Training the Next Generation of Biomedical Researchers
Challenges and Opportunities
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We have entered an era of great excitement and challenge in the life sciences, in which scientific knowledge is changing and accruing rapidly. Many new areas of study, including functional genomics, tissue engineering, and bioinformatics, are being pursued with increasingly powerful techniques, and they present extraordinary opportunities for improving our understanding of health and disease. Safe and effective approaches for translating these multidisciplinary efforts into clinically relevant advances will require careful evaluation by highly trained clinical investigators. To make the most of these opportunities, new approaches and competencies will be required of the next generation of researchers who, more than ever before, will need to be familiar with diverse scientific disciplines and be able to collaborate with scientists skilled in those disciplines.

Yet, we currently face major challenges in attracting the best minds to academic biomedical research and in retaining them. This is due, in part, to the wealth of opportunities available in other pursuits and, in part, to the expansion of knowledge and capabilities required of today’s investigators. The latter has led to an ever-increasing duration of training, which can exceed the patience and resources of multi-year trainees who already carry substantial burdens of debt. The next generation of independent, creative investigators (and the scientific mentors they will eventually become) is thus at significant risk; shortages in fields such as biostatistics, computational biology, and clinical research are already becoming acute. Major innovations may now be needed in our approaches to recruiting, educating, training, retraining, and retaining the future research work force. Changes in the nature, as well as the content, of training will likely be called for to encompass broader disciplines and to foster appreciation for multidisciplinary collaborative research and facility in conducting it.

With these imperatives in mind, the National Heart, Lung, and Blood Institute (NHLBI) recently undertook a review of the scientific content of its training and career development programs. It became apparent that greater representation is needed in areas that will be crucial to biomedical research in the coming decades, such as informatics, biostatistics, functional genomics, computational science, integrative physiology, and social and behavioral medicine. Results of the review were shared at a meeting of experts convened November 2 through 3, 1999, to determine how our training and career development programs could best be adapted to serve the needs of the coming generation of biomedical researchers. The workshop report is available on the NHLBI website at http://www.nhlbi.nih.gov/funding/training/train-rev.htm. Many of its recommendations are as relevant to the scientific community we serve as to the Institute itself, for it is the community that designs, reviews, and implements nearly all of the training programs we support. Key recommendations regarding scientific competencies required of future investigators, approaches to multidisciplinary training, and the changing nature of mentorship are highlighted here for the consideration of readers involved in producing tomorrow’s scientists.

Scientific Competencies for the 21st Century
It is increasingly apparent that knowledge of information technology, expertise in computation, and understanding a broad array of scientific disciplines will be essential to the success of future investigators. This will be particularly important as we strive to take full advantage of the promise of functional genomics, in which DNA array technologies may open the door to understanding how tens of thousands of genes—in interaction with environmental risk factors—pave the way for susceptibility to cardiovascular, lung, and blood diseases. To achieve our goals, we will need to place greater emphasis on the mathematical basis of biomedical science. This will most likely involve establishing training programs in medical informatics, encouraging new alliances between academia and industry, and extending our thinking beyond the traditional disease-focused orientation. Although the development of oral and written communication skills has always been important in any scholarly endeavor, it is more apparent than ever that these skills will be essential to the success of an undertaking of this magnitude and complexity.

Key recommendations in this area include developing new courses and expanding existing training programs to address new technologies and competencies, including training components in new research programs, and providing opportunities for retraining and continued education for investigators at all stages of career development.

Multidisciplinary Training
The participants in our meeting identified innovation and collaboration as the 2 principal ingredients of a successful
research program for the 21st century. Although capitalizing on the rapid evolutions in multiple disciplines will require broadly trained investigators, no one individual investigator can possibly be expected to possess all the necessary knowledge and skills. Independent thinking has always been the hallmark of the successful investigator, and this will almost certainly not change in the foreseeable future; however, only through teamwork can we achieve the synergy to make the most of the new opportunities. Increased contact among investigators, trainees, and institutions is needed, and we now have a unique opportunity to enable that through the use of current communications and information technology. Additionally, we must evolve in our thinking about what constitutes an excellent training program and enthusiastically embrace approaches that, in another era, may have seemed too exploratory or unfocused.

Key recommendations in this area include encouraging broad, multidisciplinary approaches to research at all stages of training; having the scientific community develop innovative approaches to research training that emphasize multidisciplinary approaches, networking, and collaboration, and linking multiple institutions that have unique expertise into “virtual” training centers; and reducing the emphasis on independent research support, both in academia and at the National Institutes of Health, as a measure of academic success.

**Recruiting and Retaining Capable Researchers**

This is not a new topic but, rather, one that has been discussed for years by those of us who are concerned about maintaining the “pipeline” of new investigators. The rewards of a research career are tangible to many who have chosen that path, but they are often perceived as remote, strenuous, expensive, and uncertain by young students. Efforts are needed at all levels—from elementary and secondary schools, where “hands-on” experiences may strike a spark, through postgraduate programs that assist participants in maintaining career momentum—to address this issue.

Key recommendations include developing programs to attract capable students to scientific careers early in their decision-making process; enhancing financial support for trainees entering areas of critical shortages; improving outreach, including the dissemination of information about the value of research in general and the availability of support for research training; and developing partnerships with industry.

**Mentorship**

The importance of strong mentorship emerged as a major theme of the NHLBI meeting. This is the linchpin of developing young talent, yet its crucial elements have been only loosely and informally articulated. It is essential that mentorship be viewed as a “professional” activity, that mentoring skills be taught to our investigators and rewarded, and that new approaches to mentorship that respond to the challenges of multidisciplinary research be explored and developed.

Key recommendations in this area include developing materials and programs for training in mentorship, encouraging team approaches to mentorship to enhance the multidisciplinary nature of training, providing adequate support for the efforts of mentors, and increasing the evaluation of mentorship plans in training and career development award applications.

**Diversity in the Workforce**

Ensuring that the research workforce reflects the cultural and ethnic diversity of the American population has long been a part of the NHLBI vision. This is a very important but very challenging goal, and efforts to date have met with only modest success. Meeting participants emphasized the critical need to interest young members of racial/ethnic minority groups in biomedical research as early in their educations as possible and to provide mentors and role models who are themselves members of such groups. A review of programs that have been successful in attracting minority trainees to research careers identified the importance of scholarship support, bridging programs from secondary school, the close involvement of parents, and small-group and tutoring programs throughout the college years. We must build on what we know and generate fresh ideas to address this issue.

Key recommendations in this area include developing a mentorship network of experienced minority scientists who are dedicated to the ideal of diversity in the workforce, establishing targeted programs to address financial pressures and other obstacles that are faced disproportionately by minority trainees, and providing support for research infrastructures and training programs at minority institutions in scientific fields of particular need.

**The Special Case of Clinical Research**

Meeting participants expressed uniform concern that the clinical investigator, who is uniquely positioned to translate basic research advances into clinically meaningful progress, may be an endangered species. New doctors face considerable disincentives to pursue a research career, most notably financial pressures. Many who embark on the path risk being sidetracked by competing clinical responsibilities and discontinuities in support for training and career development. Providing stronger encouragement and support to young physician–scientists and facilitating the pursuit of a PhD degree after the completion of clinical training are worthwhile approaches. Serious attention should also be given to encouraging and preparing PhDs to do clinical research.

Key recommendations in this area include developing specific programs to support the training of MD-PhD investigators; establishing clinical training networks, possibly linked to current NHLBI-sponsored research networks and multicenter studies; and providing specialized training for MDs in research disciplines and for PhD scientists in clinical disciplines.

**The Challenge**

Although these recommendations were solicited by and made to the NHLBI, it is clear that the Institute can play, at most, a supporting role in these activities. The real players are you—the members of the scientific community who develop research and training programs, forge collab-
orations, establish new scientific competencies, support and reward mentors, serve as role models, review the training applications of your peers, and reach out to promising young students in your communities. Although the Institute will pursue an increased emphasis in supporting training and career development programs on evolving scientific competencies, in developing multidisciplinary training, in ensuring adequate mentorship, and in enhancing the visibility of existing training programs, we encourage the biomedical research community as a whole to examine carefully the directions in which its training programs are headed and to redirect them as necessary to meet evolving scientific needs. Our trainees are our future. The vision, creativity, commitment, and hard work of the research community must now be focused on restructuring our approach to training if we are to meet the challenges and opportunities of the next generation of biomedical investigators.

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