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ASCB 50TH ANNIVERSARY ESSAY

A Richer and More Diverse Future for Cell Biology

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Our vision: within the next few decades the composition of the faculty of cell biology, and of all biological science departments, will reflect the diverse composition of the graduate students in those departments. We are far from that reality today. Disparities in representation exist for both gender and race. Tyrone Hayes' essay in this volume provides a compelling discussion of the challenges faced by people of color in the sciences. Here we focus on gender. Fully 50% of current biology Ph.D. graduates are women. Most of those women continue training as postdoctoral fellows. Yet the percentage of women declines with each advance along the tenure-track academic career path, so that <20% of full professors in the biological sciences are women (c17 Committee on Maximizing the Potential of Women in Academic Science and Engineering, 2007); the number drops to <15% in top-tier institutions (Handelsman *et al.*, 2005).

At almost every major scientific conference the featured speakers are predominantly (typically more than 70%, and sometimes almost exclusively!) male. Meeting organizers will reasonably point out that the outstanding scientists invited as featured speakers are drawn from the pool of more established investigators. Thus the number of invitations to women is in fact proportional to their numbers in the senior faculty ranks. Often implicit in this argument is the notion that earlier differences in the numbers of women graduates are largely responsible for the paucity of women speakers and that it is just a matter of time before balance is achieved. However, the numbers show that the mere passage of time is not enough. A 2003 National Academies of Science (NAS) report comparing percentages of women assistant, associate, and full professors relative to pools of Ph.D.s who graduated 0–6, 7–15, or ≥ 16 years, respectively, before 2003 has documented a $\geq 20\%$ drop in the proportion of women at each stage (c17 Committee on Maximizing the Potential of Women in Academic Science and Engineering, 2007).

The women (and men) who leave academia and use their scientific training to follow other career paths contribute significantly to society in diverse and valuable ways. So why is the loss of women important, and how does it affect cell



Clockwise from top: Sandra Masur, Ursula Goodenough, Phoebe Leboy, Molly Carnes, Virginia Valian and Nancy Hopkins. Center: Sandra L. Schmid.

biology and biomedical research? Creating and maintaining diversity in science is important for several reasons. First, diversity provides a greater opportunity for innovation: breakthroughs emerge by looking at complex problems from diverse perspectives. Second, as some businesses are realizing and several studies have shown (Page, 2007; Polzer *et al.*, 2002), inclusive enterprises with a diverse work force that recognize and value unique individual contributions tend to be more successful than more homogeneous ones. Third, as the complexity of scientific problems increases, the need to build and to work within inter- and multidisciplinary teams increases. Women leaders have documented success in building inclusive teams that solve complex problems (Eagly and Carli, 2007; Caliper, 2005). Fourth, huge resources are invested in training graduate students and postdocs. Therefore, according to the NAS report (c17 Committee on Maximizing the Potential of Women in Academic Science and Engineering, 2007), “neither our academic institutions nor our nation can afford such underuse of precious

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human capital in science and engineering." Importantly, ample evidence shows that the slower advancement of women is not due to differences in early career aspirations, mathematical or cognitive abilities, productivity, or other objective performance criteria (c17 Committee on Maximizing the Potential of Women in Academic Science and Engineering, 2007).

What will have changed to enable this greater diversity and to more equitably harness the talented pool of today's graduate students? In other words, what are the barriers maintaining the current inequitable situation? Virginia Valian, in her book *Why So Slow: The Advancement of Women* (Valian, 1999), describes two critical factors. The first is "gender schemas," frameworks we all use to differentially perceive the roles and behaviors of men and women in our society. The second is "the accumulation of advantage," the fact that small differences add up to considerable disparities in advantage and disadvantage over time. The latter point is driven home by a computer simulation in which an equal pool of 500 men and women progress through eight stages of promotion to fill the top ten positions in a hypothetical hierarchical organization. Even if a tiny bias in favor of men—one that accounts for only 1% of the variance—operates at each decision stage, then men ultimately occupy 65% of the top positions (Martell *et al.*, 1996). As Valian puts it, "molehills can become mountains."

Gender schemas exert their influence largely outside of awareness. Although everyone intends to treat others fairly, gender schemas affect the ways in which we interact with our children, teach our students, mentor and promote our postdocs, hire our colleagues, and assess our peers' grants and papers. In numerous laboratory studies, when panels or individuals are asked to evaluate identical resumes, career accomplishments, or professional performance, average ratings are lower when the subject is identified as a woman (Handelsman *et al.*, 2005; Valian, 1999). Importantly, this disparity is true regardless of evaluators' gender. Men and women are equally likely to underrate women.

One striking study of review panels of the Swedish Medical Research Council found that to receive the same rating in "scientific competence" women applying for postdoctoral fellowships needed to publish substantially more papers and/or in higher impact journals than their male peers (Wenneras and Wold, 1997). The good news is that judges are responsive to data. Follow-up work demonstrates that since the publication of the landmark Swedish study, there is no longer any disadvantage for women applying to these review panels (Sandström and Hällsten, 2008).

In the future, if we do our job right, a career in science will be equally and highly attractive to both girls and boys. Their perception of the stereotypical scientist will be gender-neutral. Thanks to a more diverse faculty, a greater appreciation of the value of diversity, and an understanding of how unintentional differences in treatment produce unequal benefits, male and female graduate students will be mentored more effectively. Outstanding women and men who demonstrate a passion for exploration, and the requisite creativity, intuition, and deductive reasoning skills will be equally encouraged and supported in their pursuit of academic careers. Scientists will work in fluctuating multidisciplinary teams in a spirit of cooperative competition to solve complex problems. Peer review will be rigorous, yet constructive: it will be free of unintended differences in treatment based on sex or race. Institutions will be more flexible in tenure and promotion decisions for both mothers and fathers, realizing that the time they spend raising a family is an important and

integral period of a multi-decade productive career in science. Institutions will provide resources and daycare centers to accommodate parents, so that talented young faculty will be productive and supported.

Can we achieve this nirvana? We are optimistic given the enormous progress that has been made in the past decade since the release of a report on the Status of Women Faculty in Science at MIT (Massachusetts Institute of Technology, 1999). For example, at that time there were zero women in the academic administration of science or engineering. Today the President of MIT is a woman, three of five current Deans are women, two of six department chairs in science and one in engineering are women; the numbers of women faculty in science and engineering have more than doubled. Having children is now not only discussed openly, but women have actually taken maternity leaves and gotten tenure—for the first time in MIT's history. Finally, there is a daycare center in one of the most prominent and heavily trafficked places at MIT. MIT is not alone: other universities have achieved similar results. In some cases these changes were initiated through National Science Foundation ADVANCE grants (Sheridan *et al.*, 2010). In all cases they have required consistent effort and the partnership of women and men faculty with committed administrators, both male and female. To achieve our vision we will need to continue these efforts and ensure that people in leadership positions fulfill their mandate to *lead*. Fortunately, from these positive examples we now know a lot about how to support, recruit, retain, and promote the excellent women researchers who graduate from our Ph.D. programs. With increased appreciation for the importance of diversity and heightened sensitivity to unintended bias and its cumulative consequences, we can all contribute to accomplishing our vision.

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