In an Era of Scientific Opportunity,
Are There Opportunities for Biomedical Scientists?

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Abstract

Has the dramatic growth in the NIH budget affected the training and production of biomedical Ph.D.s? Examination of new survey data reveals surprising findings. Despite the need for an increased workforce to carry out the expansion in biomedical research, there has not been an increase in new U.S. doctorates awarded, and time-to-degree in the biomedical sciences is no longer increasing. Furthermore, both the frequency and length of postdoctoral appointments are decreasing for U.S. biomedical science recipients. There has been, however, continued growth in the number of foreign postdoctorals. Industrial employment of biomedical scientists continues to increase, but there has been only modest growth in tenured or tenure-track academic jobs.

These are very exciting times in the biomedical sciences. Recent discoveries have generated new interest and greater investment in biomedical research. But how have the increases in funding and other changes affected training and career opportunities? Have the deteriorating conditions observed in the 1990s continued, or have they begun to change?

Highly skilled research personnel are essential for progress in biomedical science as well as for innovation in health care, and an insufficient supply of scientists will delay the discovery of new ways to prevent, cure and treat disease. An excessive supply of research personnel, however, wastes valuable resources and human capital and will ultimately discourage talented individuals from pursing careers in science (1). Recently collected data from two National Science Foundation (NSF) surveys, the Survey of Earned Doctorates (SED) and the Survey of Doctorate Recipients (SDR), enable us to provide new perspectives on training and employment of Ph.D. biomedical scientists.

Earlier studies reported deteriorating conditions for students and postdocs

During the 1990s, in response to reports of declining opportunity, several groups examined the conditions facing young biomedical scientists. A study published by the National Research Council (NRC) in 1994 found that, during the period from 1985 to 1993, there was a severe reduction in the number of research grants made to investigators who were 36 years old or younger (2). Examining education and employment trends from 1970 through 1995, the Federation of American Societies for Experimental Biology (FASEB) found that there were increases in both the time needed to earn a Ph.D. and the time spent in postdoctoral positions (3). Growth in numbers of biotechnology jobs, combined with slow growth in academia, resulted in an increased percentage of biomedical scientists employed in industry (4). Looking at a broader study population that included all life scientists, an NRC panel reported similar findings: the world was changing for young scientists (5). Doctorate programs were taking longer to complete, postdoctoral appointments were held for longer periods of time and the proportion employed in academic careers had contracted.

Biomedical Ph.D. production is no longer increasing

Since that time, the nation has significantly increased its investment in biomedical research in order to exploit exciting new opportunities and accelerate the pace of discovery. Funding for biomedical research has increased rapidly, led by the growth of NIH, whose budget doubled from $13.6 billion in fiscal year 1998 to $27.3 billion in fiscal year 2003. Industry funding for biomedical research also rose dramatically in the 1990s (6). Yet concerns remain about the length of training, number of trainees and the status of young scientists (7).

In the 1990s, there was an increase in the number of new Ph.D.s awarded and growth in the length of time spent working on doctoral degrees. Some analysts asserted that the expansion was driven by the need for more workers in the laboratory (8). As funding for biomedical research grew dramatically in the late 1990s, has the number of graduate students and new Ph.D.s increased as well?

The number of biological science graduate students at doctoral granting institutions in 2001 was 54,099, the same level as reported for 1995. Similarly, the number of these students employed as research assistants in 2001 (19,146) was equal to the number employed as research assistants in 1995 (9). Data from the SED indicate that the number of new Ph.D.s awarded in the biomedical sciences by U.S. institutions has been stable at around 5,000 since 1996 [Figure 1].

In recent years, the length of time required to earn a degree in the biomedical sciences in the U.S. has also stabilized. After increasing from 6.0 years in1980 to 6.9 years in 1993, the median "registered" time-to-degree has remained at this level for the past 8 years.

Fewer U.S. postdocs and less time in postdoctoral appointments

The growth in funding for biomedical research has resulted in a larger number of grants and, at NIH, an increase in the size of the average award. Since personnel costs have historically averaged approximately 60% of research grant budgets (10), it is safe to assume that the demand for research personnel has increased. If the larger workforce to carry out the experiments has not resulted in more graduate students, has the increased funding been associated with greater use of postdoctoral scientists? Additionally, are biomedical scientists staying in the postdoctoral pool for longer periods of time, continuing the trend of the mid-1990s?

The postdoctoral pool has continued to grow. The number of biomedical scientists with postdoctoral appointments increased from 14,907 in 1996 to 16,913 in 2001 (9). This increase is approximately the same size as the growth over the previous five-year period and does not reflect any acceleration due to the increase in funding for biomedical research. Almost all of the growth is due to increasing numbers of foreign postdocs [Figure 2].

The growth and extension of postdoctoral training for U.S. biomedical Ph.D.s peaked in the mid-1990s and has begun to decline in recent cohorts. In 1973, only 27.4% of the U.S. biomedical Ph.D.s took postdoctoral positions; this percentage grew through 1995 when 63.3% of the biomedical scientists who earned their Ph.D.s in the previous two years held

postdoctoral appointments at the time of the survey [Figure 3] (11). This trend is now reversing, however, and the percentage in postdoctoral appointments declined in each of the survey years after 1995, reaching 54.3% in 2001. Over the six-year period, there has been a sizeable drop in the percentage of recent Ph.D.s taking postdoctoral positions immediately after earning their degrees.

Earlier studies reported that the length of postdoctoral study had been increasing (3,5). For some observers, this increase represented the expansion of knowledge and growing specialization in the biomedical sciences, while others interpreted the increases as a sign of a weak employment market and use of the postdoctoral position as a holding pattern while waiting for a permanent job. Has the trend toward longer periods of postdoctoral training continued?

Data from the SDR indicate that the percentage of biomedical scientists holding postdoctoral positions for long periods of time has started to decrease. The percentage of scientists in postdoctoral positions 3-4 years after receiving their degree reached a high point of 45.9% in the 1997 survey before declining substantially over the next four years. By 2001, this percentage had dropped to 33.8%. The percentage of biomedical Ph.D.s holding postdoctoral appointments 5-6 and 7-8 years post-Ph.D has also declined.

Academic employment: modest growth in tenured faculty positions

An academic career has traditionally been the goal of most entering Ph.D. students in the biomedical sciences, and this ultimate objective is assumed in the design of graduate programs. How have hiring practices at universities and medical schools responded to the substantially increased research opportunities and funding? Has employment in the academic sector grown substantially?

There has been very slow growth since 1997 in the number of biomedical scientists holding tenured academic positions, and no increase in the number in tenure-track positions [Figure 4]. With academic postdoctoral employment declining during this period, virtually all of the growth has been in “other academic” employment, a residual category consisting of staff

scientists, instructors, “research track, soft money” faculty and other positions. Employment in this category grew rapidly during the early 1980s and has also expanded substantially in 2001, the most recent survey year.

Since many biomedical science graduate students initially aspire to become tenured faculty members, it is insightful to view tenured faculty employment from another perspective. What percentage of the graduates in any single year ultimately obtains these positions? In 1981, when lengthy periods of postdoctoral study were highly unusual, 34.3% of the biomedical Ph.D.s with 5-6 years experience held tenured or tenure-track positions. This percentage has steadily declined over the last two decades, and today’s graduates are substantially less likely to obtain a coveted tenured or tenure-track appointment than their mentors were. In 2001, only 14.4% of the Ph.D.s were in such positions 5-6 years after obtaining their degrees.

Industrial employment has increased

Academic employment has grown slowly since 1997, but almost all biomedical science Ph.D.s are employed. In SDR surveys from 1973 to 2001, the unemployment rate (12) for biomedical science Ph.D.s has fluctuated between 0.9% and 1.7%. In recent years, the overall unemployment rate has dropped from a high of 1.7% in 1995 to a ten-year low of 1.1% in 2001. A comparable decline (from 2.6% to 1.9%) was also observed for individuals who received their doctorates within the past two years. If academic employment is down, where are the jobs for biomedical science Ph.D.s?

Industrial employment of biomedical scientists has continued to increase [Figure 5]. The number of U.S. citizens and permanent residents employed in industry rose from 26,745 in 1997 to 34,513 in 2001. In percentage terms, industrially employed biomedical scientists increased from 27.3% of the population in 1997 to 31.6% in 2001, while the percentage employed in academia declined from 55.6% to 52.6%. Growth in the number of biological and medical scientists working in industry is projected to continue. For 2000 through 2010, the U.S. Department of Labor forecasts a growth rate of 21.0% for doctorate-level biological scientists and 26.5% for doctorate-level medical scientists (13).

Adapting to a changing workforce

An increasing number of new biomedical Ph.D.s will take jobs in industry. Should we adjust our Ph.D. training programs accordingly? Can we teach our students how to work effectively as part of a research team, which is the *modus operandi* in the industrial sector, rather than focusing all our attention on preparing students to become principal investigators in academia?

Our investment in biomedical research is substantially expanding, but tenured and tenure-track faculty positions are not. Team research is also growing in academia. An increasing number of scientists are contributing to our knowledge by working as collaborators on research projects headed by other scientists. As the research enterprise becomes more complex and interdisciplinary, these situations may become even more common.

In the future, progress in biomedical research will be dependent on our ability to attract talented young scientists. A major component of the academic labor force is composed of graduate students and postdoctorals, but the number of U.S. students filling these positions is leveling off and declining, respectively. Who will carry out the research? Will we continue to expand the use of postdoctorals who receive their Ph.D.s in other countries? Shall academia copy the paradigm used in industry of employing "staff scientists" to carry out the research? These are highly experienced people, beyond the training phase of the postdoctoral. If staff scientist positions are to be recognized as legitimate career outcomes, salaries need to be commensurate with training levels (14,15). We should continue to increase stipends for predoctoral and postdoctoral appointments as several groups have recommended (16,17,18,19,20). There should be a clear distinction between postdoctoral training and employment (18). NIH recommends, moreover, that individuals who are retained at institutions after five years in postdoctoral positions be converted to staff positions with appropriate compensation and benefits (17).

Conclusion

Growth in funding has not led to an increase in new doctorates awarded, a rise in the number of U.S. citizens in postdoctoral appointments or an extension of time spent in postdoctoral appointments. Some of the most disturbing trends of the 1990s have been halted or even reversed. Other patterns, including the slow growth in tenure-track academic appointments, indicate that the research workforce in the biomedical sciences is changing. Jobs are available and skilled researchers are in demand. But these are not always the same types of opportunities that earlier cohorts encountered. The changing structure of the workforce will require different conditions of employment and compensation.

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