

# Prime–boost strategies to embrace diversity and inclusion in immunology

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Immunologists appreciate the need for creative approaches to tackle complex scientific questions, which can involve not only the use of novel technologies but also the experience of scientists from diverse backgrounds. Here, we highlight measures to prime for the inclusion of women and underrepresented individuals in science to boost immunology research.

Pioneering figures in immunology (such as Élie Metchnikoff and Susumu Tonegawa) exhibited diversity of thought and approach to make significant contributions to the field. Furthermore, immunologists appreciate diversity in antibody and T cell repertoires to combat a wide array of pathogens. Therefore, it seems fitting that immunologists should value diversity and inclusion (D&I) in the immunology workforce to enhance scientific understanding.

In the United States, which reflects measures globally, D&I efforts focus on broadening the participation of women and historically underrepresented groups (African–American, Hispanic/Latino, American Indian, Alaskan Native and Pacific Islander) in the scientific workforce. Progress to improve the participation of these groups in immunology has been steady<sup>1</sup>, mainly as a result of efforts by Federal agencies such as the National Institutes of Health (NIH), in particular the National Institute of Allergy and Infectious Diseases (NIAID) and the National Institute for General Medical Sciences (NIGMS). These agencies fund programmes aimed at increasing the number of women and underrepresented scientists at the earliest stages of the career pipeline. In addition, the Obama administration has supported efforts to increase the participation of underrepresented trainees in science, technology, engineering and mathematics (STEM)<sup>2</sup>. It is important that these efforts continue in the face of funding cuts, and future efforts help to ensure women and underrepresented scientists remain in the scientific workforce at all career stages. This will require strategic coordination between government, academic and non-profit organizations and industry.

## Attraction versus retention

D&I efforts to increase the number of women and underrepresented scientists have shown gains over the past twenty years; however, these gains are not reflected in leadership and key decision-making positions. Although women of colour make up 12.5% of the US population, they constitute only 2.3% of faculty members on the tenure track or who are tenured<sup>3</sup>. Significant barriers remain

for the recruitment and, importantly, retention of women and underrepresented scientists. In many cases, barriers to career progression can stem from trainee perceptions of the workforce climate. One study found that women and underrepresented trainees were less likely to be interested in research careers at the completion of their Ph.D. degrees compared with majority men<sup>4</sup>. Creative strategies are needed to continue to increase the pool of women and underrepresented trainees and to retain current talent.

## Interventions to increase diversity

Universities and colleges are a gateway for introducing students to biomedical research. The proportion of women entering STEM graduate programmes (including immunology) exceeds men in many cases<sup>5</sup>, but there remains an imbalance in the proportion of underrepresented trainees. Several immunology programmes focus on increasing the participation of underrepresented trainees through active recruitment, fellowships, summer programmes, including women and underrepresented immunologists in seminar series, leveraging NIH-funded and other initiatives, and creating a welcoming environment for all students. Such efforts are crucial for eliminating barriers to access and mitigating feelings of isolation.

Scientific professional societies and non-profit organizations also have a key role in supporting women and underrepresented scientists. *Keystone Symposia* hosts conferences across various biomedical disciplines, including immunology. Its Diversity in Life Sciences Program (DLSP) is committed to supporting women and underrepresented scientists, which was initially accomplished through travel awards to conferences. DLSP has since expanded its efforts to include the Keystone Symposia Fellows Programme, which introduces early-career scientists to the conference-development process. The Programme further fosters professional development by promoting networking among Fellows and with preeminent scientist mentors (both underrepresented and majority). So far, the DLSP has recruited more than 50 Fellows from biomedical disciplines including immunology. The

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## Box 1 | Perspectives of successful female underrepresented scientists

**Margaret Bynoe, Associate Professor of Immunology, Cornell University, USA**

“There are small numbers of female underrepresented immunologists and disparity in funding. This disparity is not just as reported by the NIH but more widespread. Unfortunately, this can determine the trajectory of our careers. While there are a few more underrepresented scientists today compared to when I went into science in the 1990s, it will be important that more effort is put into training and development of underrepresented scientists.”

**Amariliz Rivera, Assistant Professor, Rutgers New Jersey Medical School, USA**

“As a Puerto Rican woman scientist, I have a unique perspective that influences the way I tackle scientific challenges. Biomedical research is a global enterprise, in which different perspectives are crucial for novel solutions to complex problems. Hence, enriching the immunology community by diversifying its workforce will advance scientific breakthroughs in our field. Women and underrepresented trainees benefit from mentoring programs providing career advice. Establishing a successful research program entails more than becoming technically proficient. It is important that we continue to support career development programmes that enhance the training experience of future generations of scientists.”

experiences of *Keystone Symposia Fellows* are captured in podcasts. The DLSP also hosts mentoring sessions at its immunology conferences, providing opportunities for early-career scientists and preeminent scientists to discuss relevant professional development topics.

The *American Association of Immunologists (AAI) Minority Affairs Committee (MAC)* sponsors events at the society's annual meeting that include a careers roundtable session to introduce scientists to various career options and the Vanguard Lecture, which showcases the research of a prominent underrepresented scientist. To broaden its impact, the MAC collaborates with other AAI committees and, in 2016, initiated a partnership with the *Annual Biomedical Research Conference for Minority Students (ABRCMS)*.

ABRCMS, which is organized by the *American Society for Microbiology (ASM)*, is the largest conference focused on the professional development of underrepresented undergraduates in biomedical disciplines (including immunology). It provides an opportunity to enhance the earliest stages of the scientific pipeline through poster and oral presentations, as well as professional development activities. Graduate programmes seeking to diversify their trainee populations regularly recruit at ABRCMS.

*The Partnership* focuses on developing multicultural leaders at all professional levels and in various areas (scientific and non-scientific) to foster a corporate climate that is competitive in a global economy. In 2016, The Partnership created its BioDiversity Fellows Program, which targets mid-career professionals in the life sciences. This programme helps participants to refine their leadership, relationship-building and organizational skills. The inaugural class consisted of nine individuals (including an immunologist) from across academic and government institutions and industry.

### Creative strategies to propel science forward

To ensure that we have a broad array of perspectives at the decision-making table, scientific organizations should redouble efforts to support women and underrepresented scientists. Many current initiatives focus on early stages of the pipeline; it will be equally important to support

individuals at all career stages and re-focus some efforts on later stages, as exemplified by *Keystone Symposia* and *The Partnership*.

It will also be crucial to consider a more expanded definition of a successful scientific career. Several reports emphasize the shrinking number of academic faculty appointments for a growing postdoctoral population<sup>6</sup>. Recent efforts to increase preparedness for non-academic positions include the NIH-funded *Broadening Experiences in Scientific Training (BEST)* programmes<sup>7</sup>. Other approaches include identifying measures that foster success rather than focusing on barriers for women and underrepresented scientists. The ASM surveyed biomedical researchers from various disciplines, including immunology, to determine factors that contribute to the success of underrepresented scientists (details to be published). Early results suggest the need for better preparation for non-academic positions at the graduate level. Importantly, survey participants ranked mentorship as a key contributor to success, together with financial support or NIH-funded programmes.

Finally, it will be imperative to foster better communication and cultural competency among individuals from different backgrounds. Recent reports have highlighted explicit bias against underrepresented scientists at research-intensive biomedical facilities in the United States, prompting an open debate on how to foster a more inclusive environment<sup>8</sup>. The good news is that national conversations with biomedical researchers and science policymakers are taking place — a clear signal that the scientific community is committed to achieving greater equity for women and underrepresented scientists<sup>9</sup>.

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The authors declare no competing interests.

### FURTHER INFORMATION

American Association of Immunologists: <http://www.aai.org>  
 American Society for Microbiology: <http://www.asim.org>  
 Annual Biomedical Research Conference for Minority Students: <http://www.abrcms.org/>  
 Keystone Symposia: <http://www.keystonesymposia.org/>  
 The Partnership: <http://www.thepartnershipinc.org>

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