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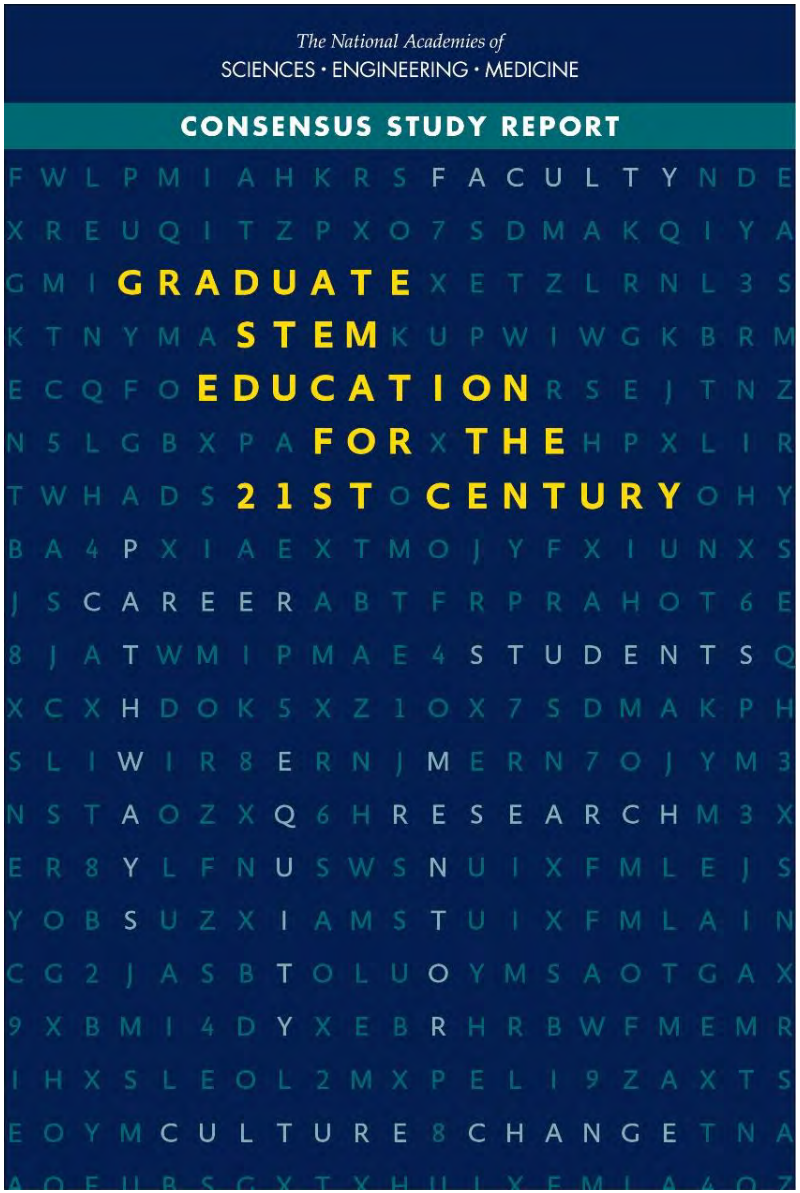
Toward More Modern STEM Graduate Education Outcomes



https://www.nap.edu/catalog/25038/graduate-stem-education-for-the-21st-century

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The Issue

- Graduate STEM education is lagging behind the evolution of science and engineering, the nature of the workforce, and the career goals and paths of its students

The world of science has changed substantially over the last 50-100 years

- The science and engineering workforce is growing
  - Becoming much more diverse
- Over 60% of new Ph.D.'s do NOT go into academic research
- The nature of science itself has changed

But we train them the same way we always have

We need to modernize graduate STEM education

- Need to redefine the outcomes
  - To better reflect today's realities and students' needs and interests

NASEM Committee began by articulating “core competencies”

- Skills every student must acquire

Core Competencies for the STEM Master's Degree

1. Disciplinary and interdisciplinary knowledge
2. Professional competencies
3. Foundational and transferrable skills
4. Research

Based on CGS recommendations

Core Competencies for the STEM Ph.D. Degree

1. Develop Scientific and Technological Literacy and How to Conduct Original Research

a. Deep specialized expertise
b. Acquire sufficient transdisciplinary knowledge
c. Identify problems and articulate research questions
d. Design a research strategy
e. Evaluate outcomes and iterate as necessary
f. Adopt rigorous standards of investigation and acquire mastery of skills needed in the field of study
g. Learn and apply professional norms and practices of the scientific or engineering enterprise

Core Competencies for the STEM Ph.D. Degree

2. Develop Leadership, Communication, and Professional Competencies

a. Develop ability to work in collaborative and team settings, including with individuals from diverse cultural and disciplinary backgrounds

b. Develop professional competencies needed to plan and implement research project

c. Acquire the capacity to communicate in many modes and to both STEM professionals and other audiences

Core competencies are the central but not only outcome goal of a modern graduate education

- Also want student exposure to range of other career options
  - Not just academic research

How to get there from here?

- Action steps for all stakeholders

Key Recommendations Relate to:

- Collecting and sharing national and institutional data on student and alumni performance and career outcomes
- Providing for career exploration and preparation
- Evolving the structure of doctoral research activities
  - And capstone projects/dissertations
- Promoting effective teaching and mentoring
- Ensuring diverse, equitable, and inclusive environments
- Improving the quality of the graduate student experience

Making Change

- Cultural and behavioral changes throughout the system
  - Reduce stigma of non-academic careers
  - Make the system more student-centric
  - Re-balance the incentive system
    - Currently overweighted toward research productivity

Key Recommendations for Institutions and Graduate Programs and Their Faculties

- Make data available on graduate program outcomes
- Provide training in and reward effective teaching and mentoring
  - Adjust promotion and tenure criteria
- Provide ways to explore a variety of careers
- Re-design capstone projects and dissertations to reflect the state of the art in STEM
- Create equitable and inclusive environments
- Provide resources to help students manage stresses and pressures of graduate education

Some things have been happening

- Both before and after the NAS study
  - Individual institutions
    - E.g., building in career exploration opportunities
  - Council of Graduate Schools (CGS)
  - Association of American Universities (AAU)
    - Pushing data career outcome transparency hard
  - National Institutes of Health (NIH)
    - Mostly NIGMS
  - National Science Foundation (NSF)
    - Most directorates

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NIGMS-Sponsored Training Program Maps

Answers to Institutional Predoctoral Training Grants (T32) Frequently Asked Questions

NIH Predoctoral Stipends, Training Related Expenses, Institutional Allowance, and Tuition/Fees Policy on NRSA Awards

Items Considered by Reviewers in Evaluating Institutional Training Grant Applications

Responsible Conduct of Research

NRSA Institutional Predoctoral Training Grants Program Description and Guidelines

T-32

The information provided below represents only a brief overview of the NIGMS-sponsored Institutional Predoctoral T32 Training programs. Applicants are strongly encouraged to carefully read the relevant T32 Funding Opportunity Announcements (FOAs) (see below), and contact program staff for specific information about these training programs.

Predoctoral T32 FOAs:

- Basic Biomedical Sciences: PAR-17-341 (NIGMS-specific Predoctoral T32 FOA)
- Medical Scientist Training Program (MSTP): PA-18-403 (NIH T32 Parent FOA)

NIGMS accepts predoctoral research training grant applications from eligible institutions to enhance graduate (Ph.D.) research training in 12 broad areas of basic biomedical sciences relevant to the NIGMS mission. In addition, NIGMS supports the integrated medical and graduate research training through the Medical Scientist Training Program (MSTP).

NIGMS encourages institutions to design training programs that are broadly-based and foundational in nature. Each program should provide high-quality research training, mentored research experiences, and additional training opportunities that equip trainees with the technical (e.g., appropriate methods, technologies, and quantitative/computational approaches), operational (e.g., independent knowledge acquisition, rigorous experimental design, and interpretation of data) and professional (e.g. management, leadership, communication, and teamwork) skills required for careers in the biomedical research workforce (i.e., the breadth of careers that sustain biomedical research in areas that are relevant to the NIH mission).

Trainees are expected to participate in a predoctoral curriculum that fosters broad, multidisciplinary approaches to research, and a thorough understanding of experimental design, including the principles of experimental rigor through formal training and mentoring activities. Programs are expected to integrate quantitative biology or advanced statistical approaches in their training curriculum to develop a mathematical fluency among all trainees. This curriculum may include quantitative problem-solving, statistical analysis and/or other didactic or hands-on activities that will enhance student understanding of the value of quantitative approaches to answering scientific questions.

- Training Program Overview
- Length of Support
- Instructions for Preparing an NIGMS Predoctoral Training Grant (T32) Application

Notes: NIGMS encourages all applicants for training grants (new as well as renewal) to contact program staff before submitting an

NSF 18-102

Dear Colleague Letter: Non-Academic Research Internships for Graduate Students (INTERN) Supplemental Funding Opportunity

August 27, 2018

Dear Colleagues:

Fostering the growth of a globally competitive and diverse research workforce and advancing the scientific and innovation skills of the Nation is a strategic objective of the National Science Foundation (NSF). The Nation's global competitiveness depends critically on the readiness of the Nation's Science, Technology, Engineering and Mathematics (STEM) workforce and NSF seeks to continue to invest in programs that directly advance this workforce. As part of this effort, a supplemental funding opportunity is available in fiscal years FY 2019 and FY 2020 to provide support for non-academic research internships for graduate students to support career opportunities in any sector of the U.S. economy. NSF currently invests in a number of graduate student preparedness activities and has historically encouraged principal investigators (PIs) to include such activities in research proposals to NSF. This Dear Colleague Letter (DCL) describes new funding opportunities at NSF to ensure graduate students are well prepared for the 21st-century STEM workforce.

BACKGROUND

With rapidly accelerating changes in technology-driven global and national economies, today's graduate students will have a wide choice of career paths to pursue over their professional lives. Graduate students have the potential to make important contributions in careers outside academia, in organizations including: startup businesses, small and large corporations, government agencies, and non-profit organizations. NSF's 2018 Science and Engineering Indicators report reveals 79 percent of master's level STEM graduates and 57 percent of doctoral degree holders work in industry or government. It is therefore important that graduate students supported by NSF grants be provided opportunities to develop skills that prepare them to be successful for a broad range of academic and non-academic career paths. In addition to deep and broad preparation in their technical areas of expertise, skills and knowledge regarding communication, innovation and entrepreneurship, leadership and management, and policy and outreach are becoming increasingly valuable to enter any sector of the workforce.

SUPPLEMENTAL FUNDING OPPORTUNITY

NSF will consider supplemental funding requests that enable PIs to request up to six months of additional support for graduate students with the following goals:

1. To provide graduate students with the opportunity to augment their research assistantships with non-academic research internship activities and training opportunities that will complement their academic research training;
2. To allow graduate students to pursue new activities aimed at acquiring professional development experience that will enhance their preparation for multiple career pathways after graduation; and
3. To encourage the participation of graduate students from groups that have traditionally been underrepresented and underserved in the STEM enterprise: women, persons with disabilities, African Americans/Blacks, Hispanic Americans, American Indians, Alaska Natives, Native Hawaiians, Native Pacific Islanders, veterans, and persons from economically disadvantaged backgrounds.

DESCRIPTION OF THE ACTIVITIES SUPPORTED

Real, lasting changes will depend on:

- Making graduate education student-centric
- Adjusting outcome goals and curricula to real-world career goals
  - While ensuring core competencies
- Reducing stigma of non-academic careers
- Rewarding high quality teaching, advising and mentoring
- Real commitment to providing a diverse, equitable and inclusive environment