research capabilities or to develop an innovative research method in collaboration with another investigator.

For More Information

Further information on MRPGs and MCAAs is available in a combined program announcement, *Research Planning Grants and Career Advancement Awards for Minority Scientists and Engineers* (NSF 94-147); or, direct inquiries to the appropriate disciplinary program officer, National Science Foundation, 4201 Wilson Boulevard, Arlington, VA 22230.

WOMEN'S PROGRAMS

Studies show that the number of women and girls who participate in science, mathematics, engineering, and technology (SMET) education and careers is low. The National Science Foundation supports several activities designed to help improve the recruitment and retention of women and girls in SMET. NSF is committed to bringing about the needed change in education and in academic and professional climates through increased awareness of the interests, needs, and capabilities of girls and women.

The Human Resource Development (HRD) Division (located in the Education and Human Resources Directorate) supports the following programs for women and girls:

- (1) Program for Gender Equity in Science, Mathematics, Engineering, and Technology**
- (2) Professional Opportunities for Women in Research and Education**

For More Information

For complete information about HRD programs targeting women and girls, visit the HRD Division home page, <http://www.ehr.nsf.gov/EHR/HRD/default.asp>.

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

The generally low participation of women in science, mathematics, engineering, and technology (SMET) is a national concern. NSF is committed to changing this by supporting activities such as the Program for Gender Equity in Science, Mathematics, Engineering, and Technology (PGESMET) (originally called Program for Women and Girls).

PGESMET seeks to increase women's participation in SMET by increasing awareness of the interests, needs, and capabilities of girls and women; promoting instructional materials and teaching methods for increasing the

interest, retention, and achievement of girls and women in SMET disciplines; and increasing the availability of student enrichment resources including mentoring. In short, efforts in PGESMET are dedicated to changing factors that have discouraged the early and continued interest in SMET, and to developing interest, knowledge, and involvement of girls and young women in these fields.

For More Information

Further information about PGESMET is available in the program announcement and guidelines NSF 99-25; or on the HRD Division home page, <http://www.ehr.nsf.gov/ehr/hrd/>.

(2) Professional Opportunities for Women in Research and Education

The Professional Opportunities for Women in Research and Education (POWRE) Program supports activities that promote the development of women as scholarly and institutional leaders in research and education. POWRE is a Foundation-wide program designed to increase the prominence of women in science and engineering and to enhance their professional advancement by providing them with funding opportunities that are not ordinarily available through regular research and education grant programs. Of special interest in this program is the prominent representation of women in the research and education community.

POWRE awards are designed to provide a one-time input of funds at a critical stage in the principal investigator's career, a means by which she can take advantage of an opportunity that will contribute to a significant, identifiable advance in her career path. They are not intended to provide support for long-term research projects or substitute for support of regular research and education projects.

For More Information

Further information about POWRE, including eligibility criteria and guidelines, is available in the POWRE program announcement NSF 98-160; or on the POWRE Web site, <http://www.nsf.gov/home/crssprgm/powre/start.htm>.

SUPPORT FOR PERSONS WITH DISABILITIES

NSF has taken a position of leadership in ensuring that persons with disabilities have the opportunity to participate fully in NSF-supported projects. Disciplinary programs throughout NSF entertain project proposals that include a disability focus or component. Additionally, NSF provides support for the following programs and activities:

- (1) Program for Persons with Disabilities**
- (2) Facilitation Awards for Scientists and Engineers with Disabilities**

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(1) Program for Persons with Disabilities

The Program for Persons with Disabilities (PPD) promotes the full participation of students with disabilities in science, mathematics, engineering, and technology (SMET) education and in career development. Specifically, PPD supports the development and implementation of innovative projects that are designed to change academic and professional climates as well as result in the full assimilation of individuals with disabilities in these disciplines. In short, PPD is dedicated to changing the factors wherein neglect, paucity, and indirection historically have stifled the early interest in science and mathematics shown by students with disabilities. PPD-supported projects also work to remove the obstacles to progress of these individuals as they prepare themselves for careers in SMET fields.

For More Information

Further information about PPD is available in the program announcement NSF 00-69; or on the Division of Human Resource Development (part of the Education and Human Resources Directorate) home page, <http://www.ehr.nsf.gov/ehr/hrd/>.

(2) Facilitation Awards for Scientists and Engineers with Disabilities

The Facilitation Awards for Scientists and Engineers with Disabilities (FASSED) provide funding for special assistance or equipment necessary to enable persons with disabilities--investigators and other staff, including student research assistants--to work on NSF projects.

For More Information

For further information on FASED, see Chapter V of the *NSF Grant Proposal Guide*, NSF 00-2, available in print or electronically at <http://www.nsf.gov/cgi-bin/getpub?nsf002>.

UNDERGRADUATE AND GRADUATE ACTIVITIES

NSF believes that it is important for students and faculty to engage in the processes of research. Hands-on learning and inquiry-based learning heighten students' understanding of and excitement about scientific concepts. Furthermore, active research experience is one of the most effective techniques for attracting and retaining talented undergraduates in careers in science, mathematics, and engineering.

On the undergraduate level, NSF's cross-directorate programs particularly target

- the enhancement of research opportunities and research experiences for students at all types of institutions, to help build a well-qualified technical workforce for the future; and
- faculty who teach at predominantly undergraduate institutions. Research at predominantly undergraduate institutions contributes to the knowledge base in science and engineering and strengthens the ability of faculty members to communicate the processes and methods of science to their students.

- (1) **Research Opportunities for Faculty**
- (2) **Research Opportunities for Students**
- (3) **Curriculum**
- (4) **Graduate and Postdoctoral Education**
- (5) **NSF Postdoctoral Fellowships**
- (6) **Graduate Research Fellowships**
- (7) **International Opportunities for Students and Postdoctoral Fellows**
- (8) **Faculty Early Career Development**
- (9) **NSF Component of the Presidential Early Career Awards for Scientists and Engineers**

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(1) Research Opportunities for Faculty

Research in Undergraduate Institutions

The Research in Undergraduate Institutions (RUI) Program targets faculty in nondoctoral departments within predominantly undergraduate institutions. The objectives of RUIs are to support high-quality research by eligible faculty members in which undergraduates are often actively involved; to strengthen the research environment in academic departments that are oriented primarily toward undergraduate instruction; and to promote the integration of research and education at predominantly undergraduate institutions.

The RUI program is composed of the following components:

- 1. Faculty Research Projects**--supported through funding for salaries and wages, research assistantships (focused on undergraduate students), travel, and other eligible costs.
- 2. Research Instrumentation Grants**--provide support for multi-investigator research projects through funding for the purchase, upgrade, or development of multiuser instrumentation or equipment.
- 3. Research Opportunity Awards (ROAs)**--enable faculty members who are located at predominantly undergraduate institutions with limited research opportunities to participate in research at other institutions under the aegis of NSF-supported principal investigators (PIs). Middle school and high school science teachers with a keen interest in research are also eligible to participate. A faculty member (or teacher) interested in becoming an ROA visiting researcher must make an arrangement with a PI who has been awarded or is currently applying for an NSF research grant. The PI and the research may be based at any type of institution normally eligible for NSF support; the award is made to the host PI and institution to support the visiting researcher.

For More Information

Prospective applicants for RUI grants and PIs interested in hosting an ROA visiting researcher are urged to contact a program officer in the appropriate discipline. For further information, including guidelines for preparing and submitting proposals, see the RUI program announcement NSF 94-79.

(2) Research Opportunities for Students

Research Experiences for Undergraduates

The Research Experiences for Undergraduates (REU) Program provides opportunities for undergraduate students to participate in active science, mathematics, and engineering (SME) research. The program supplements NSF research grants to support students who are involved in a project (REU “Supplements”) or funds special programs that engage a number of students in a project with a common focus at host institutions (REU “Sites”). Proposals for REU projects are accepted in all fields of SME supported by NSF.

For More Information

Further information, including a detailed description of the program, guidelines for preparing and submitting proposals, and a list of contact people is available at the REU Web page, <http://www.nsf.gov/home/crssprgm/reu/start.htm>.

(3) Curriculum

Combined Research-Curriculum Development

NSF’s Engineering (ENG) and Computer and Information Science and Engineering (CISE) Directorates jointly support the Combined Research-Curriculum Development (CRCD) Program. CRCD supports the development of multidisciplinary projects that integrate new and state-of-the-art research advances in emerging technological areas into upper-level undergraduate and introductory graduate engineering and computer and information science curricula.

For More Information

Further information is available in the CRCD program announcement NSF 99-72; or by contacting the following:

--in the ENG Directorate, 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) 306-1380; or by fax, (703) 306-0326; or visit the EEC Division home page, <http://www.eng.nsf.gov/eec/>; or

--in the CISE Directorate, 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) 306-1980; or visit the EIA Division home page, <http://www.cise.nsf.gov/eia/index.html>.

(4) Graduate and Postdoctoral Education

Integrative Graduate Education and Research Training

The Integrative Graduate Education and Research Traineeship (IGERT) program is an NSF-wide endeavor that was developed to meet the challenges of educating Ph.D. scientists and engineers with multidisciplinary backgrounds and to develop the technical, professional, and personal skills needed for the career demands of the future. The program is intended to catalyze a cultural change in graduate education, for students, faculty, and universities, by establishing new, innovative models for graduate education in a fertile environment for collaborative research that transcends traditional disciplinary boundaries. Additionally, IGERT works to facilitate greater diversity in student participation and preparation and contribute to the development of a diverse, globally aware, science and engineering workforce.

For More Information

For further information about IGERT, including the latest program solicitation (NSF 00-78), answers to frequently asked questions, and detailed instructions on proposal preparation and submission, visit the IGERT Web site, <http://www.nsf.gov/home/crssprgm/igert/start.htm>.

(5) Graduate Research Fellowships

The National Science Foundation (NSF) seeks to ensure the vitality of the human resource base of science, mathematics, and engineering in the United States and to reinforce its diversity. A competition is conducted for Graduate Research Fellowships, with additional awards offered for women in engineering and computer and information science. NSF Graduate Fellowships offer recognition and three years of support for advanced study to approximately 900 outstanding graduate students in the mathematical, physical, biological, engineering, and behavioral and social sciences, including the history of science and the philosophy of science, and to research-based Ph.D. degrees in science education.

For More Information

Further information is available on the Graduate Research Fellowships Web site, <http://www.ehr.nsf.gov/EHR/DGE/grf.htm>. For applications, write to Oak Ridge Associated Universities (ORAU), NSF Graduate Research Fellowships

Program, P.O. Box 3010, Oak Ridge, TN 37831-3010; or contact ORAU by telephone, (865) 241-4300; or by e-mail, nsfgrfp@orau.gov.

(6) NSF Postdoctoral Fellowships

NSF sponsors several fellowship programs for postdoctoral and senior postdoctoral research in science and engineering. These fellowships are in specific disciplines and are sponsored by the appropriate NSF organization. Contact the appropriate division listed below for more information about these fellowships.

FELLOWSHIP	CONTACT
<p>Minority Postdoctoral Research Fellowships in Biological, Social, Behavioral, and Economic Sciences</p>	<p>BIO Minority Research Fellowships Biological Infrastructure National Science Foundation 4201 Wilson Boulevard, Rm. 615 Arlington, VA 22230 Tel: (703) 306-1469</p> <p>SBE Minority Research Fellowships Cross-Directorate Activities SBER, Rm. 995 National Science Foundation 4201 Wilson Boulevard Arlington, VA 22230 Tel: (703) 306-1733</p>
<p>Postdoctoral Research Fellowships in Biological Informatics</p>	<p>Postdoctoral Research Fellowships in Biological Informatics Biological Infrastructure National Science Foundation 4201 Wilson Boulevard, Rm. 615 Arlington, VA 22230 Tel: (703) 306-1469</p>
<p>CISE Postdoctoral Research Associates in Experimental Computer Science</p>	<p>Division of Experimental and Integrative Activities National Science Foundation 4201 Wilson Boulevard, Rm. 1160 Arlington, VA 22230 Tel: (703) 306-1980</p>
<p>NSF-NATO Postdoctoral Fellowships in Science and Engineering</p>	<p>NATO Postdoctoral Fellowship Program Division of Graduate Education National Science Foundation 4201 Wilson Boulevard, Rm. 907 Arlington, VA 22230 Tel: (703) 306-1630</p>

<p>Graduate Student Industrial Fellowship</p> <p>Postdoctoral Industrial Fellowship</p>	<p>Dr. Donald Senich ENG Contact/GOALI Program National Science Foundation 4201 Wilson Boulevard, Rm. 527 Arlington, VA 22230 Tel: (703) 306-1330</p>
<p>Earth Sciences Postdoctoral Research Fellowships</p>	<p>Division of Earth Sciences National Science Foundation 4201 Wilson Boulevard, Rm. 785 Arlington, VA 22230 Tel: (703) 306-1550</p>
<p>Ridge Interdisciplinary Global Experiments (RIDGE) Postdoctoral Fellowship Program</p>	<p>Division of Ocean Sciences National Science Foundation 4201 Wilson Boulevard, Rm. 725 Arlington, VA 22230 Tel: (703) 306-1586</p>
<p>Mathematical Sciences Postdoctoral Research Fellowships (with Research Instructorship option)</p> <p>Mathematical Sciences University/Industry Postdoctoral Research Fellowships</p>	<p>Infrastructure Program Division of Mathematical Sciences National Science Foundation 4201 Wilson Boulevard, Rm. 1025 Arlington, VA 22230 Tel: (703) 306-1870 E-mail: msprf@nsf.gov</p>
<p>International Research Fellow Award</p>	<p>Research Fellow Awards Division of International Programs National Science Foundation 4201 Wilson Boulevard, Rm. 935 Arlington, VA 22230 Tel: (703) 306-1706</p>

<p>Japan Society for the Promotion of Science (JSPS) Postdoctoral Awards for U.S. Researchers</p>	<p>JSPS Postdoctoral Awards Division of International Programs National Science Foundation 4201 Wilson Boulevard, Rm. 935 Arlington, VA 22230 Tel: (703) 306-1701 E-mail: NSFJinfo@nsf.gov</p>
<p>Long- and Medium-Term Research Visits for Scientists and Engineers at Foreign Centers of Excellence</p>	<p>Long- and Medium-Term Research Visits Division of International Programs National Science Foundation 4201 Wilson Boulevard, Rm. 935 Arlington, VA 22230 Tel: (703) 306-1710</p>
<p>Science and Technology Agency (STA) of Japan Postdoctoral Awards for U.S. researchers</p>	<p>STA Postdoctoral Awards Division of International Programs National Science Foundation 4201 Wilson Boulevard, Rm. 935 Arlington, VA 22230 Tel: (703) 306-1701 E-mail: NSFJinfo@nsf.gov</p>

(7) International Opportunities for Students and Postdoctoral Fellows

NSF offers international opportunities for students and postdoctoral fellows in all NSF-supported disciplinary areas through the following activities:

- international research fellow awards for postdoctoral and junior investigators;
- dissertation enhancement awards to support dissertation research at overseas sites by graduate students enrolled in U.S. institutions; and
- research experiences for students that provide opportunities for U.S. graduate and undergraduate students to work in overseas laboratories and universities and initiate professional relationships with foreign scientists and engineers.

The Division of International Programs (INT) funds many of these opportunities as supplements to existing awards managed by NSF disciplinary divisions. INT

also accepts new proposals for dissertation enhancement awards and for the International Research Fellow Awards Program.

For More Information

Information and guidelines on proposal preparation for international programs and activities is available in the program announcement *International Opportunities for Scientists and Engineers* (NSF 96-14); or visit the INT home page, <http://www.nsf.gov/sbe/int>.

(8) Faculty Early Career Development

The Faculty Early Career Development (CAREER) Program is a Foundation-wide activity that supports junior faculty within the context of their overall career development. It combines in a single program the support of research and education of the highest quality. CAREER emphasizes the importance the Foundation 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. CAREER awards are intended to provide stable support at a sufficient level and duration to enable awardees to achieve the education and research career-development objectives of the program.

For More Information

For complete information about CAREER, visit the program's Web site, <http://www.nsf.gov/home/crssprgm/career/start.htm>.

(9) NSF Component of the Presidential Early Career Awards for Scientists and Engineers

Each year NSF selects up to 20 nominees for the Presidential Early Career Awards for Scientists and Engineers (PECASE). Nominees are selected from among the most meritorious first-year awardees supported by the Faculty Early Career Development (CAREER) Program (a description of CAREER can be found elsewhere in this section). PECASE awards recognize 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

For further information about PECASE, including eligibility factors and other pertinent information, visit the PECASE Web site, <http://www.nsf.gov/home/crssprgm/pecase/start.htm>.

OTHER CROSSCUTTING PROGRAMS AND ACTIVITIES

The programs and activities described in this section include:

- (1) Grant Opportunities for Academic Liaison with Industry**
- (2) Innovation and Organizational Change**
- (3) Global Change Research Programs**
- (4) Partnership for a New Generation of Vehicles**
- (5) International Programs**
- (6) Small Business Innovation Research Program and Small Business Technology Transfer Program**
- (7) Science and Technology Centers: Integrative Partnerships**
- (8) Major Research Instrumentation**
- (9) Collaboratives to Integrate Research and Education**

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(1) Grant Opportunities for Academic Liaison with Industry

The Grant Opportunities for Academic Liaison with Industry (GOALI) Initiative aims to synergize university/industry partnerships by making funds available to support these linkages. A particular interest of the initiative is to afford the opportunity for (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. This initiative 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 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 industry-based fellowships for graduate students and postdoctoral fellows.

For More Information

Further information about GOALI is available in the program announcement NSF 98-142; or visit the GOALI Web site, <http://www.nsf.gov/home/crssprgm/goali/start.htm>. To learn if a particular NSF directorate is involved in any GOALI-related activities, visit its home page.

(2) Innovation and Organizational Change

The Innovation and Organizational Change (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. In order 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 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.

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

For More Information

For complete information about the IOC Program, visit the program's Web site, <http://www.nsf.gov/sbe/ses/ioc/start.htm>.

(3) Global Change Research Programs

NSF global change research programs (GCRP) 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 the general processes used by governments and other organizations to identify and evaluate different types of policies for mitigation, adaptation, and other responses to changing global environmental conditions.

For More Information

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

(4) Partnership for a New Generation of Vehicles

The Partnership for a New Generation of Vehicles (PNGV) is an historic public/private partnership between the Federal Government (including 7 agencies and 19 Federal laboratories) and DaimlerChrysler, Ford, and General Motors Corporations, that aims to strengthen America's competitiveness by developing technologies for a new generation of vehicles.

PNGV's long term goals are (1) to develop an environmentally friendly car with up to triple the fuel efficiency of today's midsize cars; (2) to significantly improve national competitiveness in automotive manufacturing; and (3) to apply commercially viable innovation to conventional vehicles. PNGV's success is important to the country for a number of reasons, primarily jobs and global competitiveness (one out of every seven jobs in the United States is automotive related); reduction of U.S. dependence on foreign oil (the United States currently imports 50 percent of the oil we consume); and environmental factors (automobiles are a major contributor to atmospheric carbon dioxide, a greenhouse gas).

For More Information

To obtain further information about PNGV, write to the PNGV Secretariat, U.S. Department of Commerce, Herbert Hoover Building, Room 4845, 14th Street & Constitution Ave., NW, Washington, D.C. 20230; or contact by telephone, (202) 482-6260; or by fax, (202) 482-6275. To inquire via e-mail, send messages to pngv-info@ta.doc.gov and type "PNGV Question" in your subject line. Also available is an electronic information request form, accessible from the PNGV Web site.

(5) International Programs

Support of international activities is an integral part of NSF's mission of promoting 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 Division of International Programs (INT) 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 INT programs are organized on a regional or country basis. Prospective applicants should also

consider international opportunities supported by other parts of the Foundation and elsewhere.

For More Information

Information and guidelines on proposal preparation for international programs and activities is available in the program announcement *International Opportunities for Scientists and Engineers* (NSF 96-14); or visit the INT Web site, <http://www.nsf.gov/sbe/int>.

(6) Small Business Innovation Research Program and Small Business Technology Transfer Program

Small Business Innovation Research 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 Small Business Innovation Research (SBIR) Program is a Government-wide program intended to stimulate technological innovation, utilize 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 process that involves three phases. 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 considered 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.

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 one-third, and in Phase II, up to one-half. Members of academic institutions can participate either through a subcontract to the institution or as consultants.

For More Information

For further information about the SBIR Program, visit the SBIR Web site, <http://www.eng.nsf.gov/sbir/>.

Small Business Technology Transfer Program

The Small Business Technology Transfer (STTR) Program is also a Government-wide program. It 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. The partners make an agreement that covers rights to the technology involved in the proposal prior to starting the Phase I work.

For More Information

For further information about the STTR Program, visit the STTR Web site, <http://www.eng.nsf.gov/sbir/>.

(7) Science and Technology Centers: Integrative Partnerships

The Science and Technology Centers (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, 30 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

For further information, write to the Office of Integrative Activities (OIA), National Science Foundation, 4201 Wilson Boulevard, Room 1270, Arlington, VA 22230; or contact by telephone, (703) 306-1040; or by e-mail, nsf_oia@nsf.gov; or visit the OIA home page, <http://www.nsf.gov/od/oia/start.htm>.

(8) Major Research Instrumentation

The Major Research Instrumentation (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.

Additionally, the program assists in the acquisition or development of major research instrumentation by U.S. institutions 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 encouraged.

For More Information

For further information, write to the Office of Integrative Activities (OIA), National Science Foundation, 4201 Wilson Boulevard, Room 1270, Arlington, VA 22230; or contact by telephone, (703) 306-1040; or by e-mail, nsf_oia@nsf.gov; or visit the OIA home page, <http://www.nsf.gov/od/oia/start.htm>.

(9) Collaboratives to Integrate Research and Education

The Collaboratives to Integrate Research and Education (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 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

exchanges of faculty and students. It should be noted, however, that CIRE is not a general infrastructure program for minority-serving institutions.

For More Information

For further information, write to the Office of Integrative Activities (OIA), National Science Foundation, 4201 Wilson Boulevard, Room 1270, Arlington, VA 22230; or contact by telephone, (703) 306-1040; or by e-mail, nsf_oia@nsf.gov; or visit the OIA home page, <http://www.nsf.gov/od/oia/start.htm>.

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. Support is provided 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 cells, organs, and organisms, to studies of populations and ecosystems. It encompasses processes that are internal to the organism as well as 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.

The BIO Directorate supports programs and activities through the following:

- **Crosscutting Programs and Activities**
- **Division of Biological Infrastructure (DBI)**
- **Division of Environmental Biology (DEB)**
- **Division of Integrative Biology and Neuroscience (IBN)**
- **Division of Molecular and Cellular Biosciences (MCB)**

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.

Group Proposals in the BIO Directorate

Increasingly, many important research problems in science can be addressed best by groups of investigators. A group approach may not only result in a more comprehensive treatment of many scientific problems, but also may provide innovative opportunities for the training of students. NSF has long recognized the importance of this mode of research by encouraging submission of group proposals. For further information on proposal submission, see the *NSF Grant Proposal Guide* (NSF 00-2).

The need for increased attention to small-group research and training in biology has been identified by several recent 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, for collaborative studies focused on a single problem. BIO programs will evaluate both proposals from individual investigators and group proposals as part of the programs' portfolio of activities within existing budgets. As is the case for proposals from individual investigators, group proposals may provide for the training of students, and industrial collaborations may be involved if appropriate. Investigators interested in submitting a group proposal may contact the appropriate BIO program for further advice and guidance.

Submission of Proposals to the BIO Directorate

Starting May 3, 1999, all unsolicited proposals directed to programs in the BIO Directorate must be submitted, at least partially, through NSF's FastLane System. For details on this new policy, see the NSF Dear Colleague Letter on the BIO Directorate's use of FastLane technology (NSF 99-83), issued February 8, 1999. The document is available at <http://www.nsf.gov/pubs/1999/nsf9983/nsf9983.htm>. General information about FastLane is available at <https://www.fastlane.nsf.gov/>.

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

Review of duplicate proposals that have been sent to another federal agency will be suspended until the other agency takes final action. Exceptions are made for proposals from beginning investigators, for conferences or workshops, or for fellowships, and in cases in which a proposer and the federal program managers have previously agreed to a joint review and possible joint funding. A beginning investigator is defined as an individual who has not previously been a principal investigator on any federally funded award except a doctoral dissertation improvement grant, fellowship, or research planning grant. Applicants are encouraged to contact a program officer by phone or e-mail concerning their proposals.

Deadlines and Target Dates for BIO Programs and Activities

Many programs in the BIO Directorate have an established deadline or target date for the submission of proposals. To confirm a date, refer to the NSF E-Bulletin (<http://www.nsf.gov/home/ebulletin/>); 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 announcement stating otherwise, proposals must conform to all format requirements in the NSF *Grant Proposal Guide* (NSF 00-2), with special attention to page limitations, font size, and appendix materials. Some programs or specific competitions have program announcements that provide more details about the activities described in this Guide.

CROSSCUTTING PROGRAMS AND ACTIVITIES

In addition to the programs mentioned in this section, the Directorate for Biological Sciences takes an active role in several crosscutting programs and activities.

In fiscal year 1998 the new Plant Genome Research Program was initiated. In addition, BIO provides support for early development of academic faculty as both educators and researchers through such programs as Faculty Early Career Development (CAREER); computational biology; research conferences, symposia, and workshops; the purchase of scientific equipment for research purposes; maintenance and improvement of research collections; research directed toward micro-organisms; basic research in conservation and restoration biology; research in biotechnology; and biosystems analysis and control. Also provided are active research participation grants for high school students (Research Awards for Minority High School Students [RAMHSS]), undergraduates (Research Experiences for Undergraduates [REU]), and faculty from predominantly undergraduate institutions (Research Opportunity Awards [ROA]); graduate education and research training (Integrative Graduate Education and Research Training [IGERT]); postdoctoral research fellowships; and, in selected areas, doctoral dissertation improvement grants.

For More Information

For further information about these and other initiatives, see the alphabetical listing on the BIO Directorate Programs and Deadlines web site, <http://www.nsf.gov/bio/programs.htm>, located on the BIO home page, <http://www.nsf.gov/bio/>.

Further information on any of the programs listed here is also available on the NSF Crosscutting Programs home page, <http://www.nsf.gov/home/crssprgm/start.htm>.

DIVISION OF BIOLOGICAL INFRASTRUCTURE (DBI)

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

DBI supports research through the following program clusters:

- **Instrument-Related Activities Cluster**
- **Research Resources Cluster**
- **Training Cluster**

For More Information

For further 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) 306-1470; or visit the DBI home page, <http://www.nsf.gov/bio/dbi/start.htm>.

INSTRUMENT-RELATED ACTIVITIES CLUSTER

This cluster of programs is within the Division of Biological Infrastructure (DBI) and is composed of the following:

- 1. Multi-User Equipment and Instrumentation Resources for Biological Sciences**
- 2. Research at Undergraduate Institutions (RUI) Proposals for Multi-User Equipment and Instrumentation Resources for Biological Sciences**
- 3. Joint NSF/NIH Multi-User Instrumentation**
- 4. Instrument Development for Biological Research**
- 5. Improvements in Facilities, Communications, and Equipment at Biological Field Stations and Marine Laboratories (FSML)**

For More Information

The information in this section briefly describes the programs and activities in the Instrument-Related Activities Cluster. For complete 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. Cost sharing of the capital cost by the institution is required. For more information, see program announcement NSF 98-137.
- 2. 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 94-79). 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 (a) the user group is conducting research in NSF-supported subject areas and (b) 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.
- 3. Joint NSF/NIH Multi-User Instrumentation**—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 the program announcement *Multi-User Equipment and Instrumentation Resources for Biological Sciences* (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.
- 4. 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.

- 5. Improvements in Facilities, Communications, and Equipment at Biological Field Stations and Marine Laboratories (FSML)**—Supports refurbishment, rehabilitation, enhancement, acquisition, construction, and planning at field stations and marine laboratories. Sites are required to have a plan for archiving data in electronic form and for making these scientific databases available to the community. Support can be provided for necessary computer equipment, connectivity, and development of scientific data bases and communication systems. Significant cost sharing is required. For more information, see program announcement and guidelines NSF 98-17.

RESEARCH RESOURCES CLUSTER

This cluster of programs is within the Division of Biological Infrastructure (DBI) and is composed of the following:

- 1. Biological Databases and Informatics**
- 2. Plant Genome Research**
- 3. Support of Living Stock Collections**
- 4. Biological Research Collections**

For More Information

The information in this section briefly describes the programs and activities in the Research Resources Cluster. For complete information, visit the cluster's web site, <http://www.nsf.gov/bio/dbi/dbiresearch.htm>.

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- 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 utility to the scientific community. For more information, see program announcement NSF 99-91.
- 2. Plant Genome Research**—Initiated as a program in fiscal year 1998 as 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 fiscal year 1998, this program held two separate competitions (see program

announcements NSF 98-30 and NSF 98-52). Results of both competitions are available at <http://www.nsf.gov/bio/pubs/awards/genome98.htm>.

In fiscal year 1999, the program continued activities supported under NSF 98-30 and supported new collaborative research and infrastructure projects under announcement NSF 99-13. Results of this competition are available at <http://www.nsf.gov/bio/pubs/awards/genome99.htm>.

The new program announcement for fiscal year 2000 (NSF 99-171) has been published. The goals of this program are to support research on plant genomics and to accelerate the acquisition and utilization of new knowledge and innovative approaches to elucidate fundamental biological processes in plants. During the past 2 years, a significant investment has been made for building the plant genome infrastructure in the United States. To take advantage of new technologies, databases, research tools, and biological resources that have resulted from the earlier awards, this year's competition focuses on functional genomics--the identification of functions of a pathway or a cluster of genes at a genomic scale. Emphasis is placed on plants of economic importance and plant processes of potential economic value. The program will consider research on the genomics of plant-associated microbes including fungi, if addressed within the context of host-microbial interactions.

In addition, the program will continue to participate in the interagency activities to further develop the national plant genome research initiative as described in the report *National Plant Genome Initiative*, published in January 1998 by the Office of Science and Technology Policy.

- 3. 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 by this program 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.
- 4. 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 98-126.

TRAINING CLUSTER

This cluster of programs is within the Division of Biological Infrastructure (DBI) and supports training-related activities.

This cluster is composed of the following:

1. **Research Experiences for Undergraduates (REU) Sites**
2. **Collaborative Research at Undergraduate Institutions**
3. **Integrative Graduate Education and Research Training (IGERT)**
4. **Postdoctoral Research Fellowships**
5. **Minority Postdoctoral Research Fellowships**
6. **Postdoctoral Research Fellowships in Biological Informatics**
7. **Postdoctoral Research Fellowships in Microbial Biology**

For More Information

The information in this section briefly describes the programs and activities in the Training Cluster. For complete information, visit the cluster's web site, <http://www.nsf.gov/bio/dbi/dbitraining.htm>.

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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 96-102.
2. **Collaborative Research at Undergraduate Institutions**—Supports multidisciplinary collaborative research groups at predominantly undergraduate institutions. These groups are composed of at least three faculty members representing at least two disciplinary areas, and up to 10 undergraduates who will work on a biological research project that requires a cross-disciplinary approach. Submission of a preproposal is required before a full-length proposal will be accepted. Competitions will be on a biennial cycle, with the next one anticipated in fiscal year 2001. For more information, see program announcement NSF 99-11.
3. **Integrative Graduate Education and Research Training (IGERT)**—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, NSF has developed an agency-wide initiative that will sponsor the development of innovative research-based graduate education and training programs in Ph.D.-degree-granting institutions. The IGERT Program will support 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 educational 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

For further information on IGERT including the IGERT program announcement (NSF 98-96), answers to frequently asked questions about the program, detailed instructions on preparing and submitting an IGERT preproposal or formal proposal, and the names of cognizant NSF staff, visit the IGERT web page on the NSF Crosscutting Programs home page, <http://www.nsf.gov/home/crssprgm/>.

- 4. Postdoctoral Research Fellowships**—Offered in selected areas to U.S. citizens and nationals and to 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 awards to individuals, and applications are submitted directly by the applicant to the 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 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 for submission of applications are described below.

- 5. 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 Alaskan 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 prior to preparing a fellowship application. For more information, see program announcement NSF 94-133.
- 6. Postdoctoral Research Fellowships in Biological Informatics**—Provide training to young scientists in preparation for careers in biological informatics in which research and education will be integrated. There is an increasing need for training in biological informatics at all occupational levels, and it is expected that the recipients of these fellowships will play an important role in training the future workforce. For more information, see program announcement NSF 98-162.
- 7. 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 (e.g., *E. coli*, *Saccharomyces cerevisiae*, 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 among 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 also are not eligible for support. For more information, see program announcement NSF 99-142.

DIVISION OF ENVIRONMENTAL BIOLOGY (DEB)

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 (LTER) sites; doctoral dissertation research; research conferences and workshops; Undergraduate Mentoring in Environmental Biology (UMEB); and a variety of other NSF-wide activities.

DEB supports research through the following program clusters:

- **Systematic and Population Biology Cluster**
- **Ecological Studies Cluster**

For More Information

For further 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) 306-1480; or visit the DEB home page, <http://www.nsf.gov/bio/deb/start.htm>.

SYSTEMATIC AND POPULATION BIOLOGY CLUSTER

This cluster of programs within the Division of Environmental Biology (DEB) supports research on the patterns and causes of diversity within and among populations and species. Research projects may involve any group of organisms, including terrestrial, freshwater, and marine taxa, and range in subject from microbes to multicellular plants, animals, and fungi.

This cluster is composed of the following:

1. **Population Biology**
2. **Systematic Biology**
3. **Biotic Surveys and Inventories**

For More Information

The information in this section briefly describes the programs and activities in the Systematic and Population Biology Cluster. For complete information, visit the cluster's web site, <http://www.nsf.gov/bio/deb/debsysbio.htm>.

- 1. Population Biology**—Focus areas include (1) molecular population studies, including analyses of the causes and consequences of variation and change in biochemical characteristics; RNA and DNA sequences; the population genetics of mobile elements; the evolution of genic and genomic organization and functioning; and the evolution of organismal development; (2) population and quantitative genetics directed at understanding the genotypic and phenotypic variation of populations during microevolution; geographical differentiation; organismal adaptation to changing environments; natural hybridization; and speciation; and (3) studies from an ecological and evolutionary perspective of the life history and life cycle phenomena of terrestrial, freshwater, and wetland organisms; animal and plant demography of age- and stage-structured populations; and population dynamics, including linear, nonlinear, and stochastic approaches.
- 2. Systematic Biology**—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 [PEET]; see program announcement and guidelines NSF 97-21 for further information, including deadline dates); (3) understanding of processes that underlie the origin and maintenance of taxonomic diversity; and (4) theoretical and empirical studies of biogeographical, co-evolutionary, and paleobiological patterns to develop models of the origin, diversification, distribution, and extinction of species and evolutionary lineages and to determine the tempo and mode of evolutionary change.
- 3. Biotic Surveys and Inventories**—Focuses on 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 98-158.

ECOLOGICAL STUDIES CLUSTER

This cluster of programs within the Division of Environmental Biology (DEB) 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.

This cluster is composed of the following:

- **Ecosystems Studies**
- **Ecology**
- **Long-Term Ecological Research (LTER)**
- **Long-Term Research in Environmental Biology (LTREB)**

For More Information

The information in this section briefly describes the programs and activities in the Ecological Studies Cluster. For complete information, visit the cluster's web site, <http://www.nsf.gov/bio/deb/debecological.htm>.

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1. **Ecosystems Studies**—Support 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 start-up 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 page.

DIVISION OF INTEGRATIVE BIOLOGY AND NEUROSCIENCE (IBN)

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, symposia, computational biology, and a variety of NSF-wide activities.

The IBN Division supports research through the following program clusters:

- **Developmental Mechanisms Cluster**
- **Neuroscience Cluster**
- **Physiology and Ethology Cluster**

For More Information

For further 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) 306-1420; or visit the IBN Division home page, <http://www.nsf.gov/bio/ibn/start.htm>.

DEVELOPMENTAL MECHANISMS CLUSTER

This cluster of programs located in the Division of Integrative Biology and Neuroscience (IBN) supports research on the nature, control, and evolution of those processes that comprise the life cycle of organisms. Approaches range from molecular genetic and genomic analysis of developmental processes to the experimental manipulation of whole organisms. Included 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 included are studies that explore the mechanisms of development in an evolutionary context.

This cluster is composed of the following general areas of research:

- 1. Plant and Microbial Developmental Mechanisms**
- 2. Animal Developmental Mechanisms**
- 3. Evolution of Developmental Mechanisms**

For More Information

The information in this section briefly describes the programs and activities in the Developmental Mechanisms Cluster. For complete information, visit the cluster's web site, <http://www.nsf.gov/bio/ibn/ibndevelop.htm>.

NEUROSCIENCE CLUSTER

This cluster of programs located in the Division of Integrative Biology and Neuroscience (IBN) supports research on all aspects of 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.

This cluster is composed of the following:

1. **Behavioral Neuroscience**
2. **Computational Neuroscience**
3. **Developmental Neuroscience**
4. **Neuroendocrinology**
5. **Neuronal and Glial Mechanisms**
6. **Sensory Systems**

For More Information

The information in this section briefly describes the programs and activities in the Neuroscience Cluster. For complete information, visit the cluster's web site, <http://www.nsf.gov/bio/ibn/ibnneuro.htm>.

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1. **Behavioral Neuroscience**—Focuses on the neural regulation of behavioral events ranging from simple movements to complex adaptive and interactive responses. Molecular, cellular, and systems approaches are used to investigate sensorimotor integration, biological rhythms, and cognitive functions such as attention, spatial representation, and learning and memory. Studies are encouraged that employ a variety of novel techniques, including regulation and manipulation of gene expression and genomic analyses, and functional brain imaging, to study behavior within an evolutionary and ecological context.
2. **Computational Neuroscience**—Focuses on the computational functions of neurons, neural circuits, and nervous systems and encourages the development and testing of mathematical or computer models of neural systems. In addition to experimental studies on animals, the activity welcomes theoretical approaches for developing innovative, testable concepts that will clarify and extend current experimental observations in all areas of neuroscience.
3. **Developmental Neuroscience**—Focuses on the development, regeneration, and aging of the nervous system. The use of model systems that elucidate basic mechanisms and principles is encouraged. Current studies include aspects of cell lineage and determination, axonal navigation and cell

migration, regulation of gene expression, neuronal morphogenesis and neuron-glia interactions, synaptic specificity and plasticity, cell death, and the relationship of neural developmental mechanisms with learning. Studies typically employ a variety of approaches, including cellular and molecular techniques, genetic and genomic analyses, and the study of development at the systems or behavioral level.

4. **Neuroendocrinology**—Focuses 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. Behavioral paradigms and molecular techniques are used to study the basic mechanisms underlying neuroendocrine development and the interaction between physiology, the environment, and gene expression.
5. **Neuronal and Glial Mechanisms**—Focuses on innovative approaches and techniques using novel model systems to explore the cellular and molecular mechanisms of neuronal and glial cell function, including energy metabolism, ion and substrate transport, and synaptic mechanisms. Major thrusts include the genetic and biophysical bases of a membrane's electrical properties, their regulation by intracellular second messengers, and the integration of metabolism and signaling activity by interactions between neurons and glia in both the peripheral and central nervous systems.
6. **Sensory Systems**—Focuses on the mechanisms by which the nervous system acquires, encodes, and processes information about the environment. This includes research on neural processes at the molecular, cellular, systemic, and behavioral levels and psychophysical correlates of sensory neural processes. Topics include sensory transduction; neural coding and integrative mechanisms; and comparative aspects of sensory capabilities, including vision, hearing, touch, taste, smell, equilibrium, electrosensation, magnetic sensation, and other senses.

PHYSIOLOGY AND ETHOLOGY CLUSTER

This cluster of programs located in the Division of Integrative Biology and Neuroscience (IBN) supports integrative studies of physiological functions at the genomic, cellular, systemic, and organismal levels, and animal behavior in both field and laboratory settings.

This cluster is composed of the following:

1. **+Animal Behavior**
2. **Ecological and Evolutionary Physiology**

3. **Integrative Animal Biology**
4. **Integrative Plant Biology**

For More Information

The information in this section briefly describes the programs and activities supported in the Physiology and Ethology Cluster. For complete information, visit the cluster's web site, <http://www.nsf.gov/bio/ibn/ibnphysio.htm>.

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1. **Animal Behavior**—Focuses on the mechanisms, development, functions, and evolution of all animal behaviors, studied observationally and experimentally in laboratory and natural settings. Specific areas include 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. These areas are neither limiting nor mutually exclusive, and interdisciplinary collaborations and other projects that integrate diverse approaches, including functional genomics, to the study of behavior are particularly encouraged. This program also considers Long-Term Research in Environmental Biology (LTREB) proposals.
2. **Ecological and Evolutionary Physiology**—Supports research that addresses 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. This program also considers Long-Term Research in Environmental Biology (LTREB) proposals.
3. **Integrative Animal Biology**—Focuses on the basic physiological mechanisms at the molecular, cellular, tissue, organ, and whole-animal levels. The program's encompassing theme is "the whole animal as an integrated system." It includes research on integrative aspects of comparative physiology, functional morphology, endocrinology, epithelial transport, and biomechanics. (Note that studies focusing on the nervous system are supported by the IBN Division's Neuroscience Cluster.) A description of these programs can be found on the cluster's web page, <http://www.nsf.gov/bio/ibn/ibnphysio.htm>.

4. Integrative Plant Biology—Supports research on plants as functional units, integrating genomic, molecular, biochemical, and biophysical approaches to the understanding of plant form and function. Other examples include whole-plant, tissue, and organ physiology; sensory mechanisms; and hormonal and environmental regulation of plant function. Other examples include plant physiological interactions with pathogens, nitrogen-fixing organisms, mycorrhizae, and other beneficial or pathogenic organisms in the rhizosphere; and interactions with parasites, epiphytes, endophytes, and other commensal interactions. The emphasis is on understanding the physiological and metabolic basis of plant responses to such interactions. Also supported is research on the physiological and biochemical mechanisms through which plant function adapts to changing environmental conditions.

DIVISION OF MOLECULAR AND CELLULAR BIOSCIENCES (MCB)

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

Investigator-initiated research proposals are considered in the following programs: Biomolecular Structure and Function, Biomolecular Processes, Cell Biology, and Genetics. Programs in the MCB Division also support fundamental studies leading to technological innovation, proposals with substantial computational components, and multidisciplinary and small-group research. Biodiversity and biotechnology are major focal points of the MCB Division.

Particularly encouraged by programs in the MCB Division are proposals that involve microbial biology, plant biology, theoretical/computational aspects of molecular and cellular studies, molecular evolution, and biomolecular materials. Genomic approaches are encouraged in all areas. In fiscal year 1999, the division coordinated a special BIO-wide competition for Microbial Observatories (see program announcement NSF 00-21, available electronically at <http://www.nsf.gov/cgi-bin/getpub?nsf0021>). In addition, the division supports a variety of NSF-wide activities, including research on Biocomplexity and Life in Extreme Environments, and Foundation-wide activities designed to promote integration of research and education such as Faculty Early Career Development (CAREER) and Research at Undergraduate Institutions (RUI). The division also considers proposals for limited support of special meetings and workshops.

The MCB Division supports research through the following program clusters:

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

For More Information

For further 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) 306-1440; or visit the MCB Division home page, <http://www.nsf.gov/bio/mcb/start.htm>.

BIOMOLECULAR STRUCTURE AND FUNCTION CLUSTER

This cluster of programs located in the Molecular and Cellular Biosciences (MCB) Division 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.

This cluster is composed of the following:

1. **Molecular Biochemistry**
2. **Molecular Biophysics**

For More Information

The information in this section briefly describes the programs and activities in the Biomolecular Structure and Function Cluster. For complete information, visit the cluster's web site, <http://www.nsf.gov/bio/mcb/mcbstructure.htm>.

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1. **Molecular Biochemistry**—Emphasizes the correlation of function with known structures of biological macromolecules and supramolecular structures such as multienzyme complexes, membranes, and viruses. Additional emphases 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. Approaches typically include a combination of biochemical, molecular biological, chemical, physical, and genetic techniques. Increasingly a combination of these techniques is being used in an integrated manner to explore the function and mechanisms of action of gene products identified from research in genomics.
2. **Molecular Biophysics**—Supports multidisciplinary research at the interfaces of biology, physics, chemistry, mathematics, and computer science. Emphasis is on research on the structure, dynamics, interactions, and functions of biological macromolecules, including the three-dimensional structures of macromolecules at atomic resolution; assembly and architecture of supramolecular structures (e.g., multienzyme units, viruses, membranes, and contractile proteins); energy transduction; structure and dynamics of photosynthetic reaction centers; and mechanisms of electron and proton

transfer in biological systems. Typical approaches and techniques include theory and computation; x-ray diffraction; magnetic resonance; optical spectroscopy; specialized microscopy, such as atomic force; and mass spectrometry. Information from genome sequencing projects and informatics methods are providing new opportunities. For example, bioinformatics methods for parsing genes into protein domain encoding regions, methods for automated analysis of protein structures, and computational approaches for comparing new structures with structures available in the protein data base are playing an increasing role in molecular biophysics research.

BIOMOLECULAR PROCESSES CLUSTER

This cluster of programs located in the Molecular and Cellular Biosciences (MCB) Division 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.

This cluster is composed of the following:

- 1. Biochemistry of Gene Expression**
- 2. Metabolic Biochemistry**

For More Information

The information in this section briefly describes the programs and activities in the Biomolecular Processes Cluster. For complete information, visit the cluster's web site, <http://www.nsf.gov/bio/mcb/mcbprocess.htm>.

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- 1. Biochemistry of Gene Expression**—Supports 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**—Supports 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

This cluster of programs located in the Molecular and Cellular Biosciences (MCB) Division supports research on the structure, function, and regulation of plant, animal, and microbial cells. Cluster programs and activities support research that will utilize both traditional and innovative methodologies and encourage multidisciplinary approaches, technique development, modeling, and approaches that exploit genomic information.

This cluster is composed of the following:

- 1. Cellular Organization**
- 2. Signal Transduction and Cellular Regulation**

For More Information

The information in this section briefly describes the programs and activities in the Cell Biology Cluster. For complete information, visit the cluster's web site, <http://www.nsf.gov/bio/mcb/mcbcell.htm>.

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- 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

This cluster of programs located in the Molecular and Cellular Biosciences (MCB) Division 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, but are not limited to, 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 methodology used should be appropriate to the questions asked about genetic structure and function. The review process for proposals is organized around the areas described below, although interdisciplinary proposals or proposals that ask genetic questions but use methodology from other scientific disciplines will be coreviewed in a manner that will ensure effective and fair evaluation of each proposal.

The cluster is composed of the following:

- 1. Eukaryotic Genetics**
- 2. Microbial Genetics**

For More Information

The information in this section briefly describes the programs and activities in the Genetics Cluster. For complete information, visit the cluster's web site, <http://www.nsf.gov/bio/mcb/mcbgenetics.htm>.

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- 1. Eukaryotic Genetics**—Supports genetic studies of eukaryotic organisms, with the exception of fungi. Studies of both organelle and nuclear genomes are included. Also included are studies of viruses of these organisms as well

as parasitic or symbiotic interactions at the genetic level. Epigenetic phenomena, molecular evolution, and genomics are also areas of interest.

- 2. Microbial Genetics**—Supports genetic studies of eubacteria, archaeobacteria, and fungi, including yeast. Also included are studies of the genetics of bacterial viruses and other infectious agents of bacteria and fungi. 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 COMPUTER AND INFORMATION SCIENCE AND ENGINEERING

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

- To enable the United States to uphold 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 initiative. The directorate's activities in fiscal year (FY) 2000 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 IT research centers. Complete descriptions of the program and details on proposal submission will be available on the CISE Directorate home page (<http://www.cise.nsf.gov/>) in early FY 2000.

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

For further 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**
- **21st Century Workforce**

For More Information

For further information on these and other NSF crosscutting programs and activities, visit the NSF Crosscutting Programs home page, <http://www.nsf.gov/home/crssprgm/start.htm>.

DIVISION OF COMPUTER-COMMUNICATIONS RESEARCH (C-CR)

The Division of Computer-Communications Research (C-CR) supports research in a broad array of areas as well as interdisciplinary research in the context of computer science and engineering. This interdisciplinary research includes research on challenge problems, biocomputing, and computational biology. Basic themes of C-CR work center on parallel and distributed systems, high confidence systems, security, reliability, applied algorithms, and problem-solving environments.

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

- **Communications**
- **Computer Systems Architecture**
- **Design Automation**
- **Numeric, Symbolic, and Geometric Computation**
- **Operating Systems and Compilers**
- **Signal Processing Systems**
- **Software Engineering and Languages**
- **Theory of Computing**

For More Information

For further 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) 306-1910; or visit the C-CR Division home page, <http://www.cise.nsf.gov/ccr/index.html>.

- **Communications (COM)**—Supports research on the sciences, technologies, and algorithms that facilitate the efficient representation and transmission of information. Projects may address a variety of different communication contexts, including wireless, wireline, and optical systems; and research into the related fields of magnetic and optical data storage. Research supported by the COM program is distinguished from that in the networking research programs in ANIR by its focus on point-to-point issues as well as methodologies associated with the lower OSI layers (e.g., the physical layer and the data link layer), while the ANIR programs address higher-layer issues confronted in multiuser networks. Areas supported by COM include the following: compression of speech, images, video, and data; efficient modulation and coding

for the reliable transmission of information over inherently unreliable (and/or constrained) channels; multiple-access methodologies; algorithms for the detection of signals in noise as well as the estimation, acquisition, and tracking of signal parameters; cryptography and data security; and information theory, including fundamental assessments of what is and is not achievable in the various communications functions.

- **Computer Systems Architecture**--Supports fundamental research on new computing systems. Focus is on new architecture ideas and concepts will form the basis for solving computing problems likely to arise in the future. Broadly this covers design, implementation, and evaluation of novel computing structures and technologies. Theoretical and small scale experimental studies are supported, as are assessments of fault tolerance and performance. Research on system software, when intimately connected to the architecture or hardware is supported.

Currently, special attention is given to research in the following areas: metrics (benchmarks, new applications, non-performance metrics); parallelism (including small-scale and mpps); systems of systems (latency reduction, bandwidth increase, processor-in-memory, I/O, interconnects, new device support); small-scale MPs (roughly 2 to 100 nodes) (synchronization, communication, protection, memory system structure, reliability, performance metrics, compiler architecture interaction); memory (bandwidth, latency questions, hierarchy management); interconnect (fault tolerance, dynamics of faults and recovery, reliability, quality of service); processor-in-memory (PIM) (single and multiple PIMs, new architectures); input/output (availability, scalable I/O, performance, data stream management, low overhead protection, latency tolerance); single-thread computing (prediction and speculation, architectural support, control simplification); multiple-thread computing (multiscalar, dynamic sharing, communication, synchronization, multiple independent processors); protection (non-trusted applications coming in off the net, security, privacy).

- **Design Automation (DA)**—Supports basic research in Electronic Design Automation (EDA) and those areas in which VLSI design technology is applicable, such as systems-on-a-chip, embedded systems, and multi-technology (optical, micro-electro-mechanical, etc.) design methods. Research covers all phases of the complete design cycle for integrated circuits and systems, from conception through manufacturing test. Topical areas of VLSI design technology include: (1) theoretical foundations, models, algorithms, tools, analysis, synthesis, simulation, validation and verification; (2) system design methodologies: systems-on-a-chip, multi-chip, and multi-technology systems; (3) manufacturing: fault models and algorithms for diagnosis and test in digital, analog and mixed signal designs; and (4) design and system prototyping methods, tools, environments, especially the information infrastructure aspects.

- **Numeric, Symbolic, and Geometric Computation (NSGC)**—Supports fundamental research in areas where advanced algorithmic and computational

techniques are coupled with mathematical methods of analysis. The specific program areas include computationally-oriented numerical analysis, mathematical optimization, symbolic and algebraic computation, computational geometry, computational logic and automated deduction, and computer graphics. The program also supports advanced computational techniques for 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. The program also encourages the integration of numeric, symbolic, geometric, and graphic techniques into problem-solving environments to support computational science and engineering. Innovative applications of advanced computational and graphic techniques in scientific and engineering applications, manufacturing and design, proof support systems, and prototypic and design verification are also welcome.

- **Operating Systems and Compilers (OSC)**—Supports research on the development, design, evaluation, and implementation of computing systems ranging from operating systems, compilers, and run-time systems to middleware for the integration of heterogeneous systems and information sources. In operating systems and distributed systems, topics of interest include the development of mechanisms and APIs for uniform access and management of resources in LANs and WANs; middleware infrastructure for building scalable services; resource management for new applications and quality-of-service requirements; security, and electronic commerce. In compilers and run-time systems the topics of interest include dynamic compilation; techniques that include various models of storage consistency and storage-hierarchy performance; and compiler support for programming on the Web.

- **Signal Processing Systems (SPS)**—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 multidimensional 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.

Currently, special attention is given to antenna array processing with application to wireless communications systems, especially cellular telephony, personal communications systems, and wireless local area networks; signal compression for reduced data rate with applications to 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 SAR.

- **Software Engineering and Languages (SEL)**—Supports 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.

- **Theory of Computing (ToC)**—Supports fundamental research in three areas. *Core theory* covers computational complexity, cryptography, interactive computation, computational learning, parallel and distributed computation, computation on random data, on-line computation, and reasoning about knowledge. *Fundamental algorithms* include developing combinatorial, approximation, parallel, on-line, numerical, geometric, and graph algorithms that transcend application domains. *Application-specific theory* supports 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, and investigators are encouraged to pursue strategies that mix theory with experimentation.

DIVISION OF INFORMATION AND INTELLIGENT SYSTEMS (IIS)

The Division of Information and Intelligent Systems (IIS) strives to increase the ability to use information to benefit people by supporting research to 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 technology and are complementary to bandwidth and disk space. IIS fundamental research foci include universal access, human language technology, knowledge modeling, scientific laboratories, 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 Library and STIMULATE (Speech, Text, Image, and Multimedia Advanced Technology Effort) initiatives.

The IIS Division supports the following programs and activities:

- **Computation and Social Systems**
- **Human-Computer Interaction**
- **Information and Data Management**
- **Knowledge and Cognitive Systems**
- **Robotics and Human Augmentation**
- **Special Projects**

For More Information

For further 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) 306-1930; or visit the IIS Division home page, <http://www.cise.nsf.gov/iis/index.html>.

- **Computation and Social Systems (CSS)**—Encourages and supports research in two broad and highly interrelated areas: (1) integration, sustainable use, and impacts of information technology on groups, organizations, communities, and societies; and (2) theories and technologies for reasoning, decision making, interaction, and collaboration in groups, organizations, communities, and societies. The research addresses issues and technologies at the level of groups, organizations, communities, and societies, and human-centered as well as technological aspects. Examples of topics include impacts and policy implications of information technology; integration of information

technologies in workplaces and communities; social and organizational informatics; theories of knowledge, action, and information processing at group, organization, and societal levels; economics of information technology, computation, and networks; theories and models of organizational information/knowledge processing and coordination; knowledge networking and collaboratories; multiagent systems and distributed artificial intelligence; computer-supported cooperative work and decision making; and computational organization research.

- **Human Computer Interaction (HCI)**—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.

- **Information and Data Management (IDM)**—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 modeling; information organization and information process management; information access and knowledge discovery/datamining in distributed heterogeneous systems; system architecture and implementation; and evolutionary system development and administration for enhancement of conventional databases, scientific databases, multimedia information systems, digital libraries, knowledge discovery, and expert systems.

- **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 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, linguistic cognition, and combinations of these in intelligent agents. Fundamental research in these areas may have as a goal, the application of integrated design and manufacturing, network management, medical diagnosis, data mining, intelligent tutoring, etc.

- **Robotics and Human Augmentation (RHA)**—Supports research fundamental to the design of machines and systems that implement some characteristics of intelligence so that the machines can serve effectively to augment human activities. Research topics include machine sensing, perception, and action; automatic representation, reasoning, and planning for complex physical tasks involving temporal and spatial relationships; integration of sensing and modeling of task environments; hardware and algorithmic design of robotic

systems, including micro- and nano-scale systems; communication and sharing of task control between human and machine and among machines; and linking and cooperation among geographically separated robotics resources.

- **Special Projects**—Supports research activities that explore new relationships among computing, communication, and digital content from human-centered perspectives in order to support communities of users in scholarly, social, and work contexts. The program promotes interdisciplinary and topical fusion. In particular, it manages the Digital Libraries Initiative, a multiagency research program designed to create large knowledge bases, the technology needed to access them, and the means for improving their usability in a wide range of contexts.

DIVISION OF ADVANCED COMPUTATIONAL INFRASTRUCTURE AND RESEARCH (ACIR)

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 the Partnerships for Advanced Computational Infrastructure (PACI) Program, and through the Advanced Computational Research Program.

The ACIR Division supports the following programs and activities:

- **Advanced Computational Research**
- **Large Scientific and Software Data Set Visualization**
- **Partnerships for Advanced Computational Infrastructure**
- **Terascale Computing System**

For More Information

For further 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) 306-1970; or visit the ACIR Division home page, <http://www.cise.nsf.gov/acir/index.html>.

- **Advanced Computational Research (ACR)**--Focuses on the research needed to advance the state-of-the-art in high-end computing and bring advanced computational capabilities to bear on fundamental science and engineering problems. Current focus areas include programming environments and tools, visualization and data handling, and scalable numerical algorithms. ACR also supports work on multidisciplinary analysis and design, heterogeneous computing, web-based meta-computing, computational steering, and remote collaboration on high performance computing applications. An area of growing interest is algorithm scalability, addressing such issues as latency-tolerant algorithms, and research into means to handle complex multi-level memory hierarchies. For specific program information, see program announcement NSF 98-168.
- **Large Scientific and Software Data Set Visualization**--Supports research to improve our ability to understand large data sets, simulation results, and software systems, and encourages use of these improved methods on data sets

from experiments and simulations of real scientific interest and on large software systems. The initiative has two primary focus areas:

1. Very large visualizations, the overall goal of which is to develop general, extensible methods that enable the understanding of very large (multi-gigabyte to terabyte) data sets from simulations, experiments, and data collections from the natural and social world. Subtopics of particular interest include interactive exploration of very large data sets; processing and presentation of real-time data from high-bandwidth sources; access and visualization of distributed data sets; extraction of features and behaviors for study (including uncertainty); and building scalable software systems for visualization.
2. Visualization, as a tool for assisting software robustness and usability. The overall goal is to provide new techniques and tools for program understanding and development. Subtopics of particular interest include on-line and a posteriori visualization of program state; performance measurement and visualization; new depictions of program behaviors; and use of visualization in program development, debugging, and performance analysis.

For specific program information, see program announcement NSF 99-105.

- **Partnerships for Advanced Computational Infrastructure (PACI)**— Supports two partnerships, the National Computational Science Alliance and the National Partnership for Advanced Computational Infrastructure, with each consisting of a leading edge site and a significant number of partners (more than 60 geographically distributed partner institutions in all). PACI provides the foundation for meeting the expanding need for high-end computation and information technologies required by the U.S. academic community. The activities of the partnerships are structured along four thrusts that provide the following: (1) access to a diverse set of advanced and mid-range compute engines and data storage systems and experimental machine architectures; (2) enabling technologies, by developing both software tools for parallel computation and software to enable use of the partnership's widely distributed architecturally diverse machines and data sources to effectively use the partnership's very large distributed systems; (3) application technologies, by engaging groups in high-end applications to develop and optimize their discipline specific codes and software infrastructures and to make these available to the program as a whole, as well as to researchers in other areas; and (4) education outreach and training, building growing awareness and understanding of how to use high performance computing and communications resources, and broadening the base of participation to help ensure the nation's continued world leadership in computational science and engineering. For specific program information, see program announcement NSF 96-31.

- **Terascale Computing System**--NSF bears special responsibility for this national research program that provides a terascale computing system in support of science and engineering research in the United States. The system will be balanced in terms of processor speed, memory, communication, and storage systems. It is expected that at least a portion of the system will be installed and either in full production or friendly-user mode by February 2001, with the full production system available shortly thereafter. The system will be part of a portfolio of resources provided by the Partnerships for Advanced Computational Infrastructure (PACI) Program and will supplement the capabilities that will continue to be available through the PACI partnerships. NSF does not intend to start another freestanding supercomputer center with this award. For specific program information, see program announcement NSF 00-29.

DIVISION OF ADVANCED NETWORKING INFRASTRUCTURE AND RESEARCH (ANIR)

The Advanced Networking Infrastructure and Research (ANIR) Division, is composed of two basic research programs and one experimental facility program. The overall goals of the programs in the ANIR Division are

- to focus on the fundamental science and technology needed to facilitate the efficient, high-speed transfer of information through networks and distributed systems;
- to support larger and more multidisciplinary projects, specialized hardware/software and networks for networking systems research, and mechanisms for developing research agendas as well as enhance community development; and
- to support research, development, implementation, and testing of advanced, high-performance network testbeds and related technologies in support of the distributed information technology goals of the research and education communities in the United States.

The ANIR Division supports the following programs and activities:

- **Advanced Networking Infrastructure**
- **Networking Research**
- **Special Projects in Networking**

For More Information

For further 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) 306-1950; or visit the ANIR Division home page, <http://www.cise.nsf.gov/anir/index.html>.



- **Advanced Networking Infrastructure (ANI)**—Provides high-performance infrastructure and supports research, development, implementation, and testing of advanced, high-performance network testbeds and related technologies in support of the distributed information technology goals of the research and education communities across the United States. Additionally, the program seeks

to enable the use of novel and advanced research applications across all disciplines of science and engineering, coordinate interactions with international research partners, and promote the analysis, improvement, and evolution of the Internet.

- **Networking Research**—Focuses on the fundamental science and technology needed to facilitate the efficient high-speed transfer of information through networks and distributed systems. Projects funded span the entire spectrum, 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 networks 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 protocols.
- **Special Projects in Networking**—Differs from the Networking Research Program in that it supports larger and more multidisciplinary projects, specialized hardware and software or networks for networking systems research, and mechanisms for developing research agendas and enhancing community development. 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, data bases, software, signal processing, control theory, and devices. Theoretical research activities address the next generation of networking and typically 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.

DIVISION OF EXPERIMENTAL AND INTEGRATIVE ACTIVITIES (EIA)

The Division of Experimental and Integrative Activities (EIA) supports experimental research spanning several areas and often involving infrastructure needs.

In particular, EIA promotes the development of experimental computer and communications research; furthers the evolution of multidisciplinary research involving CISE and other disciplines; contributes to the creation of a diverse personnel pool; carries out exploratory and prototype projects that cross organizational boundaries; operates special international activities; and supports special studies and analyses of issues that affect disciplinary areas supported by the CISE Directorate. Additionally, EIA plays a major integrative role in CISE by linking research and education through support for both CISE-specific and NSF-wide activities.

The EIA Division supports the following programs and activities:

- **CISE Advanced Distributed Resources for Experiments (CADRE)**
- **CISE Educational Innovation**
- **CISE Minority Institutions Infrastructure**
- **CISE Postdoctoral Research Associates**
- **CISE Research Infrastructure**
- **Collaborative Research on Learning Technologies**
- **Combined Research-Curriculum Development**
- **Digital Government**
- **Experimental Partnerships**
- **Instrumentation Grants for Research in CISE**
- **Integrative Graduate Education and Research Training**
- **Major Research Instrumentation**
- **Next Generation Software**
- **NSF-CONACyT Collaborative Research Opportunities**
- **NSF - CNPq Collaborative Research Opportunities**
- **Professional Opportunities for Women in Research and Education**
- **Research Experiences for Undergraduates**
- **Special Projects**

For More Information

For further 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) 306-1980; or visit the EIA Division home page, <http://www.cise.nsf.gov/eia/index.html>.

- **CISE Advanced Distributed Resources for Experiments (CADRE)**--To complement research and education activities, the program supports the establishment and maintenance of CISE Advanced Distributed Resources for Experiments (CADRE). These are unique resources that, once established, can be accessed remotely by researchers around the country. Resources can be diverse, including, for example, hardware such as prototyping testbeds; software such as code libraries for experimental compiler research; repositories such as collections of human discourse data; and services such as brokers to bring together creators and users of educational materials. The program anticipates making about five awards per year averaging \$400,000 per year for 4 years. For specific program information, see program announcement NSF 98-127.
- **CISE Educational Innovation**--Supports innovative educational activities at the undergraduate level in computer and information science and engineering that transfer research results into the undergraduate curriculum. Projects supported are expected to show promise as a national model of excellence by acting as a prototype for use by a broader segment of the CISE community. Proposals may address a variety of educational activities, including but not limited to, the development of courses, instructional technologies, software, and other educational materials. A related program, Combined Research and Curriculum Development, in cooperation with the Engineering Directorate, supports multidisciplinary projects in upper level undergraduate and introductory graduate level curricula. For specific program information, see program announcement NSF 99-80.
- **CISE Minority Institutions Infrastructure**--Provides awards to aid efforts that might significantly expand the numbers of minority students attracted to and retained in computer and information science and engineering disciplines. Eligible institutions must be minority institutions (defined by significant percentages of minority students). The program considers a variety of activities including, but not limited to, 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%) is expected. For specific program information, see program announcement NSF 96-15.
- **CISE Postdoctoral Research Associates**--The objective of these awards is to increase 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. For specific program information, see program announcement NSF 97-169.

- **CISE Research Infrastructure**--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. CISE area Ph.D. degree-granting departments or partnerships with at least one such partner are eligible. Outreach to underrepresented groups is another program goal. For specific program information, see program announcement NSF 00-5.

- **Collaborative Research on Learning Technologies**--Stimulates research on the integration of technology with learning at all levels of education--grades K-12, college and university, etc.--and from learning in the classroom to self-directed and lifelong learning. Projects supported through this program should involve a significant research component in the information, computer, communications, and computational science and engineering aspects of learning technologies. For specific program information, see program announcement NSF 97-18.

- **Combined Research-Curriculum Development (CRCD)**--Is jointly supported by the CISE and Engineering (ENG) Directorates. The program emphasizes the need to incorporate exciting research advances in important technology areas into the upper level undergraduate and graduate engineering curricula. A major objective of this program is to stimulate faculty researchers to place renewed value on quality education and curriculum innovation in the context that education and research are of equal value and complementary parts of an integrated whole.

Each project supported by CRCD focuses on a particular topic that is of industrial and national importance in areas supported by both Directorates. Additionally, each CRCD project contains 5 major components: research, curriculum development, a team of participants (faculty and students), project evaluation plans, and cost-sharing of at least 25%. For specific program information, see program announcement NSF 99-72.

- **Digital Government**--The Federal Government is a major user of information technologies, a collector and maintainer of very large data sets, and a provider of critical and often unique information services to individuals, states, businesses, and other customers. Yet, most Federal agencies are struggling with the creation of a strategic vision and an operational philosophy for information technologies. The goal of this program is 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, by supporting projects that innovatively, effectively, and broadly address potential improvement of agency, interagency, and intergovernmental operations and government/citizen interaction. For specific program information, see program announcement NSF 99-103.

- **Experimental Partnerships**--Provides opportunities in support of multidisciplinary, group-oriented research in topics that are within the domain of CISE programs and activities. Experimental partnerships focus on a single problem whose solution requires scientific advances, both in experimental computer science and engineering, and in one or more partner disciplines within CISE. The program anticipates making up to 14 awards (depending on available funds) per year; awards are expected to average \$500,000 per year for up to 5 years. For specific program information, see program announcement NSF 98-127.
- **Instrumentation Grants for Research in CISE**--Provides support to groups with 2 to 5 participating projects for the purchase of research equipment, instrumentation, or software for research in CISE areas. Both graduate degree-granting and four-year institutions are eligible. Significant matching--usually 33%--is required. For specific program information, see program announcement NSF 98-132.
- **Integrative Graduate Education and Research Training (IGERT)**--The goal of this NSF-wide, multidisciplinary program is to enable the development of innovative, research-based, graduate education and training activities that will produce a diverse group of new scientists and engineers well-prepared for a broad spectrum of career opportunities. Projects supported must be based upon a multidisciplinary research theme and organized around a diverse group of investigators from Ph.D.-granting institutions in the United States with appropriate research and teaching interests and expertise. For specific program information, see program announcement NSF 98-96.
- **Major Research Instrumentation**--An NSF wide program that supports projects that have one primary research focus and whose infrastructure requirement is too costly for other programs. All institutions are eligible, with a limit of two proposals from each institution per year. Matching at the 30% level is expected. For further information, see program announcement NSF 99-34; or visit the Major Research Instrumentation Program home page, <http://www.nsf.gov/od/oia/programs/mri/start.htm>.
- **Next Generation Software (NGS)**--Fosters multidisciplinary software research under two components: Technology for Performance Engineered Systems (TPES) and Complex Application Design and Support Systems (CADSS). The overall thrust of NGS is research and development for new software technologies integrated across the systems' architectural layers, and supporting the design and the operation cycle of applications, computing and communications systems, and delivering quality of service (QoS).

The TPES component will support research for methods and tools leading to the development of performance frameworks for modeling, measurement, analysis, evaluation, and prediction of performance of complex computing and communications systems, and of the applications executing on such systems.

The CADSS component will support research on novel software for the development and run-time support of complex applications executing on complex computing platforms. This includes programming models, new compiler and run-time technology, application composition environments, and debugging tools. CADSS-fostered technology breaks down traditional barriers in existing software components in the application development, support, and runtime layers, and will leverage TPES-developed technology for delivering QoS. For specific program information, see program announcement NSF 99-8.

- **NSF-CONACyT Collaborative Research Opportunities**--NSF and the Consejo Nacional de Ciencia y Tecnologia (CONACyT) (National Council of Science and Technology Research) of Mexico are supporting 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. Proposals to NSF from researchers at institutions in the United States are subject to standard NSF review procedures and will be processed by the CISE Directorate and by NSF's Directorate for Engineering. Proposals are accepted in all areas usually covered by the Directorate. For specific program information, see program announcement NSF 96-145.

- **NSF-CNPq Collaborative Research Opportunities**--NSF and CNPq- Conselho Nacional de Desenvolvimento Cientifico e Tecnologico da Pesquisas (National Council of Scientific and Technological Research) in Brazil jointly support this initiative, the purpose of which is to support new efforts in international cooperative research in any CISE-related area where the efforts are likely to produce positive, complementary, and synergistic effects.

The initiative seeks to advance scientific 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.

Proposals from Brazilian researchers and research institutions are selected and administered by CNPq's ProTem Office (Programa Tematico Multiinstitucional em Ciencia da Computacao) and are subject to the standards for submission and review of that organization. Proposals to NSF from researchers at institutions in the United States will be subject to standard NSF review procedures outlined in the NSF *Grant Proposal Guide (GPG)* (NSF 00-2) and will be processed by the CISE Directorate.

For More Information

For further information on the NSF-CNPq Collaborative Research Opportunities Initiative, see the program announcement NSF 98-139; or contact Dr. Larry Brandt, Program Director, by telephone, (703) 306-1981, or by e-mail, lbrandt@nsf.gov. Information is also available by visiting the NSF-CNPq Web site, <http://www.cnpq.br>.

- **Professional Opportunities for Women in Research and Education**--This NSF-wide program has the objectives of providing opportunities for further career advancement, professional growth, and increased prominence of women in the science and engineering (S&E) disciplines supported by NSF. Additionally, the program encourages more women to pursue careers in S&E by providing greater visibility for women scientists and engineers in academic institutions and in industry. POWRE is targeted at women scientists and engineers who currently (1) hold non-tenured academic positions or industrial positions; (2) hold academic tenured or tenure-track positions; or (3) plan to enter or re-enter academia. For specific program information, see program announcement NSF 98-160.

- **Research Experiences for Undergraduates (REU)**--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, a Foundation-wide effort, is designed to help meet this need. This program has two components: one supports sites for several students; the other supplements awards to existing research grants for one or two students. For specific program information, see program announcement NSF 96-102.

For More Information

For further information on REU-Sites, contact the program director by telephone, (703) 306-1981. For information on a supplement to an existing award, contact the program director in charge of the award.

- **Special Projects in the EIA Division**--Supports activities to expand opportunities for women, minorities, and persons with disabilities in computer and information science and engineering and for special workshops, symposia, and analytical studies 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.

DIRECTORATE FOR EDUCATION AND HUMAN RESOURCES

The Directorate for Education and Human Resources (EHR) is responsible for the health and continued vitality of the Nation's science, mathematics, engineering, and technology education and for providing leadership in the effort to improve education in these areas.

The EHR Directorate supports programs and activities through the following:

- **Division of Graduate Education (DGE)**
- **Division of Undergraduate Education (DUE)**
- **Experimental Program to Stimulate Competitive Research (EPSCoR)**
- **Division of Elementary, Secondary, and Informal Education (ESIE)**
- **Division of Educational Systemic Reform (ESR)**
- **Division of Human Resource Development (HRD)**
- **Division of Research, Evaluation, and Communication (REC)**

For More Information

For further information, visit the EHR Directorate home page, <http://www.ehr.nsf.gov/ehr2000f/default.asp>.

DIVISION OF GRADUATE EDUCATION (DGE)

The programs in the Division of Graduate Education (DGE) promote the early career development of scientists and engineers by providing fellowships and traineeships for graduate and postdoctoral study. All DGE programs encourage the integration of research and education and seek to ensure a steady flow of diverse, high-ability scientists, mathematicians, and engineers to the Nation's workforce.

DGE supports research and education through the following programs and activities:

- **Graduate Research Fellowships**
- **Integrative Graduate Education and Research Training**
- **NSF-NATO Postdoctoral Fellowships in Science and Engineering**
- **Travel Grants for NATO Advanced Study Institutes**

For More Information

For further information, write to the Division of Graduate Education, National Science Foundation, 4201 Wilson Boulevard, Room 907, Arlington, VA 22230; or contact the division by telephone, (703) 306-1630. For information such as program announcements and application forms, visit the DGE Home Page, <http://www.ehr.nsf.gov/EHR/DGE/dge.htm>.

Graduate Research Fellowships

Graduate Research Fellowships promote the strength and diversity of the Nation's scientific and engineering base. NSF Graduate Research Fellowships 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. For the fiscal year 2000 awards, the stipend for each fellow is \$15,000 for a 12-month tenure, and an annual cost-of-education allowance of \$10,500 is made available to the awardee's institution for each year of tenure, in lieu of tuition and fees.

Eligibility Requirements for Graduate Research Fellowships

To be eligible for this nationwide merit competition, an individual must be a citizen, national, or permanent resident of the United States, and at or near the beginning of graduate study.

For More Information

For fiscal year 2000 applications, write to Oak Ridge Associated Universities (ORAU), NSF Graduate Research Fellowships Program, P.O. Box 3010, Oak Ridge, TN 37831-3010; or contact ORAU by telephone, (865) 241-4300; or by e-mail, nsfgrfp@orau.gov.

Application forms and instructions are also available on the Graduate Research Fellowships Application Forms Web site, <http://www.ehr.nsf.gov/EHR/DGE/grfp.htm>.

Information on Graduate Research Fellowships is also available in the Crosscutting Investment Strategies section of this Guide.

Integrative Graduate Education and Research Training

NSF places high priority on the preparation of Ph.D.'s who are equipped with multidisciplinary backgrounds and with the technical, professional, and personal skills essential to address the career demands of the future. To meet these needs, NSF has created an agency-wide graduate education program called Integrative Graduate Education and Research Training (IGERT). In contrast to Graduate Fellowships, to which individuals apply, IGERT considers proposals from Ph.D. institutions.

IGERT's primary goal 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. The IGERT program integrates research and education, emphasizing 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 (i.e., minorities), to ensure preparation of a diverse science and engineering workforce; and

- a well-defined strategy for assessment of project performance.

For More Information

For complete information, visit the IGERT Web site, <http://www.nsf.gov/home/crssprgm/igert/start.htm>; or see the Crosscutting Investment Strategies section in this Guide.

NSF-NATO Postdoctoral Fellowships in Science and Engineering (including Special Fellowship Opportunities for Visiting Scientists and Engineers 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-defined partner countries. Approximately 30 awards are made each year to U.S. scientists or engineers to enable them to conduct research in other NATO member or NATO partner countries, and to visiting 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

U.S. citizens, nationals, permanent residents, or citizens of NATO partner countries, who have received their doctoral degree in science and engineering within the past five years, or who will have done so by the start of the fellowship, are eligible for the program. Applications from citizens of NATO partner countries must be submitted through a principal investigator at a U.S. institution.

For More Information

To request further information, send an e-mail to DGE staff at nsf-nato@nsf.gov; or visit the program's Web site, <http://www.ehr.nsf.gov/EHR/DGE/nato.htm>.

Travel Grants for NATO Advanced Study Institutes

NSF awards travel grants of \$1,000 each to enable junior U.S. scientists to attend select NATO Advanced Study Institutes held predominantly in the NATO member countries of Europe. These 2- to 3-week instructional courses, 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 Travel Grants

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 three years, and has been accepted at a NATO institute.

For More Information

To request further information, send an e-mail to DGE staff at nato-asi@nsf.gov; or visit the program's Web site, <http://www.ehr.nsf.gov/EHR/DGE/asi.htm>.

DIVISION OF UNDERGRADUATE EDUCATION (DUE)

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, to enter the workforce with 2- or 4-year degrees, to continue their formal education in graduate school, or to 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, mathematics, engineering, and technology (SMET) education for all students, including SMET majors, prospective teachers of grades pre-K to 12, students preparing for the technical workplace, and students in their role as citizens in a technological society.

Projects submitted to programs in DUE are encouraged to incorporate, as appropriate, features that address one or more of four themes that have been targeted for special emphasis. These themes are teacher preparation, professional development for faculty, increasing diversity within SMET fields, and 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 SMET education will be considered.

DUE supports the following programs and activities:

- **Advanced Technological Education**
- **Course, Curriculum, and Laboratory Improvement**
- **NSF Collaboratives for Excellence in Teacher Preparation**
- **NSF Graduate Teaching Fellows in K-12 Education**
- **NSF Computer Science, Engineering, and Mathematics Scholarships**

For More Information

Further information on DUE activities, including detailed descriptions of programs and guidelines for the preparation and submission of proposals, is available in the *DUE Program Announcement and Guidelines* (NSF 98-45).

For additional 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) 306-1666; or by e-mail, undergrad@nsf.gov; or visit the DUE home page, <http://www.ehr.nsf.gov/EHR/DUE/start.htm>.

Advanced Technological Education

The Advanced Technological Education (ATE) Program is managed jointly by DUE and the Division of Elementary, Secondary, and Informal Education (ESIE). 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 the following two 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 experiences for students, faculty, and teachers; or national conferences, workshops, and similar activities focusing on issues in technological education.
- **Centers of Excellence for Advanced Technological Education**—As national or regional hubs with a comprehensive mission, centers engage in the full range of activities described above for Projects, provide models and leadership for other projects, and act as clearinghouses for educational materials and methods.

Proposals in both tracks must evidence 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

For further information, visit the ATE Program Web site, <http://www.ehr.nsf.gov/EHR/DUE/programs/ate/ate.htm>.

For further information on the ESIE Division, visit the ESIE home page, <http://www.ehr.nsf.gov/EHR/ESIE/index.html>.

Course, Curriculum, and Laboratory Improvement

The Course, Curriculum, and Laboratory Improvement (CCLI) Program supports projects that are expected to improve undergraduate science, mathematics, engineering, and technology (SMET) 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.

NSF invites proposals to improve undergraduate SMET education in a broad spectrum of institutions, including 2-year colleges, 4-year colleges, and universities. Projects may involve a single institution, be a collaborative effort among several institutions, or be a collaboration with business and industry partners.

The CCLI Program has three major tracks:

- **Educational Materials Development**—The result of these projects is the development of innovative materials that incorporate effective educational practices to improve student learning in SMET areas. Products of these projects have the potential for national dissemination, adaptation, and implementation.
- **Adaptation and Implementation**—These projects result in improved SMET education at institutions through the adaptation and implementation of exemplary materials, laboratory experience, and educational practices.
- **National Dissemination**—These projects facilitate large-scale, national, professional development opportunities for faculty through workshops, short courses, or related activities.

For More Information

For further information, visit the CCLI Program Web site, <http://www.ehr.nsf.gov/EHR/DUE/programs/ccli/ccli.htm>.

NSF Collaboratives for Excellence in Teacher Preparation

The NSF Collaboratives for Excellence in Teacher Preparation (CETP) Program promotes systemic improvement in the science, mathematics, engineering, and technology (SMET) preparation of prospective teachers at the pre-K to grade 12 levels. CETP projects provide prospective teachers with the in-depth subject matter and teaching knowledge necessary to implement the national mathematics and science standards as well as emerging learning technologies. A principal objective of the CETP Program is to engage SMET and education faculties and their departments in collaboration to influence teacher preparation certification programs.

The CETP Program has two focuses to develop and institutionalize comprehensive change in teacher preparation:

- **System-Wide Focus**—Projects encompass an entire university system or a collection of colleges or universities that span a State or other geographic region. In addition, the projects involve K–12 schools and their administrative systems.

- **Institutional Focus**—Projects involve either one large institution with a high level of teacher production, along with its feeder institutions, or the logical alliance of a number of institutions whose combined efforts represent a major contribution to teacher production and placement within a defined local area.

Special Note: Projects that serve as building blocks toward comprehensive reform of teacher preparation are encouraged in the Advanced Technological Education and Course, Curriculum, and Laboratory Improvement Programs.

For More Information

For further information, visit the CETP Program Web site, <http://www.ehr.nsf.gov/EHR/DUE/programs/cetp/cetp.htm>.

NSF Graduate Teaching Fellows in K–12 Education

The NSF Graduate Teaching Fellows in K–12 Education (GK–12) Program supports fellowships and associated training that will enable graduate students and advanced undergraduates to serve in K–12 schools as resources knowledgeable about both the content and applications of science, mathematics, engineering, and technology (SMET). Academic institutions apply for awards to provide fellowships for graduate and advanced undergraduate students in SMET disciplines. Grantee institutions are responsible for selecting the fellows and providing activities that prepare the fellows to serve effectively as resources for K–12 education. Expected outcomes include improved communication and teaching skills for the fellows, enriched learning by K–12 students, professional development opportunities for K–12 teachers, and strengthened partnerships between institutions of higher education and local school districts.

For More Information

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

NSF Computer Science, Engineering, and Mathematics Scholarships

The primary objective of the NSF Computer Science, Engineering, and Mathematics Scholarships (CSEMS) Program is to provide educational opportunities in computer science, computer technology, engineering, engineering technology, or mathematics to low-income, academically talented students. Through this program, grantee institutions establish scholarships that promote full-time enrollment and completion of degrees in higher education in the above fields. NSF in accordance with the American Competitiveness and Workforce Improvement Act of 1998 (P.L. 105-277) established the program. The

Act reflects the Nation's need to increase substantially the number of graduates of associate, baccalaureate, and graduate degree programs in these fields. The expected outcomes of this program include:

- improved education for students in the stated fields;
- increased retention of students to degree completion;
- improved professional development, employment, and further higher education placement of participating students; and
- strengthened partnerships between institutions of higher education and related employment sectors.

The eligibility criteria for CSEMS scholarship recipients include:

- U.S. citizens, nationals, or aliens admitted as refugees at the time of application;
- financial need, defined here as eligibility for U.S. Department of Education Pell Grant or Graduate Assistance in Areas of National Need; and
- full-time enrollment in computer science, computer technology, engineering, engineering technology, and mathematics degree programs at the associate, baccalaureate, or graduate level.

Most scholarship recipients are also expected to be students likely to receive their degree in a CSEMS discipline by the close of the grant period (2 years). Grantee institutions are expected to provide the student-support infrastructure necessary for the successful graduation of their scholarship recipients.

For More Information

For further information, visit the CSEMS Program Web site, <http://www.ehr.nsf.gov/EHR/DUE/programs/csems/csems.htm>.

EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH (EPSCoR)

The Experimental Program to Stimulate Competitive Research (EPSCoR) increases the research and development (R&D) competitiveness of 18 States and the Commonwealth of Puerto Rico. The States are Alabama, Arkansas, Idaho, Kansas, Kentucky, Louisiana, Maine, Mississippi, Montana, Nebraska, Nevada, North Dakota, Oklahoma, South Carolina, South Dakota, Vermont, West Virginia, and Wyoming.

Three types of EPSCoR awards and an accompanying outreach program support improvements in R&D competitiveness:

- **EPSCoR Cooperative Agreements**—Are 36-month awards of up to \$3 million to support infrastructure improvements in science and technology areas selected by the State's EPSCoR governing committee as being critical to the State's future R&D competitiveness.
- **EPSCoR Grants**—Are 24-month nonrenewable standard grants of up to \$500,000 to initiate projects that are consistent with State and institutional science and technology improvement strategies and have high potential for significant short-term impact on the State's research competitiveness and for acquiring sustained non-EPSCoR support.
- **EPSCoR Co-funding**—Involves co-funding of proposals submitted to NSF's regular grant programs by investigators working in research areas that have been identified as EPSCoR State R&D priorities.
- **Outreach**—Involves senior NSF personnel working with EPSCoR researchers and their institutions to acquaint them with NSF priorities, programs, policies, and procedures.

For More Information

For further 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) 306-1683; or by e-mail, jhoehn@nsf.gov; or visit the EPSCoR home page, <http://www.ehr.nsf.gov/EHR/EPSCOR/start.htm>.

DIVISION OF ELEMENTARY, SECONDARY, AND INFORMAL EDUCATION (ESIE)

Programs in the Division of Elementary, Secondary, and Informal Education (ESIE) work together to provide all students in grades pre–K to 12 with quality learning opportunities in science, mathematics, and technology (SMT), and inform the general public about SMT. ESIE seeks to achieve its goals by supporting projects that develop and implement models of high-quality instructional materials, strengthen teacher competencies in SMT content and pedagogy, prepare students for the technological workforce, facilitate transitions from secondary school to higher education and the workplace, promote the public understanding of SMT, and provide stimulating learning environments outside school. Additional goals of the ESIE Division include stimulating the development of innovative materials and strategies that actively engage parents in their children’s education; promoting the use of learning technologies to ensure that education is more accessible and adaptable to varied learning styles; and providing opportunities for teachers and teacher/student teams to work beside practicing scientists, engineers, mathematicians, and technologists in research settings.

The ESIE Division supports the following programs and activities:

- **Teacher Enhancement**
- **Instructional Materials Development**
- **Informal Science Education**
- **Presidential Awards for Excellence in Mathematics and Science Teaching**
- **Advanced Technological Education**

For More Information

For further information on ESIE activities, write to the Division of Elementary, Secondary, and Informal Education, National Science Foundation, 4201 Wilson Boulevard, Room 885, Arlington, VA 22230; or contact the division by telephone, (703) 306-1620; or visit the ESIE Division home page, <http://www.ehr.nsf.gov/EHR/ESIE/index.html>.

Teacher Enhancement

The Teacher Enhancement (TE) Program supports professional development projects that will lead to new levels of teacher competence, and a supportive school culture that will empower teachers to engage all students in rich and challenging science, mathematics, and technology (SMT) education coursework. The TE Program supports the following types of projects:

- **Local Systemic Change (LSC)** projects, which are district-level activities representing a shift in focus from the professional development of the individual teacher to that of the teacher within the context of whole school organizations. LSC projects implement exemplary instructional materials consistent with recognized standards for content and pedagogy.
- **Leadership** projects, which build national, regional, and local infrastructure to support school reform, delivery of professional development, school or district mentors, and change agents.
- **Teacher and Teacher-Student Development through Research Experience** projects, which provide teachers and teacher/student teams with opportunities to work in research-rich environments. Experiences are then implemented in the classroom.
- **Professional Development Materials** projects, which develop training materials for teachers and instructional SMT leaders in grades pre–K to 12.
- **Technology in Support of Professional Development** projects, which find innovative ways to utilize educational technologies in providing teachers with the support needed to go beyond the typical in-service course.

Eligibility Requirements for TE

The TE Program has special eligibility requirements beyond the standard NSF requirements. Please refer to the *ESIE Division Program Announcement* (NSF 98-4), which can be accessed through the TE Web site, <http://www.nsf.gov/pubs/1998/nsf984/program.htm#14>.

Instructional Materials Development

The Instructional Materials Development (IMD) Program supports the development of materials and assessment strategies aligned with national standards to promote the improvement of science, mathematics, and technology (SMT) instruction at all levels. Supported projects should enable students to acquire sophisticated content knowledge, higher order thinking abilities, and problem-solving skills.

Projects supported by IMD are designed for the success of all students, regardless of background, ability, or future educational plans. Projects should promote students' positive attitudes toward SMT, and positive perceptions of themselves as learners. By incorporating investigative, hands-on science and mathematics, the materials facilitate changes in the basic delivery of classroom instruction. Although demonstration models may be funded, projects are expected to be national in scope so that, upon completion, materials will be ready for utilization by teachers and students across the Nation.

Eligibility Requirements for IMD

The IMD Program has special eligibility requirements beyond the standard NSF requirements. Please refer to the *ESIE Division Program Announcement* (NSF 98-4), which can be accessed through the IMD Web site, <http://www.nsf.gov/pubs/1998/nsf984/program.htm#11>.

Informal Science Education

Projects supported by the Informal Science Education (ISE) Program provide rich and stimulating opportunities outside the formal school setting where individuals can increase their appreciation and understanding of science, mathematics, and technology (SMT). ISE projects take place in diverse environments and involve the use of various media. Projects generally reach large audiences and have the potential for significant regional or national impact.

The ISE Program seeks to promote public understanding of SMT through collaborative efforts, especially when such efforts bridge the informal and formal education communities. Through collaborations, partners combine their resources and expertise to develop more effective strategies for reaching diverse target audiences, particularly those traditionally underrepresented in SMT disciplines. The program also strives to stimulate parents and other adults to become proponents for quality SMT education.

For More Information

The ISE Program has special eligibility requirements beyond the standard NSF requirements. Please refer to the *ESIE Division Program Announcement* (NSF 98-4), which can be accessed through the ISE Web site, <http://www.nsf.gov/pubs/1998/nsf984/program.htm#10>.

Presidential Awards for Excellence in Mathematics and Science Teaching

The Presidential Awards for Excellence in Mathematics and Science Teaching (PAEMST) Program is operated by NSF on behalf of the White House. Since its inception in 1983, the program has provided national recognition for

over 2,700 outstanding elementary and secondary mathematics and science teachers in all 50 States and U.S. territories. Award recipients participate in a recognition program in Washington, DC, where they are honored by the White House, NSF, other Federal agencies, the National Academy of Sciences, the business community, and various professional organizations. Awardees receive a \$7,500 grant from NSF to improve science or mathematics education in their schools and districts.

For More Information

The Presidential Awards Program has special eligibility requirements beyond the standard NSF requirements. Further information on these requirements is available on the Presidential Awards Web site, <http://www.ehr.nsf.gov/EHR/ESIE/awards/default.htm>.

Advanced Technological Education

The ESIE Division and the Division of Undergraduate Education jointly support the Advanced Technological Education (ATE) Program. The ATE Program supports projects that strengthen the science and mathematics preparation of technicians who are being educated for the high-performance workplace of advanced technologies. ESIE supports exemplary projects in advanced technological education that have a strong secondary school focus.

ATE supports the following types of activities involving secondary education: national and regional Centers of Excellence for Advanced Technological Education; curriculum and instructional materials development, teacher enhancement, and student projects; and workshops, conferences, seminars, studies, and other special projects.

For More Information

For further information on ATE, including eligibility requirements, visit the ATE Web site, <http://www.nsf.gov/pubs/1998/nsf984/program.htm#15>.

For further information on the Division of Undergraduate Education (DUE), visit the DUE home page, <http://www.ehr.nsf.gov/EHR/DUE/start.htm>.

DIVISION OF EDUCATIONAL SYSTEM REFORM (ESR)

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 and mathematics 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 from 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 curriculum, policy, professional development, assessment, resource allocation, and student performance.

The proposing system develops a unitary plan of reform that must delineate the curriculum, professional development, and assessment components that will ensure a transition to a high-quality, standards-based mathematics and science education for all students. Awardees enter into cooperative agreements with NSF, specifying accountability for reaching the goals of a reform plan that must result in demonstrable and wide-ranging improvements in student achievement.

The ESR Division supports improvement in K–12 education through the following programs and activities:

- **Urban Systemic Program (USP)**
- **Rural Systemic Initiatives (RSI)**

For More Information

For further information, write to the Division of Educational System Reform, National Science Foundation, 4201 Wilson Boulevard, Room 875, Arlington, VA 22230; or contact the division by telephone, (703) 306-1690; or visit the ESR Division home page, <http://www.ehr.nsf.gov/EHR/ESR/index.htm>.

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Urban Systemic Program

The Urban Systemic Program (USP) in science, mathematics, and technology education was established in fiscal year 1999 through the merger of two existing efforts: the Urban Systemic Initiative (USI) Program and the Comprehensive Partnerships for Science and Mathematics Achievement

(CPMSA). Through this combined effort, NSF seeks to stimulate interest, increase participation, improve achievement, and accelerate career advancement and success of all students of the participating urban school districts.

The importance of USP is evidenced by the fact that urban school systems in the United States enroll approximately half of all public school students in grades K to 12. Studies point to a continued disparity between the academic performance of these students and that of their counterparts in suburban schools. The challenge is to eliminate this disparity while supporting an upward trajectory for all.

Several organizational components of NSF are engaged in the design and implementation of USP, as are private foundations, business and industry, and other Federal agencies. Principal participants in urban areas must collaborate to develop a rich array of networks and partnerships that will ensure that all children learn quality science and mathematics.

Eligibility Requirements for USP

Over 200 urban school districts in the United States and Puerto Rico are eligible for USP, as determined by 1996 data from the U.S. Department of Education's National Center for Education Statistics. Urban school districts that meet the following requirements are eligible to participate:

1. a student population of at least 25,000 students;
2. an agreement to provide a high-quality K–12 science and mathematics program for students;
3. the existence of an established infrastructure for reform with the implementation of a standards-based curriculum significantly under way at the district-level; and
4. an agreement to submit the proposal from the office of the superintendent or chief school officer who must serve as the principal investigator.

Rural Systemic Initiatives

The Rural Systemic Initiatives (RSI) Program seeks to promote systemic improvement in science, mathematics, and technology education for students in rural and economically disadvantaged regions of the Nation. RSI is particularly concerned with those students who have been underserved by NSF programs, and seeks to ensure sustainability of improvements made through the RSI Program by encouraging community development activities in conjunction with instructional and policy reform.

Students in rural areas, particularly those characterized by high and persistent poverty, typically receive much less instruction in science and mathematics than do students in suburban or advantaged urban classrooms. Moreover, societal conditions add to the barriers that keep these students from achieving. Taken together, these circumstances negatively affect a child's chances of pursuing a postsecondary degree or career that could provide a better quality of life.

The premise of RSI is that a variety of educational, economic, and social factors must be aligned to significantly affect the achievement levels of students in disadvantaged circumstances. Therefore, RSI proposals must be submitted on behalf of consortia formed to address curriculum reform, teacher preservice and in-service education, policy restructuring, assessment, and implementation of national standards, as well as the economic and social well being of the targeted regions.

Eligibility Requirements for RSI

Regions that are eligible under RSI are composed of rural counties that have been designated under the U.S. Department of Agriculture's County Types Code as 6–9, and in which 30 percent or more of school-age children (ages 5 through 17) are living in economic poverty, as determined by the 1990 census. Currently, six implementation awards are being supported. Proposing consortia must include representatives from State and local education agencies, business and industry, local school districts, community colleges, health and human service agencies, and economic development agencies.

DIVISION OF HUMAN RESOURCE DEVELOPMENT (HRD)

The Division of Human Resource Development (HRD) has primary responsibility for broadening the participation of groups underrepresented at the K–12, undergraduate, and graduate levels in science, mathematics, engineering, and technology, and improving the research infrastructure of minority institutions. The division operates and coordinates a range of programs that focus on increasing the presence in science and engineering of underrepresented minorities, women and girls, and persons with disabilities.

The HRD Division supports programs and activities in the following focus areas:

- **Minorities**
- **Women and Girls**
- **Persons with Disabilities**

For More Information

Write to the Division of Human Resource Development, National Science Foundation, 4201 Wilson Boulevard, Room 815, Arlington, VA 22230; or contact the division by telephone, (703) 306-1630; or visit the HRD Division home page, <http://www.ehr.nsf.gov/EHR/HRD/default.asp>.

MINORITIES

Minority groups underrepresented in science, mathematics, engineering, and technology (SMET) disciplines include American Indians/Alaskan Natives (Native Americans), Blacks (African Americans), Hispanics, and Pacific Islanders. Current HRD efforts for minority and other students are focused on two major objectives: student development and strengthening the research capabilities of minority institutions. Division programs represent a coherent effort to stimulate organizational and institutional change, markedly improve the quality of educational opportunities available to minority and other students, and increase the quality and quantity of these students pursuing degrees in SMET disciplines.

Minority programs in the HRD Division are grouped into three focus areas:

- 1. Undergraduate**
- 2. Graduate**
- 3. Research/Education Infrastructure**

For More Information

For complete information on HRD programs for minorities, visit the HRD Division home page, <http://www.ehr.nsf.gov/EHR/HRD/default.asp>.

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1. Undergraduate Focus

The Louis Stokes Alliances for Minority Participation

The Louis Stokes Alliances for Minority Participation (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 SMET fields. This objective facilitates the long-term goal of increasing the production of Ph.D.'s in SMET 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 development of approaches tailored to the institutional setting for achievement of program goals in SMET undergraduate education. Supported activities include, among others, 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 for LSAMP

Academic institutions that have a track record of educating minority and other students in SMET disciplines are eligible to apply to all programs under this initiative. Nonprofit organizations serve as members of the alliance or partnership.

2. Graduate Focus

Minority Graduate Education

The Minority Graduate Education (MGE) Program seeks to significantly increase the number of Black (African-American), Hispanic, and American Indian/Alaskan Native (Native American) students receiving doctoral degrees in the sciences (physical and life science disciplines), mathematics, and engineering (SME). The lack of role models and mentors in the professoriate

constitutes a significant barrier to producing minority SME graduates, and NSF is particularly interested in increasing the number of minorities who will enter the professoriate in these disciplines. Specific objectives of the MGE Program are (1) to develop and implement innovative models for recruiting, mentoring, and retaining minority students in SME doctoral programs and (2) to develop effective strategies for identifying and supporting underrepresented minorities who want to pursue academic careers.

The MGE Program also supports a research effort to identify major factors that occasion 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 SME workplace. To accomplish this objective, 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.

3. Research/Education Infrastructure Focus

Presidential Awards for Excellence in Science, Mathematics, and Engineering Mentoring

Mentoring and role modeling are important in developing talent among groups traditionally underrepresented in science, mathematics, and engineering (SME). Therefore, in 1996, the White House Office of Science and Technology Policy, through its National Science and Technology Council, established the Presidential Awards for Excellence in Science, Mathematics, and Engineering Mentoring (PAESMEM) Program.

Through the PAESMEM Program, awards are made to individuals who have given outstanding and sustained mentoring and effective guidance to a significant number of students at the K–12, undergraduate, or graduate education levels; or to institutions and organizations that, through their programming, have enabled a substantial number of students underrepresented in SME to successfully pursue and complete the relevant degree programs. The awardees serve as examples to their colleagues and national leaders in fully developing the Nation's human resources in science, mathematics, engineering, and technology. Administered by NSF, each award includes a grant of \$10,000 and a presidential commemorative certificate. Approximately 20 (10 individual and 10 institutional) one-time awards are made annually.

Eligibility Requirements for PAESMEM

To be eligible for PAESMEM, the individual, institution, or organization must be nominated by a colleague, administrator, institution, organization, or student.

Centers of Research Excellence in Science and Technology

NSF recognizes that academic institutions with significant minority student enrollments play a vital role in conducting research that contributes to our knowledge base in all disciplines, and in educating minority students who go on to careers in the fields of science, mathematics, engineering, and technology. The Centers of Research Excellence in Science and Technology (CREST) Program makes substantial resources available to upgrade the capabilities of the most research-productive minority institutions. These resources provide increased opportunities for minority faculty and students to engage in research. At the same time, the program enables these institutions to use their resources and research to increase the effectiveness of related SMET activities for other institutions in their regions.

Eligibility Requirements for CREST

Institutions participating in CREST are those that have (1) at least a 50 percent enrollment of minority students from groups that are underrepresented in SMET; (2) graduate programs in NSF-supported fields of science or a baccalaureate program in engineering; (3) demonstrated strengths in NSF-related fields, as evidenced by an existing or developing capacity to offer doctoral degrees in one or more SMET disciplines; (4) a willingness and capacity to serve as a regional resource center; and (5) a demonstrated commitment to enrolling and graduating minority scientists and engineers.

Historically Black Colleges and Universities

NSF's Historically Black Colleges and Universities (HBCU) Initiative seeks to address historical underrepresentation of minorities in baccalaureate and doctoral degree ranks in science, engineering, and mathematics (SEM). The HBCU Initiative sponsors activities to strengthen SEM education and research infrastructure, including support for research experiences for undergraduates, scientific instrumentation, development of partnerships with other academic institutions and industrial laboratories, research-based teaching and learning, and faculty development.

WOMEN AND GIRLS

The Human Resource Development (HRD) Division supports the following programs for women and girls:

- 1. Program for Gender Equity in Science, Mathematics, Engineering and Technology**

2. Professional Opportunities for Women in Research and Education (POWRE)

For More Information

For complete information about HRD programs targeting women and girls, visit the HRD home page, <http://www.ehr.nsf.gov/EHR/HRD/default.asp>.



1. Program for Gender Equity in Science, Mathematics, Engineering, and Technology

All of the divisions within the Education and Human Resources Directorate encourage projects that address the participation of women and girls in science and engineering. Because women are underrepresented in most disciplines, the HRD Division supports focused interventions that are specifically directed toward increasing the number of women as full participants in the mainstream of the Nation's scientific and technological enterprise. The Program for Gender Equity in Science, Mathematics, Engineering, and Technology (PGE) supports the following activities.

- **Large Collaborative Projects**—The projects must build on existing research about gender and the science, mathematics, engineering, and technology (SMET) infrastructure and must involve multiple institutions demonstrating significant commitment. Permanent change should be effected, and projects should leverage support from other activities. Projects may address educational issues from grade school through graduate school. The goals and activities of the project may reflect target populations in order to address special needs and interests based on educational level, race, ethnicity, rural/urban environment, and physical disabilities. The target populations may be a mix of students, teachers, counselors, parents, community leaders, administrators, teacher-educators, faculty, student and adult mentors, and others.
- **Planning Grants**—Planning grants are available to determine the feasibility of a project, conduct studies, and build collaborative efforts. Planning grants should improve the quality and success of complex proposals. Only one planning grant proposal per institution will be accepted in any one year.
- **Small Experimental Projects**—The projects are directed to critical transition points that facilitate or hinder the successful participation of women and girls in SMET education, from grade school to graduate school and on to careers. Projects are small and focused and involve only one or a few institutions in

developing or testing an innovative approach to problem-solving. The approach should build on current research and models of how social, learning, and teaching factors facilitate the interest, motivation, and achievement of girls and women in SMET.

- **Information Dissemination Activities**—Supported activities include, but are not limited to, 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 science, engineering, and mathematics. The activity can focus on research topics or on the development and dissemination of strategies for reducing the barriers for women and girls in these fields.

2. Professional Opportunities for Women in Research and Education

The Professional Opportunities for Women in Research and Education (POWRE) Program is an NSF-wide effort aimed at increasing the prominence of women in science and engineering research and education. POWRE helps provide professional growth and career advancement with funding opportunities not ordinarily available through regular NSF grant programs.

For More Information

Further information on the POWRE Program, including information on eligibility criteria and guidelines, is available on the POWRE Web site, <http://www.nsf.gov/home/crssprgm/powre/start.htm>. Information is also available on the Crosscutting Investment Strategies section in this Guide

PERSONS WITH DISABILITIES

Program for Persons with Disabilities

The goals of the Program for Persons with Disabilities (PPD) are to develop new methods of teaching science and mathematics, increase the awareness and recognition of the needs and capabilities of students with disabilities, promote the accessibility and appropriateness of instructional materials and learning technologies, and increase the availability of mentoring resources.

Program efforts are focused on changing the factors of neglect, paucity, and lack of direction that historically have stifled the early interest in science and mathematics shown by students with disabilities and impeded their advancement as they prepared themselves for careers in science, engineering, and mathematics.

NSF encourages persons with disabilities to participate fully in all supported programs. Activities supported under PPD include the following:

- **Demonstration Projects for Persons with Disabilities**—Projects should promote the development and dissemination of innovative intervention strategies that reduce the barriers that inhibit the interest, retention, and advancement of students with disabilities in SMET education and career tracks.
- **Information Dissemination Projects**—Support is available for symposia, workshops, and development of information on techniques, instructional materials, technologies, and adaptations that promote full inclusion and participation of students with disabilities in SMET curriculums.
- **Research and Development Projects**—Support is provided for projects that improve learning opportunities in SMET education for students with disabilities through the development of innovative technology.

For More Information

For complete information on the PPD Program, including eligibility and deadline information, visit the PPD Web site, <http://www.ehr.nsf.gov/ehr/hrd/ppd/>.

DIVISION OF RESEARCH, EVALUATION, AND COMMUNICATION (REC)

The mission of the Division of Research, Evaluation, and Communication (REC) is to lay a strong foundation for teaching and learning in science, mathematics, engineering, and technology (SMET) using the results of research in technology utilization, content, pedagogy, assessment, and policy-oriented studies and indicators. The REC Division supports projects that integrate research with educational practices, including those that provide the groundwork for the use of technology. The division provides support for the EHR Directorate's participation in the Interagency Education Research Initiative (IERI). REC activities also contribute to the fundamental understanding of the development and implementation of science and mathematics programming across the EHR Directorate, and its impact through periodic program evaluations.

The REC Division supports the following programs and activities:

- **Education Research**
- **Evaluation**

For More Information

For further information on REC activities, 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) 306-1650; or by e-mail, REC@nsf.gov; or visit the REC Division home page, <http://www.ehr.nsf.gov/EHR/REC>.

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Education Research

The REC Division is developing a new, comprehensive education research program to support the knowledge base that undergirds improvements in mathematics and science instruction, to provide more efficient use of educational technologies, and to develop a more effective mathematics and science instructional workforce. The program will support projects in basic research on 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; and policy studies. Emphasis will be placed on development and applications of educational technologies, piloting of technologies to assess their effectiveness in classrooms,

and large-scale implementation across entire education systems. Special studies and indicator development will be supported in order to define the context and monitor the state of the educational enterprise.

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 for the purpose of program improvement, accountability, and the generation of new knowledge for the educational community at large. Evaluations are usually supported through competitively awarded contracts to outside organizations. Occasionally, the program solicits grant proposals for evaluative studies of NSF or other national science and mathematics programs of interest. The program may also accept proposals for the development of innovative techniques, approaches, and methodologies for the general improvement of educational evaluation.

DIRECTORATE FOR ENGINEERING

The Directorate for Engineering (ENG) supports engineering research and education in a competitive environment that places strong emphasis on 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. Although the research supported by ENG is fundamental in nature, much of it focuses 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.

A large fraction of ENG funds is invested in investigator-initiated research, much of which exploits opportunities in three major technologies: micro/nano systems, information technology, and biotechnology. ENG's investment in these technologies can be expected to enable significant advances in health care, manufacturing, education, and commercial services. ENG invests a smaller but significant portion of its budget in selected targets of opportunity, particularly in areas where these three technology streams converge. For example, in fiscal year 1999, ENG launched the initiative Engineering Microsystems: XYZ on a Chip, which encourages the development of novel applications and the exploration of nonelectrical processes at the microscale. An example of work supported in this area involves the development of a retinal microchip prosthesis that within the next few years may be able to provide artificial vision to blind people afflicted by retinal diseases.

To amplify its efforts, ENG focuses on facilitating dynamic partnerships among industry, academe, other Federal agencies, State and local governments, professional societies, and foreign countries. 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 up exciting new areas of research.

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

The ENG Directorate 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

For further 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 Engineering (ENG) Directorate also takes an active role in the following NSF-wide programs and activities: the Faculty Early Career Development Program (CAREER), Research Experiences for Undergraduates (REU), Professional Opportunities for Women in Research and Education (POWRE), Integrative Graduate Education and Research Training (IGERT), Graduate Fellowships, Grant Opportunities for Academic Liaison with Industry (GOALI), Major Research Instrumentation (MRI), undergraduate activities, minority and women's programs, and programs for persons with disabilities.

For More Information

For further information on these and other NSF crosscutting programs and activities, visit the NSF Crosscutting Programs home page, <http://www.nsf.gov/home/crsspgrm/start.htm>.

Engineering-Wide Activities

The ENG Directorate also has programs that are available across all of its divisions. These include the Combined Research-Curriculum Development (CRCD) Program and supplemental support for underrepresented research assistants on engineering grants.

For More Information

For further information on CRCD or supplement support programs, see the Engineering Education and Centers Division section, elsewhere in the ENG Directorate section of this Guide; or visit the EEC Division home page, <http://www.eng.nsf.gov/eec/>.

DIVISION OF BIOENGINEERING AND ENVIRONMENTAL SYSTEMS (BES)

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

- Expands the knowledge base of bioengineering at scales ranging from proteins and cells to organ systems, including mathematical models, devices, and instrumentation systems. At this time, BES is particularly interested in tissue engineering and the development of biological substitutes; biosensors such as devices that use a biological component; food processing (especially with respect to food safety); and metabolic engineering, including the application of systems analysis tools to understand metabolic transport.
- Applies engineering principles to the models and tools used in understanding living systems; to the development of prototypes for new and improved devices or software for persons with disabilities; and to products for human health care. Emphasis is placed on engineering research that contributes to better and more efficient health care delivery and aid to people with disabilities.
- 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.
- Advances fundamental engineering knowledge of the ocean environment and develops technological innovation related to conservation, development, and use of the oceans and their resources.

The BES Division supports the following programs and activities:

- **Biochemical Engineering & Biotechnology**
- **Biomedical Engineering & Research to Aid Persons with Disabilities**
- **Environmental Engineering**

For More Information

For further information, write to the Bioengineering and Environmental Systems Division, National Science Foundation, 4201 Wilson Boulevard, Room 565, Arlington, VA 22230; or contact the division by telephone, (703) 306-1320; or by fax, (703) 306-0312; or visit the BES Division home page, <http://www.eng.nsf.gov/bes/>.



- **Biochemical Engineering & Biotechnology**—Supports research that links the expertise of engineering with the life sciences to provide a fundamental basis for the 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. Some examples of projects include biological microorganisms for the transformation of organic raw materials (biomass) into useful products; fermentation and recombinant DNA processes; and food processing, especially the safety of the Nation's food supply. Research areas include but are not limited to, cell culture systems; metabolic engineering; sensor development; bioreactor design; separation and purification processes; monitoring, optimization, and control methods; and process integration.
- **Biomedical Engineering & 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. This 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.
- **Environmental Engineering**—Supports sustainable development research with the goal of applying engineering principles to reduce adverse effects of solid, liquid, and gaseous discharges into land, fresh and ocean waters, and air that result from human activity and impair the value of those resources. The program also supports research on innovative biological, chemical, and physical processes used alone or as components of engineered systems to restore the usefulness of polluted land, water, and air resources. Emphasis is on engineering principles underlying pollution avoidance as well as pollution treatment and reparation. 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.

DIVISION OF CHEMICAL AND TRANSPORT SYSTEMS (CTS)

The Chemical and Transport Systems (CTS) Division supports research that contributes to the knowledge base that is important for a large number of industrial manufacturing processes and also for some natural processes that involve the transformation and transport of matter and energy. The transformation processes may be chemical, biological, physical, or a combination. The industrial processes involve a wide range of technological pursuits and are found in such industries or areas as aerospace, electronics, chemicals, recovery of natural resources, the environment, petroleum, biochemicals, materials, food, power generation, and allied activities.

CTS supports research that involves the development of fundamental engineering principles, process control and optimization strategies, 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 processing. These principles are also applied to naturally occurring systems such as rivers and lakes, coastline areas, and the atmosphere, especially in populated areas. Increased emphasis is being placed on environmentally benign chemical and material processing, nanotechnologies, molecular modeling, and effective coupling of research and education.

The CTS Division supports the following programs and activities:

- **Chemical Reaction Processes**
- **Interfacial, Transport, and Separation Processes**
- **Fluid and Particle Processes**
- **Thermal Systems**

For More Information

For further information, write to the Chemical and Transport Systems Division, National Science Foundation, 4201 Wilson Boulevard, Room 525, Arlington, VA 22230; or contact the division by telephone, (703) 306-1371; or by fax, (703) 306-0319; or visit the CTS Division home page, <http://www.eng.nsf.gov/cts/>.

- **Chemical Reaction Processes**—There are two sub-elements to this program: Process and Reaction Engineering and Kinetics, Catalysis, and Molecular Processes. Activities supported through these sub-elements include research on rates and mechanisms of important classes of catalyzed and

uncatalyzed chemical reactions as they relate to the design, production, and application of catalysts, chemical processes, and specialized materials; 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; molecular motors; 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 data bases and intelligent data management; distributed and collaborative reactive process characterization; bioinspired reactive process design; nanofabricated reactive processes; nanophase control in reactive processes; electrochemical and photochemical processes; environmentally sustainable and abundant feedstocks; wasteless pathways and pollution prevention; low-temperature chemical processes; single-step processing; combined reaction and separation; design and optimization of complex chemical processes, including scheduling and supply chain modeling; dynamic modeling and control of processes; sensors for chemical or life systems for process and quality control; processing of materials for electronics, optoelectronics, quantum, and single-electron computing; magnetic and ferroelectric materials for digital data storage; fine and specialty chemicals, including pharmaceuticals, agrochemicals, intermediates for consumer products, transportation, foods, flavors, and fragrances; reactive processing of polymers, ceramics, and thin films; global integration of chemical processes within the service economy; and interactions between chemical reactions and transport processes in reactive systems and the use of this information in the design of complex chemical reactors.

- **Interfacial, Transport, and Separation Processes**—There are two sub-elements to this program: Interfacial, Transport, and Thermodynamics and Separation and Purification Processes. Activities supported through these sub-elements include research in areas related to interfacial phenomena and mass transport phenomena, separation science, and phase equilibrium thermodynamics. Research in these areas supports various aspects of engineering technology, with the major focus on chemical and material processing and bioprocess engineering. Research conducted in this program also contributes to the division's emphasis on developing basic knowledge useful to the minimization and remediation of hazardous waste emissions in chemical processes. In addition, the program provides support for novel fundamental approaches and theories dealing with the thermodynamics of complex fluids and transport phenomena at interfaces, with applications to biological systems and the processing of nanoscale materials and thin films.
- **Fluid and Particle Processes**--There are two sub-elements to this program: Particulate and Multiphase Processes, and Fluid Dynamics and Hydraulics. Activities supported through these sub-elements 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 nanostructures, and fluid and solid system interactions. The common research theme across this broad range of topical areas is the expectation that new conceptual understanding, innovative approaches to a recognized problem, and/or the identification of a new line of investigation will be established as a result of the proposed research. Research is sought that contributes to improving the basic understanding, efficiency, and control of existing systems that involve the dynamics of fluids and particulates, and the innovative uses of fluids and particles in materials development, manufacturing, biotechnology, and the environment.

- **Thermal Systems**—There are two sub-elements in this program. The first, Thermal Transport and Thermal Processing element supports projects that seek a basic understanding of heat transfer, particularly at the micro- and nanoscale level, and that apply heat and mass transfer principles to technologically related fields. Examples are Category one: radiation in thin films, phonon transfer, laser/radiation interaction, solidification, porous media, microjet cooling, phase change materials, interfacial waves, rheology, and crystal growth; and Category two: manufacturing, laser processing and machining, welding, gas turbines, heating and ventilating, biotechnology, fluidized beds, and cryogenics. The overall goal is to learn more about the fundamentals of heat transfer and transport processes that improve the efficiency of industrial systems.

The second, Combustion and Plasma Systems element supports research on understanding the fundamental physical and chemical processes involved in combustion; providing principles for addressing major problems in the combustion arena, such as pollutant formation in combustion, energy-conversion inefficiencies, and fire hazards; elucidating the fundamental science and engineering principles necessary for the application of plasma technology to such situations as chemical conversion, materials refining, energy recovery, and biosystems modification; and demonstrating how combustion or plasma processing can be applied to solve problems in such areas as the production of fine powders or thin films, waste destruction, sterilization, and surface modification. Major topics covered include flame chemistry; fluid dynamics of combustion; incineration; internal combustion engines, including diesels; pollutant formation from combustion; diagnostics for combustion and plasmas; plasma chemistry and physics; plasma applications; and combustion synthesis, including SHS. Priorities include projects related to environmental quality (both prevention and amelioration) and new manufacturing techniques, especially for materials. Support includes 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.

DIVISION OF CIVIL AND MECHANICAL SYSTEMS (CMS)

The Civil and Mechanical Systems (CMS) Division 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 simulation, to enable revolutionary advances in our nation's civil and mechanical systems.

The CMS Division supports the following programs and activities:

- **Dynamic System Modeling, Sensing, and Control (DSMSC)**
- **Geotechnical and GeoHazards Systems (GHS)**
- **Infrastructure and Information Systems (IIS)**
- **Solid Mechanics and Materials Engineering (SMME)**
- **Structural Systems and Engineering (SSE)**

For More Information

For further 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) 306-1360; or by fax, (703) 306-0291; or visit the CMS Division home page, <http://www.eng.nsf.gov/cms/>

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- **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 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; and modeling, synthesis, simulation, and prototyping of intelligent systems and their components. Research of this type will advance the knowledge-base for integration of sensors, actuators, controllers, and power sources for autoadaptive applications.

- **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 geoenvironmental contamination; transferability of laboratory results to field scale; and non-destructive and in situ evaluation. GHS support is given for research that will increase geotechnical and geohazards knowledge necessary to mitigate the impacts of natural and technological hazards on both the constructed and the natural environment. A broad spectrum of research is supported, including the use of data from laboratory and field experiments to verify design procedures and methodologies; simulation of phenomena; and collection of data from catastrophic events, including rapid-response reconnaissance inspections.
- **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 impacts on infrastructure system design, construction, maintenance, and operation and control, and includes networking technology; internet-based data systems; voice and data communications technologies; and GIS-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.
- **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, nano-structured 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 macro-scale structural behavior.
- **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 indoor environmental conditions. 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.

DIVISION OF DESIGN, MANUFACTURE, AND INDUSTRIAL INNOVATION (DMII)

The Division of Design, Manufacture, and Industrial Innovation (DMII) seeks to extend the intellectual foundations of design and manufacturing by identifying key research and education issues in partnership with industry, government, and academe and funding projects to address them.

The overall goals of DMII include supporting research that will deepen our understanding of the processes, machinery, and systems that comprise modern manufacturing and making the country's manufacturing base more competitive by increasing its rate of innovation and responsiveness to changing needs. Emphasis is on research that employs a blend of experimental, analytical, and computational efforts directed toward developing economically competitive and environmentally compatible technologies. Included are methodologies for concurrent design and production of products with engineered microstructures and properties, innovative fabrication and assembly techniques, and integrated enterprise-wide production systems.

DMII supports research that will lead to the improvement of industrial productivity in the United States as well as the commercialization of new knowledge by the small business community through NSF's Small Business Innovation Research (SBIR) Program.

The DMII Division supports the following programs and activities:

- **Design and Integration Engineering**
- **Manufacturing Processes and Equipment**
- **Operations Research and Production Systems**
- **Innovation and Organizational Change (IOC)**
- **Small Business Innovation Research (SBIR)**
- **Industry/University Liaison Program**

For More Information

For further information, write to the Division of Design, Manufacture, and Industrial Innovation, National Science Foundation, 4201 Wilson Boulevard, Room 550, Arlington, VA 22230; or contact the division by telephone, (703) 306-1330; or by fax, (703) 306-0298; or visit the DMII Division home page, <http://www.eng.nsf.gov/dmii/>.

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- **Design and Integration Engineering**—Supports the creation of new knowledge to develop the fundamental principles of and procedures for

engineering design. This includes theories of design; methodologies for and models of design; and organization and management techniques for the effective use of engineering design systems. Particular focus is on the development of an overarching theory of manufacturing systems to allow the effective design of the information and communications framework required to interface the hardware and software elements of a modern computer-integrated manufacturing system. While the primary objective is to bridge design and manufacturing, efforts are also aimed at integrating all aspects of the manufacturing life cycle.

- **Manufacturing Processes and Equipment**—Supports the development of new knowledge to improve the predictability and productivity of existing manufacturing processes and equipment and the innovation of new manufacturing processes and equipment. This will allow manufacturing of a broad range of products from a wide range of new and recycled materials, including metals, polymers, ceramics, composites, and specially engineered materials. The program aims to understand the fundamental behavior of materials and machines during processing; to develop novel manufacturing processes and machine prototypes; and to control manufacturing process and operations during the production of actual parts.

- **Operations Research and Production Systems**—Supports analytical and computational research geared toward the improvement of productivity of engineered systems. Support is given to research that is driven by relevant problems in manufacturing, logistics, and service systems. The Operations Research element welcomes innovative research proposals that are oriented toward basic methodologies and motivated by problems relevant to engineering. The Production Systems element encourages research driven by real and relevant industrial problems in all aspects of production operations, including manufacturing, communications, transportation, and service. Investigators interested in submitting a proposal to the Production Systems element are strongly encouraged to establish ties with an appropriate industrial partner or partners.

- **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 (ENG), Social, Behavioral, and Economic Sciences (SBE), and Education and Human Resources (EHR) jointly support IOC.

The program supports research using theory combined 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. IOC supersedes and extends its scope beyond those of two former NSF programs:

Management of Technology Innovation (MOTI) and Transformations to Quality Organizations (TQO).

For More Information

For further information, visit the Social and Economic Sciences (SES) Division (in the SBE Directorate) home page, <http://www.nsf.gov/sbe/ses/start.htm>.

- **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. SBIR-supported projects should have significant potential for commercialization and public benefit, if the research is successful. This three-phase program offers incentives for converting research done in Phases I and II into commercial application in Phase III, with the final effort funded by private capital. NSF also supports the Small Business Technology Transfer (STTR) Program to link entrepreneurs to the academic research community (for more on STTR, see "Industry/University Cooperative Liaison Program," elsewhere on the DMII Web page).

For More Information

A combined program solicitation for the SBIR and STTR Programs is produced annually. The current version (NSF 99-57) is available electronically at <http://www.nsf.gov/pubs/1999/nsf9957/start.htm>. The solicitation is widely publicized by the Small Business Administration and is announced in the *Commerce Business Daily* and sent to NSF's small business mailing list.

For complete information on either program, visit the SBIR/STTR Web site, <http://www.eng.nsf.gov/sbir/>.

- **Industry/University Liaison Program**--Is composed of two sub-activities that encourage industry/university collaboration: Grant Opportunity for Academic Liaison with Industry and Small Business Technology Transfer.
1. **Grant Opportunities for Academic Liaison with Industry (GOALI)** aims to synergize industry/university partnerships by making funds available for the support of an eclectic mix of industry/university linkages. Specifically, GOALI provides support (a) to conduct research and gain experience with production processes in an industrial setting; (b) for industry scientists and engineers to bring industry's perspective and integrative skills to academe; and (c) 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.

For More Information

For further information, visit the GOALI Initiative Web site, <http://www.nsf.gov/goali/>, or the NSF Crosscutting Programs home page, <http://www.nsf.gov/home/crssprgm/>.

- 2. Small Business Technology Transfer (STTR)** is a Federal program that links entrepreneurs to the academic research community and encourages commercialization of Government-funded research by the private sector, thus reinforcing the efforts of the Small Business Innovation Research (SBIR) Program (see information on the SBIR Program, elsewhere on the DMII Web page). 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, with the final effort funded by private capital.

For More Information

A combined program solicitation for the STTR and SBIR Programs is produced annually. The current version (NSF 99-57) is available electronically at <http://www.nsf.gov/pubs/1999/nsf9957/start.htm>. The solicitation is widely publicized by the Small Business Administration and is announced in the *Commerce Business Daily* and sent to NSF's small business mailing list.

For complete information on either program, visit the SBIR/STTR Web site, <http://www.eng.nsf.gov/sbir/>.

DIVISION OF ELECTRICAL AND COMMUNICATIONS SYSTEMS (ECS)

The Electrical and Communications Systems (ECS) Division supports research and education to improve the fundamental understanding of devices and components and to define and apply the principles of information-based systems for control, communications, and computation. The study of micro- and nanoelectronic, photonic, and electromechanical devices and their integration into circuits and microsystems is a core discipline of electrical engineering. Modern computing and communication systems are based on these devices, and trends toward smaller devices raise new research challenges to fabricate nanoscale structures and to understand quantum principles that dominate their behavior. Research on the principles of analysis and the design of systems is a second core area in electrical engineering, and the convergence of control, communications, and computation forms the basis for new research directions in intelligent engineering systems. Learning and self-adaptive systems, distributed systems and networks, hybrid discrete and continuous representation, high-performance simulation and domain-specific computing, and biologically based search and optimization algorithms are research topics of current interest. The integration of device research and systems principles leads to broad applications in telecommunications, power and energy, environment, transportation, biomedicine, manufacturing, 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 that facilitate research and education activities.

The ECS Division supports the following programs and activities:

- **Electronics, Photonics, and Device Technologies (EPDT)**
- **Control, Networks, and Computational Intelligence (CNCI)**
- **Integrative Systems**
- **Resources and Infrastructure**

For More Information

For further 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) 306-1339; or by fax, (703) 306-0305; or visit the ECS Division home page, <http://www.eng.nsf.gov/ecs/>.

- **Electronics, Photonics, and Device Technologies (EPDT) (formerly Physical Foundations of Enabling Technologies)**—Seeks to improve the fundamental understanding of devices and components based on the principles of electronics, photonics, electromagnetics, electro-optics, electromechanics, and related physical phenomena, and to enable the design of integrated microsystems that define new capabilities and applications. Experimental and theoretical studies of nanoscale electronic and photonic devices and principles, use of nanotechnology for device fabrication, and related topics in quantum 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, including plasma-based processing techniques.

- **Control, Networks, and Computational Intelligence (CNCI) (formerly Knowledge Modeling and Computational Intelligence)**—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, 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 for 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 is applied to the development of simulation, design, and decision tools for engineering applications.

- **Integrative Systems (IS)**—Stimulates innovative research in areas that integrate device concepts and systems principles to develop 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 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 that range from drug delivery to microsurgery. A second example is a wireless network of hand-held 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. 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.

- **Resources and Infrastructure**—ECS, in partnership with other NSF directorates and Government agencies, provides nationwide research and education resources. They include the National Nanofabrication Users Network (NNUN), National Center for Computational Electronics (NCCE), Multiuser MEMS Processes (MUMPS), U.S.-Japan Joint Optoelectronics Project, MOS Implementation Services (MOSIS), and others. Additionally, NSF's Engineering Research Centers (ERCs) and Industry/University Cooperative Research Centers (I/UCRCs) affect many of the research areas of the ECS community. Researchers and educators are encouraged to build linkages with these facilities and fully utilize the infrastructure. ECS also seeks to enhance academic infrastructure through supplemental and focused grant opportunities and through the international collaborations described in the overview of the Engineering Directorate.

DIVISION OF ENGINEERING EDUCATION AND CENTERS (EEC)

The Engineering Education and Centers (EEC) Division seeks to stimulate new paradigms in engineering research and education that will accelerate technology and education innovation and improve the quality and diversity of engineering graduates entering the technical workforce. To achieve this mission, EEC facilitates integrated partnerships that cross disciplines and focus on technological systems. For example, academe is linked with industry and the States, and diverse academic institutions are joined in curricular and educational innovations. The objective is to speed the rate of technological innovation and to yield well-rounded, professionally oriented engineers who have a global outlook as well as the ability to assume leadership roles in industry, academe, and society.

The EEC Division supports the following programs and activities:

- **Engineering Research Centers (ERCs)**
- **Industry/University Cooperative Research Centers (I/UCRCs)**
- **Engineering Education**
- **Combined Research--Curriculum Development Program**
- **Supplemental Funding for Support of Women, Minorities, and Physically Disabled Engineering Research Assistants**

For More Information

For further 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) 306-1380; or by fax, (703) 306-0326; or visit the EEC Division home page, <http://www.eng.nsf.gov/eec/>.

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- **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 with education at both the graduate and undergraduate levels, producing curriculum innovations derived from the systems focus of the ERCs' strategic research goals. ERCs aim to build trusted partnerships with industry, develop shared infrastructure, and increase the capacity of engineering and science graduates to contribute to the U.S. competitive edge. They provide a system perspective for long-term engineering research and education, enabling fresh technologies, productive engineering processes, and innovative products and services.

- **Industry/University Cooperative Research Centers (I/UCRCs)**--Develop long-term partnerships among industry, academe, and government. The centers are catalyzed by a small investment from NSF and are primarily supported by center members, with NSF taking a supporting role in their development and evolution. I/UCRCs stimulate highly leveraged industry/university cooperation by focusing on fundamental research recommended by Industrial Advisory Boards. Each center is established to conduct research that is of interest to both the industry and the university with which it is involved, with the provision that the industry must offer major support to the center at all times. The centers rely primarily on the involvement of graduate students in their research projects, thus developing students who are knowledgeable in industrially relevant research.
- **Engineering Education**—Stimulates innovation and reform in engineering education so that graduates may better serve the needs of the next century. Very high among the priorities is an increase in the recruitment and retention of students, especially women, underrepresented minorities, and people with disabilities.

A recent NSF initiative in engineering education is the Action Agenda for Engineering Curriculum Innovation ("Action Agenda") Program. The program provides support for faculty to develop and implement new approaches to improve engineering education and to encourage outstanding students-- particularly from underrepresented groups--to enter the field. The Action Agenda Program builds on the successful developments that have resulted from the NSF Engineering Education Coalitions and other new concepts for the reform and improvement of engineering education. The program is to be a catalyst in facilitating the exploration of innovations that improve the quality of engineering education for the next century. NSF through the Action Agenda Program seeks to increase the involvement of engineering faculty who are highly active in research and scholarly endeavors in education innovation. For more information, see the latest Action Agenda program announcement (NSF 99-169), available electronically at <http://www.nsf.gov/cgi-bin/getpub?nsf99169>.

EEC also participates in NSF's 21st Century Workforce initiative that builds on the successes and experiences of systemic reform in grades K through 12. EEC will continue to support the outreach of engineering education improvements through many programs in which new educators 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. The support will be provided through appropriate outreach programs and activities.

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

- **Supplemental Funding for Support of Women, Minorities, and Physically Disabled Engineering Research Assistants**—Provides supplemental funding for investigators who wish to include women, underrepresented minorities, and physically disabled undergraduate or high school students as research assistants on their projects. Supplemental funding of up to \$5,000, including indirect costs, may be requested for each student to be 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 GEO Directorate 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

For further information, visit the GEO Directorate home page, <http://www.geo.nsf.gov/>.

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 Inter-American Institute for Global Change Research**
- **Information Technology Research**
- **Biocomplexity in the Environment**

For More Information

For further information on these and other NSF crosscutting programs and activities, visit the NSF Crosscutting Program's home page, <http://www.nsf.gov/home/crssprgm/start.htm>.

EDUCATION AND OUTREACH ACTIVITIES

Global Learning and Observations to Benefit the Environment (GLOBE)

In addition to the discipline-specific education and outreach activities supported by the three GEO Divisions, 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

For further information on the interagency activities of the GLOBE Program, visit the program's home page, <http://www.globe.gov/>.

For further information on GLOBE activities within NSF, contact the GLOBE Program Director in the Directorate for Geosciences by telephone, (703) 306-1515, 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 is available in the EHR section of this Guide.

DIVISION OF ATMOSPHERIC SCIENCES (ATM)

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 United States scientific community in international scientific research endeavors, such as the World Climate Research Program.

The ATM Division supports the following programs and activities:

- **Lower Atmospheric Research Programs**
- **Upper Atmospheric Research Programs**
- **Lower Atmospheric Facilities**
- **Upper Atmospheric Facilities**
- **National Center for Atmospheric Research**
- **UNIDATA**

Submission of Proposals to ATM

Proposals may be submitted at any time during the year for all programs in the ATM Division except those involving the allocation of observational and computing facilities. Proposals should be submitted to the appropriate NSF program and should follow the guidelines printed in the *NSF Grant Proposal Guide* (NSF 00-2). For projects that propose the use of lower atmospheric observing facilities and/or large amounts of computing resources (200 General Accounting Units or greater), 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 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 prior to the actual deadline for submission of proposals.

Any questions regarding 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 on the World Wide Web.

For More Information

For further 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) 306-1520; or visit the ATM Division home page, <http://www.geo.nsf.gov/atm/>.

Lower Atmospheric Research

The following programs compose the Lower Atmospheric Research section in the ATM Division. For more complete information, visit the ATM Division home page, <http://www.geo.nsf.gov/atm/start.htm>.

- **Atmospheric Chemistry**—Supports research to measure and model the concentration and distribution of gases and aerosols in the lower and middle atmosphere. 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.
- **Climate Dynamics**—Supports research on the processes that govern climate and the causes of climate variability and change, 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.
- **Large-Scale Dynamic Meteorology**—Supports basic research to improve the understanding and prediction of atmospheric motion, from synoptic to planetary scales. Research topics include general circulation, synoptic-scale weather phenomena, atmospheric predictability, and improved parameterization of physical processes and numerical methods for use in large-scale models.
- **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.
- **Physical Meteorology**—Supports research on the physics of the atmosphere, with a special emphasis on cloud physics; atmospheric electricity; radiation; the boundary layer and turbulence; and the initiation, growth, and propagation of gravity waves. The program also sponsors the development of new techniques and devices for atmospheric measurements.

- **Paleoclimate**—Supports the retrieval, analysis, and interpretation of high-quality paleoclimate data sets, and the development of numerical models of the Earth's paleoclimate system. Research is designed to establish a history of the Earth's climate and to understand the processes that govern natural climate variability.

Upper Atmospheric Research

The following programs compose the Upper Atmospheric Research section in the ATM Division. For more complete information, visit the ATM Division home page, <http://www.geo.nsf.gov/atm/start.htm>.

- **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.
- **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 nonlinear, three-dimensional plasma physics models. The analysis of data from all sources, whether ground-based or from spacecraft, is also supported.
- **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.

Lower Atmospheric Facilities

The Lower Atmospheric Facilities (LAF) 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 NCAR, a four-engine Lockheed Electra and 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 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 LAF Proposals

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

For More Information

For further information, write to the following addresses or visit the corresponding home pages on the World Wide Web:

- Division Director, Atmospheric Technology Division, NCAR, P.O. Box 3000, Boulder, CO 80307-3000; <http://www.atd.ucar.edu>.
- Facility Manager, Wyoming King Air, Department of Atmospheric Science, P.O. Box 3038, University Station, Laramie, WY 82071; <http://www-das.uwyo.edu/atsc/facilities/index.shtml>.

- Facility Manager, T-28, Institute of Atmospheric Sciences, South Dakota School of Mines and Technology, Rapid City, SD 57701; http://www.sdsmt.edu/newintro/main_academic.html.
- Facility Manager, CSU-CHILL Radar, Department of Atmospheric Sciences, Colorado State University, Fort Collins, CO 80523; <http://olympic.atmos.colostate.edu/CHILL/CSU-CHILL.html>.

Upper Atmospheric Facilities

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 Upper Atmospheric Facilities (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 Radar Facility**—Located in Sondre Stromfjord, Greenland, this facility is operated by SRI International under an NSF cooperative agreement. The facility allows observations on the edge of the polar cap, the cusp, and the northern part of the auroral oval.
- **Millstone Hill Radar**—Located near Boston, Massachusetts, and operated by the Massachusetts Institute of Technology (MIT) under an NSF cooperative agreement, this facility is located south of the auroral oval in a region where significant midlatitude phenomena are observed. The radar provides observations of high-altitude regions from almost directly above the radar in Sondre Stromfjord to almost directly above the next radar in the chain located at Arecibo, Puerto Rico.
- **Arecibo Observatory**—Located in Arecibo, Puerto Rico, this observatory is operated by Cornell University's National Astronomy and Ionosphere Center (NAIC) under an NSF cooperative agreement. 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. The UAF Program also supports the high-frequency heating facility located near the observatory.
- **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.

Eligibility Requirements for UAF Proposals

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

For More Information

For further information, write to the following addresses or visit the corresponding home pages on the World Wide Web:

- Director, Sondrestrom Radar Facility, Radio Physics Laboratory, SRI International, Menlo Park, CA 94025; <http://128.18.44.75/iono/issfsond.html>.
- Director, Millstone Hill Radar, MIT, Haystack Observatory, Westford, MA 01886; <http://hyperion.haystack.edu/homepage.html>.
- Director, NAIC for Arecibo Observatory, Cornell University, Ithaca, NY 14853; <http://www.naic.edu/>.
- Jicamarca Radio Observatory Project, Department of Electrical Engineering, Cornell University, Ithaca, NY 14853; <http://dartagnan.ee.cornell.edu:8001/radar/jro/jicamarca.html>.

National Center for Atmospheric Research

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

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

The facilities at NCAR serve the entire atmospheric sciences research community and some ocean scientists. 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 the Lower Atmospheric Facilities section of 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 interact with NCAR scientists.

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.

For More Information

For further information, 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/>.

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 ATM Division. UNIDATA serves a broad community, including teaching and research professionals in weather forecasting, climate studies, atmospheric analysis and modeling, and related disciplines. NSF provides equipment grants to support UNIDATA activities at universities.

For More Information

For further information, visit the UNIDATA home page, <http://www.unidata.ucar.edu/>.

DIVISION OF EARTH SCIENCES (EAR)

The Division of Earth Sciences (EAR) supports research in any area of geology, geophysics, geochemistry, paleobiology, and hydrology, including interdisciplinary or multidisciplinary proposals that may involve one or more of these disciplines. Especially welcome are proposals for research in newly emerging areas of science that may not fit easily into one of these categories. For evaluation, proposals received are assigned to one of the individual Research Support Programs or to Instrumentation and Facilities Programs, as appropriate.

Research programs and activities in the EAR Division are organized in the following areas:

- **Core Research Support**
- **Special Emphasis Areas**

For More Information

For additional information about the programs in the EAR Division, see the publication *Earth Sciences Research at the National Science Foundation* (NSF 96-50).

Further information also is available by writing the Division of Earth Sciences, National Science Foundation, 4201 Wilson Boulevard, Room 785, Arlington, VA 22230; or contacting by telephone, (703) 306-1550; or visiting the EAR Division home page, <http://www.geo.nsf.gov/ear/>.

CORE RESEARCH SUPPORT PROGRAMS

The Division of Earth Sciences (EAR) supports the best research proposals received in any of the disciplines supported by the division, 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 compose 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 considered very broad 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 earth sciences project support and that offer broad support for major sections of the earth sciences community. The program also funds research as part of the interagency and international Continental Scientific Drilling and Exploration Program.

For More Information

For further information on Continental Dynamics, contact the program by telephone, (703) 306-1559, 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 all 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 the Earth Sciences Postdoctoral Research Fellowship Program and EAR's participation in Foundation-wide programs such as Research Experiences for Undergraduates (REU) Sites.

For More Information

For further information on Education and Human Resources, contact the program by telephone, (703) 306-1557, or visit the EAR Division home page, <http://www.geo.nsf.gov/ear/>.

3. Geology and Paleontology—Supports studies 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 supported by the program include paleontology, paleoecology, stratigraphy, paleoclimatology, geomorphology, glacial geology, sedimentology, soil genesis, sedimentary petrology, diagenesis, and organic geochemistry.

For More Information

For further information on Geology and Paleontology, contact the program by telephone, (703) 306-1551; 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, gravity, and electrical fields and its internal temperature distribution. Support also is given for geophysical studies of active deformation, including GPS-based geodesy, and fundamental laboratory studies of properties and behavior of earth materials in support of geophysical observation and theory.

For More Information

For further information on Geophysics, contact the program by telephone, (703) 306-1556, 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

For further information on Hydrologic Sciences, contact the program by telephone, (703) 306-1549, 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 systems for a significant segment of the earth sciences research community, and the funding of research technicians.

For More Information

For further information on Instrumentation and Facilities, contact the program by telephone, (703) 306-1558, 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, economic geology, and meteoritics. Supported research includes field, laboratory, theoretical, and computational studies.

For More Information

For further information on Petrology and Geochemistry, contact the program by telephone, (703) 306-1554, or visit the EAR Division home page, <http://www.geo.nsf.gov/ear/>.

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

For More Information

For further information on Tectonics, contact the program by telephone, (703) 306-1552, or visit the EAR Division home page, <http://www.geo.nsf.gov/ear/>.

SPECIAL EMPHASIS AREAS

Within the Division of Earth Sciences (EAR), certain research areas may be selected for emphasis on the basis of special scientific opportunities. Frequently, these are related to areas of national priority such as the Environment and 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)
- Environmental Geochemistry and Biogeochemistry (in progress)
- Fundamental Earthquake Studies of the National Earthquake Hazard Reduction Program (NEHRP) (NSF 92-93)
- Life in Extreme Environments (LExEn)
- Earth Sciences Postdoctoral Research Fellowships (NSF 93-93)
- Water and Energy: Atmospheric, Vegetative, and Earth Interactions

DIVISION OF OCEAN SCIENCES

The Division of Ocean Sciences (OCE) supports basic research to further understanding of all aspects of the global oceans and their interactions with the Earth and the atmosphere. The division also offers opportunities to participate in global change research programs and other focus programs.

OCE supports projects dealing with disciplinary studies of biological, geological, physical, and chemical processes in the ocean and ocean technology. The division also supports the operation, acquisition, construction, and conversion of major shared-use oceanographic facilities needed to carry out oceanographic-related research programs.

- **Ocean Sciences Research Section**
- **Oceanographic Centers and Facilities Section**
- **Ocean Drilling Program**

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) 306-1580; or visit the OCE Division home page, <http://www.geo.nsf.gov/oce/>.

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OCEAN SCIENCES RESEARCH SECTION

The Ocean Sciences Research Section is composed of the following programs:

1. **Biological Oceanography**
2. **Chemical Oceanography**
3. **Marine Geology and Geophysics**
4. **Physical Oceanography**
5. **Ocean Technology and Interdisciplinary Coordination**

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) 306-1580; 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. Marine Geology and Geophysics—Supports research on the structure of continental margins, oceanic rise systems, and deep-sea sedimentary basins; the evolution of ocean basins; processes controlling exchanges of heat and chemical elements between seawater and oceanic rocks; tectonic and volcanic activity at midocean ridges; chemical and mineralogic variations in marine sediments; the deposition, erosion, and distribution of marine sediments; geologic and oceanographic processes controlling sedimentary systems; past oceanic circulation patterns and climates; the evolution of microfossil groups; paleoenvironmental controls on fossil groups and sediment types; and interactions of continental and oceanic geologic processes.

4. 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.

5. Ocean 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 a particular research project. The scope of projects varies from short-term feasibility studies to development, construction, and at-sea testing of a prototype to demonstrate that useful and applicable data are obtained. 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).

OCEANOGRAPHIC CENTERS AND FACILITIES

NSF supports the construction, conversion, acquisition, and operation of major shared-use oceanographic facilities. The University-National Oceanographic Laboratory System (UNOLS) schedules these facilities and expeditionary programs.

This program supports expensive facilities that are necessary for NSF-funded research and training of oceanographers. Examples of these facilities are ships, submersibles, large shipboard equipment, and shared-use instruments to collect and analyze data.

NSF encourages local contributions from non-Federal funds; however, there is no fixed requirement for institutional contributions.

Eligibility Requirements for Oceanographic Centers and Facilities Proposals

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 under this program, institutions should seek advice from the Oceanographic Centers and Facilities (OCF) Section. Specific instructions on how to submit proposals for ship operations, technicians, shipboard equipment, and oceanographic instrumentation can be found in the publication *Oceanographic Centers and Facilities Section Guidelines* (NSF 94-124, in revision).

For More Information

For further information, contact the Oceanographic Centers and Facilities, Division of Ocean Sciences, National Science Foundation, 4201 Wilson Boulevard, Room 725, Arlington, VA 22230; or contact the section by telephone, (703) 306-1576; or visit the OCE Division home page, <http://www.geo.nsf.gov/oce/>.

OCEAN DRILLING PROGRAM

The 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, located at Columbia University.

- **U.S. Science Support**—NSF provides funding for the participation and drilling-related research performed by U.S. scientists. Activities include investigations of potential drilling regions, especially by means of regional geophysical field studies; the feasibility and initial development of downhole instruments and techniques; and downhole geophysical and geochemical experiments.

In addition, NSF will consider proposals for studies that lead to a long-range definition of future drilling objectives. To be considered for support, proposed projects should be clearly relevant to the drilling plans of the international drilling community and focus on predrilling or drilling-concurrent activities. Postcruise studies should generally be submitted through other appropriate NSF programs in the areas of ocean and earth sciences and polar programs.

Additional support for U.S. scientists may be obtained through the JOI U.S. Science Advisory Committee (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); and support for U.S. scientists participating on the drill ship, and for necessary follow-up studies related to initial publication of drilling results.

In addition, 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.

For More Information

For further information, write to the Ocean Drilling Program, Oceanographic Centers and Facilities Section, Division of Ocean Sciences, National Science Foundation, 4201 Wilson Boulevard, Room 725, Arlington, VA 22230; or contact the program by telephone, (703) 306-1581; or visit the OCE Division home page, <http://www.geo.nsf.gov/oce/>.

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 regarding 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/Default.html>.

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.

DIRECTORATE FOR MATHEMATICAL AND PHYSICAL SCIENCES

The programs in the Mathematical and Physical Sciences (MPS) Directorate 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

For further information, visit the MPS Directorate home page, <http://www.nsf.gov/mps/>.

OFFICE OF MULTIDISCIPLINARY ACTIVITIES (OMA)

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 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 pre-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, international organizations), seeds cross-cutting 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 FY 2000 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 bio- and biomedical-related sciences.

For More Information

For further 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) 306-1946; or visit the OMA home page, <http://www.nsf.gov/mps/oma/start.htm>.

DIVISION OF ASTRONOMICAL SCIENCES (AST)

The overall objective of the Astronomical Sciences (AST) Division is to increase our knowledge of the universe. Support is given for research aimed at determining the composition, structure, and evolution of planets, stars, and galaxies, including our Sun and the Milky Way. AST also supports the development and operation of three National Astronomy Centers, and provides the United States' share of the funding for the operation of the Gemini Observatories, an international partnership.

The AST Division supports the following programs and facilities:

- **Advanced Technologies and Instrumentation**
- **Education, Human Resources, and Special Programs**
- **Electromagnetic Spectrum Management**
- **Extragalactic Astronomy and Cosmology**
- **Galactic Astronomy**
- **Planetary Astronomy**
- **Stellar Astronomy and Astrophysics**
- **Facilities**

For More Information

For further 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) 306-1820; or visit the AST Division home page, <http://www.nsf.gov/mps/ast/start.htm>.

- **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 technologies and innovative techniques in astronomical research.
- **Education, Human Resources, and Special Programs**--Coordinates research support in special areas that are astronomy related. Programs include Research Experiences for Undergraduates (REU) Sites and Supplements, Presidential Early Career Awards for Scientists and Engineers (PECASE), Faculty Early Career Development (CAREER), Research at Undergraduate Institutions (RUI), Professional Opportunities for Women in Research and Education (POWRE), and programs for underrepresented minorities. For a

complete description of these programs, see the Crosscutting Investment Strategies section in this Guide.

- **Electromagnetic Spectrum Management**--Is responsible for ensuring the access of the scientific community to portions of the radio spectrum that are needed for research purposes. Coordinates with other government agencies, the uses of the radio spectrum for research purposes and obtains spectrum support for NSF radio communication systems when required.
- **Extragalactic Astronomy and Cosmology**--Supports theoretical and observational studies of extragalactic objects, ranging from nearby galaxies to the most distant quasars, and their relevance to galactic evolution and cosmology.
- **Galactic Astronomy**--Supports theoretical and observational studies of the structure and evolution of the Milky Way galaxy; the distribution, position, and motion of stars in the galaxy; the characteristics of star clusters in the galaxy; the interstellar medium; and the properties of atoms and molecular constituents of the interstellar medium.
- **Planetary Astronomy**--Supports theoretical and observational studies of the detailed structure and composition of planetary surfaces, interiors, atmospheres, and satellites; the nature of small bodies such as asteroids and comets; and the origin and development of the solar system.
- **Stellar Astronomy and Astrophysics**--Supports 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; the effects of mass loss, rotation, and magnetic fields; and the properties of atoms and molecules that are relevant to stellar astronomy.

FACILITIES

NSF astronomical facilities and instrumentation 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 AST Division supports the following facilities

1. **National Astronomy and Ionosphere Center**
2. **Gemini 8-Meter Telescopes**
3. **National Optical Astronomy Observatories**
4. **National Radio Astronomy Observatory**



1. National Astronomy and Ionosphere Center (NAIC)--NSF supports NAIC, a visitor-oriented national research center focusing on radio and radar astronomy and atmospheric sciences. NAIC's headquarters, located 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 research and observing instrumentation, including receivers, transmitters, and digital data acquisition and processing equipment. 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 5 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

For further information, visit the NAIC Web site on the AST Division home page, <http://www.nsf.gov/mps/ast/naic.htm>.

Information is also available by writing to the Director, National Astronomy and Ionosphere Center, Cornell University, Ithaca, NY 14853; or visiting the NAIC home page, <http://aosun.naic.edu>

2. Gemini 8-Meter Telescopes--An international partnership project involving the United States, the United Kingdom, Canada, Australia, Chile, Brazil, and Argentina. The project involves the construction 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 Mauna Kea telescope will be infrared optimized and will have superb image quality; the Chilean telescope will be its near twin. The start of scientific operations is expected in June 2000 for Gemini North and early in 2001 for Gemini South.

When operational, these telescopes will provide astronomers from the partnership countries with world-class observing facilities. Observing time will be assigned on the basis of scientific merit.

NSF acts as the executive agency for the partnership, and the Association of Universities for Research in Astronomy, Inc. (AURA)--a consortium of 20 major universities--is managing the construction of the telescopes.

For More Information

For further information, visit the Gemini Web site on the AST Division home page, <http://www.nsf.gov/mps/ast/gemini.htm>; or the Gemini Telescopes home page, <http://www.gemini.edu/>.

3. National Optical Astronomy Observatories (NOAO)--NSF supports NOAO, a national center for research in ground-based optical and infrared astronomy and solar physics. Large optical telescopes, observing instrumentation, and data analysis equipment as well as 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 located 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 located on Kitt Peak, a 2,089-meter mountain 90 kilometers southwest of Tucson, Arizona. KPNO includes the 3.5-meter WIYN telescope, the 4-meter Mayall telescope, a 2.1-meter general-purpose reflector, a 92-centimeter coudé-feed (associated with the 2.1-meter reflector), and a 0.9-meter equipped for wide-field imaging. A full complement of state-of-the-art spectroscopic, photometric, and imaging instrumentation is available for use on these telescopes.

- **Cerro Tololo Inter-American Observatory (CTIO)**--Provides qualified scientists 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, located 482 kilometers north of Santiago, Chile. The observing facilities are located on Cerro Tololo, a 2,194-meter mountain on the western slopes of the Andes, 64 kilometers inland from La Serena.

CTIO operates six telescopes, including the 4-meter Blanco telescope, which is a near twin to the 4-meter Mayall at Kitt Peak. The other telescopes are a 1.5-meter, a 0.91-meter, a 0.61-meter reflector, a Schmidt telescope (on loan from the University of Michigan), and a 1-meter reflector (on loan from Yale University). These telescopes are equipped with instruments similar to those at KPNO.

- **National Solar Observatory (NSO)**--Is devoted to research in the fields of solar physics, solar/terrestrial relationships, and related areas. NSO makes available to qualified scientists the world's largest collection of modern optical solar telescopes and auxiliary instrumentation designed to observe the solar photosphere, chromosphere, and corona.

NSO has observing facilities atop Kitt Peak, Arizona (NSO/KP) and Sacramento Peak, New Mexico (NSO/SP). The Kitt Peak facilities consist of 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 and is also used for planetary and stellar observations and for laboratory high-resolution spectroscopy. The principal instruments of NSO/SP are the 0.76-meter

aperture Solar Vacuum Tower Telescope, equipped with spectrographs, optical benches, and the Advanced Stokes Polarimeter; and the Evans Solar Facility, equipped with a 40-centimeter aperture coronagraph, spectrographs, and a coronal photometer. The NSO also operates the Global Oscillation Network Group (GONG), a worldwide network of instruments for helioseismology; and the GONG Data Center in Tucson, Arizona.

For More Information

For further information, visit the NOAO Web site on the AST Division home page, <http://www.nsf.gov/mps/ast/noao2.htm>. Information also is available by writing 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 help 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 located in Charlottesville, Virginia. Observing sites are located in Green Bank, West Virginia; Kitt Peak, near Tucson, Arizona; 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.

Currently operated at the Green Bank site is a 43-meter aperture instrument that permits the study of spectral lines and continuum emission at centimeter wavelengths. 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.

A 12-meter millimeter-wavelength telescope located on Kitt Peak is capable of both continuum and spectral-line studies at wavelengths from 1 centimeter to as short as 1 millimeter.

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.

For More Information

For further information, visit the NRAO Web site on the AST Division home page, <http://www.nsf.gov/mps/ast/nrao.htm>. Information also is available by writing to the Director, National Radio Astronomy Observatory, Edgemont Road, Charlottesville, VA 22903; or visiting the NRAO home page, <http://www.nrao.edu>.

DIVISION OF MATHEMATICAL SCIENCES (DMS)

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 supports the following programs and activities:

- **Disciplinary Programs**
- **Mathematical Sciences Infrastructure**
- **Grants for Vertical Integration of Research and Education**
- **Cross-Disciplinary Interaction**

Proposals for General Conferences, Workshops, Symposia, Special Years, and Related Activities in DMS

Proposals submitted to DMS for general conferences, workshops, symposia, special years, and related activities should be submitted to the appropriate disciplinary program. Proposals should be submitted one year before the start of the activity. Contact the division for information on proposal requirements.

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*--These grants enable faculty members to expand their skills and knowledge into areas beyond their disciplinary expertise, to subsequently apply that knowledge to their research, and to enrich the educational experiences and career options for students. These grants support interdisciplinary experiences at the principal investigator's (PI's) institution (outside the PI's department), or at academic, financial, or industrial institutions, in a nonmathematical science environment.

For More Information

For further 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) 306-1870; or visit the DMS home page, <http://www.nsf.gov/mps/dms/start.htm>.

DISCIPLINARY PROGRAMS

The Division of Mathematical Sciences supports the following disciplinary programs:

- **Algebra and Number Theory**
- **Analysis**
- **Applied Mathematics**
- **Computational Mathematics**
- **Geometric Analysis**
- **Statistics and Probability**
- **Topology and Foundations**

For More Information

For further information about the disciplinary programs described in this section, 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) 306-1870; or visit the DMS home page, <http://www.nsf.gov/mps/dms/start.htm>.

- **Algebra and Number Theory**--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.
- **Analysis**--Supports research on properties and behavior of solutions of differential equations; variational methods; approximations and special functions; analysis of several complex variables and singular integrals; harmonic analysis and wavelet theory; Kleinian groups and 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.

- **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, but are not limited to, partial differential equations that model natural phenomena or arise from problems in science and engineering, continuum mechanics, reaction-diffusion and wave propagation, dynamical systems, asymptotic methods, numerical analysis, variation methods, control theory, optimization theory, inverse problems, mathematics of biological or geological sciences, and mathematical physics.
- **Computational Mathematics**-Computation is increasingly important in all sciences. Mathematics plays a unique role in providing the development of basic algorithms and techniques that are necessary to carry out computations. Proposals from interdisciplinary teams of mathematical, computer, and general scientists are encouraged in an effort to develop critical computational techniques from algorithm development through implementation. Proposals for innovative computational methods within the mathematical sciences also are encouraged.
- **Geometric Analysis**--Supports research on differential geometry and its relation to partial differential equations and variation principles; aspects of global analysis, including the differential geometry of complex manifolds and geometric Lie group theory; geometric methods in modern mathematical physics; and geometry of convex sets, integral geometry, and related geometric topics.
- **Statistics and Probability**--Statistical theory and methods are used to plan scientific experiments and to understand and analyze data. Major subfields include parametric and nonparametric inference, sequential analysis, multivariate analysis, Bayesian analysis, experimental design, time series analysis, resampling methods, and robust statistics. Almost all of these subfields are computationally intensive. Probability theory is the study of mathematical structures that provide tractable models to statistics and many diverse areas, such as physics, chemistry, biology, biosciences, geosciences, and engineering. Major subfields include stochastic processes, limit theory, infinite particle systems, stochastic analysis in Banach spaces, martingales, and Markov processes.
- **Topology and Foundations**--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; general topology and continua theory; and mathematical logic, including proof theory, recursion theory and model theory, foundations of set theory, and infinite combinatorics.

Mathematical Sciences Infrastructure

The Mathematical Sciences Infrastructure Program supports activities that differ from the usual types of research projects such as the work of research institutes. Activities supported include the following:

- **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, see the Crosscutting Investment Strategies section in this Guide. 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 fiscal year 2000. 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 (a) be a citizen, national, or lawfully admitted permanent resident alien of the United States as of January 1, 2000; (b) have earned by the beginning of his or her fellowship tenure a doctoral degree in one of the mathematical sciences listed above, or had research training and experience equivalent to that represented by a Ph.D. in one of those fields; and (c) have held the doctorate for no more than 2 years as of January 1, 2000.

Grants for Vertical Integration of Research and Education

The Division of Mathematical Sciences seeks to assist universities in preparing undergraduate students, graduate students, and postdoctoral fellows for a broad range of opportunities in the mathematical sciences, and to encourage departments in the mathematical sciences to consider a spectrum of educational activities and their integration with research. Through the Grants for Vertical Integration of Research and Education (VIGRE) Program, DMS supports efforts by institutions with Ph.D.-granting departments in the mathematical sciences to carry out innovative educational programs, at all levels, that are integrated with the department's research activities. Proposals should have a core, coherent plan for integration of an undergraduate research experience; a graduate traineeship program; a postdoctoral fellowship program; and undergraduate and graduate curriculum reviews.

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 these exciting research opportunities:

- 1.** In the area of biosciences, striking advances in biology, computer science, and the mathematical sciences are creating opportunities to collaborate on research work with 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.
- 2.** 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; 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 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.

DIVISION OF PHYSICS (PHY)

The Division of Physics (PHY) supports a wide range of activities in the various fields of physics. The primary mode of funding is to individual investigators or small groups, although the division does fund the operation of three large-scale accelerator facilities--the Cornell Electron Storage Ring (CESR), the Indiana University Cyclotron Facility (IUCF), and the Michigan State University National Superconducting Cyclotron Laboratory (NSCL)--and smaller centers in atomic, molecular, and optical physics and in theoretical physics. The division also is responsible for the construction and operation of the Laser Interferometer Gravity Wave Observatory (LIGO).

The research activities in the Physics Division are inextricably linked to education and support about 800 graduate students who are fully engaged in research programs. Some of these programs 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 49 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 (RET) through grants to provide grade K to 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 that are intended to convey the excitement of physics to students in grades K to 12 and to help educate the public at large in forefront science.

The PHY Division supports the following programs and activities:

- **Atomic, Molecular, Optical, and Plasma Physics**
- **Elementary Particle Physics**
- **Gravitational Physics**
- **Nuclear Physics**
- **Particle and Nuclear Astrophysics**
- **Theoretical Physics**
- **Education and Interdisciplinary Research**

For More Information

For further 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) 306-1890; or visit the PHY Division home page, <http://www.nsf.gov/mps/phy/start.htm>.

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- **Atomic, Molecular, Optical, and Plasma Physics**--In the field of Atomic and Molecular Physics, support is provided 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 both confined magnetic structures and in laser plasma interactions.

Two centers and facilities 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 (NIST). JILA conducts leading-edge research in many aspects of atomic, molecular, and optical physics. The Center for Ultrafast Optical Science (CUOS) at the University of Michigan develops new ultrafast laser tools and applies them in the study of coherent control, high-field laser/matter interactions, and biological and medical problems.

- **Elementary Particle Physics**--Supports research on the properties and interactions of elementary particles, the most fundamental building blocks of matter. 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 (LHC), located 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 upilon physics; and facilitates an aggressive program of synchrotron radiation research at the Cornell High-Energy Synchrotron Source (CHESS), which is operated by the Division of Materials Research. The CESR facility is in the process of being upgraded to produce higher luminosity. Upon completion, CESR will be among the highest luminosity electron-positron colliders in the world in this energy range.

- **Gravitational Physics**--Emphasizes the theory of strong gravitational fields and their application to astrophysics and cosmology, computer simulations of strong and gravitational fields, gravitational radiation; and construction of a quantum theory of gravity. The program oversees the management of the construction, commissioning, and operation of the Laser Interferometer Gravity Wave Observatory (LIGO), and provides support for LIGO users and other experimental investigations in gravitational physics and related areas.

- **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 two national user facilities. These are the Indiana University Cyclotron Facility (IUCF), a light-ion cyclotron and booster/storage ring facility; and the National Superconducting Cyclotron Laboratory (NCSL), 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.

- **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.

- **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 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 activities at facilities such as the Institute for Theoretical Physics at the University of California at Santa Barbara and the Harvard-Smithsonian Institute for Theoretical Atomic, Molecular, and Optical

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.

- **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, including biology, medicine, 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.

DIVISION OF CHEMISTRY (CHE)

The Chemistry (CHE) Division 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 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.

The CHE Division supports the following programs and activities:

- **Analytical and Surface Chemistry**
- **Inorganic, Bioinorganic, and Organometallic Chemistry**
- **Organic Chemical Dynamics**
- **Organic Synthesis**
- **Experimental Physical Chemistry**
- **Theoretical and Computational Chemistry**
- **Chemistry of Materials**
- **Office of Special Projects**
- **Chemistry Research Instrumentation and Facilities (CRIF)**

For More Information

For further 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) 306-1840; or visit the CHE Division home page, <http://www.nsf.gov/chem/>.

- **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).

- **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-size 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).
- **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).
- **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).

- **Experimental Physical Chemistry**--Supports experimental research directed at the molecular level of understanding of the physical properties of chemical systems. Experimental methodologies employed include frequency domain and time domain spectroscopic techniques covering the entire range of the electromagnetic spectrum, time-resolved dynamical studies of state-selected and mass-selected systems, and reactive scattering in molecular beams. Chemical systems studied range from single isolated molecules or ions to clusters, liquids, and solids. Chemical properties of interest include molecular structure and the shape of the ground and excited electronic-state potential energy surfaces, chemical dynamics of unimolecular and bimolecular chemical processes, time-resolved internal energy redistribution and state-to-state dynamics in molecular systems, and solute/solvent interactions in clusters and liquids. 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); and various programs in the Materials Research Division (MPS Directorate).
- **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).
- **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.

- **Office of Special Projects**--Supports or coordinates the support for most of the infrastructure programs and activities with which the CHE Division is involved. Examples include the Research Experiences for Undergraduates (REU), Faculty Early Career Development (CAREER), and Research Sites for Educators in Chemistry (RSEC), as well as various special-purpose grants in education, outreach, and graduate training. The office also manages the Division's involvement in other large-scale projects, such as the Science and Technology Centers. For complete information on these programs, see the Crosscutting Investment Strategies section in this Guide.
- **Chemistry Research Instrumentation and Facilities (CRIF)**--Supports the purchase or upgrade of departmental multi-user instrumentation, departmental instrumentation for junior faculty members who are establishing their academic careers, instrumentation development, and chemistry research facilities. The first two topics focus on departmental development and are 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).

DIVISION OF MATERIALS RESEARCH (DMR)

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 coreview and cofunding of highly meritorious proposals across program, division, or directorate boundaries is supported as appropriate.

DMR supports the following programs and activities:

- **Metals**
- **Ceramics**
- **Electronic Materials**
- **Materials Theory**
- **Condensed Matter Physics**
- **Solid-State Chemistry**
- **Polymers**
- **Materials Research Science and Engineering Centers**
- **Instrumentation**
- **National Facilities**

For More Information on DMR

For further information, including lists of awards and their abstracts and target and deadlines for proposal submission, visit the DMR home page, <http://www.nsf.gov/mps/dmr/start.htm>; or contact the division by telephone, (703) 306-1810; or write to the Division of Materials Research, National Science Foundation, 4201 Wilson Boulevard, Room 1065, Arlington, VA 22230.

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- **Metals (MET)**--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.

- **Ceramics (CER)**--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.
- **Electronic Materials (EM)**--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.
- **Materials Theory (MT)**--Supports theoretical research in the topical areas represented in other DMR programs, including condensed matter physics, polymers, solid-state chemistry, metals, electronic materials, and ceramics. MT is the primary source of funding at NSF for condensed matter theory. The program supports research that advances analytical and computational techniques for materials research. A broad spectrum of research is supported using electronic structure calculations, many-body theory, statistical mechanics, and Monte Carlo and molecular dynamics simulations, along with other techniques, including advanced scientific computing. The emphasis is on an atomistic approach to understanding materials properties and processes, from the atomic to the microstructural scale. Areas of recent interest include strongly correlated electron systems; low-dimensional systems; non-equilibrium phenomena, including pattern formation, microstructural evolution, and fracture; high-temperature superconductivity; nanostructured materials and mesoscale phenomena; and soft condensed matter, including systems of biological interest.
- **Condensed Matter Physics (CMP)**--Supports fundamental experimental research on the physical properties of amorphous, ordered, and nanostructured solids; classical, quantum, and partially ordered fluids; and the interfaces of such condensed phases. Materials being investigated include metals, insulators, semiconductors, amorphous solids, liquid crystals, and biomolecular materials. Phenomena of interest include phase transitions; localization; electronic, magnetic, and lattice structure of solids; superconductivity; elementary excitations, including electronic, magnetic, plasma, and lattice; transport and optical properties; and nonlinear dynamics. Development of new experimental techniques is an important part of this activity. Synthesis, characterization, and

analysis of new materials by novel methods are also of interest. In addition, research is supported on condensed matter under extreme conditions, such as low temperatures, high pressures, and high magnetic fields.

- **Solid-State Chemistry (SSC)**--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; 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.

- **Polymers (POL)**--Supports basic research and education on the materials aspects of polymeric science that is 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.

- **Materials Research Science and Engineering Centers (MRSECs)**--Support interdisciplinary materials research and education while addressing fundamental problems in science and engineering that are important to society. MRSECs require outstanding research quality and intellectual breadth; they provide support for research infrastructure and flexibility in responding to new opportunities, and they 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 further information about the MRSECs program and the research and education activities of each center, visit the MRSEC home page, <http://www.nsf.gov/mps/dmr/mrsec.htm>.

- **Instrumentation for Materials Research (IMR)**--Supports the development and acquisition of state-of-the-art instrumentation to carry out advanced materials research. The program supports major shared instruments essential to the needs of investigators conducting research that spans two or more disciplinary areas within DMR, or more than one NSF division; and instrumentation required by one or more investigators conducting research in a single disciplinary area within DMR that has a total cost of approximately \$100,000 or more. The program strongly encourages submission of proposals for the development of new instruments that have the potential to solve important materials problems, proposals that will significantly advance measurement capabilities, and proposals that could lead to new discoveries.
- **National Facilities (NAF)**--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

For further information on these facilities, contact them 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>

OFFICE OF POLAR PROGRAMS

The Earth's polar regions offer compelling scientific opportunities, but their isolation and their extreme climates challenge the pursuit of these opportunities.

NSF programs support research in the Arctic and the Antarctic both to improve understanding of the regions and their relationship with global processes and to seize opportunities presented by the regions as research platforms. These programs support investigations in a range of scientific disciplines.

NSF can deploy and provide operational support to modern field and laboratory science throughout the Antarctic. Selected areas of capability are in place in the Arctic, and improved logistics are under development there as well.

The Office of Polar Programs (OPP) comprises the following:

- **Crosscutting Programs and Activities**
- **Antarctic Sciences**
- **Arctic Sciences**

For More Information

For further information, visit the OPP home page, <http://www.nsf.gov/od/opp/>.

CROSSCUTTING PROGRAMS AND ACTIVITIES

In addition to the programs mentioned in this section, the Office of Polar Programs (OPP) takes an active role in the following crosscutting programs and activities:

- **Biocomplexity in the Environment**
- **Information Technology Research**
- **21st Century Workforce**

For More Information

For further information on these and other NSF crosscutting programs and activities, visit the NSF Crosscutting Programs home page, <http://www.nsf.gov/home/crssprgm/start.htm>.

ANTARCTIC SCIENCES

United States Antarctic Program

The United States Antarctic Program (USAP) is the name for U.S. Government-sponsored activities in the region roughly south of 60° south latitude, which includes all of Antarctica and much of the Southern Ocean. NSF funds and manages the program and the operational support provided by contractors and the military in support of the range of U.S. Antarctic interests and the Nation's adherence to the Antarctic Treaty.

USAP-supported research has three thrusts:

- (1) to understand the Earth and its systems, with emphasis on Antarctica's influence on and response to these systems;
- (2) to utilize Antarctica as an ideal research platform by supporting studies made possible by the unique conditions on the continent and in the surrounding oceans; and
- (3) to explore the Antarctic geographical frontier.

USAP supports research that can be done best in the Antarctic or that can be done only in the Antarctic.

Research support is available in USAP through the following:

- **Antarctic Aeronomy and Astrophysics**
- **Antarctic Biology and Medicine**
- **Antarctic Geology and Geophysics**
- **Antarctic Glaciology**
- **Antarctic Ocean and Climate Systems**
- **Antarctic Operational Support**

Eligibility Requirements for USAP

U.S. academic institutions and academically related nonprofit organizations may submit a proposal for research support. Industry and State and local agencies may also be eligible. Other Federal agencies are eligible to coordinate their research needs within the framework of NSF-supported Antarctic logistics. NSF encourages proposals from women, minorities, and persons with disabilities and proposals for research that include undergraduates under guidelines established by NSF programs such as Research Experiences for Undergraduates. All persons proposing to work in the Antarctic must pass a physical examination whose standards are specified by USAP.

Deadlines and Target Dates for USAP

The annual deadline for receipt of proposals to USAP is June 1; cross-directorate proposals may have a separate deadline. To confirm a deadline date, refer to the E-Bulletin (see link in this Guide); the OPP home page, <http://www.nsf.gov/od/opp/>; or the appropriate program office.

Literature

The following literature and related items about Antarctica are available from OPP. Please contact the source indicated.

- ***The Antarctic Journal of the United States*** (established in 1966) reports on U.S. activities in Antarctica, related activities elsewhere, and trends in the U.S. Antarctic Program. OPP annually publishes and distributes electronically two review issues that include papers by members of the Antarctic science and logistics communities. OPP distributes printed copies of these issues to members of the U.S. and international Antarctic science communities, representatives of private organizations in the United States, and other Federal agencies with an interest in Antarctic research, policy, and logistics, and the managers of their national Antarctic programs.

The *Antarctic Journal* is available by subscription or by single copy through the U.S. Government Printing Office. To request prices or order individual issues, contact the Superintendent of Documents, U.S. Government Printing Office, P.O. Box 371954, Pittsburgh, PA 15250-7954. To place an order by telephone, call (202) 512-1800; or visit the GPO home page, <http://www.access.gpo.gov/>.

For back issues of the journal, contact Mr. David Friscic by e-mail, dfriscic@nsf.gov, or write David Friscic, Information Assistant, Office of Polar Programs, National Science Foundation, Room 755, Arlington, VA 22230.

- Publications containing research recommendations are available from the Polar Research Board of the National Academy of Sciences (NAS). For more information, write to the Polar Research Board, National Academy of Sciences, 2101 Constitution Avenue, NW, Washington, DC 20037; or contact NAS by telephone, (202) 334-3479; or visit the NAS home page, <http://www.nas.edu/>.
- Between 1962 and 1998, the Library of Congress (LOC) published the *Antarctic Bibliography* with support from NSF. This Antarctic database can be searched on-line at LOC's Cold Regions Bibliography Web site, <http://lcweb.loc.gov/rr/scitech/coldregions/access.html>.

The bibliography also is available commercially on CD-ROM from the National Information Services Corporation [NISC], 3100 St. Paul Street, Suite 6, Baltimore, MD 21218; or by telephone, (410) 243-0797. The CD-ROM is a subscription service that is updated every 6 months.

- The U.S. Geological Survey (USGS) has Antarctic reconnaissance and geologic maps of portions of Antarctica at various scales. For a copy of Antarctic maps, price list, and order form, write to Information Services, U.S. Geological Survey, Box 25286, Federal Center, Building 41, Denver, CO 80225; or contact USGS by telephone, 1-800-USA-MAPS; or visit the USGS home page, <http://www.usgs.gov/>.
- Ice cores, ocean-bottom sedimentary cores, terrestrial sedimentary cores, dredged rocks, biological specimens, meteorites, and ocean-bottom photographs are available for study. For more information, refer to *Antarctic Research Program Announcement*, NSF 00-72.
- NSF's Antarctic Artists and Writers Program supports documentation of America's Antarctic heritage by providing Antarctic access (but not funds) to painters, poets, photographers, authors, educational specialists, and representatives of related genres. For details, visit the OPP home page, <http://www.nsf.gov/od/opp>, and click on "Opportunities for Participation."

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 00-72).

For operational questions, contact the Polar Research Support Section at (703) 306-1032; or visit the Raytheon Polar Services Company Web site, <http://rpssc.raytheon.com>.

Specialists are available in the areas of logistics, field camps, research ships, laboratory support, waste management, environmental protection, safety, and Antarctic Conservation Act permits.

Research and education proposals that do not require fieldwork or that will use samples already in U.S. depositories are also 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/>.

Further information is also available by contacting the following:

- **Office of Polar Programs, (703) 306-1030**
- **Antarctic Aeronomy and Astrophysics, (703) 306-1033**
- **Antarctic Biology and Medicine, (703) 306-1033**
- **Antarctic Geology and Geophysics, (703) 306-1033**
- **Antarctic Glaciology, (703) 306-1033**
- **Antarctic Ocean and Climate Systems, (703) 306-1033**
- **Polar Research Support, (703) 306-1032**



Antarctic Aeronomy and Astrophysics

The Antarctic Section's Aeronomy and Astrophysics Program, supports research projects in the following areas:

1. **Astrophysics**
2. **Long-Duration Ballooning**
3. **Upper Atmosphere Physics**



1. **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.
2. **Long-Duration Ballooning**—In cooperation with the National Aeronautics and Space Administration (NASA), NSF has developed the capability to launch balloon science payloads from McMurdo Station. These payloads weigh over 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 can in some cases serve as a low-cost substitute for space flight.
3. **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.

Antarctic Biology and Medicine

The Antarctic Biology and Medicine Program supports research projects in the following areas:

1. **Marine Biology/Biological Oceanography**
2. **Medical Research**
3. **Terrestrial and Freshwater Biology**

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1. **Marine Biology/Biological Oceanography**—Supports research on the oceans around Antarctica, which make up one of the world's most productive regions. Research objectives are to understand the structure and function of the Antarctic marine ecosystems and to determine the major features and adaptations of organisms and acquire more knowledge of their distribution, abundance, and dynamics. Major focus is on ship- and shore-based studies that stress trophodynamics, including detailed investigations at all trophic levels. Topics of particular interest include krill, ice-edge ecosystems, and low-temperature adaptations.
2. **Medical Research**—Biomedical studies are directed toward epidemiology of viral infections and physiological and psychological attributes of people in small, isolated groups.
3. **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 features and adaptations of organisms and to gain further knowledge of their distribution, abundance, and dynamics.

Antarctic Geology and Geophysics

The Antarctic Geology and Geophysics Program supports research projects in the following areas:

1. **Marine Geology and Geophysics**
2. **Terrestrial Geology and Geophysics**

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- 1. 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.
- 2. 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 are a relatively new element of the program. An aerogeophysical facility has been developed with the capability of acquiring ice-elevation, ice-thickness, and magnetic and gravity data over the continent. 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.

Antarctic Glaciology

The Antarctic Glaciology Program supports studies on the world's largest ice sheet. Covering 97 percent of the Antarctic continent and up to 4.8 kilometers thick, the ice sheet 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.

Antarctic Ocean and Climate Systems

The Ocean and Climate Systems Program supports research projects in the following areas:

1. **Atmospheric Sciences**
2. **Physical and Chemical Oceanography**



1. **Atmospheric Sciences**—Antarctica has an active relationship with regional weather and climate patterns, and perhaps with global ones as well. 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 have proven to be reflections of global atmospheric changes on many scales. The primary research objectives are to improve present understanding of the physical processes of the atmosphere, determine the relationship between events and conditions in the Antarctic atmosphere and global events, and determine the region’s role in past and present global climate.
2. **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 ventilation and a major source 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 major effect on general oceanic circulation. Research objectives are to determine the dynamics of formation and distribution of water masses, currents, and sea ice; investigate the relationship between oceanic and atmospheric circulation systems and the physical basis for biotic productivity; and investigate the relationship between the Southern Ocean and climate.

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); Twin Otter 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 will support Antarctic research.

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.

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. Air access via a Chilean station on King George Island has been arranged in the past. 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 and ships and some field camps provide voice and data communications, including Internet access, to locations outside Antarctica.

Non-U.S. Facilities—International Cooperation

NSF strongly encourages scientists from the United States to participate in cooperative research programs and activities sponsored by (and involving) other Antarctic Treaty nations.

Scientists interested in submitting a proposal for such a program are 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.

ARCTIC SCIENCES

Arctic Research Program

NSF's Arctic Research Program seeks to gain a better understanding of the Earth's biological, geological, chemical, and sociocultural processes and the interactions of ocean, land, atmosphere, life, and human systems. Arctic research is supported at NSF by the Office of Polar Programs (OPP) and by other disciplinary programs within the National Science Foundation (NSF). These programs are linked through an internal NSF Arctic Affiliates system that consists of representatives from other NSF programs that support Arctic research. The system is structured in such a way as to provide coordination across NSF disciplines and to enable joint review and funding of Arctic proposals and 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.

Under an agreement with the United States Navy, access to a nuclear submarine is available annually for research in the Arctic Ocean. Researchers are encouraged to pursue this possibility with OPP or with the Office of Naval Research. Further information on other agency programs is presented in the journal *Arctic Research of the United States* (NSF 99-55) and the *U.S. Arctic Research Plan* (NSF 97-148) and its biennial revisions.

As the Arctic is the homeland of Native peoples, attention must be given to all aspects of research and education that may potentially affect their lives. An interagency statement, "Principles for the Conduct of Research in the Arctic," has been developed. All Arctic research grantees are expected to abide by these guidelines, which are presented in the publication *Arctic Research Program Opportunities* (NSF 98-72).

The Arctic Research Program comprises the following principal programs:

- **Arctic Natural Sciences**
- **Arctic Social Sciences**
- **Arctic System Sciences**
- **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 1. Proposals for workshops, Small Grants for Exploratory Research, or dissertation improvement grants can be submitted at any time.

Submission of Proposals for Arctic Research

Proposals for field programs requiring research support in the categories listed on the Logistics Coordination Form (NSF Form 1370) must be submitted with sufficient lead time to ensure scheduling and availability. Logistics proposals must be submitted no later than the February 15 target date of the calendar year preceding the year in which the research will be conducted. Proposals requiring an oceanic research vessel must be submitted either to the Division of Ocean Sciences by February 15 of the year preceding the proposed cruise dates or to OPP's Arctic Program by the February 15 target date, to allow 9 months precruise notification. A minimum of 9 months advance notice is required for research vessels needing clearance for Russian waters. Proposals for fieldwork not requiring research support capabilities listed on the Logistics Coordination Form must be submitted no later than the August 1 target date of the preceding year.

For More Information

Arctic research projects are supported by OPP and by other disciplinary divisions and programs at NSF. The publication *Arctic Science, Engineering, and Education: Directory of Awards* (the latest edition, NSF 98-101, is for fiscal year 1997) is produced annually and contains a compilation of all NSF Arctic and related research grants from the previous fiscal year.

Further information about any of the Arctic programs and activities mentioned in this section is available in the publication, *Arctic Research Program Opportunities* (NSF 98-72). 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/>.

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Arctic Natural Sciences

The Arctic Natural Sciences Program supports research in glaciology and in atmospheric, biological, earth, and ocean sciences. 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:

1. **Atmospheric Sciences**
2. **Biological Sciences**
3. **Earth Sciences**
4. **Glaciology**
5. **Ocean Sciences**

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1. **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.
2. **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. OPP also participates in the Life in Extreme Environments (LExEN) Initiative (see program announcement NSF 99-43).
3. **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.

- 4. Glaciology**—OPP is the focal point for glaciological research within NSF. Glaciological research 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.
- 5. Ocean Sciences**—Oceanic research in the Arctic 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 global climate. Proposals concerned with the interdependencies of chemical and physical processes and marine organisms and productivity are encouraged.

Arctic Social Sciences

The Arctic Social Sciences Program 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 Arctic Social Sciences 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 to 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 a 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 NSF Form 1207 with the IRB approval date (if available) or exemption subsection from the Common Rule identified in the space provided.

Arctic System Science

The overall goals of the Arctic System Science (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 has 3 linked components for which proposals are encouraged:

(1) Ocean/Atmosphere/Ice Interactions (OAI) (see the OAI home page, <http://arcss.colorado.edu/Projects/oai.html>);

(2) Land/Atmosphere/Ice Interactions (LAI) (see the LAI home page, <http://arcss.colorado.edu/Projects/lai.html>); and

(3) Paleoenvironmental Studies, which has had two projects: Paleoclimates from Arctic Lakes and Estuaries (PALE) (see the PALE home page, <http://arcss.colorado.edu/Projects/pale.html>) and Greenland Ice Sheet Program Two (GISP2) (see the GISP2 home page,

<http://arcss.colorado.edu/Projects/gisp2.html>). Paleoenvironmental proposals are now considered within the Earth System History Initiative of the United States Global Change Research Program (see publication NSF 97-161).

ARCSS further develops a fourth component, Human Dimensions of the Arctic System (HARC) (see publication 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.

Other Arctic Support

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

- 1. Arctic Research Support and Logistics**
- 2. Arctic Research and Policy**

1. Arctic Research Support and Logistics

The Arctic Research Support and Logistics (ARS) 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 need for field support in the context of their proposal and should consider the following in particular: increased mobility to and within the Arctic; increased safety potential of satellite-based global personnel phone networks; use of field staff trained and experienced in field (and boat) safety and first aid; and utilizing equipment improved for use during fieldwork in Arctic conditions.

Support from the RSL Program includes but is not limited to, 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/or budget explanation should outline the field plan and associated costs.

The program manager from the program supporting the fieldwork, in consultation with the manager of the RSL 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 other entity will be responsible for coordinating the support with the principle investigators, consistent with the agreements between the investigators and their program managers. In other cases, the work can be proposed as a large coordinated activity, supported at some level by the support contractor. The contractor manages other resources too, including use of military airlift; support to and within Greenland; and support at Prudhoe Bay/Deadhorse Alaska, the Alaskan North Slope, and Seaward Peninsula, excluding Barrow, which is supported by the Barrow Arctic Science Consortium.

Investigators are encouraged to discuss their projects with the Arctic contractor, VECO Polar Resources (visit their Web site at <http://www.veco.com/vpr>), to get information on support options prior to preparing their proposal. All work should be described in the proposal. If it appears likely they will not be provided by a support entity, costs should be included as well. If in doubt, include the costs.

Work in Greenland

There are special requirements for fieldwork in Greenland. Investigators considering work in Greenland should obtain the Danish Polar Center application form. A copy of the form should be included with the proposal submitted to OPP.

To obtain a copy of this form electronically, visit the Arctic Logistics Information Access Service at <http://www.nsf.gov/od/opp/arctic/logistic/start.htm>.

2. Arctic Research and Policy

OPP supports the management of Arctic data and material, and is responsible for the development of the Arctic Data Directory (ADD) which contains information on several hundred Arctic data sets. The objective is to make these resources more readily available to researchers. Proposals to integrate data and information management are encouraged. For more information, visit the ADD home page, <http://www-ak.wr.usgs.gov/aedd/history.html>.

DIRECTORATE FOR SOCIAL, BEHAVIORAL, AND ECONOMIC SCIENCES

The goals of the Social, Behavioral, and Economic Sciences (SBE) Directorate 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 SBE Directorate 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 Studies (SRS)**
- **Division of International Programs (INT)**

For More Information

For further information, visit the SBE Directorate home page, <http://www.nsf.gov/sbe/>.

CROSSCUTTING PROGRAMS AND ACTIVITIES

In addition to the programs mentioned in this section, the Social, Behavioral, and Economic Sciences (SBE) Directorate takes an active role in the following crosscutting programs and activities:

Thematic Areas:

- Information Technology Research
- Biocomplexity in the Environment
- 21st Century Workforce

National Science and Technology Council (NSTC) Crosscuts:

- High Performance Computing and Communications and Information Technology (HPCCIT)
- U.S. Global Change Research Program

For More Information

For further information on these and other NSF crosscutting programs and activities, visit the NSF Crosscutting Programs home page, <http://www.nsf.gov/home/crssprgm/start.htm>.

DIVISION OF BEHAVIORAL AND COGNITIVE SCIENCES (BCS)

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 human dimensions of global change, learning and intelligent systems, integrative graduate education and research training, and human capital.

For More Information

For further 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 visit the BCS Division home page, <http://www.nsf.gov/sbe/bcs/start.htm>.

ANTHROPOLOGICAL AND GEOGRAPHIC SCIENCES CLUSTER

This cluster of programs is within the Division of Behavioral and Cognitive Sciences (BCS) and is composed of the following:

1. **Archaeology and Archaeometry**
2. **Cultural Anthropology**
3. **Geography and Regional Science**
4. **Physical Anthropology**

For More Information

The information in this section briefly describes the programs and activities in the Anthropological and Geographic Sciences Cluster. For complete information, visit the BCS Division home page, <http://www.nsf.gov/sbe/bcs/start.htm>.

- 1. Archaeology and Archaeometry**—Supports archaeological research that contributes to an anthropological understanding of the past. Both fieldwork and nonfieldwork are eligible for support. Through a special archaeometry competition, the program provides support for projects that conduct archaeometric work of anthropological significance and that develop archaeometric techniques.
- 2. Cultural Anthropology**—Supports basic research on the causes and consequences of cross-cultural 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 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, but are not limited to, human genetic variation, human adaptation, human osteology, 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. Child Learning and Development**
- 2. Human Cognition and Perception**
- 3. Linguistics**
- 4. Social Psychology**

For More Information

The information in this section briefly describes the programs and activities in the Cognitive, Psychological, and Language Sciences Cluster. For complete

information, visit the BCS Division home page,
<http://www.nsf.gov/sbe/bcs/start.htm>.



- 1. Child Learning and Development**—Supports research on cognitive, social, and biological processes related to children's and adolescents' 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 demographic and cultural characteristics in children's learning and development.
- 2. Human Cognition and Perception**—Supports research on human perceptual and cognitive processes, including the development of these processes. Emphasis is on research strongly grounded in theory. Research topics include vision, audition, haptic perception, attention, object recognition, language processing, spatial representation, motor control, memory, reasoning, and concept formation. The program encompasses a wide range of theoretical perspectives such as experimental computation, connectionism, and ecological perception, and a variety of methodologies such as experimental studies and computational modeling. Research involving acquired or developmental deficits is appropriate if the results speak to basic issues in the study of normal perception or cognition.
- 3. Linguistics**—Supports scientific research of all types that focuses on natural human language as an object of investigation. The program supports research on the syntactic, semantic, phonetic, and phonological properties of individual languages and of language in general; the psychological processes involved in the use of language; the development of linguistic capacities in children; social and cultural factors in language use, variation, and change; the acoustics of speech and the physiological and psychological processes involved in the production and perception of speech; and the biological bases of language in the central nervous system.
- 4. Social Psychology**—Supports research on human and social behavior, including cultural influences and development over the lifespan. Research topics include aggression; altruism; attitude formation and change; attitudes and behavior; attributional processes; emotion; environmental psychology; group decision making, performance, and process; intergroup relations;

interpersonal attraction and relations; nonverbal communication; person perception; personality processes; prejudice; the self; social comparison; social cognition; social influence; and stereotyping.

DIVISION OF SOCIAL AND ECONOMIC SCIENCES (SES)

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.

SES conducts special initiatives and competitions on a number of topics such as human dimensions of global change, learning and intelligent systems, integrative graduate education and research training, and human capital.

For More Information

For further information, write to the responsible program director, Division of Social and Economic Sciences, National Science Foundation, 4201 Wilson Boulevard, Room 995, Arlington, VA 22230; or visit the SES Division home page, <http://www.nsf.gov/sbe/ses/start.htm>.

ECONOMIC, DECISION, AND MANAGEMENT SCIENCES CLUSTER

This cluster of programs is within the Division of Social and Economic Sciences (SES) and is composed of the following:

- 1. Decision, Risk, and Management Science**
- 2. Economics**
- 3. Innovation and Organizational Change (IOC)**

For More Information

The information in this section briefly describes the programs and activities in the Economic, Decision, and Management Science Cluster. For complete information, visit the SES Division home page, <http://www.nsf.gov/sbe/ses/start.htm>.



- 1. Decision, Risk, and Management Science**—Supports research that explores fundamental issues in management science, risk analysis, societal and public policy decision making, behavioral decision making and judgment, and organizational design. Research funded by the program is directed at increasing the understanding and effectiveness of decision making by individuals, groups, organizations, and society. 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; new product and service development; and the development and integration of new technologies.

Three NSF directorates jointly support the program: Social and Economic Sciences (SES); Engineering (ENG); and Education and Human Resources (EHR). 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 (CDA)**
- 2. Methodology, Measurement, and Statistics (MMS)**
- 3. Science and Technology Studies (STS)**
- 4. Societal Dimensions of Engineering, Science, and Technology: Ethics and Values Studies, Research on Science and Technology (SDEST)**

For More Information

The information in this section briefly describes the programs and activities in the Methods, Cross-Directorate, and Science and Society Cluster. For complete information, visit the SES Division home page, <http://www.nsf.gov/sbe/ses/start.htm>.

- 1. Cross-Directorate Activities (CDA)**—Provides information about various cross-directorate programs in which the Social, Behavioral, and Economic Sciences Directorate participates. For activities related to the social and behavioral sciences, the program administers the Research Experiences for Undergraduates (REU) Sites and Minority Postdoctoral Research Fellowships Programs, and coordinates the Faculty Early Career Development (CAREER), Presidential Early Career Awards for Scientists and Engineers (PECASE), Professional Opportunities for Women in Research and Education (POWRE), and Small Business for Innovative Research (SBIR) Programs. Also in the areas of social and behavioral sciences, the program officers for CDA can provide information about special opportunities NSF offers for minority and women investigators and for education initiatives. For a complete description of these programs, see the Crosscutting Investment Strategies section in this Guide.

For More Information

For further information on these and other NSF crosscutting programs and activities, visit the NSF Crosscutting Programs home page, <http://www.nsf.gov/home/crssprgm/start.htm>.

- 2. Methodology, Measurement, and Statistics (MMS)**—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 data bases and data collection procedures; the collection of unique data bases 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 (STS)**—Supports historical, philosophical, 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 (SDEST)**— This program combines two former programs in the SBE Directorate: Ethics and Values Studies (EVS) and Research on Science and Technology (RST). The EVS component of the SDEST Program focuses on developing and transmitting knowledge about ethical and value dimensions associated with science, engineering, and technology. The RST component focuses on improving approaches and information for decision making about the management and direction of science, engineering, and technology.

SOCIAL AND POLITICAL SCIENCES CLUSTER

This cluster of programs is within the Division of Social and Economic Sciences (SES) and is composed of the following:

- 1. Law and Social Science**
- 2. Political Science**
- 3. Sociology**

For More Information

The information in this section briefly describes the programs and activities in the Social and Political Sciences Cluster. For complete information, visit the SES Division home page, <http://www.nsf.gov/sbe/ses/start.htm>.



- 1. Law and Social Science**—Supports scientific research on law and lawlike systems of rules. This program encourages theoretically focused empirical studies aimed at advancing scientific knowledge about the impact of law; the nature, sources, and consequences of variations and changes in legal institutions and legal decision making; and the dynamics of normative ordering in society. Included are studies of dispute processing, administrative and judicial decision making, social control, compliance and deterrence, the regulatory role of law, legal and social change, and related inquiries on the relationship between legal processes and other social processes. The program supports cross-cultural research through its Global Perspectives on Sociolegal Studies initiative.
- 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, but are not limited to, 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 research on problems of human social organization, demography, and processes of individual and institutional change. This program encourages theoretically focused empirical investigations aimed at improving the explanation of fundamental social processes. Included is research on organizations and organizational behavior, migration and immigration, social movements, race/ethnicity/minority relations, work and labor markets, stratification and mobility, family, education, crime and delinquency, social networks, gender roles, population dynamics, group processes, and the sociology of science and technology.

DIVISION OF SCIENCE RESOURCES STUDIES (SRS)

The Division of Science Resources Studies (SRS) provides policy makers, researchers, and the public with high-quality data and analyses for making informed decisions about the Nation's science, engineering, and technology enterprise. Most of the division's work is performed internally and through contractual agreements with other Federal agencies and appropriate non-Federal organizations. Funding support for analyses of science and technology resources, including science and technology human resources, research and development resources, social and economic impacts of information technology, and international studies, as well as research using the SRS Division's extensive databases are occasionally supported through external grant awards.

Using data from its surveys, SRS produces numerous reports on important topics in science, engineering, and technology. The following are examples of widely referenced SRS publications. The publication numbers cited here are for the latest editions:

- *Science and Engineering Indicators* (NSB 98-1)
- *Women, Minorities, and Persons with Disabilities in Science and Engineering: 1998* (NSF 99-338)
- *National Patterns of R&D Resources: 1999* (NSF 00-306);
- *Science and Engineering Degrees, by Race/Ethnicity of Recipients: 1989-96* (NSF 99-332); and
- *Science and Engineering Research Facilities at Colleges and Universities: 1998* (No NSF number assigned to latest version; available electronically on the SRS Division home page, <http://www.nsf.gov/sbe/srs/stats.htm>).

Also available are special reports and data and issue briefs on topics related to the science, engineering, and technology enterprise. Data products such as microdata files are made available to the research community. To help acquaint customers with SRS databases, the division also offers the following publications:

SESTAT: A Tool for Studying Scientists and Engineers in the United States (NSF 99-337)

SESTAT and NIOEM: Two Federal Databases Provide Complementary Information on the Science and Technology Labor Force (NSF 99-349)

For More Information

For further information on programs and activities in the SRS Division, or to obtain copies of SRS publications, visit the SRS home page at <http://www.nsf.gov/sbe/srs/>; or write to the Division of Science Resources Studies, National Science Foundation, 4201 Wilson Boulevard, Room 965, Arlington, VA 22230; or contact the office by telephone, (703) 306-1780.

DIVISION OF INTERNATIONAL PROGRAMS (INT)

Research and education in science and engineering benefit immensely from international cooperation. The Division of International Programs (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.

Submission of Proposals to the INT Division

The INT Division 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.

The INT Division typically supports the travel and incremental international living costs of the U.S. participants in the activity. Further information such as special considerations and funding provisions for certain geographical regions or countries can be found on the INT Division home page, <http://www.nsf.gov/sbe/int/start.htm>, and in the program announcement *International Opportunities for Scientists and Engineers* (NSF 96-14).

Eligibility Requirements for the INT Division

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 and Korea Summer Programs, which accept applications from individuals who are U.S. citizens or permanent residents. Proposals submitted to the INT Division normally compete in one of five regional groupings. Proposals for International Research Fellow awards are in a separate competition.

For More Information

For further information about activities supported by the INT Division, contact the relevant program office listed below or write to the Division of International Programs, National Science Foundation, 4201 Wilson Boulevard, Room 935,

Arlington, VA 22230; or contact the division by telephone, 1-800-437-7408; or by e-mail, intpubs@nsf.gov. Information is also available on the INT Division home page, <http://www.nsf.gov/sbe/int/start.htm>.

International Research Fellow Awards

(worldwide)	(703) 306-1711
Africa, Near East, and South Asia	(703) 306-1707
The Americas	(703) 306-1706
Central and Eastern Europe	(703) 306-1703
East Asia and the Pacific	(703) 306-1704
Japan and Korea Program	(703) 306-1701
Western Europe	(703) 306-1702

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Directory: C:\My Documents\Publications\Guide to Programs
Template: R:\WWUSER\OFFICE\TEMPLATE\Normal.dot
Title: DIRECTORATE FOR BIOLOGICAL SCIENCES
Subject:
Author: CBARTLET
Keywords:
Comments:
Creation Date: 06/12/00 10:55 AM
Change Number: 167
Last Saved On: 06/28/00 3:18 PM
Last Saved By: cbeyer
Total Editing Time: 615 Minutes
Last Printed On: 06/28/00 3:18 PM
As of Last Complete Printing
Number of Pages: 214
Number of Words: 65,085 (approx.)
Number of Characters: 370,990 (approx.)