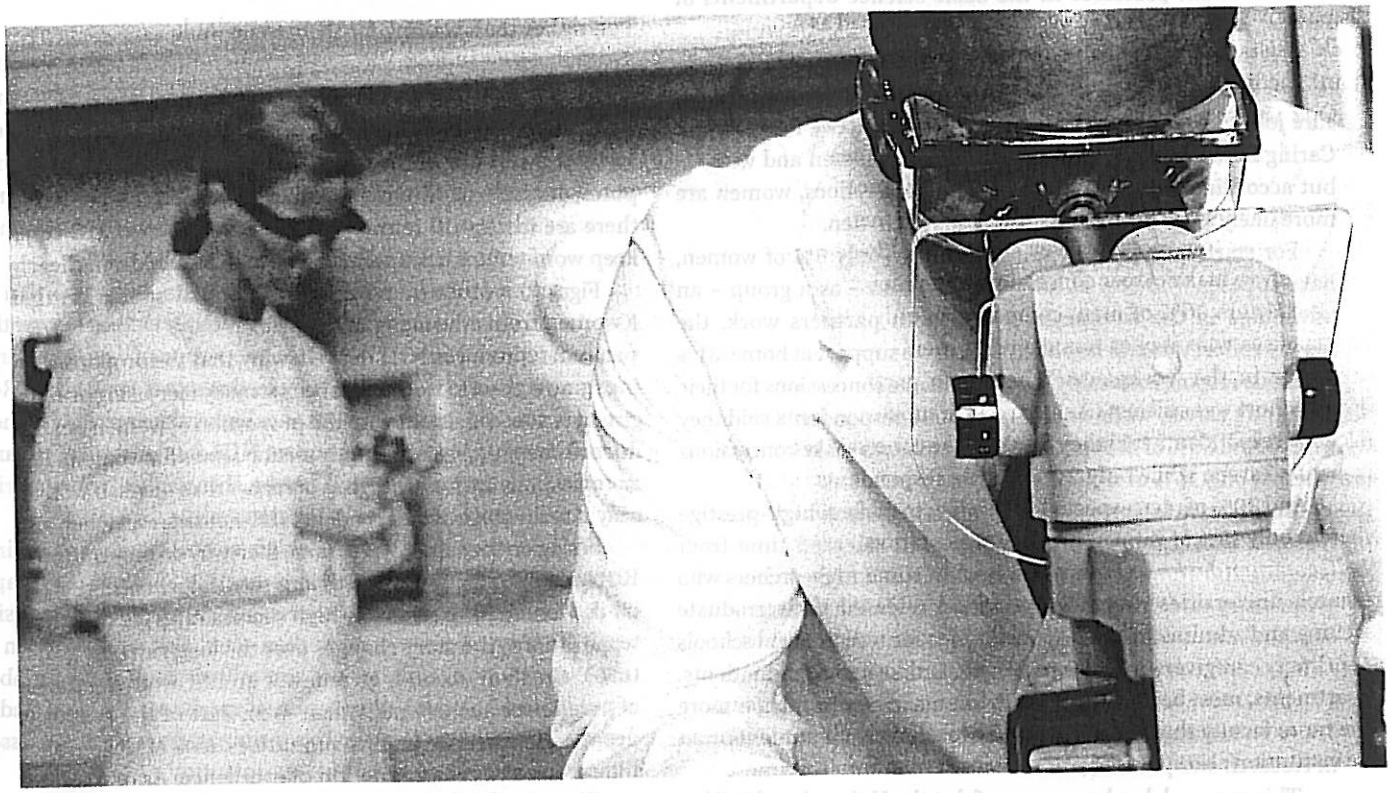
JANUARY 2008 Careers



Fixing the Leaky Pipeline

Why aren't there many women in the top spots in academia?

By Phoebe Leboy

Back in 2006, I took a quick survey of the basic science departments in medical schools to see how women were doing in science. Close to half of the top 10 National Institutes of Health-funded academic health centers had no women among their junior tenure-track faculty in their biochemistry and cell biology departments. Looking at such statistics, a young woman might get the impression that her shot at the faculty positions at these schools would be difficult, if not out of reach. When I surveyed the schools, Harvard Medical School had 23 tenure-track faculty members in its cell biology and biochemistry/ molecular pharmacology departments, but none were women (since then, two women have joined the ranks). Why are so few women making it onto the tenure ladder at major medical schools?

These top institutions represent an extreme example of a general problem. For example, the NIH reports that only 20% of their senior scientists are women. Postdoctoral award data show that the biomedical pipeline is filled with good candidates, but disproportionately few get into the tenure track stream at major research institutions. Clearly some major leaks along the way are causing only a trickle of women to make it to the top.

The postdoc to tenure track leak

One of the most significant leaks in the pipeline occurs during the postdoc to tenure-track transition (*EMBO Reports*, 8:977-81, 2007). At the University of Pennsylvania, where I was on the faculty for 42 years, the basic science departments in the ▸

In 2004 women earned:

- 40% of U.S. PhDs in biochemistry
- 48% of U.S. PhDs in cell biology
- 47% of NIH postdoctoral awards
- 42% of NIH research career (K) awards

Looking at statistics, a young woman might get the impression that her shot at the faculty positions at these schools would be difficult, if not out of reach.

medical school had 18 women who were tenure-track assistant professors in 1999. By 2007 the number had dropped to four. In the past five years, only one woman has been hired as a tenure-track assistant professor in the basic science departments of Penn's medical school.

One widely acknowledged reason for the dearth of women in tenure-track assistant professor positions is that these high pressure jobs coincide with a woman's last best chance for children. Caring for a newborn child is a stress on both men and women, but according to a recent survey of NIH postdocs, women are more likely to make career concessions than men.

For starters 36% of men, compared to only 8% of women, have spouses who stay at home, giving men – as a group – an advantage in the workplace. When both partners work, the female cohort was still less likely to receive support at home. 31% of female respondents said they would make concessions for their husband's career, while only 21% of male respondents said they would. And 30% of men expected their wives to make concessions whereas only 15% of women had that expectation.

Recommendations: Follow the lead of some high-prestige research universities that have provided released time from teaching and administrative responsibilities for researchers who are primary caregivers – male and female. Unlike undergraduate departments, most basic science departments in medical schools have more faculty than are required for teaching their students. The institution also stands to gain, because grant funding is more apt to be maintained when junior faculty maintain momentum in research and publications.

This approach has been successful at the University of California, Berkeley, where 45% of tenure-track women take advantage of "reduced duties" policies.

When filling a faculty position, publicize the fact that your institution has family-friendly policies, and then actively recruit women rather than waiting for them to apply.

The assistant professor to tenure leak

Rearing children during the most demanding times in a scientist's career is just one of the issues women face. Many academic women don't have children. According to a UC, Berkeley-based survey of nearly 9,000 tenure track scientists across UC campuses, 48% of tenure track women did not have children. Clearly there are factors other than feelings of familial obligation that keep women from advancing in science.

Figure 2 reproduces NIH data showing that the proportion of K-series grants given to women has been steadily increasing over the years, and is now consistent with the proportion of women emerging from biomedical postdocs. Study section scores for women's R01 grant applications are now as high as or higher than men's. If women do make it to the stage of independent NIH-funded researcher, and are competing on the same level as men, then why do they comprise only 20% of senior faculty at prestigious medical schools?

While women have relatively high success rates for their first R01 applications, the story changes over the long run (see graph on p. 70). On their second, or renewal grants, women consistently have lower success rates than men. Part of the reason is that grant reviewers, like tenure committees, look at the number of publications as a major criterion of excellence. As one candid department chair explained it to a terminated assistant professor I know: "Quality is no substitute for quantity."

Women scientists, on average, do produce fewer publications than men (*EMBO reports*, 8:982-7, 2007). Why is that? Several answers have been suggested by the National Academies of Science ▸

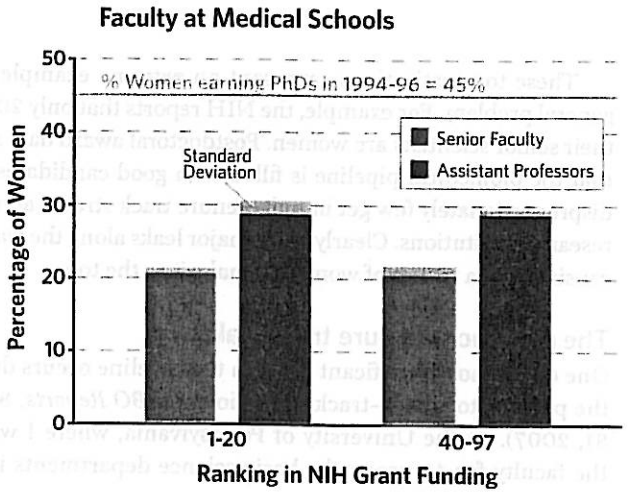


Fig 1. Women earned 45% of biomedical PhD in 1994-96. More than ten years later, women constitute around 20% of senior faculty and less than 30% of junior faculty in medical school basic science departments.

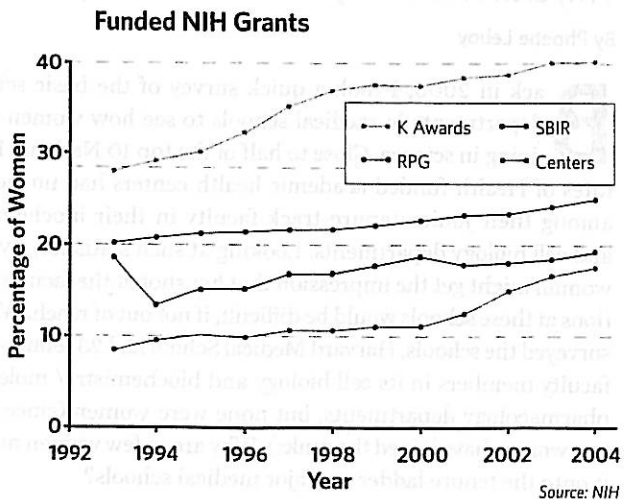
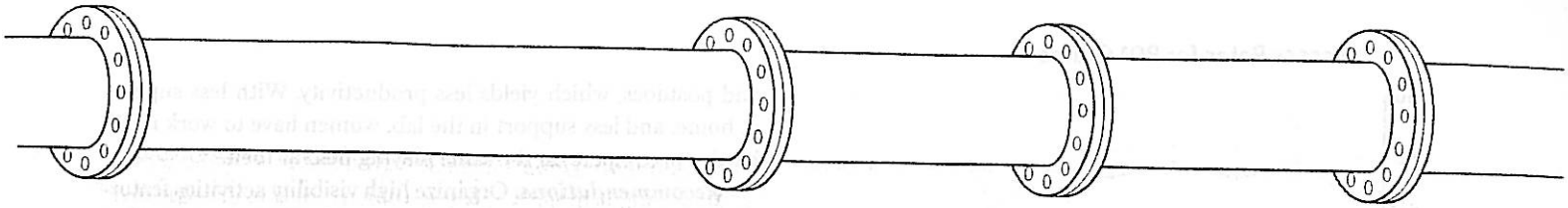


Fig 2. While women get over 40% of K awards series, women recieve less than 20% of NIH research center grant awards.



Help women stay in science

A female scientist gives her top 10 list for men, and our readers respond with tips of their own.

By Laura Mays Hoopes

Editor's Note: In October, we published online an article written by Laura Mays Hoopes, in order to spark discussion on gender disparity in science. More than 70 readers wrote comments, a sample of which are included at the end of this article. To see all of the comments, go to www.thescientist.com/news/display/53655/.

Here are Hoopes' tips followed by suggestions from our readers to help keep women in science:

1. Call a woman scientist from time to time, to chat about science, a recent breakthrough, your puzzling results, their puzzling results. Even better, call one once a week.

2. Every time you have to recommend a scientist to speak at your seminar series, replace "young man" in your thoughts with "young woman" or even "old woman."

3. If you're on a hiring or tenure committee, don't start reading the files until after you review the primary literature on unconscious bias. You can access references from Jo Handelsman's site (www.plantpath.wisc.edu/fac/joh/joh.htm).

4. Support the development of a child care center at your university or college. Women produce babies and they need the day care.

5. When you are organizing a scientific meeting, invite some women scientists to be speakers.

6. When you walk through the posters, where women who were not invited present their work, stop and talk with them about what they've been doing. When you do, don't look over her shoulder, listen.

7. When you chat with a woman scientist at a scientific meeting, invite her to join you and your friends for a lunch or dinner. She may eat in her room to avoid eating alone in a restaurant while watching you and your (male) friends laughing at the next table.

8. When you think about someone to appoint to an editorial board or to write a review article, be sure to consider women as well as your particular favorite young men and male cronies.

9. When you are looking for a nominee for an award (I'm not talking about the awards for the BEST WOMAN, I'm talking about research awards in general), replace that "young hotshot man" image with a "young hotshot woman" image. Or even an "old hotshot woman." If you don't know anyone to consider, E-mail me at lhoopes@pomona.edu and I can suggest someone.

10. When you're spoiling for a fight, call the National Library of Medicine and complain that you can't properly track the publications women have produced for your award committee because they have no way to let PubMed know all of their different names so they can be connected in one list of publications.

Laura Mays Hoopes is a writer and the Halstead-Bent Professor of Biology and Molecular Biology at Pomona College.

TIPS FROM OUR READERS:

» Men can help women in science by playing a larger role in childrearing, and broadcasting the importance of that role to their students, says Marc J.E.C. van der Maarel.

» "Advancement in science is related to prestige and quality of personal network," writes Anthony Dennis. One way to bolster that network is that is to get on the board of promising start-up companies. "Next time you look for a board member, pick a qualified female," says Dennis, himself a CEO.

» Help new moms in your lab with advice and support. "Resist the urge to see them as lost causes who are personally responsibility for having made poor, career-jeopardizing choices," writes Penelope Duerksen-Hughes.

» Introduce your female colleagues or students to leaders in the scientific community and engage them in conversation about their work with others, writes Suzanne Wuerthele. It's a great way to encourage and validate any student.

» Give women advice on how to recruit good graduate students and post-docs, writes Marguerite Butler. Finding motivated students and fellows "can be akin to winning the lottery."

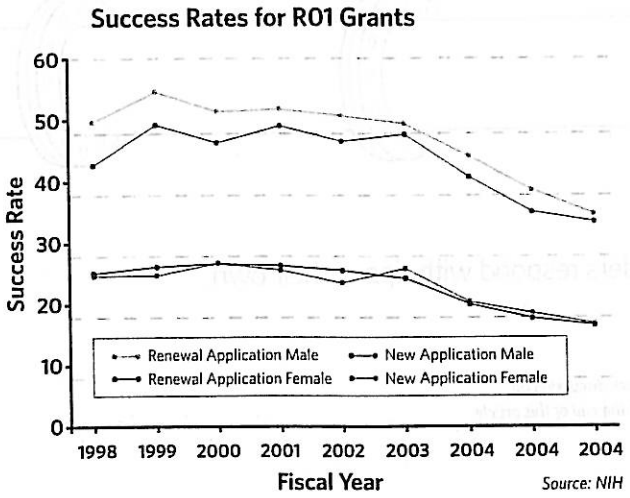


Fig 3. In the first round of R01 awards, women do as well as men. But women trail men on renewal awards.

2007 report, "Beyond Bias and Barriers." One reason suggested in the report is that women, on average, devote more time to teaching and mentoring than men. Another is that women value advising students while men give greater emphasis to competition. The NAS report also suggests another possibility that has been largely ignored to date: that women have less access to the support systems and resources that increase faculty productivity.

In the world of biomedical research, good graduate students and postdocs are the hands and minds that can convert an excellent scientist into a highly productive scientist. They will drive the output of papers, contribute ideas and data leading to new research avenues, and markedly increase the overall productivity of the lab.

Successful graduate students and postdocs are savvy about what it takes to succeed in today's world of science. Both male and female graduate students perceive young women scientists as having less prestige, less clout, fewer contacts and less funding. The result is that women assistant professors are less likely to attract high quality graduate students and postdocs.

As far as money is concerned, those trainees would be right. As Charlotte Schubert reported in *Nature Medicine* (11:1129, 2005), for every funding dollar allocated to a research grant of a male principal investigator (PI), the average grant of a female PI provides 80 cents. This is, in part, because women are less likely to be PIs on NIH grants with larger dollar caps. Center grants with big budgets are consuming an increasing portion of the NIH budget, but less than 17% of center grants are awarded to women, compared to 24.5% of R awards (R01, R03, R21). As more and more funding dollars are shifted to large multi-investigator projects, the ability of women to gain parity in dollars per grant will no doubt decline further.

The data showing that women receive less money per grant and publish fewer papers contribute to the perception that young female scientists have less status and influence. The bottom line is a vicious cycle: less productivity yields fewer good students and postdocs, which yields less productivity. With less support at home, and less support in the lab, women have to work much harder to compete on the same playing field as men.

Recommendations: Organize high visibility activities featuring the accomplishments of junior women faculty to increase their status with graduate students. Seek out women faculty to be PIs on multi-investigator grants, center grants, and core facilities grants to boost parity. Then evaluate scientists for promotion based on the quality of research they produce – using citation rates, for example – rather than the number of publications and how much income they bring in. Some high prestige institutions assess the quality of their scientists' work by asking for, and reading, the 4-5 papers that the researchers identify as their most seminal work.

The awards leak

Once all of these challenges have reduced the availability pool, there is yet another considerable issue to overcome: the perception of excellence. The recent NAS report describes studies showing how the stereotype that women scientists are less prestigious is still prevalent.

What's keeping search and award committees from thinking of the many highly-qualified female candidates? Why do so few female scientists get awards like a Lasker or the Nobel for their contributions to science? The subtle bias described in the NAS report suggests that women do not fit the image both men and women have of prestige and leadership.

According to the Recognition of the Achievements of Women In Science, Medicine, and Engineering (RAISE) project's website, only 8.6% of Lasker Awards since 1991 have gone to female scientists. The RAISE project also reports that of the 474 awards they've counted, a full 33% have never gone to women.

Recommendations: I looked at the invited speakers at the Keystone symposia – one of the most well-regarded set of conferences in the life sciences – and tallied the number of invited speakers across 32 meetings encompassing seven fields. When a woman was present on the search committee the percentage of speakers who were women was 32%, while without any women among the organizers the percentage dropped to 25%, a statistically significant difference. Make sure all search committees for faculty positions as well as conferences contain a critical mass of women. Actively recruit women for leadership roles. Reconsider your personal definition of a driven and impressive scientist.

What's keeping search and award committees from thinking of the many highly-qualified female candidates?

These are not the only solutions, but they're a start. Until academic science begins to address why top tier institutions have so few women among their biomedical faculty, young women are likely to find their prospects unsatisfactory and choose other options. ■

Phoebe Leboy is a professor of biochemistry emerita at the University of Pennsylvania, and the current president of the Association for Women in Science.

By Richard Gallagher

EDITORIAL

Am I Sexist?

Here's how *The Scientist* will take action to support women in science.

IT'S ALWAYS A SHOCK TO REALIZE THAT YOU'RE IN THE WRONG. AS THIS issue was going to press, I found myself tut-tutting at the data that Phoebe Leboy presented (p. 67) on the number of women scientists in the more senior positions at academic institutions. At the end of 2006, Harvard Medical School had no women among 23 tenure-track faculty in cell biology and biochemistry/ molecular pharmacology. Two have joined since then, but that's still a scandalous figure. The number of female assistant professors at the University of Pennsylvania has dropped from 18 to four in the last eight years? Shocking! Why don't the crusty old beggars that run research play fair?

Just because there isn't a conscious bias doesn't mean that it doesn't exist.

Then I became uneasy: What is my own record in recognizing senior female researchers? The answer is, very poor. At *The Scientist* one of the ways of acknowledging leadership in the life sciences is to invite leaders to serve on our Editorial Advisory Board. A quick glance at page 11 will show you that it's an outstanding group of people. But you'll also see that it's light on women members: There are precisely three, out of 22. At 14%, I'm in Harvard Medical School territory. That's hardly the ideal position from which to criticize the NIH (my original intention), which reaches the giddy heights of 20% women among its senior scientists.

Umpteen complexities that don't exist in selecting an advisory board factor into the hiring of senior scientists, but perhaps looking at how we at *The Scientist* select our advisory group will shed some light on the wider problems of recognition for women in science.

There are two main criteria for our board members. First, they must be at the peak of their chosen profession. Roughly half are prominent researchers, while the others are notable leaders in some aspect of the business of science. Second, they should have some inclination towards the mission of *The Scientist*, which is to provide life sciences professionals with useful, entertaining, and accurate coverage of their world.

In practice, deputy editor Ivan Oransky and I identify candidates through articles they've written. Or, better, we meet scientists at talks. Neither of us considers ourselves sexist, and we don't believe that gender is a factor in excelling in research or business. We've editorialized in support of women in academia.[1]

So why the paucity of women on our board? A 2005 article in *Science* identified four cultural and structural impediments to women in science.[2] Three of the four – the low number of women trained, hostility from colleagues, and balancing family and work – do not apply in our case. I have to conclude that I fall into the fourth category: "People who are committed to egalitarian principles and believe that they are not biased may nevertheless unconsciously or inadvertently behave in discriminatory ways." The article describes programs in which "faculty members are encouraged to recruit women by deliberate action to overcome unconscious biases and to cultivate professional relationships with promising women scholars at professional meetings."

Laura L. Mays Hoopes provides other, more pointed suggestions on page 70, which prompted some lively exchanges on our Web site. Of course, not everyone agrees that there's a problem: "The last time I checked, science was about just that, science, and not what gender you are," wrote one commenter. "If you do good science, can plan and execute the experiment well, draw the right conclusions, and ask the right questions, no one cares what you look like." That's just wrong. Just because there isn't a conscious bias doesn't mean that it doesn't exist, as my example illustrates.

The solution in my case is clear: Direct action. Most of the leaders we will invite to join the board in the near future will be women, with the aim of having women comprise a minimum of one-third of the members by the end of this year.

If this seems like affirmative action, I make no apologies for it. In cases where there the path to a just goal is littered with complexities that will cause endless delay, setting quotas is often the best way of cutting through the clutter. I'd like to see institutions set strict ratios on the numbers of senior female scientists that they must employ too – the sooner the better. ■

rgallagher@the-scientist.com

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2. J. Handelsman et al., "More women in science," *Science*, 309:1190–1, 2005.

Science vs. the Female Scientist

By Shirley M. Tilghman

In the last two years, we have witnessed a flurry of concern over the under-representation of women and minorities in science and engineering. The concern does not arise from a belated appreciation that women and minorities have been denied access to careers in science. Rather it comes from projections of a significant shortfall in scientists around the turn of the century, caused, at least in part, by the reduced number of white males choosing scientific careers.

This reminds me of the explanation given by a president of an all-male university for why he favored co-education. He explained that unless

First of two parts

the institution admitted women, it would no longer be able to compete for the best male students, who were being attracted to co-ed campuses. The inclusion of women, in his eyes, was a solution to a problem.

Likewise, today women and minorities are viewed as one solution to a manpower problem in the sciences. Despite the base underpinnings of the motive, this may be a unique opportunity to bring about a greater participation of women and minorities in science. In fact, many universities have commissioned studies on improving recruiting and retention of women students and faculty in science and engineering. Programs abound in government and the philanthropic community to encourage the inclusion of women and minorities.

What are the realistic prospects for these endeavors? First, we need to understand what has stood in the way of women in science.

You can look at the last 20 years in two ways, depending on whether you are an optimist or pessimist. The optimist sees that between 1966 and 1988, the percentage of women receiving science, medical or engineering degrees increased dramatically. In 1966, 23 percent of the bachelor's degrees in science were awarded to women; by 1988, that figure had risen to 40 percent. Women now compose 38 percent of medical school enrollments. As for science doctorates, women earned 9 percent of the total in 1966 and 27 percent in 1988.

The first thing a pessimist would find in the same 20-year span is that the increase in women in scientific and medical careers has not been steady. Most of the increase came in the 1970's, with very little progress after 1982. The second thing a pessimist would note is that the women who have been trained are not in leadership positions in proportion to their representation in the field. The most common response to this is that enough time has not passed for women graduates to have acquired the appropriate seniority. But this is not the case.

Finally, the pessimist would point out that the increases are the average of highly disparate disciplines and hide large differences between fields. For example, in psychology women receive more than half of new doctorates, while in engineering they earn just 7 percent. If you look carefully, almost no progress has been made in increasing the number of women practicing physics, mathematics and engineering in the last 50 years.

Physics and mathematics are clearly at one extreme. In the life sciences, a slightly different dynamic is at work. Fifty percent of bachelor's degrees in biology are awarded to women. There is a drop in graduate and medical schools, where 35 to 40 percent of the graduating classes are female.

Only then do women begin to disappear from the system. By almost every measure, postgraduate women in the life sciences are faring less well than their male colleagues. If one takes as a measure of success those who have reached the status of principal investigator of a National Institutes of Health grant, just 19 percent are women. Where are the other 19 percent who received M.D.'s and Ph.D.'s? They are in non-tenure-track positions in which they often cannot compete for research funds.

What the different experiences of women in the physical and life sciences tell us is that multiple forces are at work to retard the rate at which women enter the scientific work force. Yet I believe that the common thread is the role that culture plays in determining career choices for women.

The cultural issues begin with the low expectations that our education system sets on the performance of females in science, especially in physics and math. This culminates in the hierarchical culture of the laboratory, which evolved in the absence of females. This notion that cultural biases are at the basis of the problem is sobering, as cultures are difficult to change. However, if we indeed have to change the culture, we need to understand its underpinnings and where the pressure points lie.

Let's begin with education. A study by Joan Girgus for the Pew Charitable Trust Science Education Program revealed that differences in the two sexes can be detected as early as 9 years of age, when girls report fewer science-related experiences, such as looking through a telescope. By 13, girls are less likely than boys to read science articles and books, watch science shows or have science hobbies. The cues girls receive in these formative years are not always subtle. Mattel Inc. recently marketed a Barbie doll that says, "I hate math!" when poked in the stomach. I shudder to think what Ken says back!

Another example comes from the experience of a young assistant professor at Princeton. In high school, she obtained the highest grades in science. Shortly before graduation, her principal called her in and asked if she would be willing to forgo the traditional science award so that the second-ranked student, a male, could receive it. The explanation was that he would be better able to use it, as he was headed for a career in science. To the principal, it was inconceivable that this young woman would also consider such a career.

These are shocking stories, the more so because they occurred in the 1980's and 1990's, not the 1950's. This failure of our society, particularly our educators, to equate women with careers in science, and the propensity to discount their achievements when they persist with this ambition lies at the heart of the problem.

In universities, the trend of discouraging women from science careers continues. The number of declared freshman science majors of both sexes is three times the number who will actually graduate with a degree in science or engineering. However, the percentage decline is greater for women than men. The only exception to this is instructive: women's colleges lose far fewer of their science undergraduates to other fields. Surely this is telling us that in an environment that places high expectations on women's achievement, women flourish in science.

> Enter a lab, and relive the 1950's.

When questioned about their experiences as science majors, women at co-ed colleges complain of feelings of isolation in a large class of males, of being ignored by faculty and of not being taken seriously. Women who begin college well-qualified and strongly motivated lose their self-esteem.

I think the difference between the numbers who overcome these hurdles in the physical vs. the biological sciences is directly attributable to the number of women practicing each discipline. It is slowly becoming accepted that women make good biologists, and consequently women are no longer discouraged from following this path. Put another way, the rich tend to get richer. All but the most determined women will tend to gravitate to the environment which is most positive and rewarding, and that tends to be where other women have already led the way. ❑

Shirley M. Tilghman is an investigator of the Howard Hughes Medical Institute and professor of molecular biology at Princeton. This is excerpted from a speech to the Olin Conference on Women and the Culture of Science at Washington University in St. Louis on Oct. 21, 1992.

Science vs. Women — A Radical Solution

By Shirley M. Tilghman

Science, like all human activity, has its individual cultural milieu. The culture of science evolved in a period when it was being practiced exclusively by men, and that has greatly influenced the outcome. It is a men's game and it continues to be played by men's rules.

Although we would like to believe that scientists are driven by a desire to understand some aspect of the natural world, in fact they are also driven by a desire for personal recognition. Sociologists of science like Robert Merton have identified this need for personal recognition as a motivating force in science. This can lead to behavior which is, at the very least, unattractive: aggressive attacks on competitors, secrecy, sometimes even prevarication.

Linda Wilson, president of Radcliffe and a chemist, recently raised a firestorm by suggesting that the fierce rivalries and ruthless competition among scientists was incompatible with the inclusion of women and minorities in science. She predicted that there will be little change in women's participation until scientific decorum changes. The predictable reaction from men was to extol aggression as the fuel that drives the enterprise and to argue that any attempt to civilize scientific discourse will be its undoing.

Feminists have generally had two responses to this issue. On one side, it has been acknowledged that aggression is a necessary quality for a scientist and that we should be encouraging it in our female students. The opposite view is that women should and will stay out of science so long as it is practiced in such a distasteful way. I find the latter position unappealing at best: ceding the playing field to males will lead to no change. My response is, as much as possible, to encourage my female students to be verbal, confident and curious.

The second cultural aspect that dramatically affects the prospects for women's participation in science careers is the jealous demands on our time. A friend of mine once described science as a black hole, prepared to suck up whatever proportion of your life that you allow it. This complete devotion to science was fostered in the culture of the 50's in which women stayed home and raised families while their husbands conquered the secrets of the universe.

When women began to enter science careers in the 1940's and 1950's, they were expected to renounce any intention of having a family. This is the ultimate un-level playing field, one that persists to this day. Women have paid a terrible price for the success they have realized in the last 20 years. Study after study of all fields, not just science, document that women have forgone marriage and

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children for their success.

The problem of reconciling a scientific career with some semblance of a normal life is exacerbated by the tenure system. A woman is usually 30 years of age before assuming an assistant professorship at a university, which puts her tenure decision at age 35 to 36. Thus her critical scientific years, in which she is establishing her reputation, and her peak reproductive years coincide. This is a dirty trick. Many in my own generation chose to forgo child-bearing until the security of tenure had been granted, only to find that their biological clock had stopped ticking.

Institutions are beginning to grapple with this problem, with different solutions. Some have initiated programs allowing women to have one or more years before the tenure decision to compensate for the time lost in child-bearing. Others have adopted policies to allow both fathers and mothers to take this option.

I favor an even more radical solution: abolish tenure entirely, in favor of rolling appointments that are reviewed regularly. Tenure is no friend to women. It does not protect them from institutional discrimination. Rather it rigidifies their career path when they need maximum flexibility.

Ultimately we must solve this conflict between work and family if we hope to increase the participation of women in science. The alternative is to accept that women will never reach parity or continue to pay an unequal price for their success.

It is not sufficient to improve child care, though that is certainly a worthy short-term goal. And I would not advocate a society in which our children are raised by efficient and subsidized surrogate parents. Rather I would like to create a workplace in which our roles in our families and in society are equally valued. I have sat through too many late-night sessions at scientific meetings listening to my male colleagues brag about their busy schedules and long absences from home.

Science will never be a 9-to-5 profession. It just doesn't work that way. There will always be the astrophysicist who has to spend weeks at a telescope on a mountain in Hawaii, the geologist who runs when the volcano blows, the biologist who has to give injections every three hours round the clock.

On the other hand, I don't believe that science must be practiced to the exclusion of all other human activity. The system I object to confuses quantity with quality. It is not the number of hours you work that determines your contributions to science: it is the quality of your insights and your creativity. The distinction between quantity and quality needs to be continually pointed out, and I suspect that it is going to take women to do it. Most important, we must begin by declaring it loud and clear to our students, who still fear that the two are the same.

What are the prospects for changing the cultural milieu to make it more hospitable for women? There is only one solution and that is the recruitment of more women into science. Numbers really matter. When women reach a critical mass in a field, the cultural barriers naturally begin to slip away.

I would suggest that the greatest change will come in institutions that focus in the short term on the senior faculty level. University faculties are extraordinarily hierarchical, and the graduate students and assistant professors at the bottom of the totem pole are very vulnerable. They are excluded from the most serious decisions on hiring and promotion, and often find it difficult to have their voices heard when they are included in decisions.

Abolish tenure, for starters.

When women at the lowest level are vocal, they are too often dismissed as strident. Senior women, on the other hand, participate in all aspects of decision-making, and their presence in senior-level deliberations acts as a brake on the more egregious forms of discrimination. They provide the example to young students and faculty that women can have successful science careers. By acting as mentors, they can interpret not just the science, but the scientific culture.

Focusing on the hiring and retention of senior women is clearly not a national solution: there just aren't enough senior women in most fields of science. But it is a solution for institutions eager to change rapidly, and to take a leadership role.

The reason we care so much about this subject is that science is an extraordinary profession. I know of few other professions where the excitement that brought you to the field in the first place is sustained over so many years. It would be a tragedy to exclude women from all this fun.

Shirley M. Tilghman is an investigator of the Howard Hughes Medical Institute and professor of molecular biology at Princeton. This is excerpted from a speech at the Olin Conference on Women and the Culture of Science at Washington University in St. Louis on Oct. 21, 1992.

THE NEW YORK TIMES

OP-ED

TUESDAY, JANUARY 26, 1993

Nurturing Women Scientists

Nationwide and institution-sized surveys show a leaky pipeline partially patched, but the reservoir still far from full. **By Jill U. Adams**

When the US National Institutes of Health (NIH) surveyed its postdoctoral fellows in 2003, more than 1,300 of them answered questions ranging from marital and family status to their views on the value of a good salary, flexible hours, and other workplace issues. One result was particularly worrying. While women and men both felt equally well trained for a career in academic science, women were less confident about their chances to land a position, much less achieve tenure.

Elisabeth Martinez, who was a postdoc at the time and helped design the above survey, expected preparedness and career outlook to be in alignment. With her task force colleagues, Martinez, now an instructor at the University of Texas Southwestern Medical Center, predicted that women might feel less ready—but they didn't. "By and large women felt equally well prepared, and yet there was still a bit of a confidence issue," she said.

This finding bodes poorly for efforts to close the gender gap in representation at higher levels of the academic ladder. And yet, those involved in such efforts—in academia, government, and industry—continue to move forward, casting a wider net for hiring, pushing family-friendly initiatives, and increasing the emphasis on mentoring.

"It is reasonable to assume that those women who have assessed the situation carefully recognize that they're going to have more problems than men," says **Phoebe Leboy,** the president-elect of the Association of Women in Science (AWIS). "So you can call it lack of confidence or you can call it an accurate perception of the situation."

One reason women might have grounds for less confidence in their careers than men has to do with the pressures of raising a family, says Leboy. But even putting family issues aside, she says, "Women are going to have a harder time than men succeeding" at every stage of the tenure-track academic career.

Leboy points to data made available by the NIH that showed women lagging behind men in terms of grants per investigator, dollars per grant, success in getting grants renewed, and responsibility for big budget center grants. And because success is so closely tied to funding, particularly in academic health centers, says Leboy, all of these things mean that women are having a harder time achieving tenure than men.

Add all this to what Leboy calls "the escalating rat race in academia" and it paints a bleak picture.

Looking Past the Numbers

It's no longer a pipeline issue, says **Nancy Nielsen,** president-elect of the American Medical Association. She cites the National Academy of Sciences (NAS) report from last year which showed that although women have earned more than half of the Bachelor's degrees awarded in science and engineering since the year 2000, their representation on university faculties remains woefully low. Indeed, for those with Ph.D.s in engineering and science, four times more men than women hold full-time faculty positions. And minority women with doctorates are less likely than white women, or men of any racial or ethnic group, to be in tenure positions.

It's a problem of numbers, but as is so often the case, numbers do not tell the whole story. A survey of faculty at Princeton five years ago looked at promotion, compensation, and retention by gender. "The major finding was that we have made progress in attracting and retaining women faculty," said **Joan Girgus,** a psychology professor who serves as a special assistant to the dean of faculty, a post that was created as a direct recommendation of the survey's task force. "But, we still found that continued »


Elisabeth Martinez

"By and large women felt equally well prepared and yet there was still a bit of a confidence issue."


Phoebe Leboy

UPCOMING FEATURES

Postdoctoral Scientists 1—February 22

Careers in Preclinical Drug Discovery and Development (online only)—March 7

Focus on Asia —March 21

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"We put programs into place, not just to have a program, but so it will actually benefit employees. We do these things because we believe it's right."
—Lisa Zanetto

women were underrepresented."

When the Princeton survey team looked beyond the quantitative data, one thing they found was that women were less likely to request extensions of tenure for childbirth than were men. "Now this is really odd, right?" Girgus said. "When we asked people to comment, they said things like: we don't know if it's okay to ask for it, we're afraid we'll be seen as less serious, we're afraid we'll be penalized in the tenure consideration."

Princeton's response? Make the extension of the tenure clock automatic. When a tenure-track faculty member, male or female, brings a new child home, the dean of faculty sends a letter with a new tenure date and a book for the baby, said Girgus.

In addition to the postdoc study run by Martinez, the NIH conducted an extensive survey of its tenure-track and tenured scientists (as well as other staffers) to examine gender issues. In general, "women do not perceive the NIH as a female-friendly environment," said **Joan Schwartz,** an Assistant Director in the Office of Intramural Research. "But to tell you the truth we don't know how exactly to define that because we didn't ask them what they meant by it."

Schwartz is presently conducting followup focus groups on the same populations to try to get at specifics. "We need to understand what the issues are so we can work on coming up with solutions," she said. "That's the ultimate goal—to develop practical solutions."

Beyond Education and Training

Obviously, progress has been made. One success story found in the NAS report is the number of women getting Ph.D.s in science and engineering. In biomedical science, some 45 percent of postdoctoral fellows are women. As the problem—women leaving science or their careers stalling—moves to a later juncture on the career path, the solutions must be tailored to a different set of circumstances.

Put a different way, the problem of equal representation of women has moved from the education and training realm to the employment realm. Academic science might look no further than corporate America to find expertise in the practices of hiring, career development, and family-friendly policies.

"Attention to career development and advancement is more part of the culture of industry than it is in academia," says **Gail Cassell,** who is vice president of scientific affairs at Eli Lilly and Company and was previously a department chair in microbiology at University of Alabama Schools of Medicine and Dentistry at Birmingham. "Lilly certainly invests a lot of time and resources in nurturing the careers of females in both technical and management positions."

Employees at Eli Lilly undergo evaluations twice a year and, in addition to being evaluated by their bosses, those in supervisory positions receive performance reviews from peers and the people they manage. With multiple inputs going into an employee's review, the process is more objective than the opinion of a single person, like one's boss. This continual feedback "improves the individual, improves the system, and builds a better relationship between employee and employer," says Cassell.

From an employer's perspective, evaluations help identify talent and hold onto it. "So you don't turn around and they're being courted by one of your competitors. Succession planning is a very important part of human resources here. I'm not so sure that's the case at universities, particularly with administrative positions."

Kourtney Davis, senior director of worldwide epidemiology at GlaxoSmithKline, can speak to her company's helping her meet her objectives. Earlier this year, she co-chaired a women in science program that pulled together women across the whole R&D organization to offer networking and mentoring. Davis says it was a great chance to promote opportunities for women. "It was also on my development plan, because I want to work on leadership outside of my department." She credits the company's human resources team for trying to find opportunities for women scientists to increase their leadership skills.

With regard to family-friendly policies, both GlaxoSmithKline and Eli Lilly were recognized by *Working Mother* magazine as two of the top 100 companies in America, based on measures of work force, compensation, child care, leave policies, and the like.

Davis jokes that she's a poster child for the company's family-friendly programs. With each of her two children, Davis took advantage of extended leave—time beyond paid maternity leave—and then came back at reduced hours for another three to six months. "I also telecommute one day a week," she says. "My supervisor has been incredibly supportive."

The biotech firm Genencor has gone so far as to provide a lactation room and the services of a lactation consultant, says **Lisa Zanetto,** director of human resources for R&D. Employees at continued »

American Medical Association
www.ama-assn.org

Association of Women in Science (AWIS)
www.awis.org

Eli Lilly and Company
www.lilly.com

Genencor
www.genencor.com

GlaxoSmithKline
www.gsk.com

National Institutes of Health (NIH)
www.nih.gov

National Science Foundation
www.nsf.gov

Princeton University
www.princeton.edu

Rensselaer Polytechnic Institute
www.rpi.edu

University of Alabama, Birmingham
www.uab.edu

University at Buffalo School of Medicine and Biomedical Sciences
www.smbs.buffalo.edu

University of Texas Southwestern Medical Center
www.utsouthwestern.edu

the company also take advantage of flextime schedules, backup day care, and using sick days to take care of sick children.

Zanetto notes that men use family-friendly policies too, like the single dad who works a reduced-hour schedule. The philosophy behind these programs is based on the belief that employees are the company's greatest asset. "We put programs into place, not just to have a program, but so it will actually benefit employees," she says. "We do these things because we believe it's right."

Eli Lilly's commitment to diversity has led the company to create a new position, a vice president of diversity. The company also helped fund the NAS report on academic science and has encouraged the academy to do a followup study on women scientists and engineers in industry.

"With our scientific talent pool being what it is today around the globe, you want that diversity to ensure success," Cassell says. "You have to have it."

"You cannot presume to have tapped the best talent if you do not tap the complete talent pool."
—Shirley Ann Jackson, right

Changing Culture

Industry differs from academia in how achievement is measured. "In industry, as in much of corporate America, rewards are considered for the team, for how the team does," says Nielsen, which affects not only how science is done, but how scientists are judged.

By contrast, the emphasis in academia is on individual achievement. That works against women, says Nielsen, who adds that for all the talk about partners sharing home and family duties, "the reality is women still do the brunt of that."

Nielsen, who is senior associate dean for medical education at the University at Buffalo School of Medicine and Biomedical Sciences, illustrates the contrast with a change she's witnessed in clinical medicine. Thirty years ago obstetrics and gynecology was dominated by men, but now the majority of residents in any OB/GYN program are women, she says. "I think it was because the life of an OB/GYN being on call all the time was very difficult. In the old days solo practice was the model." Now group practice is more common and allows doctors in a large group to have a very reasonable call schedule. "They can have a life," says Nielsen. "And those are issues for my medical students, male and female. They want a reasonable life balance."

Several universities have launched initiatives to change the culture of academic science and to increase the representation of women on the faculty at the highest ranks. The National Science Foundation has been funding many of these efforts through its ADVANCE program. One of the first awardees was the University of Wisconsin at Madison. "The unique thing about these awards is they're really working on the institution level," says **Jennifer Sheridan**, who directs UW-Madison's Women in Science and Engineering Leadership Institute. "This kind of money has never been put at the top, at a system level before. It's always been a 'fix-the-women' approach."

One of UW-Madison's approaches is to educate faculty—those who serve on hiring and tenure committees—about research-based evidence on unconscious bias. Studies have shown that identical resumes are perceived differently depending on the gender of the name at the top. "We use the research as a way in," says Sheridan, to persuade science faculty that if they're not paying attention, these biases can emerge. "It takes the blame off men," she says, "because women do it, too."

The hiring workshops have been effective at Wisconsin, says Sheridan, who has measured a positive correlation between departmental participation in hiring workshops and more women hired. In addition, responses on climate surveys showed that new hires were more satisfied with the hiring process. "The workshops talk a lot about the interview process and treating candidates respectfully," she says.

Another NSF grantee is Rensselaer Polytechnic Institute, which has created a program called RAMP-UP (Reforming Advancement Processes through University Professions). Rensselaer President **Shirley Ann Jackson** said the program is focused on two things: "We are working to improve career progression for women from the junior faculty ranks to the senior ranks, and to expand recruitment of accomplished women at the senior level."

Startup packages and access to resources will be looked at more carefully. In addition, the institute is expanding its mentoring and coaching services to better guide women faculty through the advancement process.

"It starts at the departmental level, because that is where hiring starts and where the promotion and tenure process occurs," Jackson said. In addition, the "tone at the top" is important, she says. "It is essential to set clear expectations. I am very focused on the need to ensure that the processes affecting the progression of women faculty—and of all people in their careers here at Rensselaer—are fair and consistent."

To fill looming gaps in the science, technology, engineering and mathematics (STEM) work force, Jackson says the United States must engage more women and minorities. "Demographics are changing. Women and minorities now constitute one-half to two-thirds of the population, yet they have traditionally been underrepresented in the STEM fields. If we are to sustain our capacity for innovation, it must be an all-in proposition. You cannot presume to have tapped the best talent if you do not tap the complete talent pool."

CREDIT: RENSSELAER POLYTECHNIC INSTITUTE

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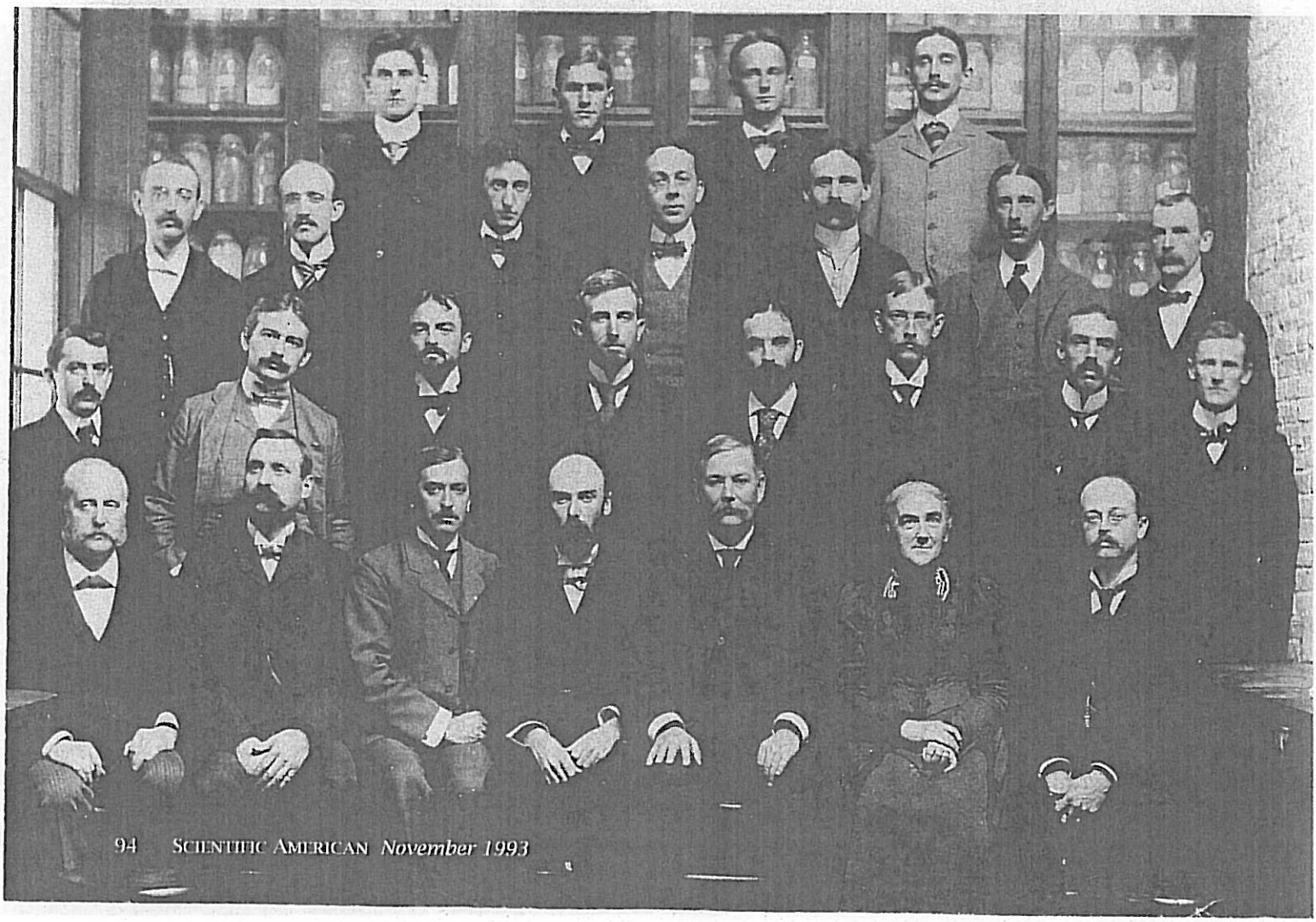
A Lab of Her Own

by Marguerite Holloway, *staff writer*

There is no one story to tell about women in science. C. Dominique Toran-Allerand just received tenure—after 20 years at Columbia University, after watching male peers enjoy promotion, after listening to colleagues laugh when she requested recommendations. "They thought I was joking," explains the neuroscientist, who studies the role of hormones in brain development, with light bitterness in her voice. "People generally did not believe I did not have tenure."

Cheryl Ann Butman, a tenured biological oceanographer at the Woods Hole Oceanographic Institution, moves clothes at midnight from a backpack, unemptied since her return from a Gordon Conference, into a canvas bag. In four hours she will leave on a cruise to place research equipment on the ocean floor. Downstairs, Bradford Butman, branch chief of the U.S. Geological Survey in Woods Hole, washes dishes. He is just back from a meeting. The race against time is interrupted when Dylan, their two-year-old, has a nightmare. The evening is remarkable only in that both scientists are home. "Once Brad met me at the airport, handed Dylan to me and then got on a plane himself," Butman recalls.

Kay Redfield Jamison, a psychiatrist at the Johns Hopkins University School of Medicine who studies creativity and manic-depressive illness, would rather not talk about problems that women may encounter. "The system is a harsh one, but it is for men as well," she asserts. "In the end, you just have to get your work done. How many women really spend much time thinking about these things?"



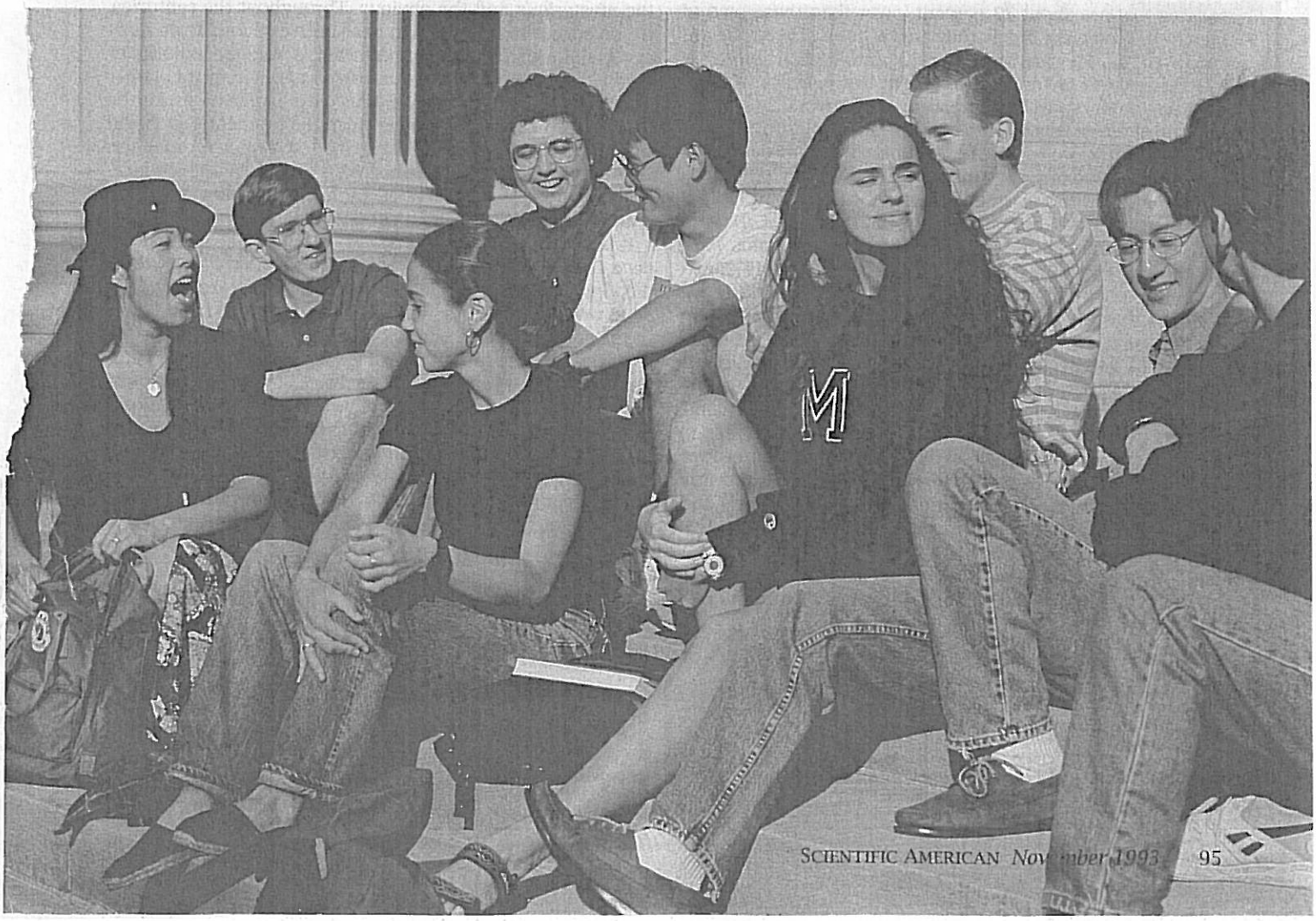
Despite decades of struggle, women remain a small minority in the scientific community

Some find it hard to avoid doing so. A researcher at a prestigious women's college describes being told to "go knit or do whatever it is you women do" when she asked for comments on her grant application to the National Institutes of Health.

The experiences of these scientists and the challenges they face are as varied as the women themselves and as the research they do. Which is perhaps why the fight that women wage so that they and their daughters can practice science remains unfinished. Although their struggle to enter and to advance in this overwhelmingly male-dominated field parallels the struggles of women in other professions, science seems a uniquely well fortified bastion of sexism. "How shocking it is that there are any women in science at all," remarks Sandra Harding, a philosopher at the University of Delaware.

Despite speeches, panels and other efforts at consciousness-raising, women remain dramatically absent from the membership of the informal communities and clubs that constitute the scientific establishment. Only 16 percent of the employed scientists and engineers in this country are female. At a finer level of detail, the numbers of women in dif-

A FACE IN A CROWD characterizes the situation of many female scientists. Ellen Swallow Richards was the first woman on the faculty of the Massachusetts Institute of Technology (opposite page). *She is shown in 1900 with her chemistry department colleagues. Today there are more women in science, as these students on the steps of the M.I.T. library illustrate* (this page). *But they make up only 16 percent of U.S. working scientists.*



Some of the Women in Science Today

Biological oceanographer at the Woods Hole Oceanographic Institution in Massachusetts. Butman studies the physical dynamics of organisms—such as examining how the formation of stacks of mussels improves their ability to feed.

CHERYL ANN BUTMAN

Pediatrician who recently became U.S. surgeon general. Elders was formerly the director of the Arkansas Department of Health.

JOYCELYN ELDERS

Biochemist ...s Wellcome ... elion won the 1988 Nobel Prize in Physiology or Medicine with her colleague George H. Hitchings for their work on compounds that led to the development of drugs to treat leukemia, organ transplant rejection, malaria, gout and herpesvirus infection.

GERTRUDE BELLE ELION

ferent disciplines and positions are so low that a recitation of the statistics sounds like a warped version of "The Twelve Days of Christmas": 1 percent of working environmental scientists, 2 percent of mechanical engineers, 3 percent of electrical engineers, 4 percent of medical school department directors, 5 percent of physics Ph.D.'s, 6 of close to 300 tenured professors in the country's top 10 mathematics departments, and so on.

"There is still so much to be done," rues Jane Z. Daniels, director of women's programs at the National Science Foundation (NSF). "The traditional areas of science for women are still those areas where there is the most growth. There is not a lot of change in physics, geology and engineering. Those are the ones where the stereotypes have been preserved." Other fields are not quite so male heavy. Forty-one percent of working biologists and life scientists are women. Nearly half of all psychology and neuroscience graduate students are female. According to the American Chemical Society, women constituted 17 percent of their members in 1991, up from 8 percent in 1975.

Regardless of their field, women scientists typically earn salaries that are about 25 percent lower than those paid to men in the same positions, they are twice as likely to be unemployed and they are rarely promoted to high positions (in 1989, 7 percent of tenured faculty in the sciences were female). Women report less encouragement from their peers and supervisors, less mentoring and help with professional advancement as well as greater isolation and harassment.

These conditions persist despite more than two decades of efforts to redress an imbalance that was brought to light in large part by the women's movement. In the past 20 years an array of federal and other educational programs have sought to attract women into science. These attempts gained some momentum in 1988, when a congressional study announced that the U.S. would need more than half a million scientists and engineers by the year 2010. As men were dropping out of science, women and members of minority groups were seen as possible replacements.

The cumulative attention has brought about some gains. In 1989 women received 27.8 percent of the doctorates in science and engineering, whereas in 1966 only 8 percent of such degrees were awarded to women. The NSF recently found that differences in science scores between girls and boys on some standardized tests had decreased. The U.S. Equal Employment Opportunity Commission has also documented an increase in the number of female full professors.

"I have never seen a period in history where they are trying to encourage women so much," notes Londa Schiebinger, a historian of science at Pennsylvania State University. "But I think what is extremely interesting is that there is all this funding and this goodwill, and they are still dropping like flies." Attrition has increasingly led many observers to examine the culture of science for clues about why so few women stay in the field. What, if anything, ask the researchers, is it about science that continues to exclude or deter women from remaining in research?

"They have been attempting to get more women into science, trying to fix the women, give them enough science courses, prevent them from falling behind," Schiebinger, who wrote *The Mind Has No Sex? Women in the Origins of Modern Science*. "But we can't fix the girls, we have to fix science, get it to be something they want to do. We have to look deeply into the culture of science and see what is turning women off."

Peering into the scientific establishment to pinpoint the origins of the problem—why so few women?—reveals both the mysterious and the obvious. Throughout the centuries, for no cogent reason, women have been excluded from most aspects of professional and political life. And the majority of fields have until recently remained male. Within this larger tradition of sexism, there are some clear explanations for the absence of women in science. From the moment they begin to be socialized, most girls are directed away from science. This subtle and overt deterrence can been seen in the educational system and is fortified by the perceptions of many male scientists that women simply should not be scientists.

It is not that there have historically been no women in science. Only nine women may have been awarded a Nobel Prize as opposed to more than 300 men, but there are many unsung women who have made vital contributions in all fields. In the past decade or so, historians have increasingly begun to describe these mostly invisible participants. In 1982 Margaret W. Rossiter, a historian of science at Cornell University, published a lengthy account of American women who did science before 1940. "People said the book would not be very long, because there were no women of consequence. They were wrong," says Rossiter, who is working on her next tome: women in science from 1945 to 1972. Although many workers were tucked away as assistants and technicians, their

Some of the Women in the History of Science

HYPATIA

Circa 370–415
Egyptian mathematician, teacher and philosopher who was murdered by a group of monks. One legend has it that these holy men resented the fact that a woman was lecturing.

MARIA SIBYLLA MERIAN

1647–1717
German biologist who extended the field of entomology through her observations and illustrations of the life cycle of caterpillars and butterflies. She supported herself by publishing books and by designing fabrics.

SOPHIE GERMAIN

1776–1831
Self-taught French mathematician and physicist who produced original work in number theory and the theory of elasticity. Germain was excluded from the male scientific community and received recognition for her work only late in life.

Professor of biology and medicine at Brown University and feminist scholar. Fausto-Sterling has written extensively about the biology of sex differences and is currently doing research on *Planaria*.

ANNE FAUSTO-STERLING

Astronomer at the Harvard-Smithsonian Center for Astrophysics. Geller and her colleague John P. Huchra discovered the Great Wall of galaxies, a structure that runs for three billion trillion miles and contains 1,700 galaxies.

MARGARET GELLER

Entomologist at Stanford University. Gordon, who does research on ants, is one of the few women studying social insects. She is currently observing how information is passed from generation to generation in harvester ant colonies in Arizona.

DEBORAH M. GORDON

contributions were invaluable. She found many of them hidden in footnotes in books about male scientists.

Other researchers have traced the roots of the scientific establishment's attitude toward women. Each period of history and each culture are, of course, characterized by a different prevailing view, but there is no shortage of "documentation" by males of the physical and mental inferiority of women. In the late 1880s, following a series of studies on the small size of women's brains—and, not insignificantly, their enormous pelvic bones, all the better to bear children with—a friend of Charles Darwin's summed up that illustrious scientist's view of women's intellectual powers: "It must take many centuries for heredity to produce the missing five ounces of the female brain."

The emergence of the modern scientific establishment appears to have institutionalized many of these perceptions. Historian David F. Noble of York University in Toronto argues that the first universities were monastic, organized by the Christian church, and thus excluded women. In his book *A World without Women: The Christian Clerical Culture of Western Science,* he discusses how this segregation persisted in the academies and institutions that arose with modern science. The Royal Society was established in 1662 and did not admit women until 1945. Before then, as Schiebinger notes, the only woman in the Royal Society was a skeleton in the anatomy collection. Today 2.9 percent of the "fellows" are female.

Some institutions have better records, but by and large, women were not made to feel at home in the inner sanctum of science and were denied access to traditional training. Beatrix Potter, for instance, was an accomplished mycologist—in fact, she was the first person to report on the symbiotic aspects of lichen and to catalogue the fungi of the British Isles. But Potter was not allowed to join any professional scientific societies because of her sex. So, fortunately for English-speaking children and their parents, she turned to writing and illustrating children's books. The 1880 official minutes from "The Misogynist Dinner of the American Chemical Society," unearthed by Rossiter, are part of the same tradition.

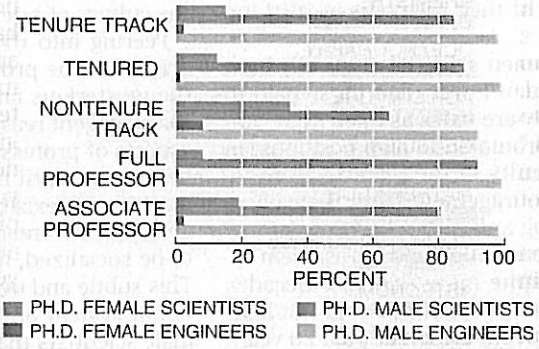
It is the vestiges of these attitudes and the impenetrability of the elite social institutions that most frustrate female scientists still. The National Academy of Sciences currently has only 70 female members, out of 1,750 living scientists. "There is still resentment between the old guard and women," says Betty M. Vetter, executive director of the Commission on Professionals in Science and Technology. She adds bluntly, "It will change when they die."

By maintaining a male majority, many institutions perpetuate the status quo, preventing women from participating in forums where important contacts are made. Women "don't get invited to write as many book chapters, and they don't get a chance to network as much. It is not a question of a more or less collaborative style," comments Christina L. Williams, a neuroscientist at Barnard College. "You do what you can do. You can't get yourself invited to things if you don't get invited."

Studies have found that meetings organized by men usually have a male majority—no matter what the percentage of women in the field. Only 24 percent of the speakers at past meetings of the American Society for Cell Biology, which is roughly 50 percent female, were women, even when the conferences were organized by women, notes Susan Gerbi, president of the society. When men organized the conferences, less than 10 percent were female. "It is not men sitting around saying, 'Don't invite women,'" Williams explains. "It is done blindly, and it is just that there is no concerted effort. A lot of the people in power in science are still men."

Another place where similar discrimination may occur is on editorial boards. Staff at many scientific publications remains mostly male and has shown a tendency to accept more male-authored papers or to invite men to do review articles. It is not clear, however, that selection of papers would change

Academic Rank of Doctoral Scientists, 1990



SOURCE: National Science Foundation; the statistics are for U.S.

MARIA MITCHELL

1818–1889
Established the Vassar College Observatory in the U.S., one of the earliest and most important astronomy programs for women. In 1847 Mitchell, who learned astronomy from her father and her own reading, received widespread acclaim for the discovery of a comet.

MARY EDWARDS WALKER

1832–1919
Surgeon and feminist who worked as a nurse and, later, as the first female assistant surgeon in the American Civil War. Walker adopted male dress for her work in the field.

ELLEN SWALLOW RICHARDS

1842–1911
Engineer lauded as the "woman who founded ecology." Richards, denied a deserved Ph.D. in chemistry at the Massachusetts Institute of Technology, was the first woman to be elected to the American Institute of Mining and Metallurgical Engineers.

Professor of computer science at Harvard University. A pioneer in the subdiscipline of artificial intelligence known as natural language processing, Grosz works on ways to make computers easier for people to use by incorporating features of human dialogue into computer systems.

BARBARA GROSZ

Chairperson of the department of anatomy at Harvard Medical School. Hay studies the regeneration of cells and tissues. She made some of the first electron micrograph autoradiographs, a substantial contribution to the study of cytology.

ELIZABETH DEXTER HAY

Microbiologist at Harvard University. Huang studies the replication of RNA animal viruses.

ALICE S. HUANG

if editorial boards were more sexually balanced. A study conducted in the early 1980s asked 180 men and 180 women to rate comparable papers. One third of the papers was supposedly written by John T. McKay, another third by Joan T. McKay and the final series by J. T. McKay. Both the women and men gave the "John T." papers the highest score. Whatever the cause, Harriet Zuckerman of the Andrew W. Mellon Foundation and Jonathan R. Cole of Columbia have found that women tend to publish 30 percent fewer papers than do their male colleagues in the first 12 or so years of their careers. The disparity increases over time.

One controversial solution to making meetings more reflective of the work force, thereby spreading the wealth of information and contacts, is affirmative action. Last year the NSF announced it would not fund conferences unless a number of women proportionate to the number in the field were invited. "You hope it is not going to lead to less qualified women being asked," Williams says. "But there is no reason that it should. There are plenty of good women out there in all fields."

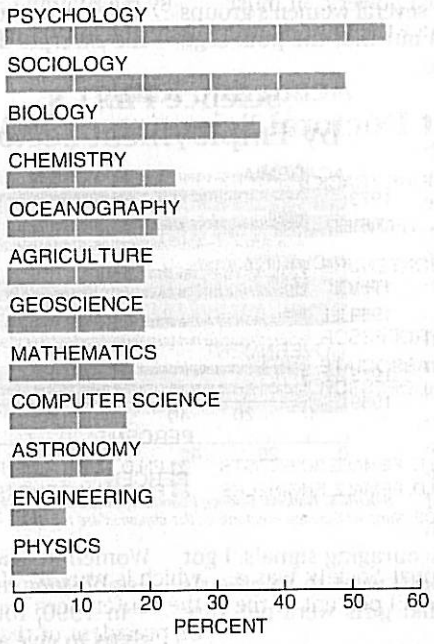
Opinions about affirmative action are, inevitably, mixed. An editorial in *Nature* bemoaned the NSF's new "quota" policy. "There is no evidence that sex is related to success in scientific research," the editors wrote, "and no inherent justification for holding women out for special treatment as part of a formal policy carrying the bludgeon of budgets." Many female scientists also view legislative remedies with some skepticism. "I personally do not want any favors because I am a woman. I want to be competitive on a gender-free basis," Toran-Allerand says. Her view echoes that of many female scientists, in particular those who struggled through the system before it was subjected to feminist scrutiny. Many of those who succeeded, including Nobel laureates Gertrude Belle Elion and Rita Levi-Montalcini, did not want special attention as women in science—they just desperately wanted to do their science.

Toran-Allerand, who was the only woman in both her medical school class and residency, attributes some of this to a double standard for women. "In the past, women were really an intellectual elite. You had to be slightly crazy if you wanted to go do that in that kind of environment," she comments. A woman "who interviewed me at Yale said I had to realize that the women had to be perfect. There were so few women; they could not tolerate any imperfection. The imperfections in the men would be accepted because there were so many of them that they would even out over the population."

With more women in science, such pressures have been alleviated—to a point. Many scientists and educators have noted that scientific institutions are not the only source of discouragement for women: the educational system does not foster a love of science in girls (for that matter, however, it has not been wildly successful in recent years with boys either). Most teachers of kindergarten through eighth grade are women, and many are not well versed in science. They do not serve as effective role models for young girls interested in science. In addition, many stereotypes—of scientists as nerds, as mad and as male—persist. "The basic idea is that if you are a woman interested in science, you are gender confused," notes Catherine J. Didion, executive director of the Association for Women in Science.

Research by the American Association of University Women has found that at all educational levels, boys receive more attention than do girls in the classroom. The effect is independent of the teacher's sex. Adults also encourage boys to be assertive in answering questions and expressing opinions. Therefore, a young woman who pursues a career in science needs a particularly strong endowment of mettle.

Doctorates Awarded to Women, by Field, in 1989



SOURCE: National Science Foundation, the statistics are for U.S.

SOFIA KOVALEVSKAIA

1850–1891
Russian mathematician who did work on partial differential equations. She is thought to be the first woman to receive a doctorate in mathematics, from the University of Göttingen in 1874.

MARIE S. CURIE

1867–1934
French scientist who discovered radium and polonium. She shared the 1903 Nobel Prize in Physics with her husband, Pierre Curie, and Henri Becquerel. In 1911 she won the Nobel Prize in Chemistry.

FLORENCE RENA SABIN

1871–1953
Medical researcher who studied the development of the lymphatic system and, later, tuberculosis. She fought to modernize public health laws in the U.S. Sabin was the first woman to be elected to the National Academy of Sciences.