

Say “YES” to Growing Diverse Young Scientists – The National Cancer Institute Youth Enjoy Science (YES) Research Education Program

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COMMENTARY

The 21st century is an extraordinary time for biomedical research with rapid advances across multiple fields fueled by powerful technologies. The biomedical sciences accounted for six of Science magazine’s top 10 breakthroughs in 2021 (1) and some of the fastest-growing and most-rewarding careers are open to graduates with biomedical research expertise. Such vitality can only be sustained through an ever-replenishing pool of well-prepared and diverse young scientists.

Preparation of a strong biomedical research workforce must begin in the early years. Studies show that bright minds may be lost to science long before reaching the college years. Junior Achievement Teens and Careers survey in 2018 suggests that by middle-school, many US-based students begin to lose interest in science, technology, engineering, and mathematics (STEM), with 76% of teenage boys and 89% of teenage girls losing interest in STEM careers (2). Some studies indicate a loss of confidence of children aged 6-11 in their ability to pursue science (3), while other studies suggest that the interest in science is not lost, but instead never constituted (4). Early intervention strategies in research education provide a foundation upon which essential scientific skills and visions can develop. Strong early intervention research education programs can change a young student’s trajectory in life and career.

The challenges of attracting talents to the sciences are heightened for the engagement of students from population groups that are underrepresented in these disciplines, but the necessity is unequivocal (5). Diversity enhances excellence in research and problem solving and is a critical ingredient in alleviating disparities in clinical studies and care (6-9). Despite increasing awareness and recognition of this, Black or African Americans, Hispanics or Latinos, and American

Indians or Alaska Natives collectively accounted for 23% of the total STEM workforce and only 15% of those with a Bachelor’s degree or higher in 2019 while they represented 30% of the employed U.S. population (10). Similar underrepresentation also exists for individuals with disabilities and individuals from disadvantaged backgrounds (11-13). These gaps are already visible at the middle and high school levels for the underrepresented students and reflected in the persistent lag in math scores, less access to experienced math and science teachers and less available funding (10, 14).

The National Cancer Institute (NCI) Center to Reduce Cancer Health Disparities (CRCHD) addresses the compelling need to enhance workforce diversity in cancer research through the Continuing Umbrella of Research Experiences (CURE) Program. The CURE Program funds opportunities to enrich and diversify the talent pool, address strategic and scientific areas of interest, and expand and extend the period of training so that students and trainees can be better prepared to reach research independence. Over the past 25 years, CURE has trained around 5,000 students and scientists from underrepresented populations.

Analysis of the CURE in its early years revealed that while the program supported trainees from high school through investigator level, the number of high school and undergraduate participants were extremely low. To strengthen the early stages of the biomedical research training pipeline, CRCHD established the NCI Cancer Center (CC) Supplements for High School and Undergraduate Students Research Experiences (P30S) Program. The P30S Program provides funding for CCs to engage high school and undergraduate students from underrepresented populations in cutting edge cancer research. The overall goals are to inspire interest in biomedical sciences, help envision research as a career path, and

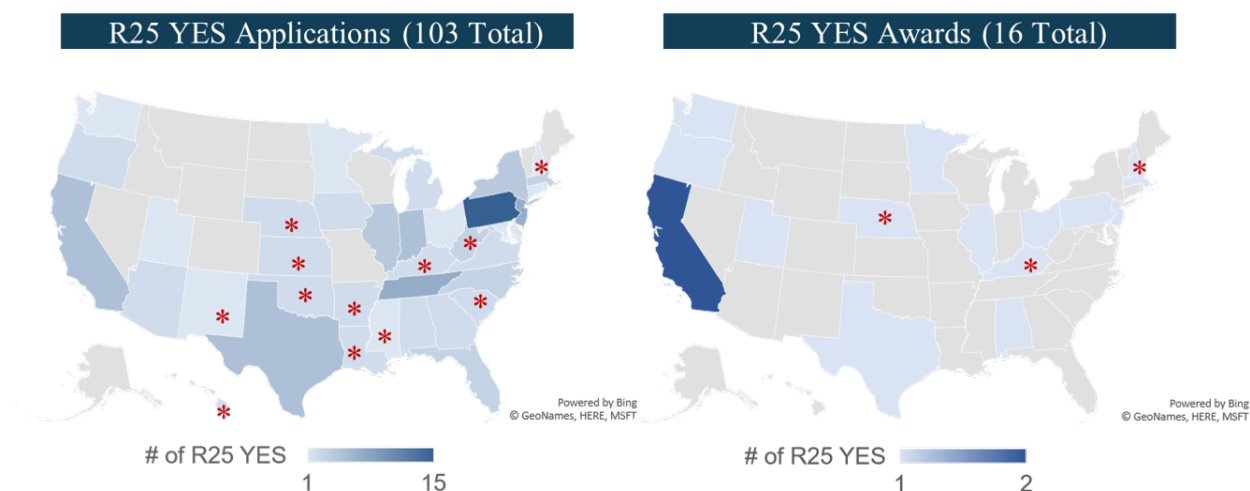


Figure 1. Applications (Left) and Awards (Right) of the R25 YES. Applications were received by the National Cancer Institute during FY 2017-19, with corresponding awards issued during FY 2017-20. * denotes Institutional Development Award (IDeA)-eligible states, which are states with historically low levels of National Institutes of Health funding.

strengthen practical research skills. In alignment with these goals, CCs can develop unique programs that capitalize on their research strengths and are responsive to their target populations. More than 40 CCs have participated in the P30S Program, 12 of which have participated for a decade or more. Fourteen CCs provided longitudinal tracking data of their students to the NCI. Over the period of 2001-2013, these 14 P30S supported about 1,500 high school and undergraduate students (constituting 44% of the entire CURE portfolio during the same period), with an overall academic matriculation rate of 94% and a retention rate in health or science-related fields of 88%.

Experience with the P30S Program concurred with literature that shows the benefits and the necessity of intervention at a point earlier than high school to successfully engage the students in science. The NIH Scientific Management Review Board's Report on Pre-college Engagement in Biomedical Science recommended prioritizing early intervention research education strategies and identified key findings and

suggestions to optimize activities aimed at engaging pre-college students in biomedical science (15). In 2014, the P30S supported a pilot program initiating a first cohort of middle school students from West Baltimore to the CURE Program. The progress of these students has been astounding, and the potential impact of this program on their academic, career and life paths is visible even at this early stage. The success of this pilot demonstrated the feasibility of including middle school students in the CURE Program.

CRCHD expanded the P30S Program in 2016 into the R25 NCI Youth Enjoy Science (YES) Research Education Program. Compared with the P30S, the YES broadens these institutional programs beyond CCs and extends the participants to include middle school students as well as teachers and faculty in addition to high school and undergraduate students. The foundational elements of the P30S remain the same in the YES: an unwavering focus on enhancing diversity, a sustained mentored engagement of young scientists in research, and holistic support of students which can help

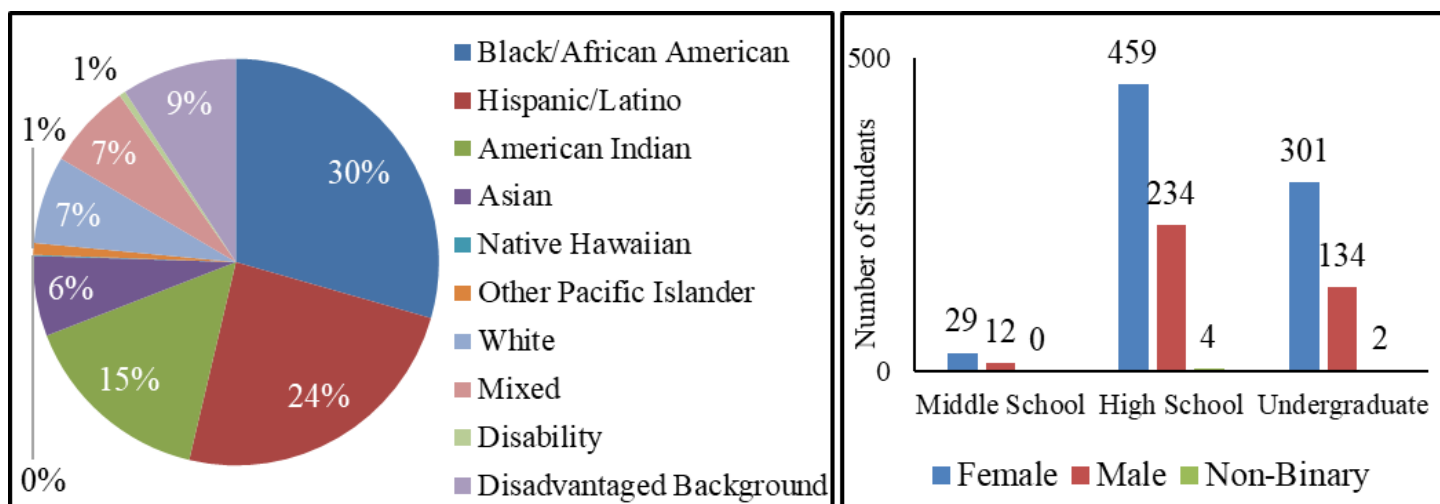


Figure 2. Demographics and Academic Level of R25 YES Students (Fiscal Year 2018-21). Total n = 1,175.

to overcome often-complex barriers to career advancement. Each YES program delivers these elements through well-integrated activities of research experience, curriculum or methods development, and outreach that ensures meaningful engagement of families and communities as well as other support for the students.

Collaboration at multiple levels is at once a necessity and the icing on the cake for the YES Program. Within each YES, the program team collaborates with educators, mentors, families, communities and other stakeholders to deliver a strong and supportive program. Several YES programs collaborate with other research education and training programs at the same institution or a partner institution to offer the students a connected pipeline experience. All YES awardees meet periodically to share experiences, ideas, and resources, which has been especially helpful during the pandemic and sometimes leads to more formal collaborations. The YES Program enjoys a natural synergy with the Science Education Partnership Award (SEPA) Program from the National Institute of General Medical Sciences (16) that supports STEM and Informal Science Education activities (17) for pre-kindergarten to grade 12 (P–12) students. The YES and SEPA awardees benefit from the combined STEM and research education network.

The initial Funding Opportunity Announcement (FOA) for the YES Program (PAR-17-059) was published in November 2016, and the first applications were submitted by January 2017. NCI received 103 applications from across the country during the ensuing three years, 16 of which were awarded (Figure 1). Of the 39 active P30S programs in 2016, 28 applied for the YES and 12 were awarded. Between Fiscal Year (FY) 2018 and FY 2021, the YES programs supported 41 middle school students, 697 high school students, 437 undergraduate students, 3 middle school teachers, 51 high school teachers and 31 undergraduate faculty. Of the 1,175 students, 30% identify as Black/African American, 24% as Hispanic/Latino, 15% as American Indian, 1% as Native Hawaiian or Other Pacific Islander, 6% as Asian, 7% as White, 7% as from two or more races, 9% as individuals from disadvantaged backgrounds and 1% as individuals with disabilities (Figure 2). The achievement of such diversity is a testament to each YES program's thoughtful and meticulous recruitment approach.

The R25 YES thrives because of the passion, dedication and resolute commitment of the Principal Investigators, Program Managers, Program Coordinators, and their teams. In this issue, these YES program leaders will share their experiences, from program design to implementation to student tracking and evaluation and much more. For the YES students, participation in this program may be a journey of discovery in developing their scientific identity, a journey of growing resilience that turns challenges into opportunities, a journey of envisioning a research career and building a founda-

tion to start, and a journey of recognizing and nurturing their potential to benefit their communities through science.

The R25 YES reissued as an RFA in 2021 (18) and continues to attract outstanding applications. The future of the program is as full of bright promise as the talented and diverse young scientists who prevail over challenges and learn to forge their paths in research exploration. The YES Program empowers the students in career choices – they can choose to do many things, but the hope is that they will choose to say “YES” to biomedical and cancer research.

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Author Contributions

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ABBREVIATIONS

CC: Cancer Center; CRCHD: Center to Reduce Cancer Health Disparities; CURE: Continuing Umbrella of Research Experiences; FOA: Funding Opportunity Announcement; FY: Fiscal Year; NCI: National Cancer Institute; SEPA: Science Education Partnership Award; STEM: Science, Technology, Engineering, and Mathematics; YES: Youth Enjoy Science

WORKS CITED

1. Advancing Diversity and Inclusion in High Education. U.S. Department of Education, 2016. <https://www2.ed.gov/rschstat/research/pubs/advancing-diversity-inclusion.pdf>

2. AlShebli, B.K., Rahwan, T. and Woon, W.L. (2018) The preeminence of ethnic diversity in scientific collaboration. *Nature Communication*, 9, 5163. <https://doi.org/10.1038/s41467-018-07634-8>
3. Anderhag, P., Wickman, P.-O., Bergqvist, K., Jakobson, B., Hamza, K.M. and Säljö, R. (2016), Why do secondary school students lose their interest in science? Or does it never emerge? A possible and overlooked explanation. *Science Education*, 100, 791-813. <https://doi.org/10.1002/sce.21231>
4. Breakthrough of the Year: 2021. Science.org <https://www.science.org/content/article/breakthrough-2021>
5. Center for Advancement of Informal Science Education (CAISE). <https://www.informalscience.org/>
6. Eckstrand, K. L., Potter, J., Bayer, C. R., and Englander, R. (2016). Giving context to the physician competency reference set: Adapting to the needs of diverse populations. *Academic Medicine: Journal of the Association of American Medical Colleges*, 91(7), 930–935. <https://doi.org/10.1097/ACM.0000000000001088>
7. Freeman, R., and Huang, W. Collaboration: Strength in diversity. *Nature* 513, 305 (2014). <https://doi.org/10.1038/513305a>
8. Increasing College Opportunity for Low-Income Students. https://obamawhitehouse.archives.gov/sites/default/files/docs/increasing_college_opportunity_for_low-income_students_report.pdf
9. Junior Achievement USA. 2018. 2018 Teens and Careers. <https://jausa.ja.org/dA/9b65808000/criticalIssuePdfDocument/Teens%20and%20Careers%202018%20Executive%20Summary.pdf>
10. Lei, R. F., Green, E. R., Leslie, S. J., and Rhodes, M. (2019). Children lose confidence in their potential to “be scientists,” but not in their capacity to “do science”. *Developmental Science*, 22(6), e12837. <https://doi.org/10.1111/desc.12837>
11. Morgan, I., Amerikaner, A. Funding Gaps 2018. The Education Trust. <https://edtrust.org/resource/funding-gaps-2018/>
12. National Cancer Institute Youth Enjoy Science Research Education Program (National Cancer Institute). <https://grants.nih.gov/grants/guide/rfa-files/RFA-CA-21-020.html>
13. Notice of NIH’s Interest in Diversity (National Institutes of Health) (2019). <https://grants.nih.gov/grants/guide/notice-files/NOT-OD-20-031.html>
14. Report on Pre-College Engagement in Biomedical Science. Scientific Management Review Board, National Institutes of Health, 2015. https://smrb.od.nih.gov/documents/announcements/SMRB_Report_2015_FINAL_revised_508.pdf
15. Science and Engineering Indicators. NSB-2022-1, National Science Board, 2022. <https://nces.nsf.gov/indicators>
16. Science Education Partnership award (SEPA; National Institute of General Medical Sciences). <https://nihsepa.org/>
17. Tsai, J., Ucik, L., Baldwin, N., Hasslinger, C., and George, P. (2016). Race matters? Examining and rethinking race portrayal in preclinical medical education. *Academic Medicine: Journal of the Association of American Medical Colleges*, 91(7), 916–920. <https://doi.org/10.1097/ACM.0000000000001232>
18. Women, Minorities, and Persons with Disabilities in Science and Engineering. National Center for Science and Engineering Statistics (NCSES). National Science Foundation, 2021. <https://nces.nsf.gov/pubs/nsf21321/>