

**Needs Assessment of the NIGMS
Research Supplements to Promote
Diversity in Health-Related Research:
Final Report**

Final report

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From Insight to Impact
– worldwide

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The views expressed in this document are these of Abt Associates and do not reflect the views of the National Institute of General Medical Sciences

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Executive Summary

As stated in the Program Announcement,¹ the Supplements to Promote Diversity in Health-Related Research program sponsored by the National Institutes of Health (NIH) aims to “improve the diversity of the research workforce.” To achieve this goal, the program provides supplemental funding to current NIH grantees (Principal Investigators, or PIs) to recruit individuals from underrepresented racial and ethnic groups, with disabilities, and from disadvantaged backgrounds for a research training experience in their laboratories. Individuals from all education and career levels are eligible to receive support through the supplements.

The National Institute of General Medical Sciences (NIGMS) has been an active participant in this NIH-wide effort, contributing 10% of the total Diversity Supplements funding since the program was established in the 1980s. To justify continued program expenditures, NIGMS contracted with Abt Associates to conduct a “needs assessment” study of its Diversity Supplements program. The study aimed to answer the following questions:

1. What problems or needs is the program attempting to address?
2. Whom does the program serve?
3. Are the needs of program participants being addressed? If not, what program modifications can be made to address these needs?
4. What are appropriate program goals?
5. For each program goal, what would be a reasonable standard of performance to achieve within a specific time period? How should these standards be measured?

Methodology

To address the study questions, we analyzed program documents, reviewed the literature on minority participation, interviewed NIH staff, and surveyed a small sample of program participants from fiscal years 1997 to 2001. Our analyses of the funding applications revealed that they were submitted and stored as paper records and a small number of application files had been misplaced or lost. Application materials that were available could be used to collect a variety of information related to the characteristics of trainee candidates (names, race/ethnicity, gender, career levels, career goals, education, GPAs, publications, past funding support) and to the proposed training experience (duration and location of training, grantee names, type of parent grant, funding amounts). None of the records examined contained contact information for the trainees or any references that could help locate them in the NIH databases.

Application files were used to construct a survey sample of 45 Principal Investigators and 45 of their trainees. The samples included (1) up to nine PIs for each of the six trainee categories eligible for support (high school students, undergraduate students, post-BS/post-MS students, graduate students, postdoctoral researchers, and faculty) and (2) the researchers who trained under them. Email addresses for all Principal Investigators could be found on the Internet using their names and institutional affiliations and the questionnaires were sent to them first. In the body of the questionnaire, PIs were asked to provide any information that could help locate the trainees. The majority of PIs offered current trainee contact information, an old email address, or at least a clue to where to look for trainees; this information was used as a starting point. However, even with PIs' help, only 17 of 45 trainees could be located for inclusion in the study sample.

¹ Available at: <http://grants.nih.gov/grants/guide/pa-files/PA-08-190.html>. Accessed March 15, 2009.

Key informant interviews with 11 staff from NIGMS and 4 staff from other Institutes and Centers were conducted to learn about the program processes at NIGMS and at other NIH Institutes. At our request, NIGMS recommended the interview subjects, chosen to represent a breadth of roles and responsibilities as well as divergent views. All respondents appeared to be knowledgeable about the program.

Findings

Several changes have been recently introduced to the Supplements program, including a reduction of support duration for graduate students and postdoctoral researchers, an increased emphasis on supporting junior scientists, a decrease in support for faculty, and a requirement for a more detailed and specific mentoring plan. Further, Program Officers at NIGMS, who in the past shared the task of reviewing the Supplement applications for postdocs and faculty, are now invited to comment on all applications. Responses from the interviews revealed that these changes have not been endorsed by all NIGMS staff implementing the program. It was recommended by several interviewees that the program policies and procedures be further discussed internally and subsequently made more clear and transparent to the extramural community.

By examining specific program goals communicated in the Program Announcement, we concluded that they neither adequately communicated the vision of NIGMS staff nor accurately reflected program activities. Furthermore, the wording of the goals was very general, complicating any assessment of program performance. We proposed revised program goals and made suggestions on how and when performance against these goals could be measured.

While the program is advertised through a variety of means, some respondents noted that the outreach could be improved, especially since participation of high school and college students remains low. However, few specific suggestions were offered and prior attempts by NIGMS to recruit junior trainees have been unsuccessful. No trainee tracking system has been established at NIGMS, although the majority of Institute staff interviewed appeared to be in favor of collecting some data on program participants.²

Analysis of program records indicated that NIGMS expenditures from fiscal years 1997 to 2007 amounted to \$68 million, nearly doubling during that period. Historically, between 75% and 90% of the supplements applications submitted were funded. The applicants typically received the dollar amount that they requested per year, although the number of years for which the support was sought was sometimes reduced. While individuals with disabilities and from disadvantaged backgrounds were also targeted in the Program Announcement, the support went overwhelmingly to racial and ethnic minorities. For the 10-year period examined (1997 to 2007), the trainee population was roughly divided between African Americans and Hispanics, with a small percentage of Native Americans and Pacific Islanders. Over 50% of trainees were women, but their representation declined precipitously at more senior career levels. Seventy-five percent of researchers receiving support were graduate students and postdoctoral scientists. The average support duration for 1997 to 2001 ranged from a few months for high school students, undergraduates, and faculty to about two years for graduate students and postdocs. Trainee candidates in that period were a well-qualified group as indicated by GPAs, number of published papers, and prior financial support. The vast majority planned to become researchers.

The interviews and the survey revealed that the Supplements program was viewed very favorably by NIH staff, Principal Investigators, and the trainees. Further, we began to document that participation in the program has contributed to the entry of minority trainees into the research workforce, as 76% of trainees

² A data system is currently being developed and tested by IRMB (NIGMS feedback on this report, April, 2009).

for whom data could be obtained through the survey held research positions in academia, government, or industry. Most attributed their career choices at least in part to the training experience. Regardless of career choice, many trainees viewed their participation in the program as an important stepping stone to the next stage in their professional lives.

Like the trainees, the majority of Principal Investigators contacted appeared to have benefited from the program, by advancing their research agendas, improving mentoring skills, and deriving personal satisfaction from helping a minority researcher. It is arguable that participation in the program has changed PI behavior, as most respondents claimed that they would support another minority student in the future or have already done so.

Recommendations

While the positive aspects of the program were many, the study findings suggested a few potential areas for improvement. The following are several recommendations on how to optimize the management of the program by NIGMS staff, increase participant satisfaction, and enhance the program's effectiveness in accomplishing its goals:³

- **Engage program staff in the discussion of new program policies and procedures;**
- **Clearly communicate the program vision and goals to the extramural community and provide explicit guidance on the contents of the application and on the review criteria;**
- **Develop electronic procedures for more reliable receipt, internal processing, and storage of supplement funding applications and other program documents;**
- **Develop a trainee tracking system;**
- **Conduct a systematic outcome evaluation;**
- **Engage with other Institutes and Centers to learn from their experiences with the Supplements program;**
- **Provide explicit guidance on the content of annual reporting;**
- **Revise the program goals with clear accountable performance metrics so that the program outcomes can be tracked and used for quality improvements over time; and**
- **Develop a sustainable network of alumni and support a community of minority researchers.**

³ The order of recommendations was suggested by NIGMS to reflect their importance

Chapter 1: Introduction

The number of racial and ethnic minorities receiving doctoral degrees in the life sciences is significantly lower than their representation in the general population of the United States.⁴ While a relatively high proportion of minority students enter college with the intention of majoring in mathematics and sciences, relatively few graduate with degrees in these fields.^{5,6} Among those who abandon science are students with high scholastic aptitude test (SAT) scores, good grade point averages (GPAs), and an impressive record of high school science honors.⁷ Several factors that contribute to these trends have been identified in the literature, including academic and cultural isolation, lack of family and peer support for academic achievement, real and perceived discrimination, and decreased motivation and performance in the face of negative stereotypes.^{8,9,10}

To reverse these trends, colleges, universities, and funding agencies have established a variety of intervention programs aimed at improving the recruitment and retention of minorities in scientific fields. The Supplements to Promote Diversity in Health-Related Research program sponsored by the National Institutes of Health (NIH) is one of these efforts. The goal of the Supplements program is to “improve the diversity of the research workforce”¹¹ by providing additional funding to current NIH grantees to support individuals from underrepresented racial and ethnic groups, with disabilities, and from disadvantaged backgrounds. Researchers at education and career levels ranging from high school students to faculty are eligible to be supported with the supplemental funding. While the Supplements program is an NIH-wide effort,¹² some participating Institutes and Centers (ICs) have developed their own application policies and procedures that pertain to their grantees.^{13,14}

⁴ PhD recipients in life sciences in 2006: 274 African Americans (4.6%), 261 Hispanic/Latinos (4.3%), and 15 American Indian/Alaska Natives (0.25%). Percentages of these groups in the US population: 13.4% African American, 14.8% Hispanic/Latino, 0.68% American Indian/Alaskan Native (National Science Foundation Survey of Earned Doctorates, 2006 and US Census, 2006).

⁵ Brown SV. The preparation of minorities for academic careers in science and engineering. In: G. Campbell, R. Denes, C. Morrison, Eds. *Access Denied: Race, Ethnicity, and the Scientific Enterprise*. New York: Oxford University Press; 2000:239-268.

⁶ May GS, Chubin DE. A retrospective on undergraduate engineering success for underrepresented minority students. *Journal of Engineering Education*. 2003;92:1-13.

⁷ Grandy J. Persistence in science of high-ability minority students: results of longitudinal study. *Journal of Higher Education*. 1998;69:589.

⁸ Steele CM, Aronson J. Stereotype threat and the intellectual test performance of African Americans. *Journal of Personality and Social Psychology*. 1995;69:184.

⁹ Ogbu JU. Immigrant and involuntary minorities in comparative perspective. In: Gibson MA, Ogbu JU, eds. *Minority Status and Schooling*. New York: Garland; 1991.

¹⁰ Seymour E, Hewitt N. *Talking about Leaving: Why Undergraduates Leave the Sciences*. Boulder, CO: Westview; 2000.

¹¹ Available at: <http://grants.nih.gov/grants/guide/pa-files/PA-08-190.html>. Accessed March 15, 2009.

¹² *Ibid.*

¹³ Procedures and Supplementary Information for Preparation, Submission, and Review of Applications for Diversity and Reentry Research Supplements for NINDS Grantees. Available at:

The National Institute of General Medical Sciences (NIGMS) has been an active participant in the Supplements program since its establishment in the late 1980s, and has contributed 10% of the total NIH funding over the years. This report describes the results of the “needs assessment” study of the NIGMS Diversity Supplements program that was commissioned by the Institute. The study aimed to address the following questions:

1. What problems or needs is the program attempting to address?
2. Whom does the program serve?
3. Are the needs of program participants being addressed? If not, what program modifications can be made to address these needs?
4. What are appropriate program goals?
5. For each program goal, what would be a reasonable standard of performance to achieve within a specific time period? How should these standards be measured?

The goal of this study’s data collection and analyses activities was to provide answers to these questions through interviews with NIH staff, analyses of program records, and surveys of PI and trainee participants.

Since the Diversity Supplements program is one of many efforts to boost minority participation in the sciences, we began the needs assessment study by reviewing the literature and examining the outcomes of several well-known and extensively studied programs with similar goals. These included the Meyerhoff Scholars Program, the Louis Stokes Alliance for Minority Participation, the Biology Undergraduate Scholars program, the Graduate Research Fellowship, the McKnight Fellowship Program, the Faculty Early Career Development Program, and a few other programs described in detail in the Literature Review (Appendix A). Collectively, the findings from these studies provided supportive evidence on the effectiveness of several strategies that may improve the recruitment and retention of minorities in the sciences. These strategies included enhancing academic preparation, providing financial, social, and mentoring support, and engaging students in research and professional development activities. In the course of the study, we examined whether the Diversity Supplements program effectively draws on these approaches in serving its participants.

This report includes six chapters and four appendices. Following the next chapter on the methodology for the needs assessment study, the findings are presented related to program management (Chapter 3), participant characteristics (Chapter 4), and program results (Chapter 5). Finally, conclusions and recommendations for program improvements based on the study findings are discussed in the final chapter (Chapter 6). The appendices include the study’s Literature Review (Appendix A), Data Abstraction Protocol (Appendix B), NIH Staff Interview Protocol (Appendix C), and Survey Instruments (Appendix D).

http://www.ninds.nih.gov/funding/areas/office_of_minority_health_and_research/diversity_supplements_procedures.htm. Accessed March 15, 2009.

¹⁴ Procedures and Supplementary Information for Preparation, Submission, and Review of Applications for Diversity and Reentry Research Supplements for NIMH Grantees. Available at: <http://www.nimh.nih.gov/research-funding/training/diversity-and-reentry-research-supplements-for-nimh-grantees.shtml>. Accessed March 15, 2009.

Chapter 2: Methodology

Four data collection approaches were used to conduct this needs assessment study: (1) analyses of program records, (2) a review of the literature, (3) interviews with NIH staff, and (4) a survey of program participants. Each approach added to our understanding of the program infrastructure, processes, and results and informed the design of subsequent data collection strategies. For example, the review of several hundred application files helped to construct the survey samples. The literature review revealed specific needs of minority populations and strategies shown to have a positive effect on minority participation in the sciences, highlighting key aspects of the research experience to examine with program participants. The four data collection strategies are described in the next sections.

Analyses of Program Records

NIGMS maintains records for all the applications received for funding through the Supplements program. Decisions about the subset of applications to include in the study were driven by the scope, duration, and goals of the needs assessment. In consultation with the project's Advisory Committee, applications from the funding years 1997 to 2001 were chosen for inclusion in this study because sufficient time would have elapsed since the research experience for trainees' careers to have matured, and this time period maximized our likelihood of tracking participants and their recall of the events compared to the earlier cohorts.

Applications for supplement funding at NIGMS are available only in paper format, so the review of records was done manually at the Institute. To ensure consistency and decrease the burden of data collection, we developed an "abstraction matrix," an MS Excel spreadsheet (Appendix B), into which specific information from each application was systematically entered by a research analyst. To ensure their accuracy, the Abt Project Director verified the data extracted for an initial sample of applications.

NIGMS staff reviewed and approved the tool, which contained the following data fields:

- Parent grant number
- Principal Investigator's identifiers (name and institution)
- Trainee candidate's identifiers and demographic information (name, gender, race/ethnicity, institution at time of award)
- Trainee candidate's career level and number of years at this level (e.g., second year graduate student)
- Start date and length of supplement support
- Trainee candidate's educational characteristics (degrees earned with institutions and years, GPAs)
- Trainee candidate's career goals
- Trainee candidate's prior support
- Trainee candidate's prior publications

The completeness of the set of applications available in the NIGMS paper files was checked by comparing it to two sources: (1) the outcome reports for the Diversity Supplements program compiled annually by each Institute and Center and available on the NIH website,¹⁵ and (2) an internal NIGMS

¹⁵ Available at: <http://grants.nih.gov/training/outcomes.htm>. Accessed March 20, 2009.

Excel spreadsheet containing data on all funded supplements for FY2001–2007 (this spreadsheet also served as a source of data for the NIH website). The comparison of these three sources revealed some inconsistencies. For example, for FY2001, a year captured by each of the sources, there were 71 new awards reported on the NIH website, 76 entries for new awards in the NIGMS spreadsheet, and 63 paper records stored in NIGMS filing cabinets (Table 1). Although there was no paper trail to describe or explain the discrepancies, we conclude that they were most likely due to a combination of paper file loss and human error. The analyses of program participation in Chapter 4 were based on data drawn from a combination of 335 paper records for 1997 to 2001 (Abt files) and an additional 700 records from the NIGMS Excel file for 2002 to 2007.¹⁶

Table 1: Total Number of NIGMS Records Reviewed

Fiscal Year	# of records abstracted from paper files	# of new awards reported on the NIH website	# of new awards listed on the NIGMS spreadsheet
1997	82	Unavailable	Unavailable
1998	66	83	Unavailable
1999	62	75	Unavailable
2000	62	70	Unavailable
2001	63	71	76
TOTAL	335	299	76

As part of the parent grant annual reports, grantees receiving the supplements are required to include information on the progress of the research supported by these funds. We requested five annual reports chosen at random, one from each education or career level supported by the supplements.¹⁷ Of the five reports requested, two (for a high school and a graduate trainee) could not be found. For the remaining three grants, we were provided with the sections in the annual reports pertaining to the Diversity supplements. We assumed that these portions represented the entirety of information on the supplements that was included in the annual reports. The reports were reviewed for the information about the types of activities supported by the supplements.

Literature Review

A literature review was conducted in order to anchor the needs assessment study in existing research on the causes of minority underrepresentation in the sciences and the efficacy of intervention strategies, and to inform the design of data collection instruments as well as the analyses and interpretation of findings for the study. The review included articles, reports, and books that examined the reasons for minority underrepresentation in scientific fields, as well as evaluations that explored the outcomes of programs designed to increase the participation of these groups. The sources for the review were identified through a variety of means: (1) a list of publications and evaluations from our prior work; (2) searches of PubMed, ISI, and LexisNexis databases; (3) back issues of the *Journal of Women and Minorities in Science and Engineering*, a publication devoted entirely to the issues directly relevant to the review; (4) reference lists of identified articles; (5) Google searches to identify any “grey literature” that might have been missed in the searches of academic databases; and (6) NIGMS staff recommendations

¹⁶ NIGMS excel file as well as paper files also contained application data for the re-entry program. These were excluded from the study.

¹⁷ 5R01GM54226 (high school); 5R01GM59406 (undergraduate); 5R01GM52847 (graduate); 5R01GM61867 (postdoc); and 5R01GM34310 (faculty).

of additional articles, books, and reports. The inclusion criteria and limitations of the studies are discussed in Appendix A.

Interviews with NIH Staff

Interviews with stakeholders within the NIH were conducted to gather their views of the program. At our request, NIGMS suggested the names of 14 staff to interview for this study. Individuals on the list were deliberately selected to represent a variety of roles in managing and implementing the Diversity Supplements program, in order to capture various perspectives on the program changes currently being introduced. In addition to the individuals recommended by NIGMS, we interviewed three persons who were suggested by respondents or identified through the analyses of program-related data. Interview subjects included 12 individuals from NIGMS (program officers, division directors, a grants manager, program directors, and an associate director for extramural activities) and 4 individuals from other Institutes and Centers (NHGRI, NIMH, NINDS, and OER). The Project Officer at NIGMS supervising the needs assessment sent an invitation email to prospective interviewees, introducing the study and the Abt team. One respondent outside of NIGMS declined an interview because her participation in the study had not been approved by her Institute director. The resulting response rate was 94%.

An interview protocol was developed and shared with NIGMS staff and all suggested revisions were incorporated. The protocol contained four sections: (1) respondent background; (2) program goals and changes; (3) program administration and oversight; and (4) program outcomes (see Appendix C for the protocol). If a respondent's involvement with the program was limited to a particular area, we focused on the subset of relevant questions during the interview. This was the case, for example, with a grants management officer. All interviews were semi-structured using an interview guide; while the interviewer led the conversation to cover all areas of interest, respondents could steer the dialogue in a new direction. The interview guide, as well as communication and data handling procedures, were approved by the Abt Associates Institutional Review Board.¹⁸

The interviews were conducted in person or by telephone. When consent was granted by an interviewee, the interview was digitally recorded as a back-up to the notes; these recordings were used to fill any gaps in the interview notes or to verify key points made by respondents. For each respondent, answers were entered directly in the interview protocol, so that the data could be easily organized by topic and compared across individuals.

Surveys of Program Participants

Surveys were sent to program participants from 12 groups:

- Principal Investigators supporting high school students (PI-HS)
- Principal Investigators supporting undergraduate students (PI-UG)
- Principal Investigators supporting post-BS/post-MS students (PI-PB/PI-PM)
- Principal Investigators supporting graduate students (PI-GS)
- Principal Investigators supporting postdoctoral researchers (PI-PD)
- Principal Investigators supporting faculty (PI-F)
- High school students (HS)
- Undergraduate students (UG)
- Post-BS/post-MS students (PB/PM)

¹⁸ Abt IRB #0371.

- Graduate students (GS)
- Postdoctoral researchers (PD)
- Faculty (F)

We developed 12 protocols tailored to the unique program-related experiences and outcomes expected within each group (Appendix D). The survey instruments were divided into three sections – application decision and training goals, training processes and accomplishments, and final thoughts and recommendations – and included a mix of multiple-choice and open-ended questions. Respondents were also asked to verify their name, institution at the time of training, and type/duration of training, all of which had been pre-entered into each survey.

Due to the restriction in the Paperwork Reduction Act and the short timeframe of the project, the number of respondents was limited to nine within any of the target groups. The respondent samples were constructed based on the abstracted records. We chose to survey PIs and trainee candidates in pairs – that is, the survey was first administered to the PIs and then to the candidates who trained under them. The maximum number of respondents in the surveys could have been 108 (12 x 9); however, for some respondent groups, the number of records was less than 9 per group. For example, only 7 high school students were supported through the supplements between 1997 and 2001, the period selected for this study (Table 2). In these instances, all respondents in the group were included in the sample. In other respondent groups, the number of participants greatly exceeded 9 (e.g., undergraduate students). For these categories, we purposively sampled one or two trainees per year, selecting those whose training period was the longest. We reasoned that PIs would be more likely to remember these trainees and the impact of the supplements should be easier to document and to attribute.

Emails containing individualized questionnaires (pre-filled with respondent name, affiliation, type and duration of training provided or received) were sent to all subjects in the survey sample. Respondents were offered the option of returning completed questionnaires via email or answering the questions by telephone. Only one respondent preferred the telephone. Since trainee contact information was unavailable from applications, the survey was first sent to the PIs. In the survey, PIs were asked to provide any information that would help us locate the trainees; this was used as a starting point in searching for trainees. Surveys were emailed to all trainees we could locate (Table 2). Survey subjects were allowed two weeks to complete the survey, and after that two reminders were sent to non-respondents at approximately one-week intervals. In some cases, the answers provided by respondents were clarified by email or telephone.

Table 2: Number of Individuals in NIGMS Records, Included in the Survey Samples, and Responding to the Surveys

PIs			Trainees		
Subgroup	# in records	# in sample (responded)	Subgroup	# in records	# in sample (responded)
PI-HS	7	7 (3)	HS	7	7 (0)
PI-UG	69	9 (3)	UG	69	7 (3)
PI-PB/PM	4	4 (2)	PB/PM	4	4 (0)
PI-GS	155	9 (8)	GS	155	9 (5)
PI-PD	92	9 (8)	PD	92	9 (6)
PI-F	8	7*(4)	F	8	7 (3)
TOTAL	335	45 (31)		335	45 (17)

*A faculty trainee candidate with disability was excluded.

Of the 45 PIs who received the questionnaires, 4 declined to participate because they could not recall the experience. Two others told us that they were included erroneously – in one case, the trainee never joined the lab and the supplement was withdrawn and in the other case, the trainee was a masters' student and not a postdoc – and these two individuals were excluded from the sample. Thirty-one PIs completed the questionnaires (Table 2); excluding the erroneous records and including the declines, the response rate across all PI groups was 81%.¹⁹

With the help of the PIs, we were able to obtain contact information for 21 of the 45 trainees (Table 2). Of the 21 trainees contacted, 17 responded to the survey. The response rate across the trainee groups was also 81%,²⁰ although we were only able to reach 38% of the trainees in our initial sample (17 out of 45, Table 2).

Study Limitations

The study had several limitations. First, since all applications were available only as paper records, the process of abstracting the information was very time-consuming (it took three weeks for 335 records). Further, some records were misplaced, missing entirely, or erroneous. The most serious limitation of the records, however, was that neither applications nor progress reports contained any contact information for the trainees or any clue to help track them. Thus, we could not reach the trainees, unless their contact information was available on the Internet or provided by their former mentor.

Second, the small sample size was a serious limitation of the data collection. Due to the OMB constraints, we could not survey more than 108 individuals, and this sample was further partitioned into subgroups (Table 2). In addition, because the instruments were different from each other, aggregation and comparison of data between subgroups was difficult.

Third, recall was an issue for several respondents. Four PIs declined participation because they could not recall a student who spent just a few months in their labs nearly 10 years ago. In retrospect, it would have been preferable to select a more recent cohort for short-term trainees.

Finally, it is possible that responses were somewhat biased toward individuals with more positive training experiences. This bias could have manifested itself in two ways. First, dissatisfied participants from both groups might have been less likely to respond to the surveys. Second, PIs who had a negative experience with their trainees might have been less likely to have the knowledge of their whereabouts, in many cases eliminating these individuals from the study.

¹⁹ Calculated as follows: $31[\text{responded}] + 4[\text{declined}]/45 - 2[\text{errors}] = 0.81$.

²⁰ Calculated as follows: $17[\text{responded}]/21[\text{available contacts}] = 0.81$.

Chapter 3: Program Management and Implementation

Findings reported in this chapter were based on data gathered in interviews with the NIH staff and through analyses of program documents. The goal for these data collection and analyses activities was to understand the Institute's vision for the program as well as the management and implementation processes at NIGMS and across NIH. At the end of this chapter, we present a "roadmap to the program" in the form of a logic model, which is based on the findings described below.

Program Philosophy

According to the Program Announcement, the goal of the Supplements program is to "improve the diversity of the research workforce by supporting and recruiting students, postdoctorates, and eligible investigators from groups that have been shown to be underrepresented."²¹ Since this mission is conceptually simple, it was not surprising to find an agreement among the NIH staff on what the program was trying to achieve. In contrast, respondents had different views on how the program should be administered. A few interviewees were in favor of providing funding to virtually every applicant to the program, to give a large number of individuals a chance at advancing their scientific careers. Others advocated investing only in PIs who were committed to trainees' research careers, and in trainees who showed the potential and drive to succeed in a demanding academic environment.

Several recent changes to the program policies and procedures were designed to move it towards the latter, more selective approach. First, PIs are being required to include mentoring plans that are tailored to specific trainee needs, so that NIGMS can judge their potential as mentors and their commitment to the candidate. Second, the award duration is being reduced from 3–4 years to 1–2 years for graduate students and for postdocs, to put more pressure on the PIs and the trainees to apply for other funding sources and to select for the PIs who are willing to continue supporting trainees beyond the duration of the supplement. Support for the faculty will be reduced.

Although some NIGMS staff endorsed this new direction, others were not entirely comfortable with the changes being made. Supporters agreed that the changes would better align with the program's stated goals. Additionally, shortening the length of support, and thus reducing the investment per PI, would allow more researchers to participate in the program. Shifting support towards more junior researchers at the expense of faculty and senior graduate students/postdocs would similarly free up additional funds. Finally, the shorter award duration would motivate trainees to apply for competitive funding instead of relying on the supplements, making participation in the program, in the words of one interviewee, "a stepping stone rather than a fallback."

NIGMS staff who disagreed with the changes being made to the program had two basic objections. The first objection was that the program was already working well and did not need to be altered; at a minimum no changes should be introduced until the program was evaluated. The second argument was that requesting more information and/or limiting support duration might turn some PIs away from the program, and could ultimately reduce minority participation. The dissenters also pointed out that consensus among NIGMS staff about the appropriateness of the changes had not been reached. Some Program Officers also noted that the changes had not been well communicated and that it was unclear to them what these new policies were and what was now expected of them. Although all of these respondents were able to describe the changes when pressed to do so, there was uncertainty among the staff about how (and how rigidly) to apply them. Some respondents also expressed a concern that

²¹ Available at: <http://grants.nih.gov/grants/guide/pa-files/PA-08-190.html>. Accessed March 20, 2009.

the changes had not been made public. They suggested that program goals and policies should be made more transparent, to NIGMS staff and to the grantees, and that the Institute should consider soliciting feedback about the program from the extramural community. It was noted by some respondents that the more restrictive requirements for funding faculty/investigators are not clear and need to be put in writing for NIGMS staff and applicants. Note that the interviews revealed that plans are under way to better inform NIGMS staff and PIs about the new vision for the program.

Program Administration and Oversight

Advertisement and program outreach. The Diversity Supplements program is advertised via three mechanisms: (1) to the entire scientific community on the NIH and NIGMS websites; (2) directly to NIGMS grantees by parent grant project officers and through the Institute newsletter “Feedback Loop”; and (3) to a wider minority audience at national community conferences (such as the Annual Biomedical Research Conference for Minority Students and the Society for the Advancement of Chicanos and Native Americans). NIGMS and other ICs reserve a booth at these events, where Institute representatives distribute materials related to the Diversity Supplements program. In the near future, NIH also plans to launch a diversity web page that will describe all NIH training programs aimed at promoting diversity in the scientific workforce, including the Supplements program. Despite these efforts, roughly half of respondents believed that outreach to PIs and to potential trainees could be improved, although only a few specific suggestions were offered (such as sending a “welcome wagon letter” to new grantees and frequent reminders to all grantees). In the past NIGMS staff tried to recruit students from local high schools, but abandoned the effort as ineffective.

Review process. Within the past year, changes to the assignment of applications to NIGMS staff have occurred. As of the time of writing of this report, the following process has been established. First, interested PIs contact a designated individual who is listed in the program announcement²² or, less frequently, the Program Officer who handles the parent grant. If encouraged, PI submits an application, which is checked for completeness. Applications to support postdocs and faculty/investigators, which require more in-depth technical expertise, are sent to the Program Officers (to make the review process more systematic, standard review/recommendation forms have been developed for internal use by Program Officers). Applications from all other groups are reviewed by the Program Director; while Program Officers are invited to comment on the applications, the extent of this feedback has varied.

Funding recommendations are reviewed by the Division/Center Directors and by the Diversity Supplement Committee and are forwarded to the grants management office and to the Associate Director for Extramural Activities for funding decisions. When the application is approved for funding, PIs receive an email notifying them of the positive outcome and the notice of award is sent to the grantee institution shortly thereafter. Most applicants receive the amount they request per year, although the duration of the funding is sometimes reduced.

Interviewees reported that the pace of application review had slowed down considerably in the few months prior to the interview, and that some applications had been misplaced. Insufficient communication between NIGMS staff regarding the status of each application further contributed to processing delays. It should be noted, however, that these interviews were conducted shortly after the change in program leadership and many of these management and communication issues may be resolved when the transition is complete.²³

²² Currently, Dr. Whitmarsh.

²³ Many of the issues have been resolved (feedback from NIGMS on this report, April 2009)

Respondents were asked about the qualities they looked for in a PI and in a trainee candidate. For PIs, most interviewees emphasized the mentoring plan, which they expected to be thoughtful and tailored to trainees' specific needs, and the qualities of the PI as a mentor. Commitment to the candidates' professional development was also commonly mentioned. Less frequently cited factors were enthusiasm for the research program, a productive laboratory environment, PI's career level, evidence that the candidate's career will be enhanced, and the research topic. This lesser emphasis on the scientific aspects of the application was not surprising since PIs' parent grants, which are in the same general area as the supplements, have already undergone rigorous peer review.

For trainee candidates, NIGMS officers tried to evaluate their potential for becoming successful scientists using various indicators. These signs of potential success included good academic performance (high GPA, academic awards), suitable personal qualities (independence, enthusiasm, commitment to a scientific career), and favorable laboratory environment (adequacy of candidate preparation for the lab, match between the PI and the candidate's goals and interests). However, several respondents noted that applications typically do not contain sufficient information to adequately evaluate the trainee and that they relied largely on the applicant PIs' judgment to select good candidates.

Respondents were also asked whether they would recommend against awarding the supplement if the candidate appeared qualified for competitive sources. The answers varied. Some respondents said that they approved such applications, because the candidates did not yet have the funding and there is no guarantee that they would obtain it. Others told us that such applications are "discouraged" or "strongly discouraged," which in practice might amount to a rejection.

Respondents identified additional information that could help them evaluate an application, but which is not currently requested explicitly. One respondent suggested paying closer attention to a trainee's goals and needs in order to consider how he or she will benefit from the proposed training experience. Another suggestion was to take into account the size of the hosting laboratories, to evaluate whether the candidates will "get the attention they need." Finally, one interviewee recommended requesting information on the number of minority students that the PI has supervised, and on the career outcomes of these students.

Progress reports. PIs are required to include information on the supplement funding in parent grant annual reports. We found that no guidance is provided to the PIs on the content of the report or the level of detail. The previous director reviewed the relevant sections of all progress reports and provided feedback to the PIs. The new director, who is interested in continuing this practice, cannot currently afford the time this would require.

We requested and received the portions on the Diversity Supplements from three annual progress reports. In two of the three, the sections were very brief, about half a page in length; the third was a page and a half long. More importantly, in the first two reports the only information included was related to trainee research progress. The third and longer report also contained a reference to two manuscripts co-authored by the trainee, which were in submission at the time, and a statement that the trainee had resigned from the laboratory to attend law school in patent law and to take a position in a law firm. None of the reports reviewed stated training and career goals, discussed the mentoring process, or offered any details on the benefits of the experience to the trainee.

Trainee tracking. No outcome data on trainees supported through the program have been collected, although most NIH respondents appeared to be in favor of some type of trainee tracking. Suggestions for trainee tracking included adding trainee names to the IMPAC II database, asking all alumni to keep the NIH updated on their careers in exchange for grant application-related mentoring from Program

Officers, and requiring trainees to report to the tracking system at the conclusion of the supplement funding and again five to seven years later. Two respondents saw no need for the tracking system. One of these said that it would not benefit him in his duties as a Program Officer. Another argued that it was very costly and would be of little value because of the difficulty in attributing career outcomes to the supplement funding. All respondents agreed that trainees would be difficult to track if they had left academia. One respondent at NIGMS has attempted to locate the trainees 10 years after the funding ended, but gave up the effort because the process was very time-consuming and inefficient.

Interviewees stated that some Institutes and Centers have developed systems to track trainees. For example, NINDS has a system called "SPIN" that is undergoing testing at several Institutes. NIMH has also put in place some form of trainee tracking. One interviewee told us that beginning in the summer of 2009 NIH will maintain basic information (e.g., name, institution) on all individuals who are supported by NIH funds, including trainees. Each individual will receive a unique identifier so that it will become possible to track their receipt of NIH funding in the future.

Variability among Institutes and Centers. Several interviewees commented on the lack of consistency in how the program is implemented across NIH. One respondent noted that there was "tremendous variability" from Institute to Institute in the application cycle, review process, career levels targeted, success rates, expectations from the candidates, and tracking procedures, and yet there was no communication between the Institutes to share the benefits and limitations of these various approaches. One respondent pointed out that inconsistency in program policies and procedures may cause confusion for PIs with grants from several NIH Institutes. On the other hand, respondents suggested that with the large number of NIH staff involved in managing these programs across the agency, reaching consensus on how the program should be implemented might be difficult.

While researching publically available program data, we came across a document developed by NIMH that outlines that Institute's policies and procedures related to the supplements.²⁴ Based on the interviews, we noticed that the information communicated in this document was very much in accord with the vision for the program held by the Program Director and many of the staff. The guidance document emphasized the requirement for a detailed career development plan, significantly expanding the wording in the Program Announcement.²⁵ Further, PIs were directed to provide evidence of mentoring experience and describe career outcomes for all past trainees supported through the supplement funds. Junior PIs with little mentoring experience were encouraged to propose an additional mentor.

As mentioned above, NIGMS Program Officers expressed a concern that stricter application guidelines could discourage some PIs from applying for the supplements, resulting in a negative impact on diversity. Since these were reasonable concerns, we asked a knowledgeable person at NIMH whether any change had occurred in the volume of applications or in their nature and quality. This individual acknowledged that since the guidance was posted several years ago, some PIs did appear unwilling to commit the time and effort that was clearly required by the program. However, the Institute did not experience any difficulties in recruiting the number of applicants it could support.²⁶ This respondent thought that the quality of applications had improved.

²⁴ Available at: <http://www.nimh.nih.gov/research-funding/training/diversity-and-reentry-research-supplements-for-nimh-grantees.shtml>. Accessed March 20, 2009.

²⁵ Available at: <http://grants1.nih.gov/grants/guide/pa-files/PA-08-190.html>. Accessed March 20, 2009.

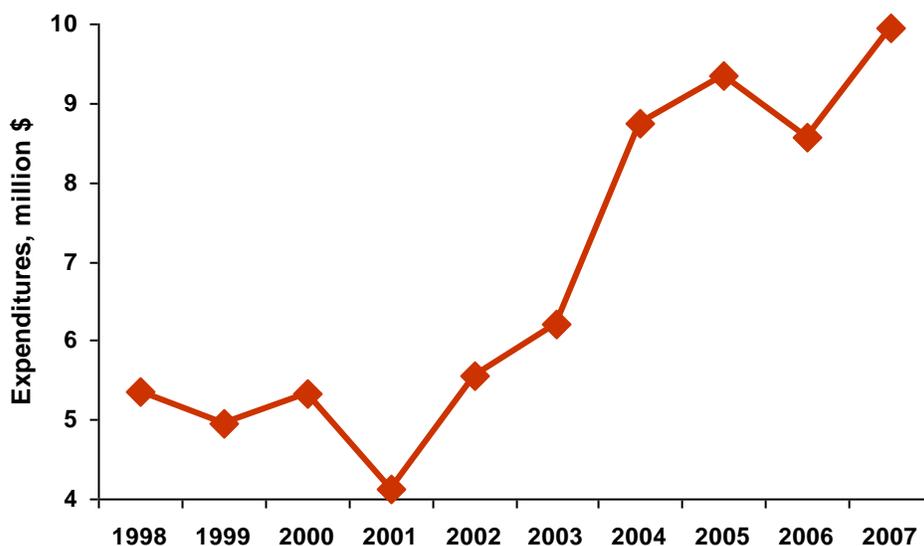
²⁶ We examined publically available outcome data for NIMH for trends. We found that the number of new awards declined between 1998 and 2001 (from 51 to 23), but the annual expenditures remained flat

We also learned that at NIMH all supplement applications are submitted and processed electronically. Using its tracking data, the Institute had conducted a study of a 10-year cohort of trainees. Success in this study was measured by the fraction of trainees who had submitted an independent funding application (the result was about 60%).

Program Expenditure and Application Success Rate

Data on the Supplements programs from each Institute and Center are compiled into reports and posted annually on the NIH website.²⁷ Using these reports, we obtained information on NIGMS expenditures. We found that spending on the Supplements program at the Institute has doubled in the past 10 years, from just over \$5 million in 1998 to nearly \$10 million in 2007 (Figure 1), and has amounted to \$68 million over that period. The NIGMS's monetary contribution to the Supplements program relative to its total budget has also been steadily growing over the past 10 years and in recent years has exceeded that of all other participating ICs (Figure 2).

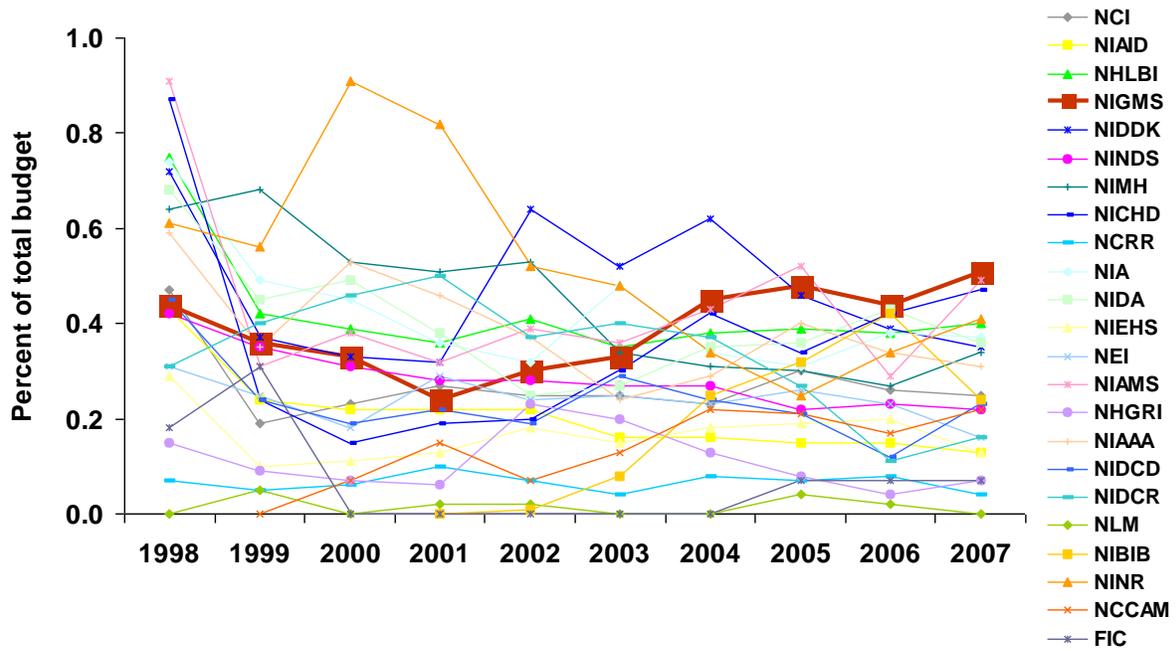
Figure 1: NIGMS Expenditures over a 10-year Period



(\$2,649,176 in 1998 and \$2,235,292 in 2001). The respondent could not recall the exact time when the guidance was posted.

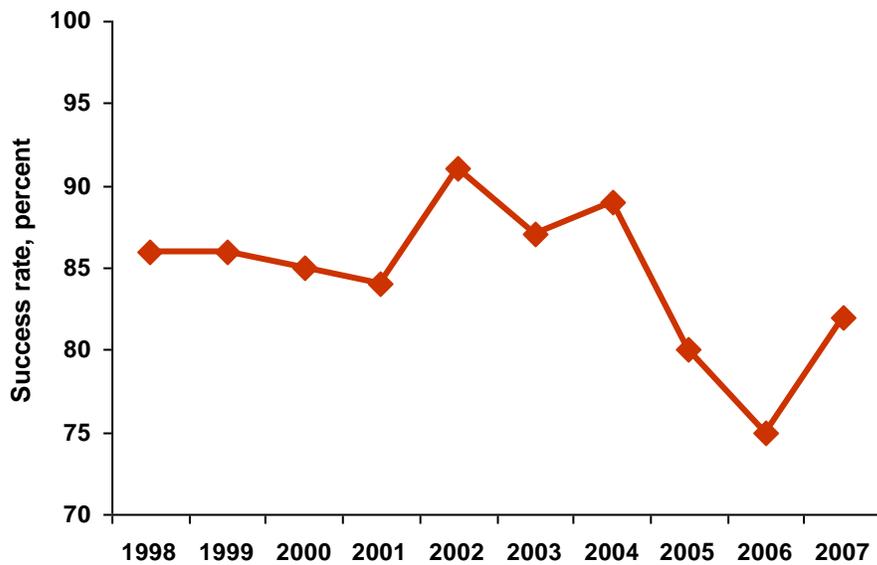
²⁷ Available at: <http://grants.nih.gov/training/outcomes.htm>. Accessed March 20, 2009.

Figure 2: Supplement Program Expenditures Relative to Total Budget across NIH



Between 75% and 90% of all applications were funded (Figure 3), ostensibly due to an efficient pre-screening process, which eliminates ineligible applicants before the applications are submitted. No record of this process is maintained, however.

Figure 3: Supplements Application Success Rate at NIGMS

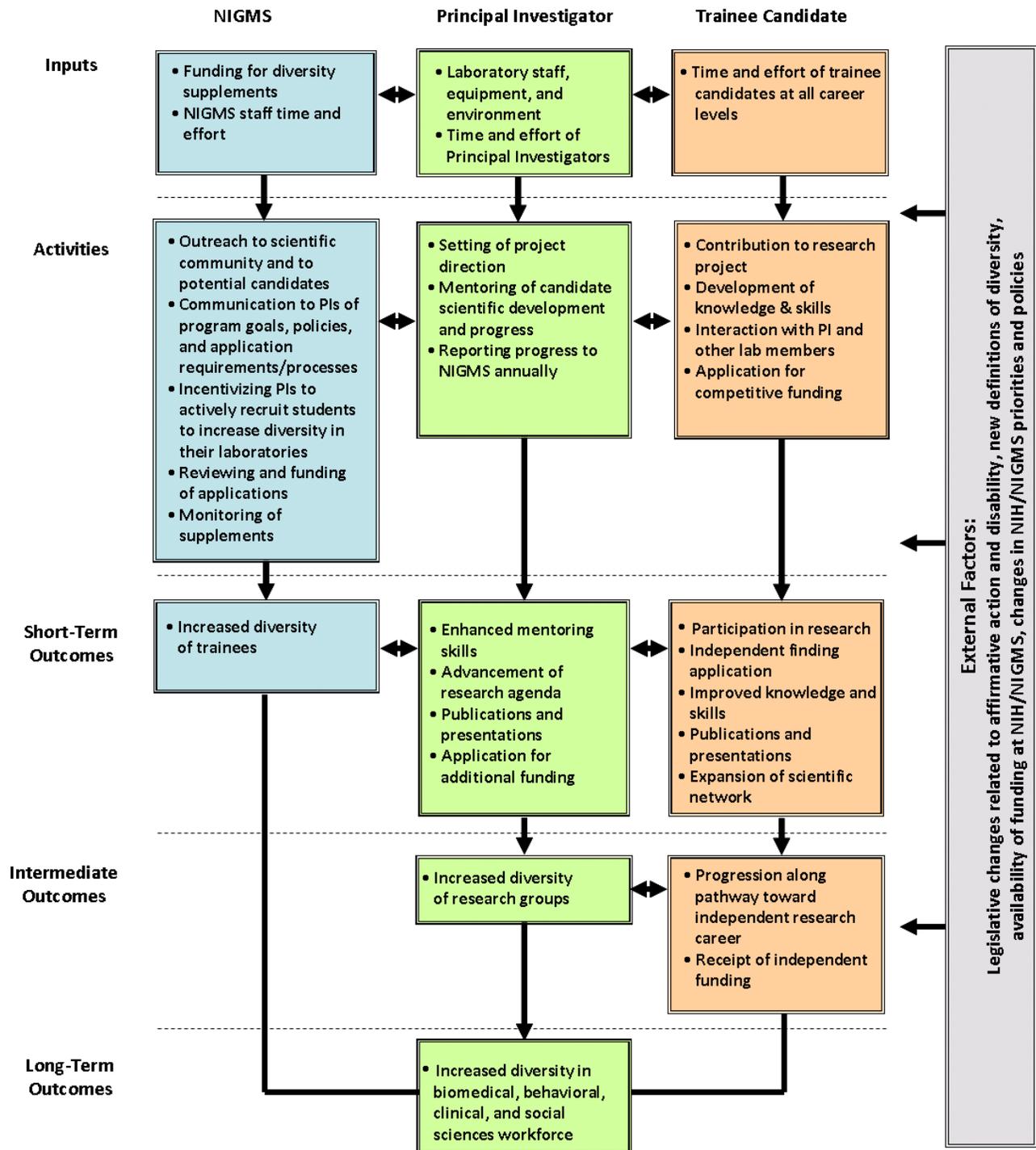


In conclusion, some changes have been recently introduced to the program, including a reduction in support duration for graduate students and postdocs, an increased emphasis on supporting researchers in their early career stages, narrowing of support for faculty, and a requirement for more detailed and trainee-specific mentoring plans. These changes, however, have not been accepted by all NIGMS staff implementing the program. It was recommended that the program policies and procedures be made more transparent internally and to the extramural community.

While the program is being advertised through a variety of means, some respondents felt that the outreach, particularly toward trainees from high school and college levels, could be improved, as their participation remains low. However, few specific suggestions on how to improve the outreach were offered and prior attempts by NIGMS to reach out to potential junior trainees have been unsuccessful. NIGMS expenditures between fiscal years 1997 and 2007 have amounted to nearly \$70 million, doubling during that period. No trainee tracking system has been established at NIGMS, and annual progress reports examined did not contain any information about trainee location or career progression.

The findings about the operation of the Supplements program are displayed in a logic model format to serve as a tool for guiding future evaluation efforts on how the various program elements and activities are hypothesized to relate to expected program outcomes (Figure 4). The contributions to the program by NIGMS (noted in the blue boxes), program activities that take place at the Institute, and desired outcomes (also program goals), have all been discussed in this chapter. In the green and orange boxes, we describe the program inputs and outputs by its beneficiaries, Principal Investigators and trainee candidates. Information pertaining to these program aspects is presented in Chapter 4.

Figure 4: Program Logic Model for the NIGMS Diversity Supplements Program



Chapter 4: Program Participants

One of the unique characteristics of the Diversity Supplements program is that it provides support to individuals at all education and career levels, from high school students to faculty. To be eligible, trainee candidates must be individuals from racial or ethnic groups underrepresented in science, individuals with disabilities, or individuals from disadvantaged backgrounds. To guide the applicants, definitions of eligible groups are provided in the Program Announcement.²⁸ The minority status of the trainee candidate is subject to verification by the applicants' university; application files reviewed contained a signed statement by the applicant and a note from NIGMS reviewers regarding minority status. It was unclear whether and how disability status or disadvantaged background are confirmed, but as reported below, individuals from these groups represent a very small percentage of all participants.

This chapter reports our findings on the characteristics of the program participant population using NIGMS Excel files for FY2001–2007 and Abt Excel files created from paper applications for FY1997–2001. Combining these data sources resulted in a sample of 1,035 participants for 10 fiscal years, from 1997 to 2007.

According to NIGMS staff, sufficient funds so far have been available at the Institute to support all qualified applicants. While the program is “application driven” – that is, no effort is made to distribute the awards by career stage – several respondents expressed a preference for funding high school and college students, in order to give underrepresented minorities early encouragement to pursue a career in scientific research and for cost-effectiveness. NIGMS staff reported that while funding requests for high school and college candidates are almost always approved, these groups remain difficult to recruit and their participation lags behind that of graduate students and postdocs.

The analyses of trainee characteristics using the constructed files revealed that the participant pool was biased toward graduate students and postdocs, who constituted 72% of all trainees (Figure 5). Undergraduate students and post-baccalaureate/post-masters students made up 23% of the population, followed by faculty (3%) and high school students (2%). Almost all trainee candidates were either African American (48%) or Hispanic American (43%), with the remaining percentages divided between Native Americans (3%) and Pacific Islanders (5%, data not shown). Examination of the relationship between race/ethnicity and career level showed that African Americans were better represented at junior career levels (high school to post-baccalaureate) and Hispanics at more senior career levels (graduate students and postdocs, Figure 6).²⁹ The third participant characteristic examined was gender. We found that 56% of the trainees were women (data not shown), but the representation of female trainees declined from junior to senior career levels, a trend which was consistent with the national statistics (Figure 7).³⁰

²⁸ Available at: <http://grants.nih.gov/grants/guide/pa-files/PA-05-015.html#SectionIII>. Accessed March 20, 2009.

²⁹ T-test; p=0.03.

³⁰ Leboy PS. Presentation to the Association of Women in Science. 2008. Available at: <http://www.awis.org/news/documents/Leboy-AAPTforwebsite.pdf>. Accessed March 20, 2009.

Figure 5: Participant Career Levels for NIGMS Diversity Supplement Grants, 1997 to 2007

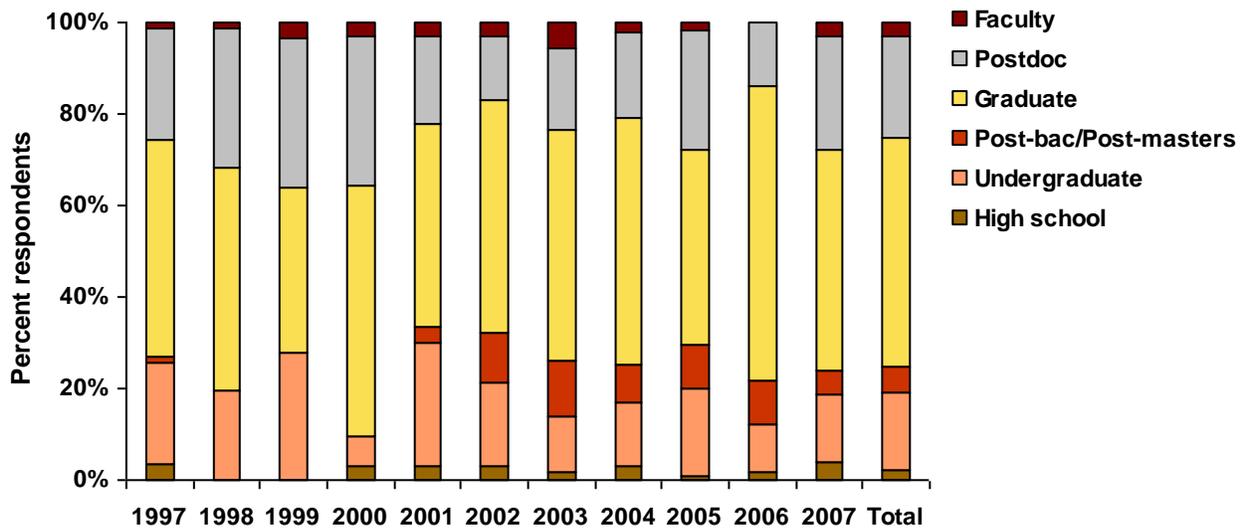


Figure 6: Participant Race and Ethnicity by Career Stage for NIGMS Diversity Supplement Grants, 1997 to 2007

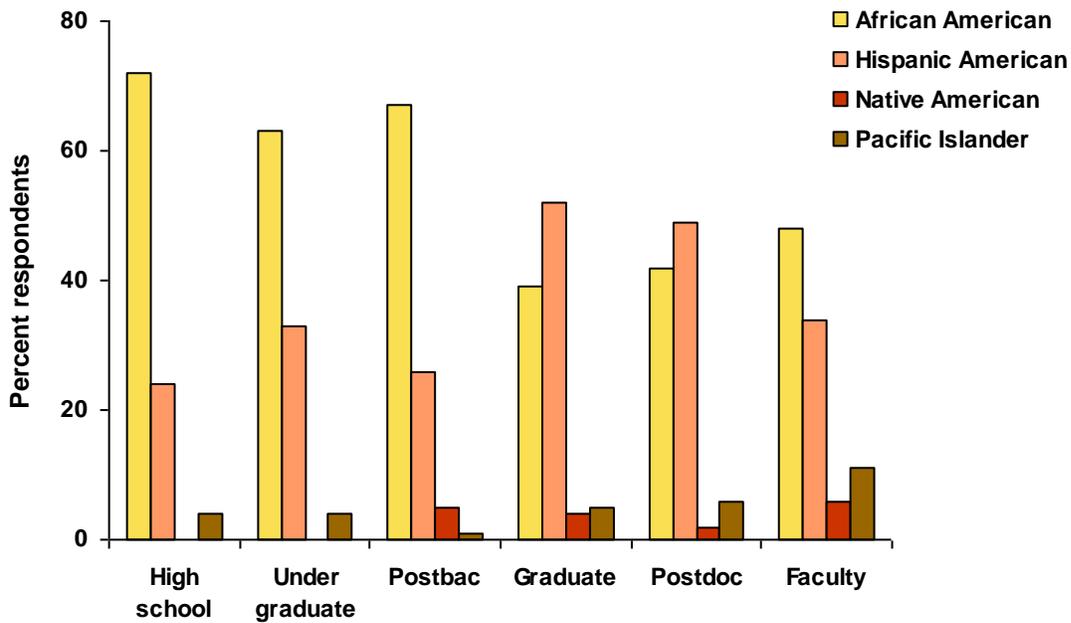
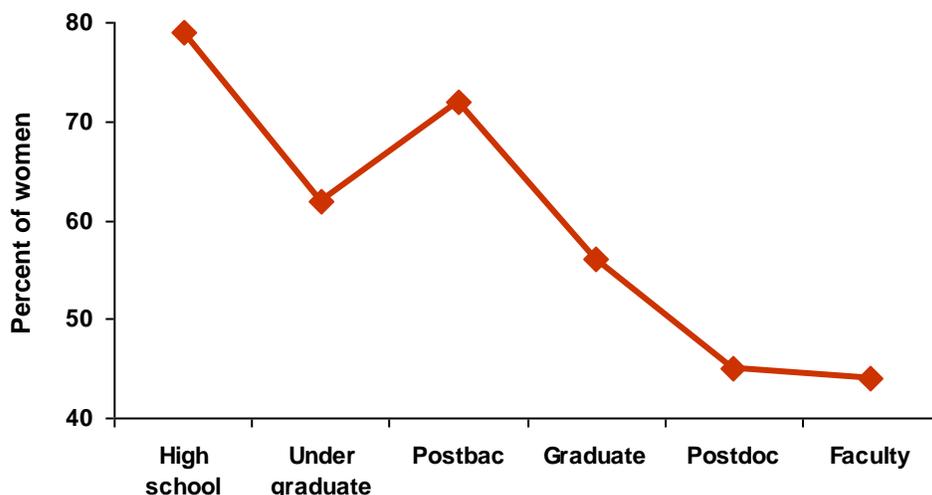


Figure 7: Representation of Women by Career Stage for NIGMS Diversity Supplement Grants, 1997 to 2007



The participant data presented above were based on the combined NIGMS and Abt datasets (2001–2007 and 1997–2001). The Abt dataset was reconstructed from the application records and contained more information, which allowed additional analyses. First, we examined trainee candidates’ academic standing and productivity prior to program participation. Data on grade point averages (GPAs) available for 81 undergraduates and graduate students revealed that almost 50% of trainee candidates had earned GPAs of 3.5 or higher and 75% had earned GPAs of 3.0 or higher (Figure 8). These trends indicated that by this measure the majority of undergraduate and graduate trainee candidates were in good or very good academic standing prior to their participation in the program. An examination of the candidates’ publication records and prior funding support showed that their accomplishments were consistent with what would be expected from biological scientists at their career stage. Most graduate students had none or 1–2 publications (average 1.1), postdocs had 3–4 publications (average 3.4), and faculty had 9–10 publications (average 9.4, Figure 9).

Figure 8: Distribution of Grade Point Averages for Undergraduate and Graduate Trainees Supported by the NIGMS Diversity Supplements Program, 1997 to 2001

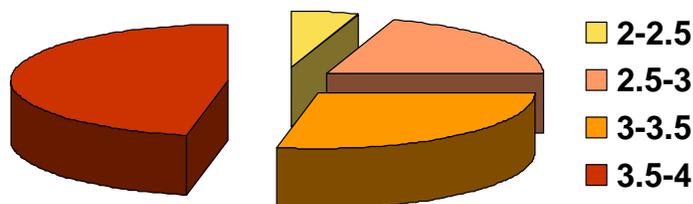
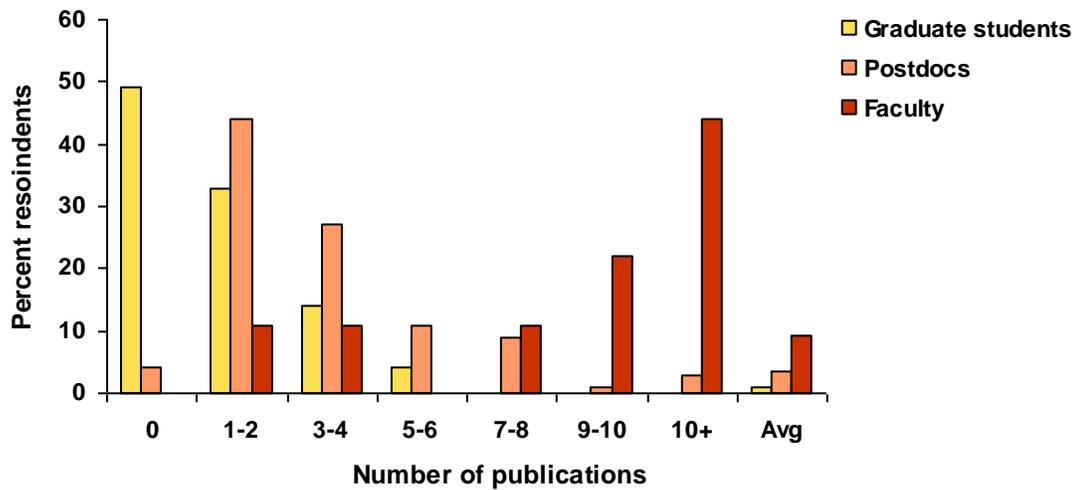
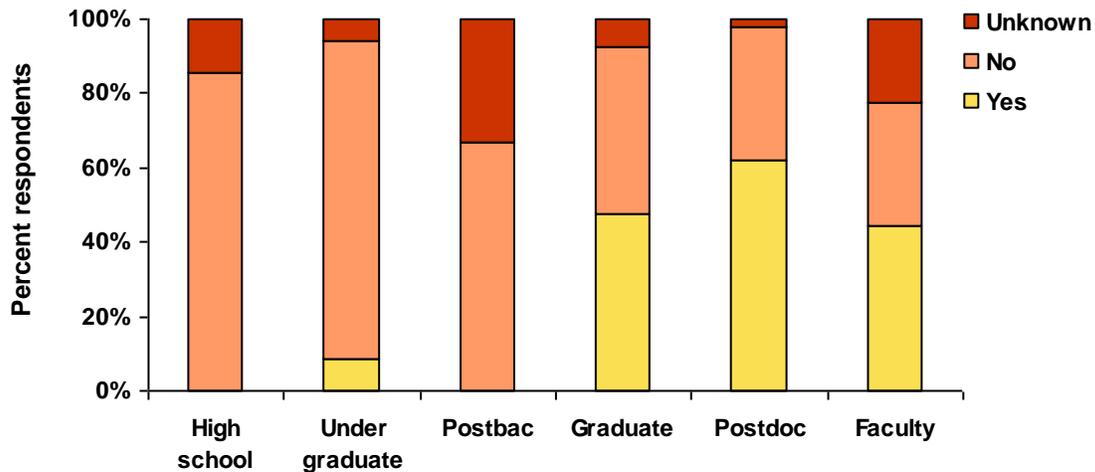


Figure 9: Trainee Publications Prior to Participation in the NIGMS Diversity Supplements Program, 1997 to 2001



Past support trends were also as expected, with little funding up to the graduate level, followed by a steady increase among more advanced scientists (Figure 10). Types of funding included both individual support and institutional support (about 40% and 60% of trainees, respectively), with NIH providing the lion’s share of funds, the trend typical for the biomedical research community (Table 3).³¹

Figure 10: Prior Funding Support by Trainee Category for NIGMS Diversity Supplements Program, 1997 to 2001



³¹ Hamilton Moses III, MD, E. Ray Dorsey, MD, MBA, David H. M. Matheson, JD, MBA, Samuel O. Thier, MD. Financial Anatomy of Biomedical Research. *JAMA*. 2005;294:1333-1342.

Table 3: Funding Support Sources for Trainees Supported by the Diversity Supplements Program, 1997 to 2001

Support source	Number of candidates
NIH T32/other inst. training programs	39
NIH MARC	36
NIH F31/F32	21
NIH MBRS	12
NIH Diversity supplement	9
NSF fellowships	21

It emerged from the records that the vast majority of the candidates aspired to careers in basic or medical research (Table 4), although a few trainee candidates indicated that they planned a career in medicine (15 individuals or 7%).

Table 4: Career Goals of NIGMS Diversity Supplements Program Trainees, 1997 to 2001

Career goal	Number of candidates	Percent of candidates
Basic or medical research	170	76
Basic research or industry	21	9
Medicine	15	7
Doctoral degree	8	4
Basic research or medicine	3	1
Teaching or research	3	1
Other	3	1
Uncertain	1	0
TOTAL	224	99

As discussed in Chapter 2, allowable period of support for graduate and postdoctoral candidates is being reduced from 3–4 years to 1–2 years, with the preference given to trainees in the first two years of their academic careers. These policies do not apply to high school and college students for whom support is almost always provided. To determine whether these new policies represent a significant programmatic change, we examined historical trends for support duration and participant seniority.

Statistics on the duration of support are presented in Figure 11. We found that between 1997 and 2001, graduate students and postdocs received an average of 25.4 months and 23.9 months of support, respectively. The duration of support for all other groups was shorter: 7.7 months for high school students, 12.3 months for undergraduate and post-baccalaureate students, and 19.8 months for faculty. Thus, the vast majority of trainee candidates in the sample received between 1 and 2 years of support.

Further, it emerged from the data that most graduate and postdoctoral trainees had received support in their first two years, a pattern similar to what is currently envisioned for the program (Figure 12). Undergraduates tended to participate in the program towards the end of college, in their junior and senior years, which was not surprising, as college students often need time to explore their career interests and to find a mentor who will accept them into the laboratory.

Figure 11: Training Duration for NIGMS Diversity Supplements Program, 1997 to 2001

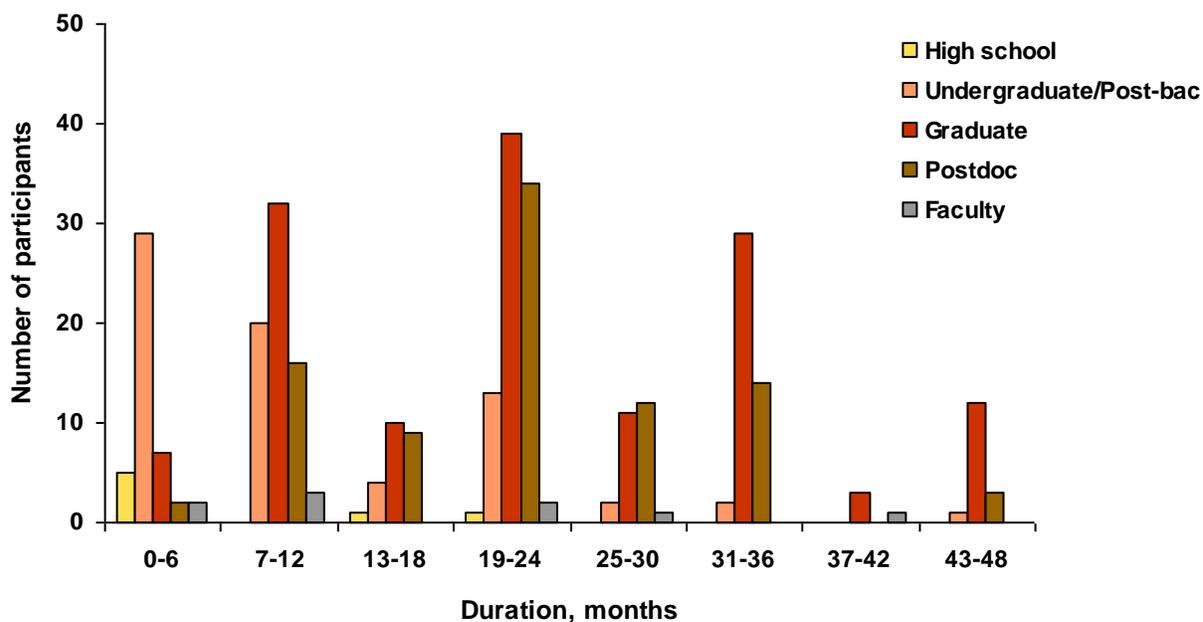
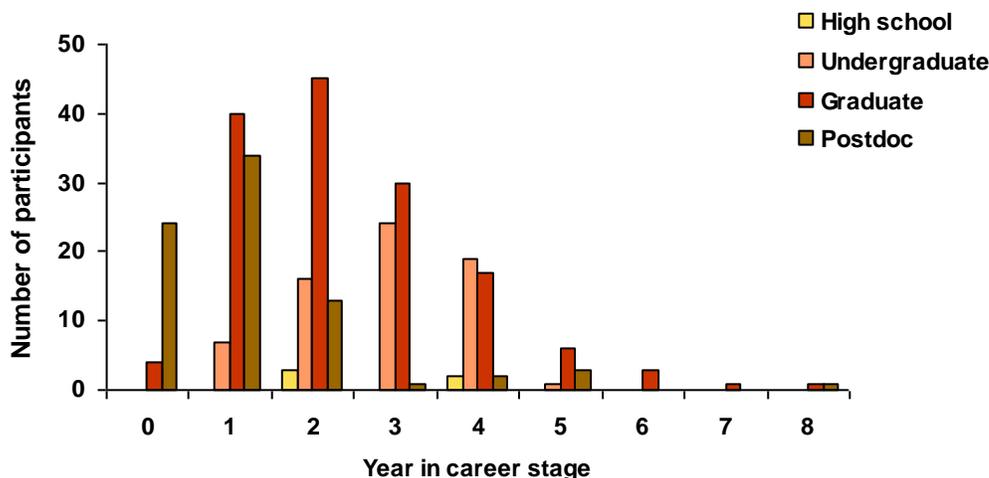


Figure 12: Seniority of Trainees in NIGMS Diversity Supplements Program, 1997 to 2001



In conclusion, we found that trainees participating in the program were roughly half African American and half Hispanic. The majority was graduate students and postdoctoral researchers and more than half were women. Prior to receiving support, trainee candidates were in good academic standing and demonstrated levels of productivity consistent with typical biomedical scientists at their career levels. Graduate students and postdocs received, on average, two years of support and all other participants one year of support or less. In the next chapter, we focus on the program outcomes.

Chapter 5: Program Results

While information presented in the previous chapter described the trainee population served by the program, the focus of this chapter is on the nature of participant experiences and their career achievements. To begin documenting these aspects of the program, we administered email surveys to a small number of PI-trainee pairs. It is important to note that these surveys are just an initial step in assessing program impacts on the participants. Since the survey sample size was small, and the participants were not randomly selected, survey findings cannot be generalized to the entire program. Further, participants' experiences and outcomes were considered in isolation, without any comparison to nonparticipants or to any other relevant group. Despite these limitations, the survey results revealed that the program has made a real difference in the professional lives of its participants.

Tracking Respondents

As discussed in Chapter 2, the first stage of the survey process was to email customized survey instruments to 45 Principal Investigators. Before sending the emails, we verified PI contact information using web searches and found that 8 of the 45 PIs had changed institutions; however, their email addresses were easily available on the Internet. All emails sent to PIs appeared to have reached their destinations.

In the body of the PI questionnaire, we explained that we planned to send a similar survey to their trainees and asked the PIs to provide any information on trainee whereabouts (Appendix D). Assistance from the PIs was instrumental to our ability to reach the trainees. Although the training events took place nearly 10 years ago, many PIs in the survey sample had some knowledge of trainees' current positions, or kept trainees' personal email addresses, or at least had an idea where trainees went after leaving the labs. Of the 31 PIs who responded to the survey, 22 (71%) provided some information on their trainees (Table 5). As best as we were able to verify, this information was generally correct.

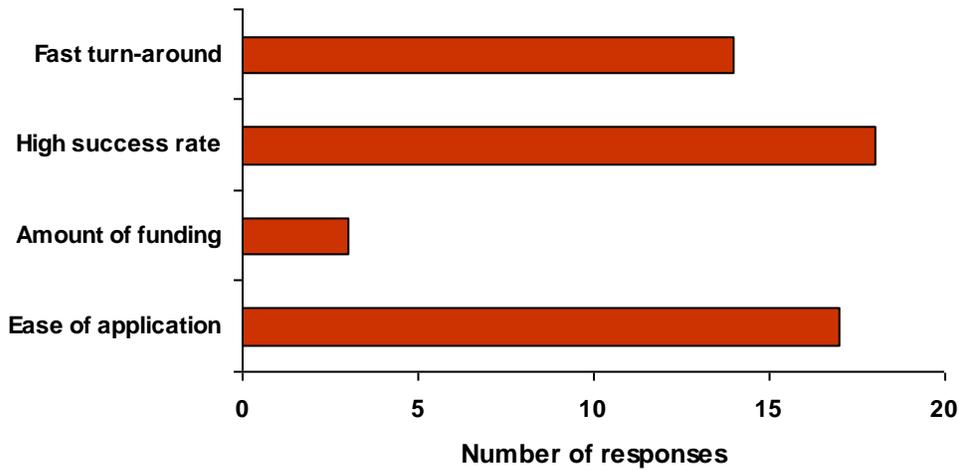
Table 5: Principal Investigators' Knowledge of Trainee Contact Information

PI category	Number of PIs who provided concrete contact information	Number of PIs who provided a clue about trainees' location	Number of PIs with no information on trainees
PI-HS	0	1	2
PI-UG	3	1	2
PI-PB/PM	0	1	1
PI-GS	6	1	1
PI-PD	4	3	1
PI-F	0	2	1
TOTAL	13 (42%)	9 (29%)	6 (19%)

Supplement Application

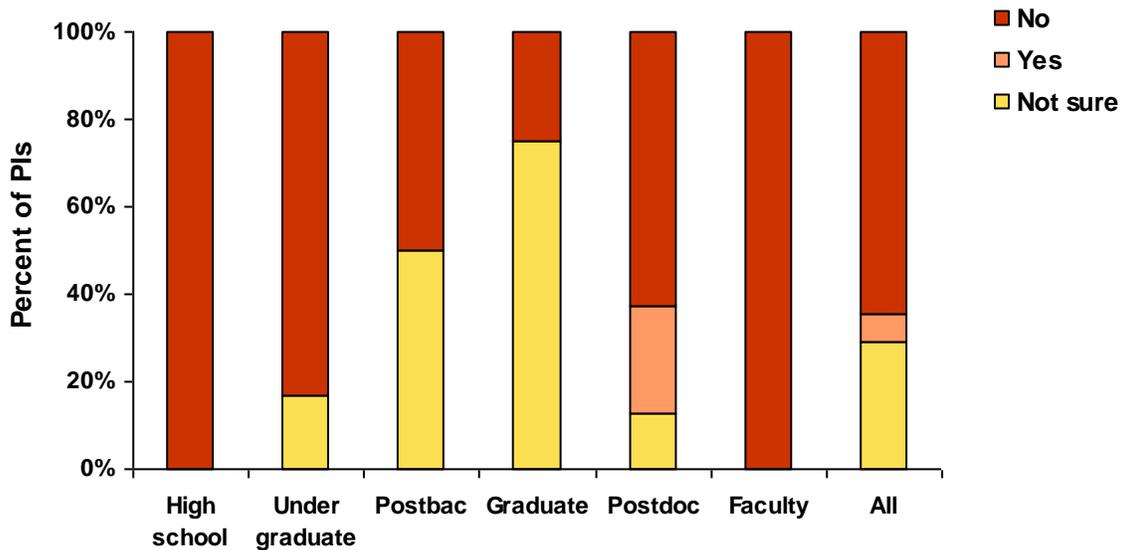
Most of the PI respondents selected a combination of three answer choices offered for why they had decided to apply for the supplements: ease of application process, high success rate, and fast turnaround (Figure 13). A few PIs provided additional comments, such as "the cost of funding does not detract from grant" (1 response); "ideal support mechanism" (2 responses); "encouraged by NIH" (1 response); "free money for another minority student" (1 response); "I had no other options" (1 response); and "trainee had no other options" (1 response). One PI commented that he had had "excellent students in the past."

Figure 13: Reasons to Apply for the Supplement Funding Reported by the Principal Investigators



The majority of respondents (65%) claimed that they would be unable to support the trainee without the supplement funds (Figure 14). In particular, none of the PIs supporting high school or faculty trainees had alternative sources of support, probably because few programs at NIH offer funding for trainees at these career levels. These limited data indicated that the Supplements program bridges an important gap in the array of funding opportunities for research training.

Figure 14: Availability of Alternative Sources of Support Reported by the Principal Investigators



Trainees learned about the program from their current mentor (8 of 17 or 47%), from another PI (4 of 17 or 24%), from a previous mentor (4 of 17 or 24%), or directly from NIH (1 of 17 or 6%, data not shown). Unfortunately, these data did not directly address the question of whether PIs actively recruited minority students or applied for funding to support students who had already joined their research groups.

When asked why they decided to support this particular trainee, PIs provided several answers. Most commonly, trainees were interested in PIs' research and PIs had an appropriate project (Table 6), although a number of PIs also wished to help the student financially and/or wanted to increase minority representation in the sciences. Many PIs thought that the trainee showed promise to become a successful scientist.

Table 6: Decisions to Support the Trainee Reported by the Principal Investigators

Why did you decide to support this trainee?	Number of responses
The student was interested in my research	19
I had the appropriate assignment	18
The student needed financial support	14
The student would increase diversity in the biomedical workforce	11
I believed that this student showed potential to become a successful scientist	11
I wanted to help the student acquire specific or transferrable skills	8
The students was recommended by a colleague, a friend, or a relative	5
I wanted to help the student get into a good college/graduate program	4
I had good experience in the past	1
TOTAL	91

Training Process

Goals. Our analyses of the data revealed significant similarities in the goals trainees and PIs had for the training experience (Table 7). The most commonly reported goals were the development of skills and dissemination of the work (publications and presentations), followed by guidance and mentoring, research position, and degree attainment.

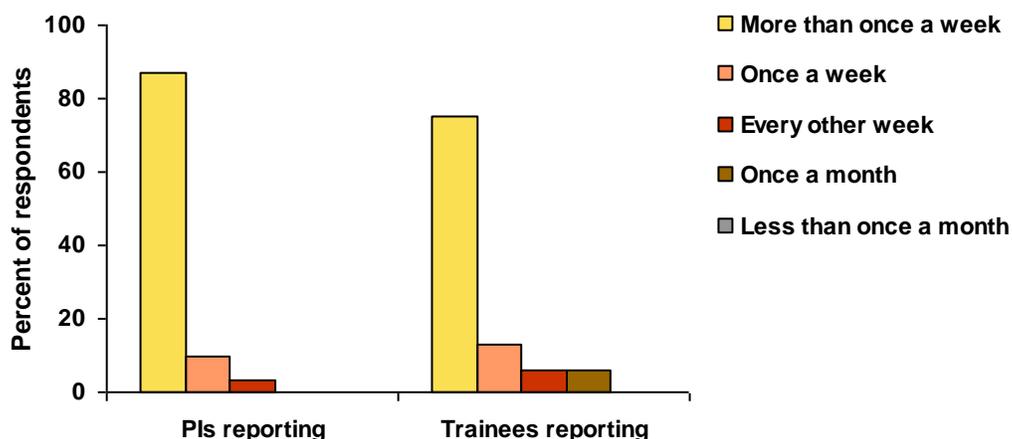
Table 7: Training Goals Reported by Trainees and Principal Investigators

What were your goals for the training?	PIs	Trainees
Development of skills	16	14
Publications and public presentations	14	10
Guidance and mentoring	11	6
Independent research position/postdoc	8	7
Completion of degree	8	5
Follow-up funding support	6	3
Contribution to science	–	7
TOTAL	63	52

Mentoring. Since mentoring has been identified in the literature as key to a successful training experience (Appendix A), various aspects of the PI-trainee relationship were examined in some detail. All but two PIs reporting in the survey were primarily responsible for trainee oversight (one undergraduate and one post-baccalaureate trainee were supervised by postdocs). All trainees said that PIs were their mentors in the lab. The vast majority of PIs and trainees met more often than once a

week (Figure 15). There appeared to be general agreement between the two groups on the frequency of interaction, although PIs tended to recall that the meetings had occurred somewhat more often (Figure 15).

Figure 15: Frequency of Interaction as Reported by Principal Investigators and by Trainees



The majority of respondents appeared to be satisfied with the mentoring, albeit the level of satisfaction was lower among the trainees. Ninety percent of PIs thought that they had provided the assistance trainees needed and 69% of trainees were satisfied with the level of assistance they had received (another 25% of trainees were somewhat satisfied, data not shown). When asked whether they would characterize their PI as a good mentor, 15 of 17 trainees (88%) responded in the affirmative, and the remaining 2 said “yes and no” and “no.” As requested in the survey, these individuals provided elaborating comments: “Scientifically, he was a good mentor, but he could not, nor did he try, to relate to me as a person. We had nothing in common beyond science. I did not feel I could talk to him about some of the challenges that I faced as a minority postdoc.” And, “I would not characterize my PI as a good mentor because I found him not easily approachable.”

Challenges. PIs were asked to report in the survey on the challenges of the training experience. About a third of the PIs indicated that they had experienced none (Table 8). The biggest challenge to this group appeared to be their inability to devote as much time to the trainee as was necessary (7 PIs), followed by trainees’ lack of knowledge and skills to carry out the project (5) and trainees’ level of time commitment (5). Interestingly, one PI noted that he had no understanding of the research conditions at minority institutions.

When a similar question was posed to the trainees, four reported no challenges (24%, Table 8). The biggest single challenge for the trainees was the pace of progress (24%). A few noted that getting a degree took a lot longer than they expected. As we briefly mentioned above in our discussion of mentoring relationships, it also emerged that a few trainees experienced some difficulties interacting with their mentors. For example, one trainee said: “although I did get along with PI, I didn’t get enough mentoring during the process to bench mark my progress ... there were some fundamental problems with who my advisor thought would go forward in academia and who he thought wouldn’t. I guess he guessed wrong in my case.”

Table 8: Training Challenges as Reported by the Principal Investigators and by Trainees

Training challenges reported by PIs	Number of PIs
None	10
Not enough time for trainee	7
Insufficient knowledge and skills	5
Insufficient level of commitment or personality problems	5
Lack of meaningful contribution by trainee	2
Lack of understanding of research conditions at minority institutions	1
Training challenges reported by trainees	Number of trainees
None	4
Slow progress	4
Interaction with PI	2
Difficulty balancing my work with obligations outside of the lab	2
Cultural adjustment	1
Insufficient knowledge and skills	1

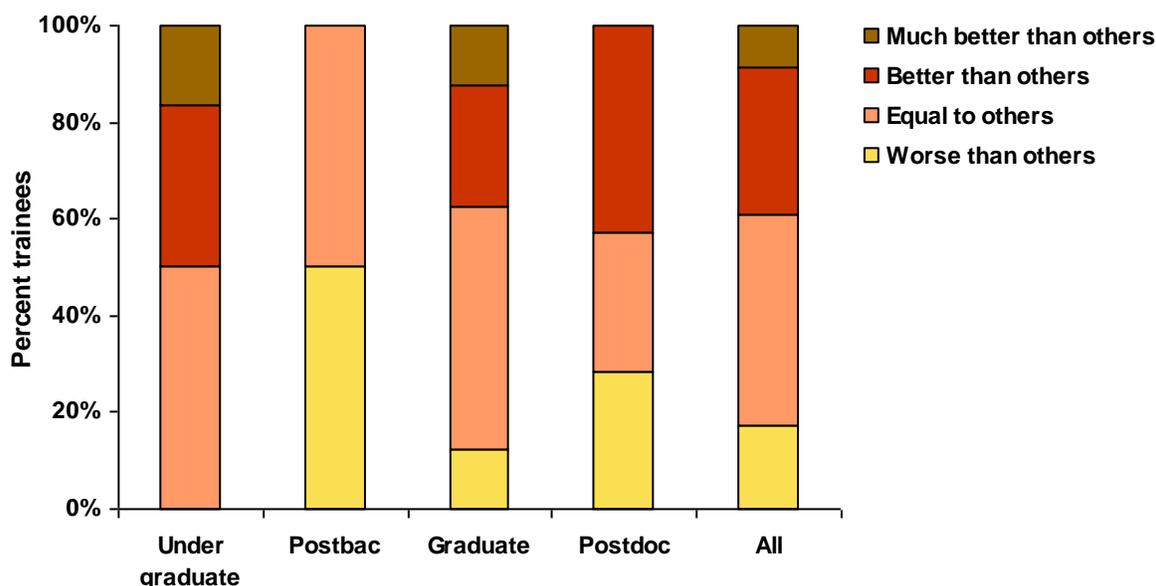
Challenges reported by many respondents were typical of a student-mentor relationship in biomedical sciences. It is not uncommon for PIs to feel that students lack appropriate training or do not put in as much time as their advisors would have liked. Students often feel that laboratory work is slow and all-consuming.³² However, as illustrated by one PI, some trainees made an extraordinary adjustment:

[The undergraduate student] went to a high school where, as he explained, he did pretty well but he kept that to himself – it was not cool to be academically talented. Now he was in a major where the premeds predominated. He made a bigger cultural leap coming from Detroit to East Lansing academia than my students who come from Beijing or Bombay, who are already familiar with the overall environment. His English skills were a challenge at first; I realized we didn't speak the same language and for the first few months in the lab the longest conversation we had was reading off a DNA sequence. During one of his group meetings he gave us an illustrated talk to describe terms used in Detroit that we had to pick up. Finally, he didn't have the kind of push from home that many students grow up with, so every step up the ladder had to be made without any reference to "this is the way the world works." The trip to D.C. to the national fly conference was the first time on an airplane. The lunch at the Chinese restaurant there was the first time he'd seen that food. And of course doing science, including experimental procedures, analysis, and discussion was a new world.

Participant satisfaction. While both PIs and trainees reported some challenges, the majority appeared to have had quite a successful research experience. For example, when asked to compare individuals supported through the supplements to other students they had mentored in the past, a large majority of the PIs (19 of 23 or 83%) felt that trainees were as good as or better than their peers (Figure 16). Undergraduates and graduate students were the least successful groups (Figure 16).

³² Gewin V. Learning to mentor. *Nature*. 2005;436:436-437.

Figure 16: Comparison of Trainees to Their Peers as Reported by the Principal Investigators



Several PIs elaborated on the success of a trainee:

[Postdoc] did an outstanding job on the proposed research. He collected excellent data and several fine papers resulted. He was an outstanding colleague who helped students in my lab and contributed greatly to our projects.

[Graduate student] was a smart, successful, kind and generous person.

[Graduate student] showed all the “right” features: drive, ambition, dedication.

When asked whether they would support the same student again, 68% said “yes,” 19% said “no,” and the rest noted that the student would not benefit from the same experience (data not shown). PIs who would not support the student again reported that he or she lacked enthusiasm for science (2 respondents), did not like bench work (1 respondent), had “personality issues” (1 respondent), or “did not gain from the experience” (1 respondent). Note that while not every PI would choose to support the same students, all were interested in participating in the program again and three have already done so.

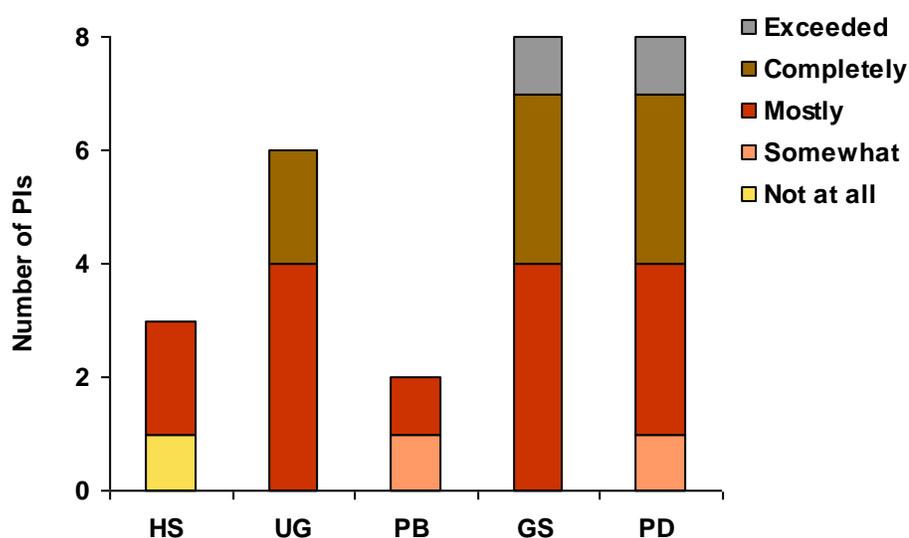
A number of PIs said that, in retrospect, they would have done some things differently. Most commonly mentioned were improvements to mentoring/supervision aspects of the training (10 respondents). PIs wished they had spent more time with the student, made sure the student was interested, set up clearer expectations and monitored progress, had assigned a student to a different supervisor in the lab, or encouraged a student to take a remedial writing course (data not shown). Several PIs would have given the trainee a different project.

Training Outcomes

In the surveys, respondents were asked to report whether they achieved the goals set for the training and how they had benefited from the experience. To determine how many trainees remained in research, respondents were also asked to indicate their current position, title, and type of employing organization. Data related to program outcomes are presented below.

Achievement of goals. The majority of PIs were positive about the accomplishment of training goals, although the level of enthusiasm varied somewhat by the training level (Figure 17). Mentors of graduate students and postdocs appeared most satisfied, reporting that some trainees had exceeded all goals. High school students emerged as the least successful group, but note that the number of these students in the sample was small. It is possible that high school trainees were less rigorously chosen, since NIGMS funds all applications that propose to support this group. Alternatively, PIs may have had little experience with high school students and their expectations may have been unrealistic. Unlike the rest of the PIs, mentors supporting the faculty trainees were asked to express their opinions regarding the accomplishment of goals in an open-ended format (Appendix D). All three responses received were either negative or ambivalent: “worked hard, but did not have the talent,” “was pleased with the result,” and “worked hard, but could not solve technical problem.”

Figure 17: Accomplishment of Training Goals as Reported by PIs



Trainees were also asked whether they had met their goals for the research experience. All but three trainees responded in the affirmative (data not shown). These three did not reach their goal of obtaining a faculty position and two had changed career direction. In contrast with PIs’ views, all faculty candidates indicated that they had achieved their goals.

Benefits of program participation. All trainees – whether they remained in research careers or not – reported having benefited from the experience. The top benefit for trainees was acquiring laboratory skills, followed by publishing papers and making a contribution to science (Table 9). Other benefits included moving to the next career step, affirmation of career choice, financial support, and learning the reality of being a scientist – in our view, all important and lasting benefits.

Table 9: Self-reported Benefits to Trainees

How did you benefit from the training experience?	Number of trainees by career level (number in sample)				
	UG (N=3)	GS (N=5)	PD (N=6)	F (N=3)	Total (N=17)
Laboratory skills	3	4	6	-	13
Publications	-	5	5	2	12
Contribution to science	2	4	5	-	11
Acceptance into good program	3	2	3	-	8
Affirmation of my career decision	2	3	3	-	8
Financial support	2	4	2	-	8
Learning the reality of being a scientist	3	3	-	-	6
Mentoring	-	1	2	1	4
Meeting scientists	2	-	-	-	2
Expanding my expertise	-	-	-	1	1
Collaboration	-	-	-	1	1
Relief from teaching load	-	-	-	1	1
No benefit	0	0	0	0	0

UG=undergraduate; GS=graduate; PG=postdoc; F=faculty

Similarly, almost all PIs reported benefiting from the training experience (Table 10). Advancing their research goals was mentioned by nearly half of the PIs. Some noted that the experience helped re-focus the project or move it into a new direction. One PI benefited from trainees “altruism”:

[Postdoc] was very productive during his stay in the laboratory and contributed to several grants that I had at the time. Probably the biggest benefit of having [him] in the laboratory was his altruism. He was the ultimate “team player” helping nearly everyone whenever he could. Despite this, he was able to stay productive and focus on his own projects as indicated by his publication record during this time period.

The survey revealed that many PIs gained more than “a pair of hands”: eight reported personal satisfaction from developing a minority scientist, two became friends with the trainee, and two emerged from the experience better prepared to mentor future students from similar backgrounds. One PI wrote:

I have come away with a much better appreciation of how best to reach out to students coming from a non-privileged position, and what sort of challenges stand between them and entry into the professional workforce. I think that this experience has been beneficial in advising graduate students in our program who come from similar backgrounds.

Table 10: Self-reported Benefits to Principal Investigators

How did you benefit from the training experience?	Number of PIs by trainee career level (number in sample)						Total (N=31)
	HS (N=3)	UG (N=6)	PB (N=2)	GS (N=8)	PD (N=8)	F (N=4)	
Helped move project forward	2	4	-	2	5	2	15
Personal satisfaction	-	-	2	-	3	3	8
Friendship with trainee	-	1	-	-	1	-	2
Helped others in my lab	-	-	-	-	2	-	2
Learned to mentor minority student	-	1	1	-	-	-	2
No benefit	-	-	-	-	1	-	1

HS=high school; UG=undergraduate; PB=post-bac; GS=graduate; PG=postdoc; F=faculty

Trainees career outcomes. Since the goal of the Supplements program is to diversify the research workforce, a key outcome of the training is persistence in research. Therefore, we examined how many trainees in our sample had made this career choice. Of 45 trainees, 17 provided information on their current employment in the survey. PIs had some knowledge about an additional 7 trainees (Table 11). Based on these limited data, 9 (43%) of trainees have a position in academia, 5 (24%) are physicians or other medical professionals, 3 (14%) are employed by the pharmaceutical industry or looking for a position in industry, and 4 (19%) are government employees (including one at NIH). **More than three-quarters of the trainees (76%) became biomedical researchers.**

In the opinion of several NIH staff, expectations for persistence in research should be reduced if trainees receiving support were only just beginning their education (high school and undergraduate students). We examined career levels of trainees who had abandoned research. Survey data revealed that of five individuals known to have chosen non-research careers – one genetic counselor, two physicians, one pharmacist, and one nurse – two participated in the program as college students, two as post-baccalaureate students, and one as faculty (data not shown). Thus, most trainees who had chosen non-research professions participated in the program early on in their careers.

One of the most important determinants of academic success is a researcher's ability to obtain independent funding. A review of trainee funding records using CRISP, a public NIH grants database, revealed that of 35 trainees who either had elected academia or could not be reached, 8 (23%) had received funding from NIH (data not shown). This number may be an underestimate however, because female trainees who had changed their names through marriage would not have been captured. Further, some trainees may be receiving support from other sources, which would not be recorded in CRISP. Of 9 trainees verified or suggested by PIs to be in academia, 5 (55%) had funding from NIH.

Table 11: Career Choices Made by Trainees

Career choice	From survey, verified with trainee	From PIs, unverified with trainee
Academia [§]	3 Assistant Professors 2 Associate Professors 1 Professor 1 Head of Research Facility 1 Programmer	1 Assistant Professor
Medicine [¶]	1 Genetic counselor	2 Physicians 1 Nurse 1 Pharmacist
Industry*	1 Research Scientist 1 Looking for position in industry 1 Senior Scientist	
Government [‡]	1 Program Director 1 Research Chemist 1 Research Scientist 1 Team Leader	
Other	1 Died	1 Went to college 1 Not interested in research
TOTAL	17	7

[§]**Academia:** Washington State U, U of Missouri, Penn State U, Western Michigan U, Rutgers, SUNY, Meharry Medical College, UC Irvine

[¶]**Medicine:** Dartmouth, Harvard Medical School, UCSF, U of Tennessee Memphis

^{*}**Industry:** Exelixis, Wyeth

[‡]**Government:** NIH/NCI, USDA, CDC

Attribution of outcomes. One of the challenges of program evaluation is attribution of observed outcomes to the activities of the program being examined, particularly when trainees have benefited from multiple sources of support. We took an approach of asking trainees directly whether, how, and to what extent their participation in the program had contributed to their career choices. With the exception of a single trainee, all respondents reported benefits of the program (Table 12). This one trainee noted that he had already developed a commitment to research, and would have found a way to continue along this career path with or without the supplement funding. For the remaining 15, participation in the program had influenced their careers in a number of different ways. Most commonly, trainees reported that their supplement-supported research experience helped them advance to the next career level or affirm a career choice (Table 12). Individual statements about their experiences enhance the data presented in Table 12:

I decided that I did not want to work in a lab full time. I really enjoyed the work and do miss it a little but I wanted a more patient care position. I was able to get a job quickly after graduating which allowed me the time to research career options. I would have never gotten the job as a research assistant without the research experience.

I was ready to give up on a scientific research career, [but] because of this experience I was offered a job in government using the very skills I gained in my experience under the NIH supplement.

Career choice – not at all. Advancement – instrumental.

Table 12: Attribution of Career Outcomes to Program Participation

How did the experience contribute to your career choice?	Number of trainees
Helped me obtain a job/advance to the next career level	7
Affirmed my career choice	3
Brought focus to my career goals and research program	2
Was critical to my career path	2
Helped me develop skills of a scientist	1
Helped me learn to be responsible at work	1
Helped me obtain federal funding	1
Allowed me time to generate data	1
Allowed me to publish papers	1
None	1

Faculty participants claimed some of the strongest benefits of participation:

I believe I wouldn't have become a tenured professor without the knowledge I gained through the program.

It contributed tremendously to my choice to stay in research in an academic setting.

Expression of gratitude to NIH. Survey subjects were invited to elaborate more qualitatively on their views about minority support in general and the Supplements program specifically. A number of participants used the space provided to express satisfaction with the program and to offer thanks to NIH:

An excellent program; I feel that it is doing what it was designed to do. (PI)

The resources brought in through the diversity supplements program were extremely useful for [faculty candidate's] professional success in giving her additional time and resources to work toward her promotion and tenure. Her success as a minority science role model has probably done more than anything else to attract younger qualified minorities into science. (PI)

I would like to express my endless gratitude to the NIH Diversity Supplement Program for helping me achieve success in my PhD/Postdoctoral training. Thank you. (Trainee)

It's a great program since minority scientists are given the chance to excel in their chosen field irrespective of family income and skin color but due to their capabilities, unique talents and hard work. Thank you for giving me the opportunity. (Trainee)

General Comments about the Program

Survey respondents made several programmatic suggestions. One of the most common views expressed was the importance of early intervention:

These kids come from an environment where success is not the norm. They attend poor schools, and unless they are exceptionally industrious and bright, they will move on to a minority college. In these schools, there is often too little insistence on independent thinking or expectation of outstanding effort. The earlier there is intervention to disrupt this cycle the better, but even college or grad school intervention by a dedicated mentor can make a difference. (Trainee)

These comments were consistent with our observation that respondents overwhelmingly ranked support for high school and college students as most efficacious for recruitment and retention of minorities in the sciences (85% of PIs and 94% of trainees, data not shown). Clearly, NIGMS efforts to support younger researchers resonated with respondents' views.

A few respondents recommended that the Institute increase its efforts in advertising the program. One PI suggested sending an NIH staff member to minority colleges to educate students and faculty about research opportunities outside of their institution. Another PI said that it might be helpful to highlight the program to investigators receiving their first R01 or R21 grants. This PI noted that most young faculty members were unaware of this opportunity.

A number of trainees expressed a wish to meet fellow program participants and other minority researchers supported by the NIH. Their comments highlighted the need for a vanishingly small number of minority researchers to have their own community in a predominantly white academic culture:

Perhaps some kind of gathering for all supplement participants would have been nice ... to connect with fellow participants and build connections for the future. I currently know very few scientists of color. This gathering could have been a way to build a support network. (Trainee)

It would be great to interact with the community in this group. (Trainee)

Partner up with the NIH MARC program and minority NRSA awardees. (Trainee)

A few respondents advocated changes to the mentorship aspects of the program, suggesting pairing minority trainees with committed mentors, ideally with the same background, and requiring a more detailed mentoring plan:

The best way to enhance minority participation is to pair minorities with mentors that are genuinely interested in their success. It helps if this person has similar background or came from similar circumstances as the mentee, then the mentee would be able to envision their mentor's life as their own. Also, exposure to the positives of being a scientist is crucial. I think pairing students with a scientist/mentor of color (never hurts to have more than one mentor!) while participating in the diversity supplement program would help with maintenance of minorities in research related fields. (Trainee)

The supplement program functions if the minority participant chooses the appropriate mentor to further his/her career objectives. Particular emphasis should be made on the participation of the mentor in developing the skills of the mentee, by requesting a detailed plan of action. (Trainee)

Based on my own experience with several minority undergrad and grad students I think that most research mentors, myself included, do not have sufficient background preparation to mentor minority students from economically disadvantaged backgrounds. (PI)

The survey data revealed that PIs applied for the supplements funds because of perceived ease and speed of the application and review processes. The majority of PIs would not have been able to support the trainees without the supplements. Trainees and PIs had similar goals for the training experience and many were satisfied with the training process. While PIs and trainees met on a frequent basis, some respondents indicated experiencing challenges related to the mentoring aspects of the training. Many PIs and trainees reported having accomplished all goals and most derived some benefits from the training experience. The final chapter presents our conclusions based on the findings discussed in this report and contains specific recommendations to NIGMS staff.

Chapter 6: Conclusions and Recommendations

NIGMS contracted with Abt Associates to conduct a needs assessment study of the Diversity Supplements program. The study sought to address the following key questions:

1. **What problems or needs is the program attempting to address?**
2. **Whom does the program serve?**
3. **Are the needs of program participants being addressed? If not, what program modifications can be made to address these needs?**
4. **What are appropriate program goals?**
5. **For each program goal, what would be a reasonable standard of performance to achieve within a specific time period? How should these standards be measured?**

The findings from our examination of program data, interviews with NIH staff, feedback from program participants, and a review of the literature are summarized in the next sections for each of the study questions.

What problems or needs is the program attempting to address?

The aim of the NIGMS Diversity Supplements program is to meet an urgent and compelling need for a more diverse research workforce. Minority program intervention literature suggests that a variety of strategies can enhance students' success in science, including academic integration; social, mentoring, and financial support; development of knowledge and skills; and strengthening of ties to the academic community. The Supplements program draws on several of these approaches by providing individuals underrepresented in science a unique and valuable opportunity to participate in a research experience under the mentorship of an accomplished investigator. To motivate potential mentors to recruit underrepresented minorities into their research groups, the program offers monetary supplements to active research grants. The program has been designed to make the process of obtaining the supplement funds relatively easy: the application is short, the review is fast, and the success rate is high. To expand the size of the target populations, the program is open to eligible individuals at all career levels, including high school students, for whom little support is available from other sources. Despite its somewhat informal application and review processes, the program is not intended to augment the investigators' workforce by providing easy funds for an additional pair of hands. Rather, the goal of the program is to place minority individuals in a productive and nurturing research environment, under the guidance of mentors who are committed to their success in a biomedical research career.

Whom does the program serve?

The program serves two groups of participants: Principal Investigators, who receive funding to support a trainee to conduct research in their laboratories, and trainees recruited from populations underrepresented in science. While the Program Announcement identifies its target populations as individuals from racial and ethnic minorities, with disabilities, and from socially, culturally, economically, or educationally disadvantaged backgrounds,³³ we found that the vast majority of support has gone to racial and ethnic minorities. It is likely that some of the minority individuals come from economically disadvantaged families, but it was not evident from our examination of the program whether this criterion

³³ PA-05-015 and PA-08-190.

was used in making funding decisions. In 10 years starting in 1997, a total of 20 researchers with disabilities (about 2%) received support.

While NIH staff emphasized their preference for supporting trainee candidates at junior career levels (high school and undergraduate students), the trainee population for the 10-year period examined was heavily weighted toward graduate students and postdocs (75%). Support typically went to graduate students and postdocs in their first two years of training (57% and 73%). About half of the trainee population was African American and half Hispanic (48% and 43%); 56% were female. African Americans were more heavily represented among junior researchers and Hispanics among senior researchers, and representation of women declined at more senior career levels. The average support duration was a year or less for high school students, undergraduates, and faculty and about two years for graduate students and postdocs. Trainees in our surveyed subsample (1997–2001) were a well-qualified group as indicated by GPAs, number of published papers, and prior financial support. The vast majority planned to become researchers.

Are the needs of program participants being addressed? If not, what program modifications can be made to address these needs?

PIs chose to apply for the supplements because of the relative ease of the application process and because they had an appropriate assignment for a minority student who was interested in their research, but did not have independent funding support. Two-thirds of PIs responding to the survey claimed that they would not have been able to support their trainee without the supplement funds. The most commonly mentioned training goals included the development of skills, publications and presentations, and guidance and mentoring. These goals were similar for PIs and trainees surveyed. The majority of survey respondents felt that they had accomplished their goals or exceeded them.

Every trainee, regardless of subsequent career choice, and virtually all PIs reported some benefits of the experience. The benefits for trainees were scientific (publishing their work, making a contribution to science), financial, and career-related (affirmation of career choice, learning the reality of being a scientist, getting into a good graduate program). PIs also reported scientific gains (moving the project forward, publishing papers, getting help for other lab members), but in addition they appeared to derive personal benefits from the experience (satisfaction in developing a minority student, friendship with trainee, learning how to mentor a minority student).

The findings suggested that participation in the program has contributed to the entry of minority trainees into a research workforce, as 76% of trainees in the survey currently hold research positions in academia, government, or industry. Most attributed their career choices, in part, to the training experience. Survey results also revealed that the research experience supported by the supplements was valuable to those trainees who had abandoned research. Regardless of career choice, many trainees viewed their participation in the program as an important stepping stone to the next stage in their professional lives.

The challenges experienced by some of the participants were typical of those frequently discussed for biomedical researchers. PIs cited their inability to spare enough time for the trainees, trainees' lack of knowledge and skills to carry out the project, and insufficient commitment to research. For trainees, the main challenges were the slow pace of progress, interaction with their mentors, and finding a balance between professional and personal lives. It is worth noting that about a third of PIs and a quarter of trainees reported experiencing no challenges.

Participants reported high level of satisfaction with the program, and several trainees thanked NIH for the opportunity. All survey respondents would participate in the program again; 78% of the PIs would

support the same individual. That said, roughly half of survey respondents would have made some changes to the experience, primarily involving various aspects of mentoring and supervision.

What are appropriate program goals?

The two most recent Program Announcements (PA-05-015 and its re-issue PA-08-190) state that the goals of the Supplements program are as follows:

1. Recruitment of the most talented researchers from all groups;
2. Improvement in the quality of the educational and training environment;
3. Balancing and broadening of the perspective in setting research priorities;
4. Improvements in the ability to recruit subjects from diverse backgrounds into clinical research protocols; and
5. Improvements in the Nation's capacity to address and eliminate health disparities.

Our analyses of the program suggested that these goals do not adequately communicate the vision of NIGMS staff implementing the program or accurately reflect program activities. Further, the goals stated in the announcements were not specific enough to be measurable, making it difficult to assess program performance. We recommend the following revised goals based on the findings of this study:

1. To recruit candidates from underrepresented minorities, individuals from disadvantaged backgrounds, and individuals with disabilities who may not be fully ready for regular or non-targeted sources of funding, but who have the potential and drive to become successful scientists;
2. To select mentors who have demonstrated a commitment to the candidates' research careers, and who would provide a productive environment for acquiring knowledge and skills required to perform competitively at the next career stage and to succeed in research;
3. To advance the objectives of the parent grant and the research career of the trainee candidate; and
4. To facilitate changes in individual and institutional behavior that will result in the improved inclusion of individuals from underrepresented minorities, individuals from disadvantaged backgrounds, and individuals with disabilities on regular or non-targeted sources of support.

For each program goal, what would be a reasonable standard of performance to achieve within a specific time period? How should these standards be measured?

Program evaluators have argued that the success of research training programs should be defined more broadly than persistence in a research career. For example, the authors of the report "Assessment of NIH Minority Research and Training Programs" asserted that regardless of ultimate career choice, research experience provides participants with a unique and valuable training opportunity that should be considered in the evaluation of any minority initiative.³⁴ While indisputably the Supplements program benefits are wide-ranging, the reality of justifying the allocation of limited resources dictates that the program performance should be measured first and foremost against a narrower goal of training future biomedical, clinical, and behavioral science researchers. However, it is important to document a broader range of program outcomes. In fact, feedback provided by PIs and trainees in the Supplements program revealed that participating in the program was instrumental to the upward mobility not only of research-bound individuals, but also of those who have chosen different career paths. Capturing these

³⁴ Assessment of NIH Minority Research and Training Programs: Phase 3. National Research Council of the National Academies. Washington, DC. 2005:25. Report.

outcomes, in conjunction with evidence for persistence in research, would strengthen the case for continued support of minority trainees, in particular at junior career stages.

Another point considered when developing measures of performance was that the Supplements program provides support to individuals on the continuum of career levels. Clearly, it would not be appropriate to expect the same levels of commitment to a research career from a high school student as from a faculty member and, correspondingly, “success” should be defined and measured differently for career groups. Suggested performance indicators, linked to the revised program goals, are presented in Table 13.

Table 13: Program Goals Linked to Performance Indicators		
Goal	Measurable indicator of performance	
	Principal Investigator	Trainee
G1. To recruit candidates from underrepresented minorities, individuals from disadvantaged backgrounds, and individuals with disabilities who may not be fully ready for regular or non-targeted sources of funding, but who have the potential and drive to become successful scientists		<ul style="list-style-type: none"> Evidence of potential prior to participation: good academic record (GPA, scholarly honors) and productivity (publications, funding) Evidence of drive: persuasive career statement with defined training goals (enrollment into a graduate program, attainment of a PhD, independent funding application)
G2. To select mentors who have demonstrated a commitment to the candidates’ research careers, and who would provide a productive environment for acquiring knowledge and skills required to perform competitively at the next career stage and to succeed in research	<ul style="list-style-type: none"> Detailed and persuasive trainee career development plan (including plans for follow-up funding support and plans to advance to next career stage) Successful mentorship record (ideally including mentoring of minority trainees) Evidence that trainee will receive adequate guidance and attention (with a possibility of secondary mentor in a large research group) Evidence of a match between PI and trainee interests 	<ul style="list-style-type: none"> Evidence that trainee has acquired knowledge and skills (learning laboratory techniques, writing papers and funding applications, presenting research findings) Frequency and extent of PI-trainee interaction; satisfaction with mentoring relationship Evidence that trainee has integrated into research group (collaboration with other members, help from more senior researchers)
G3. To advance the objectives of parent grant and research career of trainee candidate	<ul style="list-style-type: none"> Publications, follow-up funding support, promotion, tenure Improved mentoring skills 	<ul style="list-style-type: none"> For high school and undergraduate trainees: entering college and earning a science degree, improved understanding of scientific research and academic culture, development of mentoring relationships and ties to the academic community, improved self-confidence, improved ability to make career choices For graduate, postdoctoral, and faculty trainees: PhD attainment, publications, grant or fellowship application, academic or research

Table 13: Program Goals Linked to Performance Indicators

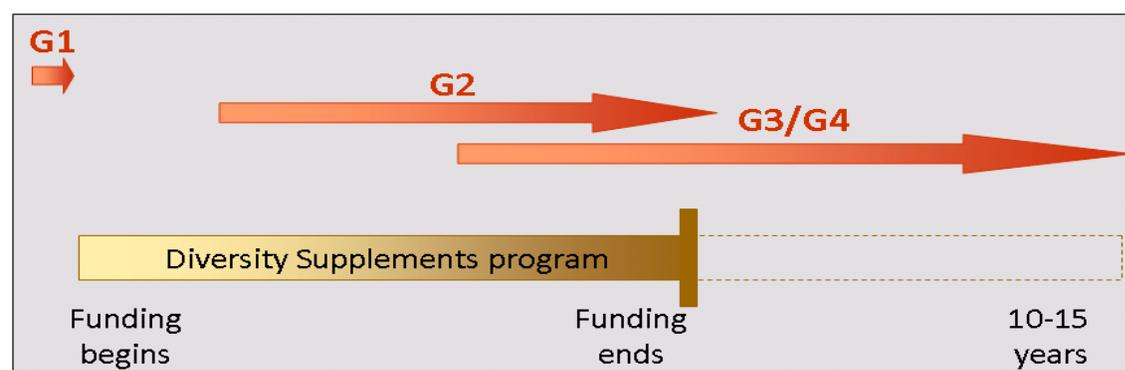
Goal	Measurable indicator of performance	
	Principal Investigator	Trainee
G4. To facilitate changes in individual and institutional behavior that will result in the improved inclusion of individuals from underrepresented minorities, individuals from disadvantaged backgrounds, and individuals with disabilities on regular or non-targeted sources of support	<ul style="list-style-type: none"> Improved understanding of issues faced by minority researchers Number of minority individuals at all career levels in research group Inclusion of minority trainees on research or training grants 	position, formation of peer network

As some of the proposed program goals pertain to the recruitment process, while others to the training experiences and outcomes, the timeframe for assessing the accomplishment of these goals is expected to vary. Figure 18 presents a rough timeline for measuring program performance that can guide future program evaluations. Achievement of the first goal – recruitment of suitable trainee candidates (G1) – can be assessed before the training begins or early on in the training process. Data contained in the supplement applications should contain the information necessary to measure whether this goal has been reached, in particular if trainees are required to provide more specific and persuasive career statements.

The second goal of the program (G2) is the selection of mentors committed to trainees’ career success, who would offer a productive and positive training environment. As illustrated in Figure 18, performance in this area can be measured at any time during the training process, although assessment shortly after the training experience occurs may yield a more complete picture. A participant survey is the best tool to collect the necessary data.

The last two goals (G3 and G4) are related to program outcomes and, therefore, would be best measured toward the end of the training experience at the earliest. Some of the key outcomes – such as attainment of a faculty position by a trainee or changes in a PI’s behavior – can take many years to manifest themselves. Participant surveys, bibliometric studies, and analyses of data from a tracking database, if available, are all appropriate data collection and analysis strategies.

Figure 18: Proposed Timeline for Measuring Program Performance



While the positive aspects of the program were many, we identified a few potential areas for improvement. We conclude this report with several suggestions on how to optimize the management of the program by NIGMS staff, increase participant satisfaction, and enhance program effectiveness in accomplishing its goals.

Engage program staff in the discussion of new program policies and procedures

Several changes are being introduced to the program, including to the process of application review, target population, and duration of support. From conversations with NIGMS staff we found that a consensus on new policies and procedures has not yet been reached by all the Institute staff participating in the program. Some respondents said that they were uncertain what the new policies were and how these should be implemented or how rigidly applied. We recommend that the program leadership more actively engage all parties involved in the discussion of program vision and of new policies and procedures being introduced.

Clearly communicate the program vision and goals to the extramural community and provide explicit guidance on the contents of the application and on the review criteria.

The Program Announcement provides only general guidelines related to the program goals and application and review processes, presumably to allow individual Institutes and Centers to develop more specific policies and procedures appropriate to their missions. We found that a number of ICs crafted additional documents that provide clarification to their grantees. The National Institute of Mental Health, for example, posted a particularly informative and detailed document.³⁵ First, the document elaborates on the content of the application, specifying what should be included in mentoring and career development plans and in the candidate career statement. Second, the guidance sets the stage for assessing program performance by providing concrete outcome measures: the candidates are expected to submit a grant application at the end of the support period and PIs previously supported through the supplements must include a description of outcomes resulting from that training experience. At NIMH, this additional guidance has resulted in improved application quality and in the selection of PIs more committed to trainee candidates. We suggest that NIGMS develop a similar document for its grantees.

Develop electronic procedures for more reliable receipt, internal processing, and storage of supplement funding applications and other program documents

Currently, the processes of application submission and review have not been computerized at the Institute. Applications exist only as paper records, which are passed between NIGMS staff during the review process, resulting in occasional document loss and misplacement, slowing down the review process, and making any assessment of program outcomes very time consuming. We suggest that NIGMS develop an electronic system of application receipt, processing, and tracking that can be shared by all program staff. NIGMS could potentially use the electronic system used by NIMH as a starting point.

³⁵ Procedures and Supplementary Information for Preparation, Submission, and Review of Applications for Diversity and Reentry Research Supplements for NIMH Grantees. Available at: <http://www.nimh.nih.gov/research-funding/training/diversity-and-reentry-research-supplements-for-nimh-grantees.shtml>. Accessed March 25, 2009.

Develop a trainee tracking system

In the course of the study we experienced first-hand the challenge in finding former trainees. Of 45 trainee candidates in our sample, we were able – with PIs’ help – to obtain email contacts for 21 and limited information for an additional 6. If a goal of NIGMS is to document trainee career outcomes, there clearly is a need to establish a trainee tracking system. NIGMS may be able to build on electronic tracking systems other Institutes and Centers have already developed (for example, NIMH) or are in the process of developing (for example, NINDS). At a minimum, we recommend that NIGMS requires participating PIs to report on trainee whereabouts at the conclusion of the supplement funding and/or parent grant. This would provide a starting point for locating the trainees, at no additional cost to the Institute.

Conduct a systematic outcome evaluation

While a comprehensive documentation of program outcomes was beyond the scope of this needs assessment, we recommend that NIGMS implement an ongoing evaluation of program outcomes so that timely program improvements can be made. Although the data we used for this study were limited, we believe the findings were suggestive of what the program needs to address internally and with the extramural community. Further, we were able to document important program results and to obtain several useful suggestions for program improvement. This needs assessment study can form a foundation for a more extensive and systematic outcome evaluation.

Engage with other Institutes and Centers to learn from their experiences with the Supplements program

Findings from the interviews revealed that other NIH Institutes and Centers have developed their own approaches to the Supplements program. The National Institute of Mental Health, and possibly other ICs, has conducted an internal program assessment. We believe that NIGMS might benefit from collaborating with other NIH entities about their experiences with the supplements. We recommend that NIGMS systematically collect data from the other ICs as they revise their programs.

Provide explicit guidance on the content of annual reporting

All grantees receiving the supplements must include some description of how the funds are spent in their annual reports. The three reports examined contained very short descriptions. More importantly, all were focused almost entirely on the developments in trainee research projects, providing no information on other aspects of the training, such as mentoring or progress toward the achievement of career goals. We suggest that PIs be given specific guidance on what information to include in the supplement report. This would make the reports more useful for internal grant monitoring purposes and for any future assessments of the program. Furthermore, by requiring that PIs report on trainee career development, plans for next steps, and mentoring activities, NIGMS would emphasize that these aspects of the experience are no less important than research accomplishments.

Revise the program goals so that program outcomes can be systematically measured and used to improve quality over time

As discussed above, the general wording of program goals neither adequately communicates the vision of NIGMS staff implementing the program nor accurately reflects program activities. Furthermore, the goals lack specificity to allow for systematic assessment of program performance. We suggest a revised wording, which conveys the activities of the program in more explicit and measurable terms.

Develop a sustainable network of alumni and support a community of minority researchers

Several trainees noted that they would like to establish ties to fellow program participants and to other minority researchers supported by NIH. We understand that some suggestions by the trainees for meeting each other – such as a conference where they would present their work to the next generation of trainee candidates – might be beyond what NIGMS is able to offer. On the other hand, small efforts by the Institute could go a long way in anchoring the community of minority researchers. For example, a listserv to which trainees can voluntarily add their names can be advertised to NIGMS grantees on the NIH website or at the national minority conferences. If a trainee tracking system is established, there might be a way to link interested trainees who report into the system. In addition to benefiting former trainees, these efforts will help “spread the word” about the program to the minority community and may prove useful for the recruitment of new candidates. Finally, this might be a fruitful joint initiative with other NIH Institutes and Centers.

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Appendix A: Literature Review

Introduction

Statistical data indicate that participation of racial and ethnic minorities in science and engineering remains disproportionately low: of all doctoral degree recipients in 2004, only 2.8% were African American and 2.7% Hispanic, whereas these groups make up 12% and 14%, respectively, of the US population (National Science Foundation, 2007a). To redress the disparity in science participation, federal agencies and foundations have sponsored numerous programs over the past 20 years. The National Institutes of Health (NIH) has been at the forefront of these efforts with the *Supplements to Promote Diversity in Health-Related Research* program launched in the late 1980s, among other initiatives. All NIH Institutes and Centers participate in the Supplements program and in the past 10 years the agency's investment in the program has exceeded \$660 million.³⁶

The National Institute of General Medical Sciences (NIGMS) has demonstrated its commitment to the goal of diversifying the scientific research workforce. The Institute has contributed 10% of the total NIH funding for the Supplements program. Further, the NIGMS contribution as a percentage of its total budget has been steadily growing and in the past two years has exceeded that of all other Institutes and Centers.³⁷ In addition to the Supplements program, the Institute administers two other well known research and training programs – *Minority Access to Research Careers (MARC)* and *Minority Biomedical Research Support (MBRS)* - as well as a number of Special Initiatives.³⁸

To justify continued allocation of resources, NIGMS commissioned Abt Associates to conduct a “needs assessment study” of its Diversity Supplements program. The study had several objectives: (1) to identify whom the program serves and what their needs are; (2) to identify what changes, if any, are warranted to better address these needs; (3) to specify program goals and propose revisions if necessary; and (4) to provide information on what the program can achieve and how to assess performance. This literature review is a component of the needs assessment study. The aim of the review was to anchor the study in existing research on the causes of minority underrepresentation in the sciences and the efficacy of intervention strategies. The review would inform the design of data collection instruments as well as the analyses and interpretation of findings.

We begin the review with a description of our search strategies and inclusion criteria. In the chapter that follows, we outline several factors that have been suggested in the literature as contributing to underrepresentation in the sciences by racial and ethnic minorities. We proceed to the discussion of findings that emerged from the assessments of several well-characterized intervention programs and conclude with the relevance of the findings to the needs assessment study.

³⁶ Calculations were based on the Diversity Supplement outcomes data for FY1998-2007. Available at: <http://grants1.nih.gov/training/outcomes.htm>. Accessed February 13, 2009.

³⁷ Relative to the total budget for each IC in FY2007. Calculations were based on the Diversity Supplement outcomes data for FY2006-2007 and the NIH budget appropriations for the same years. Available at: <http://grants1.nih.gov/training/outcomes.htm> and <http://www.aaas.org/spp/rd/health09p.pdf>. Accessed February 13, 2009.

³⁸ Available at: <http://www.nigms.nih.gov/Minority/>. Accessed March 1, 2009.

Methodology

We reviewed the literature that seeks to understand the reasons why certain groups are underrepresented in scientific fields, as well as evaluations of programs that aim to increase the participation of groups underrepresented in science. Items to be included in the review were identified through a variety of means. We started with a list of publications and evaluations familiar to us from our research to understand participation in science, and our evaluations of programs to promote science education. We supplemented this list with searches of PubMed, ISI, and LexisNexis³⁹ and retrieved relevant references (the reference lists of these articles were reviewed for additional items). Further, we skimmed all back issues of the *Journal of Women and Minorities in Science and Engineering*, a publication devoted entirely to the issues directly relevant to this review. Finally, we conducted Google searches to identify any “grey literature” which might have been missed in the searches of academic databases.

In selecting studies for inclusion in the review, we assessed whether they met the following criteria: (1) focus on intervention programs in the natural sciences; (2) focus on minority populations; and (3) use of experimental or quasi-experimental designs. Some, but not all studies included in the review satisfied all of these criteria. For example, due to the paucity of literature assessing intervention programs at postdoctoral and faculty levels, we present two studies that included a small fraction of minorities in the sample, but did not analyze program outcomes expressly for minority populations. Furthermore, we found that all studies that we were able to identify had some design flaws that may have biased the results or their interpretation. These limitations included small sample size, imperfect comparison groups or their absence, and difficulty in attributing positive outcomes to the interventions being studied. The authors appeared to be generally aware of these limitations and often commented on alternative explanations for the findings. We make every attempt to clearly articulate these limitations.

Finally, while the Diversity Supplements program is intended to support individuals with disabilities and from disadvantaged backgrounds in addition to underrepresented minorities, in practice most of the funds have been awarded to racial/ethnic minorities.⁴⁰ For this reason, our review is focused on these populations.

Factors Linked to Minority Underrepresentation in the Sciences

We begin by briefly reviewing several factors which have been suggested in the literature as contributing to underrepresentation of minorities in the sciences. Some of these factors are generally accepted by social scientists; others are still in dispute for lack of conclusive experimental evidence.

Academic preparation

Adequate academic preparation is widely considered critical to the persistence of minorities in the sciences. This is hardly surprising, as only those individuals who are best prepared can succeed in a

³⁹ For example, we performed queries that included combinations of words that references race (*e.g.*, African American), subject area (*e.g.*, scientific), and outcome (*e.g.*, research career). “Diversity and academic institutions,” “scientific research careers and minority,” and “workforce diversity and biomedical science” are some examples of the queries.

⁴⁰ For example, of 634 new awards across the NIH in FY 2007, only three were made to individuals from disadvantaged backgrounds (unclear how many by NIGMS) and 20 to individuals with disabilities (2 by NIGMS). Data from <http://grants.nih.gov/training/outcomes.htm>. Accessed March 10, 2009.

highly competitive and demanding academic environment. A number of quantitative indicators illustrate the differences in academic preparation between ethnic groups: African Americans and Latinos lag behind whites and Asians in SAT scores,⁴¹ in Advanced Placement program participation,⁴² and in earning bachelor's and doctoral degrees⁴³ (College Board, 2003; College Board, 2008; National Science Foundation, 2007b).

The factors that contribute to these trends have been extensively studied. Research suggests that the largest share of variation in educational attainment between whites and non-whites (one-half to two-thirds) can be attributed to educational and socio-economic background of the family (reviewed in Kao, 2003). Family circumstances can influence academic achievement in a number of ways. College educated parents tend to play a more active role in managing their children's education (Lareau, 2000). Higher income families have a variety of tools at their disposal – tutors, psychologists, counselors – to help underperforming children (Massey, 2003). Children of college educated parents are more aware of career opportunities in the sciences (Lewis and Collins, 2001).

The debate continues on how to explain the remaining variation in educational outcomes (Gao and Thompson, 2003) and a number of theories have been put forward. Anthropologist John Ogbu, one of the most influential theorists of minority school performance, argued that African Americans develop an “oppositional identity” relative to whites (Ogbu, 1991). The thesis of this “oppositional theory” is that African Americans, who have experienced discrimination, distrust the dominant cultural norms, including the notion that schooling results in socioeconomic mobility, and consequently are not motivated to strive for academic success.

Another hypothesis that attempted to explain minority underachievement is the “theory of stereotype threat” developed by the psychologist Claude Steele (Steele, 1997). Steele argued that performance of minorities in a testing situation is adversely affected by the prevailing stereotype that these groups are intellectually inferior. Experimental testing of this theory has produced supporting results. Steele himself has demonstrated that in conditions where stereotype threat is removed, individual performance was improved (Steele and Aronson, 1995). Likewise, Aronson showed that students placed in the conditions of high stereotype threat exhibited reduced intellectual performance compared to students placed in the conditions of low stereotype threat (Aronson, 1998).

Peer influence

Some investigators suggested a link between peer influence and academic success (“theory of peer influence”). They argued that minority students, who tend to associate with less academically-striving peers, are disadvantaged compared to whites by their social network (reviewed in Massey, 2003). Massey notes, however, the difficulty of establishing a causal relationship in studies of peer influence: if correlation is observed between aspirations of subjects and their peers, it may be impossible to establish whether this correlation is a result of peer influence or a selection into a particular peer group (Massey, 2003).

⁴¹ 429/425 math/writing for African Americans, 461/449 for Latinos, and 532/518 for whites (2003)

⁴² 5.9% for African Americans; 13.4% for Latinos, and 63% for whites (2007)

⁴³ Bachelor's degrees: 8.4% African American and 7.3% Latino; PhD degrees: 2.8% African American and 2.7% Latino in 2004

Aspirations

Another somewhat controversial link is between academic aspirations and attainment. The studies that concluded that aspirations were a good predictor of educational and occupational attainment have been challenged in more recent publications (reviewed in Kao, 2003). Contemporary social scientists believe that survey instruments cannot capture the difference between individuals who are serious about schooling from individuals who simply declare ambitious goals (Kao and Tienda, 1998). These researchers point out that adolescents from all ethnic/racial backgrounds report high aspirations, and yet academic outcomes for these groups vary significantly (reviewed in Kao, 2003).

Individual characteristics

The role of personality and character in the entry and persistence in science, while intuitively obvious, appears to be a largely unexplored area of research. We were able to find only one small-scale study that examined the link between individual characteristics and career choice. McGee and Keller conducted interviews of participants in the summer undergraduate and post-baccalaureate research programs at the Mayo Clinic College of Medicine in the beginning, the end, and 8-12 months after their research experience (McGee, 2007). While the study included only 26 participants, the authors found consistent characteristics exhibited by students who chose to pursue research training (PhD or MD/PhD) versus medical training or other careers. Interestingly, these patterns appeared similar in men and women and in minority and non-minority students.

The most consistent quality of scientists, exhibited by 15 out of 18 individuals, was “curiosity to discover the unknown.” In contrast, only one of eight students who had no interest in research appeared to possess this quality. A related characteristic, prevalent in scientists, but not in non-scientists was “enjoyment of problem solving” (10 of the 12 PhD and MD/PhD students). While scientists rated independence as an important aspect of themselves and their professional environment, none of the non-scientists appeared to consider independence important. Finally, the two groups differed in their willingness to tolerate career uncertainty, with the scientists emerging as more open to the possibility of changing career direction.

While the exact nature of the contributing factors is still in dispute, educators, funders, academicians, and policymakers agree that minority populations are underrepresented in the sciences and that something must be done to bridge the gap. As a result, dozens of programs have been established over the years to boost minority participation in higher education.

Interventions

Programs

While a great number of programs have been established at university campuses to attract and retain minority students, this review is focused on a small set of extensively studied programs that have generated evaluative data. These programs are not necessarily representative of a wider range of existing interventions which may have helped many talented minority students succeed in academic careers.

High school programs

The **Stanford Medical Youth Science Program (SMYSP)** is a summer program that seeks to increase diversity in health care professions through academic enrichment activities and college admission support (Winkleby, 2007). To recruit participants, applications are sent to 250 California high schools each winter.

Of roughly 200 applications received, 24 students are selected to participate in the program. While students from all ethnic background are eligible, the program requires that they come from low income families. Participation is free of charge and includes tuition, room, and board. The program costs \$250,000 annually and is supported with grants from foundations, the federal government, private donors, and in-kind contributions by Stanford University.

Participants are housed for the summer in Stanford dormitories and divide their time between classroom instruction, hospital visits, research projects, and advising activities related to college admissions. Ten Stanford students, who often come from similar socio-economic circumstances as the participants, staff the program and serve as counselors and teachers. Each participant spends one evening a week with an assigned mentor – a medical student, graduate student, or health care professional. The students participate in a variety of cultural events and take weekend trips to other prominent universities. Family visits take place every Sunday and provide program staff with an opportunity to discuss educational options with participants' parents. All participants are surveyed annually by telephone to monitor their career progression and to update information on their whereabouts. These data are used to compile a directory, which is distributed to all participants in order to encourage continuing contact.

At the time of the program evaluation conducted in 2007, 405 students had completed the program and 96% of these participants have been followed over time (Winkleby, 2007). Students in the sample were 33% Latino, 22% African American, 4% Native American, and 41% white. The evaluation study found that 100% of the participants had graduated from high school and 99% been admitted to college. Of those admitted, 81% earned a bachelor's degree, with 57% majoring in the natural sciences. Of college graduates, 52% were enrolled in or have graduated from medical or graduate school.

In the absence of a comparison sample, the author compared SMYSP graduation rates to national graduation averages. The result appeared to be highly favorable to the program: graduation rates were 73% for SMYSP African Americans versus 5% for all African Americans and 79% for SMYSP Latinos versus 10% for all Latinos. These differences were especially striking given that all SMYSP students had come from low income families (an eligibility requirement), which makes them a statistically unlikely group to enroll in college. However, the study makes no adjustments for selection bias, and assumes that the individuals who participated in the program are similar to national populations.

Undergraduate programs

The majority of well-studied intervention programs target students at the undergraduate level. Perhaps the best known initiative is the **Meyerhoff Scholars Program** based at the University of Maryland, Baltimore County. By some accounts, this program is a gold standard for increasing minority participation in research (Leggon, 2006; BEST, 2004). Maton and Hrabowski (2004) projected that if the current trends continue, the University of Maryland will become the leading non-minority institution to grant STEM doctorate degrees to African Americans.

The Meyerhoff Scholars Program was established in 1988 as a collaboration between the Meyerhoff family and the University of Maryland. Currently, between 50 and 60 students are selected each year for the program, the majority being African American. This is a multi-component program carefully designed to simultaneously address several factors linked to minority underrepresentation. Program elements include financial support (tuition, books, room/board contingent on maintaining a B average), summer bridge (required courses in math, science, and African American studies), advising and counseling (the program employs a full-time advisor), tutoring (giving and receiving tutoring is strongly encouraged by program staff), summer research internships (each student participates in multiple internships in the US and abroad), mentoring (each student is paired with a scientist mentor), community service (all students

are encouraged to participate in these activities), and family involvement (parents are included in social events and are kept informed about students' progress).

Maton and colleagues examined whether the program has had a long-term impact, and if so, what factors contributed to its effectiveness (Maton, 2000; Maton 2004). The study sample included 93 Meyerhoff scholars and a comparison group of 35 "declines," individuals who were offered the scholarship, but turned it down and entered another university. This comparison group was chosen to address the possibility that Meyerhoff scholars performed better than the comparison group because they had been selected from among the most talented, best prepared students who would have succeeded regardless of their participation in the program. This design, however, has another limitation since the two groups of students, while possibly equally talented, might have had vastly different educational experiences contributing to the outcomes being measured.

Maton found that Meyerhoff scholars were twice as likely to graduate with science majors and achieved significantly higher GPAs than the declines. Approximately 70% of Meyerhoff students and 35% of declines entered graduate or professional schools; interestingly, the relative frequencies of scholars and declines entering medical programs were similar. The authors conclude that the program facilitated the selection of academic careers by African American students. However, they also pointed out that, despite their selection of the comparison group, the issue of attribution remains: the declines may have been less oriented towards academic success or simply less interested in science since after all, these students had elected not to enter the program (Maton, 2000).

The authors also explored what characteristics of the program were most valued by the scholars. He found that financial support topped the list (4.4 out of 5), followed closely by being part of the community (4.2 out of 5), program staff (4.2 out of 5), and summer research internships (4.2 out of 5). Respondents also offered a few negative opinions. These included excessive pressure to succeed, a narrow definition of success as attainment of a PhD (election of a medical career is not encouraged by the program), and a potential for resentment by their peers at the University of Maryland not enrolled in the program.

The study also included interviews with 10 participating science faculty, and the results suggested that the outcomes of the program may have extended beyond the participating students. Faculty respondents indicated that the program not only changed their expectations of African American students, it had positive and lasting "ripple effects" on the science program at the University generally (Maton, 2000). Among these effects, respondents cited improved enrollment of non-Meyerhoff minority students, enhanced standards of class performance, and the influence of Meyerhoff scholars as role models. Unfortunately, these interesting findings have not been followed up in a larger sample.

Another widely cited program at the undergraduate level is the **Louis Stokes Alliance for Minority Participation (LSAMP)**, which was established in 1991 by the National Science Foundation with the goal to increase the number of minority students who complete baccalaureate degrees in STEM fields (Clewell, 2005). In contrast to the Meyerhoff program based at one institution, the LSAMP program is composed of "alliances" - institutional clusters that include a dozen or more colleges, universities, national laboratories, and industry participants (in 2005, for example, there were 34 alliances with over 450 participating organizations). Funding levels to alliances range from \$300,000 to \$1,000,000 per year for five years. While each of the alliances uses educational approaches that are most appropriate to their institutional contexts, all projects appear to include research experience, summer bridges, mentoring, financial support, and tutoring.

A process/outcome evaluation of LSAMP was conducted by the Urban Institute in 2005 (Clewell, 2005). The survey of roughly 500 LSAMP participants who graduated between 1992 and 1997 found that LSAMP students had earned higher GPAs than national comparative samples of minority, white, and

Asian students (comparison data came from the National Survey of Recent College Graduates conducted by NSF). Participants were significantly more likely than comparisons to enroll in graduate programs and less likely to report challenges with obtaining employment. The authors note that the response rate in the survey was very low, 36%, but that bias analysis indicated that no bias was introduced in the sample as a result of nonresponse. A limitation of the study is in the likelihood that the institutions involved in LSAMP differ in substantive ways from all institutions in the nation, making the national sample a flawed comparison group.

Another well documented undergraduate initiative is the **Miramontes Arts and Sciences Program (MASP)**, formerly the Minorities Arts and Sciences Program, established at the University of Colorado. While this program has many similarities to Meyerhoff, its costs per participant are 5-10 times lower – about \$17,000 per student (Johnson, 2007). MASP has some of the same components as Meyerhoff and LSAMP, including summer bridge, academic enrichment seminars, financial support (for students engaged in independent research), stipends (for students with good grades), advising, and tutoring.

Johnson (2007) compared educational outcomes of 70 MASP participants to 325 African American, Latino, and American Indian non-participants that had elected science majors at the University of Colorado during the same years. She found that while participation in the program increased the likelihood of graduation, MASP students did not graduate with higher grades than comparison students. The students appeared to value the program for access to the academic community and for the ability to form relationships with the faculty, rather than for direct academic or financial support. Based on these findings, the author concluded that improvement in graduation rates was not the result of “academic remediation,” but rather of “sheltering of students from nonacademic obstacles,” such as lack of general knowledge about college education and the culture of science, lack of support, prejudice, and absence of minorities in a student body. She notes that if students could find this type of support within their departments, there would be no need for a program like MASP.

This study had several limitations. The first is a small size of the MASP participant sample. Further, the author’s overall conclusion appears to be a leap of faith. The fact that participants expressed an appreciation of the social aspects of the program over academic and fiscal aspects does not necessarily mean that these are the features of the program that led to academic success.

The **Mentorship for Undergraduate Research in Agriculture, Letters, and Science (MURALS)** program, launched in 1988, is based at the University of California, Davis campus. The program initially focused on social sciences and humanities, but has expanded to include mathematics and the sciences. The goal of the program is to socialize the students to research and to spur their interest in academic careers. The program pairs underrepresented students in good academic standing (a GPA of 3.0 or above) with faculty mentors who supervise their research projects. Most students spend at least two quarters with the same faculty mentor. The program enrolls about 50 students a year and provides a stipend to the students and the supervising faculty.

Martinez compared career outcomes of MURALS graduates to a sample of non-MURALS minority and nonminority graduates matched by GPA and by career interests (unpublished, cited by Gandara and Maxwell-Jolly, 1999). The author found that the percentage of students who enrolled in graduate programs was similar for all three groups, at about 40%. However, MURALS participants were 10 times as likely to earn doctoral degrees as the comparisons, leading Martinez to conclude that the MURALS program channels participants into the academic pipeline. Note that while the effect of the program appears significant, it is based on a small sample of 56 MURALS participants. Furthermore, program participants might have been more interested in research than the comparisons, and it is unclear how much of the positive effect can be attributed to the program.

Another program at the University of California, Davis is the **Biology Undergraduate Scholars Program (BUSP)**, which was established in 1988. The original goal of the program was to increase graduation rates in biology for underrepresented minorities, but it was later expanded to preparing students to pursue post-baccalaureate studies (Villarejo, 2007). The main focus of the program is on strengthening academic preparation of minority students in “gateway” disciplines, such as mathematics and chemistry, achieved through additional coursework. Difficulties with these courses have clearly emerged in the literature as one of the key factors responsible for attrition from science majors of minority and nonminority students alike (Barr, 2008). In addition to offering courses, the program connects the students with a network of peers and provides financial support through paid internship. The program structure is inflexible, requiring students to sign an annual contract stating that they will participate in all program activities.

Villarejo (2007) compared 2000-2003 BUSP cohorts to two earlier cohorts (1988-1994 and 1995-1999) and to BUSP non-participants for their performance in core courses. She found that BUSP student performance steadily improved over time and that they outperformed non-BUSP minority and nonminority students in calculus, basic science, and chemistry (Villarejo and Barlow, 2007). The percentage of BUSP students graduating in biology, 48% between 1995 and 1999, also steadily increased and has surpassed the campus average of 38%. The author suggests alternative explanations to observed positive trends. She provides data that demonstrate that improvement in performance of later cohorts may have been due, at least in part, to better academic preparation of later cohorts. She also notes that while BUSP participants performed better than non-participants within the same cohort, it remains unclear whether, and to what extent, BUSP student success was due to program participation, motivation, or both.

Graduate programs

The **Graduate Research Fellowship (GRF) program** sponsored by the National Science Foundation supports “outstanding graduate students in the relevant science, technology, engineering, and mathematics (STEM) disciplines who are pursuing research-based master’s and doctoral degrees.”⁴⁴ The program is opened to all applicants who have completed no more than one year of graduate study. GRF support includes a stipend and a cost-of-education allowance that can be used at any academic institution. Approximately 900 fellowships are awarded each year.

WestEd conducted an evaluation of the GRF program in 2002 (Goldsmith, 2002). The sample included 200 nonminority fellows, 87 minority fellows, and 188 “peers.” Peers were defined as students who entered the same graduate programs at the same time as GRF participants. Goldsmith found that for the 1984-1988 cohort, 74% of nonminority fellows and 61% of minority fellows completed their doctorates within 11 years. These graduation rates were an increase from the preceding five years, by 4% for nonminority fellows and by 11% for minority fellows. Non-GRF peers graduated at the steady rate of 65% with approximately the same time to graduation as the fellows.

In addition to these quantitative indicators, the study examined participant satisfaction. The fellows viewed GRF as an asset in securing additional research funding and in obtaining postdoctoral and other positions. It brought the freedom to make choices about research directions, flexibility with teaching loads, and made the fellows an asset to the faculty. The study also documented discontent among the minority participants, who reported that some of their peers believed that fellowships awarded to minority scientists were not meritorious. Note that the study found no significant differences in early career productivity between minority and nonminority fellows.

⁴⁴ Available at: http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=6201. Accessed March 25, 2009.

Regardless of race and ethnicity, many graduate fellows appeared to become progressively less committed to academic careers, choosing instead careers in government, business, and industry. The reasons cited for this shift included fierce competition for jobs, low pay, heavy work demands, challenges in balancing career and family obligations, and general disillusionment with academia.

The objective of the **McKnight Doctoral Fellowship Program (MDFP)** is to increase the number of African Americans receiving doctoral degrees in all disciplines. The program was established in 1984 as a public-private partnership between the state of Florida and the McKnight Foundation. Approximately 30 McKnight fellows are competitively selected each year from a national pool of applicants accepted for doctoral study at one of the nine participating Florida universities. The program includes financial support, orientation workshops (to introduce the fellows to the MDFP system of academic and social support), an annual meeting and graduate school conference (to assist fellows with professional development), and an annual research and writing workshop (to present research in a professional, but non-threatening setting).

Morehouse and Dawkins (2006) conducted an evaluation of McKnight Program. The study found that of 559 fellows who participated in the program between 1984 and 2006, over 87% had earned or were earning doctoral degrees. Further, McKnight fellows appeared to take an average of 5.5 years to complete the degree, an exceptionally short time compared to the national average of 7.5 years. It was unclear from the study, however, whether time-to-degree between the two samples was matched by disciplines. Furthermore, as mentioned above, comparisons to the national samples can be misleading, particularly for a highly competitive program that recruits the most talented students who are likely to be very different from national averages.

The **Compact for Faculty Diversity (COMPACT)** is a partnership of the New England Board of Higher Education, the Southern Regional Education Board, and the Western Interstate Commission for Higher Education and was established to retain minority scholars who are committed to becoming faculty. Between 1993 and 2000, the program has grown from 50 to 600 doctoral scholars (BEST, 2004). COMPACT has several components: financial support, an annual Institute for Teaching and Mentoring, assistance with faculty job searches, and mentoring of scholars' progress. The evaluation conducted by Smith and Parker (2000) revealed that by the end of 1999, 92% of graduates served by the program had earned doctoral degrees or were still enrolled in their degree programs. Of the COMPACT scholars who had completed PhDs, 70% obtained faculty positions, 18% were in post-doctoral programs, and 12% worked in college administration, industry, government, or as adjunct faculty (Smith and Parker, 2000). Multiple interventions contributed to COMPACT's success: mentoring and mentor training, long-term financial assistance, networking and professional development, and career planning and placement. While the evaluation did not include a comparison group, the authors favorably compared these outcomes to the average persistence rate of 40-50% reported in the literature.

Postdoctoral and junior faculty programs

The **Preparing Future Faculty (PFF)** program is a "national movement to transform the way aspiring faculty members are prepared for their careers. PFF programs provide doctoral students, as well as some master's and postdoctoral students, with opportunities to observe and experience faculty responsibilities at a variety of academic institutions with varying missions, diverse student bodies, and different expectations for faculty."⁴⁵

⁴⁵ Available at: <http://www.preparing-faculty.org/>

Since its establishment in 1993, PFF programs were implemented at more than 45 doctoral degree-granting institutions and nearly 300 partner institutions in the United States. The program has three features. First, PFF is organized around clusters of institutions, which typically include a doctoral degree-granting institution collaborating with various partners, such as liberal arts colleges, universities, and community colleges. Second, participants are exposed to the full scope of faculty roles and responsibilities, including teaching, research, and service, with an emphasis on how these responsibilities can differ depending on the educational setting. Finally, scholars participating in the program have multiple mentors, who provide feedback and guidance on all activities.

DeNeef conducted an evaluation of the program (DeNeef, 2002). The study included a survey of 129 alumni who had obtained a faculty position, followed by 25 in-depth telephone interviews. While the study design was imperfect – small sample size, low response rate (48%), and absence of comparison group - it nevertheless documented some interesting positive outcomes of the program. DeNeef observed that Asian and African American students valued program participation more than their white peers. The two most highly valued aspects of PFF were mentoring and career preparation. It appeared that the students sought guidance from their mentors on a wide range of professional issues and life experiences. The students spoke with their mentors about faculty duties, departmental policies, hiring criteria, reward and tenure processes, salary levels, and research/service expectations for new faculty.

Further, nearly all alumni reported that participating in the program helped them make better informed career choices by exposing them to a variety of academic career options. The program also prepared them to enter the job market by offering assistance with job applications and job interviews. As a result, program participants were able to present themselves as confident job candidates who could “fit” in an institutional environment. PFF participants also reported that as faculty they had achieved a better balance between their teaching and research responsibilities than their own graduate and postdoctoral advisors.

The goal of the **Faculty Early Career Development Program (CAREER)** supported by the National Science Foundation is to “provide stable support at a sufficient level and duration to enable awardees to develop careers as outstanding researchers and educators who effectively integrate teaching, learning and discovery.”⁴⁶

To evaluate the impact of the program, Abt Associates conducted a survey of 1,400 CAREER awardees and of 1,800 unsuccessful applicants; bibliometric analyses of 300 awardees and 300 unsuccessful applicants; and a survey of 700 department chairs at 217 CAREER universities (Carney, 2008). The CAREER program does not specifically target minority faculty, and representation of this group in the sample was small, about 10%. CAREER investigators reported several positive outcomes of the award: support for their research (98%), improved chances for tenure (96%), freedom to pursue new research topics (50%), and ability to obtain additional funding (58%). The study also found that CAREER awardees were significantly more likely to have earned tenure than unsuccessful applicants ($p < 0.001$). As indicated by the levels of research expenditure, CAREER awardees were somewhat more likely to move to more research-intensive institutions than the comparison group ($p = 0.005$). There was no difference between the two groups in regard to the number of individuals promoted to the rank of full professor.

The evaluation examined the possibility that superior performance of CAREER awardees was the result of better scientific qualifications rather than program participation. The two groups were compared for several proxy measures of academic success: the amount of time devoted to research and to other

⁴⁶ Available at: http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5262

institutional activities, the number of publications, and citation statistics. No significant differences were observed between the study and the comparison groups for any of these variables, suggesting that positive outcomes can, at least partially, be attributed to the program.

Strategies

Our examination of the literature revealed that every program reported, from high school to faculty levels, appeared to have produced some positive educational and career outcomes. Several of the programs, particularly those targeting more junior groups, resulted in improved recruitment and retention of minorities in the sciences. We observed that while most effective programs differ in target populations, scope, and duration, they shared a common approach – the focus on several mitigating strategies simultaneously. Specifically, most of these initiatives included some combination of academic preparation, financial support, research experience, social support, mentoring, and network building (Table 1). Below we summarize the evidence of effectiveness for each of these elements.

Table 1: Summary of Strategies

Program	Career level	Academic preparation	Financial support	Research experience	Professional development	Social support	Mentoring
SMYSP	HS	●	●	●	●	●	●
Meyerhoff	UG	●	●	●	●	●	●
LSAMP	UG	●	●	●	●	●	●
MASP	UG	●	●	●	●		●
MURALS	UG	●	●	●	●		●
BUSP	UG	●	●	●	●	●	●
GRF	GS		●	●			●
MDFP	GS		●	●	●	●	●
COMPAC							
T	GS		●	●	●	●	●
PFF	GS/PD		●	●	●	●	●
CAREER	F		●	●			

SMYSP = Stanford Medical Youth Science Program

Meyerhoff = Meyerhoff Scholars Program

LSAMP = Louis Stokes Alliance for Minority Participation

MASP = Miramontes Arts and Sciences Program

MURALS = Mentorship for Undergraduate Research in Agriculture, Letters, and Science

BUSP = Biology Undergraduate Scholars Program

GRF = Graduate Research Fellowship

MDFP = McKnight Doctoral Fellowship Program

COMPACT = Compact for Faculty Diversity

PFF = Preparing Future Faculty

CAREER = Faculty Early Career Development Program

Academic preparation

All programs for high school and college students provided some form of academic assistance. This is not surprising as studies have demonstrated that minority students who often enter in college from high schools with inadequate level of instruction experience difficulties with gateway courses. Barr, for example, in a longitudinal study of 362 incoming Stanford freshmen, found that negative experience in chemistry courses was cited by minority students as the principal reason for their loss of interest in continuing as pre-meds (Barr, 2008).

Summer bridges appeared to be a particularly popular form of academic support (Meyerhoff, LSAMP, MASP, SMYSP). These programs typically include intensive academic instruction in a resident setting offered during the summer prior to entering college. Although each evaluation was somewhat flawed, collectively they provided supportive evidence on the effectiveness of bridge initiatives. For example, a significant positive outcome has been reported for the California State University Alliance for Minority Participation program (LSAMP participant), which offers a summer course in pre-calculus and calculus workshops during the academic year (Alfred, 2005). The evaluation study found that retention and graduation rates with science majors were double for African American and Latino participants compared to non-participants (% retention rates: 55/60 for African American/Latino participants versus 29/41 for non-participants; % graduation rates: 41/60 African American/Latino participants versus 18/30 for non-participants).

Financial support

Minority students coming from disadvantaged backgrounds tend to be reluctant to incur debt and often hold a job to support schooling (Masey, 2003). The need to spend time away from academic activities is a well known barrier to persistence in college (Callan, 1994). All programs examined offered some form of financial support. The level of support varied, from small stipends (MURALS) to complete coverage of tuition and other expenses (Meyerhoff). Some programs supported only the students engaged in research (MASP, BUSP, GRF) or provided additional stipends to students who have earned good grades (MASP). While the programs had clearly made choices on how to invest limited resources, none appeared to have attempted a cost-benefit analysis to inform their funding strategies.

Participation in research and professional development

Many authors have argued that research experience is one of the most important factors positively effecting minority retention in the sciences and overall academic success. Lopatto, for example, reported that in a survey of 1135 students from 35 institutions, the majority characterized research experience as beneficial to their careers (Lopatto, 2004; Lopatto, 2007). Of BUSP students who entered UC Davis from 1988 to 1994, research participants graduated with a degree in biology at twice the rate of non-participants (Villarejo, 2007). Research participation is considered a key contributor to the success of Meyerhoff and LSAMP programs (Maton, 2000; Clewell, 2005). Participation in research might be beneficial in several ways: students learn marketable skills, develop self-confidence, forge relationships with the faculty, and refine career plans (Eimers, 2000; Hurtado, 2008). In addition, salaries earned through research help defray college expenses (Masey, 2003).

In addition to research experience, many programs offered other professional development opportunities, such as scholarly forums (Meyerhoff, McKnight, MASP, MDFP, COMPACT) and research/writing workshops (MDFP). Like research experience, these activities allow young scholars to make professional contacts, become socialized to the world of academia, and strengthen resumes. We were unable to find any studies that have examined how and to what extent professional development opportunities contributed to the retention of minority students or to academic success.

Social and peer support

Roughly half of the programs offered some social support, through personal counseling (McKnight, Meyerhoff), by connecting students to a network of peers (BUSP, McKnight, Meyerhoff, COMPACT), by providing campus housing to all participants (BUSP, Meyerhoff, SMYSP), and by encouraging regular family involvement (Meyerhoff, SMYSP). A number of studies suggested the efficacy of these strategies. Tinto, for example, concluded that engagement in activities outside of the classroom is critical to integration and persistence of minority students (Tinto, 1987). Meyerhoff scholars cited being part of the

community and support from program staff as some of the most valuable aspects of the program (Maton, 2000).

Mentoring

Most of the programs examined in this review included some form of mentoring. Participants in the SMYSP program are mentored by Stanford students and staff, who themselves have come from similar racial and socio-economic backgrounds. Likewise, Meyerhoff, BUSP, and MURALS programs pair each student with a faculty mentor. Postdoctoral scholars participating in the COMPACT program forge mentoring relationships with faculty members who are not in the position of their direct supervision.

Several studies examined the role of mentoring in student retention and academic success. For example, Solorzano, in interviews with 66 Mexican recipients of the Ford Foundation Minority Fellowships, found that positive mentoring experience was the most important factor in doctoral degree attainment (Solorzano, 1993).⁴⁷ Campbell evaluated the effects of a faculty/student mentor program on academic performance and retention using a “matched pairs” design, whereby mentored students were matched with non-mentored peers by gender, ethnicity, GPA, and entering enrollment status (Campbell and Campbell, 1997). The study results showed a positive effect of mentoring, as mentored students earned higher GPAs (2.45 vs 2.29), completed more units of courses per semester (9.33 vs 8.49), and had a lower drop-out rate (14.5% vs 26.3%). The extent of student-mentoring contact also correlated positively with GPA. These outcomes did not differ by gender and ethnicity of the mentor and the student, or the gender/ethnic match between the pairs.

In another study, Campbell and Campbell (2000) examined how mentors and students participating in the same program perceived the benefits and limitations of mentoring. The study of 205 faculty mentors (majority white) and 182 students (majority Latino) revealed several differences in the views of the two groups. First, the students appeared to view the relationship significantly more positively than their mentors. Further, while the groups largely concurred in their perception of mentoring benefits to the students (advice/guidance was the main benefit followed by friendship/support/ feeling connected), they differed in their views of these benefits to the mentors. Thirty-one percent of the students could not suggest any benefits at all and only 12% of the students versus 27% of the mentors viewed satisfaction of helping/sharing experience as a benefit to the mentors. The author concluded that since expectations for the mentoring experience differ between mentors and protégés, they should be explicitly addressed early on in a mentoring relationship.

While in many ways similar to mentoring, advising typically refers to interactions related to the selection of classes, career choices, or to student performance rather than to technical or intellectual guidance. Advising is often offered by administrative staff or by a faculty member who is not directly involved in the student research project. Like mentoring, advising appears to play a positive role in student retention and academic performance and lack of advising is characterized as hampering. Beatty documented that 75% of 610 undergraduates at Iowa State University needed career assistance before selecting a major (Beatty, 1983). Seymour and Hewitt (2000) observed that inadequate advising, tutoring, and counseling were cited by about 25% of students in a seven-campus study as a factor in their decision to switch out of science majors.

⁴⁷ We could not find other published studies that evaluated the outcomes of the Ford Foundation Diversity Fellowship Program. This program was not included in the chapter on interventions because the study was relatively old (1993) and focused only on a small sample of Mexican American students.

Several studies are devoted to the discussion of mentoring models and the qualities of mentors. Bussey-Jones (2006), for example, describes a volunteer mentoring group composed of minority junior and senior clinical faculty, which was formed as an alternative to traditional one-on-one senior-junior or peer mentoring. Limitations and benefits of this model have not yet been documented, however. Gandara (1999) suggests that naturally forming relationships might be more successful than formal mentoring, but again no data to support this claim have been published.

Application of Literature Review

Our review of the literature highlighted several intervention strategies that have been linked to improved recruitment and retention of minority scientists. We plan to use this information in the design of our data collection instruments, so that any observations on the Diversity Supplements program processes and outcomes can be assessed in the context of prior research.

The needs assessment study will include two data collection components: a content analysis of funded applications for the years from 1997 to 2001⁴⁸ and surveys of PIs and trainees who participated in the program. While supplement funding applications are relatively short, they contain information that can address a number of questions. For example, using data on demographic characteristics, we can document gender and ethnic composition of the trainee population as well as shifts in the representation patterns from junior to senior career levels. It is generally known that the number of women in biomedical sciences decreases during the transition from graduate school to a postdoc and, even more dramatically to the faculty level (for example, Leboy, 2008). Using extant data, we can investigate whether these patterns are representative of the Supplements program.

GPA's are an important predictor of academic success. Therefore, we can use GPA data, available for undergraduate and graduate trainees, to get a measure of academic standing for these groups. The number of publications and prior funding support are indicators of productivity and the potential to raise funds. Information on these variables is also contained in the applications and will be analyzed. Personal statements by trainee candidates, enclosed with the applications, can give a glimpse of what trainees had hoped to achieve by participating in the program.

Surveys of PIs and trainees are another data collection component. We plan to survey nine PI-trainee pairs for each of the six career levels that the program supports: high school, college, post-baccalaureate, graduate, postdoctoral, and faculty. Using survey data, we will be able to examine training goals and degree of their accomplishment, challenges faced by the participants, and benefits to them and their careers. Since mentoring is clearly an important determinant of successful research experience, we will examine PI-trainee mentoring relationships. For example, we can ask program participants to identify the primary mentor, to recount the frequency of interaction, and to evaluate the adequacy of the mentoring given and received. Surveying PI-trainee pairs might allow comparison of the views expressed by trainees and their supervising PIs on various aspects of the research experience.

Since the goal of the program is to diversify the research workforce, an important indicator of program efficacy is the number of participants who have chosen research careers. The survey will allow us to document how many trainees currently hold academic or other research positions, and if they had elected alternative careers, what were the reasons for this decision and how, if at all, they had benefited from the training experience. The literature suggests that research experience is important for forging links to faculty, boosting self-confidence, making more informed career choices, and developing valuable,

⁴⁸ This time period was chosen to allow sufficient time for trainee careers to mature.

transferable skills. Using the survey, we can begin to investigate whether participants in the Supplements program derived any of these benefits.

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Appendix B: Data Abstraction Instrument

Application identifier	1	2	3
Grant number			
Status			
Supplement type			
Program code (PAC)			
PI name			
PI institution			
Candidate name			
Candidate gender			
Candidate race/ethnicity			
Candidate career level			
Number of years in career level			
Length of support recommended by staff			
Requested start date			
Cumulative total costs of supplement			
Candidate career goal			
Candidate past research support			
Candidate institution at time of award			
BA/BS, institution			
BA/BS, year			
MA/MS, institution			
MA/MS, year			
MPH, institution			
MPH, year			
PhD, institution			
PhD, year			
MD/PhD, institution			
MD/PhD, year			
MD, institution			
MD, year			
Postdoc, institution			
Postdoc, year			
Publications (Number)			
NOTES			

Appendix C: NIH Staff Interview Protocol

A. Interviewee Information

Collect the following information for each interviewee:

- Responsibilities related to Research Supplements
- Number of years (1) in current position and (2) in role related to Research Supplements

B. Program Purpose

1. How does your institute interpret the goals of the Supplement program? [NOT FOR NIGMS] Do you see the program goals as aligned with your institute's goals?
2. Have any changes been made at your institute to the goals of the program since you became involved in its management? Were there any changes before your time?
 - What were the changes?
 - When were these changes made?
 - What were the reasons for these changes?
3. Is the program attempting to facilitate change in the PI institution related to minority recruitment and retention?
 - Have you observed any such changes?
4. Do you think any changes to the program goals or any aspect of its implementation strategies are warranted? If yes, what are they?
 - Are these changes being planned?
 - How much flexibility does your institute have to change the program?
5. Please describe how the program is managed at your institute. Have there been changes in how the program is implemented since you became involved in its management? Were there any changes before your time?
 - What were the changes?
 - When were these changes made?
 - What were the reasons for these changes?
6. How is the program advertised to the PIs? Is it necessary to expand program outreach? How could the outreach to potential applicants be improved?
7. Are there specific qualities in the PIs that your institute is looking for?
 - Who is the ideal grantee? *Probe for:*
 - a. Good mentors?
 - b. Stated goals for the trainee?
 - c. Established scientists?
 - d. Minority scientists?
 - e. Minority serving institutions?
 - How does this ideal candidate compare to those who typically receive support?

8. What qualities is your institute looking for in the proposed trainee? Are there specific features that you are looking for in his/her record?
- Who is the ideal candidate? *Probe for:*
 - a. Career stage?
 - b. Gender?
 - c. Specific racial/ethnic groups?
 - d. GPA?
 - e. Stated goals by the trainee?
 - f. Career plans?
 - How does this ideal candidate compare to those who typically receive support?
9. What criteria does the IC use in making award decisions?
- We noticed that the award rate for this program is generally very high (nearly 100%). Is this the result of the high quality of applicants or lack of choice?
 - Are there funds set-aside specifically for this program? If so, how much per year?
 - Are you generally satisfied with the applicants who receive support?
10. Do PIs generally receive the amount of funding requested? If not, what are the typical changes recommended by the NIH staff, and what is the rationale for the change?
- Could you estimate the frequency with which these changes are made (e.g. rare, half the time, frequent)?
11. Does your institute make any effort to distribute funding by trainee career stage?
12. Do you or other managing staff communicate with PIs during the review process? If so, what is the nature of these communications?
13. In your opinion, are there criteria for the PIs that are important to the success of the program, but that are NOT currently used in making award decisions? If so, what are they?
14. In your opinion, are there criteria for trainees that are important to their ultimate success, but that are NOT currently used in making award decisions? If so, what are they?
15. Are unsuccessful PIs provided with any feedback regarding their application? If so, what is the nature of the communication, and who provides it?
16. How frequently do you or other individuals at your institute communicate with grantees? What is the nature of these communications?
17. Are there any reporting requirements in place for this program?
- If not, why not? Would these be useful if implemented?
18. [Other than for NIGMS] How does your institute maintain program records for the Supplements program?
- As paper files? Electronic database? IMPAC II? eGrants or another electronic filing system?

19. [Other than NIGMS] Does your institute track trainees post-award?

- If not, why not? Would these be useful if implemented?

20. Is it realistic, in terms of staff availability and budget, to put in place a trainee tracking system and/or grant reporting requirement?

C. Program Outcomes

21. From your perspective, has the Research Supplements program been successful in meeting its goals? Why or why not?

22. What measures (or benchmarks) do you think are appropriate for assessing the success of the Research Supplements program?

23. How do measures of success differ according to the level, or career stage, of the trainee (*i.e.*, high school student, undergraduate, graduate, post-doctoral student)?

- What is your view on degree attainment as the key measure of success?

24. In your opinion, what elements, or features, of the current Research Supplements program are most important to its success?

25. In your opinion, what changes could be made to the program to make it more successful in the future?

26. In your opinion, are there any changes in NIH policies or procedures that would make the Research Supplements more successful? Are there changes that would make program administration more effective or efficient? If so, what are they?

27. Do you reject the applications if it appears that proposed trainees (at graduate level and above) are qualified to apply for non-minority support?

- Can you estimate how often that happens?
- What are other most common reasons for rejecting the applications?

28. Do you think the program may have a negative impact on trainee careers, because PIs can obtain support for them more easily through the supplements rather than encouraging trainees to apply for competing funding sources?

29. Have you observed any unanticipated consequences of the program, positive or negative? If so, what are they?

30. [Other than NIGMS] Has there been an evaluation of the Research Supplements program within the IC? If yes, would you be willing to share the results with us? Were any changes made in response to the evaluation? If so, what were they?

31. Do you have any evidence that the program facilitates retention of minorities in research?

32. Do you have a view on the effectiveness of this program compared to other diversity programs at NIH?

Appendix D: Survey Protocols

Principal investigator supporting a high school student (PI-HS)

Please make any necessary changes to the following information:

Grant number _____
Your name _____
Your institution at the time of the supplement _____

Your current institution

- Unchanged
- Name _____

Beginning of support _____
Length of support _____

Trainee name _____

Trainee career level at the time of the supplement

- High school student
 - Summer appointment
 - School-year appointment
 - Both
- Other _____

Questions:

Application decision and training goals

1. Why did you decide to support this trainee? Please check all that apply.
 - I had the appropriate assignment for a high school student
 - The student needed financial support
 - To increase diversity in the biomedical workforce
 - I believed that this student showed potential to become a successful scientist
 - Recommended by a colleague, a friend, or a relative
 - To help the student get into a good college
 - To help the student acquire specific or transferrable skills
 - The student was interested in my research
 - Other, explain in box below:

2. Why did you decide to use this mechanism of support? Please check all that apply.
 - The amount of money was greater than from other NIH funding sources
 - I heard/knew that success rate for this funding was higher than for other funding sources
 - I heard/knew that the turn-around for the proposals was short
 - Other, explain in box below:

3. Would you have been able to support this trainee without the supplement funds?
- Yes
 - No
 - I am not sure

Training process and accomplishments

4. To what extent was the student able to achieve the goals that you had set?
- Not at all
 - Somewhat
 - Mostly
 - Completely
 - Exceeded all goals

Please explain your answer:

5. Would you apply for this type of funding again? Why or why not?

6. Would you support this trainee again? Why or why not?

7. What do you think were the benefits of the supplement grant for this trainee? Please check all that apply.

- He/she developed specific laboratory skills
- He/she developed general skills (e.g., analytical thinking, writing)
- He/she developed a network of faculty and students
- Financial support
- The experience helped him/her get into college
- The experience helped him/her choose a career
- None
- Other. Please explain in box below:

8. What were the benefits of supporting this trainee for the project and to you personally?

9. What, in your view, were the challenges for the trainee? Please check all that apply.

- Being in my lab took too much time away from his/her school work
- The student's expectations were unrealistic
- The student had difficulty integrating with my research group
- The student had insufficient training to perform the task assigned
- The student did not enjoy the work
- None
- Other. Please explain in box below:

10. What were the challenges for you? Please check all that apply.

- I could not spare as much time as the student needed
- The student did not meaningfully contribute to my research project or agenda
- The student wasted reagents, other people's time and/or damaged equipment
- The student did not get along with others
- The student did not put in as much time as I had hoped
- The duration of the supplement was too short
- None
- Other. Please explain in box below:

11. Were you primarily responsible for overseeing this student?

- Yes
- No. Who was responsible? _____

12. How frequently did you interact with the student over the course of his/her stay in your lab?

- More frequently than once a week
- Once a week
- Every other week
- Once a month
- Less than once a month
- Other _____

13. Do you think the student received sufficient help and guidance?

- Yes
- No. Please explain in box below:

14. In retrospect, would you make any changes to the student's experience?

- No
- Yes. Please explain in box below:

Final thoughts and recommendations

15. At what stage in training does an intervention targeted to underrepresented minorities have the greatest impact in enabling them to go on to a career in biomedical research? Please rank your answers.

High school
 College
 Post college
 Graduate school
 Postdoc
 Faculty

16. Please share with us any other thoughts, ideas, and recommendations related to the diversity supplements program:

17. Please share with us any other thoughts, ideas, and recommendations related to enhancing minority participation in research:

18. We plan to send a similar questionnaire to your trainee to gauge his/her views about this experience (we will not share your answers with the student and they will be aggregated with other respondents' answers when reported to the NIH). If possible, please provide us with any information you have about this individual's whereabouts.

- I do not have any information about the student's whereabouts

THANK YOU FOR COMPLETING THE SURVEY!

Principal investigator supporting an undergraduate student (PI-UG/PB)

Please make any necessary changes to the following information:

Grant number _____

Your name _____

Your institution at the time of the supplement _____

Your current institution

- Unchanged
- Name _____

Trainee name _____

Trainee career level at the time of the supplement

- Undergraduate student
- Other _____

Questions:

Application decision and training goals

1. Why did you decide to support this trainee? Please check all that apply.
- I had the appropriate assignment for an undergraduate student
 - To increase diversity in the biomedical workforce
 - The student needed financial support
 - I believed that this student showed promise in becoming a successful scientist
 - Recommended by a colleague, a friend, or a relative
 - To help the student get admitted into good graduate program
 - To help the student acquire specific or transferrable skills
 - The student was interested in my research
 - Other, explain in box below:

2. Why did you decide to use this mechanism of support? Please check all that apply.
- The application process was less time consuming/easier than for other NIH funding sources
 - The amount of money was greater than from other NIH funding sources
 - I heard/knew that success rate for this funding was higher than for other funding sources
 - I heard/knew that the turn around for the proposals was short
 - Other, please explain in box below:

3. Would you have been able to support this trainee without the supplement funds?
- Yes
 - No
 - I am not sure

Training process and accomplishments

4. To what extent was the student able to achieve the goals that you had set?
- Not at all
 - Somewhat
 - Mostly
 - Completely
 - Exceeded all goals

Please explain your answer:

5. Would you apply for this type of funding again? Why, why not?

6. Would you support this trainee again? Why, why not?

7. What do you think were the benefits of the training for this student? Please check all that apply.

- He/she developed specific laboratory skills
- He/she developed general skills (e.g. analytical thinking, writing)
- He/she developed a network of faculty and students
- The experience helped him/her get into a graduate program
- The experience helped him/her choose a career path
- Financial support
- None
- Other, explain in box below:

8. What were the benefits of supporting this trainee to the project and to you personally?

9. What, in your view, were the challenges for the trainee? Please check all that apply.

- Being in my lab took too much time away from his/her course work
- The student had difficulty integrating with my research group
- The student's expectations were unrealistic
- The student had insufficient training to perform the assigned task
- The student did not enjoy the work
- The student lacked discipline, motivation, or concentration to perform the tasks assigned
- None
- Other, please explain in box below:

10. What were the challenges for you of supporting this trainee? Please check all that apply.

- I could not spare as much time as the student needed
- The student did not meaningfully contribute to my lab's research
- The student did not get along with others
- The student did not put in as much time as I had hoped
- The student wasted reagents or damaged equipment
- The duration of the supplement was too short
- None
- Other, please explain in box below:

11. Were you primarily responsible for overseeing this student?

- Yes
- No. Who was responsible? _____

12. How frequently did you interact with the student over the course of his/her stay in your lab?

- More frequently than once a week
- Once a week
- Every other week
- Once a month
- Less than once a month
- Other _____

13. Do you think the student received sufficient help and guidance?

- Yes
- No, please explain in box below:

14. In retrospect, would you make any changes to the student's experience?

- No
- Yes, please explain in box below:

15. How would you compare this student to other undergraduate students that you have supervised?

- This has been my only undergraduate student
- This student was worse than others
- This student was equal to others
- This student was better than others
- This student was much better than others
- No opinion

Final thoughts and recommendations

16. At what stage in training does an intervention targeted to underrepresented minorities have the greatest impact in enabling them to go to a career in biomedical research? Please rank your answers.

High school
 College
 Post college
 Graduate school
 Postdoc
 Faculty

17. Please share with us any other thoughts, ideas, and recommendations related to the diversity supplements program.

18. Please share with us any other thoughts, ideas, and recommendations related to enhancing minority participation in research.

19. We plan to send a similar questionnaire to your trainee to gauge his/her views about this experience (we will not share your answers with the student and they will be aggregated with other respondents' answers when reported to the NIH). If possible, please provide us with any information you have about this individual's whereabouts.

- I do not have any information about the student's whereabouts

THANK YOU FOR COMPLETING THE SURVEY!

Principal investigator supporting a graduate student (PI-GS)

Please make any necessary changes to the following information:

Grant number _____

Your name _____

Your institution at the time of the supplement _____

Your current institution

- Unchanged
- Name _____

Trainee name _____

Trainee career level at the time of the supplement

- Graduate student
- Other _____

Questions:

Application decision and training goals

1. Why did you decide to support this trainee? Please check all that apply.

- I had a project that matched the graduate student's interests
- To increase diversity in the biomedical workforce
- This student needed financial support
- The student was interested in my research
- Other, please explain in box below:

2. Why did you decide to use this mechanism of support? Please check all that apply.

- The application process was less time consuming/easier than for other NIH funding sources
- The amount of money was greater than from other NIH funding sources
- I heard/knew that success rate for this funding was higher than for other funding sources
- I heard/knew that the turn around for the proposals was short
- Other, please explain in box below:

3. Would you have been able to support this trainee without the supplement funds?

- Yes
- No
- I am not sure

4. What were your goals for the trainee during the period of support from the diversity supplement?

Please check all that apply:

- Development of skills
- Completion of a PhD or a master's degree
- Postdoctoral position
- Position outside of academia
- Guidance and mentoring

- Publications and public presentations
- Follow-up funding support
- Other, please explain in box below

5. What degree did the student obtain?
- Masters
 - Doctoral
 - The student did not obtain a degree. Please explain in box below:

Training process and accomplishments

6. To what extent, was the student able to achieve the goals that you had set?
- Not at all
 - Somewhat
 - Mostly
 - Completely
 - Exceeded all goals

Please explain your answer in box below:

7. Would you apply for this type of funding again? Why, why not?
Please explain in box below:

8. Would you support this trainee again? Why, why not?
Please explain in box below:

9. What do you think were the benefits of the supplement grant for this trainee? Please check all that apply.
- Completed his/her degree
 - Helped him/her pursue a career path
 - Provided financial support that significantly advanced the candidate's career
 - Developed transferrable skills (e.g., techniques or methods)
 - Developed specific skills (e.g., writing or teaching)
 - Obtained postdoctoral position
 - Obtained a position outside of academia
 - Developed a network of faculty and students

- Developed intellectually
- None
- Other, please explain in box below:

10. What were the benefits of supporting this student to the project and to you personally? Please explain in box below:

11. What, in your view, were the challenges for this student? Please check all that apply.

- The student had difficulty integrating with my research group
- The student had insufficient training to perform necessary tasks expected of a graduate student
- The student's expectations were unrealistic
- The student did not enjoy the work
- The students' progress was slow
- The student did not publish his/her work
- The student did not graduate
- The student did not obtain a postdoc or a non-academic position
- The student did not exhibit the discipline, motivation, or concentration needed to be successful
- None
- Other, please explain in box below:

12. What were the challenges for you? Please check all that apply.

- I could not spare as much time as the student needed
- The student did not meaningfully contribute to my lab
- The student did not get along with others
- The student did not put as much time in as I had hoped
- The duration of the supplement was too short
- None
- Other, please explain

13. Were you primarily responsible for overseeing this student?

- Yes
- No. Who was responsible? _____

14. How frequently did you interact with the student over the course of his/her stay in your lab?

- More frequently than once a week
- Once a week
- Every other week
- Once a month
- Less than once a month
- Other _____

15. Do you think the student received sufficient help and guidance?

- Yes
- No, please explain in box below:

16. In retrospect, would you make any changes to this student's experience?

- No
- Yes, please explain in box below:

17. How would you compare this student to other graduate students that you have supervised?

- This student was worse than others
- This student was as good as others
- This student was better than others
- This student was much better than others
- No opinion

Final thoughts and recommendations

18. At what stage in training does an intervention targeted to underrepresented minorities have the greatest impact in enabling them to go on to a career in biomedical research? Please rank your answers.

- High school
- College
- Post college
- Graduate school
- Postdoc
- Faculty

19. Please share with us any other thoughts, ideas, and recommendations related to the diversity supplements program.

20. Please share with us any other thoughts, ideas, and recommendations related to enhancing minority participation in research.

21. We plan to send a similar questionnaire to your trainee to gauge his/her views about this experience (we will not share your answers with the student and they will be aggregated with other respondents' answers when reported to the NIH). If possible, please provide us with any information you have about this individual's whereabouts.
-

I do not have any information about the student's whereabouts

THANK YOU FOR COMPLETING THE SURVEY!

Principal investigator supporting a postdoc (PI-PD)

Please make any necessary changes to the following information:

Grant number _____

Your name _____

Your institution at the time of the supplement _____

Your current institution

- Unchanged
- Name _____

Trainee name _____

Trainee career level at the time of the supplement

- Postdoctoral associate
- Other _____

Questions:

Application decision and training goals

1. Why did you decide to support this individual? Please explain in box below:

2. Why did you decide to use this mechanism of support? Please check all that apply.
- The application process was less time consuming/easier than for other NIH funding sources
 - The amount of money was greater than from other NIH funding sources
 - I heard/knew that success rate for this funding was higher than for other funding sources
 - I heard/knew that the turn around for the proposals was short
 - Other, please explain in box below:

3. Would you have been able to support this trainee without the supplement funds?

- Yes
- No
- I am not sure

4. What were your goals for the trainee? Please check all that apply.

- Development of skills
- Position outside of academia
- Independent research position
- Guidance and mentoring
- Publications and public presentations
- Follow-up funding support
- Other, please explain in box below:

Training process and accomplishments

5. To what extent was the trainee able to achieve the goals that you had set?
- Not at all
 - Somewhat
 - Mostly
 - Completely
 - Exceeded all goals

Please explain your answer in box below:

6. Would you apply for this type of funding again? Why or why not?

7. Would you support this trainee again? Why or why not?

8. What do you think were the benefits of the supplement grant for this postdoc?

9. What were the benefits of supporting this trainee for the project and to you personally?

10. What do you think were the challenges for this postdoc?

11. What were the challenges for you?

12. How frequently did you interact with the postdoc over the course of his/her stay in your lab?

- More frequently than once a week
- Once a week
- Every other week
- Once a month
- Less than once a month

Other _____

13. Do you think the postdoc received sufficient help and guidance?

Yes

No, please explain in box below:

14. In retrospect, would you change anything about this postdoc's experience?

No

Yes, please explain in box below:

15. How would you compare this postdoc to other postdocs that you have supervised? Why?

This postdoc was worse than others

This postdoc was as good as others

This postdoc was better than others

This postdoc was much better than others

Please explain your answer in box below:

Final thoughts and recommendations

16. At what stage in training does an intervention targeted to underrepresented minorities have the greatest impact in enabling them to go on to a career in biomedical research? Please rank your answers.

High school

College

Post college

Graduate school

Postdoc

Faculty

17. Please share with us any other thoughts, ideas, and recommendations related to the diversity supplements program.

18. Please share with us any other thoughts, ideas, and recommendations related to enhancing minority participation in research.

19. We plan to send a similar questionnaire to your trainee to gauge his/her views about this experience (we will not share your answers with the student and they will be aggregated with other respondents' answers when reported to the NIH). If possible, please provide us with any information you have about this individual's whereabouts.
-

- I do not have any information about the student's whereabouts

THANK YOU FOR COMPLETING THE SURVEY!

Principal investigator supporting a faculty member (PI-F)

Please make any necessary changes to the following information:

Grant number _____

Your name _____

Your institution at the time of the supplement _____

Your current institution

- Unchanged
- Name _____

Name of supported individual _____

Supported individual career level at the time of the supplement

- Faculty
- Other _____

Questions:

Application decision and training goals

1. Why did you decide to support this individual?

2. Why did you decide to use this mechanism of support? Please check all that apply.

- The application process was less time consuming/easier than for other NIH funding sources
- The amount of money was greater than from other NIH funding sources
- I heard/knew that success rate for this funding was higher than for other funding sources
- To increase diversity in the biomedical workforce
- I heard/knew that the turn around for the proposals was short
- Other, please explain in box below:

3. Would you have been able to support this individual without the supplement funds?

- Yes
- No
- I am not sure

4. What were your goals for this individual?

Training process and accomplishments

5. To what extent was this faculty member able to achieve the goals that you had set? Please explain in box below:

6. Would you apply for this type of funding again? Why or why not?

7. Would you support this individual again? Why or why not?

8. What do you think were the benefits of the supplement for this individual? Please choose all that apply.

- He/she received much needed financial support
- He/she learned specific methods or techniques
- He/she was able to obtain higher-level academic position
- He/she was able to publish papers
- He/she was relieved from teaching to pursue research
- He/she was able to network at the university were the training/research for the supplement occurred
- He/she obtained independent funding
- None
- Other, please explain in box below:

9. What were the benefits of supporting this individual for the project and for you personally? Please explain in box below:

10. What do you think were the challenges for this individual?

11. What were the challenges for you?

12. How frequently did you interact with this individual over the course of his/her stay in your lab?
- More frequently than once a week
 - Once a week
 - Every other week
 - Once a month
 - Less than once a month
 - Other _____

13. Do you think this individual received the help he/she needed?

- Yes
- No, please explain in box below:

14. In retrospect, would make any changes to this individual's experience in your lab?

- No
- Yes, please explain in box below:

Final thoughts and recommendations

15. At what stage in training does an intervention targeted to underrepresented minorities have the greatest impact in enabling them to go on to a career in biomedical research? Please rank your answers.

- High school
- College
- Post college
- Graduate school
- Postdoc
- Faculty

16. Please share with us any other thoughts, ideas, and recommendations related to the diversity supplements program.

17. Please share with us any other thoughts, ideas, and recommendations related to enhancing minority participation in research.

