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

Overview

A U.S. science, technology, engineering, and mathematics 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 collaborations that span institutions, disciplines, and national boundaries, and require the use of sophisticated data infrastructure, instruments, and networks of researchers. Computationally intensive and data-enabled science is dramatically changing the knowledge and experience required of researchers and other STEM professionals across all 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 and the private and public sectors.

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

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 to participate and innovate in STEM intensive careers. This goal is based on the following framework[1] to:

- *Advance Science and Engineering Research:* Support graduate students and graduate education to enable long-term contributions of new knowledge at the frontiers of science and engineering.
- *Broaden Participation to Promote Excellence in Research and Build the Next Generation STEM Workforce***:** Recruit graduate students from a variety of geographic, demographic, social, and educational backgrounds to promote the advancement of science and a highly qualified professional workforce.
- *Build Effective Models of Graduate Education and Workforce Development:* Support the development and use of innovative models and evidence-based approaches in graduate education, including education and research about promising practices and program effectiveness.

FY 2020 Investments

NSF's two major agency-wide programs in graduate education are the Graduate Research Fellowship Program (GRFP) and the NSF Research Traineeship (NRT) program. EHR leads administration for both programs. NSF-wide working groups guide the management of these programs. Both programs contain design elements recommended in major national reports[2] as ways to better prepare graduates for a broad

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[1] National Science Foundation (2016). NSF Strategic Framework for Investments in Graduate Education. National Science Foundation, Alexandria, VA. Retrieved from: www.nsf.gov/pubs/2016/nsf16074/nsf16074.pdf.
[2] National Academy of Sciences, Engineering, and Medicine. 2018. Graduate STEM Education in the 21st Century. Washington, DC: The National Academies Press. Retrieved from: https://www.nap.edu/catalog/25038/graduate-stem-education-for-the-21st-century; 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-

range of careers. GRFP has identified and supported outstanding STEM researchers since 1952. The NRT program focuses on developing researchers in high priority interdisciplinary research areas. Both programs provide professional development opportunities for graduate students, including internships and international research experiences. Ongoing evaluation and monitoring of the programs and students involved in GRFP and NRT provide rich data that will be used for gaining a better understanding of graduate program experiences and interventions, monitoring career outcomes longitudinally, and contributing to improving the understanding of STEM professional workforce development.

There are several other programs at NSF that focus on developing sectors of the STEM workforce and provide support to students in testing new models and approaches to graduate education. For example, the CyberCorps®: Scholarship for Service (SFS) program, led by EHR, addresses the national need for a cybersecurity workforce. 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. The 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. This broad suite of programs contributes substantially to the NSF investment in graduate education of the STEM research and education workforce of the future.

Graduate Research Fellowship Program
The goal of GRFP is to help build the STEM human capital necessary to ensure the Nation's leadership in advancing innovations in S&E. GRFP selects, recognizes, and financially supports graduate students with demonstrated high potential for excellence in STEM careers. Applications are welcome from students in disciplines supported by NSF, including STEM, STEM education, or STEM interdisciplinary areas. In FY 2020, GRFP will be funded at $256.90 million. The resources will support 1,600 new fellows with a cost of education allowance of $12,000 and a stipend of $34,000. The GRFP program will continue to align awards with NSF research priorities such as big data, artificial intelligence, quantum information science, and NSF's 10 Big Ideas.

GRFP Funding by Account
(Dollars in Millions)

	FY 2018 Actual	FY 2019 (TBD)	FY 2020 Request
Education and Human Resources	$142.58	-	$128.45
Research and Related Activities	142.27	-	128.45
Total	**$284.85**	**-**	**$256.90**
Number of New Fellows	2,000		1,600
Projected Fellows on Tenure[1]	5,705		5,400

[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 or STEM education field.

NSF Research Traineeship
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 innovative, effective, and scalable

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

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 with an emphasis on future scientific challenges, inclusion of both masters and doctoral students, a broader definition of trainees, and greater budgetary and programmatic flexibility. NRT addresses interdisciplinary graduate education through two approaches: traineeships and fundamental education research. Traineeships are dedicated to effective training of STEM graduate students in high-priority interdisciplinary research areas using a comprehensive training model that is innovative, evidence-based, and aligned with changing workforce and research needs. This training includes development of technical and professional skills for both research and research-related careers within and outside academia. Fundamental education research is addressed through the Innovations in Graduate Education (IGE) component of NRT, which focuses on test-bed projects aimed at piloting, testing, and validating innovative and potentially transformative approaches to graduate education, including activities such as career preparation, mentoring, partnerships, and internships. NSF expects to fund about 12-15 traineeships and up to $8.0 million in fundamental research in graduate education.

NRT Funding
(Dollars in Millions)

	FY 2018 Actual	FY 2019 (TBD)	FY 2020 Request
BIO	$2.82	-	-
CISE	7.10	-	-
EHR	33.11	-	49.53
ENG	2.79	-	-
GEO	2.77	-	-
MPS	4.54	-	-
OPP	0.72	-	-
Total	**$53.85**	**-**	**$49.53**

In FY 2020, NRT funding is consolidated into EHR.

CyberCorps®: Scholarship for Service
The SFS program addresses cybersecurity education and workforce development by providing funding to institutions for awarding scholarships to undergraduate and graduate students in cybersecurity. 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.

SFS Funding
(Dollars in Millions)

FY 2018 Actual	FY 2019 (TBD)	FY 2020 Request
$55.09	-	$55.09

Additional Programs and Activities Supporting STEM Graduate Education and Workforce Development
Louis Stokes Alliances for Minority Participation-Bridge to the Doctorate (LSAMP-BD)
The LSAMP program assists universities and colleges in diversifying the STEM workforce by increasing the number of STEM baccalaureate and graduate degrees awarded to populations historically under-represented in STEM disciplines: African Americans, Alaska Natives, American Indians, Hispanic Americans, Native Hawaiians, and Native Pacific Islanders. The LSAMP program provides funding to alliances comprised of multiple degree-granting organizations that can implement comprehensive and

sustained strategies that result in the graduation of well-prepared, highly-qualified students from underrepresented groups. The LSAMP-BD is a targeted activity where established alliances provide post-baccalaureate fellowships to cohorts of students to obtain the necessary academic and research skills to successfully earn STEM doctoral degrees and transition to the STEM workforce. LSAMP-BD funding allows institutions to provide graduate 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.

NSF Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM)
NSF established the S-STEM program 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 2005. 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 low-income, academically talented U.S. students with demonstrable 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.

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 supports STEM professionals who enroll as NSF Teaching Fellows in master's degree programs. The fellows are then able to earn teacher certification or licensing to teach a STEM discipline in an elementary or secondary school 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 are enrolled in a master's degree program in their field. The fellows participate in mentoring and professional development activities to become highly effective master teachers and leaders. They are provided salary supplements while they fulfill a five-year teaching commitment in high-need school districts. The Noyce Teaching and Master Teaching track expects to fund about 120 fellows in FY 2020.

Additional Programs Supporting STEM Graduate Education and Workforce Development

(Dollars in Millions)

Program	FY 2018 Actual	FY 2019 (TBD)	FY 2020 Request
LSAMP-BD	$16.13	-	$11.00
S-STEM	2.32	-	2.00
Noyce Teaching and Master Teaching Fellows	3.00	-	4.00
Total	**$21.45**	**-**	**$17.00**