NIH Request for Information: Future Biomedical Research Workforce

Summary of comments

January, 2012

This report covers the findings and conclusions of the comment analysis on the NIH Request for Information on the future of the biomedical workforce. The analysis was done by Ripple Effect Communications Inc. under contract # HHSN276200800275U.

Executive Summary

This report provides a summary of the comments received in response to the Request for Information (RFI): "Input into the Deliberations of the Advisory Committee to the NIH Director Working Group on the Future Biomedical Research Workforce" (NIH Guide Notice NOT-OD-11-106).

The RFI provided a list of eight issues that had been identified as important to consider when developing a model of the future biomedical research workforce. Information was requested in response to three questions related to the eight issues (or other unidentified issues).

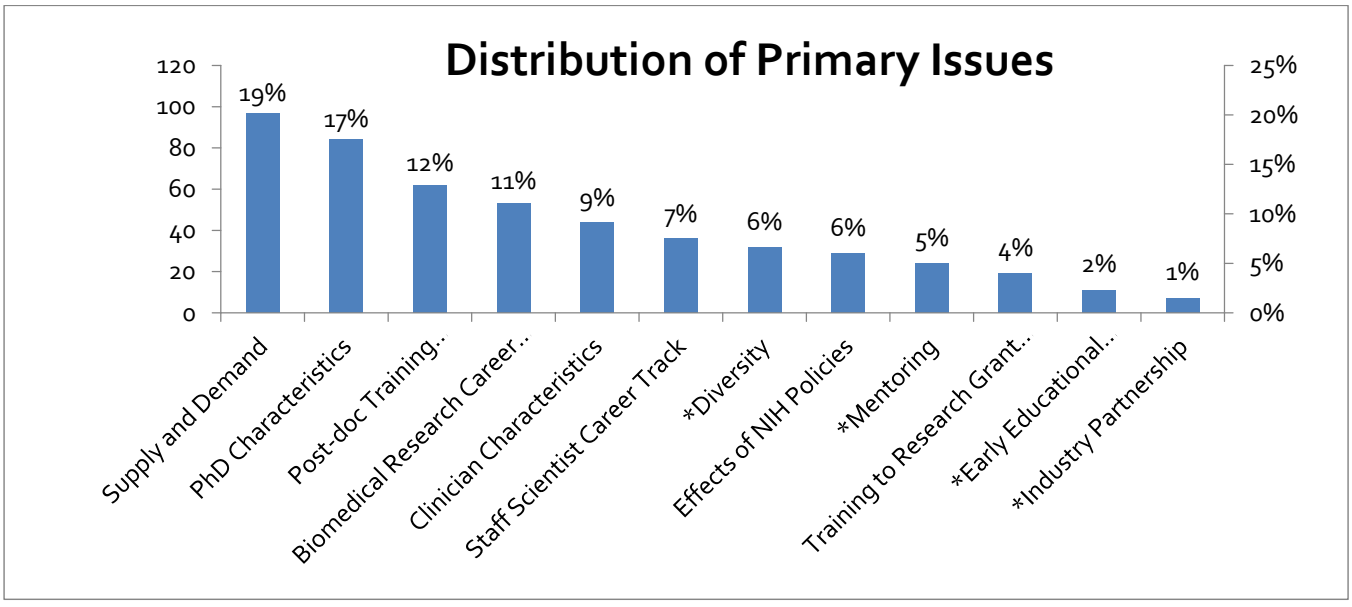
The comments received from 219 commenters were parsed into 498 "quotations" representing unique ideas, with an average of 2.3 quotations per commenter. Those quotations were key-word coded for sorting purposes.

Only 20% of the commenters replied on behalf of an organization, while 75% of the commenters provided personal input; the remaining 5% of the commenters were NIH staff. The organizations represented in the 20% were a broad cross section of NIH stakeholders, including NIH-funded investigators and research institutions.

Feedback was received on 1) how identified and unidentified issues affect institutions, scientists, or both; 2) what issue(s) are most important for the working group to address and why; and 3) how these issues should affect NIH policies or processes. The feedback was categorized into 12 primary issues, with 7 overlapping issues.

Primary Issues

The analysis process identified four primary issues in addition to the original eight primary issues included in the RFI. The distribution of primary issues, as cited by commenters, is shown in the graph.



**Issue not specified in the RFI but raised by commenters*

Overlapping (Secondary) Issues

Commenters found that most, if not all, of the primary issues were critical to the development of a sustainable biomedical workforce model. About two thirds of the comments included a secondary issue in addition to the primary issue. Therefore, we captured and analyzed the secondary issues mentioned by the commenters to help describe the overlapping and interlocking nature of the issues.

In cases where the primary and secondary issues are similar, the secondary issue covers only certain aspects of the primary issue. For example, the secondary issue of Career Appeal covers the specific issue of working conditions; whereas the primary issue of Biomedical Research Career Appeal encompasses all issues related to the attractiveness of biomedical research careers (e.g. salary, availability of research funding, working conditions).

The overlapping issues were as follows:

- **Funding.** Uncertainty and lack of funding, distribution of funding, restricted paylines, success rates, and excessive competition
- **Multi-disciplinary.** Need for multi/ inter/ trans-disciplinary research training to prepare individuals for a wide range of academic and non-academic career opportunities
- **Salary.** Inadequate compensation and benefits
- **Length of Training.** Amount of training time too long to be feasible for majority
- **Non-US Citizens.** Foreign students and post-doctoral fellows
- **Career appeal.** Working conditions (e.g. heavy workload, perception of being perceived as cheap labor, long work hours)
- **Mentoring.** Quality of career development and the need for pre-college preparation
- **Diversity.** Under-represented minority post-doctoral, fellows and junior faculty

The comments received are summarized within this report in a variety of ways to provide multiple options for the NIH ACD Working Group to review and utilize the information in their recommendations.

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Background

In April 2011, the National Institutes of Health (NIH) Advisory Committee to the Director (ACD) formed a Working Group to examine issues related to the future of the biomedical research workforce in the United States and make recommendations to the ACD that would help promote a diverse and sustainable biomedical and behavioral research workforce. As part of the process, the Working Group was tasked with gathering input from the extramural community, including students, post-doctoral fellows, investigators, scientific societies, and grantee institutions to consider various aspects of the future workforce.

The Working Group identified eight (8) issues to consider in the development of the future biomedical research workforce model:

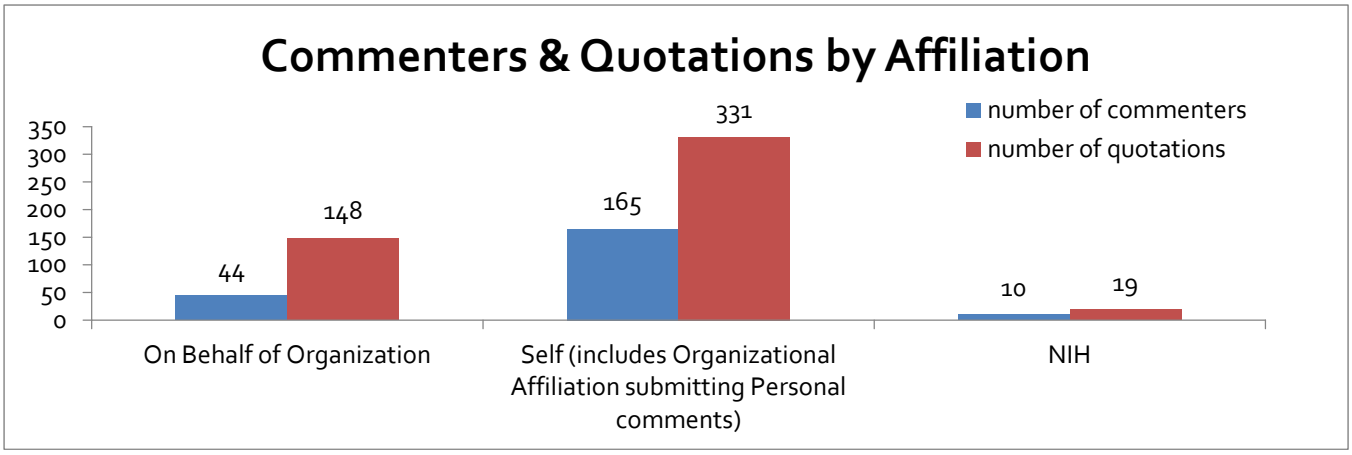
- The balance between supply, including the number of domestic and foreign trained PhDs and post-doctoral fellows, and demand, i.e. post-training career opportunities.
- Characteristics of PhD training in biomedical research, including issues such as
    - The length of the PhD training period.
    - Recommendations for changes to the PhD curriculum.
    - Training for multiple career paths (including bench and non-bench science).
- Characteristics of clinician-research training including issues such as
    - The balance between MDs and MD/PhDs
    - Career development of clinician-researchers.
    - Recommendations for changes to the curricula for training clinician-researchers.
- Length of Post-doctoral training.
- The ratio of PhD students and post-doctoral fellows on training grants to those supported by research grants.
- Possibilities for professional/staff scientist positions and the level of training required for such positions (e.g. PhD or MSc degrees).
- Issues related to the attractiveness of biomedical research careers (e.g. salary, working conditions, availability of research funding)
- The effect of changes in NIH policies on investigators, grantee institutions and the broader research enterprise.

NIH issued a Request for Information (RFI) to the community to provide input into the deliberations of the ACD Working Group. From August 17 through October 7, 2011 the extramural community submitted input to NIH on the identified issues (and other unidentified issues), the importance and effects of these issues on institutions and scientists, and how the issues should affect NIH policies and procedures.

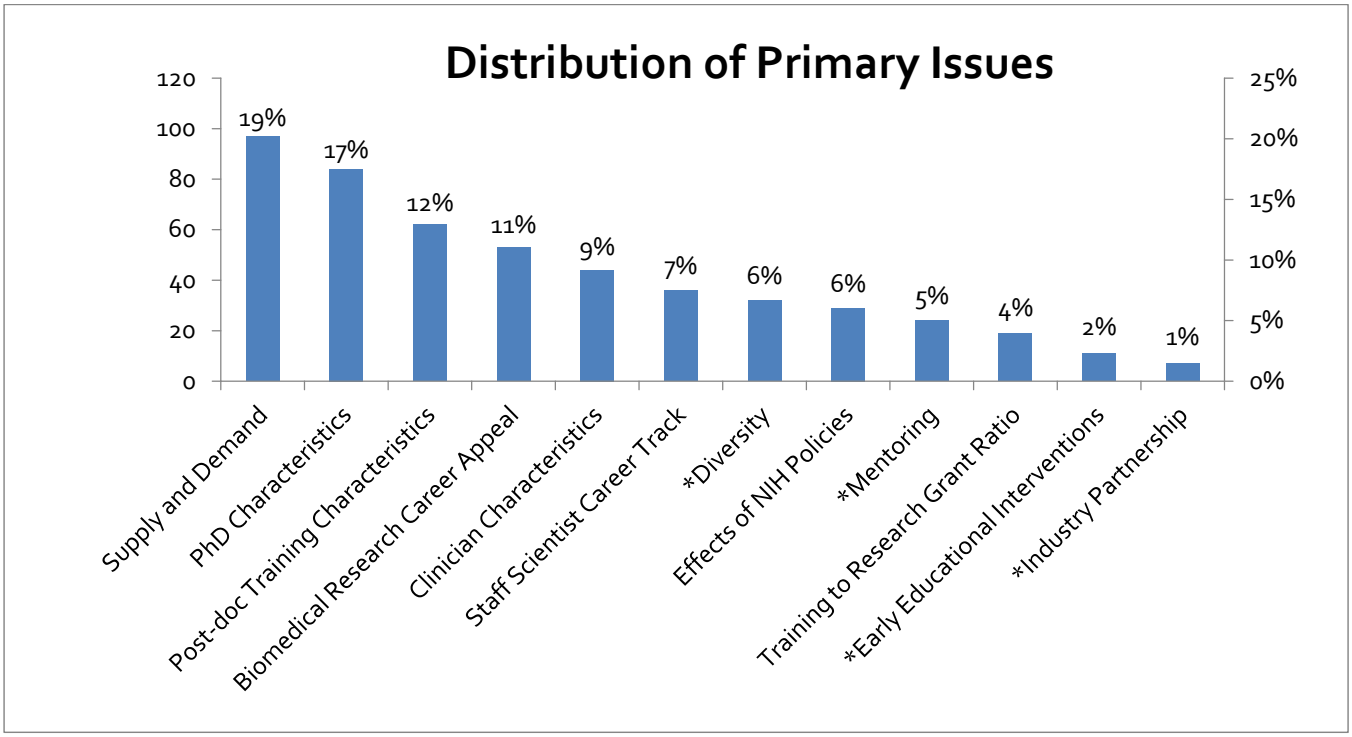
Methodology

About the Data

The primary type of submission was via an online form, but comments also were received via e-mail and postal mail. Responses from three commenters were received more than once; these duplicative comments were only analyzed once. There were a total of 219 commenters. Comments from the 219 commenters were parsed into 498 quotations, which correspond to an average of 2.3 quotations per commenter. Commenters responding on behalf of organizations provided an average of 3.4 quotations each, while commenters responding on behalf of themselves provided an average of 2.0 quotations each.



Each of the 498 quotations corresponded to one primary issue, according to the following distribution.



**Issue not specified in the RFI but raised by commenters*

Coding Scheme

The coding scheme evolved from the bottom up, by utilizing the eight issues identified in the RFI, and analyzing a sample of the responses to generate the scheme in an iterative fashion. Through this process, we identified four additional issues that were suggested by commenters. This bottom up approach was consistent with the key aspect of the RFI design which stated that all ideas and suggestions were welcome. The final issue categories and their descriptions are available in the Appendix).

The following is a list of the 12 primary issues (including 4 new* issues):

1. Supply and Demand
2. PhD Characteristics
3. Post-doc Training Characteristics
4. Biomedical Research Career Appeal
5. Clinician Characteristics
6. Diversity*
7. Staff Scientist Career Track
8. Mentoring*
9. Effects of NIH Policies
10. Training to Research Grant Ratio
11. Industry Partnership*
12. Early Educational Interventions*

Note that the issue "Post-doc Training Characteristics" is not identified as a new issue; however, it was broadened from the original primary issue, " Length of Post-doctoral Training," to be more inclusive of all the aspects of post-doctoral training that were identified by commenters.

During the coding process, we discovered that specific aspects of primary issues were appearing across all comments. To capture these "secondary" themes, overlapping issues were developed. For example, a comment on the primary issue of Supply and Demand may cite other interlocking issues such as Career Appeal or Funding.

The following is a list of the secondary issues and their descriptions:

- **Funding.** Uncertainty and lack of funding, distribution of funding, restricted paylines, success rates, indirect costs, excessive competition
- **Multi-disciplinary.** Need for multi/ inter/ trans-disciplinary research training to prepare trainees for a wide range of academic and non-academic career opportunities
- **Salary.** Inadequate compensation and benefits
- **Length of training.** Amount of training time too long to be feasible for majority
- **Non-US citizens. Foreign students and post-doctoral fellows**

- **Career appeal.** Working conditions, i.e. heavy workload, perception of being used as cheap labor, long work hours.
- **Mentoring.** Quality of career development and the need for pre-college preparation
- **Diversity.** Under-represented minority post-doctoral, fellows and junior faculty

Analysis Process

Both the primary and secondary issues were used as a starting point and expanded through successive analysis/coding iterations by a coding team. The following process was followed:

1) First, a random selection of comments was assigned to each team member to scan for meaningful quotations that addressed issues related to the future of the biomedical workforce;

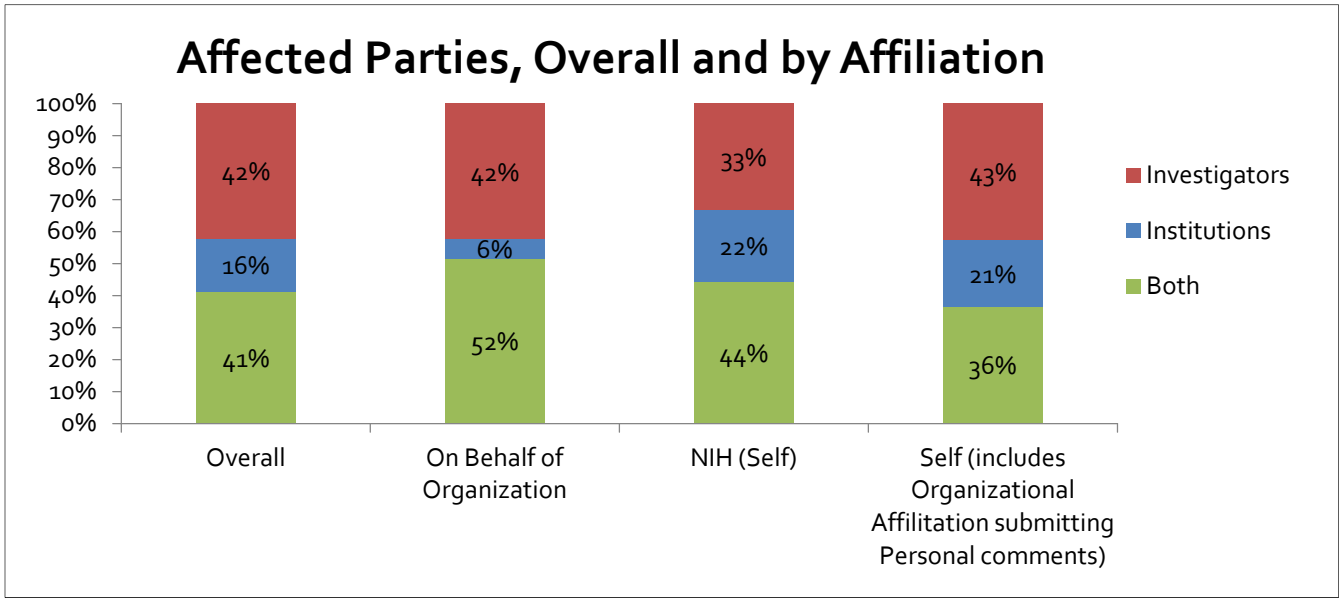
2) Team members analyzed the quotations to define the code categories (starting with the three questions identified by the RFI and the 8 issues identified by ACD) into which the quotation might belong (first cut);

3) Team members assigned the quotations into one of the existing issue code categories that best matched the quotation (second cut);

4) Finally, team members revised the code structure by creating new issues to categorize the quotations that did not fit existing issue categories.

Affected Parties

Each quotation was analyzed for affected party (investigators, institutions, or both), as cited by the commenter. Of the 498 quotations, only 319 (64%) were identified with an affected party. The distribution of affected party (for the overall data set and by affiliation) is shown in the graph below.



Priority Analysis

Commenters were asked to indicate the most important issue(s) for the working group to address. To capture and analyze responses to this question, cited issues for each commenter were given a ranking number[1]. For example, if a commenter mentioned three issues in her response, the first issue received rank 1, the second issue received rank 2, and the third issue received rank 3. The total count per issue was summed across all comments to determine the overall priority. This method allowed us to distribute the appropriate weight per issue, when commenters mentioned more than one issue. The theoretical maximum priority score for an issue was 219, and would have occurred if the issue received rank 1 from every commenter. Priority scores for each of the twelve issues, in descending order, are provided in the table below.

Issue	Priority Score
Supply and Demand	90
PhD Characteristics	85
Biomedical Research Career Appeal	67
Post-doc Training Characteristics	56
Clinician Characteristics	51
Diversity	34
Effects of NIH Policies	34
Staff Scientist Career Track	31
Mentoring	22
Training to Research Grant Ratio	15
Early Educational Interventions	9
Industry Partnership	7

As expected, the overall priority of issues followed a similar pattern to the frequency counts by issue.

[1] If issue priority was not explicitly stated by the commenter, it was assigned by the order in which the issue appeared within each comment.

Issue Priority

Commenters were asked to indicate the most important issue for the working group to address. To capture and analyze responses to this question, cited issues were given a ranking number[2] by commenter. The total count per issue was summed across all responses to determine overall priority.

As described above, the overall issue priority was similar to the overall frequency of issues. However, when considered by affiliation (self and organization), the pattern differed, as shown below.

Issue	Priority Score (Organization)
PhD Characteristics	29
Clinician Characteristics	21
Post-doc Training Characteristics	19
Supply and Demand	18
Biomedical Research Career Appeal	18
Staff Scientist Career Track	15
Diversity	12
Effects of NIH Policies	12
Training to Research Grant Ratio	12
Early Educational Interventions	2
Mentoring	1
Industry Partnership	1

Issue	Priority Score (Self)
Supply and Demand	68
PhD Characteristics	55
Biomedical Research Career Appeal	47
Post-doc Training Characteristics	36
Clinician Characteristics	30
Effects of NIH Policies	21
Diversity	20
Mentoring	18
Staff Scientist Career Track	13
Industry Partnership	6
Early Educational Interventions	5
Training to Research Grant Ratio	3

The order of issues as determined by frequency (below) is the same whether considering either the Organization or the Self perspective, but it does not correlate with the order of issues as determined by priority score for either Organization or Self.

Issue	Frequency (Organization)	Frequency (Self)
Supply and Demand	17%	20%
PhD Characteristics	15%	18%
Post-doc Training Characteristics	11%	13%
Biomedical Research Career Appeal	10%	10%
Clinician Characteristics	9%	9%
Staff Scientist Career Track	8%	6%
Diversity	7%	6%
Effects of NIH Policies	7%	5%
Mentoring	5%	5%
Training to Research Grant Ratio	5%	3%
Early Educational Interventions	3%	2%
Industry Partnerships	1%	2%

[2] Priority was assigned based on the order of issue appearance within each separate comment response.

Qualitative Analysis

The issues identified by the Working Group and commenters are discussed below in descending order by comment frequency, beginning with the issue that received the most comments, Supply and Demand.

Supply and Demand, 97 quotations [19%]

According to commenters, this was the most important issue because it affects all other issues. Commenters felt that the imbalance between supply and demand is so vast that excellent candidates cannot find work in academia. Generally, commenters agreed that NIH is training more scientists than the workforce can support; exceptions included certain specialties such as veterinary research, biostatistics, and medical informatics. Supply of research funds is largely viewed to be inadequate and, in the current environment, creates a demand for cheap labor to perform technician duties in laboratories.

Many solutions were proposed, some on the supply side, some on the demand side. Supply side remedies included reduction in trainees, and a branching career path. Demand side remedies included funding increases and revisions of funding structures. Institutions favored solutions that addressed funding distribution and increased flexibility in training outcomes. Individuals overwhelmingly called for a reduction in the number of post-doctoral fellows by various long-term measures, such as early identification of individuals who will not choose to perform a post-doctoral fellows and redirection to MS programs or non-research careers, or by limiting the long-term supply of post-doctoral fellows by various methods.

Oversupply. Some suggestions for addressing oversupply were class size reductions, raising graduate program entry requirements, and improving training for "alternative" careers. Several commenters suggested that the scientific community should return to using the Master's degree for individuals not interested in becoming academic research PIs.

Pyramid scheme. Many commenters referred to the current structure of the research workforce as a "pyramid scheme" which utilizes the cheap labor of students and post-doctoral fellows in place of hiring mid-career level researchers. This structure has negative effects on both sides of the supply-demand problem. Suggestions to address this structure included addressing the tenure model, decreasing the number of funded trainees per PI, and increasing the use of staff scientists.

Funding contraction. Limited supply of research funds was cited by many commenters as creating funding barriers for ESIs and transitioning post-doctoral fellows due to decreased success rates. Suggestions to address this issue included increasing paylines, limiting the number of large grants a single PI can have, or funding ESIs at a higher percentile.

Non-US citizens. It was frequently suggested that, as domestic appeal wanes for research careers, the workforce is being infused with students and post-doctoral fellows from other countries who are willing to endure the struggles of academic research. Because this compounds the competition for future funding, many respondents called for restrictions on the number of foreigners who may enter the graduate and post-graduate training systems. Still, a majority of organizations and some individuals asserted that more foreign students and post-doctoral fellows should be encouraged to seek training in the U.S. and stay on to contribute to the U.S. economy, rather than return to their home countries.

SECONDARY ISSUES

Most (64%) of the quotations identified a secondary issue. Those with a secondary issue were categorized as follows:

Secondary Issues for Supply and Demand	
Non-US Citizens	35%
Funding	32%
Career Appeal	11%
Salary	10%
Multi-disciplinary	6%
Length of training	3%
Mentoring	2%

IMPACT

Almost half (43%) of the commenters felt that Supply and Demand was an issue for both institutions and investigators, while 34% felt that Supply and Demand was an investigator issue and 23% felt that Supply and Demand was an institutional issue.

SELECTED PUBLIC RECOMMENDATIONS FOR NIH ACTION

- Reduce the number of students and post-doctoral fellows supported, and improve awareness and understanding of the branching career path available to new scientists (supply-side).
- Increase total funding and revise current funding structures to promote wider distribution of funds (demand-side).

PhD Characteristics, 84 quotations [17%]

Commenters suggested that career development deficiencies and failure to train for a branching career pathway are contributing to bottlenecks at the senior post-doctoral fellow stage. Many commenters asserted that variability in mentoring and career development resources in different programs results in too much variation in the PhD experience; greater structure was cited as a solution to this problem.

The most popular proposed solutions were (1) Improved career development programs that integrate alternative career pathways, (2) Increased structure in the PhD experience, and (3) Funding mechanisms to support career development.

Training curriculum changes. Many commenters expressed that typical research training is insufficient for creating independent researchers. Greater career development training was suggested for skills such as lab management, teaching, and technical writing. Some concern was expressed that there is too much variability in standard expectations, such as publication requirements for thesis defense. As a result, some students are being held to higher standards than others, which can affect length of time to degree. Increased training for cross-disciplinary and translational research were also suggested as deficiencies in some programs.

Multiple career path training. The majority of respondents, both individuals and institutions, agreed that training focused on academic PI careers is no longer sufficient, given that only a small percentage of students and post-doctoral fellows will likely obtain these positions. Many respondents expressed a hope that the NIH would "redefine success" for training grant reviews to include non-academic appointments. Beyond a lack of information regarding non-academic careers, several noted that interest in such careers may actually be discouraged by faculty.

Length of training period. Only a few commenters suggested that PhD training was too long. Several warned that imposing a reduction or cap on length of training could have a negative effect on the quality of doctoral graduates.

SECONDARY ISSUES

A strong majority (81%) of the quotations identified a secondary issue. Those with a secondary issue were categorized as follows:

Secondary Issues for PhD Characteristics	
Multi-disciplinary	55%
Length of training	16%
Funding	14%
Salary	4%
Mentoring	4%
Career appeal	3%
Non-US Citizens	1%
Diversity	1%

IMPACT

Almost half (46%) of the commenters felt that PhD Characteristics was an investigator issue; slightly less (42%) felt that it was an issue for both institutions and investigators, and only 12% felt that PhD Characteristics was an institutional issue.

SELECTED PUBLIC RECOMMENDATIONS FOR NIH ACTION

- Evaluate and consider changing the structure in the NIH-supported PhD experience.
- Provide direct funding support and encourage career development programs that integrate alternative career pathways.
- Revise training grant review policies so that non-academic career choices for former trainees are not considered training failures.

Post-doctoral Fellow Training Characteristics, 62 quotations [12%]

This issue was broadened from the original issue, "Length of Post-doctoral Training", since there were too many comments that could not be captured under the original, more specific issue. While there was some dissent, most agreed that post-doctoral training is too long and is largely the result of a bottleneck of individuals looking for faculty positions. Inadequate mentoring was another challenge cited by many as a possible cause for the lengthening of the training period. Some suggested that the inherent instability of a training position may affect the scientific work being done by these scientists.

Post-doctoral fellowship experiences seem to affect career appeal. The post-doctoral fellow lifestyle was viewed as untenable for many mid-30s professionals; this lack of appeal may result in a possible "brain drain" to industry jobs. The most popular solutions addressed salary, transition funding, and documentation of training progress.

Salary and benefits. Most commenters, both individuals and institutions, expressed concern that salary and benefits for post-doctoral fellows are insufficient and need to be increased. This issue was also one of the most common reasons cited for low career interest among students, since most students were aware that other careers would provide much better pay and benefits. Several commenters pointed to the family and retirement benefits provided to post-doctoral fellows at a life stage when these are critical needs.

Addressing the bottleneck. To alleviate the post-doctoral bottleneck, some commenters suggested increases and extensions in transition funding, while others maintained that greater use of staff scientists is the best approach. Some also expressed concern over the influx of foreign trainees at this career stage, which creates even greater competition for scarce faculty positions. The issue of a post-doctoral bottleneck seems to be a greater concern for individuals than for institutions/organizations.

Length of training. Both institutions and individuals generally agreed that the average post-doctoral fellowship has become too long. The greatest complaint noted in this issue was primarily in reference to the length and availability of transition awards, rather than on the length of the post-doctoral fellowship itself. Several commenters called for a lengthening of transition awards in today's exceptionally competitive job market. Still, some institutions are enacting caps on the number of post-doctoral years in an effort to incentivize career

development planning, a noted concern for poorly mentored post-doctoral fellows. A few respondents noted that the increasing post-doctoral fellowship length may be making candidates less desirable, not more.

Content of training. Some respondents called for more structure in the post-doctoral training experience. There was no consensus on what training ought to include or not include, but many expressed that post-doctoral fellows do not receive enough experience in non-research skills, such as teaching and grant writing. Many believed that a structured competencies-based approach, supported by NIH, would be preferable to a strict limitation on number of years.

Career development and mentoring. Most commenters seemed to agree that post-doctoral fellows do not engage in enough career development. This was especially true for post-doctoral fellows with non-academic or non-research career interests. A few commenters stressed the need for an increase in the training areas of lab management and teaching to create more self-sufficient researchers. Many others pointed out the mentoring challenges that PIs face in the current funding climate. With more time needed to write winning grants, PIs appeared to be neglecting their mentoring duties of new scientists. Overall, individual respondents felt that mentoring and career development was generally inadequate; a majority of institutions did not comment on this aspect of post-doctoral training.

Lifestyle of a post-doctoral fellow. Several commenters explained that the lifestyle of a post-doctoral fellow (hours worked, workload, and relationships with PIs) is not amenable to family life. Thus, many women of child-bearing age chose to place their career on hold at this stage or leave academia altogether. This issue appeared more often in comments from individuals than institutions.

SECONDARY ISSUES

A strong majority (82%) of the quotations identified a secondary issue. Those with a secondary issue were categorized as follows:

Secondary Issues for Post-doctoral Training Characteristics	
Length of training	27%
Funding	25%
Salary	20%
Multi-disciplinary	12%
Career appeal	8%
Mentoring	6%
Non-US Citizens	2%

IMPACT

More than half (54%) of the commenters felt that Post-doctoral Training Characteristics was an investigator issue; about one-third (36%) felt that it was an issue for both institutions and investigators, and just 10% felt that Post-doctoral Training Characteristics was an institutional issue.

SELECTED PUBLIC RECOMMENDATIONS FOR NIH ACTION

- Increase the availability and length of transition funding for senior post-doctoral fellows.

- Raise the NRSA post-doctoral stipend and mandate that all NIH-supported post-doctoral fellows (whether directly or indirectly supported) receive this amount.
- Require better documentation and monitoring of training progress and career planning.

Biomedical Research Career Appeal, 53 quotations [11%]

This issue is largely viewed as a downstream effect of the student and post-doctoral experience. Right now, students and post-doctoral fellows are largely unhappy due to the dismal economy and job outlook. Research careers are currently less appealing than careers in competing fields, including MD and MPH programs.

In general, commenters thought that the issue of career appeal is an important one and affects several other issues. Both institutions and individuals agreed that a career in biomedical research is less appealing today as a result of lower starting salaries for graduates and the increasing competition for limited research funding. Individuals seemed more concerned than institutions with career aspects such as family-friendly work environments, long hours, high stress, and benefits packages. By comparison, institutions expressed greater concern with regulatory burdens placed on current investigators. Many individuals viewed long-term institutional commitment unfavorably, citing the erosion of tenure positions and the increasing burden to fund one's own salary.

Some commenters pointed out that misinformation about graduate degrees and career opportunities led many to be dissatisfied with their career in biomedical research. What information students are given on potential graduate degree programs and career opportunities and how that information was conveyed were thought to be critical.

Improved mentoring and career development, as well as anything that addresses the supply and demand imbalance, were perceived as the best solutions.

Salary. Commenters felt that compensation is inadequate; suggesting that most faculty PhD positions start from the low to high $30,000s. A main contributing factor to the issue of low pay was attributed to students and post-doctoral fellows being utilized as technicians in labs. Institutions are utilizing NIH NRSA program salary levels as de facto guidelines – in spite of NIH clarification that the NRSA salary levels are for that program specifically.

Funding availability. Commenters deemed the availability of funding as the most critical aspect for the recruitment and retention of young and talented individuals in biomedical research. Commenters strongly felt that funding for science research must increase; suggestions to increase funding included shifting funding priorities to investigator-initiated grants (e.g. R01 grants) and basic science research, reducing and/or limiting overhead, and limiting the number or dollar amount of grants awarded to a single investigator. Other suggestions included the provision of dedicated funding mechanisms for multi-disciplinary training programs.

SECONDARY ISSUES

More than three-quarters (79%) of the quotations identified a secondary issue. Those with a secondary issue were categorized as follows:

Secondary Issues for Biomedical Research Career Appeal	
Funding	48%
Salary	40%
Length of training	7%
Multi-disciplinary	2%
Non-US Citizens	2%

IMPACT

Almost half (46%) of the commenters felt that Biomedical Research Career Appeal was an issue for both institutions and investigators, while 33% felt that it was an investigator issue and 21% felt that it was an institutional issue.

SELECTED PUBLIC RECOMMENDATIONS FOR NIH ACTION

- Encourage improved mentoring and career development.
- Establish salary standards/ guidance for non-NRSA supported postdoctoral fellows, and increase the NRSA stipend levels.
- Increase overall funding or change funding distributions that favor higher success rates, especially for transitioning and new investigators.

Clinician Characteristics, 44 quotations [9%]

Overall, individual commenters cited the pressure to increase clinic time as the main reason why the clinician researcher path is less attractive and attainable. Commenters felt that the time required to conduct research is often not adequately compensated by the institution (in terms of pay, recognition or career advancement). This makes it difficult for many MD recipients, especially for those with medical school loans to repay, to justify beginning or continuing down this career path. Both individuals and institutions suggested funding support from NIH to provide clinicians with protected time to maintain research activities.

Institutions and individuals agreed that a broader approach to training was needed and clinical/translational training should begin sooner – in medical and undergraduate school.

Balance between MDs and MD/PhDs. Commenters believed that MD/PhD degrees are valuable, but that the increasing cost of medical school, requirements and length of training, and the limited opportunities in academia make the MD/PhD career path less attractive.

Career development. Commenters felt that there is a decline in the number of MD recipients conducting clinical research in academia. Many commenters agreed that this decline is due to the pressures they face to be profitable in clinical practice (e.g. see more patients, bill more, etc.). Commenters suggested that funding support is needed to provide clinician scientists with protected time to conduct competitive research.

Training curriculum changes. Few recommendations were made with regard to curriculum changes. Commenters believed that MD and PhD recipients should be cross-trained and equally versed in translational research and quantitative studies such as physics, mathematics, engineering and informatics. Commenters cited a need for clinical research training to begin at the graduate and/or undergraduate level. Some

commenters suggested that NIH funding could provide support for medical schools to offer clinical relevant courses such as statistics, epidemiology and genomics.

SECONDARY ISSUES

Slightly more than half (57%) of the quotations identified a secondary issue. Those with a secondary issue were categorized as follows:

Secondary Issues for Clinician Characteristics	
Funding	36%
Multi-disciplinary	32%
Salary	16%
Length of training	8%
Career appeal	8%

IMPACT

More than half (53%) of the commenters felt that Clinician Characteristics was an issue for both institutions and investigators, while 33% felt that it was an investigator issue and 13% felt that it was an institutional issue.

SELECTED PUBLIC RECOMMENDATIONS FOR NIH ACTION

- Provide mechanisms to support protected time for clinician research.

Staff Scientist Career Track, 36 quotations [7%]

There was much support among individual commenters to create permanent career staff scientists positions. They saw this as a way for all parties to reap the benefits of training support provided by NIH. Institution commenters where divided, some taking a cautious approach to the idea of utilizing staff scientist in the lab, citing possible adverse effects including potential loss of innovative ideas (currently provided by graduates) and the reduction in project budgets to cover the salaries for these positions.

Career level of staff scientists. Some opined that the staff scientist position should remain at the PhD level, while others believed that over-supply of graduates could be addressed by opening this new field to Master's recipients. There was some divergence about whether staff scientist positions would be viewed as career-terminal or if they could be an additional step towards independent faculty positions.

Staff scientists vs. post-doc labor. Some commenters noted that staff scientists have different incentives and productivity profiles than post-doctoral fellows. Specifically, commenters felt that if PIs employed staff scientists instead of post-doctoral fellows, the amount of productivity received per NIH dollar would likely decrease; therefore, many expressed that NIH must fully support the move to use the more expensive staff scientists. Without this backing, PIs will continue to use student and post-doctoral fellow labor to keep budget proposals low.

SECONDARY ISSUES

Only 36% of the Staff Scientist Career Track quotations identified a secondary issue. Those with a secondary issue were categorized as follows:

Secondary Issues for Staff Scientist Career Track	
Funding	46%
Multi-disciplinary	15%
Length of training	15%
Salary	15%
Career appeal	8%

IMPACT

Half (50%) of the commenters felt that Staff Scientist Career Track was an issue for both institutions and investigators, while 44% felt that it was an investigator issue and only 6% felt that it was an institutional issue.

SELECTED PUBLIC RECOMMENDATIONS FOR NIH ACTION

- Provide grant mechanisms and change the funding policy to increase project budgets to support the costs associated with permanent staff.

Diversity, 32 quotations [6%]

Commenters believed that the issues of the biomedical workforce cannot be addressed without addressing the need for diversity. There was much fear that the current economy and funding climate will gravely affect the diversity of the workforce. Little difference was evident between individual and institutional/organizational responses to this issue. Most agreed that diversity should remain a priority in any proposed policy changes.

Most commenters that addressed this issue delivered a general call to action with few specifics on recommendations. The few that provided specific requests focused on reviewing and addressing policies within grant funding and training that adversely affect these groups. One commenter acknowledged the importance of diversity as an issue but warned NIH not to sacrifice competitiveness for diversity.

Women. Many commenters felt that there is a significant loss of women from the academic research workforce; most believe this loss is due to the negative effect that raising a family can have on a woman's career. Others proposed that the loss is caused by the disproportional size of the average lab headed by women when compared to men; smaller labs cannot compete with larger ones in terms of experimental productivity. Another issue raised by commenters was the problem of "career pacing", which occurs when individuals (usually females) take time away from research that can then reduce their eligibility for certain programs and affect competitiveness for funding later in their careers. Commenters recommended that the existing NIH family-friendly policies and NIH-ORWH Reentry program be reviewed and revised to create a mechanism for scientists who take a part-time rather than a full-time leave of absence.

Ethnic and racial minority groups. Commenters felt strongly that the low success rate among ethnic and racial minority groups was an issue that needs to be addressed. Many cited a recent *Science* article (Ginther, et.

al) as a cause for great concern within the scientific community. Specific barriers to success were not provided for these groups as they were for women; instead, most comments assumed that these barriers were well-known. Commenters proposed a diverse list of recommendations to resolve this issue including pre-college mentoring, use of social media tools to mentor, recruitment and tracking of candidates, and support of diversity specific mechanisms.

SECONDARY ISSUES

Less than half (44%) of the quotations identified a secondary issue. Those with a secondary issue were categorized as follows:

Secondary Issues for Diversity	
Funding	50%
Career appeal	21%
Non-US Citizens	14%
Multi-disciplinary	7%
Length of training	7%

IMPACT

A plurality (40%) of commenters felt that Diversity was an institutional issue; about one third (35%) felt that Diversity was an investigator issue, and only 25% felt that it was an issue for both institutions and investigators.

NIH ACTION RECOMMENDATIONS

- Expansion of targeted funding opportunities for underrepresented groups, such as loan repayment programs that will benefit minorities, who are likely to have heavier loan burdens.
- Review and modification of family friendly policies, such as family leave for trainees, and funding restrictions/preferences based on career pacing to better address issues that disproportionately occur for females.

Effects of NIH Policies, 29 quotations [6%]

The issue of NIH polices appeared throughout the responses. Commenters cited NIH policies and practices that positively and negatively affected the workforce, and offered possible solutions. Comments responding to this issue were disparate. Only two themes received attention from multiple commenters: adverse funding policies and the dissolution of the National Center for Research Resources (NCRR).

Commenters addressing the issue of funding policies expressed a range of reasons for being dissatisfied with the current funding review system. The predominant reason, for both institutions and individuals, was that securing funding has become increasingly difficult, particularly for new investigators.

Adverse funding policies for new investigators. Overall, commenters believed that established investigators are receiving an undue proportion of available funding. Some commenters acknowledged the efforts that the NIH has made to improve success rates for Early Stage Investigators (ESI). However, most felt that current

efforts are not enough to continue to draw new talent to the field. Several commenters noted that the shift away from R21 funding and the new limitation on resubmissions are especially detrimental for new investigators.

NCRR dissolution. Several commenters submitted similar responses, which expressed concern that funding and extramural support for animal-model biomedical research would be reduced with the dissolution of NCRR. These commenters urged the NIH to ensure that NCRR's commitment to animal-model research would continue following this reorganization.

Institution affiliation. Currently, scientists must be associated with an institution or hold a certain job title to apply for certain types of funding at NIH. One commenter felt that this policy was counterproductive in the current economic climate, especially for unemployed scientists who are trying to re-enter to the workforce. This policy could also be a burden for post-doctoral applicants who are unable to get institutional support.

SECONDARY ISSUES

More than half (59%) of the quotations identified a secondary issue. Those with a secondary issue were categorized as follows:

Secondary Issues for Effects of NIH Policies	
Funding	88%
Salary	6%
Career appeal	6%

IMPACT

A majority (61%) of the commenters felt that Effects of NIH Policies was an investigator issue, while 26% felt that it was an issue for both institutions and investigators, and only 13% felt that it was an institutional issue.

SELECTED PUBLIC RECOMMENDATIONS FOR NIH ACTION

- Increase funding opportunities for various grant mechanisms and research areas.
- Consider the short and long-term implications of proposed models and gather additional input from the extramural community prior to implementation.
- Restrict the amount of funding and/or number of grants one investigator may be awarded.

Mentoring, 24 quotations [5%]

As reported by commenters, the quality of mentoring varies immensely, and it has a significant effect on mentee's perspectives and career paths. Institutional commitment to career development resources was also reported to vary, which could present greater challenges for some graduates. Mentoring can improve or compound other issues such as diversity, length of training, and biomedical research career appeal.

Institutions and individuals both describe conflicts of time and interest for PIs when mentoring students and post-doctoral fellows. PIs are spending more time in the office to obtain funding and less time doing research

and mentoring new scientists. Anything that would improve current funding success rates could address this conflict. Individuals criticized the academic bias present in much of the mentoring.

Mentoring plan documentation. Many commenters suggested that all NIH-funded students and post-doctoral fellows should have documented individual development plans (IDPs), created and approved by both the mentor and mentee. The progress of such plans should be included in the annual reports to NIH for funded trainees.

Conflict interest for mentors. An additional concern for many commenters was the conflict of interest that mentors experience. Funding systems, such as the NIH, and academic promotion structures reward discovery and publications, metrics which are largely fueled by student and post-doctoral fellow productivity. This reliance on student and post-doctoral labor creates an environment where productivity is prioritized over career development, especially when pursued outside of the lab. Because mentoring is an uncompensated activity, several commenters suggested that making mentoring a part of funding reviews might provide the incentive needed to address these conflicts.

Funds for institutional program management staff. Several commenters recommended that training grants provide support for program management of the training grants, including salary support for program directors, staff, and significant faculty. Also requested on training grants were funds for purchasing training technologies.

Non-academic mentoring. Of commenters addressing non-academic career paths, most agreed that training for these paths is inadequate. Given that most current mentors were "raised" on the academic, tenure-track path, commenters expressed an absence of mentoring for non-academic careers, which has a downstream effect on the supply and demand issue.

SECONDARY ISSUES

More than half (54%) of the quotations identified a secondary issue. Those with a secondary issue were categorized as follows:

Secondary Issues for Mentoring	
Multi-disciplinary	43%
Funding	36%
Length of training	7%
Salary	7%

IMPACT

A strong majority (73%) of the commenters felt that Mentoring was an investigator issue and none (0%) felt that it was an institutional issue. The remaining 27% felt that Mentoring was an issue for both institutions and investigators.

SELECTED PUBLIC RECOMMENDATIONS FOR NIH ACTION

- Encourage a more structured mentoring experience and develop career/mentorship plans and guidelines.

- Permit training grant budgets to support the salary of mentors and support staff (e.g. training director).
- Uncouple career/mentorship from financial support and access to career development resources.

Training to Research Grant Ratio, 19 quotations [4%]

Few respondents commented on this issue; those that did respond to this issue felt that there was a need for more training grants because their flexibility allows for better career development of funded trainees. This belief was held by institutions as well as individuals.

Institutions requested an in-depth evaluation be conducted to understand the potential impact of moving students and post-doctoral fellow support off of research grants and onto training grants.

Training funds versus research funds. In terms of training goals, most commenters agreed that training funds are better at training than research funds. Training grants were described as being more flexible, more amenable to career development, and easier to track. However, commenters warned that a migration away from research funds for training purposes could have unintended consequences for institutions and for foreign students who are currently ineligible for most training grants.

Value to institutions. Commenters indicated that the funding provided by training grants is declining as the grant review requirements are on the rise. As a result, training grants are perceived as not being worth the trouble since many institutions can no longer afford to subsidize the salary shortfalls these grants contain.

Direct to trainee awards. A few individual commenters suggested that more portable awards, granted directly to the trainee, might foster independence among new trainees, enabling them to move to a new lab/institution if this would better suit their training goals.

SECONDARY ISSUES

More than half (58%) of the quotations identified a secondary issue. Those with a secondary issue were categorized over a broad group of the following secondary issues:

Secondary Issues for Training to Research Grant Ratio	
Funding	42%
Mentoring	17%
Salary	8%
Career appeal	8%
Multi-disciplinary	8%
Non-US Citizens	8%
Diversity	8%

IMPACT

Commenters were equally split (40% each) between those that felt Training to Research Grant Ratio was an investigator issue versus an issue for both institutions and investigators; only 20% felt that it was an institutional issue.

SELECTED PUBLIC RECOMMENDATIONS FOR NIH ACTION

- Conduct a thorough analysis of the benefits and drawbacks of each type of funding before instituting a change to the current ratio.
- Increase training mandates and trainee monitoring on research grants.
- Increase the use of training funds or administrative supplements that allow more time and effort for career development.

Early Educational Interventions, 11 quotations [2%]

Commenters suggested that some of the primary issues may have roots as early as K-12 education. Intervention programs prior to graduate school will likely have downstream effects on issues such as Biomedical Research Career Appeal, Diversity, and Supply and Demand. Suggestions generally called for an increase in funds devoted to programs that would affect the K-12, undergraduate, and post-baccalaureate student populations.

K-12 interventions. The ability to draw in new talent, especially underrepresented groups, may be best addressed in early education and mentoring. One commenter suggested that the NIH may wish to encourage its funded researchers to increase their community engagement as a way to increase awareness about science careers.

Undergraduate curriculum changes. Rather than lengthening or adding to the requirements for PhD degrees, it may be more appropriate to broaden or deepen undergraduate training. Additionally, commenters suggested that training for non-academic career paths could occur at the undergraduate level. Additionally, commenters suggested that training may be improved by the development and institution of competencies that would provide common metrics for PhD programs considering new applicants.

Expansion of post-baccalaureate programs. Many applicants to PhD programs may not be aware of the realities of a career in research, such as the length of the training period and investigator struggles to maintain funding levels. Without this experience, student expectations upon entering graduate school may be unrealistic. Inflated expectations may contribute to a sudden drop in motivation during the training period; expanding post-baccalaureate and pre-doctoral programs could expose potential applicants to graduate school to the realities of a research career at an earlier time point.

SECONDARY ISSUES

Most (64%) of the quotations identified a secondary issue. Those with a secondary issue were categorized as follows:

Secondary Issues for Early Educational Interventions	
Funding	43%
Mentoring	29%
Multi-disciplinary	14%
Length of training	14%

IMPACT

A strong majority (67%) of the commenters felt that Early Educational Interventions was an issue for both institutions and investigators; the remaining 34% were equally split (17% each) as to whether they felt Early Educational Interventions was an investigator issue or an institutional issue.

SELECTED PUBLIC RECOMMENDATIONS FOR NIH ACTION

- Increase funding for internship experiences, for undergrads and post-bac/pre-doc students.
- Develop undergraduate competencies that may be used as pre-requisites for PhD program applications.
- Increase overall funding for post-baccalaureate and pre-doctoral programs.

Industry Partnership, 7 quotations [1%]

Industrial research corporations can be valuable partners in the mission to improve human health. However, many viewed the relationship between industry and academia as imbalanced in terms of benefits and burdens. Specifically, industry was thought to share more of the benefits and academia was thought to share more of the burdens. Many felt that a change in partnership structure might be warranted. Although fewer than ten commenters made specific reference to partnerships between academia and industry, we've made this a primary issue since so many individuals felt that industry was a vital part of the branching career pipeline for biomedical workers. Individuals submitted all but one of the comments on this issue.

Industry capitalizing on academic efforts. Several commenters asserted that industry research capitalizes on the efforts of academia at every stage. Students trained in the academic setting often leave academia for a job in industry research, particularly in the current job market.

Industry as a training partner. One way in which industry could provide a return on the human capital it receives from academia is to create partnerships for the purpose of training students in non-academic careers. Such efforts could benefit everyone by reducing over-supply issues in academia and improving mentoring of students and post-doctoral fellows who are interested in careers in industry research. Structured fellowships for students and post-doctoral fellows within industry might also alleviate the mentoring burdens currently being experienced by academic PIs who may not be well-equipped to mentor post-doctoral fellows with non-academic aspirations. One commenter pointed out that the reason so few academic PIs have industry experience is that it is nearly impossible to break into academia after a successful career in industry.

SECONDARY ISSUES

Only two of the quotations (29%) identified a secondary issue. In both cases, the secondary issue was Mentoring.

IMPACT

Three quarters (75%) of the commenters felt that Industry Partnership was an issue for both institutions and investigators, while 25% felt that it was an investigator issue; none (0%) classified it as an institutional issue.

SELECTED PUBLIC RECOMMENDATIONS FOR NIH ACTION:

- Set up or encourage partnership agreements between private industry and individual scientists; partnerships would define focus of academic partner (discovery) and focus of industry (commercialization).
- Adopt a "net-benefit policy" in which institutions receiving NIH funds must secure a commitment from private US employers to hire an equal or greater number of scientists than those supported by the NIH monies.
- Promote partnership programs for post-doctoral fellows to provide them with a better understanding of how science is carried out in industry, which would help prepare them for career paths outside of academia.

Appendix

Additional Data

COMMENT CODING STATUS

				Counts
TOTAL COMMENTS RECEIVED	**224**	Duplicates:	3	
		Non-Responsive:	2	
Unique and Responsive Comments Received:				219
Quotations Coded To Date:				498
Mean Quotations Per Submission:				2.3

SUBMISSION METHOD

	Count	Percent
Web Form:	213	96%
Email:	7	3%
Postal Mail:	1	1%
Fax:	0	0%

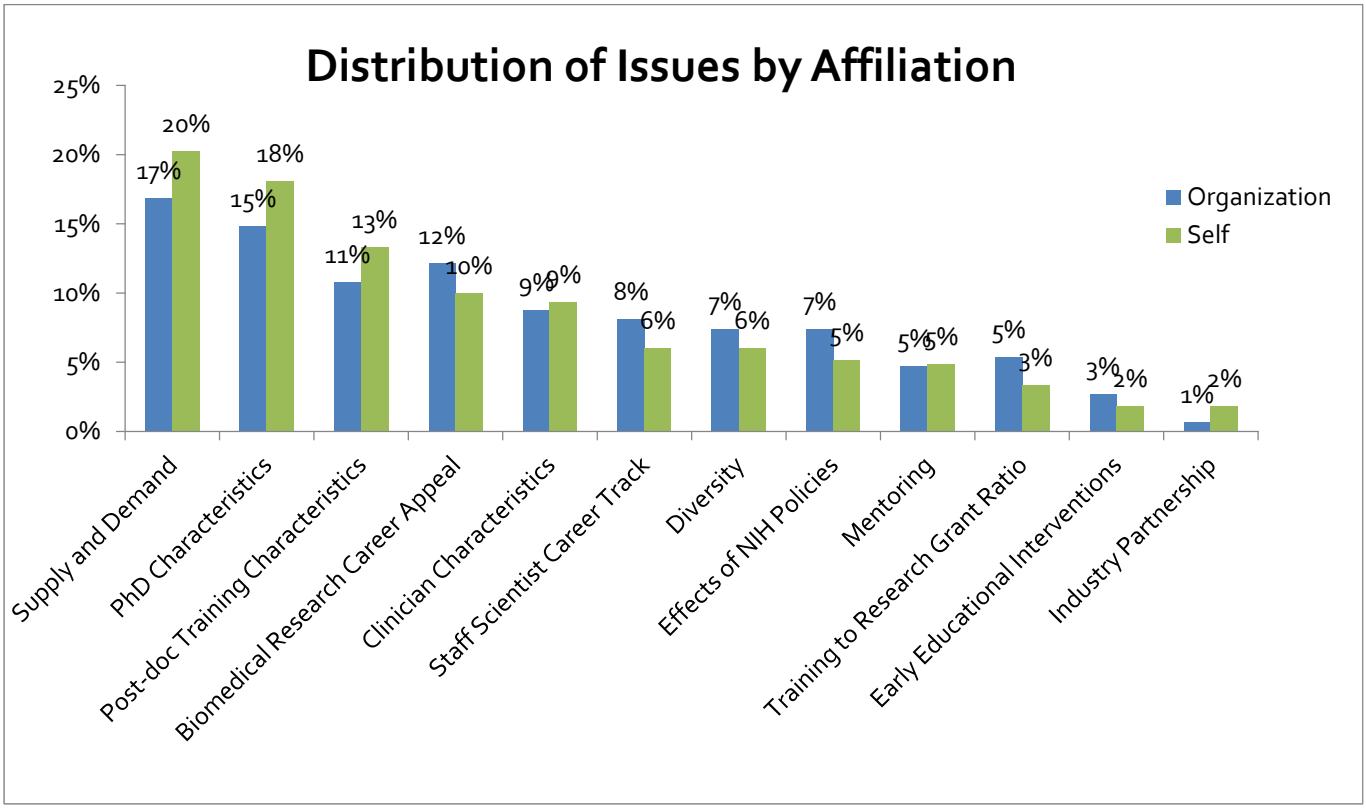
AFFILIATION CATERGORY

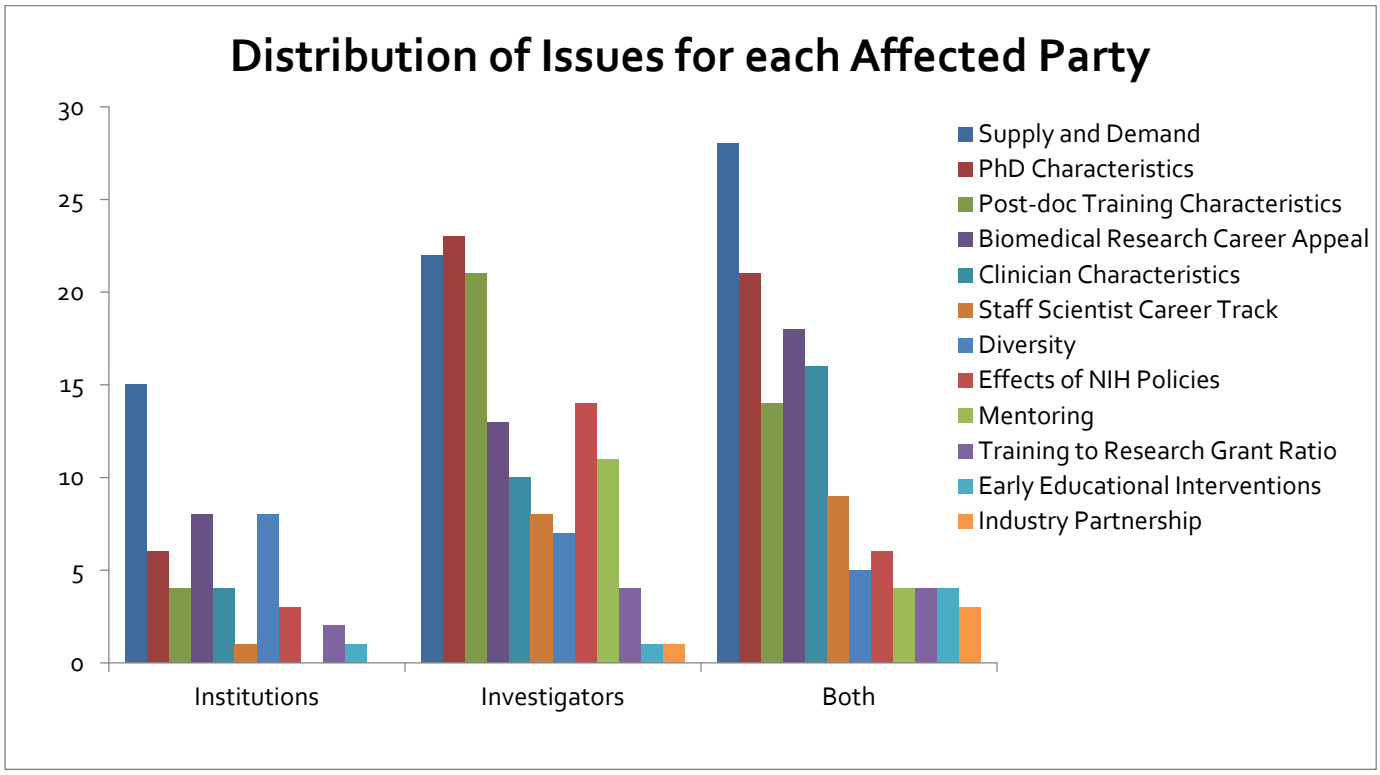
	Count	Percent
Self (Private Citizen)	165	75%
Organization	44	20%
NIH Staff	10	5%

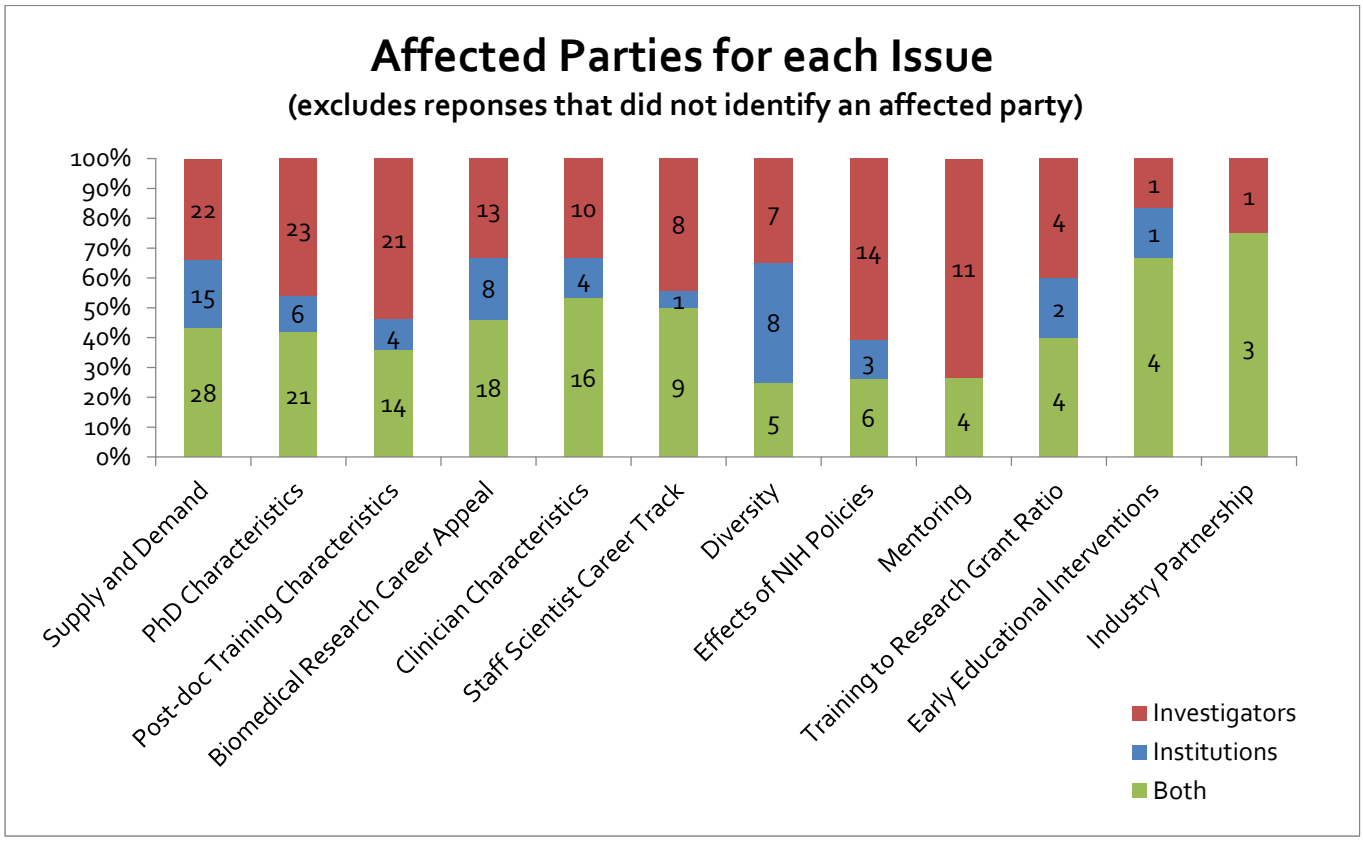
COMMENT CATERGORIES (BY FREQUENCY)

	Count	Percent
Supply and Demand	97	19%
PhD Characteristics	84	17%
Post-doc Training Characteristics	62	12%
Biomedical Research Career Appeal	53	11%
Clinician Characteristics	44	9%
Staff Scientist Career Track	36	7%
Diversity	32	6%
Effects of NIH Policies	29	6%
Mentoring	24	5%
Training to Research Grant Ratio	19	4%
Early Educational Interventions	11	2%
Industry Partnership	7	1%

ISSUES BY AFFILIATION






Affected Parties for each Issue
(excludes reponses that did not identify an affected party)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
22
15
28
23
6
21
21
4
14
13
8
18
10
4
16
8
1
9
7
8
5
14
3
6
11
4
4
2
4
1
1
4
1
3
Supply and Demand
PhD Characteristics
Post-doc Training Characteristics
Biomedical Research Career Appeal
Clinician Characteristics
Staff Scientist Career Track
Diversity
Effects of NIH Policies
Mentoring
Training to Research Grant Ratio
Early Educational Interventions
Industry Partnership
Investigators
Institutions
Both

Primary Issues and Descriptions

Issue	Description
Biomedical Research Career Appeal	Issues related to the attractiveness of biomedical research careers (e.g. salary, working conditions, availability of research funding)
Clinician Characteristics	Characteristics of clinician-research training including issues such as: • The balance between MDs and MD/PhDs • Career development of clinician-researchers. • Recommendations for changes to the curricula for training clinician-researchers.
Diversity	Under-represented minority post-doctoral, fellows and junior faculty.
Early Educational Interventions	Need for interventions prior to graduate-level training, including: • K-12 science interventions • Undergrad interventions • Post-bac/Pre-doc programs
Effects of NIH Policies	The effect of changes in NIH policies on investigators, grantee institutions and the broader research enterprise.
Industry Partnership	Problems related to relationships between academic research and commercial industry research. Examples are: • industry use of academic discovery • difficulty of industry scientists returning to academia • partnering with industry to train new scientists
Mentoring	The need to improve the quality of career development at institutions. Guidelines and monitoring of mentorships is needed as there is a lack of non-research science skills being taught.
PhD Characteristics	Characteristics of PhD training in biomedical research, including issues such as: • The length of the PhD training period. • Recommendations for changes to the PhD curriculum. • Training for multiple career paths (including bench and non-bench science).
Post-doc Training Characteristics	Length of Post-doctoral training.
Staff Scientist Career Track	Possibilities for professional/staff scientist positions and the level of training required for such positions (e.g. PhD or MSc degrees).
Supply and Demand	The balance between supply, including the number of domestic and foreign trained PhDs and post-doctoral fellows, and demand, i.e. post-training career opportunities.
Training to Research Grant Ratio	The ratio of PhD students and post-doctoral fellows on training grants to those supported by research grants.

Secondary Issues and Descriptions

Overlapping	Descriptions
Funding	Uncertainty and lack of funding, distribution of funding, restricted paylines, success rates, indirect costs, excessive competition
Multi-disciplinary	Need for multi/ inter/ trans-disciplinary research training to prepare trainees for a wide range of academic and non-academic career opportunities
Salary	Inadequate compensation and benefits
Length of Training	Amount of training time too long to be feasible for majority
Non-US Citizens	Foreign students and post-doctoral fellows
Career appeal	Working conditions (e.g. heavy workload, perception of being used as cheap labor, long work hours)
Mentoring	Quality of career development and the need for pre-college preparation
Diversity	Under-represented minority post-doctoral, fellows and junior faculty