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

Overview

The progress of science and engineering (S&E) requires a U.S. STEM workforce with graduate-level preparation in research and innovation, or in professional fields such as cybersecurity and STEM teaching. Today, S&E research increasingly demands collaborations that span institutions, disciplines, and national boundaries, requires the use of sophisticated data infrastructure and instruments, and rests on professionals who are adept at working in teams and communicating about their work. Computationally intensive and data-enabled science in areas such as AI and QIS 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 highly capable scientists and engineers who not only meet the needs of the STEM enterprise, but who also have the knowledge, skills, and preparation to lead STEM innovation in academia and the private and public sectors.

Aligned with Administration and Congressional priorities, NSF invests substantial resources to support discoverers, thus building the diverse and talented next generation of STEM research leaders and professionals in leading-edge scientific areas, across sectors and through inclusive processes. NSF makes a significant investment in the education of graduate students via research assistantships supported through research awards across the agency. The Division of Graduate Education (DGE) also supports both individual graduate students through mechanisms such as traineeships, scholarships, and fellowships, and, importantly, innovation in graduate education to best prepare future research leaders.

Goals

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 lead and innovate in STEM-intensive careers. This goal is based on an NSF strategic framework[1] that outlines the following specific aims:
1. *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.
2. *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.
3. *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 2022 Investments

NSF's two major agency-wide programs in graduate education are the NSF Research Traineeship (NRT) program and the Graduate Research Fellowship Program (GRFP). EHR's DGE leads management for both programs, with the benefit of input from NSF-wide working groups. Both programs support actions recommended in major national reports[2] as ways to better prepare graduates for a broad range of careers.

[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,

NRT has two complementary components: (1) training grants that focus on developing researchers in high-priority interdisciplinary research areas; and (2) the Innovations in Graduate Education (IGE) research program that supports research on the development and implementation of bold, new, and potentially transformative approaches to STEM graduate education and training. GRFP identifies and supports the next generation of outstanding STEM researchers by providing them with stipend support as well as a contribution towards the costs of their education. Both NRT and GRFP 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 NRT and GRFP provide rich data that will be used for gaining a better understanding of graduate program experiences and interventions, monitoring career outcomes longitudinally, and improving the understanding of STEM professional workforce development.

Several other NSF programs focus on developing sectors of the STEM workforce and supporting students in testing new models and approaches to graduate education. For example, the CyberCorps®: Scholarship for Service (SFS) program 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 from there 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.

NSF Research Traineeship

The goals of the NRT Program are to support highly effective training of STEM graduate students in convergent research areas of national priority, as well as to create, promote, and disseminate innovative, effective, and scalable models for STEM graduate student training. In FY 2022, NRT will focus particularly on traineeships that prepare students to lead in emerging industries, such as AI, QIS, Biotechnology, and Advanced Manufacturing.

NRT addresses interdisciplinary graduate education through two approaches: traineeships and fundamental research into graduate education. Traineeships emphasize a comprehensive training model that is innovative, evidence-based, and aligned with changing workforce and research needs, which effectively prepares STEM graduate students to contribute to high-priority interdisciplinary research areas. The training includes development of technical and professional skills for both research and research-related careers within and outside academia. NRT training components are made available to both NRT-funded students and other graduate students who may want to take advantage of these opportunities. NRT also seeks to support programs in diverse institution types. Fundamental education research is addressed through the IGE component of NRT, which focuses on test-bed projects aimed at piloting, testing, and validating innovative and potentially transformative approaches to graduate education of students pursuing academic master's, professional science master's, and doctoral degrees. These approaches include activities such as career preparation, mentoring, partnerships, and internships. IGE will also support broader access to these advances for the graduate education community, including graduate faculty, staff and graduate school administrators. NSF expects to fund 15-18 traineeships and invest up to $4.0 million in fundamental research on graduate education.

DC: The National Academies Press. Retrieved from: 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-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 acd.od.nih.gov/documents/reports/bmw_report.pdf

NRT Funding

(Dollars in Millions)

FY 2020 Actual	FY 2021 Estimate	FY 2022 Request
$49.63	$58.00	$58.00

Graduate Research Fellowship Program

The goal of GRFP is to identify and nurture the STEM human capital necessary to ensure the Nation's leadership in advancing innovations in S&E, with an emphasis on broadening participation. GRFP selects, recognizes, and financially supports graduate students with demonstrated high potential for excellence in STEM careers. Applications are welcome from students in all disciplines supported by NSF, including STEM, STEM education, or STEM interdisciplinary areas. In FY 2022, GRFP will be funded entirely within EHR at a total of $318.52 million. This funding will support a total of 2,500 new fellows with a cost of education allowance of $12,000 and a stipend of $34,000. The GRFP program will continue to welcome proposals from all S&E fields and also align awards with NSF and Administration research priorities, including AI, QIS, and other emerging industries.

GRFP Funding by Account

(Dollars in Millions)

	FY 2020 Actual	FY 2021 Estimate	FY 2022 Request
Education and Human Resources	$284.51	$284.52	$318.52
Research and Related Activities[2]	[142.26]	[142.26]	-
Total	**$284.51**	**$284.52**	**$318.52**
Number of New Fellows	2,007	2,000	2,500
Projected Fellows on Tenure[1]	5,664	5,820	6,170

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

[2] In FY 2022, funding will be consolidated in Education and Human Resources. Prior year funding is restated for comparability across fiscal years.

CyberCorps®: Scholarship for Service

The SFS program addresses cybersecurity education and workforce development by providing funding to institutions to support development of cybersecurity educational programs and related activities such as cyber camps, cohort building and mentoring, and to allow the award of scholarships to undergraduate and graduate students enrolled in these educational programs. In return for their scholarships, tuition, fees, health insurance, travel, and book allowances, recipients must complete a government-based internship and work after graduation for a federal, state, local, or tribal government organization in a cybersecurity-related position for a period equal to the length of the scholarship. The SFS program also supports research to improve cybersecurity education, particularly in emerging areas such as the nexus between cybersecurity and AI, through the Secure and Trustworthy Cyberspace: Education program (SaTC-EDU).

SFS Funding

(Dollars in Millions)

FY 2020 Actual	FY 2021 Estimate	FY 2022 Request
$54.99	**$60.00**	**$70.00**

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 individuals from populations historically underrepresented 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 through which established alliances provide post-baccalaureate fellowships to support transition into and success of students in STEM master's and/or doctoral programs, thus increasing their entry into the STEM workforce. In FY 2022, LSAMP expects to direct about $10.60 million toward the LSAMP-BD program.

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 reflected the national need to increase the number of American scientists and engineers. The S-STEM program provides institutions with funds for student scholarships to support low-income, academically talented U.S. students with demonstrable financial need. These scholarships, together with additional supports such as mentoring and internships, help these students earn an associate, baccalaureate, or graduate degree in STEM fields. These graduates will be highly prepared to enter and contribute to the STEM workforce. The S-STEM program emphasizes the importance of recruiting students to pursue 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 for up to four years, depending on cost of attendance and unmet financial need. S-STEM expects to offer support for about 300 Masters or PhD students in FY 2022. In addition to providing scholarship support, S-STEM projects also contribute to the knowledge base about effective STEM education by carrying out research on effective practices to recruit STEM students and support them to earn STEM degrees. S-STEM is funded through H-1B Nonimmigrant Petitioner Account receipts. In FY 2022, S-STEM expects to invest approximately $10.0 million in awards to support scholarships for graduate students.

Robert Noyce Teacher Scholarship (Noyce)
The Noyce responds to the critical need for highly effective K-12 STEM teachers and teacher leaders. Noyce supports institutions of higher education to develop and sustain comprehensive programs of study that encourage and support undergraduate STEM majors and STEM professionals to become effective K-12 STEM teachers in high-need school districts. It also supports experienced, exemplary K-12 STEM teachers to become teacher leaders in high-need school districts and to engage their colleagues in communities of practice focused on continued professional development. Furthermore, the Noyce program funds research on the effectiveness and retention of K-12 STEM teachers in high-need school districts.

Categories of Noyce Support for Graduate Education

Track	Outcome	Eligible Individuals	Support	Length of Commitment to Teach in High-need Schools
Scholarships and Stipends	Highly effective K-12 STEM teachers in high need schools/districts	STEM professionals	One-year scholarship to become certified/licensed teacher	2 years
Teaching Fellowship			One-year Scholarship to complete a master's degree in education and salary supplement* during teaching commitment	4 years
Master Teaching Fellowships	Highly effective K-12 teacher leaders in STEM education in high need schools/districts	K-12 STEM teachers without a master's degree	One-year Scholarship to complete a master's degree and salary supplement during teaching commitment	5 years**

The salary supplements support participation in mentoring and professional development to increase the Fellow's effectiveness in the classroom and/or as teacher leaders.
**The Master Teaching Fellows continue teaching in a high need school and/or school district while they are pursuing their master's degree.*

The Noyce Teaching Fellowships and Master Teaching Fellowships track expects to fund about 160 fellows in FY 2022.

Additional Programs Supporting STEM Graduate Education and Funding Workforce Development

(Dollars in Millions)

	FY 2020 Actual	FY 2021 Estimate	FY 2022 Request
LSAMP-BD	$5.38	-	$10.60
S-STEM	13.90	10.00	10.00
Noyce Teaching and Master Teaching Fellows (10A)	27.75	20.00	20.00
Total	**$47.03**	**$30.00**	**$40.60**