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OUTCOMES AND IMPACTS OF THE NATIONAL SCIENCE FOUNDATION'S PROGRAM OF MINORITY POSTDOCTORAL RESEARCH FELLOWSHIPS

Volume I - Final Report

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Acknowledgements and Disclaimer

The analyses, interpretations, and findings herein are those of SRI International and should not be interpreted as reflecting the view or official positions of the National Science Foundation or the U.S. Government.

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The SRI Project Team

CONTENTS

VII. BIBLIOMETRIC STUDY

APPENDICES (see Volume II)

LIST OF EXHIBITS

CHAPTER I: SUMMARY

Introduction

The National Science Foundation's Directorates for Biological Sciences (BIO) and for Social, Behavioral, and Economic Sciences (SBE) jointly sponsor a program[1] of Minority Postdoctoral Research Fellowships (MPRF) that provides a small number of minority Ph.D.s with opportunities for postdoctoral training of the highest quality. The purpose is to prepare members of ethnic groups that are significantly underrepresented at advanced levels in science and engineering for leadership positions in academe, industry, and government.

The SRI assessment provides strong qualitative and quantitative evidence that the MPRF program is meeting its broad goal.

The program provides opportunities to recent minority doctorate recipients to obtain additional training, gain research experience under the sponsorship of established scientists, broaden their scientific horizons, direct their research efforts across traditional disciplinary lines, and avail themselves of unique research resources, sites, and facilities, including foreign locations.

The principal mechanism is a Fellowship award of (currently) $50,000 per year. The Fellowship includes a stipend, an institutional allowance, and a special allowance for direct research-related costs. It is usually awarded for two years and may be extended for an additional year, particularly if the Fellow is to spend more than a year abroad. If in the final year a Fellow has accepted a tenure-track position at a U.S. academic institution, he or she may request a starter research grant, the amount of which depends on institutional matching funds.

From the inception of the program in Fiscal Year 1990 through Fiscal Year 2002, NSF funded a total of 173 MPR Fellowships, the great majority (141) of them in BIO fields. The MPRF study included 163 Fellows, unduplicated (one Fellow received two awards). The study population was somewhat smaller than the total number of Fellows supported through the MPRF program because only a portion of the 2002 awards had been made by the time of the study.

This study was designed to inform NSF about the career progress of MPRF recipients; the degree to which their Fellowships contributed to that progress; the size and composition of the potential pool of doctoral degree holders eligible for Fellowships; and trends in the number and demographics of postdoctoral scholars in BIO- and SBE-supported fields.

Hispanics are about three-fifths, and women are now more than one-half, of the potential pool of minority postdoctoral fellows in the biological sciences.

[1] National Science Foundation. (2000). *Minority Postdoctoral Research Fellowships and Supporting Activities.* Program Solicitation NSF 00-139. Available at http://www.nsf.gov/pubs/2001/nsf00139/nsf00139.html.

Study findings were derived from:

- an extensive web-based survey of Fellows, from those awarded at the start of the program into Fiscal Year 2002;
- an examination of their proposal and award interactions with NSF and with the National Institutes of Health (NIH);
- analyses of trend data from national surveys on enrollment, degrees, and employment in science and engineering fields;
- Fellows' publication records.

Almost all of the former Fellows had changed institutions at least once since completing their Fellowships. For the purpose of administering the survey, SRI's study team supplemented NSF's program records with searches for individual Fellows, both on the internet and in reference books. These efforts led to a fairly complete picture of Fellows' current employer institutions and academic ranks, as well as an exceptionally high response rate to the survey.

> *"The MPR Fellowship played a pivotal role in helping me obtain a tenure track position . . . It was crucial in allowing me to work on my own interests . . . and enhancing my independence. I recommend it to all the current minority students I meet."*
>
> – Assistant Professor, male, major research university, BIO field

There were 162 Fellows eligible for the survey, excluding one deceased Fellow. SRI obtained contact information for and sent the survey to 155 (96%) of these Fellows. Of those surveyed, 131 (or 84.5%) responded. Thus, SRI collected survey data on 81% of all Fellows in the study. About four-fifths (102) of the respondents had received their Fellowships in BIO fields and about one-fifth (24) in SBE fields.[2] Respondents' answers to specific survey items were generally similar whether their Fellowships had been funded by BIO or SBE. Thus, the general findings in this report cover all MPR Fellows. Any important differences between those funded by the BIO Directorate and those funded by the SBE Directorate are presented when particular results are described.

Highlights of study findings about the program itself are presented first, followed by analysis of the growing pool of underrepresented minority degree holders in SBE and BIO fields.

Findings About the Program's Effectiveness

The SRI assessment provides strong qualitative and quantitative evidence that the MPRF program is meeting its broad goal of:

> ***"preparing scientists from those ethnic groups that are significantly under-represented at advanced levels in U.S. science and engineering for tenured university professorships and for positions of leadership in industry and government."***

[2] Another five respondents could not be associated with either set of fields; their responses are included in survey totals, but not in the separate findings for BIO and SBE Fellows.

This conclusion is based on four sources of evidence:

- information about former Fellows' employer institutions and position titles;
- Fellows' survey responses and written comments;
- records of Fellows' proposal and award interactions with NSF and the National Institutes of Health (NIH);
- analyses of national data concerning the pool of minority Ph.D.s and the proportion that sought postdoctoral support.

1. Analysis of employer institutions and position titles shows that most former Fellows were in tenured or tenure-track positions at major research universities.

About three-quarters of former Fellows were employed at institutions of higher education, principally at "Doctoral/Research Extensive Universities."[3]

Of the 98 former BIO Fellows whose employers could be identified, 72 were employed at institutions of higher education, including 35 at Doctoral/Research Extensive Universities, 9 at Doctoral/Research Intensive Universities, 10 at Medical Schools, and 12 at Master's Institutions.

"The fact that I held an NSF fellowship impressed the hiring committees greatly. [The starter grant] allowed me to command the largest startup package ever for a junior faculty . . ."

– Assistant Professor, female, major research university, SBE field

Another 19 were employed in the private sector, particularly by pharmaceutical firms, and 7 were employed by various Federal government agencies.

Of the 18 former SBE Fellows whose institution could be identified, 16 were employed at institutions of higher education, including 12 at Doctoral/Research Extensive Universities, 1 at a Foreign Research University, 1 at a Medical School, and 2 at Master's Institutions.

2. Most of the former Fellows who responded to the survey indicated that their MPRF experiences had prepared them appropriately for their careers.

Specifically, at least 8 out of 10 survey respondents indicated that their Fellowship experiences (FEs):

- helped their career as a whole;
- enabled them to develop professional expertise they would not have developed otherwise;
- helped improve the quality of their current research;
- helped form the specific direction of their research;
- gave them confidence that they could perform leading-edge research.

[3] As listed in Carnegie Classification of Higher Education Institutions, 2000 edition. Available at http://www.carnegiefoundation.org/Classification/.

When asked whether the Fellowship provided various types of opportunities that they probably would not have had otherwise, the majority indicated that was the case with regard to:

- their ability to pursue specific research topics;
- their access to specific research equipment, facilities, or sites;
- their ability to direct their efforts along interdisciplinary lines that they probably would not have pursued otherwise.

3. Most former Fellows also reported that they valued their MPRF experiences highly.

All, or nearly all, former Fellows who responded indicated that they:

- found their Fellowship experiences to be valuable;
- were proud to have been a Fellow;
- would recommend the program to eligible colleagues;
- would recommend the program to eligible students.

> *The fellowship activities provided a solid foundation for my research and an opportunity to work with and meet people who had a very big impact on who I am as a person (both as a teacher and as a scholar). I am most grateful to NSF for the opportunity. I work hard to return what was provided in teaching and in research."*
>
> – Assistant Professor, male, Master's Institution, SBE field.

Given opportunities at several points in the survey to comment or expand on their responses, almost all former Fellows did so, particularly when asked to describe how their own activities had contributed to the broad goals of the program. The overwhelming majority of the comments were positive, and the general tone was one of enthusiastic support. Based on SRI's experience with similar surveys, the numbers of responses and their enthusiastic character are in themselves indications of the program's success.

The most common themes expressed by former Fellows were that the Fellowship:

- provided them with the independence to pursue their own research interests rather than those of a Principal Investigator/mentor;
- fostered self-confidence in their capabilities to perform research and to succeed in a tenure-track position;
- provided them with opportunities to work with and observe top-notch researchers and mentors;
- allowed them to perform research that made them much more qualified in the eyes of search committees;
- opened doors to the professional network in their field.

Almost half of former Fellows believed that their status as a member of an underrepresented minority group helped them in gaining their first post-Fellowship position, but three-tenths thought that their minority status had no effect, and one-tenth thought it worked against them. A

handful of former Fellows made negative comments to the effect that their participation in a program for underrepresented minorities created a "stigma" in the eyes of some colleagues, i.e., that they had been given an "unfair" advantage.

4. Analyses of NSF and NIH application records show that former Fellows were generally quite successful in obtaining awards from both NSF and NIH.

Over three stages in their careers (predoctoral, postdoctoral, and as independent Principal Investigators), more than half (90, or 54.5%) of the MPRF awardees from 1990-2002 had applied for some type of award from NIH, and 73 (44.2%) of them had received one or more awards.[4]

- More than two-thirds of MPRF awardees who had sought predoctoral support from NIH were successful in doing so.
- Twenty-five Fellows held postdoctoral traineeships from NIH before their MPRF awards. Only two Fellows applied for NIH postdoctoral fellowships prior to their MPRF awards, indicating a higher level of interest in MPRF.
- Half of the Fellows who sought NIH research or career services grants obtained them.

A large majority of MPRF awardees who later applied for other types of research funding from NSF received awards.

- More than four-fifths (82%) of the 45 former BIO Fellows who submitted research proposals to NSF were funded. They received 64 awards, for an application success rate of 48%, which is far above average.[5]
- Four of nine BIO Fellows who applied for NSF's prestigious CAREER grants were funded.
- More than half of SBE Fellows' research proposals to NSF were awarded.

> *"I also was able to use the starter grant to obtain [undergraduate research funding] for two students in my lab, one of whom was disabled . . . and a recent recipient of an NSF predoctoral fellowship. It would not have been possible to support and advise [him] had I not been in the program. His accomplishments have made me proud and should make the NSF proud as well.*
>
> – Assistant Professor, female, major research university, BIO field

[4] Information from NIH files was available only in the aggregate; thus it was not possible to identify the NIH award field as BIO or SBE.

[5] National Science Foundation. (May 2003). *Report to the National Science Board on the National Science Foundation's Merit Review Process FY2002*. NSB 03-2-66. Available at http://www.nsf.gov/nsb/documents/2003/merit_rpt/mrp.htm.

5. ***National surveys show that the MPRF program supported more than one-tenth of minority fellowship seekers in BIO fields, and about one-twentieth of those in SBE fields.***

   - Between 1989 and 2000, the MPRF BIO program supported at least 10.6% of the underrepresented minority Ph.D.s in BIO fields who sought postdoctoral fellowships.
   - During the same period, the MPRF SBE program supported 4.7% of the underrepresented minority Ph.D.s in SBE fields who sought postdoctoral fellowships.

Findings about the Program's Policies and Operations

The following are selected survey findings on Fellows' reasons for applying for and accepting the Fellowship, the adequacy of the Fellowship stipend and duration, and aspects of the Fellowship experience. Details of these and other findings are presented in Chapter IV.

1. ***The most important reasons for applying to MPRF centered on opportunities to work toward a tenured position***.

The three most important reasons for applying were: the opportunity to develop a publication record (92% of applicants), the opportunity to eventually obtain a tenured position (90%), and the opportunity to work for a particular mentor (89%).

2. ***Half of the respondents chose MPRF over other offer(s).***

Half of the respondents had been offered at least one other fellowship, but chose MPRF over the other(s) principally because the stipend was better (64%), they could apply for a starter grant (58%), or the MPRF was more prestigious (42%).

3. ***The most important factors in choosing a mentor were reputation and research interests. The mentor's minority status was the least important factor.***

In addition to reputation and research interests, over 8 in 10 respondents said the mentor's agreement to work on topics of the respondent's selection and the level of personal compatibility with the mentor were important factors in choosing a mentor.

4. ***Most former Fellows thought that the MPRF funding amounts and award duration were sufficient.***

> *"The support and feedback I received from my NSF program officers during the application process was wonderful. They were extremely patient with me . . . and their answers were always extremely helpful."*
>
> – Assistant Professor, male, major research university, BIO field

Most respondents (92%) indicated that the amount of the Fellowship stipend was sufficient, and the same percentage indicated that the amounts for materials and expenses were sufficient. Most (88%) thought that the Fellowship had sufficient flexibility to enable them to take advantage of diverse opportunities.

5. Former Fellows found the program workshops to be generally useful.

Four-fifths had attended one or more program workshops at NSF, during or after their Fellowship. Almost all thought the workshops were useful for meeting NSF staff and other minority Fellows, for networking generally, and for intellectual stimulation.

6. About half of the former Fellows were satisfied with their opportunities to mentor minority students, but almost a third were not.

About half (51%) of former Fellows indicated that they were satisfied with their opportunities to mentor minority students during the Fellowship period, but another one-third (32%) were not satisfied. Almost two-thirds (63%) were satisfied with their opportunities to mentor non-minority students.

Findings About the Pool of Scholars Eligible for MPRF

1. The pool of eligible scholars has doubled over the past 12 years but remains relatively small.

Annual numbers of BIO degrees earned at all levels (baccalaureate, master's, and doctorate) by underrepresented minorities more than doubled from 1989 to 2000. A total of 139 doctorates were awarded in BIO fields in 1989, and the number increased slowly to 320 by 2000. Overall, 2,822 biological science doctorates were awarded to members of underrepresented minority groups in that 12-year period—which represented 5.7% of all doctorates in the biological sciences awarded to U.S. citizens and permanent residents during that time.

The annual numbers of doctorates in SBE fields awarded to members of underrepresented minority groups nearly doubled during the same period, from 264 in 1989 to 514 in 2000. Overall, 3,278 doctorates in the social and economic sciences, and 1,425 doctorates in the behavioral sciences, were awarded to underrepresented minorities between 1989 and 2000. These numbers represented 10.5% and 9.3%, respectively, of all doctorates in these fields awarded to U.S. citizens and permanent residents during the period.

2. In 2000, Hispanics were about three-fifths, and women more than one-half, of the potential pool of minority postdoctoral fellows in the biological sciences.

From 1989 to 2000, more BIO doctorates were awarded to Hispanics (3.3% of the total awarded) than to blacks (2.1%) or American Indian/Alaska Natives (0.3%). In 2000, Hispanics earned 185, or almost three-fifths, of the 320 BIO doctorates awarded to underrepresented minorities.

The proportion of women among underrepresented minorities obtaining doctorates in BIO fields increased substantially from 1989 to 2000, to the point where they represented more than one-half of the recipients. The proportional increase for underrepresented minority women as a whole was far greater than that for white or Asian/Pacific Islander women.

3. In 2000, women accounted for almost one-half of underrepresented minorities who received doctorates in the social and economic sciences, and about three-quarters of those who received doctorates in the behavioral sciences.

In the social and economic sciences, the proportion of women among underrepresented minority Ph.D.s grew by about one-fifth between 1989 (41.9%) and 2000 (49.7%); most of this growth was due to the increased presence of black women (up from 40.5% of all black Ph.D.s in 1989 to 53.9% in 2000). In the behavioral sciences, women's proportion was only slightly higher in 2000 (75.3%) than in 1989 (72.1%), but it was already substantial at the beginning of the period.

Women also gained as a proportion of white and Asian/Pacific Islander Ph.D.s, but not to the same extent as among underrepresented minorities. At the end of the period, women represented about 46% of white and Asian/Pacific Islander Ph.D.s in the social and economic sciences and about 62% of those in the behavioral sciences.

CHAPTER II: THE MPRF PROGRAM

This chapter describes the status of underrepresented minorities at the postdoctoral level, and the goals, processes, and award rates of the MPRF program.

Status of Underrepresented Minorities in Advanced Levels of Science and Engineering

"Science and technology have been and will continue to be the engines of U.S. economic growth and national security," the National Science Board noted in its August 2003 report on the Nation's science and engineering workforce.[6] The Board also noted, however, that:

> ***"The number of native-born S&E graduates entering the workforce is likely to decline unless the Nation intervenes to improve success in educating S&E students from all demographic groups, especially those that have been underrepresented in S&E careers."***

1. The minority sectors of the U.S. S&E workforce are growing rapidly.

According to the Bureau of Labor Statistics,[7] U.S. jobs are growing fastest in areas that require knowledge and skills stemming from a strong grasp of science, engineering, and technology. The Census Bureau projects[8] that, as a percentage of the working-age population, non-Hispanic white males will decline from 37% in 1995 to 26% in 2050. Over the same period, the percentage of blacks in the workforce will increase from 12% to 14%, Hispanics from 10% to 24%, and Asians from 4% to 9%. The end result is that currently underrepresented groups will increase from about a quarter of the workforce in 1995 to nearly half in 2050.

Minority students are pursuing college education in greater numbers than ever before. The percentage of minority undergraduates earning S&E degrees has increased steadily, from 15.8% in 1990 to 24.0% in 1998.[9] The percentage of undergraduate degrees in the biological sciences earned by underrepresented minorities rose from 20.1% in 1990 to 27.6% in 1998; in the social sciences including psychology, the figure rose from 14.0% to 23.6%.

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[6] National Science Board. (August 14, 2003). *The Science and Engineering Workforce Realizing America's Potential.* Arlington VA: National Science Foundation. Report NSB 03-69. Available at (http://www.nsf.gov/nsb/documents/2003/nsb0369/nsb0369.pdf).

[7] Bureau of Labor Statistics, (September 2000), *Land of Plenty*, as noted in Committee on Equal Opportunities in Science and Engineering (CEOSE), (2000), *2000 Biennial Report to the United States Congress,* Arlington, VA: National Science Foundation. Available at http://www.nsf.gov/od/CEOSE/start.htm.

[8] J. Day. (1996). *Population Projections of the United States by Age, Sex, Race, and Hispanic Origin: 1995 to 2050*. U.S. Census Bureau. (As noted in CEOSE, 2000).

[9] National Science Foundation, Division of Science Resources Studies. (2001). *Science and Engineering Degrees, by Race/Ethnicity of Recipients: 1990-1998.* NSF 01-327. Arlington, VA: National Science Foundation. Table 1 (data represent U.S. citizens and permanent residents).

2. The presence of underrepresented minorities at advanced levels is sparse.

At the most advanced level of the Nation's science and engineering workforce, fewer than 1 in 33 of U.S. tenure-track faculty is black and fewer than 1 in 40 is Hispanic.[10] The numbers of American Indian/Alaska Native and Pacific Islander faculty are even smaller. This lack of diversity has several consequences, including:

- little opportunity for minority faculty to be viewed as role models—an important incentive for minority students to persist in their own STEM education; [11]
- intense pressure on the small number of minority faculty members to serve on institutional and professional committees at non-minority institutions—which tends to cut into time available for their research and teaching;
- feelings of personal and professional isolation among faculty[12] and students in institutions where their numbers are sparse.

3. In the life sciences, the overall supply of doctorate recipients exceeds the demand.

In a 1998 report,[13] a committee of the National Research Council tasked with examining the implications of recent trends in the careers of life scientists found that:

- the opportunity for new Ph.D.s to secure an academic appointment had steadily narrowed since the 1960s;
- the number of doctorates in the life sciences awarded annually by American universities began to rise sharply in 1987, with the majority of the increase coming from awards to foreign nationals;
- the level of doctorate production in the biological sciences in the mid-1990s exceeded the availability of jobs in academe, government, and industry where Ph.D.s could independently use their training;
- as a result of these and other factors, "Intense competition for jobs has created a 'crisis of expectation' among young scientists" such that "further increase in the competition could discourage the best from entering the field."

The Committee recommended that, on the whole, the life sciences community constrain the rate of growth in the number of graduate students "*except under rare and special circumstances, such as a program…to encourage the education of members of underrepresented minority groups*."

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[10] CEOSE, ibid.

[11] Several student newspaper articles found on the Internet, notably: Matthew Kane, (November 15, 2000), "Tufts Students Lament Lack of Minority Professors," *Tufts Daily*.

[12] SRI International, Center for Science, Technology, and Educational Development. (April 2000). *Retention of Women and Minority Faculty and Staff at the Ohio State University.* Arlington, VA: SRI International.

[13] National Research Council, Committee on Dimensions, Causes, and Implications of Recent Trends in the Careers of Life Scientists. (1998). *Trends in the Early Careers of Life Scientists.* Washington, DC: National Academy Press.

Program Description and Major Goals

Since Fiscal Year 1990, NSF's Directorates for Biological Sciences and for Social, Behavioral, and Economic Sciences have jointly sponsored a Minority Postdoctoral Research Fellowships program. The goal is to prepare scientists from ethnic groups that are significantly underrepresented at advanced levels in U.S. science and engineering for (1) tenured university professorships, from which they can apply to be Principal Investigators (PIs) on research grants and serve as mentors to an increasingly diverse student body; and (2) attain positions of leadership in industry and the public sector.

To reach this goal, the program provides opportunities to recent minority doctorate recipients to obtain additional training, gain research experience under the sponsorship of established scientists, broaden their scientific horizons, direct their research efforts across traditional disciplinary lines, and avail themselves of unique research resources, sites, and facilities, including foreign locations. The principal mechanism is a Fellowship award of (currently) $50,000 per year, normally for two years (although an additional year may be granted, particularly if the Fellow is to spend more than a year abroad). The award includes a monthly stipend, an allowance for research materials and related expenses, and an institutional allowance.[14]

At the end of the postdoctoral period, Fellows are eligible to apply for a one-year research starter grant of up to $50,000, depending on the amount of matching by the Fellow's institution. An additional benefit of the Fellowship is the opportunity to participate in NSF's annual workshops for mentors and Fellows, which provide a forum for discussing ways to foster a productive and supportive training environment during the postdoctoral period and in the early stages of the Fellow's research career.

Program Eligibility and Activities

Applicants to the MPRF program must be members of an eligible minority group; must be U.S. citizens or permanent residents; and must apply within four years after receiving the doctorate or within one year before receiving the doctorate. Also, they must not have completed two or more years of postdoctoral support at the time the MPR Fellowship is initiated.

Fellows are selected on, among other things, their ability, the suitability and commitment of their sponsoring scientist and the host institution, the quality of their research plan, and the likely impact of the Fellowship on the applicant's development as a scientist. A total of 173 Fellowships were awarded between 1990 and 2002, the great majority of them (141) in BIO fields.

The number of BIO awards has ranged from 10-14 annually, for an application success rate of 33% for the overall 1990-2002 period.

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[14] National Science Foundation. (2000). *Minority Postdoctoral Research Fellowships and Supporting Activities.* Program Solicitation NSF 00-139. Available at http://www.nsf.gov/pubs/2001/nsf00139/nsf00139.html.

Exhibit II-1: Summary of BIO MPRF Activity: 1990-2002

Fiscal Year	Applicants	New Fellowships	Travel Awards	Starter Grants
1990	33	8	2	
1991	48	10	6	
1992	21	10	1	
1993	34	11	3	1
1994	37	13	3	1
1995	39	10	2	7
1996	45	14	1	0
1997	31	9	2	2
1998	39	11	2	0
1999	23	13	2	6
2000	26	9	1	6
2001	30	11	1	1
2002	26	12	0	4
Total	**432**	**141 (33%)**	**24**	**28**

The numbers of MPRF awards in SBE fields, while small relative to those in BIO fields, show an upward trend since 1999.

Exhibit II-2: Summary of SBE MPRF Activity: 1990-2002

Fiscal Year	Applicants	New Fellowships
1990	10	1
1991	1	1
1992	2	1
1993	3	2
1994	5	1
1995	11	5
1996	3	1
1997	0	0
1998	7	3
1999	7	3
2000	10	4
2001	12	7
2002	13	5
Total	**84**	**34 (40%)**

CHAPTER III: STUDY DESIGN

This chapter summarizes the steps taken by SRI to design the study as a whole and to develop, test, and administer the survey of MPR Fellows. Information about the steps taken to analyze the Fellows' proposals to NIH and NSF and to analyze their publication records is presented in Chapters V and VII, respectively. Steps taken to analyze the potential pool of MPRF candidates are presented in Chapter VI.

Study Focus

NSF asked SRI to focus the study around four questions:

1. What did the awardees do during their award period (and extension, if granted)?
2. To what extent have the Fellows' research projects achieved their narrower and immediate scientific goals, and to what extent is this reflected in the formal scientific record?
3. How, if at all, did the awardees use their experience to shape their career direction and development?
4. How do awardees' employment and work activity patterns compare with patterns in national data, and how does their proposal and award history compare with that of other faculty members who received doctorates in the comparable fields and time periods?

Conceptual Model

SRI first created a conceptual model of the possible outcomes and impacts, both intended and unintended, of MPRF awards on Fellows' career development. To develop the model, SRI:

- studied program documents, proposal files, and other background materials;
- reviewed formal and informal literature, including other fellowship studies;
- interviewed several NSF officials;
- interviewed nine former Fellows by telephone.

The interviews with Fellows explored:

- their reasons for applying to the program;
- activities they undertook during the Fellowship;
- their employment and work patterns;
- effects of the Fellowship on their careers in terms of teaching, research, and service;
- effects of the Fellowship on their career aspirations and career choices;
- how they used their Fellowship experience to shape their career direction and development;
- types of extrinsic factors that constrained their careers.

The conceptual model included information about:

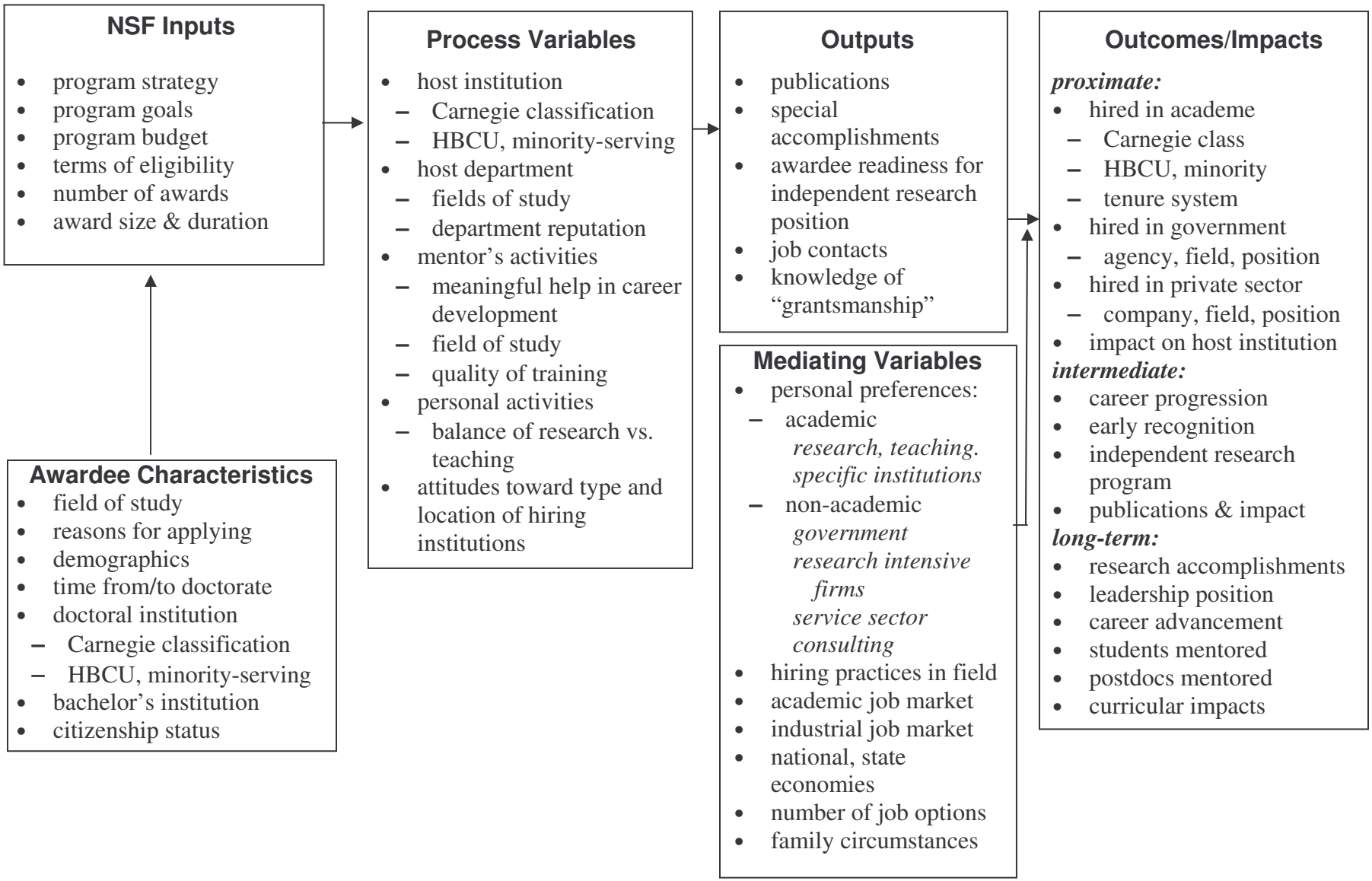
- program context, development, and goals;
- program inputs (terms of eligibility, annual funding levels, and the number, distribution, and duration of awards);
- awardee characteristics (age, research field, research experience, time from doctorate, doctoral institution and host institution);
- mediating variables, such as:
  - career development factors *intrinsic* to the Fellow (such as preference for academe vs. industry and research vs. teaching, prior or subsequent postdoctorates, and institutions attended);
  - *extrinsic* factors (such as hiring practices in the field and job market, the academic and national economy, industrial opportunities in the field, and family circumstances);
- outputs, including Fellows' publications and their impact on research;
- program impacts on Fellows' experiences and career trajectories, on their host institutions, and on the colleagues and students they may have mentored or inspired.

The model is presented in Exhibit III-1.

Survey Instrument

The design of the survey instrument was grounded in the conceptual model and in the information provided in the interviews. SRI also examined several questionnaires previously designed for other studies of postdoctoral fellows, young researchers, and industry researchers. Drafts of the MPRF survey instrument were reviewed both by NSF staff (to ensure that it was responsive to their major questions and realistic in its approach) and by SRI staff (to ensure proper wording, skip patterns, etc.). Following OMB approval, SRI prepared a web-based version of the survey instrument. The Microsoft Word version of the web survey is presented in Appendix A.

Exhibit III-1. Conceptual Framework for MPRF Outcomes and Impacts Study



Survey Administration

In parallel with survey development, SRI constructed a database of contact information for the awardees. As expected, problems arose because almost all of the former Fellows had changed institutions at least once since completing their Fellowships. Thus, SRI's study team supplemented NSF's program records with searches for individual Fellows, both on the internet and in reference books. In addition to enabling more Fellows to be contacted, these efforts led to a fairly complete picture of Fellows' current employer institutions and academic ranks.

The survey was primarily administered on the web. SRI has found web administration to have several important advantages over other forms of survey administration: lower cost (no printing, postage, or data entry costs, except for those respondents who choose to reply on paper); less burden on recipients, because skip patterns are handled by the computer; and few data errors, because the computer enters the data automatically and can check for out-of-range or logically inconsistent responses.

The initial step was to verify e-mail addresses and research current ones for those that were no longer usable. Then each Fellow for whom SRI had a valid e-mail address was notified of the survey URL, provided a unique identification number with which to access the survey web page, and offered the option of receiving the survey instead by postal mail or e-mail. Most Fellows chose to use the web-based version. Fellows without a valid e-mail address were sent a paper version of the survey, and their responses were entered into the survey database by SRI. This first effort yielded about half of the eventual responses.

To raise the response rate, SRI sent reminders every two weeks by e-mail and postal mail. After four months, remaining non-respondents were telephoned if their phone number was available. Of the 155 Fellows whom SRI was able to contact, 131 (or 84.5%) eventually responded. This means that survey data were collected for 81% of all Fellows in the study, excluding the one deceased Fellow.

CHAPTER IV: SURVEY RESULTS

This chapter provides employment information on Fellows gathered in preparation for the survey, and the results of the data collected by the survey, including open-ended responses from the Fellows.

Employers of Survey Respondents

The findings in this section are based on data developed by SRI in the course of obtaining and verifying contact information for the survey. This approach provided more extensive information about Fellows' employers than did their survey responses, although the two sources of information were consistent.

About three-quarters of former Fellows (those who had completed their Fellowships at the time they responded to the survey) were employed at institutions of higher education, particularly at those classified as "Doctoral/Research Extensive Universities."[15] Most of the others were employed by industry or by Federal government agencies.

BIO Fellows

Of 98 former BIO Fellows employed at the time of the survey in MPRF fields, 72 were at institutions of higher education, including 35 at Doctoral/Research Extensive Universities, 9 at Doctoral/Research Intensive Universities, 10 at Medical Schools, and 12 at Master's Institutions (see Exhibit IV-1). Twenty-four of these 72 Fellows were employed by Minority or Minority-Serving Institutions.[16] The second largest employer of former BIO Fellows was the private sector (19), followed by Federal government agencies (7). Pharmaceutical firms employed most of the former BIO Fellows who worked in the private sector, but two were employed by law firms, performing patent-related work.

Thirty-six of the former BIO Fellows employed by academic institutions were Assistant Professors at the time of the survey, 12 were Associate Professors, 3 were Professors, and 11 held positions with other titles, e.g., Research Associate. The positions of the other ten BIO Fellows employed by academic institutions could not be determined.

[15] As listed in Carnegie Classification of Higher Education Institutions, 2000 edition. Available at http://www.carnegiefoundation.org/Classification/.

[16] Includes all categories (Historically Black, Minority-Serving, etc.).

Exhibit IV-1: Employers of Former BIO Fellows

Employer Type	Examples	Former Fellows	At MI
Doctorate/Research Extensive University	Yale, Cornell, Tufts	35	2
Doctorate/Research Intensive University	Univ. of California–San Francisco, Univ. of Puerto Rico	9	5
Foreign Research University	Univ. of British Columbia	1	n/a
Nonprofit Research Institution	Woods Hole Oceanographic Institution	1	n/a
Medical Institution	Meharry Medical College, Univ. of Massachusetts Medical School	10	6
Master's-granting Institution	San Francisco State Univ.	12	7
Baccalaureate-granting Institution	Spelman College	2	2
Associate's-granting Institution	Black Hawk College	2	2
Subtotal, Academic		**72**	**24**
Government	NIH, USDA	7	
Industry	Novartis, DuPont	17	
Law Firm	(Patent Attorney)	2	
Total Employed in BIO Fields		**98**	**24**
Out of Science *		4	

* Deceased or known to have moved to other fields (e.g., social work), etc.
MI = Minority Institution (all types); n/a = not applicable

SBE Fellows

A total of 19 SBE Fellows had completed their Fellowships by the time they responded to the survey (see Exhibit IV-2). Seventeen of these former Fellows were employed by institutions of higher education (12 by Doctoral/Research Extensive Universities, 1 by a Foreign Research University, 1 by a Medical School, and 2 by Master's Institutions; the institution type of the

other Fellow could not be determined). One of the 17 was at a Minority or Minority-Serving Institution. Industry employed the other two former SBE Fellows.

Of the 17 former Fellows at academic institutions, 9 were Assistant Professors at the time of the survey, 2 were Associate Professors, 2 were Professors, and 4 held positions with other titles, e.g., Adjunct Assistant Professor.

Exhibit IV-2: Employers of Former SBE Fellows

Employer Type	Example(s)	Former Fellows	At MI
Doctorate/Research Extensive University	Columbia Univ., Univ. of Southern California	12	1
Foreign Research University	Univ. del Valle de Guatemala	1	
Medical Institution	Brown Univ. School of Medicine	1	
Masters-granting Institution	Texas A&M International	2	
Unknown Institution Type		1	
Subtotal, Academic		**17**	**1**
Industry		2	
Total Employed in SBE Fields		**19**	**1**

MI = Minority Institution (all types)

Principal Findings from Survey Item Responses

Responses of former Fellows to specific survey items, as well as their extensive written comments, demonstrate that almost all of them value the program very highly. This section presents the major findings from the survey.

Overall Satisfaction with MPRF Experiences

1. MPRF experiences were highly valued by former Fellows.

- All, or nearly all, former Fellows who responded:
  - found their Fellowship experiences (FEs) to be valuable;
  - were proud to have been a Fellow;
  - would recommend the program to eligible colleagues;
  - would recommend the program to eligible students.

- 92% believed that their FEs helped their career as a whole. The percentage was markedly higher for the 87 BIO respondents (96%) than for the 15 SBE respondents (72%). Two of the SBE respondents felt that their FEs had hindered their career, and one respondent indicated that there had been no effect.

2. MPRF experiences increased Fellows' confidence, knowledge, and skills.

When asked about certain specific contributions of their FEs to their careers:

- 91% agreed that their FEs led to a professional expertise they would not have developed otherwise.

- 86% indicated that their FEs helped improve the quality of their current research; 80% indicated that it helped form the specific direction of their research; and 73% felt that it helped the progress of their research.

- 84% indicated that their FEs gave them confidence that they could perform leading-edge research.

- 79% indicated that their FEs put them on an equal footing with non-minority postdoctoral researchers of equal qualifications when it came to securing their first post-Fellowship position.

- 59% overall (62% of BIO respondents and 47% of SBE respondents) agreed that their FEs taught them most of what they needed to know about preparing grant proposals.

- 53% indicated that their FEs helped them succeed in obtaining post-Fellowship funding; 14% said their FEs did not help; and 31% didn't know whether their FEs had helped or hindered them in this regard.

- While 29% indicated that their FEs helped them gain tenure, a majority (57%) indicated that they did not know whether their FEs had helped or hindered in that respect, or that the question did not apply to them.

3. Former Fellows were highly satisfied with their research experiences, and most had opportunities they would not have had otherwise.

Almost all former Fellows (98%) agreed that they were satisfied with the opportunities they had to conduct research during their Fellowship, and most (89%) were satisfied with their opportunities for collaboration with others.

Nearly nine-tenths (89%) indicated that the specific research topic they undertook at the start of their Fellowship was their first choice. One-third indicated that their research interests changed as a result of their Fellowship.

When asked whether the Fellowship provided various types of opportunities that they probably would not have had otherwise:

- 72% agreed that was the case with their ability to pursue specific research topics;
- 72% agreed that was the case with regard to access to specific research equipment, facilities, or sites;
- 62% agreed that they were able to direct their efforts along interdisciplinary lines they probably would not have pursued otherwise.

Applying for and Choosing MPRF

1. The most important reasons for applying to MPRF centered on opportunities to work toward a tenured position.

The most important reasons for applying to MPRF were:

- the opportunity to develop a publication record (92%);
- the opportunity to eventually obtain a tenured position (90%);
- the opportunity to work for a particular mentor (89%);
- the opportunity to apply for a starter grant (74%);
- the fact that the Fellowship could be used at any institution (73%).

The importance of some other reasons varied by respondents' sex:

- the opportunity to gain access to specialized equipment (77% of women, 56% of men);
- the opportunity to work in the desired location in the U.S. (69% of women, 49% of men).

2. Half of the respondents chose MPRF over other offer(s).

Half of the respondents had been offered at least one other fellowship, but chose MPRF over the other(s) principally because the stipend was better (64%), they could apply for a starter grant (58%), or the MPRF was more prestigious (42%). Women, more than men, were inclined to choose MPRF because it was more prestigious than other offers (57% vs. 29%), while men were more likely to choose MPRF for the opportunity to apply for a starter grant (67% vs. 48%).

3. The most important factors in choosing a mentor were reputation and research interest. The mentor's minority status was the least important factor.

The factors that respondents considered important in choosing a mentor were:

- the mentor's reputation as a researcher (98%);
- the match of research interests (97%);
- the mentor's agreement to work on topics of the respondent's selection (85%);
- the level of personal compatibility with the mentor (83%);
- the mentor's reputation as a supervisor (72%);

- the geographic location of the mentor (64%);
- the mentor's agreement for the respondent to have sufficient time to search for a position (45%).

The mentor's agreement to allow time to search for a position was more important to women (52%) than to men (38%), as was the geographic location of the mentor (69% vs. 58%). Whether the mentor was a minority scientist mattered very little (important to only 5% of all respondents), and whether the mentor was not a minority scientist did not matter.

In the course of their Fellowship, 15 Fellows (14 of them in BIO fields) made a permanent change in their host institution. Nine of them did so primarily to change mentors and/or to change direction of research, and six did so for family reasons.

Program Conditions and Administration

1. Most former Fellows thought that the MPRF funding amounts and award duration were sufficient.

Most respondents (92%) indicated that the amount of the Fellowship stipend was sufficient, and the same percentage indicated that the amounts for materials and expenses were sufficient. Most (88%) thought that the Fellowship had sufficient flexibility to enable them to take advantage of diverse opportunities.

The mean duration of completed Fellowships overall was 27.72 months, but the duration was notably longer for women: 30.53 months, compared with 25.61 months for men. These figures are less than the usual awarded duration of 36 months because, in many cases, the Fellowship was terminated early when the incumbent accepted a post-Fellowship position. The mean optimal duration suggested by respondents was 35.13 months.

One Fellow commented that the requirement that starter grants were to be used by institutions to "top up" the Fellow's initial funding package, while appropriate for a large institution, can be difficult for a smaller minority institution to meet.

2. Former Fellows found the program workshops to be generally useful.

Four-fifths of the respondents had attended one or more program workshops at NSF during or after their Fellowship. Almost all thought the workshops were useful for meeting NSF staff and other minority Fellows, for networking generally, and for intellectual stimulation. About four-fifths found them useful for learning about research in one's field, learning about obtaining grants/funding, or for meeting researchers in other fields. Almost two-thirds found the workshops useful for presenting their own research. Nearly three-fifths did not find the workshops useful for identifying opportunities for research collaboration. Women (73%), more than men (57%), found the workshops useful for opportunities to present their research and also for networking (97% vs. 81%).

When asked whether workshop participation was useful to their mentors for better understanding the MPRF program, 43% of respondents said the item did not apply to them, 29% said it was not useful, and 28% found it to be useful for that purpose.

Specific Experiences During the Fellowship

1. Former Fellows engaged in a number of non-research activities during their Fellowships, including mentoring both minority and non-minority students.

Principal non-research activities engaged in by respondents during their Fellowship were: attending workshops (76%), guest lecturing/teaching (48%), advising non-minority students (46%), advising minority students (44%), and attending seminars (40%). Most (71%) participated at least once in some sort of activity intended to influence students to consider careers in science.

About one-half of respondents (51%) indicated that they were satisfied with their Fellowship opportunities to mentor minority students, but another one-third (32%) were not. Almost two-thirds (63%) were satisfied with their opportunities to mentor non-minority students.

2. Fellows sought and received advice about identifying their needs for skills and knowledge, but many did not receive the advice they needed on other topics.

Respondents were asked whether in the course of their Fellowship, they needed advice on various topics, whether they received such advice, and whether they were satisfied with that advice (see Exhibit IV-3).

Exhibit IV-3: Types of Advice Sought and Received by Fellows

Topic	Needed Advice	Received Advice	Satisfied with Advice
a. Identifying skill and knowledge needs	80%	73%	85%
b. Developing plans to address those needs	69%	52%	79%
c. Identifying career options	66%	44%	77%
d. Matters facing minority researchers in the field	43% BIO 73% SBE	17% BIO 23% SBE	58% BIO 30% SBE
e. Matters facing all researchers in the field	87%	80%	64%
f. Preparing grant proposals	81% BIO 87% SBE	58% BIO 27% SBE	74% BIO 40% SBE
g. Preparing curriculum vita	48%	40%	73%
h. Preparing for job interviews	78%	58%	79%

Women (89%) were more likely than men (73%) to report needing advice on identifying skill and knowledge needs, and on discussing matters facing minority researchers (64% vs. 38%). Women were more likely than men to have received advice about career options (57% vs. 34%), about all matters relating to research in their field (89% vs. 73%), and about preparing a *curriculum vita* (56% vs. 27%).

Principal Findings from Open-Ended Responses

Given opportunities at several points in the survey to comment or expand on their responses, almost all former Fellows did so, particularly when asked to describe how their own activities had contributed to the broad goals of the program. The overwhelming majority of the comments were positive, and the general tone was one of enthusiastic support. SRI's survey experience leads us to observe that, aside from the contents of particular remarks, the broad, deep, and supportive nature of the comments as a whole demonstrate the enthusiasm and positive feelings of Fellows about the program.

The most common themes in Fellows' comments were that the Fellowship:

- provided them with the independence to pursue their own research interests rather than those of a PI/mentor;
- fostered self-confidence in their capabilities to perform research and to succeed in a tenure-track position;
- provided them with opportunities to work with and observe top-notch researchers and mentors;
- allowed them to perform research that made them much more qualified in the eyes of search committees;
- opened doors to the professional network in their field.

Some Fellows noted that academic search committees were impressed with the prestige of the Fellowship and with the potential for the Fellow's receiving a starter grant. A few gave examples of how they have "given back" to the minority research community by, e.g., sponsoring summer workshops and mentoring undergraduates.

A handful of former Fellows made negative comments. Three expressed concerns that their participation in a program for underrepresented minorities created a "stigma" in the eyes of some colleagues, i.e., that the Fellow had been given an "unfair" advantage. One respondent wrote a lengthy comment saying that the program is not needed because it funds accomplished upper middle class students who would have succeeded anyway, while another wrote a lengthy comment to the effect that the program is needed because minority graduate students tend to come from lower middle class backgrounds.

Almost half of former Fellows believed that their status as a member of an underrepresented minority group helped them in gaining their first post-Fellowship position, but three-tenths believed that their minority status had no effect, and one-tenth thought it worked against them.

Excerpts of Comments by Former Fellows

Comments are characterized by the writer's sex, type of employer institution, field of research (BIO or SBE), and, where applicable, rank or job title. Institutional classifications are those of the latest (2000) edition of the Carnegie Classification of Institutions of Higher Education. The following abbreviations are used:

DRE = Doctoral/Research University – Extensive
DRI = Doctoral/Research University – Intensive
M1, M2 = Masters College or University I or II
B-LA = Baccalaureate College, Liberal Arts
AA = Associates College

Also MI = Minority or Minority-serving Institution

Whether the Program is Meeting Its Stated Goals

"I . . . am now the only minority tenure track faculty member in my department. My NSF postdoc fellowship is why I am here—the research area I was moving into was exactly what my institution was interested in, [the Fellowship] gave me the flexibility to follow my own intellectual interests, and the prestige . . . was an important factor in my successful job search and negotiations. . . This fellowship is, in my opinion, one of the most important programs the NSF supports."

– Assistant Professor, male, D/R Extensive, BIO

"I had the daunting goal of using my NSF postdoc to switch academic fields. [Extending] my postdoc to a third year was critical. . . to integrate and present my research in the language of my new discipline. . . The fact that I held an NSF fellowship impressed the hiring committees greatly as well as the potential for receiving start-up funds, [which] allowed me to command the largest startup package ever for a junior faculty in the college of social and behavioral sciences. This allowed me to join the faculty with a lot more prestige [and] respect . . ."

– Assistant Professor, female, D/R Extensive, SBE

"The MPR Fellowship played a pivotal role in helping me obtain a tenure track position . . . It was crucial in allowing me to work on my own interests . . . and enhancing my independence. It was also crucial in providing the starter grant . . . as this money was extremely helpful in getting my lab up and running. I recommend it to all the current minority students I meet."

– Assistant Professor, male, D/R Extensive, BIO

"The fellowship activities provided a solid foundation for the research that I am currently involved with. Additionally, it provided me with an opportunity to work with and meet people who had a very big impact on who I am as a person (both as a teacher and as a scholar). I am most grateful to NSF for the opportunity that was provided me. I work hard to return what was provided in teaching and in research."

– Assistant Professor, male, Master's I, SBE

"While the MPR program helped me intellectually and professionally, it does not affect my discipline . . . which is dominated by white males, and which has historically discriminated against women and people of color in hiring and promotion."

– Assistant Researcher, female, D/R Extensive, SBE

"It helped me make my case for obtaining my current tenure track job, and the starter grant was a definite help in establishing my laboratory. I also was able to use the starter grant to obtain [undergraduate research funding] for two students in my lab, one of whom was disabled . . . and a recent recipient of an NSF predoctoral fellowship. It would not have been possible to support and advise [him] and encourage him in his professional and scientific development . . . had I not been in the program. His accomplishments have made me proud and should make the NSF proud as well."

– Assistant Professor, female, D/R Extensive, BIO

"The importance of the research starter grant cannot be overemphasized. It was a key part of the negotiating process during my job search . . . the university knew that I could walk away from the offer and still have an excellent position waiting ahead of me. Plus the words "NSF Postdoctoral Fellowship..." when I was introduced at my seminar sounded so cool."

– Assistant Professor, male, D/R Extensive,

"I have a great track record for my type of institution in receiving funding and getting more minority (and non-minority) students into the pipeline to higher degrees. My mentor helped me with understanding the organization of a lab and the work of a PI . . . I currently have six students in graduate programs to the Ph.D. (including two minority students) and one who has finished. There are also several with Masters or Professional degrees. I don't think I could have been nearly as successful without my time with [mentor's name]. . ."

– Associate Professor, male, Master's I, BIO

"My next position was another postdoc. It was (is) too competitive in my old field to get a faculty job after one postdoc job that generated only 3 publications."

– Scientist, male, major Federally-sponsored laboratory, BIO

The Importance of a Satisfactory Mentor

Most respondents indicated that their experience with their mentor was satisfactory. Those who did not have a satisfactory experience with their mentor were asked to comment on the reasons.

"My mentors did not see me as a 'minority' and did not discuss career issues. When I decided to leave my fellowship before it was completed, I got plenty of career advice about how 'bad' a decision I was making, but no assistance on finding another position. The fellowship for my mentors was a way to fund my research project and since I decided that I really wanted to teach at an HBCU, I was rejecting their way of life. Mentoring graduate students, minority or otherwise, was actually discouraged."

– Researcher, female, Federal agency, BIO

"My supervisor simply wasn't a mentor. Although he pushed me to be a better scientist, he rarely if ever provided any guidance as to what it means to be a professional scientist [or] an academic. I had no say in the management of the research funds . . . My supervisor even wanted me to turn over the research allowance to him . . . Furthermore, he basically used my work to further his professional development, rather than using it to further [mine]—despite the fact that he was a full professor . . . at [highly regarded research university]."

– Visiting Fellow, female, D/R Extensive, BIO

"In retrospect I realize that my expectations were too high for the PI that I chose to work with. He wasn't prepared to help foster career development, rather he was more concerned with treating his post-docs as a "pair of hands" to collect data. In reality, I think most PIs are self-serving. Now that I'm a Research Assistant Prof, I can see how there needs to be a balance between the PI's needs and the needs of their post-docs."

– Female, nonprofit organization, BIO

Suggestions for Improving the Program

"The support and feedback I received from my NSF program officers during the application process was wonderful. They were extremely patient with me . . . and their answers were always extremely helpful. During the fellowship tenure itself they were always available to answer questions, and they were genuinely happy for me when I got my job."

– Assistant Professor, male, D/R Extensive, BIO

"I think the power and importance of this aspect of the fellowship is greatly underappreciated. A second year of "starter grant" funds to new faculty would have an even GREATER impact than the one year. The first year of funding helps the lab to get 'off the ground.' A second year of funding would go directly into productivity and publications."

– Unidentified Respondent

CHAPTER V: ANALYSES OF NIH AND NSF PROPOSAL DATA

This chapter summarizes key findings from the analyses of proposal records from NIH and NSF, discusses the techniques used for the analyses, and presents detailed results.

Highlights

NIH Proposals

Over three stages in their careers (predoctoral, postdoctoral, and as independent Principal Investigators), more than half (90, or 54.5%) of the MPRF awardees from 1990-2002 had applied for some type of award from NIH, and 73 (44.2%) had received one or more awards.

- More than two-thirds of MPRF awardees who sought predoctoral support from NIH succeeded.
- Twenty-five MPRF awardees held postdoctoral traineeships from NIH before their MPRF awards.
- Only two MPRF awardees (both BIO) applied to NIH for postdoctoral fellowships, indicating that MPRF was not a second choice to NIH for most MPRF recipients.
- Half of the MPRF awardees who sought NIH research or career services grants obtained them.

NSF Proposals

As of November 2003, 45 former BIO Fellows had submitted 150 non-MPRF grant applications to NSF and received 64 awards, for an application success rate of 48 percent (16 were still pending). As of January 2004, 11 former SBE Fellows had submitted 20 non-MPRF grant applications and received 10 awards, for an application success rate of 55 percent (2 were still pending). These rates compare favorably with award rates for all of NSF and the BIO and SBE Directorates.

- More than four-fifths of the BIO Fellows who submitted research proposals were funded, for an applicant success rate of 82%.
- Four of nine BIO Fellows who applied for NSF's prestigious CAREER grants received awards.
- One of the ten awards received by SBE Fellows was a CAREER grant; another was an ADVANCE grant.

NIH Methodology and Detailed Findings

Matching Process

Records for the MPRF recipients in Fiscal Years 1990-2002 were matched by SRI subcontractor ORC Macro, Inc. against traineeship and fellowship records in the NIH Trainee and Fellow File and against grant records in the NIH Consolidated Grant Applicant File.[17] Matching criteria included name (first, last, middle initial), social security number, doctorate institution, and doctorate year. Doctorate years in the MPRF records initially came from NSF's PARS file and the ProQuest Digital Dissertations database. The years in these two databases were sometimes inconsistent and sometimes inaccurate. If an MPRF record was determined to be a good match with one or more NIH records but the doctorate year differed in the MPRF and NIH records (usually by one year), the doctorate year in the NIH record was used for analysis. Doctorate years in the NIH files come from NSF's Doctorate Records File, which contains the results of the Survey of Earned Doctorates, the definitive source of doctoral data.

Counting Applications and Awards

NIH counts every record, including noncompeted amendments, as separate records. For this study, SRI and ORC Macro developed a different methodology that (1) counted competed fellowship and grant applications/awards as separate records but (2) counted multiple traineeship appointments to the same training grant as one appointment. More specifically:

- *Fellowships and grants:* An individual's records that had the same application type, institute, serial number, and support year were collapsed and counted as one application. Application types "New," "Competing Continuation," and "Change of Institute or Division (Competing Continuation)" were counted as separate applications/awards.

- *Traineeships:* Trainees themselves do not compete for traineeships; they are appointed to a training grant that was previously competed and awarded to a Principal Investigator. All of a trainee's records with the same institute and serial number were counted as one application/award for this analysis.

[17] At the time of the match, SRI had received information on 165 individuals from the MPRF program officers. Two of these individuals were later determined to be ineligible for the MPRF study and were deleted from the BIO group of Fellows before the survey was administered. However, because the complex NIH/MPRF matching process had already been done and analysis was well underway, it was too late to remove the two ineligible individuals from this analysis. One of the two ineligibles did match one or more NIH records; SRI cannot identify individuals from the more detailed results, so it is unknown whether this person ever received an award from NIH.

Detailed Findings[18]

This analysis includes noncompeted traineeship appointments (all of which are awards), as well as competed fellowships and competed research grants. Both predoctoral and postdoctoral applications and awards are covered. MPRF awardees received support from NIH in the form of predoctoral and postdoctoral traineeships, predoctoral fellowships, and research grants (which were all funded after the Fellows obtained their doctorates).

Overall Success Rates

Of the 165 MPRF recipients in 1990-2002,[19] 90 (54.5%) had applied for predoctoral and/or postdoctoral support from NIH, and 73 (44.2%) received NIH support. The overall *applicant* (person) success rate was 81.1%. Because some individuals submitted multiple applications to NIH, the *application* success rate was lower at 65.1%.

Of the 90 MPRF awardees who applied for NIH support, 80 were in BIO fields and 10 were in SBE fields. Applicant success rates were similar in the two areas; 81.3% of BIO Fellows and 80.0% of SBE Fellows who applied for NIH predoctoral and/or postdoctoral support received awards. The application success rates were 65.4% for BIO Fellows and 61.9% for SBE Fellows.

There was more predoctoral than postdoctoral activity among BIO and SBE Fellows, in terms of both applicants and applications for NIH support. All together, MPRF awardees made 147 predoctoral vs. 62 postdoctoral applications to NIH, including appointment forms for noncompeted traineeships. Most activity was not competitive.

The application success rate for BIO Fellows was about 65% at both the predoctoral and postdoctoral levels. For SBE Fellows, application success was substantially greater at the postdoctoral level (71.4%) than at the predoctoral level (57.1%)—but both percentages are based on small numbers.

Mechanism of Support

At the predoctoral level, 53 of 75 applicants to NIH received a total of 95 awards (out of 147 applications submitted): 43 of the 53 NIH awardees received noncompeted traineeship appointments; 15 received competed fellowships (5 of the 53 awardees received both types of awards).

At the postdoctoral level, 33 of 42 applicants to NIH received a total of 41 awards (out of 62 applications submitted): 25 of the 33 NIH awardees received noncompeted traineeship appointments (all held before the MPRF award); 10 received competed grants (2 of the 33 awardees received both).

[18] Information from NIH files was available only in the aggregate; thus, it was not possible to identify the NIH award field as BIO or SBE.

[19] See footnote 17 on previous page.

There were only 3 applications to NIH for competed postdoctoral fellowships, submitted by 2 MPRF awardees in BIO before they received their MPRF awards. None of the 3 NIH fellowship applications was awarded. These data indicate that *the MPRF program was not a second choice to NIH for 88 of the 90 matched MPRF awardees*.

Competed grants account for the remaining 31 applications submitted to NIH after the doctorate—22 for research grants, of which 8 were awarded (in R01, R03, R15, and R29 programs); and 9 for career services grants, of which 5 were awarded (in K01, K02, and K14 programs). (See Exhibit V-1 for capsule program descriptions.) All of these programs feature efforts to attract underrepresented minority applicants.

Exhibit V-1: NIH Programs that Awarded Grants to MPRF Recipients

R01 – Research Project Grants (traditional)
R03 – Small Research Grants
R15(a) – Mental Health Projects Conferences
R15(b) – Academic Research Enhancement Awards (AREA)
R29 – First Independent Research Support & Transition (FIRST) Award
K01 – Research Scientist Development Award – Research and Training
K02 – Research Scientist Development Award – Research
K14 – Minority School Faculty Development Awards

Exactly half of the MPRF recipients who applied for NIH grants (10 of 20) received one or more grant awards, for an *applicant* (person) success rate of 50%; the application success rate was lower at 41.9%. These rates compare very favorably with overall NIH application success rates; the NIH-wide rate in 2003 was 30%.[20]

Success rates were higher for research career program grants (K activities) than for research grants (R activities). However, the number of awards was larger for research grants.

Most of the NIH grants that were awarded followed the MPRF award. Only two individuals applied for NIH grants before the MPRF award, and both were funded. One of these persons received another NIH grant after the MPRF award. It is reasonable to expect that the number of applications and awards for NIH grants will increase as the number of years since receipt of the doctorate increases.

Nine of 17 BIO Fellows who applied for NIH grants received one or more grants, for an applicant success rate of 52.9%; the application success rate was 40.7%. Among SBE Fellows, one of three grant applicants was awarded, and that person received two grants, resulting in a higher application success rate (50.0%) than applicant success rate (33.3%).

[20] From "Chart of Grant Success Rates at NIH" in *Science,* February 13, 2004, vol. 303, p. 936.

NSF Methodology and Detailed Findings

Matching Process

NSF establishes a unique identification number for each Principal Investigator who submits a proposal of any kind. Using MPRF recipients' names and other identifying information (such as employer institution), SRI was able to find the identification numbers for MPRF awardees.

Counting Applications and Awards

MPRF applications and awards were removed from the database, as well as MPRF "starter grants." Thus the base for analysis contained only those proposals submitted subsequent to the MPRF award. Proposals pending decision, and any withdrawn by the applicant, were also discarded. NSF application success rates were calculated as proposals awarded divided by the total number of proposals submitted.

Detailed Findings

Former BIO and SBE Fellows submitted proposals to NSF for other types of research funding after their MPRF award. About 50% of the applications were awarded.

BIO Fellows

As of November 2003, 45 former BIO Fellows had submitted 150 non-MPRF research proposals to NSF after their Fellowship was completed. More than four-fifths of them (37, or 82.2%) received at least one award. These 45 BIO Fellows received a total of 64 NSF awards, for an application success rate of 48% (of the 150 proposals, 134 had been reviewed and 16 were pending when the analysis was performed).

Most of the 45 former BIO Fellows who applied for NSF research grants submitted one or two proposals, but 4 Fellows submitted 11 or 12 proposals each, for a total of 46 proposals. Excluding 5 proposals that were pending at the time of the analysis, the application success rate for these 4 individuals alone was 37% (15/41).

Within the totals presented above, 9 individuals submitted 12 CAREER proposals, of which 4 were funded and 6 declined, for an application success rate of 40% (2 were pending).

The application success rates for BIO Fellows compare favorably with the five-year average rates ending in 2003 for all of NSF (32%), all of the BIO Directorate (29%), all minority Principal Investigators (29%), and all new Principal Investigators (22%).[21]

[21] National Science Foundation. (May 2003). *Report to the National Science Board on the National Science Foundation's Merit Review Process FY 2002*. NSB 03-2-66. Available at http://www.nsf.gov/nsb/documents/2003/merit_rprt/mrp.htm.

SBE Fellows

As of January 2004, 11 former SBE Fellows had submitted a total of 20 non-MPRF proposals. Ten of those proposals were awarded and 8 declined, for an application success rate of 55% (2 were pending at the time of the analysis). These rates compare very favorably with the five-year SBE average award rate of 35%. One of the awards was for a CAREER proposal and one for an ADVANCE proposal.

CHAPTER VI: ANALYSIS OF THE NATIONAL POSTDOCTORAL POOL

This chapter describes the pools of students and degree recipients in BIO and SBE fields who are or were potentially eligible for MPRF support. The period covered is 1989-2000. The chapter also examines the postdoctoral plans of Ph.D.s who received their doctorates during this period, and estimates the proportion that obtained MPRF awards. The last section of the chapter looks at the employment of 1989-1998 Ph.D.s who resided in the United States in 1999.

Highlights

MPRF BIO Pool

- The pool of potential minority postdoctorates in BIO fields more than doubled during the 1990s but remains fairly small. In 2000, underrepresented minorities received 10,844 bachelor's degrees, 749 master's degrees, and 320 doctorates in biological science fields.

- From 1989 to 2000, underrepresented minorities earned a total of 2,822 doctorates in the biological sciences—or 5.7% of all biological science doctorates awarded to U.S. citizens and permanent residents during the 12-year period. Hispanics received 3.3% of these doctorates, blacks 2.1%, and American Indians/Alaska Natives 0.3%.

- Within the 12-year total, biochemistry (385) accounted for the largest number of doctorates received by underrepresented minorities, followed by molecular biology (319), bacteriology and microbiology (267), neuroscience (222) and physiology (185).

- About 71% (1,898) of the underrepresented minority Ph.D.s in the biological sciences planned on obtaining a postdoctorate after graduation. Within this group, more than three in five were either seeking or had already obtained a fellowship. The MPRF BIO program supported an estimated 127 (10.6%) of the 1,197 new Ph.D.s who sought postdoctoral fellowships.

- Universities have long been the primary setting for postdoctoral work. More than three-fourths (76.9%) of underrepresented minority Ph.D.s with definite postdoctoral appointments by graduation planned to undertake their postdoctoral work at universities. Most others were headed to Federal labs or facilities or into nonprofit organizations.

- The Federal government was the major source of postdoctoral support in the biological sciences. More than 58% of underrepresented minority Ph.D.s with postdoctoral commitments obtained most of their support from the Federal government; 23% were supported primarily by a university.

MPRF SBE Pool

- The pool of potential minority postdoctorates in SBE fields nearly doubled during the 1990s but remains fairly small. In 2000, underrepresented minorities received 37,409 bachelor's degrees; 4,213 master's degrees; and 514 doctorates in social, behavioral, and economic fields (154 doctorates in the behavioral sciences and 360 in the social and economic sciences).

- Of the 1,425 behavioral science doctorates awarded to U.S. citizens and permanent residents between 1989 and 2000, underrepresented minorities received 9.3%: blacks 4.3%, Hispanics 4.5%, and American Indians/Alaska Natives 0.5%. The five largest doctoral specialties for underrepresented minorities were developmental/child psychology (235 doctorates); social psychology (165); experimental psychology (91); developmental/individual or family psychology (90); and physiological psychology or psychobiology (88).

- Underrepresented minorities received 10.5% of the 3,278 doctorates awarded in social and economic sciences between 1989 and 2000. Hispanics earned 3.8% of these degrees, blacks 6.1%, and American Indians/Alaska Natives 0.6%. Nearly three-fourths of the doctorates were in sociology (680 doctorates), political science or government (545), economics (517), anthropology (330), and public policy analysis or public administration (329).

- More than one-fifth (921) of underrepresented minority Ph.D.s in SBE fields planned on having a postdoctoral appointment after graduation. Two-thirds (621) were seeking fellowship opportunities or had already received a fellowship. The MPRF SBE program awarded fellowships to an estimated 4.7% of those Ph.D.s planning on a fellowship after graduation.

- Colleges and universities were by far the most likely setting for postdoctoral work in SBE fields. Of the underrepresented minority Ph.D.s in the social and economic sciences who definitely had a postdoctoral appointment by graduation, 87.4% planned to undertake their postdoctoral work at a university. The figure was nearly as high among underrepresented minority Ph.D.s in the behavioral sciences (81.6%). More than 13% of behavioral science Ph.D.s and 9% of those in the social and economic sciences had postdoctoral commitments at Federal government facilities or nonprofit organizations.

- Universities were the primary source of postdoctoral support for a majority (51.7%) of underrepresented minority Ph.D.s in the social and economic sciences. In the behavioral sciences, the Federal government was the major funder of postdoctoral work, providing most of the support for just over half (50.2%) of Ph.D.s with postdoctoral commitments after graduation.

Data Sources and Methodology

Four national data sets from surveys conducted by NSF and the National Center for Education Statistics (NCES) are the foundation for this review:

- The National Center for Education Statistics (NCES)' Completions Survey, Integrated Postsecondary Education Data System (IPEDS) – bachelor's and master's degree recipients (potential postdocs);
- NSF's Graduate Students Survey (GSS) – graduate enrollments (potential postdocs);
- NSF's Survey of Earned Doctorates (SED) – new doctorate recipients and their immediate postgraduation plans (potential and actual postdocs);
- NSF's Survey of Doctorate Recipients (SDR) – Ph.D.s in the U.S. workforce (actual postdocs).

For comparability with the MPRF program, the data analyzed here are restricted to U.S. citizens and permanent residents; to the 1989-2000 period (when most, 154 of 163, MPRF recipients in this study earned their doctorates), and to the fields included in the MPRF program.

For analyses at the doctoral level, BIO and SBE field data include only those specialties identified by the MPRF program officers as being covered by the program. (These definitions match those used in the survey of MPRF awardees conducted for this study). For example, MPRF BIO fields include some specialties classified as agriculture in the SED and SDR, and exclude some specialties classified in these surveys as biological sciences. The SBE definition has similar adjustments.

Also, for analyses of new Ph.D.s from the SED, the doctorate field counts were adjusted by postdoctoral study and employment fields. That is, a person who did *not* receive a doctorate in a BIO or SBE field, but who planned further study or employment after graduation in one of those fields, was counted as a BIO or SBE Ph.D. (This adjustment could not be made to the SDR data on Ph.D.s in the U.S. workforce because the SDR occupation taxonomy is not sufficiently compatible with the SED field taxonomy.)

The analyses of predoctoral data—bachelor's and master's degrees, graduate enrollments—are based on broader field definitions. Broader definitions were used because (1) it is not possible to identify all of the doctorate specialties at predoctoral levels, and (2) a substantial number of students change broad fields, or at least specialties, between the bachelor's/master's degrees and the doctorate. Thus, BIO at the predoctoral levels includes all fields defined as biological sciences by NSF and NCES in their published reports. Also, because the MPRF program covers several agricultural specialties, the entire discipline of agriculture sciences has been added to the BIO definition at the predoctoral level. Similarly, the SBE definition includes

all fields defined by NSF and NCES as social sciences (including economics) and behavioral sciences.

The discussion in this chapter focuses on the categories of underrepresented minorities covered by the MPRF program. It is not possible to identify Pacific Islanders in the national data sets as that group is just now being collected separately from Asians. Blacks and American Indians/Alaska Natives who are also Hispanic are counted only as Hispanics, as is standard practice in NSF and NCES reporting. To allow comparisons with whites and Asians/Pacific Islanders, Appendix C contains tables with data for all of the racial/ethnic groups.

Overview of Potential and Actual Postdoctoral Pools

This part of the chapter looks at degrees awarded to underrepresented minorities in BIO and SBE fields at the bachelor's, master's, and doctoral levels; graduate enrollments of underrepresented minorities in BIO and SBE programs; and the postdoctoral plans of new doctorate recipients who are underrepresented minorities. For convenience throughout the remainder of this chapter, postdoctoral appointments are referred to as "postdocs."

Bachelor's and Master's Degrees

In the 12 years from 1989 to 2000, underrepresented minorities made remarkable gains in educational attainment (see Exhibit VI-1). Their annual numbers of bachelor's and master's degrees increased more than twofold in both BIO and SBE. In 2000, underrepresented minorities earned 10,844 bachelor's degrees in BIO fields and 37,409 bachelor's degrees in SBE fields. Not surprisingly, the numbers of master's degrees awarded in the two areas were much smaller (749 in BIO and 4,213 in SBE), but these figures represent substantial increases over the numbers a decade earlier. Most of these graduates will not complete a doctorate. However, these pipeline figures show that the pool of *potential* postdocs is growing rapidly in both BIO and SBE.

Graduate Enrollments

Between 1992 and 2000, the annual number of underrepresented minorities enrolled in graduate school increased by 49.3% in BIO (to 5,398 in 2000) and by 44.4% in SBE (to 22,138). These numbers include students in doctoral programs as well as those in master's programs. (Note: The data on permanent residents cannot be disaggregated from total foreign graduate students prior to 1992.)

Exhibit VI-1: Degrees and Graduate Enrollments of Underrepresented Minorities in MPRF Fields: 1989-2000 (annual number and percent change)

Field	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	% Change 1989 to 2000
Biological Sciences (BIO)													
Bachelor's degrees	4,548	4,691	4,979	5,523	6,102	6,840	7,379	8,656	9,351	10,443	(10,644)	10,844	138.4%
Graduate enrollments	na	na	na	3,615	4,120	4,085	4,560	4,754	5,054	5,193	5,381	5,398	(1992-2000) 49.3%
Master's degrees	357	324	394	422	459	570	532	603	686	633	(691)	749	109.8%
Doctorates	139	158	172	191	207	238	259	257	257	310	314	320	130.2%
Social, Behavioral, & Economic Sciences (SBE)													
Bachelor's degrees	16,315	18,160	20,769	24,384	26,458	29,020	30,312	32,005	33,810	34,836	(36,123)	37,409	129.3%
Graduate enrollments	na	na	na	15,333	16,818	17,170	18,090	18,702	19,246	19,828	20,848	22,138	(1992-2000) 44.4%
Master's degrees	1,565	1,745	1,925	2,106	2,346	2,699	3,179	3,394	3,713	3,814	(4,014)	4,213	169.2%
Doctorates	264	313	356	317	344	368	414	416	415	487	495	514	94.7%

Source: **(Bachelor's and master's degrees):** National Science Foundation/Science Resources Statistics, *Science and Engineering Degrees, by Race/Ethnicity of Recipients: 1989-97* and *1991-2000*. Data from Department of Education/National Center for Education Statistics, IPEDS Completions Survey. Data for 1999 estimated as average of 1998 and 2000; NCES did not release 1999 figures. **(Graduate enrollments):** National Science Foundation/Science Resources Statistics, Survey of Graduate Students and Postdoctorates in Science and Engineering (special tabulations from WebCASPAR). **(Doctorates):** National Science Foundation/Science Resources Statistics, Survey of Earned Doctorates (special tabulations from Doctorate Records File). Data on permanent residents in 1989-91 cannot be separated from total foreign enrollments.

Doctorates

The best indicator of the future postdoc pool is the number of Ph.D.s who graduated in recent years and the number who planned on a postdoc as their first position after graduation.

In terms of the average numerical change between 1989 and 2000, the total number of doctorates earned by underrepresented minorities increased by more than 16 annually in the biological sciences, by more than 14 in the social and economic sciences, and by more than 8 in the behavioral sciences.

Growth in BIO doctorates among underrepresented minorities is similar to that for bachelor's and master's degrees in BIO fields. Between 1989 and 2000, the annual number of BIO doctorates earned by underrepresented minorities increased by 130.2%, from 139 to 320.

The annual number of SBE doctorates awarded to underrepresented minorities during this period increased by 94.7%, from 264 to 514. Within SBE, the percentage change was far greater in the behavioral sciences (+152.5%, up from 61 to 154 doctorates) than in the social and economic sciences (+77.3%, up from 203 to 360 doctorates), although the number of doctorates in the social and economic sciences exceeded the behavioral science number, as well as the biological science number, in every year from 1989 to 2000.

The spread between the biological sciences and the social and economic sciences has narrowed considerably. By 2000, the biological sciences lagged behind the social and economic sciences by only 40 doctorates, whereas in 1989, the difference was 64 between much smaller totals.

(Appendix Table C-1 presents annual numbers of doctorates earned by underrepresented minorities in each of the *specialties* included in the BIO and SBE definitions. Appendix Table

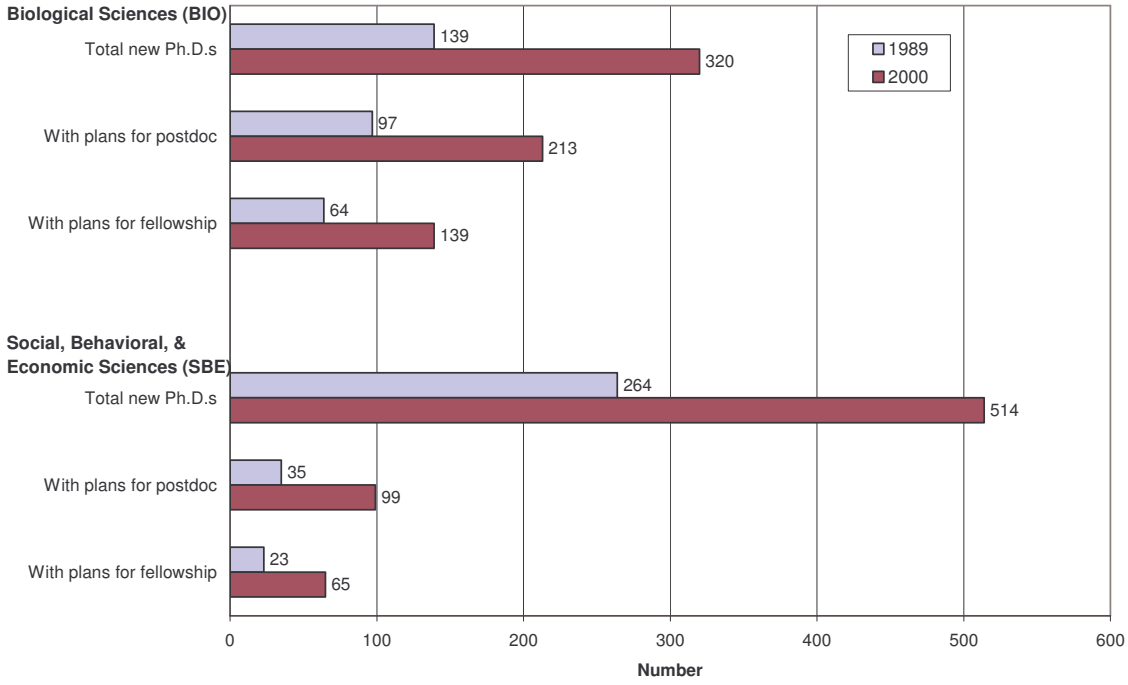
C-2 shows the numbers of doctorates in the three broad MPRF disciplines by racial/ethnic group, as well as the percentage distribution of men and women within each group.)

Postdocs

The number of new Ph.D.s who planned on a postdoc as their first position after graduation also grew (Exhibit VI-2). The postdoc number in BIO more than doubled, from 97 in 1989 to 213 in 2000. In SBE it nearly tripled, from 35 to 99.

Growth in the number of fellowships paralleled the overall postdoc numbers. A total of 1,197 BIO Ph.D.s and 621 SBE Ph.D.s who graduated in the 1989-2000 period planned on a fellowship soon after graduation. The MPRF program provided fellowships to an estimated 127 (10.6%) of the BIO Ph.D.s and an estimated 29 (4.7%) of the SBE Ph.D.s.

Exhibit VI-2: Underrepresented Minority Ph.D.s in MPRF Fields with Plans for Postdoc After Graduation: 1989 and 2000 (number)



Source: National Science Foundation/Science Resources Statistics, Survey of Earned Doctorates (special tabulations from Doctorate Records File).

The postdoc numbers discussed here include Ph.D.s who *aspired* to a postdoc as their first position after graduation as well as those who had a commitment for a postdoc by the time they graduated. Because some aspirations may not come to fruition, it is likely that the numbers of new Ph.D.s who actually went on a postdoc soon after graduation is somewhat smaller than the numbers shown in Exhibit VI-2. Exhibit VI-3 compares the total numbers (including aspirations) with the numbers of new Ph.D.s who had a postdoc *definitely* lined up through a signed contract or other firm arrangement. The true numbers of postdocs among new Ph.D.s probably lie between these two sets of numbers. Exhibit VI-3 presents data on degrees and postdocs for each of the underrepresented minority groups in the aggregate 1989-2000 period.

Exhibit VI-3: Degrees and Postdocs of Underrepresented Minorities in MPRF Fields, by Race/Ethnicity: 1989-2000 Aggregate (number)

	Total Underrepresented	Blacks	Hispanics	American Indians/ Alaska Natives
Biological Sciences				
Bachelor's degrees	90,000	42,724	42,750	4,526
Master's degrees	6,420	2,857	3,173	390
Doctorates	2,822	1,029	1,630	163
% of all Ph.D.s in BIO fields	*5.7%*	*2.1%*	*3.3%*	*0.3%*
Total planning postdoc	1,898	681	1,108	109
Fellowship	1,197	436	693	68
Research associateship	483	158	301	24
Traineeship	46	22	23	1
Other	172	65	91	16
Postdoc "commitment"	1,443	497	857	89
Fellowship	921	318	550	53
Research associateship	342	109	211	22
Traineeship	37	18	18	1
Other	143	52	78	13
Social & Economic Sciences				
Bachelor's degrees	220,876	122,562	89,024	9,290
Master's degrees	16,909	9,671	6,282	956
Doctorates	3,278	1,911	1,191	176
% of all Ph.D.s in social sciences	*10.5%*	*6.1%*	*3.8%*	*0.6%*
Total planning postdoc	492	309	157	26
Fellowship	319	200	106	13
Research associateship	122	73	41	8
Traineeship	9	7	1	1
Other	42	29	9	4
Postdoc "commitment"	268	164	96	8
Fellowship	197	120	71	6
Research associateship	46	25	21	0
Traineeship	2	2	0	0
Other	23	17	4	2
Behavioral Sciences				
Bachelor's degrees	118,725	63,666	50,442	4,617
Master's degrees	17,804	9,663	7,321	820
Doctorates	1,425	651	691	83
% of all Ph.D.s in behavioral sciences	*9.3%*	*4.3%*	*4.5%*	*0.5%*
Total planning postdoc	429	176	228	25
Fellowship	302	124	160	18
Research associateship	90	35	50	5
Traineeship	17	7	9	1
Other	20	10	9	1
Postdoc "commitment"	290	121	153	16
Fellowship	219	90	117	12
Research associateship	47	19	25	3
Traineeship	11	4	6	1
Other	13	8	5	0

Source: See Exhibit VI-1 for degree and graduate enrollment data. Postdoc data from National Science Foundation/Science Resources Statistics, Survey of Earned Doctorates (special tabulations from Doctorate Records File).

BIO Fields

Underrepresented minorities earned 90,000 bachelor's degrees, 6,420 master's degrees, and 2,822 doctorates in BIO fields during this 12-year period (see Exhibit VI-3). Their doctorates represent 5.7% of all BIO doctorates awarded to U.S. citizens and permanent residents between 1989 and 2000.

At each degree level, Hispanics accounted for more BIO degrees than blacks and American Indians/Alaska Natives, although blacks received nearly as many bachelor's degrees as Hispanics. The difference between the two groups is greatest at the doctoral level; Hispanics earned 1,630 doctorates in BIO, compared with 1,029 earned by blacks. The numbers of degrees received by American Indians/Alaska Natives were very small in comparison. (See Appendix Tables C-2 and C-3 for the total number of doctorates earned by each racial/ethnic group in the aggregate 1989-2000 period.)

Almost 71% (1,898) of the BIO Ph.D.s who reported immediate postgraduation plans counted on obtaining a postdoc; 1,443 of these Ph.D.s already had signed a contract or made some other type of firm arrangement for a postdoc. The percentage of Ph.D.s with plans for a postdoc was similar for each of the underrepresented groups but slightly higher for American Indians/Alaska Natives and Hispanics than for blacks. (See Appendix Tables C-4 to C-8 for the postgraduation plans of all racial/ethnic groups.)

More than three in five (63.1%, or 1,197) of the BIO Ph.D.s with postdoc plans had a fellowship lined up or had hopes of obtaining one. As noted earlier, the MPRF program accounted for an estimated 10.6% of these BIO fellowships.

SBE Fields

The numbers of degrees in SBE fields were much larger than the BIO numbers (see Exhibit VI-3). Between 1989 and 2000, underrepresented minorities received 339,601 bachelor's degrees in SBE fields, 34,713 master's degrees, and 4,703 doctorates (3,278 in the social and economic sciences, and 1,425 in the behavioral sciences). These doctorates represent 10.1% of all SBE doctorates awarded to U.S. citizens and permanent residents in the 1989-2000 period, 10.5% of the total in the social and economic sciences, and 9.3% of the total in the behavioral sciences. With one exception, blacks earned substantially more degrees at each level than Hispanics and American Indians/Alaska Natives. Hispanics outnumbered blacks in behavioral science doctorates.

Plans for a postdoc after graduation were far less common among SBE Ph.D.s than among BIO Ph.D.s. Only 21.2% of SBE Ph.D.s had plans for a postdoc, and only 558 of these 921 Ph.D.s had a postdoc definitely lined up by the time they graduated. In SBE as in BIO, blacks were somewhat less likely to go into a postdoc position after graduation than were Hispanics and American Indians/Alaska Natives. This was true, however, only in the behavioral sciences; blacks had a higher postdoc rate than the other groups in the social and economic sciences.

More than two-thirds (67.4%, or 621) of the SBE Ph.D.s planning a postdoc after graduation had already obtained a fellowship or were looking for one. The MPRF program awarded an estimated 4.7% of these SBE fellowships.

The next section of this chapter provides more detailed information from the SED on Ph.D.s who earned their doctorates in the 1989-2000 period—the number of Ph.D.s in each of the specialties that make up BIO and SBE and descriptions of new Ph.D.s' plans for right after graduation. The final section of this chapter analyzes SDR data on the employment of Ph.D.s in 1999 and their postdoc history.

Detailed Findings About New Ph.D.s – 1989-2000

This part of the chapter looks at the doctorate specialties of new Ph.D.s within each of the MPRF disciplines; examines the growth in the annual numbers of doctorates earned by each underrepresented group and in the numbers earned by women within each group; and further explores the plans of new Ph.D.s after graduation.

Between 1989 and 2000, underrepresented minorities received a total of 30,741 doctorates, including those in non-MPRF fields, for 8.9% of all doctorates awarded to U.S. citizens and permanent residents during the period (see Appendix Table C-3, which gives numbers of doctorates for all racial/ethnic groups, including whites and Asians/Pacific Islanders). A quarter (7,525) of the doctorates earned by underrepresented minorities were in MPRF fields.

Of the three underrepresented minority groups, blacks accounted for the most doctorates in the social and economic sciences (6.1% of all doctorates in the field), while Hispanics accounted for the most doctorates in the biological sciences (3.3%) and behavioral sciences (4.5%). In comparison, Asians/Pacific Islanders earned 13.3% of all doctorates in the biological sciences, 7.7% in the social and economic sciences, and 4.0% in the behavioral sciences.

Doctorate Specialties

Exhibits VI-4 and VI-5 present the numbers of doctorates earned by underrepresented minorities in the specialties included in the BIO and SBE definitions for this study. The top 5 specialties in each MPRF discipline, in terms of the total number of doctorates awarded to underrepresented minorities in the 1989-2000 period, are highlighted.

Within the biological sciences, biochemistry ranked first with 385 doctorates to underrepresented minorities during this period (see Exhibit VI-4). Molecular biology, bacteriology/microbiology, neuroscience, and human/animal physiology completed the top 5.

Exhibit VI-4: Underrepresented Minorities with Doctorates in Biological Sciences, by Specialty and Race/Ethnicity: 1989-2000 Aggregate (number)

	Total Under-represented	Blacks	Hispanics	American Indians/ Alaska Natives
Biological Sciences, Total	**2,822**	**1,029**	**1,630**	**163**
Agronomy or Crop Science	55	27	25	3
Anatomy	41	18	23	0
Bacteriology or Microbiology	267	104	150	13
Biochemistry	385	150	209	26
Biometrics or Biostatistics	44	31	13	0
Biophysics	67	22	40	5
Biotechnology	16	5	11	0
Botany, Other	40	10	26	4
Cell Biology	146	47	90	9
Conservation or Renewable Natural Resources	18	8	10	0
Developmental Biology or Embryology	41	14	27	0
Ecology	99	26	67	6
Endocrinology	29	9	16	4
Entomology	75	23	51	1
Environmental Science	57	24	29	4
Fisheries Science/Management	20	7	8	5
Forest Biology	3	2	1	0
Genetics	111	31	74	6
Horticulture	31	13	16	2
Immunology	116	43	69	4
Molecular Biology	319	119	181	19
Neuroscience	222	74	134	14
Physiology, Human/Animal	185	90	88	7
Plant Pathology	52	18	32	2
Plant Physiology	24	5	18	1
Wildlife/Range Management	26	6	13	7
Zoology, Other	71	11	53	7
Biological Sciences, Other	262	92	156	14

Note: The top 5 specialties, in terms of total numbers, are highlighted.

Source: National Science Foundation/Science Resources Statistics, Survey of Earned Doctorates (special tabulations from Doctorate Records File).

Sociology was the largest specialty in the social and economic sciences (see Exhibit VI-5). Underrepresented minorities received 680 sociology doctorates in the 1989-2000 period. The next largest numbers were in political science/government, economics, anthropology, and public policy analysis/public administration.

The largest behavioral science specialty among underrepresented minority Ph.D.s was developmental/child psychology (235 doctorates). Social psychology was next largest, followed by experimental psychology, human/individual/family development, and physiological psychology/psychobiology.

Exhibit VI-5: Underrepresented Minorities with Doctorates in Social, Behavioral, and Economic Sciences, by Specialty and Race/Ethnicity: 1989-2000 Aggregate (number)

	Total Under-represented	Blacks	Hispanics	American Indians/ Alaska Natives
Social, Behavioral, & Economic Sciences, Total	**4,703**	**2,562**	**1,882**	**259**
Social & Economic Sciences, Subtotal	**3,278**	**1,911**	**1,191**	**176**
Anthropology	330	121	166	43
Criminology	99	72	22	5
Demography or Population Studies	16	7	9	0
Econometrics	16	8	8	0
Economics	517	288	218	11
Geography	63	24	31	8
History/Philosophy of Science & Technology	22	11	11	0
International Relations/Affairs	117	72	42	3
Linguistics	138	47	85	6
Political Science or Government	545	341	179	25
Public Policy Analysis or Public Administration	329	238	79	12
Sociology	680	412	229	39
Statistics	14	7	6	1
Urban Affairs/Studies	126	90	30	6
Social Sciences, Other	266	173	76	17
Behavioral Sciences, Subtotal	**1,425**	**651**	**691**	**83**
Cognitive Psychology or Psycholinguistics	57	17	35	5
Comparative Psychology	12	2	9	1
Development, Human/Individual/Family	90	57	26	7
Developmental/Child Psychology	235	121	105	9
Experimental Psychology	91	37	46	8
Physiological Psychology or Psychobiology	88	41	40	7
Psychometrics	17	5	10	2
Quantitative Psychology	12	2	9	1
Social Psychology	165	95	65	5
Psychology, Other	658	274	346	38

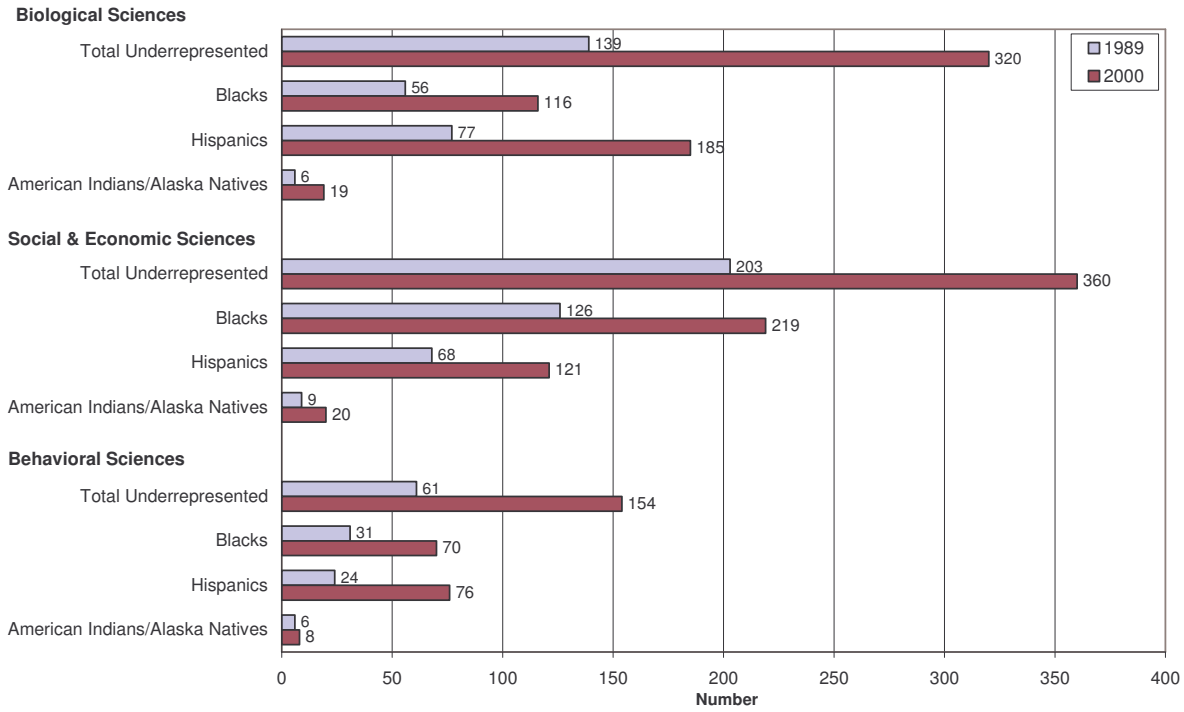
Note: The top 5 specialties, in terms of total numbers, are highlighted.

Source: National Science Foundation/Science Resources Statistics, Survey of Earned Doctorates (special tabulations from Doctorate Records File.

Race/Ethnicity of New Ph.D.s

Exhibits VI-4 and VI-5 provided the numbers of doctorates earned by each of the underrepresented minority groups in the three MPRF disciplines during the entire 1989-2000 period. Exhibit VI-6 compares the numbers in 1989 and 2000 for each group.

Exhibit VI-6: Underrepresented Minorities with Doctorates in MPRF Fields, by Race/Ethnicity: 1989 and 2000 (number)



Source: National Science Foundation/Science Resources Statistics, Survey of Earned Doctorates (special tabulations from Doctorate Records File).

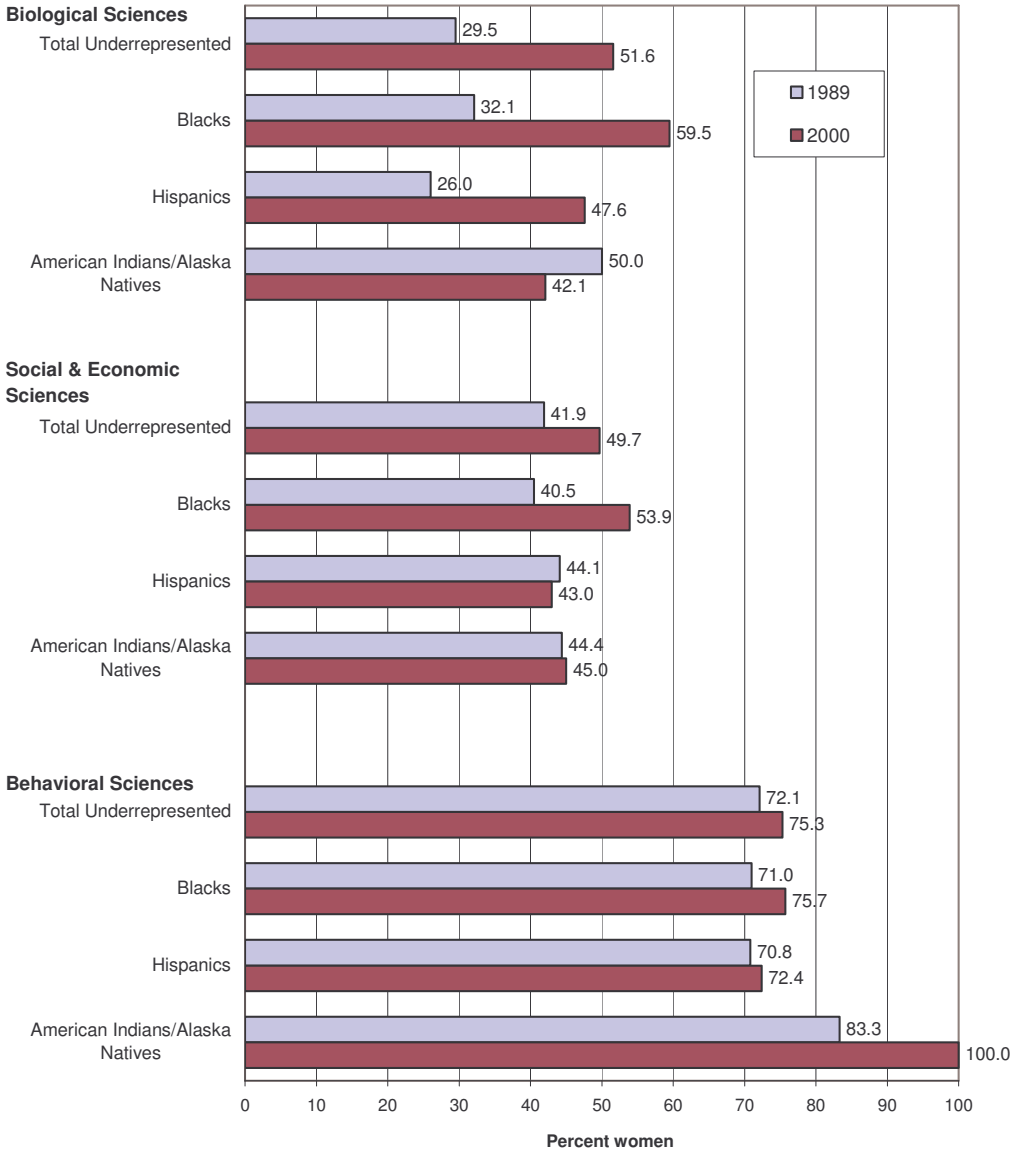
Growth was for the most part greater in the biological sciences and the behavioral sciences than in the social and economic sciences. Between 1989 and 2000, the annual number of doctorates awarded to blacks and Hispanics in the biological sciences more than doubled, and the number awarded to American Indians/Alaska Natives more than tripled. In the behavioral sciences, the annual number more than tripled for Hispanics and more than doubled for blacks. The increase for American Indians/Alaska Natives was very small in the behavioral sciences, but their annual number of doctorates in the social and economic sciences more than doubled. (See Appendix Table C-2 for 1989 and 2000 numbers for all racial/ethnic groups, including whites and Asians/Pacific Islanders.)

Compared with the other underrepresented groups, Hispanics earned the most doctorates in the biological sciences in both 1989 and 2000 (57.8% of the total for underrepresented minorities in 2000), and blacks earned the most in the social and economic sciences (60.8% in 2000). Although blacks led in behavioral science doctorates in 1989, Hispanics received the largest number in 2000 (49.4%).

Sex of New Ph.D.s

In the 1989-2000 period, women accounted for 43.3% of all doctorates awarded to underrepresented minorities in the biological sciences, 43.4% in the social and economic sciences, and 65.7% in the behavioral sciences (see Appendix Table C-2). Since 1989, they have increased their presence relative to men in each of the underrepresented groups and in every MPRF discipline, except among American Indian/Alaskan Natives in the biological sciences and among Hispanics in the social and economic sciences (Exhibit VI-7).

Exhibit VI-7: Underrepresented Minority Women with Doctorates in MPRF Fields, by Race/Ethnicity: 1989 and 2000 (percent of all Ph.D.s in racial/ethnic group)



Source: National Science Foundation/Science Resources Statistics, Survey of Earned Doctorates (special tabulations from Doctorate Records File).

Women have been particularly prominent in the behavioral sciences, earning a large majority of the doctorates in each racial/ethnic group, both in 1989 and in 2000. By 2000, three-fourths of the behavioral science doctorates awarded to underrepresented minorities went to women.

Women also received more than half (51.6%) of the biological science doctorates awarded to underrepresented minorities in 2000—a large increase from 29.5% in 1989. Among blacks in the biological sciences, women's share was 59.5% in 2000, an increase of 27.4 points since 1989. The change for underrepresented minority women was far greater than for white and Asian/Pacific Islander women (see Appendix Table C-2 for data on whites and Asians/Pacific Islanders).

Just under half of all doctorates in the social and economic sciences received by underrepresented minorities went to women. In 2000, black women earned 53.9% of all doctorates in the field that were awarded to blacks; they were the only women to receive a majority of the doctorates within their racial/ethnic group in each of the MPRF disciplines.

Postgraduation Plans

Of the 7,525 underrepresented minorities in MPRF fields who graduated in the 1989-2000 period, 7,021 reported postgraduation plans (see Exhibit VI-8). More than two in five (2,819) of those who reported plans intended to pursue further study or training (including postdocs) rather than employment after graduation. (For this discussion, also see Appendix Tables C-4 to C-8, which show the postgraduation plans for all racial/ethnic groups.)

Exhibit VI-8: Postgraduation Plans of Underrepresented Minority Ph.D.s in MPRF Fields, by Race/Ethnicity: 1989-2000 Aggregate (number)

	Total Under-represented	Blacks	Hispanics	American Indians/ Alaska Natives
Biological Sciences				
Plans for postdoc	**1,898**	**681**	**1,108**	**109**
Plans for employment	**778**	**284**	**453**	**41**
Academe	338	124	196	18
Industry/self-employment	198	74	116	8
Government	112	41	63	8
Other	56	19	37	0
Unknown employer	74	26	41	7
Social & Economic Sciences				
Plans for postdoc	**492**	**309**	**157**	**26**
Plans for employment	**2,601**	**1,490**	**966**	**145**
Academe	1,745	968	681	96
Industry/self-employment	190	101	78	11
Government	291	200	75	16
Other	210	120	79	11
Unknown employer	165	101	53	11
Behavioral Sciences				
Plans for postdoc	**429**	**176**	**228**	**25**
Plans for employment	**823**	**410**	**369**	**44**
Academe	425	223	182	20
Industry/self-employment	114	54	52	8
Government	99	44	48	7
Other	124	69	51	4
Unknown employer	61	20	36	5

Source: National Science Foundation/Science Resources Statistics, Survey of Earned Doctorates (special tabulations from Doctorate Records File.

The postgraduation plans of Ph.D.s vary substantially by field. The vast majority of underrepresented minority Ph.D.s in the social and economic sciences (84.1%) and in the behavioral sciences (65.7%) planned on obtaining a regular job in the workforce or on returning to one they already held. The case was opposite in the biological sciences, where only 29.1% of new Ph.D.s had employment plans after graduation.

In each of the MPRF disciplines, the largest proportion of new Ph.D.s with employment plans either had already found a job in academe or were hoping to find one. A large majority of such Ph.D.s in the social and economic sciences (71.6%) intended to work in the academic sector, as did 55.8% of behavioral science Ph.D.s. The figure was lower among Ph.D.s in the biological sciences (48.0%) as industry attracted 28.1% of the group.

Since the 1970s, one or more postdocs have been required in many biological science fields, and the propensity toward further study or training is striking in all racial/ethnic groups. Among the underrepresented minority Ph.D.s who graduated between 1989 and 2000, 70.9% of those in the biological sciences, versus 34.3% in the behavioral sciences and 15.9% in the social and economic sciences, planned on taking a postdoc soon after graduation. Moreover, the number of postdocs among new Ph.D.s in the biological sciences (1,898) was almost four times larger than the numbers in the social and economic sciences (492) and in the behavioral sciences (429).

A comparison of the postdoc numbers with those for academic employment reveals interesting differences among the MPRF disciplines. Among underrepresented minorities in 1989-2000, the number of behavioral science Ph.D.s with immediate employment plans in academe (425) was about the same as the number with plans for a postdoc (429). In the social and economic sciences, however, the number of Ph.D.s with plans for a job in academe was more than 3.5 times larger than the number with plans for a postdoc. The distribution was the reverse in the biological sciences, with the postdoc number more than 5.5 times larger than the academic employment number.

About 71% of blacks and Hispanics and about 73% of American Indians/Alaska Natives who received doctorates in the biological sciences between 1989 and 2000 planned to take a postdoc soon after graduation. There was greater variation in the social, behavioral, and economic sciences. Of the three underrepresented minority groups, Hispanics had the highest postdoc rate in the behavioral sciences (38.2%). Blacks had the highest rate, at 17.2%, in the social and economic sciences.

Postdocs were more common in some specialties than in others. In 15 of the 27 specialties within the biological sciences, a majority of underrepresented minority Ph.D.s expected to have a postdoc after graduation, and in 11 of these specialties, the postdoc rate exceeded the average (70.9%) for all biological science specialties combined (Exhibit VI-9). More than 4 in 5 underrepresented minority Ph.D.s in 9 specialties reported plans for a postdoc: anatomy, biochemistry, biophysics, cell biology, endocrinology (highest at 89.7%), immunology, molecular biology, neuroscience, and human/animal physiology. The largest numbers of postdocs were in biochemistry (308) and molecular biology (256). Although its postdoc rate was

somewhat lower at 75%, bacteriology/microbiology had the third largest number (189) of postdocs among the specialties within the biological sciences.

Exhibit VI-9: Postdoc Rates of Underrepresented Minority Ph.D.s in Biological Sciences, by Specialty: 1989-2000 Aggregate (number of postdocs and percent of all Ph.D.s in specialty)

	Total with Plans for Postdoc (N)	Postdoc Rate (%)
Biological Sciences, Total	**1,898**	**70.9**
Agronomy or Crop Science	19	39.6
Anatomy	29	82.9
Bacteriology or Microbiology	189	75.0
Biochemistry	308	83.0
Biometrics or Biostatistics	9	21.4
Biophysics	53	85.5
Biotechnology	9	56.3
Botany, Other	16	42.1
Cell Biology	122	83.6
Conservation or Renewable Natural Resources	4	23.5
Developmental Biology or Embryology	28	68.3
Ecology	45	48.4
Endocrinology	26	89.7
Entomology	33	45.2
Environmental Science	10	19.2
Fisheries Science/Management	3	16.7
Forest Biology	1	33.3
Genetics	85	77.3
Horticulture	11	37.9
Immunology	96	85.0
Molecular Biology	256	82.3
Neuroscience	182	85.8
Physiology, Human/Animal	144	82.3
Plant Pathology	24	53.3
Plant Physiology	11	47.8
Wildlife/Range Management	4	15.4
Zoology, Other	45	67.2
Biological Sciences, Other	136	59.4

Note: The 9 specialties with postdoc rates above 80 percent are highlighted. Although the postdoc rates are lower in the other specialties, some of those specialties have substantial numbers of postdocs.
Source: National Science Foundation/Science Resources Statistics, Survey of Earned Doctorates (special tabulations from Doctorate Records File).

Plans for further research or training after graduation were much less prevalent in the social, behavioral, and economic sciences (see Exhibit VI-10). Among the 9 specialties within the behavioral sciences, the highest postdoc rates for underrepresented minority Ph.D.s in the 1989-2000 period were in physiological psychology/psychobiology (76.1%, 67 postdocs) and comparative psychology (66.7%, but only 8 postdocs). The largest number of postdocs within the behavioral sciences was in developmental/child psychology (69), which had a much lower postdoc rate of 31.1%.

Postdocs were least common in the social and economic sciences. In only 5 of the 14 specialties did one-fourth or more of underrepresented minority Ph.D.s have plans for a postdoc after graduation. One-third of Ph.D.s in history/philosophy of science and technology and in statistics planned additional study after graduation, as did one-fourth of those in anthropology, demography/population studies, and international relations/affairs. Except for anthropology, though, the specialties with the highest postdoc rates had small numbers of postdocs. The largest numbers—accounting for nearly two-thirds of all postdocs in the social and economic sciences—were in sociology (112), anthropology (76), political science/government (67), and geography (59).

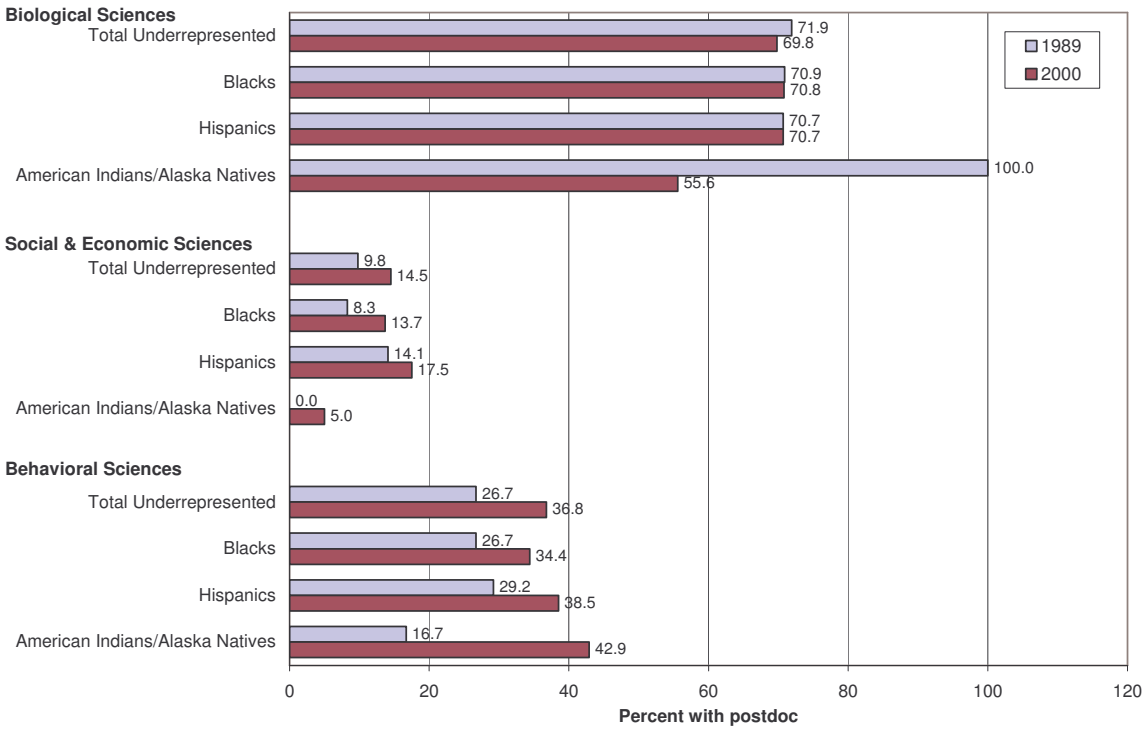
Exhibit VI-10: Postdoc Rates of Underrepresented Minority Ph.D.s in Social, Behavioral, and Economic Sciences, by Specialty: 1989-2000 Aggregate (number of postdocs and percent of all Ph.D.s in specialty)

	Total with Plans for Postdoc (N)	Postdoc Rate (%)
Social, Behavioral, & Economic Sciences, Total	**921**	**21.2**
Social & Economic Sciences, Subtotal	**492**	**15.9**
Anthropology	76	24.6
Criminology	10	10.2
Demography or Population Studies	4	26.7
Econometrics	2	12.5
Economics	59	12.0
Geography	7	12.1
History/Philosophy of Science & Technology	7	33.3
International Relations/Affairs	27	25.0
Linguistics	17	12.9
Political Science/Government	67	13.0
Public Policy Analysis or Public Administration	31	9.9
Sociology	112	17.6
Statistics	4	33.3
Urban Affairs/Studies	14	11.7
Social Sciences, Other	55	22.4
Behavioral Sciences, Subtotal	**429**	**34.3**
Cognitive Psychology/Psycholinguistics	27	49.1
Comparative Psychology	8	66.7
Development, Human/Individual/Family	17	21.2
Developmental/Child Psychology	69	31.1
Experimental Psychology	35	39.8
Physiological Psychology or Psychobiology	67	76.1
Psychometrics	7	43.8
Quantitative Psychology	4	33.3
Social Psychology	42	26.4
Psychology, Other	153	29.4

Note: The specialties with the highest postdoc rates are highlighted. Although the postdoc rates are lower in the other specialties, several of those specialties have larger numbers of postdocs.
Source: National Science Foundation/Science Resources Statistics, Survey of Earned Doctorates (special tabulations from Doctorate Records File).

Among U.S. citizens and permanent residents overall, the percentage of Ph.D.s planning on a postdoc after graduation decreased between 1989 and 2000 in the biological sciences but increased in the social and economic sciences and in the behavioral sciences (more so in the latter). Interestingly, whites and Asians/Pacific Islanders accounted for nearly all of the decrease in the biological sciences (see Appendix Table C-6). Exhibit VI-11 shows that the postdoc rates in the biological sciences for blacks and Hispanics were about the same in 2000 as in 1989, and, at just under 71%, nearly identical to each other. Although the rate for American Indians/Alaska Natives dropped substantially, the numbers were too small to have an impact on the overall decrease in the field for U.S. citizens and permanent residents.

Exhibit VI-11: Postdoc Rates of Underrepresented Minority Ph.D.s in MPRF Fields, by Race/Ethnicity: 1989 and 2000 (percent of all Ph.D.s in racial/ethnic group)



Source: National Science Foundation/Science Resources Statistics, Survey of Earned Doctorates (special tabulations from Doctorate Records File).

The comparison of 1989 and 2000 data obscures some interesting fluctuations in the postdoc rates of biological science Ph.D.s during the intervening years. Although there was some variation by racial/ethnic group, the general pattern was one of a peak in the mid-1990s (1995 for underrepresented minorities and Asians/Pacific Islanders; 1993 for whites), followed by a substantial dip and then further decline through 1997. The rates for each of these groups turned upward in 1998 and 1999 but then declined again in 2000. The postdoc rate for underrepresented minorities in the biological sciences reached 76.4% in 1995, dropped to 70.2% in 1996, declined further to 68.2% in 1997, rose slightly to 69.2% in 1998 and further to 70.5% in 1999, then slipped again to 69.8% in 2000. The 2000 percentage was the same as in 1993.

In the behavioral sciences, the postdoc rate increased in every racial/ethnic group, including whites and Asians/Pacific Islanders. In the social and economic sciences, only Asians/Pacific Islanders had a lower postdoc rate in 2000 than in 1989. The increases in both disciplines were greater for underrepresented minorities than for whites and Asians/Pacific Islanders. Note, however, that the numbers of Ph.D.s with postdocs in these fields are quite small (especially for minorities), which can make percentage changes appear more exaggerated than they really are.

In the social and economic sciences in 2000, only 28 blacks, 20 Hispanics, and 1 American Indian/Alaska Native planned on taking a postdoc right after graduation, yet these numbers were double those in 1989. The postdoc numbers in the behavioral sciences nearly tripled during the same period, but in 2000, there were still only 22 blacks, 25 Hispanics, and 3 American Indians/Alaska Natives with plans for a postdoc soon after graduation. The erratic fluctuations in the intervening years in both of these fields undoubtedly reflect the small annual numbers of postdocs. As was the case with Ph.D.s in the biological sciences, the postdoc rates in the social and economic sciences and in the behavioral sciences peaked by the mid-1990s and dropped notably in the year following the peak, but the rates both before and after were so erratic that no other pattern can be discerned nor can reliable comparisons be made between fields or racial/ethnic groups.

Data for underrepresented minorities in the overall 1989-2000 period show postdoc plans to be more common among women than among men in each of the MPRF disciplines. However, some shifts occurred during this period. By 2000, men were more likely than women to have postdoc plans in the biological and behavioral sciences.

The postdoc rate increased for both underrepresented minority men and women in the social and economic sciences and in the behavioral sciences. In the biological sciences, the rate rose slightly for men but dropped for women. Three-fourths of women who earned biological science doctorates in 1989 intended to take a postdoc right after graduation; by 2000, that proportion had fallen to two-thirds. Among men in the biological sciences, the postdoc rate increased by a point, from 70.8% to 71.9%.

Postdoc Mechanisms

Fellowships are by far the most common mechanism through which postdoctoral research or training is obtained. Among underrepresented minority Ph.D.s in the 1989-2000 period who had plans for a postdoc after graduation, 63.1% in the biological sciences, 64.8% in the social and economic sciences, and 70.4% in the behavioral sciences had either obtained a fellowship by graduation or were hoping for one (see Exhibits VI-12 and VI-13).

Although fellowships were most prominent, mechanisms varied by specialty within each of the MPRF disciplines. For underrepresented minority Ph.D.s in the biological sciences, fellowships were the primary postdoc mechanism in 16 of the 27 specialties (see Exhibit VI-12). Research associateships were more common in 9 specialties: agronomy/crop science; biotechnology; botany; entomology; environmental science; forest biology; horticulture; plant pathology; and wildlife/range management. In biometrics/biostatistics and conservation/

renewable natural resources, the number of underrepresented minorities with fellowship plans was equal to the number with research associateships.

Exhibit VI-12: Postdoc Mechanism of Underrepresented Minority Ph.D.s in Biological Sciences, by Specialty: 1989-2000 Aggregate (number with postdoc plans and percent mechanism)

	Total with Plans for Postdoc (N)	% Fellowship	% Research Associateship	% Traineeship	% Other
Biological Sciences, Total	**1,898**	**63.1**	**25.4**	**2.4**	**9.1**
Agronomy or Crop Science	19	42.1	52.6	0.0	5.3
Anatomy	29	62.1	13.8	3.4	20.7
Bacteriology or Microbiology	189	64.0	24.9	2.1	9.0
Biochemistry	308	62.7	26.3	1.9	9.1
Biometrics or Biostatistics	9	44.4	44.4	11.1	0.0
Biophysics	53	54.7	28.3	3.8	13.2
Biotechnology	9	33.3	66.7	0.0	0.0
Botany, Other	16	43.8	50.0	0.0	6.2
Cell Biology	122	66.4	21.3	1.6	10.7
Conservation or Renewable Natural Resources	4	50.0	50.0	0.0	0.0
Developmental Biology or Embryology	28	60.7	25.0	7.1	7.1
Ecology	45	66.7	28.9	0.0	4.4
Endocrinology	26	65.4	19.2	3.8	11.5
Entomology	33	48.5	51.5	0.0	0.0
Environmental Science	10	40.0	60.0	0.0	0.0
Fisheries Science/Management	3	66.7	33.3	0.0	0.0
Forest Biology	1	0.0	100.0	0.0	0.0
Genetics	85	68.2	23.5	1.2	7.1
Horticulture	11	36.4	63.6	0.0	0.0
Immunology	96	71.9	20.8	2.1	5.2
Molecular Biology	256	63.7	24.6	3.1	8.6
Neuroscience	182	69.8	15.9	3.8	10.4
Physiology, Human/Animal	144	62.5	16.0	4.2	17.4
Plant Pathology	24	29.2	66.7	4.2	0.0
Plant Physiology	11	54.5	45.5	0.0	0.0
Wildlife/Range Management	4	25.0	75.0	0.0	0.0
Zoology, Other	45	73.3	24.4	0.0	2.2
Biological Sciences, Other	136	64.0	24.3	1.5	10.3

Source: National Science Foundation/Science Resources Statistics, Survey of Earned Doctorates (special tabulations from Doctorate Records File).

Among underrepresented minorities in the behavioral sciences, fellowships were the primary mechanism in all but two specialties (see Exhibit VI-13). Research associateships outnumbered fellowships in human/individual/family development. Postdocs in quantitative psychology were evenly distributed between fellowships and research associateships. In the social and economic sciences, fellowships were the most common mechanism in every specialty.

Exhibit VI-13: Postdoc Mechanism of Underrepresented Minority Ph.D.s in Social, Behavioral, and Economic Sciences, by Specialty: 1989-2000 Aggregate (number with postdoc plans and percent mechanism)

	Total with Plans for Postdoc (N)	% Fellowship	% Research Associateship	% Traineeship	% Other
Social, Behavioral, & Economic Sciences, Total	**921**	**67.4**	**23.0**	**2.8**	**6.7**
Social & Economic Sciences, Subtotal	**492**	**64.8**	**24.8**	**1.8**	**8.5**
Anthropology	76	67.1	21.1	0.0	11.8
Criminology	10	50.0	30.0	0.0	20.0
Demography or Population Studies	4	50.0	25.0	0.0	25.0
Econometrics	2	50.0	0.0	50.0	0.0
Economics	59	59.3	37.3	3.4	0.0
Geography	7	71.4	28.6	0.0	0.0
History/Philosophy of Science & Technology	7	85.7	14.3	0.0	0.0
International Relations/Affairs	27	66.7	29.6	3.7	0.0
Linguistics	17	52.9	35.3	0.0	11.8
Political Science/Government	67	70.1	16.4	1.5	11.9
Public Policy Analysis or Public Administration	31	45.2	29.0	3.2	22.6
Sociology	112	72.3	19.6	2.7	5.4
Statistics	4	75.0	25.0	0.0	0.0
Urban Affairs/Studies	14	57.1	28.6	0.0	14.3
Social Sciences, Other	55	61.8	29.1	0.0	9.1
Behavioral Sciences, Subtotal	**429**	**70.4**	**21.0**	**4.0**	**4.7**
Cognitive Psychology/Psycholinguistics	27	63.0	33.3	0.0	3.7
Comparative Psychology	8	62.5	25.0	12.5	0.0
Development, Human/Individual/Family	17	35.3	47.1	17.6	0.0
Developmental/Child Psychology	69	72.5	21.7	0.0	5.8
Experimental Psychology	35	77.1	17.1	2.9	2.9
Physiological Psychology or Psychobiology	67	85.1	11.9	0.0	3.0
Psychometrics	7	42.9	28.6	28.6	0.0
Quantitative Psychology	4	50.0	50.0	0.0	0.0
Social Psychology	42	59.5	28.6	2.4	9.5
Psychology, Other	153	71.9	17.0	5.9	5.2

Source: National Science Foundation/Science Resources Statistics, Survey of Earned Doctorates (special tabulations from Doctorate Records File).

Blacks had the highest fellowship rate in the biological sciences (64.0%); Hispanics had the highest rate (67.5%) in the social and economic sciences; and American Indians/Alaska Natives had the highest rate (72.0%) in the behavioral sciences (see Appendix Table C-5). For the most part, the fellowship rates for the three underrepresented minority groups were higher than those for whites and Asians/Pacific Islanders

Women were more likely than men to expect a fellowship in each of the MPRF disciplines. In the biological sciences, 67.1% of underrepresented minority women with plans for a postdoc counted on receiving a fellowship, compared with 59.8% of underrepresented minority men. The corresponding figures were 71.9% vs. 67.2% in the behavioral sciences, and 67.1% vs. 62.9% in the social and economic sciences.

Primary Source of Postdoc Support

This section on sources of support and the subsequent section on postdoc settings require additional restrictions on the data in order to provide valid results. Only Ph.D.s who reported "definite" postgraduation plans (a signed contract or other commitment) at the time they completed the SED are included; all earlier discussions in this chapter included Ph.D.s who had aspirations for a postdoc but who did not have one definitely in hand by the time they graduated. The data in this section and the next are further restricted to Ph.D.s who indicated they would be staying in the United States for the postdoc.

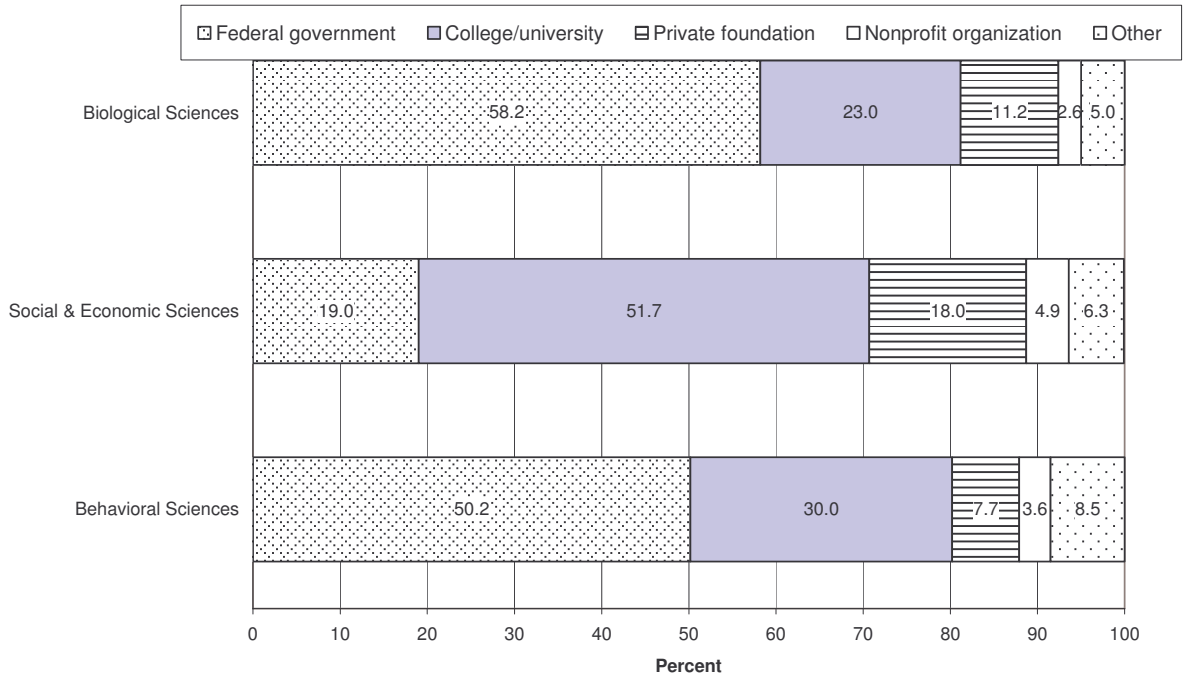
These two restrictions leave a population of 1,662 underrepresented minority Ph.D.s in MPRF fields who reported the main source of support for their impending postdoc. More than 52% (867) of this group received most of the support for their first postdoc from the Federal government, a lower percentage than for whites but higher than for Asians/Pacific Islanders (see Appendix Table C-7 for data on all racial/ethnic groups). Almost 28% of underrepresented minorities in MPRF fields received most of their postdoc support from a college or university. American Indians/Alaska Natives and Hispanics indicated higher levels of support from the Federal government than did blacks, and correspondingly lower levels of support from colleges and universities.

These variations reflect the different field concentrations of the groups; black Ph.D.s tend to be more concentrated than the other underrepresented groups in the social and economic sciences, and less concentrated in the biological and behavioral sciences. Exhibit VI-14 shows that, among underrepresented minority Ph.D.s who graduated between 1989 and 2000, Federal support for the first postdoc was highest in the biological sciences (58.2%, 704 Ph.D.s). A majority of behavioral science Ph.D.s planning postdocs (50.2%, 124 Ph.D.s) also received most of their support from the Federal government. Federal support was much less common in the social and economic sciences (19.0%, 39 Ph.D.s).

U.S. colleges and universities were the major provider of postdoc support in the social and economic sciences (51.7%), and they were the second largest provider in the biological (23.0%) and behavioral sciences (30.0%). Private foundations played a notable role in the social and economic sciences. They provided most of the postdoc support for more than 18.0% of underrepresented minority Ph.D.s in the field, nearly as many as were primarily supported by the Federal government.

The Federal government provided the major funding for more than one-half of all fellowships and research associateships and for more than two-fifths of all traineeships received by underrepresented minorities who earned doctorates in MPRF fields between 1989 and 2000. Colleges and universities were the second largest source of support for each of these mechanisms, but more so for research associateships and traineeships than for fellowships.

Exhibit VI-14: Primary Source of Postdoc Support for Underrepresented Minority Ph.D.s in MPRF Fields with Commitments in the United States: 1989-2000 Aggregate (percent)



Source: National Science Foundation/Science Resources Statistics, Survey of Earned Doctorates (special tabulations from Doctorate Records File).

In the biological sciences, the Federal government was by far the largest source of funding for both fellowships (60.7%) and research associateships (56.5%), while traineeships were supported equally by the Federal government and by colleges and universities (44.8% each). A majority of behavioral science Ph.D.s who had fellowships (51.5%) or research associateships (57.1%) at graduation also received their main support from the Federal government. The figures were much smaller in the social and economic sciences, with only 16.3% of fellowship recipients and 28.1% of research associateship recipients indicating the Federal government as their primary source of postdoc support. Colleges and universities provided most of the funding for fellowships (53.8%) and research associateships (40.6%) in the social and economic sciences.

Postdoc Setting

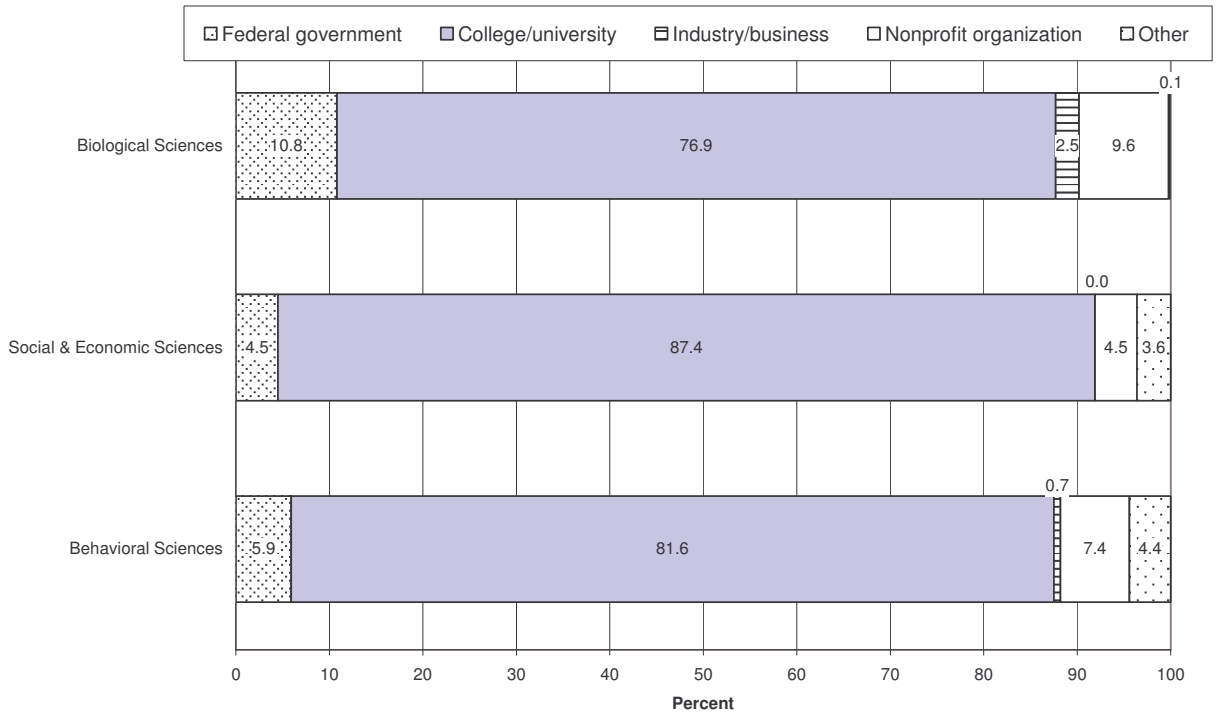
The data in this section are available only for Ph.D.s who graduated between 1989 and 1996 because nonacademic settings were not coded in 1997-2000. This reduced population leaves 923 underrepresented minorities with doctorates in MPRF fields who reported the setting for their upcoming postdoc.

Most postdoctoral study and training take place in academe. Almost 79% of underrepresented minority Ph.D.s in MPRF fields who had postdoc commitments at graduation planned on taking their postdoc at a college or university—about the same percentage as for whites and slightly higher than for Asians/Pacific Islanders (see Appendix Table C-8). Of all the racial/ethnic groups, Hispanics were the most likely to have postdoc commitments at a college or

university (81.3%), and American Indians/Alaska Natives (75.0%) and blacks (76.1%) were the least likely. More than 11% of both American Indians/Alaska Natives and blacks were heading to a Federal government facility for the postdoc—a larger percentage than in the other groups. About 9% of Ph.D.s in every racial/ethnic group except American Indians/Alaska Natives had postdoc commitments in a nonprofit organization. Industry/business drew fewer first-time postdocs—2% of all underrepresented minorities, 3% of whites, and 4% of Asians/Pacific Islanders.

Among underrepresented minority Ph.D.s with postdoc commitments at graduation, 76.9% in the biological sciences, 87.4% in the social and economic sciences, and 81.6% in the behavioral sciences indicated they would be undertaking their postdoc study at a college or university (Exhibit VI-15). Federal government labs and institutes were the second most common locale in the biological sciences, reported by 10.8% of new Ph.D.s with postdoc commitments, and nonprofit organizations were third, reported by 9.6%. In the behavioral sciences, more underrepresented minority Ph.D.s were heading to nonprofit organizations for their postdocs than to Federal facilities. These two settings were equally common among Ph.D.s with postdocs in the social and economic sciences (4.5% each).

Exhibit VI-15: Postdoc Setting for Underrepresented Minority Ph.D.s in MPRF Fields with Commitments in the United States: 1989-1996 Aggregate (percent)



Note: Data on nonacademic settings are not available after 1996.
Source: National Science Foundation/Science Resources Statistics, Survey of Earned Doctorates (special tabulations from Doctorate Records File).

Detailed Findings About Employment of 1989-1998 Ph.D.s in 1999

Data from the Survey of Doctorate Recipients (SDR) provide an opportunity to examine the employment of Ph.D.s in 1999. The analysis in this section includes individuals who earned U.S. doctorates in MPRF fields between 1989 and 1998 and who were also U.S. citizens or permanent residents living in the United States in April 1999. The focus is on underrepresented minorities, but information on Ph.D.s in other racial/ethnic groups is presented for comparison.

This section looks at the employment status and characteristics of the Ph.D.s. In addition, to evaluate the effect of postdocs on future positions, comparisons are made between Ph.D.s who had previously held a postdoc but were not on a postdoc in 1999 (*prior postdoc*) and those with no postdoc experience (*no prior postdoc*). It should be noted that the number of Ph.D.s with prior postdocs presented in this analysis is somewhat of an undercount. There are two reasons for this: (1) The SDR is conducted biennially rather than annually; thus, if an individual held a postdoc between survey cycles, that postdoc would not be on record in the SDR. (2) Not all survey members respond to every survey they receive; thus, if an individual earned a doctorate in 1992 and was on a postdoc in 1993 but did not respond to the SDR until 1999 (by which time he/she was employed), that individual would count as never having held a postdoc.

Characteristics of Underrepresented Minority Ph.D.s

In 1999, there were 2,462 underrepresented minorities residing in the United States who had earned a biological science doctorate between 1989 and 1998. Their distribution by sex was 59% male and 41% female. Their distribution by race/ethnicity was 58% Hispanic, 34% black, and 8% American Indian/Alaska Native. These Ph.D.s were either employed (70%), on a postdoc (27%), or not employed (3%) in 1999 (see Exhibit VI-16).

Exhibit VI-16: Characteristics of Underrepresented Minority Ph.D.s on Postdocs, by Field of Doctorate: 1999

	BIO	SBE		
	Total	Total	Psychology	Social Sciences & Economics
Total	2,462	3,443	1,062	2,381
	100%	100%	100%	100%
Sex				
Male	1,444	1,703	358	1,345
	59%	49%	34%	56%
Female	1,015	1,740	704	1,036
	41%	51%	66%	44%
Race/Ethnicity				
Hispanic	1,439	1,534	564	970
	58%	45%	53%	41%
Black	831	1,786	473	1,313
	34%	52%	45%	55%
American Indian/ Alaska Native	190	123	25	98
	8%	4%	2%	4%
Employment Status				
Postdoc	671	227	99	128
	27%	7%	9%	5%
Employed	1,712	3,044	939	2,104
	70%	88%	88%	88%
Not employed	76	173	24	149
	3%	5%	2%	6%

Source: National Science Foundation/Science Resources Statistics, Survey of Doctorate Recipients.

The 3,433 underrepresented minority Ph.D.s in the social, behavioral, and economic sciences were 49% male, 51% female, 45% Hispanic, 52% black, and 4% American Indian/Alaska Native. In 1999, 7% of these Ph.D.s held postdocs, while 88% were employed and 5% were not employed.

Postdocs

Underrepresented minorities in biological science fields who held a postdoc in 1999 were most frequently working in an educational institution (78%), followed by the government sector (11%). The distribution of postdocs across sectors was similar for white and Asian/Pacific Islander Ph.D.s, although a slightly higher percentage (80%) of white postdocs were in educational institutions (see Exhibit VI-17).

Among underrepresented minority Ph.D.s in the social, behavioral, and economic sciences, the number holding a postdoc in 1999 was too small to be reliably distributed across sectors by racial/ethnic group. For the three groups combined, however, 76% were in educational institutions and 13% held a postdoc in the government sector.

Exhibit VI-17: Sector of Ph.D.s on Postdocs, by Field of Doctorate: 1999

	Total	Educational Institution	Business/ Industry	Government	Other
Biological Sciences					
Underrepresented minorities	671	524	32	74	41
	100%	78%	5%	11%	6%
Whites	7,664	6,116	354	679	515
	100%	80%	5%	9%	7%
Asians/Pacific Islanders	2,855	2,196	154	330	175
	100%	77%	5%	12%	6%
Social, Behavioral, & Economic Sciences					
All racial/ethnic groups *	1,333	1,007	38	172	116
	100%	76%	3%	13%	9%

* Underrepresented minority SBE Ph.D.s who held postdocs in 1999 cannot be shown separately because numbers are too small to be reliable.

Source: National Science Foundation/Science Resources Statistics, Survey of Doctorate Recipients.

Employment Sector

Among underrepresented minority Ph.D.s in the biological sciences who were employed as opposed to being on a postdoc in 1999, those with previous postdoc experience were far more likely to be employed in an educational institution (77%) than were those who had not held a postdoc (48%) (see Exhibit VI-18). Conversely, 15% of those with prior postdocs were employed in business/industry, compared with 37% of those with no prior postdoc. A postdoc experience had less of an impact on whites' distribution by sector: of those with a prior postdoc, 58% were in an educational institution and 31% were working in business/industry, compared with 54% and 29%, respectively, of those with no prior postdoc. Asians/Pacific Islanders were

more likely to be employed in business/industry and less likely to be in an educational institution than either whites or underrepresented minorities.

Because the individual racial/ethnic groups are too small to be reliably distributed, underrepresented minority Ph.D.s in the social, behavioral, and economic sciences cannot be analyzed based on prior postdoc status. In addition, due to the small number of Asians/Pacific Islanders in the field, they have been combined with whites for this analysis. It can be noted, however, that a larger proportion of all underrepresented minority Ph.D.s in the field were employed in educational institutions in 1999 (72%) than of white/Asian/Pacific Islander Ph.D.s with or without prior postdoc experience (66% and 63%, respectively).

Exhibit VI-18: Sector of Employed Ph.D.s, by Field of Doctorate: 1999

	Total	Educational Institution	Business/ Industry	Government	Other
Biological Sciences					
Underrepresented minorities					
Prior postdoc	546	422	81	14	30
	100%	77%	15%	2%	6%
No prior postdoc	1,166	561	426	135	45
	100%	48%	37%	12%	4%
Whites					
Prior postdoc	8,145	4,725	2,491	633	297
	100%	58%	31%	8%	4%
No prior postdoc	15,118	8,115	4,426	1,890	687
	100%	54%	29%	13%	5%
Asians/Pacific Islanders					
Prior postdoc	2,737	1,331	1,251	121	34
	100%	49%	46%	4%	1%
No prior postdoc	2,427	1,012	1,109	203	103
	100%	42%	46%	8%	4%
Social, Behavioral, & Economic Sciences					
Underrepresented minorities					
Total *	3,043	2,254	277	217	296
	100%	72%	9%	7%	10%
Whites & Asians/Pacific Islanders **					
Prior postdoc	1,384	911	252	126	95
	100%	66%	18%	9%	7%
No prior postdoc	28,515	17,931	5,629	2,511	2,444
	100%	63%	20%	9%	9%

* Underrepresented minority SBE Ph.D.s with and without prior postdocs have been aggregated because, when shown separately, numbers are too small to be reliable.

** The numbers for Asians/Pacific Islanders are too small to be shown separately from whites.

Source: National Science Foundation/Science Resources Statistics, Survey of Doctorate Recipients.

Occupation

Biological science Ph.D.s were more likely to be employed as biological scientists than to have any other occupation, regardless of prior postdoc status or racial/ethnic background (see Exhibit VI-19). However, among underrepresented minorities, those with a prior postdoc were more likely to be employed as biological scientists than those with no prior postdoc (53% and 37%, respectively). For whites and Asians/Pacific Islanders, having held a prior postdoc made less of a difference as to whether or not they were employed as biological scientists.

In the biological sciences, underrepresented minority Ph.D.s with a prior postdoc were more likely (40%) than whites (31%) and Asians/Pacific Islanders (17%) who had a prior postdoc to be employed as postsecondary teachers in 1999. Among Ph.D.s with no prior postdoc, the percentage of postsecondary teachers was 30% for underrepresented minorities and whites but only 11% for Asians/Pacific Islanders.

Exhibit VI-19: Occupation of Employed Ph.D.s, by Field of Doctorate: 1999

	Total	Post-secondary Teacher	Biological Scientist	Computer Scientist	Engi-neer	Mathematician/ Physical Scientist	Social/ Economic/ Behavioral Scientist	Psychol-ogist	Health Occup.	Other Occup.
Biological Sciences										
Underrepresented minorities										
Prior postdoc	546	220	292	S	S	S	S	S	S	16
	100%	40%	53%							3%
No prior postdoc	1,166	345	430	36	S	32	S	S	123	192
	100%	30%	37%	3%		3%			11%	16%
Whites										
Prior postdoc	8,145	2,504	4,251	160	93	43	S	S	381	715
	100%	31%	52%	2%	1%	1%			5%	9%
No prior postdoc	15,118	4,511	6,382	302	175	500	65	S	1,409	1,774
	100%	30%	42%	2%	1%	3%	0%		9%	12%
Asians/Pacific Islanders										
Prior postdoc	2,737	456	1,557	92	30	27	S	S	262	313
	100%	17%	57%	3%	1%	1%			10%	11%
No prior postdoc	2,427	270	1,168	111	43	158	S	S	393	284
	100%	11%	48%	5%	2%	7%			16%	12%
Social, Behavioral, & Economic Sciences										
Underrepresented minorities										
Total *	3,043	1,792	14	5	38	3	241	342	30	579
	100%	58%	0%	0%	1%	0%	8%	11%	1%	19%
Whites & Asians/Pacific Islanders **										
Prior postdoc	1,236	554	119	S	S	29	181	272	S	78
	100%	45%	10%			2%	15%	22%		6%
No prior postdoc	25,701	12,764	268	434	319	345	3,613	3,436	348	4,174
	100%	50%	1%	2%	1%	1%	14%	13%	1%	16%

S = suppressed due to small cell count.

* Underrepresented minority SBE Ph.D.s with and without prior postdocs have been aggregated because, when shown separately, numbers are too small to be reliable.

** The numbers for Asians/Pacific Islanders are too small to be shown separately from whites.

Source: National Science Foundation/Science Resources Statistics, Survey of Doctorate Recipients.

In the social, behavioral, and economic sciences, postsecondary teaching was the occupation of the largest proportion of Ph.D.s, accounting for 58% of underrepresented minority Ph.D.s and for 45% or 50% of whites/Asians/Pacific Islanders, depending on prior postdoc status. Again, the underrepresented minority Ph.D.s in this field cannot be presented by prior postdoc status.

CHAPTER VII: BIBLIOMETRIC STUDY

Bibliometrics is the analysis of quantifiable aspects of published scientific literature. A bibliometric study of MPRF recipients was undertaken as part of the overall study to see if it was possible to gauge the publication productivity of individual Fellows before and after their Fellowship experiences, in terms of both number of publications in recognized journals and the impact of those publications as measured by citations to them.

Highlights

BIO Fellows

- The 87 BIO Fellows included in the data (a subset of 1990-2001 awardees) produced a total of 416 publications, ranging from 1 to 28 per individual, for an average of 4.78 each.
- 33 of these BIO Fellows published both before and after their MPRF awards. Their aggregate individual rates of publication increased slightly between pre- and post-award years—up by a tenth (0.10) of a publication per year.
- More of these Fellows increased their rate of publication (14) than decreased it (11), with 8 cases being indeterminate or equal.

SBE Fellows

- The SBE list used for this analysis included 29 Fellows who received MPRF awards in 1990-2001. Of these, 8 (28%) generated a total of 39 publications that appeared in the database, or an average of 1.34 papers per year overall.
- The number of publications per individual SBE Fellow ranged from 1 to 11. Six of the Fellows had before-and-after publications, although only two had a sufficient number in each time period to compare the pre- and post-award publications patterns with any degree of confidence.

Data Sources and Methodology

Identifying Fellows' Journal Articles

This bibliometric analysis involved putting the names of the SBE and BIO Fellows into the format used by the Institute for Scientific Information (ISI)[22] in compiling its database of research publications. That is, compound names were pulled together and all names listed in two ways: (1) with first initial only, and (2) with both first and middle initials (e.g., John Edward Garcia-Lopez as GARCIALOPEZ J and GARCIALOPEZ JE). Listing the MPRF recipients

[22] Thomson Institute for Scientific Information, main office Philadelphia, PA (http://www.thomsonisi.com) or (http:www.isinet.com).

with both their first initial and all initials ensured that publications that did not include more than the first initial would not be missed, although it increased the number of publications that had to be screened to identify legitimate MPRF authors' papers.

ISI was then contracted to match the resulting list to their database from 1991 onward; the span of the database covered 1991 to, generally, 2000—with a few 2001 papers included. ISI coverage included journals in the *Science Citation Index* (SCI) and the *Social Sciences Citation Index* (SSCI), as well as those in the *Arts and Humanities Index* and several specialized citation index databases in fields such as mathematics and computer science.

The resulting database, delivered by ISI in the form of Microsoft Access and an ISI-developed interface, contained 42,506 author names. Many of these were attached to multi-authored papers where the MPRF author was not necessarily the first author. It was then necessary to look up each MPRF author name and run through the individual listing of publications, which includes all of the author addresses listed in the journal with the paper, to determine that the publication was (probably) a legitimate MPRF recipient's work. Available address information collected for other purposes, including contact information for the MPRF survey, was used to screen the publications. As many as four addresses were available for each Fellow:

1. the school from which they received their Ph.D.;
2. the institution with which they affiliated during their MPRF;
3. the institution from which they came, returned, or went following their MPRF;
4. a more current postal or e-mail address reflecting a subsequent move.

Such screenings are not without their hazards. Many individuals have "homographs," i.e., other individuals with identical last names and initials. The hazard obviously increases when only one initial is available. Ironically, more than 300 publications had to be screened in order to identify only six evidently legitimate publications for Lino Gonzalez, Jr. (GONZALEZ L), while a not entirely credible plethora of 28 were found for the somewhat more specific Fernando A. Gonzalez (GONZALEZ FA). In such cases, an effort was made to take into account the field of the publications and, if possible, to check a university web listing for collateral information. For example, such a web check confirmed that the individual writing about turtle and sturgeon populations was indeed the same individual. A close examination of the journals, titles, and other aspects of the ISI data on the L GONZALEZ papers suggested that all were valid hits. While the analysis must be conditioned with this cautionary element, the look-ups were usually quite unambiguous, even when there had been some mobility since award of the MPRF.

Limitations of the Analysis

The approach taken in this analysis was experimental, although logical in terms of the data available. The lack of an external baseline for comparisons meant that the MPRF awardees had to serve as baselines for themselves individually, as well as contribute to the collective baselines for the separate BIO and SBE groups. An initially proposed comparison group was deemed infeasible due to privacy concerns of the databases that would have been needed to compile it. Fundamentally, the only comparative statistics available related to the "before" and "after" data

on individual Fellows. Publications came before and after the date of MPRF award, and there were varying times since the award was made in which to publish and accumulate citations.

Measuring Publication Productivity

The ISI data relate to "productivity" (number papers published), and "impact" of individual papers over time (number of citations received normalized for time since publication and journal of publication). Specifically, productivity was taken to be the number of papers published over an *elapsed* number of years, and the years were classified as before the MPRF award and those after. *Before* means transparently before the MPRF was awarded, to which was added two years to account for publications in the pipeline when the MPRF was received. *After* identifies publications that were published *at least two* years after the year of the MPRF award. This methodology was based on a combination of analytic experience with publication cycles and the relation of work to publication content. Because publication pipelines can vary from journal to journal, it is not entirely fair to attribute all papers published at least two years after (and thereafter) to work based on the MPRF experience, but there is no other way of differentiating the publications. Elapsed years were counted on the basis of the initial year of publication until the final year of the pre-MPRF or post-MPRF publications in the database.

Thus, an individual with four publications over five elapsed years before the MPRF award year would be given a productivity ratio of four divided by five, or 0.80. If the same individual had three publications in two elapsed years after the MPRF award, the rate would be 3/2, or 1.5 per year. In terms of outcome, the example's increase in the rate of publication represents a potential case of positive program outcome.

There is a range of variance in terms of the elapsed years available for individual Fellows to have published, both before and after their Fellowships. Some had no publications before, some had none after, and some had no publications at all. Inevitably, some had almost no time (or publications) on one or the other side of the Fellowship. This was because some Fellows had obtained awards and track records prior to receiving the MPRF award, as well as the fact that the year of MPRF awards ranged from 1990 to 2001 (records for seven 2002 Fellows included in the survey were received too late to be included in the bibliometric study). Effectively, awardees from 1998 on had no time to publish as "post-award" was defined. The aggregate data neither reflect nor normalize for such variations.

Measuring Impact

Impact is measured by comparing the actual number of citations accumulated by a given paper to those that would be expected for a paper published in the same journal at the same time (i.e., year). The data available were used to compile the years and number of each MPRF recipient's publications and an "expectation ratio." The latter was computed by dividing the actual number of citations to a given publication by the number of expected citations, i.e., the ratio is over one if the actual number exceeds the expected number of citations, and less than one if the reverse is the case. These were compiled over the total number of the Fellow's publications as represented in the database and averaged for the before-award and after-award periods available. In this analysis the problematic cases were those in which the average impact

ratio for either the before- or after-period consisted of a single data point, while the other consisted of more numerous publications. Again, the aggregate data analysis neither excludes such cases nor has any way of measuring how they might have skewed the results.

The only other variable that could be adduced to the analysis was the relationship of the number of publications before and after the date of the MPRF award, and also of the citations to those that came before as opposed to after the award. An arbitrary decision was made to characterize publications occurring during the year following the award and thereafter as post-MPRF publications.

Findings About BIO Fellows

The BIO list of Fellows was much longer than the SBE list—129 BIO Fellows vs. 29 SBE Fellows.[23] The large number of BIO Fellows posed a resource dilemma, because, in addition to the overall number, the BIO awardees were far more likely to publish. Therefore, the number to be analyzed was limited to 87 because of the time required to collect the data for each Fellow. A number of Fellows had relatively common ethnic names and only one initial, while others required going through similarly common names with both a fairly specific two-initial combination and then the single first initial to ensure that no publications were missed. With as many as 28 publications being found for a given Fellow, the verification process was time-consuming. There being no reason to believe that the Fellows who followed in the alphabetic list were substantially different from those for whom data had already been collected, it was decided to stop at 87 in deference to the limited project resources. Of the 87 Fellows for whom the data were collected, only 16 (187%) had no publications in the database, compared with 72% of the SBE Fellows (see Exhibit VII-1).

The 87 Fellows included in the data produced a total of 416 publications, an average of 4.87 each. The year of publication ranged from 1990 to 2000, the average year being 1996, one year earlier than the SBE average. The number of publications ranged from 1 to 28. There were 33 Fellows with before-and-after publications. About eleven (13%) of these Fellows had the same type of limited data points on one side or another of the dividing line that has the potential of skewing the statistical results (i.e., multiple publications on one side of the dividing line and only one on the other), far less than the two-thirds among the much smaller SBE population.

Aggregate individual rates of publication increased slightly between pre- and post-MPRF years—up by a tenth (0.10) of a publication per year. More Fellows increased their rate of publication (14) than decreased (11), with 8 being equal and 38 indeterminate (i.e., no publications on one or the other side of the dividing line to make comparisons). The average overall impact ratio was above one at 1.33, but the difference in terms of before-and-after the MPRF award was a negative 0.23. The outcomes in terms of impact ratio were about evenly divided. A total of 15 Fellows had an increased ratio, 17 had a decreased ratio, and only 1 had an actual no change (i.e., none of these were indeterminate due to an absence of before-or-after publications).

[23] Records for four BIO Fellows and three SBE Fellows funded in 2002 and included in the MPRF survey were received too late to be included in the bibliometric study.

Exhibit VII-1: Bibliometric Outcomes for BIO and SBE Fellows

Data Points	BIO Fellows	SBE Fellows
Number of Fellows	133	32
Number matched against ISI database	129	29
Number included in analysis	87	29
Number with no publications	16	21
Number with publications	71	8
Total publications in analysis	416	40
Years of publication range	1990-2000	1991-2001
Number of publications range	1-28	1-11
Average number of publications	4.78	1.38
Average year of publication	1996.2	1997.1
Number of Fellows with publications before and after Fellowship	33	8
Difference in publications per year from before to after Fellowship	+0.10	-0.19
Number with increased rate of publication	14	1
Number with decreased rate of publication	11	3
Number with no rate change or indeterminate	8	4
Average impact ratio of publications overall	1.33	1.02
Difference in impact ratio of publications from before to after Fellowship	-0.23	-1.19
Number with increased impact ratio	15	1
Number with decreased impact ratio	17	3
Number with no change or indeterminate	1	4

Note: "No change" means equal numbers of publications before and after the fellowship. "Indeterminate" means that the Fellow's award was late in the time-series and there was no time in which publications could appear.

Findings About SBE Fellows

The SBE award list included 29 Fellows who received their MPRF awards between 1990 and 2001. Of the 29 Fellows, only 8 (28%) generated a total of 40 publications that appeared in the database, or an average of 1.38 papers per year overall (see Exhibit VII-1). The year of publication ranged from 1991 to 2001, with 1997 being the average year (i.e., most publications were relatively recent—a year more so than the BIO Fellows' average publication). The number of publications ranged from 1 to 11. Six of the Fellows had before-and-after publications, although only two had a sufficient number in each time period to compare the pre- and post-award publications patterns with any degree of confidence.

Individual rates of publication fell slightly between pre- and post-award years—down about a fifth of a publication per year (-0.19). Only one Fellow had an increased rate, three went down, and four remained about the same. Although the *average* impact ratio was almost exactly one (0.98), the difference in terms of before-and-after the MPRF award represented a negative 1.19. Much of the negative effect came from one Fellow who had an average impact ratio of 5.25 for two pre-MPRF publications, then dropped to an average of 0.93 for seven publications appearing after the Fellowship. Two Fellows had a small increase in their publications' average impact factor, and four had a decrease. Two Fellows showed no change. One had literally no change (one publication before and one publication after the MPRF award). The other was indeterminate because she received the MPRF award in 2000 and thus had no post-MPRF publications to compare with her two pre-MPRF papers.

Looking at the outcomes, there is no strong pattern among the SBE Fellows. Three are indeterminate for lack of data, and one is positive on one factor and negative on the other. Two are positive onn both outcomes, but not strongly so. One is negative on both productivity and impact. One is negative on impact only, with the productivity outcome indeterminate. No particularly strong conclusions can be drawn, although four of the Fellows show increased publications in their post-MPRF environment.

Final Observations

The analytic approach for this bibliometric study was experimental because the data were limited and unique to a particular program and to individual Fellows. Sweeping conclusions are not in order, but a few observations can be made.

Outcomes vary in terms of fields. Despite the originally related nature of the two MPRF programs, there were differences in outcomes, particularly of publication productivity rates, as well as less clear cut patterns in the span and level of citation impact of publications. Most SBE Fellows appear to have been in the fields of psychology and neuroscience, while more BIO Fellows were in areas dealing with molecular biology and genetics than in other BIO fields.

The outcomes, as measured in terms of these available bibliometric data, are relatively neutral or positive. None is "smashingly" favorable or unfavorable. The negatives are not great, the positives all to the good.

Overall, there is no strong evidence, based on the data analyzed here, of any significant negative outcomes, and the aggregate data are encouraging in terms of the program outcomes in publication indicator data. There are clear differences in terms of publication outcomes between fields supported by SBE and fields supported by BIO. The BIO Fellows are probably more paradigmatic in terms of their scientific publishing behavior than the SBE Fellows.