*Investing in the Future*

# National Institute of General Medical Sciences

# Strategic Plan for Biomedical and Behavioral Research Training

FINAL

February 16, 2011

# THE FUTURE OF DISCOVERY

The National Institute of General Medical Sciences (NIGMS) of the National Institutes of Health (NIH) has a long-standing commitment to fostering a highly capable biomedical and behavioral research workforce.

Science and the conduct of research continue to evolve, though, as do workforce needs. It is our responsibility to stay attuned to these new needs and opportunities. As Director of NIGMS, I want to be sure that all of our activities related to the training of scientists are aligned with our commitment to build an excellent, diverse research workforce to help achieve the NIH mission, now and in the long term.

Toward that goal, in 2010 the Institute launched a process to examine our activities and general philosophy of research training. The coming pages describe the result of that process. In summary, the NIGMS Strategic Plan for Biomedical and Behavioral Research Training presents several actions that relate directly to four key themes. A detailed, contextual discussion of these themes begins on page 7.

At the outset of this endeavor, we reasoned that since NIGMS-sponsored training does not operate independently--indeed, it is a subsystem within a complex training network—the Institute needed to gather information and data to understand the major influences and trends. In so doing, we noted several realities about the current biomedical and behavioral research training landscape in the United States. As we collected input and analyzed current NIGMS programs, we took into account each of these concepts, which are articulated below.

***NIGMS is only one of many funders of research training.*** Although NIGMS views research training as a critical activity and a key component of our Congressionally mandated mission, the Institute is only one of many funders of research training in the United States. Most predoctoral and postdoctoral research trainees, even if they receive NIH support, also receive funds from non-NIH sources. In fact, NIH-sponsored training grants and fellowships account for a minority of all U.S. biomedical and behavioral research training-related dollars.[1] Although research training is a core responsibility for NIGMS, because the Institute has a limited source of funds available for this endeavor, our role in this arena is to focus on quality rather than quantity.

***The most prevalent mode for support of research trainees—for both NIGMS and NIH—is research project grants, most often R01s.*** As we undertook this assessment of NIGMS-sponsored research training, we considered it crucial to look broadly at training as it occurs in its many forms. A large proportion of pre- and postdoctoral trainees are supported via research grants, and this fraction has risen steadily over the last decade and a half. This situation exists because many members of NIH-funded research teams include graduate students and postdoctoral researchers who engage in research as a key component of their training activities.

***Many different career outcomes that can contribute to the NIH mission are available to trainees.*** It is evident that today's biomedical and behavioral research trainees receiving some level of NIH support continue to seek a range of career paths.[2] NIGMS recognizes the various avenues in which a well-trained scientist can make meaningful contributions to society. These include research careers in academia, government or the private sector, as well as careers

centered on teaching, scientific policy, patent law, communicating science to the public, and other areas.

***Time to scientific independence is longer than it has ever been, likely too long.*** We know that in addition to the observed shifts in the types of careers sought and obtained by research trainees, the amount of time spent in training is longer than ever. The average age of recipients of a first NIH R01 grant--admittedly, just one measure of independence--is now 42 years.[3] In the mid-1970s, only 10 percent of recent doctorates remained postdoctoral trainees after 3 to 4 years. Today, that fraction has grown considerably, with 40 percent of recent doctorates still in postdoctoral positions after 3 to 4 years.[4]

***The U.S. biomedical research workforce does not mirror U.S. diversity*****.** One of the most important issues facing biomedical and behavioral research is the fact that our nation's workforce does not look like America.[5] In 2008, the make-up of the U.S. population was slightly more than 60 percent Caucasian. By 2050, the Census Bureau predicts, this proportion will drop below 50 percent, due largely to growth in the Hispanic population. Existing data from the National Science Foundation (NSF) and other sources shows a striking lack of correlation in the level of representation among research trainees, and even more so, among science and engineering faculty.[6,7]

It is no secret that the practice of biomedical and behavioral research is a time- and labor-intensive exercise, with administrative responsibilities that extend beyond addressing the key activities of conducting innovative research and mentoring trainees. Staying funded and assuring access to high-quality resources is a necessary part of the job. NIGMS is sensitive to, and is making a conscious effort to reduce, any potential administrative burdens that may coincide with proposed changes to research training.

Active discussions among various sectors of the biomedical and behavioral research community are consistent with our own observations and conclusions about gaps and opportunities in research training.[8,9,10] Ultimately, a healthy biomedical and behavioral research enterprise requires that government, academia, industry and other partners work together toward common goals that recognize the essentiality of high-quality mentoring and career guidance for the next generation of scientists. Our future, the future of discovery--and the utilization of such discovery for the benefit of humankind--depends on it.

Jeremy M. Berg, Ph.D., Director, NIGMS
January 2011

## WHAT IS SUCCESS?

In the current knowledge-based economy, assuring the existence of a well-trained scientific workforce is more vital than ever to the future of our nation's health and global competitiveness. But how do we achieve this goal? How can we know if we are taking the appropriate actions toward growing a capable biomedical and behavioral research workforce?

More fundamentally, do we know success when we see it?

> For *society*, success is having a strong and diverse cadre of creative thinkers and innovative problem solvers.
>
> For *a research institution*, success is advancing knowledge through teaching and the conduct of research.
>
> For *an individual*, success is acquiring the skills and knowledge to obtain and enjoy a successful and rewarding scientific career.

Beyond the abstract, though, a successful career means different things to different people.

For example, many researchers cherish the excitement and novelty that life as a bench scientist brings. Indeed, an academic research career has many pluses, including freedom to explore the unknown, flexibility and variability in daily routine, travel and exposure to diverse cultures, and the opportunity to make an impact on health that could affect many people. Moreover, researchers generally enjoy a good reputation: A 2009 report revealed that 70 percent of Americans surveyed believe that scientists contribute "a lot" to society's well-being.[11]

However, a multitude of factors affect the supply and demand for science-related jobs, especially those in academia. Several decades ago, for example, trainees completed their doctorates and--entering a well-matched labor market--had their choice of a range of tenure-track academic research positions. Today, only a small proportion of students who earn an American science doctorate will obtain the type of faculty position that enables them to apply for the highly competitive grants that support academic research.

Thus, not all trainees choose an academic path today, nor should they. In an increasingly technical world, a variety of professions benefit from well-trained scientists who address critical societal needs. Many trainees possess the skills and passion to contribute their scientific expertise to the worlds of business, policy, teaching or writing. A 2002 survey from the Council of Graduate Schools—the "Ph.D.s: Ten Years Later" study—found that 10 to 13 years after degree completion, more than half of those with science and engineering doctorates in biochemistry, computer science and electrical engineering were employed in academia. The remainder worked in industry, government, or a range of other settings.[12]

Supply and demand will continue to shift, both from predictable events and from unforeseen circumstances. Regardless, NIGMS considers it vital that research training adopt a modern view of the multiplicity of meanings of success. Thus, the Institute believes that success is best

defined through basic competencies acquired throughout a trainee's graduate and postgraduate period. Success means that a well-trained scientist:

- is conversant in a common set of biological/biomedical principles;
- can identify an important problem and knows how to address it;
- has a range of career options and the ability to choose among them; and
- is competitive in his or her chosen field, interest area, specialty or discipline.

While NIGMS recognizes that defining success is best achieved through recognizing the above competencies that serve an array of employment outcomes, the Institute does not believe that "anything goes." Rather, NIGMS is committed to research training as a directed, intentional activity that fosters individual creativity through quality mentoring, as well as one that encourages trainees to take responsibility in pursuit of finding rewarding careers that fit their personal skill sets.

NIGMS is fully aware that many of the actions required for achieving this goal fall outside the Institute's purview, as well as that of NIH. Yet, that does not diminish the need for NIGMS to recognize and expect quality research training that strikes an adequate balance between breadth and depth. Doing so will enable the greatest degrees of freedom for the scientists of tomorrow.

*PULL QUOTE:*

*"We all know that being a professional scientist is more than simply doing experiments."*

*--Participant, NIGMS research training strategic plan stakeholder meeting*

## NIGMS Strategic Plan for Biomedical and Behavioral Research Training

NIGMS plays a significant role in biomedical and behavioral research training funded by the Federal Government, supporting nearly half of all NIH-sponsored predoctoral students in training programs at colleges, universities and medical centers across the country. In addition, as noted earlier in this plan, NIGMS supports the majority of its trainees on research project grants, or R01s. Because training is a core element of the NIGMS mission, the Institute takes very seriously its leadership role in encouraging practices and approaches that prepare trainees for research as well as a range of other valuable and productive scientific careers.

NIGMS recognizes that fostering fundamental change to achieve this goal can be challenging. It is also clear that the needs and opportunities presented in this plan cannot be fully addressed or pursued by NIGMS alone. Indeed, implementing many of the objectives will require a healthy, active partnership among all stakeholders engaged in high-quality research training.

The NIGMS Strategic Plan for Biomedical and Behavioral Research Training results from extensive stakeholder input combined with a careful and thoughtful analysis of NIGMS core values and activities. The key themes listed below constitute our vision for the future of research training; specific actions related to each theme appear in the next section.

- **Research training is a responsibility shared by NIH, academic institutions, faculty and trainees.**

- **Research training focuses on student development, not simply selection of talent.**

- **Breadth and flexibility enable research training to keep pace with the opportunities and demands of contemporary science and provide the foundation for a variety of scientific career paths.**

- **Diversity is an indispensable component of research training excellence, and it must be advanced across the entire research enterprise.**

# THE NIGMS VISION

## Research training is a responsibility shared by NIH, academic institutions, faculty and trainees.

Several contributors influence the activities and outcomes of students and postdoctoral scholars. Although many in the scientific community look to NIGMS to provide leadership in research training, the Institute acknowledges, and expects, the sustained efforts of multiple partners toward achieving successful outcomes in research training as well as fostering the cultural change that is needed to do so. In gathering input for this plan, the Institute heard about many programs--as well as about faculty who mentor individual trainees--that have experimented successfully with novel teaching methods and expanded career guidance such as unconventional modes of "on-the-job" training. However, such faculty and institutions have sometimes hesitated to promote and/or continue these activities for fear of faring poorly when their grant applications are reviewed.

Actions associated with this theme speak to the need for cooperation, collaboration and clear communication among all parties involved in research training within the biomedical and behavioral sciences.

- ***Action: Articulate more clearly NIGMS' aims and expectations for high-quality research training.***

All research trainees should become proficient in a set of competencies that enable the pursuit of a successful scientific career. NIGMS will examine and communicate its criteria to recognize the range of program elements and outcomes that promote optimal learning, foster innovation and advance quality training.

- ***Action: Examine and adjust the allocation of NIGMS training resources across and within scientific areas and institutions.***

NIGMS will reconsider how it allocates training funds in order to meet its priorities, mission and obligations, and to promote a better integration of research training within institutions. These strategies aim to increase responsiveness to changing needs in the biomedical workforce; avert duplication of effort; and also enhance efficiencies in recruitment, retention, diversity and mentorship.

- ***Action: Promote the identification and exchange of effective methods to continually improve all research training activities.***

NIGMS encourages training programs and approaches that are adaptive. By identifying strengths that help define good examples, the Institute will facilitate and promote a collaborative process that invites faculty and educators within and across institutions to share experiences, outcomes and "best practices."

- ***Action: Monitor and evaluate NIGMS' training activities, and adjust as needed to achieve desired goals and outcomes.***

NIGMS will capture appropriate current baseline data on its training activities and establish data-driven mechanisms to evaluate outcomes. The Institute will also stay apprised of trends, developments and actions that impact training but are outside the purview of NIH. Periodic analyses will be provided to grantees and applicants via the NIGMS Web site and other channels.

*PULL QUOTE:*

*"No two students are the same or develop along the same trajectory, so mentoring must be continually customized, adjusted and redirected to meet each student's needs."*

—*Jo Handelsman, in* Entering Mentoring[13]

**Research training focuses on student development, not simply selection of talent.**

Today's biomedical and behavioral research environment doesn't always put the needs of the trainee first. Indeed, as NIGMS gathered input from stakeholders across the country, the Institute identified a broadly articulated dissatisfaction with the attention trainees receive. One of the principal deficits was said to be in the mentoring associated with R01-supported training, both predoctoral and postdoctoral. NIGMS asserts that training is an intentional, not incidental, endeavor, and that the process of guidance and teaching need not diminish research productivity. In fact, many investigators believe that research training and laboratory productivity are synergistic.

Actions related to this theme address the notion that those who train—faculty and other mentors—must recognize and understand the strengths and limitations of trainees and tailor training strategies appropriately.

- ***Action: Strongly encourage the use of individual development plans (IDPs) on all NIGMS-sponsored training and research awards.***

NIGMS believes that IDPs are an essential ingredient of all NIGMS-sponsored research that supports any training. The Institute envisions that these plans will also be very beneficial for designing, monitoring and measuring trainee progress and success. This action will promote a clear definition of the roles and expectations of students, postdoctoral scholars and faculty from the outset of any training experience.

- ***Action: Establish guidelines for, and strongly encourage, training plans for all R01s and other research grant applications that request support for graduate students or postdoctoral trainees.***

Competencies in scholarship are the desired outcome of high-quality training in any of its various forms. NIGMS believes that all grantees supporting students and postdoctoral scholars on research grants should prepare training plans to assure quality mentoring and career guidance throughout the training period.

- ***Action: Encourage institutions and faculty to identify and adopt evidence-based practices so that students receive the mentorship necessary to develop essential career skills.***

Mentors serve multiple roles throughout a scientist's development, and their guidance and influence are critical to trainee success. As a consequence, it is paramount that all NIGMS-supported research trainees have access to high-quality mentoring. NIGMS strongly encourages institutions and their faculty to seek available resources and time to help foster effective mentoring skills. NIGMS also underscores the need for trainees to actively seek multiple mentors—within departments and institutions, across institutions and with non-academic scientists and personnel.

- ***Action: Encourage institutions and their faculty to accelerate time to scientific independence for all trainees.***

The rising time to independence is a concern that is well recognized by the entire biomedical and behavioral research community (Figure 2), and various steps have been taken to reverse the trend. NIGMS supports all efforts that aim to set trainees free to explore and individualize their careers as soon as possible after receiving their degrees, and the Institute encourages research institutions to revisit the traditional demands and expectations of research training that extend trainee time commitments.

*PULL QUOTE:*

*"There's an elephant in the room . . . at the end of the day, most graduate students are working in laboratories with PIs [who] are focused on one thing: productivity."*

*--Participant, NIGMS research training strategic plan stakeholder meeting*

**Breadth and flexibility enable research training to keep pace with the opportunities and demands of contemporary science and provide the foundation for a variety of scientific career paths.**

The NIGMS mandate is to support the training of the biomedical and behavioral researchers of tomorrow. But one clear and overarching theme that has emerged throughout the development of this plan is the need to change the perception of what constitutes a successful training outcome. The idea that success is limited to academic research careers must be modified and broadened to include those careers in industry, government, education, communications, law and other sectors that require sophisticated research skills. Because these nonacademic career opportunities exist and are attractive to many trainees, NIGMS believes that research training must be both broad and flexible. NIGMS also recognizes the value of training experiences that foster an ability to work effectively in a range of research settings. Creating a vibrant learning culture for diverse students and work styles is an effort that rewards all participants.

Actions related to this theme address the understanding that students and postdoctoral scholars benefit from exposure to diverse people and situations throughout training to promote professional success.

- ***Action: Promote inclusion of a variety of perspectives, backgrounds and approaches among faculty and trainees.***

Solving problems of importance in biomedical and behavioral science requires bringing together people with different cultural and ethnic backgrounds, scientific expertise, working styles and perspectives. NIGMS believes that research institutions should teach the skills that foster interactions that will prepare trainees to cross disciplinary boundaries and promote maximal collaboration.

- ***Action: Encourage exposure to multiple career path options for graduate students and postdoctoral trainees.***

NIGMS endorses the value of institutional programs and activities that highlight a variety of careers. The Institute encourages faculty and institutional staff to explore the availability of short- and long-term exposures to a range of scientific careers so that trainees can fully appreciate the breadth of opportunities available to those trained for research.

- ***Action: Increase collaboration with societies, professional associations and other organizations to build awareness of the breadth of scientific career options and opportunities.***

NIGMS encourages collaborations and partnerships with industry, professional organizations and community organizations that sponsor formal and informal learning about the array of career opportunities in biomedical and behavioral science. Many existing, high-quality resources on science careers include publications, Web sites, speaker's bureaus, fellowships and teacher-training programs.

*PULL QUOTE:*

*"From the point of view of workplace needs, of course we need the product of our biomedical training to go into all kinds of careers."*

*--Participant, NIGMS research training strategic plan stakeholder meeting*

**Diversity is an indispensable component of research training excellence, and it must be advanced across the entire research enterprise.**

Studies have demonstrated that students trained in racially, ethnically and otherwise diverse academic settings in higher education acquire important skills and perspectives that enable them to identify and solve problems of societal importance.[14,15,16,17] Moreover, for some time, the social science literature has pointed to the value of exchanging different perspectives, thoughts and ideas in generating productive and inventive solutions.[18,19,20,21] Legal decisions have also held that "the type of diversity at the core of a compelling educational interest is a diversity of individuals--their backgrounds, cultures, and life experiences--of which race and ethnicity may be only two of several determinants."[22]

For many years, NIH training grant programs have required applicants to specify how their proposed programs will recruit and retain trainees from underrepresented groups.[23] Yet despite these long-standing efforts from NIH and other entities across the biomedical and behavioral research landscape to increase the number of scientists from underrepresented groups, diversity across the board still falls far short of mirroring that of the U.S. population (Figure 3). This situation highlights a stark reality that historically underrepresented groups are now the most rapidly growing segment of the U.S. population, and thus the need for change is urgent. Equally if not more troubling is the fact that faculty minority representation is especially low, providing a scant number of role models for youth considering research careers.

Actions related to this theme underscore the need for the government and institutions to actively pursue, and monitor the impact of, a range of approaches to enhance diversity in biomedical and behavioral research.

- ***Action: Champion and articulate the societal benefits of a diverse biomedical and behavioral research workforce that mirrors the diversity of the U.S. population.***

NIGMS is committed to meeting this multidimensional challenge. To achieve this goal, collaboration is essential among government, academic institutions, communities, professional societies and organizations, and the private sector.

- ***Action: Establish and apply high standards for institutions to actively recruit, effectively mentor and diligently nurture students through the completion of their programs.***

NIGMS will articulate clear diversity expectations in all NIGMS-sponsored funding mechanisms, not just formal training grants. In addition to bolstering the recruitment of students from underrepresented groups, NIGMS urges institutions and their faculty to implement approaches that follow and support students *throughout* their research training so that trainees are competitive to enter the scientific workforce.

- ***Action: Assure that potential trainees are evaluated in an unbiased and inclusive manner.***

NIGMS will examine application and review criteria that may carry unintentional bias. In turn, the Institute will assure its own ability to monitor compliance by ensuring that staff and

reviewers heed special considerations for people from backgrounds currently underrepresented in biomedical and behavioral research.

- ***Action: Encourage institutions to examine their own demographic data on trainees.***

NIGMS will urge institutions to examine and address any gender and racial or ethnic disparities in outcomes among predoctoral and postdoctoral trainees.

*PULL QUOTE:*

*"One of the problems that we hear from our students [who] go on to postdocs at majority institutions is how isolated they feel. You cannot address a diversity issue by having one African American student in your program."*

*--Participant, NIGMS research training strategic plan stakeholder meeting*

## LOOKING FORWARD

Research institutions, government agencies and professional organizations share the responsibility for assuring that the nation's pool of trainees can meet the needs presented by modern society. Aligning goals and outcomes is paramount to the entire research enterprise's ability to ensure excellent training for the next generation of biomedical and behavioral researchers.

In launching the development of the NIGMS Strategic Plan for Biomedical and Behavioral Research Training, the Institute's aim was to identify actions to assure that NIGMS-sponsored research training remains high-quality, yet nimble enough to respond to change. There is every reason to believe that such change will continue, and thus efforts at this juncture will need to be continually revisited over time.

As it develops implementation plans that support the concepts presented in this strategic plan, the Institute is committed to transparency and a continued dialogue with stakeholders to explore the most effective and efficient methods for achieving the plan's intent.

## LISTENING TO STAKEHOLDERS

NIGMS organized several avenues through which it collected input from stakeholders, including faculty members, administrators, current and former predoctoral and postdoctoral trainees, industry representatives, representatives of professional and scientific organizations, and other interested parties. The venues[24] included:

- An online questionnaire (open March 2 to April 21, 2010)
- Four regional stakeholder meetings:
    - April 29, 2010 in Philadelphia, Pa.
    - May 12, 2010 in San Francisco, Calif.
    - May 25, 2010 in Chicago, Ill.
    - June 4, 2010 in Atlanta, Ga.
- An online Webinar discussion on June 11, 2010

In all venues, NIGMS initiated discussion by asking participants to respond to the following seven questions:

- What constitutes "success" in biomedical research training from the perspectives of an individual trainee, an institution and society?
- What can NIGMS do to encourage an optimal balance of breadth and depth in research training?
- What can NIGMS do to encourage an appropriate balance between research productivity and successful outcomes for the mentor's trainees?
- What can NIGMS do through its training programs to promote and encourage greater diversity in the biomedical research workforce?
- Recognizing that students have different career goals and interests, should NIGMS encourage greater flexibility in training, and if so, how?
- What should NIGMS do to ensure that institutions monitor, measure and continuously improve the quality of their training efforts?
- Do you have other comments or recommendations regarding NIGMS-sponsored training?

NIGMS contracted with Ripple Effect Communications to attend all of the stakeholder meetings and the Webinar, and to independently read and verify all comments received in response to this request for information as the Institute developed this strategic plan. Ripple Effect's summary report is posted on the NIGMS Web site at XXX.[25] NIGMS received a robust response from the community--primarily from academia (administration, faculty, postdoctoral trainees and students), as well as professional societies (see Table 1). In total, the Institute received 1,653 responses from more than 300 people to its requests for input. However, despite our attempts to engage industry in gathering input, the data we collected as part of this process came primarily from the academic community. Because of the workforce issues uncovered throughout the analysis, receiving greater input from industry would have been preferable, and NIGMS continues to seek active, bidirectional communication with this group.

Table 1. Distribution of NIGMS Stakeholder Responses

| Role Type | Total Responses | Percent |
|---|---|---|
| Faculty | 582 | 35% |
| Postdoctoral Trainee | 257 | 16% |
| Administration | 212 | 13% |
| Student | 208 | 13% |
| Professional Society | 166 | 10% |
| Joint Faculty & Administration | 120 | 7% |
| Industry | 41 | 2% |
| All Other (includes Government) | 67 | 4% |
| **Total Responses** | **1653** | **100%** |

## SIDEBARS, TEXT BOXES AND PULL QUOTES

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**Defining Trainees**

Throughout this document, the term "trainee" is used broadly, to represent students and postdoctoral scholars supported by any type of funding.

## **NIGMS AND RESEARCH TRAINING** (sidebar)

NIGMS is one of 27 NIH institutes and centers. The Institute's mission is focused primarily on basic research and research training. The majority of the NIGMS budget[26] funds individual research project grants, mainly R01 grants, with approximately 10 percent[27] of the NIGMS budget funding research training programs[28] and individual fellowships for predoctoral and postdoctoral trainees.

The NIGMS training investment continues to set a high standard for research training as it relates to research skills and the acquisition of career-related knowledge. The Institute recognizes the broader effects of its institutional training grants and other research training policies for their broader impact on many students and faculty beyond those supported by NIGMS training programs.

Although NIGMS is considered NIH's "training institute" by virtue of the number, breadth and forward-thinking features of its training programs, the Institute readily acknowledges that the bulk of NIGMS- and NIH-supported graduate students and postdoctoral scholars receive support from research grants throughout at least part of their training. Notably, R01-supported training support has risen substantially in the past few decades (Figure 1), and this trend is expected to continue.

NIGMS-sponsored training covers a wide spectrum of topical areas relevant to the Institute's mission. However, and in contrast to the philosophy and practice of various categorical NIH institutes, NIGMS-funded training aims to provide broad-based skills and approaches applicable to a range of different fields and careers.

The recruitment and retention of researchers who collectively bring diversity to the pool of NIH-supported researchers has been a long-supported activity at NIH, and a mission-specific endeavor at NIGMS. Diversity programs began at NIH in 1972. This emphasis grew, and now NIGMS hosts and manages a range of programs in this area.

## **CAREER PLANNING** (sidebar)

For decades, trainees and advisors have monitored progress and productivity, and taken steps toward achieving career goals. Recently, however, some professional organizations--recognizing the value of planning and an increasing need for it in the complex world of modern science--have created templates[29, 30] that simplify this process. For example, the NIH intramural research program requires individual development plans (IDPs) for all of its trainees.[31]

In support of the use of IDPs, a 2003 Sigma Xi survey of postdoctoral trainees, "Doctors Without Orders," observed that postdoctoral success--as measured by the number of publications and the absence of postdoctoral trainee/mentor conflict--correlated with only two factors: a structured postdoctoral program and taking advantage of career/professional development programming.[32] IDPs are a tool for identifying and achieving professional development needs and career objectives during training as well as a vehicle to facilitate communication between trainees and their mentors.

## **MENTORING: ANCIENT ART, CURRENT NECESSITY** (sidebar)

The relevance and importance of mentoring date back to ancient times. In his epic poem *The Odyssey*, the Greek poet Homer described Mentor as a "wise and trusted counselor" charged by Ithaca's King Odysseus to care for his belongings when he left to fight the Trojan War.

The value of good mentorship has stood the test of time, and indeed, mentoring spans virtually all endeavors and professions. It has been a mainstay of research training since the first experimentalists took apprentices under their wing. But today, the best research training goes well beyond this traditional apprenticeship model. Modern science is increasingly a team endeavor that weaves together ideas and approaches from multiple disciplines. It is not uncommon, and it is often encouraged, for trainees to seek multiple mentors who can provide guidance on various aspects of career development.

Nevertheless, not everyone is born a gifted teacher. Effective mentoring may not come naturally to all scientists who operate a laboratory staffed with personnel at various levels of experience and ability. Many professional organizations and scientific societies have published mentoring guides that highlight evidence-based practices, and most scientific conferences host sessions devoted to the value and art of excellent mentorship.

An effective mentor serves many roles: faculty adviser, career counselor, skills consultant and role model. The relationship is a blend of personal and professional, but the underlying core elements include trust, respect, understanding and empathy.

## **THE POSTDOC EXPERIENCE: FINDING A GOOD FIT** (sidebar)

Choosing a postdoctoral position that is a good fit is one of the most important decisions in a trainee's career path. While seeking interesting and meaningful science is one component of this decision, other factors include a potential advisor's training track record (where do trainees end up?); the training environment (is collaboration encouraged?); career options (will the experience provide exposure to various paths to success?); and, of course, personal chemistry with the faculty advisor.

The National Postdoctoral Association worked with NIH and NSF to establish a standard definition of a postdoctoral scholar[33] as:

> "An individual who has received a doctoral degree (or equivalent) and is engaged in a temporary and defined period of mentored advanced training to enhance the professional skills and research independence needed to pursue his or her chosen career path."

The expansive range of career options available to scientists today calls for a wide array of skills, including the ability to communicate clearly and persuasively; good management skills; effective business development and operational abilities; and a careful eye to the role of ethical, social and legal parameters that impact the conduct and results of science. An effective postdoctoral training experience goes beyond doing advanced research and increasing knowledge in a given area and nurtures the above mentioned skills.

## **WHY DIVERSITY MATTERS** (sidebar)

Diversity is a term that covers substantial ground, comprising a range of characteristics: skill set and life experiences, race, ethnicity, gender, religion, geographic origin, socio-economic background, disability and more. Diversity and excellence are clearly linked: Several well-designed studies have concluded that increasing diversity within academic settings has beneficial effects for all students, and that diversity and excellence are anything but mutually exclusive concepts.[34,35,36] Moreover, specifically related to scientific innovation and problem-solving, social scientists have long observed the ability of heterogeneous groups to derive a greater number of alternatives and perspectives that lead to more complete and inventive solutions.[37,38,39,40]

We cannot delay any longer in assuring that the U.S. biomedical and behavioral workforce accurately resembles national demographics. Studies predict that if our country does not succeed in removing disparities in higher education, especially within science and engineering, significant negative effects on our economic security and civic development are likely to ensue.[41] Legal precedent substantiates the need for all parties to move swiftly and definitively to address this imbalance.[42] The U.S. Supreme Court has recognized that educational benefits associated with student diversity, as related to both teaching and preparing a capable modern workforce, are compelling as a matter of law.[43] Importantly, doing so must extend beyond achieving "diversity for diversity's sake," "racial balancing" or remedying societal discrimination.

NIGMS believes that it is essential that the United States achieves true diversity in biomedical and behavioral research. The challenge of reaching this vital goal is not simple, however, and it must be approached thoughtfully: Efforts intended to promote diversity that are either mismanaged or left unmanaged can cause misunderstanding and conflict.[44,45]

The task upon all of us, as partners in biomedical and behavioral research training, is timely and consequential. Academia, government, industry and local communities must continue to work together toward an innovative and diverse future of discovery.

**Figures for NIGMS Strategic Plan for Biomedical and Behavioral Research Training**

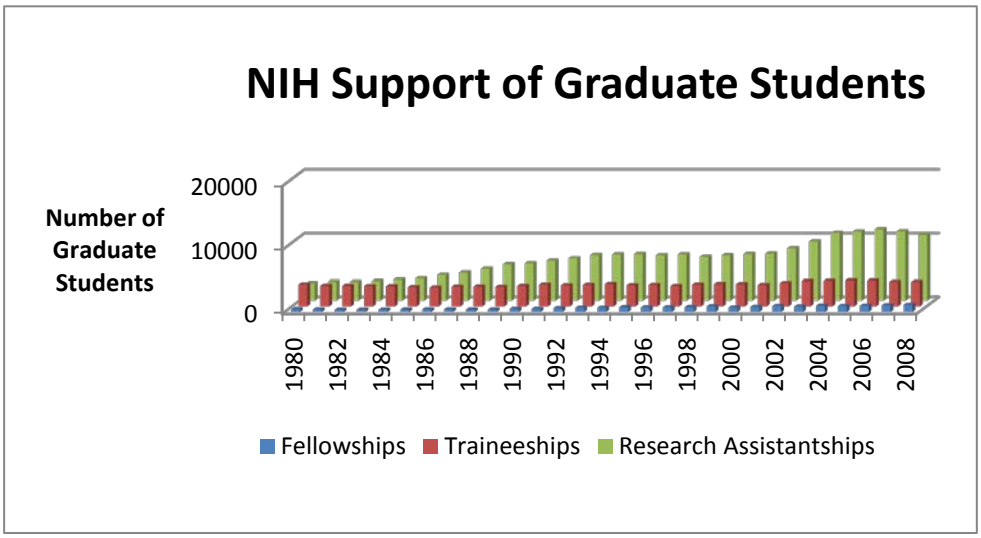


**Figure 1A**

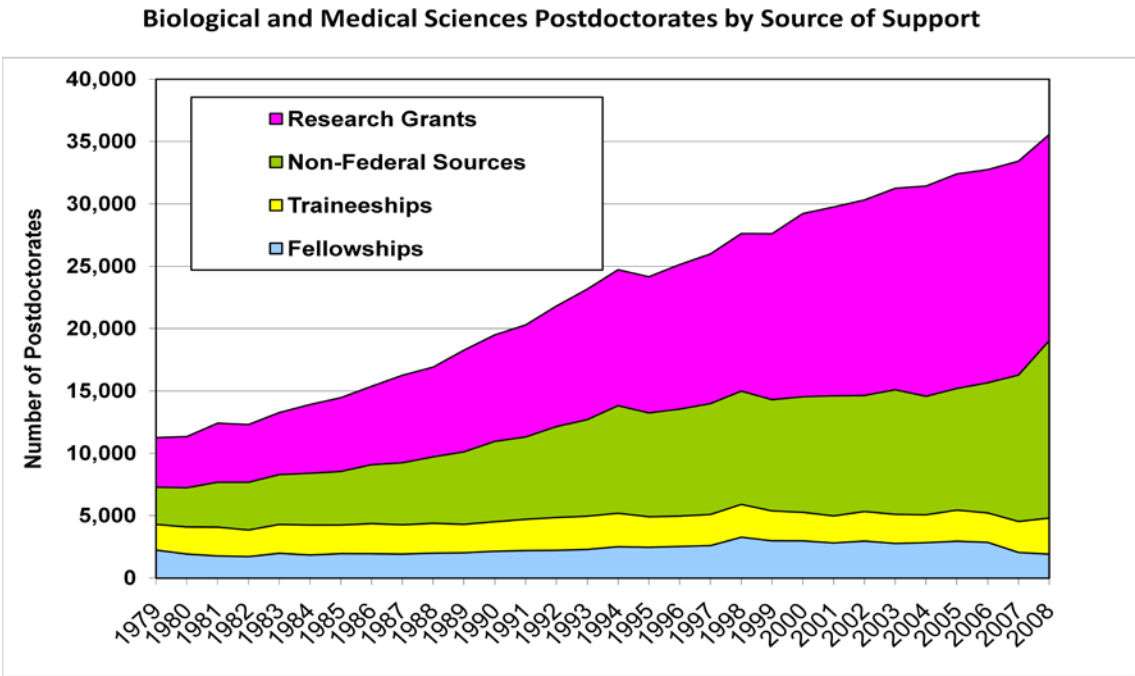


**Figure 1B**

**Figure 1. Many trainees (graduate students, A, and postdoctoral scholars, B) are supported on research grants, not through training programs.**

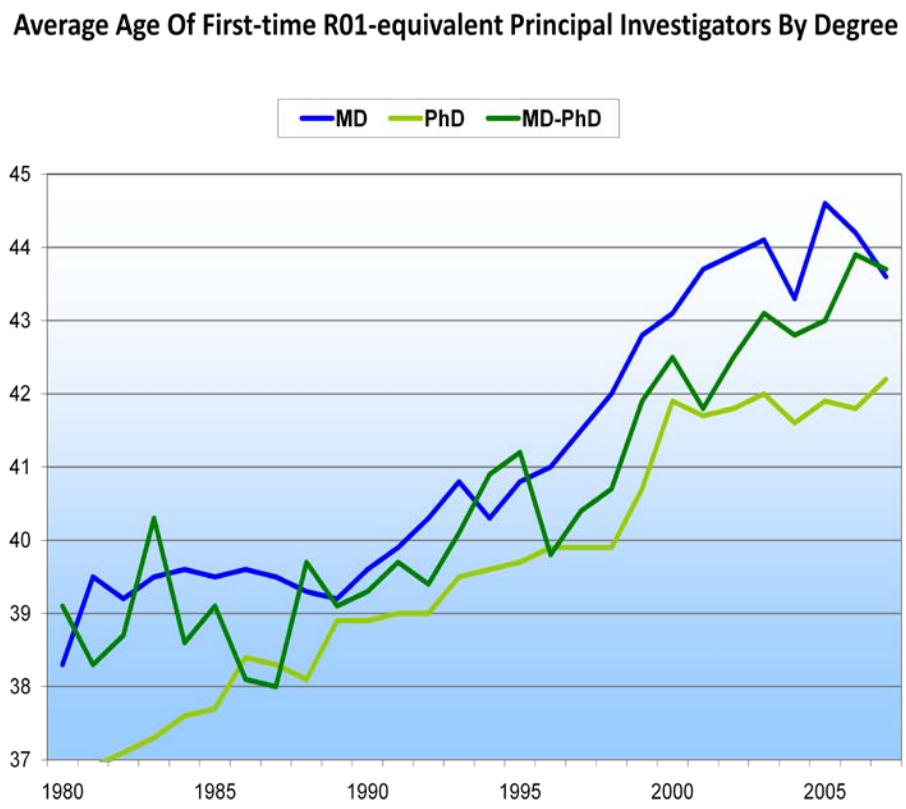


**Figure 2. The amount of time spent in training has risen substantially over the last few decades.**

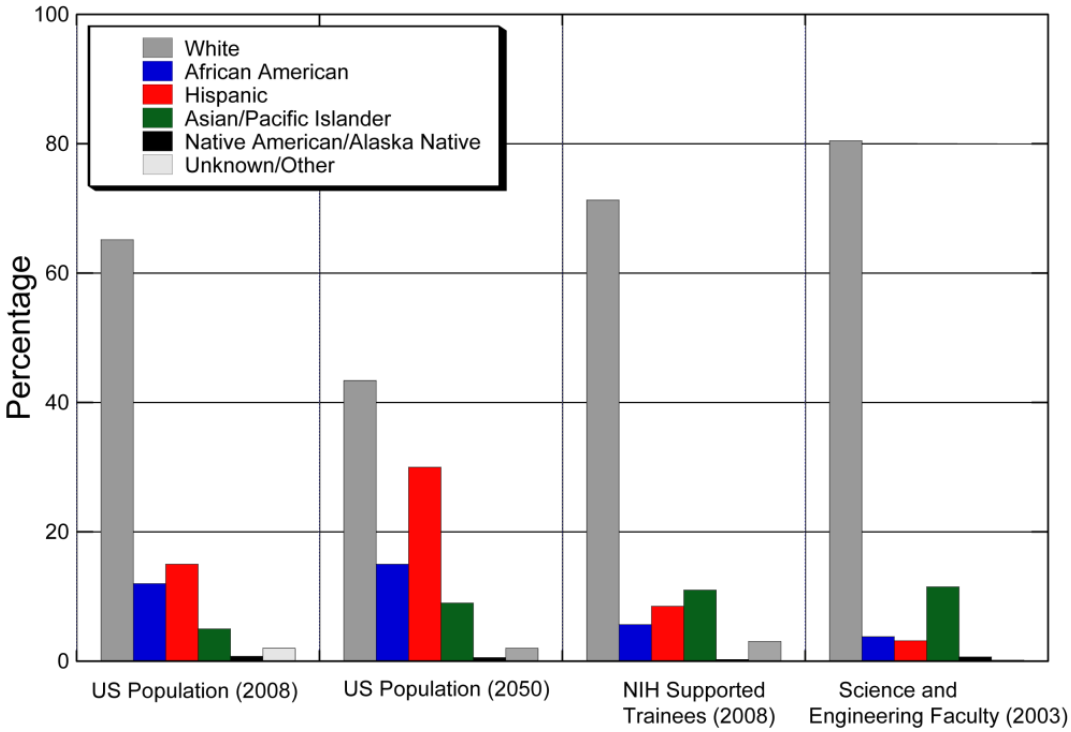


**Figure 3. The U.S. research workforce does not mirror U.S. diversity.**

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