

**Testimony for the Senate Subcommittee on Science,  
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I wish to express my sincere pleasure in being asked to speak at this important hearing on my two favorite topics, science and women in science. I come to you as a practicing scientist, researcher and educator. I have the best job in the world. Back home in my wonderful state of Oregon, and the University of Oregon, I have the privilege to spend my days working closely with my research students on experiments that employ lasers to understand chemical and biological processes at surfaces. In my 23 years as a professor in the field of chemical physics I have graduated numerous PhD students who currently occupy positions in companies, government laboratories, colleges and universities around the country. In order to carry out this state-of-the-art research program, each year I spend endless hours raising at least a half million dollars from the Federal research agencies relevant to my work, from agencies such as NSF, DoE and DOD. I have published volumes of papers on our results and have served on numerous national and statewide committees that oversee the health and vitality of the scientific enterprise in this country. Through all of this, a passion of mine has been the recruitment and promotion of females in scientific careers, from my first faculty appointment at Bryn Mawr College to my current role as founder and chair of a national organization called COACh, the Committee on the Advancement of Women Chemists that is based at the University of Oregon

In my parallel role of mother, I have the opportunity to spend part of my days hanging around rainy soccer and baseball fields. One of the unexpected pleasures of this has been to watch hordes of young girls playing team sports, an experience that I never had as a young girl since I was pre-Title IX. As I watch these girls learning to be aggressive, competitive, goal oriented and team players, I wonder if these personality traits will translate later into them being more capable of dealing with workplace issues for which many of us were not prepared. For the girls who choose to go into male dominated fields of science and engineering, will these traits make the daily battles easier? Will they have the benefit of female science teachers in their college education and graduate school who can serve as role models, coaches, confidants and cheerleaders, a benefit that most of us in my peer group never had. For those young women entering college today, the likelihood is low, particularly if they attend one our top 50 research universities. In engineering, they will have to look beyond 12 male faculty members to find the female. Physics is worse, chemistry and computer science slightly better at around 1:10.

Unfortunately, these numbers have shown minimal improvement in recent years relative to the increase in the number of female undergraduate students in these disciplines, Why? The factors are complex, just as the potential solutions. Given the challenges that lie ahead in national security, technology and the global economy, we can not afford to leave half of our population behind. We must recruit, educate and promote a higher percentage of our women in technical fields.

Our country continues to be the world leader in science and technology because of the excellent training and exceptional research accomplishments of scientists in this country. *Those that scale the career ladder to obtain advanced degrees in science and engineering are the engines of the enterprise.* Science breakthroughs generally depend upon years of accumulation of data from fundamental or basic research. This basic research is largely done at universities, decreasingly at government laboratories, with the assistance of graduate students and postdoctoral associates. The peer review process is the tool we use to measure scientific quality in this basic research, the backbone of our research enterprise that is essential to identifying and rewarding the best science. Unlike sports where women's sports and men's sports programs are often separated, we do not separate our science by gender, nor do we want to. *Our bodies are different, but our minds are comparable and strong, intellectually equal.*

The ladder that one must climb to make contributions to the research enterprise is daunting to anyone. The 4-5 years spent to obtain a bachelors of science or engineering degree is followed by 5-7 years of graduate research work leading to masters and Ph.D degrees. Those interested in becoming a professor at a college or university, or research leader at a government laboratory require an additional 2-4 years of postdoctoral experience. All of these levels are usually done at different schools in different cities across the country. The ones who choose to go into academia enter as assistant professors with 5-6 more years to establish an independent national reputation that will ensure them a tenured position, i.e. secure employment. Receiving tenure in those 5-6 years is generally the biggest career challenge. It entails developing a research program that includes building a laboratory with state-of-the-art research instrumentation, obtaining research funds from peer reviewed proposals sent to numerous funding agencies, recruiting and training as many graduate students and postdoctoral associates as you can afford with the money you raise, conducting the experiments with the knowledge that only a fraction of your ideas will produce publishable results, publishing the results in peer reviewed journals, hoping that your discoveries will make a significant contribution to your field, giving talks all around the country to get your work known, and in the end, having your final research portfolio judged by experts from around the world who collectively believe that you deserve tenure. Your teaching accomplishments have a varying influence on the final decision depending on your university. Once you receive tenure the next 5-7 years are spent trying to advance from associate professor to full professor rank. Advances beyond this point make you increasingly

eligible to win major awards or be elected to the prestigious National Academy of Sciences and Engineering – our Hall of Fame which is open to both men and women.

For an 18 to 22 year old, the climb up the ladder appears to be filled with uncertainty, professionally, financially and personally. The rigors of graduate school often demand a 60-70 hour work week. With an average stipend of \$18-20K, this equates to roughly \$5-6 per hour. This low stipend leaves little if any ability to pay off undergraduate student loans, buy a house, save money, afford children or associated childcare. For females, each rung that one climbs on the ladder brings additional, gender-based, challenges. For many departments, there are few if any female faculty to serve as role models, advisors or mentors. One recurring concern that I hear from female undergraduate and graduate students around the country who are interested in an advanced degree or academic career path relates to the possibility to pursue this path and still have a family. Academic institutions in general do not send a positive message to women about having children. Unlike industry and government laboratories, most academic science and engineering departments have no policy for pregnancy or maternity leave for graduate students. Affordability, availability of good and flexible childcare, delaying children until after tenure, low income and long work hours, the lack of family friendly graduate policies all contribute to women jumping off the academic science ladder and leaving science, or choosing a career that does not assist our ability to populate our academic institutions with more female faculty members and consequently female students.

For those women who choose to move further up the academic ladder, many factors slow their progress relative to their male colleagues. These factors have a very damaging cumulative effect on a woman's career (1). They arise from biases that originate in the culture of our scientific community and society. For example, research shows that for two identical papers, one version with a female first author and the other with a male first author, harsher reviews were obtained for the version with the female author (2). A Swedish study shows that women have to have five times the accomplishments as their male colleagues in order to get similar recognition (2). Women, for various reasons are often saddled with heavier service and teaching loads than their male colleagues, providing an additional impediment to their career advancement (1). Both women and men react negatively to women who take a leadership role in a group (3,4). Awards or programs that are given exclusively to women to assist in their progress up the ladder are largely ignored or often resented in the tenure, promotion and award process because these advances are perceived to not have been given the rigorous review process of nongender based advances. My women colleagues around the country often hear "she won that award or got elected to that position only because she was female". The message that she is not deserving of her accomplishments comes through unequivocally, and can be very damaging. This accumulation of disadvantage means that, as the years progress, the impact on her ability to make the top rungs of the ladder and be an influential player in the education

and research scene can be substantial. Those familiar with accumulated interest know that even a small 1% lower investment per year leads to an overall lower investment value of 25% over a 30 year period.

The bottom line is, in order for women to “flood” the higher ranks of science as they have in sports it is critical that we recognize the inherent differences in these two very different career paths as we seek to devise a solution. If Title IX is used as a tool, the key is in the implementation. Because of the flexibility that Title IX provides, there are good solutions and bad solutions and we must seek only what is best for both the scientific enterprise and women. I and my academic women colleagues of COACH believe that the approach must be targeted at a number of identifiable levels:

- (1) Every researcher and educator that receives federal funding for scientific research that involves graduate students and research associates has the responsibility to assist in broadening the participation of women in the scientific enterprise. The National Science Foundation is on the forefront of trying to make change in the culture with the October 1 mandate that all research proposals will now be judged on *both* scientific excellence *and* the broader impact (Criteria 2) which includes the recruitment and retention of women in underrepresented fields.
- (2) All funding agencies that support research programs that involve trainees such as research undergraduate students, graduate students and postdoctoral associates need to take appropriate action to assure that women are active players and leaders in the current and future scientific and technological workforce. At a minimum, all need to follow the lead of NSF Criteria 2 in the evaluation process if the research grant involves training of graduate students and postdoctoral associates.
- (3) Educational institutions receiving federal research funding need to demonstrate a commitment and sustained progress in increasing the number of female educators and participants in their scientific enterprise and eliminate barriers that impede the progress of these groups in their institutions. Those involved in hiring, tenure and promotion need to be aware of the documented factors that contribute to the slow rate of progress of women in their academic pursuit and act appropriately.

It is vital for both the security of our nation and the health of our global economy that this nation’s workforce be comprised of the best and brightest minds that this country can supply. I look forward to the day when young women coming up the system enthusiastically embrace the joy and satisfaction that comes with a career in science. I deeply appreciate this opportunity to share with you some of the joys and concerns associated with being a woman in science. Thank you very much, Senator Wyden and Senator Allen.

References:

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