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Commentary

Patching the Leaks: Revitalizing and Reimagining the STEM Pipeline

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We identify problematic areas throughout the Science, Technology, Engineering and Mathematics (STEM) pipeline that perpetuate racial disparities in academia. Distinct ways to curtail these disparities include early exposure and access to resources, supportive mentoring networks and comprehensive training programs specifically for racially minoritized students and trainees at each career stage. These actions will revitalize the STEM pipeline.

INTRODUCTION

The academic "pipeline" is a metaphor used to depict the journey taken to achieve the desired career in Science, Technology, Engineering and Mathematics (STEM) fields. While we acknowledge that multiple pipelines of different shapes, forms and sizes exist in higher education, we cannot ignore the "leaks" that prevent scientists from achieving their career aspirations (Hernandez et al., 2013). Thus, STEM *still* has a diversity and retention problem. Many programs and initiatives aimed at increasing Persons Excluded from science because of Ethnicity and Race (P.E.E.R) or racially minoritized individuals have been developed, specifically aimed at Black or African Americans, Latinx or Hispanic Americans, American Indians, Alaska Natives, Native Hawaiians, and Native Pacific Islanders (Asai, 2020). Despite these initiatives to increase P.E.E.R participation, these programs often fail to meet the challenges of engaging, supporting, and empowering P.E.E.R scientists in the long-haul (Asai, 2020). Therefore, as racially minoritized scientists are disproportionally subject to falling out of the pipeline, (Libassi, 2018) we suggest ways the pipeline can be reinforced to support the next generation of scientists as they navigate this journey (Figure 1).

We will describe retention strategies that ensure P.E.E.R. scientists are successful in their field of study. As previous research demonstrates, diversity supports discovery and innovation (Hofstra et al., 2020). Therefore, it is essential to develop a research enterprise committed to bolstering intentional training and retention of P.E.E.R. trainees in STEM-related fields. Additionally, we detail mechanisms by which institutions can generate a welcoming and inclusive environment that support P.E.E.R. researchers both academically and professionally, while providing proactive encouragement, thought-provoking engagement and a willingness to create a culturally competent environment. Most importantly, we hope that institutions and allies will work together to cultivate a workforce that supports racially minoritized scientists through an inclusive, supportive and equitable environment. Here, we suggest evidence-based strategies for leaders to incorporate into their diversity and inclusion efforts, including mechanisms to provide a supportive environment, safe spaces, and how to retain a diverse scientific workforce at all stages in the academic pipeline. To this end, we use our personalized experiences to emphasize revised mechanisms that will improve the pipeline throughout each stage.

Undergraduate

As a consequence of limited systemic access to post-secondary education, many P.E.E.R students face the difficult

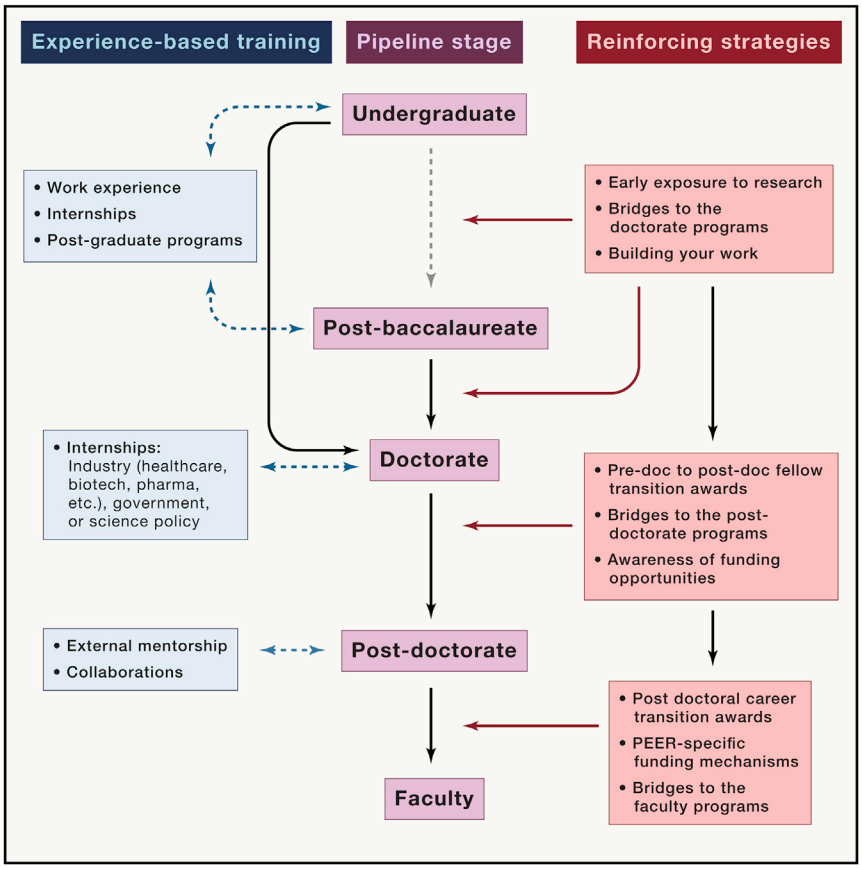

Figure 1. Diagram of a Multidimensional Academic Pipeline

In the center, we show defined training stages within the academic pipeline moving from least experienced at the top (undergraduate) to most experienced at the bottom (faculty). We depict successful progression through the pipeline as black arrows transitioning from undergraduate to the optional post baccalaureate training phase, then to the doctorate, post doctorate, and ultimately faculty phase. On the left, we represent valuable experience-based training mechanisms that the scientists can draw from without exiting the pipeline. This continuous process of receiving experience-based training is depicted as an orange dotted arrow. On the right, we demonstrate reinforcing strategies that can support the transition of trainees from one stage to the next.

challenge of being the first individual in their family and community to attend college (Estrada et al., 2016). To overcome the disparity in experience and familial college counseling, it is essential for P.E.E.R students to become integrated into the academic community as early as possible. Data collected by the National Institute of General Medical Sciences and the Howard Hughes Medical Institute illustrates a significantly less robust undergraduate pipeline for P.E.E.R students compared to White students (Estrada et al., 2016). Therefore, to improve the P.E.E.R undergraduate pipeline, we recognize the need to identify and address the barriers and failures at an institutional level. We propose several feasible solutions to enhance the STEM pipeline.

Early exposure and research training for minoritized students are key components to fuel the pipeline (Hernandez et al., 2013). Internships provide an opportunity for intensive exploration and mentorship outside of the classroom (Lane, 2016). Typically, undergraduates have access to summer research internships through selective programs, which are often conducted away from their home institution (i.e., externships) and are supported by both private and government funds (Table 1). Externships provide critical opportunities for P.E.E.Rs to improve their toolkit before entering graduate school. However, externships should not be the only opportunity for enriching STEM experiences outside the classroom. For example, P.E.E.R undergraduates should be encouraged to conduct research at their home institution (or institutional allies) during the academic year as well, and there are programs to support this (Table 1). While it is common practice to offer undergraduates research positions for course credit, paid research opportunities, such as through federal Work-Study programs in the U.S.A., should be provided as well to ensure programmatic reach to P.E.E.R.s who may otherwise seek non-STEM employment due to socioeconomic status. In addition, opportunities to present research conducted via internships or externships at conferences (Table 2) provides students exposure to other research institutions as well as experience communicating scientific research to a broad audience, which are an essential skills for success in applying to graduate school.

Strong mentoring relationships are needed for P.E.E.R.s because imposter syndrome and limited knowledge regarding the optimal strategies for acquiring extracurricular experiences of academic value (e.g., internships, co-ops), can prevent students from leaving the proverbial sink basin and truly entering the academic pipeline. However, classroom-focused approaches to identifying mentors have limited success due to the lack of time/priority and the potential lack of suitable mentors within the home institution. As such, it is advantageous for undergrads to identify mentors outside of their immediate educators, including both within and outside their home institutions (Jones-London, 2020). Developing a network of mentors, particularly with shared cultural identities and practices, encourages students to self-identify with a position of excellence and can reduce feelings of inadequacy and disconnection from the academic community (Bryson, 2020). One mechanism undergraduates may use to increase the diversity of mentors within their network is to take advantage of formalized mentoring programs (Table 2). Another method is to attend national and international professional meetings, such as the Society for Neuroscience and enroll in their Neuroscience Scholars mentoring network program. Programs such as these allow students to meet researchers from

Table 1. Resources for P.E.E.R Trainees in the STEM Pipeline

Support Programs	Links
Undergraduate	
[a]NIH T34: Bridges to the Baccalaureate Research Training Program	https://www.nigms.nih.gov/research/mechanisms/pages/bridgesbaccalaureate.aspx
Summer Research Opportunities Program (SROP)	https://www.btaa.org/resources-for/students/srop/introduction
Research Experiences for Undergraduates (REU)	https://www.nsf.gov/crssprgm/reu/reu_search.cfm
Amgen Scholars Program at [a]NIH (Amgen)	https://www.training.nih.gov/amgenscholars
Summer Undergraduate Research Fellowship (SURF)	https://www.nist.gov/surf
Summer Research Early Identification Program (SR-EIP)	https://www.theleadershipalliance.org/programs/summer-research
Alliances for Graduate Education and the Professoriate (AGEP)	https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5474
Maximizing Access to Research Careers Undergraduate Student Training in Academic Research (MARC)	https://www.nigms.nih.gov/training/marc/pages/ustarawards.aspx
Research Training Initiative for Student Enhancement (U-RISE)	https://www.nigms.nih.gov/training/RISE/
[a]NASA: Minority University Research and Education Project (MUREP)	https://www.nasa.gov/stem/murep/about/index.html
Ronald E. McNair Achievement Program (McNair)	https://mcnairscholars.com
Post-graduate	
[a]NIH T32: Bridges to the Doctorate Programs	https://www.nigms.nih.gov/research/mechanisms/pages/bridgesdoctoral.aspx
[a]NIH R25: Postbaccalaureate Research Education Program (PREP)	https://www.nigms.nih.gov/training/PREP
[a]NSF: Louis Stokes Alliances for Minority Participation (LSAMP) Bridge to the Doctorate (BD)	https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=13646
[a]NIH Postbaccalaureate Intramural Research Training Award (CRTA, Cancer Research Training Award, in the National Cancer Institute)	https://www.training.nih.gov/programs/postbac_irta
Research Training Initiative for Student Enhancement (G-RISE)	https://www.nigms.nih.gov/training/RISE/Pages/G-RISE-T32.aspx
Graduate School	
[a]NIH T32: Initiative for Maximizing Student Development (IMSD) Program	https://www.nigms.nih.gov/training/IMSD
Alfred P. Sloan Graduate Scholarship and Minority PhD Programs	http://sloanphds.org
Scientist Mentoring & Diversity Program (SMDP)	http://smdp.icpdprograms.org/
American Association for the Advancement of Science (AAAS) Science & Technology Policy Fellowships	https://www.aaas.org/programs/science-technology-policy-fellowships
Porter Physiology Development Fellowship	https://www.physiology.org/professional-development/awards/trainees/porter_fellowship?SSO=Y
Howard Hughes Medical Institute (HHMI) Gilliam Fellowships	https://www.hhmi.org/science-education/programs/gilliam-fellowships-advanced-study
High Energy Physics Center for Computational Excellence: Graduate Student Summer Internship Program (HEP-CCE)	https://hepcce.org/?page_id=2630
Department of Energy Computational Science Graduate Fellowship (DOE CSGF)	https://internships.fnal.gov/csgf/
[a]NIH Blueprint D-SPAN Award (F99/K00)	https://neuroscienceblueprint.nih.gov/nih-blueprint-d-span-award-f99k00
Graduate Fellowships in Engineering and Science (GEM)	https://internships.fnal.gov/graduate-fellowships-in-engineering-and-science-gem/
Ruth L. Kirschstein Individual Predoctoral National Research Service Award (NRSA) for MD/PhD and other Dual Degree Fellowships (F30)	https://researchtraining.nih.gov/programs/research-education/F30
Ruth L. Kirschstein National Research Service Award Individual Predoctoral Fellowship to Promote Diversity in Health-Related Research (F31)	https://researchtraining.nih.gov/programs/fellowships/F31#

(*Continued on next page*)

Table 1. *Continued*

Support Programs	Links
Research Dissertation Grant to Enhance Workforce Diversity (R36)	https://researchtraining.nih.gov/programs/research-education/r36
Postdoctoral	
Institutional Kirschstein-NRSA training program (T32)	https://researchtraining.nih.gov/programs/training-grants/T32
Ruth L. Kirschstein National Research Service Award (NRSA) Individual Postdoctoral Fellowship (F32)	https://researchtraining.nih.gov/programs/fellowships/f32
Association of Schools and Programs of Public Health/[a]EPA Environmental Health Fellowship Program	https://www.aspph.org/study/fellowships-and-internships/asppheps-environmental-health-fellowship-program/
Grass Fellowships at the Marine Biological Laboratory	https://www.mbl.edu/research/grass-foundation/fellowships/
Howard Hughes Medical Institute (HHMI) Hanna Gray Fellows Program	https://www.hhmi.org/programs/hanna-h-gray-fellows-program
E.E. Just Life Science Fellowship	https://scholarships.uncf.org/Program/Details/f96d339f-6854-4c5f-ac72-e9721eba5001
Burroughs Wellcome Fund Postdoctoral Enrichment Program	https://www.bwfund.org/grant-programs/diversity-science/postdoctoral-enrichment-program
Institutional Research and Academic Career Development Awards (IRACDA) (K12)	https://grants.nih.gov/grants/guide/pa-files/PAR-19-366.html
Career Transition Award (K22)	https://researchtraining.nih.gov/programs/career-development/k22
MOSAIC Postdoctoral Career Transition Award to Promote Diversity (K99/R00)	https://www.nigms.nih.gov/training/careerdev/Pages/MOSAIC.aspx
Ford Senior Postdoctoral Fellowship	https://sites.nationalacademies.org/pga/fordfellowships/pga_171940
Mentored Research Scientist Career Development Award (K01)	https://researchtraining.nih.gov/programs/career-development/k01#
Research Supplements to Promote Re-Entry into Biomedical and Behavioral Research Careers (Admin Supp - Clinical Trial Not Allowed)	https://orwh.od.nih.gov/career-development-education/re-entry-biomedical-research-careers
All Stages	
Research Supplements to existing [a]NIH grants to Promote Diversity in Research	https://www.nigms.nih.gov/research-training/research-training-grant-programs/high-school-programs
Minority Health and Health Disparities Research Training Program (MHRT)	https://www.nimhd.nih.gov/programs/extramural/domestic-international-research-training.html
[a]CDC Short- and Long-term Fellowships	https://www.cdc.gov/fellowships/short-term/index.html and https://www.cdc.gov/fellowships/full-time/index.html
Oak Ridge Institute for Science and Education (ORISE) Fellowships by [a]DOD and [a]FDA	https://orise.orau.gov and https://orise.orau.gov/fda/current-research-opportunities.html

[a]United States Government Institutions: Centers for Disease Control and Prevention (CDC), Department of Defense (DOD), Department of Energy (DOE), Environmental Protection Agency (EPA), Food and Drug Administration (FDA), National Aeronautics and Space Administration (NASA), National Science Foundation (NSF) and National Institute of Health (NIH).

other institutions that they may adopt as mentors.

Post-Graduate

Early exposure to scientific research is key to P.E.E.R. training success; however, for many student populations resources are the limiting factor. The post-graduate phase is a key transition within the pipeline and an opportunity for underserved minoritized students to gain the toolkit needed to tackle graduate education successfully including both scientific and communication skills. An array of post-graduate experiences including but not limited to the traditional Master's degree route and the umbrella of NIH-funded Bridges and Postbaccalaureate programs (Table 1), serve as gateways into the PhD curriculum. These initiatives are meant to provide recent undergraduates from minoritized groups in STEM-related fields a 12- to 24-month regimen of highly structured and customized career plan development. The focal points are activities, seminars, coursework, exam preparation and laboratory research experiences to enhance the participants' qualifications and preparation for graduate school.

However, postbaccalaureate programs are not all equally structured with the same ideology to train P.E.E.R scientists

Table 2. Professional Conferences and Mentoring Networks for P.E.E.R scholars.

Organizations	Links
Professional Conferences	
American Indian Science and Engineering Society (AISES)	https://conference.aises.org/about
American Physical Society (APS)	https://www.aps.org/programs/minorities/
American Society for Biochemistry and Molecular Biology (ASBMB)	https://www.asbmb.org
American Society for Cell Biology (ASCB)	https://www.ascb.org
Annual Biomedical Research Conference for Minority Students (ABRCMS)	https://www.abrcms.org
Association of American Medical Colleges (AAMC)	https://www.aamc.org
Biomedical Science Careers Program (BSCP)	https://www.bscp.org
Experimental Biology (EB)	https://experimentalbiology.org/2021/home.aspx
Gordon Research Conferences (GRC)	https://www.grc.org
Institute on Teaching and Mentoring Annual Conference	https://instituteonteachingandmentoring.org/
Minority Postdoc Conference	https://www.minoritypostdoc.org
National Association of Mathematicians (NAM)	https://www.nam-math.org
National Association of Medical Minority Educators (NAMME)	https://nammenational.org
National Conferences on Undergraduate Research (NCUR)	https://www.cur.org/what/events/students/ncur/
National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE)	https://www.nobcche.org
National Society of Black Engineers (NSBE)	https://nsbe.org/home.aspx
National Society of Black Physicists (NSBP)	https://www.nsbp.org
Society for Advancement of Chicanos/Hispanics & Native Americans in Science (SACNAS)	https://www.sacnas.org
Society for Neuroscience (SFN)	https://www.sfn.org
Society of Black Academic Surgeons (SBAS)	https://www.sbas.net
Society of Hispanic Professional Engineers (SHPE)	https://www.shpe.org
Mentoring Networks	
Advancing Minorities' Interest in Engineering (AMIE)	https://www.amiepartnerships.org
American Association of Blacks in Energy (AABE)	https://www.aabe.org
Association of American Indian Physicians (AAIP)	https://www.aaip.org
Blacks In Technology (BIT)	https://www.blacksintechnology.net
Minorities in Agriculture, Natural Resources & Related Sciences (MANRRS)	https://www.manrrs.org
National Action Council Minorities in Engineering (NACME)	https://www.nacme.org
National Association of Black Geologists and Geophysicists (NABGG)	http://www.nabg-us.org
National Hispanic Health Foundation (NHHF)	https://www.nhmafoundation.org
National Hispanic Science Network (NHAN)	https://www.the-nhsn.org
National Institute of Health's National Research Mentoring Network (NRMN)	https://nrmnet.net/about-nrmn-2/
Neuroscience Scholars Program (NSP)	https://www.sfn.org/initiatives/diversity-initiatives/neuroscience-scholars-program
Sloan Scholars Mentoring Network (SSMN)	https://www.ssrc.org/programs/view/sloan-scholars-mentoring-network/

to be successful. Some postbaccalaureate programs are unaware of the novel approaches and pragmatic solutions that would level the playing field for minoritized scholars at this career stage. Therefore, a specified paradigm is critical to facilitating the success of minoritized scholars during this phase. There are both potential benefits and pitfalls for the post-graduate phase. The PREP and Bridges programs organically provide a community to help minoritized scholars to thrive (Table 1). For example, by incorporating cohorts of P.E.E.R graduate trainees into shared resource programs at research institutions. This effort is fulfilled through a weekly journal club, which becomes the basis for maintaining cohesion in the graduate community through recruitment and retention initiatives. The weekly journal club serves as a safe space for minoritized scholars to seek peer guidance on presentations, troubleshooting experiments, and dealing with unexpected dilemmas. However, these types of programs can also be wasted efforts if not intentional and genuine in pursuit. Of key importance are avoiding both the savior and dismissive mentalities toward developing P.E.E.R. scholars. It is

also essential to have the ability to identify students who would benefit from this program, versus fulfilling institutionalized quota. Scientific trauma can arise from a bad or unfruitful research experience during this phase—so it's imperative to have personalized experiences for PREP and Bridges students to thrive in the STEM pipeline.

It is also essential to keep in mind that most postbaccalaureate programs offer research experience, contrary to a Master's program. In the United States, the misconception that a master's degree is required to pursue advanced research training is strikingly prevalent among P.E.E.R communities in STEM (Hodapp and Woodle, 2017). Primary investigators must actively work to erase this stigma. Although a postbaccalaureate is not associated with a terminal degree, this is potentially a more favorable option to gain advanced training. The benefits of a postbaccalaureate program include but are not limited to increasing one's maturity, scientific investigation exposure, gaining new knowledge and simultaneously applying what's being taught to the bench—which is key to thriving in graduate school. However, getting into a postbaccalaureate or Master's program is not always feasible or warranted due to economic hardships. Becoming a lab technician may be the best alternative move to gain experience, exposure and resources. Most importantly, working as a lab technician provides financial stability, avoids school loans, and provides research experience which may result in a publication. All of this is harder to achieve in specialized programs.

Taken together, this phase of the pipeline can be summarized as the time in which students are thrown into the pool with a life jacket and taught to swim before their doctoral phase begins. Thus, matching the student with the right opportunity can launch the successful trajectory of a young trainee's career.

Graduate School

Starting a doctoral program is possibly the most challenging transition within the academic pipeline because students must acclimate to a new scientific community while navigating a frequently unfamiliar academic process. Further complicating this situation are the lack of support structures available to incoming P.E.E.R graduate students (Stachl and Baranger, 2020). The main components of a doctoral program that directly contribute to the success of the individual are: **(1)** awareness of funding opportunities, **(2)** high-quality constructive (active) mentoring, **(3)** a personal support community compromised of strong scientific influencers, and **(4)** comprehensive scientific training and professional development. Within these four areas, there are strategies that can be employed by mentors and institutions to retain P.E.E.R graduate students so they are well-supported, valued, and adequately prepared for the next steps in their academic career.

The responsibility of identifying funding opportunities should be shared between the mentor-mentee and doctoral program administration. While fellowship opportunities have been created specifically to broaden P.E.E.R participation in STEM, securing independent funding should never be a requirement for admission to or completion of a PhD program. Such pressure can be internalized and cause undue stress that may manifest as anxiety, a diminished sense of identity and self-worth and an overall feeling of being used for minoritized status.

Students with their own funding (or who are eligible for NIH Diversity supplements) may absorb the view that their value expires when their funding expires, particularly if the student receives little in the way of mentorship and scientific development or their funds are used for general lab supplies. It is critical to dedicate these funds for P.E.E.R. career development and advancement, as this encourages the student to seek further funding and become a more attractive candidate for advanced positions (Jones-London, 2020). Furthermore, students who successfully earn funding reflect positively upon the University and their training mentor. Many NIH grants for PIs and Institutions require disclosure of trainee outcomes. Therefore, having students who have successfully obtained and directed the use of their own funding can aid in the success of obtaining more institutional funding for P.E.E.R trainees.

A supportive community of family, friends, mentors, colleagues and especially faculty that P.E.E.R. students can identify with, are key in creating an atmosphere of encouragement and advocacy on their behalf. Often, students experience personal and scientific struggles during the course of their graduate career. During trying times, it is critical to have a support system invested in the student. To support the well-being of P.E.E.R trainees, mentors should encourage participation in tailored support systems, (Stachl and Baranger, 2020) (Tables 1 and 2). Encouraging mentees to seek additional support will expand their current reach, establishing a structured community. Participation and engagement in activities specifically tailored for training and mentoring minoritized students are critical for P.E.E.R. career development.

In addition, there are many opportunities for P.E.E.R students to extend beyond their research scope, which can come from internships in healthcare and science policy (Table 1). All of these enable them to gain exposure to social justice experiences. Internships outside of the Academy often appeal to P.E.E.R trainees as they provide avenues to concretely engage in activities which address matters that disproportionately impact their communities (Estrada et al., 2016).

Postdoctoral

Postdoctoral scholars are at an incredibly vulnerable stage in their careers (Lambert et al., 2020) where they are often the only P.E.E.R scientist in a given research environment (Andrianantoandro, 2020). According to a recent NSF survey, only 2.9% of STEM postdoctoral trainees identified as Hispanic, 1.7% as African American, 0.1% as American Indian or Alaska Native and 0.1% as Native Hawaiian or Other Pacific Islander (NCSES Survey of Graduate Students and Postdoctorates in Science and Engineering (GSS), 2018). Postdoctoral training supports the acquisition of specialized knowledge and skills to enable scientists to achieve independence before launching into their next career stage. However, the imbalanced composition of the postdoctoral landscape can isolate P.E.E.R fellows and diminish their postdoctoral productivity. As such, in order to maximize the postdoctoral experience, P.E.E.R postdoctoral scholars must receive mentorship and sponsorship that demonstrates that

fellows are highly valued members of the scientific community.

To ensure a diverse population of scientists at the postdoctoral stage, mentors must be intentional in sponsoring and advocating for racially minoritized scholars. Formalized infrastructure must be in place when the scholar arrives to provide training and community support, while integrating the postdoctoral fellow into the academic research environment to support the success of the scholar (Gibbs et al., 2016). T32 and IRACDA (K-12) institutional programs support postdoctoral fellows in research and pedagogy, yet these programs are not specifically tailored for P.E.E.R scholars (Table 1). For this reason, we propose that institutions generate P.E.E.R-specific postdoctoral training grants and enable fellows to apply for such funding on a rolling basis. Within this proposed program, departments would provide formal training tailored to minoritized individuals in professional development pertinent to achieving an academic career. These training grants should require fellows to generate a mentoring committee composed of their department chair, senior faculty members and their main mentor- all of whom can provide additional scientific expertise and objective oversight of their research plan. Training would also include guidance on scientific and grant writing, applying for faculty positions, preparing for interviews and negotiating job offers, which is often particularly difficult for P.E.E.R scholars who have proceeded through academic life undervalued by institutions and their peers. Our proposed program would enable fellows to be fully engaged and integrated into the scientific community. We strongly believe that this type of training environment will promote the success of P.E.E.R postdoctoral fellows in the early phase of their training, while working to build the support community required for them to launch their research career.

Furthermore, we propose a new model by which institutions can increase their P.E.E.R representation at the faculty level by integrating current senior postdoctoral fellows into a ''Bridge-to-Faculty'' program at their postdoctoral institutions. Ideally, institutions would dedicate funds toward a set number of faculty positions for participants in this program. The structure of this program would be similar to the NIH K99/R00 MOSAIC Pathway to Independence Award, the HHMI Hanna Gray Fellows Program, the E.E. Just Life Science Fellowship, the Ford Senior Postdoctoral Fellowship and the Burroughs Wellcome Fund Postdoctoral Enrichment Program (Table 1). In our proposed program, senior postdocs would be given additional mentor training for 1-2 years and provided ''start-up'' funding mechanisms by their home institutions to support their independent research program. Eligibility for this program would be based on years of postdoctoral experience and would especially support P.E.E.R. scientists with unconventional career trajectories, while also taking any lapses in postdoctoral training into consideration, such as parental- or dependent-care leave. As a participants in this program, postdocs would gain access to additional mentorship via a senior-mentoring committee team, with departmental oversight, and through involvement and engagement in faculty meetings. They would learn how to manage a lab and budget, allowing P.E.E.R. scientists to get acquainted with the academic faculty environment. This unique opportunity would provide an institution with the ability to invest in P.E.E.R postdoctoral scholars, who may ultimately become tenured-faculty members.

CONCLUSION

Successful matriculation through the academic pipeline depends on moving variables and conquering uncharted terrain for many minoritized scientists. There is not a specific formula nor universal approach that can prevent the leakiness of the pipeline. However, intentional and personalized direction, exposure, opportunities and guidance to P.E.E.R trainees throughout each stage of the pipeline will support the trajectory of scholars' career endeavors. To ensure the impactful and high-quality demands for scientific research are met, it is quintessential to have an inclusive scientific table of independent investigators represented by every race, creed, nationality and background. Representation at the investigator and leadership level across academic, government and industrial sectors is the key component and ingredient for properly increasing diversity to revitalize the scientific pipeline.

Innovative and outside the box thinking will ultimately patch the leaks. As an example of a holistic approach to revamping the pipeline, we encourage and recommend that home research-intensive institutions develop an internal ''bridge program'' where minoritized scholars can matriculate through the pipeline from undergraduate into their postdoctoral appointment and ultimately faculty position—thus allowing the student to fully re-engage with a course of action. The ''leak'' of minoritized students during the undergraduate stage often occurs because they are the first generation to attend college from their families and communities. Unfortunately, this hurdle challenges the scientific rigor often encountered in undergraduate institutions. Students who once majored in the sciences may find themselves performing below average overall by the end of their senior year. Instead of applying to a post-baccalaureate program, the student should have the opportunity to enroll at the home institution through this initiative as an opportunity to regain redemption. The home institution provides the opportunity for the student to participate in Master's level courses and conduct research. All of which can be later used toward credit for classes and an early start on what could potentially be their thesis PhD project. In addition to this, minimum research exposure is the limiting factor for succeeding at the graduate level; therefore, this mechanism can rectify the level and depth of scientific investigation. After successfully completing the Master's phase, the student would have the choice and ability to enroll in graduate school in-house or at other institutions. This proposed mechanism enables us to meet the challenges of an ever-changing world—diverse voices together will help shape research priorities and academic medicine broadly moving forward in the 21st century. Accordingly, it's wise for us to take what we have learned about the pipeline and apply what can be improved while considering what should be avoided in the future to build and revitalize a structure that fosters scientific discovery.

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