



Broadening Engagement through Engineering At MIT (BEEAM)

Program Description BEEAM (**B**roadening **E**ngagement through **E**ngineering **A**t **M**IT) is a year-round high school science education and research program, designed for rising juniors and seniors, developed by the Massachusetts Institute of Technology in conjunction with the NSF Science and Technology Center on Emergent Behaviors of Integrated Cellular Systems (EBICS). BEEAM seeks to expand student participation in all kinds of research – both disciplinary and interdisciplinary – because research experience is one of the most effective modes for attracting students to and retaining them in science, technology, engineering, and mathematics (STEM) and therefore preparing them for careers in STEM.^{1,2,3}

Broader Impacts In 2017, 26.8% of undergraduate engineering majors were from underrepresented minority groups and female students comprised less than 25% of this population.⁴ BEEAM provides scientific resources, opportunity, and access to underrepresented students who are interested in STEM. We strive to fill the leaky research experience pipeline and to produce the next generation of researchers, a diverse group of leaders who are proficient in science and engineering, and a community to support and develop scientists in the emerging field of engineered biological systems. BEEAM hopes that participants, through their research experiences and interactions with the program activities, will learn about possible career paths and that their experiences in this program will help them set and achieve STEM-inspired goals.

Program Goals To inspire high school students from underrepresented minority groups to aspire to a wider range of career opportunities, including earning advanced degrees in STEM. Through obtaining an increased awareness and understanding of STEM and the required skills and confidence to be successful, new and exciting career path possibilities and opportunities will become imaginable. Through active participation in research projects specifically designed for the BEEAM program, each scholar will:

- receive valuable educational experiences and professional development opportunities.
- practice and enhance their scientific writing and communication skills.
- have high-quality interactions with MIT students, faculty, other research mentors, and staff.
- develop a new perspective on how classroom academic learning relates to furthering scientific knowledge by hands-on experimentation to test hypotheses.

Participant Activities Under the mentorship of a MIT STEM departmental research faculty member and a postdoctoral research scholar within the corresponding laboratory, BEEAM scholars will develop research and problem-solving skills through conducting and taking ownership of a research project. In addition to gaining first-hand experience in a research laboratory, BEEAM scholars will participate in several professional development activities during their time at MIT for scholastic enrichment and growth, such as:

- attending undergraduate career fairs and workshops outlining the best practices for selecting and applying to STEM focused undergraduate programs
- learning how to craft and deliver an effective scientific research poster/PowerPoint presentation
- practicing presenting their research project (poster and oral presentation) to the scientific communities at MIT and across EBICS



- connecting with other EBICS high school STEM researchers in Project ENGAGES (Engaging New Generations At Georgia Tech through Engineering & Science) at the Georgia Institute of Technology and SpHERES (Sparking High Schoolers' Excitement for Research in Engineering & Science) at the University of Illinois Urbana-Champaign
- attending a national STEM conference to present their BEEAM research (SACNAS, ABRCMS, or BMES)
- participating in various professional and personal development workshops on topics including EHS training, exploring mentoring, time management, resume writing, goal setting, and networking.

Participant Research Support Each BEEAM scholar will be expected to perform supervised research efforts for 15 hours per week for the Fall and Spring semesters and during the Independent Activity Period (the month of January). During the Summer semester, the BEEAM scholar will conduct 35 hours per week of mentored, full-time research. Each BEEAM scholar will receive a total stipend of \$4,620 for their full-time research efforts during the 11-week Summer semester. For their part-time research efforts during the 13-week Fall and 13-week Spring semesters, a total stipend of \$4,680 will be distributed (\$2,340 per semester). During IAP, the BEEAM scholar will earn a stipend of \$900. To assist with commuting, each BEEAM scholar will have prepaid, monthly unlimited access to the MBTA (Massachusetts Bay Transit Authority) trains and busses. Additionally, BEEAM will provide up to \$250 financial support to offset some of the associated cost with undergraduate college application fees. The table below shows a breakdown of the BEEAM scholar's research support. If needed, participants can coordinate modifications to the schedule below with the Program Manager.

Summer 2019		Fall Semester 2019		January (IAP) 2020		Spring Semester 2020	
Start	24 June	Start	4 Sept	Start	2 Jan	Start	4 Feb
End	2 September	End	11 Dec	End	1 Feb	End	14 May
Days	51	Days	65	Days	24	Days	65
Weeks	11	Weeks	13	Weeks	5	Weeks	13
Hours/Week	35	Hours/Week	15	Hours/Week	15	Hours/Week	15
Stipend/Week	\$420	Stipend/Week	\$180	Stipend/Week	\$180	Stipend/Week	\$180
Total	\$4,620	Total	\$2,340	Total	\$900	Total	\$2,340

1 Year Total BEEAM Stipend Support: \$7,860

Table 1 Stipend Support A breakdown of each BEEAM scholar's start and end dates per academic semester and Individual Activity Period (IAP); the corresponding research hours per week; the total number of weeks per semester and for IAP; and the total stipend earned.

MIT Faculty's and Mentor's Commitments The BEEAM program provides an opportunity for postdoctoral fellows to mentor high school students in research while gaining valuable mentoring and project management experience.

Research advisor's commitment

- The research advisor will need to email Caley Allen, PhD (the EBICS Education and Diversity Program Manager) at calallen@mit.edu:
 - providing approval for the mentor to submit a research project title and description.
 - confirming and supporting the mentor's full-year availability.



- agreeing that mentoring a high school student is a good fit for the mentor and the research lab.

Research mentor's commitment

- With their research advisor's support, the BEEAM mentor will contact Caley Allen, PhD at calallen@mit.edu to:
 - submit a research topic/project title with a brief description.
 - outline how the proposed project will allow the high school student to evolve their research into an independent, supervised project.
 - agree that they are available to mentor the BEEAM scholars throughout the full academic year and summer; June 2019 through May 2020.

As a BEEAM mentor you will be asked to attend an orientation session in May 2019 (exact date will be determined soon). Additionally, mentors will be invited to events throughout the year to highlight the program and to support their BEEAM scholar.

MIT Research Mentor Support The participation of and support for our BEEAM mentors is an integral part of the success of BEEAM as we strive to increase retention of minority students within STEM to produce a diverse group of leaders who are proficient in science and engineering. A mentor-mentee relationship has many unique features and serving in the role of mentor involves providing highly individualized guidance based on the mentee's background, life, and work experiences. Most importantly, the mentor must have an avid interest in helping a BEEAM scholar reach their life and career goals. In direct recognition of the BEEAM mentor's dedication and research efforts, we will fund the mentor to attend and present at one national scientific research conference with their BEEAM mentee (who also should submit an abstract to present at the conference). This conference provides opportunities for developing scientists from underrepresented backgrounds and provide professional development workshops and seminars that will be meaningful and useful. Target conferences include ABRCMS, SACNAS, BMES, and ERN.

Program Evaluation and Assessment External evaluation is an integral component and is conducted for both formative and summative purposes. At the end of each semester, a progress report and evaluation will be conducted on the mentee and mentor to collect data on impact, institutionalization, and experience. Program evaluation seeks to provide valid and useful information to participants, EBICS leadership and program managers, MIT faculty and mentors, and NSF funders to guide program improvement and direction, assess short- and long-term effectiveness and impact, and increase the likelihood of sustainability.

BEEAM Outcomes, Year 1 Two highly motivated high school students from underrepresented backgrounds were interviewed and selected from public high schools in the Boston-Cambridge area, Cambridge Rindge and Latin School and the Boston Collegiate Charter School, to participate and conduct cutting-edge research inside of the Department of Biological Engineering. Jhaleah Delisme joined Professor Linda Griffith's research laboratory in May 2017 under the co-mentorship of Alex Brown. During the summer of 2017, Jhaleah fabricated hydrogels and through the addition of fluorescent beads, she was able to image the gels using the LEICA fluorescent microscope. Nia Abdurezak joined Professor Roger Kamm's research laboratory in May 2017 under the mentorship of Cynthia Hajal. Over the last year, she has acquired a breadth of laboratory



skills and is now able to conduct several procedures on her own, including microfluidic device fabrication, immunostaining, and imaging using phase contrast microscopy and confocal microscopy. In May 2018, Nia conduct an individual project in relation with her final AP Biology presentation. In the summer of 2018, Nia earned a prestigious summer internship at the Broad Institute and participated in the Broad Summer Scholars Program. Nia resumed her research efforts in Prof. Kamm's research laboratory in September 2018. Nia is a graduating senior and is applying to top-ten universities to earn her degree in Biological Engineering.

References

1. Berger, J. and Milem, J. (1999). The Role of Student Involvement and Perceptions of Integration in a Casual Model of Student Persistence. *Research in Higher Education*, 40(6), 641-664
2. French, B. F., Immuekus, J. C., and Oakes, W. C. (2005) *An Examination of Indicators of Engineering Students' Success and Persistence*, 94(4), 419-425
3. Knight, D. W, Carlson, L. E., and Sullivan, J. F. (2007) *Improving Engineering Student Retention through Hands-On, Team Based, First-Year Design Projects*, International Conference on Research in Engineering Education, Honolulu HI.
4. Brain L. Yoder (2017) *Engineering By The Numbers*, US Department of Education, Institute of Education Sciences: National Center for Education Statistics