

search workforce will function as part of complex systems that emphasize inter-professional 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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