

COMMENTARY

To Teach or Not

I have refrained from using these pages to voice my opinion on various matters during the past five years that I have been editor of THE PLANT CELL. I have done this because I felt that it was not my role to editorialize on matters of interest to plant biologists, but rather to provide scientific direction for the journal and leave the commentary to others. Because this is my last issue as editor of THE PLANT CELL, however, I want to comment on a matter that I feel strongly about and have been deeply dedicated to throughout my academic career—undergraduate teaching.

There is a crisis in American science that, from my vantage point as a professor at a large research university, appears to be deepening—the shortage of young people who are choosing science as a career and going on to graduate school to pursue Ph.D. degrees. Although I do not have any credible numbers, it is my perception that this crisis is particularly acute in the plant sciences. There are many cultural and sociological factors that cause young people to track on to a particular career, and I am sure that others have carried out critical studies to document why one individual chooses a certain career over another. However, my experience tells me that the current culture of American research universities may influence this choice in a negative way; that is, turn students away from science rather than stimulate them to pursue a challenging and rewarding scientific career. On the surface, this seems like a contradiction. After all, there has never been a more exciting time to answer basic biological questions. And, certainly, at research universities such as UCLA, large numbers of researchers are busily pursuing exciting research programs that should catch the eye and the interest of undergraduate students—science and nonscience majors alike. However, rather than attracting the young individuals that are required to sustain our scientific future, it may be that

these large research programs are unintentionally doing the opposite—turning away and turning off the brightest and most motivated students, exactly those whom we as scientists want and need to attract.

All of us who have trained and worked at large research universities know that what gets attention, and gets you ahead, is your research program. You are hired from your postdoc on the basis of your research productivity and research potential. You are given tenure and promoted on the basis of your standing in the international research community—as documented by the number of papers you have published, the grants you have received, and the talks you have given worldwide. And this is “back-breaking” work. The pressures of establishing a productive research program, attracting funds, training graduate students and postdocs, and writing research papers are enormous, as all of us know who do research for a living. More importantly, this is the area in which we receive most of our professional recognition and rewards. The system is research driven, and institutionalized on such a scale that there is little time for anything else, even though our jobs as professors require us to pay attention to our major clientele, the undergraduates who pay thousands of dollars for a quality education. This, in my opinion, is the crux of the problem.

In my 20 years as a professor at two American research universities, I have not observed one individual being granted tenure on the basis of imaginative, creative, and innovative undergraduate teaching—using the usual criteria that are applied to research evaluations. By contrast, on numerous occasions (more than I would like to admit), individuals with mediocre teaching records have been granted tenure and promotions on the basis of their research work. Clearly, research universities require teaching to be

considered when evaluating an individual for tenure, promotions, and/or salary increases. However, the reality is that teaching takes a distant second to research in the promotion process. Under these circumstances, it is not surprising that faculty members will give a grant deadline or a manuscript a higher priority than delivering an incisive, rigorous, and inspiring lecture to their undergraduates, even if they are dedicated teachers and have their “hearts” in the right place. Simply put, excellent undergraduate teaching is appreciated, it is encouraged, it is even rewarded with plaques and commendations, but in the overall scheme of moving up the academic ladder at large research universities, it doesn't count for much. This situation must change.

This academic year I carried out a difficult and challenging experiment to try to see for myself why undergraduates don't choose to pursue scientific research careers. I volunteered to teach four courses: (1) a course for science and nonscience freshman students entitled *The Frontiers of Molecular Biology—A Historical Perspective*; (2) a course for upper level life science students entitled *The Principles of Molecular Biology*; (3) an *Honors Seminar* course that was a satellite to the molecular biology course; and (4) a course for both science and nonscience majors entitled *The Human Genome—Prospects for a Super Race?* I have completed teaching three of these courses, and I am teaching *The Human Genome* course at the present time. Although teaching these courses has inconvenienced my graduate students and postdocs, whose manuscripts have not been edited in a timely way, as well as causing worry to THE PLANT CELL's management staff at production time, I have obtained a new perspective on why undergraduates stay away from research careers.

Each of my courses attracted a distinct population of students; however, over the

COMMENTARY

course of the year, students representing almost every major on campus—biology, biochemistry, microbiology, psychology, economics, linguistics, engineering, history, Far East studies, English, political science, communication, drama, and others—were present in at least one of the courses. The total student population was around 400, and out of this population fewer than 10 students had initially thought of going into a scientific research career. What I found, however, was that the problem was not that the students were turned off to experimental science but that they had never been exposed to it in a conceptual way that conveyed its excitement and relevance to their lives. Much to my surprise, drama majors delighted in spooling DNA in front of the class, and biology majors were turned on to the excitement of the process of science by reading popular books such as James Watson's *The Double Helix*, Stephen Hall's *Invisible Frontiers*, and Natalie Angier's *Natural Obsessions*, which convey the daily dynamics of how science is done, how rewarding it is to individuals who do it, and how relevant the solutions to scientific problems are to their own lives. And most of the students were intrigued and challenged by films such as *Inherit the Wind*, which show how science can affect the political structure and laws of the society in which they live.

This is all anecdotal, but I was surprised and pleased to have several nonscience

students even consider turning away from law and business and think about changing their majors to molecular biology, and I was flooded by requests from pre-health care students who had never really considered graduate school to do projects in the lab. What I learned in a rather non-scientific way was that my undergraduate students were not bored or uninterested in science, but that they had rarely, if ever, been exposed to the excitement and process of research biology—how research is carried out, how scientists are just like "the rest of us," how rewarding a scientific discovery is, and how much effort, creativity, and imagination go into a scientific thought. And this is not because we, as professors at research universities, don't care enough about our undergraduate students to give them this experience, it is simply because there is no time or reward system to encourage the effort that it takes to inspire undergraduates in the classroom.

One of the solutions, of course, is to put undergraduate teaching on an equal footing with research in hiring and promotion decisions at research universities, that is, to implement what is already codified in most faculty governance documents. Clearly, excellent research and excellent undergraduate teaching are not mutually exclusive. In fact, as I have found over the years, they are symbiotic and influence each other in many exciting and creative ways. However, it is also important to

change the culture of research universities so that individuals who emphasize teaching over research are not relegated to the status of second-class citizens, but rather are held in high esteem for their innovative undergraduate teaching efforts and the balance, leadership, and creative classroom ideas they provide for those who choose to spend more time at the bench.

All of us who have active research programs witness on a daily basis the excitement of discovery, and we have learned firsthand how gratifying and rewarding it is to make these discoveries ourselves. Because of the low numbers of undergraduates who are pursuing science as a career, I worry about who will make the scientific breakthroughs in the next generation. It is time to roll up our sleeves and infuse in our undergraduates the excitement all of us feel about science. If we do that, we will begin to turn the tide in our favor and attract the brightest and most creative undergraduates to our graduate schools. If we are successful, we will then be able to use the outstanding infrastructure of our research universities to train the innovative, imaginative, and productive scientists of tomorrow.

Robert B. Goldberg
Department of Biology
University of California
Los Angeles, CA 90024-1606