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COMMENTARY

Young Biomedical Scientists: Undervalued and Overabundant

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Biomedical research is a success by any standard. It has led to treatments and preventive practices that have caused rates of death from the major killers—heart disease, cancer, and stroke—to decline steadily over the past few decades (National Center for Health Statistics, 2002: Table 30). Hundreds of new drugs have been approved over the past decade (U.S. Food and Drug Administration, 2002), and another 1000 potential drugs are under development (Pharmaceutical Research and Manufacturers of America, 2002). The past year alone has seen breakthroughs in understanding afflictions as diverse as sickle cell anemia, tuberculosis, breast cancer, Alzheimer's disease, depression, and substance abuse.[1]

Yet in this golden age of biomedicine, many people are surprised to learn that universities in the United States are training too many biomedical scientists. The resulting surplus has left many young researchers embittered and discouraged, and it threatens the future success of the research enterprise. The danger is that fewer of the most talented young people will pursue careers in the life sciences.[2] Such "brain drain" already has occurred in the physical sciences and engineering (Zumeta and Raveling, 2002, 2003). Can the life sciences be far behind?

If biomedical research declines as an attractive career option, the subsequent decrease in the quality of research will affect us all. Not only will improvements to health care and prevention dwindle, but emerging threats such as antimicrobial resistance and novel infectious diseases may rapidly negate previous gains (Gratz, 1999; Cohen, 2000; World Health Organization, 2003). In an era when biomedical science plays an increasingly important role in national security and the economy, this is an option that none of us can afford.

As several recent studies indicate, the overabundance of biomedical scientists and its detriments are perhaps most apparent in the plight of the estimated 25,000+ life-science postdoctoral fellows, or postdocs, in the United States (National Academy of Sciences, 2000).

After earning a Ph.D. in a discipline such as microbiology or genetics—a feat that takes a median time of more than seven years beyond a bachelor's degree (National Research Council, 1998)—a young biomedical scientist striving for an independent position in academia or industry usually spends a few years as a postdoc. Although ostensibly temporary trainees, postdocs, to paraphrase Shirley Tilghman, president of Princeton University and director of a National Academy of Sciences study on the careers of life scientists, are increasingly stuck in a professional "holding pattern"—burning precious fuel, waiting to land (Holden, 1998; National Research Council, 1998).[3]

Under the guidance of a professor, postdocs write research papers and help train graduate students, but most of their time is spent conducting experiments. The demands of research, exacerbated by intense competition for a relatively small number of independent positions, are grueling (Freeman et al., 2001). Sixty-hour workweeks and few vacation days are often the norm for postdocs at leading universities (Vogel, 1999; Freeman et al., 2001; and the author's personal observations).

Despite their dedication, many postdocs receive salaries near the minimum level set by the National Institutes

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of Health—just $34,200 for a newly minted Ph.D. (National Institutes of Health, 2003). With their status between graduate students and faculty, postdocs often work on short-term contracts with limited health benefits and no retirement plan (National Academy of Sciences, 2000).

The long hours and low pay of a training position are tolerable provided that one has a reasonable chance for advancement after a few years, as is the case for medical residents and law clerks. But whereas medical residency is a step toward a specialty certification and a one-year clerkship can lead to a lucrative position with a law firm, often a four-year stint as a postdoc in a prestigious laboratory simply leads to another stint: many postdocs are on their third or even fourth appointment (Schmidt, 1999; National Academy of Sciences, 2000; and the author's personal observations).

Lower salaries and fewer benefits make postdocs a more efficient expenditure of research funds than laboratory technicians, so they are often hired to fill a specialized niche rather than to broaden their training (Freeman et al., 2001). Indeed, much evidence suggests that postdocs are increasingly used as cheap labor. The National Research Council (1998) reports that since 1973 the fraction of life-science Ph.D.s employed as postdocs upon graduation has doubled, and the fraction of those remaining as postdocs after 5-6 years has increased more than sevenfold. A report by the National Science Foundation entitled *Has the Use of Postdocs Changed?* reaches a similar conclusion (Regets, 1998). A survey of Harvard Ph.D.s shows that graduates of even that elite institution are similarly mired (Vogel, 1999).

The result is that many biomedical scientists are nearly 40 years old before obtaining their first independent position, with some of their most creative and energetic years behind them. The situation will only worsen as the 4% average annual increase in Ph.D.s granted in the biomedical sciences over the past decade continues to outstrip the creation of independent positions in academia and industry (National Research Council, 1998).

Fortunately, there are a few simple, low-cost measures that can be taken to improve the circumstances of young scientists (National Research Council, 1998; National Academy of Sciences, 2000). First, postdocs must be given such basic rights as access to health insurance and formal representation in their university's decision-making process.[4]

Postdoctoral appointments should be geared toward producing independent scientists rather than supplying inexpensive lab workers. To this end, committees of a few professors should be established to monitor the training and professional development of each postdoc, providing accountability for both postdocs and their supervisors. Funding agencies—both public and private—should limit to a period of, say, five years the total time that they support a scientist as a postdoctoral fellow, after which they should make available to qualified applicants more independent and permanent funding opportunities. Such agencies can also create additional chances for advancement for outstanding postdoctoral researchers by establishing a limited number of competitive, semi-independent "career transition" grants or research assistant professorships (National Research Council, 1998; Freeman et al., 2001; Zumeta and Raveling, 2002, 2003).

Most important, population control of scientists is necessary to ensure the long-term health of biomedical research (National Research Council, 1998). Young people are drawn to biomedical Ph.D. programs by a genuine interest in science, the prestige of an advanced degree, and, perhaps most importantly, training grants and nominal stipends that make Ph.D. studentships seem attractive compared to other educational opportunities, at least initially. But the number of students accepted into such Ph.D. programs must be held constant until the job market can absorb new graduates (National Research Council, 2000). Because public policy (rather than market forces) largely sets the demand for biomedical Ph.D.s, federal agencies must take a lead role in regulating the number of such scientists (Freeman et al., 2001; Zumeta and Raveling, 2002, 2003). Agencies that fund graduate students through research grants must limit to current levels the number that they support. Despite short-sighted objections from faculty (who rely on graduate students and postdocs for teaching and research) and university administrators (who use expanded or new programs to compete for federal funds), such measures are necessary to stem the growing surplus of life scientists.

Young scientists themselves can ease the overcrowding by broadening their training and exploring alternative careers.[5] Few graduate students and postdocs take advantage of the breadth of courses offered by most universities, although a class or two in business administration, public policy, or information technology would greatly enhance their marketability.

The problems that affect young life scientists threaten us all. By addressing them now, we will ensure the rich rewards of biomedical research for the future.

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Notes

1. For descriptions of recent advances in biomedical science, see the National Institutes of Health website at http://www.nih.gov/news.

2. Zumeta and Raveling (2002) used scores on the Graduate Record Examination to gauge the quality of U.S. citizens intending to pursue various educational and career options. Of the 13,691 students in the top cohort for the quantitative

portion of the test in 2002 (those scoring greater than 750 out of a possible 800), 867 intended to pursue graduate study in the biological sciences.

3. Tilghman was named president of Princeton in 2001. See http://www.princeton.edu/pr/smt/bio.html.

4. At some institutions, young scientists have made strides in these areas by forming formal postdoctoral associations. The National Postdoctoral Association, which seeks to give postdocs a unified voice on national issues, maintains a website that provides information and resources that may be useful for postdocs interested in forming associations at their own institutions: http://www.nationalpostdoc.org.

5. Next Wave (http://nextwave.sciencemag.org), a website sponsored by American Association for the Advancement of Science, is an excellent resource for young scientists who are interested in alternative careers.

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