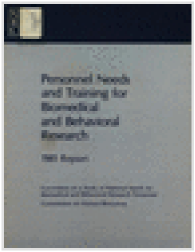

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PERSONNEL NEEDS AND TRAINING
FOR BIOMEDICAL AND BEHAVIORAL RESEARCH

THE 1981 REPORT

of the

COMMITTEE ON A STUDY OF NATIONAL NEEDS
FOR BIOMEDICAL AND BEHAVIORAL RESEARCH PERSONNEL

COMMISSION ON HUMAN RESOURCES

NATIONAL RESEARCH COUNCIL

National Academy Press
Washington, D.C.
1981

NOTICE: The project that is the subject of this 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 National Research Council was established by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and of advising the federal government. The Council operates in accordance with general policies determined by the Academy under the authority of its congressional charter of 1863, which establishes the Academy as a private, nonprofit, self-governing membership corporation. The Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in the conduct of their services to the government, the public, and the scientific and engineering communities. It is administered jointly by both Academies and the Institute of Medicine. The National Academy of Engineering and the Institute of Medicine were established in 1964 and 1970, respectively, under the charter of the National Academy of Sciences.

The work on which this publication is based was performed pursuant to Contract No. NO1-OD-9-2112 with the National Institutes of Health of the Department of Health and Human Services. Support for this project came from Evaluation Set-Aside funds (Section 513 of the PHS Act), Evaluation Project No. NIH 75-1.

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NATIONAL RESEARCH COUNCIL

OFFICE OF THE CHAIRMAN
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WASHINGTON, D.C. 20418

January 29, 1982

The Honorable Richard S. Schweiker
Secretary of Health and Human Services
Washington, D.C. 20201

Dear Mr. Secretary:

It is a pleasure to present to the Department of Health and Human Services for transmittal to the Congress, the 1981 report of the Committee on a Study of National Needs for Biomedical and Behavioral Research Personnel. This is the sixth annual report in the continuing study undertaken by the National Research Council pursuant to Title I of the National Research Act of 1974 (PL 93-348). The work for this report has been supported under Contract NO1-OD-9-2112 with the National Institutes of Health.

The Act states (Section 473 (a)) that the purposes of the study are to: "(1) 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; (2) assess (A) current training programs available for the training of biomedical and behavioral research personnel which are conducted under this Act at or through institutes under the National Institutes of Health and the Alcohol, Drug Abuse, and Mental Health Administration, and (B) other current training programs available for the training of such personnel; (3) identify the kinds of research positions available to and held by individuals completing such programs; (4) determine, to the extent feasible, whether the programs referred to in clause (B) of paragraph (2) would be adequate to meet the needs established under paragraph (1) if the programs referred to in clause (A) of paragraph (2) were terminated; and (5) determine what modifications in the programs referred to in paragraph (2) are required to meet the needs established under paragraph (1)."

Since the submission of the 1979 report the Committee has made substantial progress in responding to the goals of the Act. This is particularly true for the area of inquiry concerning research manpower needs in the Clinical Sciences where much new information has been obtained and analyzed by the Committee.

We hope the present report will be helpful and shall be glad to discuss it with you and your staff.

Yours sincerely,

Frank Press

Frank Press
Chairman

Enclosure

PREFACE

This report of the Committee on National Needs for Biomedical and Behavioral Research Personnel is the sixth in a continuing study conducted in response to the National Research Service Award Act of 1974 and its amendments.

In the Act, Congress re-authorized the training programs of the National Institutes of Health (NIH) and the Alcohol, Drug Abuse, and Mental Health Administration (ADAMHA), and requested the National Academy of Sciences (NAS) to conduct a continuing study of the nation's need for biomedical and behavioral research personnel. The study would establish the specific subject areas in which such personnel were needed and the kinds and extent of training to be provided. It was a difficult and challenging task.

The Academy accepted the task proposed for it by Congress, and in 1975 this Committee was established within the Commission on Human Resources to accomplish it. Individuals were selected from a wide variety of fields of expertise to serve on the Committee. The members included persons from many of the biomedical and behavioral fields and from other quantitative fields, such as economics and statistics, as well. But it was recognized that assistance would be required from those with a wider range of knowledge, and so panels of experts were formed to advise the Committee in specific areas.

Although the composition of the Committee and its advisory groups has changed over the years, this general structure has prevailed with only minor modification. The Committee and Panels, with the assistance of its staff and consultants--and occasionally with help from contractors--have conducted the studies reported in this and the previous five reports. Robert J. Glaser, M.D., was the first chairman of the Committee, serving from 1975 to 1977. He was succeeded by Henry W. Riecken, Ph.D., who served until 1980.

The Committee has continued to develop the approach to the task and to refine its methods. We have accepted the interpretation that "national needs" should be determined largely by current labor-market demand and by our best judgment about the conditions that are likely to prevail in the near future. A substantial body of data has been developed during the course of this study to help us assess market conditions. To this we now have added the contributions of three major studies designed to broaden our understanding of critical issues in the clinical sciences area. In addition, the analytical models of the market that provide the basis for our projections have been updated and refined for the present report. One of the outcomes has been a revision of some previous assumptions about how these markets have been functioning.

Most of the new studies and the overall emphasis in this year's report concern the clinical sciences area. In addition, however, the numerical recommendations for each of the five broad areas of research training previously reported upon--basic biomedical sciences, behavioral sciences, clinical sciences, health services research, and nursing research--have been re-examined and updated as appropriate. The report contains a number of non-numerical recommendations concerning the specific subject matter areas. The last chapter deals with current federal programs for increasing the participation of underrepresented minority-group members in the biomedical and behavioral disciplines.

The authorizing legislation, renewed and modified several times since 1974, was extended in August for 2 years through FY 1983 by passage of the Omnibus Budget Reconciliation Act of 1981 (Public Law 97-35). Three important changes made by this legislation were: 1) the waiver of payback obligation by recipients of NRSA support for the first 12 months of research training taken under this program; 2) the selective emphasis placed on recruiting more physicians into careers in biomedical research and clinical investigation; and 3) the elimination from coverage by the Act of the research training program of the National Center for Health Services Research.

In closing I thank the many individuals who have served previously as members of this Committee and its advisory Panels for their contributions to the accumulated knowledge upon which the present Committee relied heavily in preparing this report.

Robert L. Hill, Ph.D.
Chairman

ACKNOWLEDGMENTS

As in its past reports, the Committee's work is the result of the efforts of many individuals and organizations.

Among the many who provided assistance to us we wish particularly to acknowledge the staffs of the National Institutes of Health (NIH), the Alcohol, Drug Abuse, and Mental Health Administration (ADAMHA), and the Health Resources Administration (HRA). Our special thanks go to Dr. Donald Fredrickson, immediate past director of NIH and his staff, notably Drs. William Raub, Doris Merritt, and William Batchelor. In addition, Dr. Charles Miller of the National Institute of General Medical Sciences (NIGMS), Dr. Bernard Lepovetsky of the National Cancer Institute (NCI), and Dr. Nicholas Moriarity of the Division of Research Grants (DRG) provided valuable data and information on training programs. The Committee also appreciates the generous assistance of Ms. Michele Harvey and Dr. Frank Sullivan of ADAMHA, Ms. Jo Eleanor Elliott, Director of the Division of Nursing, HRA, and her staff members, Drs. Marie Bourgeois and Adele Wood.

In the pursuit of its major research effort this year in the clinical sciences, the Committee wishes to acknowledge the contributions of the following individuals and organizations: Drs. Thomas Morgan, Charles Sherman, and Paul Jolly of the Association of American Medical Colleges (AAMC); Drs. Martin Block and Scott Swisher of Michigan State University; and Dr. Richard Scheffler of George Washington University.

Over the past two years, the Committee has conducted a series of site visits to predoctoral training programs in the basic biomedical sciences. The promise of confidentiality constrains us from naming specific institutions and individuals; however, the Committee wishes to pay special thanks to those university administrators, faculty, and students who contributed their time and effort to this activity.

The Committee's work on minority participation in biomedical and behavioral research was aided by many individuals. Particular thanks are due to Dr. Harold Delaney, Executive Vice President of the American Association of State Colleges and Universities, for his guidance in many phases of this effort. In addition, our survey of federal programs for minority research training was assisted by staff members from the Department of Health and Human Services, the Department of Education, and the National Science Foundation.

Within the Commission on Human Resources, Dr. Harrison Shull, Chairman, and Dr. William Kelly, Executive Director, have provided advice and assistance at all phases of the study. Mr. Porter Coggeshall, staff director of another study, has contributed frequently to the analysis of data. In addition, Mr. Herbert Soldz and the staff of the Data Processing Office have provided valuable support.

The Committee is pleased to recognize the capable work and many contributions made by all the members of its staff under the overall direction of Dr. Herbert B. Pahl, Staff Director. Specifically, thanks are accorded to the senior professional staff, Dr. Allen M. Singer, Study Director for Data and Analyses, and Drs. Russell Hilmoe, Robert G. Snyder, and Samuel S. Herman, Executive Secretaries of the Basic Biomedical, Behavioral, and Clinical Sciences Panels, respectively. The assistance of Dr. Pamela Ebert-Flattau, former Executive Secretary of the

Behavioral Sciences and Health Services Research Panels, during the initial phase of this year's report is also appreciated. Special note is also made of the heavy administrative load carried this year by the Staff Director and Mrs. Kay C. Harris, Administrative Officer, particularly in connection with preparing this year's report concurrently with meeting other project responsibilities.

Finally, the Committee is pleased to thank the following support staff: Mr. J. Richard Albert and Ms. Delores H. Thurgood for excellent technical assistance; and Mmes. Imani R. Ansari, Jacquelyn C. Johnson, and Janie B. Marshall for outstanding secretarial assistance and other support services.

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ABBREVIATIONS

AAMC	Association of American Medical Colleges
AAU	Association of American Universities
ADAMHA	Alcohol, Drug Abuse, and Mental Health Administration
CHR	Commission on Human Resources
F/S	*Faculty/Student Ratio
FY	Fiscal Year
GMENAC	Graduate Medical Education National Advisory Committee
GNP	Gross National Product
HRA	Health Resources Administration
HSR	Health Services Research
MARC	Minority Access to Research Careers
MBS	Minority Biomedical Support
MCAT	Medical College Admissions Test
MSU	Michigan State University
N/A	Not Available
NCHSR	National Center for Health Services Research
NIH	National Institutes of Health
NIMH	National Institute of Mental Health
NRC	National Research Council
NRE	Nursing Research Emphasis
NRSA	National Research Service Award
NSF	National Science Foundation
PI	Principal Investigator
R and D	Research and Development

*Faculty, in this report, is defined as all Ph.D.'s, M.D.'s, and equivalent degree holders who are employed by an academic institution whether or not they are on regular faculty appointments. Persons on postdoctoral appointments are not included.

EXECUTIVE SUMMARY

Introduction and Summary of Numerical Recommendations, Fiscal Years 1982-1985

In this year's report, we seek to advance our understanding of the labor market for health research personnel, with special emphasis on the clinical sciences; update our recommendations based upon an analysis of the current market situation and projections for the next few years; and discuss other relevant policy issues, including the stabilization of federal support and the recruitment of minorities.

We emphasize the need to stabilize fundamental training in the basic disciplinary areas at the predoctoral level and to use specialized training at the postdoctoral level to meet short-term national research priorities. We endorse the use of the training grant mechanism because of the stability that it provides to departments and institutions.

In carrying out our charge to specify the nation's needs for biomedical and behavioral research personnel, we have undertaken an analysis of the current supply/demand situation and have made projections to 1985. Since most of these scientists are employed in colleges and universities, the projections are focused primarily on the academic sector, but considerable attention has been given this year to the fast-moving developments in the private sector. The models used to make projections of academic demand have been updated and extended with the most recent data.

In the last part of Chapter 1, we provide summary tables with overall recommendations for FY 1982-1985 as regards numbers, levels, and types of awards for each major area of research training, and estimates of the costs attendant to their implementation.

Clinical Sciences

In light of the decline in recent years in the number of physicians electing to pursue research training under NRSA programs, factors presumed to be influencing career decisions are examined in depth. Data from two Committee-sponsored studies suggest that intellectual stimulation and challenge of the search for knowledge are major incentives for selecting a research career. Also significant is exposure to and participation in research activities. Financial disadvantages of a research career were not regarded as disincentives by young physicians who recently chose an academic career. By contrast, income expectations were of moderate importance to those who selected a career in private practice. While the NRSA payback obligation appeared in several studies not to deter research career plans, the evidence for such a view remains inconclusive.

Graduates of four principal NIH-supported programs for the research training of physicians are compared in terms of several performance measures. All programs were highly successful in producing physician investigators, although there were differences in persistence in research, publication activity, and rate of advancement.

Labor market data show that personnel shortages continue in the clinical science fields, primarily because of the strong demand in medical schools for faculty members to conduct research as well as teach and provide patient care, and the difficulty in recruiting young physicians for research careers. This situation has existed for some time now and has prompted us to recommend special emphasis on NRSA training programs in clinical fields.

There are signs of improvement in market balance, but conflicting trends make interpretation difficult. Funds available to support clinical faculty in medical schools are not growing as fast now as in the early 1970's, while teaching responsibilities have grown in recent years at about 5 percent per year. Perhaps most importantly, the number of M.D.'s and other health professionals participating in NIH research training programs has not changed appreciably since 1976 and is currently well below the level we consider appropriate.

In the next few years, we foresee somewhat slower growth in medical student enrollments and very little real growth in clinical R and D expenditures after adjusting for inflation. However, medical school income from patient care should continue to show real growth of about 6 percent per year. As a result, clinical faculties are expected to expand by almost 3 percent per year through 1985. The way the system operates to produce the supply of clinical scientists governs to a large extent the role to be played by NRSA programs.

Most of the individuals taking faculty appointments in clinical departments of medical schools have not had a period of formal research training--only about 21 percent of newly hired clinical faculty members in recent years have had some postdoctoral research training. This percentage formerly was much higher, and we view the reduction as symptomatic of the problems facing medical schools in their recruitment efforts. In developing our recommendations, we have attempted to encourage a higher level of research capability for clinical investigation. The intended result is that by 1985, at least one-third of the individuals joining clinical faculties will have had some postdoctoral research training.

Basic Biomedical Sciences

A review of recent data indicates that the demand for research scientists in the basic biomedical sciences in the academic sector remains generally favorable. We are therefore cautiously optimistic about academic employment opportunities in these fields. Projections of demand for academic research personnel are based on the dynamics of faculty change and on assumptions of modest growth in enrollments and research and development funds. Continued steady demand or modest growth is projected through 1985. In addition, developments in some biomedical science fields are creating expanded opportunities in the business sector, but it is too early to make quantitative projections of this demand. Because of the generally favorable outlook through 1985, we reaffirm our recommendations for NRSA predoctoral and postdoctoral support in the basic biomedical science fields through 1985.

In past years we have attempted to document the role of training grants in improving the quality of both the training environment and training programs. This year, we have undertaken in-depth reviews of a limited number of programs to ascertain the impact of losses of this support on predoctoral programs. The findings indicate substantial negative effects on such areas as recruitment, curriculum, and intellectual vitality.

Predoctoral and postdoctoral research training are primarily conducted in the nation's leading research universities. To provide high-quality, up-to-date training, it is essential that they have modern instrumentation and facilities. Recent reports indicate that the quality of research instrumentation and facilities, even at leading institutions, has seriously declined. We discuss these reports and endorse the need to improve research facilities and instrumentation.

Behavioral Sciences

The analysis of market conditions highlights differences between clinical and nonclinical segments of the behavioral sciences, which possess different training and employment characteristics. Market indicators are examined, including changes in labor force size, enrollments, and Ph.D. production; ability to find jobs; field-switching; research activity; and utilization of postdoctoral training. Evidence indicates that the market for the research-intensive nonclinical fields remains soft overall, while the market for the practice-oriented clinical fields remains strong. We have made projections of faculty demand through 1985 and also report new projections of the number of NRSA postdoctoral trainees needed to meet this academic demand. Based upon these analyses and projections, we reaffirm our previous recommendations to decrease predoctoral support and increase postdoctoral support.

Implementation of our past recommendations by ADAMHA has been hindered by budgetary constraints and slow acceptance by the professional community. We continue to encourage the efforts by ADAMHA to effect the recommendations. We are concerned also over reductions in research and research training support in the behavioral sciences. While noting that some reductions may be warranted as part of broader national policy, we believe that cutbacks that are so deep that they disrupt high-quality programs will risk long-term damage to these programs and to future research. Another matter of concern has been recent attempts to eliminate "social" research and research training. We discuss the mistaken nature of this argument and instead recommend that the proper basis for making awards, apart from quality, should be their health-relatedness.

Health Services Research and Nursing Research

Health services research and nursing research were not studied in depth this year. We do, however, review briefly the status of agency training programs. Federal funding for both programs remains meagre, at levels we believe do not permit the development of adequate numbers or quality of training. The present report contains the highlights of the 1977 survey of health services research trainees and principal investigators. The findings indicate that trainees and researchers remain active in health services research, thus confirming the success of prior federal support programs. In nursing research, we are concerned about the growth in the number of doctoral programs in schools of nursing without a strengthening of the training quality in existing doctoral programs.

Minorities in the Biomedical and Behavioral Sciences

We believe that the pool of students from which scientists come should reflect the broad ethnic and cultural heritage of the nation. This is not only a matter of equity; it is a matter of quality and talent as well. In order to maintain the high quality and vitality of scientific research in the future, it is important for the nation to take full advantage of the talent of all its citizens. Thus, we support the full participation of minorities in science as a necessary step toward the fullest use of this country's human resources. From our review of the literature from 1974 to 1980 on the participation of minorities in the sciences, it is clear that a wide range of education-related problems exists, beginning in the primary grades and continuing through post-secondary levels. These problems, which discourage minorities from pursuing science education, include cultural differences, lack of science career information and vigorous recruitment, weak academic preparation, inflexible college admissions criteria, and inadequate financial resources.

We also have examined national data on enrollments and degrees that demonstrate that the flow of minority students through the highest levels of the education system remains limited. Those who have continued on from the baccalaureate to earn the doctorate are concentrated in nonscience fields. Although minorities were gradually increasing as a proportion of new doctorates in all fields from 1974 to 1980, Blacks and Hispanics remain severely underrepresented in the biomedical sciences. Despite significant growth, minorities are still underrepresented in the behavioral sciences as well.

Current federal programs intended to increase the number of minorities earning Ph.D.'s are examined. At this time their efficacy has not been determined. In addition, it must be acknowledged that such programs are ultimately faced with an impossible task unless accompanied by efforts at earlier educational levels to increase the number of minority students who are academically prepared and motivated to pursue science careers.

Recommendations

General

The Committee recommends that federal support for research training should be stabilized and provided at levels commensurate with the scope of national needs. At the center of federal policy there should be an irreducible number of trainees who are supported in the basic disciplines regardless of fluctuations in demand for short-term research needs. Additions and reallocations in support may be undertaken as special needs come and go. In this way the benefits of stability can be achieved while providing a flexibility to respond to changing priorities in the nation's research needs. The level of stabilization should be determined after reviewing available data, findings, and recommendations, including those of this Committee.

Clinical Sciences

1. The Committee recommends that 2,400 traineeships and 400 fellowships be awarded annually for postdoctoral research training in the clinical sciences from FY 1982 through FY 1985. The Committee also urges a greater emphasis on filling these training positions with physicians. Most of the funding should be in the form of training grants, which are particularly suited to meet the needs of the physicians whose doctoral training usually involves only limited research participation and, as previously recommended, approximately 15 percent for individual fellowships.

2. The Committee recommends that an annual enrollment of 725 trainees in the Medical Scientist Training Program (MSTP) should be maintained through FY 1985 and high priority given to preserving this level should it become necessary to reduce the overall number of NRSA trainees.

Basic Biomedical Sciences

1. The number of predoctoral trainees and fellows supported annually in the basic biomedical sciences should be maintained at 4,250 in each year from the present through FY 1985.

2. The number of federally funded postdoctoral awards in the basic biomedical sciences should be maintained at 3,200 annually for FY 1982-1985.

3. While training grants should continue to be awarded on the basis of national competition, it should also be recognized that a minimum number of grant-supported trainees, the number of which will vary with the specific training program, is essential to ensure the critical mass necessary for a vital and effective training program.

Behavioral Sciences

1. While reductions in training support may be necessitated by overall budget constraints, it is important that some training support be preserved in the health-related behavioral and social sciences and that this support be directed to the highest-quality programs.

2. All fields of the behavioral and social sciences continue to make valuable contributions to the solution of health problems. Beyond quality, the proper criterion for awarding behavioral and social science training grants should remain the relevance of the applications to the solution of health problems that are the responsibility of NIH and ADAMHA.

3. The Committee reaffirms its position that training in the behavioral sciences shift its emphasis from predoctoral to postdoctoral. A gradual phasing in is recommended so that a level of 390 predoctorals and 910 postdoctorals will be supported annually by 1985.

4. The training grant should be the predominant mechanism of support in the behavioral sciences with an 80 percent/20 percent traineeship to fellowship ratio. In addition, because of the importance of the institutional support component of the award in planning and administering health-related training programs in behavioral science departments, the Committee strongly endorses the continuation of the training grant mechanism.

Health Services Research and Nursing Research

1. It is recommended that 330 health services research trainees and fellows be supported annually through FY 1985.

2. NRSA support for nursing research training should rise to 300 trainees and fellows annually from FY 1982 through FY 1985. No more than 15 percent of these trainees should be at the post-doctoral level.

Minorities

Current federal programs that recruit and train minority students in the biomedical and behavioral sciences should be evaluated in order to identify the most successful approaches to increasing minority participation in the sciences. Existing programs should be continued pending the outcome of this evaluation.

1. INTRODUCTION AND SUMMARY OF NUMERICAL RECOMMENDATIONS, FISCAL YEARS 1982-1985

OBJECTIVES OF THE 1981 REPORT

The Committee's objectives for this year's report are five-fold: (1) to revise and extend through FY 1985 its specific recommendations on the numbers of NRSA awards that should be provided for the support of predoctoral and postdoctoral research training in the areas of the basic biomedical and behavioral sciences, health services research and nursing research, and the numbers of postdoctoral awards in the clinical sciences; (2) to recommend an appropriate distribution of these awards between traineeships and fellowships for each of these broad categories of training; (3) to present the results of special studies conducted for the Committee concerning recruitment of more M.D.'s into clinical investigation; (4) to report upon recent Committee studies and new analyses of data on recruitment, training, and employment of minorities in research careers in the biomedical and behavioral sciences, and (5) to discuss several program and policy issues, including the need to stabilize federal support for research training.

STABILIZATION OF RESEARCH TRAINING SUPPORT

Stabilization of federal support for graduate education has been an objective endorsed over the years by many reports that have examined the federal role in graduate education. The National Science Board (1969, p. 21) argued strongly for stability in federal support:

> A graduate program can maintain high quality only if it can be assured of continuity of essential financial support. Significant short-term variations in funding are especially serious, for they are destructive to morale. It is more difficult and requires longer time to build high quality than to destroy it.

The National Board on Graduate Education (1974, p. 15), in another important study, also endorsed stability:

> Short-run stop-and-go policies toward graduate education and research are highly destabilizing and very inefficient whatever their origin or motivation. Abrupt shifts in federal policy can be particularly damaging, given the federal government's significant role in supporting research and graduate students.

More recently, the National Commission on Research (1980, p. 13) cautioned against sharp fluctuations in training support because of difficulties in predicting personnel needs and the complexities of the research training system.

The Committee has not directly addressed the issue of stability in its previous reports. It seems appropriate at this time, however, to consider the issue, particularly in light of recent congressional concern regarding "the proper balance between stabilized research support and stabilized training support" (U.S. Congress House, 1980).

Over the years of its deliberations, the Committee has had a dual concern in response to its congressional mandate: (1) how to produce a core of talent that will constantly replenish the research labor force, and (2) how to assure a responsiveness to changing national research needs. The first concern emphasizes stability, while the latter flexibility for change. To accommodate these objectives, the Committee has recommended two responses in the federal training system. The first is a realignment of overall training levels to reflect long-term labor market prospects. In the case of the basic biomedical and behavioral sciences, where there have been declining academic opportunities in the 1970's that are likely to continue through the 1980's, the Committee has recommended some reduction in the numbers of persons receiving federal support. In the clinical sciences, where there have been consistent problems in attracting clinicians into research, stabilization of the numbers of persons being supported has been recommended. In the emerging areas of health services research and nursing research, the Committee has urged modest increases in the numbers of trainees receiving support. In this way the Committee has suggested how to stabilize support at levels that are justifiable on the basis of long-term market outlooks.

The second Committee response has been to distinguish between training emphases at the predoctoral and the postdoctoral levels. The Committee has argued on the basis of strong beliefs that predoctoral training ought to be broadly grounded in the basic disciplinary areas. The emphasis here should be on sound fundamental training. However, the long lag time between entry into graduate school and entry into the labor force (5-8 years, including 2-3 years of postdoctoral training) makes the use of predoctoral training a generally inappropriate device for accomplishing more highly focused training needs. It is at the postdoctoral level that specialization should primarily occur. Stability is most essential during the long training period at the predoctoral level, while responsiveness to national needs is most appropriate and feasible at the postdoctoral level.

Another aspect of the Committee's concern for stability has been its emphasis on the training grant as the primary training mechanism. As a 5-year renewable grant which provides program as well as student support, the training grant provides an institutional continuity and focus on the research training process that individually awarded fellowships and research assistantships do not. In addition, the institutional component of the training grant provides valuable support for the training program, e.g., guest faculty seminars and research supplies. The case studies recently conducted by the Committee (see Chapter 3) confirm the destabilizing influence that abrupt withdrawal of training grants has had on some high-quality programs.

The Committee's consistent objective has been to promote the quality of research training. Its argument for the stabilization of a core of student support should not be construed as meaning that particular programs or institutions should be guaranteed support indefinitely. Training grant and fellowship awards should continue to be made on the basis of national merit competition. Only superior programs and students should receive support.

> Recommendation. The Committee recommends that federal support for research training should be stabilized and provided at levels commensurate with the scope of national needs. At the center of federal policy there should be an irreducible number of trainees who are supported in the basic disciplines regardless of fluctuations in demand for short-term research needs. Additions and reallocations in

support may be undertaken as special needs come and go. In this way the benefits of stability can be achieved while providing a flexibility to respond to changing priorities in the nation's research needs. The level of stabilization should be determined after reviewing available data, findings, and recommendations, including those of this Committee.

The need for a steady infusion of young, well-trained and creative scientists into research positions in the biomedical and behavioral sciences is absolutely essential for maintaining the vigor of the national research endeavor. Only under a national policy of stabilized federal support for research training will individuals, academic institutions, training program directors, and funding agencies be able to plan and conduct this research training in a manner that will achieve the most effective use of limited available funds.

TRAINING QUALITY

One of the principal themes of this report is the role of federal programs in enhancing the quality of health research training. This continues a theme that has been addressed in earlier reports (1976 Report, pp. 6-8; 1977 Report, pp. 185-187; 1978 Report, pp. 42-45; 1979 Report, pp. 31-34); furthermore, at its Endicott House Conference, the Committee gave this issue a high priority for investigation (reported in 1979 Report, pp. 12-15).

This commitment to high-quality training is founded on the conviction that research training is a distinct activity and not simply an incidental by-product of research and teaching activities. Without such conviction, research training as a fundamental and long-term investment may be sacrificed to the demands of short-term local or national needs. The Committee's commitment to quality in research training is reflected in its consistent emphasis on merit as the principal criterion for awarding support and its endorsement of stability in the funding process (see preceding section on stabilization of research training support).

The Committee's interest in stabilizing funds for meritorious research training is reflected in its consistent endorsement of the training grant as the primary mechanism of support. This endorsement has led to many efforts to investigate the link between training grants and training quality. This past year the Panel on Basic Biomedical Sciences conducted two case studies (and four preliminary site visits) to departments to investigate the impact of the loss of training grant support on predoctoral training quality, with particular reference to the impact on the training environment. The findings of this study, reported in Chapter 3, support the belief that training grants significantly enhance training quality through their focus on graduate training in a milieu of active research, on student support, and on ancillary support of training program activities.

In the behavioral sciences (Chapter 4), the Committee continues its emphasis on a greater utilization of postdoctoral training. The growing importance of behavioral factors in disease means that the depth of training must be increased beyond the basic foundations provided by even first-rate predoctoral training programs. Therefore, there has been consistently a recommendation to augment federal postdoctoral training support in order to improve the quality of researchers.

In the clinical sciences, the central problem has been the recruitment of clinicians into research careers. Part of this year's report (Chapter 2) presents findings on the determinants of career choice, which were obtained from studies commissioned by the Committee. The challenge of the search for new knowledge is seen to be a major incentive for pursuit of a research career. Another factor strongly influencing choice of a research career is experience during medical school as an investigator and as an author of research papers.

Finally, quality is a primary concern in the Committee's consideration of training support for minorities. The underrepresentation of minorities in the health sciences deprives these fields and the nation of an important source of talent and the benefits of a broader array of scientific interests. The Committee is therefore disturbed at the slow progress being made in the recruitment of minorities and in Chapter 6 makes a recommendation that the various federal programs directed to this purpose be continued, evaluated for their effectiveness, and modified to increase the rate of progress.

PROSPECTIVE CHANGES IN RETIREMENT

The Committee wishes to note that an unrelated congressional action on mandatory retirement taken several years ago is likely to have important effects within the coming year on the labor market for newly trained scientists. The 1978 amendments to the Age Discrimination in Employment Act exempted tenured faculty members, for a period until July 1982, from the major provision of the Act, which raised the mandatory retirement age from 65 to 70. Traditionally many colleges and universities required faculty members to retire at age 65 as a method of ensuring the vigor of their institution. Unless Congress now extends the exemption, these institutions will no longer be able to require the retirement of senior faculty members before age 70.

The magnitude of the shortrun effects produced by the expiration of the exemption are difficult to predict with precision. If, however, substantial proportions of older faculty members opt to continue teaching until age 70, this will produce a steady reduction in the number of new faculty openings over the next 5 years and thereafter result in a stable but smaller number of new positions than would be available were the exemption made a permanent one. The average age of faculty members will be forced upward and could lead to an overall reduction in research output since it would now be more difficult to retire less productive older faculty members. What will actually happen remains unclear until Congress acts on recommendations of the Department of Labor, which will reflect in part the results of a special study commissioned to appraise the effects of the exemption and its possible expiration. As a consequence, this Committee has made no alterations in its projections to reflect the effects of what could be a difficult transitional period for newly trained young scientists.

ESTIMATION OF PERSONNEL NEEDS

A fundamental task of this study is to provide an understanding and analysis of the system by which biomedical and behavioral scientists are trained and absorbed into the labor force. The mechanisms that affect career choices of students must be identified and quantified as far as possible. On the demand side, the forces that determine the number of positions available to these scientists similarly must be identified and measured. In short, a clear concept of how the education-training system works must be developed.

In its 1977 report, the Committee presented a complete description of this system and laid out the framework under which its study would be conducted (NRC, 1975-80, Chapter 2). The following discussion is a condensation and modification of that presentation and is included here in order to describe the process followed by the Committee in developing its recommendations.

The population of research scientists involved consists of the following groups of individuals:

1. Academic doctorate recipients (Ph.D., D.Sc., etc.) in the areas and fields that the Committee has defined as biomedical and behavioral sciences for purposes of this study.

2. Academic doctorate recipients in other areas who are employed in biomedical or behavioral fields.

3. Professional doctorate recipients (M.D., D.D.S., D.V.M., etc.) whose primary interests and training are in research and teaching.

4. Other professionals, usually nurses with baccalaureate degrees, whose primary interests and training are in the area of nursing research.

More than half of all biomedical and behavioral research scientists are employed by colleges and universities (Chapter 3, Table 3.1, and Chapter 4, Table 4.2). A good portion of the nation's biomedical and behavioral research is conducted in academic institutions by this group of scientists with support provided by federal agencies such as the NIH and ADAMHA. It is therefore clear that the availability of faculty positions is a critical factor affecting the employment patterns of these research scientists. Faculty positions in turn are largely determined by the level and pattern of student enrollments in the biomedical and behavioral fields and by the availability of research funds at colleges and universities.

In medical schools, clinical investigators perform patient care duties in addition to their teaching and research activities (Chapter 2). Even those clinical faculty members who are primarily engaged in research have devoted an increasing amount of time in recent years to patient care, particularly through the expansion of community health-care programs at university medical centers. This trend is likely to continue and therefore must be taken into account in estimating the future need for clinical investigators.

In the biomedical fields, a postdoctoral appointment is commonly viewed as a transition stage between the training phase and an established position as a biomedical or clinical science investigator. But it is a vital stage in which much important research is done. In fact, many view postdoctoral training to be a combination of intensive research activity and an opportunity to enhance the research techniques of the trainee under the guidance of an experienced investigator. It is generally considered to be a necessary element of training for the graduates of health professional schools, and somewhat less necessary, but nonetheless desirable, for those with Ph.D. degrees. In most behavioral science fields, however, where complex laboratory equipment and procedures are not an integral part of research, a postdoctoral period of training has been the exception rather than the rule. As indicated above, that may be changing. Further discussion of the role of postdoctoral training in each broad area is provided in the corresponding chapter of this report.

As its principal tools of analysis, the Committee has developed models--analytical schemes--of academic market demand for Ph.D. personnel in the biomedical, behavioral, and clinical sciences. The underlying hypothesis is that academic demand in these fields is composed of teaching, research, and clinical care components. Changes in the amount of funds available to support research (and patient care activities in the case of clinical faculty) cause changes in the faculty/student ratio. Changes in enrollments have a direct influence on the demand for faculty. These are the basic principles upon which our projections are based.

The assumptions used in each model cover what are considered to be the likely range of possibilities for funding levels and enrollments in the next 5 years. Projections of demand for "faculty," defined here as academically employed persons who hold a doctorate, are derived from alternative applications of the models and compared with expected growth in the Ph.D. labor force to determine whether there will be an adequate supply, a surplus (to be relieved by outward migration), or a shortage (leading to additional unfilled positions, inward migration from other fields, or appointment of the underqualified).

On the supply side, the Committee has sought to identify the factors that determine students' choices and their abilities to complete their degree programs, and to explain the system within which these factors operate.

Economic factors, some resulting from the interplay of market forces and others from public-policy decisions that affect the cost of education, play an important role in students' decisions to embark upon graduate study and to choose particular fields of specialization. Relative earnings, cost and duration of study, availability of stipends and other support, and prospects of employment in particular fields of study are examples of such factors. The contention that the specific field of study or the decision to obtain a Ph.D. is generally dependent upon economic considerations does not deny the noneconomic motivations in the demand for higher education. Rather, the argument is that marginal choices are influenced by the relative economic attractiveness of various alternative areas of study. Thus, projections of the supply of biomedical and behavioral scientists, and particularly the distribution of this supply by fields, must be grounded in accurate estimates of the future economic status of these fields relative to other fields requiring similar amounts of training.

Estimation of the economic prospects for the biomedical and behavioral sciences depends in turn on the supply response of future potential graduate students. That is, the relative salaries and prospects for employment of these scientists depend on their number in the labor force, as well as on research budgets and the numbers of graduate students to be trained. Thus, as Freeman (1971) and others have shown, the dynamics of the supply and demand for any broad area of professional manpower involves significant interactions among these factors, for which the magnitude and speed of adjustment cannot easily be estimated. For example, a decrease in the rate of real biomedical R and D expenditures can be expected eventually to reduce the relative salaries of research personnel in this area with the reductions affecting most quickly new postdoctoral entrants into the job market. This reduction in turn will tend to discourage first-year graduate enrollments in this area and perhaps undergraduate majors in biology, but may also lead to some increased utilization of the now less costly personnel in the area who have already been trained as researchers. Even more dramatically, news about unemployment or unsatisfactory employment of acquaintances who have preceded them will affect the attitudes of students toward such fields and depress graduate enrollments in the next phase of the cycle. The reduction in numbers of graduating Ph.D.'s will tend to improve their relative salary position and will subsequently affect future enrollments positively.

The key questions that these concerns raise for making projections of future needs relate to the length of time these various adjustments will take, how complete they will be, and how strong their influence will be. We do not have precise answers to these questions. They probably differ from field to field and surely are influenced by the degree to which personnel in any field have reasonably close substitutes in related fields.

Although numerical estimates must be made, it is essential to realize that projections of manpower supply and utilization inevitably must be based on judgments and assumptions. In subsequent chapters these judgments and assumptions are specified and applied to logical models of particular components of the labor market to derive estimates of future manpower supplies and utilization and recommended training levels for federal programs.

The projections of academic demand resulting from the models and the assumptions about future patterns provide the take-off points from which the recommended levels of training are derived. In its deliberations, the Committee has considered how the system has been operating--to the extent that it is revealed by the data that can be gathered--and how it is expected to operate in the next few years. Here the dynamics of faculty accession and attrition become critical factors. Data prepared for the Committee this year have provided some new insight into these dynamics and have caused modification of some previously held assumptions about attrition rates, for example, and the training background of newly hired faculty members. One of the most significant new findings is that in recent years only slightly more than 20 percent of newly hired faculty members in clinical departments of medical schools have had postdoctoral research training, whereas a decade ago this rate was much higher. Perhaps more than any other evidence, this statistic highlights the deteriorating capabilities of many young medical school faculty members to conduct clinical research. The Committee's judgment about what this percentage should be over the next few years is a key element in determining the size of the postdoctoral pool required to meet the anticipated utilization of scientists with postdoctoral training. Also to be considered are factors that determine the number of trained postdoctorals available to fill academic vacancies each year, i.e., the average length of postdoctoral training and the number that can be expected to seek academic careers.

While the federal government is an important source of support for postdoctoral training in many fields, it is clear that some support is also available from various other sources. Recent data on the portion of the postdoctoral pool supported by federal training funds is the final element considered in developing the recommended number of postdoctoral trainees to be supported under NRSA programs. The complete process is illustrated by the flow diagram in Figure 1.1.

An analagous procedure for determining the appropriate level of predoctoral training under NRSA programs has proven more elusive. The key elements here appear to be the level of Ph.D. production and the size of the postdoctoral pool, although the linkage between these variables and the amount of federal support for predoctoral training has not been established in a rigorous fashion. However, the Committee has closely monitored these quantities in this study and has tried to anticipate the needs for the 1980's. Its best judgment is that the emphasis should change from predoctoral to postdoctoral support, and recommendations have been made for a gradual reduction in overall predoctoral training under NRSA programs of more than 30 percent between 1975 and 1985.

Considerable uncertainty remains as to what can be said about the statutory mandate that the Committee specify fields that should be given priority in research training programs. This issue is intertwined with the problem of taxonomy--the labeling and classification of the fields within the areas of the biomedical and behavioral sciences.

In previous reports, the Committee has made recommendations in five broad scientific areas--basic biomedical, behavioral, clinical, health services research, and nursing research--while attempting to develop a methodology for estimating needs at more detailed levels within these areas. So far, compelling evidence of shortages in specific fields has been developed only in toxicology, epidemiology, biostatistics, and most of the clinical science fields. One fact is becoming clear as a result of this exploration--considerable mobility occurs within most of the broad areas. Individuals who receive their Ph.D. in one field are frequently found to be employed in a different but related field within the area. From the point of view of the individual involved, this might be called field-switching; from the employer's point of view it represents substitutability among the fields.

Although there is little support for the proposition that research personnel trained in different fields are completely interchangeable, field-switching data indicate that, within some limits as yet undefined, substitution can and does occur. The Committee's studies are progressing, but have not yet reached the point where fields can be grouped into those that represent homogeneous clusters within which there is considerable mobility and between which mobility is more difficult.

TRAINING DATA FOR FY 1979 AND FY 1980 AND RECOMMENDED LEVELS FOR 1982-1985

In FY 1979, the NIH, ADAMHA, and HRA provided support to 12,924 trainees and fellows under the NRSA and its predecessor programs. The total was down slightly from the 13,203 trainees and fellows supported in FY 1978 and down significantly from the peak year of training, 1969, in which the pre-NRSA training activity for full- and part-time trainees and fellows totalled 19,820 (12,083 predoctoral; 5,094 M.D., D.D.S., D.V.M., or equivalent professional degree; and 2,643 Ph.D.'s). The largest drop

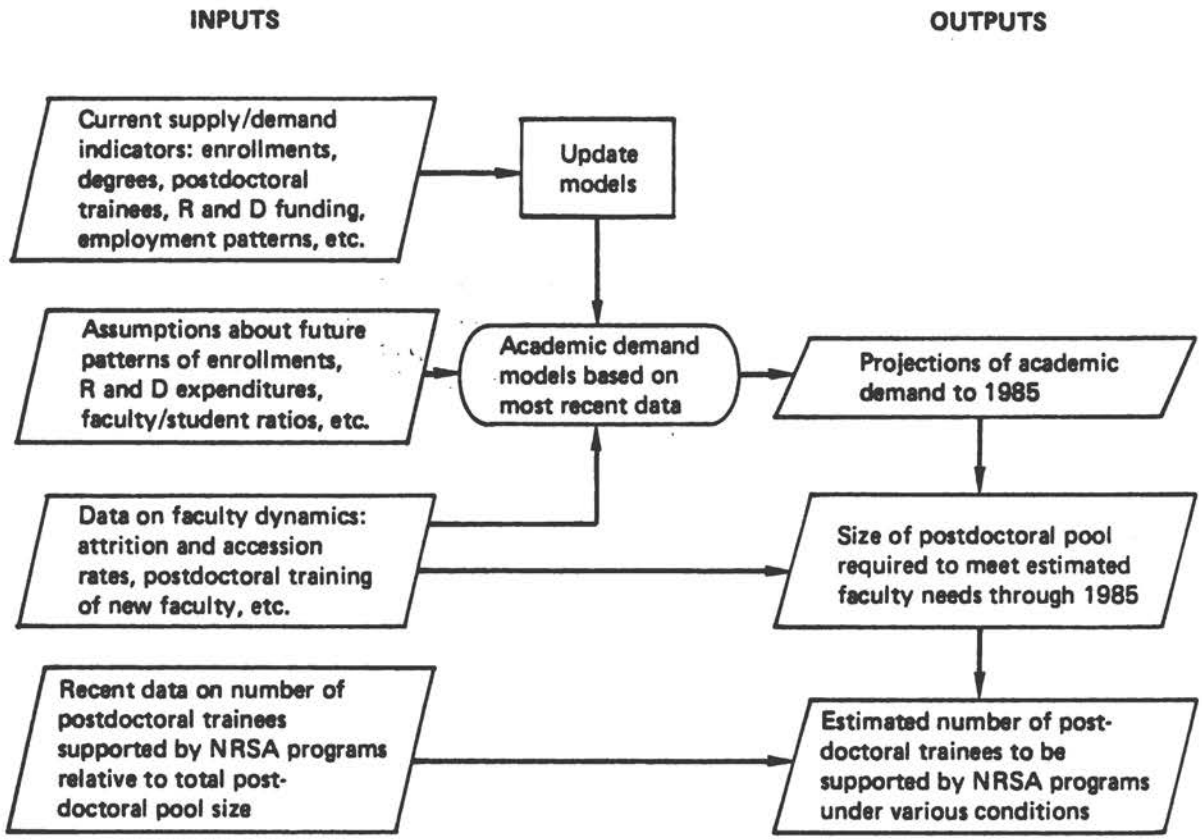


FIGURE 1.1 Flow diagram of procedure followed in deriving recommendations for postdoctoral training levels. Historical data on supply/demand indicators are updated annually and used to update the models of academic demand. The committee's assumptions about future patterns of enrollments, R and D funding, etc., are used in models to derive short-term projections of academic demand. These are combined with data on faculty attrition and accession rates and training background of new faculty members to estimate the total postdoctoral pool size needed to satisfy demand under the assumed conditions. The portion of the total postdoctoral pool to be supported under NRSA programs is then estimated also by reference to recent data.

in FY 1979 occurred in ADAHMA programs, which were reduced by 176 training positions from FY 1978 levels, while NIH provided 97 fewer awards and HRA dropped 6.

In terms of areas of training, the clinical sciences had an increase over 1978 of more than 100 positions, while the behavioral sciences lost more than 300. The remaining areas of biomedical sciences, health services research, and nursing research had only minor reductions.

In FY 1980, the total number of awards went up by 2 percent to 13,191 trainees and fellows, still below the FY 1978 level. All the increase occurred in NIH programs, which gained 407 training positions. Almost 90 percent of these were in the clinical science area. ADAMHA programs were further reduced by 140 positions, and HRA programs were reduced by 16 from FY 1979 levels.

Tables 1.1-1.3 show the data on the agencies' training awards for FY 1979 and FY 1980. Table 1.4 shows the Committee's recommended levels of training in each area for FY 1982-1985.

TABLE 1.1 Aggregated Numbers of NIH, ADAMHA, and HRA Traineeship and Fellowship Awards for FY 1979 and FY 1980[a]

		TOTAL ALL FIELDS	Biomedical Sciences	Behavioral Sciences	Clinical Sciences	Health Services Research	Nursing Research
FY 1979	TOTAL	12,924	7,356	1,126	4,139	176	127
	Predoctoral	6,453	4,101	779	1,382	81	110
	Postdoctoral	6,471	3,255	347	2,757	95	17
	Trainees	10,605	5,653	947	3,822	170	13
	Predoctoral	6,223	4,042	716	1,382	79	4
	Postdoctoral	4,382	1,611	231	2,440	91	9
	Fellows	2,319	1,703	179	317	6	114
	Predoctoral	230	59	63	0	2	106
	Postdoctoral	2,089	1,644	116	317	4	8
FY 1980	TOTAL	13,191	7,392	1,001	4,504	176	118
	Predoctoral	6,780	4,337	652	1,595	88	108
	Postdoctoral	6,411	3,055	349	2,909	88	10
	Trainees	11,137	5,784	844	4,313	174	22
	Predoctoral	6,579	4,294	591	1,595	87	12
	Postdoctoral	4,558	1,490	253	2,718	87	10
	Fellows	2,054	1,608	157	191	2	96
	Predoctoral	201	43	61	0	1	96
	Postdoctoral	1,853	1,565	96	191	1	0

[a]These are total numbers of awards for traineeships and fellowships. Data on the number of new starts for FY 1979 and FY 1980 are not available.

SOURCES: Office of the Administrator, ADAMHA (May 22, 1981); Division of Nursing, HRA (February 10, 1981 and April 9, 1981); Division of Research Grants, NIH (December 19, 1980 and August 10, 1981).

TABLE 1.2 NIH Traineeship and Fellowship Awards for FY 1979 and FY 1980[a]

			Biomedical Sciences					Behavioral Sciences	Clinical Sciences		Nursing Research
		TOTAL ALL FIELDS	Total Biomedical Sciences	Basic Biomedical Sciences	Math, Physics, Engineering, Other	Community and Environmental Health	Epidemiology and Biostatistics		Medical Scientist Program	Other Clinical Sciences	
FY 1979	TOTAL	11,391	6,940	6,467	104	135	234	185	666	3,473	127[b]
	Predoctoral	5,512	3,920	3,689	18	63	150	100	666	716	110
	Postdoctoral	5,879	3,020	2,778	86	72	84	85	0	2,757	17
	Trainees	9,291	5,330	4,946	26	129	229	126	666	3,156	13
	Predoctoral	5,388	3,902	3,671	18	63	150	100	666	716	4
	Postdoctoral	3,903	1,428	1,275	8	66	79	26	0	2,440	9
	Fellows	2,100	1,610	1,521	78	6	5	59	0	317	114
	Predoctoral	124	18	18	0	0	0	0	0	0	106
	Postdoctoral	1,976	1,592	1,503	78	6	5	59	0	317	8
FY 1980	TOTAL	11,798	6,995	6,608	97	53	237	181	665	3,839	118[c]
	Predoctoral	5,991	4,183	3,975	15	27	166	105	665	930	108
	Postdoctoral	5,807	2,812	2,633	82	26	71	76	0	2,909	10
	Trainees	9,934	5,463	5,157	24	53	229	136	665	3,648	22
	Predoctoral	5,878	4,166	3,958	15	27	166	105	665	930	12
	Postdoctoral	4,056	1,297	1,199	9	26	63	31	0	2,718	10
	Fellows	1,864	1,532	1,451	73	0	8	45	0	191	96
	Predoctoral	113	17	17	0	0	0	0	0	0	96
	Postdoctoral	1,751	1,515	1,434	73	0	8	45	0	191	0

[a]These are total numbers of awards for traineeships and fellowships. Data on the number of new starts for FY 1979 and FY 1980 are not available.
[b]Includes 109 predoctoral and 16 postdoctoral traineeship and fellowship awards in Nursing Research by the Division of Nursing, Health Resources Administration.
[c]Includes 99 predoctoral and 10 postdoctoral traineeship and fellowship awards in Nursing Research by the Division of Nursing, Health Resources Administration.

SOURCES: Division of Nursing, HRA (February 10, 1981 and April 9, 1981); Division of Research Grants, NIH (December 19, 1980 and August 10, 1981).

TABLE 1.3 ADAMHA Traineeship and Fellowship Awards for FY 1979 and FY 1980[a]

		TOTAL ALL FIELDS	Biomedical Sciences	Behavioral Sciences	Health Services Research
FY 1979	TOTAL	1,533	416	941	176
	Predoctoral	941	181	679	81
	Postdoctoral	592	235	262	95
	Trainees	1,314	323	821	170
	Predoctoral	835	140	616	79
	Postdoctoral	479	183	205	91
	Fellows	219	93	120	6
	Predoctoral	106	41	63	2
	Postdoctoral	113	52	57	4
FY 1980	TOTAL	1,393	397	820	176
	Predoctoral	789	154	547	88
	Postdoctoral	604	243	273	88
	Trainees	1,203	321	708	174
	Predoctoral	701	128	486	87
	Postdoctoral	502	193	222	87
	Fellows	190	76	112	2
	Predoctoral	88	26	61	1
	Postdoctoral	102	50	51	1

[a]These are total numbers of awards for traineeships and fellowships. Data on the number of new starts for FY 1979 and FY 1980 are not available.

SOURCE: Office of the Administrator, ADAMHA (Table S.1, May 22, 1981).

TABLE 1.4 Committee Recommendations for NIH/ADAMHA/HRA Predoctoral and Postdoctoral Traineeship and Fellowship Awards for FY 1982-85[a]

						Clinical Sciences			
			TOTAL ALL FIELDS	Basic Biomedical Sciences[b]	Behavioral Sciences[c]	Medical Scientist Program	Other Clinical Science Programs	Health Services Research	Nursing Research
1982	TOTAL	Total	12,785	7,450	1,180	725	2,800	330	300
		Predoc.	5,990	4,250	570	725	–[d]	190	255
		Postdoc.	6,795	3,200	610	0	2,800	140	45
	Trainees	Total	8,720	4,250	970	725	2,400	250	125
		Predoc.	5,690	4,250	470	725	–[d]	140	105
		Postdoc.	3,030	0	500	0	2,400	110	20
	Fellows	Total	4,065	3,200	210	0	400	80	175
		Predoc.	300	0	100	0	0	50	150
		Postdoc.	3,765	3,200	110	0	400	30	25
1983	TOTAL	Total	12,825	7,450	1,220	725	2,800	330	300
		Predoc.	5,930	4,250	510	725	–[d]	190	255
		Postdoc.	6,895	3,200	710	0	2,800	140	45
	Trainees	Total	8,750	4,250	1,000	725	2,400	250	125
		Predoc.	5,640	4,250	420	725	–[d]	140	105
		Postdoc.	3,110	0	580	0	2,400	110	20
	Fellows	Total	4,075	3,200	220	0	400	80	175
		Predoc.	290	0	90	0	0	50	150
		Postdoc.	3,785	3,200	130	0	400	30	25
1984	TOTAL	Total	12,865	7,450	1,260	725	2,800	330	300
		Predoc.	5,870	4,250	450	725	–[d]	190	255
		Postdoc.	6,995	3,200	810	0	2,800	140	45
	Trainees	Total	8,780	4,250	1,030	725	2,400	250	125
		Predoc.	5,590	4,250	370	725	–[d]	140	105
		Postdoc.	3,190	0	660	0	2,400	110	20
	Fellows	Total	4,085	3,200	230	0	400	80	175
		Predoc.	280	0	80	0	0	50	150
		Postdoc.	3,805	3,200	150	0	400	30	25
1985	TOTAL	Total	12,905	7,450	1,300	725	2,800	330	300
		Predoc.	5,810	4,250	390	725	–[d]	190	255
		Postdoc.	7,095	3,200	910	0	2,800	140	45
	Trainees	Total	8,820	4,250	1,070	725	2,400	250	125
		Predoc.	5,540	4,250	320	725	–[d]	140	105
		Postdoc.	3,280	0	750	0	2,400	110	20
	Fellows	Total	4,085	3,200	230	0	400	80	175
		Predoc.	270	0	70	0	0	50	150
		Postdoc.	3,815	3,200	160	0	400	30	25

[a]These are total numbers of recommended awards. See Table 1.1 for number of actual awards made in FY 1979 and FY 1980. The number of new starts in any given year is sensitive to fluctuations in the funding level and thus oscillates more rapidly than does the total number of awardees.

[b]Recommendations for biostatistics, epidemiology, community and environmental health, and other training fields not specifically shown in this table are included here.

[c]The allocation of awards in the behavioral science fields between traineeships and fellowships is based on the distribution that prevailed in FY 1976, i.e., 82 percent traineeships, 18 percent fellowships.

[d]A program of short-term research training (3 months) for health professions students during summer and off-quarters was authorized in 1978. The Committee has endorsed this program in principle but makes no recommendations for the number of students to be supported under it. The 1978 amendments to the NRSA Act authorized expenditures for this program of up to 4% of appropriated training funds. In FY 1980, 50 training grants were awarded with stipends for 911 trainees.

Estimated Costs

The Committee's last recommendations for training levels under the NRSA program appeared in its 1979 report. Cost estimates for the recommended program, also published in that report, were based on the new stipend levels that went into effect on July 1, 1980, and the additional assumption that stipends and other program costs would continue to increase by 5 percent per year. However, according to the most recent information from NIH, there are no plans to increase stipend levels beyond the July 1, 1980, schedule. Thus our previous cost estimates must be revised downward. Table 1.5 below shows the revised estimates for the NRSA programs using the current training recommendations under the following assumptions:

(1) stipends will remain at the levels published in the new schedule effective July 1, 1980;
(2) tuition will increase by 5 percent per year; and
(3) institutional allowances will be limited to $3,000 for predoctoral trainees and $5,000 for postdoctoral trainees.

TABLE 1.5 Estimated Cost of Recommended NIH/ADAMHA/HRA Training Programs for FY 1982-85 (millions of dollars)[a]

Fiscal Year	Type of Program	TOTAL ALL FIELDS	Biomedical Sciences	Behavioral Sciences	Clinical Sciences[b]	Health Services Research	Nursing Research
1982	TOTAL	218.9	123.4	22.0	64.1	5.4	4.0
	Trainees	141.4	61.5	18.4	55.6	4.2	1.7
	Fellows	77.5	61.9	3.6	8.5	1.2	2.3
	Predoc.	*77.3*	*61.5*	*8.1*	*2.2*	*2.4*	*3.1*
	Postdoc.	*141.6*	*61.9*	*13.9*	*61.9*	*3.0*	*0.9*
1983	TOTAL	223.2	125.8	23.6	64.3	5.4	4.1
	Trainees	144.6	63.1	19.7	55.8	4.2	1.7
	Fellows	78.6	62.7	3.9	8.5	1.2	2.4
	Predoc.	*78.4*	*63.1*	*7.4*	*2.3*	*2.4*	*3.2*
	Postdoc.	*144.8*	*62.7*	*16.2*	*62.0*	*3.0*	*0.9*
1984	TOTAL	226.9	127.7	25.1	64.4	5.5	4.2
	Trainees	147.9	64.9	21.0	55.9	4.3	1.8
	Fellows	79.0	62.8	4.1	8.5	1.2	2.4
	Predoc.	*79.6*	*64.9*	*6.6*	*2.4*	*2.5*	*3.3*
	Postdoc.	*147.3*	*62.8*	*18.5*	*62.0*	*3.0*	*0.9*
1985	TOTAL	230.0	129.0	26.7	64.5	5.5	4.3
	Trainees	150.8	66.2	22.5	56.0	4.3	1.8
	Fellows	79.2	62.8	4.2	8.5	1.2	2.5
	Predoc.	*80.3*	*66.2*	*5.9*	*2.4*	*2.5*	*3.4*
	Postdoc.	*149.7*	*62.8*	*20.8*	*62.1*	*3.0*	*0.9*

[a]Calculations were based on 1980 average cost figures derived from NIH data and assume no increase in stipends, but include a 5% per year increase in tuition.
[b]Estimate includes 1,000 predoctoral trainees in the short-term training program.

ESTIMATED TRAINING COSTS PER AWARD IN FY 1980 (dollars)

	Predoctoral					Postdoctoral				
FY 1980	Biomed. Sci.	Behavioral Sci.	Clinical Sci.	Health Services Research	Nursing Research	Biomed. Sci.	Behavioral Sci.	Clinical Sci.	Health Services Research	Nursing Research
Trainees	11,570	12,850	2,140	11,570	11,570	21,440	22,580	22,200	21,440	21,440
Fellows	11,570	12,850	-	11,570	11,570	18,900	19,130	20,960	18,900	18,900

2. CLINICAL SCIENCES

The Committee defines clinical investigation as research on patients; on samples derived from patients as part of a study on the causes, mechanisms, diagnosis, treatment, prevention, and control of disease; or on laboratory animals by scientists identifiable as clinical investigators on the basis of their other work. As a mode of scholarly inquiry, clinical investigation takes many forms. It may consist of the systematic observation of individual patients in a controlled environment or large-scale clinical trials involving thousands of subjects and the pooled effort of investigators in multiple institutions. It includes carefully controlled studies to elucidate the mechanisms of disease, or epidemiologic research to uncover leads as to the etiology of disease. An essential aim of clinical investigation is to translate new knowledge, through applied research, into new technology and modes of treatment, as well as the validation of new technology through clinical trials.

The clinical investigator[1] generally has an M.D. or other health professional doctorate. The Committee recognizes that basic scientists also participate in clinical investigation. As part of the clinical investigation team, they have a multifaceted role that may range from studying isolated tissue components derived from patients to close collaboration with a physician-investigator in research requiring experimental manipulation of human subjects and their environment. Moreover, they often help to ensure the application of state-of-the-art technology to clinical investigation. While such participation is to be encouraged, there will always be an overriding need for the physician investigator who is uniquely prepared to recognize research opportunities presented by human disease, to formulate researchable questions, to design experiments for answering those questions, and to perform personally the work entailed in those experimental designs. In many cases it will be necessary to study patients intensively, permitting the clinical situation to guide the nature of the questions, as well as the manner of seeking their answers. In addition, legal, ethical, and regulatory constraints establish the primacy of the physician in clinical investigation. In short, the physician investigator has a very special role both in bringing clinical insights to bear in the laboratory and in translating new knowledge into the context of medical practice.

Given this irreplaceable role, the Committee reiterates its concern over the precipitous decrease in postdoctoral training of physicians. As can be seen in Table 2.1, the number of persons with a health professional doctorate receiving training under NIH training programs has declined in both absolute numbers and as a percentage of total postdoctoral trainees/fellows supported by NIH from 1971 to 1979. While some of the decline can be attributed to the elimination of predominantly

TABLE 2.1 Distribution of NIH Postdoctoral Trainees and Fellows by Degree Type, 1971–79[a]

Year		Total	M.D.'s[b]	Ph.D.'s[b]
1971	#	7,532	4,631	2,901
	%	100.0	61.5	38.5
1972	#	7,393	4,466	2,927
	%	100.0	60.4	39.6
1973	#	5,466	3,612	1,854
	%	100.0	66.1	33.9
1974	#	6,313	3,522	2,791
	%	100.0	55.8	44.2
1975	#	5,957	2,874	3,083
	%	100.0	48.2	51.8
1976	#	4,884	1,950	2,934
	%	100.0	39.9	60.1
1977	#	5,295	1,906	3,389
	%	100.0	36.0	64.0
1978	#	5,683	1,954	3,729
	%	100.0	34.4	65.6
1979	#	5,613	1,923	3,690
	%	100.0	34.3	65.7

[a]These data represent individuals who actually served in NIH-supported traineeship or fellowship positions. Thus these counts may differ slightly from those shown in Chapter 1 which represent awards, not individuals on duty. Includes Fogarty International Center programs.
[b]"M.D." and "Ph.D." also include equivalent doctorate degrees. Persons with both M.D. and Ph.D. degrees are shown under "M.D.".

SOURCE: National Institutes of Health (1966–81).

clinical training programs early in that period, the decrease in more recent years probably reflects a diminished interest in research careers on the part of the young physician (see p.28). The Committee believes that the decline has serious implications for the future of patient-centered and disease-oriented research.

THE TRAINING OF PHYSICIAN INVESTIGATORS

With the movement of clinical medicine "from anecdotal empiricism to an approach based on analysis and experimentation," clinical investigation has become the bridge between basic and clinical science (Thier, 1980). In that process it has become enormously sophisticated and complex. It is appropriate therefore to ask how the young physician acquires the diverse scientific and clinical skills needed for a successful career in clinical investigation.

Clinical research training is heterogeneous in nature, duration, sources of support, and degree of formality of the training experience. The newly trained physician investigator is not the product of a distinct course of study, such as the curriculum leading to the M.D. degree or graduate medical education programs aimed at eligibility for primary specialty board certification. Although the physician enters research training most commonly at the end of the last year of the residency program, there are many points along the continuum of medical education at which the decision for a research career may be made. Individuals enter research training at different stages of their educational and professional careers and with varying amounts of research experience. Moreover, there is a diversity of paths for transition from the trainee pool to the community of productive clinical researchers.

Medical School

Despite this diversity, the development of a clinical investigator in most cases begins in medical school where research opportunities can take several forms. Some medical students receive their first exposure to research by repeating classical experiments in basic science or by casual laboratory interactions with faculty members. Other students may develop a firsthand acquaintance with the laboratory through summer extramural experiences, such as research fellowships. Short-term training for periods of up to 3 months, for example, is currently supported by NRSA institutional awards for 964 trainees in 65 health professional schools. In some medical schools fellowships similar to the former NIH Post-Sophomore Research Fellowships are available to specially selected students. These awards provide an opportunity for a student to interrupt regular coursework with a full year of advanced study and research.

Students who have developed a strong interest in research during their premedical education have an opportunity in three-quarters of United States medical schools to combine medical and graduate studies in programs leading concurrently to the M.D. and Ph.D. degrees (M.D./Ph.D.). A selected subset of 24 medical schools have 6 year dual degree programs funded through the NRSA Medical Scientist Training Program of the National Institute of General Medical Sciences. Another source of potential clinical investigators is comprised of students who enter medical school with the Ph.D. degree (Ph.D./M.D.). The postgraduation research plans of this group are compared in a later section of this chapter, with those of concurrent M.D./Ph.D.'s and medical students who do not earn a Ph.D. degree.

Residency

The pattern for including a research experience within a standard residency varies considerably among clinical specialties. Some residencies, including a number of surgical specialties, routinely include from 3 months to 1 year of clinical research experience. The rationale, however, is to prepare clinicians who can keep abreast of advances in the specialty, rather than to produce clinical investigators. By contrast, research experience is no longer considered as part of the general training requirements in other specialties such as pediatrics and internal medicine. During the period of residency, as a general rule, the young physician will have had little or no training in the discipline of the laboratory, the design and execution of experiments, and the understanding of complex instruments and research technology. In short, to become a productive investigator, he/she needs to start a second and new career.

Post-Residency

Research training has traditionally been intermixed with clinical specialty training for most physicians who later pursued careers in academic medicine. This reflects the fact that many clinical research activities must be conducted in patient care settings. In internal medicine, for example, research-oriented residents completing the general program subsequently entered subspecialty training, e.g., cardiology, gastroenterology, rheumatology, etc., with the goal of additional certification in that subspecialty and acquisition of research experience. Many of these subspecialty fellowship programs received support from federal training grants. Recent debate over the need for additional subspecialists has prompted questions by federal and other funding agencies as to whether it is appropriate for public funds to be used for research training provided in connection with subspecialty training. This has resulted in diminished funding of subspecialty fellowships which, in turn, has reduced the number of opportunities for training in clinical investigation.

At the end of the residency, physicians with research training in their background can work as postdoctoral research fellows under individual preceptors. NRSA fellowships are well-suited as a support mechanism for this purpose. Such support is particularly applicable to graduates of joint M.D./Ph.D. programs, most of whom take at least 3 years of residency training in a clinical specialty. Residency schedules, however, are relatively inflexible, permitting little or no contact with laboratory research during this period. This discontinuity makes reentry into the laboratory extremely difficult, especially in light of the rapid pace of conceptual and methodologic advance in biomedical research. To compete successfully as a physician investigator, a postdoctoral fellowship in a basic or clinical research laboratory is virtually a necessity. Most physicians emerging from residency programs, unlike post-Ph.D. trainees who have already been in the laboratory for several years, are not adequately prepared to write research fellowship proposals. For them 2 or 3 years of individually tailored training in either a basic science or clinical department would be needed to accomplish the coursework, seminar participation, and independent study/research for a career in clinical investigation.

DETERMINANTS OF CAREER CHOICE

The Committee in previous reports noted the increasing indications that young physicians may be less likely to view clinical investigation as an attractive career option. Various factors presumed to be affecting their career decisions were highlighted, including testimony at a public meeting on the effect of increasing national emphasis on the training of primary care physicians. Recognizing the need for a clearer insight into the underlying attitudes and values, the Committee assigned high priority to research in this area. Since publication of its last report, three studies commissioned by the Committee for this purpose have been completed.

Career Plans of Medical Students

The first study, which was carried out by the Association of American Medical Colleges, was based on a December, 1979, survey of all medical school seniors who expected to graduate in 1980 (AAMC, 1981b). Included in this survey were questions on choice of various career paths, as well as attitudes toward research. The responses were matched with records of answers provided by each student to a questionnaire administered with the Medical College Admissions Test (MCAT), the individual's MCAT scores, and with records from the application for admission to medical school.

Students were asked to indicate their first, second, and third preference for alternative careers in research, clinical practice, and administration. For purposes of analysis, respondents were assigned on the basis of their first and second choices of career alternatives to three groups--"Research Firsts," "Research Seconds," and "Non-Researchers." Research was checked as the first choice of 21.8 percent of respondents; 12.2 percent checked research as their second choice but not as first; 66.0 percent checked only clinical practice as first and second choices. From a comparison of the three groups, some of the findings were as follows.

Test Scores

The groups differ significantly in their mean MCAT scores. "Research Firsts" and "Research Seconds" had the highest and second highest mean for all four (Verbal, Quantitative, General, and Science) tests.

Gender

There was no statistically significant difference between the sexes regarding preferences for research career. "Research Firsts" and "Research Seconds" both had virtually the same distribution of males and females as in the total group of respondents.

Experiences During Medical School

Somewhat less than one-quarter of all respondents reported having participated in a research project as an investigator during medical school. Grouped according to career plans, 45.3 percent of "Research Firsts" and 24.2 percent of "Research Seconds" reported such an experience, compared with 16.3 percent of the "Non-Researchers." A similar pattern can be observed with respect to publications.

Approximately 15 percent of all respondents had been sole or joint authors of research papers during their undergraduate medical years. For the three groups the percentage were "Research Firsts," 31.4 percent; "Research Seconds," 15.0 percent; and "Non-Researchers," 10 percent.

Debt

The data do not indicate that anticipated accumulated debt at graduation from medical school operates as a disincentive to choice of research career.

Factors Influencing Research Career Choice

Respondents were asked to indicate the relative influence each of nine factors played in their consideration of research involvement in their ensuing medical careers. The three factors of highest importance to both "Research Firsts" and "Research Seconds" were: opportunity to work in the academic community, challenge of search for new knowledge, and research experience while a premedical or medical student. These factors were substantially more important, however, to "Research Firsts" than to "Research Seconds," who scaled them all to be of "moderate," rather than "major," influence. A fourth factor, "availability of research training support," was scaled to be of "moderate" importance to "Research Firsts" and "Research Seconds" and of "minor" influence to "Non-Researchers."[2] Finally, all three groups rated as being of "minor" or "no importance" four factors proposed by many observers as hypotheses to explain the declining entry of physicians into research training. These factors were: uncertain availability of research funds after completion of training, increasing frustrations of researchers in conducting clinical research, financial disadvantages of a research career, and obligation to pay back research training support by continued research activity.

Plans of M.D./Ph.D.'s and Ph.D./M.D.'s

Ninety-eight percent of graduates of the NIH-sponsored Medical Scientist Training Program (MSTP) indicated research careers as their first choice, compared to 90 percent of other M.D./Ph.D.'s. Ph.D.'s who subsequently earn the M.D. degree are about half as likely as concurrent M.D./Ph.D.'s to select a research career first (53 percent), but they are over twice as likely to choose research as are 1980 graduates earning the M.D. degree only (21 percent).

Comparison with Earlier Graduates

The AAMC Graduation Questionnaire has been administered annually since 1978. Comparable data on career preference are also available from a questionnaire sent to the entire graduating classes of a sample of 28 medical schools in 1960. Responses to these questionnaires, taken together, permit an assessment of changing student attitudes toward research careers.

The classes of 1960, 1978, 1979, and 1980 compare as follows:

Graduation Class	Percent Favoring Research Careers
1960	39.0
1978	22.4
1979	20.3
1980	21.8

There is no clear trend in the last 3 years, but for all 3 the level of research interest is noticeably less than it was in 1960. The percentage of graduating seniors in the 3 recent years who will fulfill their expressed plans is unknown, but it would have to be a high proportion to equal the level of research participation of the Class of 1960.[3]

Economic Incentives/Disincentives

Scheffler (1975), in an earlier study using 1971 income data, presented empirical estimates of the rate of return or loss to post-M.D. trainees in biomedical science who subsequently pursue careers as faculty members of a medical school, researchers at NIH, or employees in private industry. In each of the career paths the training produced an economic net loss to the trainee over his/her professional lifetime relative to the alternative of a career in private practice. Moreover, the discounted value of the net loss was relatively large.[4] The loss varied substantially by specialty field and increased with the length of post-M.D. training. Under sponsorship of the Committee, the author has updated his earlier work and has applied a similar method of calculation to physicians, dentists, and veterinarians (Scheffler, 1981). In general, the results of the later study show that the net lifetime economic loss, in terms of 1979 income data, is less than that reported earlier.

For the three professions there was net loss in income associated with postdoctoral training. Training was assumed to last 2 years, with stipends at 1980 NIH levels and a discount rate of 12 percent. Physicians pursuing a career at NIH sustain a lifetime economic loss of about $170,000, which is $100,000 more than the loss incurred by medical school faculty on a base salary. Dentists employed at NIH stand to forego about $111,000 in lifetime income in comparison to dental practice careers, with little economic differences between NIH employment and dental school faculty careers. Using different discount rates, the same comparisons yield the following results in terms of lifetime economic loss:

	Lifetime Economic Loss Discount Rate		
	12%	8%	0%
Physicians			
at NIH	$170,000	$242,000	$645,000
at Medical School	$ 70,000	$127,000	$239,000
Dentists at NIH	$111,000	$164,000	$550,000

Compared to physicians and dentists, veterinarians have small economic losses, whether employed by the federal government or a veterinary school. The economic losses varied considerably by specialty for physicians undertaking 2 years of postdoctoral training and selecting a career either at NIH or on a medical school faculty (see Appendix Table A9). The largest economic loss--$241,000 at the 12 percent discount rate--would be incurred by anesthesiologists choosing an NIH career. Psychiatrists would realize an economic gain of approximately $25,000 as medical school faculty members (base salary plus supplemental earnings), but by contrast would lose $34,000 in a career at NIH. For several specialties, such as radiology, obstetrics/gynecology, and internal medicine, NIH careers produce an economic loss of over $155,000, averaging 2.8 times the losses to medical faculty. Comparing the losses in 1971 and 1979, the author found that for five of the seven specialties studied, the economic losses increased for employment at NIH, whereas for five specialties, losses declined for employment at medical schools over this period.

The percent of loss accruing during the first 5 years following postdoctoral training is also of some interest. This derives from the fact that some individuals may select careers using a shorter time horizon because they do not assume they will remain in this career path. Based on the same rate of return methodology as for the earlier calculations, 42 percent of the loss in a NIH career accrues during the first 5 years after training, while 61 percent of the career loss accrues for employment at a medical school (base salary).

How large would postdoctoral research training stipends need to be, it was asked, to reduce to zero the economic losses calculated for physicians, dentists, and veterinarians? In other words, what size of stipend would make the monetary rewards in each of these careers equivalent to those in private practice? Scheffler's analysis suggests that physicians who pursue a research career at NIH would need to receive a training stipend of about $63,000 per year for 2 years in order to reduce their economic losses to zero in comparison to careers in medical practice. For those employed in medical schools, it would be about $30,000 per year. Current stipend levels are about $16,000. To produce the same effect for dentists employed at NIH or on a dental school faculty would require a stipend in excess of $50,000. Veterinarians would need a stipend level of about $25,000.

The suitability of rate of return models has been criticized on grounds that earnings are only part of the determinant of rational personal investment in human capital. Few people choose a career solely on the consideration of earnings. Instead, most give greater weight to their anticipated overall career satisfaction. A significant part of the return on training may in fact be personal satisfaction of dedicated biomedical research scientists as they enhance their knowledge and skills. Also, as noted elsewhere in this chapter, many consider the challenge of the search for new knowledge to be a nonpecuniary benefit that more than offsets the higher remuneration obtainable from clinical practice. Thus, to the degree that nonpecuniary benefits of careers in biomedical science offset the monetary aspects, the measured rate of return to investment in post-M.D. training will have little consequence in influencing the decision to undertake research training. In sum, the effect of ignoring the career satisfaction aspect of training in calculating private rates of return is to underestimate the rate of return to investment in training.

Research Careers in Internal Medicine

Under Committee sponsorship, researchers at Michigan State University have studied the factors influencing choice between careers in academic medicine and private practice. Responses to a mail questionnaire were received from more than 200 physicians, representing a national sample of those who had completed their subspecialty training in internal medicine by June, 1979, who had already decided for or against going into academic medicine, and who were regarded by their training program directors as possessing the qualifications for a career in academic medicine. The sample was designed to provide an approximately equal distribution of academic and nonacademic deciders.

A notable finding was the absence of a significant difference between the two groups in either current salary or aggregate debt. Moreover, there were no apparent financial pressures influencing the career choices. Respondents appeared to be fully aware of potential differences in future income. Those moving into private practice expected higher income than their academic colleagues both 3 and 10 years from the time of the survey. Those choosing academic medicine expected their income to be about 30 percent less in 3 years than those in private practice, and about 17 percent less after 10 years. Income expectations appeared to be of moderate importance to those choosing a practice career and of relatively minor importance to those selecting an academic career.

The study noted a primary emphasis on intellectual stimulation by those selecting careers in academic medicine. It is the importance of intellectual stimulation, along with considerably greater interest in clinical research, that most clearly distinguishes those selecting academic medicine. This is in contrast to those selecting practice, who seem to be most oriented toward patient care and interaction, and who also consider other factors important such as personal autonomy, availability of "call" coverage, ability to locate in one community, and salary.

In rank-ordering the desirability of various career activities, the biggest difference between the two groups was in the rating of primary care. It was as though primary care was perceived as the reciprocal of research. Accordingly, the fact of having made the choice of primary care virtually excludes for that individual the possibility of performing research.

Discussion

The study of economic rate of return, cited above, has documented that the early and lifelong earnings of physicians in academic medicine are less than comparable average earnings of physicians in private practice. This fact, plus a high level of debt accumulated before graduation from medical school, have been commonly perceived to serve as disincentives for following a research career. However, other studies raise some question as to the extent to which financial factors, such as debt burden and differential earnings, at current levels serve as deterrents to selection of a research career. Certainly, one should not forget that in the heyday of National Research Council fellowship support for M.D. investigators, the relatively enormous income differential between research and practice careers seemed not to operate as a disincentive (Cain and Bowen, 1961). Moreover, income figures may be deceptive, since averages for clinical practice can be distorted by the earnings in a relatively few subspecialties. In addition, faculty salaries in clinical departments have increased to a point where it is not uncommon for a starting salary of an assistant professor to triple the salary received in the last year of residency training.

Data from the Michigan State University study and from analysis of the AAMC Graduation Questionnaire underline the key role of intellectual stimulation as an incentive for a research career. Its importance as a discriminant between academic and practice "deciders" was the basis for a recommendation in the MSU study that intellectual curiosity be emphasized in the selection process for medical students and fellows.

Data from comparisons of future physician researchers and nonresearchers document the need for providing undergraduate medical students with the time and opportunity to acquire firsthand knowledge of the excitement of working in a research laboratory. This conclusion is reinforced by a finding from a study of factors affecting the career decisions of more than 1,100 members of the American Society for Clinical Investigation and the American Federation for Clinical Research (Davis and Kelley, 1981). The largest fraction of respondents indicated that their research career decision had been made during medical school and that the most important events influencing this decision had occurred during the same period.

In both the Michigan State University study and the AAMC survey of graduating seniors, payback was seen not to have been a serious deterrent to research career planning. In addition, the survey of successful clinical investigators by Davis and Kelley showed that the payback obligation was perceived to be a relatively minor factor in the decision-making process. The findings for "recent deciders" in internal medicine may be flawed, however, owing to the very small number of respondents who had received NRSA training. Moreover, the AAMC finding should be interpreted with some caution, inasmuch as the decision on incurring a payback obligation was for most medical school seniors some 3 or more years in the future. Similarly, the results from the survey of established investigators may have limited value, since they really represent answers to hypothetical questions. In sum, although it is possible that payback is less of a deterrent than is widely believed, evidence for such a view remains inconclusive.

COMPARISON OF TRAINING PROGRAMS

The National Institutes of Health have for many years administered both extramural and intramural research training programs for physicians. In addition to postdoctoral traineeships and fellowships (Trainees/Fellows), extramural funds have supported since 1964 a Medical Scientist Training Program (MSTP) in which trainees concurrently pursue the M.D. and Ph.D. degrees. In addition, intramural funds support two other research training programs. One is for Research Associates who devote most of their time, under a preceptor, to laboratory research in biomedical science. The second is for Clinical Associates who participate in both clinical and laboratory research, as well as in clinical activities under the immediate supervision of senior investigators. The Medical Scientist Training Program averages 6 years in length, compared with just over 2 years for the other three programs.

Given the decline since 1974 in numbers of physicians receiving research training, the continuing need for physician investigators, and the limitations on NIH research training funds, the Committee considered it important to compare output of these principal routes for research training of physicians. A recent study by the Association of American Medical Colleges undertook such a comparison, using the following output measures: (a) percent of trainees who remain in research, (b) research productivity in terms of publications and type of journals in which papers are published, (c) rate of advance in academic or research positions, and (d) success in competing for NIH research grants (AAMC, 1981b). The 53 persons completing the Medical Scientist Training Program between 1968 and 1973 served as the reference group. For each of these 53 trainees, a comparable student who subsequently was trained during those years in each of the other three programs was identified. The comparison student was of the same age and sex, entered the same (or a similar) medical school with comparable undergraduate education, and had comparable Medical College Admission Test (MCAT) scores taken at about the same time.

The fourfold comparison revealed that:

(1) All four programs were highly successful in producing physician investigators. MSTP had the highest proportion of graduates--74 percent--who could be confirmed as currently involved in research. Comparable figures for Research Associates, Clinical Associates, and Trainees/Fellows were 58 percent, 58 percent, and 47 percent, respectively. When program graduates engaged in other medical school faculty activity are included, the percentages rise to 89 percent, 75 percent, 68 percent, and 62 percent, respectively. As a percent of graduates with known current career status, 94 percent of MSTP and 95 percent of Research Associates were in research and teaching. Comparable percentages for Clinical Associates and Trainees/Fellows were 86 percent and 83 percent, respectively.

(2) By 1981 a significantly larger proportion of MSTP graduates than of participants in the three other programs had attained tenured faculty rank. About 42 percent of MSTP graduates who had joined faculties achieved tenure, compared with 17 percent of former Research Associates and Trainees/Fellows and 4 percent of Clinical Associates.

(3) Research grant success rates at NIH did not appear to discriminate among the four groups. MSTP graduates, Clinical Associates, and Trainees/Fellows had higher approval rates and better average priority scores than those for all applicants. Judged by only a small number of applications, the performance of former Research Associates was mixed--relatively low approval rate but excellent average priority scores for approved applications.

(4) Publication performance for graduates of the four training programs showed marked differences in the quantity and scientific depth of the articles they published. MSTP graduates were the most prolific authors, having published 995 articles by 1981, compared with 716 articles by Research Associates, 673 by Clinical Associates, and 408 by Trainees/Fellows. All groups published articles in journals of all four scientific "levels,"[5] but the distribution by "level" differed substantially. MSTP graduates and Research Associates, for example, published predominantly in journals characterized by a high degree of scientific rigor, e.g., Journal of Biological Chemistry and American Journal of Physiology. Former Clinical Associates and Trainees/Fellows published most frequently in journals, such as the New England Journal of Medicine, which contain a mixture of reports on clinical investigation and clinical observation. Of the four groups of trainees, former Clinical Associates published most frequently in journals emphasizing clinical observation, e.g., the Journal of the American Medical Association.

With respect to these findings several comments are in order. First, the MSTP reference group included all of the first 53 successful graduates of this very selective program. Because of the rigorous matching criteria, however, the three comparison groups may not be entirely representative of all the graduates of each of these training programs. Second, the significantly larger proportion of MSTP graduates achieving tenured academic rank by 1981 may have resulted mainly from the advantage of their having undergone the rigorous research experience required to earn the Ph.D. degree. Third, differences in the publication history suggest strongly that the four programs had different products. MSTP graduates and Research Associates appeared to conduct much basic, as well as clinical, research. Research by former Clinical Associates and Trainees/Fellows included a relatively higher proportion of clinical observations and clinical investigations. MSTP graduates were clearly the most prolific authors, whereas former Trainees/Fellows made notably fewer contributions to the medical and scientific literature. Fourth, the finding that Trainees/Fellows, even in the absence of a payback obligation, continued at a substantial level their teaching and research involvement runs counter to a widespread belief that a majority of these people entered practice rather than academic careers. Verification of this finding was accomplished through a direct matching of all recipients of NIH extramural research training support with the Medical Faculty Roster of the Association of American Medical Colleges. Of the 26,307 physicians who received such postdoctoral training support through 1975-1976, 13,527, or 51 percent, were on the Faculty Roster in 1981. This figure is compatible with the 47 percent noted in item 1, above, for the comparison sample of the study. This corroboration of the sample data provides a basis for believing that NIH fellowship and traineeship support over several decades has been successful in producing researchers and teachers.

RESEARCH TRAINING AND RESEARCH CAREER LONGEVITY

Follow-up studies such as the above suggest that participation in formal research training programs enhances the trainees' subsequent research productivity. Proof of this proposition is hard to obtain because there are many factors, obvious and subtle, that could also affect an individual's productivity. Since measuring their separate effects is extremely difficult, it is necessary to rely instead on certain measurable relationships that give evidence for or against the proposition.

One such link is that between the duration of research grant support and previous research training experience. Recently developed data presented in Table 2.2 show that those scientists with NIH-supported postdoctoral training survived much longer in the competition for NIH research grants than those without such postdoctoral training. Ph.D. scientists, it should be noted, exhibit a similar pattern. Futhermore, the difference is consistent over the period of years shown. To the extent that survival time as a principal investigator is an acceptable measure of research productivity, these data clearly imply that postdoctoral research training is an important factor in subsequent research success.

TABLE 2.2 Length of Career as NIH Principal Investigator With and Without NIH Postdoctoral Training

Fiscal Year of First Research (R01) Award		With NIH Postdoctoral Training		No NIH-Supported Postdoctoral Training	
		M.D.'s	Ph.D.'s	M.D.'s	Ph.D.'s
1957	Yrs. as NIH P.I. (median)	16.8	16.7	11.8	10.8
	No. of P.I.'s	76	135	447	515
1958	Yrs. as NIH P.I. (median)	20.5	17.8	10.1	11.7
	No. of P.I.'s	46	97	276	321
1959	Yrs. as NIH P.I. (median)	16.5	13.5	10.4	8.7
	No. of P.I.'s	88	134	418	565
1960	Yrs. as NIH P.I. (median)	10.3	12.8	7.9	6.9
	No. of P.I.'s	120	162	467	568
1961	Yrs. as NIH P.I. (median)	11.6	11.7	6.9	5.8
	No. of P.I.'s	101	143	343	497
1962	Yrs. as NIH P.I. (median)	9.8	10.4	6.7	5.9
	No. of P.I.'s	159	174	351	508
1963	Yrs. as NIH P.I. (median)	10.7	11.2	5.7	5.4
	No. of P.I.'s	160	215	290	455
1964	Yrs. as NIH P.I. (median)	9.2	11.2	4.4	4.4
	No. of P.I.'s	203	207	388	640
1965	Yrs. as NIH P.I. (median)	8.4	11.3	4.0	4.7
	No. of P.I.'s	210	215	301	436
1966	Yrs. as NIH P.I. (median)	9.2	11.2	4.9	4.8
	No. of P.I.'s	245	203	268	394
1967	Yrs. as NIH P.I. (median)	8.6	10.0	5.0	5.4
	No. of P.I.'s	215	210	233	420
1968	Yrs. as NIH P.I. (median)	7.2	10.2	5.7	7.1
	No. of P.I.'s	166	166	145	279
1969	Yrs. as NIH P.I. (median)	6.8	8.3	6.3	6.7
	No. of P.I.'s	194	248	124	293
1970	Yrs. as NIH P.I. (median)	8.5	8.6	8.4	6.1
	No. of P.I.'s	155	171	89	206

SOURCE: National Research Council (1958–80, 1974–81, 1979a, special tabulation 5/19/81).

RESEARCH INVOLVEMENT

Knowledge of the relative time/effort devoted to research by M.D. faculty is important to an understanding of the clinical research manpower pool. Since publication of the Committee's last report, information has become available on the reported percentage of total hours devoted by M.D. faculty to research (AAMC, 1981b). In addition to current involvement, estimates of percent of time spent by faculty members on research in the 1st, 5th, 10th, and 15th year of faculty employment have been obtained. The survey from which these data were derived defined research activity broadly to include all research-related teaching, patient care, and administration (including service on human subjects review committees). The data, it should be emphasized, describe magnitude of research effort only. No attempt was made in this case to measure outcomes such as research quality and productivity. Average research time varied by specialty group, ranging from 13 to 34 hours per week for all physicians on the faculty. M.D. faculty in the basic sciences spent 62 percent of their time in 1980 in research, while medical specialists (pediatrics, internal medicine, neurology, etc.) spent 39 percent; surgical specialists (surgery, orthopedics, urology, etc.), 22 percent; hospital-based specialists (anesthesiology, pathology, radiology), 23 percent; and behavioral specialists (psychiatry), 30 percent of their work time in research activities.

M.D. basic science faculty had the highest reported percentage of time in research activities over the span of a career, ranging from 75 percent at an estimated average age of 40 to 55 percent at age 55. Medical specialists under age 40 averaged 37 to 46 percent of their time in research, with a decline to 27 percent at average age 55. Surgical specialists, in general, have the longest work week and the lowest percent of time in research. In all of the specialty groups, including both clinical specialties and basic sciences, the older cohorts spend proportionally less time in research than do younger cohorts.

NON-M.D. SCIENTISTS IN CLINICAL INVESTIGATION

As seen in Table 2.1., the proportion of NIH postdoctoral traineeship and fellowship positions filled by M.D.'s has dropped from 66.1 percent in 1973 to 34.1 percent in 1978. During this period the number of Ph.D. bioscience researchers continued to expand, with an annual net growth of more than 9 percent in the pool of postdoctoral appointees in the academic sector (NRC, 1981a). In addition, reduced opportunities for tenure-track appointments in basic science departments have given rise to a growing movement of young Ph.D. scientists into clinical investigative units. Against this background it is not surprising that one of the questions being asked of the Committee concerns the role of the Ph.D. scientist in clinical investigation. The subject was explored at a joint meeting in April 1981 of the Committee's Panel on Basic Biomedical Sciences and Panel on Clinical Sciences. While the Committee plans to issue a separate report on this subject, the following summary reflects the scope of the panelists' discussions.

Available Data Sources

At least five files contain data on numbers of non-M.D. scientists engaged in research conforming to various definitions and classifications of clinical investigation. It would also be possible from this data base to compare Ph.D. faculty in clinical and basic science departments with respect to age, NIH grant success, postdoctoral support years, field switching, academic rank, etc.

Variation by Clinical Specialty

The research role of Ph.D.'s in clinical departments varies with the specialty. In contrast to medicine, surgery, and pediatrics, the Ph.D.'s role appears to be more sharply delineated and related to the nature of the specialty in departments of psychiatry, comparative medicine, obstetrics/gynecology, nuclear medicine, and epidemiology (commonly a part of community medicine, preventive medicine and public health, etc.). For example, research in reproduction, especially the study of mechanisms of hormone action and their control of normal and abnormal function, is now frequently centered in obstetrics/gynecology departments. For research of this type the suitably trained Ph.D. has an obvious role.

Future Outlook

The outlook for recognition of Ph.D. scientists in clinical departments as aspirants for senior faculty rank and tenure is not encouraging. Economic factors, such as lack of income-producing options for the Ph.D. scientist, when and if grant support is discontinued, are dominant. Where exceptions exist, they usually involve Ph.D.'s with a clinical or service potential, as in the case of a Ph.D. audiologist or speech therapist in a department of otolaryngology or a radiation physicist in a therapeutic radiology division. This situation derives in part from the fact that patient fee income has grown since 1968 at a rate of more than 25 percent per year and has overtaken R & D funds as a source of revenue for medical schools.

Need for Additional Information

In earlier discussions of this topic, too much emphasis may have been given to the wrong issue. The concern should be over how to maximize the Ph.D.'s participation in clinical investigation, rather than on the departmental setting in which he/she has a primary faculty appointment. Consequently, it seems worthwhile to identify models where Ph.D. involvement in clinical investigation has been demonstrably effective and to study on a case-by-case basis the factors that have promoted productive interactions between M.D. and non-M.D. researchers. Examples of sites for such study are the National Heart, Lung, and Blood Institute's Specialized Centers of Research, the National Institute of Child Health and Human Development Mental Retardation Centers, and departments of comparative medicine.

THE MARKET FOR CLINICAL SCIENTISTS

This Committee has repeatedly expressed concern over both the apparent dwindling interest in research careers on the part of young physicians and the growing number of budgeted vacancies on clinical faculties in medical schools. Its projections of demand for full-time clinical faculty made in 1978 indicated continued growth over the next 5 years due to expanding enrollments, clinical R & D expenditures, and service income.

Current Indicators

The latest data exhibit some conflicting trends, as can be seen in Table 2.3. There has been an apparent increase in the number of physicians reporting research as their primary activity to the American Medical Association (line 3a)[6], yet clinical research expenditures at medical schools dropped by more than 6 percent in 1979 after adjusting for inflation (line 2a). NIH research grants awarded to M.D.'s increased in absolute numbers but declined as a percentage of total competing grants to all investigators (lines 3c and 3d). However as Wyngaarden (1979) points out, the number of NIH grants awarded on behalf of new M.D. principal investigators has not changed appreciably since 1968. The number of medical students, residents, and clinical fellows went up sharply in 1979 (line 1a) but the number of M.D.'s receiving research training under NIH-supported programs remained at low levels (line 1b).

On the demand side, growth in medical school income derived from patient care activities has slowed noticeably (in real terms) in the last few years after rising rapidly in the early 1970's.[7] Clinical R and D expenditures also turned down in 1979. The net result is that since 1976 the total funds available to support clinical faculty (above that generated by tuition) have grown at about 3 percent per year, a slower pace than that of a few years earlier (line 2c).

On the supply side, the number of M.D.'s applying for and receiving NIH research grants has turned upward since 1976 (lines 3c and 3e). However, the number of young physicians entering research training programs is still far below the level that the Committee believes is appropriate in light of its past recommendations. As noted in Table 2.1, the number of M.D.'s and other health professionals participating in NIH research training programs is currently only 40 percent of the number that were doing so in 1971. This is a continuing cause for concern because a period of postdoctoral research training is considered essential for an M.D. to become a successful clinical researcher.

Sorting out the implications of these patterns for the future supply and demand for clinical investigators is the goal of the remainder of this chapter.

Projections Through FY 1985

It is well known that medical school faculty[8] members generally distribute their activities in varying proportions among teaching, research, patient care, and administration. The Committee's model of demand for clinical faculty is therefore based on the hypothesis that the

TABLE 2.3 Current Trends in Supply/Demand Indicators in the Clinical Sciences

	1973	1975	1976	1977	1978	1979	Annual Growth Rate from 1973 to Latest Year	Latest Annual Change	Average Annual Change from 1973 to Latest Year
1. SUPPLY INDICATORS (New Entrants):									
a. Medical students, residents, and clinical fellows	86,376	94,212	99,070	104,303	107,201	112,911	4.6%	5.3%	4,423
Professional doctorates participating in NIH training programs:									
b. Training grants and fellowships[a]	3,612	2,874	1,950[b]	1,906	1,954	1,923	-10.0%	-1.6%	-282
c. Training on research grants (full-time equivalents)	547	565	509	N/A	N/A	N/A	- 2.4%	-9.9%	-13
2. DEMAND INDICATORS:									
a. Expenditures for clinical R and D in medical schools (1972 $, mil.)	$192	$236	$228	$259	$269	$252	4.6%	-6.3%	$10.0
b. Medical service income in medical schools (1972 $, mil.)	$150	$238	$306	$311	$316	$336	14.4%	6.3%	$31.0
c. Total clinical R and D and medical service funds (1972 $, mil.)	$342	$475	$534	$571	$585	$588	9.5%	0.5%	$41.0
Budgeted vacancies in medical schools:									
d. Clinical departments	1,271	1,564	1,812	1,822	2,011	2,107	8.8%	4.8%	139
e. Basic science departments	575	609	672	633	696	721	3.8%	3.6%	24
f. Clinical faculty/student ratio[c]	0.278	0.279	0.289	0.290	0.308	0.300	1.3%	2.6%	.004
3. LABOR FORCE:									
a. M.D.'s primarily engaged in research	8,332	7,944	8,514	9,786	11,437	14,515	9.7%	26.9%	1,031
b. Full-time faculty in clinical departments	24,047	26,280	28,602	30,207	33,059	33,913	5.9%	2.6%	1,644
NIH research grants awarded to M.D.'s:									
c. Number of competing grants	1,010	1,435	1,243	1,257	1,489	N/A	8.1%	18.5%	96
d. % of total competing grants	35%	29%	29%	30%	27%	N/A	- 5.1%	-10.0%	-1.6%
M.D. applicants for NIH research grants:									
e. Number of competing applicants	2,291	2,722	2,757	3,114	3,527	N/A	9.0%	13.3%	247
f. % of total competing applicants	31%	29%	29%	29%	27%	N/A	- 2.7%	-6.9%	-0.8%
g. M.D. success rate (awards/applicants)	.44	0.53	0.45	0.40	0.42				

[a]Includes Fogarty International Center programs.
[b]Does not include Transition Quarter.
[c]Ratio of full-time clinical faculty to total of medical students, residents, and clinical fellows.

SOURCES: AMA (1960–80, 1963–74, 1975–79); NIH (1966–81); NRC (1979a, Query #5).

number of full-time clinical faculty in medical schools in any year _t_ is dependent on medical student enrollment in year _t_ (representing the teaching component of demand), funds available to support clinical research (representing the research component), and funds generated by patient care activities (representing the patient care component).[9] In the case of the latter two components, it is further assumed that these funds impinge on the demand for faculty over a period of years. In other words, funds generated in year _t_ affect the demand for faculty in years _t_, _t_ + 1, and _t_ + 2.

The projection model relies for its input on assumptions about future growth in clinical funds (clinical R and D revenue plus service income) and medical student enrollment. Figures 2.1-2.3 may assist in making these judgments about future patterns. They show the trends in funding and enrollment variables from 1961 to 1979 and projections to 1985 under several assumptions about future growth rates.

Figure 2.1 shows that the growth in clinical R and D expenditures in medical schools, expressed in constant dollars, has been approximately linear from 1961 to 1979. If this linear trend is projected to 1985, the clinical R and D figure would reach $375 million, which corresponds to a growth rate of almost 7 percent per year. However, in view of the extreme budgetary pressures that exist today, the Committee and its Panel on Clinical Sciences believe it is unrealistic to assume that such growth will continue over the next few years. A more realistic appraisal is that there will be very little real growth in clinical R and D expenditures through 1985. Under the most pessimistic conditions foreseen by the Committee, there would be a decline of 1 percent per year in these funds from the 1979 level after adjusting for inflation.

Income from patient care services reported by medical schools grew rapidly from 1968 to 1976 (Figure 2.2). Since 1976, the growth has slowed somewhat, although in 1979 it was still up a strong 6.3 percent, which is quite close to the most likely growth rate (6 percent) assumed by the Committee in its 1978 report. Figure 2.2 shows the projections of fee income to 1985 based on growth rates of 12 percent, 6 percent, and 2 percent per year.

Combining the growth estimates of clinical R & D funds with those of service income, we arrive at the following real growth rate estimates for the monetary variable of the model through 1985: 8.6 percent per year (high estimate), 4.0 percent per year (most likely estimate), 0.8 percent per year (low estimate).

With regard to medical school enrollments, the third component of the demand model, the Committee this year has broadened its definition to include not only medical students but also residents and clinical fellows since all three contribute varying amounts to the demand for clinical faculty. The number of medical students has grown from less than 44,000 in 1972 to over 60,000 in 1979, a growth rate of more than 5 percent per year. But several recent developments have occurred that are likely to produce slower growth in the 1980's. For one thing, a study published late in 1980 by the Graduate Medical Education National Advisory Committee (GMENAC) found evidence of a potential excess of 145,000 physicians by the year 2000 unless steps are taken now to curtail the supply (GMENAC, 1981, Vol. I, p. 10). The GMENAC report recommended that entering medical school classes be reduced 10 percent from 1978 levels by 1984, that no new schools be established, and that the influx of foreign medical graduates be restricted.

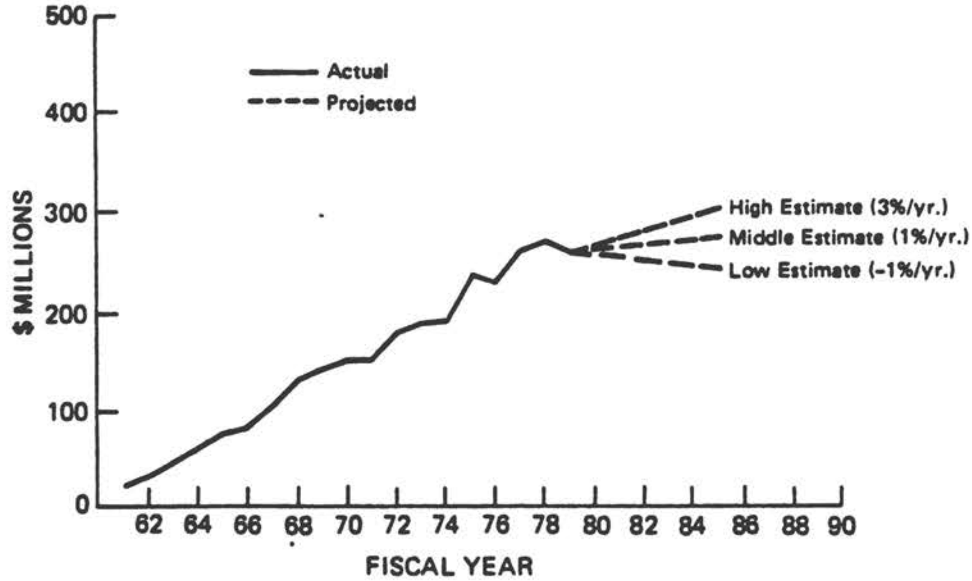


FIGURE 2.1. Clinical R and D expenditures in medical schools (1972 $). See Appendix Table A7.

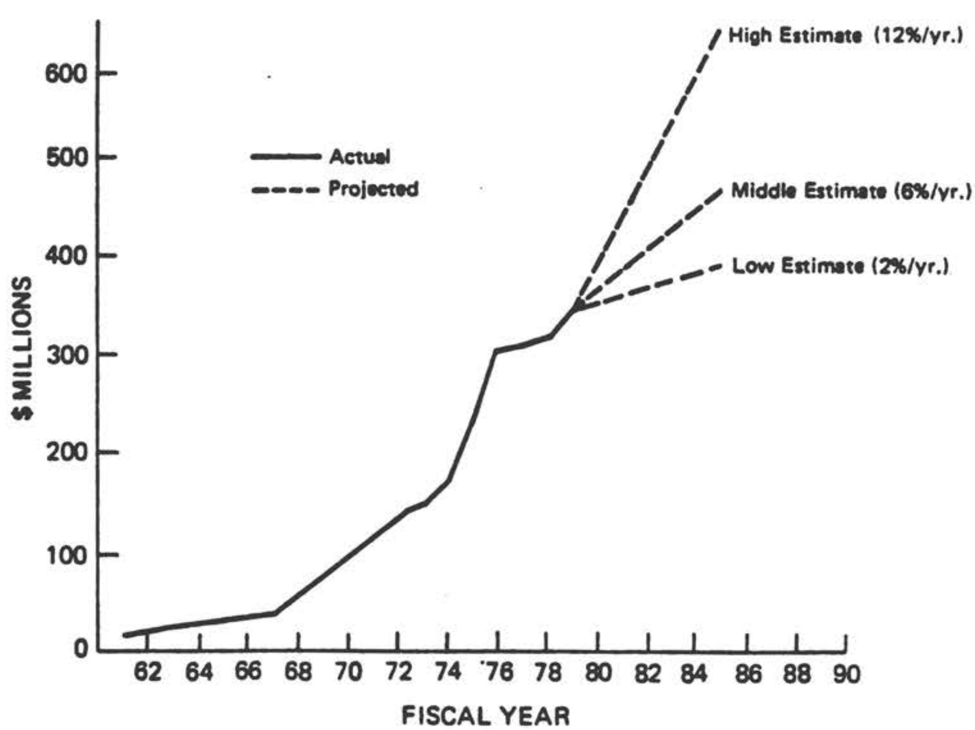


FIGURE 2.2 Service income reported by medical schools (1972 $). See Appendix Table A7.

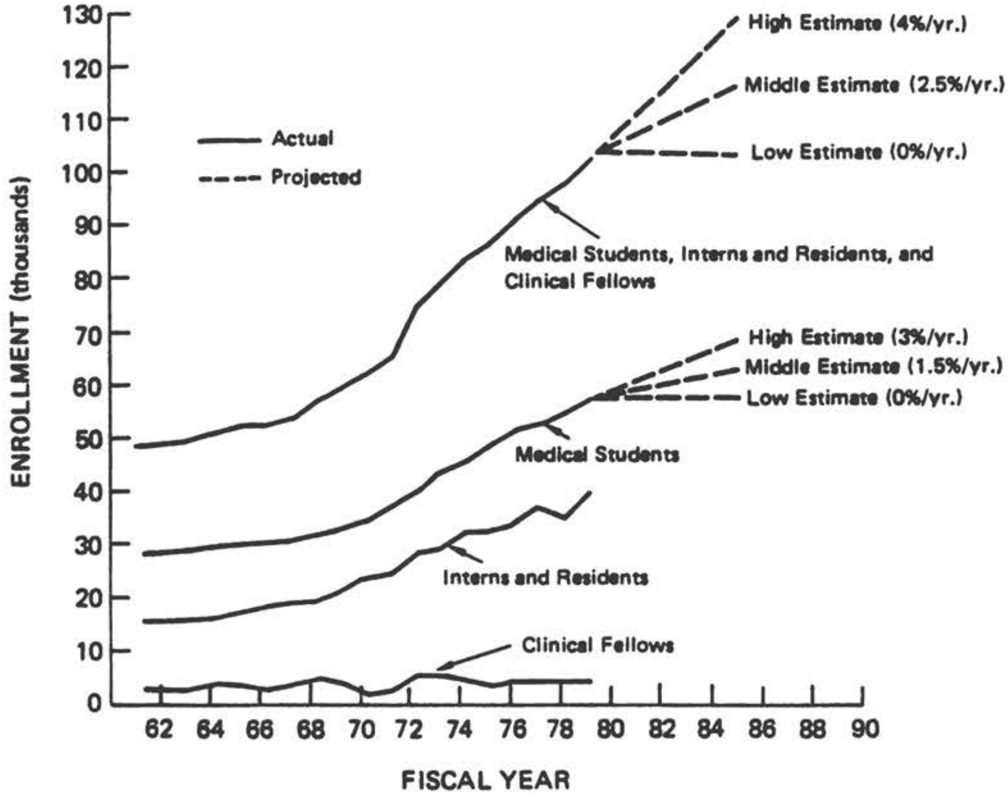


FIGURE 2.3 Medical students, interns and residents, and clinical fellows. See Appendix Table A6.

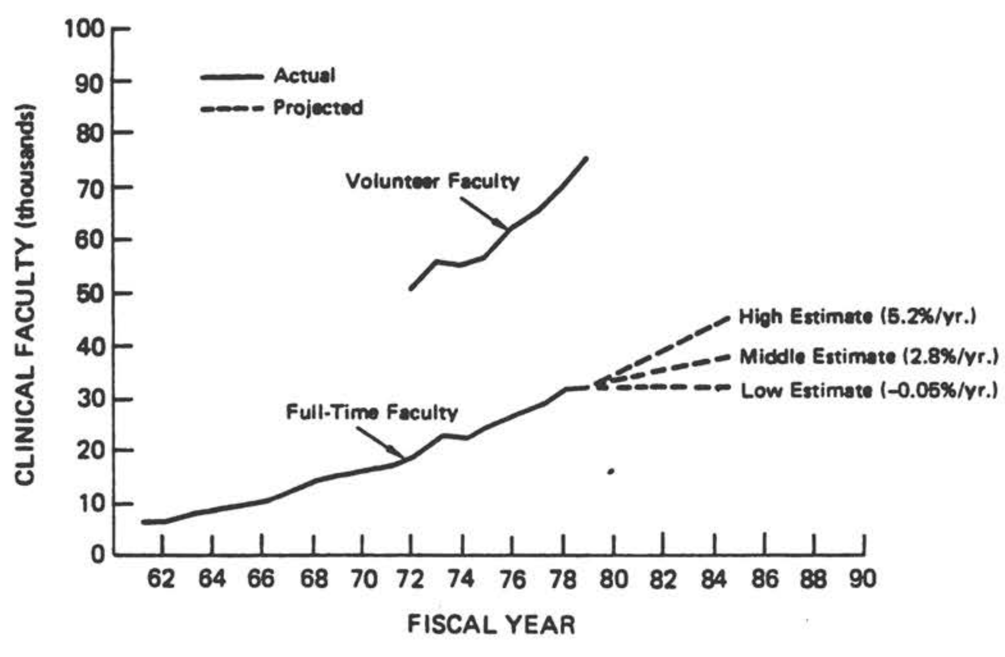


FIGURE 2.4 Clinical faculty in medical schools. Faculty is defined here as a full-time appointment in a clinical department regardless of tenure status. See Appendix Table A6.

Second, the funds provided by Congress to encourage medical schools to expand their enrollments (capitation grants), which have been declining throughout the 1970's, were rescinded for FY 1981 and have not been reauthorized for FY 1982. On the other hand, medical schools are also under heavy financial pressure and are likely to resist any attempts to reduce enrollments. The net effect, as seen by the Committee and its Panel on Clinical Sciences, is that the current growth in medical student enrollment will not continue but will average about 1.5 percent per year through 1985 (Figure 2.3).

The number of residents and clinical fellows is almost as large as the number of medical students and has been growing faster in recent years. Therefore, the Committee assumes that the total number of medical students, residents, and clinical fellows will grow at an average rate of 2.5 percent per year through 1985. The upper and lower limits on this growth rate are assumed to be 4 percent and 0 percent, respectively.

Given these assumptions about future growth in the monetary and enrollment variables, the model produces the estimates of demand for full-time clinical faculty through 1985 shown in Figure 2.4 and Table 2.4. Under the most likely circumstances foreseen by the Committee (the middle panel of Table 2.4, assumptions II and B), full-time clinical faculty in medical schools will grow to almost 40,000 by 1985. This means an average of about 1,000 new positions will be created each year due to expansion of faculty and another 2,000 vacancies will occur each year because of attrition. Exactly how these estimated 3,000 positions will be filled is crucial to determining the national needs for training clinical scientists. For this we must know something about the dynamics of faculty accession and attrition in medical schools.

The Committee is fortunate to have recently received such information from a study it commissioned the Association of American Medical Colleges (AAMC, 1981b) to do. That study provided data on several topics concerning medical school faculty, some of which are discussed elsewhere in this report. Of immediate interest here are data on hiring of clinical faculty members with research training background. Up to now it has been assumed that all demand created by expansion and attrition due to death and retirement would be filled by former postdoctoral trainees. But the new data show that this is an unrealistic assumption. From 1975 to 1978 only about 21 percent of all new appointments in clinical departments had postdoctoral research training.

The AAMC data also show that a significant amount of attrition from medical school faculties (about 4 percent per year) takes place because of changes in employment and causes other than death and retirement. Attrition rates therefore have been modified in Table 2.4 to reflect this.

There are still some important gaps in our knowledge of the system that need to be filled in as this study develops. Nevertheless sufficient data have accumulated to attempt a more rigorous estimate of postdoctoral training needs based on the projections than has been possible heretofore. Using the most likely projections from Table 2.4, Table 2.5 shows how these estimates translate into estimates of the number of clinical science postdoctoral trainees required to meet the expected demand under certain conditions. At each step of the calculation, the estimates are compared to the actual data where available.

Line 1 of Table 2.5 shows the annual demand for full-time clinical faculty broken down into demand created by expansion, death and

TABLE 2.4 Projected Growth in Medical School Clinical Faculty, 1980–85, Based on Projections of Medical School Enrollment, Clinical R and D Expenditures, and Medical Service Income in Medical Schools[a]

Assumptions about Medical Student Enrollment (medical students, residents, and clinical fellows)		Assumptions about Real R and D Expenditures and Medical Service Income in Medical Schools: I. Will expand at about 8.6%/yr. to $964 million in 1985	II. Will expand at about 4.0%/yr. to $744 million in 1985	III. Will expand slightly, about 0.8%/yr. to $616 million in 1985
A. Will grow at 4%/yr., reaching 143,000 students by 1985	Expected size of clinical faculty in medical schools (CF) in 1985	45,950	43,610	41,600
	Annual growth rate in CF from 1980 to 1985	5.2%	4.3%	3.5%
	Average annual increment due to faculty expansion	2,000	1,620	1,280
	Annual replacement needs due to:[b]			
	death and retirement	400	390	380
	other attrition	1,760	1,700	1,660
	Expected number of positions to become available annually on clinical faculties	4,160	3,710	3,320
B. Will grow at 2.5%/yr., reaching 131,000 students by 1985	Expected size of clinical faculty in medical schools (CF) in 1985	42,120	39,970	38,120
	Annual growth rate in CF from 1980 to 1985	3.7%	2.8%	2.0%
	Average annual increment due to faculty expansion	1,370	1,010	700
	Annual replacement needs due to:[b]			
	death and retirement	380	370	360
	other attrition	1,670	1,620	1,590
	Expected number of positions to become available annually on clinical faculties	3,420	3,000	2,650
C. Will show essentially no growth from 1979 to 1985, leveling off at 113,000 students	Expected size of clinical faculty in medical schools (CF) in 1985	36,320	34,470	32,870
	Annual growth rate in CF from 1980 to 1985	1.1%	0.3%	-0.05%
	Average annual increment due to faculty expansion	400	90	-170
	Annual replacement needs due to:[b]			
	death and retirement	350	340	330
	other attrition	1,550	1,510	1,470
	Expected number of positions to become available annually on clinical faculties	2,300	1,940	1,630

[a]Faculty in this table is defined as a full-time appointment in a clinical department regardless of tenure status. These projections are based on the following relationship:

$(CF/S)_t = \exp(-1.59683-103440/D_t) + 0.13$, where CF = size of clinical faculty in medical schools; S = medical students, residents, and clinical fellows; D = a weighted average of the last 3 years of clinical R and D expenditures plus medical service income in medical schools, i.e., $D_t = 1/4(D_t + 2D_{t-1} + D_{t-2})$.

[b]Based on an estimated replacement rate of 1.0% annually due to death and retirement, and 4.4% annually due to other attrition. See Association of American Medical Colleges (1981a).

TABLE 2.5 Estimated Number of Clinical Research Postdoctoral Trainees Needed to Meet Expected Demand for Clinical Faculty Through 1985 Under Various Conditions

	Actual (1975–78 average)				Projected (1980–85)
	Total	M.D.'s	Ph.D.'s	Other Degrees	Total
1. Demand for full-time clinical faculty--annual average:	3,673	2,982	454	237	3,000
a. due to expansion of faculty	2,113	1,783	280	50	1,010
b. due to death and retirement	128	97	18	13	370[a]
c. due to other attrition	1,432	1,102	156	174	1,620[b]
2. To reduce budgeted vacancies--annual average[c]					150
3. Demand for veterinary and dental school clinical faculty	(16% of med. school demand)[d]				500
4. Total annual accessions[e]	3,673	2,982	454	237	3,650
a. % with postdoctoral research training	21.4%	18.6%	55.9%	–	35.0%
5. Total accessions with postdoctoral research training--annual average	(35% of all accessions)				1,280
6. Size of clinical science postdoctoral pool--annual average	3,000 – 5,000				
Size needed to meet academic demand assuming a 2-yr. training period and portion of trainees seeking clinical faculty positions is:					
a. 60%					4,270
b. 50%					5,120
7. Annual number of clinical science postdoctoral trainees to be supported under NRSA programs:	2,310				
a. if 50% of pool is supported under NRSA					2,140 – 2,560
b. if 60% of pool is supported under NRSA					2,560 – 3,070

[a]Assumes an attrition rate due to death and retirement of 1.0% per year.
[b]Assumes an attrition rate due to other causes of 4.4% per year.
[c]In 1978 there were 2,011 budgeted vacancies in clinical departments of medical schools. The demand for clinical faculty generated by the need to reduce this level to 1,000 by 1985 is about 150 per year.
[d]In 1978 there were 3,544 full-time clinical faculty members in U.S. dental schools and an estimated 1,869 full-time equivalent clinical faculty members in U.S. schools of veterinary medicine. This total (5,413) was 16% of the full-time clinical faculty in U.S. medical schools. Thus the demand for dental and veterinary school clinical faculty is estimated at 16% of medical school demand, or 500 per year.
[e]Accessions are defined as new hires or those who rejoin faculties from nonfaculty positions. Inter-faculty transfers are not counted as accessions. Data on the percentage with postdoctoral research training were derived from newly hired faculty members only, which are 85% of total accessions. We are assuming that the same percentage applies to all accessions.

SOURCES: Data from 1975–78 taken from American Dental Association (1971–79a), Association of American Medical Colleges (1980, 1981a), Association of American Veterinary Medical Colleges (1978). Projections were derived by this Committee.

retirement, and other attrition. The projections assume a 1.0 percent death and retirement rate and a 4.4 percent attrition rate due to other factors.

Line 2 indicates that demand for an additional 150 clinical faculty members per year is created by the need to reduce budgeted vacancies in clinical departments. These have doubled in the past decade, and the Committee views this growth as an indicator of shortages. It is appropriate, therefore, to attempt to reduce budgeted vacancies in clinical departments to 1,000 in 1985 from their 1979 level of about 2,000.

Line 3 is the estimated demand for clinical faculty at dental and veterinary schools. This demand component is estimated to be 16 percent of medical school demand, or 500 per year.

Line 4 is the sum of lines 1 to 3. This total, 3,650, is the expected annual demand through 1985 under the conditions stated.

Line 4a shows the percentage of accessions having some postdoctoral research training. The current figure of 21 percent represents a severe deterioration in the research preparation of clinical faculty members. Of the present faculty in medical specialties who graduated from medical school between 1963 and 1967, more than 40 percent had postdoctoral research training (AAMC, 1981b, p. 12). The Committee believes it is important to restore this percentage to near its former level in order to maintain the research capability of medical schools.

Line 5 shows the estimated number of accessions needed with postdoctoral research training assuming that 35 percent of all accessions have this training. Note that transfers from one academic institution to another are not counted as accessions.

Line 6 gives the estimated size of the current pool of clinical research trainees (no hard data are available on the size of the pool). Assuming a 2-year training period and a 60 percent yield, a pool size of about 4,270 would be needed to produce the estimated 1,280 trained clinical researchers required each year, i.e., 4,270 = (1,280 x 2)/ 0.6.

Finally, line 7 provides estimates of the number of clinical science postdoctoral trainees to be supported by the NRSA program.

It is encouraging to note that the Committee's projections of faculty demand are supported by the AAMC study. The findings in both cases are quite close. The Committee projects an annual demand of about 3,000 full-time medical school clinical faculty positions based on a likely growth rate of almost 3 percent per year through 1985, while the AAMC study, using age-specific attrition rates, confirms that if faculty does indeed grow by 3 percent per year, the annual demand for full-time clinical faculty would be just over 3,100 per year (AAMC 1981b, p. 253).[10]

But clearly the new information the Committee has received has required readjustment in some of the assumptions made about faculty dynamics. Perhaps the biggest adjustment is in the previous assumption that all demand for clinical faculty would be satisfied by people with research training experience. If the AAMC data accurately reflect the current situation, only about one out of five new hires in clinical departments has had research training. This fact also cautions against equating research with an academic career, for it implies that the majority of people choosing to become members of clinical faculties do not have a research background. While it may be true that most clinical researchers are also faculty members, these data strongly suggest that only a minority of clinical faculty members have the inclination or training required for a research career.

"Graying" of the Faculty and Research Productivity

The relationship between age and research productivity takes on added significance with the realization that faculties in most fields are likely to be static or show only moderate growth in the coming decade. In one of the more important aspects of its study, the AAMC (1981a) showed how research output varies with the age of the clinical investigator. Peak productivity, as measured by the annual number of publications in selective journals, is generally reached around mid-career for most clinical investigators and thereafter declines.[11] These results suggest that medical school faculties tend to become less productive as the age distribution increases. To prevent aging of faculties, there must be a continuous infusion of younger members, preferably with research training experience.

In the most probable circumstances foreseen by the Committee, clinical faculty growth will average almost 3 percent per year through 1985. At this rate, the average age of clinical faculties will increase only slightly, and research output will increase at about the same rate as faculty growth according to the AAMC report (AAMC, 1981b, p. 64). But should faculty growth be slower than expected in the next decade, a significant amount of faculty aging will occur, with a resultant decline in average productivity. The AAMC estimates that if there is no faculty growth from 1980 to 1990, the average research output of physicians in medical schools will drop by more than 6 percent, and in surgical specialties by almost 14 percent. The research training programs can thus be viewed as a kind of insurance policy that tends to stabilize the research capability of medical schools despite varying demographic and economic conditions.

RECOMMENDATIONS

In view of the outlook for continued shortages of clinical scientists to staff the faculty of medical schools and conduct clinical investigations, and the need to encourage physicians and other health professionals to undertake research training in preparation for research careers, in the sections below the Committee makes two recommendations for training in the clinical sciences area.

Traineeships and Fellowships

> Recommendation. The Committee recommends that 2,400 traineeships and 400 fellowships be awarded annually for postdoctoral research training in the clinical sciences from FY 1982 through FY 1985. The Committee also urges a greater emphasis on filling these training positions with physicians. Most of the funding should be in the form of training grants, which are particularly suited to meet the needs of the physician whose doctoral training usually involves only limited research participation, and, as previously recommended, approximately 15 percent for individual fellowships.

In recommending federal support of 2,800 postdoctoral trainees and fellows in the clinical sciences, the Committee is well aware of the fact that not all of these awards will be made to physicians. It is appropriate that some of these trainees will hold the Ph.D. and other nonhealth professional doctorates, just as some M.D.'s will receive training under grants awarded to basic biomedical science departments. Currently, physicians hold about 70 percent of all the postdoctoral traineeships awarded by NIH in the clinical sciences.[12] While it is difficult to define the optimal proportion, 85 percent may represent a reasonable proportion of M.D.'s in the pool of clinical science trainees and fellows supported under NRSA programs. It would be compatible, for example, with the observed ratio of M.D.'s to total full-time faculty in clinical departments of medical schools (AAMC, 1981a).

There are difficulties in achieving a prompt increase in the proportion of clinical science training positions held by physicians. The relatively small number of physician applicants for NIH postdoctoral research fellowships and traineeships in recent years is one aspect of the problem. Another is NIH's lack of leverage for influencing the change directly, since trainee appointments are the responsibility of the individual training program director. It is nevertheless of critical importance that NIH examine all possible means for augmenting the physician component of the clinical sciences training pool. For example, consideration could be given to implementing a 1979 recommendation of the Committee to offer a postdoctoral clinical research experience for MSTP graduates, most of whom go on to a clinical residency. Since their research training up to that point has generally been in basic science, such an experience would be advantageous as a bridge for those aspiring to become clinical investigators. Since inclusion of a clinical research component would require support outside of the usual source of residency funding, the Committee recommended consideration of a special type of award for this purpose. To foster progress in this direction, the Committee reiterates its suggestion that Specialty Boards and Residency Review Committees be encouraged to develop training policies for the clinical investigator that would lead to Board certification without appreciably lengthening the training process.

Another suggested approach is to change NIH guidelines regarding full-time involvement in traineeships and fellowships. A requirement of less than full-time participation could attract women physicians with research interests, who are temporarily out of the labor force. Also, it could facilitate the combination of research and clinical training within a given year of residency.

Medical Scientist Training Program

Initiated in FY 1964 with three grantee institutions and support for 17 trainees, the Medical Scientist Training Program has experienced uninterrupted growth. By FY 1976 it involved 18 institutions and 465 trainees. As a result of continued expansion thereafter, endorsed with enthusiasm by the Committee, trainee enrollment is now approaching 700. In its 1979 report, the Committee proposed a ceiling of 725 trainees in the Program through FY 1982. Further expansion, it was felt, should await the development of more analytic information regarding the Program, including comparative costs of other research training programs for physicians. As reported elsewhere in this chapter, a start has been made toward assembling the information.

Additional analyses are needed, however, to explore possibilities for enhancing cost-effectiveness through administrative modifications in the Program and to determine its optimal size in relation to the totality of NIH training activities. Until these further analyses can be made, and in view of the steady build-up that has occurred, the Committee believes it prudent to retain the currently recommended enrollment level through FY 1985.

> Recommendation. The Committee recommends that an annual enrollment of 725 trainees in the Medical Scientist Training Program (MSTP) should be maintained through FY 1985 and high priority given to preserving this level should it become necessary to reduce the overall number of NRSA trainees.

NOTES

1. Unless otherwise specified, the term clinical investigator refers in this chapter mainly to physicians. It should be noted, however, that clinical investigation under the Committee's definition is also performed by other health professionals, e.g., dentists and veterinarians, as well as by scientists holding the Ph.D. and equivalent degrees.

2. Since opportunity costs for physicians who pursue doctoral research training are relatively high, it is reasonable to infer that a loss of fellowship and traineeship support could diminish the already small proportion of medical school seniors looking to a research career.

3. A study comparing career preferences at graduation with career performance after 17 years was reported in 1979 (Sherman and Morgan, 1979). Approximately 28 percent of 1960 medical school graduates had contributed to the medical and scientific literature by 1977. The study also found that 44 percent of the 1960 graduates expressing research plans did eventually conduct and publish research, and 8.3 percent of those without research plans published research in addition to carrying a medical practice.

4. A discount rate is an interest rate used to compute the value today of a sum of money to be received in the future. For example, 1 dollar to be received a year from now is currently worth about 89 cents at a discount rate of 12 percent.

5. For a full description of research "level" and its derivation, see Narin (1976) and Sherman and Morgan (1979).

6. The AMA data themselves present some conflicts. Although the number of physicians reporting research as a primary activity has increased, the number with unknown activity has increased even faster, which creates some uncertainty about how to interpret these data. The increase in research activity reported to the AMA is puzzling, since it goes in the opposite direction of data the Committee has compiled on the number of physicians participating in the research training programs of NIH. Furthermore, since the AMA survey contains no standard definition of research activity, the interpretation is subject to wide variation among the respondents, and in many cases it may differ from the Committee's definition.

7. Patient fee income data are taken from AMA (1960-80) but are known to be understated there because of the way medical schools account for such funds. Some schools report all patient fee income, while others receive and report only a fraction of the total. The remainder is channeled through independent corporations and hence is not accountable by the Dean's Office.

The difference between reported and actual fee income is unknown, but the Committee's Panel on Clinical Sciences believes that more and more of these funds are moving out of the schools' spheres of direct accountability.

8. The clinical faculty data used in this analysis are taken from the annual survey of medical schools conducted by the Liaison Committee on Medical Education and published annually in the Journal of the American Medical Association (AMA, 1960-80). The definition of clinical faculty

used in that survey is an appointment in a clinical department at any rank. Residents and fellows are excluded unless actually serving as faculty members. The definition does not mention tenure or tenure-track positions, and so presumably all appointments, whether on the tenure-track or not, are counted as faculty.

9. The specific form of the model has been developed from the additional hypothesis that the ratio of full-time clinical faculty to medical student enrollment ($\underline{F}/\underline{S}$) will vary in accordance with the amount of R and D funds and fee income ($\underline{M}$). But because of tenure and other limitations on faculty hiring, the rate of growth in the $\underline{F}/\underline{S}$ ratio in response to increasing funds will not be linear but will decrease as the funds increase. This suggests a logistics or Gompertz-type relationship that typifies many growth processes. Fitting this model to the data for 1961 to 1978 produces the following specific functional form:

$$(\underline{F}/\underline{S})_t = e^{(-1.6 - 103440/\underline{M}_t)} + 0.13,$$

where:

- $\underline{F}$ = full-time clinical faculty in medical schools;
- $\underline{S}$ = medical student enrollment including residents and clinical fellows; and
- $\underline{M}$ = weighted average of clinical R&D expenditures plus fee income in medical schools ($\underline{R}$); $\underline{M}_t = 1/4\ (\underline{R}_t + 2\underline{R}_{t-1} + \underline{R}_{t-2})$.

10. The data shown on p. 253 pertain to all full-time faculty in medical schools, while the Committee's projections are for full-time clinical faculty in medical schools only. Averaging the AAMC data over the years 1980-1985 and allocating proportionately to clinical science faculty gives a projected annual need for 3,166 based on a 3 percent growth estimate.

11. These results should be interpreted with caution. It is easy to confuse "cohort" effects with age effects, e.g., older people may have poorer publication records because the conditions under which they were trained, recruited, and promoted may have differed substantially.

12. Special tabulation prepared for this Committee by NIH, February 2, 1981, of trainees occupying positions awarded in FY 1978.

3. BASIC BIOMEDICAL SCIENCES

During the past year, the Committee and its advisory Panel on Basic Biomedical Sciences have reconsidered each of its most recent recommendations in light of the present status of those factors that are relevant to the training of biomedical scientists and their employment. In particular, attention has been given to (1) updating the model projecting supply and demand for biomedical research personnel, (2) relationships between graduate student enrollment and doctoral degrees awarded, (3) changing employment patterns for young investigators, and (4) the effect of training grant support on the quality of the training program. Assessments of these subjects as they relate to personnel needs in the biomedical sciences are discussed in this chapter.

It is important at this point to emphasize that the term "faculty," as used in this chapter, includes all biomedical scientists holding doctoral degrees, except those having appointments for postdoctoral training, who are employed by academic institutions. Thus, it refers to individuals with regular academic faculty appointments as well as those occupying research positions. When reference is made to those having full academic responsibilities, including that of serving as principal investigator under research grants and contracts, the term "regular faculty" is used. Projections of demand for biomedical science Ph.D.'s in academia are based on needs for all faculty--regular and research (nonfaculty doctoral research staff)--positions.

To properly assess the data and recommendations presented in this report, it is essential to understand how scientific training is obtained in the basic biomedical sciences and what roles are played by various agencies and elements in the scientific community in this process. We shall give a general description of the career path of the average scientist and the characteristics of a typical graduate training program, but there is great variability from individual to individual and from program to program.

THE TRAINING OF BASIC BIOMEDICAL SCIENTISTS

It seems to be generally true that many students entering college have already made decisions about the broad field in which they will pursue their education. Those who have the potential for a career in the biomedical sciences have taken a college preparatory course in high school that includes chemistry, physics, and a substantial amount of mathematics where these have been available. While the requirement for a strong mathematical preparation is somewhat less important for students wishing to obtain an undergraduate degree in biology, as compared to chemistry and physics, such preparation is essential for students who wish to enter a graduate program and obtain an advanced degree in one of the basic biomedical sciences. It is with this group that we are concerned. The importance of the undergraduate program and its prerequisites lies in the limits that these rigorous preparatory courses place on the numbers of students qualified to proceed into graduate study and who ultimately supply the national need for highly trained personnel in the biological sciences.

During the past 10 years the number of students opting to pursue undergraduate degrees in biology has increased steadily. On many campuses, biology is the most popular single major. Simultaneously, the number of students enrolling for undergraduate degrees in chemistry and physics has declined. These changes reflect not only the public's awareness of the major advances that have been and are being made in biological knowledge but also the social relevance of the study of biology. In addition, the desire of large numbers of college students to qualify for medical school has led to increased enrollments in undergraduate biology programs. Indeed, a majority of biology majors are aiming for careers in the practice of medicine or one of the other health professions. Nonetheless, a small but vital percentage have a commitment to a career in research in the basic biomedical or clinical sciences.

Graduate training programs in the basic biomedical sciences primarily recruit from the pool of undergraduate students in biology and chemistry. Much smaller numbers come from undergraduate backgrounds in physics, mathematics, or other science disciplines. By far the largest number of students entering graduate training in the basic biomedical sciences were undergraduate majors in biology. For most students the training program requires 5 to 6 years of study and research effort. Students are required to formulate and pursue a research program that constitutes a significant contribution to knowledge in some specialized field and to demonstrate a mastery of research skills. Although the period is one of training, it must also be viewed as a period in which the student's ability to function creatively as a thinker and as a doer is developed and thoroughly evaluated. Most students take advanced courses in their disciplines and related fields during the first two years and devote the principal portion of the final 2 or 3 years in the program to research. Research is carried out with the day-to-day guidance of a regular faculty member who serves as the mentor, and it involves periodic evaluation by a committee of scientists in the discipline and related fields. Completion of the Ph.D. often requires that the work submitted in the thesis be accepted for publication in a refereed journal, and it always requires that the student present and defend his or her thesis in a public forum.

An effective environment for graduate education in the sciences requires that many resources be brought into conjunction. They include excellent faculty, highly qualified students, specialized laboratory buildings and complex equipment, good library and computing resources, and a tradition of open and free inquiry. Many U.S. universities have created such environments. It is tempting to try to estimate the cost of such systems for education and research, and attempts have been made to do so. There is no question that costs for quality graduate education are high and must include the costs of faculty, facilities, equipment, energy, shared resources, and so forth. These costs are met from a multitude of income sources including tuition, endowment, state appropriations, research grants from federal and other agencies, and gifts from various sources. Support for trainees (in the form of stipends) is a vital but relatively small part of the total cost.

In most graduate programs in the basic biomedical sciences, students are provided with stipends or tuition remission, or both, drawn from a variety of sources. Many students support themselves as teaching assistants and research assistants. Stipends for such positions are approximately $5,000 per year. They are intended to cover basic living expenses for the student with the understanding that the main objective of the student is to pursue the educational program required for the Ph.D. degree. Another large group of students support themselves by loans, personal finances, and/or employment not related to academic pursuits. The latter tends to compete for attention and detract from graduate studies and to extend the period required for students to complete their program. Those who support themselves with jobs outside the academic institution may take 8 or more years. Institutions attempt to provide the more able students with support through traineeships or fellowships or as teaching assistants or research assistants since the experience gained in teaching and research generally is much more appropriate to the career goals of students than is work outside the academic environment.

Important elements among the mechanisms for support of graduate students are the training grant and fellowship programs of federal agencies. In the basic biomedical sciences these programs are primarily funded by the National Institutes of Health under NRSA, although a small number of fellowship awards in these fields are made by the National Science Foundation. Training grants provide institutions with funds to support a number of students by paying a stipend (currently $5,040 for predoctoral trainees). Students awarded these traineeships do not need to support themselves by working as teaching assistants and research assistants or in outside employment. More importantly, they are relatively free, compared to students supported by research grants/contracts or other mechanisms, to choose the area in which they will work, the specific research topic they will address, and the approaches they will take. Training grants also pay tuition for trainees and provide funds through the institutional allowances for supplies and special services to facilitate their educational and research programs. Students awarded traineeships generally complete their graduate programs in 4 or 5 years and move rapidly and with vigor into postgraduate training, thus conserving national and institutional resources (NRC, 1976a). The cost to the federal government for stipend (currently $5,040) and tuition is approximately $11,000 per year per <u>predoctoral</u> trainee. In addition, the training grant may provide up to $3,000 per trainee for other items such as research support and seminar speakers for the program. Since university expenses, such as costs for faculty and facilities are very substantial, the cost to the federal government through the training grant represents only a small part of the total cost.

Fellowships awarded to individuals--almost always persons who hold the doctorate--represent another important mechanism for facilitating the training of highly qualified individuals. Fellowships are awarded on the basis of a proposal from the applicant and his or her sponsor which defines specific objectives for research training and education. The competition is tough. Most fellowships are awarded for 2 to 3 years of postdoctoral research training and provide a stipend and an allowance for tuition costs and some research expenses. Unlike training grants, they do not provide funds for the training institution to develop special training programs. The average fellowship cost to the federal government is approximately $19,300 per <u>postdoctoral</u> fellow per year. This includes a stipend (approximately $14,000 average) and up to $5,000 for tuition, if required, and research support.

For most doctoral degree recipients in the basic biomedical sciences, achievement of final career objectives requires that training continue for a period of 2 to 4 years. In this postdoctoral period young scientists attempt to find a position in the laboratory of an established scientist whose work interests them and will extend their expertise and knowledge. The postdoctoral training period may involve a substantial shift in interest for the young scientist or may refine and extend work already begun. Both alternatives have advantages. The trainee who enters a new area contributes fresh insights and benefits by gaining a broader perspective for future studies. There are no formal aspects to most postdoctoral training programs. Training is tailored to individual needs. The trainee has the opportunity for uninterrupted research and scientific development. Most postdoctoral trainees or fellows are highly productive and a large proportion of the nation's research productivity in the basic biomedical sciences can be traced to the efforts of this group. Postdoctorals are provided with stipends (currently averaging $13,000 to $14,000) from research grants, from postdoctoral fellowships granted on the basis of review of individual research proposals, or through training grants awarded by federal agencies, principally the National Institutes of Health.

It is important to note that the training of most basic biomedical scientists occurs in the major research universities. Students are trained by regular faculty members who are themselves successful and productive scientists. This arrangement ensures that the skills learned and the intellectual attitudes developed are conducive to successful research careers. Those faculty members must generate funds to support the research laboratory in which students can pursue research. Most such support is obtained by competition in the peer-reviewed programs of the National Institutes of Health and the National Science Foundation.

Individuals trained in the basic biomedical sciences through predoctoral and postdoctoral programs, such as those receiving NRSA training grant and fellowship support from the National Institutes of Health, find employment in a wide variety of settings. Many, currently a majority (NRC, 1981a), find employment at academic institutions in regular faculty positions that offer an opportunity to continue research as independent investigators and to train graduate and postgraduate students in their own laboratories or in research positions as key members of the larger research teams. Alternatively, those in research positions may seek funds and pursue their own research programs. Some find positions in academic institutions with a principal focus on teaching and training undergraduate, professional, and graduate students in the basic biomedical sciences. Still others obtain research and administrative positions with federal agencies and private research institutes, or in industrial laboratories, where there is an increasing demand for biomedical scientists. On the average, graduates move into permanent employment 7 or 8 years after they have obtained the baccalaureate degree.

The choice with respect to permanent employment may depend in part on salary. Although there is a considerable range, first salaries in academic positions at the doctoral level average $20,000 to $22,000 per annum (1981), while those in industry are significantly higher. In areas of current rapid development such as genetic engineering and toxicology, academia and industry compete vigorously and starting academic salaries can be higher. Nevertheless, the financial incentives for a career in biomedical research are not great. In addition, those graduate students who have both the personal and academic qualifications required for admission to medical school must set aside the option of an intrinsically interesting career in medicine and the financial rewards such careers provide. Further, the current air of uncertainty with respect to research funding and the current lack of a national commitment to science make it difficult for current practitioners to present a rosy picture of the prospects for a scientific career to the next generation. Given the long period required to train for a scientific career (7-8 years after the bachelor's degree), the financial and other disincentives must be counterbalanced by strong personal motivation to add to knowledge and by assistance in meeting the cost of education. At a minimum, financial support must be provided for the initial stages of training. The federal training grant and fellowship programs are vital in providing this support.

THE MARKET FOR BIOMEDICAL SCIENCE PH.D.'S

In its previous reports, the Committee has evaluated data obtained from a number of agencies to make recommendations of the number of trainees needed. A supply and demand model has been used to assess the relationships between the production of Ph.D. scientists, the need for research personnel in universities, and the commitment of funds from various sources to research and development in the basic biomedical sciences. The number of individuals receiving Ph.D. degrees in the biomedical sciences and the number holding postdoctoral appointments were taken as indicators of supply. Demand indicators were undergraduate and graduate enrollments in the basic biomedical sciences, and the availability of funds for research and development (R and D), both of which drive the demand for faculty in these fields. These data, combined with conservative estimates of future trends, have been used to make recommendations about the number of trainees needed.

Significant problems exist in making projections from the available data. First, current data are not always available. For example, undergraduate enrollments in particular fields cannot be measured directly but must be estimated from B.A. degrees awarded 2 years later. And since the latest available data on B.A. degrees is for 1979, we can provide estimated undergraduate enrollments in biomedical and behavioral fields only through 1977. Second, changes within specific personnel groups are not measurable--only the number of people in broadly defined categories is known. Third, it had been assumed in the past that turnover in the pool of career scientists in U.S. colleges and universities was principally due to retirement and death. More recent assessments indicate this is not the case--there is a substantial amount of switching between academic and nonacademic positions. Finally, life science R and D expenditures have grown faster than expected in recent years.

This section presents the most recent data on personnel in training and employed in the basic biomedical sciences, and assesses prospects for future employment and needs for training.

Current Indicators

The last complete analysis of the market for biomedical sciences Ph.D.'s was presented in the 1978 report of this Committee. The principal finding, based largely on 1977 data, was that the Ph.D. labor force of biomedical scientists appeared to be expanding somewhat faster than the number of positions traditionally held by them. Ph.D.'s entering the labor force who could not find permanent positions were taking postdoctoral appointments and remaining in these temporary positions for extended periods. While Ph.D. production had remained practically level since 1971, the postdoctoral pool had continued to grow at a rate exceeding 12 percent per year. The Committee was concerned that this continuing growth reflected a softness in the biomedical science job market.

Data now available for 1979 show that little deterioration has occurred in the market for biomedical science Ph.D.'s, and in some respects the situation has improved. Between 1977 and 1979 employment of biomedical science Ph.D.'s at colleges and universities expanded by 5.4 percent per year--slightly better than the average of 5.3 percent per year experienced since 1973 (Table 3.1, line 3b).

Perhaps the main stimulus for demand was provided by the growth in R and D funding, which increased at colleges and universities by 4.4 percent in real terms between 1977 and 1978, significantly above the 3 percent annual growth rate of the 1970's (Table 3.1, line 2b). NIH research grant expenditures also showed substantial real increases in both 1978 and 1979 (line 2c). The Committee does not foresee continued growth of this magnitude in R and D funds but expects real growth to be about 1 percent per year for the next few years.

Biomedical science enrollments grew steadily during the first half of the 1970 decade but now show signs of stabilizing. The latest year for which we can provide an estimate of undergraduate enrollments in the biomedical science fields is 1977. These data show that total biomedical science graduate and undergraduate enrollments increased almost 3 percent per year from 1973 to 1977, but declined in 1977 from the 1976 levels (line 4d). Total graduate enrollment in biomedical science fields (line 4b) continued to increase by about 3 percent per year through 1979.

Another prominent feature of the current market for biomedical science Ph.D.'s is the continued increase in the postdoctoral pool. The Committee noted in 1978 that this indicator of the health of the market was already at an abnormally high level. Yet the pool has grown despite the fact that the rate of Ph.D. production has not increased substantially since 1971 (lines 1a, 1c). The implications of these trends, while not completely understood, are discussed in a subsequent section of this chapter. The Committee would like to devote considerable effort to examining this issue in the coming year.

Projections Through FY 1985

Basic Biomedical Science Faculty

Since the education and training of a scientist takes 6 to 8 years postbaccalaureate, the Committee must look beyond the current market situation to anticipate the supply/demand balance that will prevail several years from now. In past reports, the Committee has made 5-year projections of demand in universities for doctorate-level scientists. These projections are based on a model that relates the biomedical science Ph.D. faculty/student ratio (F/S) to a lagged function of life science R and D expenditures in colleges and universities (see Figure 3.1).[1] The model coefficients were derived from data for the period 1962-1977.

TABLE 3.1 Current Trends in Supply/Demand Indicators for Biomedical Science Ph.D.'s

	1973	1975	1976	1977	1978	1979	Annual Growth Rate from 1973 to Latest Year	Latest Annual Change	Average Annual Change from 1973 to Latest Year
1. SUPPLY INDICATORS (New Entrants):									
a. Ph.D. production[a]	3,518	3,516	3,576	3,462	3,512	3,636	0.6%	3.5%	20
b. % of Ph.D.'s without specific employment prospects at time of graduation	6.5%	5.5%	5.3%	6.3%	5.1%	4.5%	-5.9%	-11.8%	-0.3%
c. Postdoctoral appts.[b]	4,123	5,346	N/A	6,342	N/A	7,334	10.1%	7.5%	535
2. DEMAND INDICATORS:									
a. National expenditures for health-related R and D (1972 $, bil.)	$3.53	$3.69	$3.80	$3.96	$4.11	$4.29	3.2%	4.4%	$0.127
b. Life science R and D expenditures in colleges and universities (1972 $, bil.)	$1.45	$1.49	$1.57	$1.60	$1.67	N/A	2.9%	4.4%	$0.044
c. NIH research grant expenditures (1972 $, bil.)	$0.792	$0.897	$0.944	$1.00	$1.06	$1.17	6.7%	10.4%	$0.063
3. LABOR FORCE:[b]									
a. Total	43,618	50,585	N/A	55,060	N/A	62,450	6.2%	6.5%	3,139
b. Academic (excl. postdocs.)	24,940	28,563	N/A	30,568	N/A	33,980	5.3%	5.4%	1,507
c. Business	5,328	6,779	N/A	7,002	N/A	8,550	8.2%	10.5%	537
d. Government	4,660	5,083	N/A	5,130	N/A	5,493	2.8%	3.5%	139
e. Non-profit	2,849	3,265	N/A	3,989	N/A	4,805	9.1%	9.8%	326
f. Self-employed	515	841	N/A	863	N/A	1,192	15.0%	17.5%	113
g. Other (incl. postdocs.)	4,913	5,527	N/A	6,715	N/A	7,748	7.9%	7.4%	472
h. Unemployed and seeking	413	527	N/A	793	N/A	682	8.7%	-7.3%	45
4. BIOMEDICAL ENROLLMENTS:[b]									
a. First-year graduate	17,511	18,876	18,756	18,073	N/A	17,487	0.0%	-1.6%	-4
b. Total graduate	34,888	38,314	39,322	39,260	N/A	41,739	3.0%	3.1%	1,142
c. Medical and dental schools	65,922	74,220	77,011	78,289		84,933	4.3%	4.3%	3,169
d. Estimated undergraduate[c]	379,268	424,539	439,946	425,863	N/A	N/A	2.9%	-3.2%	11,649
e. Total biomedical graduate and undergraduate enrollment	480,078	537,073	556,279	543,412	N/A	N/A	3.1%	-2.3%	15,834

[a]Foreign nationals who received their doctorates from U.S. universities are included.
[b]Since labor force and graduate enrollment data are not available for 1978, latest annual change represents average annual growth rate from 1977–79. Graduate enrollment data for 1979 use the "biological science" category defined by the U.S. Department of Education which is a slightly different set of fields from the Committee's definition. Foreign nationals who received their doctorates from U.S. universities are included in labor force data.
[c]Estimated by the formula $U_i = (A_{i+2}/B_{i+2})C_i$ where U_i = biomedical science undergraduate enrollments in year i; A_{i+2} = biomedical B.A. degrees granted in year i+2, excluding health profession B.A.'s; B_{i+2} = total B.A. degrees granted in year i+2; C_i = total undergraduate enrollments in year i.

SOURCES: American Dental Association (1971–79a), AMA (1960–80), NIH (1966–81), NRC (1958–80, 1973–80), NSF (1975–79), U.S. Department of Education (1948–81, 1959–79, 1961–79, 1973–77, 1974–80).

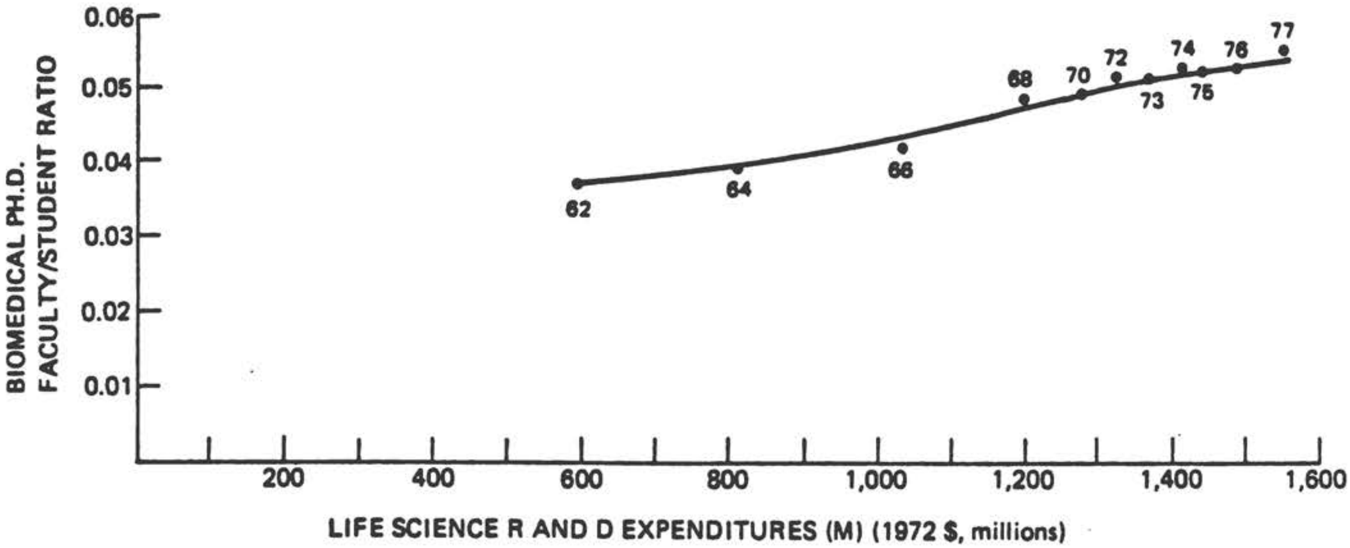


FIGURE 3.1 Ph.D. faculty/student ratio in the biomedical science fields as a lagged function of life science R and D expenditures in colleges and universities, 1962-77. M is a weighted average of the last three years of R and D expenditures, i.e., $M = \frac{1}{4}(R_t + 2R_{t-1} + R_{t-2})$. Ph.D. faculty excludes postdoctoral appointees. Solid line represents the estimated growth curve. See note 1 for the mathematical form of the model. The data are shown in Appendix Table A2.

To project faculty (see explanation of "faculty" at the beginning of this chapter) demand, the future behavior of life science R and D expenditures and biomedical science enrollments must be estimated. Figure 3.2 shows the behavior of these variables since 1960 and some projections of growth to 1985.

Demographic data suggest that total enrollments in colleges and universities will peak in the early 1980's and then begin a 10-year decline, following the pattern set by the U.S. population age 20-24 (Figure 3.3(a)). The effect on particular fields is much harder to predict. Accordingly, biomedical science enrollments in Figure 3.2(c) have been projected to 1985 using three assumptions about growth rates. The high growth rate of 4 percent per year and the low assumption of no growth represent probable upper and lower boundaries. The middle assumption of 2 percent per year is considered most likely.

Similar assumptions are made for life science R and D expenditures (after adjusting for price changes--see Figure 3.2(a)). These three assumptions about future R and D patterns together with the three assumptions about future enrollment growth produce nine combinations to be considered.

The projections of faculty demand derived from these assumptions are shown in Figure 3.2(b) and (d), and in Table 3.2. Under the most likely assumption of a 1 percent per year increase in real R and D expenditures (assumption II of Table 3.2), the faculty/student ratio would rise slightly according to the model described earlier. Biomedical science enrollments are also expected to increase by about 2 percent per year through 1985 (assumption B of Table 3.2). Under these assumptions, the model projects that academic demand for biomedical science Ph.D.'s generated by growth of faculty is expected to be about 700 per year through 1985, an annual growth rate of 2.1 percent. Comparing this with the 5.3 percent annual rate of growth since 1973 (Table 3.1), we project a slower rate of growth in the academic employment of biomedical science Ph.D.'s due to expansion of faculties over the next 5 years, based on these assumptions.

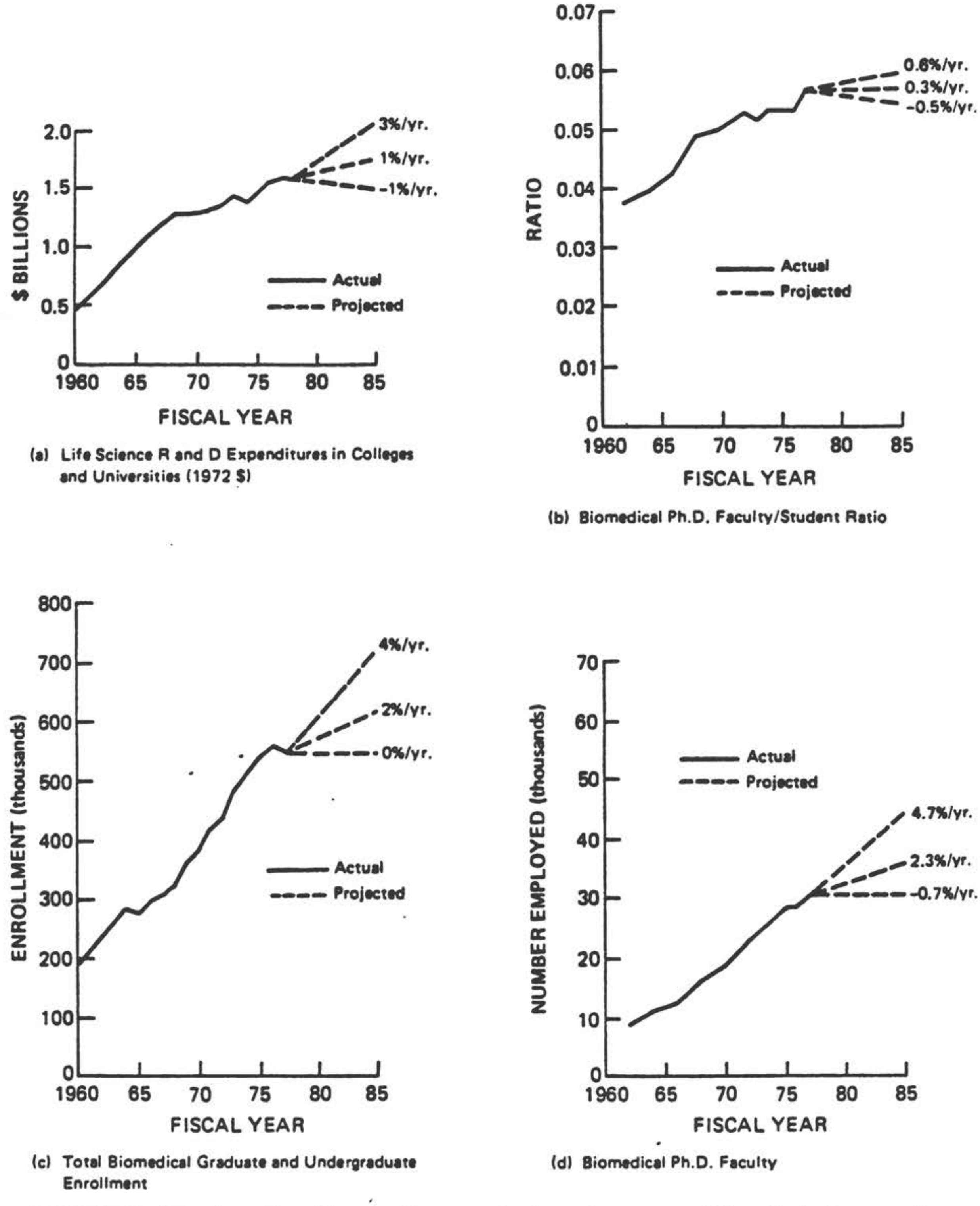
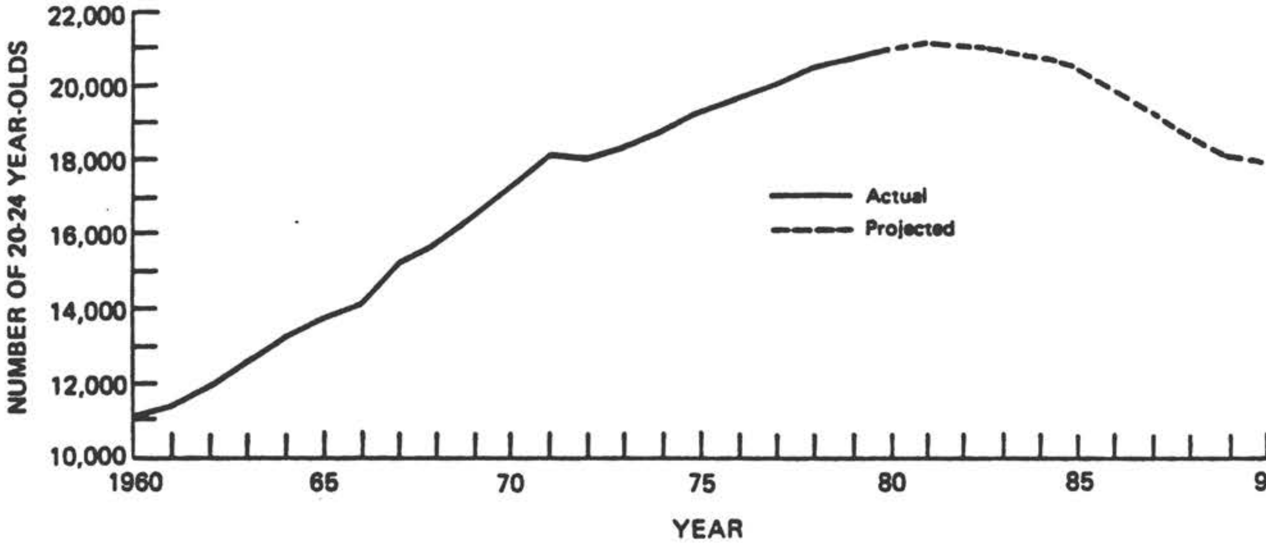
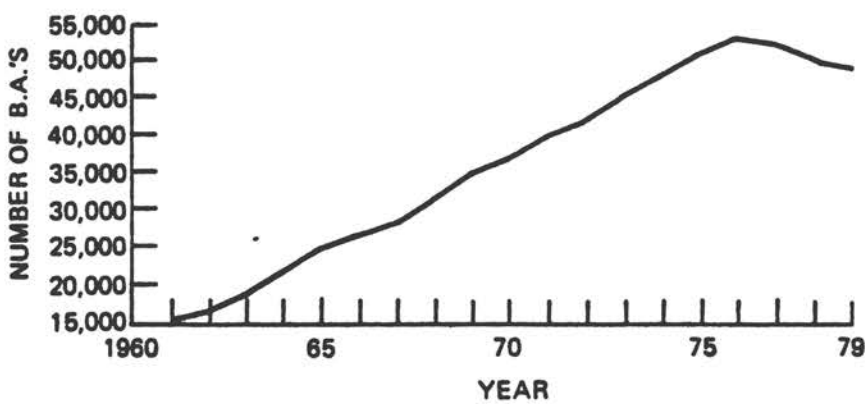


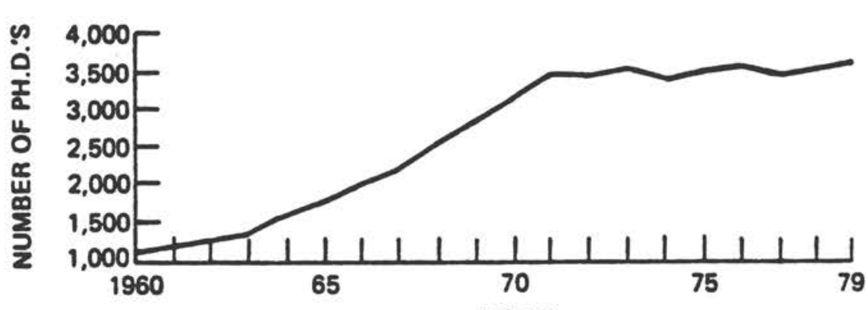
FIGURE 3.2 Life science R and D expenditures, academic employment, and biomedical science enrollment, 1960-77, with projections to 1985. Projections are stated in terms of expected annual growth rates for high, middle, and low estimates. See Appendix Table A2.



(a) U.S. Population Estimates of 20-24 Year-Olds, 1960-90. See Appendix Table A3.



(b) B.A.'s Awarded Annually in Biomedical Sciences, 1961-79. See Appendix Table A1.



(c) Ph.D.'s Awarded Annually in Biomedical Sciences, 1960-79. See Appendix Table A3.

FIGURE 3.3 Trends in population and biomedical science degrees, 1960-79.

TABLE 3.2 Projected Growth in Biomedical Science Ph.D. Faculty, 1978–85, Based on Projections of Enrollment and R and D Expenditures[a]

Assumptions about Graduate and Undergraduate Enrollments in the Biomedical Sciences and Medical and Dental Schools		Assumptions about Real R and D Expenditures (in constant 1972 dollars)[b] in the Life Sciences in Colleges and Universities: I. Will grow at 3%/yr. to \$2.1 billion in 1985	II. Will grow at 1%/yr. to \$1.7 billion in 1985	III. Will decline by 1%/yr. to about \$1.5 billion in 1985
A. Will grow at 4%/yr., reaching 744,000 students by 1985	Expected size of biomedical Ph.D. faculty (F) in 1985	43,810	42,260	39,640
	Annual growth rate in F from 1978 to 1985	4.6%	4.1%	3.3%
	Average annual increment due to faculty expansion	1,650	1,460	1,140
	Annual replacement needs due to:[c]			
	death and retirement	370	370	350
	other attrition	1,120	1,090	1,050
	Expected number of academic positions to become available annually for biomedical Ph.D.'s	3,140	2,920	2,540
B. Will grow at 2%/yr., reaching 637,000 students by 1985	Expected size of biomedical Ph.D. faculty (F) in 1985	37,510	36,180	33,940
	Annual growth rate in F from 1978 to 1985	2.6%	2.1%	1.3%
	Average annual increment due to faculty expansion	870	700	420
	Annual replacement needs due to:[c]			
	death and retirement	340	340	320
	other attrition	1,020	1,000	970
	Expected number of academic positions to become available annually for biomedical Ph.D.'s	2,230	2,040	1,710
C. Will show essentially no growth from 1977 to 1985, leveling off at 543,000 students	Expected size of biomedical Ph.D. faculty (F) in 1985	32,010	30,880	28,960
	Annual growth rate in F from 1978 to 1985	0.6%	-0.1%	-0.7%
	Average annual increment due to faculty expansion	180	40	-200
	Annual replacement needs due to:[c]			
	death and retirement	310	310	300
	other attrition	940	920	890
	Expected number of academic positions to become available annually for biomedical Ph.D.'s	1,430	1,270	990

[a]Faculty is defined in this table as all academically employed Ph.D.'s, excluding postdoctoral appointees. See note 1 to this chapter for a description of the model used to compute the projections.
[b]Deflated by the Implicit GNP Price Deflator, 1972 = 100.
[c]Based on an estimated replacement rate of 1.0% annually due to death and retirement, and 3.0% annually due to other attrition. These estimates were derived from NRC (1973–80).

Faculty growth is only one component of the academic demand for biomedical scientists. The dynamics of faculty flow show a significant attrition from faculties for reasons other than death and retirement. According to the NRC's Survey of Doctorate Recipients (NRC, 1973-80), about 3 percent of biomedical science Ph.D.'s employed in basic science departments leave the faculty each year for other types of employment. This creates a replacement need in addition to deaths and retirements that must be filled either by people entering academic employment from other sectors or through the training pipeline. In addition, the data show that although the postdoctoral appointment is the usual route in the biomedical sciences to an academic post, not all faculty vacancies are filled by people with postdoctoral research training. In recent years in medical schools, the percentage of newly hired biomedical science Ph.D.'s with postdoctoral training has been less than 60 percent.

Also to be considered in determining training needs are the length of the postdoctoral training period and the yield from the postdoctoral pool in terms of the percentages that seek academic research careers. Knowledge of these aspects of the system is incomplete, but Table 3.3 shows how the system appears to have operated in the past few years and how it might operate in the near future.

TABLE 3.3 Estimated Number of Basic Biomedical Science Postdoctoral Trainees Needed to Meet Expected Academic Demand Through 1985 Under Various Conditions

	Actual[a] (1975-79 average)	Projected (1978-85)
1. Academic demand for biomedical Ph.D.'s—annual average:	2,480	2,040
a. due to expansion of faculty	1,350	700
b. due to death and retirement	190	340[b]
c. due to other attrition	940	1,000[c]
2. To reduce budgeted vacancies—annual average[d]		50
3. Total annual accessions[e]	2,480	2,090
a. % with postdoctoral research training	56%	70%
4. Total accessions with postdoctoral research training—annual average (assuming 70% of all accessions have postdoctoral research training)		1,460
5. Size of biomedical postdoctoral pool—annual average	7,334 (1979)	
Size needed to meet academic demand assuming a 3-yr. training period and portion of trainees seeking academic positions is:		
a. 60%		7,300
b. 70%		6,260
6. Annual number of biomedical postdoctoral trainees to be supported under NRSA programs:	3,255 (1979)	
a. if 40% of pool is supported under NRSA		2,500 - 2,920
b. if 50% of pool is supported under NRSA		3,130 - 3,650

[a]These estimates in lines 1-3 were derived from actual data on Ph.D.'s in basic science departments of colleges and universities using the results of the NRC's Survey of Doctorate Recipients.

[b]Assumes an attrition rate due to death and retirement of 1.0% per year.

[c]Assumes an attrition rate due to other causes of 3.0% per year.

[d]In 1979 there were about 720 budgeted vacancies in basic science departments of medical schools. The demand for basic biomedical science faculty generated by the need to reduce the number of unfilled positions is about 50 per year through 1985.

[e]Accessions are defined as new hires or those who rejoin faculties from nonfaculty positions. Inter-faculty transfers are not counted as accessions. Data on the percentage with postdoctoral training were derived from newly hired medical school faculty members only, which are 80% of total accessions in medical schools. We are assuming that the same percentage applies to all accessions.

SOURCE: Data from 1975-79 taken from National Research Council (1973-80). Projections were derived by this Committee.

Line 1 of Table 3.3 shows the annual demand for Ph.D. faculty in the basic biomedical sciences. As explained earlier, our definition of faculty includes those individuals hired for purely research staff positions as well as those on regular faculty appointments, but excludes those in postdoctoral training status. The projections are taken from the middle column of Table 3.2 using an assumed growth in R and D funds of 1 percent per year and an assumed enrollment growth of 2 percent per year. These figures are broken down into demand created by expansion, death and retirement, and other attrition. The projections assume a 1.0 percent per year death and retirement rate and a 3.0 percent per year attrition rate due to other causes based on results from the Survey of Doctorate Recipients (NRC, 1973-80).

Line 2 indicates demand for an additional 50 Ph.D.'s per year is created by the need to reduce budgeted vacancies in biomedical science departments. In 1979 there were about 720 such vacancies in medical schools alone, and they have been growing at about 3 percent per year since 1970. While some of these unfilled positions are the result of normal market inefficiencies, others could be the result of long-term unsatisfied demand. It seems appropriate, therefore, to assign a modest number to estimates of future demand in order to prevent further growth in these unfilled positions.

Line 3 is the sum of lines 1 and 2. This total is the expected annual demand for biomedical science Ph.D. faculty under the conditions imposed.

Line 3a shows that the percentage of accessions with postdoctoral training is expected to be 70 percent. This estimate is based on the data for medical schools where 56 percent of the new hires have postdoctoral training. In other research-oriented institutions this percentage is projected to be much higher so that, on the average, 70 percent or more of accessions will have postdoctoral experience. It should be noted that about 75 percent of NIH R and D funds are disbursed to the 50 leading research universities and institutes, and it is in these that the demand for trained research scientists must be met.

Line 4 gives the estimated number of accessions with postdoctoral training assuming that 70 percent of all accessions have such training. Note that transfers from one academic institution to another are not counted as accessions.

Line 5 shows the size of the postdoctoral pool using the most recent data and the projected size needed under certain conditions. It is assumed here that the average length of postdoctoral training is 3 years--the median time spent on a postdoctoral training appointment for the 1972 cohort of biomedical science Ph.D.'s was more than 31 months (see NRC 1981a, p. 326). If all postdoctoral trainees sought academic positions, the pool size would have to be 3,000 to produce 1,000 trained researchers each year. Because the yield from the pool is likely to be much less than 100 percent, the pool size required to meet the projected academic demand given the above assumptions has been estimated for 60 percent and 70 percent yield conditions.

We recognize that financial support for postdoctoral training comes from a number of sources other than federal training grant and fellowship programs. Currently about 44 percent of all biomedical science postdoctoral training appointees are supported under the NRSA training program. Line 6 provides estimates of the number of biomedical science postdoctoral trainees and fellows to be supported by the NRSA programs assuming that the distribution of funds from the various sources will remain approximately the same through 1985.

Commercial Market for Basic Biomedical Scientists

The nation's colleges and universities are the major employers of biomedical science Ph.D.'s, accounting for almost 55 percent of the labor force (Table 3.1, line 3b). The category classified as "Other" in Table 3.1, line 3g, which in 1979 represented 12 percent of the labor force, is, for the most part, also associated with colleges and universities. About 95 percent of this group hold temporary positions as postdoctoral trainees and postdoctoral research associates. The projected demand for postdoctorals to fill academic positions has been discussed above. In a later section of this chapter--"Postdoctoral Trainees and Academic Research Staff"--additional opportunities for permanent employment of these individuals are considered. Other major sectors of employment of biomedical Ph.D.'s include business, government laboratories, and nonprofit organizations.

The business sector is one of the fastest growing segments of the market for biomedical scientists (Table 3.1, line 3c). From 1973 to 1979, there were two periods, 1973 to 1975 and 1977 to 1979, when the number of biomedical science Ph.D.'s employed in the business sector increased by more than 20 percent. Between 1977 and 1979, the annual increase averaged 775 persons or more than 10 percent per year--almost twice the growth rate of the academic sector.

To gain some insight into the type of businesses exhibiting increases, a further analysis of the business labor force was prepared using the industry classification code (Table 3.4). In this tabulation seven of the eight categories showing average annual growth rates over 20 percent for the period 1977 to 1979 account for 39 percent, or 596, of the 1,548 biomedical Ph.D.'s added in the overall business group. In these seven categories the average annual increase in number of employees ranged from 12 to 85. Thus, while the growth rate was fairly high, the number of employees involved is relatively small. Since the businesses involved include mining, construction, petroleum refining, transportation and communications, computer services, and medical services, the meaning of these increases is difficult to evaluate without descriptions of the positions held. The increases may have resulted from an increase in the number of doctoral-level jobs in these businesses or the entry of biomedical doctorate holders into jobs having no relationship to their training, or from a combination of these. Recent growth in the medical services category resulted from increased demand for analytical services funded by third-party payers. There have been successful efforts by third-party payers to restrict the growth in the use and costs of medical services, and these restrictions will severely reduce the number of new jobs for biomedical doctorates in this field. Determination of the relevance of the other categories to the future market for biomedical scientists will depend on the availability of more detailed information and further study.

The other category in the business sector showing appreciable growth and accounting for 47 percent, or 731, of the biomedical Ph.D.'s added in this sector between 1977 and 1979 is that of Non-Classifiable Companies.

TABLE 3.4 Employment of Biomedical Science Ph.D.'s in Business and Industry, 1973-79

	1973	1975	1977	1979	Annual Growth Rate from 1973 to 1979	Annual Growth Rate from 1977 to 1979	Average Annual Change from 1973 to 1979
TOTAL BUSINESS AND INDUSTRY	5,328	6,779	7,002	8,550	8.2%	10.5%	537
Agriculture, Forestry, and Fisheries	76	67	42	66	-2.3%	25.4%	-2
Mining	0	0	5	75	–	287.3%	13
Construction	6	7	27	64	48.4%	54.0%	10
Manufacturing	4,439	5,591	5,799	6,233	5.8%	3.7%	299
Chemicals and drugs	2,826	3,819	4,075	4,192	6.8%	1.4%	228
Petroleum refining	138	130	94	254	10.7%	64.4%	19
Medical instruments	183	268	302	295	8.3%	-1.2%	19
Other	1,292	1,374	1,328	1,492	2.4%	6.0%	33
Transportation, Communication, Electric, Gas, and Sanitary Services	39	69	71	159	26.4%	49.6%	20
Wholesale and Retail Trade	37	111	61	70	11.2%	7.1%	6
Chemicals and drugs	5	31	14	15	20.1%	3.5%	2
Other	32	80	47	55	9.4%	8.2%	4
Finance, Insurance, and Real Estate	52	50	25	35	-6.4%	18.3%	-3
Services	389	414	389	534	5.4%	17.2%	24
Personal	0	0	0	0	–	–	–
Computer	13	0	21	69	32.1%	81.3%	9
Medical	170	121	113	283	8.9%	58.3%	19
Education	0	0	0	0	–	–	–
Other	206	293	255	182	-2.0%	-15.5%	-4
Non-classifiable Companies	290	470	583	1,314	28.6%	50.1%	171

SOURCE: National Research Council (1973–80).

Many are small biomedical research firms, some of which have recently been established. They are so new or so small that they could not be assigned an industry classification code. A number of them are recognized as being heavily involved in recombinant DNA technology. An obvious growth industry at this time is genetic engineering, and the increase in the number of jobs provided by these companies is expected to continue for the next 3 to 5 years. However, the extent of this growth will be limited because of the nature of the companies. They are supported by both investors and large corporations who view genetic engineering as an alternative to the established procedures for producing chemicals in large quantities. In addition to genetic engineering, this type of development requires new types of process engineering that may be more limiting. Until continuous synthetic processes have been developed and shown to be economically competitive, there may be little increase in the rate of addition of biomedical doctorates to this field.

There are indications that several of the larger chemical and pharmaceutical companies are planning expansion in their life science operations over the next several years. While it is clear that the extent of expansion and the levels of the positions to become available vary with the industry, the specific information needed to formulate useful predictions is not available. Even with these considerations and the recent growth experience, opportunities in business are expected to plateau, albeit at a higher level, in the next 3 to 5 years unless the economy and corporate profitability improve markedly.

With respect to the remaining categories making up the labor force, government employment of biomedical scientists has been essentially constant during the 6-year period shown, and no appreciable change is anticipated during the next few years. The steady growth rate of the nonprofit group (Table 3.1, line 3e), which includes research scientists and research administrators, may continue but is more likely to decrease somewhat.

During the period 1973-1979, the average increase in biomedical science Ph.D.'s employed in the commercial sector was approximately 1,000 per year (Table 3.1). On this basis, it is reasonable to predict that approximately this number of new positions will become available in each of the next five or six years.

Priority Fields

The basic biomedical sciences constitute a broad group of fields of study and research, including areas such as genetics, molecular biology, biostatistics, bioengineering, toxicology, and epidemiology. There are substantial differences in the training environments of these fields, in the required preparatory training, and in the kinds of individuals attracted to them. Because of the diversity, the Committee's Panel on Basic Biomedical Sciences attempted to obtain data that would reflect both the distribution of practicing scientists across these disciplines and, more importantly, their flow into the disciplines and the market for such trainees. Ideally, the Panel would like to be able to identify disciplines or areas that should be given priority with respect to training support.

During 1980 an analysis was undertaken of data collected in connection with a study of postdoctoral training in the sciences and engineering (NRC, 1981a). Data were obtained by an extensive questionnaire sent to postdoctoral trainees and recent degree recipients from which information about their expectations with respect to employment, the kinds of positions held, job offers, job inquiries, and so forth was collected. Some of these data were used in an effort to compare employment situations of recent Ph.D. recipients in various specialty fields within the basic biomedical sciences. The analysis was intended to provide information to identify fields in which career opportunities have been most promising in recent years and those fields in which opportunities have been especially scarce. Initial assessments revealed samples in some fields that were too small for accurate analyses. Further compilations are necessary to properly complete the study. The Committee believes that the study may provide a basis for recommending priorities for future funding, but that it is inappropriate to make such recommendations now for the following reasons.

First, realistic indicators of demand, such as number of job offers or interviews, are likely to vary greatly among subgroups for reasons other than market strength. For example, in biostatistics, postdoctoral training has been uncommon, and most of those trained in this field enter permanent positions immediately upon receipt of the Ph.D. On the other hand, molecular biologists traditionally take 3 to 4 years of postdoctoral training. When 1980 Ph.D. recipients are asked about permanent job offers, the responses will differ predictably in various fields, and it is incorrect to conclude that the market for molecular biologists is soft, simply because in 1980 individuals who obtained the degree during that year have almost no offers of permanent employment--they do not seek it until near completion of postdoctoral training.

Second, in many subgroups, the number of respondents was quite small. The statistical analysis of their responses is, therefore, less reliable. In addition, a small number of highly specialized personnel generally produces a strong demand. This does not imply, however, that the market itself is very large. It is entirely possible that the supply is reasonably adequate or that the needed increase in supply can be achieved with relatively small increases in the number of trainees.

Third, the nation's biomedical research effort is a search for scientific knowledge and for solutions to a wide range of technical problems. Managing the personnel flow is a means to these ends. An apparent imbalance between trained personnel and employment opportunities may signal either a need to reduce the number being trained or a need to capitalize on the talent of already trained personnel for a cost-effective research initiative in the area.

The examples given illustrate the complexity of evaluating the data obtained in the recent study. Nevertheless, the Committee believes that assessments can be made and that further analyses of the data now available will allow more precise targeting of areas of need than is now possible.

In previous reports, the Committee has recognized that shortages of investigators exist in three areas: toxicology, epidemiology, and biostatistics. This assessment, although not based on precise numerical data, is still considered to be accurate on the basis of the Committee's perception of strong demand in these disciplines.

Conclusions

Current production of Ph.D. biomedical scientists is significantly below the levels anticipated previously by many analysts on the basis of indicators available at the time. As noted in the succeeding section, there are some perturbations in the system that cannot currently be explained.

Even if enrollments in medical schools, undergraduate biological science programs, and biomedical science graduate programs remain stable, and R and D funds increase at only 50 percent of recent rates, demand for academic faculty can be expected to remain at current levels. A significant factor sustaining this demand is the loss of experienced faculty members to other types of employment. This factor, the extent of which is revealed by recent data, largely explains the increase in this year's estimates of academic demand for biomedical science Ph.D.'s compared to those in previous Committee reports.

Industrial and business opportunities for biomedical scientists appear to be increasing steadily and contributing to the current strong market.

ASSESSING PH.D. PRODUCTION IN THE BASIC BIOMEDICAL SCIENCES

Total graduate student enrollment in the basic biomedical sciences, beginning in 1960 at about 11,000 students, increased steadily to almost 42,000 in 1979, the last year for which data are available (Figure 3.4). Over this period, first-year graduate student enrollment increased from about 5,500 students to 18,900 in 1975 and 1976 and then decreased to 17,500 in 1979. Ph.D.'s awarded in the biomedical sciences during these same years increased from 1,100 in 1960 to 3,500 in 1971 and remained at that level through 1978 but then rose slightly to 3,636 in 1979. Of those awarded degrees in 1971, about 13 percent did not have U.S. citizenship. The proportion increased to 16 percent in 1974 and has since decreased to 12 percent in 1979. In considering the enrollment and degree award data, it must be borne in mind that not all students enrolled were pursuing programs leading to the Ph.D. and that to complete requirements for the doctoral degree requires a minimum of 4 to 5 years. Most other graduate degrees require only 2 to 3 years. If the decreases in first-year graduate student enrollment in the biomedical sciences between 1975 and 1979 continue, even though total enrollments have increased over the same period, it may be appropriate to predict that the number of doctoral-level scientists produced will begin to decrease by the mid-1980's. This trend may also be influenced by the projected decline in the U.S. population of ages 20 to 24, the time at which most students begin graduate studies.

The fact that Ph.D. production has remained constant for a number of years during which graduate student enrollment has continued to increase is a matter of some interest, but available data do not permit a full understanding or explanation of this phenomenon. Several factors may be involved. For example, the number of students enrolling in doctoral degree programs may be relatively constant, while increasing numbers may be entering master's degree or other nondoctorate degree programs. Information derived from data on graduate student enrollment and degrees awarded (Appendix Tables A2 and A3) seems to indicate that the number of students terminating graduate studies without completing a degree increased approximately four-fold between 1961 and 1977. The number decreased by 11 and 4 percent for 1978 and 1979, respectively. Data in NRC annual reports on doctorate recipients (NRC, 1972-81) show, for field

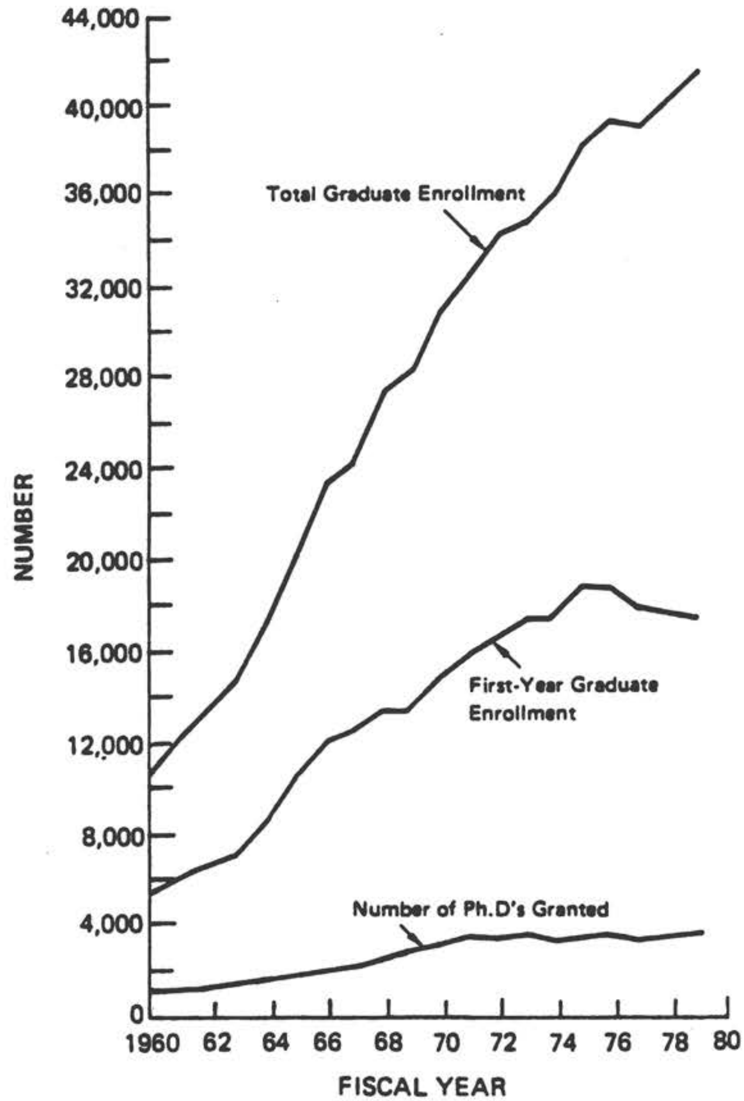


FIGURE 3.4 Graduate enrollment and Ph.D. production in basic biomedical science fields, 1960-79. See Appendix Tables A2 and A3.

groupings similar to, but not identical with, those included under the basic biomedical sciences for the present study, that the time to complete degree requirements has increased about 9.5 percent (approximately 0.5 year) since 1971.[2] This increasing time may be a factor in the continued growth of total graduate enrollment because first-year enrollment and the number of degrees awarded each year have remained almost constant. The time may be influenced by several considerations. As research problems become more complex, the time required to gain sufficient understanding, experience, and knowledge to embark on an independent career becomes greater. Probably a more important consideration in this regard is the amount, level, and type of support available to graduate students for research training. Data on sources of support for full-time graduate students show that as the percent of students receiving federal support has declined, the percent dependent on self-support has increased, especially in the biosciences since 1974 (Table 3.5). Thus, although enrolled as full-time students, many self-supported students necessarily devote a portion of their time, which otherwise would be devoted to studies, to part-time employment to earn subsistence. There are reports also that substantial numbers of students who have financial support that is intended to allow full-time for study and research find it necessary to take leave for periods of 1 year or more to accumulate supplemental funds. These interruptions lead to delay in completion of the degree or, since some do not return, to increased attrition.

The data in Table 3.5 indicate that the percentage of biomedical science students receiving support from federal sources has fallen from 44 (1967) to 32 (1978). These figures mask a more dramatic change. The percentage receiving federal fellowship or training grant support has decreased since 1970, while the proportion being paid from research grants has remained essentially unchanged (NSF 1973-77). Since research grants awarded to regular faculty sponsors are to pursue well-defined research goals, this change limits the range of options available to students for training and research. In a sense, students working as research assistants should be viewed as self-supported since they provide a service for the salary they are paid.

In summary, during the last 5 to 7 years the research training system has been subject to a number of significant changes in the enrollment, retention, and graduation of trainees. To better understand its current status and to form a basis for future projections, certain data need to be updated and additional kinds of information need to be obtained. It appears that there has been an increase in the time required to obtain the Ph.D. degree (NRC, 1972-80), a trend that does not serve the national interest.

POSTDOCTORAL TRAINEES AND ACADEMIC RESEARCH STAFF

In the preceding section, "The Market Outlook For Biomedical Science Ph.D.'s," the postdoctoral population was considered in relation to the needs to fill regular faculty and nonfaculty doctoral research staff vacancies in the colleges and universities of the United States. As noted earlier and in Table 3.1, doctorate-level biomedical scientists in these positions represent about 55 percent of those employed in this sector of the labor force. For most of the disciplines included under the biomedical sciences, postdoctoral training is an essential element in preparation for an academic research career. Also, government agencies, industry, independent research institutes, and the military increasingly recruit from the postdoctoral pool. Together they constitute significant elements affecting market demand.

The steady increase since 1970 in the number of biomedical science Ph.D.'s holding postdoctoral appointments has been a cause of concern since the inception of this study in 1974. It must be recognized that the data on the number of persons in postdoctoral positions includes foreign nationals. Unfortunately a quantitative assessment of the proportion is not available at this time. The overall growth continued, at a slightly reduced rate, even with steady-state Ph.D. production over the same period. In the past, the growth was perceived as the system's

TABLE 3.5 Sources of Support for Full-Time Graduate Science Students in Ph.D.-Granting Departments by Field and Year

Field	Source of Support	Fiscal Year 1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	Change Since 1970
		(% of students supported by each source)												
Total All Science Fields	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
	Institutional	35.8	33.8	35.2	35.7	36.9	37.0	38.6	41.6	39.7	38.3	38.5	38.3	2.6
	Federal	37.7	41.8	39.6	36.6	34.4	31.7	30.0	27.4	25.3	23.9	23.2	23.7	-12.9
	Other outside	9.9	10.0	9.1	9.1	9.2	8.9	8.3	8.6	8.6	8.4	8.8	9.0	- 0.1
	Self	16.6	14.4	16.1	18.6	19.5	22.4	23.1	22.4	26.3	29.4	29.4	29.0	10.4
Physical Sciences	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
	Institutional	39.1	38.0	39.5	41.4	43.9	45.3	48.5	52.1	50.4	50.2	50.0	49.9	8.5
	Federal	47.3	49.4	46.7	43.7	41.0	38.0	35.1	32.2	31.2	31.3	31.7	32.4	-11.3
	Other outside	6.2	6.7	6.8	6.6	7.0	6.9	5.9	5.8	6.8	6.4	6.7	6.7	0.1
	Self	7.4	6.0	6.9	8.3	8.0	9.8	10.5	9.9	11.6	12.1	11.6	11.0	2.7
Engineering	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
	Institutional	26.9	24.1	25.1	26.0	26.8	26.5	26.8	29.9	29.6	28.1	29.0	28.2	2.2
	Federal	42.6	45.3	42.7	40.0	38.7	36.0	36.4	34.7	31.4	28.9	28.8	29.1	-10.9
	Other outside	17.5	16.2	15.7	16.1	14.9	14.0	12.7	13.1	13.3	12.6	13.4	14.4	- 1.7
	Self	13.0	14.4	16.4	17.9	19.6	23.5	23.1	22.3	25.7	30.4	28.7	28.2	10.3
Mathematics	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
	Institutional	47.3	46.8	49.6	50.2	53.5	52.8	55.0	60.5	62.4	61.0	61.2	61.0	10.8
	Federal	29.9	31.4	29.5	27.5	24.1	20.0	16.0	13.1	10.4	9.2	9.1	9.7	-17.8
	Other outside	3.8	5.3	4.1	4.9	5.5	5.3	4.9	5.5	5.2	6.1	5.6	5.8	0.9
	Self	19.0	16.5	16.9	17.4	17.0	22.0	24.1	20.9	22.1	23.7	24.1	23.5	6.1
Bioscience	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
	Institutional	35.9	34.5	32.8	36.0	36.4	37.1	37.9	39.5	36.8	35.8	36.2	36.6	0.6
	Federal	44.0	48.4	39.8	43.5	41.2	37.2	37.0	33.2	32.4	32.3	30.9	31.6	-11.9
	Other outside	4.4	6.6	6.1	5.9	5.9	6.7	6.3	7.0	6.7	6.2	7.9	7.0	1.1
	Self	15.7	10.5	12.2	14.6	16.5	19.1	18.8	20.4	24.1	25.8	25.9	24.8	10.2
Behavioral Science	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
	Institutional	33.8	32.3	32.8	26.0	33.5	34.2	33.8	38.4	36.9	36.0	35.1	36.1	10.1
	Federal	37.8	42.0	39.8	40.0	33.7	31.5	27.6	24.4	21.3	20.0	17.6	16.9	-23.1
	Other outside	4.7	6.6	6.1	6.7	7.1	6.5	7.3	7.4	6.6	6.2	6.4	6.7	0
	Self	23.7	19.1	21.2	24.9	25.7	27.8	31.1	29.7	35.2	37.9	40.9	40.4	15.5

SOURCE: National Science Foundation (1973–79).

response to a reduction in faculty employment opportunities for biomedical science Ph.D.'s. This perception was a major element in the Committee's decision to recommend, in its 1976 and 1977 reports, a reduction of 30 percent in the number of predoctoral trainees to be supported through federally funded training grants, but to maintain the number of postdoctoral trainees and fellows. It is too early to know whether the reduction in predoctoral training support will decrease the number of graduates seeking postdoctoral appointments.

It is important, however, to draw attention to other factors that must be considered as contributing to the size of the postdoctoral pool. These include a continued strong demand, fed by the availability of positions funded on research grants, for postdoctorals to do research and the demand by hiring organizations (universities in particular) for more extensive research training for new faculty. In addition, more and more research is being conducted by teams of postdoctorals, working under senior investigators, rather than by graduate students. In some programs experiencing decreases in graduate enrollments, faculty research productivity has suffered until additional postdoctoral associates could be recruited as replacements. While the postdoctoral team operation is most prevalent at the major research universities, industries also use such teams to accomplish their expanding research and development activity. In fact, industrial support of training, which has been common in such fields as chemistry and physics, has very recently been extended to the biological sciences. With the changing patterns of research operations and the evidence of increasing demands for postdoctorals, it is essential to monitor the number of open positions for postdoctoral personnel and to evaluate the changing roles of Ph.D. scientists in university and institutional research programs.

At many universities, the nonfaculty doctoral research staff is assuming a more important role and the number holding positions is increasing. As the terminology implies, these researchers are engaged full time in research. Although they do not have tenure, they have a considerable amount of job security and the promise of long-term careers in academic research. Even though the job situation and levels of responsibility of research scientists in this group are quite different from those holding temporary postdoctoral appointments for training, many of the titles are similar. These title similarities may be a source of errors in identifying postdoctoral trainees and may contribute to uncertainty in assessing the size and dynamics of the "postdoctoral pool."

The demand for personnel to pursue research as nonfaculty doctoral research staff appears to be increasing, while the training of new Ph.D.'s is decreasing or holding steady. Thus, there will be more nonfaculty positions in academic research laboratories. Depending on classification by institutions, this may cause an anomalous change in the faculty/student ratio as the number of faculty members serving only in a research capacity increases. From an NRC study (NRC, 1978a) it was reported that the nonfaculty doctoral research staff in 1977 numbered approximately 4,200 and represented 3 percent of all Ph.D. scientists and engineers employed in academia. About 37 percent of these were in the biosciences areas. Although this doctoral research staff is small in number, its contributions to the research accomplishments at the institutions are disproportionately greater. The NRC report states that between 1975 and 1977 the number holding these research staff positions increased 20%, about 2 1/2 times the regular faculty growth rate.

Projections of the number of postdoctoral trainees needed to meet academic demand each year through 1985 (Table 3.3) include those needed to fill regular faculty and nonfaculty doctoral research staff positions. The Committee will continue to monitor the role and composition of the postdoctoral pool.

QUALITY IN GRADUATE TRAINING

The Committee and its Panel on the Basic Biomedical Sciences, in considering the role of training in stabilizing the supply of highly qualified personnel, have been concerned not only with the quantitative aspects of supply and demand but also with the effects that training grants and fellowships have on the quality of the training environment. Several attempts have been made to obtain quantitative and statistically valid data on such qualitative aspects of training as qualifications of trainees, numbers of applicants to programs, quality of seminar programs, availability of special courses, freedom of trainees to select research areas, and so forth. The variability of programs has made comparison of collected data about existing training programs almost meaningless. Each program has been tailored to the needs and qualifications of its faculty, available local support, local physical resources, and other institutional individualities.

It is almost equally difficult to detect the effect of reduction of federal training support on the quality of graduate programs. Academic research departments give top priority to the training of graduate students and postdoctorals. As training grant support has been reduced, every other financial resource has been tapped to replace it so that in many instances the quantitative indicators of quality initially have been little affected. However, there are limits to an institution's ability to compensate for such reductions. It is the Committee's opinion, based on experiences in its members' institutions, that the limits have been reached and that very real reductions in the quality have occurred in many programs.

Some measures are apparent. For example, in the section of this chapter titled "Assessing Ph.D. Production in the Basic Biomedical Sciences," the increase in time taken to complete training is discussed. This is a direct response to the changing support pattern and reflects a general decline in the quality of the graduate experience. The Committee is attempting to obtain more precise data concerning the career patterns of graduate students in the basic biomedical sciences and the reasons for the extension of time taken to obtain the degree and for leaving predoctoral programs.

In a 1976 survey of biomedical and behavioral science departments conducted by the Committee, department chairpersons indicated that the loss of training grant support resulted in significant reductions in program activities. Support for course work, student research, student travel, laboratory assistants, and visiting faculty programs were reported as seriously affected (1978 Report, pp. 44, 276).

During 1979-1980 the Panel undertook a study, which included site visits by staff and members of the Panel, of several training programs at each of four universities. The intent of these visits was to evaluate by direct observation the roles that training grants for predoctorals had on the general quality of graduate training and to assess the impacts, both short- and long-term, of changes in funding patterns and levels during the past several years. Although many negative effects were ascribed to decreases in training grant support, the Committee concluded that it was not possible to achieve a valid perspective on the effects of funding changes in specific programs by a site visit assessment of several programs simultaneously on a university-wide level. In an attempt to assess the impact of loss of training grants on the departments incurring the loss, several of the departments included in this study were asked to provide copies of annual reports prepared for intra-institutional purposes. Although these reports attested to the financial impact of the loss of training grant support, they were not a rich source of information about program quality. Again, the focus of the reports was too broad, concerning all of the activities of the departments with principal concern for institutional budget reductions and other local matters.

Case Studies of the Impact of the Loss of Training Grant Support on Training Programs

Despite the problems encountered, the Committee and the Panel recognize the importance of obtaining an assessment of the quality of training programs and, in particular, the impact of lost training grant support on program quality. Having concluded that statistically reliable data across institutions cannot be obtained, it was decided to obtain case study data on a small number of specific programs. Although such a small sample cannot be considered to reflect national numerical trends, the information does offer reliable and documentable examples of specific responses.

Two programs, one in physiology and one in bioengineering, were selected and studied independently and fairly exhaustively. The site visitors were provided access to faculty, students, administrators, and departmental records. Both departments had lost all (or almost all) of their training grant support during the last 2 years. The loss of training grant support was due almost exclusively to budgetary constraints and not to a decline in the quality of the training programs as reflected by priority scores received in national competition in the NIH peer-review process. Site visits included a thorough review of the status of the program both before and after the loss of training grant support, and interviews with many of the staff and students. Detailed reports were provided to the Panel, which included data on student admissions, enrollments, sources of support, and numbers of degrees awarded for each department.

Training programs in different disciplines and/or universities are not identical in all respects but they do have in common many essential features that are often enhanced when training grant support is available. In attempting to study the effect of loss of training grant support, the Committee has discovered substantial benefits that accrue to having some support. The following significant points emerged from this study.

- For these two departments, neither of which has an undergraduate program, the training grant assured that a sufficient number of graduate students would be in training to warrant the presentation of advanced and special courses. In the absence of a critical mass of students, such courses are being eliminated. In addition, the ability to innovate in the curriculum is largely lost. In both cases, some concern was expressed regarding the viability of the graduate program in the long term.

- Both departments had great difficulty in recruiting new graduate students.

  In the bioengineering department, most new students accepted for graduate study, when not assured of stipend support, enrolled elsewhere or left the field. Students already in the program, having lost stipends, found positions in industry to support themselves. Unfortunately, they tended to stay there without completing the Ph.D. or extended their training period by several years. Although high salaries in industry are a distraction at all times, the effect is greatest when other sources of support for graduate study are eliminated.

  In the physiology department, funds were not available to support students during the first 2 years of the program when course work is heavy. Without such support, recruitment of qualified students was virtually impossible. Students either went to other programs or pursued professional studies. Once in the program students tended to stay and were supported as research assistants in later years.

- In both departments, loss of the shared responsibility for the training program reduced the cohesiveness of the department. The effects this may have on joint research and future training cannot be fully assessed, but the effect seems to be real.

- In both departments, peer discussion and criticism at the student level, important in the training process, lost vitality with decreased enrollments.

- Research productivity in some laboratories in both departments decreased due to loss of vital contributions by students. Recovery was dependent on recruiting additional postdoctorals.

- Seminar programs that are vital for both training and research have been reduced.

- Student travel to scientific meetings and support for student research have been eliminated. Students are now constrained to work on projects funded by competitive grants to regular faculty members who are their mentors.

- In the bioengineering department, recruiting regular faculty members became difficult due to the uncertain status of the graduate training program.

- Support staff, important for the bioengineering training program, was reduced with termination of training grant funding.

TRAINING ENVIRONMENT

Universities, charged with the education of future scientists, should have available the instrumentation and facilities needed to ensure the highest quality training for predoctoral and postdoctoral students. It is generally assumed that the leading research universities will have such resources and that they will be available to the students as they prepare for independent research careers. However, there have been several reports (Abelson, 1978; Blout et al, 1978; Coulter, 1979; Berlowitz et al., 1981) indicating that the quality of research instrumentation and facilities in university laboratories has seriously declined, and there is little indication that this process will be reversed under current policies and fundings.

Instrumentation

With the rapid pace of instrument development, many instruments purchased only a few years ago are now obsolete. In addition, the cost of many new instruments and the expense of maintaining them threatens to make certain high technologies inaccessible to many university researchers. Without up-to-date instruments the capacity of researchers to contribute to new knowledge will be greatly impaired. Furthermore, opportunities to improve the state of the art, develop superior instruments, and expand their uses, all frequent accomplishments in university laboratories, are being compromised.

It is difficult, if not impossible, to obtain data on the effects of the deteriorating quality of university instrumentation on the training environment. However, a study by the Association of American Universities (AAU, 1980) examines the scientific instrumentation needs of research universities and identifies some of the problems being encountered. The Executive Summary of the report for that study will be found in Appendix B1.

Facilities

As in the case of instrumentation, training and research programs cannot operate at full capacity if facilities are inadequate. With federal support for construction and renovation of research facilities severely diminished--virtually eliminated, increasing pressure is placed on university funds. Malfunctions in aging facilities may severely impede research efforts. Projects may have to be abandoned when costly renovations are necessary to meet federal regulations.

Estimates of university facilities and special research equipment requirements were gathered in another study by the Association of American Universities (AAU, 1981). The Executive Summary of the report for that study is provided in Appendix B2.

Conclusion

Although innovative research is accomplished in industrial, government, and nonprofit research center laboratories, as well as at universities, it is the university research and educational programs that are critical for training the scientists of the future for all fields of employment. Training in and of itself, together with the instruments with which it is done and the specialized facilities in which it is done, must be given a high national priority.

In recognition of the difficulties being encountered by universities in providing up-to-date facilities and instruments for their research and training programs, the Committee strongly endorses the recommendations presented in the two AAU reports for the revitalization of university research instrumentation and facilities.

RECOMMENDATIONS

Predoctoral Training Levels

In its deliberations, the Committee considered the data discussed in preceding sections of this chapter and drew on the experiences of its own members. It strongly endorses continuation of federal support for the previously recommended number of predoctoral basic biomedical science trainees (Table 3.6) through the training grant programs of NIH and ADAMHA. The recommended number represents a 30 percent reduction from the level of 6,000 trainees supported in FY 1975 when the Committee began its study, but further reduction does not seem justified at this time. The number of traineeships proposed represents approximately 10 percent of the total graduate enrollment in the biomedical sciences.

This recommendation is supported by indications that students supported by traineeships or fellowships have achieved higher Ph.D. attainment rates and have completed their training more rapidly (NRC, 1976a), thus conserving federal and institutional resources. Also, these individuals, following postdoctoral training, frequently as federally supported trainees or fellows, tend to remain in research, and are highly productive. Predoctoral institutional training grants also make a major contribution to the vigor and quality of programs in the biomedical sciences and the funds should be provided for support of programs as well as trainees.

> Recommendation. The number of predoctoral trainees and fellows supported annually in the basic biomedical sciences should be maintained at 4,250 in each year from the present through FY 1985.

Postdoctoral Training Levels

The Committee has previously recommended provision of 3,200 awards (Table 3.6) for support of postdoctoral training through FY 1982 and finds no evidence that adjustment in this annual level for FY 1982-FY 1985 is warranted at this time. These awards do not add to the doctoral labor force but provide for advanced training to increase technical skills and experience so essential to successful independent research careers. In many instances postdoctorals use this training period to gain experience in new fields or in new technologies. At the same time, they contribute significantly to the vigor of research and the advancement of science.

The Committee intends to monitor closely the supply/demand balance and will recommend adjustment of the number of awards for later years if necessary.

> Recommendation. The number of federally funded postdoctoral awards in the basic biomedical sciences should be maintained at 3,200 annually for FY 1982-1985.

TABLE 3.6 Committee Recommendations for NIH and ADAMHA Predoctoral and Postdoctoral Traineeship and Fellowship Awards in the Basic Biomedical Sciences

Agency Awards and Committee Recommendations	Fiscal Year										
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Actual Awards											
Total	9,199	8,216	6,526	6,294	7,356	7,392					
Predoctoral	6,003	4,449	3,809	3,680	4,101	4,337					
Postdoctoral	3,196	3,767	2,717	2,614	3,255	3,055					
1976 Recommendations											
Total		8,600	8,600	8,600							
Predoctoral		5,400	5,400	5,400							
Postdoctoral		3,200	3,200	3,200							
1977 Recommendations											
Total					7,450	7,450	7,450				
Predoctoral					4,250	4,250	4,250				
Postdoctoral					3,200	3,200	3,200				
1978 Recommendations[a]											
Total						7,450	7,450	7,450			
Predoctoral						4,250	4,250	4,250			
Postdoctoral						3,200	3,200	3,200			
1981 Recommendations											
Total								7,450	7,450	7,450	7,450
Predoctoral								4,250	4,250	4,250	4,250
Postdoctoral								3,200	3,200	3,200	3,200

[a] Affirmed in the 1979 Report (Issued May, 1980).

Training Grant Awards

Studies of the effect of loss of training grant support on training programs show marked decreases in the quality of instruction, reduced access to special programs and instrumentation, and decreases in interdisciplinary efforts when grant support is substantially reduced or terminated. These effects may not be immediately evident and, in different programs, may produce different specific outcomes. In general, however, the end-point is a decrease in the vitality of the program and in the range of options it provides.

In response to the Committee's 1976 survey, department chairpersons indicated that reductions in training grant support led to limitations in student research, student travel, visiting faculty programs and laboratory courses. Reductions in numbers of trainees were offset by directing funding for other aspects of the program toward student support. In the Committee's recent case studies, the virtual elimination of training grant support led to substantially decreased enrollments, principally due to loss of funding for new students. These effects were accentuated by concomitant decreases in funding from other sources.

While the case study findings do not constitute proof, they do indicate that loss of training support can lead to critically diminished student numbers with reductions in courses offered, and in curriculur innovation. The accompanying decrease in communication among students, can substantially decrease the quality of the educational program.

While the Committee recognizes that no hard and fast measures can be developed to establish minimum grant size in so diverse a set of training programs as exist in the basic biomedical sciences, it believes that a training grant, in order to be effective, must assure a critical mass of students and serve as a cohesive force for the training program.

> Recommendation. While training grants should continue to be awarded on the basis of national competition, it should also be recognized that a minimum number of grant-supported trainees, the number of which will vary with the specific training program, is essential to ensure the critical mass necessary for a vital and effective program.

NOTES

1. A constrained growth curve of the Gompertz type fits the data for 1962-1977 quite well, resulting in the following mathematical form of the model:

$$(\underline{F/S} - 0.037) = (0.023)e^{-e^{[1.5 - 29363(\underline{M}-550,000)]}}$$

where: $\underline{F/S}$ = ratio of biomedical science Ph.D. faculty to total graduate and undergraduate biomedical science enrollment;

$\underline{M}$ = weighted average of last 3 years of real life science R and D expenditures in colleges and universities; $\underline{M} = 1/4\ (\underline{R}_t + \underline{2R}_{t-1} + \underline{R}_{t+2})$. These expenditures are adjusted for price changes by means of the GNP price deflator.

2. The data on enrollments and Ph.D. production include non-U.S. citizens, but that fact does not account for the increasing time required to complete the Ph.D. degree. In fact, foreign students, who represent 11.5 percent of all Ph.D. recipients in the biological sciences in 1980, appear to take less time than U.S. citizens to complete the Ph.D. program.

4. BEHAVIORAL SCIENCES

This past year the Committee and its Panel on Behavioral Sciences have examined current data on the supply and market for Ph.D.'s in the behavioral sciences, investigated future needs for the training of persons with particular areas of specialty, evaluated agency programs for the support of persons in training in these fields, and reviewed recommendations of prior years in light of the findings from these analyses. Because attempts are being made this year by some parts of the federal government to formulate a distinction between behavioral and social science, a distinction which the Committee believes to be without foundation, the Committee also addresses this issue. In addition, the Panel held two conferences on problems related to training in behavior and health and the recruitment of clinicians for mental health research. The proceedings of the workshop on establishing training programs in behavior and health, held in January 1980, was published this year (NRC, 1981b). The program of the symposium on the recruitment of clinicians for mental health research, held in June 1980, is contained in Appendix B3.

THE TRAINING OF BEHAVIORAL SCIENTISTS

The description in Chapter 3 of the training of basic biomedical scientists is also a description of the training of those behavioral scientists whose orientations are strongly biological. The patterns of training for behavioral scientists are even more varied than those for the biological scientists, however, for the fields are more diverse in content and in methodologies, and the career objectives of persons earning higher degrees in the behavioral sciences include not only health-related purposes, but a wide variety of others, from studies that involve substantial historical and documentary analyses, to those that involve highly mathematical and analytical processes. The domains of the social and behavioral sciences include economics, political science, psychology, sociology, anthropology, and certain portions of geography, history, speech and hearing sciences, and linguistics. In addition, certain professions use a large component of the methodologies of the behavioral sciences. These include such fields as nursing, business, law, and journalism. For operational purposes, the Committee continues to define the behavioral sciences as psychology, anthropology, sociology, and speech and hearing sciences because these are the fields most closely involved in investigating health problems.[1]

The preparation of adequate numbers of persons with doctoral degrees in the behavioral sciences for the resolution of health problems and for an understanding of the most appropriate ways to deliver health care services has required a substantial augmentation of resources in the behavioral sciences during the past 30 years. This growth has been accompanied by more and more support from health agencies, especially as the importance of the voluntary activities of the patients has become more and more apparent to health practitioners. In addition, the field of psychology has become more health oriented, with the clinical psychologists, in particular, making significant contributions in the mental health area.

Young persons who contemplate entering the behavioral sciences make their decisions about entry at a somewhat later time in their life than do persons who plan to enter medicine. To young students, the behavioral sciences are less apparent than medicine as occupations that could be attractive to them and in which they could play an appropriate role. While television has more recently given attention to such occupations as clinical psychology, young students very frequently find little to help discriminate this field from other health fields. As young persons enter college, the study of some of the behavioral sciences gives evidence that people are making contributions to society in these domains. They also see rewarding career opportunities in fields that draw upon the behavioral sciences, such as business and law. As students study these fields, many of them are attracted to them as lifetime occupations. Some of the ablest of these become research contributors in the various fields.

Undergraduate education in the behavioral sciences must include a broad background of work in a number of disciplines in order for graduate study to be effective. Many undergraduate students do not recognize this and must augment their work at the graduate level with additional work in biology, mathematics and statistics, computer science, or in such fundamental areas as philosophy, chemistry and biochemistry, or history. Thus, the graduate educational programs of such students are more varied in content than one would expect for persons who would presumably have decided upon an area of specialization upon entry into graduate work.

The variety of career options available to persons in the behavioral sciences is also accompanied by a great variety of possibilities for student support in graduate schools of arts and sciences. Since most behavioral science departments are in academic units that have large teaching responsibilities for undergraduates, the most common form of support for graduate students is as teaching assistants. Some graduate students, particularly in the later years of study, become employed on research projects as research assistants. Others are awarded traineeships and fellowships under federal programs. In the behavioral sciences, traineeships and fellowships support only a small proportion of graduate students. Even in psychology, where traineeships and fellowships exist in somewhat larger numbers, these awards still support less than 15 percent of the students in doctoral departments. Accordingly, modest variations in the amount of traineeship and fellowship support seem to have little effect on Ph.D. production. As of 1978, NRSA awards alone supported only 1,160 (or 3 percent) of the 36,500 full-time graduate students in the behavioral sciences. It should be noted that NRSA awards may be utilized only for the purpose of research, and not clinical, training.

Reviews of the use of the training grant mechanism in various institutions have indicated its great value in strengthening a department and improving the options for support in a way that makes possible a substantial improvement in the planning of graduate programs for students entering the health fields. While the evidence of need for large numbers of such persons to be supported is not as convincing today as it was in earlier times, it is clear that a department that loses support in the form of a training grant encounters serious difficulties in developing the appropriate educational programs for those students who plan health careers. Those departments that have experienced diminished support through training grants, or who have lost them entirely, report a diminished quality of training programs provided for persons entering the health fields (1978 Report, pp. 68-69). The proportion of graduate students planning to enter health fields varies from department to department and field to field. The largest single group of such persons are the clinical psychologists. The training grants for them have, in the past, supported preparation for clinical activity or for research activity. If clinical training grants vanish, the importance of the research training grant will perforce increase.

The department that wishes to provide an excellent program of training for a doctoral candidate who intends to enter a health-related part of the behavioral sciences has a difficult task without outside help. The training program must incorporate not only the essential components of the discipline that provides an adequate base for a research career, but also programs outside the department and in health settings in order to relate the basic graduate education to the needs of those settings. If the program does not include such components, the individual is less likely to make an important contribution to health research and is more likely either to engage in routine and easily generated research or else to choose a career in a clinical or applied setting and undertake little or no research. The Ph.D. in the behavioral sciences who is able to apply the methods and the theoretical bases of the behavioral sciences to the problems faced in the health care system is a valued member of a health research team.

The need for a more comprehensive educational background for the behavioral science investigator in the health fields is so great that the Committee has emphasized the postdoctoral program for health fields as the essential ingredient for developing the cadre of experienced and versatile investigators that will be required in the future. The Committee has been willing, while acknowledging that some colleagues hold a contrary view, to sacrifice overall numbers in order to assure that the quality of a very well prepared group could be maintained and to assure that there will be enough of them in the future. Providing comprehensive education for this group does not require one to specify that each person who accepts such a postdoctoral traineeship would spend time in a health-related facility, for to do so would necessitate one knowing what the best pattern of education is for each such person. The Committee does believe that the limitations of the predoctoral educational period are too great to assure that an adequate number of persons will have studied in depth a sufficient breadth of material to enable them to contribute to the fullest extent in the next generation. The Committee has attended particularly to those graduate programs that endeavor to deal with the relationships between behavior and medicine, and is convinced that this domain of study will produce savings in health care delivery and greater effectiveness in the treatment of a large number of disorders.

THE MARKET FOR BEHAVIORAL SCIENCE PH.D.'S

In monitoring the state of the labor market for behavioral scientists, the Committee and its Behavioral Sciences Panel have found that while behavioral scientists have been fully employed and adequately utilizing their research skills there have been indications of a softening in demand and a shift in employment prospects from nonclinical to clinical fields. The latest analysis indicates a continuation of these patterns. It is important to keep in mind, however, that there are subfields, especially within the nonclinical sciences, that vary substantially with respect to the relationship between supply and job opportunities within them. Data are not available to permit a finer field analysis. Care should be taken, therefore, not to assume that all subfields are experiencing the same market conditions.

Current Indicators

Beginning with its 1978 Report, the Committee has differentiated between clinical and nonclinical behavioral science in its analysis of market conditions. Data gathered to aid in the assessment of national needs for behavioral scientists have provided increasing evidence of the diverse patterns of employment, enrollments, and Ph.D. production in these segments. The clinical segment, composed of clinical psychology, counseling and guidance, and educational psychology, is heavily oriented towards nonacademic employment and is currently enjoying a rather strong market for the services of this group of Ph.D.'s (Figure 4.1). On the other hand, the nonclinical segment, composed of nonclinical psychology, anthropology, sociology, and speech and hearing sciences is heavily dependent on academic employment and consequently is facing a weakening demand brought on largely by the prospect of reduced faculty needs in the face of declining enrollments.

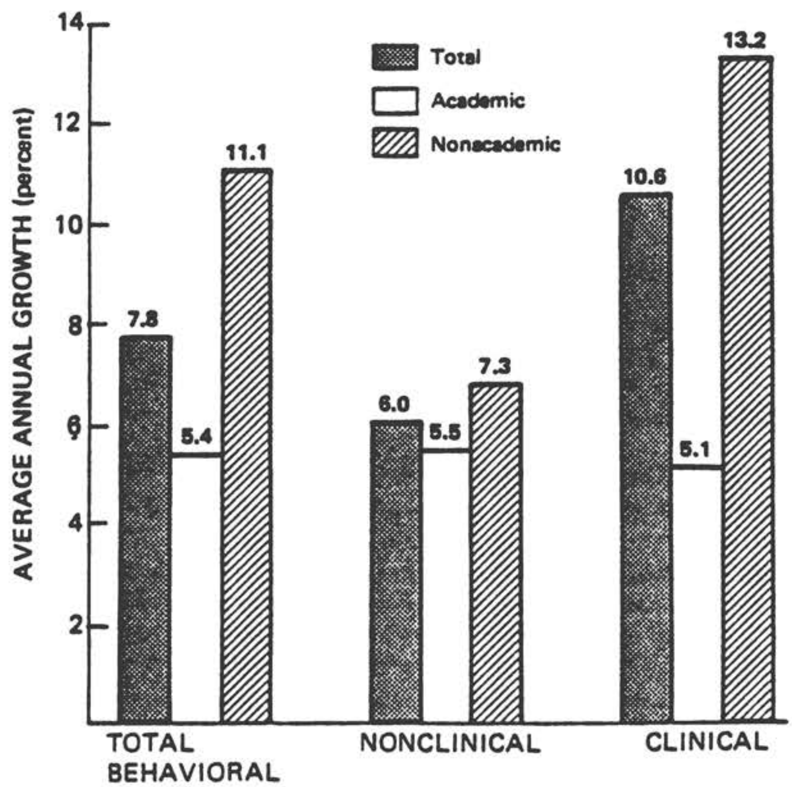


FIGURE 4.1 Average annual growth in behavioral science labor force by broad field and employment sector, 1973-79. See Table 4.2.

Unemployment remains low for both nonclinical and clinical fields (Table 4.1 and Table 4.2, lines 3h and 3p). The percent still seeking jobs at graduation (the "SEEK" variable) is also similar for both behavioral fields (Table 4.1); however, it has increased over the course

TABLE 4.1 Employment Situations for Recent Ph.D. Recipients in the Behavioral Sciences

Field of Doctorate	Percent Unemployed in 1979[a]	1977–79 Ph.D.'s Percent Still Seeking Job at Graduation[b]	1978 Ph.D.'s Ratio of Job Offers to Inquiries[c]
Total Behavioral Sciences	2.0	13.9	.095
Clinical Fields	1.1	15.0	.169
Nonclinical Fields--Total	2.6	13.5	.069
Nonclinical Psychology	2.7	12.9	.070
Anthropology	0.9	16.2	.049
Sociology	3.8	13.4	.077
Other Sciences and Engineering	1.0	8.3	.115

[a]Percent of the 1978 Ph.D. recipients active in the labor force who were unemployed and seeking positions.
[b]Percent of 1977–79 Ph.D. recipients who were still seeking employment positions at the time they had completed requirements for their doctorates.
[c]Ratio of the total job offers received (excluding postdoctoral appointments) to the total number of inquiries made by 1978 Ph.D. recipients.

SOURCE: National Research Council (1958–80, 1979b).

of the 1970's (Table 4.2, lines 1b and 1e) and is higher than in other science and engineering fields (Table 4.1). Other market indicators demonstrate considerable differences in labor market conditions between nonclinical and clinical fields. When looking at the ratio of job offers received to job inquiries made by 1978 Ph.D.'s, one sees that there was only 1 offer per 14 inquiries in the nonclinical fields (which is below the average for other sciences and engineering) compared to 1 offer per 6 inquiries in the clinical fields (which is well above the average for other fields) (Table 4.1). These differences are reinforced by other market indicators, including employment, enrollments, Ph.D. production, field switching, and research activity, which follow.

Nonclinical Behavioral Fields

- More than 75 percent of the nonclinical behavioral scientists were employed in academia in 1979 (Table 4.2, line 3b). While academic employment for this group increased by about 1,000 or 2.3 percent annual rate over the 1977 level, the growth rate in academic employment has slowed perceptibly in the last half of the 1970 decade. No strong trend toward nonacademic employment by nonclinical behavioral scientists is apparent.

- Estimated undergraduate enrollments increased in 1976, but dropped in 1977, the latest year for which we can provide undergraduate enrollment estimates, to below the 1973 levels (line 4a). First-year graduate enrollments in nonclinical behavioral science fields dropped sharply in 1977 (line 4c). Total graduate enrollments also declined (line 4e).

TABLE 4.2 Current Trends in Supply/Demand Indicators for Behavioral Science Ph.D.'s[a]

	1973	1975	1976	1977	1978	1979	Annual Growth Rate from 1973 to Latest Year	Latest Annual Change	Average Annual Change from 1973 to Latest Year
1. SUPPLY INDICATORS (New Entrants):									
Nonclinical fields:									
a. Ph.D. production[b]	2,484	2,793	2,897	2,895	2,745	2,738	1.6%	-0.3%	42
b. % of Ph.D.'s without specific employment prospects at graduation	8.9%	11.0%	13.0%	12.8%	13.8%	13.2%	6.8%	-4.3%	0.72%
c. Postdoctoral appts.[c]	384	515	N/A	644	N/A	816	13.4%	12.6%	72
Clinical fields:									
d. Ph.D. production[b]	1,055	1,145	1,293	1,353	1,465	1,497	6.0%	2.2%	74
e. % of Ph.D.'s without specific employment prospects at graduation	11.1%	13.6%	13.7%	15.0%	15.4%	14.8%	4.9%	-3.9%	0.62%
f. Postdoctoral appts.[c]	105	247	N/A	379	N/A	301	19.2%	-10.9%	33
2. DEMAND INDICATORS:									
a. Behavioral sciences R and D expenditures in colleges and universities (1972 $, mil.)	$128.0	$116.8	$106.7	$103.0	$102.5	N/A	-4.3%	-0.5%	$-5.1
3. LABOR FORCE:[c]									
Ph.D.'s employed in nonclinical behavioral fields:									
a. Total	19,833	23,732	N/A	26,670	N/A	28,055	6.0%	2.6%	1,370
b. Academic (excl. postdocs.)	15,259	18,433	N/A	20,118	N/A	21,072	5.5%	2.3%	969
c. Business	960	1,212	N/A	1,387	N/A	1,498	7.7%	3.9%	90
d. Government	1,006	1,289	N/A	1,651	N/A	1,603	8.1%	-1.5%	99
e. Non-profit	1,081	1,271	N/A	1,340	N/A	1,512	5.8%	6.2%	72
f. Self-employed	372	460	N/A	501	N/A	455	3.4%	-4.7%	14
g. Other (incl. postdocs.)	871	699	N/A	1,025	N/A	1,325	7.2%	13.7%	75
h. Unemployed and seeking	284	368	N/A	648	N/A	590	13.0%	-4.6%	51
Ph.D.'s employed in clinical behavioral fields:									
i. Total	11,536	14,760	N/A	17,557	N/A	21,072	10.6%	9.6%	1,589
j. Academic (excl. postdocs.)	4,280	5,064	N/A	5,432	N/A	5,770	5.1%	3.1%	248
k. Business	51	169	N/A	412	N/A	446	43.5%	4.0%	66
l. Government	1,115	1,222	N/A	1,405	N/A	1,768	8.0%	12.2%	109
m. Non-profit	3,354	4,759	N/A	5,559	N/A	6,553	11.8%	8.6%	533
n. Self-employed	1,501	2,263	N/A	3,142	N/A	4,746	21.2%	22.9%	541
o. Other (incl. postdocs.)	1,132	1,218	N/A	1,528	N/A	1,688	6.9%	5.1%	93
p. Unemployed and seeking	103	65	N/A	79	N/A	101	-0.3%	13.1%	-1
4. BEHAVIORAL SCIENCE ENROLLMENTS:									
a. Est. undergraduate[d]	695,614	668,097	671,847	634,631	N/A	N/A	-2.3%	-5.5%	-15,246
b. First-year graduate[e]	26,269	29,376	31,545	29,778	N/A	N/A	3.2%	-5.6%	877
c. est. nonclinical	19,744	21,561	22,677	21,043	N/A	N/A	1.6%	-7.2%	325
d. est. clinical	6,525	7,815	8,868	8,735	N/A	N/A	7.6%	-1.5%	552
e. Total graduate[f]	48,216	55,383	59,056	58,289	N/A	N/A	4.9%	-1.3%	2,518
f. est. nonclinical	36,081	40,544	42,135	41,106	N/A	N/A	3.3%	-2.4%	1,256
g. est. clinical	12,135	14,839	16,921	17,183	N/A	N/A	9.1%	1.5%	1,262

[a] In this table clinical behavioral fields include clinical and school psychology, counseling, and guidance; nonclinical behavioral fields include anthropology, sociology, nonclinical psychology, and speech and hearing sciences.
[b] Foreign nationals who received their doctorates from U.S. universities are included.
[c] Since labor force data are not available for 1978, latest annual change represents average annual growth rate from 1977–1979. Foreign nationals who received their doctorates from U.S. universities are included.
[d] Estimated by the formula $U_i = (A_{i+2}/B_{i+2})C_i$, where U_i = behavioral science undergraduate enrollments in year i; A_{i+2} = behavioral science B.A. degrees awarded in year i+2; B_{i+2} = total B.A. degrees awarded in year i+2; C_i = total undergraduate enrollments in year i.
[e] First-year graduate enrollments in clinical behavioral fields are estimated by the formula $CG1_i = (CP/TP)_{i+2}E1_i$, where $CG1_i$ = first-year clinical graduate enrollments in year i; $(CP/TP)_{i+2}$ = ratio of clinical psychology Ph.D.'s to total psychology Ph.D.'s awarded in year i+2; $E1_i$ = first-year graduate enrollments in psychology in year i.
[f] Total graduate enrollments in clinical behavioral fields are estimated by the formula $CG_i = (CP/TP)_{i+2}\,E_i$, where CG_i = clinical graduate enrollments in year i; $(CP/TP)_{i+2}$ = ratio of clinical psychology Ph.D.'s to total psychology Ph.D.'s awarded in year i+2; E_i = psychology graduate enrollments in year i.

SOURCES: NRC (1958–80, 1973–80), NSF (1975–79), U.S. Department of Education (1948–81, 1959–79, 1973–77, 1974–80).

- Behavioral science R and D expenditures at colleges and universities have been steadily declining at 4 percent per year in constant dollars since 1972 (line 2a).

- Ph.D. production in nonclinical behavioral science fields appears to have reached a peak in 1976 at about 2,900. Since then it has been declining slowly. The 1979 level was down 0.3 percent from 1978. On the other hand, postdoctoral appointments in these fields continue to grow rapidly. In 1979 there were 816 individuals on such appointments, up 33 percent from the 1977 level (line 1b).

Clinical Behavioral Fields

- Perceptions of better career opportunities in the clinical behavioral fields have attracted people from other areas. There has been a definite shift in the make-up of the behavioral science Ph.D. labor force during the 1970's towards employment in clinical fields and away from the nonclinical fields. In 1979, 43 percent of the behavioral science Ph.D. labor force was employed in clinical fields, up from 37 percent in 1973 (Table 4.2, lines 3a and 3i)

- In contrast to the nonclinical behavioral sciences, most clinical behavioral scientists are employed in the nonacademic sector. More than 72 percent of Ph.D.'s employed in clinical fields were employed in the nonacademic sector in 1979 and many of them were self-employed or employed by nonprofit organizations (lines 3m and 3n). Employment of clinical behavioral scientists in the business sector has also grown quite rapidly during the 1970's (line 3k).

- First-year graduate enrollments in the clinical behavioral sciences were down slightly in 1977 but total graduate enrollments continued their long string of annual increases that began in 1968 (line 4d).

- Ph.D. production in the clinical behavioral fields continued to increase, reaching about 1,500 in 1979 (line 1c). Despite this increase, the number that were unemployed in 1979 was about the same as in 1973. Postdoctoral appointments dropped to about 300 from their 1977 peak of 379 (line 1d).

Field Switching

Field switching is a useful indicator of the relative health of a field. High mobility into a field from other fields usually indicates demand in excess of supply (shortage), while the converse conditions indicate a surplus of personnel in the field. A National Research Council study of postdoctorals in science and engineering (NRC, 1981a) collected data on the net mobility into behavioral science fields for 1972 and 1978 Ph.D.'s. Net mobility was defined as the difference between the number of doctorates employed in a field and the number of doctorates in that field, expressed as a percentage of the number of doctorates in that field. Table 4.3 indicates a clear trend in mobility between 1972 and 1978 Ph.D.'s, with clinical fields showing a positive and increasing inflow while the nonclinical sciences show an increasing outflow.

TABLE 4.3 Net Field Switching by 1972 and 1978 Ph.D. Recipients in the Behavioral Sciences

Field of Doctorate	Net Mobility into the Field[a] 1972 Ph.D.'s	1978 Ph.D.'s
Total Behavioral Sciences	-16.2	-16.9
Clinical Fields	+12.0	+16.1
Nonclinical Fields--Total	-29.4	-36.8
Nonclinical Psychology	-32.5	-31.7
Anthropology	-40.7	-45.4
Sociology	-11.8	-44.7

[a]Difference between the number of doctorates employed in a field and the number with doctorates in that field, as a percentage of the number with doctorates in that field.

SOURCE: National Research Council (1979b).

Figure 4.2 demonstrates that the clinical behavioral fields retain a high percentage of their Ph.D.'s (85.4 percent) with only 7.2 percent of clinical Ph.D.'s going to nonclinical behavioral fields and the remainder going to other sciences and nonsciences. In contrast, only 57.0 percent of nonclinical behavioral Ph.D.'s remained in their fields for employment, with over 14 percent going into each of clinical behavioral fields, other sciences, and nonsciences. The largest switch occurred in nonclinical psychology where 23.0 percent of the Ph.D.'s are employed in clinical behavioral jobs (see Appendix Table A10). It is likely that many of those switching to clinical fields are leaving research in the process as noted in the following section.

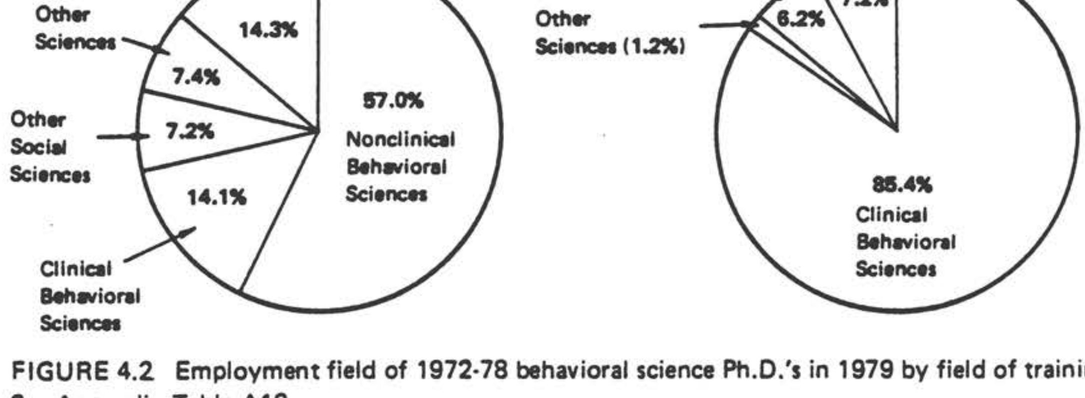


FIGURE 4.2 Employment field of 1972-78 behavioral science Ph.D.'s in 1979 by field of training. See Appendix Table A10.

Research Activity

While the employment situation in the clinical behavioral fields appears more favorable than that in nonclinical behavioral fields, it is clear that nonclinical scientists are much more heavily involved in research in 1979 than their clinical counterparts (Table 4.4). Nonclinical scientists spent an average of 30 percent of their time in research compared to 13 percent of clinical scientists' time. The differences are most striking when examining employment sector. Clinical behavioral scientists in academia spend a much higher portion of their time in research (21 percent) than those in nonacademic settings (9 percent). On the other hand, for nonclinical Ph.D.'s, almost as much time is spent in research in nonacademic employment (28 percent) as in academia (32 percent). These data indicate that nonclinical behavioral scientists continue to utilize their research skills in a variety of research settings.

TABLE 4.4 Average Time Spent in Research in 1979 by 1972 Behavioral Science Ph.D.'s by Sector of Employment

Employment Sector		Behavioral Sciences Total	Clinical	Nonclinical	All Sciences
All Sectors	N	2,757	876	1,881	15,168
Avg. Time in Research	(%)	25	13	30	36
Academic	N	1,626	281	1,345	8,215
Avg. Time in Research	(%)	30	21	32	34
Nonacademic	N	1,097	595	502	6,795
Avg. Time in Research	(%)	18	9	28	39
Unknown	N	34	0	34	158
Avg. Time in Research	(%)	21		21	9

SOURCE: National Research Council (1979b).

Utilization Of Postdoctoral Training

The Committee and its Panel on Behavioral Sciences have consistently taken the position that the behavioral sciences should move toward more active use of postdoctoral training so that beginning scientists might obtain a higher level of research skills and knowledge acquisition. The underlying argument is that the field of behavior and health has reached a level of sophistication that increasingly requires training beyond the predoctoral level. This argument was reinforced in a workshop on training in behavior and health sponsored by the Panel in January 1980 (NRC, 1981b), in which the conferees concluded that postdoctoral training was an important device for gaining needed knowledge and research skills.

The Committee and Panel have sought to monitor recent developments in the utilization of postdoctorals in the behavioral sciences. The size of the postdoctoral pool has risen from about 500 in 1973 to 1,100 in 1979, an average annual growth of almost 15 percent (see Table 4.2). Of course, the increase has taken place from a very small base. An NRC study (NRC, 1981a, p. 77) estimated that in 1979 postdoctorals in psychology comprised only 3 percent of doctoral scientists in this field in academia. Growth in postdoctorals has occurred most consistently in the nonclinical fields (13 percent annually) while the clinical sciences have experienced a decrease in the latest period (1977-1979) after an earlier rapid growth (Table 4.2).

One of the most important outcomes of postdoctoral training is expected to be increased research activity. While postdoctoral training in the behavioral sciences is still in its incipient stages, with beneficial results largely in the future, it is encouraging to note that available data indicate that those who have taken postdoctoral appointments spend a considerable portion of their employment time in research. Once again using data from the recent NRC study of postdoctorals (Table 4.5), one can see that 1972 behavioral science Ph.D.'s who had postdoctoral experience spent significantly more time in research in 1979 (38 percent) than those who did not (22 percent). The effect was most pronounced in the clinical fields where postdoctoral experience resulted in a more than doubling of time spent in research (25 percent compared to 12 percent for those without). In the nonclinical behavioral sciences those with postdoctoral experience spent 42 percent of their time in research compared to 28 percent of those who did not. The only exception to this pattern is sociology, where those without postdoctoral training spent more time in research (33 percent) than those with it (24 percent); however, only 10 percent of sociology Ph.D.'s take postdoctorals (NRC, 1981a, p. 112).

TABLE 4.5 Average Time Spent in Research in 1979 by 1972 Behavioral Science Ph.D.'s by Postdoctoral Experience

	Total		With Postdoctoral Experience		Without Postdoctoral Experience	
Field of Postdoctoral	N	%	N	%	N	%
Total Behavioral	2,757	25	464	38	2,293	22
Clinical	876	13	100	25	776	12
Nonclinical--Total	1,881	30	364	42	1,517	28
Nonclinical Psychology	1,206	30	248	48	958	26
Sociology	355	32	45	24	310	33
Anthropology	320	30	71	33	249	29

SOURCE: National Research Council (1979b).

Projections Through FY 1985

The next step in the analysis is to attempt some short-term projections of the market so that appropriate recommendations for current training programs can be based on best estimates of future needs. So far it has not been possible to demonstrate that a direct relationship exists between academic demand for behavioral Ph.D.'s and some measure of research activity, such as behavioral science R and D expenditures in colleges and universities. Although the latter have fallen more than 20 percent from their peak in 1972 (Figure 4.3), the faculty-student ratio, i.e., the ratio of behavioral science Ph.D. faculty to total behavioral science enrollment in colleges and universities (F/S) has continued to rise.[2] Why this is so, and whether this ratio will continue to increase, remain open questions. As a result, the projection methodology in the behavioral sciences relies simply on the Committee's assumptions about future trends in enrollments and the F/S ratio.

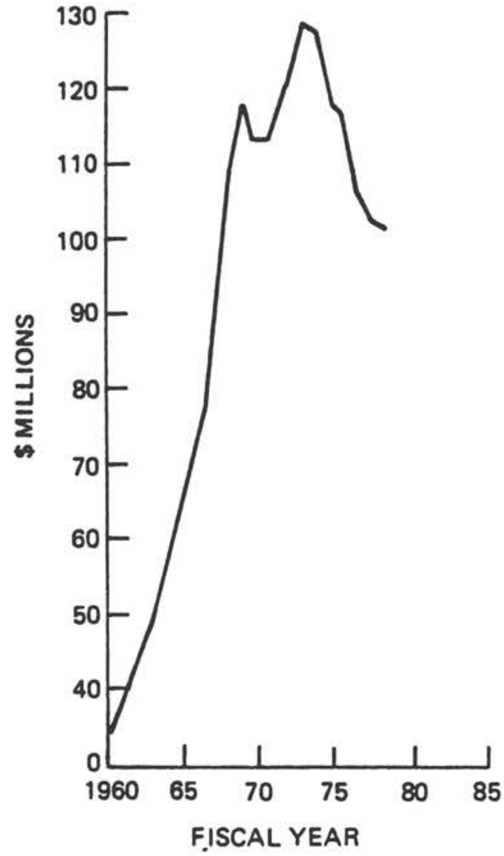
The Committee's projections of academic demand for behavioral science Ph.D.'s are based on the following three assumptions about the behavioral science F/S ratio: (a) that the F/S ratio will continue to increase significantly through 1985, but at a slower rate of growth than that which has occurred since 1972; (b) that the F/S ratio will increase moderately through 1985; and c) that the F/S ratio will decline from its present (1977) value of 0.037 to 0.035 in 1985.

Behavioral science graduate and undergraduate enrollments have fluctuated in a narrow range after reaching a peak in 1972. But the latest estimates for 1977 show a sharp drop. For these enrollments, a similar set of assumptions has been made: (a) that behavioral enrollments will increase moderately through 1985, (b) that behavioral enrollments will remain essentially at the 1977 level of about 700,000 through 1985, and (c) that enrollments will decline to about 600,000 students by 1985.

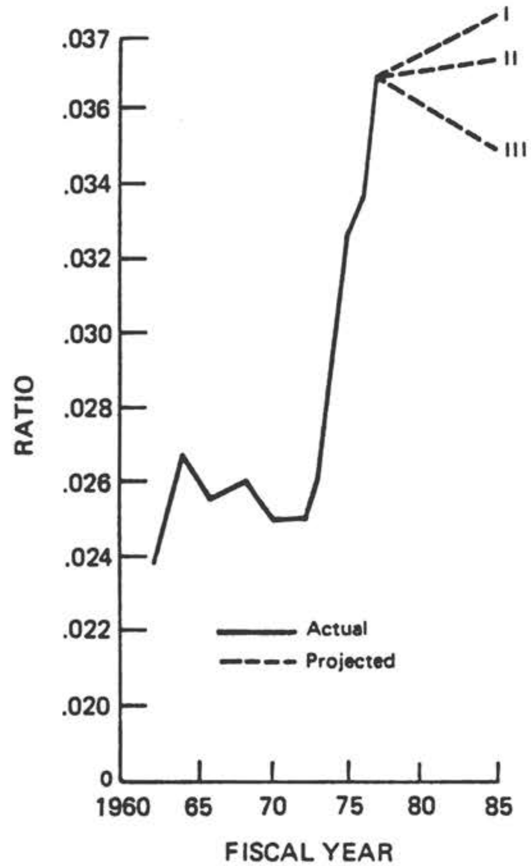
As usual, it is hoped that these assumptions represent upper and lower bounds on the future pattern of these two variables and that the middle assumption represents the most likely case. The resulting projections of academic demand for behavioral science Ph.D.'s (both clinical and nonclinical) are shown in Table 4.6.

Under the most optimistic set of assumptions, behavioral science Ph.D. faculty would expand at 2.4 percent per year through 1985--a level that would just about preserve the current supply/demand balance in the system. In the worst case, behavioral science faculty would contract by more than 2 percent per year.

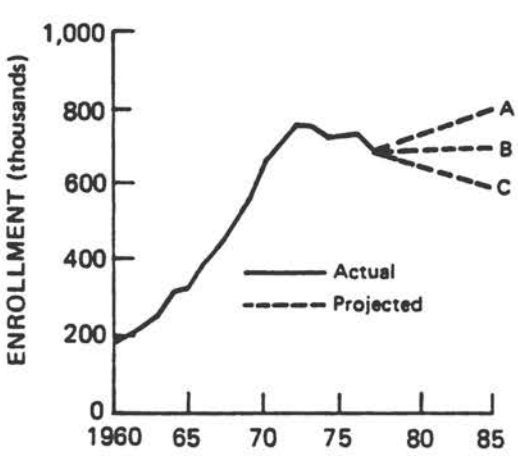
In the most likely case, about 1,260 behavioral Ph.D. faculty positions would be created each year through 1985 due to expansion and attrition of faculty under these assumptions. But since an estimated 2,260[3] behavioral Ph.D.'s per year have found academic employment during the period 1973 to 1979, the projections suggest a considerably slower rate of growth in the academic sector in the next few years. This conclusion clearly reinforces the Committee's recommendation to shift the emphasis in the training programs from predoctoral to postdoctoral support. By so doing, the NRSA programs would preserve the important contributions that postdoctoral appointees make to academic research while at the same time assist



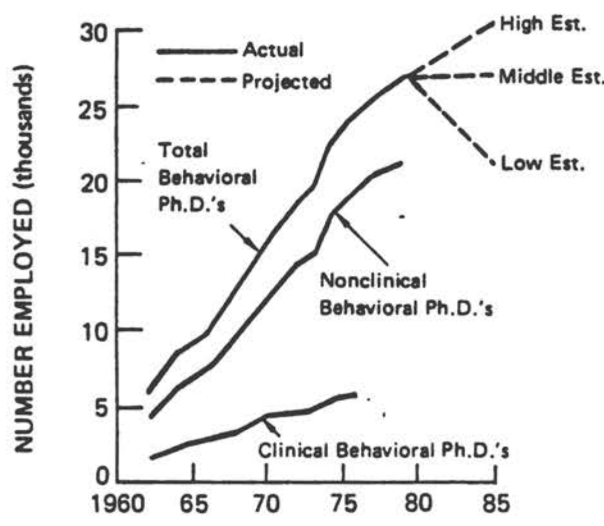
(a) Behavioral Science R and D Expenditures in Colleges and Universities (1972 $)



(b) Behavioral Ph.D. Faculty/Student Ratio



(c) Total Behavioral Graduate and Undergraduate Enrollment



(d) Behavioral Science Ph.D. Faculty

FIGURE 4.3 Behavioral science (psychology, sociology, and anthropology) enrollment, R and D expenditures, and academic employment, 1960-78, with projections to 1985. See Appendix Table A5.

TABLE 4.6 Projected Growth in Behavioral Science Ph.D. Faculty, 1978–85, Based on Projections of Enrollment and Faculty/Student Ratios[a]

Assumptions about Behavioral Science Undergraduate and Graduate Enrollment		Assumptions about the Faculty/Student Ratio for Behavioral Ph.D.'s in Colleges and Universities: I Will continue to grow, reaching 0.0385 by 1985	II Increases slightly to 0.0375 by 1985	III Declines to 0.035 by 1985
A. Will continue to grow, reaching 800,000 students by 1983	Expected size of behavioral science faculty (F) in 1985	30,800	30,000	28,000
	Annual growth rate in F from 1978 to 1985	2.4%	2.0%	1.1%
	Average annual increment due to faculty expansion	660	560	310
	Annual replacement needs due to:[b]			
	death and retirement	280	280	270
	other attrition	990	970	940
	Expected number of academic positions to become available annually for behavioral Ph.D.'s	1,930	1,750	1,520
B. Will remain at about the 1977 level (700,000) through 1985	Expected size of behavioral science faculty (F) in 1985	26,950	26,250	24,500
	Annual growth rate in F from 1978 to 1985	0.7%	0.3%	-0.5%
	Average annual increment due to faculty expansion	180	90	-130
	Annual replacement needs due to:[b]			
	death and retirement	260	260	250
	other attrition	930	910	870
	Expected number of academic positions to become available annually for behavioral Ph.D.'s	1,370	1,260	990
C. Will decline to 600,000 students by 1985	Expected size of behavioral science faculty (F) in 1985	23,100	22,500	21,000
	Annual growth rate in F from 1978 to 1985	-1.3%	-1.6%	-2.8%
	Average annual increment due to faculty expansion	-310	-380	-570
	Annual replacement needs due to:[b]			
	death and retirement	240	240	230
	other attrition	850	840	810
	Expected number of academic positions to become available annually for behavioral Ph.D.'s	780	700	470

[a]Faculty is defined in this table as all academically employed Ph.D.'s, excluding postdoctoral appointees.
[b]Based on an estimated replacement rate of 1.0% annually due to death and retirement and 3.5% annually due to other attrition. These estimates were derived from NRC (1973–80).

their training in problem areas that are vital to the research programs sponsored by the federal government.

Of course there is the possibility that the nonacademic sector will expand rapidly enough to absorb all behavioral scientists, even at the current rate of Ph.D. production. At least the clinical behavioral scientists currently seem to be finding ample opportunities in the nonacademic sector, but it is not likely that these are research oriented positions. It should also be noted that making precise estimates of the state of the market in the clinical sciences is difficult, the more so because a substantial percentage are engaged in private practice. It is impossible to predict how long this source of employment will continue to increase and how long it will be available to nonclinical Ph.D.'s seeking to switch fields. In addition, the impact on the labor market of the recent expansion of professional schools of psychology, which are unrelated to traditional academic programs, is difficult to predict.

Using its most likely projections of academic demand, the Committee has attempted to estimate the appropriate size of the behavioral science postdoctoral pool needed under these circumstances. To do so requires certain information about the behavioral science employment and training system for which we have only approximate data. In some cases the Committee has used estimates that exceed past postdoctoral utilization in the behavioral sciences. This is because the Committee's intent has been to break with prior practice and encourage the extensive use of postdoctoral training where previously there was little. The Committee regards such increased estimates as necessary and realistic. Using these best estimates we can provide some rough guidelines on the size of the postdoctoral pool needed under certain conditions. The Committee's recommendation for postdoctoral NRSA support to rise from 610 in FY 1982 to 910 in FY 1985 averages 760 annually and therefore falls within the limits of our estimates of the need for average annual postdoctoral support, as shown in Table 4.7.

Line 1 of Table 4.7 shows the expected annual demand for academic positions resulting from the Committee's most likely set of assumptions in Table 4.6. The attrition rates used here, derived from the National Research Council's biennial survey of Ph.D. employment (NRC, 1973-80), are 1 percent per year for death and retirement and 3.5% per year for other attrition.

Line 2 shows the number of accessions needed with postdoctoral research training to satisfy expected demand if 25 percent and if 35 percent of all accessions have such training. Data from a study of postdoctorals (NRC, 1981a, p. 148) indicate that slightly under 20 percent of 1978 Ph.D.'s in the behavioral sciences took postdoctoral appointments in 1979. The Committee believes that this should increase so that at least 35 percent of each new cohort will have postdoctoral training.

Line 3 shows the size of the postdoctoral pool needed assuming a 2-year training period on the average, and two assumptions about the academic yield from the pool. The 2-year postdoctoral training period for behavioral scientists is confirmed by other data from the same study of postdoctorals (NRC, 1981a, p. 326). The assumption about academic yield from the postdoctoral pool is an estimate based upon overall academic employment in the labor force (55 percent).

TABLE 4.7 Estimated Number of Behavioral Science Postdoctoral Trainees Needed to Meet Expected Academic Demand Through 1985 Under Various Conditions

	Projected (1978–85)
1. Academic demand for behavioral science Ph.D.'s––annual average:	1,260
a. due to expansion of faculty	90
b. due to death and retirement	260[a]
c. due to other attrition	910[b]
2. Total accessions[c] with postdoctoral research training––annual average:	
a. if 25% of accessions have postdoctoral research training	320
b. if 35% of accessions have postdoctoral research training	440
3. Size of behavioral science postdoctoral pool (1,117 in 1979) Size needed to meet demand assuming a 2-yr. training period and portion of trainees seeking academic positions is:	
a. 50%	1,280 - 1,760
b. 60%	1,070 - 1,470
4. Annual number of behavioral science postdoctoral trainees to be supported under NRSA programs (395 in 1979):	
a. if 30% of pool is supported under NRSA	320 - 530
b. if 40% of pool is supported under NRSA	420 - 700
c. if 50% of pool is supported under NRSA	540 - 880

[a]Assumes an attrition rate due to death and retirement of 1.0% per year.
[b]Assumes an attrition rate due to other causes of 3.5% per year.
[c]Accessions are defined as new hires or those who rejoin faculties from nonfaculty positions. Inter-faculty transfers are not counted as accessions.

SOURCE: Table 4.6.

Line 4 estimates the number of behavioral science postdoctoral appointees to be supported under NRSA programs by applying percentages to the smallest and largest numbers in line 3. Currently 35 percent of the behavioral science postdoctoral pool is supported under NRSA. Because the Committee believes that federal policy should take the lead in encouraging greater use of the postdoctorals, a 50 percent level of NRSA support of the postdoctoral pool is also specified.

IMPLEMENTATION OF PRIOR RECOMMENDATIONS

The Committee's recommendations in the behavioral sciences over the last 6 years have remained consistent with respect to the numbers of trainees and fellows supported, the level of dollars expended, and the distribution of awards between predoctoral and postdoctoral levels. The core of the recommendations has been, within a framework of a constant dollar level of support, to redistribute awards in the behavioral sciences from the traditional predoctoral emphasis (70 percent/30 percent predoctoral to postdoctoral) to one of postdoctoral emphasis (70 percent/30 percent postdoctoral to predoctoral). The Committee recommended that this transition be completed by FY 1981. The rationale for this recommendation was that the less favorable labor market for behavioral scientists, especially in academia, dictates a decrease in predoctoral support, while the growing sophistication of behavioral research in the area of health warrants an increase in postdoctoral support.

Over the last 2 years the Committee has been concerned that the transition from a predominantly predoctoral program to one that ispredominantly postdoctoral has proceeded too slowly. Rather than an orderly transition, the ratio has moved slowly toward a higher postdoctoral concentration (34.9 percent in FY 1980) via a sharp decline in predoctoral awards (63 percent decrease since 1975) with a level of postdoctoral support that rose between 1975 and 1977 but has since remained basically constant (see Table 4.8 on p. 102).

As a result of this concern, the Panel on Behavioral Sciences sent a letter to the ADAMHA Administrator inquiring about ADAMHA's policy with respect to implementing this change. The Administrator responded that his agency supported the Committee's recommendations and was making strong efforts to implement such a policy. The efforts made by ADAMHA included (1) giving priority to postdoctoral awards in their announcements, (2) funding most postdoctoral applications with good priority scores, and (3) encouraging applicants to emphasize postdoctoral training. An indication of the success of these efforts was that in FY 1980 the proportion of new and competing awards that were postdoctoral was 55 percent.

The Administrator reported, however, that significant external impediments have been imposed that have constrained ADAMHA's ability to respond more rapidly:

- Overall funds available for research training have lost ground to inflation. ADAMHA's training funds rose only slightly in current dollars, from $19.4 million in FY 1976 to $20.0 million in FY 1980, a decline in real dollars of 23 percent.

- As a result of the mandated increase in stipend levels in FY 1980, the same amount of funds could support many fewer graduate students and postdoctorals.

- Although there has been progress in responding to the Committee's recommendations, the professional field has been slow in broadening its emphasis to include more postdoctoral training (due to the break from past patterns of training) . This situation is improving over time.

The result of these conditions has meant that ADAMHA has had little flexibility in the administration of its resources. Cutbacks have had to be made in both predoctoral training grants and fellowships. The loss of these funds and the recent increases in stipend levels has sharply reduced the agency's ability to finance new postdoctoral awards. Another factor inhibiting the transition is that certain programs targeted for minority groups and epidemiology training have priority for predoctoral support, and ADAMHA has exempted them from the switch to postdoctoral emphasis.

The Committee is cognizant of these constraints on the ability of ADAMHA to plan effectively and to implement a policy of emphasizing post-doctoral training. The Committee is pleased that ADAMHA remains committed to effectuating this policy and appreciates its efforts to make progress in this direction. The Committee believes that a stabilization of federal support for research training (see Chapter 1) would restore to ADAMHA the means to implement this policy.

A related issue of continuing concern to the Committee and Panel has been the support of behavioral science trainees by NIH. Trainee support data provided by NIH have shown a rapid decline in predoctoral trainees between FY 1975 and FY 1980 (from 587 to 105) and a slight increase in postdoctoral trainees (74 to 76) in that period. As a result, the percentage of postdoctoral trainees has increased greatly (from 11 percent to 42 percent) but almost wholly as a result of reductions in predoctoral trainees. In a letter to the NIH Director on January 21, 1981, the Panel requested clarification of NIH policy regarding the support of behavioral scientists. In particular, inquiry was made about the possibility that the actual number of behavioral science trainees supported by NIH was being masked by their classification under clinical research training programs. In response, reclassification by NIH, based upon trainee field rather than field of training grant, demonstrated that in fact more behavioral science students are being trained; however, under either classification, the increase in the number of postdoctorals has been quite small.

RECOMMENDATIONS

Levels of Federal Funding for Research and Research Training

The Committee has taken note of the likely reductions in federal funding for research in certain areas, and proposed reductions in funding for research training in the social sciences. If the federal government elects to reduce funding for research, the Committee believes that as a natural consequence it is fully appropriate for those areas of research related to health to be reduced in funding as well. It should be recognized, however, that any reduction in the overall level of federal funding in health research will probably reduce the number of persons who will be interested in electing careers in this area. The likelihood of a fulfilling career in health research is an important ingredient in the choices made by young persons. Should there be public evidence of a reduction in interest in supporting work in this area, the consequences will be substantial, and for a considerable period of time irreversible.

Should national policy for reduction of all federal funding lead to a proportionate reduction in overall federal funding for training grants, the Committee sees certain short-term disadvantages but fewer long-term disadvantages as long as cutbacks are not too severe. A reduction in funding for training grants would be painful in that many programs of very good quality would be able to attract and support a smaller number of students. However, if the training grant reduction still permits the funding of a sufficient number of institutions of high quality to ensure the continuance of the very best training programs, the Committee would see this as a not particularly serious problem for the disciplines in the behavioral and social sciences. In addition, the Committee sees possible training budget reductions as a much more serious problem in those departments that are housed in medical schools, that have few alternative forms of support available for the very best of their students.

The Committee has had a long-standing concern for the protection of high-quality training programs. Thus, it views with apprehension any prospect of reducing support in the behavioral and social sciences to such an extent that high quality training programs would be impaired. These training programs are critical for the study of the behavioral aspects of the treatment of disease, aspects that have come more and more to the fore as being important to the appropriate treatment of a wide variety of diseases. In studies of the etiology of disease, the work in these domains has been among the most important. The Committee believes that a substantial number of very able persons should continue to be supported in the very best programs, especially at the postdoctoral level, to ensure continuance of this level of research effort during a time when careers in this area will be becoming less and less attractive to young people.

> Recommendation. While reductions in training support may be necessitated by overall budget constraints, it is important that some training support be preserved in the health-related behavioral and social sciences and that this support be directed to the highest quality programs.

Behavioral Science Versus Social Science

ADAMHA and other federal agencies have been directed to make a distinction between the behavioral sciences and the social sciences. The social sciences are to be reduced in funding or eliminated, but the behavioral sciences shall continue to get support. The Committee believes that this distinction is without merit, that any attempt to implement such a policy would have negative consequences. The Committee also believes that the decision to fund research in the behavioral and social sciences should be made by ADAMHA in the same way that it makes decisions about all of its areas of support. A proposal should be funded if it is of high quality and if it will produce effects directly related to the improvement of health care. Training grants should be funded if the programs will produce persons who will make such a significant contribution to research, if the number of persons prepared in this area would be insufficient were the training grant not in place, or if the quality of persons so trained would be inadequate for the tasks ahead were the training grant not awarded.

The Committee supposes that the distinction between the behavioral and social sciences has been made on the erroneous assumption that social scientists have supported the social programs of prior administrations, and that with reduction in those social programs, there is an obvious need to reduce the number of persons in social science. This assumption rests on a misapprehension. Social science and social activism are not the same. The research produced by persons with Ph.D.'s in the behavioral and social science disciplines--psychology, sociology, and anthropology--has proven a valuable aid in understanding the ways in which human beings behave under varying conditions, including the effectiveness of social programs. This group of dedicated scientists is highly useful to society, and more persons like them need to be prepared in the next generation. In particular, our stock of behavioral and social scientists is essential to the development of solutions to important health problems in the future.

The Committee believes that certain domains are not fully appropriate for funding by ADAMHA in terms of its agency mission. In the past the review of proposals from programs only marginally related to alcohol, drug abuse, and mental health has been in the main negative. It is expected that those reviews will continue to be negative. With a reduction in funds, the more traditional programs are likely to survive at the expense of innovative and experimental programs. This will be a short-term disadvantage to the field but not ruinous in terms of the maintenance of an adequate number of research personnel in the next generation. The Committee recommends that ADAMHA assure itself of the direct health relatedness of a proposal and of a training program, without concern for the vague and questionable distinction between behavioral science and social science.

> Recommendation. All fields of the behavioral and social sciences continue to make valuable contributions to the solution of health problems. Beyond quality, the proper criterion for awarding behavioral and social science training grants should remain the relevance of the applications to the solution of health problems that are the responsibility of NIH and ADAMHA.

Predoctoral and Postdoctoral Awards

Over the last 4 years, the Committee has consistently and firmly recommended a transformation of NRSA training support from a predoctoral to a postdoctoral emphasis. Its rationale has been a dual concern for a declining academic labor market, pointing toward reduced predoctoral support, and a need for an increased sophistication in research training, implying greater postdoctoral support. These conditions continue to exist at this time. Recent employment patterns and the employment outlook through 1985 described earlier in this chapter indicate continued problems in the employment of nonclinical behavioral scientists. At the same time, the growing complexity of research problems in behavioral and health argue strongly for the acquisition of more depth of training experience. The Committee thus sees the demand for more highly skilled researchers increasing at the same time that the overall demand for numbers of researchers remains soft.

The Committee's recommendations over the years have been intended to help lead the way in responding to these new needs in employment and training. Rather than simply extrapolating from past practice, the Committee has sought to encourage the professional community to offer more extensive training through the provision of greater numbers of postdoctoral awards. The Committee's prior recommendations were based on maintaining a constant dollar training budget using FY 1975 as a baseline and a transformation of the traditional predoctoral training emphasis (70 percent/30 percent predoctoral to postdoctoral) to a predominantly postdoctoral emphasis (30 percent/70 percent predoctoral to postdoctoral). The Committee believes that its reexamination of the market and its new analysis of the demand for postdoctorals sustain its prior recommendations.

Since these recommendations were first made, the agencies' implementation has been slowed because of budget constraints and the professional community's reluctance to depart from tradition and establish a postdoctoral training pathway. Even so, the size of the postdoctoral pool has increased at an average annual rate of almost 15 percent between 1973 and 1979, although the numbers remain small. The Committee believes that, if ADAMHA is given an adequate and stable budget, the rapid growth in the postdoctoral pool can be continued and the quality of training strengthened.

Originally, the Committee proposed that its recommendations be implemented by FY 1981 (Table 4.8). Because of budget restrictions, however, this goal will clearly not be reached this year as proposed. The Committee therefore must reformulate its recommendations to allow for a phasing in through FY 1985, as indicated in the last section of Table 4.8. Budget reductions have led to cutbacks in predoctoral support that are rapidly approaching the Committee's recommended level of 390. The task at hand is to increase substantially the level of postdoctoral support over the next 4 years.

> Recommendation. The Committee reaffirms its position that federal support for training in the behavioral sciences shift its emphasis from predoctoral to postdoctoral. A gradual phasing is recommended so that a level of 390 predoctorals and 910 postdoctorals will be supported annually by FY 1985.

Training Grants and Fellowships

In all its prior reports the Committee has recommended the continuance of the training grant mechanism as a way of improving the quality of graduate education in the behavioral sciences at the predoctoral and postdoctoral levels. Today, the Committee sees even more clearly the need for the continuance of this program. The increasing uncertainty of behavioral and social science research funds, which support research assistants at the graduate level, and decreasing enrollments that will decrease the number of teaching assistants needed to teach undergraduates means that alternate sources of support for the ablest of the graduate students in the country will diminish sharply in the coming years. This has led the Committee to the belief that serious problems will arise in the future if training support is not continued.

The training grant is the most effective training mechanism because it provides an opportunity for departmental planning and the optimal use of scarce departmental resources. In particular, the institutional support component provides an important supplementary source of funds with which to structure a training program. This is especially important for health-related training in the behavioral sciences, which frequently lacks an institutional commitment within large behavioral science departments and in medical schools. The Committee is convinced that recent proposals for eliminatimg institutional support from training grants, if effected, would have an immediate detrimental impact on training quality and would reduce the value of the training grant substantially.

TABLE 4.8 Committee Recommendations for NIH and ADAMHA Predoctoral and Postdoctoral Awards in the Behavioral Sciences

Agency Awards and Committee Recommendations	Fiscal Year 1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Actual Awards[a]											
Total	1,966	1,855[b]	1,695	1,498	1,126	1,001					
Predoctoral	1,754	1,496[b]	1,340	1,160	779	652					
Postdoctoral	212	359[b]	355	338	347	349					
1976, 1977, 1978, 1979 Report Recommendations											
Total		1,860	1,740	1,590	1,490	1,390	1,300				
Predoctoral		1,500	1,200	850	745	575	390				
Postdoctoral		360	540	740	745	815	910				
1981 Report Recommendations											
Total								1,180	1,220	1,260	1,300
Predoctoral								570	510	450	390
Postdoctoral								610	710	810	910

[a]Data on actual awards for FY 1975–78 differ somewhat from previous reports due to revisions made by ADAMHA.
[b]Includes Transition Quarter.

The Committee continues to believe that some fellowship support ought to be made available in predoctoral areas where field work is necessary, e.g., anthropology, and in postdoctoral training areas that do not yet possess institutional training grants.

> Recommendation. The training grant should be the predominant mechanism of support in the behavioral sciences with an 80 percent/20 percent traineeship to fellowship ratio. In addition, because of the importance of the institutional support component of the award in planning and administering health-related training programs in behavioral science departments, the Committee strongly endorses the continuation of the training grant mechanism.

NOTES

1. While the field of psychiatry is closely related to the behavioral sciences, the responsibility for the measurement of market demand in this field has been assigned to the clinical sciences.

2. The term "faculty" as used here includes those who are employed by an academic institution without faculty rank, such as research appointees. Postdoctoral appointees are excluded from this definition of faculty. The terms "faculty" and "academic" are used here interchangeably.

3. About 1,220 positions per year have been created by faculty expansion and another (estimated) 1,040 have been created by attrition, assuming an attrition rate of 4.5 percent per year (1.0 percent due to retirement and 3.5 percent due to other causes such as leaving the field).

5. HEALTH SERVICES RESEARCH AND NURSING RESEARCH

Since the Committee's last report, little improvement has been made in the funding of the Committee's recommended programs in the areas of health services research and nursing research. In the past year, a hiatus has existed in the Committee's work in these areas. In this year's report, the Committee reviews its approach to health services research (HSR) and presents the results of a 1977 survey of HSR trainees and researchers. In nursing research, the Committee reviews the status of the federal programs for the support of training in nursing research.

HEALTH SERVICES RESEARCH PERSONNEL

From its inception, the Committee has strongly supported the need for training in the area of health services research. Early attention by the Committee led to the recognition of health services as an area to be specifically included under the purview of NRSA. However, passage earlier this year of the Omnibus Budget Reconciliation Act of 1981 (Public Law 97-35) deleted from the NRSA Act the authority for the National Center for Health Services Research (NCHSR) to use this mechanism to support research training. The Committee views with concern this diminished and unfocused federal role in health services research training as limiting the supply and quality of personnel who are trained to study the many pressing problems in this area. The Committee continues to believe that the increasing importance of health care and the implications that the provision of health services has for the quality of life for all Americans have made health services research an essential area. The training of competent health services researchers remains central to this task.

The nature of health services research provides challenges not present in the other areas under the Committee's purview. Because health services research is not a traditional discipline, but rather the selected application of a variety of disciplines to health services, the Committee and its Panel on Health Services Research had first to define what constitutes this area. The problem was magnified by the fact that health services research lacks readily identifiable boundaries. Previously used definitions therefore have varied according to the policy issues being studied at a particular time.

In its 1978 Report, the Committee provided a definition of health services research that it still believes encompasses the diverse aspects of this area:

> Health services research is theoretical or applied research which examines the organization and performance of health care delivery systems and makes possible informed health care policy. It is a distinct area of inquiry in which systematic methods are applied to problems of the allocation of finite health resources and the improvement of personal health care services.

Because health services research utilizes the perspectives of many disciplines, it is useful to view it in terms of a matrix of research disciplines and research problems. Figure 5.1 presents the matrix, slightly modified from its first use in the 1978 Report (p. 115) of disciplines (e.g., behavioral and social sciences, biomedical sciences, and other fields) and problem areas (e.g., health personnel, ambulatory

Primary Discipline of Research Training	Major Research Problem Areas							
	Health Personnel Mental Health Personnel	Ambulatory Care Child Health Services Dental Health Services Emergency Health Services Health Services for the Disadvantaged Indian Health Services Long-Term Care Nursing Health Services Pharmacy-Related Health Services Rural Health Care Services Mental Health Services Drug Abuse Prevention Programs Alcoholism Prevention Programs	Inflation and Cost Containment Health Insurance	Quality Assurance Health Facilities	Legal Aspects of Health Care Health Politics	Community Studies Health Education Sociobehavioral Aspects of Health Care	Health Services Design and Development (including technology transfer)	Other
Behavioral/Social Sciences Anthropology Economics Political Science Psychology Sociology								
Biomedical Sciences Biostatistics Bioengineering Epidemiology								
Public Health								
Other Fields Operations Research Health Administration Health Education Public Administration								

FIGURE 5.1 Primary disciplines of health services research training and major research problem areas.

care, mental health services, health insurance, quality assurance, and legal studies).

The Committee has also emphasized that health services research is not simply an applied field, but one that involves fundamental research as well. A full range of research methodologies may be utilized, including statistical and computer analysis, case studies, clinical studies, survey research, evaluation research, technology assessment, and decision and policy analysis.

Evaluation of the labor market in an interdisciplinary area such as this is difficult. For health services research, measuring the flow through the training pipeline cannot be done in the usual ways because so much of the training occurs outside of traditional degree granting departments. In addition, many health services researchers have received nontraditional training, coming to the field with professional degrees or academic doctorates in associated disciplines. To obtain such information, a survey was undertaken in 1977 of two cohorts of individuals who could be identified as important segments of the health services research labor force: 1) approximately 770 individuals who received support from the health services research training programs of the NCHSR and the Alcohol, Drug Abuse, and Mental Health Administration (ADAMHA) between 1970 and 1976, and 2) approximately 600 individuals who were principal investigators on NCHSR research grants and contracts between 1960 and 1976. The response rate of both cohorts was 80 percent.

The survey results indicate that there are two distinct populations of health services researchers. One, principal investigators, is older, almost exclusively men (91 percent) and is comprised of a large number of medical degree holders (36.8 percent) as well as research doctorate holders (41.3 percent). The second group, former trainees, is younger, includes more women (46 percent), and is comprised predominantly of research doctorate holders (68.4 percent) with a much smaller portion of medical doctorates (9.4 percent). The changing pattern of degree holders confirms the Committee's earlier judgment that health services research has been moving from an earlier period, where either no formal graduate training was received or where training was received informally in midcareer, to a time when formal training is the norm.

As for employment, health services researchers compare favorably with their biomedical and behavioral science counterparts. Over 90 percent of HSR trainees and principal investigators were employed full- or part-time, as was the case in these other fields. Furthermore, unemployment was very low (2 percent or less) in all fields. Almost 70 percent of HSR trainees and 64 percent of the principal investigators were employed in educational institutions, slightly lower than for biomedical scientists and somewhat higher than for behavioral scientists. Eighty-nine percent of HSR trainees spent some time in research, with an overall average of 38 percent in research. Once again biomedical trainees showed a higher average time spent in research (56 percent) than HSR trainees, with behavioral trainees somewhat lower (24 percent). Most importantly, approximately 77 percent of trainees and 81 percent of the principal investigators were engaged in health services research at the time of the survey.

Overall, the results of the survey indicate that federal support for training in health services research has generated a cadre of health services researchers who are fully employed and actively utilizing their HSR skills. In addition, there has been no significant loss of federally supported HSR trainees from academic to industrial employment.

These findings support the Committee's previous recommendations that a broad program of federal support for HSR training is warranted. Unfortunately, a positive federal response to this call has not been made. The only current HSR training program is limited to mental health services research in which ADAMHA supports 174 trainees (87 predoctoral and 87 postdoctoral) and 2 fellows as of FY 1980. NIH, which had previously indicated that it did support HSR training, has recently reviewed its programs and concluded that it does not provide such support. NCHSR, which supported 440 students in 1972, was forced to phase out its training programs shortly thereafter because no funds have been provided to NCHSR for this purpose.

Recommendation. It is recommended that 330 health services research trainees and fellows be supported annually through FY 1985.

NURSING RESEARCH PERSONNEL

Since the inclusion of nursing research by Congress under the authority of the NRSA Act in 1976, the Committee has examined personnel requirements in this area and come to recognize it as a distinct and emerging area of scientific inquiry. Thus, in addition to its numerical recommendations of modest increases in student support, the Committee has made several recommendations in earlier reports designed to improve the research training capability of doctoral nursing programs: (1) increasing use of training grants, (2) utilizing basic science departments with established relationships with nursing schools, (3) focusing support on "well-qualified" schools of nursing with existing capability for research training, (4) phasing out fellowship support in the nonsciences, (5) providing a limited amount of postdoctoral support for advanced training, and (6) instituting a midcareer training program for the upgrading of research skills of current nursing school faculty.

Although the HRA Division of Nursing had research training authority prior to 1977, it initiated awards under NRSA only at that time. Having made its initial recommendations, the Committee has taken the position that the programs should be given an opportunity to become established before an evaluation is attempted. Therefore, while a full evaluation of these training programs will not be undertaken in this report, a review of their status will be useful. The Committee wishes to thank the HRA Division of Nursing for its cooperation in providing relevant information.

The principal observation to be made about the development of the HRA nursing research training program is that it has not been funded at a level that would permit reasonable, modest growth. After a start-up increase from FY 1977 to FY 1978, funding has remained level at just under $1 million annually through FY 1980. With high inflation rates, the number of individuals supported has declined from 127 to 109 between FY 1978 and FY 1980 and is anticipated to fall further in FY 1981. The number of fellowships, primarily predoctoral, has decreased from 122 to 95 in that period. In FY 1977, 3 institutional training grants, primarily postdoctoral, were awarded and renewed through FY 1980; however, no new awards have been made since then. The training grants have been quite small, supporting a total of 30 trainees over the entire FY 1977-1980 period. Because of the budgetary constraints, the nursing programs have not reached the level recommended by the Committee, which was 270 fellows and trainees by FY 1981.

While recommending that the preponderance of support be directed to the predoctoral level, the Committee also supported the use of up to 15 percent of the awards as postdoctoral appointments as high-quality candidates present themselves. To date, 13 postdoctoral fellowships and 20 traineeships have been awarded between FY 1977 and FY 1980, or 7 percent of all new awards.

One of the primary objectives of the Committee's recommendations for federal support for nursing research training has been to provide seed money not previously available for nursing schools to develop high-quality training programs. The Committee believes that the impact of the limitations on funding thus far provided has been to inhibit this development. Furthermore, the proliferation of doctoral training programs in nursing schools in the last few years has also detracted from efforts to develop quality training. The number of doctoral granting nursing schools has risen from 16 in 1977 to 23 in 1981, an increase of over 40 percent. The Committee remains concerned, therefore, that the unevenness in quality of research training programs evident in its 1977 survey and site visits (1978 Report, pp.131-138) has been perpetuated rather than alleviated. Given the limited resources, both federal and nonfederal, for nursing research training, the Committee has suggested that available funds be directed toward improving programs of demonstrated capability and that an expansion of doctoral programs be avoided until a core of quality programs has been developed.

One positive program designed precisely to strengthen nursing research has been the Nursing Research Emphasis (NRE) grants of HRA. A onetime opportunity, the NRE grants were awarded in the fall 1980 to 10 schools of nursing with doctoral programs at an average level of support of $115,000 per grant per year. The grants are for 3 years, with a possible renewal to 5 years. The purpose of the program is to stimulate the development of nursing research by providing funds for faculty research. Applicants were required to demonstrate their research capacity and specify the projects that would be conducted. Among the 10 grants, there are 47 component studies on children; adolescents; beginning families and parenting; aged, chronically ill, and terminally ill; and minorities and other underserved groups. The Committee is pleased that the Division of Nursing at HRA is making this important effort to enhance the research capabilities of doctoral nursing programs.

Recommendation. NRSA support for nursing research training should rise to 300 trainees and fellows annually from FY 1982 through FY 1985. No more than 15 percent of these trainees should be at the postdoctoral level.

6. MINORITIES IN THE BIOMEDICAL AND BEHAVIORAL SCIENCES

The identification and development of science talent is important for the future vitality of scientific research. In the past, white males have constituted a disproportionately large share of the pool of students prepared for science careers. The talents of those outside that pool, i.e., minorities and women, have thereby been lost to science and either have been applied to other areas or remained undeveloped because of limited education or because no effort was made to identify those with talent and interest them in science careers. Because academic ability is not limited to white male students, full development of the nation's science talent means identifying that ability and encouraging an interest in science among minority and nonminority students of both sexes.

Furthermore, this development is essential because demographic trends show that in the next 20 years minorities will constitute an increasing portion of the U.S. population, especially in the pool of potential college students. For example, among 18- to 24-year-olds, the proportion of Blacks and other racial minorities (excluding Hispanics) is expected to grow from 14.3 percent in 1980 to 17.9 percent by 1990, and will reach 18.9 percent by the year 2000 (U.S. Bureau of the Census 1965-80 No. 704). It is important to recognize the potentially significant impact of minorities on the supply of scientists and, thus, their possible contribution to scientific research.

Although it would be absurd to propose a "Chicano biochemistry" or "Black biophysics," one should recognize that minorities, like everyone else, will apply their own values in determining what is an appropriate or interesting problem in health research. Minority scientists are more likely than nonminorities to focus on problems of particular significance to the minority population -- hypertension, for example -- thus broadening the scope of scientific inquiry. A more diverse scientific community can result in greater diversity in research, from which the sciences will benefit.

Finally, increasing the participation of minorities in the sciences is also a matter of fairness. The persistent underrepresentation of Blacks, Hispanics, and American Indians among doctoral scientists amounts to their near exclusion from the science professions. This inequity must be eliminated for the good of both science and minority groups.

To understand the issues affecting the participation of minorities in the biomedical and behavioral fields, the Committee reviewed the recent (1974-1980) literature on minorities in the sciences and prepared two background documents, an Issues Paper and an Annotated Bibliography of the references used. These documents, which summarize the literature, are available to interested readers upon request.[1] Although the literature describes a wide range of problems that contribute to the low representation of minorities in science careers, there is a clear emphasis on those early factors that discourage minority students from pursuing science education, beginning in the primary grades and continuing through postsecondary levels. These factors, cited by numerous authors, include the following: cultural and language differences; lack of early development of an aptitude for mathematics or science; weak academic preparation, especially in mathematics; lack of science career information, adult role models, and vigorous recruitment; inflexible college admissions criteria; and inadequate financial resources.

In addition to reviewing the relevant literature, the Committee examined the most recent statistics on minority representation among students in higher education and doctorate recipients, particularly in the biomedical and behavioral fields. The Committee also reviewed the current federal programs to train minority students in those fields. They are described later in the chapter. Earlier discussions of minorities that appeared in the Committee's Reports from 1977 to 1979 are summarized at the end of this chapter.[2]

The Committee's analysis of minority Ph.D.'s in the biomedical and behavioral sciences is limited to consideration of U.S. citizens and permanent visa holders among American Indians, Hispanic Americans, Blacks, and Asians. Although Asians are not underrepresented among students and degree recipients in graduate science education, they are included in these analyses because they are considered a minority group by the U.S. Office for Civil Rights for purposes of affirmative action at all educational levels.

In the following discussion the representation of minority group members in the biomedical and behavioral sciences is compared to their proportions in the total U.S. population. The percentages of minorities in the population for both 1970 and 1980 are given in Table 6.1 as reference points against which to consider the data presented in this chapter.

TABLE 6.1 Percent of Racial/Ethnic Minorities in the U.S. Population

Race/Ethnic Group	1970 (%)	1980 (%)
American Indians	0.4	0.6
Blacks	11.1	11.7
Asians	0.8	1.5
Hispanics	4.5	6.4

SOURCE: U.S. Bureau of the Census (1981).

MINORITY PH.D.'S IN THE BIOMEDICAL SCIENCES

Data from the National Research Council's Survey of Earned Doctorates for the period 1974 through 1980 show that Blacks and Hispanics remain severely underrepresented among Ph.D.'s in the biomedical sciences. American Indians are represented in roughly the same proportion as in the total population, while Asians are statistically overrepresented. The total number of minority Ph.D.'s, including Asians, in biomedical fields has remained stable for the last 7 years, even though the total number of biomedical doctorates awarded annually increased in 1979 and 1980 (Figure 6.1 and Appendix Table A11). Thus, in the last 2 years the percentage of minorities among biomedical Ph.D.'s has declined slightly.

The persistent underrepresentation of Blacks and Hispanics is conspicuous. From 1974 to 1980 Blacks were no more than 2.0 percent and Hispanics no more than 1.1 percent of all biomedical doctorates awarded annually, while Asians constituted at least 5.5 percent of the total each year. American Indians amounted to at least 0.4 percent of biomedical Ph.D.'s every year until 1980 when they were 0.3 percent.

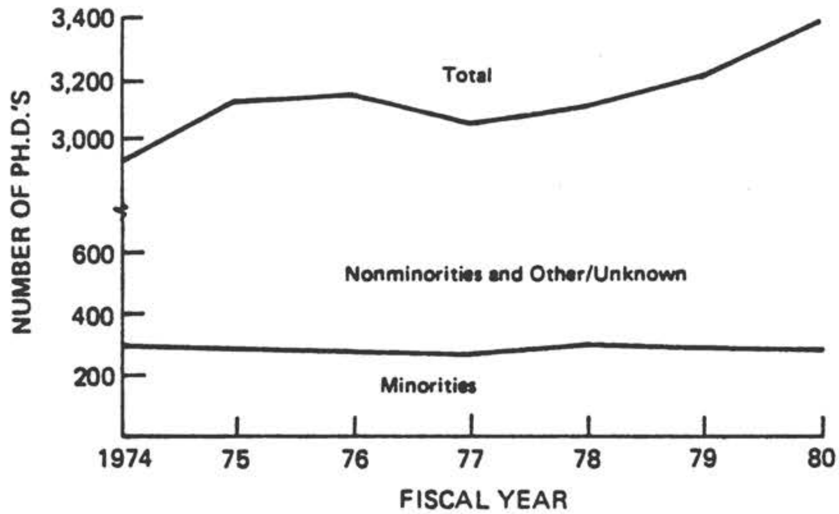


FIGURE 6.1 1974-80 doctorate recipients in the biomedical sciences: U.S. citizens and permanent visa holders. See Appendix Table A11.

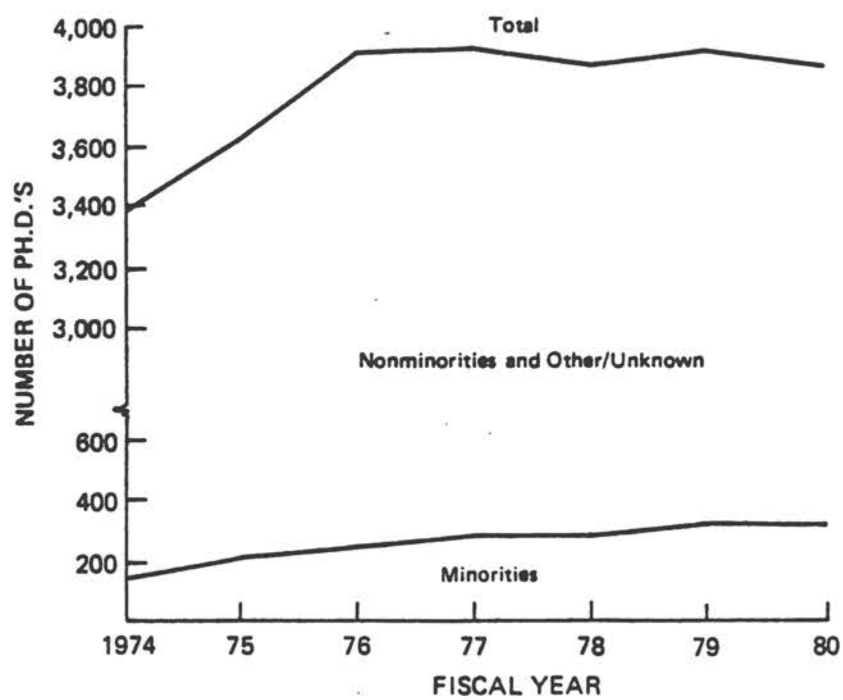


FIGURE 6.2 1974-80 doctorate recipients in the behavioral sciences: U.S. citizens and permanent visa holders. See Appendix Table A14.

Time to Complete the Doctorate

In the biomedical fields, Black Ph.D.'s take a longer time than others to complete their doctorate after receiving the bachelor's degree, primarily due to time not enrolled in graduate study. Although the median time that biomedical Ph.D.'s are enrolled in graduate study is about the same for nonminorities (5.7 years) and for Blacks (6.1 years), the median total time between the bachelor's and doctoral degrees is 3 years longer for Black Ph.D.'s, who take 10.0 years, compared to 6.8 years for nonminorities (Appendix Table A17). This difference is illustrated in another way in Figure 6.3, showing the median age of Blacks and nonminorities at three times: receipt of baccalaureate, entrance to graduate school, and receipt of doctorate. When they have entered graduate school, Blacks are already 1 1/2 years older than nonminorities. By the receipt of doctorate the median age of Blacks is 4 years greater than that of nonminorities, a result of interruptions in study between the bachelor's and doctor's degrees. While the reasons for these interruptions cannot be determined from existing data, it is likely that in large measure they result from financial pressures which arise during the long training period. Thus, the longer time that Blacks take to earn their Ph.D.'s in the biomedical sciences may simply reflect the economic problems common to all students of modest means.

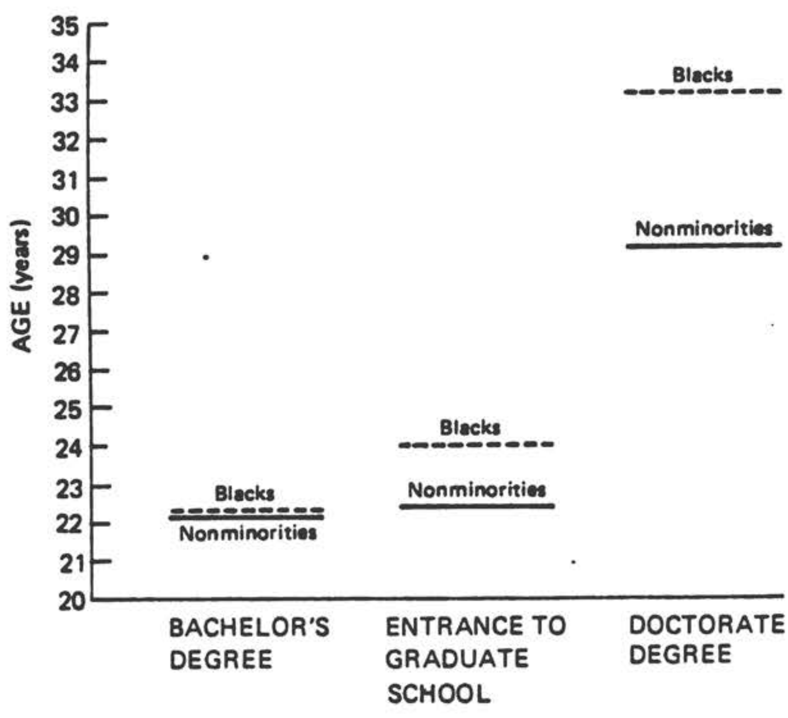


FIGURE 6.3 Median age of 1974-80 Ph.D.'s in the biomedical sciences: Blacks and nonminorities. See Appendix Table A16.

Sources of Graduate Student Support

For both minority and nonminority Ph.D.'s in the biomedical sciences, except Asians, the teaching assistantship was the most frequent source of support during graduate school (Appendix Table A12). This source was followed by research assistantships and the student's own earnings. Asians reported the highest percentage (57 percent) of research assistantships for all biomedical Ph.D.'s. About the same percentages of nonminorities, Blacks, and Hispanics reported self-support (32-34 percent), but more American Indians (38 percent) and fewer Asians (21 percent) cited it. Asians reported support by NIH fellowships less frequently than did non-minorities while Black Ph.D.'s cited them more frequently. All four minority groups, however, received NIH traineeships less frequently than did the 33 percent of nonminorities who held them: 22 percent of Blacks, 20 percent of Asians, 26 percent of Hispanics, and 30 percent of American Indians. Among other sources of support, National Direct Student Loans and other loans were used more frequently by American Indians, Blacks, and Hispanics than by nonminorities; Asians cited loans less frequently than did other racial/ethnic groups.

Plans for Postdoctoral Study

In recent years the percent of all biomedical Ph.D.'s planning postdoctoral study has grown steadily from 50 percent in 1974 to 65 percent in 1980 (Appendix Table A13). Minorities have shared in this trend in roughly the same proportions as nonminorities, except for Blacks, a much smaller percentage of whom have reported postdoctoral study plans. In 1980, for example, 67 percent of nonminority Ph.D.'s in the biomedical fields reported they planned postdoctoral study, while only 37 percent of Blacks had such plans. The reasons for this difference, evident since 1974, are unknown, and until the postdoctoral activity of Black Ph.D.s has been examined, the Committee can only note this fact. However, one can speculate that both positive and negative factors may be responsible for this difference. The demand for Black doctorates may have created a favorable market in which postdoctoral experience may not be a job prerequisite for Black Ph.D.'s. The NRC Committee on Postdoctorals cited evidence that minority scientists and engineers are in demand and noted that many of them took faculty positions immediately after completing their doctoral programs (NRC, 1981a, pp. 143-146). On the other hand, economic necessity and the lack of role models to guide them may militate against postdoctoral study by Blacks. We have reported that minority Ph.D.'s, with the exception of Asians, are older and have more dependents than others do at the time of doctorate (1977 Report, p. 172). The Ford Foundation has recognized the latter factors by establishing a Postdoctoral Fellowship Program for Minorities with special provisions addressed to these problems.

In its 1977 Report, the Committee noted that the percentage of Blacks planning postdoctoral study was much smaller than other Ph.D.'s and recommended that a special effort be made by each agency to encourage qualified minority applicants to undertake postdoctoral training by establishing a special postdoctoral fellowship program targeted to minorities (1977 Report, p. 173). This was not done. However, the most recent data show that the percentage of Blacks planning postdoctoral study continues to be much smaller than others. The Committee, therefore, urges the agencies to reconsider its previous recommendation.

At the same time, the agencies should encourage qualified minority Ph.D. candidates to pursue postdoctoral education and should support them through existing programs in an effort to include them in the mainstream of scientific research and training.

MINORITY PH.D.'S IN THE BEHAVIORAL SCIENCES

The total number of doctorates awarded in the behavioral sciences increased from 1974 to 1976, then levelled off until 1980 (Figure 6.2 and Appendix Table A14). During this period minority representation has grown among Ph.D. awardees in the behavioral sciences in contrast to the stability of that representation in the biomedical fields. The number of Ph.D.'s awarded to Hispanics increased from 23 in 1974 to 73 in 1980. The number of Ph.D.'s awarded to Blacks has grown from 79 in 1974 to 156 in 1980. Thus, there has been a three-fold rise in Hispanic Ph.D.'s and a near doubling of Blacks. However, in order to approach their proportions in the national population, they would have had to grow much faster than they did in these years.

The percentage of all behavioral sciences Ph.D.'s planning postdoctoral study has gradually increased since 1974 (Appendix Table A15), but not to the same level as in the biomedical fields. For example, in 1980 while 65.5 percent of biomedical doctorates planned further study, only 16.2 percent in the behavioral sciences had such plans. For American Indians and Blacks the percentage of those planning postdoctoral study has been somewhat lower than for nonminorities, 7.1 and 12.2 percent, respectively, while it has generally been higher for Asians and Hispanics, 17.3 and 16.4 percent, respectively. The percentages of American Indians, Asians, and Hispanics fluctuate widely from year to year, but this variability may be exaggerated because the numbers of Ph.D.'s are very small.

MINORITIES IN THE EDUCATIONAL "PIPELINE"

According to the 1979 Survey of Doctorate Recipients, U.S.-born minorities excluding Asians were only 1.6 percent of the estimated Ph.D. labor force in science and engineering. Although this underrepresentation is widely recognized as a persistent problem at the doctorate level, it is the result of the limited flow of minority students into science at the lower educational levels. Data on enrollments and degrees earned by race are sparse and do not permit one to follow a group of individuals through the educational "pipeline" from the undergraduate to the doctoral level. Still, the data available do provide a profile of students and degrees at several points in time. These data are summarized in Table 6.2 for Blacks and in Table 6.3 for Hispanics.

These figures support two conclusions: First, minorities are represented less among bachelor's degree holders than among undergraduate enrollees, and still less among Ph.D. recipients. Second, minority graduate students are concentrated in nonscience fields, especially education. These facts are the result of both the small number of minorities who continue on to graduate education and the lack of minority students selecting science careers. Increasing minority representation among biomedical and behavioral scientists will require increasing the

TABLE 6.2 Summary of Data on Blacks in the Educational "Pipeline"

	1976	1977	1978	1979	1980
UNDERGRADUATE LEVEL					
Percentage of Total Bachelor's Degrees:[a]					
All Fields	6.4	7.5	N/A	6.5	N/A
Education	9.1	8.9	N/A	9.0	N/A
Biological Sciences	4.3	4.5	N/A	5.0	N/A
Psychology	6.4	6.7	N/A	7.5	N/A
Percentage of Total Undergraduate Enrollment:[b]					
All Fields	10.2	N/A	10.2	N/A	N/A
Percentage Distribution by Type of Institution:[c]			100.0		
Universities			13.9		
4-Year Colleges			44.1		
2-Year Colleges			42.0		
GRADUATE LEVEL					
Percentage of Total Master's Degrees:[a]					
All Fields	6.5	6.7	N/A	6.4	N/A
Education	9.7	10.0	N/A	9.7	N/A
Biological Sciences	3.3	2.9	N/A	3.1	N/A
Psychology	5.3	6.1	N/A	5.9	N/A
Percentage of Total Graduate Enrollment:[b]					
All Fields	6.6	N/A	5.7	N/A	N/A
Biological Sciences	2.6	N/A	2.6	N/A	N/A
DOCTORATE LEVEL					
Percentage of Total Ph.D.'s:[d]					
All Fields	4.0	4.3	4.2	4.2	4.1
Education	9.4	10.0	9.1	8.6	8.8
Biomedical Sciences	1.8	1.4	2.0	1.5	1.4
Behavioral Sciences	3.5	3.5	3.5	4.1	4.0
Percentage Distribution of Black Doctorates:[d]	100.0	100.0	100.0	100.0	100.0
Physical Sciences	2.6	3.7	4.9	4.7	2.6
Engineering	1.8	1.3	1.2	1.8	1.6
Life Sciences	6.4	5.7	7.1	5.5	6.2
Social Sciences	16.5	18.8	19.3	20.2	20.3
Education	59.4	57.7	54.3	51.4	55.0
Humanities	8.6	9.0	8.2	11.7	9.4
Other Fields	4.7	3.8	4.9	4.8	4.8

[a]From U.S. Department of Education (1948–81).
[b]From U.S. Department of Education (1961–79).
[c]From U.S. Department of Education (1980).
[d]From NRC (1958–80).

NOTE: Blacks were 11.1 percent of the U.S. population in 1970 and 11.7 percent in 1980.

TABLE 6.3 Summary of Data on Hispanics in the Educational "Pipeline"

	1976	1977	1978	1979	1980
UNDERGRADUATE LEVEL					
Percentage of Total Bachelor's Degrees:[a]					
All Fields	2.6	3.5	N/A	3.2	N/A
Education	2.2	2.3	N/A	2.5	N/A
Biological Sciences	2.7	2.9	N/A	3.8	N/A
Psychology	3.3	3.4	N/A	4.0	N/A
Percentage of Total Undergraduate Enrollment:[b]					
All Fields	4.8	N/A	5.3	N/A	N/A
Percentage Distribution by Type of Institution:[c]			100.0		
Universities			12.7		
4-Year Colleges			32.9		
2-Year Colleges			54.4		
GRADUATE LEVEL					
Percentage of Total Master's Degrees:[a]					
All Fields	2.0	2.2	N/A	2.1	N/A
Education	2.2	2.3	N/A	2.5	N/A
Biological Sciences	1.4	1.5	N/A	1.7	N/A
Psychology	2.7	3.9	N/A	2.4	N/A
Percentage of Total Graduate Enrollment:[b]					
All Fields	2.2	N/A	2.3	N/A	N/A
Biological Sciences	1.4	N/A	1.6	N/A	N/A
DOCTORATE LEVEL					
Percentage of Total Ph.D.'s:[d]					
All Fields	1.3	1.7	2.0	2.0	1.8
Education	1.7	2.0	2.5	2.5	2.2
Biomedical Sciences	0.7	0.9	1.1	1.0	0.9
Behavioral Sciences	1.1	1.5	1.9	1.8	1.9
Percentage Distribution of Hispanic Doctorates:[d]	100.0	100.0	100.0	100.0	100.0
Physical Sciences	7.2	11.6	5.6	9.5	7.2
Engineering	4.4	4.6	5.9	4.5	5.8
Life Sciences	8.8	7.4	8.7	8.7	8.9
Social Sciences	17.9	17.7	21.6	19.9	21.9
Education	34.2	29.7	30.5	31.2	31.7
Humanities	22.0	25.5	23.2	24.1	21.3
Other Fields	5.5	3.4	4.5	2.2	3.1

[a]From U.S. Department of Education (1948–81).
[b]From U.S. Department of Education (1961–79).
[c]From U.S. Department of Education (1980).
[d]From NRC (1958–80).

NOTE: Hispanics were 4.5 percent of the U.S. population in 1970 and 6.4 percent in 1980.

pool of minorities who are both academically prepared and motivated to pursue graduate education in the sciences. Current programs to assist the college and graduate training of minority science students are facing an impossible task if unaccompanied by long-range efforts to increase the flow of minorities into higher education. While the critical primary and secondary school levels are not within the direct purview of the Committee, nonetheless educators at those levels are urged to support programs to identify and encourage the development of science talent among minority students.

CURRENT PROGRAMS FOR MINORITY STUDENTS

The Committee found the current federal programs for increasing the participation of underrepresented minorities in the biomedical and behavioral disciplines to be quite varied. Although they have similar objectives, they take different forms such as institutional training grants, fellowships, and research projects, and are operated by different federal departments and agencies. The Committee has identified the major programs for minorities within the Department of Health and Human Services, the Department of Education, and the National Science Foundation and has outlined these in Table 6.4. The remainder of this chapter provides brief descriptions of a few of these programs.

The Minority Access to Research Careers (MARC) programs of the National Institutes of Health and the Alcohol, Drug Abuse, and Mental Health Administration fall directly within the purview of this Committee since they are under the authority of the National Research Service Award Act. These include the Honors Undergraduate Research Training Grants, Faculty Fellowships, Graduate Institutional Training Grants, and the Predoctoral Fellowship Program, which are intended for the students and faculty of minority institutions. The core of the MARC programs, however, is the Honors Undergraduate Program, which began in FY 1977 to support college juniors and seniors. The first graduates of this program began their predoctoral training in the 1978-1979 academic year and could have completed 4 years of graduate study by the spring of 1982. However, it is too early to predict when they will earn their Ph.D.'s, although the median registered time between the B.A. and Ph.D. is about 6 years (see Appendix Table A17). This program has received strong support from NIH in the past and has shown vigorous growth to date. In FY 1981 there were 35 institutional grants with funds for 305 trainees, compared with 12 grants with 76 trainees in FY 1977.

From the outset the strategy of this program was to develop the environment for high-quality research training within minority colleges, which attract a great number of talented undergraduates. The institutional support component of the NRSA training grants has been a crucial feature of this program, making it possible for minority institutions without doctoral programs to begin training a cohort of potential scientists who would be able to enter and complete doctoral study in major research universities. Therefore, the elimination or any substantial reduction of indirect costs and institutional allowances from NRSA training grants would affect minority schools more severely than others, and would seriously jeopardize the future of the MARC Honors Undergraduate program. The Committee hopes that will not occur. The NIH should continue to follow the careers of those trainees who have participated to date, so that the results of the past investment in this program will be known.

The Predoctoral Fellowship Program, designed for students who have completed the Honors Undergraduate Program, and who have already proven their ability to move on to graduate study in research universities, is only in its first year.

Although not a training program per se, the NIH Minority Biomedical Support (MBS) program shares the MARC program's objective of increasing the number of minorities in research careers. The MBS program is technically a program of institutional research project grants funded by the NIH and ADAMHA, which employ faculty and students at minority institutions. A special feature of the MBS program is its emphasis on undergraduate participation in all phases of research from conceptualization to reporting results at meetings and in scientific journals. The Annual MBS Symposium provides an opportunity for students to present their work in a national forum and serves as a strong incentive to academic achievement. In addition to the biomedical research conducted since the MBS Program began in 1973, the program has provided support for 2,878 students who completed bachelor's degrees, 76 percent of whom continued on to graduate or professional schools, and 30 students who completed Ph.D.'s as of 1979.

The MARC and MBS programs thus both emphasize identifying and recruiting talented students at the college level and assisting in their further development, an emphasis essential to improving the flow of minorities into doctoral education.

Another approach to training minority scientists is taken by the Minority Hypertension Research Development Summer Program, which awards NRSA training grants to university medical school Hypertension Centers for continuing summer training programs in cooperation with minority institutions. One of today's major health problems, hypertension affects one-seventh of the U.S. adult population and is of particular concern to the Black population, of whom an estimated one-third have high blood pressure. The program seeks to enhance the research capabilities of the trainees and encourage the recruitment and development of minority investigators in hypertension. The minority institutions provide trainees from among their faculty and graduate students, while the training centers provide the research facilities and preceptors, who guide the activity of individual trainees. The summer of 1980 was the program's fourth year of operation and involved 17 Hypertension Training Centers with 68 minority institutions. In that summer 133 trainees, 93 faculty, and 40 graduate students participated in the 12-week session. This program employs the research training mechanism of the NRSA institutional grant in the highly focused research setting of the Hypertension Centers. The Committee encourages NIH to thoroughly evaluate the effectiveness of this innovative approach to training.

In the Alcohol, Drug Abuse, and Mental Health Administration there is another variation on the use of the NRSA authority, the Minority Fellowship Programs. These are administered by four professional associations: the American Nurses' Association, the Council on Social Work Education, the American Psychological Association, and the American Sociological Association. The associations receive NRSA funds from the National Institute of Mental Health (NIMH) and award fellowships to minority group members, providing support for up to three years of doctoral study in their fields. In FY 1980 these programs supported the

TABLE 6.4 Profile of Federal Programs for Minority or Disadvantaged Students in the Biomedical and Behavioral Sciences

Name of Program	Administered By	Authorizing Legislation	Date Begun	Eligible Applicants	Education Level	Award Type	FY 1980 Appropriation	Number of Awards/FY 1980	Target Fields	Program Purpose or Service
DEPARTMENT OF HEALTH AND HUMAN SERVICES										
MARC Honors Undergraduate Research Training	NIH/NIGMS	NRSAA	FY 1977	4-yr. minority institutions	U	Training grant	$ 3.6 M. (total MARC)	35 grants 237 positions	Biomedical/ Behavioral	Research training
MARC Predoctoral Fellowship Program		NRSAA	FY 1981	Graduates of Honors Undergrad. Program	G	Fellowship		–	Biomedical/ Behavioral	Research training
MARC Graduate Institutional		NRSAA and earlier authority	early 1970's (T02 awards)	No more applications accepted	G	Training grant		4 grants/approx. 40 positions	Biomedical	Research training
MARC Faculty Fellowships		NRSAA	FY 1972	Faculty of minority institutions	G, P	Fellowship		approx. 20	Biomedical	Research training
MARC Visiting Scientist Awards		P.L. 94-278 Title XI	FY 1972	Minority institutions	Faculty	Fellowship		Only 6 since 1972	Health Research	Strengthen research and teaching programs
Minority Biomedical Support (MBS)	NIH/DRR	PHS Act as amended	FY 1972	2- and 4-yr. minority institutions	U, G, P	Inst. research project	$13.5 M.	500 projects at 80 inst.	Biomedical	Promote research careers, conduct NIH research

Minority High School Research Apprenticeships available through Biomedical Research Support Grants (BRSG)	NIH/DRR	PHS Act as amended	FY 1980	Minority H.S. students		Supplement to inst. BRSG awards	$ 0.4 M.	200 apprenticeships	Health Research	Summer jobs to interest minorities in health research
Minority Hypertension Research	NIH/NHLBL	NRSAA	FY 1977	Med. school/ minority institutions	G, P	Training grant	$ 0.48 M.	17 awards with 133 positions	Hypertension	Research training during summer
MARC Honors Undergraduate Research Training Grants	ADAMHA	NRSAA	FY 1980	4-yr. minority institutions	U	Training grant	$177,500	2 grants, 12 positions	Alcohol, Drug Abuse, Mental Health or related areas	Research training
MARC Faculty Fellowships	ADAMHA	PHS Act as amended	FY 1980	Faculty of minority institutions	G, P	Fellowship	$ 38,000	1 fellowship	Same as above	Research training for minority inst. faculty
Minority Fellowship Programs	NIMH and professional associations:	NRSAA except in psychiatry	FY 1975	Minority students	G	Fellowship	$ 2.5 M. (ADAMHA contribution only)	See below	See below	Increasing the number of minority mental health professionals and behavioral scientists
	American Nurses Association							13	Nursing	
	Council on Social Work Education							14	Social Work	
	American Sociological Association							48	Sociology	
	American Psychiatric Association (clinical training only)							16	Psychiatry	
	American Psychological Association							36	Psychology	

TABLE 6.4 Profile of Federal Programs for Minority or Disadvantaged Students in the Biomedical and Behavioral Sciences (cont'd.)

Name of Program	Administered By	Authorizing Legislation	Date Begun	Eligible Applicants	Education Level	Award Type	FY 1980 Appropriation	Number of Awards/FY 1980	Target Fields	Program Purpose or Service
NATIONAL SCIENCE FOUNDATION										
Minority Research Initiation (MRI)	–	–	FY 1972	Minority faculty with no previous research support	F	Research grant	$1.0 M.	20 approx.	All sciences	Provides first research grant for minority faculty
Minority Graduate Fellowships	–	–	FY 1979	Minority grad.	G	Fellowship	$1.1 M.	55 fellows	All sciences	Portable fellowships
Minority Institutions Graduate Traineeships (MIGT)	–	–	FY 1977	Minority institutions granting masters or doctorates	G	Institutional traineeships	$1.1 M.	48 trainees among 16 institutions	All sciences	Stipends for grad. students at minority schools
Research Apprenticeships for Minority High School Students	–	–	FY 1980	Colleges and univ. conducting scientific research	H.S.	Institutional grants	$0.6 M.	240 students	All sciences	All year participation in research activities
DEPARTMENT OF EDUCATION										
Biomedical Sciences Program	–	P.L. 95-561 Title III	FY 1980	Post-secondary schools	H.S.	Project grant	$3.0 M.	12 with approx. 2,400 students	Biomed. including medicine & allied health	Projects to educate & motivate students from economically disadvantaged backgrounds in preparation for biomedical careers

Graduate and Professional Opportunities Program (G*POP)	–	H. Ed. Act of 1965 Title IV	FY 1978	Higher ed. institutions	G	Institutional and fellowship awards	$8.8 M.	1,002 fellowships at 116 inst./33 also received inst. awards	Academic and professional fields except medicine	Grants to prepare members of traditionally underrepresented groups for academic or professional careers
Minority Institutions Science Improvement Program (MISIP)	–	–	FY 1972	2- and 4-yr. minority institutions	U	Project grants (several types)	$5.0 M.	19 inst. grants	All sciences	Grants for wide range of science development activities

Abbreviations:

NIH	National Institutes of Health	NSF	National Science Foundation	H.S.	High School
DRR	Division of Research Resources	ED	Department of Education	U	Undergraduate
NIGMS	National Institute of General Medical Sciences	HHS	Department of Health and Human Services	G	Graduate
NHLBI	National Heart, Lung, and Blood Institute	PHS	Public Health Service	P	Postdoctoral
ADAMHA	Alcohol, Drug Abuse, and Mental Health Administration	NRSAA	National Research Service Award Act	F	Faculty
NIMH	National Institute of Mental Health	MARC	Minority Access to Research Careers	M.	Million
		BRSG	Biomedical Research Support Grant		

SOURCE: Published reports and announcements of programs, as well as oral and written information from the program staff.

following number of research fellows: Nursing 13, Social Work 14, Sociology 48, and Psychology 36. The programs began in 1975, and by 1979 42 fellows had completed Ph.D.'s, including 10 psychologists, 6 nurses, 5 social workers, and 11 sociologists.

Since FY 1979, the National Science Foundation (NSF) has also sponsored a Minority Graduate Fellowship Program, which awards 3-year fellowships on the basis of a national competition open only to members of underrepresented minority groups. The awards provide support for study leading to master's or doctor's degrees in all science fields. In 1979 the NSF gave 65, and in 1980 55, new fellowships to minority graduate students; in 1981 105 new awards were offered, including 32 in the life and medical sciences. A continuous number of such awards could have a noticeable impact on the pool of minority Ph.D.'s.

A significant nongovernmental program at the graduate level, the Ford Foundation's Graduate Fellowships for Blacks, Chicanos, Puerto Ricans, and American Indians, ended this year. The Ford program provided funds for doctoral dissertation research and supported 1,650 Ph.D. candidates during its existence from 1969 to June 1981. A new program, however, got under way in 1980 when the Ford Foundation initiated a Postdoctoral Fellowship Program for Minorities under the auspices of the National Research Council. In both 1980 and 1981 35 grants were awarded to Ph.D.'s for 1 year of study in the humanities and the sciences.

While most of the current national programs support minorities at the higher levels of academic training, there are also programs at the high school level to attract minorities of ability. The Biomedical Research Support Grants (BRSGs) of the National Institutes of Health provide Minority High School Research Apprenticeships in the form of summer jobs designed to interest minorities in health research. Some 200 students participated in the summer of 1980, the first year of that program. The Biomedical Sciences Program administered by the Department of Education made its first awards in FY 1980 to selected postsecondary schools that developed 5-year projects to motivate, educate, and prepare high school students from economically disadvantaged backgrounds for biomedical careers.

RECOMMENDATION

All of the existing programs mentioned above deserve close monitoring by their sponsors and should be improved if possible. The Committee commends the respective agencies for their efforts and supports their common goal of attracting more minorities into research careers. However, since there is a lack of literature evaluating the various approaches taken, the Committee has no basis on which to judge whether one method is superior to another.

> Recommendation. Current federal programs that recruit and train minority students in the biomedical and behavioral sciences should be evaluated in order to identify the most successful approaches to increasing minority participation in the sciences. Existing programs should be continued pending the outcome of this evaluation.

NOTES

1. Staff working documents describing the review of literature (1974-1980) on minorities in science, Issues Affecting the Participation of Minorities in Science and An Annotated Bibliography on Issues Affecting the Participation of Minorities in Science, by Richard Albert and Dr. Harold Delaney, are available upon request by writing to: Committee on a Study of National Needs for Biomedical and Behavioral Research Personnel, 2101 Constitution Avenue, N.W., Room JH 717, Washington, D.C., 20418.

2. In its 1977 Report the Committee first discussed minority participation in the biomedical and behavioral sciences. Upon examining data compiled by the National Research Council's Survey of Earned Doctorates, the Committee found a gradual increase during the years 1973 to 1976 in minority representation among doctoral recipients in all areas of learning but a decrease in the percent of minorities in the biomedical sciences. An examination of the baccalaureate fields of doctorate recipients showed that many minority Ph.D.'s, especially Blacks with baccalaureates in the biomedical fields, shifted to graduate study in other areas, principally education, where they earned their doctoral degrees. Survey data also showed that minority doctorates, except Asians, took longer to earn the degree and received it at a later age than Whites. A strikingly high percentage (25 percent) of 1973-1976 Black doctorates in the biomedical/behavioral sciences interrupted their graduate study for more than 3 years. All minority doctorates, except Asians, had more dependents at the time they completed their degrees than did Whites. Black Ph.D.'s also were less likely than Whites to pursue postdoctoral study. However, the Committee believed that employment prospects in science fields appeared good for minority doctorates.

The Committee concluded that in order to provide more opportunities for minorities to enter and to complete predoctoral programs, efforts were needed in addition to the NIH programs of Minority Access to Research Careers, Minority Biomedical Support, and the ADAMHA Minority Fellowship Programs. The Committee made two recommendations designed to encourage more minority applicants to enter and complete graduate training without undue delay: (1) ADAMHA should provide predoctoral support for minorities starting with the first year of graduate training, instead of the third year under then-current policy, to meet the financial needs of these students; and (2) special efforts should be made by each agency to encourage qualified minority applicants to undertake postdoctoral training by establishing a special postdoctoral fellowship program for minorities (1977 Report, pp. 170-173). While the second recommendation was never implemented ADAMHA did change its policy in 1977 in accordance with the first recommendation.

In its 1978 Report the Committee again addressed the participation of minorities but only in its section on behavioral sciences. The Committee reiterated its recommendation that ADAMHA waive its "two-year restriction" for minority students in the belief that this change would promote the recruitment of minority scientists through current NRSA programs. However, the Committee did commend the agency for its efforts in developing special programs for minorities. Finally the Committee noted that it had commissioned a study to review the issues affecting the recruitment and training of minorities in science careers (1978 Report, pp. 77-78), the results of which are reported in this chapter.

In the 1979 Report the Committee noted its approval of ADAMHA's change in policy to support promising first- and second-year students who otherwise would not have the resources to pursue full-time research training. The Committee also noted ADAMHA's announcement of its new Minority Access to Research Careers (MARC) programs in fields relating to alcoholism, drug abuse, and mental health, and commended the agency for its efforts to provide National Research Service Award support to minority group students (1979 Report, pp. 45-46).

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APPENDIX A

TABLE A1 Biomedical Science Baccalaureate Degrees and Undergraduate Enrollment

	B.A. Degrees (excluding first professional)			Total Undergraduate Degree-Credit Enrollment (thousands)	
Fiscal Year	Total B.A.'s	Biomed. Sci.[a]	Ratio of Biomed. Sci. to Total B.A.'s	Incl. First Professional[b]	Excl. First Professional[c]
1960				3,402	3,334
1961	365,337	15,588	0.0427	3,610	3,538
1962	382,822	16,424	0.0429	3,891	3,813
1963	410,421	18,704	0.0456	4,207	4,123
1964	460,467	22,207	0.0482	4,529	4,438
1965	492,984	24,612	0.0499	4,342	4,255
1966	524,117	26,336	0.0502	4,829	4,732
1967	562,369	28,157	0.0501	5,161	5,058
1968	636,863	31,221	0.0490	5,557	5,437
1969	734,002	34,816	0.0474	6,043	5,909
1970	798,070	36,868	0.0462	6,528	6,376
1971	846,110	40,000	0.0473	6,889	6,719
1972	894,110	42,000	0.0470	7,104	6,913
1973	930,272	45,000	0.0484	7,199	6,998
1974	954,376	47,434	0.0497	7,395	7,187
1975	931,663	50,493	0.0542	7,833	7,610
1976	934,443	52,642	0.0563	8,468	8,234
1977	928,228	51,783	0.0558	8,559	8,312
1978	930,201	49,701	0.0534	8,722	8,471
1979	931,340	47,717	0.0512	8,709	8,452

[a]Figures for 1960-70 and 1974-79 were from U.S. Department of Education (1948-81). Those for 1971-73 were estimated by CHR to remove the distortion in the series produced by a change in the survey taxonomy in 1971. These figures do not include health professions.

[b]Figures for 1960-64 were from U.S. Department of Education (1961-79). Those for 1969-76 were from U.S. Department of Education (1973-77). Those for 1977-79 were from U.S. Department of Education (1974-80). Figures for 1965-68 were estimated.

[c]Figures for 1960-67 were estimated at 98 percent of the previous column. Those for 1968-79 were obtained by subtracting first professional enrollment from the previous column. 1968-77 first professional enrollment data were obtained from U.S. Department of Education (1959-79), 1978-79 data from U.S. Department of Education (1974-80).

TABLE A2 Determinants of Academic Employment for Biomedical Science Ph.D.'s

Fiscal Year	Enrollments: Total Biomed. Sci. and Grad. and Undergrad. (S)	Estimated Biomed. Sci. Undergrad.[a]	Biomed. Sci. Graduate[b]	Medical and Dental Schools[c]	Estimated Biomed. Sci. Academically Employed Ph.D.'s[d] (excl. postdocs.) (F)	Ratio of Biomed. Sci. Academically Employed Ph.D.'s Relative to Total Biomed. Enrollment (F/S)	Life Science R and D Expenditures in Colleges and Universities[e] (1972 $, thousands) (LSRD)
1960	197,419	143,037	10,717	43,665	8,194	0.0415	504,012
1961	217,311	161,236	12,207	43,868	8,667	0.0399	590,141
1962	241,946	183,890	13,465	44,591	9,140	0.0378	687,295
1963	265,787	205,839	14,881	45,067	10,220	0.0385	809,240
1964	286,169	223,002	17,475	45,692	11,300	0.0395	937,543
1965	279,693	213,042	20,347	46,304	12,085	0.0432	1,034,577
1966	302,264	231,977	23,432	46,855	12,870	0.0426	1,135,854
1967	312,108	239,917	24,347	47,844	14,496	0.0464	1,204,881
1968	328,160	251,170	27,497	49,493	16,122	0.0491	1,255,485
1969	359,086	279,349	28,496	51,241	17,652	0.0492	1,274,692
1970	384,027	299,507	30,843	53,677	19,181	0.0499	1,306,618
1971	414,661	325,018	32,603	57,040	21,134	0.0510	1,323,698
1972	438,745	343,587	34,203	60,955	23,087	0.0526	1,352,601
1973	480,078	379,268	34,888	65,922	24,940	0.0519	1,445,536
1974	511,247	404,881	36,111	70,255	27,145	0.0531	1,406,427
1975	537,073	424,539	38,314	74,220	28,563	0.0532	1,493,979
1976	556,279	439,946	39,322	77,011	29,566	0.0531	1,569,167
1977	543,412	425,863	39,260	78,289	30,568	0.0563	1,599,585
1978	N/A	N/A	40,500	81,460	32,274	N/A	1,667,186
1979	N/A	N/A	41,739	84,933	33,980	N/A	N/A

[a]Estimated by the formula $U_i = (A_{i+2}/B_{i+2})C_i$, where U_i = biomedical undergraduate enrollment in year i; A_{i+2} = biomedical baccalaureate degrees awarded in year i+2; B_{i+2} = total baccalaureate degrees awarded in year i+2; C_i = total undergraduate degree-credit enrollment in year i (excluding first professionals). See Appendix Table A1 for supporting data.

[b]Figures for 1960-77 were from U.S. Department of Education (1959-79) except the one for 1966, which was estimated by CHR. The figure for 1979 was from U.S. Department of Education (1961-79); it represents the "biological science" category defined by the Department of Education, which is a slightly different set of fields from the Committee's definition. The figure for 1978 was interpolated.

[c]Medical school enrollment figures were from American Medical Association (1960-80). Dental school enrollment figures were from American Dental Association (1971-79a).

[d]Figures for 1962-70 were estimated by CHR. Figures for 1972-79 were from NRC (1973-80), except those for 1976 and 1978, which were interpolated. Foreign nationals who received doctorates from U.S. institutions are included.

[e]Figures for even years from 1964-70 and for 1972-78 were from NSF (1975-79). Those for other years were estimated by CHR. The Implicit GNP Price Deflator (U.S. Bureau of the Census, 1978) was used to obtain 1972 $ amounts. See Appendix Table A7.

TABLE A3 U.S. Population Estimates of 20-24 Year Olds; First-Year Graduate Enrollment in the Biomedical Sciences; and Number of Biomedical Science Ph.D.'s

Fiscal Year	Population Estimates of 20-24 Year-Olds[a]	First-Yr. Graduate Enrollment in Biomed. Sci.[b]	Biomed. Sci. Ph.D.'s[c]
1960	11,116	5,370	1,096
1961	11,408	6,025	1,136
1962	11,889	6,642	1,272
1963	12,620	7,137	1,341
1964	13,152	8,542	1,552
1965	13,679	10,430	1,753
1966	14,063	12,034	1,961
1967	15,197	12,511	2,181
1968	15,748	13,301	2,545
1969	16,484	13,343	2,854
1970	17,184	14,835	3,171
1971	18,089	15,845	3,482
1972	18,033	16,722	3,454
1973	18,345	17,511	3,518
1974	18,740	17,538	3,415
1975	19,242	18,876	3,516
1976	19,630	18,756	3,576
1977	20,007	18,073	3,462
1978	20,461	17,780	3,512
1979	20,726	17,487	3,636

[a]From U.S. Bureau of the Census (1965-80).
[b]Figures for 1960-77 were from U.S. Department of Education (1959-79). The figure for 1979 was from U.S. Department of Education (1961-79); it represents the "biological science" category defined by the Department of Education, which is a slightly different set of fields from the Committee's definition. The figure for 1978 was interpolated. Foreign nationals who received doctorates from U.S. institutions are included.
[c]From National Research Council (1958-80).

TABLE A4 National Expenditures for Health-Related R and D ($ billions)

	Actual Dollars[a]				Constant 1972 Dollars[b]			
Year	Total	Federal	Private Industry	Other	Total	Federal	Private Industry	Other
1952	0.197	0.103	0.052	0.042				
1953	0.214	0.107	0.058	0.049				
1954	0.237	0.119	0.061	0.057				
1955	0.261	0.139	0.062	0.060				
1956	0.312	0.162	0.079	0.071				
1957	0.440	0.229	0.126	0.085				
1958	0.543	0.279	0.170	0.094				
1959	0.648	0.351	0.190	0.107				
1960	0.900	0.448	0.253	0.199				
1961	1.096	0.574	0.312	0.210	1.582	0.828	0.450	0.303
1962	1.337	0.782	0.336	0.219	1.896	1.109	0.477	0.311
1963	1.545	0.919	0.375	0.251	2.158	1.284	0.524	0.351
1964	1.710	1.049	0.400	0.261	2.352	1.443	0.550	0.359
1965	1.903	1.174	0.450	0.279	2.561	1.580	0.606	0.376
1966	2.124	1.316	0.510	0.298	2.766	1.714	0.664	0.388
1967	2.359	1.459	0.580	0.320	2.986	1.847	0.734	0.405
1968	2.576	1.582	0.661	0.333	3.119	1.915	0.800	0.403
1969	2.785	1.674	0.754	0.357	3.212	1.931	0.870	0.412
1970	2.846	1.667	0.795	0.384	3.114	1.824	0.870	0.420
1971	3.167	1.877	0.860	0.430	3.299	1.955	0.896	0.448
1972	3.527	2.147	0.925	0.455	3.527	2.147	0.925	0.455
1973	3.735	2.225	1.033	0.477	3.530	2.103	0.976	0.451
1974	4.431	2.754	1.171	0.506	3.820	2.374	1.009	0.436
1975	4.688	2.832	1.306	0.550	3.686	2.226	1.027	0.432
1976[c,d]	5.084	3.059	1.446	0.579	3.797	2.285	1.080	0.432
1977	5.594	3.396	1.587	0.611	3.959	2.403	1.123	0.432
1978[d]	6.249	3.811	1.770	0.668	4.108	2.506	1.164	0.439
1979	7.093	4.321	2.055	0.717	4.286	2.611	1.242	0.433

[a]Figures for 1952-62 were supplied by the Office of Resource Analysis, NIH; those for 1963-79 were from NIH (1966-81). Items may not sum to total due to rounding.
[b]The Implicit GNP Price Deflator (U.S. Bureau of the Census, 1978) was used to obtain 1972 $ amounts. See Appendix Table A7.
[c]Figures for 1976 include Transition Quarter funds.
[d]Estimated.

TABLE A5 Determinants of Academic Employment for Behavioral Science Ph.D.'s[a]

Fiscal Year	Enrollments: Total Behavioral Grad. and Undergrad. (S)	Estimated Behavioral Graduate[b]	Estimated Behavioral Undergrad.[c]	Total Behavioral B.A.'s[d]	Ratio of Behavioral B.A.'s to Total B.A.'s[e]	Estimated Behavioral Academically Employed Ph.D.'s (excl. postdocs.)[f] (F)	Ratio of Behav. Academically Employed Ph.D.'s to Total Behavioral Enrollment (F/S)	Behav. Sci. R and D Expenditures in Colleges and Universities[g] (1972 $, thousands)
1960	172,976	12,748	160,228	N/A	N/A	N/A	N/A	34,336
1961	194,799	14,960	179,839	16,527	0.0452	N/A	N/A	40,188
1962	225,508	15,376	210,132	18,398	0.0481	5,339	0.0237	46,803
1963	257,638	16,606	241,032	20,862	0.0508	N/A	N/A	55,108
1964	304,376	18,782	285,594	25,376	0.0551	8,143	0.0268	64,055
1965	316,576	20,949	295,627	28,820	0.0585	N/A	N/A	70,526
1966	382,914	24,074	358,840	33,728	0.0644	9,783	0.0255	78,311
1967	431,901	25,057	406,844	39,072	0.0695	N/A	N/A	97,996
1968	495,959	29,883	466,076	48,295	0.0758	12,915	0.0260	118,490
1969	575,776	34,003	541,773	59,040	0.0804	N/A	N/A	113,303
1970	650,254	36,508	613,746	68,413	0.0857	16,175	0.0249	113,384
1971	706,924	40,356	666,568	77,629	0.0917	N/A	N/A	120,703
1972	750,453	44,707	705,746	86,066	0.0963	18,602	0.0248	129,875
1973	743,830	48,216	695,614	92,289	0.0992	19,539	0.0263	127,956
1974	724,278	51,712	672,566	97,432	0.1021	22,324	0.0308	118,826
1975	723,480	55,383	668,097	92,609	0.0994	23,497	0.0325	116,754
1976	730,903	59,056	671,847	87,446	0.0936	24,524	0.0336	106,679
1977	692,920	58,289	634,631	81,491	0.0878	25,550	0.0369	103,019
1978	N/A	N/A	N/A	75,899	0.0816	26,196	N/A	102,496
1979	N/A	N/A	N/A	71,109	0.0764	26,842	N/A	N/A

[a]Behavioral sciences include sociology, anthropology, psychology (clinical and nonclinical), and speech and hearing sciences.
[b]From U.S. Department of Education (1959-79).
[c]Estimated by the formula $U_i = (A_{i+2}/B_{i+2})C_i$, where U_i = behavioral science undergraduate enrollments in year 1; A_{i+2} = behavioral science baccalaureate degrees awarded in year i+2; B_{i+2} = total baccalaureate degrees awarded in year i+2; C_i = total undergraduate enrollments in year i (excluding first professionals). See Appendix Table A1 for supporting data.
[d]From U.S. Department of Education (1948-81).
[e]See Appendix Table A1 for total B.A. degrees.
[f]Figures for 1962-70 were estimated by CHR. Figures for 1972-79 were from NRC (1973-80), except those for 1976 and 1978, which were interpolated. Foreign nationals who received doctorates from U.S. institutions are included.
[g]Figures for even years from 1964-70 and for 1972-78 were from NSF (1975-79). Those for other years were estimated by CHR. The Implicit GNP Price Deflator (U.S. Bureau of the Census, 1978) was used to obtain 1972 $ amounts. See Appendix Table A7.

TABLE A6 Medical School Full-Time Faculty, Budgeted Full-Time Faculty Vacancies, and Student Enrollments, 1961-80

	Full-Time Faculty Positions						Student Enrollments					
	Filled Positions			Budgeted Vacancies					Interns, Residents, and Clin. Fellows	Clin. Faculty Relative to		Volunteer Faculty in Clin. Depts.
Fiscal Year	Total	Clin. Depts.	Basic Sci. Depts.	Total	Clin. Depts.	Basic Sci. Depts.	Total	Medical Students		Total Enroll.	Medical Students	
1961	11,111	7,108	4,003	784	515	305	50,580	30,288	20,292	0.1120	0.2346	N/A
1962	12,040	7,698	4,342	836	488	348	52,009	31,078	20,931	0.1181	0.2496	N/A
1963	13,681	8,965	4,716	826	476	350	52,752	31,491	21,261	0.1341	0.2646	N/A
1964	14,468	9,632	4,836	915	514	401	54,221	32,001	22,220	0.1377	0.3009	N/A
1965	15,514	10,381	4,133	955	579	376	55,448	32,428	23,020	0.1423	0.3201	N/A
1966	17,149	11,489	5,660	1,115	672	443	56,444	32,825	23,619	0.1508	0.3499	N/A
1967	19,296	13,292	6,004	1,374	854	520	57,939	33,423	24,516	0.1669	0.3977	N/A
1968	22,163	15,435	6,728	1,585	1,015	570	61,828	34,538	27,290	0.1793	0.4469	N/A
1969	23,014	16,627	7,098	1,691	1,112	579	64,261	35,833	28,428	0.1826	0.4640	N/A
1970	24,706	17,183	7,523	1,634	1,093	541	67,161	37,669	29,492	0.1854	0.4562	N/A
1971	26,504	18,451	8,053	1,490	982	508	71,259	40,487	30,772	0.1882	0.4557	N/A
1972	29,469	20,902	8,567	1,737	1,241	496	81,644	43,650	37,994	0.1900	0.4789	53,233
1973	33,550	24,047	9,503	1,846	1,271	575	86,376	47,546	38,830	0.2028	0.5058	59,078
1974	33,172	23,643	9,529	2,093	1,492	601	91,036	49,808	41,228	0.1977	0.4747	58,169
1975	36,336	26,280	10,056	2,173	1,564	609	94,212	53,143	41,069	0.1848	0.4945	60,497
1976	39,330	28,602	10,728	2,484	1,812	672	99,070	56,244	42,826	N/A	0.5085	66,048
1977	41,394	30,207	11,187	2,455	1,822	633	104,313	57,276	47,037	N/A	0.5274	69,720
1978	44,762	33,059	11,703	2,707	2,011	696	107,201	59,950	47,251	N/A	0.5514	74,337
1979	46,598	33,913	12,685	2,828	2,107	721	112,911	62,754	50,157	N/A	0.5404	80,743
1980	48,829	35,969	12,860	3,032	2,264	768	N/A	64,195	N/A	N/A	0.5603	77,759

SOURCES: Association of American Medical Colleges (1972-79), American Medical Association (1960-80).

TABLE A7 Medical School R and D Expenditures and Professional Fee Income, 1960-79[a] ($ thousands)

Fiscal Year	R and D in Medical Schools						Professional Fee Income		Implicit GNP Price Deflator[b] (1972 = 100)
	Current Dollars			1972 Dollars					
	Total	Federal	Nonfed.	Total	Federal	Nonfed.	Current	1972 $	
1960	136,076	93,349	42,728	198,073	135,879	62,195	10,909	15,879	68.7
1961	167,515	118,891	48,624	241,724	171,560	70,164	12,838	18,525	69.3
1962	206,234	156,667	49,567	292,530	222,222	70,308	15,500	21,986	70.5
1963	264,418	206,705	57,713	369,299	288,694	80,605	16,681	23,297	71.6
1964	311,845	252,284	59,561	428,948	347,021	81,927	18,576	25,552	72.7
1965	342,901	280,562	62,338	461,509	377,607	83,900	21,840	29,394	74.3
1966	375,116	307,402	67,715	488,432	400,263	88,171	25,203	32,816	76.8
1967	420,232	344,480	75,751	531,939	436,051	95,887	30,248	38,289	79.0
1968	473,270	389,609	83,661	572,966	471,682	101,284	48,051	58,173	82.6
1969	489,314	395,814	93,500	564,376	456,533	107,843	65,304	75,322	86.7
1970	489,607	381,788	107,819	535,675	417,711	117,964	89,554	97,980	91.4
1971	480,979	366,006	114,973	501,020	381,256	119,764	115,191	119,991	96.0
1972	546,026	435,409	110,617	546,026	435,409	110,617	142,041	142,041	100.0
1973	598,008	481,706	116,302	565,225	455,299	109,926	158,607	149,912	105.8
1974	648,000	519,000	129,000	558,621	447,414	111,207	200,921	173,208	116.0
1975	771,000	614,000	157,000	606,132	482,704	123,428	303,028	238,230	127.2
1976	826,000	659,000	167,000	616,878	492,158	124,720	410,000	306,199	133.9
1977	940,000	752,000	188,000	665,251	532,201	133,050	440,000	311,394	141.3
1978	997,000	797,000	200,000	655,490	523,997	131,493	481,000	316,239	152.1
1979	1,099,000	883,000	217,000	664,048	533,535	131,118	556,000	335,952	165.5

[a]From American Medical Association (1960-80). Items may not sum due to rounding.
[b]From U.S. Bureau of the Census (1978).

TABLE A8 Estimated Clinical R and D Expenditures in Medical Schools[a]

Fiscal Year	NIH Clinical Research as a % of Total Research Obligation[b]	Medical Schools (1972 $, thousands) Estimated Clinical R and D	Clinical R and D + Professional Fee Income	Weighted Sum of Clinical R and D Expenditures in Last 3 Years	Weighted Sum of Medical Service Income in Last 3 Years	Weighted Sum of Clin. R and D Expenditures + Med. Service Income in Last 3 Years
1960	9.5	18,817	34,696			
1961	10.0	24,172	42,697			
1962	12.0	35,104	57,090	25,566	18,729	44,295
1963	13.5	49,855	73,152	36,059	21,449	57,508
1964	15.0	64,342	89,894	49,789	23,533	73,322
1965	16.5	76,149	105,543	63,672	25,949	89,621
1966	18.0	87,918	120,734	76,140	29,289	105,429
1967	20.0	106,388	144,677	89,593	33,329	122,922
1968	22.5	128,917	187,090	107,403	41,892	149,295
1969	25.0	141,094	216,416	126,329	57,489	183,818
1970	28.0	149,989	247,969	140,274	76,699	216,973
1971	30.0	150,306	270,297	147,845	97,818	245,663
1972	32.0	174,728	316,769	156,332	120,001	276,333
1973	34.0	192,177	342,089	172,985	138,496	311,481
1974	34.0	189,931	363,139	187,253	153,768	341,021
1975	39.0	236,391	474,621	202,108	183,640	385,748
1976	37.0	228,245	534,444	222,740	238,967	461,707
1977	39.0	259,448	570,842	238,082	290,506	528,588
1978	41.0	268,751	584,990	253,973	311,307	565,280
1979	38.0	252,338	588,290	262,322	319,956	582,278

[a]See note to this table for estimation procedure and Appendix Table A7 for supporting data.
[b]Estimates for 1969-75 were derived from data supplied by John James, Division of Research Grants, NIH. Other years were estimated by CHR.

NOTE TO TABLE A8:

ESTIMATING CLINICAL RESEARCH EXPENDITURES

An estimate of the amount of support for clinical R and D in U.S. medical schools is needed in order to refine our model of demand for clinical faculty. The source of most of the medical school data we have been using is the annual edition of JAMA devoted to medical education, but this source does not contain the required estimate. The best data we can obtain from JAMA are on total R and D expenditures in medical schools. This is the variable used in demand models in the 1977 report.

The approach taken to derive an estimate of clinical R and D expenditures in medical schools is to apply a correction factor to total R and D expenditures. A correction factor which seems appropriate is the proportion of total NIH obligations that goes to support clinical research. From 1969 to 1979, this proportion has increased by 44 percent as shown below.

Clinical Research as Percent of NIH Obligations (NIH, 1975; NSF, 1960-80)

1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
25%	38%	30%	32%	34%	34%	39%	37%	39%	41%	38%

In the absence of any direct measurements, the above percentages offer the best available means of estimating clinical R and D expenditures in medical schools. Accordingly, they have been used to produce the data shown in Table 2.3.

There is of course a serious problem of defining clinical research which clouds any attempt to measure its support. The NIH estimates were derived generally from its Central Scientific Classification System (CSCS) in which each research grant is classified according to its primary field or discipline. If that discipline falls within a group identified as clinical science, then the grant is tabulated as such. All program project and center grants are identified as clinical by the NIH.

The classification of any grant is admittedly subjective. Therefore estimates derived by this process are subject to considerable uncertainty. Other classification schemes in use at NIH would be likely to produce different estimates of clinical research from those derived from the CSCS system. But the latter have one advantage—they were produced for a series of years under a constant definition. Thus while the absolute levels may not be very precise, the change from year to year seems to have somewhat more validity.

TABLE A9 Professional Lifetime Net Loss of Undertaking 2 Years of Post-M.D. Research Training[a]

	Career Setting		
		Medical School Faculty	
Specialty	NIH	Base Only[b]	With Supplement[c]
Anesthesiology	$241,000	$81,178	$95,330
Internal Medicine	155,922	60,569	60,580
Obstetrics/Gynecology	185,779	73,287	45,706
Pediatrics	104,229	39,742	28,521
Psychiatry	34,301	2,282 (net gain)	25,135 (net gain)
Radiology	168,567	74,344	67,129
Surgery	103,638	45,300	28,964

[a]Assumes training stipend of $16,000 per year (1979 dollars) and a 12% discount rate.
[b]Income from a fixed annual amount.
[c]Eligible to receive income from practice plan activity.

SOURCE: Scheffler (1981, p. 12).

TABLE A10 Employment Field of 1972-78 Behavioral Science Ph.D.'s in 1979 By Field of Training

	Field of Training					
			Nonclinical Behavioral			
Field of Employment	TOTAL	Clinical Behavioral	Total	Nonclinical Psychology	Anthropology	Sociology
Total, All Fields	24,486	8,296	16,190	9,873	1,982	4,335
Total Behavioral Sciences	19,176	7,684	11,492	7,577	1,151	2,764
Clinical Sciences	9,368	7,083	2,285	2,268		17
Nonclinical Sciences -- Total	9,808	601	9,207	5,309	1,151	2,747
Nonclinical Psychology	5,863	582	5,281	5,234		47
Anthropology	1,206	19	1,187	12	1,151	24
Sociology	2,739		2,739	63		2,676
Other Social Sciences	1,214	25	1,189	298	386	505
Basic Biomedical Sciences	800	27	773	497	159	117
Other Life Sciences	325	2	323	131	43	149
Engineering, Math, Physics	144	47	97	58		39
Nonsciences	2,827	511	2,316	1,312	243	761
		Percent Distribution				
Total, All Fields	100.0	100.0	100.0	100.0	100.0	100.0
Total Behavioral Sciences	78.4	92.6	71.1	76.9	58.1	63.8
Clinical Sciences	38.3	85.4	14.1	23.0		0.4
Nonclinical Sciences -- Total	40.1	7.2	57.0	53.9	58.1	63.4
Nonclinical Psychology	23.9	7.0	32.6	53.0		1.1
Anthropology	4.9	0.2	7.3	0.1	58.1	0.6
Sociology	11.2		16.9	0.6		61.7
Other Social Sciences	4.9	0.3	7.2	2.9	19.5	11.6
Basic Biomedical Sciences	3.3	0.3	4.8	5.0	8.0	2.7
Other Life Sciences	1.3		2.0	1.3	2.2	3.4
Engineering, Math, Physics	0.6	0.6	0.6	0.6		0.9
Nonsciences	11.5	6.2	14.3	13.3	12.3	17.6

SOURCE: National Research Council (1973-80).

TABLE A11 Biomedical Science Ph.D.'s by Racial/Ethnic Group and FY 1974-80: U.S. Citizens and Permanent Visa Holders

Racial/Ethnic Group		1974	1975	1976	1977	1978	1979	1980
Total		2,921	3,120	3,142	3,055	3,114	3,248	3,408
Minorities Subtotal	(N)	272	268	265	263	301	288	286
	(%)	9.3	8.6	8.4	8.6	9.7	8.9	8.4
American Indian	(N)	12	11	12	25	24	12	9
	(%)	0.4	0.4	0.4	0.8	0.8	0.4	0.3
Black	(N)	59	52	58	42	62	48	49
	(%)	2.0	1.7	1.8	1.4	2.0	1.5	1.4
Asian	(N)	179	173	174	169	181	194	199
	(%)	6.1	5.5	5.5	5.5	5.8	6.0	5.8
Hispanic	(N)	22	32	21	27	34	34	29
	(%)	0.8	1.0	0.7	0.9	1.1	1.0	0.9
Nonminorities	(N)	2,445	2,713	2,731	2,661	2,604	2,765	2,916
	(%)	83.7	87.0	86.9	87.1	83.6	85.1	85.6
Other/Unknown	(N)	204	139	146	131	209	195	206
	(%)	7.0	4.5	4.6	4.3	6.7	6.0	6.0

SOURCE: National Research Council (1958-80).

TABLE A12 Sources of Support During Graduate Study of 1974-80 Biomedical Science Ph.D.'s by Racial/Ethnic Group: U.S. Citizens and Permanent Visa Holders

	Racial/Ethnic Group							
	All	American Indian	Black	Asian	His-panic	Minor-ities	Non-minor-ities	Other/ Unknown
Total 1974-80 Ph.D.'s	22,008	105	370	1,269	199	1,943	18,835	1,230
Number Reporting	21,748	105	370	1,262	198	1,935	18,597	1,216
Source of Support	**Percentage of Each Group Receiving Support from Any of These Sources**							
NSF Fellowship	4.5	2.9	2.7	1.4	3.5	2.0	4.8	4.1
NSF Traineeship	3.8	3.8	2.4	2.4	4.5	2.7	4.0	2.7
NIH Fellowship	7.8	7.6	9.5	4.8	8.1	6.1	8.0	6.8
NIH Traineeship	31.5	30.5	22.2	19.3	26.3	21.2	33.2	21.8
Natl. Defense Education Act Fellowship	3.5	4.8	3.0	0.9	2.0	1.6	3.9	1.6
Other Dept. Health, Education, Welfare	5.0	2.9	8.4	2.5	4.5	3.9	5.2	3.2
Atomic Energy Commission Fellowship	0.7	0.0	0.3	0.6	1.0	0.5	0.7	0.6
Natl. Aeronautics & Space Admin.	0.5	0.0	0.8	0.4	0.0	0.4	0.5	0.4
GI Bill	8.8	9.5	9.7	1.7	9.6	4.4	9.6	4.3
Other Federal Support	4.4	3.8	7.3	2.1	3.0	3.3	4.6	2.9
Woodrow Wilson Fellowship	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Other U.S. National Fellowship	1.7	1.0	8.9	1.3	6.6	3.3	1.5	1.1
University Fellowship	16.2	9.5	17.3	17.8	21.7	17.7	16.3	12.6
Teaching Assistantship	45.2	43.8	36.8	45.6	43.4	43.6	46.2	33.1
Research Assistantship	37.9	38.1	23.2	56.3	30.8	46.4	37.7	28.0
Educational Funds of Industry	2.6	3.8	4.1	3.7	4.0	3.8	2.6	1.6
Other Institutional Funds	7.2	6.7	7.3	5.7	6.6	6.1	7.4	5.3
Own Earnings	33.4	38.1	31.6	21.1	34.3	25.4	34.9	23.4
Spouse's Earnings	30.7	37.1	27.0	22.1	31.3	24.8	32.0	19.7
Family Contribution	14.0	9.5	7.6	12.9	14.6	11.9	14.6	8.1
Natl. Direct Student Loan	6.4	11.4	10.5	4.3	9.1	6.4	6.6	4.2
Other Loans	8.7	12.4	10.8	4.9	11.1	7.1	9.1	5.4
Other Support	3.8	3.8	7.3	2.3	7.6	3.9	3.8	3.4

SOURCE: National Research Council (1958-80).

TABLE A13 Percentage of 1974-80 Biomedical Science Ph.D.'s Planning Postdoctoral Study by Racial/Ethnic Group: U.S. Citizens and Permanent Visa Holders

Racial/Ethnic Group		1974	1975	1976	1977	1978	1979	1980
Total	(%)	50.3	57.5	58.3	61.3	63.3	63.8	65.5
Minorities Subtotal	(%)	57.7	58.2	58.9	60.8	54.8	58.7	64.0
American Indian	(%)	50.0	72.7	41.7	68.0	58.3	50.0	66.7
Black	(%)	18.6	36.5	41.4	33.3	35.5	33.3	36.7
Asian	(%)	70.4	63.6	67.8	68.6	62.4	64.9	70.4
Hispanic	(%)	66.6	59.4	42.9	48.1	47.1	61.8	65.5
Nonminorities	(%)	50.8	58.0	58.8	62.3	65.0	65.3	66.8
Other/Unknown	(%)	34.3	46.8	48.6	40.5	56.5	49.2	49.5

SOURCE: National Research Council (1958-80). See Appendix Table A11 for number of Ph.D.'s earned each year.

TABLE A14 Behavioral Science Ph.D.'s by Racial/Ethnic Group and FY 1974-80: U.S. Citizens and Permanent Visa Holders

Racial/Ethnic Group		1974	1975	1976	1977	1978	1979	1980
Total		3,399	3,651	3,945	3,949	3,892	3,937	3,883
Minorities Subtotal	(N)	149	211	246	289	285	329	318
	(%)	4.4	5.8	6.2	7.3	7.3	8.4	8.2
American Indian	(N)	13	15	24	35	22	31	14
	(%)	0.4	0.4	0.6	0.9	0.6	0.8	0.4
Black	(N)	79	111	140	137	138	163	156
	(%)	2.3	3.0	3.5	3.5	3.5	4.1	4.0
Asian	(N)	34	40	40	56	50	64	75
	(%)	1.0	1.1	1.0	1.4	1.3	1.6	1.9
Hispanic	(N)	23	45	42	61	75	71	73
	(%)	0.7	1.2	1.1	1.5	1.9	1.8	1.9
Nonminorities	(N)	3,040	3,272	3,552	3,509	3,393	3,402	3,399
	(%)	89.5	89.6	90.1	88.9	87.2	86.4	87.5
Other/Unknown	(N)	210	168	146	151	214	206	166
	(%)	6.2	4.6	3.7	3.8	5.5	5.2	4.3

SOURCE: National Research Council (1958-80).

TABLE A15 Percentage of 1974-80 Behavioral Science Ph.D.'s Planning Postdoctoral Study by Racial/Ethnic Group: U.S. Citizens and Permanent Visa Holders

Racial/Ethnic Group		1974	1975	1976	1977	1978	1979	1980
Total	(%)	11.0	11.3	13.0	14.2	16.0	14.7	16.2
Minorities Subtotal	(%)	5.4	8.5	11.4	10.4	15.4	13.4	14.2
American Indian	(%)	0.0	6.7	8.3	8.6	9.1	16.1	7.1
Black	(%)	3.8	8.1	6.4	7.3	10.9	12.9	12.2
Asian	(%)	8.8	7.5	15.0	12.5	18.0	17.2	17.3
Hispanic	(%)	8.7	11.1	26.2	16.4	24.0	9.9	16.4
Nonminorities	(%)	11.4	11.6	13.3	14.5	16.0	15.1	16.2
Other/Unknown	(%)	8.1	7.7	7.5	13.2	15.9	10.7	19.9

SOURCE: National Research Council (1958-80). See Appendix Table A14 for number of Ph.D.'s earned each year.

TABLE A16 Median Age of 1974-80 Ph.D.'s in the Biomedical and Behavioral Sciences by Racial/Ethnic Group: U.S. Citizens and Permanent Visa Holders

	Racial/Ethnic Group				
Field of Ph.D.	American Indian	Black	Asian	Hispanic	Nonminorities
	Median Age in Years at Doctorate				
Biomedical Sciences	29.71	33.22	30.54	30.60	29.21
Behavioral Sciences	32.19	31.68	31.98	31.13	30.41
	Median Age in Years at Entrance to Graduate School				
Biomedical Sciences	22.55	24.00	23.24	23.27	22.38
Behavioral Sciences	22.29	23.13	22.64	23.34	22.53
	Median Age in Years at Baccalaureate				
Biomedical Sciences	22.21	22.34	22.34	22.42	22.12
Behavioral Sciences	22.48	22.27	22.20	22.58	22.15

SOURCE: National Research Council (1958-80).

TABLE A17 Time Lapse from B.A. to Ph.D. of 1974-80 Ph.D.'s in the Biomedical and Behavioral Sciences by Racial/Ethnic Group: U.S. Citizens and Permanent Visa Holders

	Racial/Ethnic Group				
Field of Ph.D.	American Indian	Black	Asian	Hispanic	Nonminorities
	Registered Time: Median Number of Years Enrolled from B.A. to Ph.D.				
Biomedical Sciences	5.38	6.14	6.01	5.83	5.66
Behavioral Sciences	5.70	6.05	6.79	5.96	5.90
	Total Time: Median Number of Total Years from B.A. to Ph.D.				
Biomedical Sciences	6.75	9.96	7.85	7.19	6.79
Behavioral Sciences	8.07	8.02	9.44	7.83	7.65

SOURCE: National Research Council (1958-80).

APPENDIX B

APPENDIX B1

The Scientific Instrumentation Needs of Research Universities

EXECUTIVE SUMMARY

OBJECTIVES OF THE STUDY

- assess the current status of scientific instrumentation in major research universities
- identify factors which facilitate or impede its development, acquisition, use, and maintenance
- estimate the future consequences of present funding policies
- recommend appropriate policy changes

METHODOLOGY

- sixteen universities, six national and government laboratories, and nine commercial laboratories were visited; about 80 department heads and over 250 researchers and research administrators were interviewed in the universities; in addition, the views of approximately 60 researchers and research managers were gathered in visits to national, government, and commercial laboratories
- five fields of science and engineering were studied: physics, chemistry, biological sciences, earth sciences, and electrical engineering
- numerical data on instrumentation acquisition, age, and replacement were gathered from 14 universities and four commercial laboratories

THE PROBLEM

Instrumentation is essential for progress in experimental research. Scientific knowledge has advanced rapidly; new instruments, more costly but qualitatively superior to earlier ones, have allowed measurements previously impossible. The rate of change has been great, competition among researchers intense. The capacity of university researchers to work at the frontiers of knowledge has important consequences for the nation's future research productivity and for the training of future generations of scientists and engineers.

The federal government has adopted a variety of funding policies for the support of research instrumentation: the competitive project system, special instrumentation programs, formula grant programs, block-funded centers, federally sponsored research centers, and regional instrumentation centers chief among them. For about 15 years, federal support for basic research has gradually declined; now support levels are further strained by rapid inflation. But inflationary price increases are simply the rising baseline upon which are superimposed the frequently much larger increases resulting from instrumentation advances.

ASSESSMENT

The great diversity of instrumentation needs found among institutions visited precludes simple generalizations. However, problems in the acquisition, use, and maintenance of research instrumentation were found in all of the leading universities visited. The precise configuration of these needs and problems varies widely. The capabilities of institutions and departments to meet them do also.

University researchers face great difficulty in replacing worn-out or obsolete instrumentation and in acquiring new instruments needed for frontier research. A comparison of university instrumentation inventories with those of two leading commercial laboratories reveals that the median age of university equipment is *twice* that of the commercial laboratories' instrumentation. Even the nation's major research universities have not kept pace in meeting instrumentation needs. Researchers heavily dependent upon federal funds have witnessed grant size fall behind escalating research requirements. As a result, many work with inadequate tools that impair the pace of research, force closure of lines of inquiry, strain operations and maintenance budgets, and compromise the advanced education of graduate students.

Start-up funds for new faculty often are shrinking as costs rise. Support equipment is needed to test, calibrate, and augment primary instruments. Often it is especially difficult to fund. Funding for operation and maintenance costs is increasingly difficult to obtain. As a result, faculty and students sacrifice research time to these routine tasks.

Many research facilities are in need of renovation or replacement; federal funding for these purposes has decreased, however, and universities lack the funds to respond. Signs that aging facilities now impede research were found in many laboratories and support facilities.

Local university needs vary widely, reflecting the unique circumstances under which each institution operates and the great diversity between and even within the five fields studied. Present funding policies do not provide sufficient flexibility to deal with such local circumstances.

When compared with government and commercial laboratories visited, most university laboratories fare poorly. The best-equipped industrial laboratories surpass almost all university laboratories visited. One university researcher captured the sense of disparity and observed, "the ivory towers are now in industry." The director of one leading industrial research laboratory described the struggle of university researchers as he has observed them as "pathetic." When asked to contrast their laboratories with foreign laboratories, a number of university researchers stated that many, most notably those in Japan and West Germany, are now superior.

CONCLUSION

The quality of research instrumentation in major university laboratories has seriously eroded. Not all, but many researchers in the nation's best-funded universities are struggling to work effectively with obsolete tools. The equipment being used in the top-ranked universities has a median age twice that of the instrumentation available to leading industrial research laboratories.

Three *causes* are identified:

- a relative decrease in instrumentation support
- inflexibility within the project system
- insufficient support for maintenance

Three major *consequences* are:

- diminished research productivity
- reduced training capacity
- decline in international competitive status

RECOMMENDATIONS

Federal policy for the support of research instrumentation should provide for a basic three-part funding strategy:

- strengthen instrumentation funding in the project system
- expand special instrumentation programs
- create in the National Science Foundation a new, supplemental formula grant program to provide needed flexibility to meet diverse institutional needs

FUTURE STUDIES

Five studies are recommended: 1) a thorough analysis of foreign research funding policies and programs and their implications for the competitive stature of American science should be undertaken; 2) a study of cooperative research arrangements between industries and universities and the factors—including federal policies—that encourage and discourage them is needed; 3) the planned assessment of regional instrumentation centers should include consideration of the concerns documented in this report; 4) universities should assess current instrumentation policies and develop mechanisms and incentives designed to promote effective sharing of instrumentation; 5) an assessment of the costs and benefits of federally-mandated equipment inventory and reporting systems should be undertaken.

SOURCE: Association of American Universities, 1980.

APPENDIX B2 **THE NATION'S DETERIORATING UNIVERSITY RESEARCH FACILITIES**

EXECUTIVE SUMMARY

OBJECTIVES OF THE SURVEY

This survey of 15 leading universities had three objectives:

-- In the institutions surveyed, document expenditures for research facilities and major ($100,000 or more) equipment, without regard to source of funds, over the last four years in the following six fields:

- Biological Sciences
- Chemical Sciences
- Earth Sciences
- Engineering
- Physics
- Medical Schools (10)

-- Provide responsible estimates, prepared by those universities, of expenditures for research facilities and major equipment that would be required over the next 3 years to meet the research and training needs of only current faculty.

-- From researchers and department heads, acquire assessments of the major consequences for science, industry, and government if the accumulating facilities needs of their institutions are not addressed.

FINDINGS

In many of the science and engineering departments surveyed, a substantial backlog of research facilities and equipment needs is accumulating. Projected funding needs over the next three years equal almost twice the level of expenditures by universities for their research laboratories and equipment over the past four years. Already, institutions often are unable to provide their basic science and engineering researchers and students with either the modern laboratories or equipment needed to conduct state-of-the-art research and education programs.

The loss of federal contributions to the support of research facilities and the absence of compensatory sources of support has forced many institutions to renovate and repair only those facilities in greatest need. Even this work often is carried out in a necessarily piecemeal fashion which is uneconomical over the long term. Working under such conditions, researchers unavoidably compromise their productivity and future competitiveness.

Relatively few construction projects have been completed in recent years in a majority of the physical sciences and engineering departments surveyed. Many institutions estimate substantial needs for new laboratories, for the expanded modernization and repair of old laboratories and for modern research equipment. Details are provided in the following report and the appendicies. The survey's principal findings are the following:

- In the last four years, for the six fields surveyed, fifteen leading universities together spent $400 million from all sources for facilities and major equipment. Half of those expenditures was for a relatively small number of new construction projects; the remaining half, spread over a larger number of generally less costly funding projects, was for facility modernization, major repair and renovation, and special purpose research equipment.

- In the next three years, the 15 universities estimate they should spend almost twice as much ($765 million) just to provide the necessary research facilities and special research equipment for current faculty only. These estimates are in current dollars and, therefore, do not include the added effects of inflation.

- New construction to replace outmoded facilities accounts for almost 60% of total projected funding requirements across all fields.

- In addition, substantial needs for major research equipment were identified in all six fields. These equipment estimates include only major items costing at least $100,000. As the 1980 AAU report to the National Science Foundation found, most departments also have serious deficiencies of less costly analytical instrumentation and support equipment.

RECOMMENDATIONS

The problems of obsolescence in the nation's university research facilities have been growing for more than a decade. To solve them, a new national investment strategy is needed. That strategy should provide direct, balanced support for university facilities from federal agencies and provide investment incentives designed to involve industry, the states, and the universities in a coordinated effort. The following steps are suggested as starting points:

1. Key Executive agencies should develop a mechanism to periodically assess the condition of university research laboratories and the consequences for the nation of that condition. Such assessments should involve the Office of

Science and Technology Policy, the National Science Foundation, the Department of Defense, the Department of Energy, the Department of Health and Human Services, the Department of Agriculture and the National Aeronautics and Space Administration. The views of industry and the universities also should be solicited.

If the initial review corroborates the assessment of this suvey the following recommendations should be considered:

2. The facilities and equipment program earlier proposed to be undertaken by the National Science Foundation but deferred should be restored as a priority initiative in FY 1983.

3. The Department of Defense, Department of Energy, the National Aeronautics and Space Administration, the Department of Health and Human Services, and the Department of Agriculture should establish research instrumentation and facilities rehabilitation programs targeted on the fields of science and engineering of primary significance to their missions. The National Science Foundation should assist in the development, implementation, and coordination of those activities.

4. Incentives should be provided to encourage industries and the states to join with universities and the federal government in renewing the nation's university research laboratories.

5. Interest costs incurred in the construction, modernization, renovation, and repair of facilities in which federally supported research programs are carried out should be allowable indirect costs under OMB Circular A-21.

SOURCE: Association of American Universities, 1981.

APPENDIX B3 SYMPOSIUM ON THE RECRUITMENT OF CLINICIANS FOR MENTAL HEALTH RESEARCH

National Academy of Sciences
Auditorium
Washington, D.C.

June 19, 1980

CHAIRMAN: Dr. Kenneth Clark
Rochester University

MORNING SESSION

8:00 a.m.	REGISTRATION
8:30	OPENING REMARKS: Dr. Gardner Lindzey, Chairman Panel on Behavioral Sciences, Committee on a Study of National Needs for Biomedical and Behavioral Research Personnel
	ADDRESS: Dr. Gerald Klerman, Administrator, Alcohol, Drug Abuse, and Mental Health Administration
	ADDRESS: Dr. Herbert Pardes, Director National Institutes of Mental Health
9:45	Questions and Answers: Audience
10:00	PANEL ON RESEARCH TRAINING ISSUES IN PSYCHIATRY
	Dr. Theodore Manschreck, Massachusetts General Hospital
	Dr. Robert Wallerstein, University of California, San Francisco
	Dr. Daniel Freedman, University of Chicago
10:45	Questions and Answers: Audience
11:00	PANEL ON RESEARCH TRAINING ISSUES IN CLINICAL PSYCHOLOGY
	Dr. Peter Nathan, Rutgers University
	Dr. Seymour Feshbach, University of California, Los Angeles
	Dr. Robert Carson, Duke University
11:45	Questions and Answers: Audience
Noon	Lunch

AFTERNOON SESSION

1:00 p.m.	ADDRESS: Dr. David Hamburg, President, Institute of Medicine

APPENDIX B3 (cont'd.)

1:30	PANEL ON RESEARCH TRAINING ISSUES IN PSYCHIATRIC NURSING AND SOCIAL WORK
	Dr. Ann Burgess, Boston University
	Dr. Dixie Koldjeski, East Carolina University
	Dr. Scott Briar University of Washington
2:15	Questions and Answers: Audience
2:30	PUBLIC COMMENTS
	Speakers: Constance Holleran, American Nurses Association
	Luther Christman, Rush-Presbyterian-St. Lukes Medical Center, Chicago
	Michael Pallak, American Psychological Association
	Hans Strupp and Gloria Waterhouse, Vanderbilt University
	Pranab Chatterjee, Case Western Reserve University
	Chauncey A. Alexander, National Association of Social Workers
	Arthur J. Katz, Council on Social Work Education
	Marvin Stein/Jerry Weiner American Association of Chairmen of Departments of Psychiatry
3:15	CLOSING REMARKS: Dr. Kenneth Clark
3:30	ADJOURNMENT

APPENDIX B4 Biomedical and Behavioral Science Fields Used in the Survey of Earned Doctorates

Biomedical Fields	Behavioral Fields
Anatomy and embryology	Anthropology
Animal physiology	Clinical psychology
Biochemistry and molecular biology	Nonclinical psychology including:
Biomathematics and biostatistics	counseling and guidance
Biomedical engineering	developmental and gerontological
Biophysics	educational
Environmental sciences	school psychology
General biology	experimental
Genetics	comparative
Immunology	physiological
Microbiology including parasitology and bacteriology	industrial and personnel
Pathology	psychometrics
Pharmacology, pharmaceutical chemistry, and pharmacy	social
Public health and epidemiology	general psychology
Veterinary medicine	other psychology
Zoology	Sociology
Other biosciences including cytology and nutrition	Speech and hearing sciences
Other medical sciences	

SOURCE: National Research Council (1958-80).