EDUCATION AND TRAINING

Creating the Future Biomedical Research Workforce

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As an NIH task force ponders the future of the U.S. biomedical research workforce, clinical and translational scientists can contribute crucial insights and should share comments by 7 October 2011.

With the current focus in Washington on jobs and the stagnating U.S. economy, it is timely that the Advisory Committee to the Director of the U.S. National Institutes of Health (NIH) has assembled a task force composed of leaders in the scientific community (*1*) to examine the future of the biomedical research workforce (Fig. 1). The clinical and translational research community has an opportunity to provide this task force with important perspectives that should become part of their upcoming strategic report to the NIH director's office. Here we offer information and ideas to help inform NIH's development of "a model for a sustainable, diverse, and productive U.S. biomedical workforce" (*1*).

THE TASK

The initial deliberations of the NIH workforce working group [see notice NOT-OD-11-106 (*2*)] identify important issues that must be addressed to retain the best of the current biomedical research system, including robust basic science efforts, while considering current and future realities and concerns of biomedical scholars, such as demographic diversity, length and types of training, and the need for a variety of posttraining career paths. In this vein, there are key questions to be asked: What is the future market for trainees in what seems to be a stagnant job and funding environment? Will the demand for the workforce in industry wane as private investment in research and development trends downward (*3*, *4*)? How can the United States maintain a sufficiently robust pipeline of American scientists? What should the role of the United States be in training international doctoral and postdoctoral scholars who may choose to return to their country of origin after their training periods? How will the United States bridge the impending "valley of retirement" as current NIH grant holders begin to vacate our universities and academic health centers?

Workforce development in general is an important end in itself, necessary for an informed and economically advanced populace and an open, productive society. The erosion of the K-16 pipeline that feeds the U.S. workforce is threatened daily by economic adversity and ill-advised policy decisions. The areas of science and technology have the potential to enrich both the workforce and job market, but this requires well-trained educators, academic and private-sector investigators, science writers, policy experts, and research program administrators.

Fig. 1. The unanswered question. As an NIH task force contemplates the future of the biomedical research workforce, the translational science community can contribute vital views on training, mentorship, and new career paths.

Biomedical workforce development is also the means to two specific ends that shape the nature of our culture and the quality of life of our people: elimination of health inequities and improvement of population health, both of which necessitate raising the quality of health care for all. Knowledge and technology that produce sustainable improvements in health and quality of life begin with early translational research efforts and are completed by implementation science and outcomes research, the science of health care delivery, comparative effectiveness research (CER) (*4*), and personalized approaches to medicine (*5*). Population health improvement also uses CER methods and the study of well-defined patient cohorts, such as community groups or cohorts of patients in health care systems or Health Innovation Zones. True health gains will occur only if we move beyond the current paradigm and embrace real-life assessment of innovations guided by modern scientific approaches such as genomics, informatics, and methods that ensure translation of results into public policy.

EMBRACING CHANGE

If we accept this broader charge for biomedical science, then workforce development requires new approaches:

(i) *New people.* The workforce must evolve as science evolves. The broad range of biomedical research, from basic to implementation science, needs a workforce that is specifically trained to provide skills in leadership, systems engineering approaches, and continuous quality improvement, as well as the traditional scientific disciplines.

(ii) *New skills.* Biomedical science trainees require a new set of core knowledge competencies, such as bioinformatics, statistics, the "omics," nanotechnology, regenerative biology, economics, social and behavioral sciences, and communication.

(iii) *New ways to work.* Given the need for experts in a host of burgeoning knowledge domains, the future biomedical re-

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search workforce will function as part of complex systems that emphasize interprofessional and interdisciplinary teams. These research teams will work at disciplinary interfaces, such as the integration of phenotypical medical information (as contained in electronic health records and well-characterized tissue repositories) with genomic and epigenetic data from mega patient cohorts (*6*). Such efforts will make use of new data-intensive learning systems (*7*).

(iv) *New partnerships.* Training of the workforce of the future will require academic–industry research partnerships as well as input from policy-makers, economists, community leaders, patient advocates, and patients and other consumers. New partnerships between the public and private sectors will create an environment that judges the value of novel research and technology according to their contributions to the solving of health issues, the addressing of broad societal needs, and the economic vitality of the world.

(v) *New evaluation metrics.* Short- and long-term evaluation of the results of workforce training methods is a major focus of several working groups within the Clinical and Translational Science Awards (CTSA) consortium, the Howard Hughes Medical Institute (HHMI) Med into Grad initiative, and other programs. Traditional outputs (such as peer-reviewed research papers published in high-quality journals and principal-investigator status on research grants) should be augmented by outcomes that measure the kinds of productivity defined by the new parameters noted above, including effective collaboration across disciplines and outcomes related to career pathways beyond academia. Taken together, these new approaches can position the workforce to make true advances at the interfaces of science.

SHAPING THE NEW WORKFORCE

Members of the NIH director's task force have the ability to recommend alignment of available training resources with the new goals outlined above. For example, training grants may be awarded not only for discipline-specific training but also for interdisciplinary collaboration that is a nidus for trainees and mentors from diverse knowledge arenas such as bioengineering, clinical sciences, social sciences, and bioinformatics. The task force may draw upon the new alignment and repurpose workforce development resources both from NIH (individual and institutional K and T awards; New Innovator Awards) and private foundations (Burroughs Wellcome Fund Career Awards at the Scientific Interface and HHMI pipeline initiatives).

To this end, the task force should seek advice from the American Association of Medical Colleges Graduate Research, Education, and Training (GREAT) group, which has a considerable record of identifying issues of importance to scholars and mentors. Furthermore, the CTSA Education and Career Development group (*8*) is in the process of completing a white paper that provides practical solutions in six areas for career development of clinical and translational research scholars, with an emphasis on interdisciplinary investigations. The following are some key recommendations supported by the group: (i) Clinical and translational research requires the development of a qualitatively different investigator. (ii) Promotion and tenure requirements should reflect the emerging value of team science and mentoring. (iii) The trajectory of training includes a long-term commitment by institutions. (iv) Discipline-specific training is still required, but curricula designed to promote teamwork and interdisciplinary training will promote innovation. (v) Ph.D. trainees can take advantage of multiple pathways to a successful and satisfying career. (vi) Mentoring requires a centralized infrastructure, and rewards for mentors will promote excellence.

This CTSA Education and Career Development group report could become the faculty-development complement to the NIH director's proposed National Center for Advancing Translational Sciences (NCATS) (*9*), which is being designed to reengineer the scientific infrastructure in order to hasten the benefits of translational research to improve public health.

The future biomedical workforce will be asked to advance human health within an increasingly complex R&D and policy environment. The NIH task force can benefit greatly from broad input that adds new perspectives to their deliberations. We encourage our clinical and translational research colleagues to share their insights and ideas with the task force. The deadline for comments is 7 October 2011 (*10*).

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