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EDITORIAL

What Comes Next? Simple Practices to Improve Diversity in Science

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Relative to our occurrence in the American workforce, black and brown scientists are underrepresented in science, technology, engineering, and math (STEM) fields. Though not insulated from cynics, there generally appears to be manifold support among the chemistry community to ensure underrepresented groups have equal participation in the field. This is clear given the emergence of support statements from several high-profile faculty members, many of whom are editors and board members of the fields' most important journals. What's lacking, however, are tractable action plans that can eliminate structural prejudice in science. In today's climate, a passionate plea against inequity (often delivered through social media or other powerful platforms) will rightfully and undoubtedly attract viewership. However, as the civil rights activists of the 1950s and 1960s would say, "What happens after the message is delivered?" In this editorial, we highlight examples of bias in science. Based on our experiences (chemists from industry, a historically black college and university (HBCU), and both private and public R1 universities), we offer solutions that will ensure scientists from underrepresented groups gain and maintain equal participation in science.

BACKGROUND

The Science and Engineering Equal Opportunities Act (SEEOA) was signed into law 40 years ago by President Jimmy Carter. The law states, "it is in the national interest to promote the full use of human resources in science and engineering and to insure the full development and use of the scientific and engineering talents and skills of men and women, equally, of all ethnic, racial, and economic backgrounds." The goals were two-fold. First, the legislation appointed the National Science Foundation (NSF) with the task of safeguarding the involvement of underrepresented groups in American STEM fields. Second, the law enabled the NSF to play offense against bias, i.e., provide tools to assist the STEM community in eradicating the prejudices that hinder equal participation. To monitor the problem, the NSF compiles the so-called "STEM census", a nationwide analysis of the country's progress (or lack thereof) in ensuring equal access and representation.[1] The data feed into comprehensive accounts (such as the women, minorities, and persons with disabilities report) used by institutions such as funding agencies, nonprofit organizations, and colleges and universities. Diversity efforts and policies in higher education depend on these reports as they are the most accurate "receipts" available regarding demographics in STEM.

The present state of chemistry, arguably, faces more complex scientific challenges than it did in 1980 when SEEOA was enacted. However, based on reports from the NSF and the American Chemical Society (ACS), representation in chemistry is only marginally more inclusive than four decades ago. Indeed, the late Prof. Gilbert Stork stated: "One could argue that chemistry is no more accessible for a black chemist in 2013 than it was in 1916 when St. Elmo Brady earned his Ph.D."[2] This is unacceptable. If we are to provide the most innovative solutions to the frontier challenges facing science, black and brown chemists must have a seat at the table.[3]

While it appears to be consensus support of this ideal, there are few tractable plans that have been put forward to move the needle. In this editorial, we offer insight into structural problems encountered by black and brown scientists in STEM. While our purview is that of early career scientists, we also offer insight from a pool of students across the country. Finally, we offer actionable steps that can be employed immediately to assist in the promotion and development of black and brown scientists. Our concluding remarks are addressed directly to trainees. Many of you are facing the

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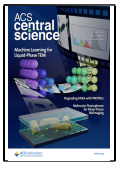

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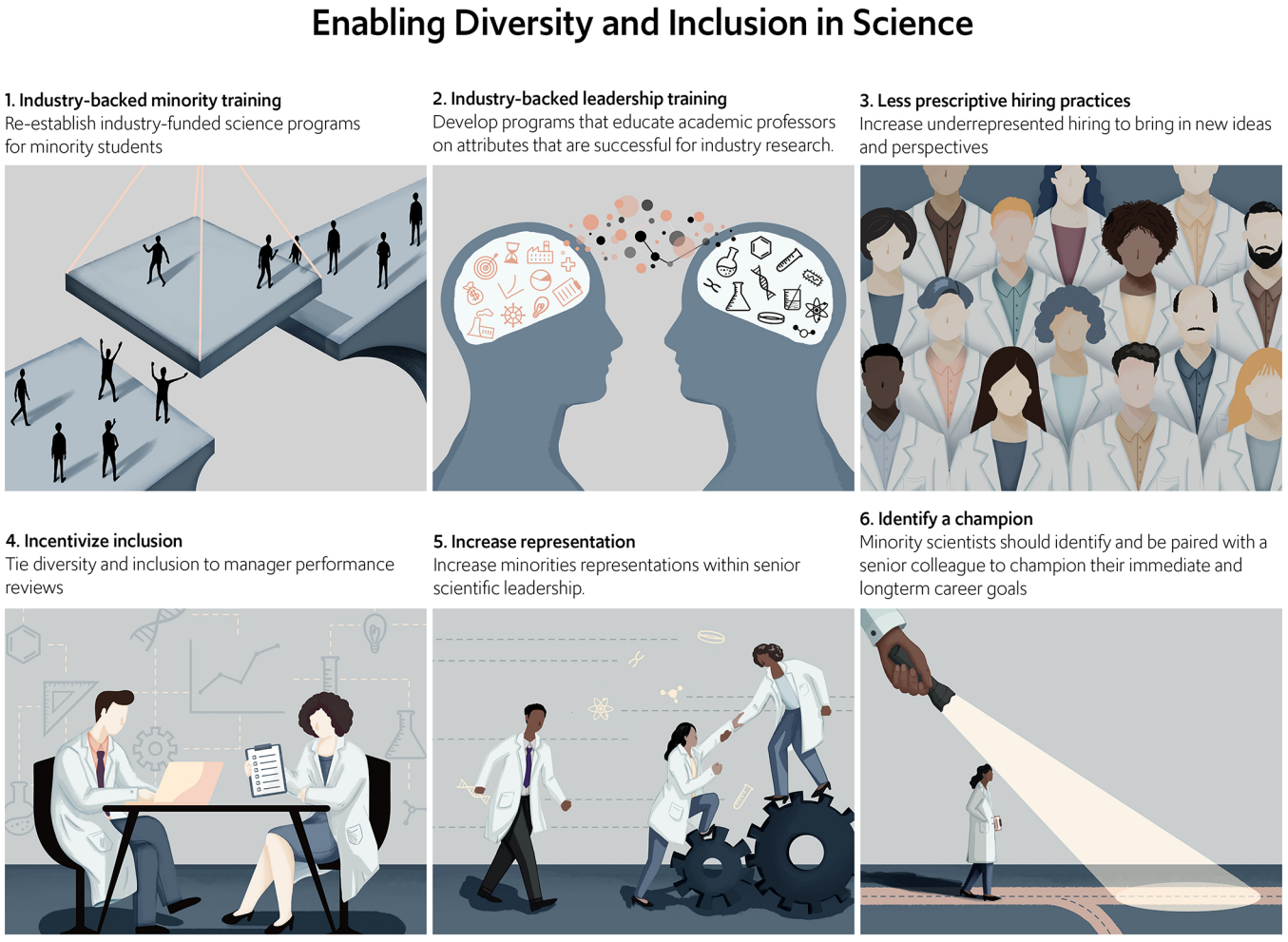

Figure 1. Pictorial representation of strategies to enable diversity and inclusion.

most critical stage of your career. Many of you are in departments lacking faculty of color. We want you to know that there are professionals working to change the system and that there is a role for you as well. Before we begin, we would be remiss to not mention that the initial plan for this manuscript was to showcase 8–12 perspectives from faculty and industry scientists across the country. Sadly, several feared retribution from colleagues, mentors, bosses, and advisors if their names were affiliated with this editorial—a tragedy that speaks to the scope of the problem we face and the urgency with which change must occur.

ENABLING DIVERSITY AND INCLUSION IN SCIENCE

– Olugbeminiyi O. Fadeyi, Merck & Co., Inc.

Diversity has long been recognized as a pillar of innovation. This is well supported by studies showing teams of diverse backgrounds exceed homogeneous groups in innovating and solving complex problems[4−6] and has led to large companies embracing diversity as a key global initiative.[7] Despite this understanding and effort, Black Americans, Hispanic/Latin-x, and Native Americans/Pacific Islanders account for just 5.6%, 7.5%, and 0.5%, respectively, of the total work force in science and engineering, far below the national demographic for these groups.[8] Furthermore, if one now only considers the number of scientists belonging to these demographics who are involved in core research and development activities, the percentage is strikingly lower. For the majority of us, the simple exercise of perusing your LinkedIn connections for scientists who are Black, Hispanic/Latin-X, or Native American/Pacific Islander will also make that point.

The attrition of underrepresented minority scientists in their journey from the dreams of youthful scientific exuberance to an impactful research career should alarm us all. This poses an urgent threat to scientific innovation by missing out on diverse minds and talent, and simultaneously exposes several ugly cracks in the American developmental journey of a scientist. While it is tempting to want to counter these ominous trends with grandiose solutions, incremental changes can be as impactful and beneficial. Below are a series of practices and changes to mindset and/or policies (Figure 1). Though simple in nature, they can go a long way in countering the challenges faced by underrepresented minorities

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to use their talents to thrive as scientists. Importantly, these solutions were crafted with two critical realities that we all need to embrace: (1) not every scientist comes from similar backgrounds with identical access to resources, and (2) racial and socio-economic disparities are not the fault of the aspiring scientist, but a reflection of centuries of inequalities that have manifested in the form of slavery, prison sentencing, neighborhood and school access—in addition to others. These realities are essential for creating a mindset that can implement the solutions below. If not, reading further is futile. Finally, the motivation for these solutions comes from practices already used by the pharmaceutical and biotech industry in diminishing and even eradicating certain diseases through innovative technologies and medicines. There is no reason why many of those learned practices cannot be reimagined toward tackling the disease of diversity attrition and racism in the sciences. This includes effective partnering with academia to enable early stage outreach, accepting and owning our role in the problem, respecting the complexity of the problem, and incentivizing appropriate behaviors.

(1) *Re-establish industry-funded science programs for minority students.* Programs such as the United Negro College Fund - MSD (UNCF-MSD) fellowship played important roles in connecting with early career scientists to provide access to mentoring, connections to career scientists, and exposure to real-world scientific problems. Industry and university parties should discuss partnering efforts to re-ignite programs that can specifically enable minority scientists.

(2) *Institute industry-academic leadership training programs.* The purpose of this program is to increase the awareness of academic professors/educators on attributes that are successful for industry research. This is important for two reasons: (1) since all industry scientists come through academia, there should be increased awareness on factors that bring success in industry, and (2) this can remove some bad practices early on that hurt diversity in science. Successful scientific careers will not be determined by how much science you know, but on being system thinkers, intellectually honest and humble, and empathetic and charitable.[9] By educating academic professors on factors that lead to successful industry careers, industry can help initially set the bar for effective scientific behavior and practices.

(3) *Change hiring process to be less prescriptive.* Because there is comfort in sameness, we need to install practices early on to dismantle the formation of homogeneous groups and teams. This can be done at the hiring process by removing strict or unspoken requirements that a candidate must come from only certain schools or laboratories, or have done exactly x, y, and z. This will help alter the candidate pool where ethnic, cultural, and experiential backgrounds can be more easily considered. Daria Hazuda, VP of Infectious Diseases Discovery & CSO of MRL Cambridge Exploratory Science Center, Merck & Co., Inc., has said, "The emphasis needs to change to a mindset where hiring managers value talent rather than skills. In addition, current hiring practices are largely reactive and focused on filling positions rather than proactively recruiting diverse talent. A significant shift in organizational and cultural diversity requires a more deliberate and sustained intervention and investment. To make substantive inroads in diversity, proactive identification and commitment to the acquisition of diverse talent and matching the expertise and goals of the talented candidates within an organization as an ongoing and active process needs to occur rather than relying on attrition to facilitate such change."

(4) *Develop formal mentoring programs and sponsorships to empower underrepresented minorities.* Maria-Jesus Blanco, Senior Director at Sage Therapeutics and 2020 Vice-Chair of ACS MEDI, has said, "Having a mentor is important for any scientist interested in pursuing a gratifying career in pharma and academia. For underrepresented minorities, the impact of mentoring and sponsorship is even more critical to provide career development support overcoming barriers, and unconscious biases. Relying only on informal mentoring and networking efforts is not enough to make a true difference and minimize racism and bias faced by minority professionals. Minorities developed with these programs could, in turn, be mentors to others, thus systematically decreasing the gender and racial gaps in academia and pharma."

(5) *Link diversity and inclusion to manager performance reviews.* Use quantitative metrics for assessment, such as when was the last time one of your minority team members gave a talk, how many of their ideas did you enable them to test out, how many times have you supported them to go before leadership or interact with your own boss in the last year? This should no longer be done for box checking.

(6) *Managers need to be more vulnerable and transparent.* Managerial behavior is perhaps the single most important factor in advancing the career of a minority scientist. While a minority scientist may not relate on skin color or life experiences, they can relate on the emotional underpinnings that make us all human. By being more

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vulnerable about their own failures/shortcomings/insecurities with their team members, managers can become more relatable. Rob Oslund, a chemical biologist from Merck & Co., Inc., Cambridge, MA, USA, who has worked on diverse teams, said "Racial and/or socio-economic disparities can be a huge threat toward not only doing good science but feeling like you truly belong. This is where the role of vulnerability can go a long way in countering this issue. Leaders or mentors who share their own insecurities, setbacks, or failures through emotional exposure make themselves more approachable and relatable. This very simple practice can help lower the barrier that any scientist might feel and be the starting point for meaningful conversations."

(7) *Do not wait for your manager or leadership to act.* Denial and inactivity will continue to have ripple effects throughout the industry. Not only will we continue to miss out on amazing talent that will choose to do something else with their lives, but we will be left with a homogeneous talent pool for biotech and startup industries to pull from.

(8) *Increase minority representation within scientific leadership.* It is imperative that underrepresented scientists find role models within scientific leadership that look like them. This not only gives the scientist someone to look up to, but also sends the message that top leadership positions are within their realm of possibilities. Sadly, we often lose scientific talent to other sectors of the company or outside simply because minority leaders have more visible roles.

(9) *Be careful with statistics.* Wearing diversity statistics as a badge of honor does not equate with having and supporting a diverse environment (McNamara Fallacy—when you cannot measure what is important, what you can measure becomes important). This type of numbers focus can lead to a lack of vigilance on factors that truly harm diverse environments. Staying connected to your teams through active and continued conversations and/or questionnaires/polling can help keep your finger on the cultural pulse of your environment.

(10) *Keep the conversation going.* Importantly, have conversations about race with your own demographic. Be vulnerable in admitting what you don't know and be willing to listen to each other.

UNDERSTANDING THE SCOPE OF THE PROBLEM

– Steven D. Townsend, Vanderbilt University

Implicit bias exists in science. At a recent conference, a senior faculty member in chemistry joked that he remembered my application for graduate school 15 years earlier. Unfortunately, the admissions committee "did their homework" and didn't admit me to their program because "you grew up too poor". Those eight words are direct quotes. This senior faculty member elaborated further, stating that the committee felt my family would hinder any success I could achieve in any professional field. I tell this story because, clearly, even scientists harbor strong stereotypes. Such typecasts translate into assumptions about differences in scientific ability based on gender, ethnicity, and race. This is a primary driver behind the lack of diversity in science.[10] The bias manifests itself throughout the pipeline in a number of ways that have been well-studied. For example, when applying for grant support from the National Institutes of Health (NIH), white scientists are more successful than those who are black and brown, even after accounting for academic lineage and productivity.[11] This is just one manifestation of a fundamental problem in chemistry—the ignorance regarding the scope of the problem. Based on the (possibly naïve) hypothesis that some percentage of bias in science is born out of obliviousness, my goal in this section is to identify problems that can be addressed immediately if highlighted and the right solution is brought to bear.

Problem 1. URM scientists are asked to dismantle an institution we didn't build. Racial terror and violence are a central part of the American story. However, if you ask a person whether or not they're racist (or prejudice), they hearken back to images of black bodies hanging from trees, the trail of tears, or Japanese internment camps. After all, who would want to draw parallels with the people who committed those acts. This is a problematic viewpoint, though, because bigotry is more than overt displays of racism which are easily identifiable —it's a spectrum of behaviors. In chemistry, the ideology of bias has been employed in a systematic manner such that we now have a system where white scientists often hold unimpeded power over nonwhite colleagues and trainees. It is the default setting. Power is held by one segment of the community, even if unwillingly. The institutional bias that we see in chemistry means that even if a white individual does not embrace bigotry, it is likely they benefit from a rigged system.

Solution. Given the current climate, a number of white colleagues across chemistry have asked me what I thought was the solution to bias in chemistry. The primary solution is to aggressively diversify the field. Unfortunately, for the past several decades, that solution has been met with lukewarm enthusiasm and/or effort. Thus, my thoughts on immediate actions are two-fold. First, I believe that our white colleagues need to have in depth conversations with

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other white people—colleagues, friends, and family members. The current system was not built by black and brown chemists. While our leadership is needed to make the system equitable, it is unfair to ask people of color to shoulder the workload in dismantling the system.

A second solution is for departments to employ internal reviews that include faculty of color from other departments. Non-STEM fields are extraordinarily more diverse than STEM fields.[12] For example, while black faculty account for fewer than 3% of the chemistry field, the percentage is between 9 and 15% in English and sociology—close to parity. A promising tool to eradicate bias is to leverage colleagues in other fields (where diversity is less of an issue) to assist in identifying and solving problems.

Problem 2. Students who are from a financially insecure background are at a disadvantage. Prof. Nicola Pohl (Indiana University) told me that the greatest disclosure we can provide our students is to let them know we grew up "financially insecure". I've sent money home to my family every year since entering college as an undergraduate. I've mentored students who send money home to their families and take care of relatives who are sick and shut in. Our field is largely organized such that trainees who have financial stability perform better.[13−15] The chemistry community is complicit, if not causal, in this disparity. Because our system considers trainees adults when it comes to effort, but students when it comes to compensation, we underpay them while requesting maximum performance of duty. Aside from the obvious financial burden placed on students, there are mental costs as well. Nationwide, I've met several students who have been accused by their advisor of being "distracted" by so-called "non-essential, non-work" activities.

Solution. The solution to this problem is to treat trainees as employees rather than students working for the minimum wage. Graduate students are underpaid. A living wage provides the resources for trainees, whom a vast number of faculty claim should behave more like adults, to take care of their adult responsibilities. The most difficult aspect of addressing this challenge, however, is to get mentors, who are generally well compensated, to understand the mental toll of financial insecurity. I've encountered senior colleagues across the country who've questioned why I help my family financially—all while describing to me how they send their children to the best schools. I've yet to figure out how to get someone to understand that my family is just as deserving of support as theirs.

Problem 3. Problems are not a figment of our imagination. I have family members who have completed alcoholics anonymous (AA) and gamblers anonymous (GA). As a child, they would tell me that the first step in solving any problem is recognizing there is one. Accordingly, it is important that leadership not let problems go unheard. I recently had a meeting with a group of black men in science. We concluded that there are several structural issues that we face on a day-to-day basis that are distracting at best—dangerous at worse. Moreover, the issues we face are often ignored when brought to nonblack leadership. For example, racial slurs, token statements, and microaggressions ("I'm sorry that there's not many black people at this conference, but this foundation is only about excellence...") are routine. Often, complaints to leadership are met with responses such "do you have proof" or "what should I do?" When problems arise, leaders are often caught off-guard and lack a plan of action.

Solution. When encountering racism (or related problems), it is important to use your Title IX and equity offices. When you encounter a problem, it is not your job to decide intent or provide analysis. Similarly, leadership must take our roles as mandatory reporters seriously and resist casting judgment on an accusation.

Increased representation is another tool in combating bias—more on this below. It is so central to solving the problem that it is discussed several times in this essay. I spend significant time with students on issues not related to chemistry. I am concerned, though, for students who don't have faculty members of color to confide in. I won't harp on the need to grow our numbers at the faculty level nationwide because, due to either resistance or apathy, that's apparently not a fast process. There are, however, actions departments and companies can take immediately to cause positive change. First, make sure you have well-supported chapters of National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBBChE) and Society for Advancement of Chicanos/Hispanics and Native Americans (SACNAS). These organizations, among others, provide community. Second, make sure students of color meet black faculty during seminar visits to build a network.

Problem 4. Most departments don't have faculty members who are people of color. As I've just mentioned, the professoriate plays a critical role in dispensing knowledge to students through course instruction and advancing the field through research. Like all sectors of the workforce, the professoriate should resemble the country's demographics.[16] Unfortunately, this is far from the case in most STEM departments. As a result, talented individuals from URM groups remain a poorly tapped resource. The implications are a serious limitation to the diversity of

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thought and a low probability that research efforts will address the needs of all segments of society.[17] How many chemists have programs focusing on lupus or vitiligo?[18−20] Finally, the poor representation of underrepresented minority (URM) faculty in academia results in little to no role models for students of color.

Solution. What I share with you are two solutions that I have benefited from. As a second-year graduate student, I received a fellowship from Pfizer. In addition to making connections with other students of color, I was also able to visit Groton to meet industrial scientists who were women and/or ethnic minorities. I also spent several hours working mechanisms with a man I soon learned was Prof. E. J. Corey! The program was an excellent example of an academic−industrial partnership. In year three, I earned a fellowship from the UNCF/Merck Science Initiative. I credit this program, and the people I met at Merck, as one of the three primary influences on my scientific career. In fact, I've known my Merck mentor, Anthony Ogawa, for almost 15 years and still seek his counsel.

ADDRESSING POOR REPRESENTATION, CRITICAL MASS, AND A LACK OF FACULTY TRAINING

− Shanina Sanders Johnson, Spelman College

Problem 1: In addition to the lack of minority faculty, many graduate departments in chemistry do not have a critical mass of minority students. Therefore, graduate student access to minority faculty and peers for support, socialization, and guidance is lacking. Minority faculty, when available, provide a support mechanism for students of color. In the absence of support from minority faculty or other personnel, peer support can fill the gap to some degree. However, many graduate departments do not have a critical mass of minority students that could serve to foster community among minority graduate students and combat feelings of isolation and imposter syndrome.[21] This type of community can also give graduate students an avenue to develop a science identity[22] and relationships that support their emotional health and sense of belonging, which can encourage them to stay in the field.[23] I keenly remember looking for other black faces at orientation when I began my graduate career. I only saw one. There were a handful in the department overall, but we were not in close proximity. After losing a close relative a few days into my graduate school orientation and returning home from the funeral, the feelings of isolation became even more apparent. Although I ended up joining a group with a supportive advisor and collegial group members, I often did not share the same interests, hobbies, or values of my colleagues, which hindered me from the close relationships that many of them formed.

Solution. In addition to recruiting a diverse faculty, chemistry departments should intentionally recruit cohorts of minority students and have dedicated funds to develop and/or maintain resources that will allow for high levels of retention among the cohorts. This includes efforts to maintain a positive racial climate, cultural spaces for students, and intensive support programs. Some of the highlights of my graduate career were assisting in creating a chapter of National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE) on the campus, attending a Sister Circle event with Dr. Valerie Ashby, a Black professor from the chemistry department, and interacting with Black students from other graduate programs through the Black Graduate Student Association. The latter was not active during my entire tenure at the institution. The Department also hosted an annual Slayton A. Evans Jr. lecture in honor of Dr. Evans, the first Black chemistry professor at UNC. Having events or organizations like these that are properly funded and staffed along with intentional recruiting and support programs should happen alongside efforts to diversify faculty in order to encourage retention not only in graduate school, but in the field of chemistry.

Problem 2: Faculty are not trained in mentoring. Institutions should hire faculty who are committed to diverse institutions and offer professional development in mentoring to support the retention of women and students of color. Mentoring interactions with faculty at the graduate student level can have a strong influence on students' science identity and persistence in the field; however, most faculty do not receive formalized mentor training.[24] In cases where they do, it is unlikely that the training also addresses cultural and gender concerns. It is known that most minority students and women prefer mentors with similar backgrounds. However, in the absence of sufficient representatives from these groups, current faculty should actively engage to fill those roles.[25]

Solution. Institutions should create a culture that values quality mentorship of students. Faculty should be provided training to effectively mentor students that includes the topics of explicit and implicit bias and cultural competency. As previously stated, most faculty mentors in chemistry will not belong to a minority group.[26] In order to provide advocacy and support for students of color and women, faculty must be able to practice self-reflection and learn strategies that will build student trust and allow for open communication. Ideally, students should have a mentoring network that is able to sustain them throughout their chemistry

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career. Having faculty who truly care about building diverse and inclusive communities, who equip themselves with the tools to do so, is key in providing the foundation for this type of sustained support.

CULTIVATING ENVIRONMENTS OF EMPOWERMENT INSTEAD OF DISCRIMINATION

– Marie C. Heffern, University of California, Davis

Words and actions are rarely neutral when it comes to diversity issues in STEM. Thus, it is important to consider strategies to empower black and brown scientists in short-term activities and to cultivate an environment of sustained support. When people ask about my journey in academia, some may be surprised by the anecdotes that shape the story. In this section, I hope to share how subtle actions related to identity can influence one's career trajectory. Indeed, an article in *Science* in 2001 noted that our efforts to improve diversity in STEM should focus on achieving a "tossed salad" rather than a "melting pot", that is, appreciating the unique identities of diverse groups of scientists and empowering differences rather than having differences become isolating and exclusive.[27]

Problem 1: Implicit bias affects the development of science identity. As an undergraduate student, I had a spotlight article written about me with the intention of celebrating my research achievements. The article started with, "former high school cheerleader interested in studying theater, Marie Anne Cuevas may seem an unlikely student to excel in nanoscience." While the line was intended to serve as a catchy entry to the story, it was certainly an odd start. This statement caused me to wonder what it would take to be a student "likely" to excel in science. It also caused me to fear that I would never be taken seriously. When I received the NSF GRFP, two different people suggested I received the award because I was a Filipina woman. This suggestion signaled to me that receiving a fellowship would always be downplayed. Reading posts on #BlackintheIvory demonstrates that such experiences of microaggression are not unique.

The purpose of this section, however, is not to discuss how implicit bias catalyzes imposter syndrome and insecurities, but rather to highlight how the accumulation of these experiences directly affects the development of science identity.[28] Here, I am referring to the concept of science identity as it is defined by Ruz & Schunn: one's self-conceptualization and self-categorization as a scientist or "science type person" as it emerges from participating in the norms, socialization, and practices of the scientific community.[29] A strong science identity is key to improving URM participation in STEM and pursuing a science career.[30,31] Microaggressions that result from implicit bias (that bring into question whether a scientist is valued for their work versus their race) threaten identity development.

Solution. As mentioned earlier, one key step is recognizing that not only does implicit bias exist, but to understand that it can directly challenge the development of a trainee's science identity. One way to combat this challenge is to enhance community-wide support of URM scientists' development. Training to educate on and celebrate efforts in diversity, equity, and inclusion (DEI) should not only be communicated but encouraged for all faculty, students, and staff in a department, not only those in minoritized groups. Faculty members can assist by advertising these events to their sphere of influence (research group and students in courses).

Through much of my scientific career, I have put effort into assimilating or minimizing my racial identity in fear that it threatened my perceived scientific identity. In the few years that I've been a professor, I have received emails from other young Filipino scientists who have expressed that by virtue of me being a professor, they have increased belief that they can achieve the same. This has served as motivation for me to be more open about my racial identity. There is immense power in highlighting the science of black or brown scientists in the classroom, in our research groups, and in seminars and conferences.

When I consider the development of my own science identity, I attribute a great deal of it to the mentors who encouraged me to pursue my scientific interests. All of my research advisors have encouraged me to think independently and trust my scientific intuition. As what may seem like a superficial example, I think back to my undergraduate experience with Prof. Richard Brutchey. We were trying to scale up a vapor-diffusion synthesis for barium titanate that needed minimal atmospheric exposure. My first thought was to go to my favorite store, Target, and pick up the food container that looked like it had the strongest seal. Instead of telling me that what I did was not scientific, we integrated the container into our set up with the assist of a glovebag! To me, even just the acceptance of a quirky solution was encouragement that if my experiment didn't have to look like a "traditional experiment", then I didn't necessarily have to look like a "traditional scientist" to do science. My graduate advisor, Thomas Meade, told me that he wanted to see my fingerprints all over my projects—an encouragement that my fingerprints were a celebrated influence on my science. When I was interviewing for faculty positions, my postdoctoral advisor, Chris Chang, advised me to be myself. None of my advisors are Filipina women, but nonetheless their words of affirmation of my science identity have been influential in battling the insecurities and fears of not

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belonging. One immediate solution to the problem of representation is to consider how we affirm science identity.

Lastly, I think it is important to promote structures of community and support for black and brown scientists to help shape our science identity in the context of our racial identity. On this front, I believe that UC Davis has provided an excellent model. Upon my arrival, I was appointed as a Center for the Advancement of Multicultural Perspectives (CAMPOS) Scholar. The program provides an excellent community for faculty of color.

Problem 2: Homophily in professional and social networks can disadvantage URMs. Success in STEM is strongly influenced by the network we build at all stages (and this can be said beyond academia). Studies have shown that homophily, that is, the tendency to associate with those who are similar, exists in social networks. However, what we may not frequently consider is how these social networks impact professional networks.[32] As a consequence, the presence of homophily can negatively impact the success of and accumulate disadvantages to URMs in STEM by limiting access to resources, collaborations, advocates, and thus visibility.

Homophily is not so overt in the chemistry community, for which I am grateful. However, I think this problem deserves mention as I have interacted with students who have felt "left out" in informal networking scenarios. While there are several factors that influence whether a young scientist is welcomed into a network, practicing homophily in our networking challenges the path to success.

Solution. By at least acknowledging that this tendency exists is the first step to strategizing empowerment of URMs via our approach to network building. One way that individuals in influential positions can address this challenge is by serving as advocates for young URM scientists to bolster access to resources. I have been a benefactor of advocacy within the bioinorganic community as both mentors and peers have assisted in helping me gain visibility and exposure to the community. Moreover, I feel fortunate that during my first year at UC Davis, the running joke was that I was "overmentored"—I had a group of four faculty serving on my department mentoring committee as well as a committee of CAMPOS mentors. A committee of mentors, whether it be formalized or not, is one such approach under which URMs can access a broader network.

As conference organizers, faculty/TAs in the classroom, and advisors of research groups, perhaps we can consider the potential challenge of homophily. How can we promote both formal and informal heterophilous opportunities? At the "Metals in Medicine" Gordon Research Conference, tables were set aside for students to have lunch with speakers. This type of structure may be a potential avenue for facilitating networking for URMs.

Similar to the CAMPOS program for faculty, the UC Postdoctoral President's Fellowship Program provides a community of current and past fellows to serve as a support system. The academic workshops and retreats associated with the fellowship provide training to help fellows organize their academic package and critically assess components such as the CV. During stages of critical transitions, these types of communities can provide resources that may otherwise be missing for minoritized groups. Within our chemistry department at Davis, a graduate student, Lucy Luong, started the Chemistry Peer Mentorship Program, which provides minoritized and/or first-generation students interactions with other undergraduates (the peer mentors) and unique interactions with participating faculty. This program is highly impactful to participating students and builds their confidence to network with faculty.

CONCLUSION

In closing, we felt the need to speak directly to trainees rather than provide a summation of the thoughts we've already shared. In recent times we've looked into the faces of the next generation of scientists and observed resignation, the type of exhaustion, anger, and sadness that you see when people have acquiesced to the system. What we request is that you not be defeated by thoughts that the current system is as good as it will ever be. As El-Hajj Mailk El-Shabazz (Malcolm X) stated: "The future belongs to those who prepare for it today." We hope that we can offer some advice.

(1) Strengthen and cultivate your skillset. Achievement is the fastest and most sustainable route to accessing the leadership positions that will help you fundamentally change the system. Never fall victim to adversity, including the current scientific landscape.

(2) Visibility is important to increasing the diversity of the scientific pipeline. It is essential that after we have maxed out our time in the lab (priority #1) that we make time to volunteer for scientific and social events within and outside of our organizations, departments, and universities.

(3) Don't be content; speak up when you feel like you or others aren't receiving the support and acknowledgment that's been earned. Identify allies to help champion the cause.

(4) You are important. Take care of your mental and physical health. The future of the science depends on your talents.

(5) Be proactive within your organization (in and outside your department) in addressing systemic issues. While

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a number of problems that we face are obvious, leaders in the field have blind spots. Take the initiative to provide counsel on issues that our communities encounter. Once you are a professional, seek leadership and management roles within your organization.

(6) Speak out against all elements and practices that do not promote diversity and inclusion. For trainees, pay close attention to graduate student recruiting. For professionals, play a role in promotion and internal events/programs. Remember, it is not your job to cast judgment on "how bad" an incident is (if you observe something troubling). It is your job to make sure problems are taken to the proper authority.

(7) Seek external opportunities that promote your visibility and the visibility of others. Give a voice to those who feel they are voiceless. Such opportunities for collaboration include nominating speakers for conferences, nominees for awards, or teaming up to write an editorial!

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Notes

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REFERENCES

(1) Buffington, C.; Cerf, B.; Jones, C.; Weinberg, B. A. STEM Training and Early Career Outcomes of Female and Male Graduate Students: Evidence from UMETRICS Data Linked to the 2010 Census. *American Economic Review* **2016**, *106* (5), 333−338.

(2) Wang, L. St. Elmo Brady gains chemical landmark status. *Chem. Eng. News* **2019**, *97* (27), 32−33.

(3) Hofstra, B.; Kulkarni, V. V.; Munoz-Najar Galvez, S.; He, B.; Jurafsky, D.; McFarland, D. A. The Diversity-Innovation Paradox in Science. *Proc. Natl. Acad. Sci. U. S. A.* **2020**, *117* (17), 9284−9291.

(4) Wooten, L. P. The Diversity Bonus: How Great Teams Pay Off in the Knowledge Economy. *Admin. Sci. Q.* **2019**, *64* (3), Np30−Np32.

(5) Freeman, R. B.; Huang, W. Collaboration: Strength in diversity. *Nature* **2014**, *513* (7518), 305.

(6) AlShebli, B. K.; Rahwan, T.; Woon, W. L. The preeminence of ethnic diversity in scientific collaboration. *Nat. Commun.* **2018**, *9* (1), 5163.

(7) Podsiadlowski, A.; Groschke, D.; Kogler, M.; Springer, C.; van der Zee, K. Managing a culturally diverse workforce: Diversity perspectives in organizations. *Int. J. Intercult Rel* **2013**, *37* (2), 159−175.

(8) *Science & Engineering Indicators. Demographic Trends of the S&E Workforce*. NSB-2019-8, National Science Board, 2019.

(9) Snow, S. Our Leaders of Tomorrow Are Going to Need These 4 Rare Skills. *Forbes*, June 4, 2020.

(10) Leslie, S. J.; Cimpian, A.; Meyer, M.; Freeland, E. Expectations of brilliance underlie gender distributions across academic disciplines. *Science* **2015**, *347* (6219), 262−5.

(11) Ginther, D. K.; Schaffer, W. T.; Schnell, J.; Masimore, B.; Liu, F.; Haak, L. L.; Kington, R. Race, ethnicity, and NIH research awards. *Science* **2011**, *333* (6045), 1015−9.

(12) Li, D.; Koedel, C. Representation and Salary Gaps by Race-Ethnicity and Gender at Selective Public Universities. *Educational Researcher* **2017**, *46* (7), 343−354.

(13) Paschall, K. W.; Gershoff, E. T.; Kuhfeld, M. A Two Decade Examination of Historical Race/Ethnicity Disparities in Academic Achievement by Poverty Status. *J. Youth Adolesc* **2018**, *47* (6), 1164−1177.

(14) Oulhote, Y.; Grandjean, P. Association Between Child Poverty and Academic Achievement. *JAMA Pediatr* **2016**, *170* (2), 179−80.

(15) Jurecska, D. E.; Chang, K. B.; Peterson, M. A.; Lee-Zorn, C. E.; Merrick, J.; Sequeira, E. The poverty puzzle: the surprising difference between wealthy and poor students for self-efficacy and academic achievement. *Int. J. Adolesc Med. Health* **2012**, *24* (4), 355−62.

(16) Stanford, F. C. The Importance of Diversity and Inclusion in the Healthcare Workforce. *J. Natl. Med. Assoc.* **2020**. DOI: 10.1016/j.jnma.2020.03.014

(17) Fernandez, C. P. Creating thought diversity: the antidote to group think. *J. Public Health Manag Pract* **2007**, *13* (6), 670−1.

(18) Chaiamnuay, S.; Bertoli, A. M.; Roseman, J. M.; McGwin, G.; Apte, M.; Duran, S.; Vila, L. M.; Reveille, J. D.; Alarcon, G. S. African-American and Hispanic ethnicities, renal involvement and obesity predispose to hypertension in systemic lupus erythematosus: results from LUMINA, a multiethnic cohort (LUMINAXLV). *Ann. Rheum. Dis.* **2007**, *66* (5), 618−22.

(19) Gonzalez, L. A.; Toloza, S. M.; McGwin, G., Jr.; Alarcon, G. S. Ethnicity in systemic lupus erythematosus (SLE): its influence on susceptibility and outcomes. *Lupus* **2013**, *22* (12), 1214−24.

(20) Gran, S. Vitiligo and skin cancer: is it a question of ethnicity? *Br. J. Dermatol.* **2020**, *182* (4), 825−826.

(21) Chakraverty, D. Impostor phenomenon in STEM: occurrence, attribution, and identity. *Stud. Grad. Postdr. Educ.* **2019**, *10* (1), 2.

(22) Ramsey, L. R.; Betz, D. E.; Sekaquaptewa, D. The effects of an academic environment intervention on science identification among women in STEM. *Soc. Psychol. Educ.* **2013**, *16*, 377−397.

(23) Fisher, A. J.; Mendoza-Denton, R.; Patt, C.; Young, I.; Eppig, A.; Garrell, R. L.; Rees, D. C.; Nelson, T. W.; Richards, M. A. Structure and Belonging: Pathways to success for underrepresented minority women and women PhD students in STEM fields. *PLoS One* **2019**, *14* (1), e0209279.

(24) Woolston, C. A message for mentors from dissatisfied graduate students. *Nature* **2019**, *575* (7783), 551−552.

(25) Sanford, M. S. Equity and Inclusion in the Chemical Sciences Requires Actions not Just Words. *J. Am. Chem. Soc.* **2020**, *142* (26), 11317−11318.
(26) Shulman, J. Survey of Ph.D. Programs in Chemistry. https://www.acs.org/content/acs/en/education/students/graduate/survey-of-phd-programs-in-chemistry.html (accessed July 1, 2020).
(27) Sambrano, G. S. Underrepresented Minorities in Science: Enhancing Diversity in Science. *Science* **2001**, March 2.
(28) Chrousos, G. P.; Mentis, A. F. Imposter syndrome threatens diversity. *Science* **2020**, *367* (6479), 749−750.
(29) Vincent-Ruz, P.; Schunn, C. D. The nature of science identity and its role as the driver of student choices. *Int. J. STEM Educ.* **2018**, *5* (1), 48.
(30) Kim, A. Y.; Sinatra, G. M. Science identity development: an interactionist approach. *Int. J. STEM Educ.* **2018**, *5* (1), 51.
(31) Stets, J. E.; Brenner, P. S.; Burke, P. J.; Serpe, R. T. The science identity and entering a science occupation. *Soc. Sci. Res.* **2017**, *64*, 1−14.
(32) Rainey, K.; Dancy, M.; Mickelson, R.; Stearns, E.; Moller, S. Race and gender differences in how sense of belonging influences decisions to major in STEM. *Int. J. STEM Educ.* **2018**, *5*, No. 10, DOI: 10.1186/s40594-018-0115-6.

https://dx.doi.org/10.1021/acscentsci.0c00905
ACS Cent. Sci. 2020, 6, 1231−1240