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THE CAREER ACHIEVEMENTS OF NIH PREDOCTORAL TRAINEES AND FELLOWS

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The Committee on National Needs for
Biomedical and Behavioral Research Personnel

Institute of Medicine

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NOTICE: The project that is the subject of the report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

The Institute of Medicine was chartered in 1970 by the National Academy of Sciences to enlist distinguished members of the appropriate professions in the examination of policy matters pertaining to the health of the public. In this, the Institute acts under both the Academy's 1863 congressional charter responsibility to be an adviser to the federal government and its own initiative in identifying issues of medical care, research, and education.

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PREFACE

In 1974 Congress passed the National Research Service Awards Act, which mandated the National Academy of Sciences to "establish (A) the Nation's overall need for biomedical and behavioral research personnel, (B) the subject areas in which such personnel are needed and the number of such personnel needed in each such area, and (C) the kinds and extent of training which should be provided such personnel" (U.S. Congress, 1974, Section 473). In response to this request a study committee was formed in early 1975--originally under the aegis of the Commission on Human Resources and now under the Institute of Medicine. During the first nine years of its existence the committee has concentrated its efforts on projecting the demand for research personnel in the biomedical and behavioral fields and on recommending the size of federally sponsored training programs required to meet the projected demand. In arriving at its recommendations the committee has considered the impact of federal training programs on the quality of the eduational experience offered as well as on the numbers of graduates produced. A total of seven reports have been completed--each containing updated recommendations and findings from studies and analyses specifically commissioned by this committee. Yet until now no comprehensive assessment has been undertaken of the career outcomes of NIH-supported graduate students.

Such a study is long overdue--from two perspectives. The last study of this kind was done by another NRC committee under the chairmanship of Paul Saltman (NRC, 1976), and examined the achievements of individuals who had received NIH predoctoral support prior to FY1973. Since that time significant changes in the NIH predoctoral training program have occurred, including the phasing out of the (FO1) fellowship program and substantial reductions in trainee awards. In addition, we regret that completion of this study is almost a year behind schedule, primarily as the result of a change in employment positions by the first author. This reassignment took place in the intermediate stages of the project and prohibited him from devoting his full energies to this important task.

Much of the credit for this study must be given to Bob Hill and members of his committee (listed on page v), who volunteered many hours to consideration of the analytical design and objectives, discussions of the preliminary results, and review of this manuscript.

Also substantively involved in the planning and execution of this activity were members of the Committee's advisory Panel on Basic Biomedical Sciences (listed on page vi), chaired by Bob Barker. Without the contributions and approval of these two groups this study could never have been carried out. We express our appreciation to individual members of the panel and parent Committee for their many constructive criticisms and suggestions, as well as for their patience and understanding with regard to the delay in completing this project.

The project was a bit unusual in the extent to which we relied on the cooperation and assistance of the study sponsor, the National Institutes of Health (NIH). Much of the data used in the analyses were compiled by the NIH or were derived from data collection activities sponsored by the NIH. In particular, we would like to thank Chuck Sherman, Helen Gee, and other members of the Manpower Evaluation Advisory Committee who offered many constructive suggestions in the preliminary phases of the study. We also thank Ruth Kirschstein and her staff at the National Institute of General Medical Sciences (NIGMS) for their encouragement and interest in this undertaking. Throughout the project we have been greatly impressed by the receptivity and interest demonstrated by staff at the NIH.

We should not overlook the contributions of those within the Institute of Medicine and the Office of Scientific and Engineering Personnel who worked closely with us in this effort. George Boyce and his fellow programmers have been marvelous in completing highly complex tables in very tight deadlines. Allen Singer and his highly competent staff provided the administrative and technical support when it was most needed. Howard Garrison was most helpful in assisting with the development and analysis of the regression models presented in the final chapter of this report. Finally, special thanks must go to Dee Cooper, whose energy and spirit in producing this manuscript have been remarkable.

Porter E. Coggeshall

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EXECUTIVE SUMMARY

This study, conducted under the aegis of the Institute of Medicine (IOM) Committee on National Needs for Biomedical and Behavioral Research Personnel and in consultation with the staff of the Director of the National Institutes of Health (NIH), examines the extent to which NIH-supported graduate students have been successful in their pursuit of careers in biomedical research. The early career activities and accomplishments of FY1967-81 Ph.D. recipients who had received at least nine months of NIH predoctoral support are compared with the records of other biomedical science graduates. For purposes of these analyses, two comparison groups are used. Group I includes FY1967-81 biomedical science Ph.D.s who had obtained their graduate education in university departments/programs holding NIH traineeships but who had not been paid NIH predoctoral stipends themselves. (Those who had been awarded a total of 1-8 months of NIH training support are also included in this group.) Group II comprises all other FY1967-81 biomedical science graduates who had never held NIH traineeships or fellowships while in graduate school.

The study results indicate that former NIH predoctorals have outperformed members of the two comparison groups, in terms of a diverse set of career outcome measures. Among the key findings are the following:

- By FY1981, more than two-thirds of the NIH trainees and fellows supported prior to FY1976 had earned doctorates, compared with an estimated overall completion rate for biomedical science graduate students of less than 50 percent (Chapter 3, Table 3.1).

- Individuals in the study group were considerably more likely to have subsequently received NIH postdoctoral fellowships or traineeships than were members of either comparison group (Chapter 4, Table 4.2).

- Former NIH predoctorals were also more likely to become involved (at later stages in their careers) in NIH-sponsored activities (Chapter 5, Table 5.4).

- In comparison with Groups I and II, an appreciably larger fraction of the study group applied for NIH research grants (Chapter 6, Table 6.1).

- Those in the study group who applied for NIH research grants have been more successful in obtaining awards than have those in either comparison group (Chapter 6, Table 6.8).

- Former NIH trainees and fellows have authored, on the average, more articles than have their biomedical science colleagues (Chapter 7, Table 7.2).

- Articles written by members of the study group have typically received more citations in the bioscience literature (Chapter 7, Table 7.4).

In addition, more than three-fifths of all FY1967-81 Ph.D. recipients awarded NIH research grants during the FY1967-82 period had received NIH training grant or fellowship support at some point during their graduate education (Chapter 6, Figure 6.5).

Although the observed differences among the three groups are not necessarily large, the findings are remarkably consistent for the numerous indices examined--leading to the overall conclusion that former NIH predoctoral trainees and fellows have been more likely to pursue careers in biomedical research and have been more successful in this pursuit than their colleagues. That does not necessarily mean, however, that these same students might not have done just as well had NIH predoctoral support not been available to them. Since the NIH awards have been made on the basis of criteria directly and indirectly related to the recipients' abilities and interest in biomedical research, it cannot be determined whether their superior records of achievement may be attributed to the selection process, the training they received, or a combination of these and other factors. Nevertheless, one may conclude from the study findings that graduates of the NIH predoctoral training programs have been highly successful in pursuing careers in biomedical research.

To probe further into the factors influencing early career achievements, a series of multiple regression models were developed. On the basis of this modeling effort (described in Chapter 8), two overall conclusions were reached. First, all three independent variables examined--years of experience, reputation of the Ph.D. institution, and total months of NIH predoctoral support--together explain only a small portion of the variance associated with each of the outcome measures examined. There are undoubtedly many other factors (such as a biomedical scientist's abilities, research interests, postdoctoral training experience, employment history, etc.) that influence research productivity. Secondly, NIH predoctoral support has played a small but significant role in explaining various measures of career achievement--even after the effects of an individual's level of experience and the reputed quality of his or her doctoral institution have been removed.

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1. STUDY ORIGIN AND METHODOLOGY

In the late 1950s the federal government escalated its investment in biomedical research, and for the next decade or more the national effort in basic research on health-related problems grew at an unprecedented pace. This rapid expansion resulted in an immediate need for highly skilled investigators. In response to this need the National Institutes of Health (NIH) greatly expanded its extramural research training programs, which had been established by the National Cancer Act of 1937. Between 1961 and 1972 these programs furnished financial assistance, through individual fellowships and institutional training grants, to more than 30,000 graduate students who successfully completed their Ph.D. training[1] in a broad spectrum of health-related disciplines. Since 1972 the NIH predoctoral fellowship programs (individual awards) have been phased out, and the numbers of graduate students supported on training grants (institutional awards) have been much reduced. Nevertheless, the NIH training programs have continued to play an important role in graduate education in the biomedical sciences. During the past ten years more than one out of every three Ph.D. recipients in these fields have received some NIH training support while in graduate school.[2]

In the decade of the 1960s much emphasis was placed on developing and expanding the university departments responsible for educating promising young investigators in the biomedical sciences. In the years that followed there has been greater emphasis on maintaining and improving the vitality of the university training milieu that had been established in the earlier period. The fundamental intent of the NIH training programs, however, has remained unchanged: (a) to ensure

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[1] In addition, during the 1961-72 period the NIH provided postdoctoral training grant and fellowship support to more than 27,000 biomedical scientists who had recently received Ph.D., M.D., or other doctoral degrees (NRC, 1976).

[2] Of the 39,203 individuals receiving doctorates between FY1972 and FY1981, 15,453 had been NIH trainees or fellows at some point during their graduate training (see Table 3.2 in Chapter 3).

that an adequate supply of well-qualified investigators will be available to meet national needs for biomedical research personnel and (b) to enhance the quality of training provided to promising young investigators. The study described herein examines the role that the NIH training programs have played in the early career development of talented young scientists.

This study is a part of a much larger activity undertaken by the National Academy of Sciences (NAS).[3] In response to a congressional mandate (U.S. Congress, 1974, Section 473) a committee was formed in 1975 to assess the national needs for biomedical and behavioral research personnel and to make specific recommendations regarding the appropriate levels of federal involvement in research training in these fields. Since its inception the committee has issued seven reports, and studies are now underway in preparation for an eighth. These reports have focused primarily on projection of future needs for investigators trained in health-related disciplines and the recommended levels of federal support required to meet these needs. Also mentioned in the Congressional mandate is the requirement to "identify the kinds of research positions available to and held by individuals completing [federally supported] training" (U.S. Congress, 1974, Section 473, paragraph 3). The study presented in this report is intended to address this particular issue--examining the extent to which those individuals who had received predoctoral support from NIH research training programs have been successful in pursuing careers in biomedical research.

Earlier Studies

In 1969 a National Research Council (NRC) committee, chaired by Dr. John A. D. Cooper, issued a report (NRC, 1972) evaluating the graduate training programs supported by the National Institute of General Medical Sciences (NIGMS) during the 1958-67 period. This report examined the impact that NIGMS training grant and fellowship programs had had on both university departments and the graduate students who had received stipends. Findings from the study demonstrated that:

(1) NIGMS trainees and fellows completed their graduate training in 1-2 years shorter time than did other students from the same set of departments;

(2) the fraction of NIGMS-supported students who successfully completed requirements for their doctorates compared favorably with the completion rates for other groups of bioscience students;

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[3]Until November 1982 the study was conducted under the aegis of the Commission on Human Resources of the National Research Council; since then the study has been administered by the Institute of Medicine.

(3) NIGMS trainees and fellows were more likely than other bioscience Ph.D. recipients to take postdoctoral fellowships immediately after completing their graduate training; and

(4) NIGMS-supported students published more frequently (and their articles received more citations) than did other graduates from the same set of departments.

On the basis of its overall findings the study committee concluded that the NIGMS training programs "did have measurable positive impacts" on the graduate students as well as on the university departments and that the programs should be expanded to meet future requirements for young investigators in the biosciences. The committee also recommended continued evaluation of these programs.

In 1975 another NRC committee, headed by Paul Saltman, completed a study of the impact of NIH training programs on the career patterns of bioscientists. The report (NRC, 1976) contains information about the career outcomes of individuals who had received NIH research training support prior to 1973. This study encompassed all predoctoral and postdoctoral training programs sponsored by the ten institutes involved in research training at that time. The study findings pertaining to the NIH predoctoral programs are, for the most part, consonant with results from the earlier evaluation of the NIGMS programs. For example, NIH-supported graduate students were found to have attained their Ph.D. degrees more frequently and in shorter periods of time than did other bioscience students. Also, former NIH predoctoral trainees and fellows were more likely to be employed in university settings and to be involved in R&D activities than were other bioscientists. On the other hand, little difference was found in the publication rates of NIH-supported predoctorals[4] and other graduates (although the articles by the former group did receive, on the average, a larger number of citations per article). From its analyses the committee concluded:

> The Ph.D. degree, and the supported period of training, seem to take on the role of a catalyst that produces the required impetus towards a research career in those so inclined. In this view, the predisposition towards research becomes the necessary condition and the education and training become the sufficient conditions for a high level of research activity (NRC, 1976, p. 77).

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[4]Not included in this group were individuals who subsequently received NIH postdoctoral training grant or fellowship support.

Since the release of the Saltman committee's report several studies concerned with the training and utilization of NIH-supported bioscientists have been undertaken, including those sponsored by the Committee on National Needs for Biomedical and Behavioral Research Personnel. In this committee's 1977 report, for example, findings were presented from a national survey of FY1971-75 Ph.D. recipients in the biomedical sciences who had been requested to provide information about their research training and current employment situations. Survey results showed that, while nearly two-thirds of those who as graduate students had received NIH or ADAMHA[5] training grant or fellowship support pursued postdoctoral training, many of them were forced to prolong their postdoctoral apprenticeships because of difficulty in obtaining faculty appointments at major research universities (Coggeshall et al, 1978). A 1981 study (Sherman et al, 1981, pp. 177-193) commissioned by this same committee compared the research involvement of pre-1973 graduates supported under the NIGMS Medical Scientist Training Program with graduates of three other NIH-sponsored training programs for physician scientists. Sherman found that NIGMS program graduates, all of whom had earned combined M.D.-Ph.D. degrees, were most successful in terms of both their attainment of academic tenure and the prolificacy with which they published. In the committee's 1981 report data were presented concerning the average length of time individuals have been principal investigators on NIH research grants. These data indicated that former NIH postdoctoral trainees/fellows had held NIH grants considerably longer than other principal investigators (NRC, 1981a, pp. 34-35). Other analyses pertaining to the research careers of biomedical scientists have been completed by staff at the NIH. None of the work undertaken since the Saltman committee's study, however, provides a comprehensive assessment of career outcomes (i.e., employment history, involvement in research, and record of publication productivity) of graduates of NIH-supported training programs.

Methodology

The analyses presented in this report focus primarily on the early career outcomes of FY1967-81 Ph.D. recipients who had received at least 9 months of predoctoral training grant or fellowship support from the NIH. (An analogous study of former NIH postdoctoral trainees and fellows is already underway.) The NIH predoctoral population supported during this 15-year span includes approximately 24,000 graduates, most of whom were funded through institutional training grants. In assessing the career development of these individuals five general factors were considered:

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[5]The Alcohol, Drug Abuse, and Mental Health Administration has supported a small number of graduate students in biomedical science departments who were involved in training relevant to behavioral research problems.

(1) attainment of the research doctorate[6];
(2) postdoctoral research training experience;
(3) early career employment;
(4) demonstrated interest and success in obtaining federal support for research; and
(5) record of publication.

For each of the five factors several alternative indices have been analyzed, with the findings presented in Chapters 3-7.

Much of the information required for the analyses has been compiled from existing NIH and NRC data files. The population of individuals who received NIH predoctoral support has been identified from the NIH Roster of Trainees and Fellows (maintained by the NRC). This file[7] includes name, social security number, training institution, and other biographic data that were useful in matching individual records in other files, as well as detailed information about each training appointment held (e.g., type of award, sponsoring institute, length of tenure, highest degree held and sought). Records in this file have been collated with records in the NIH Consolidated Grant Applicant File[8] (see Figure 1.1). The latter file has been used to identify all individuals who have applied for NIH research grants[9] during the FY1967-82 period and contains specifics about each application. Of particular interest to this study are data on the fraction of former NIH trainees and fellows who have applied for NIH research grants, the fractions receiving approved and funded awards, the ratio of the total number of awards to the number of applications, and the "average priority score" assigned to grant applications. Comparable data have also been obtained concerning FY1973-82 applicants for National Science Foundation (NSF) research grants in health-related disciplines.[10] Taken together, it is estimated that the NSF and NIH

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[6]Used in the analysis of this factor is an expanded study population of more than 32,000 graduate students (identified from records in the NIH Roster of Trainees and Fellows) who had received NIH training grant or fellowship support during the FY1967-80 period.

[7]At the time this study was undertaken, the file (NRC, 1974-82) contained records for approximately 170,000 individuals who had received NIH training grant and/or fellowship support (at either the predoctoral or postdoctoral level) during the FY1938-80 period.

[8]The collation of the trainee/fellow file with the grant applicant file has been updated routinely by NRC staff working in cooperation with the NIH Division of Research Grants. The latter file (NRC, 1979-83) included records for approximately 150,000 principal investigators who applied for NIH research grants or contracts during the FY1938-82 period.

[9]For purposes of this study only those applying for research awards through the Research Projects (R), Research Program Projects and Centers (P), or General Research Clinical Centers (M) programs were included.

[10]Missing from the NSF grant applicant record is the priority score given to the application and an indication of whether or not the application had been approved for funding.

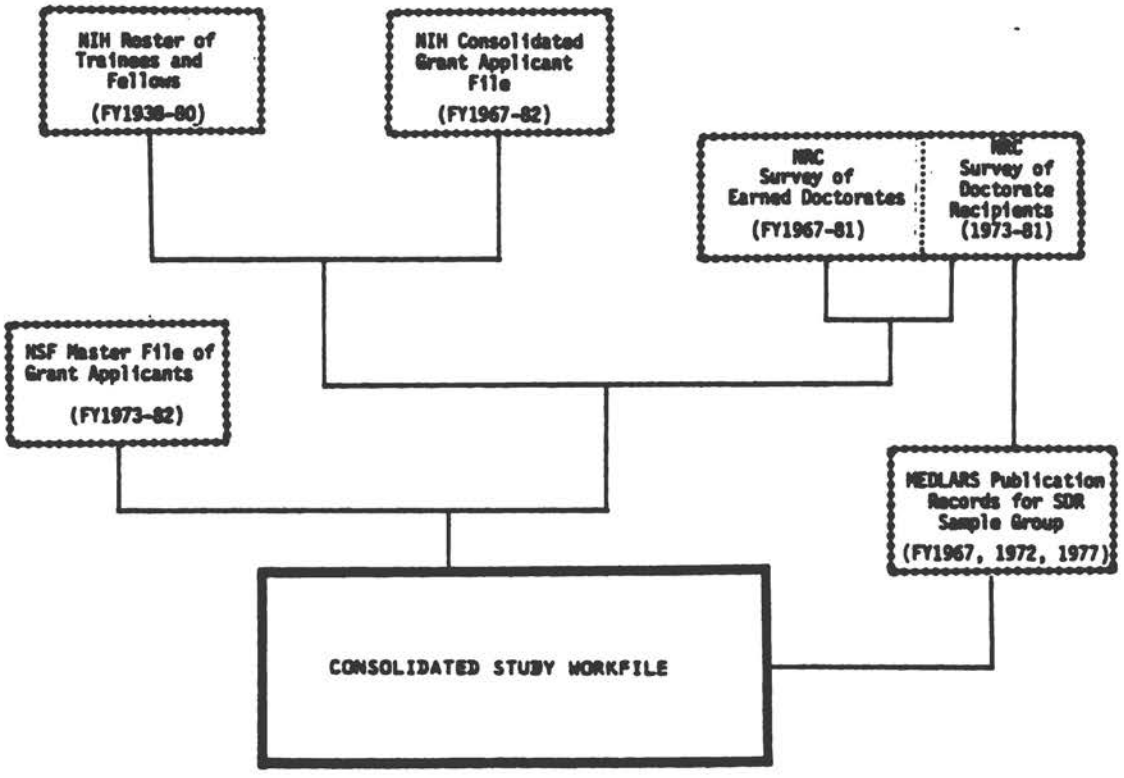

FIGURE 1.1 Data source files and collations

research awards have accounted for approximately 85 percent[11] of the federally funded grants to biomedical scientists.

As described in Figure 1.1, records from the two NIH files and the NSF file have also been linked to individual records contained in the NRC Doctorate Records File--matching on name, social security number, and other biographic data. Since the NRC file contains records for virtually all individuals who have earned Ph.D. or equivalent research doctorates from U.S. universities (since 1920), the results of this collation have been particularly valuable in determining whether or not NIH predoctorals successfully completed their doctoral training. The Doctorates Records File also contains information on the educational background (e.g., institution and field of doctorate, time-to-Ph.D., and sources of predoctoral support) and the employment plans of these graduates (as reported at the time they had completed requirements for their doctorates). This information is useful in assessing the graduate training experiences of NIH trainees and fellows and their plans for postdoctoral study. In addition, appropriate comparison groups have been drawn from the population of

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[11]Based on unpublished data (NRC, 1973-82, 1981 Survey).

50,000 biomedical scientists included in the file who had received their doctorates between FY1967 and FY1981. (As discussed later in this chapter, the availability of information about the careers of other biomedical science Ph.D. recipients who had not received training grant or fellowship support is essential to the interpretation of the study findings.) For a random sample of approximately 15 percent of the graduates, detailed information about their actual employment situations in 1973, 1975, 1977, 1979, and 1981 is available from the NRC Survey of Doctorate Recipients. From responses to this survey it has been possible to determine how many of these graduates have pursued careers in research and how many have obtained faculty positions in major research universities.

Data have also been compiled--through a contractual agreement between the NIH and Computer Horizons, Inc.--on the 1970-80 publication records of a sample of FY1967, FY1972, and FY1977 biomedical science Ph.D recipients. Included were 1,900 individuals who had responded one or more times to the NRC Survey of Doctorate Recipients during the 1973-81 period. As mentioned above, these individuals represent approximately 15 percent of the biomedical science Ph.D. population in these three cohorts. Since each respondent had provided detailed information about his or her employment situation, it was possible to identify individual authors on the basis of name, institutional affiliation, and field of training or employment.[12] For each individual, counts were derived on the number of articles published during this eleven-year span and the number of citations to these articles. Included are any published articles appearing in a set of 275 journals that cover a wide range of biomedical research interests. These data provide an important index of the research productivity of graduates in the three cohorts.

Analyses and Interpretation

The data resources described in the preceding pages furnish multiple criteria by which the research involvement and early career success of former NIH trainees and fellows may be judged. Findings are presented in the seven chapters that follow. Chapter 2 describes trends in the numbers of NIH predoctoral awards made during the FY1967-80 period, with particular attention to recent changes in the number of individual recipients and the average number of months of predoctoral support they received. In Chapter 3 an analysis is made of the Ph.D. completion rate for NIH trainees and fellows, the median time required to earn their doctorates, and their institutions and fields of graduate training. Considered in Chapter 4 is the frequency with which the Ph.D. graduates have pursued postdoctoral research training. Information presented in Chapter 5 describes the 1973-81 employment histories of recent Ph.D. recipients--including their involvement in research activities and their representation on faculties at major research institutions. Chapter 6 examines how many

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[12] A more detailed description of the author identification process is given in Chapter 7.

of these individuals have applied for NIH and/or NSF research grants and their success in obtaining grant awards. In Chapter 7 a detailed analysis is made of the numbers of published articles authored by a selected sample of FY1967, FY1972, and FY1977 graduates and the numbers of citations to these articles. These publication records, along with the information on research grant awards, constitute the primary criteria for assessing the early career success of young investigators. A summary of the findings presented in Chapters 2-7 is given in Chapter 8, along with an extended analysis of some results.

Information regarding the research involvement and early career success of former NIH predoctorals, although of some intrinsic interest to the NIH and the IOM committee, may be more meaningful when contrasted with information concerning other groups of biomedical scientists. As already mentioned, two comparison groups have been selected from the population of FY1967-81 Ph.D. recipients in biomedical disciplines who were included in the NRC Doctorate Records File. Group I includes biomedical science Ph.D.s who had been graduate students in university department programs that had NIH training grant awards, but who themselves had not received a total of at least 9 months[13] of NIH training grant or fellowship support. These individuals were identified on the basis of their doctoral institution, field, and year of graduation. Also selected in this group are Ph.D. graduates who had received between one and eight months of NIH support during their entire period of predoctoral training. Group II includes other biomedical science Ph.D.s who were identified as having been graduate students in university departments that had no NIH predoctoral training grant funding. The distinction between the two comparison groups is important. Individuals in Group I, while not recipients of NIH predoctoral stipends, may have indirectly benefited from having been in graduate programs that had NIH training grant awards, which provided partial support for tuition, faculty salaries, travel, and other educational expenses as well as student stipends. Furthermore, all of the individuals in this group obtained their graduate education in university programs that had been judged by faculty peers to merit NIH training grant awards. Those in Group II, on the other hand, had been in doctoral programs which at that time did not hold NIH predoctoral training grant awards, and as many as one-fifth of this group had been enrolled at universities which at that time had no NIH predoctoral funding in any academic departments.

In interpreting any differences found between the comparison groups and the former NIH predoctorals, one must keep in mind that NIH trainees and fellows had been selected (presumably) on the basis of criteria directly or indirectly related to their abilities and interest in biomedical research. Consequently, former NIH predoctorals may be expected a priori to have stronger records of career achievement.

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[13]The requirement that an individual must have had at least 9 months of NIH predoctoral support to have been included in the study population is somewhat arbitrary; nevertheless, the advisory committee and panel members agreed that to be considered a product of the NIH training programs an individual should have received support for at least a full academic year.

Whether the demonstrated achievements by this group of individuals may be attributed to the selection process, the training they received, or a combination of these and other factors cannot be ascertained from this analysis. This point is repeated several times throughout this report since it is fundamental to the interpretation of the findings. The study is designed to examine the career achievements of former NIH predoctorals and compare their accomplishments with those of other biomedical science graduates. To the extent that the findings reveal that the NIH group has outperformed other graduates, one may conclude that the NIH predoctoral training programs have been successful in meeting one of their primary objectives. The study results, however, provide absolutely no basis for judging whether or not this same group of students would have done equally as well had NIH predoctoral training grant and fellowship stipends not been available to them. Nor do the results provide a basis for assessing the cost-effectiveness of the NIH training programs.

Any explanation of career outcomes must, of course, take into account the age and/or years of experience of the subjects. An individual's record of publication, for example, is partially dependent upon how long that individual has been involved in research; an individual's history of applying for and obtaining federal research funding is influenced by the span of time that he or she has been an independent investigator. In most of the tabular material presented in this report, the results are analyzed according to the time at which the individual entered or completed graduate training. For analyses pertaining to attainment of the doctorate, postdoctoral training, and federal research grant applications, data are available for the entire study population, and thus results are reported for each cohort (i.e., graduation class) of individuals. For analyses pertaining to employment histories, data are available for a sample of approximately 15 percent of the population, and it has been necessary (for purposes of statistical accuracy) to report results for combined cohorts (e.g., FY1967-68 Ph.D. recipients). Also considered in the analytical design are what are sometimes referred to as "era effects." During the past 15 years there have been significant changes in the career prospects for biomedical scientists. Fewer recent graduates have found faculty positions in major research institutions, and more have pursued careers outside the academic environs (IOM, 1983, p. 63). Furthermore, in recent years the competition for NIH research funding has greatly intensified, and the likelihood of a young investigator obtaining such funding has diminished. In addition, during the last ten years the typical length of postdoctoral apprenticeship for a biomedical scientist has increased from two to three years.[14] All of these factors are likely to affect the career patterns of young biomedical scientists and should be kept in mind in comparing the outcomes of groups of individuals who completed their graduate training at different points in time.

Despite these caveats this assessment, focusing on the extent to

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[14]For a more detailed discussion of these changes, see IOM, 1983, Chapter 3.

which former NIH predoctoral trainees and fellows have been successful in pursuing careers in biomedical research, should be of considerable interest to the Congress, to the NIH, and to the biomedical community as a whole. Preliminary results from the analyses were delivered to the NIH last fall and have already been used by NIGMS staff members in preparing a response to congressional inquiries regarding the subsequent employment and career success of graduates of that institute's training programs. Such questions are likely to be asked of other NIH training programs as well, as greater and greater constraints are placed on federal budgets. Although limited information is available for selected training programs (e.g., the aforementioned study of Medical Scientist Training Program graduates), a comprehensive examination of the career outcomes of former NIH trainees and fellows is required to provide satisfactory answers to such questions. Results from NRC studies by the Cooper and Saltman committees, while useful from an historical perspective, are now well out-of-date. The findings presented in this report provide a more accurate basis for responding to these questions. Of particular relevance to NIH program administrators are the detailed data presented in Appendix D describing the career accomplishments of predoctorals sponsored by each institute. Furthermore, in view of what many knowledgeable observers consider to be dimininishing employment prospects in the academic sector for biomedical scientists, there is increasing interest on the part of faculty, postdoctorals, graduate students, and prospective graduate students regarding alternative career opportunities available to them. The findings from this study should provide information useful to those facing career choices, as well as to those responsible for making federal policy decisions. Also, the extensive data base created for this study represents a valuable resource to the NIH, the IOM committee, and others interested in examining different aspects of the NIH training and research funding.

2. NIH PREDOCTORAL TRAINING PROGRAMS, FY1967-FY1980

For purposes of this study the NIH predoctoral population includes all individuals who as graduate students received a total of nine months or more support from any of the following NIH training activities[1]: Graduate Training Program (T01), Combined Undergraduate and Graduate Training Program (T03), Medical Scientist Training Program (T05 and T32), Institutional National Research Service Award (T32), and Predoctoral Fellowship Award (F01). Specifically excluded from the study population are those individuals supported through the Minority Access to Research Careers Institutional Grant (T34) and the Short-Term Research Training Award (T35) since neither of these programs is primarily intended to provide assistance to graduate students seeking Ph.D.s or equivalent research doctorates.[2] During the 14-year span between FY1967 and FY1980 the NIH made approximately 101,000 predoctoral awards (Table 2.1) to 32,000 individuals (Table 2.2). The vast majority of these awards have been funded through the institutional training grant mechanism; fewer than 7 percent were funded via the F01 individual fellowship program, which by the mid-1970s had been phased out. More than two-thirds of the predoctoral awards were supported by the National Institute of General Medical Sciences (NIGMS), which has had primary responsibility for basic research training encompassing a broad spectrum of biomedical science specialty areas. The National Institute of Child Health and Human Development (NICHHD), the National Institute of Allergy and Infectious Diseases (NIAID), and the National Cancer Institute (NCI) each accounted for more than 5 percent of the FY1967-80 awards, while each of the other seven institutes contributed a somewhat smaller share.

Of particular relevance to this study is the appreciable decline that has occurred in the number of predoctoral awards made annually by the NIH. Between FY1969 and FY1980 the number of graduate students each year holding NIH traineeships or fellowships dropped by about 50

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[1]For a description of these activities, see NIH, 1981.

[2]The T34 program, for the most part, supports minority students at the undergraduate level, while the T35 program is designed to provide stipends to medical students.

percent, and the number of first-time trainees and fellows declined by even more (Figure 2.1). While some of this decrease may be attributed to the elimination of the predoctoral fellowship program, it should be

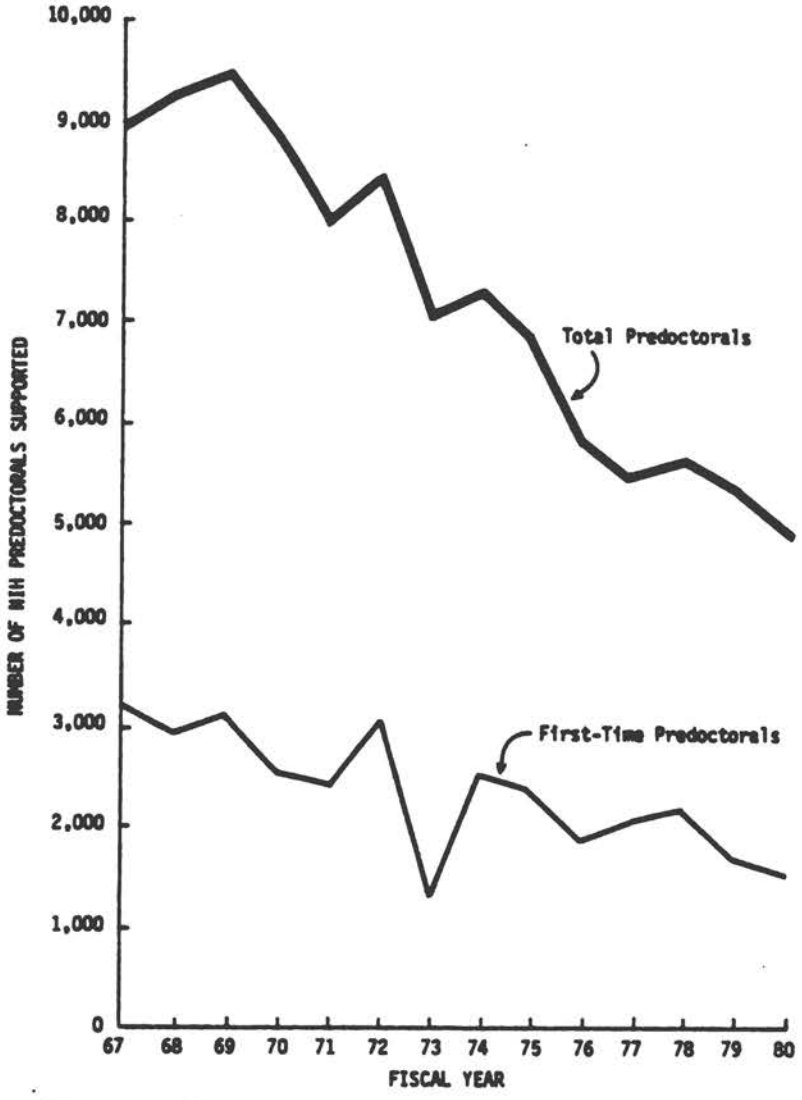

FIGURE 2.1 Number of predoctoral trainees and fellows supported by the NIH, FY1967-80. See Table 2.1.

noted that this trend has continued long after the elimination of the FOI program. With the exception of the FY1972-74 period, the decline in predoctoral awards has been remarkably steady. In FY1972--the year prior to the impoundment of funds for NIH research training--the number of predoctorals supported was significantly higher than in either the preceding or succeeding year. In FY1974--the year after impoundment--the number supported was also relatively high. It has been suggested that the additional predoctoral support provided in these two years tended to offset the significant reductions that occurred in FY1973.

As illustrated in Figure 2.2, there are some striking differences among the NIH institutes with regard to the 14-year trends in predoctoral training. In addition to the emergence of new training

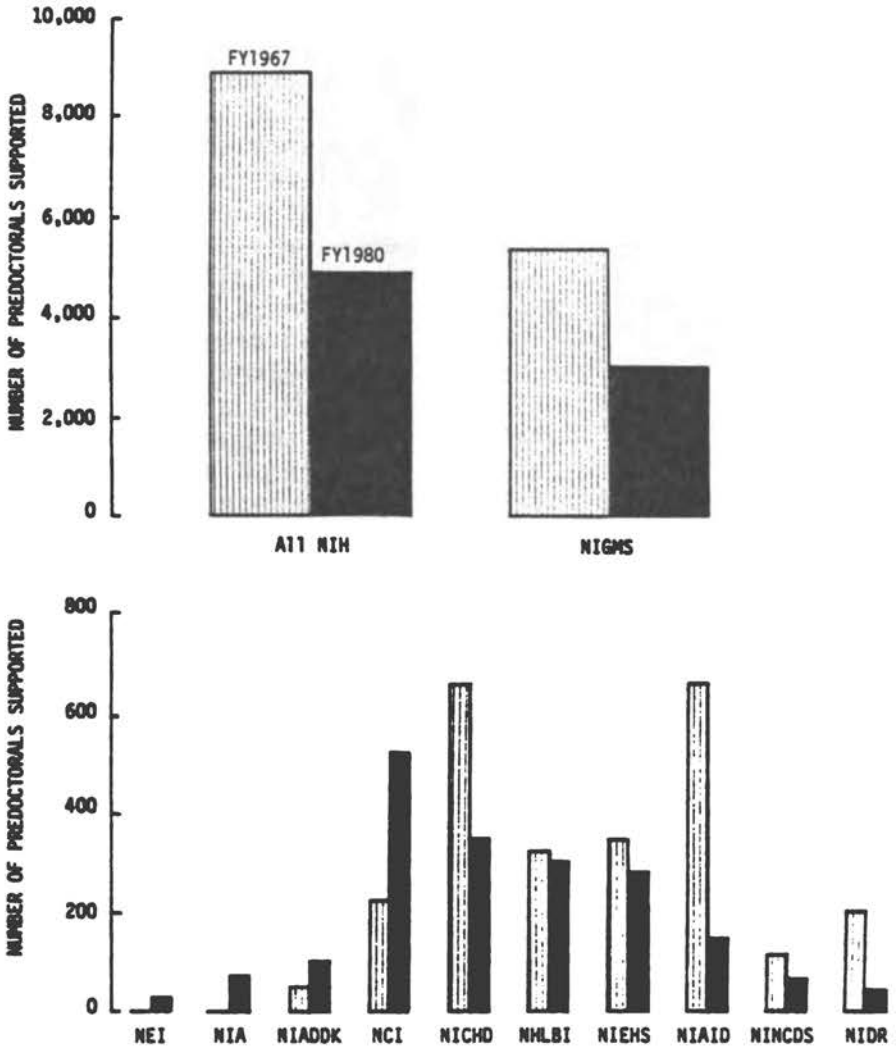

FIGURE 2.2 Number of predoctoral trainees and fellows supported by NIH institutes in FY1967 and FY1980. Note that upper and lower scales differ by a factor of 10. See Table 2.1.

programs within the National Institute on Aging (NIA) and the National Eye Institute (NEI), there was also expansion in predoctoral training funded by the National Institute of Arthritis, Diabetes, and Digestive and Kidney Diseases (NIADDK) and by the NCI. By FY1980, in fact, the NCI was second only to NIGMS in terms of the number of predoctorals supported. In contrast, the numbers of graduate students receiving stipends from the NIAID and the National Institute of Dental Research

(NIDR) fell by more than 75 percent during this 14-year span. Predoctoral training sponsored by each of the other institutes has also waned, although not as abruptly. As may be seen in Figure 2.2, NIGMS throughout this period has provided a majority of the NIH research training support for graduate students, but its share has decreased from 71 percent in FY1967 to 61 percent in FY1980. A principal reason for this decline was the elimination of the predoctoral fellowship program, which had been sponsored almost exclusively by NIGMS.

Despite the steady reduction in NIH support for predoctoral training, the number of students involved in graduate study in the biomedical sciences rose by more than 40 percent during the 1970-78 period (IOM, 1983, p. 175). Since 1978 graduate enrollments have subsided, but have remained well above the level of the early 1970s. Consequently it is not surprising to find that the fraction of graduate students in the biomedical sciences who held NIH traineeships or fellowships has diminished appreciably. In fall, 1975 approximately 17 percent of the population were being supported by NIH training stipends (Figure 2.3); by 1981 this figure had dropped to 13 percent. This loss was compensated by substantial increases in the fractions of students paid on research grants funded by NIH and other federal agencies. In addition to federal sources of support, biomedical science students have relied extensively on teaching assistantships and on self-support. It is not surprising to note, however, that with the increasing costs of graduate education in recent years the fraction of students relying primarily on personal sources of support has fallen significantly.

Accompanying the decline in the number of NIH predoctoral appointments was a modest decrease in the average length of time an individual held such appointments. As reported in Table 2.3, during the FY1970-77 period an NIH predoctoral typically received a total of 26-30 months of support (the somewhat larger medians for FY1973 and FY1974 are presumed to be an artifact of the impoundment of federal funds). Since FY1978 the medians have fallen below 25 months of funding--at a level comparable to that observed in the late 1960s. The FY1980 average of less than 24 months, the lowest recorded, may be slightly underestimated since it includes individuals who may have received additional predoctoral support in subsequent years, for which data were unavailable at the time of this analysis. While median length of predoctoral support provided by NIGMS has gradually but steadily declined during the FY1967-80 period, the medians noticeably increased for those students who received awards from either NCI or NHLBI. From these and other data presented in this chapter it is apparent that there is considerable variation in the patterns of predoctoral support provided by the different institutes. For the interested reader, detailed data describing the career and accomplishments of predoctorals sponsored by each institute are presented in Appendix D. However, no systematic attempt has been made to analyze differences among institutes. Nor has there been an attempt to distinguish between the records of achievement of former fellows and trainees. In the chapters that follow the analyses focus on the outcomes of former NIH predoctorals--irrespective of the institute from which they received support or the type of award they received--and compare their accomplishments with those of other groups of young biomedical scientists.

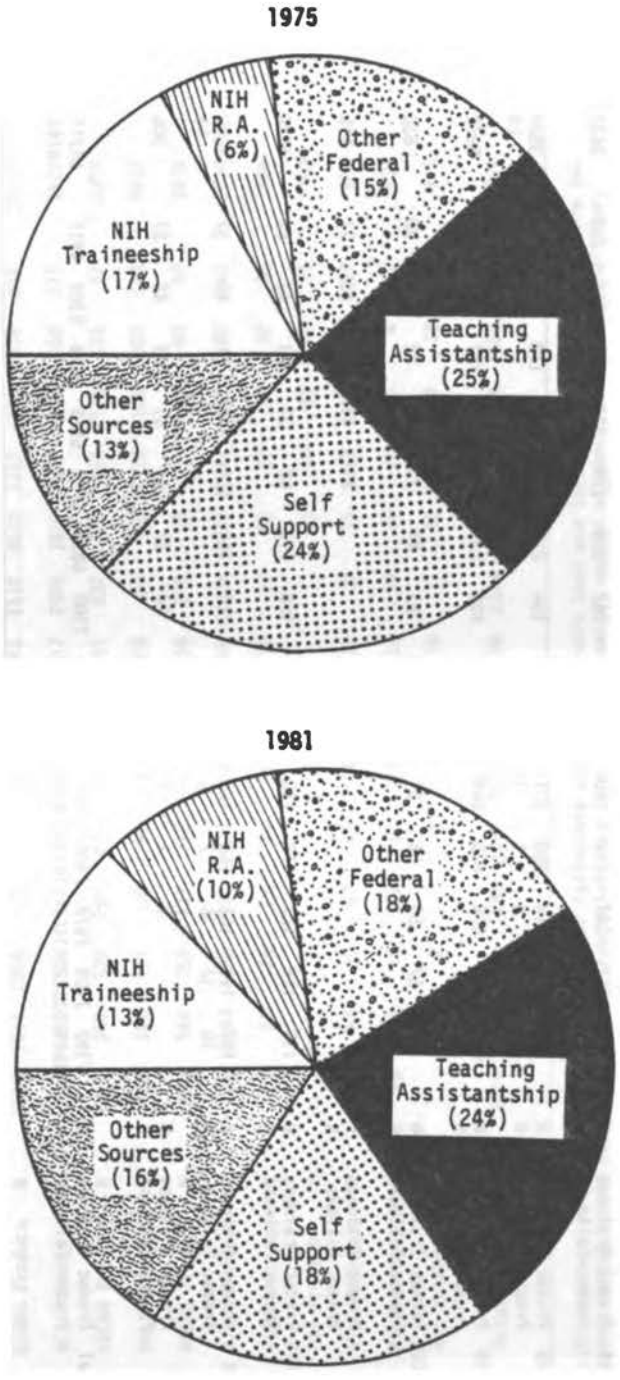

FIGURE 2.3 Distribution of primary sources of support for graduate students enrolled in Ph.D.-granting biomedical science departments, 1975 and 1981. See NSF, 1973-83.

TABLE 2.1 Number of NIH Predoctoral Trainees and Fellows Supported Each Year, FY1967-80

NIH Training Support(a)			Fiscal Year of Funding 1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	Total 1967-80
NIGMS	Predoc Trainees(b)	N	4827	5004	5170	4943	4797	5350	4735	4893	4780	3864	3743	3761	3456	3030	62353
	Predoc Fellows(c)	N	1531	1518	1442	1016	662	280	149	52	14	4	3				6671
NCI	Predoc Trainees	N	219	233	235	229	230	297	268	319	399	535	490	537	534	523	5048
	Predoc Fellows	N															
NICHD	Predoc Trainees	N	660	744	846	711	725	715	495	704	580	465	457	461	415	347	8325
	Predoc Fellows	N															
NHLBI	Predoc Trainees	N	317	317	287	247	220	293	231	262	218	222	223	241	266	293	3637
	Predoc Fellows	N															
NIEHS	Predoc Trainees	N	348	391	419	390	371	269	204	194	219	151	179	178	231	280	3824
	Predoc Fellows	N	8	2	9	4	1										24
NIAID	Predoc Trainees	N	659	636	678	628	669	689	521	485	286	203	113	127	129	149	5972
	Predoc Fellows	N															
NIADDK	Predoc Trainees	N	52	57	54	56	54	83	60	53	47	23	49	72	80	98	838
	Predoc Fellows	N															
NIA	Predoc Trainees	N										91	99	88	66	71	415
	Predoc Fellows	N															
NINCDS	Predoc Trainees	N	113	128	121	143	118	147	136	150	119	60	33	53	43	62	1426
	Predoc Fellows	N															
NIDR	Predoc Trainees	N	197	199	165	160	167	274	221	212	144	124	78	51	40	37	2069
	Predoc Fellows	N	10	12	16	7	5	3									53
NEI	Predoc Trainees	N			3	1	2	9	9	28	37	48	51	49	42	27	306
	Predoc Fellows	N															
Total	Predoc Trainees	N	7392	7709	7978	7508	7353	8126	6880	7300	6829	5786	5515	5618	5302	4917	94213
	Predoc Fellows	N	1549	1532	1467	1027	668	283	149	52	14	4	3				6748

(a)Predocs who received NIH training grant or fellowship support from more than one institute in a fiscal year are included in the counts for the institute from which they received the greater number of months of support that year.
(b)Includes appointments supported under the Medical Scientist Training Program (T05) as well as those in all other pre-Ph.D. programs (T01, T03, T32).
(c)Includes appointments supported under the F01 predoctoral fellowship program, but does not include those in the MARC programs.

SOURCE: National Institutes of Health, Roster of Trainees and Fellows.

TABLE 2.2 Number of Individuals Receiving NIH Predoctoral Training Support for the First Time, FY1967-80

NIH Training Support(a)		First Year of NIH Predoctoral Funding														Total 1967-80
		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	
NIGMS Predocs	N	2053	1914	2066	1544	1478	1827	781	1445	1515	1073	1317	1358	1014	848	20234
NCI Predocs	N	80	93	80	67	75	149	50	137	186	229	147	198	160	171	1822
NICHD Predocs	N	285	350	339	297	277	300	122	351	237	177	182	194	151	97	3359
NHLBI Predocs	N	134	126	121	90	90	143	75	126	93	109	97	109	101	104	1517
NIEHS Predocs	N	200	144	159	133	132	90	27	96	115	45	97	102	80	99	1519
NIAID Predocs	N	239	193	226	212	223	253	89	200	106	68	61	51	52	61	2034
NIADDK Predocs	N	23	26	26	24	24	50	17	19	27	13	27	32	32	36	376
NIA Predocs	N										46	50	39	27	31	193
NINCDS Predocs	N	47	51	45	57	45	75	43	57	39	15	18	27	17	32	568
NIDR Predocs	N	68	62	49	57	51	171	37	57	29	35	28	17	4	12	677
NEI Predocs	N			2		2	7	3	19	17	16	14	17	12	6	115
Total Predocs	N	3129	2959	3113	2481	2397	3065	1244	2506	2364	1826	2038	2145	1650	1497	32414

(a)Predocs who received NIH training grant or fellowship support from more than one institute in a fiscal year are included in the counts for the institute from which they received the greatest number of months of support that year.

SOURCE: National Institutes of Health, Roster of Trainees and Fellows.

TABLE 2.3 Median Number of Months of NIH Support Received as a Predoctoral Trainee or Fellow During the FY1967-80 Period

	Latest Year of NIH Predoctoral Funding(a)													
NIH Training Support(b)	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
NIGMS Predocs, Total N	1852	1981	2167	2108	1698	1558	1430	1607	1942	1445	1349	1335	1332	3030
Median Months Support	26.3	28.5	31.7	32.8	33.7	33.9	38.3	36.3	36.2	33.6	33.6	29.1	26.0	24.0
NCI Predocs, Total N	77	69	83	75	86	81	92	153	151	207	151	167	214	522
Median Months Support	21.8	25.7	16.0	21.7	27.5	21.0	23.9	24.0	21.5	22.0	30.0	28.0	28.0	23.9
NICHD Predocs, Total N	240	249	366	286	312	305	211	328	252	184	193	204	184	347
Median Months Support	13.8	21.2	20.6	21.0	22.0	22.0	24.1	24.0	22.3	23.7	23.6	21.8	24.0	23.6
NHLBI Predocs, Total N	111	147	121	119	81	136	95	146	100	102	101	85	90	292
Median Months Support	12.8	18.0	20.6	21.2	17.6	14.0	20.3	23.6	23.5	18.2	22.0	23.6	23.9	23.6
NIEHS Predocs, Total N	102	128	169	158	196	88	93	108	106	83	57	45	96	282
Median Months Support	12.4	15.5	23.5	22.9	22.8	24.5	27.8	22.2	14.5	22.3	26.3	17.0	24.5	22.1
NIAID Predocs, Total N	182	180	244	217	243	246	237	256	134	133	45	57	42	149
Median Months Support	24.0	24.0	24.0	24.4	21.3	28.2	24.5	29.2	27.1	22.0	12.7	24.0	23.5	21.2
NIADUK Predocs, Total N	22	30	26	26	27	41	28	31	38	5	16	25	26	97
Median Months Support	21.5	13.5	12.1	22.0	12.2	11.9	24.5	20.0	16.0	(c)	(c)	22.0	32.0	22.0
NIA Predocs, Total N										46	42	47	33	71
Median Months Support										21.5	17.5	22.0	18.2	20.0
NIADDS Predocs, Total N	40	43	35	67	54	56	43	84	75	45	10	27	18	62
Median Months Support	16.5	19.2	24.3	22.7	20.5	12.0	24.1	23.5	24.2	23.7	(c)	21.0	(c)	16.5
NIDR Predocs, Total N	52	74	72	58	62	104	69	93	58	72	42	16	19	37
Median Months Support	29.5	31.0	25.0	25.0	37.0	12.4	24.2	30.2	36.2	33.8	25.0	(c)	(c)	27.0
NEI Predocs, Total N			1	1	1	3	2	14	6	17	19	20	21	27
Median Months Support			(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	29.0	35.7	26.0
All NIH Predocs N	2678	2901	3284	3115	2760	2618	2300	2820	2862	2339	2025	2028	2075	4916
Median Months Support	24.1	24.5	26.0	28.0	28.4	26.7	33.6	32.9	28.7	26.3	29.8	24.3	24.8	23.8

(a) Some predocs supported in the most recent years may have received additional NIH support since 1980 which would not be reflected in the median months of support reported here.
(b) Individuals who received NIH predoctoral training grant or fellowship support from more than one institute are included in the counts for the institute from which they received their most recent predoctoral appointment.
(c) Medians based on fewer than 20 cases are not reported.

SOURCE: National Institutes of Health, Roster of Trainees and Fellows.

3. ATTAINMENT OF THE RESEARCH DOCTORATE

One of the most direct measures of the success of NIH predoctoral training programs pertains to attainment of the research doctorate. As discussed in the first chapter of this report, the NIH programs have been intended, from the start, to identify the most promising young investigators and to enhance their progress toward careers in biomedical research. The initial step in this progression--attainment of the Ph.D.--has generally been considered to be a prerequisite for any young scientist who desires to become an independent investigator in a biomedical science discipline. For a graduate student not acquiring this credential all paths to careers in basic research are blocked--with the (rare) exception of a student transferring to medical school and completing M.D. and post-M.D. training. Thus, the frequency with which former NIH predoctorals have successfully completed requirements for their Ph.D.s may be viewed as a primary criterion in judging the extent to which NIH research training programs have met their goals. Earlier evaluations (mentioned in Chapter 1) of NIH and NSF training programs relied extensively on this measure as a preliminary indicator of career achievement.

For purposes of this analyis the determination of whether an individual trainee or fellow earned a research doctorate was based on a computerized collation of the NIH Trainee-Fellow File with the NRC Doctorate Records File, both of which are described in Chapter 1. Since most of the individual records in both data files contain full names, social security numbers, and graduate training institutions, there is every reason to believe that the results of this collation are highly reliable. To verify this presumption, a sample of 100 cases was randomly selected from the population of NIH predoctoral trainees and fellows for whom no records had been matched in the NRC file (i.e., individuals presumed not to have successfully completed requirements for their doctorates). For each case a thorough investigation was made to determine whether in fact the individual had received a Ph.D. Among the sources checked were university commencement books, rosters of annual Ph.D. awards by U.S. institutions (including cross-reference names), records of other NIH training appointments, and NIH and NSF research grant applications. From this investigation it was determined that 6 out of the 100

predoctorals in the sample had earned doctoral degrees (although their records had not been matched in the NRC file). One of the six unmatched cases was a woman who had changed her name after receiving NIH support but prior to earning her doctorate. One individual had earned his Ph.D. according to the registrar's office of the university, but was not included in the commencement program or on the roster of graduates sent to the Doctorate Records File office. Another three cases were not matched because of inconsistencies in the spelling of the individuals' names in the two data files (and missing social security numbers). The remaining case belonged to an individual with two unlinked training records in the NIH Trainee-Fellow Master File. One of these records was matched with the Doctorate Records File, but the other was not since it was presumed to belong to a different individual. On the basis of this investigation we can be reasonably confident that the Ph.D. attainment rates reported here are underestimated by no more than 10 percent.

Before examining results of the analysis, we should mention three additional points. First, it is conceivable that the underestimation of attainment rates (described above) may be partially compensated by "false matches"--i.e., cases for which the training record has been erroneously linked with a Ph.D. record. The likelihood of a "false match" occuring is slight, however, since the algorithm used in the collation required a high probability of agreement. Second, it should be noted that, for the analyses that follow, doctoral attainment is defined to include receipt of a Ph.D. or an equivalent research doctorate from a U.S. university. Awards from foreign institutions or nonaccredited domestic universities are excluded, as are M.D. and other professional doctorates.[1] Finally, and most important, reliable estimates of Ph.D. attainment rates have been compiled only for those individuals who had received NIH predoctoral support. Comparable data for other graduate students are (regrettably) lacking. This is considered to be a serious limitation since we have available to us no unequivocal standard with which the doctoral completion rates of NIH trainees and fellows may be directly compared.

Doctoral Attainment Data presented in Table 3.1 (in the last section of this chapter) reveal that nearly two-thirds of the 33,805 individuals who had received NIH predoctoral support between FY1967 and FY1979 had earned Ph.D.s by FY1981. Those supported since FY1974 had significantly lower doctoral attainment rates, as should be expected since many of them may not have had sufficient time to have completed their training by FY1981. To compensate for this artifact the completion percentages of FY1975-1979 predoctorals[2] have been adjusted on the basis of the average length of time it has taken earlier cohorts of NIH trainees and fellows to receive their doctorates. The revised completion estimates are shown in Figure

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[1]The combined M.D.-Ph.D degree is, however, included.

[2]In this analysis cohorts are identified according to the latest year in which an individual received NIH predoctoral training support.

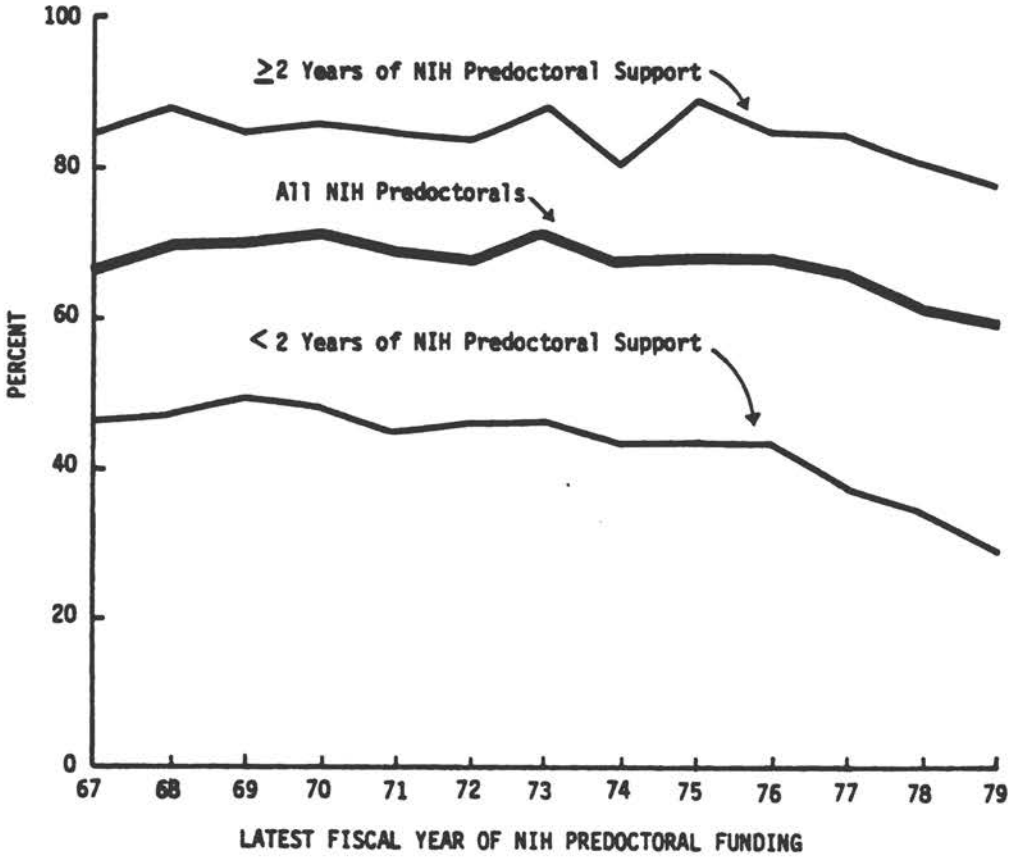

FIGURE 3.1 Percent of NIH-sponsored predoctorals who earned or were expected to earn Ph.D.s, FY1967-79. Percentages for FY1975-79 are estimated (see text).

3.1. In effect, the adjusted[3] percentages for FY1975-79 predoctorals represent "projections" of the proportions of trainees expected to earn their doctorates.

From this analysis it is readily apparent that those graduate students who had held NIH traineeships and fellowships for longer periods of time were more likely to earn Ph.D.s than were those who had held NIH appointments for shorter periods. As shown in Figure 3.1, approximately 85 percent of those receiving two years or more of NIH support successfully completed their graduate training. In contrast, the Ph.D. attainment rate for predoctorals supported for shorter durations was only about half of this figure. While the data presented in Table 3.1 suggest a strong, positive correlation between length of NIH predoctoral support and attainment of the doctorate, the interpretation of this relationship is problematic. Many graduate

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[3]The divisors used to adjust FY1975, FY1976, FY1977, FY1978, and FY1979 percentages were .96, .93, .86, .76, and .56, respectively.

students not completing requirements for the Ph.D. may have left school in the first or second year of their training and consequently would not have been enrolled long enough to have received 24 months of NIH funding. Conversely, the relatively high completion rates for those holding NIH predoctoral traineeships or fellowships for at least two years reflects, in part, the fact that these individuals must have "survived" the rigors of the initial stages of training--i.e., course work and preliminary laboratory experience.

It is of further interest to note that the (adjusted) Ph.D. attainment rate for the total NIH predoctoral group has been gradually declining in recent years. Approximately 59 percent of the FY1979 cohort are expected to earn doctoral degrees. Prior to FY1976 the corresponding percentages are at least 7 points higher. The factors underlying this recent trend are not fully understood, but evidence from other sources (IOM, 1983, Appendix Tables B2 and B3) suggests that this may very well be part of an overall decline in the fraction of graduate students in the biomedical sciences who completed requirements for the doctorate. During the early and mid-1970s graduate enrollments in these fields expanded at a very rapid pace, yet comparatively little growth was observed in the number of doctoral awards made in subsequent years.[4]

As already mentioned, no comparable estimates are available for the Ph.D. completion rates of graduate students who did not receive any NIH-sponsored training. Nevertheless, a rough approximation of the overall doctorate attainment rate for entering graduate students in biomedical disciplines can be derived by comparing the annual number of Ph.D. awards with the number of first-year students enrolled in doctorate-granting departments six-and-a-half years earlier.[5] During the 1977-81 period the ratio of these two numbers ranged between .44 and .49--estimates well below the Ph.D. attainment rates for NIH predoctorals. Although the first-year graduate enrollment figures may include a small number of individuals not seeking doctoral degrees, it seems improbable that these figures are overestimated by more than a few percent. Furthermore, results from an earlier study (NRC, 1976) of a 1956-65 cohort of bioscience graduate students indicate that less than half of those who had applied for but had not received any federal training support subsequently earned doctoral degrees. On the basis of these two independent estimates of completion rates, it is reasonable to conclude that NIH predoctorals have been more successful than their colleagues in acquiring research doctorates.

Elapsed Time-to-Ph.D. Further analysis of the training records of individuals who earned Ph.D.s during the FY1967-81 period reveals that

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[4]Unfortunately no information was available in this study to investigate what has become of those graduate students who did not complete their doctoral degrees.

[5]Data presented in Table 3.2 at the end of this chapter indicate that the median total time from entrance into graduate school to completion of the doctorate has been approximately 6.3 years for recent Ph.D. recipients.

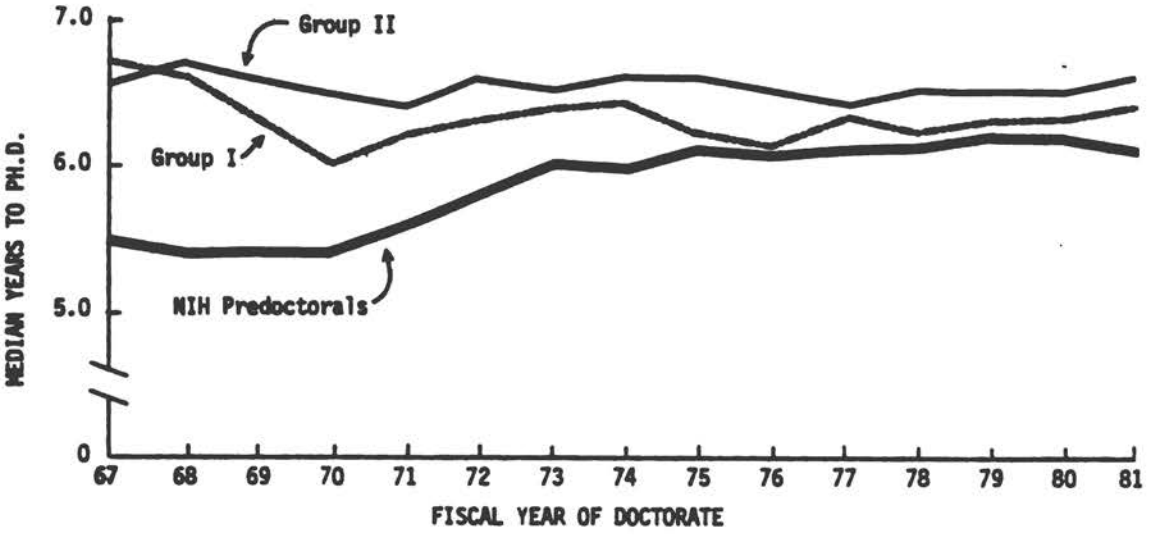

FIGURE 3.2 Median years elapsed from first enrollment in graduate school to receipt of the doctorate, FY1967-81. See Table 3.2.

NIH trainees and fellows typically obtained their degrees in shorter intervals of time than did biomedical science graduates in either of the comparison groups.[6] As illustrated in Figure 3.2, however, the magnitude of these differences has diminished in recent years. Prior to FY1971, NIH predoctorals took an average of less than five and one-half years to complete graduate training; other biomedical students required approximately one year longer. By the mid-1970s the median time-to-Ph.D. for the NIH group had increased by more than one-half year, while there was little change in the median times for the two comparison groups. Nevertheless, throughout the FY1967-81 period the average duration of graduate training for NIH-sponsored students has been consistently shorter than that for their colleagues. This finding is consonant with the results from earlier evaluations of NIH and NIGMS training programs (see Chapter 1).

Doctoral Institution It is not at all surprising to find, of course, that a substantial fraction of the NIH predoctoral support has been concentrated in the leading doctoral institutions. Of the 19,362 NIH trainees and fellows who earned doctorates between FY1970 and FY1981, almost half of them (48 percent) had received their training at 25 universities whose biomedical faculties were considered to have

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[6]As discussed in Chapter 1, two Ph.D. comparison groups have been chosen: those receiving their training in departments with some NIH training support (Group I) and those receiving their training in other biomedical science departments (Group II).

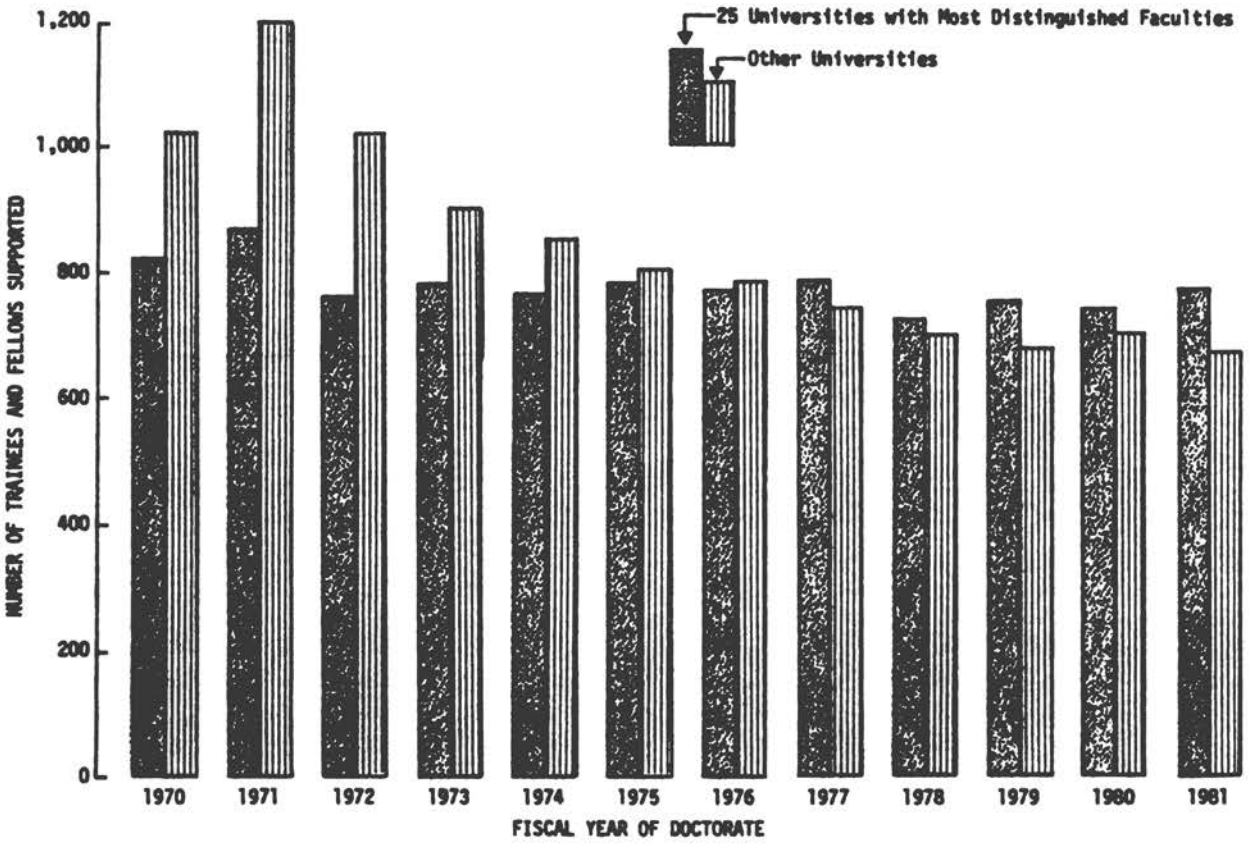

FIGURE 3.3 Number of FY1970-81 Ph.D. recipients who had received NIH predoctoral training support, by category of doctoral institution. See Table 3.3.

the most distinguished reputations[7] (Table 3.3). These same 25 universities accounted for approximately 35 percent of the doctoral awards made in the biomedical sciences during this 12-year period. Of greater interest perhaps is the fact that, although NIH training support was reduced appreciably during this period, the numbers of

[7]Reputational ratings of biomedical program faculty were determined on the basis of peer evaluations provided in the Assessment of Research-Doctorate Programs in the United States: Biological Sciences (Jones et al., 1982). See footnote (b) in Table 3.3 for a description of the method used in calculating institutional averages for reputational ratings of the scholarly quality of program faculty.

graduates from the 25 leading institutions who had received NIH stipends declined only slightly. In fact, since FY1972 the number of NIH predoctorals graduating each year from these institutions has remained between 700 and 800 (Figure 3.3). Most of the reduction in predoctoral support has been experienced in programs at other universities. Between FY1970 and FY1981 the number of NIH trainees and fellows receiving their doctorates from universities not among the leading 25 fell by as much as one-third. Since the allocation of NIH predoctoral training funds is determined on the basis of peer evaluation, it is reassuring that programs in those institutions with reputedly the most outstanding faculties have suffered less--in terms of lost training positions--than have programs in other universities. It must be remembered, nevertheless, that these data are several years out of date and do not reflect the current (1984) situation. According to NIGMS program administrators, in the last few years there has been a significant cutback in the number of trainees supported in the leading programs as well as in other places.

Doctoral Field. Throughout its history the NIH predoctoral training programs have provided stipends to students in a broad range of health-related disciplines. This fact is reflected in the data presented in Tables 3.4 and 3.5. Approximately half of the FY1967-81 Ph.D. recipients supported by the NIH received their graduate training in one of six biomedical disciplines: biochemistry (including molecular biology), microbiology, physiology, pharmacology, biophysics, and genetics. The remainder of the NIH predoctorals specialized in a host of other biomedical disciplines or in fields outside the biomedical sciences. Some readers may be surprised by the fact that nearly one-fourth of the NIH-sponsored graduates acquired their training outside the traditional biomedical areas. Most of these students, however, received their research training in health-related disciplines. It is of further interest to note that since the early 1970s the numbers of NIH trainees specializing in fields outside the biomedical sciences has declined substantially. Much of this decrease may be attributed to a sharp reduction in the numbers of chemistry students supported. One partial explanation for this reduction in chemistry is the emergence in the last decade of new biochemistry and molecular biology programs that are autonomous from chemistry departments.

Summary From the evidence presented in this chapter four conclusions may be drawn:

(1) NIH supported trainees and fellows have been more likely than other graduate students in the biomedical sciences to obtain their doctorates;

(2) they typically have completed their graduate study in shorter periods of time;

(3) a substantial fraction of the NIH predoctorals received their training in biomedical programs with highly distinguished reputations; and

(4) they specialized in a wide variety of health-related disciplines.

Although these findings indicate that the NIH predoctoral training programs have been successful in launching the careers of many young biomedical scientists, one must keep in mind that attainment of the Ph.D. is but the first step toward becoming an independent investigator. In the following chapter we consider the next step in career development--postdoctoral training.

TABLE 3.1 Number and Percent of FY1961-79 NIH Predoctoral Trainees or Fellows Awarded Their Doctorates by FY1981

		Latest Year of NIH Predoctoral Funding													
Total NIH Predoc Support		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	Total 1967-79
>35 Months Support	N	876	1032	1268	1192	1094	1054	1078	1254	1298	869	785	714	734	13248
Awarded Doctorate(a)	N	803	961	1150	1080	986	944	967	1087	1145	753	618	505	381	11380
	%	91.7	93.1	90.7	90.6	90.1	89.6	89.7	86.7	88.2	86.7	78.7	70.7	51.9	85.9
24-35 Months Support	N	595	626	668	688	580	416	531	536	417	526	464	460	528	7035
Awarded Doctorate	N	452	491	496	540	429	298	355	349	314	350	289	214	172	4749
	%	76.0	78.4	74.3	78.5	74.0	71.6	66.9	65.1	75.3	66.5	62.3	46.5	32.6	67.5
9-23 Months Support	N	870	914	1018	945	833	825	535	757	979	800	645	702	735	10658
Awarded Doctorate	N	433	463	547	482	393	404	257	345	430	332	217	189	122	4614
	%	49.8	50.7	53.7	51.0	47.2	49.0	48.0	45.6	43.9	41.5	33.6	26.9	16.6	43.7
1-8 Months Support	N	337	329	330	290	253	323	156	273	168	144	131	152	78	2964
Awarded Doctorate	N	118	123	116	109	94	122	60	96	46	46	27	31	12	1000
	%	35.0	37.4	35.2	37.6	37.2	37.8	38.5	35.2	27.4	31.9	20.6	20.4	15.4	33.7
Total NIH Supported	N	2678	2901	3284	3115	2760	2618	2300	2820	2862	2339	2025	2028	2075	33805
Awarded Doctorate	N	1806	2038	2309	2211	1902	1768	1639	1877	1935	1481	1151	939	687	21743
	%	67.4	70.3	70.3	71.0	68.9	67.5	71.3	66.6	67.6	63.3	56.8	46.3	33.1	64.3

(a)Since a significant number of those applying in the last five years may still have been in graduate training after FY1981, the percentages reported for recent predoctoral trainees/fellows underestimate the actual percent who will eventually complete their doctoral training.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows; National Research Council, Survey of Earned Doctorates.

TABLE 3.2 Median Years Elapsed from First Enrollment in Graduate School to Receipt of the Doctorate, FY1967-81 Ph.D. Recipients

		Fiscal Year of Doctorate															
FY1967-81 Ph.D. Recipients		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Total 1967-81
NIH Predoctoral Support(a)	N	1215	1562	1813	1841	2068	1780	1680	1613	1585	1552	1522	1418	1426	1441	1436	23952
Median Years to Ph.D.(b)		5.5	5.4	5.4	5.4	5.6	5.8	6.0	6.0	6.1	6.1	6.1	6.1	6.2	6.2	6.1	5.9
>35 Months Support	N	586	732	884	959	1071	918	879	872	922	960	862	740	716	664	680	12445
Median Years to Ph.D.		5.5	5.4	5.4	5.5	5.6	5.9	5.9	5.9	6.0	6.0	6.1	6.2	6.3	6.2	6.2	5.9
24-35 Months Support	N	298	423	482	427	490	420	364	326	312	287	285	333	327	352	365	5491
Median Years to Ph.D.		5.4	5.3	5.3	5.4	5.5	5.6	5.9	6.3	6.2	6.1	6.0	5.9	6.0	6.1	6.0	5.7
9-23 Months Support	N	331	407	447	455	507	442	437	415	351	305	375	345	383	425	391	6016
Median Years to Ph.D.		5.5	5.5	5.4	5.4	5.6	5.9	6.2	6.1	6.6	6.3	6.3	6.1	6.1	6.2	6.2	5.9
Other Biomedical Ph.D.s	N	1297	1443	1555	1862	2016	2179	2261	2202	2285	2352	2275	2409	2515	2630	2642	31923
Median Years to Ph.D.		6.7	6.7	6.4	6.2	6.3	6.4	6.4	6.5	6.4	6.4	6.3	6.4	6.4	6.4	6.5	6.4
Group I(c)	N	572	698	767	861	985	994	1091	951	941	929	899	918	973	953	932	13464
Median Years to Ph.D.		6.7	6.6	6.3	6.0	6.2	6.3	6.4	6.4	6.2	6.1	6.3	6.2	6.3	6.3	6.4	6.3
Group II(d)	N	725	745	788	1001	1031	1185	1170	1251	1344	1423	1376	1491	1542	1677	1710	18459
Median Years to Ph.D.		6.6	6.7	6.6	6.5	6.4	6.6	6.5	6.6	6.6	6.5	6.4	6.5	6.5	6.5	6.6	6.5
Total All Ph.D.s (above)	N	2512	3005	3368	3703	4084	3959	3941	3815	3870	3904	3797	3827	3941	4071	4078	55875
Median Years to Ph.D.		6.0	5.9	5.7	5.8	5.9	6.1	6.2	6.3	6.3	6.2	6.2	6.3	6.3	6.3	6.3	6.1

(a) Individuals who received a total of less than 9 months support are included in Group I.
(b) Based on reported number of years from first enrollment in graduate school to receipt of doctorate.
(c) Includes biomedical science Ph.D.s who had not received at least 9 months of NIH predoctoral training grant or fellowship support but were identified as having been graduate students in programs that had some NIH predoctoral training grant funding.
(d) Includes other biomedical science Ph.D.s who were identified as having been graduate students in programs that had no NIH predoctoral training grant funding.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows; National Research Council, Survey of Earned Doctorates.

TABLE 3.3 Percent of FY1970-81 Ph.D. Recipients Who Earned Their Doctorates from Universities with Distinguished Reputations in Biomedical Disciplines

		Fiscal Year of Doctorate												
FY1970-81 Ph.D. Recipients		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Total 1970-81
NIH Predoc Support(a)	N	1841	2068	1780	1680	1613	1585	1552	1522	1418	1426	1441	1436	19362
Distinguished Univ.(b)	N	823	872	762	777	765	782	773	785	719	750	737	768	9313
	%	44.7	42.2	42.8	46.3	47.4	49.3	49.8	51.6	50.7	52.6	51.1	53.5	48.1
>35 Months Support	N	959	1071	918	879	872	922	960	862	740	716	664	680	10243
Distinguished Univ.	N	450	470	446	429	458	491	534	494	423	407	382	400	5384
	%	46.9	43.9	48.6	48.8	52.5	53.3	55.6	57.3	57.2	56.8	57.5	58.8	52.6
24-35 Months Support	N	427	490	420	364	326	312	287	285	333	327	352	365	4288
Distinguished Univ.	N	179	199	161	148	150	137	116	119	155	167	166	190	1887
	%	41.9	40.6	38.3	40.7	46.0	43.9	40.4	41.8	46.5	51.1	47.2	52.1	44.0
9-23 Months Support	N	455	507	442	437	415	351	305	375	345	383	425	391	4831
Distinguished Univ.	N	194	203	155	200	157	154	123	172	141	176	189	178	2042
	%	42.6	40.0	35.1	45.8	37.8	43.9	40.3	45.9	40.9	46.0	44.5	45.5	42.3
Other Biomedical Ph.D.s	N	1862	2016	2179	2261	2202	2285	2352	2275	2409	2515	2630	2642	27628
Distinguished Univ.	N	519	543	606	622	534	564	583	565	599	629	642	630	7036
	%	27.9	26.9	27.8	27.5	24.3	24.7	24.8	24.8	24.9	25.0	24.4	23.8	25.5
Group I(c)	N	861	985	994	1091	951	941	929	899	918	973	953	932	11427
Distinguished Univ.	N	311	355	393	477	364	371	392	390	364	439	410	424	4690
	%	36.1	36.0	39.5	43.7	38.3	39.4	42.2	43.4	39.7	45.1	43.0	45.5	41.0
Group II(d)	N	1001	1031	1185	1170	1251	1344	1423	1376	1491	1542	1677	1710	16201
Distinguished Univ.	N	208	188	213	145	170	193	191	175	235	190	232	206	2346
	%	20.8	18.2	18.0	12.4	13.6	14.4	13.4	12.7	15.8	12.3	13.8	12.0	14.5
Total All Ph.D.s (above)	N	3703	4084	3959	3941	3815	3870	3904	3797	3827	3941	4071	4078	46990
Distinguished Univ.	N	1342	1415	1368	1399	1299	1346	1356	1350	1318	1379	1379	1398	16349
	%	36.2	34.6	34.6	35.5	34.0	34.8	34.7	35.6	34.4	35.0	33.9	34.3	34.8

(a)Individuals who received a total of less than 9 months support are included in Group I.
(b)Using results from the 1982 Assessment of Research-Doctorate Programs, an average for each university was computed from the mean ratings of the scholarly quality of faculty in biochemistry, cellular/molecular biology, microbiology, and physiology programs. In calculating university averages, mean ratings were weighted according to the number of 1976-80 graduates from each program evaluated. A total of 25 universities with biomedical program averages of 3.50 or higher were considered to have distinguished reputations.
(c)Includes biomedical science Ph.D.s who had not received at least 9 months of NIH predoctoral training grant or fellowship support but were identified as having been graduate students in programs that had some NIH predoctoral training grant funding.
(d)Includes other biomedical science Ph.D.s who were identified as having been graduate students in programs had no NIH predoctoral training grant funding.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows; National Research Council, Survey of Earned Doctorates.

TABLE 3.4 Field of Doctorate of FY1967-81 Ph.D. Recipients Who Received NIH Predoctoral Support, by Fiscal Year of Doctorate

Field of Doctorate		Fiscal Year of Doctorate															Total 1967-81
		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	
Total NIH Predocs(a)	N	1215	1562	1813	1841	2068	1780	1680	1613	1585	1552	1522	1418	1426	1441	1436	23952
	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total Biomedical Sciences	N	883	1107	1306	1309	1467	1281	1259	1215	1230	1226	1190	1107	1129	1193	1196	18098
	%	72.7	70.9	72.0	71.1	70.9	72.0	74.9	75.3	77.6	79.0	78.2	78.1	79.2	82.8	83.3	75.6
Anatomy & Embryology	N	70	83	88	93	106	86	76	65	66	59	54	59	45	52	40	1042
	%	5.8	5.3	4.9	5.1	5.1	4.8	4.5	4.0	4.2	3.8	3.5	4.2	3.2	3.6	2.8	4.4
Animal Physiology	N	111	143	173	145	163	133	143	120	131	100	115	108	109	124	106	1924
	%	9.1	9.2	9.5	7.9	7.9	7.5	8.5	7.4	8.3	6.4	7.6	7.6	7.6	8.6	7.4	8.0
Biochem. & Molec. Biol.	N	239	305	313	345	376	349	340	344	339	347	313	298	280	325	347	4860
	%	19.7	19.5	17.3	18.7	18.2	19.6	20.2	21.3	21.4	22.4	20.6	21.0	19.6	22.6	24.2	20.3
Biomedical Engineering	N	18	16	11	25	34	17	19	17	23	19	16	19	16	10	14	274
	%	1.5	1.0	.6	1.4	1.6	1.0	1.1	1.1	1.5	1.2	1.1	1.3	1.1	.7	1.0	1.1
Biomath. & Biostat.	N			20	21	32	29	30	22	36	33	26	24	26	27	18	344
	%			1.1	1.1	1.5	1.6	1.8	1.4	2.3	2.1	1.7	1.7	1.8	1.9	1.3	1.4
Biophysics	N	49	64	76	61	66	72	53	61	61	54	63	45	65	45	43	878
	%	4.0	4.1	4.2	3.3	3.2	4.0	3.2	3.8	3.8	3.5	4.1	3.2	4.6	3.1	3.0	3.7
Environmental Sciences	N						5	13	6	15	11	10	8	15	9	15	107
	%						.3	.8	.4	.9	.7	.7	.6	1.1	.6	1.0	.4
General Biology	N	5	15	42	42	51	40	44	48	46	39	41	44	35	39	49	580
	%	.4	1.0	2.3	2.3	2.5	2.2	2.6	3.0	2.9	2.5	2.7	3.1	2.5	2.7	3.4	2.4
Genetics	N	44	48	58	66	66	49	46	37	59	54	69	50	73	64	70	853
	%	3.6	3.1	3.2	3.6	3.2	2.8	2.7	2.3	3.7	3.5	4.5	3.5	5.1	4.4	4.9	3.6
Immunology	N						8	28	34	35	41	47	42	56	53	62	406
	%						.4	1.7	2.1	2.2	2.6	3.1	3.0	3.9	3.7	4.3	1.7
Microbiology	N	154	188	200	186	224	173	176	155	150	150	141	116	116	113	105	2347
	%	12.7	12.0	11.0	10.1	10.8	9.7	10.5	9.6	9.5	9.7	9.3	8.2	8.1	7.8	7.3	9.8
Pathology	N	4	8	15	8	12	17	20	36	36	51	42	36	29	36	25	375
	%	.3	.5	.8	.4	.6	1.0	1.2	2.2	2.3	3.3	2.8	2.5	2.0	2.5	1.7	1.6
Pharmacol. & Pharm. Sci.	N	91	101	118	100	125	127	96	116	100	112	112	123	117	125	130	1693
	%	7.5	6.5	6.5	5.4	6.0	7.1	5.7	7.2	6.3	7.2	7.4	8.7	8.2	8.7	9.1	7.1
Public Health	N	10	13	24	13	10	6	14	21	8	11	15	14	20	19	22	220
	%	.8	.8	1.3	.7	.5	.3	.8	1.3	.5	.7	1.0	1.0	1.4	1.3	1.5	.9

(continued on next page)

TABLE 3.4 (continued)

Field of Doctorate		Fiscal Year of Doctorate 1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Total 1967-81
Veterinary Medicine	N	2		1	1		2	4	7	3	2	3	1	2	3	3	34
	%	.2		.1	.1		.1	.2	.4	.2	.1	.2	.1	.1	.2	.2	.1
Zoology	N	62	74	75	80	88	68	51	28	31	30	19	19	17	14	16	672
	%	5.1	4.7	4.1	4.3	4.3	3.8	3.0	1.7	2.0	1.9	1.2	1.3	1.2	1.0	1.1	2.8
Biosciences, Other	N	17	35	70	88	67	70	71	64	65	83	65	76	82	100	90	1043
	%	1.4	2.2	3.9	4.8	3.2	3.9	4.2	4.0	4.1	5.3	4.3	5.4	5.8	6.9	6.3	4.4
Medical Sciences, Other	N	7	14	22	35	47	30	35	34	26	30	39	25	26	35	41	446
	%	.6	.9	1.2	1.9	2.3	1.7	2.1	2.1	1.6	1.9	2.6	1.8	1.8	2.4	2.9	1.9
Total Other Fields	N	332	455	507	532	601	499	421	398	355	326	332	311	297	248	240	5854
	%	27.3	29.1	28.0	28.9	29.1	28.0	25.1	24.7	22.4	21.0	21.8	21.9	20.8	17.2	16.7	24.4
Mathematics	N	17	22	10	20	18	21	19	14	22	14	9	10	11	6	7	220
	%	1.4	1.4	.6	1.1	.9	1.2	1.1	.9	1.4	.9	.6	.7	.8	.4	.5	.9
Physics	N	5	10	7	12	5	6	7	4	9	4	5	9	5	3	3	94
	%	.4	.6	.4	.7	.2	.3	.4	.2	.6	.3	.3	.6	.4	.2	.2	.4
Chemistry	N	183	213	223	222	218	136	106	78	56	62	43	54	54	39	40	1727
	%	15.1	13.6	12.3	12.1	10.5	7.6	6.3	4.8	3.5	4.0	2.8	3.8	3.8	2.7	2.8	7.2
Earth Sciences	N	2	3	2	5	1	3	5	5	3	1	3	2	4		2	41
	%	.2	.2	.1	.3		.2	.3	.3	.2	.1	.2	.1	.3		.1	.2
Engineering	N	28	51	29	25	36	36	34	35	19	18	31	31	17	20	24	434
	%	2.3	3.3	1.6	1.4	1.7	2.0	2.0	2.2	1.2	1.2	2.0	2.2	1.2	1.4	1.7	1.8
Life Sciences(b)	N	44	70	73	90	100	89	65	47	46	37	41	24	42	21	26	815
	%	3.6	4.5	4.0	4.9	4.8	5.0	3.9	2.9	2.9	2.4	2.7	1.7	2.9	1.5	1.8	3.4
Psychology	N	16	36	67	69	94	77	77	86	84	85	78	89	78	69	73	1078
	%	1.3	2.3	3.7	3.7	4.5	4.3	4.6	5.3	5.3	5.5	5.1	6.3	5.5	4.8	5.1	4.5
Social Sciences	N	19	22	43	34	72	71	69	81	74	53	78	54	63	64	41	838
	%	1.6	1.4	2.4	1.8	3.5	4.0	4.1	5.0	4.7	3.4	5.1	3.8	4.4	4.4	2.9	3.5
Other Fields	N	18	28	53	56	57	60	39	48	42	52	44	38	23	26	24	607
	%	1.5	1.8	2.9	3.0	2.8	3.4	2.3	3.0	2.6	3.4	2.9	2.7	1.6	1.8	1.7	2.5

(a)Includes individuals who received a total of at least 9 months of NIH predoctoral training grant or fellowship support.
(b)Includes agricultural sciences as well as those biological science fields not listed above in the biomedical sciences.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows; National Research Council, Survey of Earned Doctorates.

TABLE 3.5 Field of Doctorate of FY1967-81 Ph.D. Recipients Who Received NIH Predoctoral Support, by Institute of Predoctoral Training

Field of Doctorate		Institute of Most Recent Predoctoral Training											Total NIH
		NIGMS	NCI	NICHD	NHLBI	NIEHS	NIAID	NIADDK	NIA	NINCDS	NIDR	NEI	
Total NIH Predocs(a)	N	16777	871	1922	788	971	1393	181	62	413	523	51	23952
	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total Biomedical Sciences	N	13288	788	812	706	549	1279	161	7	142	324	43	18098
	%	79.2	90.5	42.2	89.5	56.5	91.8	89.0	11.3	34.4	62.0	84.3	75.6
Anatomy & Embryology	N	782	10	145	8	2	1	25	1	16	48	4	1042
	%	4.7	1.1	7.5	1.0	.2	.1	13.8	1.6	3.9	9.2	7.8	4.4
Animal Physiology	N	1303	22	91	356	43	9	18	3	47	23	9	1924
	%	7.8	2.5	4.7	45.2	4.4	.6	9.9	4.8	11.4	4.4	17.6	8.0
Biochem. & Molec. Biol.	N	4246	182	166	43	50	63	57	3	8	40	2	4860
	%	25.3	20.9	8.6	5.5	5.1	4.5	31.5	4.8	1.9	7.6	3.9	20.3
Biomedical Engineering	N	242	5	7	9	10	1						274
	%	1.4	.6	.4	1.1	1.0	.1						1.1
Biometh. & Biostat.	N	278			48	2		2		2	6	6	344
	%	1.7			6.1	.2		1.1		.5	1.1	11.8	1.4
Biophysics	N	791	22	5	22	5	5	3		1	21	3	878
	%	4.7	2.5	.3	2.8	.5	.4	1.7		.2	4.0	5.9	3.7
Environmental Sciences	N	10	2	1	9	84	1						107
	%	.1	.2	.1	1.1	8.7	.1						.4
General Biology	N	370	12	114	14	26	26	2		4	9	3	580
	%	2.2	1.4	5.9	1.8	2.7	1.9	1.1		1.0	1.7	5.9	2.4
Genetics	N	770	15	30	1	16	7			1	13		853
	%	4.6	1.7	1.6	.1	1.6	.5			.2	2.5		3.6
Immunology	N	127	106	9	2	3	151				8		406
	%	.8	12.2	.5	.3	.3	10.8				1.5		1.7
Microbiology	N	1297	121	16	10	42	814	5			40	2	2347
	%	7.7	13.9	.8	1.3	4.3	58.4	2.8			7.6	3.9	9.8
Pathology	N	258	57	5	15	11	7			1	21		375
	%	1.5	6.5	.3	1.9	1.1	.5			.2	4.0		1.6
Pharmacol. & Pharm. Sci.	N	1435	56	4	88	67	1	2		6	34		1693
	%	8.6	6.4	.2	11.2	6.9	.1	1.1		1.5	6.5		7.1
Public Health	N	79	19	21	16	46	24	6		2	7		220
	%	.5	2.2	1.1	2.0	4.7	1.7	3.3		.5	1.3		.9

(continued on next page)

TABLE 3.5 (continued)

Field of Doctorate		Institute of Most Recent Predoctoral Training											Total NIH
		NIGMS	NCI	NICHD	NHLBI	NIEHS	NIAID	NIADDK	NIA	NINCDS	NIDR	NEI	
Veterinary Medicine	N	17		1			14	2					34
	%	.1		.1			1.0	1.1					.1
Zoology	N	435	27	64	22	34	81	2		1	6		672
	%	2.6	3.1	3.3	2.8	3.5	5.8	1.1		.2	1.1		2.8
Biosciences, Other	N	641	70	117	17	49	36	32		35	34	12	1043
	%	3.8	8.0	6.1	2.2	5.0	2.6	17.7		8.5	6.5	23.5	4.4
Medical Sciences, Other	N	207	62	16	25	59	38	5		18	14	2	446
	%	1.2	7.1	.8	3.2	6.1	2.7	2.8		4.4	2.7	3.9	1.9
Total Other Fields	N	3489	83	1110	83	422	114	20	55	271	199	8	5854
	%	20.8	9.5	57.8	10.5	43.5	8.2	11.0	88.7	65.6	38.0	15.7	24.4
Mathematics	N	187	3	1	2	24	1			2			220
	%	1.1	.3	.1	.3	2.5	.1			.5			.9
Physics	N	55	19		1	5				3	11		94
	%	.3	2.2		.1	.5				.7	2.1		.4
Chemistry	N	1597	40	3	14	36	6	3	1	1	26		1727
	%	9.5	4.6	.2	1.8	3.7	.4	1.7	1.6	.2	5.0		7.2
Earth Sciences	N	10		1		25				1	4		41
	%	.1		.1		2.6				.2	.8		.2
Engineering	N	229	10	1	30	109		6	1	7	41		434
	%	1.4	1.1	.1	3.8	11.2		3.3	1.6	1.7	7.8		1.8
Life Sciences(b)	N	476	3	40	6	183	96	6		1	4		815
	%	2.8	.3	2.1	.8	18.8	6.9	3.3		.2	.8		3.4
Psychology	N	326	3	652	7				25	28	29	8	1078
	%	1.9	.3	33.9	.9				40.3	6.8	5.5	15.7	4.5
Social Sciences	N	491	1	268	5	28	2	2	23	1	17		838
	%	2.9	.1	13.9	.6	2.9	.1	1.1	37.1	.2	3.3		3.5
Other Fields	N	118	4	144	18	12	9	3	5	227	67		607
	%	.7	.5	7.5	2.3	1.2	.6	1.7	8.1	55.0	12.8		2.5

(a)Includes individuals who received a total of at least 9 months of NIH predoctoral training grant or fellowship support.
(b)Includes agricultural sciences as well as those biological science fields not listed above in the biomedical sciences.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows; National Research Council, Survey of Earned Doctorates.

4. POSTDOCTORAL RESEARCH TRAINING

For young scientists intent on pursuing careers in biomedical research the importance of postdoctoral research training experience should not be minimized:

> From the perspective of the young investigator the postdoctoral appointment has provided a unique opportunity to concentrate on a particular research problem without the burden of either the teaching and administrative responsibilities usually given to a faculty member or the formal degree requirements of a graduate student. As the competition for research positions has intensified during the past decade, the opportunity as a postdoctoral to establish a strong record of research publications has become increasingly attractive to many young scientists interested in careers in academic research (NRC, 1981b, p. 82).

The postdoctoral population in the biomedical sciences has expanded at an astonishing rate in recent years--even though there has been only a slight increase in doctoral awards. Between 1973 and 1981 the number of biomedical scientists holding postdoctoral appointments at academic institutions nearly doubled (IOM, 1983, p. 58). By 1981 an estimated 6,900 individuals held such appointments, and another 1,300 were engaged in advanced research training outside the university setting (i.e., in NIH intramural research programs, other government and industrial laboratories, and hospitals and clinics). Furthermore, during this eight-year span the average duration of a postdoctoral apprenticeship increased from an estimated two years to three years, and recently it has not been unusual for a young scientist to acquire as many as four or more years of postdoctoral experience before taking a permanent position (IOM, 1983, p. 60).

The increases in both the numbers of biomedical science postdoctorals and the length of their apprenticeships may be principally attributed to two factors. On the one hand, the postdoctoral expansion reflects "a continuation of a trend that originated in the late 1950's, a trend that may be viewed by some as a natural consequence of the advancement of scientific knowledge and techniques" (Coggeshall et al, 1978, p. 492). As biomedical research has taken on greater sophistication and complexity, it has become increasingly apparent that the highly specialized skills needed as an independent investigator cannot be fully acquired in the period a student spends as a graduate research assistant and that advanced research training would be greatly beneficial. On the other hand, the postdoctoral increases observed in recent years may also be partly attributed to a lack of career alternatives for young biomedical scientists. During the past decade the number of faculty openings in these fields (as well as in most other sciences) has diminished appreciably--a consequence of the stabilization of student enrollments and research budgets as well as the fact that relatively few faculty members have reached retirement age. Although career opportunities outside the academic environs have burgeoned during this same period, this growth apparently has not been sufficient to make up for the shortage of faculty openings. As a consequence, many of the biomedical science graduates taking postdoctorals have prolonged their apprenticeships because they were unable to obtain other types of positions they desired. Findings from a 1976 survey, for example, revealed that more than 40 percent of the postdoctorals in these fields had extended their appointments for this reason (Coggeshall et al, 1978, p. 490).

Planning Postdoctorals Whatever the factors underlying the postdoctoral expansion, it is quite evident that advanced research training has generally been considered a prerequisite for a career in biomedical research--regardless of whether that career is to be pursued in the university environs or in a government or industrial laboratory. Without this advanced training and the valuable research experience it affords, an individual's opportunities to become an independent investigator are severely limited. Thus the postdoctoral apprenticeship may be viewed as the second stage in the career development of a biomedical scientist. An analysis of the postgraduation plans of FY1967-81 Ph.D. recipients reveals that NIH-supported predoctorals have been 25-30 percent more likely than other biomedical science graduates to seek advanced research training (Table 4.1). As illustrated in Figure 4.1, during this 14-year span the fraction of NIH trainees and fellows planning postdoctorals has steadily grown--as have the corresponding fractions for the two comparison groups. By 1978, for example, nearly two-thirds of the NIH-supported graduates expected to take advanced research training appointments, compared with 58 and 51 percent of the biomedical science Ph.D.s in Groups I and II, respectively.

NIH Postdoctoral Fellowships and Traineeships A more direct, but narrowly focused, measure of postdoctoral pursuit is based on how many graduates have actually held NIH postdoctoral fellowships or

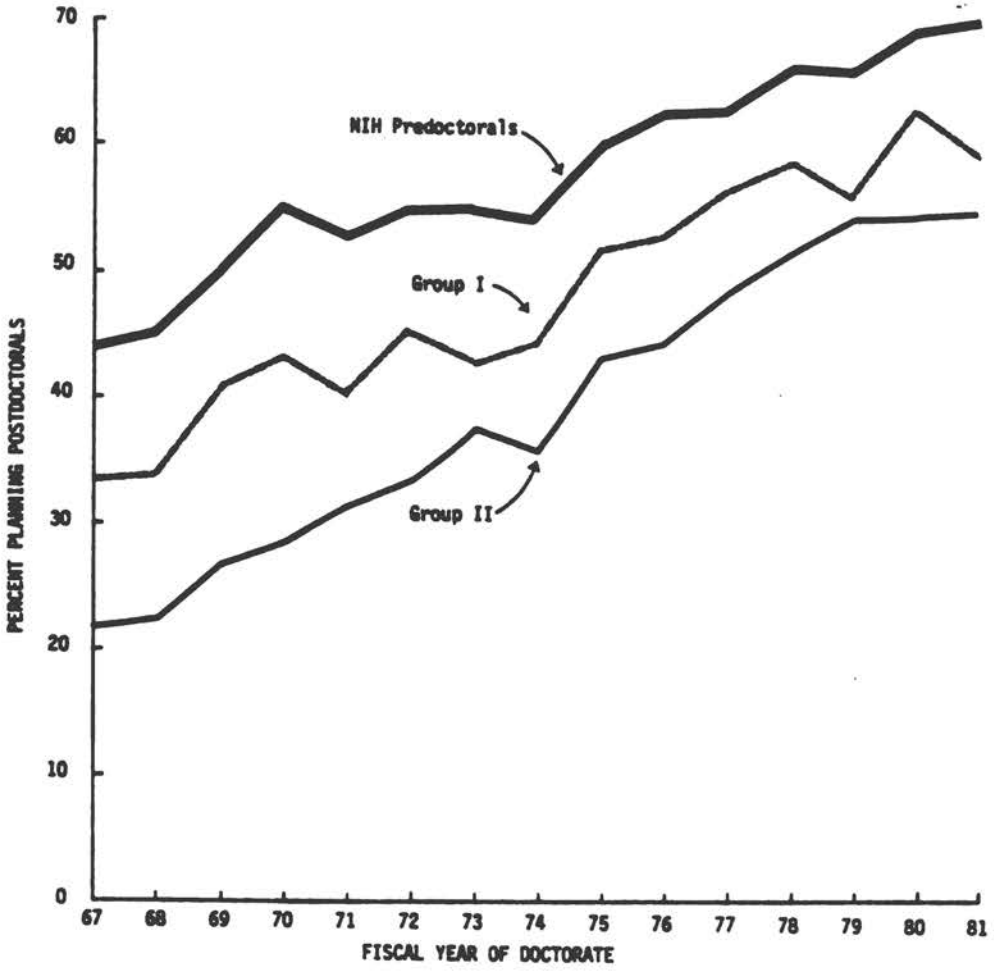

FIGURE 4.1 Percent of NIH predoctorals and other biomedical science graduate students planning to take postdoctoral appointments after receipt of their doctorates, FY1967-81. See Table 4.1.

traineeships. The data presented in Table 4.2 indicate that over the years NIH predoctorals have been almost twice as likely as other biomedical science graduates to receive NIH postdoctoral training awards. Moreover, of the 12,228 NIH postdoctorals who had earned their Ph.D.s during the FY1967-79 period, nearly three-fifths had once been NIH predoctorals. In recent years, however, the number transiting from NIH predoctoral traineeships or fellowships to NIH postdoctorals has declined--primarily as a consequence of the reduction in the number of graduate students supported--and by FY1978 former NIH predoctorals no longer constituted a majority of the NIH postdoctoral fellow and trainee population (Figure 4.2). It must be

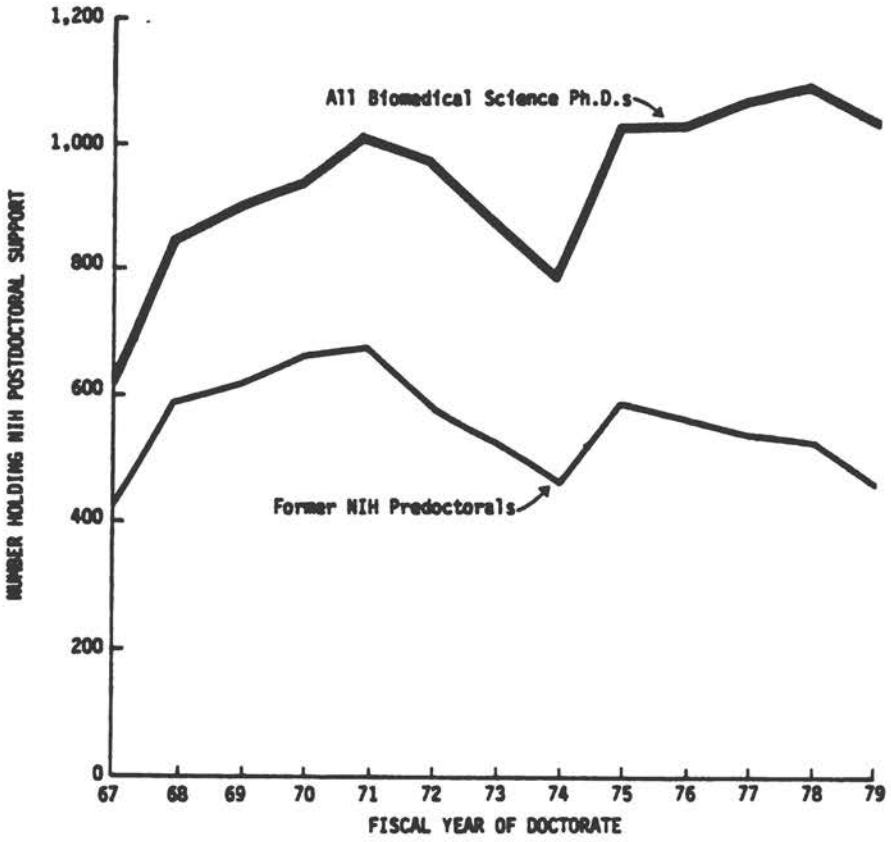

FIGURE 4.2 Number of NIH predoctorals and other biomedical science Ph.D.s who subsequently received NIH postdoctoral training grant or fellowship support, FY1967-79. See Table 4.2.

emphasized that the figures reported here do not include the many individuals who received postdoctoral support from NIH research grants and contracts as well as from other federal and non-federal sources, all of which together have accounted for an estimated 60 percent of postdoctoral funding (NRC, 1981b, p. 138). Furthermore, it is apparent that most of the postdoctoral expansion that occurred in the biomedical sciences during the late 1970s was financed by federal and nonfederal research funds, and not by increases in NIH training monies.

The tendency for the NIH to provide financial assistance for an individual scientist's training at both the predoctoral and postdoctoral levels is mirrored in the support patterns of the separate institutes. For example, more than 21 percent of the 616 Ph.D. recipients (FY1967-79) supported as predoctorals by the NCI subsequently held postdoctoral fellowships or traineeships funded by this same institute (Figure 4.3). The corresponding percentages for NHLBI and NINCDS are even slightly greater. Also remarkable is the finding that only about 5 percent of the NINCDS predoctorals received advanced training support from other NIH institutes. In contrast,

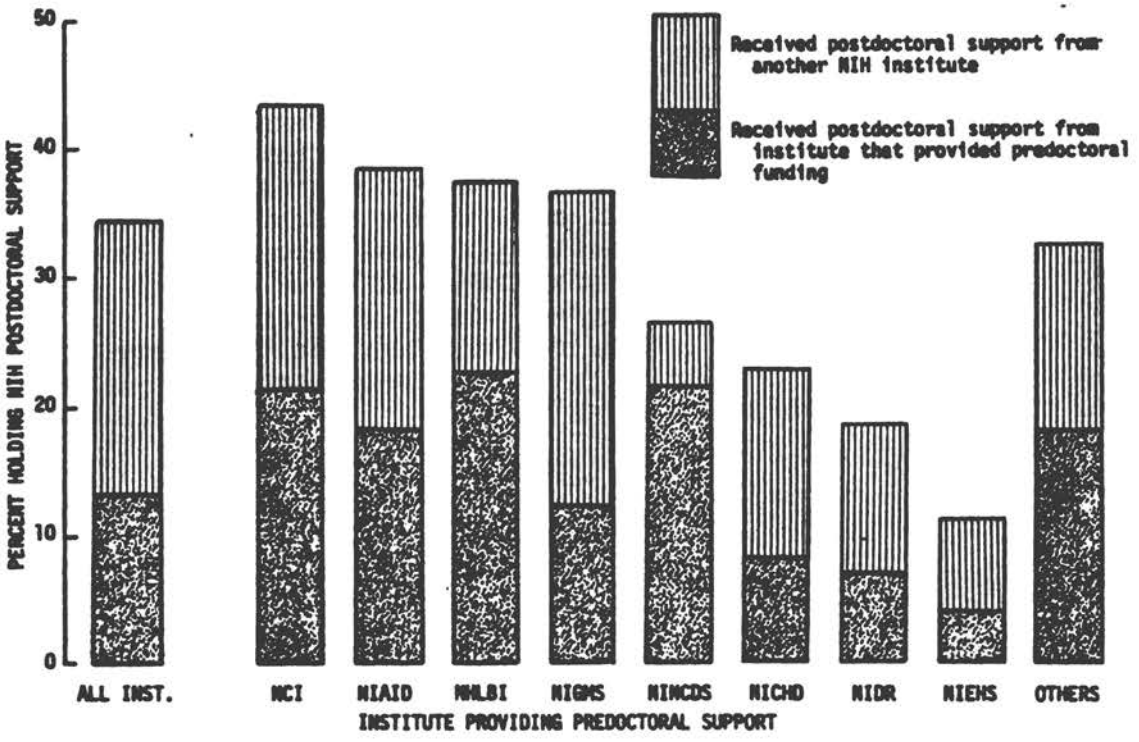

FIGURE 4.3 Percent of NIH predoctorals who subsequently held postdoctoral fellowships or traineeships from either the same institute that had provided predoctoral support or one of the other NIH institutes, FY1967-79. See Table 4.3.

more than 24 percent of the NIGMS predoctorals were awarded postdoctoral traineeships or fellowships from other institutes. This finding is, of course, consonant with the NIGMS role in offering predoctoral training in a broad range of basic biomedical disciplines.

Postdoctoral Appointments at Major Research Universities In examining the relationship between predoctoral training and career achievement, one must recognize that the features of the postdoctoral experience--e.g., the mentor and laboratory in which the advanced research training is acquired--also play a very important role in determining career outcomes. This topic will be the subject of a future report. Of further interest here is the extent to which qualitative aspects of the predoctoral training experience influence where the graduate pursues advanced training. For example, were Ph.D. recipients from the leading biomedical science programs more likely than other graduates to take postdoctoral appointments at major research establishments? Data presented in Table 4.4 indicate that NIH-supported predoctorals from universities with distinguished

reputations[1] in the biosciences planned to pursue postdoctoral training at major research institutions[2] more frequently than did NIH-supported graduates from other universities. Biomedical science Ph.D.s who had not received NIH stipends as graduate students were less likely than either of these groups to follow this same route.

Summary The principal conclusion of the analyses examined in this chapter--that NIH-supported predoctorals have pursued postdoctoral apprenticeships more frequently than have their biomedical science colleagues--may be expected to affect other career outcome measures as well. As already mentioned, those with postdoctoral experience have a better chance of obtaining faculty appointments at major research universities, and the postdoctoral apprenticeship affords an exceptional opportunity to contribute to the scientific literature. These and many other measures of early career achievement are considered in the next three chapters.

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[1]Based on peer ratings of the scholarly quality of the faculty in biochemistry, cellular/molecular biology, microbiology, and physiology programs at an institution. See footnote (b) in Table 3.3.

[2]Included are 100 academic institutions with the largest total expenditures for research and development activities in the biological sciences in FY1980.

TABLE 4.1 Percent of FY1967-81 Ph.D. Recipients Planning to Take Postdoctoral Appointments After Graduation

		Fiscal Year of Doctorate															
FY1967-81 Ph.D. Recipients		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Total 1967-81
NIH Predoc Support(a)	N	1215	1562	1813	1841	2068	1780	1680	1613	1585	1552	1522	1418	1426	1441	1436	23952
Planning Postdoc(b)	N	535	697	910	1010	1084	977	930	868	961	973	952	937	935	998	1002	13769
	%	44.0	44.6	50.2	54.9	52.4	54.9	55.4	53.8	60.6	62.7	62.5	66.1	65.6	69.3	69.8	57.5
>35 Months Support	N	586	732	884	959	1071	918	879	872	922	960	862	740	716	664	680	12445
Planning Postdoc	N	297	378	519	576	625	566	557	522	605	658	592	538	504	499	514	7950
	%	50.7	51.6	58.7	60.1	58.4	61.7	63.4	59.9	65.6	68.5	68.7	72.7	70.4	75.2	75.6	63.9
24-35 Months Support	N	298	423	482	427	490	420	364	326	312	287	285	333	327	352	365	5491
Planning Postdoc	N	119	159	203	207	224	212	184	156	177	185	160	195	219	231	258	2859
	%	39.9	37.6	42.1	48.5	45.7	50.5	50.5	47.9	56.7	54.0	56.1	58.6	67.0	65.6	70.7	52.1
9-23 Months Support	N	331	407	447	455	507	442	437	415	351	305	375	345	383	425	391	6016
Planning Postdoc	N	119	160	188	227	235	199	189	190	179	160	200	204	212	268	230	2960
	%	36.0	39.3	42.1	49.9	46.4	45.0	43.2	45.8	51.0	52.5	53.3	59.1	55.4	63.1	58.8	49.2
Other Biomedical Ph.D.s	N	1297	1443	1555	1862	2016	2179	2261	2202	2285	2352	2275	2409	2515	2630	2642	31923
Planning Postdoc	N	348	405	526	656	723	841	904	867	1060	1116	1171	1299	1374	1498	1470	14258
	%	26.8	28.1	33.8	35.2	35.9	38.6	40.0	39.4	46.4	47.4	51.5	53.9	54.6	57.0	55.6	44.7
Group I(c)	N	572	698	767	861	985	994	1091	951	941	929	899	918	973	953	932	13464
Planning Postdoc	N	191	236	315	372	397	448	467	420	484	486	510	536	543	599	551	6555
	%	33.4	33.8	41.1	43.2	40.3	45.1	42.8	44.2	51.4	52.3	56.7	58.4	55.8	62.9	59.1	48.7
Group II(d)	N	725	745	788	1001	1031	1185	1170	1251	1344	1423	1376	1491	1542	1677	1710	18459
Planning Postdoc	N	157	169	211	284	326	393	437	447	576	630	661	763	831	899	919	7703
	%	21.7	22.7	26.8	28.4	31.6	33.2	37.4	35.7	42.9	44.3	48.0	51.2	53.9	53.6	53.7	41.7
Total All Ph.D.s (above)	N	2512	3005	3368	3703	4084	3959	3941	3815	3870	3904	3797	3827	3941	4071	4078	55875
Planning Postdoc	N	883	1102	1436	1666	1807	1818	1834	1735	2021	2089	2123	2236	2309	2496	2472	28027
	%	35.2	36.7	42.6	45.0	44.2	45.9	46.5	45.5	52.2	53.5	55.9	58.4	58.6	61.3	60.6	50.2

(a)Individuals who received a total of less than 9 months support are included in Group I.
(b)Includes graduates who at the time they completed requirements for their doctorates reported that they intended to take postdoctoral appointments.
(c)Includes biomedical science Ph.D.s who had not received at least 9 months of NIH predoctoral training grant or fellowship support but were identified as having been graduate students in programs that had some NIH predoctoral training grant funding.
(d)Includes other biomedical science Ph.D.s who were identified as having been graduate students in programs that had no NIH predoctoral training grant funding.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows; National Research Council, Survey of Earned Doctorates.

TABLE 4.2 Percent of FY1967-79 Ph.D. Recipients Who Received NIH Postdoctoral Fellowships or Traineeships

		Fiscal Year of Doctorate													
FY1967-79 Ph.D. Recipients		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	Total 1967-79
NIH Predoc Support(a)	N	1215	1562	1813	1841	2068	1780	1680	1613	1585	1552	1522	1418	1426	21075
Held NIH Postdoc(b)	N	433	592	635	661	677	582	535	460	586	559	540	530	463	7253
	%	35.6	37.9	35.0	35.9	32.7	32.7	31.8	28.5	37.0	36.0	35.5	37.4	32.5	34.4
>35 Months Predoc	N	586	732	884	959	1071	918	879	872	922	960	862	740	716	11101
Held NIH Postdoc	N	252	318	374	401	415	343	348	281	402	372	348	313	242	4409
	%	43.0	43.4	42.3	41.8	38.7	37.4	39.6	32.2	43.6	38.8	40.4	42.3	33.8	39.7
24-35 Months Predoc	N	298	423	482	427	490	420	364	326	312	287	285	333	327	4774
Held NIH Postdoc	N	88	147	124	129	133	124	99	78	102	89	86	116	117	1432
	%	29.5	34.8	25.7	30.2	27.1	29.5	27.2	23.9	32.7	31.0	30.2	34.8	35.8	30.0
9-23 Months Support	N	331	407	447	455	507	442	437	415	351	305	375	345	383	5200
Held NIH Postdoc	N	93	127	137	131	129	115	88	101	82	98	106	101	104	1412
	%	28.1	31.2	30.6	28.8	25.4	26.0	20.1	24.3	23.4	32.1	28.3	29.3	27.2	27.2
Other Biomedical Ph.D.s	N	1297	1443	1555	1862	2016	2179	2261	2202	2285	2352	2275	2409	2515	26651
Held NIH Postdoc	N	204	253	256	276	335	386	345	333	441	479	530	561	576	4975
	%	15.7	17.5	16.5	14.8	16.6	17.7	15.3	15.1	19.3	20.4	23.3	23.3	22.9	18.7
Group I(c)	N	572	698	767	861	985	994	1091	951	941	929	899	918	973	11579
Held NIH Postdoc	N	110	129	158	160	193	212	174	157	206	215	224	234	228	2400
	%	19.2	18.5	20.6	18.6	19.6	21.3	15.9	16.5	21.9	23.1	24.9	25.5	23.4	20.7
Group II(d)	N	725	745	788	1001	1031	1185	1170	1251	1344	1423	1376	1491	1542	15072
Held NIH Postdoc	N	94	124	98	116	142	174	171	176	235	264	305	327	348	2575
	%	13.0	16.6	12.4	11.6	13.8	14.7	14.6	14.1	17.5	18.6	22.2	21.9	22.6	17.1
Total All Ph.D.s (above)	N	2512	3005	3368	3703	4084	3959	3941	3815	3870	3904	3797	3827	3941	47726
Held NIH Postdoc	N	637	845	891	937	1012	968	880	793	1027	1038	1070	1091	1039	12228
	%	25.4	28.1	26.5	25.3	24.8	24.5	22.3	20.8	26.5	26.6	28.2	28.5	26.4	25.6

(a) Individuals who received a total of less than 9 months support are included in Group I.
(b) Since individuals who received NIH postdoctoral fellowship or training grant support after 1980 are not counted, the percentages reported for the most recent Ph.D. recipients may be underestimated.
(c) Includes biomedical science Ph.D.s who had not received at least 9 months of NIH predoctoral training grant or fellowship support but were identified as having been graduate students in programs that had some NIH predoctoral training grant funding.
(d) Includes other biomedical science Ph.D.s who were identified as having been graduate students in programs that had no NIH predoctoral training grant funding.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows; National Research Council, Survey of Earned Doctorates.

TABLE 4.3 Number and Percent of the FY1967-79 Ph.D. Recipients Who Received Postdoctoral Fellowships or Traineeships from Any of the NIH Institutes

		Institute of Most Recent Postdoctoral Training(a)														
NIH Training Support(b)		NIGMS	NCI	NICHD	NHLBI	NIEHS	NIAID	NIADDK	NIA	NINCDS	NIDR	NEI	Other NIH	Total NIH	No NIH Postdoc	TOTAL
NIGMS Predocs	N	1849	908	351	488	84	403	560	27	563	66	120	98	5517	9444	14961
	%	12.4	6.1	2.3	3.3	.6	2.7	3.7	.2	3.8	.4	.8	.7	36.9	63.1	
NCI Predocs	N	38	131	15	9	6	32	23	1	5	3	3	1	267	349	616
	%	6.2	21.3	2.4	1.5	1.0	5.2	3.7	.2	.8	.5	.5	.2	43.3	56.7	
NICHD Predocs	N	76	45	136	19	4	12	26	5	26	7	4	21	381	1271	1652
	%	4.6	2.7	8.2	1.2	.2	.7	1.6	.3	1.6	.4	.2	1.3	23.1	76.9	
NHLBI Predocs	N	27	10	10	143	1	4	25		10	1	4	3	238	400	638
	%	4.2	1.6	1.6	22.4	.2	.6	3.9		1.6	.2	.6	.5	37.3	62.7	
NIEHS Predocs	N	17	9	6	12	34	7	5		6	1		1	98	770	868
	%	2.0	1.0	.7	1.4	3.9	.8	.6		.7	.1		.1	11.3	88.7	
NIAID Predocs	N	61	120	8	17	3	236	23	2	10	8	2	4	494	781	1275
	%	4.8	9.4	.6	1.3	.2	18.5	1.8	.2	.8	.6	.2	.3	38.7	61.3	
NIADDK Predocs	N	5	2	4	7		1	24		1	1	1	1	47	100	147
	%	3.4	1.4	2.7	4.8		.7	16.3		.7	.7	.7	.7	32.0	68.0	
NIA Predocs	N								2			1	2	5	25	30
	%								6.7			3.3	6.7	16.7	83.3	
NINCDS Predocs	N	4		4	1		2		1	79	1	5	2	99	269	368
	%	1.1		1.1	.3		.5		.3	21.5	.3	1.4	.5	26.9	73.1	
NIDR Predocs	N	16	3	3	9	1	3	12		8	35	1	1	92	398	490
	%	3.3	.6	.6	1.8	.2	.6	2.4		1.6	7.1	.2	.2	18.8	81.2	
NEI Predocs	N			1					1	1		11	1	15	15	30
	%			3.3					3.3	3.3		36.7	3.3	50.0	50.0	
Total All NIH Predocs	N	2093	1228	538	705	133	700	698	39	709	123	152	135	7253	13822	21075
	%	9.9	5.8	2.6	3.3	.6	3.3	3.3	.2	3.4	.6	.7	.6	34.4	65.6	
Other Biomedical Ph.D.s	N	1038	860	395	643	131	450	554	50	452	113	157	132	4975	21676	26651
	%	3.9	3.2	1.5	2.4	.5	1.7	2.1	.2	1.7	.4	.6	.5	18.7	81.3	
Group I(c)	N	557	405	184	280	60	215	267	13	229	49	73	68	2400	9179	11579
	%	4.8	3.5	1.6	2.4	.5	1.9	2.3	.1	2.0	.4	.6	.6	20.7	79.3	
Group II(d)	N	481	455	211	363	71	235	287	37	223	64	84	64	2575	12497	15072
	%	3.2	3.0	1.4	2.4	.5	1.6	1.9	.2	1.5	.4	.6	.4	17.1	82.9	
Total All Ph.D.s (above)	N	3131	2088	933	1348	264	1150	1252	89	1161	236	309	267	12228	35498	47726
	%	6.6	4.4	2.0	2.8	.6	2.4	2.6	.2	2.4	.5	.6	.6	25.6	74.4	

(a) Includes Ph.D. recipients who received NIH postdoctoral fellowship or training support prior to FY1981.
(b) Includes individuals who received a total of at least 9 months of NIH predoctoral training grant or fellowship support.
(c) Includes biomedical science Ph.D.s who had not received at least 9 months of NIH predoctoral training grant or fellowship support but were identified as having been graduate students in programs that had some NIH predoctoral training grant funding.
(d) Includes other biomedical science Ph.D.s who were identified as having been graduate students in programs that had no NIH predoctoral training grant funding.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows; National Research Council, Survey of Earned Doctorates.

TABLE 4.4 Percent of FY1970-81 Ph.D. Recipients Planning to Take Postdoctoral Appointments at Major Research Universities

FY1970-81 Ph.D. Recipients		Fiscal Year of Doctorate 1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Total 1970-81
NIH Predoctoral Support(a)														
Distinguished Ph.D. Univ.(b)	N	823	872	762	777	765	782	773	785	719	750	737	768	9313
Postdoc at Res. Univ.(c)	N	220	232	217	275	272	319	335	348	306	338	350	370	3582
	%	26.7	26.6	28.5	35.4	35.6	40.8	43.3	44.3	42.6	45.1	47.5	48.2	38.5
Ph.D.s from Other Univ.	N	1018	1196	1018	903	848	803	779	737	699	676	704	668	10049
Postdoc at Res. Univ.	N	253	243	210	259	258	319	288	289	299	265	342	287	3312
	%	24.9	20.3	20.6	28.7	30.4	39.7	37.0	39.2	42.8	39.2	48.6	43.0	33.0
Total	N	1841	2068	1780	1680	1613	1585	1552	1522	1418	1426	1441	1436	19362
Postdoc at Res. Univ.	N	473	475	427	534	530	638	623	637	605	603	692	657	6894
	%	25.7	23.0	24.0	31.8	32.9	40.3	40.1	41.9	42.7	42.3	48.0	45.8	35.6
Other Biomedical Ph.D.s														
Distinguished Ph.D. Univ.	N	519	543	605	622	534	564	583	565	599	629	642	630	7036
Postdoc at Res. Univ.	N	92	83	107	135	143	145	171	181	179	201	216	201	1854
	%	17.7	15.3	17.7	21.7	26.8	25.7	29.3	32.0	29.9	32.0	33.6	31.9	26.4
Ph.D.s from Other Univ.	N	1343	1473	1573	1639	1668	1721	1769	1710	1810	1886	1988	2012	20592
Postdoc at Res. Univ.	N	181	173	196	326	358	431	464	497	566	596	618	639	5045
	%	13.5	11.7	12.5	19.9	21.5	25.0	26.2	29.1	31.3	31.6	31.1	31.8	24.5
Total	N	1862	2016	2179	2261	2202	2285	2352	2275	2409	2515	2630	2642	27628
Postdoc at Res. Univ.	N	273	256	303	461	501	576	635	678	745	797	834	840	6899
	%	14.7	12.7	13.9	20.4	22.8	25.2	27.0	29.8	30.9	31.7	31.7	31.8	25.0

(a) Includes individuals who received a total of at least 9 months of NIH predoctoral training support.
(b) See footnote (b) in Table 3.3.
(c) Includes graduates who at the time they completed requirements for their doctorates reported that they intended to take a postdoctoral appointment at one of the 100 universities with the largest total expenditures for research and development activities in the biological sciences in FY1980.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows; National Research Council, Survey of Earned Doctorates.

5. EARLY CAREER EMPLOYMENT

The ultimate impact of the NIH predoctoral training programs may be measured in terms of the subsequent accomplishments of graduates supported by these programs. A fully comprehensive set of measures would require an analysis of the achievements by individual scientists during their entire careers of 30 years or more, but since this evaluation focuses on the FY1967-81 Ph.D. cohorts, such a long-term perspective is not feasible. In this chapter we examine the employment activities of NIH-supported predoctorals and other biomedical science graduates who have had up to 15 years of experience since earning their doctorates. How many of these young scientists have been involved in research? What fraction have been hired on faculties at major research universities? How many have worked on R & D projects funded by NIH or other federal agencies? These are all questions pertaining to the early career employment activities of graduates and are addressed in this chapter; in the two chapters that follow we examine their specific accomplishments--in terms of their success in obtaining federal research grants and their records of publication in biomedical science journals.

In interpreting results from an analysis of the employment of young biomedical scientists, one must be cognizant of the alternative career paths that may be followed. The stereotype of the doctoral graduate acquiring a few years of postdoctoral experience and then moving on to an appointment at a university or medical school faculty is by no means the only option available to students aspiring to careers in biomedical research. Although many have followed such paths, increasing numbers have embarked on research careers outside the academic sector. Results from a 1981 survey of biomedical scientists who had entered postdoctoral training between five and seven years earlier reveal that nearly one-third of these individuals were employed in industry, government, or other nonacademic sectors and that most were devoting a significant portion of their time to R & D activities (IOM, 1983, p. 63). Thus, any analysis of the research involvement of young biomedical scientists must not overlook those working outside the university environs.

The data presented in this chapter are derived from a biennial (1973-81) Survey of Doctorate Recipients, conducted by the National

Research Council. The survey sample[1] included approximately 15-20 percent of the Ph.D. population in the biomedical sciences, and these individuals were asked to provide detailed information about their employment situations. Of particular relevance to this analysis are questions concerning the fraction of time they devoted to various work activities and whether their work was sponsored by a federal agency. For purposes of comparison the survey results are reported for seven individual cohorts--FY1967-68 Ph.D.s through FY1980-81 Ph.D.s--and in each of the five survey years (see Table 5.1, for example). This analytical scheme enables us to take into account the number of years of experience (years since Ph.D.) of a particular cohort. For example, data pertaining to the 1975 employment situations of the FY1967-68 cohort might be compared with data about the 1977 situations of FY1969-70 Ph.D.s. All data are presented in terms of percentages of the three populations being examined in this study: former NIH predoctorals and the two comparison groups of biomedical science Ph.D.s. The numbers of survey responses on which percentages are based are given in Appendix B.

R & D Effort The survey data presented in Table 5.1 and highlighted in Figure 5.1 suggest that former NIH predoctoral trainees and fellows have, in general, been more likely to be involved in research-related activities--basic research, applied research, development/design, and management of R & D--than have members of

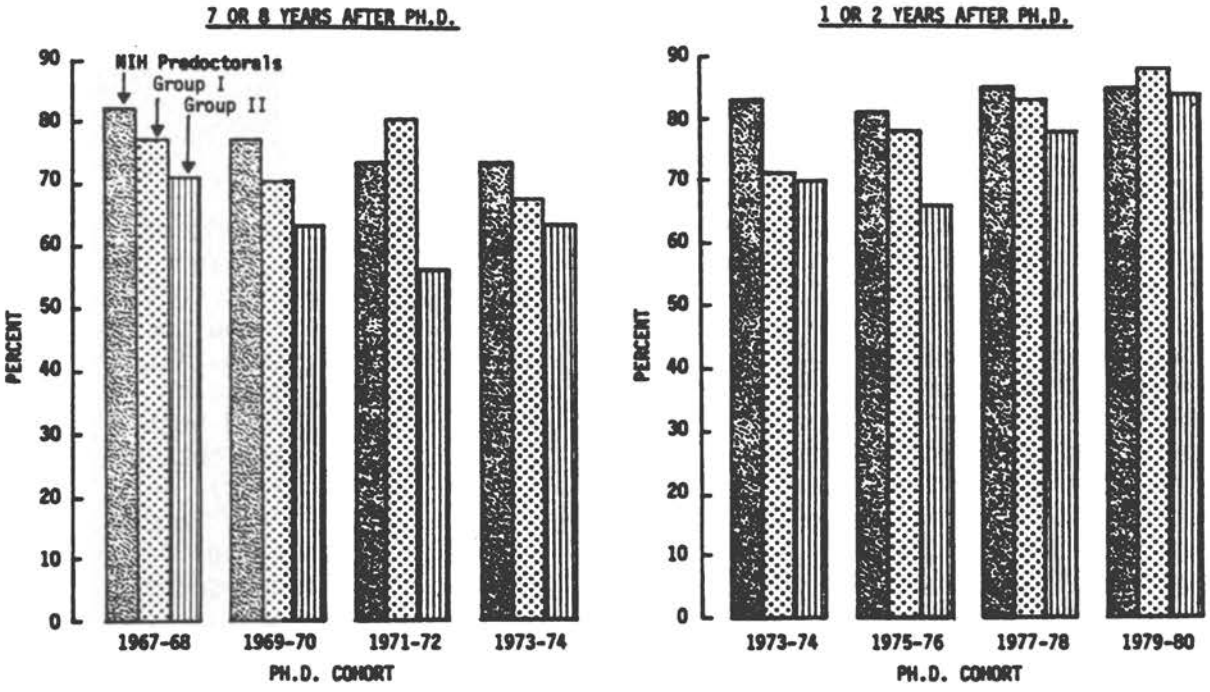

FIGURE 5.1 Percent of former NIH predoctorals and other biomedical scientists devoting at least one-fourth of their time to R & D activities, 1975-81. See Table 5.1.

[1]For a description of the sampling frame and other survey details, see NRC, 1982, Appendix B.

either comparison group. This result is observed for most (but not all) of the career stages encompassed in the analysis (i.e., from one-to-two years of postgraduate experience through seven-to-eight years). The greater involvement in research by former NIH predoctorals, especially those with only a few years experience, is not surprising, of course, since it has already been established (in the previous chapter) that individuals in this group pursued postdoctoral training more frequently than did their colleagues. It is of interest to note, however, that the differences observed are not large--nor are the results entirely consistent. The survey results for FY1971-72 Ph.D.s with seven or eight years experience, for example, indicate that proportionally more members of Group I were devoting a significant amount of time to research than were former NIH predoctorals. This and other inconsistencies in the survey findings may be attributed perhaps to the subjective nature of the data, which reflect respondents' self-reporting of time devoted to various work activities. The distinction among activities such as teaching and basic research may often be arbitrary, and the response may have been influenced more by individual preferences than by the reality of the situation. Furthermore, it should be emphasized that a large majority of all three groups of scientists claimed to devote at least one-fourth of their time to research-related activities--an indication that attrition from the pool of young investigators has not been appreciable.

Faculty Appointments Survey results also reveal that, in comparison with their biomedical science colleagues, NIH predoctorals more frequently have moved on to faculty appointments at the leading 100 research universities,[2] generally regarded as the principal locus for R & D activities (Table 5.1). Once again, however, the findings are not entirely inconsistent. As shown in Figure 5.2, FY1973-74 Ph.D.s who had received their graduate training in departments with NIH training grants but had not held NIH training awards themselves (Group I) have had greater representation on these faculties than have former NIH predoctorals in this cohort. The survey data also indicate that fewer than one-third of the biomedical science graduates have eventually taken faculty jobs at major research institutions. A significant number of other graduates have been employed in nonfaculty staff positions[3] at these 100 universities or on faculties at smaller institutions. As already mentioned, many other young investigators have been doing research outside the academic sector in government and industrial laboratories as well as in other loci. While these individuals undoubtedly have made important contributions to the national research effort, they were not eligible to have received any federal grant support[4] for their work.

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[2]The selection was based on FY1980 total university expenditures for research and development acitivities in the biological sciences.
[3]For an analysis of the growth in the nonfaculty staff population in universities and their roles in research, see NRC, 1978.
[4]Until January 1982 only scientists employed by universities or other nonprofit organizations were eligible to apply for NIH research grant support.

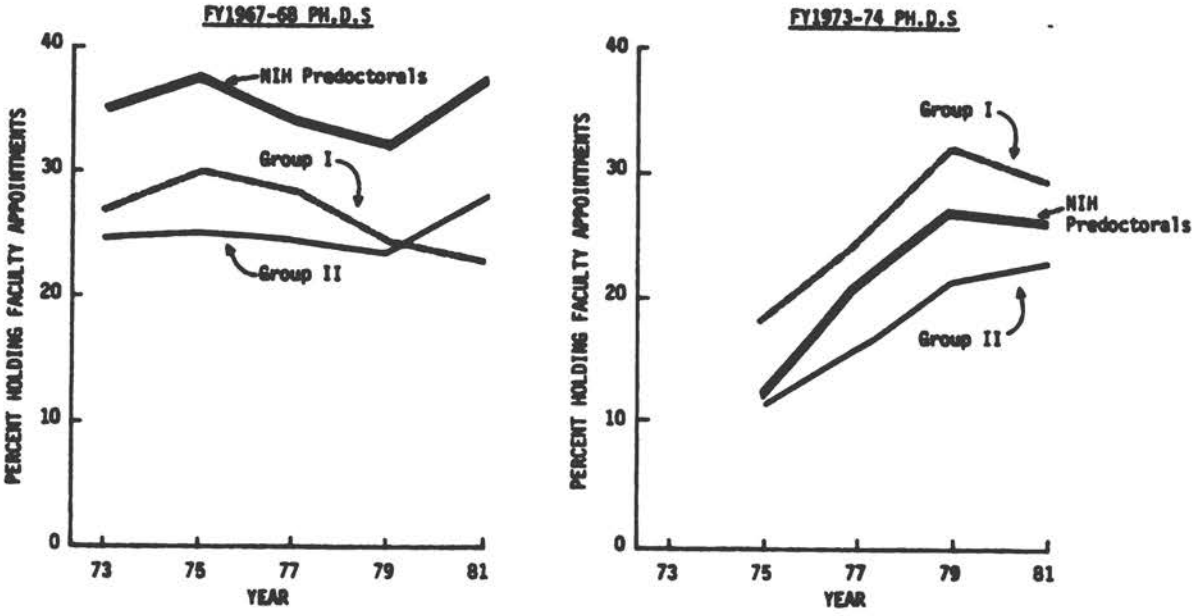

FIGURE 5.2 Percent of FY1967-68 and FY1973-74 Ph.D. recipients holding faculty appointments in the 100 largest research universities, 1973-81. See Table 5.2.

Federal Funding of Work With this restriction in mind we next turn our attention to data pertaining to participation on federally sponsored grants and contracts. Presented in Figure 5.3 are the percentages of NIH predoctorals and other biomedical scientists whose work was funded by NIH or one of the other federal agencies.[5] The percentages reported for each Ph.D. cohort have been averaged across the 1973-81 period. While the NIH predoctorals in every cohort were more likely than members of either comparison group to have received NIH support, the differences between the former NIH trainees/fellows and Group I are generally quite small. Furthermore, in terms of total federal support, no consistent differences are found between these two groups, although both have had greater involvement in federally sponsored work than has Group II. It may be noted that, for every cohort, more than half of the NIH predoctorals and those in Group I have been involved in federally funded activities. The percentages are somewhat higher for the most recent graduates--apparently a reflection of the large numbers of young scientists involved in federally sponsored research while holding postdoctoral appointments.

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[5]In addition to the NIH, the National Science Foundation and the Department of Agriculture have provided support for a substantial amount of research carried out by biomedical scientists.

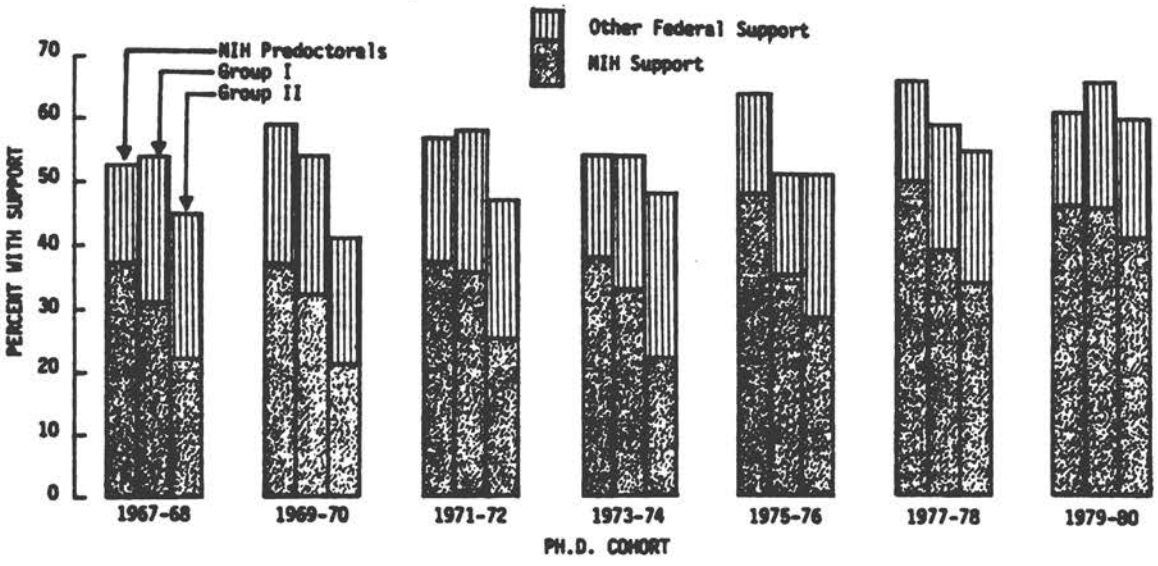

FIGURE 5.3 Percent of former NIH predoctorals and other biomedical scientists whose work was funded by NIH or other federal agencies, 1973-81 averages. See Tables 5.3 and 5.4.

Summary These and other results presented earlier in this chapter clearly demonstrate that a majority of former NIH predoctoral trainees and fellows have pursued careers in research, although there is no consistent evidence to indicate that they have been more likely to do so than have other biomedical science Ph.D.s who had received their graduate training in the same set of university departments (Group I).

TABLE 5.1 Percent of the FY1967-80 Ph.D. Recipients Who Reported that They Spent at Least One-Fourth of Their Time on Research and Development Activities, 1975-81

	Percent Devoting at Least 1/4 Time to R&D(a)				
	1975	1977	1979	1981	1975-81 Average
1967-68 Ph.D. Recipients					
NIH Predoctoral Support(b)	81.6	74.6	67.8	70.9	73.8
Biomedical Group I(c)	77.3	73.0	73.6	73.3	74.3
Biomedical Group II(d)	70.5	66.8	51.9	54.8	61.4
1969-70 Ph.D. Recipients					
NIH Predoctoral Support	82.0	77.3	80.7	76.4	79.2
Biomedical Group I	78.1	70.2	71.1	78.2	74.2
Biomedical Group II	65.5	62.6	55.0	52.0	58.9
1971-72 Ph.D. Recipients					
NIH Predoctoral Support	79.2	73.7	73.0	70.2	74.2
Biomedical Group I	75.2	73.4	80.1	75.7	76.1
Biomedical Group II	64.0	58.8	56.0	57.8	59.3
1973-74 Ph.D. Recipients					
NIH Predoctoral Support	83.1	77.6	77.5	73.3	78.0
Biomedical Group I	70.6	72.6	70.1	66.9	70.1
Biomedical Group II	69.7	62.3	61.2	63.1	64.2
1975-76 Ph.D. Recipients					
NIH Predoctoral Support		81.1	78.6	82.9	80.8
Biomedical Group I		78.3	79.0	72.9	76.9
Biomedical Group II		65.5	65.8	73.8	67.9
1977-78 Ph.D. Recipients					
NIH Predoctoral Support			85.4	87.9	86.6
Biomedical Group I			83.4	83.0	83.2
Biomedical Group II			78.4	80.2	79.3
1979-80 Ph.D. Recipients					
NIH Predoctoral Support				85.1	85.1
Biomedical Group I				87.5	87.5
Biomedical Group II				78.9	78.9

(a)R&D activities include basic research, applied research, design/development, and management of research and development.
(b)Includes individuals who received a total of at least 9 months of NIH predoctoral training grant or fellowship support.
(c)Includes biomedical science Ph.D.s who had not received at least 9 months of NIH predoctoral training grant or fellowship support but were identified as having been graduate students in programs that had some NIH predoctoral training grant funding.
(d)Includes other biomedical science Ph.D.s who were identified as having been graduate students in programs that had no NIH predoctoral training grant funding.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows; National Research Council, Survey of Doctorate Recipients.

TABLE 5.2 Percent of the FY1967-80 Ph.D. Recipients Holding Faculty Appointments in 100 Major Research Universities, 1973-81

	Percent on Faculty in Major Research Universities(a)					
	1973	1975	1977	1979	1981	1973-81 Average
1967-68 Ph.D. Recipients						
NIH Predoctoral Support(b)	35.0	37.4	34.2	31.9	36.9	35.0
Biomedical Group I(c)	26.8	29.9	28.3	24.4	23.0	26.4
Biomedical Group II(d)	24.4	24.8	24.5	23.5	27.5	25.0
1969-70 Ph.D. Recipients						
NIH Predoctoral Support	25.5	30.1	33.5	33.3	30.0	30.5
Biomedical Group I	22.0	26.0	26.3	28.7	27.0	26.0
Biomedical Group II	19.1	20.4	20.1	18.2	19.2	19.4
1971-72 Ph.D. Recipients						
NIH Predoctoral Support	15.5	24.1	28.9	24.9	29.3	24.7
Biomedical Group I	16.9	22.9	26.0	24.5	25.5	23.1
Biomedical Group II	13.4	16.4	21.5	20.3	24.0	18.9
1973-74 Ph.D. Recipients						
NIH Predoctoral Support		12.0	21.5	26.9	25.9	21.8
Biomedical Group I		18.3	24.6	32.2	29.4	26.2
Biomedical Group II		11.3	15.8	21.4	22.8	17.7
1975-76 Ph.D. Recipients						
NIH Predoctoral Support			11.5	24.1	32.7	22.8
Biomedical Group I			11.7	22.4	24.5	19.9
Biomedical Group II			8.1	19.2	19.5	15.5
1977-78 Ph.D. Recipients						
NIH Predoctoral Support				12.9	27.4	20.0
Biomedical Group I				12.3	19.8	16.2
Biomedical Group II				10.3	15.7	13.1
1979-80 Ph.D. Recipients						
NIH Predoctoral Support					11.5	11.5
Biomedical Group I					13.0	13.0
Biomedical Group II					5.6	5.6

(a)Includes the 100 academic institutions with the largest total expenditures for research and development activities in the biological sciences in FY1980.
(b)Includes individuals who received a total of at least 9 months of NIH predoctoral training grant or fellowship support.
(c)Includes biomedical science Ph.D.s who had not received at least 9 months of NIH predoctoral training grant or fellowship support but were identified as having been graduate students in programs that had some NIH predoctoral training grant funding.
(d)Includes other biomedical science Ph.D.s who were identified as having been graduate students in programs that had no NIH predoctoral training grant funding.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows; National Research Council, Survey of Doctorate Recipients.

TABLE 5.3

TABLE 5.3 Percent of the FY1967-80 Ph.D. Recipients Who Reported that They Were Working on Federally Sponsored Activities, 1973-81

	Percent Working on Federally Sponsored Activities					
	1973	1975	1977	1979	1981	1973-81 Average
1967-68 Ph.D. Recipients						
NIH Predoctoral Support(a)	56.8	57.9	54.1	47.1	49.1	53.0
Biomedical Group I(b)	55.7	57.3	52.8	54.7	50.2	54.1
Biomedical Group II(c)	51.7	51.7	51.3	35.8	32.7	44.6
1969-70 Ph.D. Recipients						
NIH Predoctoral Support	59.8	60.9	57.2	60.9	53.9	58.6
Biomedical Group I	58.4	57.0	51.6	52.6	49.5	53.8
Biomedical Group II	48.0	47.9	44.3	35.3	30.0	40.8
1971-72 Ph.D. Recipients						
NIH Predoctoral Support	63.8	56.9	55.7	53.6	54.1	56.7
Biomedical Group I	62.9	56.8	58.5	61.5	47.8	57.5
Biomedical Group II	53.6	49.1	48.8	43.9	39.8	47.3
1973-74 Ph.D. Recipients						
NIH Predoctoral Support		63.1	52.0	52.0	47.6	53.6
Biomedical Group I		59.8	60.1	55.7	42.0	54.0
Biomedical Group II		50.5	48.0	45.6	48.0	48.1
1975-76 Ph.D. Recipients						
NIH Predoctoral Support			66.0	62.0	63.3	63.7
Biomedical Group I			58.5	46.8	49.7	51.3
Biomedical Group II			53.6	52.3	46.0	50.7
1977-78 Ph.D. Recipients						
NIH Predoctoral Support				70.9	60.6	65.8
Biomedical Group I				62.2	56.6	59.3
Biomedical Group II				60.9	49.5	55.0
1979-80 Ph.D. Recipients						
NIH Predoctoral Support					61.3	61.3
Biomedical Group I					65.9	65.9
Biomedical Group II					60.4	60.4

(a)Includes individuals who received a total of at least 9 months of NIH predoctoral training grant or fellowship support.
(b)Includes biomedical science Ph.D.s who had not received at least 9 months of NIH predoctoral training grant or fellowship support but were identified as having been graduate students in programs that had some NIH predoctoral training grant funding.
(c)Includes other biomedical science Ph.D.s who were identified as having been graduate students in programs that had no NIH predoctoral training grant funding.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows; National Research Council, Survey of Doctorate Recipients.

TABLE 5.4 Percent of the FY1967-80 Ph.D. Recipients Who Reported that They Were Working on NIH-Sponsored Activities, 1973-81

	Percent Working on NIH-Sponsored Activities					
	1973	1975	1977	1979	1981	1973-81 Average
1967-68 Ph.D. Recipients						
NIH Predoctoral Support(a)	38.1	40.5	38.2	34.0	34.3	37.0
Biomedical Group I(b)	31.9	33.4	31.1	31.6	28.6	31.2
Biomedical Group II(c)	23.2	27.5	25.8	17.0	16.6	22.0
1969-70 Ph.D. Recipients						
NIH Predoctoral Support	38.6	39.4	37.7	35.1	35.4	37.2
Biomedical Group I	36.6	35.5	29.4	33.8	24.0	31.9
Biomedical Group II	29.0	27.3	23.5	15.5	10.9	21.0
1971-72 Ph.D. Recipients						
NIH Predoctoral Support	45.9	37.4	34.6	36.0	33.1	37.3
Biomedical Group I	37.5	34.6	35.9	40.2	29.3	35.5
Biomedical Group II	31.1	25.0	26.8	18.8	21.3	24.8
1973-74 Ph.D. Recipients						
NIH Predoctoral Support		46.2	39.4	36.1	29.4	37.7
Biomedical Group I		40.7	38.8	29.8	23.0	32.8
Biomedical Group II		27.9	24.2	16.5	19.6	22.2
1975-76 Ph.D. Recipients						
NIH Predoctoral Support			50.6	47.3	45.0	47.6
Biomedical Group I			42.4	32.4	30.0	34.6
Biomedical Group II			33.8	28.0	21.3	27.9
1977-78 Ph.D. Recipients						
NIH Predoctoral Support				56.0	44.7	50.4
Biomedical Group I				39.3	38.9	39.1
Biomedical Group II				38.0	30.8	34.3
1979-80 Ph.D. Recipients						
NIH Predoctoral Support					46.0	46.0
Biomedical Group I					45.7	45.7
Biomedical Group II					40.9	40.9

(a) Includes individuals who received a total of at least 9 months of NIH predoctoral training grant or fellowship support.
(b) Includes biomedical science Ph.D.s who had not received at least 9 months of NIH predoctoral training grant or fellowship support but were identified as having been graduate students in programs that had some NIH predoctoral training grant funding.
(c) Includes other biomedical science Ph.D.s who were identified as having been graduate students in programs that had no NIH predoctoral training grant funding.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows; National Research Council, Survey of Doctorate Recipients.

6. ACQUISITION OF NIH AND NSF RESEARCH GRANT AWARDS

In the preceding chapter we explored the extent to which former NIH predoctorals and other biomedical science graduates were subsequently involved in research-related activities. Among the indicators examined was the fraction of Ph.D.s who received some federal funding for their work--including principal investigators as well as individuals who played various supporting roles in the research effort. In this chapter we consider a more selective set of indices of career achievement: the application and acquisition of NIH and NSF research grant awards. These awards have been made on the basis of peer judgments of the scientific merit of the research proposal and the demonstrated competence of the principal investigator. Consequently the research grant award constitutes a criterion measure of an individual's success as an independent investigator--and one that has been frequently used in previous studies of this kind.

Nevertheless, several caveats must be kept in mind in interpreting this measure. As mentioned in the last chapter, until very recently only scientists at universities and other nonprofit organizatons have been eligible to apply for NIH research grants, and the same restriction has applied to NSF grants as well. Thus the numbers of investigators employed by pharmaceutical firms and other industrial laboratories, as well as the numbers working for federal and state government research groups, are not reflected in this measure of career achievement, even though many of these individuals have made important contributions to biomedical research. Moreover, at most academic institutions postdoctorals and other nonfaculty staff members have not been permitted to apply as principal investigators on research grants, and many new faculty members, burdened with heavy teaching loads, have been reluctant to seek their own research grants. For this reason the grant application records of young scientists are typically quite sparse. Finally, although the NIH and, to an lesser extent, the NSF have provided the bulk of support for biomedical research in this country, a signficant fraction of investigators in this field have received support from other federal agencies such as the U.S. Department of Agriculture, the Environmental Protection Agency, the Department of Defense, and the Department of Energy, as well as from various private foundations. It is

estimated[1] that the NIH funds the work of approximately 50 percent of the biomedical scientists involved in research each year, with the NSF supporting another 7 percent. As many as 30 percent are sponsored by nonfederal sources.

The first eight tables and three figures presented in this chapter deal only with NIH grants. Included are the following types of grants: Research Projects (R-awards) and Program Projects and Centers (M- and P-awards).[2] In this analysis four separate but interrelated criteria are considered:

(1) applications for NIH research grants;
(2) approved funding of grant proposals;
(3) funded awards of NIH research grants; and
(4) average priority scores assigned by peer review groups.

An individual's application for a research grant, while not a true measure of career achievement per se, does indicate that the individual has been actively pursuing a career in biomedical research. The fact that the application has been approved for funding signifies that, in the eyes of peers, the grant proposal was of sufficiently high quality and that the principal investigator merited federal support. The receipt of a funded award provides stronger indication of the high quality of the research proposal and the competence of the scientist applying for the grant. The priority score assigned to each grant application represents its relative standing, in the judgment of a review panel, to other applications received that year in a particular area of research. Only approved applications are assigned priority scores, and only those with the best (lowest) scores are funded.

NIH Research Grant Applications and Awards As illustrated in Figure 6.1, former NIH predoctorals have been more likely than members of either comparison group (a) to have applied for a NIH research grant at some point during FY1967-82 period and (b) to have been awarded a grant. While the findings consistently favor the NIH trainees in every cohort, the differences are much larger for the earlier graduates, who of course have had more time and thus greater opportunity to apply for grants. For individuals in the 1970 cohort, for example, former NIH trainees and fellows were 34 percent more likely than those in Group I to have submitted a grant application and 39 percent more likely to have obtained an award. Moreover, individuals who had acquired their graduate education in NIH-supported departments but had not themselves received training grant or fellowship stipends from the NIH (Group I) were considerably more likely than other biomedical science Ph.D.s (Group II) to apply for or obtain NIH research grants. As expected, a somewhat smaller fraction of those who had earned their doctorates since the mid-1970s have applied for grants, and while the differences among the three groups are not large, they nevertheless favor former NIH

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[1]Based on data derived from NRC, 1973-82, 1981 Survey.
[2]For a detailed list of these awards, see IOM, 1984, Appendix A.

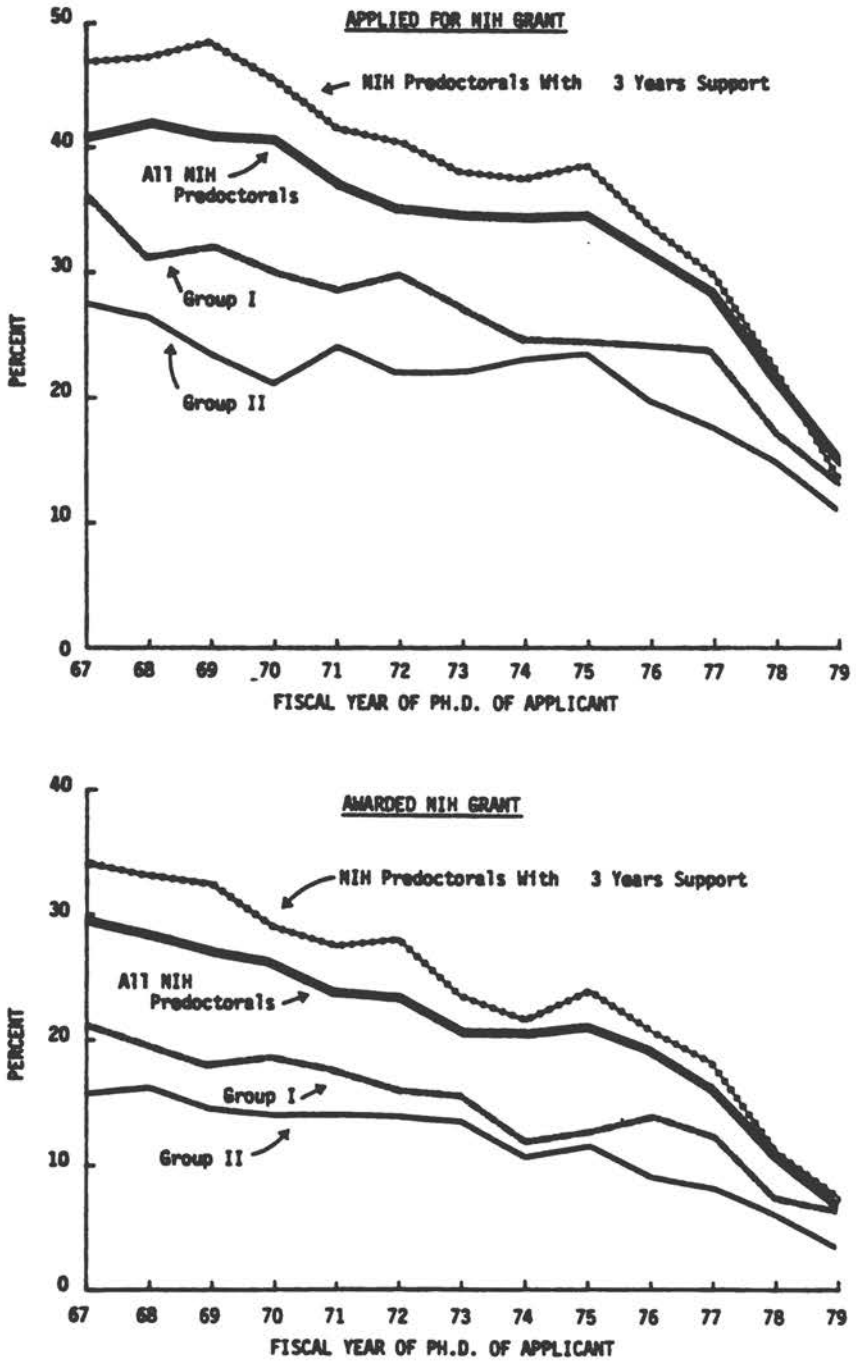

FIGURE 6.1 Percent of former NIH predoctorals and other biomedical scientists who have applied for NIH research grants and percent awarded grants during the FY1967-82 period. See Tables 6.1 and 6.3.

predoctorals. Furthermore, it is of some interest to note that those individuals who had received three years or more of NIH predoctoral stipends have applied for and have been awarded NIH research grants more frequently than have other trainees and fellows who had received less support.

Approval and Award Rates The finding that a larger fraction of former NIH trainees and fellows subsequently acquired NIH research grant awards may be partly attributed to the fact that these individuals have demonstrated greater interest in applying for grants than have other biomedical sciences graduates. Other findings, however, reveal that former NIH predoctorals have also had a higher probability of success on each of their grant applications. Two measures[3] of "success rates" are presented in Figure 6.2: (1) the percent of total NIH research grant applications that were approved for funding; and (2) the percent of applications that were actually funded. It should be pointed out that less than half of all approved

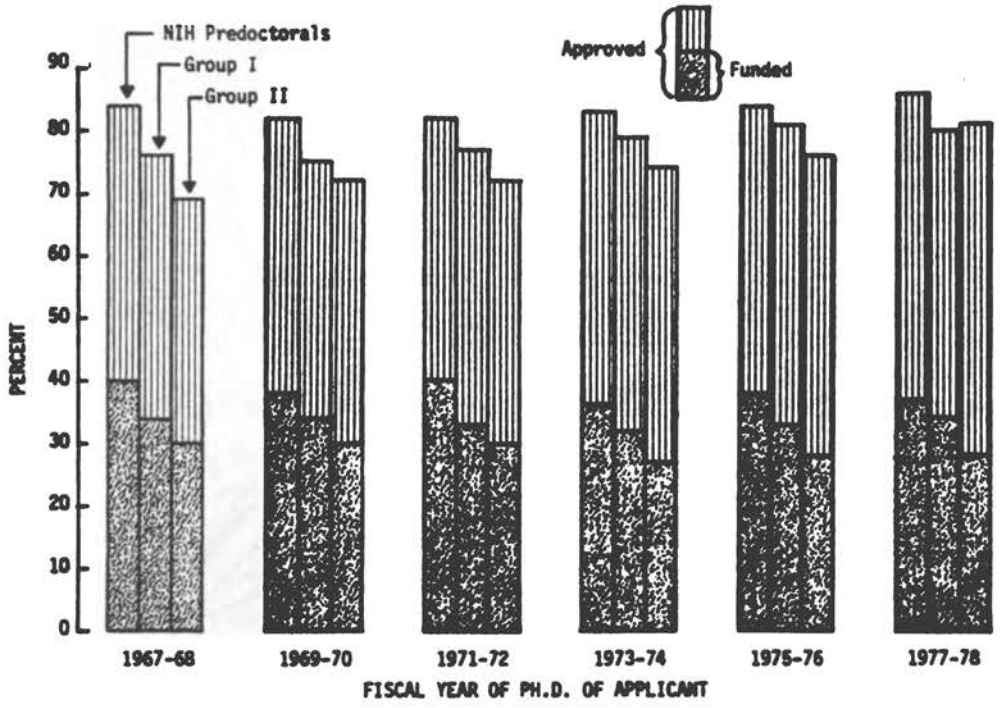

FIGURE 6.2 Percent of NIH research grant applications that were approved for funding and percent that were actually funded during the FY1967-82 period. See Tables 6.7 and 6.8.

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[3]Data for an alternative measure of success rates--the percent of applicants who had one or more research proposals funded--are given in Table 6.6. The findings are congruent with those illustrated in Figure 6.2.

research proposals were in fact funded and that this fraction has declined in recent years as a result of tighter federal funding policies. With respect to both criteria, the former NIH predoctorals have been more successful than their biomedical science colleagues in their attempts to obtain research funding. As many as 83 percent of the proposals submitted by the NIH group were approved for funding and 39 percent were actually awarded. The corresponding percentages for comparison Group I are approximately 77 percent and 33 percent, and for Group II, 73 percent and 29 percent. These differences among the three groups, while not large, are consistent for each Ph.D. cohort--with the sole exception of the FY1977-78 Ph.D.s in Group II who managed to obtain slightly higher "approval rates" than their Group I colleagues.

Priority Scores Further evidence of former NIH trainees' and fellows' superior applications for NIH research grants is illustrated by the fact that their proposals, on the average, received better (lower) priority scores than did proposals tendered by members of either Group I or Group II. Figure 6.3 presents the mean priority score for all grant applications submitted during the FY1967-82 period by individuals in each Ph.D. cohort. The scores assigned to grant proposals may range from 1.00 to 5.00, with the lowest values given to the proposals judged to be of highest quality. Priority scores were determined by independent review groups (study sections), made up of peers who were responsible for rating proposals submitted that year in a particular area of research. For purposes of this analysis, the scores have been averaged across study sections,[4] and the scale of priority ratings has been adjusted to include disapproved applications by assigning each a score of 5.00. As shown in Figure 6.3, the research proposals by former NIH predoctorals have been given "adjusted" priority scores averaging between 2.60 and 3.10, with the most recent graduates' proposals receiving somewhat lower mean ratings. The average priority scores obtained by biomedical science Ph.D.s in Group II have been typically .40 to .50 points higher than the scores of NIH predoctorals, while the mean ratings received by those in Group I have consistently fallen between these two sets. Although the significance of the magnitude of these differences is difficult to interpret, the results indicate that former NIH trainees and fellows have generally submitted stronger research proposals than those prepared by their colleagues.

NSF/NIH Research Support An analysis of FY1973-82 applications for NSF research grants[5] reveals that former NIH predoctorals have

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[4]Another analysis was carried out using standardized priority scores to take into account variations in the subjective judgments of different study sections. The results, not reported here, were entirely congruent with those presented in Table 6.5 and Figure 6.3.

[5]In this analysis both the principal investigator and any co-investigators named in the grant application have been treated as independent applicants.

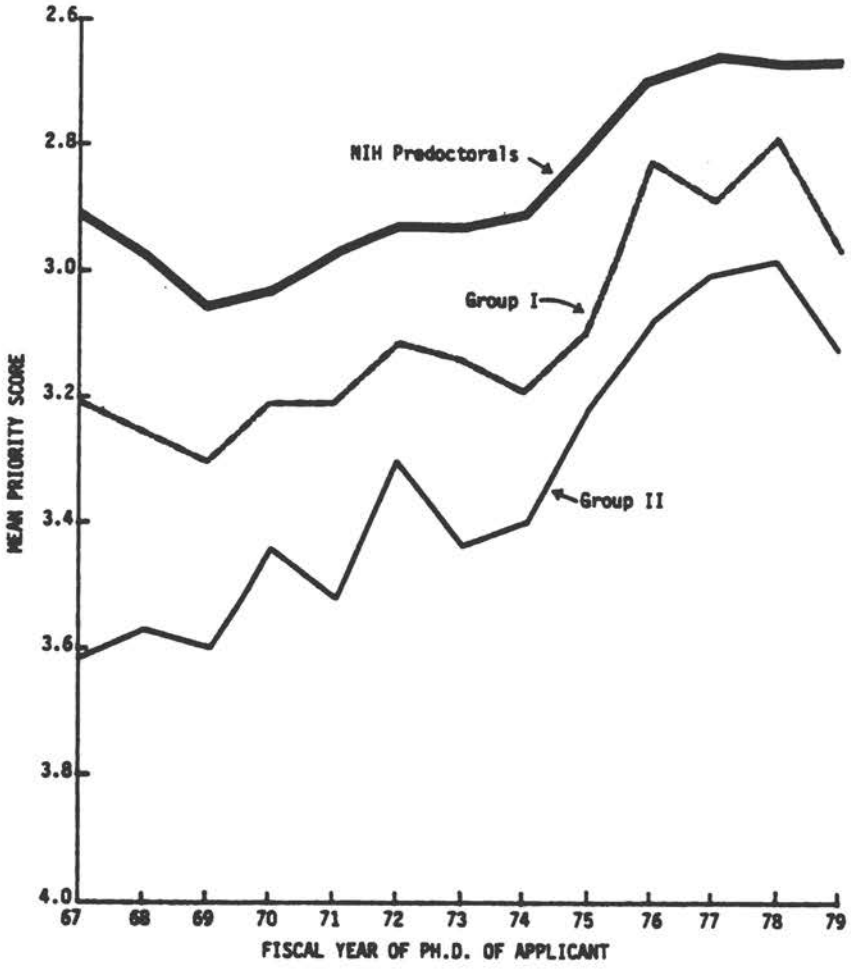

FIGURE 6.3 Mean adjusted priority scores for NIH research grant applications received during the FY1967-82 period. Priority scores range from 1.0 to 5.0, with the lowest scores given to proposals of highest quality; disapproved grant applications have been arbitrarily assigned a score of 5.0. See Table 6.5.

also been more likely than other biomedical science Ph.D.s to have applied for and to have obtained a grant from the NSF. Although the NSF has supported many fewer biomedical investigators than has the NIH, the number funded by the NSF is by no means insignificant. In the case of the FY1967-71 Ph.D. cohort, for example, as many as 21 percent of former NIH trainees and fellows have applied for NSF grants and 9 percent received at least one award during this 10-year period. As illustrated in Figure 6.4, these percentages are appreciably higher than those for either comparison group. The corresponding percentages for the more recent cohorts are, of course, much lower, but consistently favor the NIH trainees. In contrast with these results is the finding that the grant success rate--i.e., the fraction of NSF research proposals that were funded--was higher for proposals submitted by members of Group I than by former NIH predoctoral

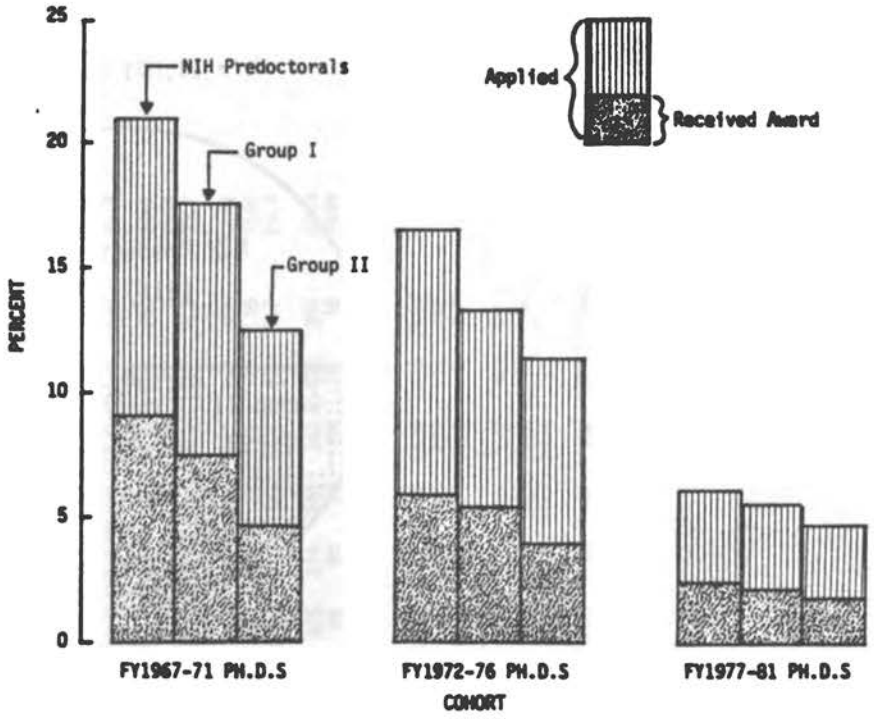

FIGURE 6.4 Percent of former NIH predoctorals and other biomedical science Ph.D.s applying for an NSF research grant during the FY1973-82 period and percent receiving an award. See Table 6.9.

trainees and fellows (Table 6.11). One possible explanation for this finding is that more individuals in the latter group received simultaneous awards from the NIH and the NSF for essentially the same research proposal and decided to accept the NIH grant since it provided a more generous institutional allowance and other benefits. However, no evidence is available to confirm this hypothesis.

Summary Although former NIH predoctorals constituted only 43 percent of the population covered in this analysis, they have received a majority of the research grant awards funded by both the NSF and the NIH (Figure 6.5). Of the 6,355 awards made by the NSF during the FY1973-82 period to individuals included in this analysis, 54 percent were acquired by investigators who had received predoctoral stipends from the NIH. Of the 14,871 awards made by the NIH during the FY1967-82 period to the same population, as many as 61 percent went to former NIH predoctorals. These and other findings presented in this chapter clearly demonstrate this group's superior achievements, in terms of both seeking and obtaining federal research grants. Whether their success may be attributed to the innate potential of those

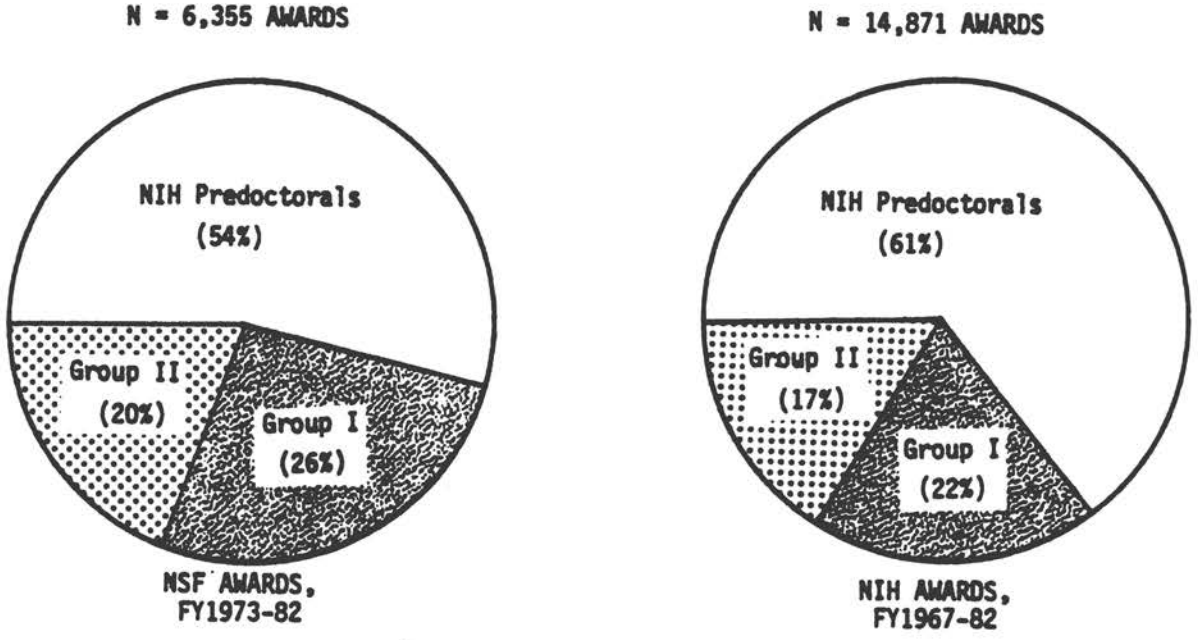

FIGURE 6.5 Proportion of NSF and NIH research grants awarded to NIH predoctorals and other FY1967-81 Ph.D. recipients in the biomedical sciences. See Tables 6.8 and 6.11.

selected to receive predoctoral stipends or to the graduate training they received cannot be determined from this analysis. Nevertheless, it is apparent that the NIH investment in predoctoral training has been fruitful.

TABLE 6.1 Percent of the FY1967-81 Ph.D. Recipients Who Applied for NIH Research Grants During the FY1967-82 Period

		Fiscal Year of Doctorate															
FY1967-81 Ph.D. Recipients		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Total 1967-81
NIH Predoc Support(a)	N	1215	1562	1813	1841	2068	1780	1680	1613	1585	1552	1522	1418	1426	1441	1436	23952
Applied for NIH Grant(b)	N	499	659	747	743	768	622	581	555	548	488	434	306	205	110	29	7294
	%	41.1	42.2	41.2	40.4	37.1	34.9	34.6	34.4	34.6	31.4	28.5	21.6	14.4	7.6	2.0	30.5
>35 Months Predoc	N	586	732	884	959	1071	918	879	872	922	960	862	740	716	664	680	12445
Applied for NIH Grant	N	276	346	429	428	443	370	332	328	353	323	259	163	95	42	9	4196
	%	47.1	47.3	48.5	44.6	41.4	40.3	37.8	37.6	38.3	33.6	30.0	22.0	13.3	6.3	1.3	33.7
24-35 Months Predoc	N	298	423	482	427	490	420	364	326	312	287	285	333	327	352	365	5491
Applied for NIH Grant	N	113	174	174	161	164	125	115	103	97	80	85	70	56	33	10	1560
	%	37.9	41.1	36.1	37.7	33.5	29.8	31.6	31.6	31.1	27.9	29.8	21.0	17.1	9.4	2.7	28.4
9-23 Months Support	N	331	407	447	455	507	442	437	415	351	306	375	345	383	425	391	6016
Applied for NIH Grant	N	110	139	144	154	161	127	134	124	98	85	90	73	64	35	10	1538
	%	33.2	34.2	32.2	33.8	31.8	28.7	30.7	29.9	27.9	27.9	24.0	21.2	14.1	8.2	2.6	25.6
Other Biomedical Ph.D.s	N	1297	1443	1555	1862	2016	2179	2261	2202	2285	2352	2275	2409	2515	2630	2642	31923
Applied for NIH Grant	N	406	417	432	469	532	558	555	523	545	499	453	383	299	154	102	6327
	%	31.3	28.9	27.8	25.2	26.4	25.6	24.5	23.8	23.9	21.2	19.9	15.9	11.9	5.9	3.9	19.8
Group I(c)	N	572	698	767	861	985	994	1091	951	941	929	899	918	973	953	932	13464
Applied for NIH Grant	N	207	217	246	259	283	296	296	234	229	222	211	157	133	71	51	3112
	%	36.2	31.1	32.1	30.1	28.7	29.8	27.1	24.6	24.3	23.9	23.5	17.1	13.7	7.5	5.5	23.1
Group II(d)	N	725	745	788	1001	1031	1185	1170	1261	1344	1423	1376	1491	1542	1677	1710	18459
Applied for NIH Grant	N	199	200	186	210	249	262	259	289	316	277	242	226	166	83	51	3215
	%	27.4	26.8	23.6	21.0	24.2	22.1	22.1	23.1	23.5	19.5	17.6	15.2	10.8	4.9	3.0	17.4
Total All Ph.D.s (above)	N	2512	3005	3368	3703	4084	3959	3941	3815	3870	3904	3797	3827	3941	4071	4078	55875
Applied for NIH Grant	N	905	1076	1179	1212	1300	1180	1136	1078	1093	987	887	689	504	264	131	13621
	%	36.0	35.8	35.0	32.7	31.8	29.8	28.8	28.3	28.2	25.3	23.4	18.0	12.8	6.5	3.2	24.4

(a) Individuals who received a total of less than 9 months support are included in Group I.
(b) Includes all individuals who submitted one or more applications for NIH research grants during the FY1967-82 period.
(c) Includes biomedical science Ph.D.s who had not received at least 9 months of NIH predoctoral training grant or fellowship support but were identified as having been graduate students in programs that had some NIH predoctoral training grant funding.
(d) Includes other biomedical science Ph.D.s who were identified as having been graduate students in programs that had no NIH predoctoral training grant funding.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows and Consolidated Grant Applicant File; National Research Council, Survey of Earned Doctorates.

TABLE 6.2 Percent of the FY1967-81 Ph.D. Recipients with NIH Research Grant Applications That Were Recommended for Approval During the FY1967-82 Period

		Fiscal Year of Doctorate															
FY1967-81 Ph.D. Recipients		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Total 1967-81
NIH Predoc Support(a)	N	1215	1562	1813	1841	2068	1780	1680	1613	1585	1552	1522	1418	1426	1441	1436	23952
Approved NIH Grant(b)	N	454	587	665	672	670	557	509	496	497	443	399	276	180	94	27	6525
	%	37.4	37.6	36.7	36.5	32.4	31.3	30.3	30.7	31.4	28.5	26.2	19.5	12.6	6.5	1.9	27.2
>35 Months Predoc	N	586	732	884	959	1071	918	879	872	922	960	862	740	716	664	680	12445
Approved NIH Grant	N	256	314	384	387	395	336	298	293	324	296	246	147	87	37	9	3809
	%	43.7	42.9	43.4	40.4	36.9	36.6	33.9	33.6	35.1	30.8	28.5	19.9	12.2	5.6	1.3	30.6
24-35 Months Predoc	N	298	423	482	427	490	420	364	326	312	287	285	333	327	352	365	5491
Approved NIH Grant	N	105	158	153	148	138	109	100	93	84	73	71	64	50	27	9	1382
	%	35.2	37.4	31.7	34.7	28.2	26.0	27.5	28.5	26.9	25.4	24.9	19.2	15.3	7.7	2.6	25.2
9-23 Months Support	N	331	407	447	455	507	442	437	415	351	306	375	345	383	425	391	6016
Approved NIH Grant	N	93	115	128	137	137	112	111	109	89	74	82	65	43	30	9	1334
	%	28.1	28.3	28.6	30.1	27.0	25.3	25.4	26.3	25.4	24.3	21.9	18.8	11.2	7.1	2.3	22.2
Other Biomedical Ph.D.s	N	1297	1443	1555	1862	2016	2179	2261	2202	2285	2352	2275	2409	2515	2630	2642	31923
Approved NIH Grant	N	329	339	337	385	425	457	458	427	458	431	390	337	242	126	75	5216
	%	25.4	23.5	21.7	20.7	21.1	21.0	20.3	19.4	20.0	18.3	17.1	14.0	9.6	4.8	2.8	16.3
Group I(c)	N	572	698	767	861	985	994	1091	951	941	929	899	918	973	953	932	13464
Approved NIH Grant	N	177	189	199	217	237	253	254	195	194	199	181	138	114	61	39	2647
	%	30.9	27.1	25.9	25.2	24.1	25.5	23.3	20.5	20.6	21.4	20.1	15.0	11.7	6.4	4.2	19.7
Group II(d)	N	725	745	788	1001	1031	1185	1170	1251	1344	1423	1376	1491	1542	1677	1710	18459
Approved NIH Grant	N	152	150	138	168	188	204	204	232	264	232	209	199	128	65	36	2569
	%	21.0	20.1	17.5	16.8	18.2	17.2	17.4	18.5	19.6	16.3	15.2	13.3	8.3	3.9	2.1	13.9
Total All Ph.D.s (above)	N	2512	3005	3368	3703	4084	3959	3941	3815	3870	3904	3797	3827	3941	4071	4078	55875
Approved NIH Grant	N	783	926	1002	1057	1095	1014	967	922	955	874	789	613	422	220	102	11741
	%	31.2	30.8	29.8	28.5	26.8	25.6	24.5	24.2	24.7	22.4	20.8	16.0	10.7	5.4	2.5	21.0

(a) Individuals who received a total of less than 9 months support are included in Group I.
(b) Includes all individuals who had one or more NIH research grant applications approved for funding during the FY1967-82 period.
(c) Includes biomedical science Ph.D.s who had not received at least 9 months of NIH predoctoral training grant or fellowship support but were identified as having been graduate students in programs that had some NIH predoctoral training grant funding.
(d) Includes other biomedical science Ph.D.s who were identified as having been graduate students in programs that had no NIH predoctoral training grant funding.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows and Consolidated Grant Applicant File; National Research Council, Survey of Earned Doctorates.

TABLE 6.3 Percent of the FY1967-81 Ph.D. Recipients Awarded NIH Research Grants During the FY1967-82 Period

		Fiscal Year of Doctorate															
FY1967-81 Ph.D. Recipients		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Total 1967-81
NIH Predoc Support(a)	N	1215	1562	1813	1841	2068	1780	1680	1613	1585	1552	1522	1418	1426	1441	1436	23952
Awarded NIH Grant(b)	N	356	443	490	477	490	423	345	335	336	294	240	148	101	54	15	4547
	%	29.3	28.4	27.0	25.9	23.7	23.8	20.6	20.8	21.2	18.9	15.8	10.4	7.1	3.7	1.0	19.0
> 35 Months Predoc	N	586	732	884	959	1071	918	879	872	922	960	862	740	716	664	680	12445
Awarded NIH Grant	N	200	243	288	279	297	260	208	188	222	198	157	81	52	19	6	2698
	%	34.1	33.2	32.6	29.1	27.7	28.3	23.7	21.6	24.1	20.6	18.2	10.9	7.3	2.9	.9	21.7
24-35 Months Predoc	N	298	423	442	427	490	420	364	326	312	287	285	333	327	352	365	5491
Awarded NIH Grant	N	85	117	115	102	97	79	66	68	55	46	42	33	25	17	5	952
	%	28.5	27.7	23.9	23.9	19.8	18.8	18.1	20.9	17.6	16.0	14.7	9.9	7.6	4.8	1.4	17.3
9-23 Months Support	N	331	407	447	455	507	442	437	415	351	306	375	345	383	425	391	6016
Awarded NIH Grant	N	71	83	87	96	96	84	71	79	59	50	41	34	24	18	4	897
	%	21.5	20.4	19.5	21.1	18.9	19.0	16.2	19.0	16.8	16.4	10.9	9.9	6.3	4.2	1.0	14.9
Other Biomedical Ph.D.s	N	1297	1443	1555	1862	2016	2179	2261	2202	2285	2352	2275	2409	2515	2630	2642	31923
Awarded NIH Grant	N	213	237	233	275	290	298	301	247	271	258	220	163	110	57	27	3200
	%	16.4	16.4	15.0	14.8	14.4	13.7	13.3	11.2	11.9	11.0	9.7	6.8	4.4	2.2	1.0	10.0
Group I(c)	N	572	698	767	861	985	994	1091	951	941	929	899	918	973	953	932	13464
Awarded NIH Grant	N	120	135	139	160	171	161	171	115	118	129	113	71	58	33	17	1711
	%	21.0	19.3	18.1	18.6	17.4	16.2	15.7	12.1	12.5	13.9	12.6	7.7	6.0	3.5	1.8	12.7
Group II(d)	N	725	745	788	1001	1031	1185	1170	1251	1344	1423	1376	1491	1542	1677	1710	18459
Awarded NIH Grant	N	93	102	94	115	119	137	130	132	153	129	107	92	52	24	10	1488
	%	12.8	13.7	11.9	11.5	11.5	11.6	11.1	10.6	11.4	9.1	7.8	6.2	3.4	1.4	.6	8.1
Total All Ph.D.s (above)	N	2512	3005	3368	3703	4084	3959	3941	3815	3870	3904	3797	3827	3941	4071	4078	55875
Awarded NIH Grant	N	569	680	723	752	780	721	646	582	607	552	460	311	211	111	42	7747
	%	22.7	22.6	21.5	20.3	19.1	18.2	16.4	15.3	15.7	14.1	12.1	8.1	5.4	2.7	1.0	13.9

(a) Individuals who received a total of less than 9 months support are included in Group I.
(b) Includes all individuals who were awarded one or more NIH research grants during the FY1967-82 period.
(c) Includes biomedical science Ph.D.s who had not received at least 9 months of NIH predoctoral training grant or fellowship support but were identified as having been graduate students in programs that had some NIH predoctoral training grant funding
(d) Includes other biomedical science Ph.D.s who were identified as having been graduate students in programs that had no NIH predoctoral training grant funding.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows and Consolidated Grant Applicant File; National Research Council, Survey of Earned Doctorates.

TABLE 6.4 Number and Percent of the FY1967-81 Ph.D. Recipients Who Had Been Awarded Research Grants from NIH Institutes by FY1982

NIH Training Support(b)		Institute of Most Recent NIH Research Grant Award(a)												
		NIGMS	NCI	NICHD	NHLBI	NIEHS	NIAID	NIADDK	NIA	NINCDS	NIDR	NEI	Other NIH	Total NIH
NIGMS Predocs	N	767	463	238	421	66	266	330	59	402	56	164	238	3470
	%	22.1	13.3	6.9	12.1	1.9	7.7	9.5	1.7	11.6	1.6	4.7	6.9	100.0
NCI Predocs	N	18	57	8	5	3	16	8	3	8		2	2	130
	%	13.8	43.8	6.2	3.8	2.3	12.3	6.2	2.3	6.2		1.5	1.5	100.0
NICHD Predocs	N	35	17	75	12	2	4	12	20	13	2	4	41	237
	%	14.8	7.2	31.6	5.1	.8	1.7	5.1	8.4	5.5	.8	1.7	17.3	100.0
NHLBI Predocs	N	4	4	6	89	3	2	19	1	5	1	4	7	145
	%	2.8	2.8	4.1	61.4	2.1	1.4	13.1	.7	3.4	.7	2.8	4.8	100.0
NIEHS Predocs	N	4	7	1	10	9	5	2	1	2	1	2	10	54
	%	7.4	13.0	1.9	18.5	16.7	9.3	3.7	1.9	3.7	1.9	3.7	18.5	100.0
NIAID Predocs	N	18	72	7	8	5	91	9	8	10	6	7	4	245
	%	7.3	29.4	2.9	3.3	2.0	37.1	3.7	3.3	4.1	2.4	2.9	1.6	100.0
NIADDK Predocs	N	3	7	1	2			11	3	1	2			30
	%	10.0	23.3	3.3	6.7			36.7	10.0	3.3	6.7			100.0
NIA Predocs	N				1				2					3
	%				33.3				66.7					100.0
NINCDS Predocs	N		2	2	4	1	1	2		33	2	3	6	56
	%		3.6	3.6	7.1	1.8	1.8	3.6		58.9	3.6	5.4	10.7	100.0
NIDR Predocs	N	2	8	2	5	1	2	15	3	3	56		3	100
	%	2.0	8.0	2.0	5.0	1.0	2.0	15.0	3.0	3.0	56.0		3.0	100.0
NEI Predocs	N											8		8
	%											100.0		100.0
Total All NIH Predocs	N	851	637	340	557	90	387	408	100	477	126	194	311	4478
	%	19.0	14.2	7.6	12.4	2.0	8.6	9.1	2.2	10.7	2.8	4.3	6.9	100.0
Other Biomedical Ph.D.s	N	379	488	262	418	62	273	315	52	308	138	163	258	3116
	%	12.2	15.7	8.4	13.4	2.0	8.8	10.1	1.7	9.9	4.4	5.2	8.3	100.0
Group I(c)	N	241	261	140	214	24	152	177	20	172	71	74	115	1661
	%	14.5	15.7	8.4	12.9	1.4	9.2	10.7	1.2	10.4	4.3	4.5	6.9	100.0
Group II(d)	N	138	227	122	204	38	121	138	32	136	67	89	143	1455
	%	9.5	15.6	8.4	14.0	2.6	8.3	9.5	2.2	9.3	4.6	6.1	9.8	100.0

(a) Includes Ph.D. recipients who received NIH research grant support prior to FY1983.
(b) Individuals who received a total of less than 9 months support are included in Group I.
(c) Includes biomedical science Ph.D.s who had not received at least 9 months of NIH predoctoral training grant or fellowship support but were identified as having been graduate students in programs that had some NIH predoctoral training grant funding.
(d) Includes other biomedical science Ph.D.s who were identified as having been graduate students in programs that had no NIH predoctoral training grant funding.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows and Consolidated Grant Applicant File; National Research Council, Survey of Earned Doctorates.

TABLE 6.5 Average Adjusted Priority Score for All NIH Research Grant Applications by FY1967-81 Ph.D. Recipients Who Applied During the FY1967-82 Period

FY1967-81 Ph.D. Recipients		Fiscal Year of Doctorate 1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Total 1967-81
NIH Predoctoral Support(a)																	
Total Grant Applications	N	499	659	747	743	768	622	581	555	548	488	434	306	205	110	29	7294
Mean Priority Score(b)		2.91	2.97	3.05	3.03	2.97	2.93	2.93	2.91	2.80	2.70	2.66	2.67	2.67	2.76	2.58	2.89
Biomedical Group I(c)																	
Total Grant Applications	N	207	217	246	259	283	296	296	234	229	222	211	157	133	71	51	3112
Mean Priority Score		3.21	3.25	3.30	3.21	3.21	3.11	3.14	3.19	3.10	2.82	2.89	2.78	2.97	2.85	3.06	3.10
Biomedical Group II(d)																	
Total Grant Applications	N	199	200	186	210	249	262	259	289	316	277	242	226	166	83	51	3215
Mean Priority Score		3.61	3.57	3.60	3.44	3.52	3.30	3.43	3.40	3.22	3.08	3.00	2.98	3.13	3.19	3.22	3.32
All Ph.D. Recipients (above)																	
Total Grant Applications	N	905	1076	1179	1212	1300	1180	1136	1078	1093	987	887	689	504	264	131	13621
Mean Priority Score		3.13	3.13	3.19	3.14	3.13	3.06	3.10	3.10	2.99	2.84	2.80	2.80	2.90	2.92	3.02	3.04

(a)Includes individuals who received a total of at least 9 months of NIH predoctoral training grant or fellowship support.
(b)In averaging priority socres, disapproved applications were arbitrarily assigned a value of 5.00.
(c)Includes biomedical science Ph.D.s who had not received at least 9 months of NIH predoctoral training grant or fellowship support but were identified as having been graduate students in programs that had some NIH predoctoral training grant funding.
(d)Includes other biomedical science Ph.D.s who were identified as having been graduate students in programs that had no NIH predoctoral training grant funding.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows and Consolidated Grant Applicant File; National Research Council, Survey of Earned Doctorates.

TABLE 6.6 Percent of the FY1967-81 Ph.D. Recipients Applying for NIH Research Grants Who Received One or More Awards by FY1982

		Fiscal Year of Doctorate															
FY1967-81 Ph.D. Recipients		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Total 1967-81
NIH Predoctoral Support(a)																	
Total Grant Applicants	N	499	659	747	743	768	622	581	555	548	488	434	306	205	110	29	7294
Awarded Research Grant	N	356	443	490	477	490	423	345	335	336	294	240	148	101	54	15	4547
	%	71.3	67.2	65.6	64.2	63.8	68.0	59.4	60.4	61.3	60.2	55.3	48.4	49.3	49.1	51.7	62.3
Biomedical Group I(b)																	
Total Grant Applicants	N	207	217	246	259	283	296	296	234	229	222	211	157	133	71	51	3112
Awarded Research Grant	N	120	135	139	160	171	161	171	115	118	129	113	71	58	33	17	1711
	%	58.0	62.2	56.5	61.8	60.4	54.4	57.8	49.1	51.5	58.1	53.6	45.2	43.6	46.5	33.3	55.0
Biomedical Group II(c)																	
Total Grant Applicants	N	199	200	186	210	249	262	259	289	316	277	242	226	166	83	51	3215
Awarded Research Grant	N	93	102	94	115	119	137	130	132	153	129	107	92	52	24	10	1489
	%	46.7	51.0	50.5	54.8	47.8	52.3	50.2	45.7	48.4	46.6	44.2	40.7	31.3	28.9	19.6	46.3
All Ph.D. Recipients (above)																	
Total Grant Applicants	N	905	1076	1179	1212	1300	1180	1136	1078	1093	987	887	689	504	264	131	13621
Awarded Research Grant	N	569	680	723	752	780	721	646	582	607	562	460	311	211	111	42	7747
	%	62.9	63.2	61.3	62.0	60.0	61.1	56.9	54.0	55.5	55.9	51.9	45.1	41.9	42.0	32.1	56.9

(a)Includes individuals who received a total of at least 9 months of NIH predoctoral training grant or fellowship support.
(b)Includes biomedical science Ph.D.s who had not received at least 9 months of NIH predoctoral training grant or fellowship support but were identified as having been graduate students in programs that had some NIH predoctoral training grant funding.
(c)Includes other biomedical science Ph.D.s who were identified as having been graduate students in programs that had no NIH predoctoral training grant funding.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows and Consolidated Grant Applicant File; National Research Council, Survey of Earned Doctorates.

TABLE 6.7 Percent of All NIH Research Grant Applications by FY1967-81 Ph.D. Recipients That Were Approved for Funding During the FY1967-82 Period

		Fiscal Year of Doctorate															
FY1967-81 Ph.D. Recipients		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Total 1967-81
NIH Predoctoral Support(a)																	
Total Grant Applications	N	2352	2986	3159	2923	2695	2121	1741	1553	1280	1039	756	493	284	145	37	23564
No. Approved for Funding	N	1946	2525	2587	2391	2209	1764	1469	1277	1067	872	650	426	235	119	29	19566
	%	82.7	84.6	81.9	81.8	82.0	83.2	84.4	82.2	83.4	83.9	85.0	86.4	82.7	82.1	78.4	83.0
Biomedical Group I(b)																	
Total Grant Applications	N	957	1034	1018	1019	1020	923	969	640	581	513	398	267	198	95	66	9698
No. Approved for Funding	N	729	776	759	764	776	730	750	516	462	428	325	208	157	74	44	7498
	%	76.2	75.0	74.6	75.0	76.1	79.1	77.4	80.6	79.5	83.4	81.7	77.9	79.3	77.9	66.7	77.3
Biomedical Group II(c)																	
Total Grant Applications	N	837	768	700	764	875	780	746	813	783	568	439	395	223	132	67	8890
No. Approved for Funding	N	563	538	502	550	633	566	543	606	585	446	352	324	173	97	46	6524
	%	67.3	70.1	71.7	72.0	72.3	72.6	72.8	74.5	74.7	78.5	80.2	82.0	77.6	73.5	68.7	73.4
All Ph.D. Recipients (above)																	
Total Grant Applications	N	4146	4788	4877	4706	4590	3824	3456	3006	2644	2120	1593	1155	705	372	170	42152
No. Approved for Funding	N	3238	3839	3848	3705	3618	3060	2762	2399	2114	1746	1327	958	565	290	119	33588
	%	78.1	80.2	78.9	78.7	78.8	80.0	79.9	79.8	80.0	82.4	83.3	82.9	80.1	78.0	70.0	79.7

(a)Includes individuals who received a total of at least 9 months of NIH predoctoral training grant or fellowship support.
(b)Includes biomedical science Ph.D.s who had not received at least 9 months of NIH predoctoral training grant or fellowship support but were identified as having been graduate students in programs that had some NIH predoctoral training grant funding.
(c)Includes other biomedical science Ph.D.s who were identified as having been graduate students in programs that had no NIH predoctoral training grant funding.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows and Consolidated Grant Applicant File; National Research Council, Survey of Earned Doctorates.

TABLE 6.8 Percent of All NIH Research Grant Applications by FY1967-81 Ph.D. Recipients That Were Funded During the FY1967-82 Period

FY1967-81 Ph.D. Recipients		Fiscal Year of Doctorate															Total 1967-81
		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	
NIH Predoctoral Support(a)																	
Total Grant Applications	N	2352	2986	3159	2923	2695	2121	1741	1553	1280	1039	756	493	284	145	37	23564
No. of Research Awards	N	986	1191	1221	1063	1101	822	634	552	490	394	296	169	109	57	15	9100
	%	41.9	39.9	38.7	36.4	40.9	38.8	36.4	35.5	38.3	37.9	39.2	34.3	38.4	39.3	40.5	38.6
Biomedical Group I(b)																	
Total Grant Applications	N	957	1034	1018	1019	1020	923	969	640	581	513	398	267	198	95	66	9698
No. of Research Awards	N	333	333	350	350	345	299	319	191	174	189	139	86	63	34	17	3222
	%	34.8	32.2	34.4	34.3	33.8	32.4	32.9	29.8	29.9	36.8	34.9	32.2	31.8	35.8	25.8	33.2
Biomedical Group II(c)																	
Total Grant Applications	N	837	768	700	764	875	780	746	813	783	568	439	395	223	132	67	8890
No. of Research Awards	N	241	241	204	231	255	248	211	203	215	163	127	110	55	35	10	2549
	%	28.8	31.4	29.1	30.2	29.1	31.8	28.3	25.0	27.5	28.7	28.9	27.8	24.7	26.5	14.9	28.7
All Ph.D. Recipients (above)																	
Total Grant Applications	N	4146	4788	4877	4706	4590	3824	3456	3006	2644	2120	1593	1155	705	372	170	42152
No. of Research Awards	N	1560	1765	1775	1644	1701	1369	1164	946	879	746	562	365	227	126	42	14871
	%	37.6	36.9	36.4	34.9	37.1	35.8	33.7	31.5	33.2	35.2	35.3	31.6	32.2	33.9	24.7	35.3

(a)Includes individuals who received a total of at least 9 months of NIH predoctoral training grant or fellowship support.
(b)Includes biomedical science Ph.D.s who had not received at least 9 months of NIH predoctoral training grant or fellowship support but were identified as having been graduate students in programs that had some NIH predoctoral training grant funding.
(c)Includes other biomedical science Ph.D.s who were identified as having been graduate students in programs that had no NIH predoctoral training grant funding.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows and Consolidated Grant Applicant File; National Research Council, Survey of Earned Doctorates.

TABLE 6.9 Percent of the FY1967-81 Ph.D. Recipients Who Applied for NSF Research Grants During the FY1973-82 Period

		Fiscal Year of Doctorate															
FY1967-81 Ph.D. Recipients		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Total 1967-81
NIH Predoc Support(a)	N	1215	1562	1813	1841	2068	1780	1680	1613	1585	1552	1522	1418	1426	1441	1436	23952
Applied for NSF Grant(b)	N	264	340	359	408	418	351	303	263	227	209	195	118	77	36	17	3585
	%	21.7	21.8	19.8	22.2	20.2	19.7	18.0	16.3	14.3	13.5	12.8	8.3	5.4	2.5	1.2	15.0
>35 Months Predoc	N	586	732	884	959	1071	918	879	872	922	960	862	740	716	664	680	12445
Applied for NSF Grant	N	149	174	208	217	233	198	170	152	142	141	115	54	41	13	7	2014
	%	25.4	23.8	23.5	22.6	21.8	21.6	19.3	17.4	15.4	14.7	13.3	7.3	5.7	2.0	1.0	16.2
24-35 Months Predoc	N	298	423	482	427	490	420	364	326	312	287	285	333	327	352	365	5491
Applied for NSF Grant	N	54	86	85	90	93	73	55	40	32	33	40	35	18	10	6	750
	%	18.1	20.3	17.6	21.1	19.0	17.4	15.1	12.3	10.3	11.5	14.0	10.5	5.5	2.8	1.6	13.7
9-23 Months Support	N	331	407	447	455	507	442	437	415	351	305	375	345	383	425	391	6016
Applied for NSF Grant	N	61	80	66	101	92	80	78	71	53	35	40	29	18	13	4	821
	%	18.4	19.7	14.8	22.2	18.1	18.1	17.8	17.1	15.1	11.5	10.7	8.4	4.7	3.1	1.0	13.6
Other Biomedical Ph.D.s	N	1297	1443	1555	1862	2016	2179	2261	2202	2285	2352	2275	2409	2515	2630	2642	31923
Applied for NSF Grant	N	187	221	243	274	285	298	296	276	274	273	225	178	137	65	37	3269
	%	14.4	15.3	15.6	14.7	14.1	13.7	13.1	12.5	12.0	11.6	9.9	7.4	5.4	2.5	1.4	10.2
Group I (c)	N	572	698	767	861	985	994	1091	951	941	929	899	918	973	953	932	13464
Applied for NSF Grant	N	108	128	142	141	160	163	159	117	129	124	89	66	68	30	11	1635
	%	18.9	18.3	18.5	16.4	16.2	16.4	14.6	12.3	13.7	13.3	9.9	7.2	7.0	3.1	1.2	12.1
Group II (d)	N	725	745	788	1001	1031	1185	1170	1251	1344	1423	1376	1491	1542	1677	1710	18459
Applied for NSF Grant	N	79	93	101	133	125	135	137	159	145	149	136	112	69	35	26	1634
	%	10.9	12.5	12.8	13.3	12.1	11.4	11.7	12.7	10.8	10.5	9.9	7.5	4.5	2.1	1.5	8.9
Total All Ph.D.s (above)	N	2512	3005	3368	3703	4084	3959	3941	3815	3870	3904	3797	3827	3941	4071	4078	55875
Applied for NSF Grant	N	451	561	602	682	703	649	599	539	501	482	420	296	214	101	54	6854
	%	18.0	18.7	17.9	18.4	17.2	16.4	15.2	14.1	12.9	12.3	11.1	7.7	5.4	2.5	1.3	12.3

(a) Individuals who received a total of less than 9 months support are included in Group I.
(b) Includes all individuals who submitted one or more applications for NSF research grants during the FY1973-82 period.
(c) Includes biomedical science Ph.D.s who had not received at least 9 months of NIH predoctoral training grant or fellowship support but were identified as having been graduate students in programs that had some NIH predoctoral training grant funding.
(d) Includes other biomedical science Ph.D.s who were identified as having been graduate students in programs that had no NIH predoctoral training grant funding.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows; National Science Foundation, Master File of Grant Applicants; National Research Council, Survey of Earned Doctorates.

TABLE 6.10 Percent of the FY1967-81 Ph.D. Recipients Awarded NSF Research Grants During the FY1973-82 Period

		Fiscal Year of Doctorate															
FY1967-81 Ph.D. Recipients		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Total 1967-81
NIH Predoc Support(a)	N	1215	1562	1813	1841	2068	1780	1680	1613	1585	1552	1522	1418	1426	1441	1436	23952
Awarded NSF Grant(b)	N	110	158	151	166	176	132	102	94	84	81	71	47	37	18	8	1435
	%	9.1	10.1	8.3	9.0	8.5	7.4	6.1	5.8	5.3	5.2	4.7	3.3	2.6	1.2	.6	6.0
>35 Months Predoc	N	586	732	884	959	1071	918	879	872	922	960	862	740	716	664	680	12445
Awarded NSF Grant	N	70	84	83	87	91	72	48	48	52	52	46	22	23	7	4	788
	%	11.9	11.5	9.4	9.1	8.5	7.8	5.5	5.5	5.6	5.4	5.2	3.0	3.2	1.1	.6	6.3
24-35 Months Predoc	N	298	423	482	427	490	420	364	326	312	287	285	333	327	352	365	5491
Awarded NSF Grant	N	20	41	40	34	40	29	19	16	12	14	12	13	9	5	1	305
	%	6.7	9.7	8.3	8.0	8.2	6.9	5.2	4.9	3.8	4.9	4.2	3.9	2.8	1.4	.3	5.6
9-23 Months Support	N	331	407	447	455	507	442	437	415	351	305	375	345	383	425	391	6016
Awarded NSF Grant	N	20	33	28	45	45	31	35	30	20	15	14	12	5	6	3	342
	%	6.0	8.1	6.3	9.9	8.9	7.0	8.0	7.2	5.7	4.9	3.7	3.5	1.3	1.4	.8	5.7
Other Biomedical Ph.D.s	N	1297	1443	1555	1862	2016	2179	2261	2202	2285	2352	2275	2409	2515	2630	2642	31923
Awarded NSF Grant	N	76	93	99	121	105	119	113	96	97	106	90	75	59	29	16	1294
	%	5.9	6.4	6.4	6.5	5.2	5.5	5.0	4.4	4.2	4.5	4.0	3.1	2.3	1.1	.6	4.1
Group I(c)	N	572	698	767	861	985	994	1091	951	941	929	899	918	973	953	932	13464
Awarded NSF Grant	N	53	57	66	62	54	70	68	43	43	48	30	28	29	15	6	672
	%	9.3	8.2	8.6	7.2	5.5	7.0	6.2	4.5	4.6	5.2	3.3	3.1	3.0	1.6	.6	5.0
Group II(d)	N	725	745	788	1001	1031	1185	1170	1251	1344	1423	1376	1491	1542	1677	1710	18459
Awarded NSF Grant	N	23	36	33	59	51	49	45	53	54	58	60	47	30	14	10	622
	%	3.2	4.8	4.2	5.9	4.9	4.1	3.8	4.2	4.0	4.1	4.4	3.2	1.9	.8	.6	3.4
Total All Ph.D.s (above)	N	2512	3006	3368	3703	4084	3959	3941	3815	3870	3904	3797	3827	3941	4071	4078	55875
Awarded NSF Grant	N	186	251	250	287	281	251	215	190	181	187	161	122	96	47	24	2729
	%	7.4	8.4	7.4	7.8	6.9	6.3	5.5	5.0	4.7	4.8	4.2	3.2	2.4	1.2	.6	4.9

(a) Individuals who received a total of less than 9 months support are included in Group I.
(b) Includes all individuals who were awarded one or more NSF research grants during the FY1973-82 period.
(c) Includes biomedical science Ph.D.s who had not received at least 9 months of NIH predoctoral training grant or fellowship support but were identified as having been graduate students in programs that had some NIH predoctoral training grant funding.
(d) Includes other biomedical science Ph.D.s who were identified as having been graduate students in programs that had no NIH predoctoral training grant funding.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows; National Science Foundation, Master File of Grant Applicants; National Research Council, Survey of Earned Doctorates.

TABLE 6.11 Percent of All NSF Research Grant Applications by FY1967-81 Ph.D. Recipients That Were Funded During the FY1973-82 Period

FY1967-81 Ph.D. Recipients		Fiscal Year of Doctorate 1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Total 1967-81
NIH Predoctoral Support(a)																	
Total Grant Applications	N	781	1042	1038	1183	1162	912	673	584	430	415	311	159	98	41	20	8849
No. of Research Awards	N	335	422	412	461	449	337	231	212	156	165	119	66	45	20	10	3440
	%	42.9	40.5	39.7	39.0	38.6	37.0	34.3	36.3	36.3	39.8	38.3	41.5	45.9	48.8	50.0	38.9
Biomedical Group I(b)																	
Total Grant Applications	N	374	391	414	403	443	510	397	277	279	254	149	111	91	40	15	4148
No. of Research Awards	N	197	181	168	161	168	208	161	95	85	103	49	45	32	17	9	1679
	%	52.7	46.3	40.6	40.0	37.9	40.8	40.6	34.3	30.5	40.6	32.9	40.5	35.2	42.5	60.0	40.5
Biomedical Group II(c)																	
Total Grant Applications	N	164	236	277	359	346	308	308	362	285	276	215	165	91	41	33	3466
No. of Research Awards	N	49	91	119	147	130	99	101	118	106	89	75	56	30	15	11	1236
	%	29.9	38.6	43.0	40.9	37.6	32.1	32.8	32.6	37.2	32.2	34.9	33.9	33.0	36.6	33.3	35.7
All Ph.D. Recipients (above)																	
Total Grant Applications	N	1319	1669	1729	1945	1951	1730	1378	1223	994	945	675	435	280	122	68	16463
No. of Research Awards	N	581	694	699	769	747	644	493	425	347	357	243	167	107	52	30	6355
	%	44.0	41.6	40.4	39.5	38.3	37.2	35.8	34.8	34.9	37.8	36.0	38.4	38.2	42.6	44.1	38.6

(a)Includes individuals who received a total of at least 9 months of NIH predoctoral training grant or fellowship support.
(b)Includes biomedical science Ph.D.s who had not received at least 9 months of NIH predoctoral training grant or fellowship support but were identified as having been graduate students in programs that had some NIH predoctoral training grant funding.
(c)Includes other biomedical science Ph.D.s who were identified as having been graduate students in programs that had no NIH predoctoral training grant funding.

SOURCE: National Institutes of Health, Roster of Trainees and Fellows; National Science Foundation, Master File of Grant Applicants; National Research Council, Survey of Earned Doctorates.

TABLE 6.12 Percent of the FY1967-81 Ph.D. Recipients Applying for Either NIH or NSF Research Grants Who Received One or More Awards by FY1982

		Fiscal Year of Doctorate															
FY1967-81 Ph.D. Recipients		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Total 1967-81
NIH Predoctoral Support(a)																	
Total Grant Applicants	N	546	721	810	826	853	700	645	605	589	533	493	337	239	134	43	8074
Awarded Research Grant	N	390	499	548	547	573	484	397	390	383	347	300	183	130	70	23	5264
	%	71.4	69.2	67.7	66.2	67.2	69.1	61.6	64.5	65.0	65.1	60.9	54.3	54.4	52.2	53.5	65.2
Biomedical Group I(b)																	
Total Grant Applicants	N	239	259	294	307	343	353	354	274	280	271	241	191	163	94	56	3719
Awarded Research Grant	N	148	167	171	196	201	205	216	147	147	167	135	95	83	47	23	2149
	%	61.9	64.5	58.2	63.8	58.6	58.1	61.0	53.6	52.5	61.6	56.4	49.7	50.9	50.0	41.1	57.8
Biomedical Group II(c)																	
Total Grant Applicants	N	232	237	243	273	307	328	333	360	381	346	312	279	206	114	76	4027
Awarded Research Grant	N	104	126	113	156	155	177	165	171	196	177	156	133	79	38	20	1966
	%	44.8	53.2	46.5	57.1	50.5	54.0	49.5	47.5	51.4	51.2	50.0	47.7	38.3	33.3	26.3	48.8
All Ph.D. Recipients (above)																	
Total Grant Applicants	N	1017	1217	1347	1406	1503	1381	1332	1239	1250	1150	1046	807	608	342	175	15820
Awarded Research Grant	N	642	792	832	899	929	866	778	708	726	691	592	411	292	155	66	9379
	%	63.1	65.1	61.8	63.9	61.8	62.7	58.4	57.1	58.1	60.1	56.6	50.9	48.0	45.3	37.7	59.3

(a)Includes individuals who received a total of at least 9 months of NIH predoctoral training grant or fellowship support.
(b)Includes biomedical science Ph.D.s who had not received at least 9 months of NIH predoctoral training grant or fellowship support but were identified as having been graduate students in programs that had some NIH predoctoral training grant funding.
(c)Includes other biomedical science Ph.D.s who were identified as having been graduate students in programs that had no NIH predoctoral training grant funding.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows and Consolidated Grant Applicant File; National Science Foundation, Master File of Grant Applicants; National Research Council, Survey of Earned Doctorates.

7. PUBLICATION RECORDS

Perhaps the most comprehensive indication of a young investigator's research accomplishments is his or her record of publication.

> It is through publications in the scientific literature that the achievements of scientists are primarily known to the scientific community, and it is through citations to these publications that the impact of a given scientist's contributions can most conveniently be measured. This is not to suggest that these two measures, publication counts and counts of citations, constitute an all-inclusive or sufficient criterion of scientific accomplishment, but only to indicate the general significance of [these] criteria . . . (NRC, 1977, p. 46).

Unlike most of the indices examined in the previous two chapters, publication records are not limited to those employed in the academic sector and are available for the most recent as well as the older graduates. In fact, many young investigators, ineligible or not ready to apply for their own research grants, have established their "research credentials" by authoring or coauthoring articles that have appeared in refereed journals. Some individuals begin while still in graduate school--frequently in collaboration with their faculty mentors. Others contribute to the scientific literature as part of their involvement in postdoctoral research activities. As a result, most biomedical scientists interested in pursuing careers in research have already compiled records of publications by the time they have completed their graduate and postgraduate training. Moreover, they continue to build on these records throughout their careers in research --irrespective of whether they work in universities, government or industrial laboratories, or some other research setting. Thus a strong

record of published articles provides empirical evidence of a young investigator's participation in and contribution to biomedical research.

The chief limitation of publication and citation counts as measures of research productivity lies with the difficulty of compiling data that accurately reflect individual contributions to the scientific literature. The process of identifying individual authors (and coauthors) and linking them with former NIH predoctorals and other biomedical scientists in the two comparison groups involved extensive data processing and verification. For the purposes of this analysis publication records were compiled for a sample of 1,773 biomedical scientists who had earned their doctorates in one of three fiscal years: 1967, 1972, or 1977. All of these individuals had been randomly selected to participate in the NRC biennial Survey of Scientists and Engineers and had responded to at least one of the six surveys conducted during the 1973-81 period--thereby having provided at least some information on their postgraduation employment histories. The publication data examined in this analysis include all articles that appeared during the 1970-80 period in a set of 275 carefully selected journals[1] covering a broad range of biomedical research areas. A total of approximatley 21,100 articles[2] were intially linked with the 1,773 individuals in the sample, solely on the basis of author's last name and first initial. Since this list obviously included many papers by individuals who were not in the sample but who had names similar to those of sample members, the set of articles identified with each individual was carefully scrutinized to determine whether or not the individual had in fact authored each of the articles attributed to him or her. This determination was made on the basis of fields of research, institutional affiliation, full names of authors (when known), and other available clues. After thorough scrutiny the list was reduced to approximately 8,700 articles that were determined to have been authored or coauthored by sample members during the 11-year span between 1970 and 1980.

These articles were collated (by computer) with source files from the Science Citation Index (Institute for Scientific Information, 1970-80), which provided specific citations to each article. For the 8,700 articles identified, a total of 67,800 citations were found in papers that appeared in the 275 selected biomedical journals during the 1970-80 period. Because of the complexity and uncertainties involved in this collation process, there was some reason to suspect that a significant number of citations might have been missed. To investigate this possibility a random sample of 100 articles published in 1978 was selected, and citations to each article were looked up using a library copy of the 1979 and 1980 volumes of the Science Citation Index. This "look-up" uncovered as many as 857 citations (in

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[1]For a profile of these journals, see Narin, 1983.

[2]The publication records--including names of all authors and coauthors, article title, and journal and date of publication--were derived from the MEDLARS system, a computerized information system maintained by the National Library of Medicine.

this two-year span) to the 100 articles, compared with 449 citations that had been derived by the computer collation. Most of the new citations discovered in the library volumes, however, were from articles in books, foreign journals, and other publications[3], not included in the set of 275 biomedical journals, and the correlation found between the annual number of computer-derived citations to each article and the number discovered through the library search--excluding those not in the biomedical journal set--is as high as .97. Furthermore, the correlation between annual number of computer-derived citations from the restricted journal set and the citation count based on all scientific journals covered in the Science Citation Index, is .92. On the basis of these findings we conclude that the computer derivation of citation data presented in this chapter produced highly accurate indices of research productivity, even though the restriction to the 275-journal set has resulted in a substantial underestimation of the total citation count.

Record of Publication In terms of the frequency with which individual scientists have produced published articles, the early career records suggest an easily recognizable pattern. Figure 7.1

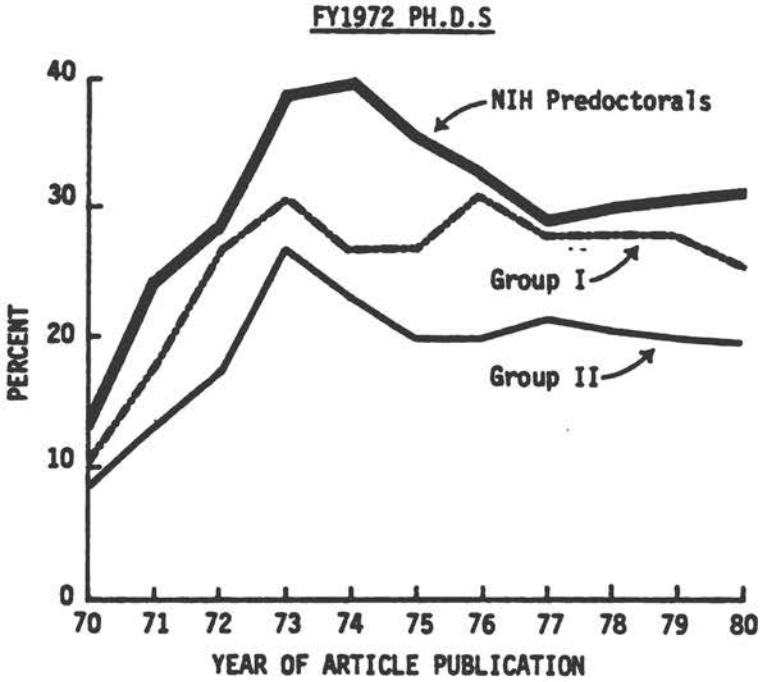

FIGURE 7.1 Percent of former NIH predoctorals and other FY1972 biomedical science Ph.D.s who had one or more articles published in a particular year, 1970-80. See Table 7.1.

[3]For a list of these other journals, see Appendix C.

describes the publication activity of FY1972 Ph.D. recipients--a group for whom we have publication data prior to their graduation, as well as for several subsequent years. Relatively few of these individuals contributed papers that were published before they had completed their doctoral training, but many produced articles in the two years immediately after graduation--presumably reflecting the publication of their doctoral dissertations. The publication frequency gradually declines over the next several years, as some young scientists finished their postdoctoral apprenticeships and moved on to career positions not involving extensive research activity or into junior faculty positions in which research time is limited. Many individuals, on the other hand, have continued to be involved in research as evidenced by the fact that in each year since 1978 more than one-fourth of all FY1972 Ph.D.s had contributed one or more published articles.

Of particular interest to this analysis is the finding that throughout their early careers former NIH trainees and fellows have been more likely to produce articles than have members of either comparison group. For the FY1972 cohort, the differences are greatest in the years immediately after graduation when approximately 40 percent of the NIH predoctorals contributed papers annually. Furthermore, 84 percent of this group had at least one article published sometime during the 1970-80 period, compared with 64 percent of the FY1972 biomedical science Ph.D.s in Group I and 56 percent of those in Group II (Table 7.1). For the FY1967 and FY1977 cohorts, similar differences were found between the NIH-supported graduates and the two comparison groups.

Total Articles and Citations The tendency for former NIH predoctorals to publish more frequently than their colleagues is reflected, as might be expected, in the total numbers of articles each individual produced during the 1970-80 period (Figure 7.2). With regard to the FY1967 Ph.D.s, for example, those who had received NIH training support produced, on the average, one-third more articles than those in either Group I or Group II. The differences in the total citations to papers by members of each group are even greater. A FY1967 graduate who had been supported by the NIH accrued an average of more than 66 article citations during the 11-year span (Figure 7.2). The comparable figures for Groups I and II are 39 and 31 citations, respectively. For the more recent cohorts, the average citation counts per individual are, of course, considerably smaller, but heavily favor the NIH predoctorals, nevertheless.

Citation Rates The higher citation counts (per individual) attributed to former NIH trainees and fellows reflect, in part, the fact that these individuals have typically produced more papers than have their biomedical science colleagues. Of further interest is whether or not the NIH-supported group has also accrued more citations per published article. Several studies (Jones, 1980) have demonstrated that this citation index is a meaningful measure of the research productivity of scientists--and one that is highly correlated with peer judgments and other measures of the quality of the scientific contribution. Figure 7.3 presents findings from an analysis of the citations to papers authored by FY1967, FY1972, and

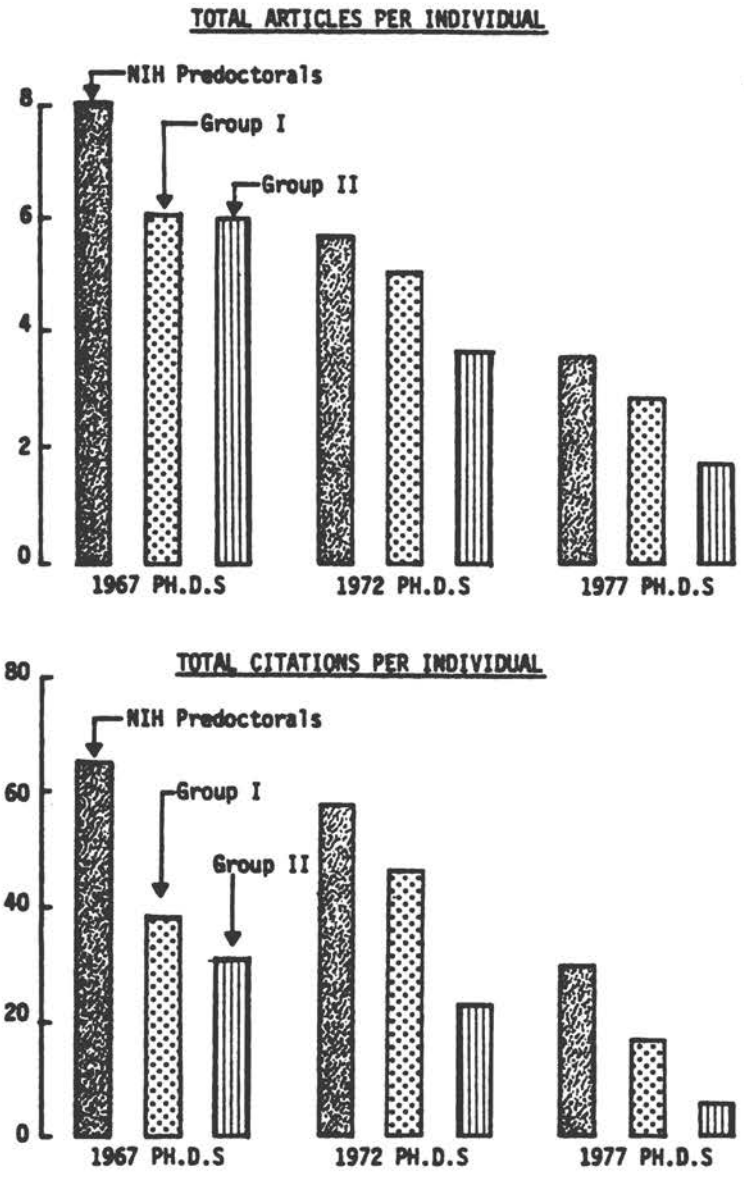

FIGURE 7.2 Average number of articles by former NIH predoctorals and other biomedical science Ph.D.s that were published during the 1970-80 period and average number of article citations received per individual. See Tables 7.2 and 7.3.

FY1977 Ph.D.s. Articles written by former NIH predoctorals in each cohort have received more citations per paper than have their Group I colleagues' articles, which in turn have been cited more frequently than articles by those in Group II. With regard to the FY1967 cohort, for example, papers authored by NIH-supported graduates were referenced in the biomedical research literature an average of 8.3 times during the FY1970-80 period, compared with an average of 6.4 and 5.3 citations to papers by graduates in Groups I and II, respectively. Somewhat surprising perhaps is the finding that papers by FY1972 Ph.D.s have been cited more frequently than have those by FY1967 Ph.D.s, even though the latter group has been publishing considerably longer (and thus their papers have had greater opportunity to accrue citations). As illustrated in Figure 7.3, this finding is applicable to the two comparison groups as well as to the NIH predoctorals. A possible explanation for the lower citation rates of FY1967 graduates is that the data reported do not include articles published prior to 1970 when many of these individuals were involved in postdoctoral training.

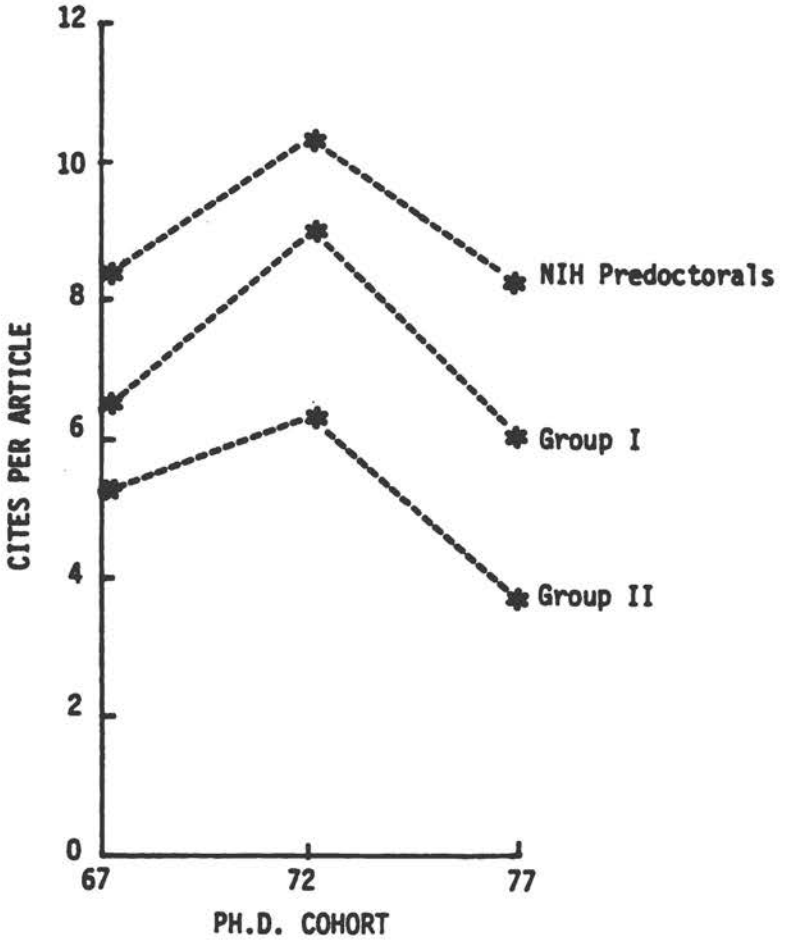

FIGURE 7.3 Average number of citations per article published during the 1970-80 period. See Table 7.4.

Publication Records of Former Postdoctorals Results presented in Chapter 4 reveal that, in comparison with other biomedical science Ph.D.s, a larger fraction of the NIH-supported trainees and fellows planned to take postdoctoral appointments after graduation. As discussed, these appointments have afforded young scientists opportunities to devote their full energies to research pursuits and at the same time compile requisite records of publications. Consequently, one might hypothesize that the differences observed in the publication records of former NIH predoctorals and their colleagues may be largely attributed to the fact that more of the former group have had postdoctoral research opportunities. To test this hypothesis separate analyses were made of the publication and citation records of graduates who indicated that they would take postdoctoral appointments after completion of their doctoral requirements and those with other postgraduation plans. Findings for the FY1972 cohort are described in Figure 7.4. The publication counts include only those articles published within three years following receipt of the doctorate (i.e, 1973-75)--a time when many of these graduates were involved in postdoctoral research training. Not at all surprising is the finding that graduates with definite plans for postdoctoral study produced approximately twice as many papers as did their colleagues. Furthermore, their papers have accrued, on the average, more than twice as many citations per article. Of greater interest is the finding that, among those who planned postdoctoral study, the NIH-supported graduates surpassed individuals in either

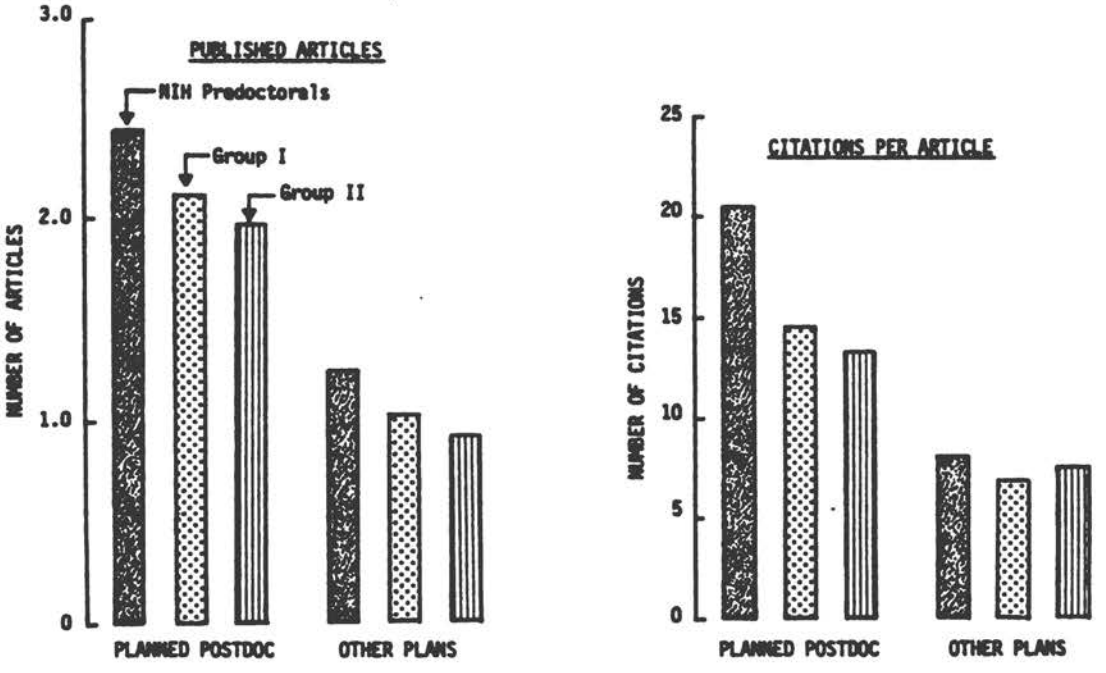

FIGURE 7.4 1973-75 publication and citation rates for FY1972 Ph.D.s with definite plans for postdoctoral study and corresponding rates for other FY1972 graduates. See Table 7.5.

comparison group--in terms of both the number of articles authored and the average number of citations per article. With respect to the publication records of those who did not have definite plans to take postdoctoral appointments, the findings are similar, although the differences between the NIH group and each of the two comparison groups are not as large. On the basis of these results we reject the hypothesis that the tendency for former NIH predoctorals to take postdoctoral apprenticeships primarily accounts for their superior records of publication.

Summary The principal findings presented in this chapter--that the NIH-supported graduates have produced more papers than their colleagues and that their papers have been cited more frequently--reinforces the conclusions reached in earlier chapters. There can be no doubt that, in comparison with other biomedical scientists, members of the NIH group have been more successful in their pursuits of careers as independent investigators. This success is measured by their demonstrated involvement in research activities (e.g., applying for federal research grants or contributing to the biomedical research literature) and by their research accomplishments (e.g., the receipt of grant awards or high article citation rates). Whether their success may be attributed to the superior ability and research potential of those selected to receive NIH predoctoral support, the quality of the graduate training they received, or perhaps other factors cannot be ascertained from this analysis. This important issue is discussed at some length in the following chapter, which provides an overall summary and interpretation of the study findings.

TABLE 7.1 Percent of FY1967, FY1972, and FY1977 Ph.D. Recipients Who Had One or More Articles Published During the 1970-80 Period

		Year of Article Publication											Any Year
		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	
FY1967 Ph.D. Recipients													
NIH Predoctoral Support(a)	N	214	214	214	214	214	214	214	214	214	214	214	214
One or More Articles(b)	N	63	81	80	85	82	76	71	70	82	66	75	161
	%	29.4	37.9	37.4	39.7	38.3	35.5	33.2	32.7	38.3	30.8	35.0	75.2
Biomedical Group I(c)	N	126	126	126	126	126	126	126	126	126	126	126	126
One or More Articles	N	38	37	37	29	31	33	32	29	31	32	32	74
	%	30.2	29.4	29.4	23.0	24.6	26.2	25.4	23.0	24.6	25.4	25.4	58.7
Biomedical Group II(d)	N	169	169	169	169	169	169	169	169	169	169	169	169
One or More Articles	N	47	49	46	49	46	37	43	43	39	43	39	104
	%	27.8	29.0	27.2	29.0	27.2	21.9	25.4	25.4	23.1	25.4	23.1	61.5
1972 Ph.D. Recipients													
NIH Predoctoral Support	N	306	306	306	306	306	306	306	306	306	306	306	306
One or More Articles	N	40	75	87	121	121	109	101	90	92	93	96	257
	%	13.1	24.6	28.4	39.5	39.5	35.6	33.0	29.4	30.1	30.4	31.4	84.0
Biomedical Group I	N	234	234	234	234	234	234	234	234	234	234	234	234
One or More Articles	N	24	42	62	72	63	63	72	65	65	65	59	150
	%	10.3	17.9	26.5	30.8	26.9	26.9	30.8	27.8	27.8	27.8	25.2	64.1
Biomedical Group II	N	279	279	279	279	279	279	279	279	279	279	279	279
One or More Articles	N	25	37	48	74	63	57	56	60	56	56	53	155
	%	9.0	13.3	17.2	26.5	22.6	20.4	20.1	21.5	20.1	20.1	19.0	55.6
1977 Ph.D. Recipients													
NIH Predoctoral Support	N	175	175	175	175	175	175	175	175	175	175	175	175
One or More Articles	N	1	5	13	16	34	36	48	64	75	63	69	151
	%	.6	2.9	7.4	9.1	19.4	20.6	27.4	36.6	42.9	36.0	39.4	86.3
Biomedical Group I	N	114	114	114	114	114	114	114	114	114	114	114	114
One or More Articles	N	2	1	5	5	8	18	16	27	36	43	36	72
	%	1.8	.9	4.4	4.4	7.0	15.8	14.0	23.7	31.6	37.7	31.6	63.2
Biomedical Group II	N	156	156	156	156	156	156	156	156	156	156	156	156
One or More Articles	N	4	2	1	7	12	13	23	26	34	36	34	80
	%	2.6	1.3	.6	4.5	7.7	8.3	14.7	16.7	21.8	23.1	21.8	51.3

(a)Includes individuals who received a total of at least 9 months of NIH predoctoral training grant or fellowship support.
(b)Includes any individuals who had authored or coauthored at least one article that had been published in the specified year.
(c)Includes biomedical science Ph.D.s who had not received at least 9 months of NIH predoctoral training grant or fellowship support but were identified as having been graduate students in programs that had some NIH predoctoral training grant funding.
(d)Includes other biomedical science Ph.D.s who were identified as having been graduate students in programs that had no NIH predoctoral training grant funding.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows and Research Publication and Citation File; National Research Council, Survey of Doctorate Recipients.

TABLE 7.2 Average Number of Articles Published by FY1967, FY1972, and FY1977 Ph.D. Recipients During the 1970-80 Period

		Year of Article Publication											
		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	All Years
FY1967 Ph.D. Recipients													
NIH Predoctoral Support(a)	N	214	214	214	214	214	214	214	214	214	214	214	214
Articles per Individual(b)		.49	.71	.67	.82	.76	.83	.65	.72	.80	.73	.82	8.00
Biomedical Group I(c)	N	126	126	126	126	126	126	126	126	126	126	126	126
Articles per Individual		.63	.54	.62	.50	.48	.52	.63	.65	.44	.55	.48	6.06
Biomedical Group II(d)	N	169	169	169	169	169	169	169	169	169	169	169	169
Articles per Individual		.53	.60	.53	.54	.50	.46	.56	.65	.54	.60	.47	5.96
1972 Ph.D. Recipients													
NIH Predoctoral Support	N	306	306	306	306	306	306	306	306	306	306	306	306
Articles per Individual		.18	.31	.45	.62	.65	.59	.59	.54	.54	.54	.68	5.71
Biomedical Group I	N	234	234	234	234	234	234	234	234	234	234	234	234
		.18	.25	.44	.53	.48	.47	.68	.63	.53	.58	.49	5.07
Biomedical Group II	N	279	279	279	279	279	279	279	279	279	279	279	279
		.10	.18	.26	.41	.41	.39	.39	.39	.41	.45	.40	3.77
1977 Ph.D. Recipients													
NIH Predoctoral Support	N	175	175	175	175	175	175	175	175	175	175	175	175
Articles per Individual		.01	.03	.09	.12	.25	.29	.38	.68	.67	.58	.65	3.64
Biomedical Group I	N	114	114	114	114	114	114	114	114	114	114	114	114
Articles per Individual		.02	.01	.06	.10	.07	.18	.25	.37	.64	.82	.60	2.91
Biomedical Group II	N	156	156	156	156	156	156	156	156	156	156	156	156
Articles per Individual		.03	.02	.01	.05	.10	.10	.20	.23	.31	.35	.35	1.74

(a)Includes individuals who received a total of at least 9 months of NIH predoctoral training grant or fellowship support.
(b)Average number of articles authored or coauthored by an individual in a specified year.
(c)Includes biomedical science Ph.D.s who had not received at least 9 months of NIH predoctoral training grant or fellowship support but were identified as having been graduate students in programs that had some NIH predoctoral training grant funding.
(d)Includes other biomedical science Ph.D.s who were identified as having been graduate students in programs that had no NIH predoctoral training grant funding.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows and Research Publication and Citation File; National Research Council, Survey of Doctorate Recipients.

TABLE 7.3 Average Number of Citations to Articles Published by FY1967, FY1972, and FY1977 Ph.D. Recipients During the 1970-80 Period

		Year of Article Publication											
		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	All Years
FY1967 Ph.D. Recipients													
NIH Predoctoral Support(a)	N	214	214	214	214	214	214	214	214	214	214	214	214
Citations per Individual(b)		6.01	7.18	8.19	9.85	9.66	9.75	5.62	4.40	3.33	1.69	.37	66.06
Biomedical Group I(c)	N	126	126	126	126	126	126	126	126	126	126	126	126
Citations per Individual		4.61	4.25	4.48	7.27	3.75	3.91	4.73	2.86	1.60	.96	.10	38.54
Biomedical Group II(d)	N	169	169	169	169	169	169	169	169	169	169	169	169
Citations per Individual		1.81	4.07	3.54	5.74	4.28	3.14	3.44	3.02	1.37	.72	.09	31.21
1972 Ph.D. Recipients													
NIH Predoctoral Support	N	306	306	306	306	306	306	306	306	306	306	306	306
Citations per Individual		1.47	4.01	5.16	12.69	10.61	9.94	6.73	4.28	2.14	1.17	.26	58.46
Biomedical Group I	N	234	234	234	234	234	234	234	234	234	234	234	234
Citations per Individual		2.10	2.76	6.11	8.59	5.62	5.74	7.02	4.00	2.92	1.28	.12	46.24
Biomedical Group II	N	279	279	279	279	279	279	279	279	279	279	279	279
Citations per Individual		.65	.95	1.70	4.97	3.65	3.78	3.35	2.20	1.49	.77	.08	23.61
1977 Ph.D. Recipients													
NIH Predoctoral Support	N	175	175	175	175	175	175	175	175	175	175	175	175
Citations per Individual		.02	.89	.71	6.26	3.95	4.79	4.40	3.98	3.03	1.61	.24	29.89
Biomedical Group I	N	114	114	114	114	114	114	114	114	114	114	114	114
Citations per Individual		.12	.16	.41	1.14	1.26	2.12	3.52	3.61	2.32	2.51	.33	17.51
Biomedical Group II	N	156	156	156	156	156	156	156	156	156	156	156	156
Citations per Individual		.29	.15	.06	.14	.44	.98	1.46	1.22	1.15	.48	.06	6.44

(a)Includes individuals who received a total of at least 9 months of NIH predoctoral training grant or fellowship support.
(b)Average number of citations to articles authored or coauthored by an individual in a specified year.
(c)Includes biomedical science Ph.D.s who had not received at least 9 months of NIH predoctoral training grant or fellowship support but were identified as having been graduate students in programs that had some NIH predoctoral training grant funding.
(d)Includes other biomedical science Ph.D.s who were identified as having been graduate students in programs that had no NIH predoctoral training grant funding.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows and Research Publication and Citation File; National Research Council, Survey of Doctorate Recipients.

TABLE 7.4 Average Number of Citations per Article Published by FY1967, FY1972, and FY1977 Ph.D. Recipients During the 1970-80 Period

	Year of Article Publication											
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	All Years
FY1967 Ph.D. Recipients												
NIH Predoctoral Support(a)												
Number of Articles	104	151	144	176	161	178	139	155	172	156	175	1711
Number of Citations	1286	1537	1753	2107	2068	2087	1202	942	713	361	80	14136
Cites per Article	12.4	10.2	12.2	12.0	12.8	11.7	8.6	6.1	4.1	2.3	.5	8.3
Biomedical Group I(b)												
Number of Articles	80	68	78	63	61	66	80	82	56	69	61	764
Number of Citations	581	536	565	916	473	493	596	360	202	121	13	4856
Cites per Article	7.3	7.9	7.2	14.5	7.8	7.5	7.5	4.4	3.6	1.8	.2	6.4
Biomedical Group II(c)												
Number of Articles	89	101	89	91	84	78	94	110	91	101	80	1008
Number of Citations	306	688	598	970	723	531	581	510	231	121	15	5274
Cites per Article	3.4	6.8	6.7	10.7	8.6	6.8	6.2	4.6	2.5	1.2	.2	5.2
1972 Ph.D. Recipients												
NIH Predoctoral Support												
Number of Articles	54	96	139	191	198	181	182	165	166	165	209	1746
Number of Citations	450	1228	1579	3884	3246	3041	2058	1309	654	359	80	17888
Cites per Article	8.3	12.8	11.4	20.3	16.4	16.8	11.3	7.9	3.9	2.2	.4	10.2
Biomedical Group I												
Number of Articles	41	59	104	125	113	111	135	124	124	135	115	1186
Number of Citations	491	646	1429	2011	1314	1343	1642	935	683	299	27	10820
Cites per Article	12.0	10.9	13.7	16.1	11.6	12.1	12.2	7.5	5.5	2.2	.2	9.1
Biomedical Group II												
Number of Articles	29	49	72	115	114	108	108	108	113	125	111	1052
Number of Citations	182	264	475	1387	1018	1056	936	615	417	214	23	6587
Cites per Article	6.3	5.4	6.6	12.1	8.9	9.8	8.7	5.7	3.7	1.7	.2	6.3
1977 Ph.D. Recipients												
NIH Predoctoral Support												
Number of Articles	1	5	16	21	43	50	67	102	117	101	114	637
Number of Citations	3	155	125	1096	691	839	770	696	531	282	42	5230
Cites per Article	3.0	31.0	7.8	52.2	16.1	16.8	11.5	6.8	4.5	2.8	.4	8.2
Biomedical Group I												
Number of Articles	2	1	7	11	8	21	29	42	61	93	57	332
Number of Citations	14	18	47	130	144	242	401	411	265	286	38	1996
Cites per Article	7.0	18.0	6.7	11.8	18.0	11.5	13.8	9.8	4.3	3.1	.7	6.0
Biomedical Group II												
Number of Articles	5	3	1	8	15	15	31	36	48	55	55	272
Number of Citations	45	24	9	22	68	153	228	191	179	75	10	1004
Cites per Article	9.0	8.0	9.0	2.8	4.5	10.2	7.4	5.3	3.7	1.4	.2	3.7

(a)Includes individuals who received a total of at least 9 months of NIH predoctoral training grant or fellowship support.
(b)Includes biomedical science Ph.D.s who had not received at least 9 months of NIH predoctoral training grant or fellowship support but were identified as having been graduate students in programs that had some NIH predoctoral training grant funding.
(c)Includes other biomedical science Ph.D.s who were identified as having been graduate students in programs that had no NIH predoctoral training grant funding.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows and Research Publication and Citation File; National Research Council, Survey of Doctorate Recipients.

TABLE 7.5 Publication and Citation Rates for FY1972 and FY1977 Ph.D. Recipients with Definite Plans for Postdoctoral Study, Compared with Rates for Other Graduates

	Postgraduation Employment Plans(a)			
	Postdoctoral Appt.		Other Positions	
	Articles	Citations	Articles	Citations
FY1972 Ph.D. Recipients				
NIH Predoctoral Support(b)				
Three Years After Ph.D.(c)	2.46	50.38	1.25	9.96
Total 1970-80 Period	6.99	86.13	4.23	19.81
Biomedical Group I (d)				
Three Years After Ph.D.	2.12	35.40	1.02	6.87
Total 1970-80 Period	6.72	75.05	3.20	14.53
Biomedical Group II(e)				
Three Years After Ph.D.	1.98	26.16	.86	6.54
Total 1970-80 Period	6.10	49.92	2.50	11.47
1977 Ph.D. Recipients				
NIH Predoctoral Support				
Three Years After Ph.D.(f)	2.09	5.89	1.79	3.55
Total 1970-80 Period	4.07	30.79	3.32	37.11
Biomedical Group I				
Three Years After Ph.D.	2.25	6.09	1.33	4.11
Total 1970-80 Period	3.47	21.46	2.26	14.44
Biomedical Group II				
Three Years After Ph.D.	1.56	3.20	.38	.15
Total 1970-80 Period	2.71	11.38	.80	2.80

(a)Includes only those individuals who had definite employment plans at the time they had completed requirements for their doctorates.
(b)Includes individuals who received a total of at least 9 months of NIH predoctoral training grant or fellowship support.
(c)Average number of articles an individual authored or coauthored during the 1973-75 period and the average number of citations to these articles.
(d)Includes biomedical science Ph.D.s who had not received at least 9 months of NIH predoctoral training grant or fellowship support but were identified as having been graduate students in programs that had some NIH predoctoral training grant funding.
(e)Includes other biomedical science Ph.D.s who were identified as having been graduate students in programs that had no NIH predoctoral training grant funding.
(f)Average number of articles an individual authored or coauthored during the 1978-80 period and the average number of citations to these articles.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows and Research Publication and Citation File; National Research Council, Survey of Doctorate Recipients.

8. SUMMARY AND INTERPRETATION OF FINDINGS

The fundamental purpose of this study, as stated in the introductory chapter, is to determine the extent to which graduate students who had received NIH training grant or fellowship awards have been successful in pursuing careers in biomedical research. In this chapter we summarize the findings presented in earlier chapters and investigate--through the use of regression models--the relative importance of NIH predoctoral support and other factors in explaining various career-achievement measures.

Included in the study population are approximately 24,000 FY1967-81 Ph.D. recipients who while in graduate school had been paid NIH stipends for a period of at least nine months. A diverse set of measures pertaining to their early career achievements and research productivity are examined in the preceding chapters. To better understand the results of these analyses, corresponding data are presented for two comparison groups. Group I comprises approximately 13,500 biomedical science Ph.D.s (FY1967-81) who had received their doctoral education in university departments/programs which held NIH training grants, but who did not themselves meet the above criterion for inclusion in the study population. Individuals were placed in this comparison group if their doctoral institution, field, and year of graduation matched those of an NIH-supported trainee. Also included in Group I are graduates who had received between one and eight months of NIH predoctoral stipend support. Group II is made up on another 18,500 biomedical science graduates who received their graduate education in programs with no NIH research training support. Taken together, the two comparison groups and the study population include all 50,000 individuals who had earned biomedical science doctorates from U.S. universities during this 15-year interval. As discussed in Chapter 3, another 6,000 members of the study population received their graduate training in chemistry, psychology, and other health-related disciplines.

Since the interpretation of the study findings relies almost exclusively on contrasts of the accomplishments of former NIH predoctorals with the accomplishments of the other two groups of biomedical scientists, the composition of the two comparison groups is

of paramount importance. Individuals in Group I received their graduate education in the same set of university departments as did NIH trainees and may very well have benefited indirectly from the training grant support provided to their programs (e.g., supplemental funding for faculty salaries, seminars, and other such educational expenses). Members of Group II, on the other hand, came from graduate programs that had no such support. Since the NIH training grant award has always been made on the basis of peer evaluation, it may be presumed that those programs without awards were, on the whole, somewhat inferior--in terms of the reputation of the faculty, the caliber of graduate students enrolled, and the overall quality of the curriculum offered.

Two other points should be made with regard to differences in the composition of the study population and comparison Group I. First, it must be recognized that, while NIH predoctoral fellows were selected on the basis of national competition, the trainees have been appointed by a training grant director, usually a senior member of the departmental faculty. It is by no means clear what criteria were typically used by training directors in determining which graduate students in the program should receive NIH stipends. Some may have appointed the most promising students in order to enhance the prospects for renewal of the training grant. Others may have selected less talented students and "saved" their strongest candidates to compete for national fellowships or to work as research assistants on federally sponsored projects. Although we have no firm basis for assessing the relative abilities of trainees and non-trainees (Group I) in the same department, it should be recognized that there may be important differences that could affect the career outcomes of the two groups. The second point pertains to the quality of the graduate programs in which NIH-supported students and their Group I colleagues received their training. While members of both groups (by definition) came from the same set of university programs, there is evidence to suggest that the NIH predoctorals were concentrated somewhat more heavily in those institutions with the strongest reputations. As illustrated in Figure 8.1, as many as 48 percent of these individuals earned their doctorates from 25 universities that had "distinguished" biomedical science programs,[1] compared with 42 percent of their Group I colleagues. This finding principally derives from the fact that programs in these 25 universities have received a proportionally larger share of NIH predoctoral training support. If one assumes that the most promising students may be found in universities with the leading biomedical science programs, then it follows that the study population, on the whole, included a somewhat more talented cadre of young investigators than those found in comparison Group I. It is not surprising, of course, to find that a much smaller proportion (only 15 percent) of those in Group II earned their doctorates from other departments in these same 25 universities.

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[1]Based on results from the 1982 Assessment of Research-Doctorate Programs--see footnote (b) of Table 3.3 and accompanying discussion in Chapter 3.

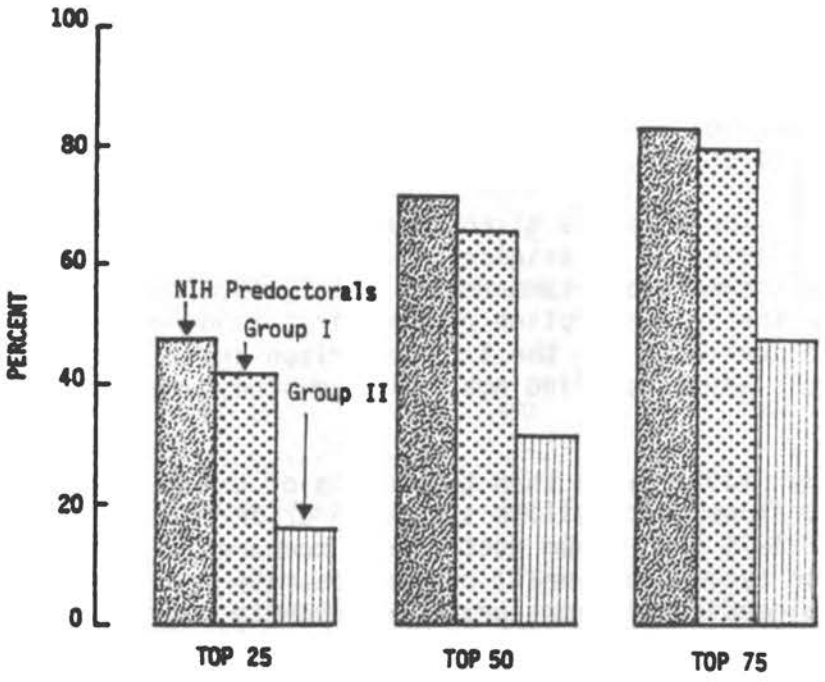

FIGURE 8.1 Percent of FY1967-81 Ph.D. recipients who earned their doctorates from universities with highest-rated biomedical science faculties. See footnote (b) in Table 3.3.

The preceding discussion indicates that there may be important differences in the overall abilities of the study population and the two comparison groups--differences that may be relevant to the findings, but could not be controlled for in this study. Moreover, there is reason to believe that career outcomes are influenced by such factors as individual motivation, career preferences, postdoctoral mentor and laboratory, and early employment history. Thus we repeat the caveat issued in the first chapter: since NIH predoctoral trainees and fellows had been selected on the basis of criteria directly or indirectly related to their abilities and interest in biomedical research, it cannot be determined from the analyses whether their superior records of achievement may be attributed to the selection process, the training they received, or a combination of these and other factors. With this caveat in mind, we proceed to summarize the key findings from this study.

Summary of Findings The analyses presented in the preceding five chapters examine a variety of indices relevant to the career achievements of young investigators in biomedical research. These indices pertain to:

- successful completion of doctoral training;
- participation in postdoctoral research training;
- involvement in research-related employment;
- application for and acquisition of federal research funding; and
- record of publication productivity.

Although the detailed analyses given in earlier chapters have taken into account the level of experience (i.e., year of doctorate) of an individual, results here are summarized for all Ph.D.cohorts combined. With the sole exception of the first finding reported below, data are available for the two comparison groups as well as for the study group. Seven key findings from the study are given in Table 8.1:

(1) By FY1981, more than two-thirds of the NIH trainees and fellows supported prior to FY1976 had earned doctorates, compared with an estimated overall completion rate for biomedical science graduate students of less than 50 percent.

(2) Individuals in the study group were considerably more likely to have subsequently received NIH postdoctoral fellowships or traineeships than were members of either comparison group.

(3) Former NIH predoctorals were also more likely to have become involved (at later stages in their careers) in NIH-sponsored activities.

(4) In comparison with Groups I and II, an appreciably larger fraction of the study group applied for NIH research grants.

(5) Those in the study group who applied for NIH research grants have been more successful in obtaining awards than have those in either comparison group.

(6) Former NIH trainees and fellows have authored, on the average, more articles than have their biomedical science colleagues.

(7) Articles written by members of the study group have typically received more citations in the bioscience literature.

The fourth and fifth columns in Table 8.1 give the ratios of the NIH predoctorals' statistics to the statistics for those in Groups I and II, respectively, and provide indices of the relative performances of

TABLE 8.1 Summary of Key Findings

	(1) NIH Predoctorals	(2) Group I	(3) Group II	(4) Ratio (1)/(2)	(5) Ratio (1)/(3)
(1) Proportion of FY1967-75 NIH predoctoral trainees and fellows who had earned doctoral degrees by FY1981 (Table 3.1)	.690	N/A	N/A		
(2) Proportion of FY1967-79 Ph.D. recipients who received NIH postdoctoral trainee or fellowship support by FY1980 (Table 4.2)	.344	.207	.171	1.66	2.01
(3) Proportion of FY1967-80 Ph.D. recipients working on NIH sponsored activities in 1981 (Table 5.4)	.418	.358	.290	1.17	1.44
(4) Proportion of FY1967-81 Ph.D. recipients who applied for NIH research grants during the FY1967-82 period (Table 6.1)	.305	.231	.174	1.32	1.75
(5) Proportion of all NIH research grant applications by FY1967-81 Ph.D. recipients that were funded during the FY1967-82 period (Table 6.8)[a]	.386	.332	.287	1.16	1.34
(6) Average number of articles authored by FY1972 Ph.D. recipients that were published between 1970 and 1980 (Table 7.2)	5.70	5.26	3.75	1.08	1.52
(7) Average number of citations per article published by FY1972 Ph.D. recipients between 1970 and 1980 (Table 7.4)	10.3	9.0	6.3	1.14	1.63

[a]This measure reflects the overall "success rate" on NIH research grant applications by members of each of the three groups.

the three groups for a particular measure. With respect to each of these seven measures, the NIH-supported predoctorals have outperformed members of either comparison group--and the same results were observed for all other indices examined in this report, as well. Furthermore, individuals in Group I, all of whom had received their graduate education in biomedical science programs with NIH training grant funding, had records of achievement for each of the seven measures that were superior to those of other biomedical science graduates (Group II). The differences observed among these three groups, while not necessarily large, are remarkably consistent for a diverse set of career outcome measures. On the basis of this evidence we conclude that graduates of the NIH predoctoral training programs have been highly successful in pursuing careers in biomedical research.

Regression Models Until now we have relied exclusively on descriptive statistics in our presentation of study results and have deferred the issue of statistical significance. This analytical approach was adopted since all of the results other than those presented in Chapters 5 and 7 are based on records of the entire study group and comparison groups, and the question of whether the observed differences among groups are statistically significant is not of interest--i.e., the data represent population parameters rather than estimates of such parameters. In the analyses in Chapters 5 and 7, which deal primarily with employment activities and publication productivity, respectively, the samples from which data are derived are sufficiently large[2] to guarantee that even small differences among group means are considered significant at the .95 confidence level.

In the remainder of this chapter we employ a multiple regression model[3] to probe more deeply into the relationship between NIH predoctoral traineeship and fellowship programs and the early career outcomes of talented young scientists. In this analysis three independent variables are considered:

(1) years of experience (Ph.D. cohort);
(2) quality of Ph.D. institution (reputational rating[4] of biomedical science faculty); and
(3) total months of NIH predoctoral support.

The first two of these variables are included in the model because of their demonstrated influence on various outcome measures. For example, it is quite evident from earlier findings that level of experience has an important bearing on an individual's cumulative career accomplishments--e.g., older graduates have typically had greater opportunity to apply for federal research grants and to contribute to biomedical science publications than have their younger colleagues. It is also

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[2]See Appendix B for a description of sample sizes.
[3]For a discussion of this model, refer to Pedhazur, 1982, Part I.
[4]See footnote (b) in Table 3.3 for a description of how this measure was derived.

reasonable to hypothesize that prestigious universities have attracted the most talented graduate students who are more likely to have compiled strong records of achievement than are Ph.D. recipients from other institutions. Of particular relevance to this study, however, is the question of whether former NIH predoctoral trainees and fellows have outperformed other biomedical science Ph.D.s--when the effects of these other two variables are taken into account. It is important to recognize that since the primary purpose of this analysis is to estimate the relative influences of each of the three independent variables described above, no attempt has been made to differentiate between individuals in comparison Groups I and II (as was done in earlier analyses). Level of NIH predoctoral support is measured in terms of how many total months an individual had received training grant and fellowship stipends--and no one in either comparison group had more than eight months of NIH support (most had no support). The multiple regression models provide a statistical technique for assessing the influences of each of the three independent variables on the following four measures of achievement (dependent variables):

(1) total number of NIH research grant applications;
(2) total number of articles published;
(3) average priority score assigned to NIH grant applications; and
(4) average number of citations per article published.

The first two measures reflect an individual's continuing interest and involvement in biomedical research; the latter two represent measures of individual accomplishments as an independent investigator. In Chapters 6 and 7 it was shown that, with respect to each of these four measures, the study population had an appreciably higher standard of achievement than either comparison group. But would these same results be obtained after taking into account each graduate's years of experience and the reputed quality of his or her Ph.D. institution?

The regression models derived to explain the total number of NIH research grant applications and the total number of published articles attributed to an individual--two measures of research involvement--are given in Figure 8.2. The first model is based on the records of 55,875 individuals who had earned their doctorates between FY1967 and FY1981 and yields a multiple correlation coefficent (R) of .284, i.e., the model accounts for approximately 8 percent (R^2) of the variance in the number of grant applications by an individual. Given in the figure are the bivariate correlation coefficients (r) describing the relationships of each of the three independent variables with the dependent variable and with each other. Not surprisingly, total months of NIH predoctoral support[5] is positively correlated with an

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[5]For the purposes of this analysis no distinction has been made between those who had received their graduate training in departments/programs with NIH training grants but had not themselves received NIH stipends (Group I) and those who had received graduate training in other settings (Group II).

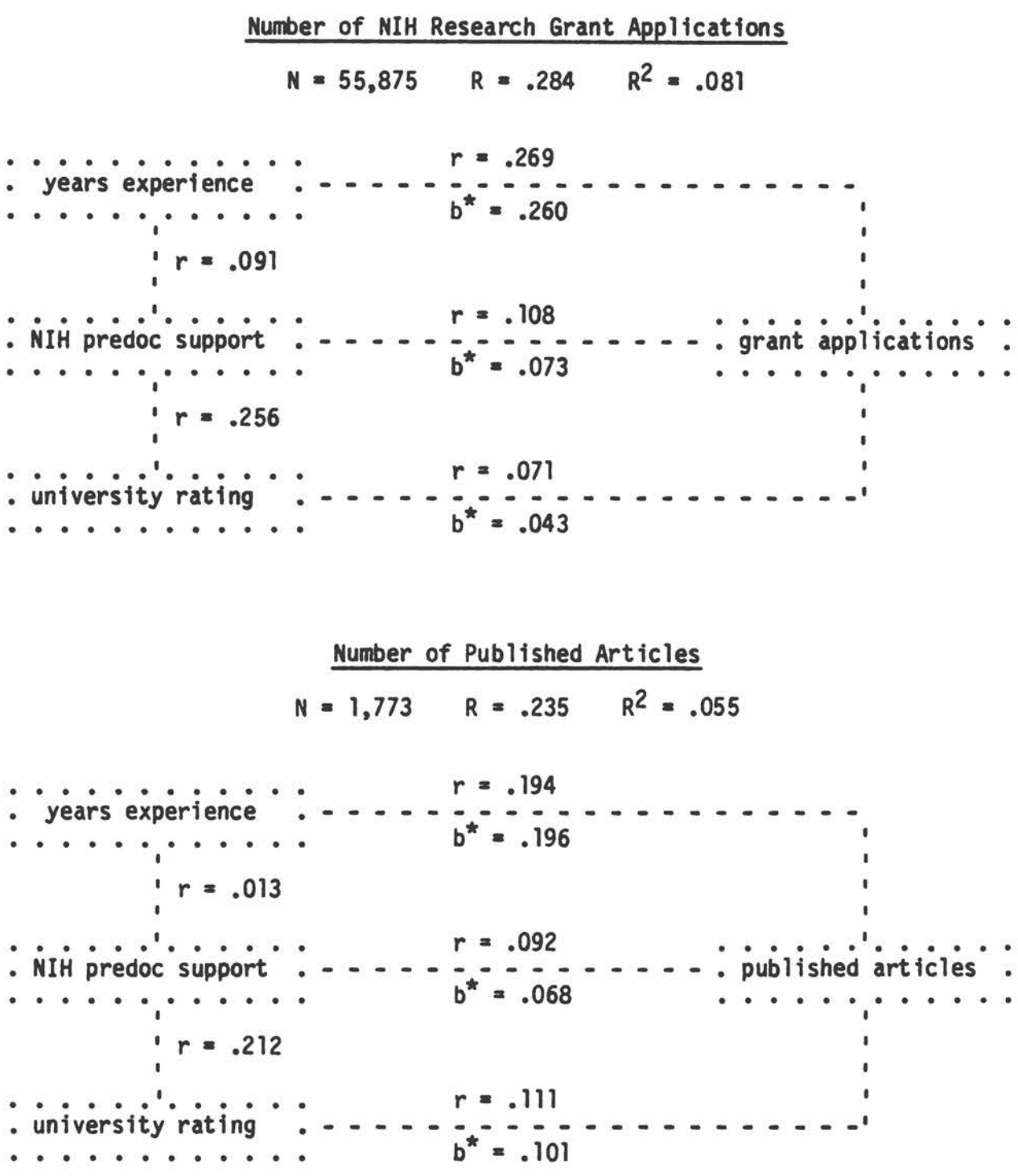

FIGURE 8.2 Regression models for predicting total number of FY1967-82 NIH research grant applications and total number of 1970-80 published articles attributed to an individual. See Appendix E for means, standard deviations, and nonstandardized regression coefficients.

individual's level of experience (r = .091) and the reputation of the biomedical faculty at his or her Ph.D. institution (r = .256), as well as with the total number of NIH grant applications made (r = .108). Also presented in the figure are the standardized regression coefficients (b^*) in the equation:

$$Y = b_1^* X_1 + b_2^* X_2 + b_3^* X_3$$

These standardized coefficients--sometimes referred to as beta weights --provide a convenient index for comparing the relative effect of each of the three independent variables on the dependent variable. As might be expected, an individual's years of experience is by far the most important variable (b^* = .260) in accounting for the total number of grant applications submitted during the FY1967-82 period. The beta weight for the NIH predoctoral support variable is considerably smaller (b^* = .073), but nevertheless statistically significant at the .99 level of confidence. Thus one may surmise from this analysis that, even after controlling for the effects of their level of experience and the reputation of their Ph.D. institution, former NIH trainees and fellows have submitted more NIH grant applications than have their biomedical science colleagues.

The model for predicting the total number of articles published between 1970 and 1980 is presented in the lower half of Figure 8.2. The coefficients are derived from an analyis of the publication records of 1,773 biomedical scientists who had earned their doctorates in FY1967, FY1972, or FY1977. In view of the smaller sample size and limited coverage of Ph.D. cohorts, it is not surprising that the model yields a somewhat smaller multiple correlation (R = .235) than the model discussed above. The inclusion of only these three Ph.D. cohorts also accounts for the relatively low correlation (r = .013) between years of experience and months of NIH predoctoral support. In many other respects the parameters describing the two models are similar. In the second model the beta weights for all three independent variables are statistically significant at the .99 confidence level, with the variable representing years of experience having the largest coefficient (b^* = .196). The correlation between months of support and number of published articles (r = .092) is not very different from the correlation between months of support and number of grant applications (shown in the first model). In each model the NIH support variable plays a small, but statistically significant role in explaining the variance associated with the dependent variable.

Figure 8.3 depicts the relationships of these same three independent variables with two outcome measures that reflect research productivity. Coefficients for the model described in the upper half of this figure are based on the average priority scores received by 13,601 scientists who had applied for NIH research grants during the FY1967-82 span. Coefficients for the other model are derived from an analysis of the average number of citations per article published by 1,204 biomedical science Ph.D.s[6] who had contributed to at least one

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[6]Included are biomedical scientists in the FY1967, FY1972, and FY1977 Ph.D. cohorts only.

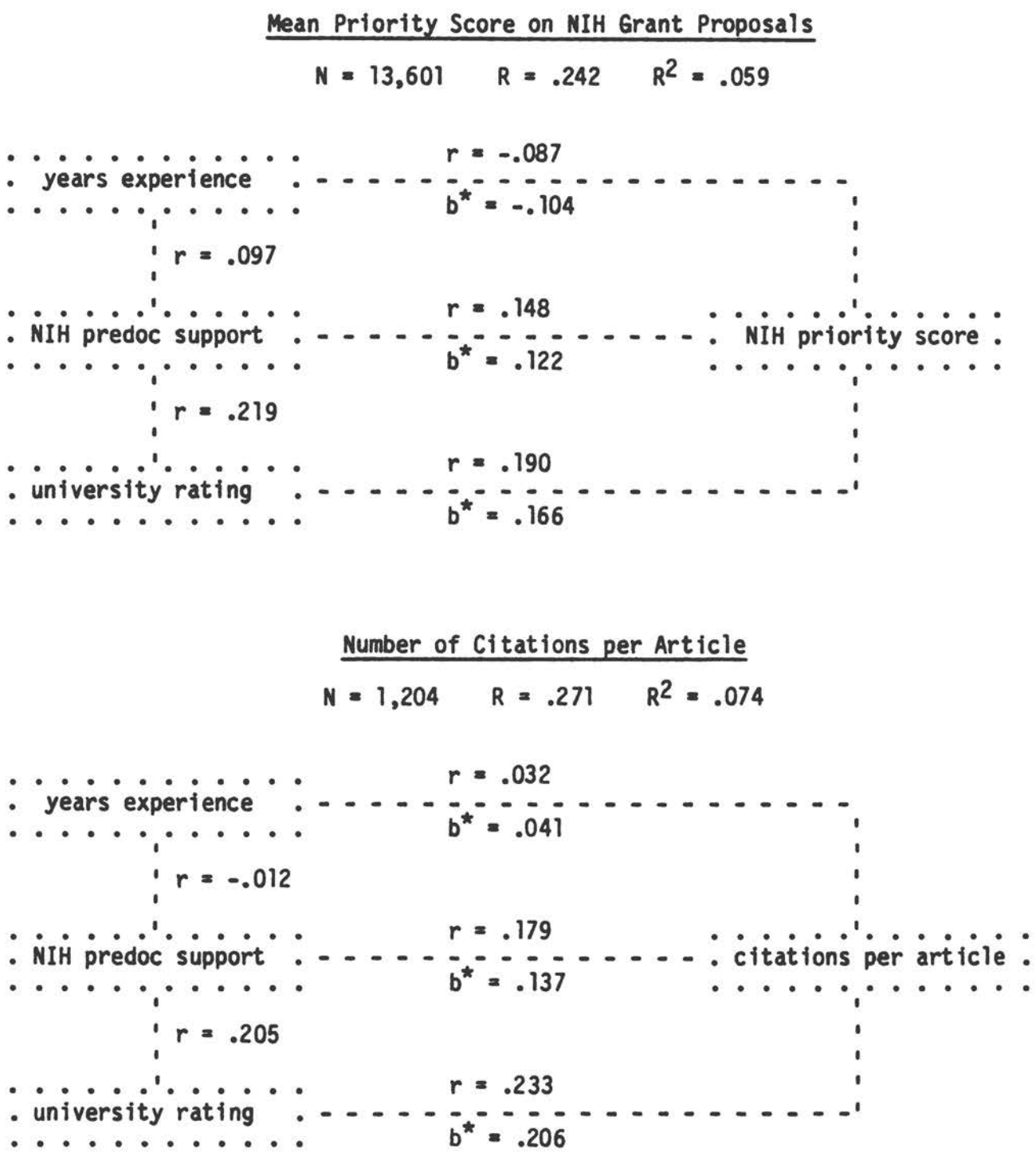

FIGURE 8.3 Regression models for predicting mean priority scores on FY1967-81 NIH research grant proposals and average number of citations per article published, 1970-80. See text for a description of data transformations of dependent variable. See Appendix E for means, standard deviations, and nonstandardized regression coefficients.

article published during the 1970-80 period. In both models data transformations of the dependent measures have been made to enhance the analysis. In the first model mean priority scores have been subtracted from a constant (5.00) so that larger values represent superior ratings. In the second model the square root of the number of citations per article has been used as the dependent measure since this transformation yields a somewhat higher correlation with each of the independent variables.[7] The overall results of the two regression analyses are similar. The equations explaining priority scores and citation rates yield multiple correlation coefficients of .242 and .271, respectively--accounting for 6 to 7 percent of the variance in the dependent measures. The NIH support variable and the university rating variable are both positively correlated with the dependent measures in the two models and have beta weights that are statistically significant at the .99 confidence level. It is of interest to note that in the regression equation explaining citations per article the beta weight attributed to years of experience is not statistically significant (at this same level). This result is not at all surprising in view of the data presented in the previous chapter (Table 7.4) which indicate that FY1972 Ph.D.s have received, on the average, more citations per published article than have FY1967 Ph.D.s.

Summary Two general conclusions may be drawn from the four regression models presented in this chapter. First, the three independent variables examined--years of experience, reputed quality of Ph.D. institution, and total months of NIH predoctoral support--together explain only a small portion (6 to 8 percent) of the variance associated with the dependent measures. There are undoubtedly many other factors (such as a scientist's abilities, research interests, postdoctoral training experience, employment history, etc.) that are relevant to individual career outcomes, but that are not captured in the regression models. Secondly, NIH predoctoral support has played a small but significant role in explaining various measures of career success--even after removing the effects of an individual's level of experience and the reputed quality of his or her doctoral institution. This finding is important since it suggests that the superior records of former NIH trainees and fellows cannot be entirely attributed to the fact that most of these individuals received their graduate training at universities with the leading biomedical science faculties. That is not to say, however, that the selectivity of the NIH predoctoral training programs is unimportant. On the contrary, many knowledgeable scientists[8] would argue that one of the greatest strengths underlying these programs has been the peer review mechanisms by which institutional training grants and individual fellowships have been awarded.

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[7]A detailed analysis of the number of citations per article reveals a highly skewed distribution, with a few individuals with exceptionally large values. The square root transformation of this measure reduces the effect of extreme values in the regression model. For a discussion of the use of this transformation in citation analyses, see Stewart, 1983.

[8]NRC, 1976, pp.6-8.

BIBLIOGRAPHY

Coggeshall, P. E., J. C. Norvell, L. Bogorad, and R. M. Bock
1978 "Changing Postdoctoral Career Patterns for Biomedical Scientists." Science. Vol. 202, November 3, pp. 487-493.

Jones, Lyle V.
1980 "The Assessment of Scholarships," New Directions for Program Evaluation. Vol. 6, pp. 1-19.

Jones, L. V., G. Lindzey, and P. E. Coggeshall, eds.
1982 Assessment of Research-Doctorate Programs in the United States: Biological Sciences. Washington, D.C.: National Academy Press.

Institute of Medicine
1938-80 Roster of NIH Trainees and Fellows. Washington, D.C.

1979-82 NIH Consolidated Grant Applicant File. Washington, D.C.

1983 Personnel Needs and Training for Biomedical and Behavioral Research: 1983 Report. Washington, D.C.: National Academy Press.

1984 Consolidated Grant Applicant File Documentation. Washington, D.C.: unpublished.

Narin, Francis
1983 Subjective vs. Bibliometric Assessment of Biomedical Research Publications. Washington, D.C.: U.S. Department of Health and Human Services.

National Institutes of Health
1970-80 Research Publication and Citation File.

1981 Activity Codes, Organizational Codes, and Definitions Used in Extramural Programs. NIH Manual Issuance 4101, October.

National Research Council
1920-81 Office of Scientific and Engineering Personnel. Survey of Earned Doctorates. Washington, D.C.

1972 Effects of NIGMS Training Programs on Graduate Education in the Biomedical Sciences. Washington, D.C.: U.S. Department of Health, Education, and Welfare.

1973-81 Office of Scientific and Engineering Personnel. Survey of Doctorate Recipients. Washington, D.C.

1976 Research Training and Career Patterns of Bioscientists: The Training Programs of the National Institutes of Health. A report of the Committee on a Study of the Impact of the NIH Research Training Programs on the Career Patterns of Bioscientists (the Saltman Committee). Washington, D.C.: National Academy of Sciences.

1977 Career Achievements of NSF Graduate Fellows: The Awardees of 1952-1972. Washington, D.C.: National Academy of Sciences.

1978 Nonfaculty Doctoral Research Staff in Science and Engineering in United States Universities. Washington, D.C.: National Academy of Sciences.

1981a Personnel Needs and Training for Biomedical and Behavioral Research: 1981 Report. Report of the Committee on a Study of National Needs for Biomedical and Behavioral Research Personnel. Washington, D.C.: National Academy Press.

1981b Postdoctoral Appointments and Disappointments. Washington, D.C.: National Academy Press.

1982 Science, Engineering, and Humanities Doctorates in the United States, 1981 Profile. Washington, D.C.: National Academy Press.

National Science Foundation

1973-83 Survey of Graduate Science Students and Postdoctorals. A computerized data file. Washington, D.C.

Pedhazur, Elazar J.

1982 Multiple Regression in Behavior Research, 2nd Ed. New York: Hold, Rinehart, and Winston.

Sherman, C. R., H. P. Jolly, E. R. Sevilla, III
1981 On the Status of Medical School Faculty and Clinical Research Manpower: 1968-1990. Washington, D.C.: Association of American Medical Colleges.

Stewart, John
1983 "Achievement and Ascriptive Processes in the Recognition of Scientific Articles." Social Forces. Vol. 62, September, pp. 166-189.

U. S. Congress
1974 National Research Service Award Act of 1974 (PL93-348).

APPENDIX A

DATA SOURCES

The information reported in this study comes from six data sources that have been collated, as described in Chapter 1. These sources include:

(1) Roster of NIH Trainees and Fellows (NRC, FY1938-80);
(2) Survey of Earned Doctorates (NRC, FY1920-81);
(3) Survey of Doctorate Recipients (NRC, 1973-81);
(4) NIH Consolidated Grant Applicant File (NRC, FY1967-82);
(5) NSF Master File of Grant Applicants (NSF, FY1973-82); and
(6) Research Publication and Citation File (NIH, 1970-80).

The first four of these sources are maintained by NRC staff, with partial or full support from the NIH. The derivation of the information contained in each computer file is briefly described in this appendix.

(1) Roster of NIH Trainees and Fellows This source includes records for approximately 170,000 individuals who had received NIH training grant or fellowship support (at either the predoctoral or postdoctoral level) during the FY1938-80 span. The data are compiled from NIH appointment records that are kept on individual fellowship or institutional training grant awards. The file is updated periodically by NRC staff--work is now underway to add awards through FY1982. The trainee-fellow file provided the basis for identifying the study population. Included in this population were any FY1967-81 Ph.D. recipients who had received a total of nine months or more support from the following NIH predoctoral training programs:

(1) Graduate Training Program (T01);
(2) Combined Undergraduate and Graduate Training Program (T03);
(3) Medical Scientist Training Program (T05 and T32);
(4) Institutional National Research Service Award (T32); and
(5) Predoctoral Fellowship Award (F01).

In addition to information about the type of award and months of predoctoral support an individual received, the file also contains data on NIH postdoctoral fellowship and training grant appointments which are analyzed in Chapter 4, as well as full name, social security number, training institution, and other biographic information that was used in collating with records from other files.

(2) Survey of Earned Doctorates This annual survey of new recipients of Ph.D. or equivalent research doctorates from U. S. institutions in all fields of learning collects information on the demographic characteristics, educational background, graduate training, and postgraduation employment plans of the doctoral graduates (FY1920-81). The data file contains records for all 50,000 individuals who earned Ph.D.s in biomedical sciences during the FY1967-81 period and for numerous graduates in other related fields as well. Since the survey population encompasses virtually all graduates of accredited doctoral programs, the file was used to determine whether or not particular individuals had completed their doctoral training, and if so, in which specialty field (examined in Chapter 3). The file also provides information on a graduate's plans to pursue postdoctoral training (examined in Chapter 4). The demographic data collected in the survey--includig full name, social security number, undergraduate and graduate institutions attended, year of birth, sex, and citizenship--were useful in collating with records in other data files. Most important, the Survey of Earned Doctorates was the source for identifying individuals to be included in the two comparison groups used in the study analyses.

(3) Survey of Doctorate Recipients This biennial survey compiles current employment information on a stratified random sample of individuals who had earned science or engineering doctorates in the preceding 42-year period. The sample selected in the biomedical sciences represents approximately one-fourth of the Ph.D. population, and between 65 and 70 percent of those surveyed provided responses in each survey year (1973, 1975, 1977, 1979, and 1981). Among the information compiled were the fraction of time an individual devotes to research and other work activities, his or her faculty rank (if applicable) and whether or not an individual's work was federally sponsored. This information is analyzed in Chapter 5. In addition, survey respondents with FY1967, FY1972, or FY1977 Ph.D.s in biomedical science fields were selected for the publication analyses (Chapter 7). Survey information on employment histories was matched with authors' institutional affiliations in order to help identify individuals with common names.

(4) NIH Consolidated Grant Applicant File This file includes records for all applications for NIH research grants and contracts. For purposes of our analyses (see Chapter 6) we have considered only FY1967-82 applications for Research Projects (R-awards), Research Program Projects and Centers (P-awards), and General Research Clinical Centers (M-awards). For each application the file contains information on the name of the principal investigator, whether or not the proposal was approved and funded, and the priority score assigned by the peer review group (study section). Disapproved applications have been arbitrarily assigned a priority score of 5.0. Application records have been summarized by individuals and then matched with records from the Survey of Earned Doctorates.

(5) NSF Master File of Grant Applicants With the cooperation of NSF staff, a file was created with all FY1973-82 applications for NSF research grants in the biological sciences. Each record includes the name of the principal investigator, the names of any co-investigators, and an indication of whether or not the proposal was funded. Not available in the file is information on whether an application was approved for funding or the priority score it received. As was the case with the NIH file described above, the NSF applications have been summarized by individual and collated with records from the Survey of Earned Doctorates. For purposes of this study the principal investigator and any co-investigator named in the grant application have been treated as independent applicants. These data are analyzed in Chapter 6.

(6) Research Publication and Citation File Publication records were compiled for approximately 1,800 individuals who had earned biomedical science Ph.D.s in FY1967, FY1972, or FY1977. As described earlier, these individuals had responded to the biennial Survey of Doctorate Recipients at least once during the 1973-81 period. For each individual a determination was made of how many articles he or she had authored or coauthored during the 11-year span between 1970 and 1980. Also tabulated was the total number of citations during this same period to the articles attributed to an individual. Both the publication and citation analyses were restricted to articles that appeared in a carefully selected set of 275 journals (listed in Appendix C) covering a broad range of areas in biomedical research. The publication records--including names of all authors and coauthors, article title, and journal and date of publication--were obtained from the MEDLARS system, a computerized information system maintained by the National Library of Medicine. The citation data were derived from the Science Citation Index, compiled by the Institute for Scientific Information. The initial processing of publication data was performed by Computer Horizons, Inc. under contract to the NIH. A description of the collation process used to derive individual publication counts is given in Chapter 7.

APPENDIX B

SURVEY RESPONSE DATA FOR TABLES 5.1-5.4

	Number of Responses in Each Survey Year					
	1973	1975	1977	1979	1981	1973-81 Average
1967-68 Ph.D. Recipients						
NIH Predoctoral Support	446	444	405	274	278	1847
Biomedical Group I	202	195	178	133	132	840
Biomedical Group II	248	237	214	170	176	1045
1969-70 Ph.D. Recipients						
NIH Predoctoral Support	566	541	491	343	366	2307
Biomedical Group I	226	222	190	143	157	938
Biomedical Group II	268	258	216	161	164	1067
1971-72 Ph.D. Recipients						
NIH Predoctoral Support	593	566	527	349	345	2380
Biomedical Group I	320	300	264	179	179	1242
Biomedical Group II	412	367	331	203	195	1508
1973-74 Ph.D. Recipients						
NIH Predoctoral Support		502	422	334	371	1629
Biomedical Group I		331	281	175	228	1015
Biomedical Group II		414	330	219	279	1242
1975-76 Ph.D. Recipients						
NIH Predoctoral Support			449	319	378	1146
Biomedical Group I			267	172	197	636
Biomedical Group II			440	286	341	1067
1977-78 Ph.D. Recipients						
NIH Predoctoral Support				331	309	640
Biomedical Group I				208	204	412
Biomedical Group II				285	272	557
1979-80 Ph.D. Recipients						
NIH Predoctoral Support					284	284
Biomedical Group I					175	175
Biomedical Group II					309	309

APPENDIX C

LIST OF BIOMEDICAL SCIENCE JOURNALS

ACT CRYST
ACT SYTOL
AM HEART J
AM J ANAT
AM J CARD
AM J CLIN N
AM J CLIN P
AM J DIG DI
AM J DIS CH
AM J EPIDEM
AM J HU GEN
AM J MED
AM J MED SC
AM J MENT D
AM J OBST G
AM J OPHTH
AM J ORTHOD
AM J ORTHOP
AM J P ANTH
AM J PATH
AM J PHYSL
AM J PSYCHI
AM J PUB HE
AM J ROENTG
AM J SURG
AM J TROP M
AM J VET RE
AM R RESP D
AM ZOOLOG
ANALYT BIOC
ANALYT CHEM
ANAT REC
ANESTH ANAL
ANESTHESIOL
ANN HUM GEN
ANN INT MED
ANN NY ACAD
ANN OTOL RH
ANN R BIOCH
ANN R BIOPH
ANN R MICRO
ANN R PHYSL
ANN RHEUM D
ANN SURG
APPL MICROB
ARCH BIOCH
ARCH DERMAT
ARCH ENV HE
ARCH G PSYC
ARCH IN MED
ARCH NE PSY
ARCH NEUROL
ARCH OPHTH
ARCH ORAL B
ARCH OTHOLAR
ARCH PATH
ARCH SURG
ARTH RHEUM
B WHO
BEHAV RES M
BIOC BIOP A
BIOC BIOP R
BIOCH PHARM
BIOCHEM
BIOCHEM GEN
BIOCHEM J
BIOCHEM MED
BIOL NEONAT
BIOPHYS J
BIOPOLYMERS
BLOOD
BR J HAEM
BR J PSYCHI
BRAIN RES
CALCIF TISS
CANC CHEMOT
CANCER
CANCER RES
CARBOHY RES
CHEM COMM
CHEST
CHILD DEV
CHROMOSOMA
CIRCUL RES
CIRCULATION
CLIN CHEM
CLIN CHIM A
CLIN EXP IM
CLIN ORTHOP
CLIN PHARM
CLIN SC MOL
COLD S HARB
COMP BIOCH
COMPUT BIOM
CURR THER R
DEVELOP BIO
DEVELOP MED
DIABETES

DIS NER SYS
EEG CL NEUR
ENDOCRINOL
EPILEPSIA
EUR J BIOCH
EUR J PHARM
EXP BRAIN R
EXP CELL RE
EXP EYE RES
EXP MOL PAT
EXP NEUROL
EXP PARASIT
EXPERIENTIA
FEBS LETTER
FED PROC
FERT STERIL
GASTROENTY
GEN C ENDOC
GENETICS
GERIATRICS
GERONTOL
HUMAN BIOL
IEEE BIOMED
IMMUNOCHEM
IMMUNOLOGY
INORG CHEM
INT J CANC
INV OPHTH V
INV RADIOL
INV UROL
J ABN PSYCH
J ACOUST SO
J AGR FOOD
J ALLERG CL
J AM CHEM S
J AM DENT A
J AM GER SO
J AM MED A
J AM VET ME
J ANIM SCI
J APP PHYSL
J APPL BE A
J BACT
J BIOL CHEM
J BIOMECHAN
J BONE - AM V
J BONE JOIN
J CELL BIOL
J CELL PHYS
J CHEM PHYS
J CHEM S
J CHEM S CH
J CHEM S D
J CHROMAT
J CHRON DIS
J CLIN END
J CLIN INV
J CLIN PHAR
J COM PHYSL
J COMP NEUR
J DAIRY SCI
J DENT RES
J ENDOCR
J EXP AN BE
J EXP C PSY
J EXP MED
J EXP PSYCH
J EXP ZOOL
J GEN MICRO
J GEN PHYSL
J GEN VIROL
J GERONTOL
J HETERO CH
J HIST CYTO
J IMMUNOL
J INFEC DIS
J INVES DER
J LA CL MED
J LIPID RES
J MED CHEM
J MED ENT
J MEMBR BIO
J MOL BIOL
J NAT CANC
J NE EXP NE
J NE NE PSY
J NERV MENT
J NEUROCHEM
J NEUROSURG
J NEURPHYSL
J NUCL MED
J NUTR
J ORG CHEM
J PARASITOL
J PED SURG
J PEDIAT
J PERIODONT
J PERS SOC

J PHARM EXP
J PHARM SCI
J PHYS CHEM
J PHYSL LON
J POL SC PP
J PROTOZOOL
J PSYCH RES
J PSYCHOL
J REPR FERT
J RETIC SOC
J SPEECH HE
J SURG RES
J THEOR BIO
J THOR SURG
J TRAUMA
J ULTRA RES
J UROL
J VIROLOGY
LAB ANIM SC
LAB INV
LANCET
LARYNGOSCOP
LIFE SCI
LIFE SCI P1
LIPIDS
MEDICINE
METABOLISM
MOLEC PHARM
MUTAT RES
N ENG J MED
NATURE
NEPHRON
NEUROENDOCR
NEUROLOGY
NEUROPHARM
NEUROPSYCHO
OBSTET GYN
ONCOLOGY
ORAL SURG O
P NAS US
P SOC EXP M
PEDIAT RES
PEDIATRICS
PERC MOT SK
PERC PSYCH
PERIODONTIC
PHARM REV
PHYSIOL REV
PHYSL BEHAV
PHYTOCHEM
PLANT PHYSL
PLAS R SURG
PSYCHOL REP
PSYCHOPHARM
PSYCHOPHYSL
PSYCHOS MED
RADIAT RES
RADIOLOGY
RESP PHYSL
SCIENCE
SEM ROENTG
SOUTH MED J
STAIN TECH
STEROIDS
SURG GYN OB
SURGERY
T AM S ART
TERATOLOGY
TETRAHEDR L
THROMB DIAT
TOX APPL PH
TRANSPLAN P
TRANSPLANT
VIROLOGY
VISION RES
VOX SANGUIN
YALE J BIOL

APPENDIX D

DETAILED DATA ON THE CAREER ACCOMPLISHMENTS OF PREDOCTORALS SPONSORED BY EACH NIH INSTITUTE

TABLE 3.1A Number and Percent of FY1967-79 NIH Predoctoral Trainees or Fellows Awarded Their Doctorates by FY1981

NIH Training Support(a)		Latest Year of NIH Predoctoral Funding													Total 1967-79
		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	
NIGMS Predocs	N	1852	1981	2167	2108	1698	1558	1430	1607	1942	1445	1349	1335	1332	21804
Awarded Doctorate(b)	N	1319	1479	1637	1587	1241	1120	1101	1138	1372	973	813	635	430	14845
	%	71.2	74.7	75.5	75.3	73.1	71.9	77.0	70.8	70.6	67.3	60.3	47.6	32.3	68.1
NCI Predocs	N	77	69	83	75	86	81	92	153	151	207	151	167	214	1606
Awarded Doctorate	N	42	39	42	39	48	42	49	87	89	125	86	85	81	854
	%	54.5	56.5	50.6	52.0	55.8	51.9	53.3	56.9	58.9	60.4	57.0	50.9	37.9	53.2
NICHD Predocs	N	240	249	366	286	312	305	211	328	252	184	193	204	184	3314
Awarded Doctorate	N	136	158	230	193	203	200	137	195	159	103	97	79	63	1953
	%	56.7	63.5	62.8	67.5	65.1	65.6	64.9	59.5	63.1	56.0	50.3	38.7	34.2	58.9
NHLBI Predocs	N	111	147	121	119	81	136	95	146	100	102	101	85	90	1434
Awarded Doctorate	N	57	76	65	57	46	79	56	90	53	49	46	42	39	755
	%	51.4	51.7	53.7	47.9	56.8	58.1	58.9	61.6	53.0	48.0	45.5	49.4	43.3	52.6
NIEHS Predocs	N	102	128	169	158	196	88	93	108	106	83	57	45	96	1429
Awarded Doctorate	N	59	76	107	102	141	54	60	69	56	56	31	16	28	855
	%	57.8	59.4	63.3	64.6	71.9	61.4	64.5	63.9	52.8	67.5	54.4	35.6	29.2	59.8
NIAID Predocs	N	182	180	244	217	243	246	237	256	134	133	45	57	42	2216
Awarded Doctorate	N	114	113	137	125	140	160	146	169	92	71	17	27	13	1324
	%	62.6	62.8	56.1	57.6	57.6	65.0	61.6	66.0	68.7	53.4	37.8	47.4	31.0	59.7
NIADDK Predocs	N	22	30	26	26	27	41	28	31	38	5	16	25	26	341
Awarded Doctorate	N	12	16	15	19	15	18	14	12	21		5	11	12	170
	%	54.5	53.3	57.7	73.1	55.6	43.9	50.0	38.7	55.3		31.3	44.0	46.2	49.9
NIA Predocs	N										46	42	47	33	168
Awarded Doctorate	N										24	17	18	3	62
	%										52.2	40.5	38.3	9.1	36.9
NINCDS Predocs	N	40	43	35	67	54	56	43	84	75	45	10	27	18	597
Awarded Doctorate	N	31	34	29	54	31	26	31	58	54	30	3	10	5	396
	%	77.5	79.1	82.9	80.6	57.4	46.4	72.1	69.0	72.0	66.7	30.0	37.0	27.8	66.3
NIDR Predocs	N	52	74	72	58	62	104	69	93	58	72	42	16	19	791
Awarded Doctorate	N	36	47	47	35	37	66	43	51	36	40	20	7	7	472
	%	69.2	63.5	65.3	60.3	59.7	63.5	62.3	54.8	62.1	55.6	47.6	43.8	36.8	59.7
NEI Predocs	N			1	1	1	3	2	14	6	17	19	20	21	105
Awarded Doctorate	N						3	2	8	3	10	16	9	6	57
	%						100.0	100.0	57.1	50.0	58.8	84.2	45.0	28.6	54.3
Total NIH Predocs	N	2678	2901	3284	3115	2760	2618	2300	2820	2862	2339	2025	2028	2075	33805
Awarded Doctorate	N	1806	2038	2309	2211	1902	1768	1639	1877	1935	1481	1151	939	687	21743
	%	67.4	70.3	70.3	71.0	68.9	67.5	71.3	66.6	67.6	63.3	56.8	46.3	33.1	64.3

(a)Includes all individuals with one or more months of predoctoral training support from an NIH institute; individuals with support from more than one institute are categorized according to the institute from which they received their most recent predoctoral stipend.
(b)Since a significant number of those applying in the last five years may still have been in graduate training after FY1981, the percentages reported for recent predoctoral trainees/fellows underestimate the actual percent who will eventually complete their doctoral training.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows; National Research Council, Survey of Earned Doctorates.

TABLE 3.3A Percent of FY1970-81 Ph.D. Recipients Who Earned Their Doctorates from Universities with Distinguished Reputations in Biomedical Disciplines

NIH Training Support(a)		Fiscal Year of Doctorate 1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Total 1970-81
NIGMS Predocs	N	1369	1523	1249	1159	1090	1048	1029	1002	922	907	905	911	13114
Distinguished Univ.(b)	N	656	704	595	575	578	571	570	581	518	525	508	527	6908
	%	47.9	46.2	47.6	49.6	53.0	54.5	55.4	58.0	56.2	57.9	56.1	57.8	52.7
NCI Predocs	N	34	23	45	34	37	45	54	68	92	119	127	128	806
Distinguished Univ.	N	11	7	24	12	13	24	28	33	43	55	68	72	390
	%	32.4	30.4	53.3	35.3	35.1	53.3	51.9	48.5	46.7	46.2	53.5	56.3	48.4
NICHD Predocs	N	114	148	150	155	178	166	145	154	124	130	134	136	1734
Distinguished Univ.	N	46	53	50	76	78	72	67	61	61	65	57	55	741
	%	40.4	35.8	33.3	49.0	43.8	43.4	46.2	39.6	49.2	50.0	42.5	40.4	42.7
NHLBI Predocs	N	42	48	49	45	59	49	54	48	52	60	73	77	656
Distinguished Univ.	N	15	15	10	16	8	10	9	13	15	18	19	27	175
	%	35.7	31.3	20.4	35.6	13.6	20.4	16.7	27.1	28.8	30.0	26.0	35.1	26.7
NIEHS Predocs	N	101	95	94	98	65	66	62	54	48	51	50	53	837
Distinguished Univ.	N	31	26	18	29	23	23	25	21	19	30	17	26	288
	%	30.7	27.4	19.1	29.6	35.4	34.8	40.3	38.9	39.6	58.8	34.0	49.1	34.4
NIAID Predocs	N	104	133	111	112	101	117	115	107	77	70	63	55	1165
Distinguished Univ.	N	41	43	39	44	36	48	45	40	25	23	30	23	437
	%	39.4	32.3	35.1	39.3	35.6	41.0	39.1	37.4	32.5	32.9	47.6	41.8	37.5
NIADDK Predocs	N	9	17	9	16	15	7	12	10	11	8	13	21	148
Distinguished Univ.	N	4	4	5	6	7	1	7	5	3	7	7	16	72
	%	44.4	23.5	55.6	37.5	46.7	14.3	58.3	50.0	27.3	87.5	53.8	76.2	48.6
NIA Predocs	N								6	10	14	18	14	62
Distinguished Univ.	N								2	3	3	10	4	22
	%								33.3	30.0	21.4	55.6	28.6	35.5
NINCDS Predocs	N	27	40	30	22	30	28	33	33	33	25	26	19	346
Distinguished Univ.	N	4	11	3	4	8	15	9	13	10	11	13	11	112
	%	14.8	27.5	10.0	18.2	26.7	53.6	27.3	39.4	30.3	44.0	50.0	57.9	32.4
NIDR Predocs	N	41	41	43	39	38	58	45	38	34	33	20	13	443
Distinguished Univ.	N	15	9	18	15	14	17	10	15	13	5	2	1	134
	%	36.6	22.0	41.9	38.5	36.8	29.3	22.2	39.5	38.2	15.2	10.0	7.7	30.2
NEI Predocs	N						1	3	2	15	9	12	9	51
Distinguished Univ.	N						1	3	1	9	8	6	6	34
	%						100.0	100.0	50.0	60.0	88.9	50.0	66.7	66.7
Total NIH Predocs	N	1841	2068	1780	1680	1613	1585	1552	1522	1418	1426	1441	1436	19362
Distinguished Univ.	N	823	872	762	777	765	782	773	785	719	750	737	768	9313
	%	44.7	42.2	42.8	46.3	47.4	49.3	49.8	51.6	50.7	52.6	51.1	53.5	48.1

(a)Includes all individuals with a total of at least 9 months of predoctoral training support from an NIH institute; individuals with support from more than one institute are categorized according to the institute from which they received their most recent predoctoral stipend.
(b)Using results from the 1982 Assessment of Research-Doctorate Programs, an average for each university was computed from the mean ratings of the scholarly quality of faculty in biochemistry, cellular/molecular biology, microbiology, and physiology programs. In calculating university averages, mean ratings were weighted according to the number of 1976-80 graduates from each program evaluated. A total of 25 universities with biomedical program averages of 3.50 or higher were considered to have distinguished reputations.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows; National Research Council, Survey of Earned Doctorates.

TABLE 4.1A Percent of FY1967-81 Ph.D. Recipients Planning to Take Postdoctoral Appointments After Graduation

NIH Training Support(a)		Fiscal Year of Doctorate															Total
		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1967-81
NIGMS Predocs	N	1018	1244	1401	1369	1523	1249	1159	1090	1048	1029	1002	922	907	905	911	16777
Planning Postdoc(b)	N	467	593	746	809	867	743	705	651	703	707	687	676	653	667	681	10355
	%	45.9	47.7	53.2	59.1	56.9	59.5	60.8	59.7	67.1	68.7	68.6	73.3	72.0	73.7	74.8	61.7
NCI Predocs	N	13	20	32	34	23	45	34	37	45	54	68	92	119	127	128	871
Planning Postdoc	N	6	8	17	19	12	29	23	23	31	42	53	65	81	99	94	602
	%	46.2	40.0	53.1	55.9	52.2	64.4	67.6	62.2	68.9	77.8	77.9	70.7	68.1	78.0	73.4	69.1
NICHD Predocs	N	22	66	100	114	148	150	155	178	166	145	154	124	130	134	136	1922
Planning Postdoc	N	10	20	37	55	46	54	54	53	60	49	53	40	54	66	74	725
	%	45.5	30.3	37.0	48.2	31.1	36.0	34.8	29.8	36.1	33.8	34.4	32.3	41.5	49.3	54.4	37.7
NHLBI Predocs	N	32	42	58	42	48	49	45	59	49	54	48	52	60	73	77	788
Planning Postdoc	N	15	14	32	21	23	23	27	33	36	37	30	31	44	50	57	473
	%	46.9	33.3	55.2	50.0	47.9	46.9	60.0	55.9	73.5	68.5	62.5	59.6	73.3	68.5	74.0	60.0
NIEHS Predocs	N	22	50	62	101	95	94	98	65	66	62	54	48	51	50	53	971
Planning Postdoc	N	4	5	8	20	30	26	21	20	17	22	17	15	22	22	21	270
	%	18.2	10.0	12.9	19.8	31.6	27.7	21.4	30.8	25.8	35.5	31.5	31.3	43.1	44.0	39.6	27.8
NIAID Predocs	N	63	85	80	104	133	111	112	101	117	115	107	77	70	63	55	1393
Planning Postdoc	N	22	35	44	64	72	72	68	63	79	81	80	56	46	43	37	862
	%	34.9	41.2	55.0	61.5	54.1	64.9	60.7	62.4	67.5	70.4	74.8	72.7	65.7	68.3	67.3	61.9
NIADDK Predocs	N	10	12	11	9	17	9	16	15	7	12	10	11	8	13	21	181
Planning Postdoc	N	2	4	7	3	9	4	8	8	4	3	6	8	1	7	11	. 85
	%	20.0	33.3	63.6	33.3	52.9	44.4	50.0	53.3	57.1	25.0	60.0	72.7	12.5	53.8	52.4	47.0
NIA Predocs	N											6	10	14	18	14	62
Planning Postdoc	N											2	3	2	5	3	15
	%											33.3	30.0	14.3	27.8	21.4	24.2
NINCDS Predocs	N	14	23	30	27	40	30	22	30	28	33	33	33	25	26	19	413
Planning Postdoc	N	3	11	9	9	11	12	7	9	14	14	10	16	13	14	10	162
	%	21.4	47.8	30.0	33.3	27.5	40.0	31.8	30.0	50.0	42.4	30.3	48.5	52.0	53.8	52.6	39.2
NIDR Predocs	N	21	20	39	41	41	43	39	38	58	45	38	34	33	20	13	523
Planning Postdoc	N	6	7	10	10	14	14	17	8	17	15	12	16	11	14	7	· 178
	%	28.6	35.0	25.6	24.4	34.1	32.6	43.6	21.1	29.3	33.3	31.6	47.1	33.3	70.0	53.8	34.0
NEI Predocs	N									1	3	2	15	9	12	9	51
Planning Postdoc	N										3	2	11	8	11	7	42
	%										100.0	100.0	73.3	88.9	91.7	77.8	82.4
Total NIH Predocs	N	1215	1562	1813	1841	2068	1780	1680	1613	1585	1552	1522	1418	1426	1441	1436	23952
Planning Postdoc	N	535	697	910	1010	1084	977	930	868	961	973	952	937	935	998	1002	13769
	%	44.0	44.6	50.2	54.9	52.4	54.9	55.4	53.8	60.6	62.7	62.5	66.1	65.6	69.3	69.8	57.5

(a)Includes all individuals with a total of at least 9 months of predoctoral training support from an NIH institute; individuals with support from more than one institute are categorized according to the institute from which they received their most recent predoctoral stipend.
(b)Includes graduates who at the time they completed requirements for their doctorates reported that they intended to take postdoctoral appointments.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows; National Research Council, Survey of Earned Doctorates.

TABLE 6.1A Percent of the FY1967-81 Ph.D. Recipients Who Applied for NIH Research Grants During the FY1967-82 Period

		Fiscal Year of Doctorate															
NIH Training Support(a)		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Total 1967-81
NIGMS Predocs	N	1018	1244	1401	1369	1523	1249	1159	1090	1048	1029	1002	922	907	905	911	16777
Applied for NIH Grant(b)	N	416	536	605	583	573	459	412	390	391	339	295	195	113	62	13	5382
	%	40.9	43.1	43.2	42.6	37.6	36.7	35.5	35.8	37.3	32.9	29.4	21.1	12.5	6.9	1.4	32.1
NCI Predocs	N	13	20	32	34	23	45	34	37	45	54	68	92	119	127	128	871
Applied for NIH Grant	N	4	12	14	18	15	23	15	16	21	26	14	25	26	5	4	238
	%	30.8	60.0	43.8	52.9	65.2	51.1	44.1	43.2	46.7	48.1	20.6	27.2	21.8	3.9	3.1	27.3
NICHD Predocs	N	22	66	100	114	148	150	155	178	166	145	154	124	130	134	136	1922
Applied for NIH Grant	N	8	28	32	44	58	38	40	62	43	35	35	24	18	10	2	477
	%	36.4	42.4	32.0	38.6	39.2	25.3	25.8	34.8	25.9	24.1	22.7	19.4	13.8	7.5	1.5	24.8
NHLBI Predocs	N	32	42	58	42	48	49	45	59	49	54	48	52	60	73	77	788
Applied for NIH Grant	N	15	21	29	17	21	24	20	19	17	16	15	14	19	11	2	260
	%	46.9	50.0	50.0	40.5	43.8	49.0	44.4	32.2	34.7	29.6	31.3	26.9	31.7	15.1	2.6	33.0
NIEHS Predocs	N	22	50	62	101	95	94	98	65	66	62	54	48	51	50	53	971
Applied for NIH Grant	N	6	7	7	16	22	5	15	9	10	9	8	5	5	6		130
	%	27.3	14.0	11.3	15.8	23.2	5.3	15.3	13.8	15.2	14.5	14.8	10.4	9.8	12.0		13.4
NIAID Predocs	N	63	85	80	104	133	111	112	101	117	115	107	77	70	63	55	1393
Applied for NIH Grant	N	30	33	29	43	49	42	54	28	39	31	31	13	5	3	3	433
	%	47.6	38.8	36.3	41.3	36.8	37.8	48.2	27.7	33.3	27.0	29.0	16.9	7.1	4.8	5.5	31.1
NIADDK Predocs	N	10	12	11	9	17	9	16	15	7	12	10	11	8	13	21	181
Applied for NIH Grant	N	5	5	5	2	6	3	5	3	2	7	4	4	3	1	2	57
	%	50.0	41.7	45.5	22.2	35.3	33.3	31.3	20.0	28.6	58.3	40.0	36.4	37.5	7.7	9.5	31.5
NIA Predocs	N											6	10	14	18	14	62
Applied for NIH Grant	N											2	2	3	3	2	12
	%											33.3	20.0	21.4	16.7	14.3	19.4
NINCDS Predocs	N	14	23	30	27	40	30	22	30	28	33	33	33	25	26	19	413
Applied for NIH Grant	N	4	10	9	8	9	9	7	11	6	8	10	4	3	1		99
	%	28.6	43.5	30.0	29.6	22.5	30.0	31.8	36.7	21.4	24.2	30.3	12.1	12.0	3.8		24.0
NIDR Predocs	N	21	20	39	41	41	43	39	38	58	45	38	34	33	20	13	523
Applied for NIH Grant	N	11	7	17	12	15	19	13	17	18	16	18	13	9	6	1	192
	%	52.4	35.0	43.6	29.3	36.6	44.2	33.3	44.7	31.0	35.6	47.4	38.2	27.3	30.0	7.7	36.7
NEI Predocs	N									1	3	2	15	9	12	9	51
Applied for NIH Grant	N									1	1	2	7	1	2		14
	%									100.0	33.3	100.0	46.7	11.1	16.7		27.5
Total NIH Predocs	N	1215	1562	1813	1841	2068	1780	1680	1613	1585	1552	1522	1418	1426	1441	1436	23952
Applied for NIH Grant	N	499	659	747	743	768	622	581	555	548	488	434	306	205	110	29	7294
	%	41.1	42.2	41.2	40.4	37.1	34.9	34.6	34.4	34.6	31.4	28.5	21.6	14.4	7.6	2.0	30.5

(a)Includes all individuals with a total of at least 9 months of predoctoral training support from an NIH institute; individuals with support from more than one institute are categorized according to the institute from which they received their most recent predoctoral stipend.
(b)Includes all individuals who submitted one or more applications for NIH research grants during the FY1967-82 period.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows and Consolidated Grant Applicant File; National Research Council, Survey of Earned Doctorates.

TABLE 6.2A Percent of the FY1967-81 Ph.D. Recipients with NIH Research Grant Applications That Were Recommended for Approval During the FY1967-82 Period

NIH Training Support(a)		Fiscal Year of Doctorate															Total 1967-81
		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	
NIGMS Predocs	N	1018	1244	1401	1369	1523	1249	1159	1090	1048	1029	1002	922	907	905	911	16777
Approved NIH Grant(b)	N	385	482	543	539	510	420	362	354	364	315	277	176	104	54	12	4897
	%	37.8	38.7	38.8	39.4	33.5	33.6	31.2	32.5	34.7	30.6	27.6	19.1	11.5	6.0	1.3	29.2
NCI Predocs	N	13	20	32	34	23	45	34	37	45	54	68	92	119	127	128	871
Approved NIH Grant	N	4	11	13	15	14	21	13	16	19	25	14	21	21	5	4	216
	%	30.8	55.0	40.6	44.1	60.9	46.7	38.2	43.2	42.2	46.3	20.6	22.8	17.6	3.9	3.1	24.8
NICHD Predocs	N	22	66	100	114	148	150	155	178	166	145	154	124	130	134	136	1922
Approved NIH Grant	N	7	24	26	34	40	28	34	50	39	26	28	23	14	6	2	381
	%	31.8	36.4	26.0	29.8	27.0	18.7	21.9	28.1	23.5	17.9	18.2	18.5	10.8	4.5	1.5	19.8
NHLBI Predocs	N	32	42	58	42	48	49	45	59	49	54	48	52	60	73	77	788
Approved NIH Grant	N	11	18	27	14	20	21	16	15	16	14	15	14	17	10	2	230
	%	34.4	42.9	46.6	33.3	41.7	42.9	35.6	25.4	32.7	25.9	31.3	26.9	28.3	13.7	2.6	29.2
NIEHS Predocs	N	22	50	62	101	95	94	98	65	66	62	54	48	51	50	53	971
Approved NIH Grant	N	5	5	5	14	18	5	12	8	9	4	8	5	5	5		108
	%	22.7	10.0	8.1	13.9	18.9	5.3	12.2	12.3	13.6	6.5	14.8	10.4	9.8	10.0		11.1
NIAID Predocs	N	63	85	80	104	133	111	112	101	117	115	107	77	70	63	55	1393
Approved NIH Grant	N	27	28	27	37	44	39	50	26	32	31	30	12	5	3	3	394
	%	42.9	32.9	33.8	35.6	33.1	35.1	44.6	25.7	27.4	27.0	28.0	15.6	7.1	4.8	5.5	28.3
NIADDK Predocs	N	10	12	11	9	17	9	16	15	7	12	10	11	8	13	21	181
Approved NIH Grant	N	5	5	4	2	4	3	4	3	2	6	4	3	3		2	50
	%	50.0	41.7	36.4	22.2	23.5	33.3	25.0	20.0	28.6	50.0	40.0	27.3	37.5		9.5	27.6
NIA Predocs	N											6	10	14	18	14	62
Approved NIH Grant	N											1	1	2	2	1	7
	%											16.7	10.0	14.3	11.1	7.1	11.3
NINCDS Predocs	N	14	23	30	27	40	30	22	30	28	33	33	33	25	26	19	413
Approved NIH Grant	N	3	8	8	5	8	9	6	8	5	7	6	3	3	1		80
	%	21.4	34.8	26.7	18.5	20.0	30.0	27.3	26.7	17.9	21.2	18.2	9.1	12.0	3.8		19.4
NIDR Predocs	N	21	20	39	41	41	43	39	38	58	45	38	34	33	20	13	523
Approved NIH Grant	N	7	6	12	12	12	11	12	15	10	14	15	11	5	6	1	149
	%	33.3	30.0	30.8	29.3	29.3	25.6	30.8	39.5	17.2	31.1	39.5	32.4	15.2	30.0	7.7	28.5
NEI Predocs	N									1	3	2	15	9	12	9	51
Approved NIH Grant	N									1	1	1	7	1	2		13
	%									100.0	33.3	50.0	46.7	11.1	16.7		25.5
Total NIH Predocs	N	1215	1562	1813	1841	2068	1780	1680	1613	1585	1552	1522	1418	1426	1441	1436	23952
Approved NIH Grant	N	454	587	665	672	670	557	509	495	497	443	399	276	180	94	27	6525
	%	37.4	37.6	36.7	36.5	32.4	31.3	30.3	30.7	31.4	28.5	26.2	19.5	12.6	6.5	1.9	27.2

(a)Includes all individuals with a total of at least 9 months of predoctoral training support from an NIH institute; individuals with support from more than one institute are categorized according to the institute from which they received their most recent predoctoral stipend.
(b)Includes all individuals who had one or more NIH research grant applications approved for funding during the FY1967-82 period.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows and Consolidated Grant Applicant File; National Research Council, Survey of Earned Doctorates.

TABLE 6.3A Percent of the FY1967-81 Ph.D. Recipients Awarded NIH Research Grants During the FY1967-82 Period

NIH Training Support(a)		Fiscal Year of Doctorate															Total 1967-81
		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	
NIGMS Predocs	N	1018	1244	1401	1369	1523	1249	1159	1090	1048	1029	1002	922	907	905	911	16777
Awarded NIH Grant(b)	N	297	368	403	396	392	324	250	250	257	206	173	98	56	32	9	3511
	%	29.2	29.6	28.8	28.9	25.7	25.9	21.6	22.9	24.5	20.0	17.3	10.6	6.2	3.5	1.0	20.9
NCI Predocs	N	13	20	32	34	23	45	34	37	45	54	68	92	119	127	128	871
Awarded NIH Grant	N	4	7	8	9	7	19	8	9	12	17	5	10	15	5	3	138
	%	30.8	35.0	25.0	26.5	30.4	42.2	23.5	24.3	26.7	31.5	7.4	10.9	12.6	3.9	2.3	15.8
NICHD Predocs	N	22	66	100	114	148	150	155	178	166	145	154	124	130	134	136	1922
Awarded NIH Grant	N	7	18	20	21	26	21	22	36	19	14	17	11	5	3	1	241
	%	31.8	27.3	20.0	18.4	17.6	14.0	14.2	20.2	11.4	9.7	11.0	8.9	3.8	2.2	.7	12.5
NHLBI Predocs	N	32	42	58	42	48	49	45	59	49	54	48	52	60	73	77	788
Awarded NIH Grant	N	9	14	21	9	16	15	12	6	8	12	9	7	7	6	2	153
	%	28.1	33.3	36.2	21.4	33.3	30.6	26.7	10.2	16.3	22.2	18.8	13.5	11.7	8.2	2.6	19.4
NIEHS Predocs	N	22	50	62	101	95	94	98	65	66	62	54	48	51	50	53	971
Awarded NIH Grant	N	3	3	2	10	11	2	4	4	5	2	3	3	2	3		57
	%	13.6	6.0	3.2	9.9	11.6	2.1	4.1	6.2	7.6	3.2	5.6	6.3	3.9	6.0		5.9
NIAID Predocs	N	63	85	80	104	133	111	112	101	117	115	107	77	70	63	55	1393
Awarded NIH Grant	N	23	19	18	20	27	28	33	12	20	23	15	4	3	1		246
	%	36.5	22.4	22.5	19.2	20.3	25.2	29.5	11.9	17.1	20.0	14.0	5.2	4.3	1.6		17.7
NIADDK Predocs	N	10	12	11	9	17	9	16	15	7	12	10	11	8	13	21	181
Awarded NIH Grant	N	4	3	3		1	3	4	2	1	3	1	2	3			30
	%	40.0	25.0	27.3		5.9	33.3	25.0	13.3	14.3	25.0	10.0	18.2	37.5			16.6
NIA Predocs	N											6	10	14	18	14	62
Awarded NIH Grant	N												1	2			3
	%												10.0	14.3			4.8
NINCDS Predocs	N	14	23	30	27	40	30	22	30	28	33	33	33	25	26	19	413
Awarded NIH Grant	N	3	6	7	4	3	4	4	5	5	6	6		3			56
	%	21.4	26.1	23.3	14.8	7.5	13.3	18.2	16.7	17.9	18.2	18.2		12.0			13.6
NIDR Predocs	N	21	20	39	41	41	43	39	38	58	45	38	34	33	20	13	523
Awarded NIH Grant	N	6	5	8	8	7	7	8	11	8	10	10	8	4	3		103
	%	28.6	25.0	20.5	19.5	17.1	16.3	20.5	28.9	13.8	22.2	26.3	23.5	12.1	15.0		19.7
NEI Predocs	N									1	3	2	15	9	12	9	51
Awarded NIH Grant	N									1	1	1	4	1	1		9
	%									100.0	33.3	50.0	26.7	11.1	8.3		17.6
Total NIH Predocs	N	1215	1562	1813	1841	2068	1780	1680	1613	1585	1552	1522	1418	1426	1441	1436	23952
Awarded NIH Grant	N	356	443	490	477	490	423	345	335	336	294	240	148	101	54	15	4547
	%	29.3	28.4	27.0	25.9	23.7	23.8	20.5	20.8	21.2	18.9	15.8	10.4	7.1	3.7	1.0	19.0

(a)Includes all individuals with a total of at least 9 months of predoctoral training support from an NIH institute; individuals with support from more than one institute are categorized according to the institute from which they received their most recent predoctoral stipend.
(b)Includes all individuals who were awarded one or more NIH research grants during the FY1967-82 period.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows and Consolidated Grant Applicant File; National Research Council, Survey of Earned Doctorates.

TABLE 6.6A Percent of the FY1967-81 Ph.D. Recipients Applying for NIH Research Grants Who Received One or More Awards by FY1982

NIH Training Support(a)		Fiscal Year of Doctorate															Total
		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1967-81
NIGMS Predocs(b)	N	416	536	605	583	573	459	412	390	391	339	295	195	113	62	13	5382
Awarded NIH Grant(c)	N	297	368	403	396	392	324	250	250	257	206	173	98	56	32	9	3511
	%	71.4	68.7	66.6	67.9	68.4	70.6	60.7	64.1	65.7	60.8	58.6	50.3	49.6	51.6	69.2	65.2
NCI Predocs	N	4	12	14	18	15	23	15	16	21	26	14	25	26	5	4	238
Awarded NIH Grant	N	4	7	8	9	7	19	8	9	12	17	5	10	15	5	3	138
	%	100.0	58.3	57.1	50.0	46.7	82.6	53.3	56.3	57.1	65.4	35.7	40.0	57.7	100.0	75.0	58.0
NICHD Predocs	N	8	28	32	44	58	38	40	62	43	35	35	24	18	10	2	477
Awarded NIH Grant	N	7	18	20	21	26	21	22	36	19	14	17	11	5	3	1	241
	%	87.5	64.3	62.5	47.7	44.8	55.3	55.0	58.1	44.2	40.0	48.6	45.8	27.8	30.0	50.0	50.5
NHLBI Predocs	N	15	21	29	17	21	24	20	19	17	16	15	14	19	11	2	260
Awarded NIH Grant	N	9	14	21	9	16	15	12	6	8	12	9	7	7	6	2	153
	%	60.0	66.7	72.4	52.9	76.2	62.5	60.0	31.6	47.1	75.0	60.0	50.0	36.8	54.5	100.0	58.8
NIEHS Predocs	N	6	7	7	16	22	5	15	9	10	9	8	5	5	6		130
Awarded NIH Grant	N	3	3	2	10	11	2	4	4	5	2	3	3	2	3		57
	%	50.0	42.9	28.6	62.5	50.0	40.0	26.7	44.4	50.0	22.2	37.5	60.0	40.0	50.0		43.8
NIAID Predocs	N	30	33	29	43	49	42	54	28	39	31	31	13	5	3	3	433
Awarded NIH Grant	N	23	19	18	20	27	28	33	12	20	23	15	4	3	1		246
	%	76.7	57.6	62.1	46.5	55.1	66.7	61.1	42.9	51.3	74.2	48.4	30.8	60.0	33.3		56.8
NIADDK Predocs	N	5	5	5	2	6	3	5	3	2	7	4	4	3	1	2	57
Awarded NIH Grant	N	4	3	3		1	3	4	2	1	3	1	2	3			30
	%	80.0	60.0	60.0		16.7	100.0	80.0	66.7	50.0	42.9	25.0	50.0	100.0			52.6
NIA Predocs	N											2	2	3	3	2	12
Awarded NIH Grant	N												1	2			3
	%												50.0	66.7			25.0
NINCDS Predocs	N	4	10	9	8	9	9	7	11	6	8	10	4	3	1		99
Awarded NIH Grant	N	3	6	7	4	3	4	4	5	5	6	6		3			56
	%	75.0	60.0	77.8	50.0	33.3	44.4	57.1	45.5	83.3	75.0	60.0		100.0			56.6
NIDR Predocs	N	11	7	17	12	15	19	13	17	18	16	18	13	9	6	1	192
Awarded NIH Grant	N	6	5	8	8	7	7	8	11	8	10	10	8	4	3		103
	%	54.5	71.4	47.1	66.7	46.7	36.8	61.5	64.7	44.4	62.5	55.6	61.5	44.4	50.0		53.6
NEI Predocs	N									1	1	2	7	1	2		14
Awarded NIH Grant	N									1	1	1	4	1	1		9
	%									100.0	100.0	50.0	57.1	100.0	50.0		64.3
Total NIH Predocs	N	499	659	747	743	768	622	581	555	548	488	434	306	205	110	29	7294
Awarded NIH Grant	N	356	443	490	477	490	423	345	335	336	294	240	148	101	54	15	4547
	%	71.3	67.2	65.6	64.2	63.8	68.0	59.4	60.4	61.3	60.2	55.3	48.4	49.3	49.1	51.7	62.3

(a)Includes all individuals with a total of at least 9 months of predoctoral training support from an NIH institute; individuals with support from more than one institute are categorized according to the institute from which they received their most recent predoctoral stipend.
(b)Includes individuals who applied for an NIH research grant during the FY1967-82 period.
(c)Includes individuals who received at least one NIH research grant award during the FY1967-82 period.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows and Consolidated Grant Applicant File; National Research Council, Survey of Earned Doctorates.

TABLE 6.7A Percent of All NIH Research Grant Applications by FY1967-81 Ph.D. Recipients That Were Approved for Funding During the FY1967-82 Period

		Fiscal Year of Doctorate															
NIH Training Support(a)		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Total 1967-81
Appl. by NIGMS Predocs	N	1977	2448	2597	2390	2111	1586	1229	1063	916	715	513	299	150	80	14	18088
Approved for Funding	N	1646	2091	2157	2008	1758	1342	1050	906	784	607	457	264	132	69	13	15284
	%	83.3	85.4	83.1	84.0	83.3	84.6	85.4	85.2	85.6	84.9	89.1	88.3	88.0	86.3	92.9	84.5
Appl. by NCI Predocs	N	22	52	48	55	45	93	44	63	49	55	23	40	43	6	4	642
Approved for Funding	N	20	46	41	41	32	79	38	55	44	51	21	35	33	6	4	546
	%	90.9	88.5	85.4	74.5	71.1	84.9	86.4	87.3	89.8	92.7	91.3	87.5	76.7	100.0	100.0	85.0
Appl. by NICHD Predocs	N	41	123	114	148	176	109	106	164	91	68	53	37	22	13	4	1269
Approved for Funding	N	33	103	87	108	133	76	85	112	63	44	36	32	17	8	3	940
	%	80.5	83.7	76.3	73.0	75.6	69.7	80.2	68.3	69.2	64.7	67.9	86.5	77.3	61.5	75.0	74.1
Appl. by NHLBI Predocs	N	43	94	128	68	71	89	68	51	34	41	29	40	25	16	7	804
Approved for Funding	N	32	73	98	45	60	71	53	41	28	33	28	33	21	12	2	630
	%	74.4	77.7	76.6	66.2	84.5	79.8	77.9	80.4	82.4	80.5	96.6	82.5	84.0	75.0	28.6	78.4
Appl. by NIEHS Predocs	N	30	30	23	61	71	9	45	30	35	15	15	7	7	10		388
Approved for Funding	N	23	19	14	33	54	8	26	22	28	8	12	7	7	8		269
	%	76.7	63.3	60.9	54.1	76.1	88.9	57.8	73.3	80.0	53.3	80.0	100.0	100.0	80.0		69.3
Appl. by NIAID Predocs	N	157	143	142	137	145	147	174	78	92	64	53	19	5	5	3	1364
Approved for Funding	N	125	118	120	108	124	130	160	68	75	61	51	17	5	5	3	1170
	%	79.6	82.5	84.5	78.8	85.5	88.4	92.0	87.2	81.5	95.3	96.2	89.5	100.0	100.0	100.0	85.8
Appl. by NIADDK Predocs	N	29	27	24	3	14	8	24	10	6	26	10	9	4	1	2	197
Approved for Funding	N	23	25	17	3	9	7	16	6	6	21	9	5	3		2	152
	%	79.3	92.6	70.8	100.0	64.3	87.5	66.7	60.0	100.0	80.8	90.0	55.6	75.0		100.0	77.2
Appl. by NIA Predocs	N											7	2	4	5	2	20
Approved for Funding	N											3	1	3	2	1	10
	%											42.9	50.0	75.0	40.0	50.0	50.0
Appl. by NINCDS Predocs	N	17	44	34	22	17	26	19	26	13	18	15	6	4	1		262
Approved for Funding	N	15	33	26	16	14	20	15	17	10	16	9	4	4	1		200
	%	88.2	75.0	76.5	72.7	82.4	76.9	78.9	65.4	76.9	88.9	60.0	66.7	100.0	100.0		76.3
Appl. by NIDR Predocs	N	36	25	49	39	45	54	32	68	40	35	35	26	15	6	1	506
Approved for Funding	N	29	17	27	29	25	31	26	50	26	29	23	20	6	6	1	345
	%	80.6	68.0	55.1	74.4	55.6	57.4	81.3	73.5	65.0	82.9	65.7	76.9	40.0	100.0	100.0	68.2
Appl. by NEI Predocs	N									4	2	3	8	5	2		24
Approved for Funding	N									3	2	1	8	4	2		20
	%									75.0	100.0	33.3	100.0	80.0	100.0		83.3
Total Appl. by Predocs	N	2352	2986	3159	2923	2695	2121	1741	1553	1280	1039	756	493	284	145	37	23564
Approved for Funding	N	1946	2525	2587	2391	2209	1764	1469	1277	1067	872	650	426	235	119	29	19566
	%	82.7	84.6	81.9	81.8	82.0	83.2	84.4	82.2	83.4	83.9	86.0	86.4	82.7	82.1	78.4	83.0

(a)Includes all individuals with a total of at least 9 months of predoctoral training support from an NIH institute; individuals with support from more than one institute are categorized according to the institute from which they received their most recent predoctoral stipend.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows and Consolidated Grant Applicant File; National Research Council, Survey of Earned Doctorates.

TABLE 6.8A Percent of All NIH Research Grant Applications by FY1967-81 Ph.D. Recipients That Were Funded During the FY1967-82 Period

		Fiscal Year of Doctorate															
NIH Training Support(a)		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Total 1967-81
Appl. by NIGMS Predocs	N	1977	2448	2597	2390	2111	1586	1229	1063	916	715	513	299	150	80	14	18088
Awarded Grant	N	839	986	1046	911	911	644	469	408	376	277	223	112	58	34	9	7303
	%	42.4	40.3	40.3	38.1	43.2	40.6	38.2	38.4	41.0	38.7	43.5	37.5	38.7	42.5	64.3	40.4
Appl. by NCI Predocs	N	22	52	48	55	45	93	44	63	49	55	23	40	43	6	4	642
Awarded Grant	N	13	24	17	16	12	46	14	22	16	22	5	11	18	5	3	244
	%	59.1	46.2	35.4	29.1	26.7	49.5	31.8	34.9	32.7	40.0	21.7	27.5	41.9	83.3	75.0	38.0
Appl. by NICHD Predocs	N	41	123	114	148	176	109	106	164	91	68	53	37	22	13	4	1269
Awarded Grant	N	17	55	42	47	60	41	40	57	20	17	18	14	5	4	1	438
	%	41.5	44.7	36.8	31.8	34.1	37.6	37.7	34.8	22.0	25.0	34.0	37.8	22.7	30.8	25.0	34.5
Appl. by NHLBI Predocs	N	43	94	128	68	71	89	68	51	34	41	29	40	25	16	7	804
Awarded Grant	N	17	35	39	15	32	18	19	8	10	17	11	8	7	6	2	244
	%	39.5	37.2	30.5	22.1	45.1	20.2	27.9	15.7	29.4	41.5	37.9	20.0	28.0	37.5	28.6	30.3
Appl. by NIEHS Predocs	N	30	30	23	61	71	9	45	30	35	15	15	7	7	10		388
Awarded Grant	N	8	5	8	14	18	3	5	7	10	4	3	3	2	3		93
	%	26.7	16.7	34.8	23.0	25.4	33.3	11.1	23.3	28.6	26.7	20.0	42.9	28.6	30.0		24.0
Appl. by NIAID Predocs	N	157	143	142	137	145	147	174	78	92	64	53	19	5	5	3	1364
Awarded Grant	N	56	53	38	40	46	45	61	21	34	28	16	4	3	1		446
	%	35.7	37.1	26.8	29.2	31.7	30.6	35.1	26.9	37.0	43.8	30.2	21.1	60.0	20.0		32.7
Appl. by NIADDK Predocs	N	29	27	24	3	14	8	24	10	6	26	10	9	4	1	2	197
Awarded Grant	N	6	5	6		4	5	12	3	2	6	1	2	3			55
	%	20.7	18.5	25.0		28.6	62.5	50.0	30.0	33.3	23.1	10.0	22.2	75.0		.	27.9
Appl. by NIA Predocs	N											7	2	4	5	2	20
Awarded Grant	N												1	3			4
	%												50.0	75.0			20.0
Appl. by NINCDS Predocs	N	17	44	34	22	17	26	19	26	13	18	15	6	4	1		262
Awarded Grant	N	8	17	14	8	5	8	5	8	8	7	6		3			97
	%	47.1	38.6	41.2	36.4	29.4	30.8	26.3	30.8	61.5	38.9	40.0		75.0			37.0
Appl. by NIDR Predocs	N	36	25	49	39	45	54	32	68	40	35	35	26	15	6	1	506
Awarded Grant	N	22	11	11	12	13	12	9	18	12	14	12	10	4	3		163
	%	61.1	44.0	22.4	30.8	28.9	22.2	28.1	26.5	30.0	40.0	34.3	38.5	26.7	50.0		32.2
Appl. by NEI Predocs	N									4	2	3	8	5	2		24
Awarded Grant	N									2	2	1	4	3	1		13
	%									50.0	100.0	33.3	50.0	60.0	50.0		54.2
Total Appl. by Predocs	N	2352	2986	3159	2923	2695	2121	1741	1553	1280	1039	756	493	284	145	37	23564
Awarded Grant	N	986	1191	1221	1063	1101	822	634	552	490	394	296	169	109	57	15	9100
	%	41.9	39.9	38.7	36.4	40.9	38.8	36.4	35.5	38.3	37.9	39.2	34.3	38.4	39.3	40.5	38.6

(a)Includes all individuals with a total of at least 9 months of predoctoral training support from an NIH institute; individuals with support from more than one institute are categorized according to the institute from which they received their most recent predoctoral stipend.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows and Consolidated Grant Applicant File; National Research Council, Survey of Earned Doctorates.

TABLE 6.12A Percent of the FY1967-81 Ph.D. Recipients Applying for either NIH or NSF Research Grants Who Received One or More Awards by FY1982

		Fiscal Year of Doctorate															
NIH Training Support(a)		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	Total 1967-81
NIGMS Predocs(b)	N	458	591	657	643	639	517	455	427	418	364	340	218	139	78	26	5970
Awarded Res. Grant(c)	N	329	415	455	452	455	375	283	294	286	244	224	125	77	44	16	4074
	%	71.8	70.2	69.3	70.3	71.2	72.5	62.2	68.9	68.4	67.0	65.9	57.3	55.4	56.4	61.5	68.2
NCI Predocs	N	4	12	14	19	15	24	15	16	22	26	15	26	29	6	4	247
Awarded Research Grant	N	4	7	8	10	7	19	11	9	14	22	6	11	19	5	3	155
	%	100.0	58.3	57.1	52.6	46.7	79.2	73.3	56.3	63.6	84.6	40.0	42.3	65.5	83.3	75.0	62.8
NICHD Predocs	N	9	31	35	45	61	41	43	64	47	41	40	28	21	15	3	524
Awarded Research Grant	N	7	21	21	24	33	22	25	40	27	17	20	17	7	7	2	290
	%	77.8	67.7	60.0	53.3	54.1	53.7	58.1	62.5	57.4	41.5	50.0	60.7	33.3	46.7	66.7	55.3
NHLBI Predocs	N	15	21	31	18	24	26	22	20	17	17	16	14	19	11	2	273
Awarded Research Grant	N	10	14	22	10	16	16	13	7	9	13	9	7	8	6	2	162
	%	66.7	66.7	71.0	55.6	66.7	61.5	59.1	35.0	52.9	76.5	56.3	50.0	42.1	54.5	100.0	59.3
NIEHS Predocs	N	7	9	9	28	30	15	25	17	15	13	11	5	5	7		196
Awarded Research Grant	N	3	3	4	16	17	9	11	7	7	3	6	3	2	3		94
	%	42.9	33.3	44.4	57.1	56.7	60.0	44.0	41.2	46.7	23.1	54.5	60.0	40.0	42.9		48.0
NIAID Predocs	N	32	34	30	48	53	45	60	29	42	38	34	13	6	3	3	470
Awarded Research Grant	N	24	22	19	22	33	29	36	13	24	28	16	4	4	1		275
	%	75.0	64.7	63.3	45.8	62.3	64.4	60.0	44.8	57.1	73.7	47.1	30.8	66.7	33.3		58.5
NIADDK Predocs	N	5	5	6	3	6	3	5	3	2	7	4	5	3	1	2	60
Awarded Research Grant	N	4	4	3		1	3	4	2	1	3	1	2	3			31
	%	80.0	80.0	50.0		16.7	100.0	80.0	66.7	50.0	42.9	25.0	40.0	100.0			51.7
NIA Predocs	N											2	2	3	3	2	12
Awarded Research Grant	N												1	2			3
	%												50.0	66.7			25.0
NINCDS Predocs	N	5	10	9	8	9	9	7	12	6	9	11	5	4	2		106
Awarded Research Grant	N	3	7	7	4	4	4	4	7	5	6	7		3			61
	%	60.0	70.0	77.8	50.0	44.4	44.4	57.1	58.3	83.3	66.7	63.6		75.0			57.5
NIDR Predocs	N	11	8	19	14	16	20	13	17	19	17	18	14	9	6	1	202
Awarded Research Grant	N	6	6	9	9	7	7	10	11	9	10	10	8	4	3		109
	%	54.5	75.0	47.4	64.3	43.8	35.0	76.9	64.7	47.4	58.8	55.6	57.1	44.4	50.0		54.0
NEI Predocs	N									1	1	2	7	1	2		14
Awarded Research Grant	N									1	1	1	5	1	1		10
	%									100.0	100.0	50.0	71.4	100.0	50.0		71.4
Total NIH Predocs	N	546	721	810	826	853	700	645	605	589	533	493	337	239	134	43	8074
Awarded Research Grant	N	390	499	548	547	573	484	397	390	383	347	300	183	130	70	23	5264
	%	71.4	69.2	67.7	66.2	67.2	69.1	61.6	64.5	65.0	65.1	60.9	54.3	54.4	52.2	53.5	65.2

(a)Includes all individuals with a total of at least 9 months of predoctoral training support from an NIH institute; individuals with support from more than one institute are categorized according to the institute from which they received their most recent predoctoral stipend.
(b)Includes individuals who applied for an NIH or NSF research grant during the FY1967-82 period.
(c)Includes individuals who received at least one NIH or NSF research grant award during the FY1967-82 period.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows and Consolidated Grant Applicant File; National Science Foundation, Master File of Grant Applicants; National Research Council, Survey of Earned Doctorates.

TABLE 7.1A Percent of FY1967, FY1972, and FY1977 Ph.D. Recipients Who Had One or More Articles Published During the 1970-80 Period

		Year of Article Publication											
		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	Any Year
1967 Ph.D. Recipients													
NIGMS Predoc Support(a)	N	177	177	177	177	177	177	177	177	177	177	177	177
One or More Articles(b)	N	52	64	66	74	66	61	58	59	69	60	66	137
	%	29.4	36.2	37.3	41.8	37.3	34.5	32.8	33.3	39.0	33.9	37.3	77.4
Other NIH Predoc Support	N	37	37	37	37	37	37	37	37	37	37	37	37
One or More Articles	N	11	17	14	11	16	15	13	11	13	6	9	24
	%	29.7	45.9	37.8	29.7	43.2	40.5	35.1	29.7	35.1	16.2	24.3	64.9
Other Biomedical Ph.D.s	N	295	295	295	295	295	295	295	295	295	295	295	295
One or More Articles	N	85	86	83	78	77	70	75	72	70	75	71	178
	%	28.8	29.2	28.1	26.4	26.1	23.7	25.4	24.4	23.7	25.4	24.1	60.3
1972 Ph.D. Recipients													
NIGMS Predoc Support	N	230	230	230	230	230	230	230	230	230	230	230	230
One or More Articles	N	30	52	67	90	86	78	74	64	65	67	72	190
	%	13.0	22.6	29.1	39.1	37.4	33.9	32.2	27.8	28.3	29.1	31.3	82.6
Other NIH Predoc Support	N	76	76	76	76	76	76	76	76	76	76	76	76
One or More Articles	N	10	23	20	31	35	31	27	26	27	26	24	67
	%	13.2	30.3	26.3	40.8	46.1	40.8	35.5	34.2	35.5	34.2	31.6	88.2
Other Biomedical Ph.D.s	N	513	513	513	513	513	513	513	513	513	513	513	513
One or More Articles	N	49	79	110	146	126	120	128	125	121	121	112	305
	%	9.6	15.4	21.4	28.5	24.6	23.4	25.0	24.4	23.6	23.6	21.8	59.5
1977 Ph.D. Recipients													
NIGMS Predoc Support	N	122	122	122	122	122	122	122	122	122	122	122	122
One or More Articles	N	1	4	8	12	27	29	35	44	49	46	49	104
	%	.8	3.3	6.6	9.8	22.1	23.8	28.7	36.1	40.2	37.7	40.2	85.2
Other NIH Predoc Support	N	53	53	53	53	53	53	53	53	53	53	53	53
One or More Articles	N		1	5	4	7	7	13	20	26	17	20	47
	%		1.9	9.4	7.5	13.2	13.2	24.5	37.7	49.1	32.1	37.7	88.7
Other Biomedical Ph.D.s	N	270	270	270	270	270	270	270	270	270	270	270	270
One or More Articles	N	6	3	6	12	20	31	39	53	70	79	70	152
	%	2.2	1.1	2.2	4.4	7.4	11.5	14.4	19.6	25.9	29.3	25.9	56.3

(a)Includes all individuals with a total of at least 9 months of predoctoral training support from an NIH institute; individuals with support from more than one institute are categorized according to the institute from which they received their most recent predoctoral stipend.
(b)Includes any individuals who had authored or coauthored at least one article that had been published in the specified year.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows and Research Publication and Citation File; National Research Council, Survey of Doctorate Recipients.

TABLE 7.2A Average Number of Articles Published by FY1967, FY1972, and FY1977 Ph.D. Recipients During the 1970-80 Period

		Year of Article Publication											
		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	All Years
1967 Ph.D. Recipients													
NIGMS Predoctoral Support(a)	N	177	177	177	177	177	177	177	177	177	177	177	177
Articles per Individual(b)		.45	.68	.69	.90	.72	.84	.65	.77	.85	.81	.90	8.27
Other NIH Predoc Support	N	37	37	37	37	37	37	37	37	37	37	37	37
Articles per Individual		.68	.84	.57	.46	.89	.81	.65	.49	.59	.32	.41	6.70
Other Biomedical Ph.D.s	N	295	295	295	295	295	295	295	295	295	295	295	295
Articles per Individual		.57	.57	.57	.52	.49	.49	.59	.65	.50	.58	.48	6.01
1972 Ph.D. Recipients													
NIGMS Predoctoral Support	N	230	230	230	230	230	230	230	230	230	230	230	230
Articles per Individual		.17	.29	.47	.60	.63	.56	.57	.52	.50	.50	.60	5.39
Other NIH Predoc Support	N	76	76	76	76	76	76	76	76	76	76	76	76
Articles per Individual		.18	.39	.42	.71	.71	.68	.66	.61	.68	.67	.93	6.66
Other Biomedical Ph.D.s	N	513	513	513	513	513	513	513	513	513	513	513	513
Articles per Individual		.14	.21	.34	.47	.44	.43	.47	.45	.46	.51	.44	4.36
1977 Ph.D. Recipients													
NIGMS Predoctoral Support	N	122	122	122	122	122	122	122	122	122	122	122	122
Articles per Individual		.01	.03	.07	.14	.29	.34	.40	.52	.62	.59	.69	3.71
Other NIH Predoc Support	N	53	53	53	53	53	53	53	53	53	53	53	53
Articles per Individual		.00	.02	.13	.08	.15	.15	.34	.72	.77	.55	.57	3.47
Other Biomedical Ph.D.s	N	270	270	270	270	270	270	270	270	270	270	270	270
Articles per Individual		.03	.01	.03	.07	.09	.13	.22	.29	.40	.55	.41	2.24

(a)Includes all individuals with a total of at least 9 months of predoctoral training support from an NIH institute; individuals with support from more than one institute are categorized according to the institute from which they received their most recent predoctoral stipend.
(b)Average number of articles authored or coauthored by an individual in a specified year.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows and Research Publication and Citation File; National Research Council, Survey of Doctorate Recipients.

TABLE 7.3A Average Number of Citations to Articles Published by FY1967, FY1972, and FY1977 Ph.D. Recipients During the 1970-80 Period

		Year of Article Publication											
		1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	All Years
1967 Ph.D. Recipients													
NIGMS Predoctoral Support(a)	N	177	177	177	177	177	177	177	177	177	177	177	177
Citations per Individual(b)		6.53	7.36	9.15	11.40	9.82	11.07	6.05	5.02	3.73	1.99	.44	72.55
Other NIH Predoc Support	N	37	37	37	37	37	37	37	37	37	37	37	37
Citations per Individual		3.51	6.35	3.59	2.41	8.89	3.46	3.57	1.46	1.41	.24	.08	34.97
Other Biomedical Ph.D.s	N	295	295	295	295	295	295	295	295	295	295	295	295
Citations per Individual		3.01	4.15	3.94	6.39	4.05	3.47	3.99	2.95	1.47	.82	.09	34.34
1972 Ph.D. Recipients													
NIGMS Predoctoral Support	N	230	230	230	230	230	230	230	230	230	230	230	230
Citations per Individual		1.63	4.43	4.96	12.44	11.37	10.17	6.54	3.82	2.07	1.00	.24	58.69
Other NIH Predoc Support	N	76	76	76	76	76	76	76	76	76	76	76	76
Citations per Individual		.99	2.74	5.76	13.46	8.29	9.25	7.28	5.66	2.34	1.68	.32	57.76
Other Biomedical Ph.D.s	N	513	513	513	513	513	513	513	513	513	513	513	513
Citations per Individual		1.31	1.77	3.71	6.62	4.55	4.68	5.03	3.02	2.14	1.00	.10	33.93
1977 Ph.D. Recipients													
NIGMS Predoctoral Support	N	122	122	122	122	122	122	122	122	122	122	122	122
Citations per Individual		.02	.75	.38	8.83	5.03	6.47	5.33	4.01	3.13	1.75	.30	35.98
Other NIH Predoc Support	N	53	53	53	53	53	53	53	53	53	53	53	53
Citations per Individual		.00	1.21	1.49	.36	1.45	.94	2.26	3.91	2.81	1.30	.11	15.85
Other Biomedical Ph.D.s	N	270	270	270	270	270	270	270	270	270	270	270	270
Citations per Individual		.22	.16	.21	.56	.79	1.46	2.33	2.23	1.64	1.34	.18	11.11

(a)Includes all individuals with a total of at least 9 months of predoctoral training support from an NIH institute; individuals with support from more than one institute are categorized according to the institute from which they received their most recent predoctoral stipend.
(b)Average number of citations to articles authored or coauthored by an individual in a specified year.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows and Research Publication and Citation File; National Research Council, Survey of Doctorate Recipients.

TABLE 7.4A Average Number of Citations per Article Published by FY1967, FY1972, and FY1977 Ph.D. Recipients During the 1970-80 Period

	Year of Article Publication											
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	All Years
1967 Ph.D. Recipients												
NIGMS Predoctoral Support(a)	177	177	177	177	177	177	177	177	177	177	177	177
Number of Articles	79	120	123	159	128	148	115	137	150	144	160	1463
Number of Citations	1156	1302	1620	2018	1739	1959	1070	888	661	352	77	12842
Cites per Article	14.6	10.9	13.2	12.7	13.6	13.2	9.3	6.5	4.4	2.4	.5	8.8
Other NIH Predoc Support	37	37	37	37	37	37	37	37	37	37	37	37
Number of Articles	25	31	21	17	33	30	24	18	22	12	15	248
Number of Citations	130	235	133	89	329	128	132	54	52	9	3	1294
Cites per Article	5.2	7.6	6.3	5.2	10.0	4.3	5.5	3.0	2.4	.8	.2	5.2
Other Biomedical Ph.Ds.	295	295	295	295	295	295	295	295	295	295	295	295
Number of Articles	169	169	167	154	145	144	174	192	147	170	141	1772
Number of Citations	887	1224	1163	1886	1196	1024	1177	870	433	242	28	10130
Cites per Article	5.2	7.2	7.0	12.2	8.2	7.1	6.8	4.5	2.9	1.4	.2	5.7
1972 Ph.D. Recipients												
NIGMS Predoctoral Support	230	230	230	230	230	230	230	230	230	230	230	230
Number of Articles	40	66	107	137	144	129	132	119	114	114	138	1240
Number of Citations	375	1020	1141	2861	2616	2338	1505	879	476	231	56	13498
Cites per Article	9.4	15.5	10.7	20.9	18.2	18.1	11.4	7.4	4.2	2.0	.4	10.9
Other NIH Predoc Support	76	76	76	76	76	76	76	76	76	76	76	76
Number of Articles	14	30	32	54	54	52	50	46	52	51	71	506
Number of Citations	75	208	438	1023	630	703	553	430	178	128	24	4390
Cites per Article	5.4	6.9	13.7	18.9	11.7	13.5	11.1	9.3	3.4	2.5	.3	8.7
Other Biomedical Ph.D.s	513	513	513	513	513	513	513	513	513	513	513	513
Number of Articles	70	108	176	240	227	219	243	232	237	260	226	2238
Number of Citations	673	910	1904	3398	2332	2399	2578	1550	1100	513	50	17407
Cites per Article	9.6	8.4	10.8	14.2	10.3	11.0	10.6	6.7	4.6	2.0	.2	7.8
1977 Ph.D. Recipients												
NIGMS Predoctoral Support	122	122	122	122	122	122	122	122	122	122	122	122
Number of Articles	1	4	9	17	35	42	49	64	76	72	84	453
Number of Citations	3	91	46	1077	614	789	650	489	382	213	36	4390
Cites per Article	3.0	22.8	5.1	63.4	17.5	18.8	13.3	7.6	5.0	3.0	.4	9.7
Other NIH Predoc Support	53	53	53	53	53	53	53	53	53	53	53	53
Number of Articles		1	7	4	8	8	18	38	41	29	30	184
Number of Citations		64	79	19	77	50	120	207	149	69	6	840
Cites per Article		64.0	11.3	4.8	9.6	6.3	6.7	5.4	3.6	2.4	.2	4.6
Other Biomedical Ph.D.s	270	270	270	270	270	270	270	270	270	270	270	270
Number of Articles	7	4	8	19	23	36	60	78	109	148	112	604
Number of Citations	59	42	56	152	212	395	629	602	444	361	48	3000
Cites per Article	8.4	10.5	7.0	8.0	9.2	11.0	10.5	7.7	4.1	2.4	.4	5.0

(a)Includes all individuals with a total of at least 9 months of predoctoral training support from an NIH institute; individuals with support from more than one institute are categorized according to the institute from which they received their most recent predoctoral stipend.

SOURCES: National Institutes of Health, Roster of Trainees and Fellows and Research Publication and Citation File; National Research Council, Survey of Doctorate Recipients.

APPENDIX E

MEANS, STANDARD DEVIATIONS, AND NONSTANDARDIZED COEFFICIENTS FOR VARIABLES USED IN THE REGRESSION MODELS

Model Predicting Number of NIH Research Grant Applications

	Mean	std. dev.	b-coefficient
dependent variable[1]	.754	1.86	-0.449 (intercept)
years experience[2]	7.65	4.20	0.116
NIH predoc support[3]	15.5	20.8	0.00658
university rating[4]	3.01	1.11	0.000721

Model Predicting Number of Published Articles

	Mean	std. dev.	b-coefficient
dependent variable[5]	4.91	7.64	-1.44 (intercept)
years experience	10.2	3.66	0.408
NIH predoc support	15.1	21.3	0.0245
university rating	2.85	1.20	0.00642

Model Predicting Mean Priority Score on NIH Grant Proposals

	Mean	std. dev.	b-coefficient
dependent variable[6]	1.95	1.15	1.56 (intercept)
years experience	9.29	3.62	-3.29
NIH predoc support	20.3	22.2	0.631
university rating	3.16	1.06	0.181

Model Predicting Number of Citations per Article

	Mean	std. dev.	b-coefficient
dependent variable[7]	2.08	1.32	1.08 (intercept)
years experience	10.1	3.65	0.0149
NIH predoc support	18.6	22.5	0.00804
university rating	2.94	1.15	0.00237

[1]Number of NIH research grant applications submitted in FY1967-82 period.
[2]Years since Ph.D., as of FY1981.
[3]Total months of NIH predoctoral support.
[4]University rating in biological sciences (scale from 1.00 to 5.00).
[5]Total articles published during FY1970-80 period.
[6]Mean priority score (scale from 1.00 to 5.00).
[7]Square root of the number of citations per published article.