POLICY FORUM: EDUCATION

Workforce Alternatives to Graduate Students?

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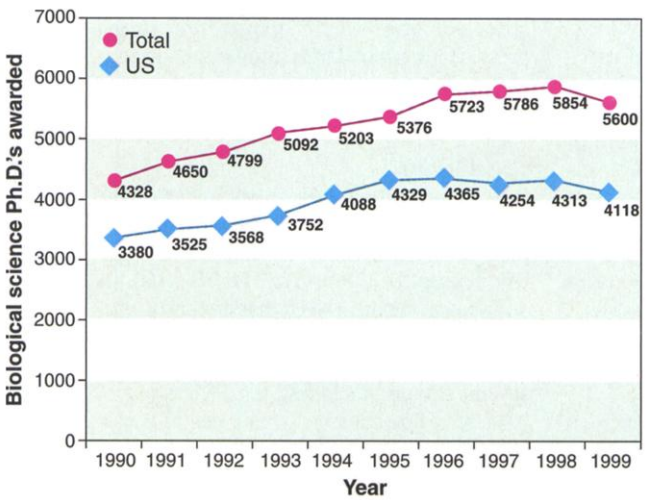
The number of biomedical Ph.D.'s awarded in the United States was fairly constant for most of the 1970s and 1980s (3400 to 3900), but increased 48% from 1987 to 1995 (*1*). Two-thirds of this increase reflects the growth in the number of non-U.S. citizens obtaining their Ph.D.'s in this country. Moreover, the length of time spent as a biomedical postdoctoral [defined by the National Science Foundation (NSF) Survey of Doctorate Recipients as a temporary position in academia, industry, or government primarily for gaining additional education and training in research] before moving into permanent careers has increased: those who were postdoctorals 7 to 8 years after receiving their Ph.D.'s rose from 2.5% of the total biomedical scientists employed in 1985 to 7.7% in 1995 (*1*). This is probably an underestimate as senior postdoctorals often acquire other titles (staff scientist, research scientist, research associate, non–tenure track Assistant Professor of Research, etc.) while they continue to perform research directed by a principal investigator (*2*). This has led to the perception that the postdoctoral period is a holding pattern for young scientists seeking permanent positions that are in scarce supply. Despite the excitement of new advances in biomedical research, many postdoctorals are dissatisfied with the apparently limited career opportunities. The crisis of unfulfilled expectations has generated several studies in the past few years (*1, 3*), the most recent of which are the National Research Council reports on Ph.D. production (*4*) and on postdoctorals (*5*). We need to initiate a new dialogue on career options in the biomedical sciences before our ability to maintain and renew the scientific workforce is seriously damaged.

Should the Number of New Biomedical Ph.D.'s Be Reduced?

Although the unemployment rate is low, it has been estimated that less than one-third of the biomedical Ph.D. recipients in 1995 were needed to fill available jobs (*6*). In fact, negative publicity about the poor biomedical job market and robust opportunities in other fields have already translated into a decline in 1999 in the number of Ph.D.'s awarded to U.S. citizens and a decline in the total number of new biomedical Ph.D.'s [(*6*) and see figure above with data from (*7*)]. However, a one-to-one correspondence between new Ph.D.'s and new academic jobs is an unreasonable standard. It is impossible to predict the future job market accurately (*1*). There are several exciting advances, often interdisciplinary in nature, whose impact on the job market cannot be quantified but that will doubtless lead to new jobs. For example, bioinformatics already represents a field in which the demand far outpaces the supply. Balancing the optimism of emerging career opportunities with the calculation of biomedical Ph.D. overproduction has led to the position that the status quo should be maintained, with no further increase in graduate student admissions (*4, 6*). Maintenance of the status quo should be an average of increases and decreases within various subfields, as opportunities vary greatly within the biomedical sciences.



PH.D.'s awarded in the biological sciences. Source: (*7*).

SOURCE: NSF

Some recent reports recommended that the use of federal predoctoral training grants (which have an educational mission) be increased, and that the number of graduate students supported on research grants (which have a primary focus on research) should decline (*4, 6*). Proponents have suggested that training grants may be a way to provide a broader, more multidisciplinary focus on training, rather than being centered only on the quality of the research product. The high standards and quality of education supported by training grants are widely appreciated, and many have argued that this mechanism for supporting graduate students should be expanded (*1, 4, 6, 8*). However, a unilateral increase in training grants would not provide a solution to the problem, as no mechanism exists to ensure that increases in training grant support would be matched by decreases in research grant support for graduate students.

Forcing grantees to use fewer graduate students would be difficult to achieve and harmful to our nation's research goals. Abrupt removal of graduate research assistants would disproportionately harm research programs at smaller research institutes that cannot support large multidisciplinary training grants. In addition, students who are not U.S. citizens or permanent residents are ineligible for federal training grant appointments. Moreover, a solution limited to restricting the supply of graduate students might result in an increased reliance on foreign postdoctorals to satisfy workforce needs (*9*). Currently, half of the biomedical postdoctorals in our nation are trained outside of the United States (*6*); commonly, they desire to establish careers with permanent positions here. Therefore, they often join their U.S.-trained counterpart for competition in the job market in this country. Proposals to limit Ph.D. production will not work, as they are unilateral solutions to a bilateral problem, because postdoctorals trained in other countries also are part of the competition for jobs. Instead, we propose that other ways need to be found to satisfy the research workforce needs.

Alternate Ways to Fill Workforce Needs

Massey and Goldman (*10*) concluded that the rate of Ph.D. production has been driven by the teaching and research needs of uni-

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versities rather than by opportunities in the job market. What are some other solutions to fill research workforce needs? Graduate teaching assistants could be replaced by instructors holding a master's or Ph.D. degree. When compared with the cost of a graduate student's stipend and tuition, this is generally a cost-neutral solution. On the plus side, there would be continuity and experience brought to the duties by permanent personnel. Institutions with an undergraduate school on the same campus could also employ advanced undergraduates to assist in courses in which they have excelled. Some teaching experience is useful for graduate students and should be maintained in scenarios such as those just described, but the driving force to admit large numbers of graduate students to satisfy teaching needs would be removed.

What alternatives exist to satisfy the research workforce needs? Research technicians with a bachelor's or master's degree are widely used in industry and their use in academia could be expanded. They lack, however, the advanced training and independence in experimental design and data analysis that comes with experience. Nevertheless, their salaries are comparable to those of postdoctorals. Another option already in wide use is to hire postdoctorals as research personnel. Because postdoctorals are in a temporary training stage (*11*), we suggest the creation (or expansion in institutions where it already exists) of positions as "staff scientists" for those who wish to remain permanently as members of the research team.

It may be time to reduce dependence on "entry level" labor (graduate students and postdocorals) and consider ways to create more "nonreplicating" staff scientist positions (for those who would not apply for grants or train students). Such positions should be treated as part of a legitimate career track (*12, 13*). The model of the independent investigator needs to be supplemented with other models of a successful career in science, and these should reflect the complex, team-oriented structure of contemporary research. Being a good research team player is already highly valued in industry and should have greater recognition in academia. Appointments as staff scientists in universities should become more prevalent, with reasonable salaries, standard employment benefits, and reasonable chances for job security and professional advancement. A legitimate career ladder for staff scientists would keep more talent in the system for longer periods of time. The need for "bodies" would be reduced, the chances of obtaining a permanent career in biomedical research would be increased, and scientific research would remain a rational career choice for bright, talented, highly motivated young people. Research grants would have to increase to accommodate reasonable salaries for staff scientists, whose performance would be peer-reviewed as part of the grant application. Additionally, a new, small grant program might be started to fund the salary and supplies of staff scientists with demonstrated excellence. The increased grant support should be seen as an investment to ensure that careers in research are inviting to talented young scientists.

Stability in the system would reduce the need for graduate students, but will never completely replace them. New scientists with new skills and outlooks are essential for progress in science. Graduate students bring with them new ideas and questions which refresh the science. In the ideal situation, the laboratory would be composed of a mix of some graduate students and postdoctorals, as well as staff scientists and research technicians. The latter positions would help to relieve the pressure to admit large numbers of graduate students as a way of gaining more hands at the bench.

Conclusions

It is incumbent upon us to try to attract the very best young minds to become participants in biomedical research and the scientific leaders of tomorrow. The National Institutes of Health (NIH) has recently proposed substantial increases in stipends for predoctorals and postdoctorals (*14*), and several groups, including the Federation of American Societies for Experimental Biology (FASEB), have endorsed these plans. As the cost of graduate student and postdocoral labor rises, the number of these individuals and the way that they are used may change as well. A smaller, better-funded cadre of young scientists will make it possible to continue recruitment of top-notch talent. There will be challenges and new approaches needed in order to "get the work done."

Alternative ways to fill workforce needs may cost more than graduate students (who often are "free" as far as the principal investigator is concerned, because their stipend and tuition often comes from the institution or a training grant). However, if we are to ensure our future success in science, research must be seen as an attractive career option for talented students and other research personnel. We should preserve a rigorous, competitive system for permanent jobs, but with reasonable outcomes for a substantial fraction of the competitors. Academia would do well to expand and validate the use of staff scientist positions. We need to broaden our definition of an acceptable career from one involving independent research to also include a career in which the individual is a team player in research or uses his or her research background as a bridge to other aspects of our society (such as journalism, patent law, public policy). This would accommodate the heterogeneity in goals of graduate schools, the evolving interests of trainees, and the wide range of useful applications of the abilities and interests of Ph.D.'s in the life sciences.

Currently, the biomedical research enterprise is pyramidal in structure (*10*); graduate students and postdoctorals comprise the very important base of this pyramid, as the workers who carry out the research. We need to adjust our modus operandi to a steady-state situation that does not require an ever-increasing influx of graduate students and postdoctorals. A high-risk, "up or out" system of graduate and postdoctoral education will not remain an attractive option for the brightest students. Alternative ways to satisfy workforce needs should be found.

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15. The views presented in this paper are solely those of the authors and are not policy statements of any scientific organization.