

National Institutes of Health addresses the science of diversity

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The US biomedical research workforce does not currently mirror the nation's population demographically, despite numerous attempts to increase diversity. This imbalance is limiting the promise of our biomedical enterprise for building knowledge and improving the nation's health. Beyond ensuring fairness in scientific workforce representation, recruiting and retaining a diverse set of minds and approaches is vital to harnessing the complete intellectual capital of the nation. The complexity inherent in diversifying the research workforce underscores the need for a rigorous scientific approach, consistent with the ways we address the challenges of science discovery and translation to human health. Herein, we identify four cross-cutting diversity challenges ripe for scientific exploration and opportunity: research evidence for diversity's impact on the quality and outputs of science; evidence-based approaches to recruitment and training; individual and institutional barriers to workforce diversity; and a national strategy for eliminating barriers to career transition, with scientifically based approaches for scaling and dissemination. Evidence-based data for each of these challenges should provide an integrated, stepwise approach to programs that enhance diversity rapidly within the biomedical research workforce.

diversity | scientific workforce | underrepresentation in science | culture | biomedical research

Despite longstanding efforts, diversifying the biomedical research workforce remains an elusive goal, and large sectors of the US population remain underrepresented. These sectors include several racial/ethnic groups; economically disadvantaged individuals; people with disabilities; and women. Certain racial/ethnic groups are represented only minimally in biomedical research: of the nation's scientific research faculty positions, 4% are African American, 4% are Hispanic, 0.2% are Native American, and 0.1% are Hawaiian/Pacific Islander (1). There has been little increase in representation of these groups over the last 10 y, despite them collectively being the most rapidly growing portion of the US population, predicted collectively to comprise the majority by 2050.

A number of factors have been shown to contribute to the lack of diversity in science, technology, engineering, and mathematics (STEM) careers in general and in biomedical research in particular (2, 3)—among them are limited infrastructure and research experiences. The National Institutes of Health (NIH) has a long track record of investing in these areas given its mission to train the next generation of biomedical researchers (4). Although this investment has increased diversity in graduate student populations, the ranks of independent investigators and academic leadership remain sparsely populated by members of underrepresented groups.

Existing evidence suggests that enhancing and sustaining diversity requires an integrated set of interventions that—much like the task of biomedical research itself—relies on a reasoned, evidence-based approach that is rooted in the scientific method. Herein, we identify the need for scientific approaches that address four crosscutting diversity challenges: (i) research to support or refute evidence that diversity among scientists enhances quality and outputs of the research itself; (ii) evidence-based approaches to recruitment and training, including defining “effective research experiences and mentoring”; (iii) interventions that mitigate individual and institutional barriers to workforce diversity; and (iv) a national strategy to scale, disseminate, and sustain diversity effectively and sustainably within the scientific workforce.

Already there are diversity approaches underway at the NIH and beyond. At present, one challenge before us is to do the hard work of disaggregating results to date into a clearer understanding of how to apply successful diversity interventions contextually. In 2013, a report of the Diversity Working Group of the Advisory Committee to the NIH Director led to the appointment of the first NIH Chief Officer for Scientific Workforce Diversity (COSWD), who is responsible for creating, implementing, coordinating, and evaluating diversity-related issues across the NIH-funded research enterprise (5). Together with the rest of NIH leadership, COSWD is addressing what we see as four major diversity challenges facing the biomedical ecosystem.

Challenge 1: Among Scientists, What Is the Impact of Diversity on the Quality and Outputs of Research?

A literature base outside biomedicine indicates that diversity has a variety of beneficial effects, but more research is needed to support or refute evidence that diversity among scientists enhances quality and outputs of the research itself. Many research scholars approaching diversity have done so from a wide range of fields outside of biomedicine, including sociology, psychology, economics, education, team science, leadership, career development, and others. This growing body of evidence showing the benefits of diversity is best informed by the logic of diversity, with individuals conceptualized as tools, who when grouped in diverse combinations, increase workgroup/team innovation and creativity. This social science research in the field of economics provides strong support that groups composed of cognitively diverse individuals develop more effective approaches to solving complex problems relative to groups that are not cognitively diverse (6). In the corporate world, sex-diverse management teams outperform others across financial performance measures such as average economic growth, return on equity,

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and debt/equity ratios (7). Similarly, companies with more sex- and race-diverse business teams demonstrated greater market share, higher sales revenue, and increased profits compared with firms with less diverse business teams (8). In the technology arena, studies have shown that cultural diversity enhances information and communication technology teams' ability to make decisions (9). In health care settings, diversity among physicians and allied health professionals improves access to care for underserved groups, develops culturally informed care, and broadens the health research agenda (10, 11). At institutions of higher education, diversity among faculty and student bodies is beneficial for student learning, skills development, and for advancing intellectual engagement and democratic outcomes (12). One recent and compelling scientific example is a 2013 study showing that sex diversity had a positive effect on the quality of science produced by collaborative working groups of academic scientists (13). Similarly, papers coauthored by ethnically diverse contributors lead to greater contributions to science as measured by impact factor and citations (14).

However, because we still lack a solid body of evidence to understand the impacts of diversity in biomedical research settings in theory and in practice, we believe it is imperative for the NIH and other biomedical institutions, organizations, and funders to encourage additional rigorous fundamental research on diversity, including that related to effective management of diverse teams and the potential conflict that may arise without appropriate goal setting and attention to cultural issues (15). Accordingly, sometime in the next year, we are planning to issue an NIH funding opportunity for researchers to submit grant proposals to investigate the link between diversity in biomedical research teams and the outputs of the research itself.

Challenge 2: Which Evidence-Based Approaches to Training and Persistence in Biomedical Research Work? And in Which Contexts?

Despite the NIH's considerable investment over the last 25 y in training programs to enhance diversity at the undergraduate, graduate, and fellowship stages of biomedical research, underrepresentation of certain groups persists at every stage, and this lack of diversity is even more significant at the independent researcher stage. As a scientific community, we are tasked with learning how to apply or develop interventions across career transition points such that diversity expands beyond the undergraduate and graduate levels to faculty and academic leadership levels. At the NIH,

we are currently piloting various recruitment and retention strategies within the NIH intramural research program (IRP).

Observational studies suggest that intense research experiences coupled with self-reported "effective mentoring" are essential for persistence in biomedical research careers. However, we still have knowledge gaps about what constitutes effective research experience and mentoring. To address this gap, in October 2014, the NIH announced the first awardees of a 5-y, \$31 million Enhancing Diversity in the NIH-Funded Workforce program focused on scientifically driven approaches to enhancing diversity. The Enhancing Diversity in the NIH-Funded Workforce program is organized as a consortium consisting of three integrated elements: the Building Infrastructure Leading to Diversity (BUILD) program awarded to 10 universities that met eligibility criteria for being underresourced as defined by the funding announcement; the National Research Mentoring Network (NRMN), and a Coordinating and Evaluation Center (CEC) (16). Through this NIH Common Fund-supported initiative, we are looking for fundamental ingredients within programs and paradigms that allow institutions to understand (and replicate) effective strategies for student engagement, research training, mentoring, faculty development, and infrastructure development.

The BUILD, NRMN, and CEC are designed to provide functional and context-dependent definitions of successful recruitment and retention approaches and will complement other ongoing NIH- and National Science Foundation (NSF)-funded research on STEM diversity that are discussed at an annual conference convening behavioral/social science and education researchers, evaluators, and faculty to facilitate dissemination and exchange of hypothesis-based research on interventions and initiatives that broaden participation in science and engineering research careers (17).

Challenge 3: Identifying Psychological and Social Factors That Mitigate Individual and Institutional Barriers to Workforce Diversity

Defining effective research experiences and mentoring to enhance recruitment and persistence in biomedical careers is a central question in the NIH's scientific approach to understanding and enhancing workforce diversity. It is also important for us to investigate scientifically the various persistent barriers that frustrate sustainable change in diversity outcomes. In particular, it is time to look more deeply at psychological and interpersonal factors that have significant impacts at the

individual and institutional levels of biomedicine. Collectively, these efforts are contributing to a significant evidence base on interventions; communication and sharing are paramount.

Research has demonstrated the powerful impact that cultural, social, and psychological factors play in the pursuit of science careers (18, 19). The NIH's Enhancing Diversity initiative addresses explicitly two factors that we know affect career entry, retention, and advancement: unconscious bias and stereotype threat. Although unconscious biases may lead scientists to make flawed decisions about hiring (20), scientifically sound data support the efficacy of interventions to mitigate bias (21, 22). Stereotypes that alter an individual's sense of belonging in science can impede performance (23, 24), but we have strong evidence from a randomized controlled trial of undergraduates that interventions can overcome these untoward effects (25). In one study conducted at an elite university, investigators randomized students to a brief social belonging intervention designed to lessen psychological perceptions of threat on campus by reframing social adversity as a common and transient experience. The semester after the intervention, students' grade-point averages (GPAs) increased significantly, and the increase persisted for 3 y. In contrast, students randomized to a control group had no increase in GPA throughout the follow-up period.

Recently, NIH-funded research has identified measures and interventions to address cultural barriers (26) and to test coaching interventions for biomedical trainees from underrepresented groups. These interventions are built on social science theories, such as communities of practice, cultural capital, and social cognitive career theory (27). In addition, NIH's Center for Scientific Review (CSR), working with the NIH Advisory Committee to the Director's Subcommittee on Peer Review, has been pursuing multiple evidence-based approaches to assess and address possible bias in NIH peer review. Efforts include testing the utility of anonymizing grant applications before review; conducting qualitative studies to gain a richer understanding of scientific, technical, and demographic issues that might affect funding disparities; using text-mining software to examine applications and reviewer critiques for evidence of potential bias; continuing to examine the process by which reviewers evaluate grant applications for indicators of bias; and continuing NIH's Early-Career Reviewer Program to provide opportunities for early-stage researchers to jump start their careers by serving on a review panel. A third of researchers who have been accepted into this program are

individuals from groups underrepresented in biomedical research.

COSWD has also begun intervention studies within the IRP to test specifically the efficacy of focused career development programming during postdoctoral and early-independent scientist career stages. We are testing the efficacy of social belonging interventions among IRP scientists from underrepresented groups, and trans-NIH experiments will measure individual and collective unconscious biases related to identity and science. We expect that our efforts to assess diversity interventions within the NIH IRP will shed light on enhancing diversity more broadly at NIH-funded institutions across the country.

Challenge 4: Develop a Scalable Strategy to Effectively Disseminate and Sustain Diversity Within the Nationwide Scientific Workforce

To complement the activities of our intramural efforts and the extramural Enhancing Diversity initiative, the NIH is developing plans, in consultation with academic leaders, for “diversity hubs of innovation,” situated regionally across the nation. Tentatively, each hub will represent a unique geocultural ecosystem consisting of one research-intensive, “traditional,” institution, grouped together with several nontraditional institutions colocated geographically. Although much more discussion and consideration of options are needed, we currently envision the hubs to be highly interdisciplinary environments involving biomedical researchers, clinicians, social scientists, educators, economists and business school faculty, evaluators, anthropologists, and community leaders representative of each hub’s geocultural context. The overarching goal of each innovation hub will be to eliminate barriers to transition across each stage in the biomedical career path, including movement into research independence and leadership positions, thus targeting a pivotal career advancement barrier. Hub activities could be designed to produce specific deliverables, including infrastructure support systems, context-specific best practices, and models for effective mentoring, as well as defining a new career path for the development of diversity scholars trained in all elements required to catalyze expansion and main-

tenance of a diverse workforce. To continue to expand the evidence base of what works, and in which settings, such “translational behavioral scientists” would conduct large-scale field experiments that are firmly anchored in social psychological frameworks.

Workforce Diversity Is a Scientific Opportunity

NIH leadership, through COSWD, is using a range of strategies and programs applied extramurally and intramurally with the central goal of understanding and documenting factors that contribute to diversity or its absence, such that evidence-based solutions can be designed and implemented in a timely manner. We acknowledge the complexity of understanding diversity in the context

of biomedical research and human health. However, we view this complexity in much the same way as we see scientific challenges presented throughout all areas of biomedical research: as opportunities to be explored using scientific principles. Moving forward necessitates a proactive, research-driven agenda and a multidisciplinary approach, underscoring the need for cognitive diversity to drive creative solutions. As two scientists who have successfully participated in paradigm shifts at two ends of the biomedical research continuum—heart transplantation (Valantine) and human genomics (Collins)—we are confident that using the rigors of the scientific method will help us realize the untapped potential of a diverse biomedical workforce.

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