MAJOR INVESTMENTS IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) GRADUATE STUDENTS AND GRADUATE EDUCATION

Overview

A U.S. science, technology, engineering, and mathematics (STEM) workforce with advanced preparation in research and innovation and in professional fields such as cybersecurity and STEM teaching, is essential for the progress of science and engineering (S&E). Today, emerging fields of S&E increasingly demand efforts across institutions, disciplines, and national boundaries and rest on the use of sophisticated data infrastructure, instruments, and networks of researchers. The growth of computationally intensive and data-enabled science is dramatically changing the knowledge and experience required of researchers and other STEM professionals across fields. Thus, the preparation of graduate students in STEM must continue to evolve to provide a supply of scientists and engineers who not only meet the needs of the STEM enterprise but who also have the knowledge, skills, and preparation to advance it and lead innovation in academia, the private sector, and government.

Investing in discoverers—that is, building through inclusive processes a diverse and talented next-generation of STEM research leaders and professionals across sectors—is an important NSF investment focus. A major portion of NSF's overall investment in graduate education and graduate students supports research assistants funded through research grants.

Goal

The goal of NSF's investments in STEM graduate education and STEM graduate students is to prepare a diverse workforce with advanced research training that is equipped to transform the frontiers of S&E and to prepare professionals, through various levels and approaches to graduate education, to participate and innovate in STEM intensive careers in ongoing and emerging areas.

NSF's graduate STEM investments will do the following:
- Support training in areas of national S&E priorities.
- Catalyze development of innovative models for graduate education with potential for scalability.
- Build the research knowledge base to inform improvements in graduate education.
- Promote professional development of graduate students for both academic and non-academic careers.

Approach

NSF's two major agency-wide programs in graduate education are the Graduate Research Fellowship program (GRF) and the NSF Research Traineeship (NRT) program. The Directorate for Education and Human Resources (EHR) has administrative leadership responsibility for both programs. Management of these programs is guided by NSF-wide working groups. Both programs contain design elements recommended in major national reports[15] as ways to better prepare graduates for a broad range of careers. GRF has identified and supported future outstanding basic STEM researchers since 1952. The program also provides opportunities for graduate students to gain research experience internationally and in federal agencies. GRF provides rich data that will be used for monitoring career outcomes longitudinally and will contribute to improving the understanding of STEM professional workforce development.

There are several other programs at NSF that focus on the development of sectors of the STEM workforce,

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[15] American Chemical Society Presidential Commission (2012). *Advancing graduate education in the chemical sciences*. American Chemical Society, Washington, DC. Retrieved from www.acs.org/content/dam/acsorg/about/governance/acs-presidential-graduate-education-commission-full-report.pdf; Biomedical Research Workforce Working Group (2012). Biomedical Research Workforce Working Group Draft Report. National Institutes of Health, Bethesda. Retrieved from http://acd.od.nih.gov/bmw_report.pdf

and integrate support to students with the development and testing of new models and approaches to graduate education. For example, the CyberCorps®: Scholarship for Service (SfS) program, led by EHR, addresses government's need for a cybersecurity workforce as authorized by Public Law Number: 113-274, establishing the Cybersecurity Enhancement Act of 2014. In addition to scholarships for undergraduate and graduate students, the program supports the expansion of existing educational opportunities and resources in cybersecurity through research on the teaching and learning of cybersecurity. Collaborators include the NSF Directorate for Computer and Information Science and Engineering (CISE), the U.S. Department of Homeland Security, and the Office of Personnel Management. The Robert Noyce Teacher Scholarship program (Noyce) provides fellowship support to members of the master teacher cohort at the graduate level and funds innovation and development in STEM teacher education approaches. In addition to GRF, NRT, SfS, and Noyce, the Alliances for Graduate Education and the Professoriate (AGEP), Louis Stokes Alliances for Minority Participation's Bridge to the Doctorate (LSAMP-BD) track, and NSF Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM) support the successful entry and transition of underrepresented and underserved populations into STEM graduate education and into the STEM workforce. Taken together, this broad suite of programs contributes substantially to the NSF investment in graduate education of the STEM research and education workforce of the future.

In FY 2018, NSF directorates will be engaged in considering how to extend the range of professional development opportunities for graduate students in the various disciplines served by NSF and are undertaking several pilot activities. EHR is pursuing collaborations with other directorates to establish additional partnerships with industry for internship opportunities to give graduate students the professional development needed to pursue successful careers in STEM and STEM-related occupations. The Division of Graduate Education (DGE) component of EHR's core research program will also emphasize research on the development of the STEM workforce.

Investment Framework
Graduate Research Fellowship Program (GRF)
The goal of GRF is to help build the U.S. STEM human capital necessary to ensure the Nation's leadership in advancing innovations in S&E. GRF selects, recognizes, and financially supports graduate students with demonstrated high potential for excellence in STEM and in their chosen careers. Applications are welcome from students in all STEM disciplines supported by NSF and in STEM interdisciplinary areas, including STEM education. Fellows have opportunities for international research through Graduate Opportunities Worldwide (GROW) and federal internships through Graduate Research Internship Program (GRIP).

GRF noteworthy activities are as follows:
- Program innovation has focused on professional development initiatives such as GROW and GRIP. The plans for evaluating GROW started in FY 2017, and the plans for evaluating GRIP will begin in FY 2018.
- The pilot survey and initial data collection for longitudinal monitoring of career outcomes of GRF recipients began in the first quarter of FY 2016. This activity is conducted in partnership among the EHR Evaluation Team, the NSF Evaluation and Assessment Capability, and the National Center for Science and Engineering Statistics. This team will develop and pilot a GRF survey instrument and process that may be used as an ongoing longitudinal monitoring system to assess program outcomes.
- EHR will conduct outreach to undergraduate institutions and encourage undergraduates to apply to GRF. In FY 2018, the agency will continue initiatives begun in FY 2014 to enhance the capacity of minority-serving institutions to increase the number of students who successfully compete for GRF awards. The GRF and LSAMP programs have designed outreach activities to LSAMP institutions with significant cohorts of STEM students who are enrolled in or preparing for graduate training. DGE will pilot activities in FY 2018 that promote professional development opportunities, preparing graduate students for careers in industry.

- In 2018, GRF will continue to partner with the Established Program to Stimulate Competitive Research (EPSCoR) to provide outreach to students and faculty in EPSCoR jurisdictions, with a special focus on minority-serving institutions located in EPSCoR jurisdictions.

Graduate Research Fellowship Program Funding by Account

(Dollars in Millions)

	FY 2016 Actual	FY 2017 (TBD)	FY 2018 Request
Education and Human Resources	$166.38	-	$123.27
Research and Related Activities	165.96	-	123.27
Total, GFR	**$332.34**	**-**	**$246.54**
Number of New Fellows	2,000	-	1,000
Projected Fellows on Tenure[1]	5,702	-	5,000

[1] Fellowship tenure status is the period of time during which fellows actively utilize the fellowship award to pursue an advanced degree in a STEM field.

NSF Research Traineeship (NRT)

The goals of NRT are to support highly effective training of STEM graduate students in interdisciplinary research areas of national priority as well as to create and promote new, innovative, effective, and scalable models for STEM graduate student training.

The NRT program is distinguished from prior traineeship programs by its emphasis on training for multiple career pathways, rotating priority research themes, inclusion of both masters and doctoral students, a broader definition of trainees, and greater budgetary and programmatic flexibility. NRT funds proposals to test, develop, and implement innovative and effective STEM graduate education models, to promote interdisciplinary and broad professional training of graduate students, and to foster fundamental research advances in support of national priorities. NRT thus provides a mechanism for developing a knowledge base about the implementation and impact of innovative graduate traineeship programs and graduate education policies. In FY 2015, the scope of the NRT program was expanded to add the Innovation in Graduate Education (IGE) Track. The IGE track is dedicated to piloting, testing, and evaluating novel, innovative, and potentially transformative approaches to graduate education, both disciplinary and interdisciplinary, to generate the knowledge required for their customization, implementation, and broader adoption. In FY 2018, the funding for IGE is $4.0 million.

In FY 2018, NRT will support new STEM graduate education pilots and models in order to transform current practices in graduate education. Additionally, the NRT traineeship track will continue to solicit proposals in the NSF-wide priority research areas. Investigator-initiated interdisciplinary-themed proposals outside the priority research themes will continue to be accepted.

NSF Research Traineeship Funding by Directorate
(Dollars in Millions)

Directorate	FY 2016 Actual[1]	FY 2017 (TBD)	FY 2016 Request[2]
BIO	$2.33	-	-
CISE	7.69	-	3.00
EHR	31.03	-	33.05
ENG	2.59	-	-
GEO	5.26	-	3.05
MPS	4.47	-	1.00
SBE	2.60	-	-
Total, NRT	**$55.98**	**-**	**$40.10**

[1] Outyear commitments for Integrative Graduate Education and Research Traineeship (IGERT) are included in the FY 2016 Actual for NRT and were $5.91 million.

[2] EHR's NRT funding includes $4.0 million for Innovation in Graduate Education (IGE) as a track within the NRT program in FY 2018.

CyberCorps®: Scholarship for Service (SfS)
The SfS program addresses cybersecurity education and workforce development through scholarships and building institutional capacity. The Scholarship Track provides funding to institutions for awarding scholarships to undergraduate and graduate students in cybersecurity. The goal of the Capacity Track is to increase the ability of the United States higher education enterprise to effectively produce cybersecurity professionals. Of the total SfS budget, approximately half supports graduate program activities. In return for their scholarships, tuition, fees, health insurance, travel, and book allowances, recipients work after graduation for a federal, state, local, or tribal government organization in a position related to cybersecurity for a period equal to the length of the scholarship.

FY 2018 activities will include increasing the number of Research Experiences for Undergraduates (REU) Sites focused on cybersecurity emphasizing experience for first- and second-year undergraduate students, especially veterans, and perhaps ultimately enabling more students to enter cybersecurity fields at the graduate level.

CyberCorps®: Scholarship for Service (SfS)
(Dollars in Millions)

FY 2016 Actual	FY 2017 (TBD)	FY 2018 Request
$49.98	-	$40.00

Additional Programs Supporting STEM Graduate Education and Workforce Development
Alliances for Graduate Education and the Professoriate (AGEP)
The AGEP program is committed to the national priority of increasing the numbers of underrepresented minorities and the numbers of persons with disabilities who enter and complete STEM graduate education and postdoctoral training, so numbers reach the level representative of the available pool.

Louis Stokes Alliances for Minority Participation-Bridge to the Doctorate (LSAMP-BD)
The LSAMP program assists universities and colleges in diversifying the STEM workforce through their efforts at significantly increasing the number of students successfully completing high-quality degree programs in STEM disciplines. Particular emphasis is placed on transforming STEM education through innovative recruitment and retention strategies and experiences in support of groups historically under-represented in STEM disciplines: African Americans, Alaska Natives, American Indians, Hispanic Americans, Native Hawaiians, and Native Pacific Islanders.

Established LSAMP alliances are eligible to apply for Bridge to the Doctorate support. LSAMP-BD funding allows institutions to provide stipend support ($32,000 per year) along with cost of education allowance to the institution for tuition, health insurance, and other normal fees up to $10,500 per year for up to two years of post-baccalaureate study. A plan for formally connecting a significant number of newly matriculated LSAMP students, including master's degree graduates, to doctoral degree programs is expected. LSAMP-BD projects are encouraged to partner with other NSF-funded programs, such as Centers of Research Excellence in Science and Technology (CREST), NSF research centers, NRT, or AGEP. In FY 2018, LSAMP-BD will continue to collaborate with GRF on effective approaches to increase the diversity of the GRF applicant pool.

NSF Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM)
The S-STEM program was established by NSF in accordance with the American Competitiveness and Workforce Improvement Act of 1998 (P.L. 105-277) as modified by P.L. 106-313 and P.L. 108-447 in 2004. The Act reflects the national need to increase substantially the number of American scientists and engineers. In addition to the long-standing scholarship support, S-STEM projects contribute to the knowledge base of research in education by carrying out research on factors such as recruitment and retention of STEM students. S-STEM is funded through H-1B Nonimmigrant Petitioner Account receipts.

The S-STEM program provides institutions with funds for student scholarships to encourage and enable academically talented U.S. students demonstrating financial need to enter the STEM workforce or STEM graduate school following completion of an associate, baccalaureate, or graduate degree in STEM fields. The program emphasizes the importance of recruiting students to STEM disciplines, mentoring and supporting students through degree completion, and partnering with employers to facilitate student career placement in the STEM workforce. S-STEM provides individual scholarships of up to $10,000 per year, depending on financial need. See the H-1B Nonimmigrant Petitioner Fees section in the EHR chapter for more information.

Robert Noyce Teacher Scholarship (Noyce)
The Noyce program seeks to encourage talented STEM majors and professionals to become K-12 mathematics and science teachers. Through the Noyce NSF Teaching Fellowship track**,** funding is provided to support STEM professionals who enroll as NSF Teaching fellows in master's degree programs leading to teacher certification or licensing to teach a STEM discipline in an elementary or secondary school by providing academic courses, professional development, and salary supplements while they are fulfilling a four-year teaching commitment in a high-need school district. The Noyce NSF Master Teaching Fellowship track provides support to experienced and exemplary K-12 STEM teachers, who are certified/licensed teachers that either possess a master's degree or have a bachelor's degree and are enrolled in a master's degree program in their field. These fellows participate in mentoring and professional development activities to become highly effective master teachers and teacher leaders and are provided salary supplements while they fulfill a five-year teaching commitment in high-need school districts.

Additional Programs Supporting STEM Graduate Education and Workforce Development

(Dollars in Millions)

Program	FY 2016 Actual	FY 2017 (TBD)	FY 2018 Request
AGEP	$8.00	-	$7.00
LSAMP-BD	10.75	-	11.00
S-STEM	140.47	-	75.00
Noyce Teaching and Master Teaching Fellows (10A)	24.51	-	20.00
Total	**$183.72**	**-**	**$113.00**