



PERSPECTIVE: DIVERSITY, EQUITY, AND INCLUSION IN BIOTECHNOLOGY

Revolutionizing Postdoctoral Training Using the Social Ecological Model: Insights and Experiences from the Propel Scholars

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Abstract

The dissatisfaction within the postdoctoral training phase has led to the drastic reduction in the number of U.S. citizens pursuing postdoctoral positions within the biological and biomedical sciences fields. Even more so, there is an obvious disparity in not only the recruitment but the retention among underrepresented groups to pursue careers as academic scientists. The proposed social-ecological model and National Institute of Health advisory committee suggests reforming the postdoctoral training phase to overcome these downward trends and disparities. Importantly, some programs like the Stanford Propel Postdoctoral Program were integrating this framework and recommendations without knowledge that they would be released 2 years later. The goal of the Propel Program is to provide social, cohort, financial, and institutional support to diverse cohorts of postdoctoral trainee to diversify the professoriate. Within this piece, several of the Propel scholars come together to provide their perspectives on how the Propel Program has benefited their postdoctoral training experience.

The academic scientific community is at a crossroads where doctoral graduates entering into postdoctoral positions with the goal of an academic faculty position has decreased. Previous documentation has consolidated the dissatisfaction with the postdoctoral experience observed over the past 5 years.¹ Most recently, the data from the U.S. National Science Foundation indicate a significant decrease in the number of postdoctoral researchers from American backgrounds, particularly in the fields of biological and biomedical sciences.^{2,3} Postdoctoral scholars are opting out of academic faculty positions due to better-paying opportunities in biotechnology and pharmaceutical industries, uncompetitive postdoctoral salaries in many metropolitan areas where prestigious institutions are located, mentorship challenges, and a scarcity of faculty positions.

The largest gap in postdoctoral trainee retention for science, technology, engineering, and mathematics (STEM) disciplines are among American Indian or Alaska Native, Black, and Latinx groups (ordered by magnitude of underrepresentation), due to historical and ongoing structural racism (National Center for Science and Engineering Statistics, 2023). Recently, Gangrade

et al. provided substantial advice and recommendations for a multifaceted comprehensive reform for supporting postdoctoral trainees to combat the logical and competitive choice against private sector alternatives.⁴ The structural changes outlined by Gangrade and colleagues (Fig. 1) draw from the social ecological model and include: (1) mentorship training for postdoctoral scholars; (2) innovative mentor selection techniques; (3) cohort models for enhanced support; (4) empowering the postdoctoral office; (5) policy level—leveraging funding agencies.⁴ At the policy level, the National Institute of Health (NIH) created an advisory committee to provide a report on re-envisioning NIH-supported postdoctoral training.

In December 2023, the NIH committee offered six suggestions as follows (Fig. 1): (1) increase pay and benefits for all NIH-supported postdoctoral scholars; (2) create and expand mechanisms to support the full talent pool of postdoctoral scholars; (3) facilitate the transition of postdoctoral scholars into their next career stage, including roles beyond academic faculty; (4) promote training and professional development of postdoctoral scholars and their mentors; (5) support safe and diverse

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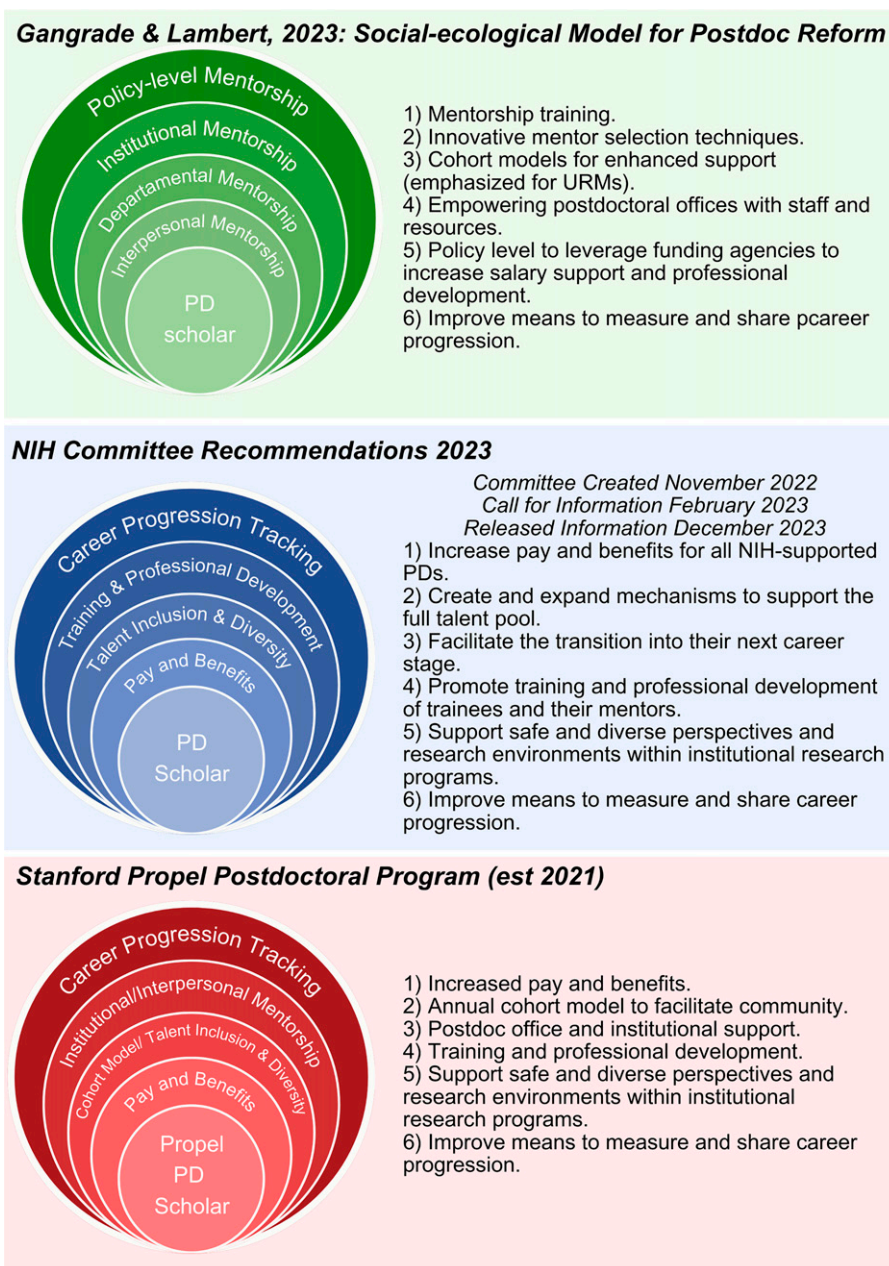


FIG. 1. Postdoctoral Training Reform and Propel Program.

Summary of the overlap between the suggested criteria by Gangrade and colleagues, NIH 2023 recommendation for postdoctoral reform, and the existing framework of the Stanford Propel Program. Abbreviations: URMs underrepresented minorities; PD postdoc or postdoctoral; NIH National Institutes of Health.

perspectives and research environments within institutional research programs; and (6) improve means to measure and share postdoctoral scholars' career progression. Overall, these six suggestions summarize the reasons for the postdoctoral shortage workforce; however, there remains institutional measures to be incorporated that can change the postdoctoral experience.

NIH Advisory Report on Re-envision NIH-Supported Postdoctoral Training.⁵

To enhance the growth and success of postdoctoral trainees aiming for academic faculty roles, it is crucial to adopt innovative solutions aligned with the social-ecological model and NIH recommendations for training reform. The social ecological model is a strong framework since it takes a holistic approach in bettering postdoctoral training from mentorship training for academic researchers, incorporating cohort models for postdoctoral trainees, and even advocating for policy level changes such as

increasing salary support. Importantly, the social-ecological model is a promising approach that fulfils the dissatisfaction that postdoctoral trainees have expressed over the two decades. Stanford University School of Medicine's Propel Postdoctoral Scholars Program (founded in 2021) had already implemented multiple aspects of the described social ecological model and NIH recommendations to restructure postdoctoral training with the goal of broadly diversifying the professoriate (Fig. 2).

In this article, we describe the Propel Program framework as a model that other institutions can adopt for a holistic and targeted approach to substantively revolutionize postdoctoral training. The objective of this article is to highlight the importance of postdoctoral programs that integrate the social-ecological model and NIH committee recommendations. To accomplish this, we present first-hand narratives from Propel scholars, offering qualitative insights into the lasting effects of transforming the postdoctoral training phase at an individual level. Following the collection of the experiences of the Propel scholars included in this article, we identified the patterns across the individual narratives that overlap with the social-ecological model and NIH recommendations. Utilizing a thematic approach for the overlap between the narratives provides a logical flow of the characteristics of the Propel Program in retaining diverse postdoctoral trainees and preparing them to enter academia as the next generation of researchers, advisors, and teachers.

Stanford's Propel Postdoctoral Scholars' Program and Framework

The mission of the Stanford Propel Postdoctoral Program (Propel, est. 2021) is to recruit and develop a distinguished group of postdoctoral scholars at Stanford to build an inclusive, diverse, and equitable professoriate. Propel has the following three core foundations (Table 1): (1) building strong community and support; (2) providing career and professional development opportunities to enrich the postdoctoral experience and preparation for an academic faculty position; and (3) resources to support scholar stipends, networking, and other relevant opportunities. Propel seeks to address many of the critical needs that all postdoctoral scholars face and the strong discrepancy for underrepresented postdoctoral scholars who face these problems at a greater rate.⁶ The framework of Propel is unique as it includes both social and institutional support for diverse and underrepresented scholars for 2 years that overlap with the published social-ecological model and NIH recommendations (Fig. 1).

Core principle 1: building strong community and support with recruitment and selection

Since its inauguration, Propel incorporated an application and interview process to select scholars who are strong candidates for support and are highly motivated to pursue academic faculty positions. The interview process for the Stanford Propel Program stands out for its commitment to fostering diversity, supporting underrepresented trainees, and supporting trainees in related endeavors. The interview process adopts a holistic approach by incorporating questions that go beyond research. These include inquiries about how trainees have overcome obstacles, their

perspectives on belonging, and their motivations for pursuing a career in academic research. With this approach, Propel and the Stanford Office of Postdoctoral Affairs can recruit a diverse cohort of scholars that will contribute to a strong community support system for each other despite their different backgrounds and research expertises but all with career objectives—to establish an independent research career within academia.

Core principle 2: providing career and professional development opportunities to prepare for academic faculty positions

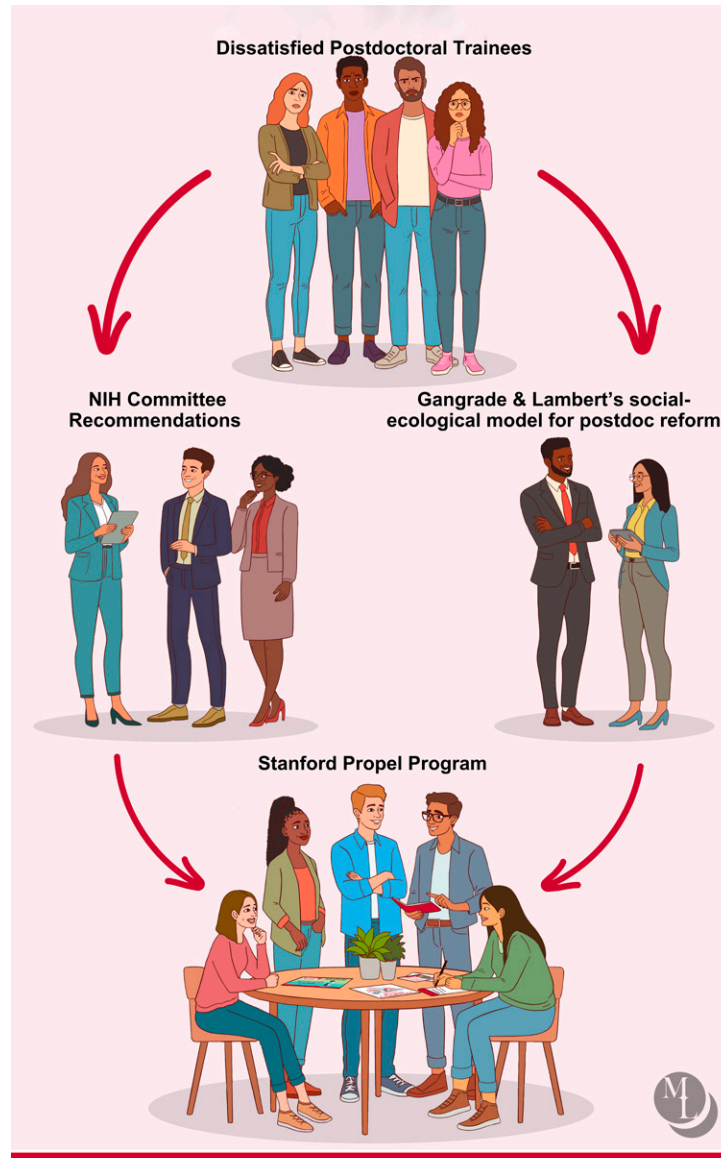
Propel's community-building is a cornerstone of its framework for career and professional development. Each Tuesday, scholars are asked to reserve 12–1 PM as "Propel Time." Frequent luncheons provide a regular platform for scholars to come together, share experiences, and establish connections across diverse backgrounds. Occasionally, these meetings feature guests, including recent Stanford faculty hires from diverse backgrounds, who share their experiences and perspectives on establishing an independent research program. These informal sessions allow scholars to ask candid questions about their career paths. In the fall, these luncheons are combined with dedicated sessions with the Stanford Grant Writing Academy, helping scholars prepare fellowship applications. Propel scholars are required to submit at least one external fellowship application in their first year, and these sessions provide guidance, structure, and help cultivate grant-writing skills early in their careers. Propel scholars have been successful in receiving competitive awards, including Howard Hughes Medical Institute (HHMI) Hanna H. Grey fellowships, NIH K99/R00 career development awards, and Burroughs Wellcome Fund CareerTransitional Fellowships and Postdoctoral Development Enrichment Awards.

Core principle 3: resources to support scholar stipends, networking, and other relevant opportunities

The Propel Program offers a competitive annual salary of \$84,000 (higher than the institutional minimum and NIH recommendation for postdoctoral trainees) and comprehensive health care benefits. Additionally, Propel scholars receive \$5,000 for supplementary funds (per year) for professional development to cover areas for which the primary advisor may not typically allocate funds. This approach thoughtfully addresses the unique needs of postdoctoral scholars, providing them with early independence in their research endeavors and enabling them to explore opportunities that align with their personal career goals and development. Propel also organizes an annual retreat for scholars, featuring invited speakers, time for reflection, community building, and professional development sessions. The retreat contributes to a holistic learning environment and offers valuable insights from accomplished individuals in various fields.

Institutional support for the Propel Program

The presence of dedicated staff from the Office of Postdoctoral Affairs and the Propel faculty advisor underscores the Program's commitment to ensuring the success and well-being of



Stanford Propel Program integrates the social-ecological model and NIH committee recommendations.



1. **Enhances** the postdoctoral experience with a focus on the biomedical field
2. **Support** and appreciate an array of diversity
3. **Create** mechanisms to overcome systemic barriers for those historically excluded from STEM
4. **Supplementary** training for careers outside of academia
5. **Overcome** the unprecedented shortage of postdoctoral trainees

- Structure:**
- Builds a bridge between the predocs, PDs, and academic landscape for restructuring
- Improved:**
- Pay & benefits
 - Institutional support
 - Policy support
 - Mentor training
 - Mentee training
 - Accountability measures
- Support diversity and inclusion:**
- Historically marginalized communities for race/ethnicity in the U.S.
 - Families
 - International trainees

FIG. 2. Strategies to Enhance the Postdoctoral Experience.

Improving the postdoctoral training phase in the biomedical field by emphasizing diversity support, overcoming systemic barriers, providing supplementary career training, and addressing the postdoctoral shortage. Key structural improvements include building connections between predoctoral students, postdoctoral scholars, and the academic landscape, as well as restructuring outdated systems. Enhancements in pay, benefits, institutional and policy support, mentor and mentee training, and accountability measures are essential. Additionally, the figure highlights the importance of inclusivity and support for historically marginalized communities, families, and international trainees.

Table 1. Summarizing Stanford’s Propel Postdoctoral Scholars’ Program and framework to showcase its overlap between the social-ecological model and NIH recommendations

<i>Propel core principle:</i>	<i>Propel specifics:</i>
<u>Core principle 1:</u> Building strong community and support with recruitment and selection	<ul style="list-style-type: none">• Written applications between interested scholar and chosen faculty mentor in the school of medicine• Holistic interview incorporating personalized questions based on experiences• Tailored questions regarding belonging and inclusivity• Emphasis on pursuing a career in academia and why they are highly motivated to pursue academic faculty positions
<u>Core principle 2:</u> Providing career and professional development opportunities to prepare for academic faculty positions	<ul style="list-style-type: none">• Propel meetings for professional development and networking between scholars• Propel meetings with newly hired assistant professors organized as a round table discussion• Propel frequent luncheons provide a regular platform for scholars to come together• Writing retreats, writing focused groups, and Stanford Grant Writing Academy presentations, Propel scholars are required to submit one fellowship application in their first year
<u>Core principle 3:</u> Provide resources to support scholar stipends, networking, and other relevant opportunities	<ul style="list-style-type: none">• \$84,000 salary (above institutional minimum and NIH recommendation)• \$5,000 professional development funds to use for opportunities that do not directly align with each scholar’s laboratory focus• Annual retreat with community building and speakers
<u>Institutional support:</u> Stanford Office of Postdoctoral Affairs and a Propel faculty advisor	<ul style="list-style-type: none">• Dedicated staff member from the Office of Postdoctoral Affairs that organize all effects to reduce post-doctoral burden of building independent communities• Propel faculty advisor who attends events and gives guidance on pursuing an academic career• Regular individual check-ins with staff and advisor

NIH, National Institute of Health.

postdoctoral scholars by efficiently managing logistical aspects, which reduces the Propel scholars’ need to organize these events themselves, unlike affinity groups. Propel personnel support includes a full-time Office of Postdoctoral Affairs staff member, Mr. Joshua Rebello, who serves as the Propel Program Manager. Dr. Sharon Pitteri (Associate Professor, Radiology) also serves as the Propel faculty advisor, adding a crucial mentorship component to the program. Regular check-ins with each scholar reflect a genuine interest in their progress and well-being, contributing to a supportive and enriching academic experience. The Propel faculty advisor provides additional mentorship and guidance to scholars, helps when scholars navigate difficult situations, and provides follow-ups tailored to individual scholars’ needs. Propel’s framework is comprehensive in its offerings and attentive to the unique needs and aspirations of cohorts, creating a truly inclusive and empowering environment for postdoctoral development. The collection of experiences from the Propel scholars/authors highlight the importance of a holistic framework in supporting postdoctoral trainees.

Stanford Propel Scholar’s First-Hand Experiences in This Novel and Unique Cohort Model
Theme 1: Financial alleviations for personal and scientific support

E.A.V.—support for families and policy implementations to enhance the postdoctoral experience. I am a first-generation Ph.D. recipient and currently a second-year Propel Postdoctoral Scholar who has benefited from the program mentally, financially, and professionally. In a capitalistic society, an individual’s income can be tied to their self-worth and respect for themselves. With many postdoctoral trainees at an age to either have or start a family, coupled with the average national postdoctoral trainee salary at \$56K, where ~ 35% of

this going to housing alone, it is no surprise that academic postdoctoral trainees are transitioning to biotech and industry. However, programs like Propel, which supports trainees for 2 years at ~\$80K/year, are a way to retain talented scientists. Personally, Propel has taught me not only to value myself more as a scientist because of the relatively high wage but also to have the freedom to control my time. As a family man, this allows me to structure my time to balance being a dedicated father and an influential scientist. Additionally, the \$5K supplemental funds will enable me to foster my professional development by covering the cost of bioinformatics courses and conference travel expenses, which are instrumental for my transitioning as an independent investigator.

There have been calls to increase the postdoctoral trainee starting salary to \$70K. I agree with this pay increase; however, I also recommend incorporating a cost-of-living adjustment into this calculation depending on location and inflation. But then the question becomes, “How can this pay increase be accommodated?” In 2022, the U.S. federal government collected \$5.03 trillion in revenue, where \$45B was allocated to NIH and \$877B to the military, making up 0.9% and 18% of the total budget, respectively. That same year, the direct economic benefit of NIH-funded research was nearly \$100 billion, more than doubling what went into the system. If policymakers, such as those in Congress, allocated federal taxpayer dollars to NIH that matches the amount of economic activity the funding agency generated from the year before (in this case, \$100B), this amount can easily accommodate the proposed pay increase plus more. It is crucial to maintain and increase the number of academic postdoctoral trainees and promote a diverse professoriate for the United States.

C. A. Headley—an innovative landscape for skill development and diverse career preparation. My perspective is that an academic research career provides intellectual freedom

that I would be hard-pressed to find elsewhere. Unfortunately, the current pathways toward attaining this freedom, often in the form of a tenure-track professorship, are confounded by the false guise of scientific meritocracy and the often-blattant racism, sexism, and gatekeeping.^{7–10} Like most underrepresented groups in science, I have always been aware of the flawed and precarious foundations upon which our academic institutions stand. Despite being fully aware of the systemic challenges that resemble a “clearly lit dumpster fire,” my romantic idealism, an insatiable curiosity toward understanding the human condition, and hypomanic tendencies are what continually propel me toward this career choice. In this context, Stanford’s Propel Postdoctoral traineeship has been like my fire academy: a transformative experience that has significantly improved my interdisciplinary scientific acumen and my steadfast commitment to diversifying the research landscape.

At the postdoctoral level, where there are far fewer funding opportunities for high-risk/disruptive science,^{11,12} Propel’s financial support was a game-changer for my research interests. Propel’s monetary support granted me the liberty, resources, and time to pursue groundbreaking work in mitochondrial transplantation within the immune-cardiovascular axis.^{13,14} The significant outcomes have led to new collaborations, provisional patents, publications, and further funding opportunities. While my primary goal has always been to become a tenure-track principal investigator, it would be unwise not to acknowledge that my research interests may divert my career toward creating a “spin-off” company or that my advocacy goals might lead me toward roles within the federal government or nonprofit entities. Propel has prepared me for these possibilities, enabling me to engage in research lobbying, attend professional development workshops, mentor students, identify new mentors for my needs, and participate in various conferences and meetings.

As echoed by other scholars, the Propel community fostered an environment where I felt an immediate sense of belonging. The regular lunch meetups, dinners, and hangouts throughout the year were more than just social events; they were opportunities for me and my peers to share our experiences, challenges, and triumphs. In conclusion, the Propel Fellowship has been a defining chapter in my academic journey. Propel has allowed me to grow as a researcher, mentor, and advocate and is directly building a foundation for a more equitable and diverse scientific community.

Theme 2: Cohort model and community building

C. A. Hayes—a story of triumph and navigating change. As a Black male and the first in my family to graduate from college, the journey from the rural South to the esteemed grounds of Stanford University was nothing short of transformative. The anticipation of navigating the high-pressure environment and esteemed institution came tinged with anxiety, expecting the looming presence of imposter syndrome. While this apprehension did not fully materialize, other challenges emerged, underscoring the pivotal role of programs like Propel in shaping a positive postdoctoral experience. One of the initial hurdles

was the stark sense of isolation. Being the only Black postdoctoral scholar in my department accentuated the need for a supportive community. Propel, with its innovative cohort experience, became a lifeline. Weekly meetups with fellow postdoctoral trainees provided a sense of camaraderie and a platform to share experiences and insights, fostering a supportive environment that transcended the isolation I initially felt. The laboratory fit, a critical aspect of the postdoctoral journey, posed another challenge. Propel’s unique approach allowed me to collaborate with two other postdoctoral trainees on a research project, providing a collaborative and constructive outlet with my peers to combine our research interests into an article proposal. Propel’s leadership and the Office of Postdoctoral Affairs stood firmly in support when the need arose to switch labs. This level of personalized assistance is rare in the postdoctoral landscape, where individuals often find themselves navigating such transitions in isolation.

As a parent, I find the flexibility to enjoy an increased salary and access supplemental funds transformative. Propel’s commitment to not limiting applications for additional funds expanded my opportunities for professional development, including conferences and resources that I use for my research but may not be widely applicable to other lab members. The collaborative spirit within Propel extended to the application process itself, with fellow postdoctoral trainees sharing insights and documents during the fellowship cycles for the NIH K99/R00 Transition to Independence, Burroughs Wellcome Fund Postdoctoral Diversity Enrichment Program, Career Awards at the Scientific Interface, and HHMI Hanna H. Gray Fellows Program. This collaborative approach eased the logistical aspects and provided a wealth of perspectives on navigating the intricate web of institutional processes regarding fellowships and external funding mechanisms. My experience as a Propel postdoctoral scholar has been instrumental in reshaping the narrative of my postdoctoral journey. The program’s commitment to inclusivity, support, and personalized guidance has alleviated challenges and empowered me to thrive in an environment that initially seemed daunting. Propel is a functioning example illustrating the transformative impact of strategic and supportive postdoctoral programs.

J.F.M.—empowering choices and community support with expanded inclusion criteria. Propel has been transformative since my interaction with their staff during the application process. As a Deferred Action for Childhood Arrivals (DACA) recipient, some postdoctoral training opportunities have been off limits for me if they are restricted to only U.S. citizens. I was pleased to see the Propel Program outwardly indicate that DACA recipients were eligible to apply for the opportunity. Further, I did not shy away from sharing my background as a Mexican immigrant who is also a first-generation college student who grew up in poverty in my application materials. The application process and the selection of the cohort showed me that the Propel Program valued, embraced, and accepted diversity across intersectional social identities. The program model in this postdoctoral program reminded me of the values embraced by

a cohort leadership program I was selected to participate in during my doctoral studies. I was a part of the inaugural cohort of the Health Policy Research Scholars Program by the Robert Wood Johnson Foundation. This cohort of doctoral students in different disciplines across the United States soon became a family and a source of support and community during a time of much stress.

Other structural elements of the Propel Program help make it an ideal postdoctoral environment. For one, I could choose a faculty mentor from the onset. My faculty mentor has become an immense source of support and guidance. The Propel Program also has no teaching responsibilities like other postdoctoral trainees in my discipline (sociology). This allows me to have a near-to-total focus on research, publications, conferences, and the job market. Having the space to focus on the outcomes often highly valued by top research universities has been freeing. Finally, the sense of community within my Propel cohort has helped me feel less isolated. Postdoctoral opportunities often force individuals to move to new places. Having a cohort has provided me with a community of support. I have leaned on this community for support on grant writing, professional advice, and even leisure activities like soccer.

A.C.V.—building a psychosocial sense of community for postdoctoral retention. As a first-generation student growing up in an area where scientific careers were anomalies, I never would have imagined myself in a position geared toward the academic professoriate. At all points of my educational training, I have been fortunate to find supportive groups that have fostered my science identity and research self-efficacy. A common theme I found among these programs that helped shape the development of my identity as a scientist was a social structure built on a cohort model for enhanced support. At the undergraduate level, I was part of the Meyerhoff Scholars Program at the University of Maryland, Baltimore County, which focuses on supporting minority undergraduates to pursue graduate studies through comprehensive STEM intervention programs.¹⁵ In graduate school, I joined a mid-sized cohort of individuals in an umbrella program focused on broad biomedical sciences training with built-in individual, interpersonal, and institutional support. One of the issues with the postdoctoral career phase is that trainees join asynchronously throughout the calendar year with a formal structure coming only from their home lab. In many cases, it is up to the individual to figure out how to manage the stressful transition from PhD to postdoctoral trainee, which can be an isolating experience.

Like the two programs mentioned above, the Propel Program has a built-in social structure that provides the necessary resources and support system for postdoctoral trainees interested in academia. In addition to what others have mentioned, what I have found particularly helpful that I could not find in my home lab was having a comradely postdoctoral cohort with similar career goals and, importantly, dedicated staff from the postdoctoral office to help us make informed and strategic decisions about career-related topics. This

created a psychological sense of community that strengthened my perception of becoming a professor and created a greater sense of belonging in academia by connecting me with fellow postdoctoral trainees and investigators from different backgrounds and career stages. More academic institutions should adopt the social-ecological model, a model that has been shown effective at the undergraduate level¹⁶ and one that many postdoctoral programs and institutions should embrace to recruit and retain postdoctoral trainees in academia.

Theme 3: Institutional support for postdoctoral trainees

A.R.N.—Propel overcomes affirmative action changes for underrepresented postdoctoral scholars. I was very optimistic and excited to receive an offer for a postdoctoral position at Stanford. This optimism was also met with uncertainty and a lingering sense of imposter syndrome that I now understand as common among underrepresented minorities (URMs) within the academic sphere. Looking back, college seemed like a distant, unobtainable goal, but I persevered and became a first-generation college graduate. My experience with Propel has been transformational through my cohort's diverse community of fellow trainees. Propel has been a direct solution to the problem of continued isolation of trainees who are the "one and only" representative race in their department. Propel has sought to address this by providing trainees regular opportunities to interact with mentors of diverse identities. This is of utmost importance for the career advancement and retention of women and URMs in academia.¹⁷ An integral part of the Propel fellowship is the regular community gathering events to circumvent the isolation and provide a network of collaboration and friendship among peers. In this context, trainees can experience support from a diverse cohort of individuals with different backgrounds, but they often experience similar challenges and barriers within academia.

Another critical aspect of Propel is the additional funds provided for research independence. These funds can be allocated toward trainee professional development, acquiring additional research skills, attending international conferences, and visiting labs, to name a few possibilities. This can be a way to level the field and facilitate postdoctoral trainees' transition to faculty positions in academia.

The recent Supreme Court ruling against using race as a factor for admissions has effectively gutted decades of efforts to make academia more equitable and just. It is a significant barrier for academic institutions that struggle to increase diversity and inclusion among historically excluded women and URMs. Moreover, it threatens other forms of diversity, both visible and invisible, that are shared across all demographics. Now more than ever, postdoctoral fellowships and cohort recruitment/retention models like Propel are needed to provide a mechanism for diverse populations to be not only represented in academia but also retained.

K.C.G.—incorporating safeguards for training at the postdoctoral level. Growing up in south Texas, a career in academic science was never discussed as a viable option. Moreover, I had little opportunity or adequate resources regarding career paths within the biomedical sciences to explore. It was not until college that I learned about scientific research and that graduate education in the biomedical sciences provides tuition and salary support. What surprised me was that I was not alone when discovering this. Many of my peers who fall within an ethnically underrepresented/disadvantaged background were unaware of this fact. I realized that this was one of the many contributors to the lack of diversity in the professoriate.

At the graduate level, many safeguards are put in place (e.g., thesis committees) that ensure one's success in completing a doctoral degree. In some cases, committees can intervene when mentor–mentee conflicts occur. Another requirement that contributes to a successful graduate career is laboratory rotations, which are critical for establishing the right fit for the trainee and mentor. Indeed, appropriate fit was something that I prioritized during the transition into my postdoctoral position. It was both exciting and daunting during this transition. It became clear to me that many of these safeguards are nonexistent as doctoral graduates transition into postdoctoral positions. Most, if not all, incoming postdoctoral scholars/fellows are limited to word of mouth and, if possible, to be invited to visit potential postdoctoral laboratories in order to assess fit. Although it is the norm, it is incredibly risky and, in some instances, scholars may end up leaving their postdoctoral laboratory due to unanticipated conflicts. For URM, this is emphasized through the lack of support, continuous subjugation to micro- and macroaggressions, and the constant stressors of pursuing a career as one or one of a few.

The Propel Program is unique in that it not only provides financial support for postdoctoral scholars but also places a heavy emphasis on inclusivity, a strong sense of community, and professional support. The program is organized and structured to bring together a cohort of scholars who demonstrate a shared interest in inclusive mentorship and a goal to become independent investigators. At the individual level, Propel is proactive in ensuring we have a healthy relationship with our postdoctoral mentor(s) and that conflict, if any, between the mentors is resolved. Key staff members within the Office of Postdoctoral Affairs also support us. Knowing this level of support within the program has helped me see that Propel is dedicated to the retention and success of its diverse group of postdoctoral scholars in the academic space. The overall support from Propel has resulted in scholars establishing collaborations and acquiring outside funding for research, and previous scholars have successfully moved on to their subsequent careers. Importantly, Propel provides a blueprint for other academic institutions to enhance the support of their postdoctoral trainees while further diversifying the professoriate.

Theme 4: Postdoctoral trainees advancing Propel through positive experiences, community support, and social recruitment

M.M.S.M.—positive experiences lead to recruiting the next generation of Propel scholars. The Propel Program is leading the battle to increase representation from marginalized communities at Stanford. As an African American male postdoctoral trainee at Stanford, Propel motivated me to empower the postdoctoral office by recruiting postdoctoral trainees who look like me. Various recommendations to reverse underrepresentation at institutions like Stanford have been proposed, but more programs like Propel must be implemented across the campus. Stanford is understaffed with URM postdoctoral scholars. Part of the mission goal for Propel is to effectively train ambitious, early-stage postdoctoral trainees, culminating in an NIH career transition award. As a Propel alumni, I plan to continue to recruit for the program upon returning to Georgia for my future career endeavors. I have already successfully recruited two of Propel's current scholars and may have one more applying soon.

An impressive body of recruitment literature has confirmed that recruiters serve the role of gatekeeper to higher education organizations, and this has proven to be disadvantageous to certain outreach practices to diverse communities.¹⁸ Even now, except a few studies focusing on recruiting educators from underserved communities, recruiting efforts must be concentrated at multiple venues to ensure maximal representation of URM communities in academia.¹⁸ As a recruiter, educator, and mentor, I will continue to help (1) find culturally sensitive instruments, strategies, policies, and procedures to recruit URM students to Propel effectively; (2) find more effective and inclusive ways of retaining these students in programs once recruited; and (3) collect data on gatekeeping factors in both the recruitment and retention of URM males and females in academia.¹⁹

S.F.—propelling toward a transition to independence through the intersectionality of identities. Creating a cohort community of URM postdoctoral trainees advances postdoctoral retention in the transition to faculty at Stanford University. It has a widespread impact as a global leader in biomedical research and education. In a postaffirmative action in United States, Propel embeds racial equity into postdoctoral trainee selection by acknowledging the importance of *community cultural knowledge* from historically marginalized groups as an academic skillset in high demand. As a member of the inaugural cohort (2021), I was selected for Propel based on my longstanding commitment to enhancing equitable representation in biomedical research and the biomedical workforce. As an Indigenous (Quechua, Peru), Black, and Latina woman from a disadvantaged background, I represent three underrepresented populations in the U.S. biomedical sciences research enterprise (NIH Interest in Diversity, NOT-OD-20-031). The intersectionality of my race, gender, and class underrepresentation shapes my foundational knowledge of the role of the social determinants of health and health disparities.

The cumulative community cultural knowledge across URM Propel postdoctoral trainees benefits Stanford's biomedical research and fosters collaborations on studies needing sociocultural expertise. For example, as the only URM faculty or postdoctoral trainee in my division, I was invited to join a Stanford grant on structural racism and health after a grant reviewer requested the inclusion of a coinvestigator with expertise in racial segregation. Second, Propel postdoctoral trainees launched our own research studies after realizing our combined expertise in health disparities research, creating some of our departments' first-ever URM research teams. Propel's cohort of URM postdoctoral trainees has improved my research training and helped me become a recipient of an NIH K99/R00 award toward my transition to a tenure-track professorship.

Thematic Summaries

Four key themes were identified from Stanford Propel Scholars that served as narrative section headers. Scholars reported that Propel transformed postdoctoral training by actively structuring a supportive environment for postdoctoral scholars through financial support, community building, institutional structures, and advancing equitable URM hiring. E.A.V. discussed the importance of going against the traditional grain that has been discussed in waiting to start a family until a faculty position has been secured. Specifically, him being a first-generation Ph.D. recipient and living in an expensive area such as the Bay area places him at a disadvantage of a well-rounded career and life in pursuance of academia without sacrificing something such as building a family. Importantly, the increased salary helped facility his ability to start a family subsequently retaining him in academia as a postdoctoral fellow and Propel scholar with the goal of entering academia. Second, C. A. Headley discusses the few opportunities for postdoctoral trainees to pursue high-risk research that is not attached to their primary mentor's funding. Hence, Propel increased salary support and supplementary professional development funds freed his internal laboratory budget to pursue cutting-edge research regarding mitochondrial transplantation.

Several scholars emphasized the importance of community support in retaining them as postdoctoral trainees. First, C. A. Hayes discusses how isolating it was to be the only Black postdoctoral scholar in the department which accentuated his need for support even more so when the chosen laboratory was not the best fit for his long-term career goals. The following two key factors within Propel helped retain him as a postdoctoral trainee: (1) his Propel funding was not tied to a research related project in the first laboratory but was a personal investment in himself, and (2) the cohort model for social support and research collaborations. J.F.M. discussed her DACA status and how that often excluded her eligibility for U.S. and institutional fellowships. The broad diversity representation within Propel, not having teaching responsibilities, and having a cohort of like-minded peers spear headed her toward success and was transformative for her postdoctoral journey thus far. Lastly, A.C.V. reflected on previous cohort models that included structural support when he was an undergraduate trainee and how that structural support fostered success across the entire group that inherently built individual, interpersonal, and institutional support. A.C.V. also reflected on how the cohort model built

a psychological sense of community for a diverse group of scholars who have different backgrounds but have had to overcome similar challenges in the academic system.

The collective narratives of institutional support were showcased through theme 3. A.R.N. has a strong background in building support groups in the workforce and the academic landscape; therefore, she values how Propel incorporates networking with diverse early career faculty at Stanford during round table luncheons. Moreover, she discusses the adversity to diversity, equity, and inclusion and today's climate, but Propel has maintained their steadfast support for diversifying the professorate which she is appreciative of. On the contrary, K.C.G. thoroughly compared the lack of safeguards for postdoctoral trainees compared with his doctoral training. The safeguards within Propel include the Office of Postdoctoral Affairs and their staff specifically for Propel scholars which serves as a blueprint for institutional postdoctoral support.

In the final theme identified, positive experiences, community support, and social recruitment have benefited the Propel alumni from cohort 1 in spreading positivity about the program, learning from each other, and building their own independent careers. Just the presence and intentionality of the Propel Program was a strong motivator for M.M.S.M. to recruit other Black scholars into the program. As stated earlier, minorities and underrepresented individuals tend to flock toward positive environments that they hear of through a form of positive-experience-story telling, and this is apparent as M.M.S.M. has already recruited three individuals that were admitted into Propel. Lastly, S.F. highlights her intersectionality of identities being Indigenous (Quechua, Peru), Black, and a Latina woman, which directly has shaped her positionality within academia especially in her department as the only URM faculty or postdoctoral trainee in her division. Her positionality has informed her research collaborations beyond and within Propel as she is an expert in structural racism and health. In the end, S.F. highlights how Propel has directly cumulated the first ever URM research team in their respective departments.

In summary, the majority of scholars (E.A.V., C. A. Hayes, C. A. Headley, J.F.M., and K.C.G.) highlighted the alleviation of financial challenges, underscoring the NIH primary recommendation. Narratives also reflected on the cohort model fostering a supportive community (scholars: J.F.M. and A.R.N.), social support (C. A. Hayes, C. A. Headley, and A.C.V.), and scientific collaboration (S.F., C. A. Hayes, and C. A. Headley) in alignment with the Social Ecological Model recommendation 3 and NIH recommendation 5. Institutional structures as described by the Social Ecological Model recommendations 4 and 5 were crucial for postdoctoral trainee retention and scientific success (S.F., C. A. Hayes, and J.F.M.). While Propel cohort 1 concluded <1 year ago, the alumni have demonstrated Propel's mission of diversifying the professoriate through securing independent funding with two NIH K99/R00 career development awards, one HHMI Hanna H. Grey Fellowship, and a faculty position.

Considerations of the Propel Program

While the Stanford Propel Program stands as a commendable initiative in fostering an inclusive and empowering environment

for postdoctoral scholars, it is essential to acknowledge certain considerations within its current framework. First, some Propel scholars receive the fellowship prior to beginning their postdoctoral training with the chosen mentor; therefore, there have been a few isolated incidents where the trainee was not a great fit for the laboratory environment. Through the isolated few incidents, the Propel team and Office of Postdoctoral Affairs has been supportive in managing conflict and assisting trainees in switching laboratory environments within the School of Medicine. The limitation is rare for Propel scholars, but these few isolated incidents have prepared the Propel team for the future if an issue arises. Second, the program does not directly intervene in laboratory conflicts. While Propel addresses various needs of postdoctoral scholars, the absence of a mechanism to handle disputes within the laboratory setting could be considered a limitation. Future iterations of the program might explore strategies to provide guidance or support in resolving such disputes with the mentor or other laboratory members. Third, Propel, in its current form, does not alter the systemic structure of the postdoctoral training phase at the broader institutional level but at an individual cohort level within the school of medicine. The Stanford Propel Program is an amazing model, but it is obvious from NIH recommendations that broader structural challenges inherent in postdoctoral training remain. Importantly, the Propel Program aligns with Gangrade and colleagues' recommendations for implementing the social ecological model to impact postdoctoral training in positive ways. Fourth, an inherent limitation is that the Propel Program is internal to Stanford University School of Medicine; thus, trainees that are not advised by primary mentors in the school of medicine are not eligible. There is potential for growth by exploring avenues for collaboration or sharing best practices with similar programs in different institutions.

Conclusions and Future Directions

Academia is at a crucial crossroads on how the future of the U.S. biomedical workforce will continue. In response to this critical juncture, Gangrade et al. (2023) and the NIH advisory committee have proposed multifaceted reforms.⁴ Utilizing an existing framework for the social-ecological model, their recommendations encompass mentorship training, innovative mentor selection techniques, cohort models for support, empowerment of postdoctoral offices, and policy-level interventions.⁴ The urgency for reform is emphasized by the NIH advisory committee's six suggestions, including increasing pay and promoting diverse perspectives. While these recommendations came in 2023, programs like Stanford Propel had already adopted similar frameworks. Addressing the postdoctoral retention gap, especially among underrepresented groups, is crucial. Embedding racial equity into every reform level is essential, given persistent disparities. Stanford Propel scholars attest to the framework's benefits implemented across cohorts 1 and 2.

Structural changes at individual, interpersonal, departmental, institutional, and policy levels are crucial for scientific advancement and societal progress. The Propel Program, through its leaders and scholars, provides a framework and qualitative

evidence of its effectiveness. While there have been strides in professional development and mentorship for underrepresented trainees, these programs often fail to address academia's oppressive and systemic structure. While the Propel Program cannot dismantle this system entirely, it has shown success in minorly circumventing some structural issues, aiding in the retention of postdoctoral trainees from diverse and historically marginalized communities. Overall, the Stanford Propel Program serves as a positive model, incorporating aspects of the social-ecological model and NIH Advisory Committee recommendations to diversify the professoriate. The first-hand accounts from the Propel Scholars fully endorse the importance of this program in the Stanford University School of Medicine and that other institutions should follow their lead in creating, establishing, and maintaining similar programs.

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Authors' Contributions

C. A. Hayes is responsible for idea conception, writing the original draft, organizing the team, and journal correspondence. All Propel scholars (C. A. Hayes, C. A. Headley, A.R.N., E.A.V., K.C.G., M.M.S.M., J.F.M., A.C.V., and S.F.) willingly provided their own experience of the program. The first-hand accounts of the experiences are from the respective coauthor/Propel scholar (initials at each section).

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