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Personnel Needs and Training for Biomedical and Behavioral Research

THE 1985 REPORT
of the

Committee on National Needs for Biomedical and Behavioral Research Personnel

Institute of Medicine
National Academy of Sciences

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

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

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

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PREFACE

This is the eighth report of the Committee on National Needs for Biomedical and Behavioral Research Personnel pursuant to the request contained in the National Research Service Awards Act of 1974 (P.L. 93-348 as amended). In that Act, Congress requested the National Academy of Sciences to conduct a continuing study of the nation's overall need for biomedical and behavioral research personnel, the subject areas in which such personnel are needed, and the kinds and extent of training that should be provided by the federal agencies authorized to provide National Research Service Awards--the National Institutes of Health (NIH), the Alcohol, Drug Abuse, and Mental Health Administration (ADAMHA), and the Division of Nursing, Health Resources and Services Administration (HRSA). The National Center for Health Services Research (NCHSR) was also authorized to provide National Research Service Awards in the Health Services Research Act of 1978 (P.L. 95-623).

A major part of this continuing study has been the development of a substantial body of data covering more than 20 years that provides much of the information needed for our assessment of the market for biomedical and behavioral research personnel. This data base--presented in the appendix--includes such items as enrollments, degrees, revenues, and expenditures in colleges, universities, medical and dental schools, and the labor force of Ph.D.s employed in the biomedical and behavioral fields. In this report we have added to this data base the latest available figures from the federal agencies and professional associations that collect them. Primarily these agencies are the National Institutes of Health, the National Science Foundation, the National Center for Education Statistics, the National Research Council, the Association of American Medical Colleges, the American Medical Association, the American Dental Association, the American Nurses Association, and the National League for Nursing.

In addition to our primary task of assessing national needs for biomedical and behavioral research personnel, this year we present the results of five special studies conducted under the auspices of this Committee. Two follow-up studies of former trainees have been conducted--the first one surveyed former participants in the Minority Access to Research Careers (MARC) Honors Undergraduate Training Program, and the second one collected data on former NIH/ADAMHA postdoctoral trainees and fellows. Both special studies, under the direction of Howard Garrison, were designed to find out what career paths the former trainees have chosen and what their accomplishments have been. A summary of findings from the MARC study is presented in Chapter 3 and complete reports on both studies will be published separately.

A third special study deals with a detailed examination of dental education and the need for dental research personnel. The results are presented in Chapter 2.

The fourth special study deals with employment in the biotechnology industry. Robert Barker, Provost at Cornell University and a member of this Committee, collaborated with the American Society for Microbiology to conduct a survey of biotechnology firms designed to collect data about their current employment of scientists and hiring plans for the next 18 months. This survey, which repeats a previous one conducted in 1983, is summarized in Chapter 3.

Finally, Samuel Herman and Allen Singer have updated a study of the movement of basic biomedical scientists into clinical departments of medical schools that was reported upon in the committee's 1983 report. The revised and updated study will be published as a separate report under the auspices of this committee.

On behalf of the Committee, I wish to express our appreciation to the many individuals and organizations that have contributed to the development of this report.

Robert L. Hill, Ph.D.
Chairman

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CONTENTS

TABLES

FIGURES

1. Introduction and Summary

Abstract

Research training programs sponsored by the federal government serve several functions: they attract able students to research careers by providing stipends, tuition, and allowances; they encourage better training environments at colleges and universities through institutional allowances that support faculty, equipment, and interdisciplinary programs; and they contribute to the nation's research enterprise by promoting the flow of well-trained young scientists into research careers. These are worthy goals, and the training programs, filtered through the peer review process, appear to have been successful in achieving them. Assessing the appropriate level of training to be provided under the National Research Service Award (NRSA) programs--the task of this study--involves consideration of these objectives together with the career and employment prospects of the trainees.

Currently we are facing a period in which faculty expansion will likely be curtailed by falling enrollments and slower revenue growth, but increased replacement demand is expected to be generated by higher rates of attrition due to death and retirement. Industrial demand for bioscientists is increasing and biotechnology firms expect academia to train the personnel they need to sustain this growth. The main issue is how to achieve the proper balance between maintaining the strength of the nation's biomedical and behavioral research effort, and adjusting the flow of young scientists entering the field to the number of research and teaching positions that are expected to become available in the next few years.

During the 1970s, training funds declined sharply relative to research funds and currently amount to less than 6 percent of research expenditures of the administering agencies--NIH, ADAMHA, and Division of Nursing, HRSA--down from 17 percent in 1971. It is the committee's view that training funds should not be further reduced. The nation must begin to plan for the 1990 decade when many current faculty members will reach retirement age and college enrollments will once again start to increase.

The issues addressed in this report are those presented to the National Academy of Sciences (NAS) by Congress in the 1974 Act that reauthorized the research training programs of the National Institutes of Health (NIH), the Alcohol, Drug Abuse, and Mental Health Administration (ADAMHA), and by subsequent amendment, the Division of Nursing of the Health Resources and Services Administration (HRSA). Congress asked the NAS to monitor the biomedical and behavioral fields, to assess the national need for research personnel in these fields, and to determine the kinds and extent of training that the government should provide.

This report examines the system under which biomedical and behavioral scientists are trained for research careers in this country and the government's programs that support such training. Those programs consist of training grants and fellowships that are designed to supplement the government's research programs in the biomedical and behavioral fields by providing support to predoctoral and postdoctoral students and their institutions. The goal of the training programs is generally to strengthen the research effort, and they do so by encouraging young scientists to pursue research careers, by selecting the best qualified candidates for support, and by fostering the development of a strong training environment through competition and the peer review process.

From the very inception of these programs in 1937, the interdependence of research and training was recognized. The National Cancer Act of 1937 established the National Cancer Institute within the National Institutes of Health and gave it authority for supporting both research and training in matters relating to the causes and treatment of cancer. The wisdom of that linkage within our universities was acknowledged recently by Donald Kennedy, President of Stanford University, who noted that the government could have followed the German model and established quasi-independent laboratories with support from the industrial sector, or it could have created a network of government laboratories.

> That it did neither guaranteed that new discovery and the training of the next generation of discoverers would take place in the same locations, thus establishing one of the great strengths of American science. That strength is well recognized in Europe; at the 1977 Nobel awards, when Americans swept the prizes for the first time, our thoughtful Swedish colleague Sune Bergstrom pondered the phenomenon and finally attributed it to the 'democracy of American science.' He meant the fellowship of the bench--the system of apprenticeship that is built upon the coexistence of research with research training. (Kennedy, 1985)

COMMITTEE'S APPROACH TO ASSESSMENT OF NATIONAL NEED

In response to its congressional charge, this committee and its predecessors have compiled a substantial data base on national trends in enrollments, degrees, employment characteristics and funding in the biomedical and behavioral fields, developed analytic models of the training system, and made projections of demand for these scientists over the short term. By means of follow-up studies, we have also examined the subsequent career achievements of former trainees and fellows. Comments and suggestions from the scientific community have been solicited at public meetings following the publication of each report. A summary of the last public meeting in May 1984 is presented in Appendix F.

In this report, we present the latest available data on the components of the system and update the projections to 1990. The complete data base is published in Appendixes A through C. A chapter is devoted to each major area of this study, which we have defined as clinical sciences, basic biomedical sciences, behavioral sciences, health services research, and nursing research. Our definition of each area is presented in Appendix D. The taxonomy is based on the fields that contribute to each area, not on the types of degrees held by the contributors. Chapter 3 includes the results of the second survey of personnel needs in the biotechnology industry.

The committee's basic approach has been to examine the systems that have evolved in this country for preparing the students for careers in biomedical and behavioral research and by which they received support for their research as independent investigators and teachers. These systems function somewhat differently in each of the major areas of concern. In the basic biomedical sciences, the typical route to a research career consists of about 7 years of graduate study leading to the Ph.D. degree, followed by 3 years of postdoctoral training. The behavioral fields, nursing research, and health services research are somewhat similar to the biomedical fields, except that postdoctoral training is less typical. In the clinical sciences, research-oriented physicians usually complete 4 years of medical school, 3 years of residency training, and 2 or more years of research training before they begin to compete for research support. Postdoctoral research training is often sought by dentists and veterinarians who intend to pursue research careers.

The committee believes that a solid understanding of how the systems have functioned in the past and how they can be expected to function in the next few years is essential to an assessment of training needs. There are some components of the training system that are vital to our assessment. Among these are the length of the postdoctoral training period, the percentage of newly hired faculty members who have some postdoctoral research training, the percentage of postdoctoral trainees who subsequently choose academic careers, and the proportions of predoctoral students and postdoctoral trainees that should be supported under NRSA programs. Each of these components is considered along with our projections of faculty demand within the relevant chapter--clinical sciences, basic biomedical sciences, or behavioral sciences. Identifying and quantifying these critical components of the system provides a rational basis for determining the appropriate numbers of federally-supported traineeships and fellowships in these fields.

One aspect of this study is quite clear--the universities and health professional schools are the locus of most biomedical and behavioral research and training sponsored by the government. The effectiveness of those programs therefore depends heavily on the availability of trained and qualified researchers among the faculty members of these institutions. Faculty members are supported by funds generated by tuition, research grants and contracts, state and local government contributions, and increasingly in medical schools by revenue from faculty practice plans. The latter has taken on an especially important role over the past 10 years as the medical schools strive to maintain revenues in the face of rising indirect costs and slower growth in enrollments, research funds, and other sources of revenue. Income from medical service plans displaced federal research grants and contracts as the largest source of funds for medical schools in the late 1970s and now accounts for over 30 percent of total revenue (AMA, 1960-84).

From the point of view of clinical research, the growth of income from medical service activities is a disturbing trend because it means that the emphasis in clinical departments of medical schools has shifted away from research toward service activities. As faculty vacancies occur, they tend to be filled by physicians whose interests are primarily in providing patient care in an academic setting rather than in research. Some basic scientists with Ph.D. degrees have moved into clinical departments to support the research and teaching activities as physicians in those departments turn more to service programs. But the pressure on medical school faculties to generate income means that young physicians may be required to perform service at the expense of research.

Partially to counterbalance this growing tendency for medical schools to concentrate on service rather than research activities, this committee has recommended in the past and continues to recommend that more research training opportunities be made available to aspiring clinical investigators. The training system should be adjusted so that a higher percentage of recruits to clinical faculties will have some research training experience. A postdoctoral appointment as a trainee or fellow is the typical mode of acquiring such experience for physicians, veterinarians, and dentists. Furthermore, the knowledge base in the biomedical sciences has expanded rapidly in recent years and this has imposed additional requirements on training. A postdoctoral appointment of about 3 years duration is now generally required because the complexity of biomedical science has increased and the array of instrumentation that must be mastered has developed rapidly. Also the boundaries between fields are disappearing (new fields such as immunogenetics and neurovirology are emerging) and it is mainly during the postdoctoral period that many bioscientists begin the process of integrating related fields with their own.

The training programs are designed to complement research programs by developing the training environment and maintaining an adequate supply of well-trained scientists. The level and distribution of training funds provided by NRSA programs should be determined so as to achieve a stable and efficient system. Sharp year-to-year variations in training levels are unnecessarily disruptive. Demand expected to be generated in the academic and other sectors must be compared with the anticipated supply. Demography, funding trends, and alternative sources of support for training are all considered in our projections and analyses.

A diversified array of disciplines contributes to the biomedical and behavioral sciences, ranging from mathematics and engineering to the clinical sciences. This diversity should be encouraged--excellent research often is produced in non-traditional areas--and the peer review system should be relied upon to select the best applications. Underlying all of these considerations is the perception that the effectiveness of the government's biomedical and behavioral research programs depends on the continual infusion of young scientists trained in the latest techniques of a science making startlingly rapid advances.

RECENT RESEARCH DEVELOPMENTS

Biological science has undergone a remarkable transformation in the past 3 or 4 decades. It has changed from a descriptive to an analytical and mechanistic field with a capacity to probe ever finer levels of organization. The growth in understanding of living things has been sufficiently dramatic and pervasive to justify use of the term "revolution" to describe the evolving state of modern biological science.

Molecular biology began as a discipline that combined the theories and methods of biochemistry, microbiology, and microbial genetics. The more recent advent of the recombinant DNA technology permitted direct study of the genes of higher organisms, including man. It became possible to observe their structure, to determine how they function as blueprints for fashioning the cellular machinery, and to decipher the controls on their operation. As described by Baltimore (1984), this startling technology could be used ". . . as a molecular microscope with which to peer into the details of genes and as a factory able to synthesize the product encoded by the genes."

The past decade witnessed other revolutionary advances in science and technology. One of the most interesting developments, for example, has been the detection and isolation of oncogenes, dominant genetic elements that apparently exist in the chromosomes of every human cell and in the cells of numerous other organisms. Oncogenes appear to play a central role in the malignant transformation of normal cells. Approximately 15-20 percent of all human tumors have been shown to contain oncogenes in their DNA. Increased understanding of oncogenes and how oncogene-encoded proteins work may make it possible to antagonize their functioning and to reverse the process of carcinogenesis.

Enriched by new tools and understanding of biochemistry, molecular genetics, and cell biology, immunobiology has become a fertile source of insights. Because of the chemical specificity of immunologic reactants and their products, researchers and clinicians have been provided with powerful and versatile techniques, such as radioimmunoassays. In addition, hybridoma-derived monoclonal antibodies promise to revolutionize many aspects of biology and medicine through their ability to identify almost any molecular structure that can be purified sufficiently to be used as an antigen.

Fundamental knowledge in the neurosciences has expanded along a broad front from cellular and molecular aspects to mechanisms of perception, learning, and emotion. The ingenious application of new technologies has hastened analysis of structural organization of the nervous system, and a detailed topography of the functional anatomy of the brain is close at hand. The chemical mechanisms by which some cells communicate, as well as the modes of action of many neuro-transmitter substances, are now understood in considerable detail. From that knowledge will emerge therapies for disorders associated with abnormalities in specific neuro-transmitter systems.

Research on the relationship between stress and other physical problems has produced some significant results. Studies of hypertension have shown that psychosocial factors are highly correlated with hypertensive episodes; psychosocial factors may also be important in the earlier stages of the disease and may play a role in the etiology of high blood pressure (Kaplan, 1980). Along with genetic factors, behavioral factors such as dietary salt intake, obesity, and psychological stress have been linked to the initiation of high blood pressure. Experimental studies involving animals have found that the brain participates at some stage in the increase of blood pressure levels. A series of experiments with rats demonstrated that conflict in learning situations was related to the development of the hypertensive state (Friedman and Dahl, 1975; Friedman and Iwai, 1976).

Studies in a new interdisciplinary research area, psychoneuro-immunology, have found that stress-responsive hormones can alter the components of the immune response (Ader, 1981). The psychosocial influences on immune function have important implications for the body's defenses against malignancy. Other studies, involving laboratory animals (Amkraut and Solomon, 1977), and human subjects (Kasl et al., 1979), have found that psychosocial factors are related to susceptibility to infectious diseases.

The biological revolution has been fueled in part by the merging of innovative instrumentation, such as lasers, large-scale integrated circuits, and computers, with fundamental insights into the nature of the living cell. Biomedical applications of lasers include laser cytofluorometry, a technique for separating cells according to size, shape, and reflective properties, and their further sorting according to, for example, their shape and DNA content--all within minutes.

A further illustration of evolving instrumentation technology is positron emission tomography (PET). This provides a non-invasive means for visualizing the metabolism of the human brain during normal activities, such as hearing, speaking, or thinking, and in diseased states in which there are deficits in sensory, motor, or cognitive processes.

Still another technology which opens up new approaches to basic biomedical problems is electron spin spectroscopy. This is a particularly sensitive tool which can be used to measure phenomena such as oxygen uptake in tissue and electron transport activities involved in intracellular energy processes. Recent refinements permit spectroscopic measurements on single muscle fibers or small numbers of cells without sacrificing resolution or sensitivity.

This rich harvest of knowledge and new technologies has made it possible to ask more sophisticated and penetrating questions. Investigators can now move with assurance in experiments that only 10 years ago would have been considered to lie almost in the realm of science fiction. In this context, the President's Biomedical Research Panel observed in its 1976 report: "There do not appear to be any impenetrable, incomprehensible diseases . . . the questions are at last here, and explorations in search of the answers are under way." The following examples attest to the soundness of that observation.

- Researchers have developed increasingly detailed "maps" of human chromosomes, which identify the individual sites of the genes responsible for particular genetic defects. Gene mapping has now identified the chromosomal sites for more than 35 such genes responsible for specific genetic disorders, such as sickle cell disease. Several years ago, for example, the site of the defective gene responsible for a common form of muscular dystrophy was pinpointed, thereby setting the stage for efforts to isolate it and to determine the nature of the molecular defect that causes this degenerative disease. Also, a genetic marker closely linked with the gene that causes Huntington's disease has been located on the short arm of human chromosome 4. This landmark discovery is a critical first step toward developing a test for presymptomatic detection of carriers of this fatal, late-onset disorder, and ultimately reducing its incidence.

- Progress has been made toward treatment of some of the genetic diseases. Investigations currently underway with respect to the Lesch-Nyhan syndrome presage developments in other areas. Specifically, scientists have recently cloned the gene for HGPRT--the enzyme missing in Lesch-Nyhan--and have injected it into cultures of cells derived from Lesch-Nyhan patients, where the cloned gene corrected the deficient function. Lesch-Nyhan syndrome, which causes severe psychomotor retardation and early death in one of every 50,000 male births, may therefore be the first candidate for gene therapy in humans, with other similar genetic metabolic diseases to follow.

- As in the case of molecular genetics, the last decade has witnessed a remarkable leap in understanding what receptors do and how they work. Receptor research has resulted in rapid and sensitive methods of following drug responses of healthy and diseased cells. Tests based on estrogen receptor determinations provide guides in the selection of alternative treatments for human breast cancers. Receptor studies have already contributed to the development of drugs with psychopharmacologic importance, and of propranolol for the treatment of hypertension. Moreover, the potential exists for a new generation of drugs of natural or synthetic origin that are much more specific in their actions and whose pharmacology will be understood at a molecular level.

- Concentrated effort on vaccine development is yielding positive results. Scientists have been able to combine vaccinia virus, previously used to immunize against smallpox, with genetic material from hepatitis B virus. This hybrid vaccinia virus has been shown to stimulate in rabbits the production of significant amounts of antibody to hepatitis B antigen. The technique has subsequently been used to combine vaccinia virus with genetic material from influenza virus, from rabies virus, and from genital herpes virus. The prospect of a single recombinant vaccine to protect individuals against many diseases represents an entirely new approach to mass immunization that may have enormous worldwide implications.

These examples are only a sample from a broad array of advances in biological sciences. But they indicate that the nation's past investment in biomedical and behavioral research and training has produced a powerful system for the development of these sciences. To maintain the momentum, talented students in universities and professional schools must be attracted to research careers by the provision of continual opportunities for training with established scientists, and adequate research funds must be made available to young investigators at the early stages of their career development.

TRAINING AND RESEARCH FUNDING TRENDS

Expenditures for the NRSA training programs totaled about $190 million in 1983, or less than 6 percent of the research expenditures of these administering agencies--NIH, ADAMHA, and Division of Nursing, HRSA (Table 1.1). With the exception of 1973 when funds were impounded, training budgets have fluctuated in a fairly narrow range since 1971 compared with other health expenditures. Consequently, after adjustment for inflation, training funds have declined by almost 6 percent per year since 1971. By contrast, national research expenditures have increased over this period by 3 percent per year, and national health care expenditures by more than 5 percent per year in real terms.

TABLE 1.1 NRSA Training in Relation to Some National Health Expenditures, FY 1971-83 (1972 $, billions)[a]

			NIH/ADAMHA/HRSA Expenditures		Research Training Relative to:		
Fiscal Year	National Health Care Expenditures (1972 $)	National Health R&D (1972 $)	R&D Grants and Contracts (1972 $)	Research Training (1972 $)	Nat'l. Health Care Expend. (%)	Nat'l. Health R&D (%)	R&D Grants & Contracts (%)
1971	87	3.3	1.0	0.18	0.20	5.3	17.0
1972	94	3.5	1.2	0.18	0.19	5.1	15.0
1973	97	3.5	1.1	0.12	0.13	3.5	10.8
1974	100	3.8	1.4	0.18	0.18	4.8	13.1
1975	104	3.7	1.3	0.14	0.14	3.8	10.6
1976	112	3.8	1.4	0.11	0.09	2.7	7.4
1977	119	4.0	1.4	0.10	0.09	2.7	7.5
1978	124	4.1	1.4	0.11	0.08	2.5	7.3
1979	130	4.3	1.6	0.10	0.08	2.4	6.5
1980	140	4.4	1.6	0.11	0.08	2.5	7.1
1981	147	4.4	1.5	0.10	0.07	2.4	6.9
1982	156	4.5	1.5	0.08	0.05	1.8	5.7
1983	165	4.7	1.5	0.09	0.05	1.9	5.8
Annual Growth Rates 1971-83	5.5%	3.0%	3.3%	−5.7%	−10.9%	−8.2%	−8.6%

[a]1972 dollars were obtained by using the U.S. Bureau of the Census Implicit GNP Price Deflator. See Appendix Table B7 for deflator.

SOURCE: NIH (1966-84). See also Appendix Table D3.

NATIONAL RESEARCH SERVICE AWARDS FOR 1983 AND 1984

In 1983, the three agencies that administer NRSA programs--the NIH, ADAMHA, and Division of Nursing, HRSA--awarded 11,579 full-time training positions under these programs (Table 1.2). This was slightly lower than the 1982 level of 11,632, and also less than the 12,825 that had been recommended previously by this committee (NRC, 1975-81, 1981 report, p. 20).

The 1983 awards were about equally divided between predoctoral and postdoctoral awards. A small number of undergraduate awards were made--almost all of them for the Minority Access to Research Careers (MARC) Honors program. An additional 1,518 awards were made in the Short-Term Training Program, primarily to health professional students. Training grant positions far outnumbered fellowships, accounting for over 83 percent of all awards.

TABLE 1.2 Aggregated Numbers of NIH/ADAMHA/HRSA Traineeship and Fellowship Awards for FY 1983 and FY 1984[a]

		TOTAL ALL FIELDS	Biomedical Sciences	Behavioral Sciences	Clinical Sciences	Nursing Research
FY 1983	TOTAL	11,579	6,929	861	3,665	124
	Predoctoral	5,207	3,425	408	1,267	107
	Postdoctoral	5,915	3,139	373	2,398	5
	MARC Undergraduate[b]	457	365	80	0	12
	Trainees	9,711	5,455	758	3,486	12
	Predoctoral	5,010	3,363	381	1,266	0
	Postdoctoral	4,244	1,727	297	2,220	0
	MARC Undergraduate[b]	457	365	80	0	12
	Fellows	1,868	1,474	103	179	112
	Predoctoral	197	62	27	1	107
	Postdoctoral	1,671	1,412	76	178	5
	MARC Undergraduate[b]	0	0	0	0	0
FY 1984	TOTAL	11,469	6,992	859	3,498	120
	Predoctoral	5,096	3,423	391	1,167	115
	Postdoctoral	5,912	3,194	382	2,331	5
	MARC Undergraduate[b]	461	375	86	0	0
	Trainees	9,578	5,508	753	3,314	3
	Predoctoral	4,863	3,339	364	1,158	2
	Postdoctoral	4,254	1,794	303	2,156	1
	MARC Undergraduate[b]	461	375	86	0	0
	Fellows	1,891	1,484	106	184	117
	Predoctoral	233	84	27	9	113
	Postdoctoral	1,658	1,400	79	175	4
	MARC Undergraduate[b]	0	0	0	0	0

[a] These are total numbers of awards for traineeships and fellowships. Data on the number of new starts for FY 1983 and FY 1984 are not available. Totals represent full-time positions only and do not include short-term traineeship and fellowship awards. In FY 1983 there were 1,518 short-term traineeships, of which 12 were prebaccalaureate, 1,394 were predoctoral, and 112 were postdoctoral. There were also 6 short-term fellowships, of which 3 were predoctoral and 3 were postdoctoral. In FY 1984 there were 1,586 short-term traineeships, of which 12 were prebaccalaureate, 1,489 were predoctoral, and 85 were postdoctoral. There were also 4 short-term fellowships, of which 3 were predoctoral and 1 was postdoctoral. See Tables 1.3 and 1.4 for further detail.

[b] These are prebaccalaureate awards in the Minority Access to Research Careers (MARC) Honors Undergraduate Training Program. See Tables 1.3 and 1.4.

SOURCES: Office of the Administrator, ADAMHA (6/15/84 and 6/10/85); Division of Nursing, HRSA (12/14/84); Division of Research Grants, NIH (4/23/85 and 7/29/85).

In FY 1984, the number of full-time NRSA training positions totaled 11,469. This was down slightly from FY 1983, almost all of the drop coming in predoctoral awards. MARC Undergraduate awards were practically unchanged from FY 1983, and awards in the short-term training program rose somewhat to 1,586.

For both FY 1983 and FY 1984, most of the training positions were allocated to the basic biomedical and clinical sciences, followed by behavioral sciences and nursing research. No awards were made by these agencies in the area of health services research. The actual and recommended distribution of awards by field is shown in the following table:

	FY 1983		FY 1984	
	Actual	Recommended	Actual	Recommended
Biomedical Sciences	59.8%	58.1%	60.9%	57.9%
Behavioral Sciences	7.4%	9.5%	7.5%	9.8%
Clinical Sciences	31.7%	27.5%	30.5%	27.4%
Nursing Research	1.1%	2.3%	1.1%	2.3%
Health Services Research	0.0%	2.6%	0.0%	2.6%
	100.0%	100.0%	100.0%	100.0%

The 1983 and 1984 training awards by field, academic level, and mechanism are shown in Table 1.3 for NIH and in Table 1.4 for ADAMHA. Note that these tables show only full-time training positions and therefore are not directly comparable to data in previous committee reports which include trainees in the short-term program.

FINDINGS AND RECOMMENDATIONS

Previous reports have made recommendations for training levels through 1987. Our recommendations in this report are directed to fiscal years 1988-90. The analyses leading to these recommendations in each major area can be found in subsequent chapters of this report.

In general, we find that the NRSA training grants and fellowships are integral parts of the overall biomedical and behavioral research programs in this country and play key roles in maintaining the vitality of those programs.

Among this committee's chief concerns expressed in its past reports have been the number of biomedical scientists serving in postdoctoral appointments for prolonged periods and the reduced number of academic positions that would likely result from declining enrollments in the 1980s. Those concerns were reflected in recommendations for a reduction in the number of predoctoral traineeships that should be provided under NRSA programs, and a stabilization of postdoctoral training levels through 1987. But the most recent data available to us indicate that the postdoctoral pool of biomedical scientists is beginning to decline, as is bioscience Ph.D. production. During the next 5 years, a large number of faculty

TABLE 1.3 NIH Traineeship and Fellowship Awards for FY 1983 and FY 1984[a]

		Biomedical Sciences						Clinical Sciences				
	TOTAL ALL FIELDS	Total Biomed. Sci.	Basic Biomed. Sci.	Math, Phys., Engr., Other	Commun./ Environ. Health	Epidemiol. and Biostat.	Behavioral Sciences	Total Clin. Sci.	Med. Sci. Prog.	Dent. Clin. Rsch.	Other Clin. Sci.	Nursing Research[b]
FY 1983												
TOTAL	10,473	6,541	6,164	114	1	262	285	3,523	677	111	2,735	124
Predoctoral	4,733	3,244	3,064	23	1	156	155	1,227	677	20	530	107
Postdoctoral	5,368	2,937	2,762	69	0	106	130	2,296	0	91	2,205	5
MARC Undergrad.[c]	372	360	338	22	0	0	0	0	0	0	0	12
Trainees	8,754	5,138	4,847	42	0	249	242	3,362	677	102	2,583	12
Predoctoral	4,593	3,211	3,038	17	0	155	155	1,227	677	20	530	0
Postdoctoral	3,789	1,567	1,471	3	0	93	87	2,135	0	82	2,053	0
MARC Undergrad.[c]	372	360	338	22	0	0	0	0	0	0	0	12
Fellows	1,719	1,403	1,317	72	1	13	43	161	0	9	152	112
Predoctoral	140	33	26	6	1	0	0	0	0	0	0	107
Postdoctoral	1,579	1,370	1,291	66	0	13	43	161	0	9	152	5
MARC Undergrad.[c]	0	0	0	0	0	0	0	0	0	0	0	0
FY 1984												
TOTAL	10,364	6,596	6,262	73	1	260	318	3,330	682	101	2,547	120
Predoctoral	4,626	3,229	3,065	9	1	154	174	1,108	682	20	406	115
Postdoctoral	5,372	3,001	2,831	64	0	106	144	2,222	0	81	2,141	5
MARC Undergrad.[c]	366	366	366	0	0	0	0	0	0	0	0	0
Trainees	8,640	5,193	4,937	2	0	254	271	3,173	682	101	2,390	3
Predoctoral	4,461	3,177	3,024	0	0	153	174	1,108	682	20	406	2
Postdoctoral	3,813	1,650	1,547	2	0	101	97	2,065	0	81	1,984	1
MARC Undergrad.[c]	366	366	366	0	0	0	0	0	0	0	0	0
Fellows	1,724	1,403	1,325	71	1	6	47	157	0	0	157	117
Predoctoral	165	52	41	9	1	1	0	0	0	0	0	113
Postdoctoral	1,559	1,351	1,284	62	0	5	47	157	0	0	157	4
MARC Undergrad.[c]	0	0	0	0	0	0	0	0	0	0	0	0

[a] These are total numbers of awards for traineeships and fellowships. Data on the number of new starts for FY 1983 and FY 1984 are not available. Awards from the Fogarty International Center are excluded. Totals represent full-time positions and do not include short-term traineeship awards. In FY 1983 there were 1,472 short-term traineeship awards, most of them in the short-term training program for health professional students (1,334 predoctoral and 83 postdoctoral, totaling 1,417 awards). There were also 55 predoctoral short-term traineeships in other programs (35 in basic biomedical sciences, 18 in clinical sciences, and 2 in behavioral sciences). In FY 1984 there were 1,564 short-term traineeship awards, 1,459 of them in the program for health professional students (1,379 predoctoral and 80 postdoctoral). There were also 105 predoctoral short-term traineeships in other programs (67 in basic biomedical sciences, 34 in clinical sciences, and 4 in behavioral sciences).

[b] Most of the awards in nursing research are from the Division of Nursing, HRSA. Figures for FY 1983 also include 12 traineeship awards from the NIH in the Minority Access to Research Careers (MARC) Honors Undergraduate Training Program.

[c] These are prebaccalaureate awards in the Minority Access to Research Careers (MARC) Honors Undergraduate Research Training Program.

SOURCES: Division of Nursing, HRSA (12/14/84); Division of Research Grants, NIH (4/23/85 and 7/29/85).

TABLE 1.4 ADAMHA Traineeship and Fellowship Awards for FY 1983 and FY 1984[a]

		TOTAL ALL FIELDS	Biomedical Sciences: Total Biomedical Sciences	Biomedical Sciences: Biological Sciences	Biomedical Sciences: Epidemiology and Biostatistics	Behavioral Sciences	Clinical Sciences[b]
FY 1983	TOTAL	1,106	388	276	112	576	142
	Predoctoral	474	181	114	67	253	40
	Postdoctoral	547	202	157	45	243	102
	MARC Undergrad.[c]	85	5	5	0	80	0
	Trainees	957	317	212	105	516	124
	Predoctoral	417	152	89	63	226	39
	Postdoctoral	455	160	118	42	210	85
	MARC Undergrad.[c]	85	5	5	0	80	0
	Fellows	149	71	64	7	60	18
	Predoctoral	57	29	25	4	27	1
	Postdoctoral	92	42	39	3	33	17
	MARC Undergrad.[c]	0	0	0	0	0	0
FY 1984	TOTAL	1,105	396	296	100	541	168
	Predoctoral	470	194	133	61	217	59
	Postdoctoral	540	193	154	39	238	109
	MARC Undergrad.[c]	95	9	9	0	86	0
	Trainees	938	315	221	94	482	141
	Predoctoral	402	162	105	57	190	50
	Postdoctoral	441	144	107	37	206	91
	MARC Undergrad.[c]	95	9	9	0	86	0
	Fellows	167	81	75	6	59	27
	Predoctoral	68	32	28	4	27	9
	Postdoctoral	99	49	47	2	32	18
	MARC Undergrad.[c]	0	0	0	0	0	0

[a] These are total numbers of awards for traineeships and fellowships. Data on the number of new starts for FY 1983 and FY 1984 are not available. Totals represent full-time positions only and do not include short-term traineeship and fellowship awards. In FY 1983 there were 46 short-term traineeships, of which 12 were prebaccalaureate in behavioral sciences, 5 were predoctoral in biological sciences, and 29 were postdoctoral (5 in biological sciences, 24 in behavioral sciences). There were also 6 short-term fellowships, of which 3 were predoctoral (2 in biological sciences and 1 in behavioral sciences), and 3 were postdoctoral (1 each in biological sciences, epidemiology/biostatistics, and behavioral sciences). In FY 1984 there were 22 short-term traineeships, of which 12 were prebaccalaureate in behavioral sciences, 5 were predoctoral in biological sciences, and 5 were postdoctoral in biological sciences. There were also 4 short-term fellowships, of which 3 were predoctoral (2 in biological sciences and 1 in behavioral sciences), and 1 was postdoctoral in behavioral sciences.

[b] Effective FY 1981, ADAMHA has been using a different system for classifying their trainees and fellows. In prior years, ADAMHA reported training in health services research but none in clinical sciences.

[c] These are prebaccalaureate awards in the Minority Access to Research Careers (MARC) Honors Undergraduate Research Training Program.

SOURCE: Office of the Administrator, ADAMHA (6/15/84 and 6/10/85).

members will reach retirement age and consequently the need for young faculty to replace them will begin to increase. In addition, NRSA research training funds have declined since 1974, both in real terms and as a percentage of research expenditures, to a level below that previously recommended by this committee. As a consequence, the number of predoctoral trainees in the basic biomedical sciences supported in 1984 was 11 percent below the committee's recommended level and is on a steep downward slope. We therefore believe that the research training programs should be restored to the recommended number of positions by 1987, and then adjusted to meet the increase in demand expected to begin in the late 1980s.

As shown in chapters 2-4, we have made projections of faculty demand under high, best-guess, and low assumptions. The range between the high and low projections in most cases is fairly wide, mainly because of the difficulties inherent in predicting future levels of academic revenues from R and D and other sources. Although we have based our recommendations on our best-guess estimates of expected demand, it must be recognized that these estimates could be thrown off by a number of factors including sudden changes in the hiring practices of universities and professional schools, shifts in federal funding patterns for biomedical research, and more radical revisions to Medicare/Medicaid and other health insurance programs.

Our recommendations, based on our best estimates of the market situation expected to prevail in the next five years and considerations of how the training system should operate in each area, are presented below.

Clinical Sciences

1. The number of full-time NRSA postdoctoral traineeships and fellowships in the clinical sciences (excluding dental clinical research--see below) should gradually be increased from the current level of less than 2,400 to 3,000 by 1990. In order to encourage more talented physicians to undertake research training, 85 percent of these postdoctoral awards should be allocated to M.D.s.

2. Dental research has not kept pace in recent years with remarkable developments in other clinical science sectors. One way to remedy that is to bolster the research training opportunities for entering faculty of dental schools where most dental investigation is conducted. Dental research training levels have fallen precipitously since 1980 and should be strengthened. The number of postdoctoral traineeships and fellowships in dental clinical research should be increased gradually from the 1984 level of about 100 to 320 by 1990.

3. The Medical Scientist Training Program (MSTP), administered by the National Institute of General Medical Sciences (NIGMS), is considered to be one of the most productive mechanisms for training physician-scientists. However, the costs of MSTP as a

share of total NIGMS funds for predoctoral training have been rising steadily. Since continuation of that trend would inevitably weaken the support of regular predoctoral programs, there is an urgent need to curb this growth in costs. To ensure an appropriate balance, we restate our earlier recommendation that MSTP's share over the near future not exceed 25 percent of NIGMS predoctoral training funds, with a target goal of 725 trainees by 1988. We believe that level should be maintained through 1990.

4. We endorse the short-term training program for health professions students and recommend its continuation. This program is designed to introduce students in medical, dental, and other health professions schools to research methods during summer and off-quarters. It provides predoctoral stipends for up to 3 months of support for research training without payback obligation.

Minority Access to Research Careers (MARC) Honors Undergraduate Training Program

This institutional grant program provides support to third and fourth year honors undergraduates at minority institutions. The program has grown from about 250 traineeships in 1980 to about 470 in 1983. About 75 percent of these positions were in the basic biomedical sciences, 20 percent in behavioral fields, and about 5 percent in nursing research. We recommend that the program be maintained at its current level for the next few years.

Basic Biomedical Sciences

1. Since 1980, the number of NRSA predoctoral awards in basic biomedical science fields has dropped by over 12 percent. With about 3,400 positions provided in 1984, the program has fallen well below the committee's recommended level. This program (excluding MARC undergraduate traineeships) should be restored to 3,750 positions in 1988 and then gradually increased to 4,150 awards by 1990.[1]

2. Postdoctoral training awards in the basic biomedical sciences should be gradually increased from the 1984 level of about 3,200 to a level of 3,800 by 1990.

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[1]In previous reports, awards made in the Minority Access to Research Careers (MARC) Honors Undergraduate Training Program have been counted as predoctoral awards. Starting with this report, awards in that program will be shown separately.

Behavioral Sciences

1. Predoctoral training in the behavioral sciences should be restored to the 1981 level of about 550 traineeships (excluding the MARC undergraduate awards) by 1987 and maintained at that level through 1990.

2. Postdoctoral training in the behavioral sciences should gradually increase to 540 awards in 1987 and then be maintained at that level through 1990.

Health Services Research

The committee has previously recommended that a modest training program be provided in health services research by the federal agencies under the NRSA authority, and that such authority be extended to the National Center for Health Services Research. In the early 1970s, the federal government provided support to over 800 health services research trainees and fellows per year (NRC, 1975-81). At present there is no training being provided under NRSA programs that is identified by the federal agencies as health services research. We affirm our previous recommendations that 330 awards be made annually in this area through 1990.

Nursing Research

Research on problems arising in nursing is supported primarily by the Division of Nursing, HRSA, and to a lesser extent by the NIH, the Veterans Administration, and private organizations such as the American Nurses Foundation and the Robert Wood Johnson Foundation. But practically all training for nursing research is provided by a small NRSA program administered by the Division of Nursing. Funding for training under NRSA programs in the Division of Nursing increased in FY 1985 to almost $2 million, but the number of trainees and fellows supported is still below the level called for by this committee in past reports. Applications for fellowships in nursing research rose 50 percent in FY 1985 and are expected to increase another 30 percent in FY 1986. We recommend that nursing research training under NRSA authority be increased from the 1985 level of about 170 awards to 320 awards by 1990.

Table 1.5 summarizes the committee's recommended number of awards by field, academic level, and mechanism for FY 1988-90. The estimated costs for the recommended programs are shown in Table 1.6.

TABLE 1.5 Committee Recommendations for NIH/ADAMHA/HRSA Full-Time Predoctoral and Postdoctoral Traineeship and Fellowship Awards for FY 1988–90[a]

Fiscal Year	Type of Program	TOTAL ALL FIELDS	Basic Biomedical Sciences[b]	Behavioral Sciences[c]	Clinical Sciences: Medical Scientist Program	Clinical Sciences: Dental Clinical Research	Clinical Sciences: Other Clinical Sciences Programs[d]	Health Services Research[e]	Nursing Research[f]
1988 TOTAL	Total	13,035	7,510	1,190	725	200	2,800	330	280
	Predoctoral	5,470	3,750	550	725	0	0	200	245
	Postdoctoral	7,095	3,400	540	0	200	2,800	130	25
	MARC Undergrad.[g]	470	360	100	0	0	0	0	10
Trainees	Total	8,715	4,110	1,030	725	170	2,400	260	20
	Predoctoral	5,145	3,750	500	725	0	0	160	10
	Postdoctoral	3,100	0	430	0	170	2,400	100	0
	MARC Undergrad.[g]	470	360	100	0	0	0	0	10
Fellows	Total	4,320	3,400	160	0	30	400	70	260
	Predoctoral	325	0	50	0	0	0	40	235
	Postdoctoral	3,995	3,400	110	0	30	400	30	25
1989 TOTAL	Total	13,465	7,760	1,190	725	250	2,900	330	310
	Predoctoral	5,540	3,800	550	725	0	0	200	265
	Postdoctoral	7,455	3,600	540	0	250	2,900	130	35
	MARC Undergrad.[g]	470	360	100	0	0	0	0	10
Trainees	Total	8,910	4,160	1,030	725	210	2,500	260	25
	Predoctoral	5,195	3,800	500	725	0	0	160	10
	Postdoctoral	3,245	0	430	0	210	2,500	100	5
	MARC Undergrad.[g]	470	360	100	0	0	0	0	10
Fellows	Total	4,555	3,600	160	0	40	400	70	285
	Predoctoral	345	0	50	0	0	0	40	255
	Postdoctoral	4,210	3,600	110	0	40	400	30	30
1990 TOTAL	Total	14,195	8,310	1,190	725	320	3,000	330	320
	Predoctoral	5,900	4,150	550	725	0	0	200	275
	Postdoctoral	7,825	3,800	540	0	320	3,000	130	35
	MARC Undergrad.[g]	470	360	100	0	0	0	0	10
Trainees	Total	9,370	4,510	1,030	725	270	2,550	260	25
	Predoctoral	5,545	4,150	500	725	0	0	160	10
	Postdoctoral	3,355	0	430	0	270	2,550	100	5
	MARC Undergrad.[g]	470	360	100	0	0	0	0	10
Fellows	Total	4,825	3,800	160	0	50	450	70	295
	Predoctoral	355	0	50	0	0	0	40	265
	Postdoctoral	4,470	3,800	110	0	50	450	30	30

[a] These are total numbers of full-time awards recommended. See Table 1.2 for actual numbers of awards made in 1983 and 1984.

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

[c] It is assumed that 90% of behavioral science predoctoral awards will be traineeships and that 80% of postdoctoral awards will be traineeships.

[d] These are full-time training positions only, 85% of which should be allocated to physicians. In addition, a program of part-time research training (up to 3 months per year) for health professions students during summer and off-quarters was authorized in 1978, with expenditures not to exceed 4% of appropriated training funds. In FY 1983, 1,417 traineeships were made available under this short-term program.

[e] It is assumed that 60% of these health services research awards will be predoctoral and 40% will be postdoctoral. Of the predoctoral awards, it is assumed that 80% will be traineeships. Of the postdoctoral awards, it is assumed that 75% will be traineeships.

[f] It is assumed that 90% of these nursing research awards will be predoctoral and 10% will be postdoctoral.

[g] The Minority Access to Research Careers (MARC) Honors Undergraduate Training Program is for prebaccalaureate students.

TABLE 1.6 Estimated Cost of Recommended NIH/ADAMHA/HRSA Training Programs, FY 1988–90 (millions of dollars)[a]

					Clinical Sciences					
Fiscal Year	Type of Program	TOTAL ALL FIELDS	Basic Biomedical Sciences	Behavioral Sciences	Total	Med. Sci. Prog.	Short-Term Training[b]	Other Clin. Postdoc.	Health Services Research	Nursing Research
1988	TOTAL	272.6	137.3	23.2	101.4	13.1	3.2	85.1	6.4	4.3
	Trainees	173.1	58.0	19.9	89.8	13.1	3.2	73.5	5.1	0.3
	Fellows	99.5	79.3	3.3	11.6	—	—	11.6	1.3	4.0
	Predoctoral	84.6	54.4	7.4	16.3	13.1	3.2	—	2.9	3.6
	Postdoctoral	183.3	79.3	14.8	85.1	—	—	85.1	3.5	0.6
	MARC Undergrad.[c]	4.7	3.6	1.0	—	—	—	—	—	0.1
1989	TOTAL	284.9	143.8	23.4	106.4	13.4	3.5	89.5	6.5	4.8
	Trainees	180.2	59.9	20.1	94.6	13.4	3.5	77.7	5.2	0.4
	Fellows	104.7	83.9	3.3	11.8	—	—	11.8	1.3	4.4
	Predoctoral	87.6	56.2	7.6	16.9	13.4	3.5	—	3.0	3.9
	Postdoctoral	192.5	83.9	14.8	89.5	—	—	89.5	3.5	0.8
	MARC Undergrad.[c]	4.8	3.7	1.0	—	—	—	—	—	0.1
1990	TOTAL	302.3	155.0	23.7	112.0	13.8	3.7	94.5	6.5	5.1
	Trainees	190.9	66.4	20.3	98.6	13.8	3.7	81.1	5.2	0.4
	Fellows	111.4	88.6	3.4	13.4	—	—	13.4	1.3	4.7
	Predoctoral	95.2	62.7	7.8	17.5	13.8	3.7	—	3.0	4.2
	Postdoctoral	202.3	88.6	14.9	94.5	—	—	94.5	3.5	0.8
	MARC Undergrad.[c]	4.8	3.7	1.0	—	—	—	—	—	0.1

[a] Calculations were based on 1984 average cost figures derived from NIH data and assumed the following: 1) a 23.8% increase in predoctoral stipends and a 36.3% increase in postdoctoral stipends for FY 1985, held constant for later years; 2) a 5% per year increase in tuition; and 3) maximum annual institutional costs of $1,500 for predoctoral trainees and fellows, $2,500 for postdoctoral trainees, and $3,000 for postdoctoral fellows. The stipend increases became effective in FY 1985.
[b] Estimate assumes 1,500 trainees for 1988, 1,600 trainees for 1989, and 1,700 trainees for 1990.
[c] The Minority Access to Research Centers (MARC) Honors Undergraduate Training Program is for prebaccalaureate students.

ESTIMATED TRAINING COSTS PER AWARD IN FY 1984 (dollars)

	Predoctoral						Postdoctoral					Prebaccalaureate
			Clinical Sciences									
FY 1984	Basic Biomed. Sci.	Behavioral Sci.	Med. Sci. Prog.	Short-Term Training	Health Services Research	Nursing Research	Biomed. Sci.	Behavioral Sci.	Clinical Sci.	Health Services Research	Nursing Research	MARC Honors Undergrad.
Trainees	12,385	11,579	15,276	1,833	12,385	12,385	22,236	22,425	22,858	22,236	22,236	13,948[a]
Fellows	12,385	11,579	—	—	12,385	12,385	17,790	18,510	20,473	17,790	17,790	—

[a] This estimate applies to all fields.

2. Clinical Sciences

Abstract

Important changes are taking place in the way medical schools are financing their operations and structuring their faculties. There is now more emphasis on revenue-generating patient care and relatively less on research. This shift has brought with it a corresponding restructuring of faculty composition and activity. Physician members of clinical departments are finding it more difficult to compete successfully for NIH research grants but Ph.D.s have gained appointments in clinical departments at a rapid pace and have increased their share of research grants. Physicians are applying for research grants at about the same rate as a decade ago but are having less success in obtaining them.

In dental schools, the financial arrangements are quite different. State and local government contributions are the dominant source of revenues and have become increasingly important as the federal contribution has been drastically curtailed. Tuition, accounting for over 20 percent of total revenue in dental schools compared with less than 6 percent in medical schools, highlights some important differences between medical and dental education. In contrast to medical education in which residents and fellows receive salary or stipend during training, many dental trainees in advanced specialty programs must pay tuition and receive no financial support from federal or other sources.

Clinical faculties in both medical and dental schools have continued to expand, financed by growth in total revenue. The committee believes that more newly hired clinical faculty members should have some research training if the professional schools are to maintain their clinical research capability.

INTRODUCTION AND OVERVIEW

In this chapter we look ahead to 1990 and try to estimate the research training levels in the clinical sciences[1] under the NRSA programs that would satisfy national needs as perceived by the committee.

The basic premise upon which the committee's assessment of national need has been developed is that the government's research training program serves as an adjunct to its research program and should be administered to ensure the availability of an adequate number of highly trained scientists to conduct that research. This has led to considerations of how large the research effort will be in the future and how many scientists will be needed to support it. Since most of the government-sponsored research in the clinical sciences is performed in medical, dental, and veterinary schools by faculty members, the committee has concentrated mainly on an analysis of these groups.

It is well known that health professions schools generally do not, and perhaps should not, prepare their students for research careers. Preparation for a research career has normally been a postdoctoral phenomenon since medical school and residency training provide little or no opportunity for the acquisition of research skills. But since physicians and dentists have a unique role to play in clinical investigation, some provision must be made for providing them with the requisite tools for a research career. Most often it is during a two or three-year period of postdoctoral training that the necessary research background is acquired. The question that concerns us in this study is how many clinical scientists should receive postdoctoral research training each year under NRSA programs? That depends in part on the number of clinical faculty positions in medical and dental schools, which in turn depends on enrollments and the availability of funds from research grants, tuition, faculty practice plans, and other sources. We will examine the trends in these variables from the early 1960s to date and then make projections of some of the key items through 1990.

MEDICAL SCHOOL TRENDS

Recent trends through 1983 in medical school enrollments, faculty, and financing are summarized in Table 2.1 and are presented in more detail in Appendix Tables A1-11.2. Here are some highlights:

- Enrollment in graduate medical education programs (residents and fellows) continued to expand sharply even though the number of medical school graduates slowed noticeably. Undergraduate

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[1] Investigators in the clinical sciences are seen as consisting mainly of physicians and dentists. It should be noted, however, that the committee's overall concept of a clinical investigator includes other health professionals, such as veterinarians and scientists holding the Ph.D. or equivalent degrees, whose principal activity is in the clinical sciences.

TABLE 2.1 Current Trends in Supply/Demand Indicators in the Clinical Sciences

	Fiscal Year								Annual Growth Rate from 1976 to Latest Year	Latest Annual Change	Avg. Annual Change from 1976 to Latest Year
	1976	1977	1978	1979	1980	1981	1982	1983[a]			
1. SUPPLY INDICATORS (New Entrants):											
a. Professional doctorates participating in NIH training grants and fellowships[b]	1,970[c]	1,927	1,981	2,005	2,195	2,131	2,186	n/a	1.7%	2.5%	36
b. M.D. degrees awarded	13,634	13,614	14,391	14,966	15,135	15,673	15,985	15,801	2.1%	−1.2%	310
2. DEMAND INDICATORS:											
a. Expenditures for clinical R and D in medical schools (1972 $, mil.)	$232	$260	$282	$273	$296	$288	$295	$315	4.5%	6.8%	$11.9
b. Professional service income in medical schools (1972 $, mil.)	$306	$391	$406	$441	$493	$526	$612	$740	13.4%	20.9%	$62.0
c. Total revenue (all sources), (1972 $, mil.)	$2,531	$2,781	$2,839	$2,965	$3,195	$3,293	$3,488	3,793	5.9%	8.9%	$180.3
d. Budgeted vacancies in medical schools:											
(1) Clinical departments	1,782	1,865	2,000	2,100	2,279	2,231	2,264	2,270	3.5%	0.3%	70
(2) Basic science departments	664	638	697	721	776	656	668	671	1.1%	0.4%	1
e. Clinical faculty/student ratio[d]	0.306	0.311	0.322	0.323	0.334	0.331	0.341	0.346	1.8%	1.5%	0.006
3. LABOR FORCE:											
a. M.D.s primarily engaged in research[e]	8,514	9,786	11,437	14,515	15,377	17,901	16,743	18,535	11.8%	10.7%	1,432
b. Full-time faculty in clinical departments	28,603	30,349	32,622	34,057	36,665	37,716	40,148	41,938	5.6%	4.5%	1,905
c. NIH research grants awarded to M.D.s:											
(1) Number of competing grants	1,301	1,301	1,538	1,676	1,482	1,450	1,357	1,466	1.7%	8.0%	24
(2) % of total competing grants	30%	31%	28%	27%	28%	27%	26%	26%	−2.0%	0.0%	−0.6%
d. M.D. applicants for NIH research grants:											
(1) Number of competing applicants	2,841	3,161	3,311	3,282	3,328	3,251	3,395	3,768	4.1%	11.0%	132
(2) % of total competing applicants	29%	29%	28%	27%	28%	26%	25%	24%	−2.7%	−4.0%	−0.7%
e. M.D. success rate (awards/applicants)	0.46	0.41	0.46	0.51	0.45	0.45	0.40	0.39	−2.3%	−2.5%	−0.01%
4. ENROLLMENTS:											
a. Medical students	56,244	58,266	60,424	62,582	64,020	65,412	66,484	66,886	2.5%	0.6%	1,520
b. Residents and clinical fellows[f]	43,908	44,795	46,444	50,188	52,491	52,871	57,504	59,138	4.3%	2.8%	2,176
c. Total	100,152	103,061	106,868	112,770	116,511	118,283	123,988	126,024	3.3%	1.6%	3,696

[a] Financial data from the University of Washington and Mayo Medical School were included for the first time in 1983.
[b] Includes Fogarty International Center programs.
[c] Does not include Transition Quarter.
[d] Ratio of full-time clinical faculty to a 4-year weighted average of total enrollments of medical students, residents, and clinical fellows (WS), where $(WS)_t = \frac{1}{2}S_t + 2S_{t-1} + 2S_{t-2} + S_{t-3}$.
[e] There is some question about the interpretation of these data since they include many trainees in graduate medical programs.
[f] The residents and clinical fellows reported here include only those in accredited programs affiliated with medical schools.

SOURCES: AAMC (1972–85, special tabulations generated annually from 1982–85); AMA (1960–84, 1963–85); NIH (1966–84); NRC (1979–85, Query #5).

medical school enrollment showed very little growth since 1981 as expected, but the total of undergraduate and graduate enrollments jumped in FY 1982 in both public and private schools as a result of the increases in graduate programs.

- Instead of proceeding at modest growth rates for a few years as expected, reported professional service income in medical schools had huge gains in FY 1982 and again in FY 1983. This revenue source increased by 16 percent in FY 1982 and 21 percent in FY 1983 after adjusting for inflation. The committee does not anticipate continued growth at these high rates.

- Clinical R and D expenditures in medical schools were about as expected, increasing moderately from 1980 to 1983.

- The growth of full-time faculty in clinical departments moderated somewhat from earlier years, but there was a sizeable jump of over 6 percent in 1982. The strong surge in service income for that year indicates that the faculty expansion was probably due more to clinical than to research activities.

Medical School Enrollments

For purposes of this study, we consider medical school enrollments to be composed of medical students plus residents and fellows in affiliated hospitals.

The number of medical students has increased only slightly since 1981, as expected, but the number of residents and fellows had larger than expected gains between 1981 and 1982 which more than offset the leveling off of medical students (Table 2.1, line 4). The net result is that total medical school enrollment increased at an annual rate of 3.2 percent from 1981 to 1983--about the same growth pattern exhibited since 1976.

The committee noted in its 1983 report (p. 22) the possibility that graduate medical programs might expand. The latest data give evidence that this has been happening. Since 1981, the number of medical school graduates increased by only 0.4 percent per year, but the number of residents and clinical fellows increased by 5.4 percent per year. The reasons are unclear but may have to do with the influx of U.S. foreign medical graduates and a lengthening of the residency years due to the growing complexity of medical services.

We expect medical student enrollment to decline by about 1 percent per year on average between 1983 and 1990 (Figure 2.1). That expectation, however, may be conservative in light of the decline since 1982 in size of the 20-24 year age group--the population from which medical school applicants are drawn. Coincident with this change, a 9 percent decrease occurred in the number of applications for the 1985-86 entering class, compared with the preceding year.

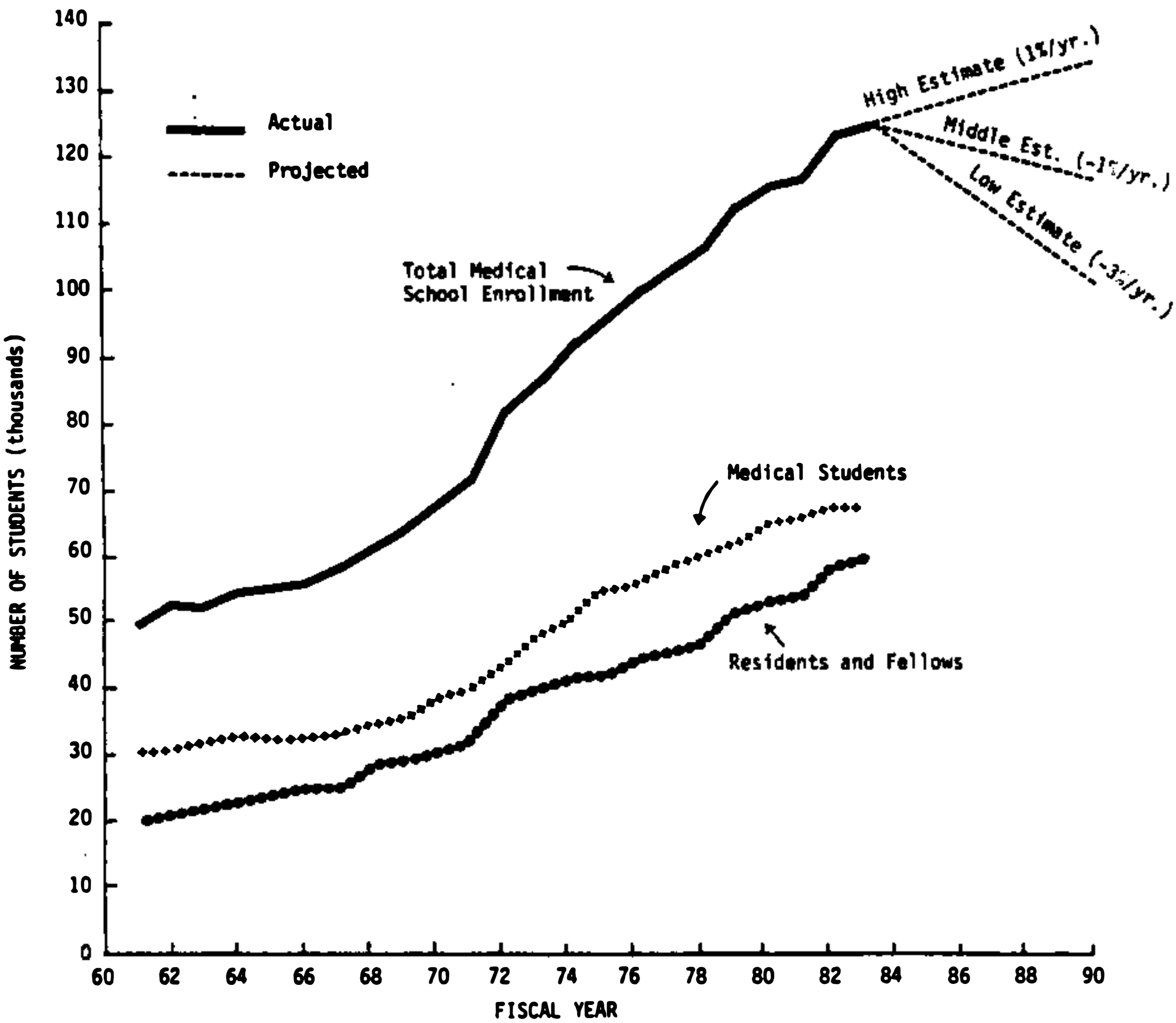

FIGURE 2.1 Medical students, residents, and clinical fellows, 1961-83, with projections to 1990. See Appendix Table A1.

Clinical R and D Expenditures

Since 1980, estimated expenditures for clinical R and D in medical schools have increased moderately after adjustment for inflation (Table 2.1, line 2a[2]). The average increase--2.1 percent per

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[2]Our estimate of clinical R and D is based on the percentage of NIH obligations that is classified as clinical. For the past three years this percentage has held steady at 38 percent. We apply this percentage to total R and D expenditures in medical schools as compiled by the AAMC to arrive at estimated clinical R and D funds.

year--was about what the committee had anticipated in its last report. We expect these funds to continue on a moderate growth path of about 0.5 percent per year in constant dollar terms between 1983 and 1990 (Figure 2.2).

Up to 1980, private medical schools have had higher levels of research expenditures than public schools in the aggregate (Appendix Table A7). But since then, public schools have overtaken private schools with respect to these expenditures. This is partly due to the fast growth in the number of public schools. Clinical R and D in public schools grew at an annual rate of 3.7 percent since 1980 as compared with only 0.5 percent per year in private schools.

Nevertheless, private schools remain generally more research-intensive than public schools, as measured by research expenditures per school. Average clinical R and D expenditures were just over $3 million per school in private schools in 1983 compared with about $2 million per school in public schools (Appendix Table A9).

Professional Service Income

Perhaps the most striking recent development is the renewed upward surge in service income generated by medical school faculty practice plans in 1982 and 1983 due mainly to the expansion of patient care activities in clinical departments. This revenue source, which grew quite rapidly in the early 1970s, appeared to be growing more moderately in the late 1970s. But in 1982 it climbed 16 percent over 1981 and 21 percent in 1983 after adjusting for inflation (Table 2.1, line 2b).

Because of changes being implemented in Medicare and Medicaid programs and the likely adoption of similar cost containment measures by other health insurers, we do not expect this rapid growth to continue. Our best guess is for real growth of about 3.5 percent per year through 1990 (Figure 2.3).

Both public and private schools showed strong gains. On a per school basis, service income grew in real terms by about 10 percent per year in both public and private schools since 1981 (Appendix Table A9).

Total Medical School Revenue

Service income and federal research funds contributed over half of all medical school revenues in 1983 (Table 2.2). Another large portion came from state and local government sources. Tuition contributed only a small amount to total revenue--less than 6 percent in 1983--but it is second only to service income in rate of growth. Increases in tuition--18.5 percent per year since 1971--and steep borrowing rates have contributed largely to the growth in student indebtedness. Despite a study finding suggesting that financial pressures do not influence career choice by internists (Block and Swisher, 1980), medical student indebtedness, as noted in several committee reports, may nevertheless operate as a deterrent to their pursuit of research training.

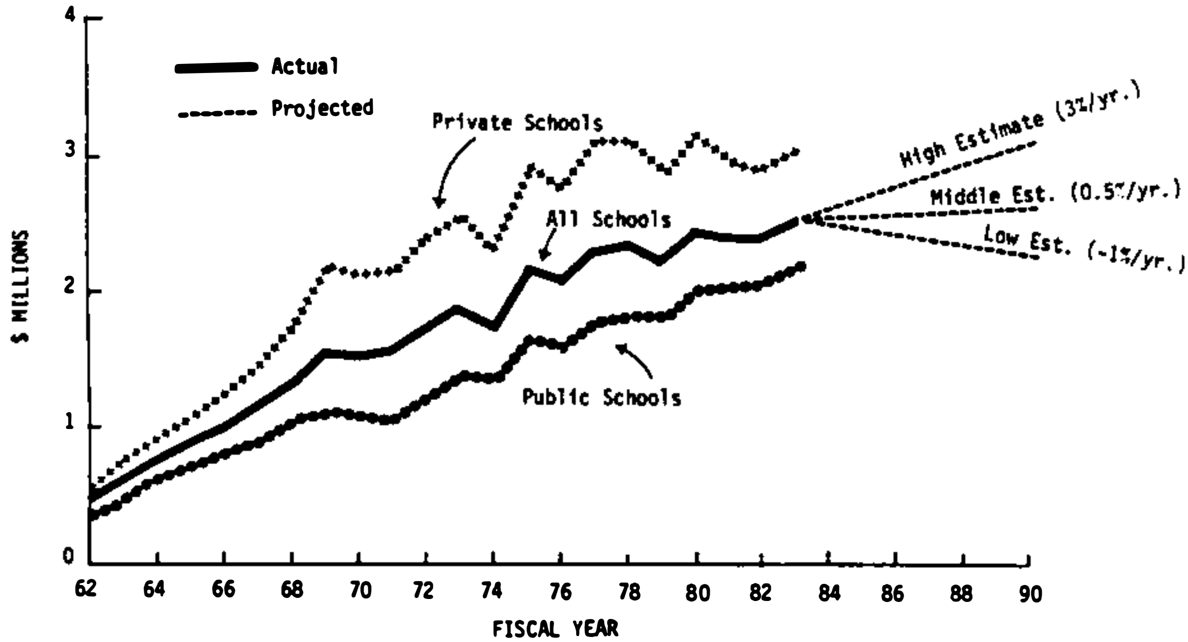

FIGURE 2.2 Clinical R and D expenditures per school in U.S. medical schools, by control of institution, 1962-83, with projections to 1990 (1972 $, millions). See Appendix Table A9.

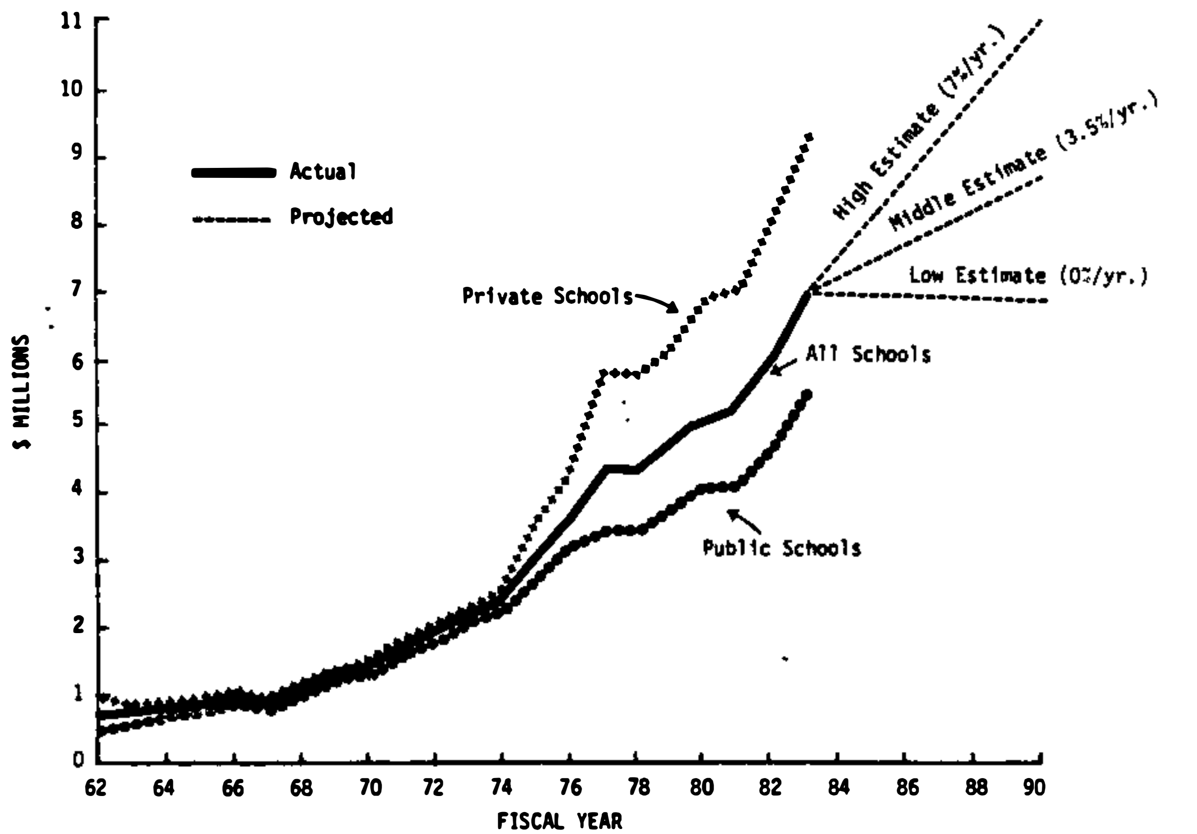

FIGURE 2.3 Professional service income per school reported by U.S. medical schools, by control of institution, 1962-83, with projections to 1990 (1972 $, millions). See Appendix Table A9.

Even with the disparate growth rates of the various components in Table 2.2, total revenue has been quite stable. In fact it has grown at a steady rate of about 5.5 percent per year since 1965 after adjustment for inflation (Figure 2.4), and we expect continued growth through 1990, but at a slower rate of about 3 percent annually.

The contrast between dental and medical school finances is quickly apparent by comparing the sources in Tables 2.2 and 2.3. Whereas medical schools depend heavily on service income and research funds, the main sources in dental schools are state and local governments and tuition. This fact has important implications in this study because it bears on the types of activities engaged in by faculty in these schools. Medical service income is generated largely through medical school faculty practice plans whereas clinic income in dental schools is largely generated in student clinics. Also, the tradition of research in medical schools is much stronger than in dental schools, but the rapid growth of service income in medical schools portends relatively less emphasis on research, especially in clinical departments.

TABLE 2.2 Trends in U.S. Medical School Revenues ($ millions)[a]

	Fiscal Year									
	1971		1976		1981		1982		1983	
Revenue Source	$	%	$	%	$	%	$	%	$	%
Federal Research	438	25.6	823	24.3	1,446	22.5	1,578	21.9	1,655	20.2
Other Federal	322	18.8	398	11.7	396	6.2	415	5.8	415	5.1
State and Local Gov't.	323	18.9	808	23.8	1,452	22.6	1,617	22.4	1,784	21.8
Tuition and Fees	63	3.7	156	4.6	346	5.4	413	5.7	482	5.9
Medical Service	209	12.2	609	18.0	1,850	28.8	2,140	29.7	2,626	32.1
Other Income	358	20.9	595	17.6	935	14.6	1,054	14.6	1,216	14.9
TOTAL	1,713	100.0	3,389	100.0	6,425	100.0	7,217	100.0	8,179	100.0

[a] The data in this table may not agree with others shown in this report. This table was derived by the AMA by combining indirect cost recoveries with the associated sponsored programs, and by segregating the service components in federal, state, and local government and nongovernment sponsored programs from the nonservice components. These service components generally involve contracts for provision of medical service in hospitals.

SOURCE: American Medical Association (*JAMA*, September 28, 1984, p. 1536).

TABLE 2.3 Trends in U.S. Dental School Revenues ($ millions)

	Fiscal Year							
	1972		1976		1981		1982	
Revenue Source	$	%	$	%	$	%	$	%
Federal Research	18	9.2	26	7.5	45	7.4	47	7.2
Other Federal	37	18.9	57	16.4	36	5.9	24	3.7
State and Local Gov't.	68	34.7	145	41.7	296	48.8	314	48.2
Tuition and Fees	36	18.4	58	16.7	116	19.1	147	22.6
Dental Clinic	21	10.7	39	11.2	74	12.2	82	12.6
Other	16	8.2	23	6.6	40	6.6	37	5.7
TOTAL	196	100.0	348	100.0	607	100.0	651	100.0

SOURCE: American Dental Association (1969–84).

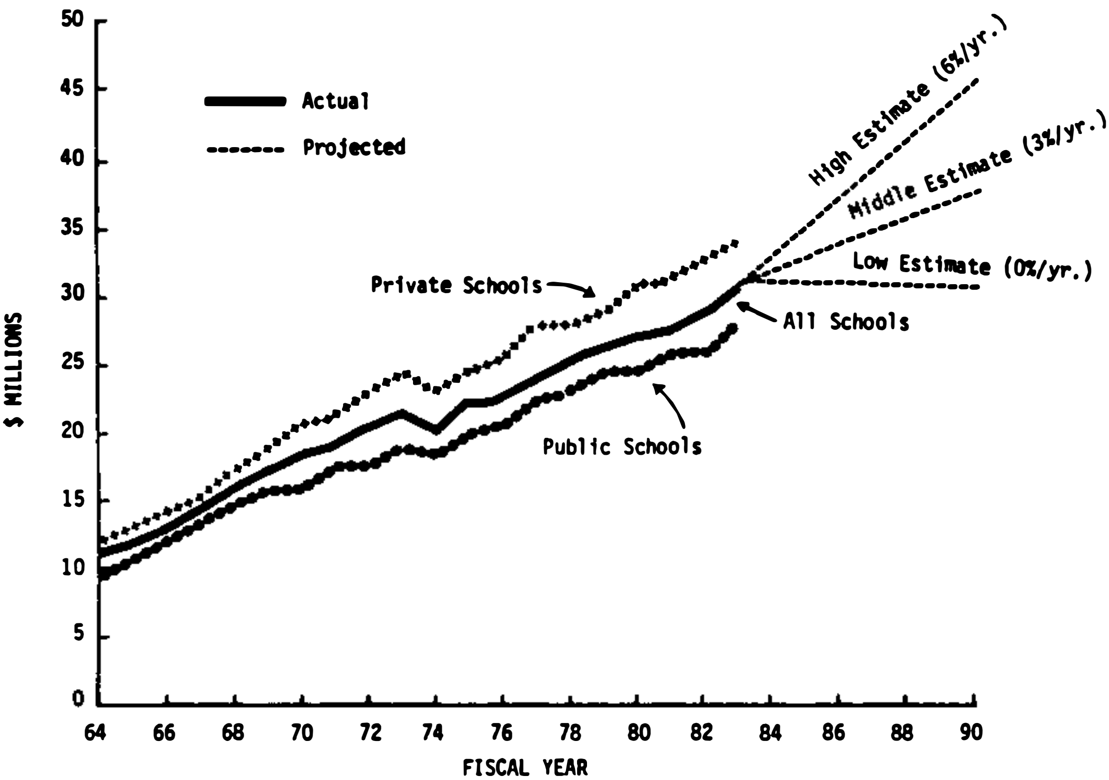

FIGURE 2.4 Total revenue per medical school, by control of institution, 1964-83, with projections to 1990 (1972 $, millions). See Appendix Table A11.2.

THE CHANGING FINANCIAL STRUCTURE OF MEDICAL EDUCATION

A striking change in the pattern of financing medical schools has occurred in the past 15 years. In 1971, federal research programs were the dominant source of funds--accounting for over 25 percent of total revenues. Gradually during the 1970s, aggregate revenues from research were overtaken by medical service income and state and local government contributions. By 1983, service income generated by faculty practice plans accounted for almost 33 percent of total revenue and had become the largest single source of funds. Federal research funds had fallen far behind at about 20 percent of revenues. Although federal research funds are still the major source of support in some research-intensive medical schools, they have nevertheless declined as a percent of total revenues even in those institutions, concurrent with a rise in the proportion of dollars derived from patient care (Rosenberg, 1985). Another important change during the 1970s was the decline of capitation grants and their ultimate termination in 1982.

Increasing dependence on medical service income has a potential for eroding institutional commitments to research and clinical scholarship. This dependence results in less time to prepare grant proposals, collect data, write papers, and generally makes it more difficult to compete successfully for grant support. In past years, some revenue derived from patient care has been made available to support research activities in clinical departments. But as pressure builds to restrain the growth of Medicare/Medicaid expenditures and cost sharing becomes more widespread in private health insurance plans, patient care revenues will face more intensive competition for their disbursement among departmental activities, and research is likely to suffer. Privately controlled schools are at particular risk in that respect because they do not receive large state and local government contributions. Publicly controlled schools are able to partly cushion the loss of federal funds with increased appropriations of state/local government monies. For most private medical schools, these funds are a relatively minor source of support. Consequently, their reliance on professional service income is more compelling. Moreover, preoccupation with financing is likely to favor the recruitment of clinician-teachers over physician-investigators as expansion of the clinical faculty decelerates.

The trend for clinical departments to hire more clinicians and fewer M.D. researchers has been reinforced by the growth of subspecialization of practice in teaching hospitals and by the increased professionalization of biomedical research. The training requirements for independent investigators have become so technically demanding that a physician, even after two or three years of a research fellowship, is generally less well-trained for research than the Ph.D. who has been preparing for such a career since the baccalaureate. There are also more Ph.D.s applying for NIH grants. These facts help explain the drop in M.D. share of competing NIH research grants, which fell from 36.1 percent in FY 1973 to 25.5 percent in FY 1983, compared with an increase from 53.4 percent to 65.5 percent over the same period for Ph.D.s (NRC, 1979-85). That decline has been attributed to reduced award rates, rather than fewer applications, by young M.D. investigators (Carter et al., 1983). Because of financial pressure it is understandable that clinical departments are placing even greater emphasis on practice over research, and/or recruiting Ph.D. scientists to help sustain a significant level of research activity.[3]

THE MARKET OUTLOOK

Our approach to the task of estimating training needs in the clinical sciences has been to try to estimate the demand for full-time

[3] The issue of the recruitment of basic scientists in clinical departments has been examined in detail by this committee and a separate report on the subject will be published soon.

faculty in clinical departments of professional schools (medical, dental, and veterinary) created by both expansion and attrition, and then to determine what adjustments should be made to the training system so that it produces the required number of trained researchers. Similar approaches have been utilized for the biomedical and behavioral sciences in Chapters 3 and 4.

To estimate demand due to expansion of faculty, we have developed analytic models that relate faculty size to enrollments and revenue. The panels associated with this committee make assumptions about the future pattern of these two (exogenous) variables--enrollments and revenue--which in turn are used to estimate future faculty size. This produces estimates of demand due to expansion (or contraction) of faculty, to which is added replacement demand created by faculty attrition due to death, retirement, and other causes.

The dynamics of the system are vital to the committee's assessment of need for training. As faculty vacancies occur, they will be filled partially by new entrants to the supply of clinical scientists. Most of them will be young physicians who aspire to careers in academic medicine, but the evidence suggests that only a moderately small portion (currently about 25 percent) of those individuals joining clinical faculties in medical schools will have had postdoctoral research training.

The number of newly hired faculty members with postdoctoral research training is a critical parameter in the system because the committee believes that the ability of medical schools to conduct an effective clinical research program depends to a large extent on the replenishment of clinical faculty by new entrants who have been exposed to research techniques through a formal postdoctoral training program of at least two years. It is also a part of the system over which there can be some administrative control. The committee has recommended that the training system be adjusted so that 35 percent* of all new hires to clinical faculty positions in medical schools would have completed a period of formal postdoctoral research training.

With estimates of demand for clinical faculty, and with a target level for the number of new hires with research training experience, the committee can estimate the number of clinical science postdoctoral trainees who should be in the pipeline each year. Three additional parameters of the training system are needed to complete the analysis: the appropriate length of the postdoctoral training period, the percentage of postdoctoral trainees who select academic careers, and the percentage of the postdoctoral trainees who should be supported under NRSA programs. These will be discussed in more detail after the projections of faculty demand are presented.

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*Although the committee believes that a substantially higher percentage could be justified, it is aware that since 1970 the highest figure achieved, even for M.D. new-hires in basic science departments of medical schools, was 37 percent (Sherman and Bowden, 1982).

DEMAND FOR CLINICAL FACULTY IN MEDICAL SCHOOLS

Enrollments, revenue, and clinical faculty size are the basic elements in the analytic model we have developed to help assess personnel needs for the clinical sciences in medical schools. The model is based on the proposition that the ratio of clinical faculty to enrollments is largely determined by the amount of funds available to support faculty in each school.

The effect of changes in enrollment on the size of clinical faculty in medical schools has been the subject of much discussion within the committee over the past several years. Enrollments have always been used in the committee's analyses as a determinant of faculty demand. But the financial structure of medical education is changing in ways that tend to lessen the dependence of clinical faculty growth on the number of students. Service income from faculty practice plans is now the single largest source of revenue in medical schools.

For the committee's 1983 report, the demand model was modified somewhat to reflect the view that yearly changes in enrollments are not immediately reflected in corresponding changes in clinical faculty. Enrollments were averaged over 4 years rather than using the current year's data. Some members feel, however, that this adjustment is insufficient and that clinical faculty size should be more directly related to total revenue.

The matter is further complicated by the relationship between clinical faculty size and medical service income. Since this income is generated by clinical faculty members, the number of faculty engaged in patient care should generally determine the amount of revenue received from this source. Others have pointed out that the relationships between enrollment and faculty, and between research and patient care revenues, vary greatly from school to school. Whether the school is privately or publicly controlled also is a factor.

Unfortunately, the data over the past two decades do not provide much help in deciding the issue. Models with and without enrollments as a component of faculty demand have approximately equal goodness-of-fit to the data. We hope that as additional data are collected, the issue may be clarified. For now the committee has elected to retain enrollment as a factor in the model.[5]

When the ratio of clinical faculty to enrollment is plotted against total revenue per school, the annual observations over the period 1964-83 form a nonlinear pattern as shown in Figure 2.5. A constrained growth curve of the following form has been fitted to these data:

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[5]The model has been modified slightly from the one used in the committee's 1983 report. The monetary variable in the model, formerly the sum of clinical R and D expenditures and medical service income per school, has been replaced by total revenue per school. This broader measure includes revenue from state and local governments and tuition, and is thought to be a more realistic determinant of the faculty/student ratio.

$$CF/WS = e^{a-b/T} + c$$

where: CF = full-time clinical faculty in U.S. medical schools
WS = 4-year weighted average of students, i.e., $(WS)_t = 1/6\ (S_t + 2S_{t-1} + 2S_{t-2} + S_{t-3})$, where S = total of medical students, residents, and clinical fellows
T = total revenue per school (1972 $, millions)
c = scaling constant: CF/WS = c when T = 0
a,b = parameters to be determined empirically

The parameters of the model were estimated from 20 annual observations covering the 1964-83 period.[6]

The model shown in Figure 2.5 is used to derive estimates of clinical faculty size for given levels of revenue (T) and enrollments (WS). In this formulation, revenue per school (T) determines the faculty/student ratio (CF/WS), which when multiplied by the enrollment estimate provides an estimate of clinical faculty size (CF).

Assumptions

To project clinical faculty size in 1990 with this model, it is necessary to make some assumptions about enrollment and revenue trends. With the assistance of the Panel on Clinical Sciences, the committee has made the following assumptions about the growth in these variables from 1983 to 1990.

1. Enrollment: Medical school enrollment, defined as medical students, residents, and clinical fellows, is expected to decline by about 1 percent per year between 1983 and 1990. The upper and lower limits on this expected change in enrollment are +1 percent per year and -3 percent per year, respectively.
2. Total revenue per school: the best-guess assumption is for real growth (after adjusting for inflation) of about 3 percent per year. Upper and lower limits on this estimate are 6 percent and 0 percent per year, respectively.

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[6]Parameters values are calculated as follows:

Parameter	Public Schools	Private Schools	All Schools
a	-0.89529	-0.53442	-0.71036
b	9,014.7	13,762.2	11,292.9
c	0.01	0.01	0.01
R^2	0.924	0.961	0.975
Std. Error	0.0475	0.0460	0.0308
N	20	20	20

R^2 is defined as the coefficient of determination. Its value must lie between 0 and 1 and is a measure of how well the assumed function fits the data, with $R^2 = 1$ representing a perfect fit. Std. Error (standard error of estimate) measures the amount of variation around the fitted curve.

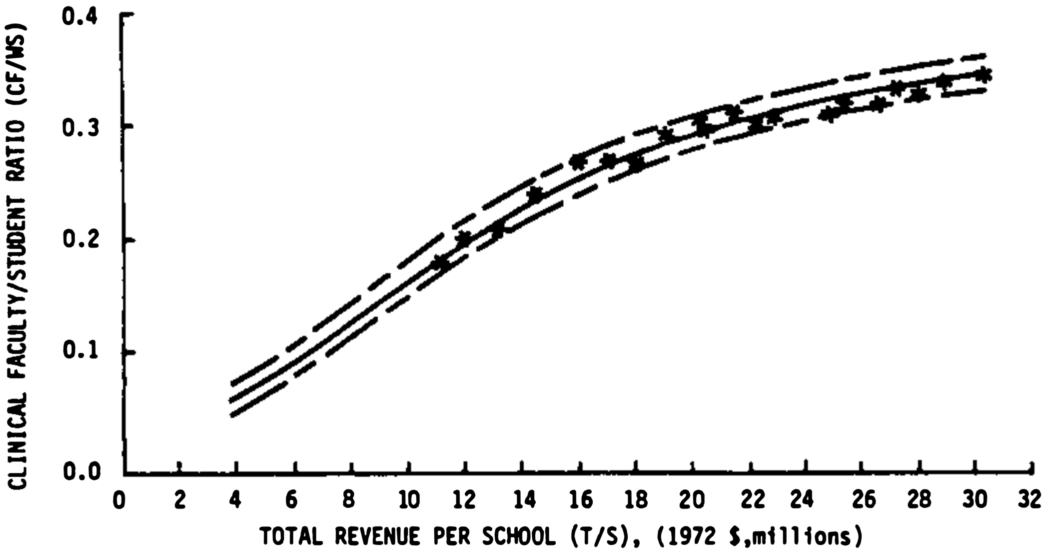

FIGURE 2.5 Clinical faculty/student ratio (CF/WS) vs. total revenue per medical school (T/S). The ratio is defined as follows: CF = full-time faculty in clinical departments of U.S. medical schools; WS = 4-year weighted average of students, i.e., $(WS)_t = 1/6(S_t + 2S_{t-1} + 2S_{t-2} + S_{t-3})$, where S = total of medical students, residents, and clinical fellows. Solid line represents a growth curve of the form: $Y = e^{(a-b/x)} + c$ with parameters a = -0.71036, b = 11292.9, c = 0.01. These were derived from 20 annual observations, 1964-83. See Appendix Tables A3 and A11.2.

The upper and lower limits placed on these assumed growth rates are used in the model to make the alternative projections shown in Table 2.4.

Projections of Demand for Medical School Clinical Faculty to 1990

Given the model and assumptions about growth in enrollment and revenue, we now make projections of clinical faculty to 1990 (Figure 2.6). The three assumptions about enrollment and three about revenue give nine combinations to consider. The results of each combination are shown in Table 2.4.

TABLE 2.4 Projected Growth in Medical School Clinical Faculty, 1983–90, Based on Projections of Medical School Enrollment and Total Revenue per School[a]

Assumptions about Medical Student Enrollment (medical students, residents, and clinical fellows: 126,000 in 1983)		Assumptions about Total Revenue per School (in constant 1972 dollars[b]) in Medical Schools ($30.6 million per school in 1983)		
		I	II	III
		Will expand at about 6%/yr. to $46.0 million per school in 1990	Will expand at about 3%/yr. to $37.6 million per school in 1990	Will remain at the 1983 level of $30.6 million per school
A. Will grow at 1%/yr., reaching 135,000 students by 1990	Expected size of clinical faculty in medical schools (CF) in 1990	54,100	49,800	45,600
	Annual growth rate in CF from 1983 to 1990	3.7%	2.5%	1.2%
	Average annual increment due to faculty expansion	1,740	1,120	520
	Annual replacement needs due to:			
	death and retirement[c]	720	690	660
	other attrition[d]	2,400	2,060	1,750
	Expected number of positions to become available annually on clinical faculties	4,860	3,870	2,930
B. Will decline by 1%/yr. to 117,500 students by 1990	Expected size of clinical faculty in medical schools (CF) in 1990	48,500	44,600	40,800
	Annual growth rate in CF from 1983 to 1990	2.1%	0.8%	−0.4%
	Average annual increment due to faculty expansion	930	380	−160
	Annual replacement needs due to:			
	death and retirement[c]	680	650	620
	other attrition[d]	2,260	1,950	1,650
	Expected number of positions to become available annually on clinical faculties	3,870	2,980	2,110
C. Will decline by 3%/yr. to 101,800 students by 1990	Expected size of clinical faculty in medical schools (CF) in 1990	43,300	39,900	36,500
	Annual growth rate in CF from 1983 to 1990	0.5%	−0.7%	−2.0%
	Average annual increment due to faculty expansion	200	−290	−780
	Annual replacement needs due to:			
	death and retirement[c]	640	610	590
	other attrition[d]	2,130	1,840	1,570
	Expected number of positions to become available annually on clinical faculties	2,970	2,160	1,380

[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:

$(CF/WS)_t = \exp(-0.71036 - 11293/T_t) + 0.01$, where CF = size of clinical faculty in medical schools; WS = weighted average of last 4 years of enrollments, i.e., $(WS)_t = \frac{1}{6}(S_t + 2S_{t-1} + 2S_{t-2} + S_{t-3})$, where S = medical students, residents, and clinical fellows; T = total revenue per school in U.S. medical schools in year t (1972 $, millions). See Appendix Tables A1, A3, and A11.2.

[b] Deflated by the Implicit GNP Price Deflator, 1972 = 100.0. See Appendix Table A7.

[c] Based on an estimated replacement rate of 1.5% annually due to death and retirement. See AAMC (1981a).

[d] Based on high, middle, and low attrition rates of 5%, 4.5%, and 4%, respectively.

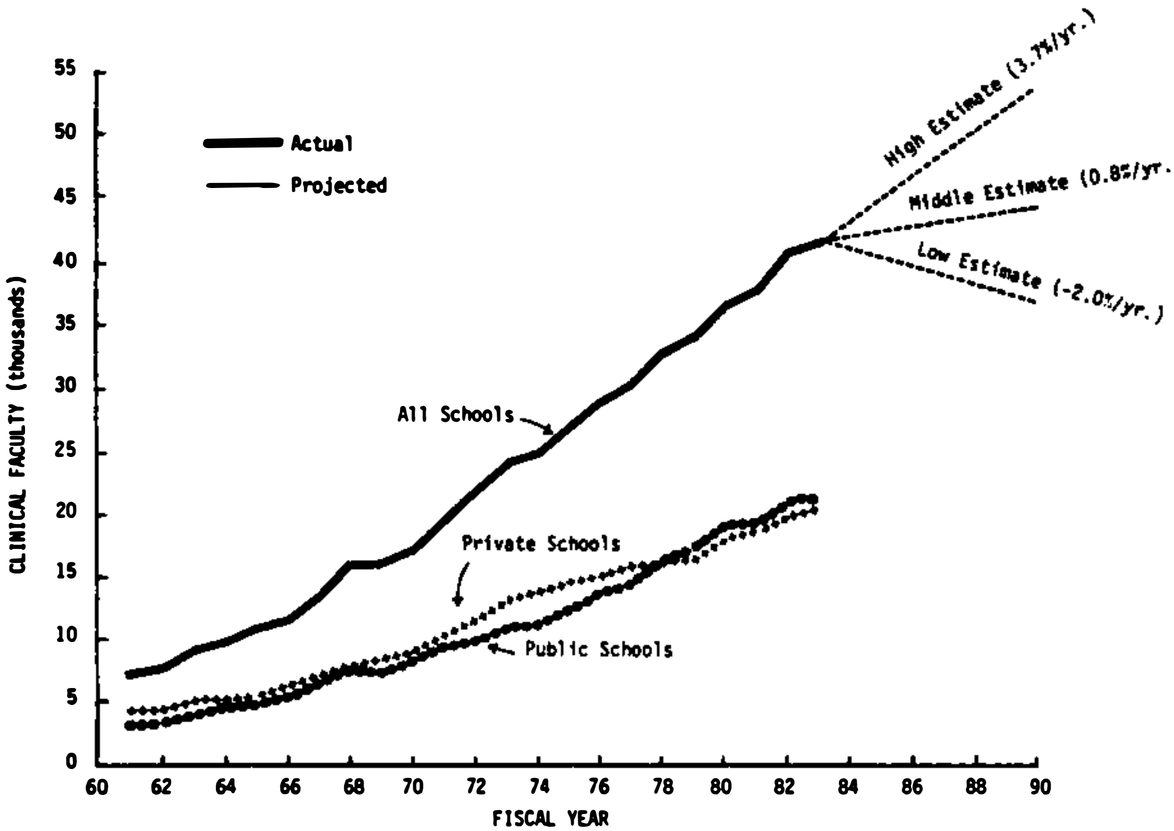

FIGURE 2.6 Clinical faculty in U.S. medical schools, by control of institution, 1961-83, with projections to 1990. Faculty is defined as full-time appointments in clinical departments regardless of tenure status. See Appendix Table A2.

Estimates of demand are derived from both expansion of faculty and replacement due to attrition. Demand due to expansion is determined by the model discussed above along with the revenue and enrollment assumptions. Demand created by attrition is estimated at 1.5 percent for death and retirement and from 4 to 5 percent per year for other reasons. The death and retirement rate estimates are higher than the 1 percent per year used in prior reports because the faculty age distribution is shifting upward and an increasing number of faculty members are expected to reach retirement age by 1990.

Under the most optimistic assumption about total revenue (assumption I in Table 2.4), these funds would grow by 6 percent per year through 1990 to about $46 million per school in constant 1972 dollars, allowing the clinical faculty/student ratio in medical schools to rise to 0.394 from its 1983 value of 0.346.[7] This

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[7]The 95 percent confidence limits on this estimate are 0.406 and 0.383, respectively. Since the most optimistic assumptions attempt to define an upper limit on our projections, we use the upper 95 percent confidence limit on CF as the most optimistic estimate.

produces an estimated upper limit for clinical faculty size of 54,100 members by 1990, for a faculty growth rate of 3.7 percent per year.

About 1,740 positions would be created by expansion, with another 720 created by attrition due to death and retirement, and 2,400 created by individuals leaving faculty positions for other employment. The total number of clinical faculty positions that would become available each year under these high growth assumptions is estimated at 4,860.

Under the middle or best-guess assumption (II of Table 2.4), revenue would expand by about 3 percent per year through 1990 to $37.6 million per school. The best estimate of clinical faculty size in 1990 under this assumption is 44,600, an increase of 380 positions per year or 0.8 percent per year over the 1983 level. Attrition from all causes would add another 2,600 positions to give an estimated total annual demand for medical school clinical faculty of 2,980. This is the committee's most likely projection.

Under the low growth assumption (III of Table 2.4), revenue would remain at the 1983 level of about $30.6 million per school through 1990. Consequently, the estimated clinical faculty/student ratio would be 0.350 with upper and lower 95 percent confidence limits of 0.357 and 0.342, respectively. Using the lower estimate of 0.342 to represent the most pessimistic conditions, we estimate that clinical faculty size under the worst-case conditions would decrease by 780 positions per year from 1983 levels. But attrition would create an estimated 2,160 positions per year for a minimum demand of 1,380 positions.

POSTDOCTORAL TRAINING NEEDS FOR MEDICAL SCHOOL CLINICAL FACULTY

Translating our projections of demand for clinical faculty in medical schools into estimated postdoctoral needs under NRSA programs requires certain additional assumptions about how the system has functioned in recent years with regard to postdoctoral training and its sources of support.

Certain features of the system are key elements in describing how it produces the trained personnel required to fill the faculty vacancies created by expansion and attrition. The elements that must be considered are as follows:

1. the number of accessions to clinical faculty positions who have (or should have) research training,
2. the appropriate length of the research training period,
3. the proportion of individuals in the research training pipeline who are expected to choose academic careers,
4. the proportion of support of the total pool of clinical research trainees that should be provided by the federal government,
5. contributions to academic demand generated by demand for clinical faculty in veterinary schools.[6]

[6]Dental school demand will be treated separately in the next section of this chapter.

The numeric values assigned to these features in Table 2.5--first presented in the committee's 1981 report--are based either on currently available data about the system (which is admittedly incomplete), or on the committee's judgment of how the system should operate.

Using the projections of academic demand derived in Table 2.4, we calculate in Table 2.5 the range of postdoctoral trainees that should be supported by NRSA programs to satisfy expected demand for clinical faculty in medical and veterinary schools under the specified conditions.

Line 1 of Table 2.5 is a summary of the projections of academic demand for the extreme cases and the best-guess estimate derived in Table 2.4.

Line 2 provides an estimate of the demand for faculty in veterinary schools.

Line 3 shows the total annual demand for clinical faculty under each set of conditions. Total annual academic demand is expected to be between 1,440 and 5,060 positions with a best guess of about 3,100 positions.

Line 4 shows the number of clinical faculty positions to be filled by individuals with postdoctoral research training experience assuming that 35 percent of all accessions to academic positions will be former postdoctoral trainees. In the best-guess case, this number is estimated to be 1,080. We are aware that currently only about 25 percent of new clinical faculty members each year have had some postdoctoral research training. For several years now this committee has been recommending that the system be adjusted so that more clinical faculty recruits will have had research training experience.

Line 5 indicates the size of the clinical science postdoctoral pool required to supply the necessary number of individuals with postdoctoral research training under certain assumptions about the length of the postdoctoral training period and the proportion of the pool seeking academic employment.

In previous reports, the committee has based its recommendations in part on the assumption of a 2-year research training period for clinical science postdoctoral trainees. Because of the rapidly growing complexity of modern clinical research, the committee has revised this assumption to a postdoctoral research training period of <u>at least</u> 2 years. Assuming that the duration of postdoctoral research training will be 2-3 years, with an average of 2-1/2 years, then the pool size needed to produce 1,080 trained scientists each year would be about 2,700. If only 50 percent of the trainees seek academic appointments after completing their training, then the necessary pool size must be 5,400. We assume that some support for postdoctoral research training is also available from sources other than the NRSA programs. This is dealt with in line 6 of this table.

Line 6 shows the estimated number of clinical science postdoctoral trainees that should be supported annually by NRSA programs under different assumptions about the proportion of total support provided by that source. The resulting range is between 1,040 under the lowest set of assumptions, and 5,300 under the highest set. The best-guess assumptions yield a range of 2,250-3,240 postdoctoral trainees needed annually to satisfy demand in medical and veterinary schools.

TABLE 2.5 Estimated Number of Postdoctoral Research Trainees Needed to Meet Expected Demand for Clinical Faculty in Medical and Veterinary Schools Through 1990 Under Various Conditions

	Projected Through 1990			
	High Estimate	Middle Estimate	Low Estimate	Annual Average 1981–83
1. Demand for full-time medical school clinical faculty—annual average:	4,860	2,980	1,380	4,260
a. due to expansion of faculty	1,740	380	−780	2,110
b. due to death and retirement[a]	720	650	590	400
c. due to other attrition[b]	2,400	1,950	1,570	1,750
2. Demand for veterinary school faculty[c]	200	120	20	
3. Total annual accessions (expected demand)[d]	5,060	3,100	1,440	
4. Total accessions with postdoctoral research training—annual average (assuming 35% of all accessions have postdoctoral research training)[d]	1,770	1,080	500	
5. Size of clinical science postdoctoral pool—annual average				3,000–5,000
Size needed to meet academic demand assuming a 2–3 year training period and portion of trainees seeking clinical faculty positions is:				
a. 60%	7,380	4,500	2,080	
b. 50%	8,850	5,400	2,500	
6. Annual number of clinical science postdoctoral trainees to be supported under NRSA programs:				2,770 (1981–82)
a. if 50% of pool is supported under NRSA	3,690–4,420	2,250–2,700	1,040–1,250	
b. if 60% of pool is supported under NRSA	4,430–5,310	2,700–3,240	1,250–1,500	

[a] Assumes an attrition rate due to death and retirement of 1.5% per year. See AAMC (1981a).

[b] Assumes high, middle, and low attrition rates of 5%, 4.5%, and 4%, respectively.

[c] Based on an independent analysis of demand in schools of veterinary medicine (NRC, 1982, p. 75).

[d] Accessions are defined as new hires or those who rejoin faculties from nonfaculty positions. Interfaculty 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.

SOURCE: Table 2.4.

DENTAL SCHOOL TRENDS

Most dental clinical research in this country is performed in dental schools by full-time faculty members in clinical departments. Over the past two years, the committee--assisted by its ad hoc Panel on Dental Research--has examined the status of dental clinical research and training. We have reviewed data collected by the American Dental Association (ADA) on the trends in faculty, enrollments, and financing of dental education since 1968. Then a model of the system was constructed and some projections of demand for dental clinical investigators through 1990 were made. Herewith are the findings and conclusions of that examination and review. The detailed data may be found in Appendix Tables A12-A20.

Number of Dental Schools (Figure 2.7 and Appendix Table A20)

Perhaps the first thing to note is that the number of dental schools grew slowly but steadily in the 1960s, then accelerated in the first half of the 1970s before leveling off in the last half. Since 1979, there have been no new schools added to the total of 60. Moreover, one institution--Emory University School of Dentistry--has recently announced plans to discontinue its predoctoral program.

All of the recent growth in number of dental schools over the past 17 years has been in the publicly controlled institutions. In 1968, the 50 dental schools were equally divided into 25 public and 25 private schools. Currently there are 35 public and 25 private schools.[9]

Dental School Enrollments (Figure 2.8 and Appendix Table A20)

Total enrollment in dental schools reached a peak in FY 1981 at about 25,000 students and has since declined for three successive years to 23,600 in FY 1984.[10] The decline has been ascribed to lower earnings expectation in the dental sector along with changes in student financial assistance that have made "...dental education a less attractive investment" (Brown and Hixson, 1984). The pattern of growth is somewhat similar to that of medical schools--accelerating in the 1960s and decelerating in the 1970s. The overall growth rate in enrollment from 1968-84 was over 2 percent per year, which is almost twice as fast as the growth in number of schools. Furthermore, enrollment continued to increase in 1980 and 1981 even though the number of schools was unchanged. Thus it is clear that dental schools have been able to expand class sizes readily in response to perceived need and financial incentives.

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[9]Eleven schools are listed by the ADA as "private-state related." In this report they are counted as private schools.

[10]Enrollment, as described here, includes predoctoral dental students and postdoctoral students in specialty and general practice residency programs at U.S. dental schools.

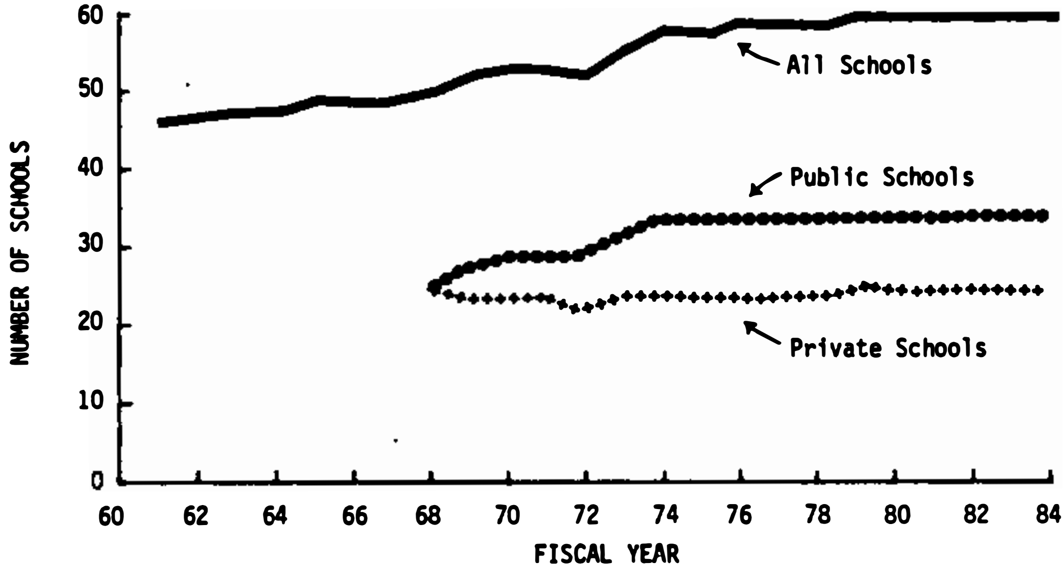

FIGURE 2.7 Number of operational U.S. dental schools, by control of institution, 1961-84. See Appendix Table A12.

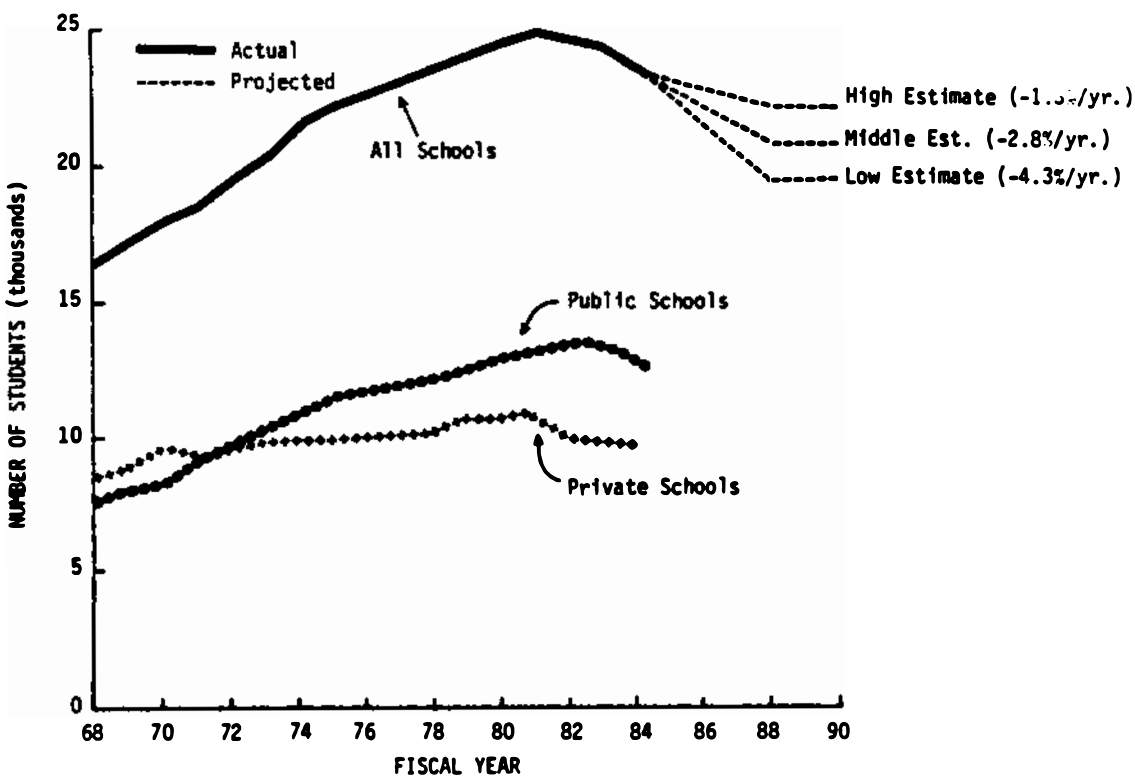

FIGURE 2.8 Enrollments in U.S. dental schools, by control of institution, 1968-84, with projections to 1990. Includes predoctoral, advanced specialty, and general purpose residency students. The committee expects enrollments to decline until 1988 and then level out to 1990. See Appendix Table A12.

We expect dental enrollment to continue to decline until 1988 and then flatten out through 1990. The best guess is for an average annual decline of 2.8 percent per year between 1983 and 1988, with upper and lower limits of -1.3 percent and -4.3 percent per year respectively. After 1988, the market for dental practitioners is expected to improve, mainly due to growing demand for dental care by the elderly. This is likely to have the effect of stabilizing the enrollment decline in dental schools.

Enrollment in public dental schools currently accounts for 57 percent of total enrollment, compared to 43 percent in private schools. This, of course, reflects the widening gap between the number of public and private schools. From 1961 through 1970, enrollment in private schools was higher than in public schools. But since 1970, public school enrollment has been greater and probably will continue to be for quite some time in view of the appreciable disparity in the number of schools in each category.

Dental School Faculty (Appendix Table A21)

Despite the downturn in dental school enrollments starting in 1982, clinical faculty in dental schools has remained stable at around 3,700 full-time members since 1981.[11] In contrast, full-time basic science faculty in dental schools declined by over 6 percent since 1982. The implication of these data is that funds necessary to maintain a level number of clinical faculty have come mainly from increases in clinic revenue, tuition, R and D funds, and state and local government support. A discussion of these sources of revenue follows.

R and D Revenue (Table 2.3 and Appendix Table A22)

Dental school R and D revenue in constant dollars has been generally rising since 1968 although there have been some rather sharp drops—notably in FY 1969 and 1975—and some flat stretches. In recent years there have also been some steep increases—real R and D increased by 14 percent in FY 1981 and by another 3 percent in FY 1982. Prior to 1981, real R and D revenue had increased at an average annual rate of only 1 percent since 1968. Nevertheless, R and D funds in dental schools are relatively minor sources of revenue, accounting for only about 7 percent of total revenue in 1982 compared to 22 percent in medical schools.

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[11] Data published by ADA in its Annual Report on Dental Education for 1983-84 show full-time clinical faculty at 4,130 positions. This number appears to be too high. Further examination by the ADA reveals that a new method of collecting and tabulating the data in 1983-84 overestimated the number. A recheck by the ADA yielded a count of 3,688, which is more in line with other data.

The National Institute of Dental Research has formulated a 5-year planning budget to exploit the scientific opportunities described in its long-range research plan, "Challenges for the Eighties" (NIH, 1983c). Although that budget incorporates an annual increase of 8 percent in constant dollars for extramural research, most of which would be awarded to dental schools, the committee believes it realistic to project an average increase of 3 percent per year in dental school R and D revenue through 1990. Upper and lower limits are projected at 6 and 0 percent respectively.

Dental Clinic Revenue (Table 2.3 and Appendix Table A23)

In contrast to service income in medical schools, which stems largely from faculty practice plans, clinic revenue in dental schools is generated largely by students. Clinic revenue has had a dramatic growth pattern during the past decade and probably is one of the keys to understanding what has been happening in dental education during the 1970s. Since 1968, real clinic revenue has increased at a steady pace of better than 7 percent per year--much faster than the growth in real R and D revenue at less than 2 percent per year.

At the beginning of the 1970 decade, clinic revenue and R and D revenue in dental schools were both at about the same level of $16 million per year in real terms. By 1983, clinic revenue at about $44 million was double the R and D revenue of about $22 million per year. Both public and private dental schools have benefited from increased clinic revenue but the growth has been somewhat faster in public schools because of their higher rate of growth in predoctoral enrollment.

We are projecting clinic revenue to increase between 0 and 4 percent per year in constant dollars through 1990, with a best guess of 2 percent per year.

Tuition and Fees (Table 2.3 and Appendix Table A24)

Another factor that has played a substantial role in dental school revenues since 1970 is tuition. In contrast to medical schools, tuition in dental schools has been an important source of funds, and in the past 10 years has become the second largest revenue source behind state and local government funds.

Tuition revenue increases in private dental schools have been especially sharp. In 1982, tuition revenue at 43 percent of total revenue in private schools was by far the largest single source of funds. In real terms it has increased at 8.3 percent per year in private schools and 6.9 percent per year in public schools since 1968.

Our projections are for continued increases of between 2 and 12 percent per year through 1990, with a best guess of 7 percent per year.

State and Local Government Revenues (Figure 2.3 and Appendix Table A25)

We may infer from the ADA reports and the data in Table 2.3 that state and local governments have always been the dominant source of support for dental schools. Clearly since 1972, this source of funds has taken on added importance as federal support has declined. In 1982, state and local government contributions made up nearly half of all dental school revenues, up from about 35 percent in 1972. During this same period, the federal government's share (excluding research funds) declined from 19 percent to less than 4 percent. Most of this decline is attributable to the elimination in 1982 of capitation grants--a program designed to encourage the expansion of enrollment in professional schools.

Modest increases are expected through 1990. Our best guess is for 2 percent per year real growth, with upper and lower limits of 4 and 2 percent per year, respectively.

Public schools, of course, rely more heavily on state and local government support than do private schools. In 1982, state and local governments contributed 64 percent of all public dental school revenue and only 15 percent of private dental school revenue.

Nonetheless, the combined federal, state, and local government contributions were still a smaller percentage of total revenue in 1982 than they were about 10 years ago. Dental schools have reacted to the declining government support by increasing tuition and clinic revenue. Medical school tuition has also increased rapidly but not nearly as fast as medical service income.

Total Revenue (Figure 2.9 and Appendix Table A26)

The above sections describe the major revenue sources for U.S. dental schools. As a result of these trends, real total revenue per school grew at an average annual rate of 9.5 percent between 1968 and 1973. After 1973, the growth slowed to about 2 percent per year. As a result of the expected increases in most revenue components--especially tuition--the committee expects growth in total revenue to continue through 1990 at about 4 percent per year, with upper and lower limits on this estimate of 7 percent and 1 percent, respectively.

Average revenue in public dental schools has been consistently higher than in private schools. Similarly, the faculty/student ratio is higher in public schools--a fact that provides a basis for modeling academic demand as explained in the next section.

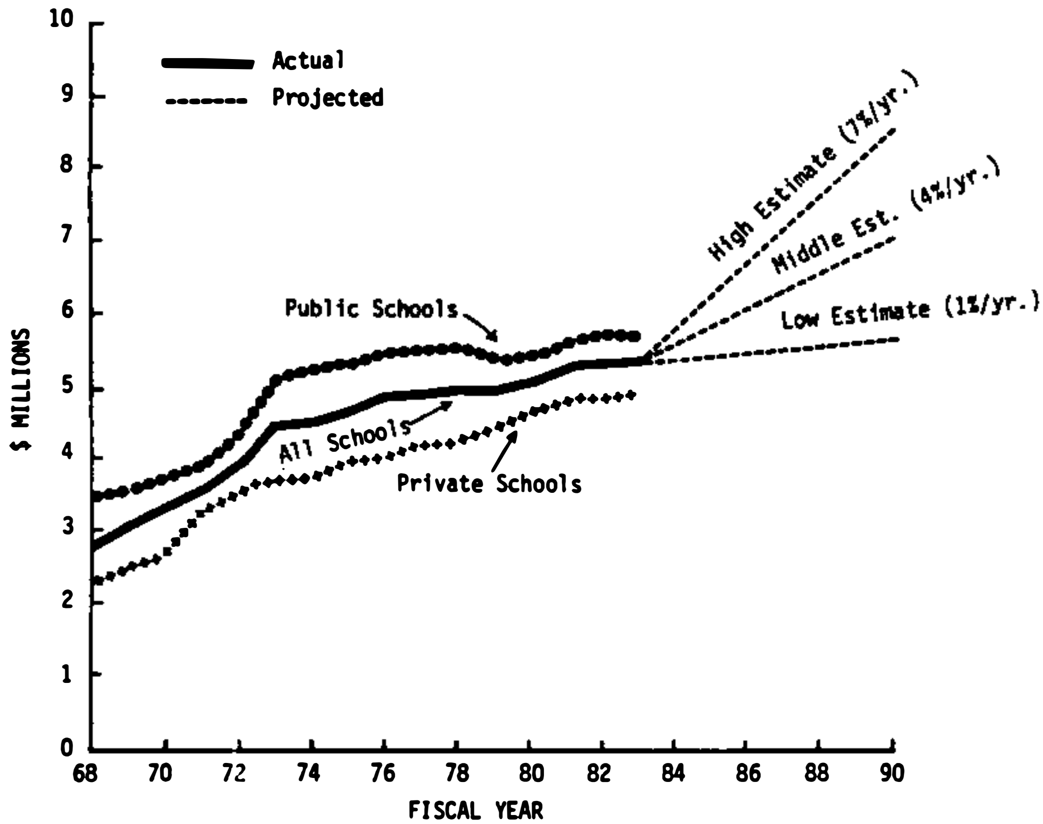

FIGURE 2.9 Total revenue per school in U.S. dental schools, by control of institution, 1968-83, with projections to 1990. See Appendix Table A18.

DEMAND FOR CLINICAL FACULTY IN DENTAL SCHOOLS

Given the behavior patterns discussed above regarding the principal variables involved in dental education, the issue now becomes one of trying to determine how they relate to one another.

Recall that the purpose of this analysis is to estimate the future demand for full-time clinical faculty members in dental schools--and ultimately to assess the need for training of dental clinical investigators. The methodology that has been applied to a corresponding analysis of medical schools involves the development of a conceptual and empirical model of the interrelationships among the variables. A similar approach will be applied here--the faculty/student ratio is specified to depend on total revenue per school. The relevant data from 1970-83 are shown in Figure 2.10.

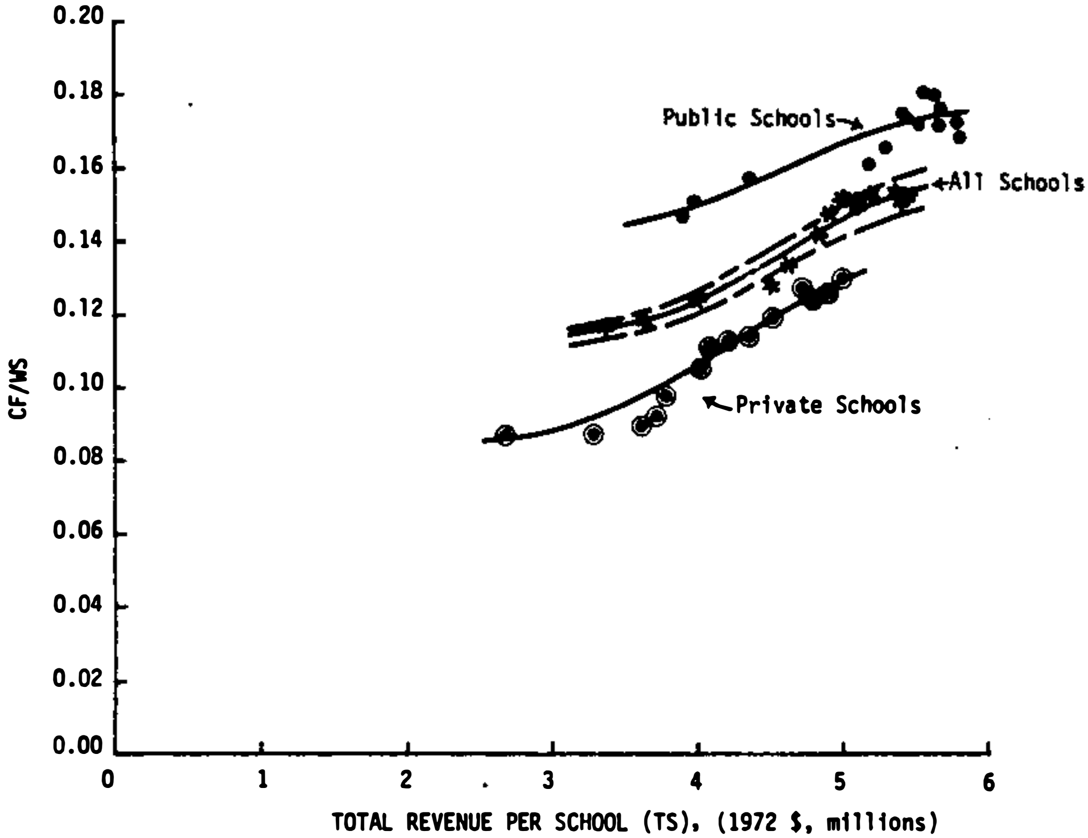

FIGURE 2.10 Dental school clinical faculty/student ratio (CF/WS) vs. total revenue per dental school (T/S). The ratio is defined as follows: CF = full-time faculty in clinical departments of U.S. dental schools; WS = 4-year weighted average of students, i.e., $(WS)_t = 1/6(S_t + 2S_{t-1} + 2S_{t-2} + S_{t-3})$, where S_t = predoctoral, advanced specialty, and general purpose residency students in year t. Solid line represents a growth curve of the form: $Y = (K-C)\exp(-e^{a-bx}) + C$ with parameters K = 0.17, C = 0.116, a = 5.388, b = 1.204. These were derived from 14 annual observations, 1970-83. See Appendix Tables A12, A13, and A18.

As in other bioscience areas, the observations form a nonlinear pattern, suggesting that a constrained growth curve might provide an adequate fit to the data. A Gompertz-type curve has been fitted to the data and is shown as the solid line in Figure 2.10.[12]

Using this model and the panel's assumptions about growth rates through 1990, we may make estimates of demand for full-time clinical faculty in dental schools (Figure 2.11).

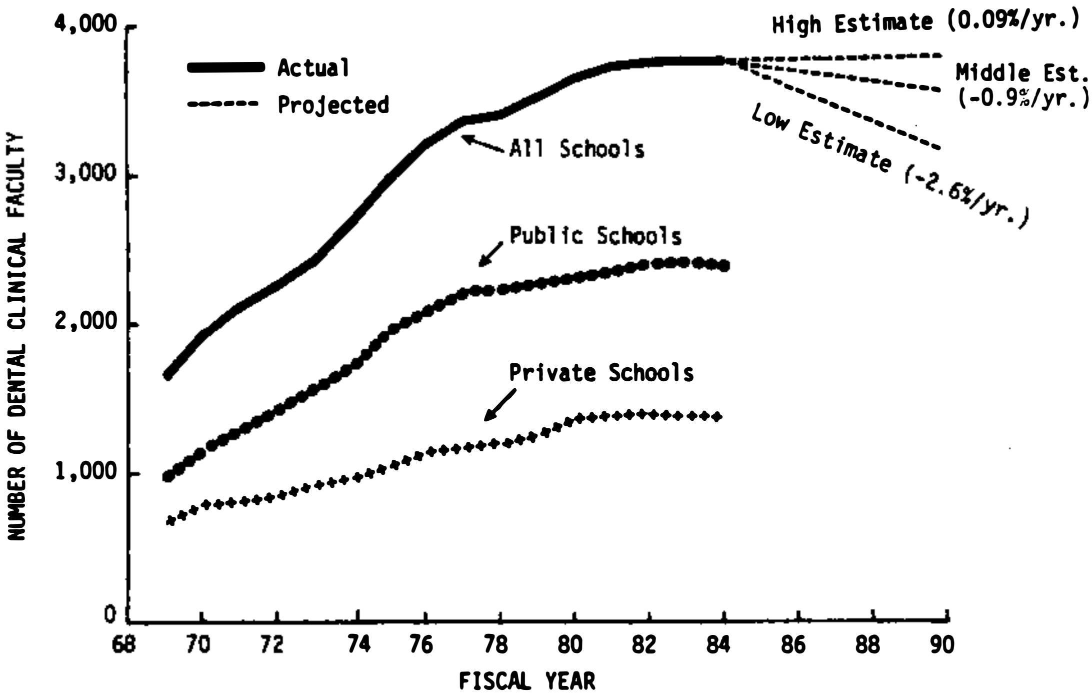

FIGURE 2.11 Full-time faculty in clinical departments of dental schools, by control of institution, 1969-84, with projections to 1990. See Appendix Table A13.

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[12]The curve has the following mathematical form:

$CF/WS = (K-C)\exp[-e^{a-b(T)}]+C$

where: CF = full-time clinical faculty in U.S. dental schools

WS = 4-yr. weighted average of enrollments, i.e.,

$WS_t = 1/6(S_t + 2S_{t-1} + 2S_{t-2} + S_{t-3})$

where: S_t = predoctoral plus advanced specialty enrollments in year t,

T = total revenue per school in U.S. dental schools (1972 $, millions).

a, b = parameters to be determined by the data.

K = asymptote: CF/WS → K as T →inf.

C = scaling constant

This function provides a good fit to the 14 annual observations 1970-83, with $R^2 = 0.95$. The dotted lines in Figure 2.10 represent the 95 percent confidence limits on the predicted values.

Under the panel's revenue assumptions, total revenue per school would grow between 1 percent and 7 percent per year between 1983 and 1990, with a best guess of 4 percent per year. Combining these estimates with the three assumptions about enrollment growth, we get nine combinations of assumptions to consider. The projections of faculty demand under each combination are shown in Table 2.6.

Under the combination of highest assumptions--I-A in Table 2.6--full-time clinical faculty would grow to 3,810 from its 1983 level of 3,786 which gives a practically negligible number of new positions due to expansion of faculty. But attrition due to death and retirement would generate an estimated 60 positions and other attrition would create another 190 vacancies for a total demand of 250 per year.

Under the best guess set of assumptions--II-B in Table 2.6--faculty would decline slightly to about 3,550 by 1990. But attrition would create 190 positions per year.

In the worst case envisioned by the panel--III-C in Table 2.6--faculty would decline by about 90 positions per year, but attrition would create about 150 vacancies per year for a net demand of about 60 positions per year.

POSTDOCTORAL TRAINING NEEDS FOR DENTAL SCHOOL CLINICAL FACULTY

The final step in this analysis of demand for dental clinical faculty members is to translate the projections derived above into recommended levels of training under NRSA programs. The procedure for this is to determine the size of the pool of trainees necessary to satisfy the projected demand using certain assumptions about how the training system works. The methodology is similar to that applied to medical schools but the parameter values used in the medical school analysis are probably inappropriate to apply to the dental training system. For example, there is justification for using an appreciably higher figure than 35 percent with respect to the annual average proportion of clinical dental faculty accessions with postdoctoral research training. One reason for a higher figure is the growing tendency for dental schools to restrict tenured and tenure-track appointments in clinical departments to individuals with a background of advanced education (specialty or general practice residency) and research training. In addition, any effort to build a capability to exploit the opportunities that have opened up in dental clinical investigation must start from a more fragile base of faculty research involvement than exists in medical schools. It is relevant in this connection that 57 percent of D.D.S. faculty in clinical departments reported a less than 10 percent involvement in research in academic year 1983-84 (AADS, 1985). The comparable portion of M.D. clinical faculty in 1982 was 37 percent (Herman and Singer, 1985).

Clinical specialty training has traditionally been interwoven with training for research for most dentists who subsequently enter careers in teaching and research. By contrast, a physician generally enters research training after completion of a standard residency. Since the residency offers the physician little or no opportunity for investigative experience, research training is often incorporated into

TABLE 2.6 Projected Growth in Dental School Clinical Faculty, 1983–90, Based on Projections of Dental School Enrollment and Total Revenue per School[a]

Assumptions about Dental Student Enrollment (dental students, general purpose residency, and advanced specialty graduate students: 23,587 in 1984)		Assumptions about Total Revenue per School (in constant 1972 dollars[b]) in Dental Schools ($5.4 million per school in 1983) — I: Will expand at about 7%/yr. to $8.7 million per school in 1990	II: Will expand at about 4%/yr. to $7.1 million per school in 1990	III: Will expand at about 1%/yr. to $5.8 million per school in 1990
A. Will decline to 22,380 students by 1990	Expected size of clinical faculty in dental schools (CF) in 1990	3,810	3,760	3,540
	Annual growth rate in CF from 1983 to 1990	0.09%	−0.08%	−0.09%
	Average annual increment due to faculty expansion	—	—	−30
	Annual replacement needs due to: death and retirement[c]	60	60	50
	other attrition[d]	190	170	110
	Expected number of positions to become available annually on dental clinical faculties	250	230	130
B. Will decline to 21,050 students by 1990	Expected size of clinical faculty in dental schools (CF) in 1990	3,590	3,550	3,340
	Annual growth rate in CF from 1983 to 1990	−0.7%	−0.9%	−1.8%
	Average annual increment due to faculty expansion	−30	−30	−60
	Annual replacement needs due to: death and retirement[c]	60	60	50
	other attrition[d]	180	160	110
	Expected number of positions to become available annually on dental clinical faculties	210	190	100
C. Will decline to 19,780 students by 1990	Expected size of clinical faculty in dental schools (CF) in 1990	3,380	3,340	3,150
	Annual growth rate in CF from 1983 to 1990	−1.6%	−1.8%	−2.6%
	Average annual increment due to faculty expansion	−60	−60	−90
	Annual replacement needs due to: death and retirement[c]	50	50	50
	other attrition[d]	180	160	100
	Expected number of positions to become available annually on dental clinical faculties	170	150	60

[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:
$(CF/WS)_t = (0.054)\exp[-e^{5.3885-1.204(TS)_t}] + 0.116$, where CF = size of clinical faculty in dental schools;
WS = weighted average of last 4 years of enrollments, i.e., $(WS)_t = \frac{1}{6}(S_t + 2S_{t-1} + 2S_{t-2} + S_{t-3})$,
where S = dental students plus GPR and advanced specialty enrollments; $(TS)_t$ = total revenue per school in U.S. dental schools in year t (1972 $, millions). See Appendix Tables A12, A13, and A18.

[b] Deflated by the Implicit GNP Price Deflator, 1972 = 100.0. See Appendix Table A7.

[c] Based on an estimated replacement rate of 1.5% annually due to death and retirement. See AAMC (1981a).

[d] Based on high, middle, and low attrition rates of 5%, 4.5%, and 4%, respectively.

subspecialty fellowships. For the dentist, therefore, research training is pursued in a period equivalent to a residency, while for the physician it is most commonly a post-residency phenomenon.

Advanced education in one of the eight dental specialties takes place predominantly in dental schools, and to a much lesser extent in other institutions. By contrast, residency training to meet basic specialty board requirements for physicians is not focused on the university campus, but occurs primarily in teaching hospitals.

The primary mechanism used by NIH for research training of dentists and physicians is the NRSA institutional training grant. Because of the link between research and specialty training for the dentist, it is far more likely to exceed the 3-year limit on NRSA postdoctoral support and to require a waiver than is the case for M.D. research trainees.

Dentists are faced with a serious disincentive to pursue training as clinical investigators. Whereas the young physician receives a salary and benefits as a hospital resident and subspecialty fellow, similar payment for the newly graduated dentist is limited largely to hospital-based training in oral surgery or oral pathology. Training in the other specialties rarely provides compensation and may indeed require tuition payment by the trainees. Consequently, NRSA training programs for dentists commonly include support for a clinical training component.

Although NIH represents the largest single source of support for postdoctoral research training of physicians, a multiplicity of private foundations, voluntary agencies, and industry-related organizations underwrite the preparation of physician-scientists. By contrast, the NIDR is essentially the only sponsor for the training of dental investigators through its NRSA postdoctoral programs and associated career development opportunities.

The parameters of a research training system for dental clinical investigators and the calculations leading to estimates of postdoctoral needs are laid out in Table 2.7.

Line 1 of Table 2.7 is a summary of the projections of demand for dental clinical faculty from the model.

Line 2 is an estimate of the contribution to demand generated by the need for clinical faculty in nondental institutions. This demand is estimated to be about 10 percent of dental school demand.

Line 3 shows total annual demand under each of three revenue conditions. In the best-guess case, we expect about 210 positions to be available each year through 1990.

Line 4 shows the number of accessions to dental school clinical faculties that should have some postdoctoral research training. Since there are currently so few qualified dental clinical investigators, a strong effort should be made to bolster the research capability of dental schools. One way of doing this is to try to modify the system such that about 1/2 of all newly hired faculty members in clinical departments of dental schools have some postdoctoral research training. Applying this factor, the best-guess case yields an estimate of 105 new hires needed each year with research training.

TABLE 2.7 Estimated Number of Dental Clinical Research Postdoctoral Trainees Needed to Meet Expected Demand for Dental Clinical Faculty Through 1990 Under Various Conditions

	Projected Through 1990			
	High Estimate	Middle Estimate	Low Estimate	Annual Average 1981–84
1. Demand for full-time clinical faculty—annual average:	250	190	60	340
a. due to expansion of faculty	—	−30	−90	130
b. due to death and retirement[a]	60	60	50	40
c. due to other attrition[b]	190	160	100	170
2. Demand for clinical faculty outside of dental school[c]	25	20	10	
3. Total annual accessions (expected demand)[d]	275	210	70	
4. Total accessions with postdoctoral research training—annual average (assuming ½ of all accessions have postdoctoral research training)[d]	140	105	35	
5. Size of dental clinical science postdoctoral pool—annual average Size needed to meet academic demand assuming a 3-year training period and portion of trainees seeking dental clinical faculty positions is:				
a. 80%	520	400	130	
b. 70%	600	450	150	
6. Annual number of dental clinical science postdoctoral trainees to be supported under NRSA programs:				124
a. if 80% of pool is supported under NRSA	420–480	320–360	100–120	
b. if 90% of pool is supported under NRSA	470–540	360–400	120–130	

[a] Assumes an attrition rate due to death and retirement of 1.5% per year. See AAMC (1981a).
[b] Assumes high, middle, and low attrition rates of 5%, 4.5%, and 4%, respectively.
[c] In FY 1982 there were 1,686 students enrolled in residency programs (specialty and general practice) in nondental school institutions. These programs are usually taught by full-time program directors at those institutions, of which there were 309 in 1982. The demand for faculty generated by these programs is estimated to be about 10% of dental school demand.
[d] Accessions are defined as new hires or those who rejoin faculties from nonfaculty positions. Interfaculty transfers are not counted as accessions.

SOURCE: Table 2.6.

Line 5 gives the size of the dental postdoctoral research training pool needed to supply the necessary number of trained dental scientists assuming that the training period lasts three years and allowing for some attrition from the pool to nonacademic positions.

There is little, if any, support for dental research training available from sources other than the federal government. Therefore, line 6 calculates the number of trainees needed in NRSA programs assuming that these programs support 80 or 90 percent of the total pool of postdoctoral trainees in dental research. In the best-guess case, the range is between 320 and 400 postdoctoral trainees.

SUMMARY

Projections of demand for full-time clinical faculty in medical, dental, and veterinary schools have been made through 1990, and then translated into numbers of clinical science postdoctoral trainees needed to satisfy this demand under specified conditions which define the training system. The committee's best estimates are as follows:

	Annual Number of Clinical Sci. Postdoctoral Trainees Needed Under NRSA Programs
For clinical faculty in medical and veterinary schools:	2,250 - 3,240
For clinical faculty in dental schools:	320 - 400
Total:	2,570 - 3,640

This spread of estimates is partly due to the difficulty inherent in making assumptions about the future levels of revenue, especially at a time when medical schools are facing possible dramatic changes brought on by demography, a potential physician surplus, and by efforts to curtail the growth in medicare/medicaid expenditures. And it is partly due to the fact that for the first time in more than 25 years, medical school enrollments are expected to decline while revenue is expected to continue to grow. The effect of these disparate trends on the size of clinical faculties cannot be determined with any specificity, and this uncertainty carries over into the assessment of training needs.

The committee's estimates of training needs through 1990 are somewhat higher than previous estimates published in its 1983 report. The principal reasons for this are, first, that we foresee faster growth in the financial factor in the demand model (total revenue) than we had projected through 1988. Second, we are recommending an adjustment to the training system for clinical scientists wherein the average length of the postdoctoral research training period is increased from two to two and one-half years. Third, we estimate that attrition due to death and retirement will begin to increase between 1983 and 1990 along with the age distribution of the faculty. Finally, our examination of the training system for dental researchers reveals that it is substantially different from the medical researchers training system, and in our opinion deserves special consideration.

3. Basic Biomedical Sciences

Abstract

A reduced number of new entrants to the supply of basic biomedical scientists and increased employment in the industrial sector have combined to produce a better balanced market in 1983. Bachelor's degrees awarded in the biosciences have been falling steadily since 1976, and graduate enrollment started declining in 1978. Ph.D. production fell in 1983, and the number of bioscientists serving on postdoctoral appointments in 1983 failed to increase for the first time in 10 years.

Over half of the bioscience Ph.D.s in the labor force was employed in colleges and universities in 1983, but there has been little growth in this sector since 1981. The most rapid growth is taking place in the industrial sector where the emphasis on commercialization of recent developments in biotechnology and genetic engineering have increased the demand for biomedical scientists. Industrial employment of biomedical Ph.D.s increased by over 9 percent per year from 1981 to 1983. Industry continues to rely on academia to produce the scientists it needs, especially those with training in the latest techniques of modern bioscience.

The committee expects little net growth in the academic sector in the next few years, but the age structure of the bioscience Ph.D. labor force is such that retirement rates are expected to increase in the second half of the 1980 decade. Continued growth in the industrial sector is expected.

INTRODUCTION AND OVERVIEW

In previous reports issued since 1976, this committee has cited the rapid growth in the number of biomedical scientists serving on postdoctoral appointments as an indicator of insufficient opportunity for these individuals to move into more permanent academic positions. There was evidence that a postdoctoral holding pattern had developed during the 1970s which resulted in many postdoctoral appointees remaining in that status for prolonged periods. As tenure-track faculty positions became more difficult to obtain, the postdoctoral trainees began moving into less traditional career paths such as nonfaculty research staff and other nontenure-track academic positions, and also into nonacademic sectors. Almost all of them either found employment in one of these situations or remained in postdoctoral status and were primarily involved in R and D activities. The unemployment rate for biomedical Ph.D.s has not been more than 1.5 percent since 1972.

The most recent data indicate that a better balance has been achieved between the inflow and outflow affecting the postdoctoral pool. Bioscience Ph.D. production and graduate enrollment have decreased while industrial employment has accelerated. This suggests another side of the postdoctoral issue--the vital role that they play in the nation's biomedical research effort. Many experts in the field have cited the importance of having this reservoir of highly trained young scientists available to work on research projects while at the same time receiving training and experience in the latest techniques, equipment, and methodology. Despite the declining growth in demand for faculty, the demand for postdoctoral trainees to participate in research projects continues to be strong.

A postdoctoral appointment of at least 3 years has become almost a prerequisite for a faculty position at many universities. Furthermore, a previous study has shown that biomedical Ph.D.s with postdoctoral training tend to be more successful and productive in their subsequent careers than those without such training (NRC, 1976a).

So, as pointed out by this committee in its 1979 report (NRC, 1975-81, p. 20), the issue of postdoctoral training is a complex one involving some important trade-offs. On the one hand, it is in the national interest to promote and encourage the availability of an ample supply of young scientists with extended training for biomedical research who contribute to a research effort in which government funding plays a major role. On the other hand, if the postdoctoral pool is large relative to the number of jobs expected to become available for biomedical scientists where their training can be fully utilized, then the resources devoted to their training will have been partially misallocated and some career aspirations will not be realized. Support for postdoctoral training under NRSA programs is a regulating mechanism for helping to achieve the proper balance between these points of view, which often pull in different directions.

In this chapter, we present our assessment of the current market for basic biomedical scientists with Ph.D. degrees and the outlook for the next 5 years. Because postdoctoral research training is an integral part of the system under which these scientists are trained and absorbed into the pool of established investigators and teachers, it becomes central to our analysis. We first describe the current market situation as revealed by the most recent data and then outline our view of the prospects for the remainder of the decade.

It should be noted that there is some overlap between the scientists we discuss in this chapter and those basic biomedical scientists who have appointments in clinical departments of medical schools. The latter are included in the data of Chapter 2 as well as in this one. In 1982, about 5,800 out of about 70,000 basic biomedical Ph.D.s in the labor force had faculty appointments in clinical departments of medical schools. This overlap in the data presents a logistical problem for our analyses but is not likely to materially affect our findings and conclusions.

CURRENT SUPPLY/DEMAND INDICATORS

The committee's assessment of the need for basic biomedical scientists and the level of training that should be provided by the federal government under NRSA programs depends heavily on an analysis of the academic labor market, since that is the dominant sector both in terms of the number of bioscientists employed and the amount of federally-sponsored research performed.

In the committee's last report published in 1983, the latest available data for most of the factors that affect the supply and demand for biomedical scientists were for 1981. Additional surveys have since provided data through 1983. The items that we monitor are those that our previous work has shown to determine the market for biomedical Ph.D.s--namely, degrees awarded, enrollments, postdoctoral appointments, R and D funding, and the distribution of biomedical Ph.D. labor force by employment sector. Recent trends in these variables from 1975 to 1983 are shown in Table 3.1 and are summarized below. More detailed data may be found in Appendix Tables B1-B18.

Although the current supply of well-trained biomedical scientists appears adequate, most of the indicators of the flow of new entrants to the future supply have turned down. There is evidence that the size of the Ph.D. labor force in biomedical fields is fast approaching a peak and the prospects for the next few years are for little, if any, growth. The postdoctoral pool of biomedical scientists--which has acted to buffer the system since 1972--appears adequate for current needs. For the rest of the 1980s, we may see a gradual reduction in the size of the postdoctoral pool as Ph.D. production declines and more opportunities open up in the nonacademic sectors. This analysis is based on the following observations.

- Enrollments and degrees granted in the biomedical fields show declines from previous years. Generally, these declines continue a trend of several years but, in some cases, they constitute the first drop in a long series of increases.

- Bioscience Ph.D. production reached an all-time high in 1982 and dropped slightly in 1983.

- Bachelor's degrees and first-year graduate enrollments in bioscience fields have been falling since 1976.

- The size of the postdoctoral pool appears to have dropped in 1983 for the first time in over 10 years.

- Academic employment of biomedical Ph.D.s increased very slightly in 1983--industrial employment grew most rapidly.

These and other developments in the biomedical fields are discussed more fully in the sections below.

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

	Fiscal Year										
	1975	1976	1977	1978	1979	1980	1981	1982	1983	Growth Rate from 1975 to Latest Year	Latest Annual Change
1. SUPPLY INDICATORS (New Entrants):											
a. Ph.D. production	3,515	3,578	3,465	3,516	3,644	3,822	3,842	3,960	3,775	0.9%	−4.7%
b. % of Ph.D.s without specific employment prospects at graduation	6.4%	6.3%	7.2%	6.0%	5.2%	4.8%	5.5%	5.4%	6.8%	0.8%	25.9%
c. Postdoctoral appointments	5,369	n/a	6,312	n/a	7,268	n/a	8,026	n/a	7,827	4.8%	−1.3%
d. B.A. degrees awarded	50,493	52,642	51,783	49,701	47,717	45,106	42,297	40,750	n/a	−3.0%	−3.7%
2. DEMAND INDICATORS:											
a. National expenditures for health-related R and D (1972 $, bil.)	$3.70	$3.81	$3.96	$4.12	$4.30	$4.44	$4.38	$4.47	$4.73	3.1%	5.8%
b. Biomedical science R and D expenditures in colleges and universities (1972 $, bil.)	$1.19	$1.26	$1.27	$1.34	$1.35	$1.42	$1.49	$1.51	$1.54	3.3%	2.0%
c. NIH research grant expenditures (1972 $, bil.)	$0.983	$0.953	$1.01	$1.08	$1.18	$1.21	$1.19	$1.16	$1.25	4.1%	7.8%
d. Ph.D. faculty/student ratio[a]	0.157	n/a	0.156	n/a	0.173	n/a	0.192	n/a	n/a	3.5%	5.5%
3. LABOR FORCE:[b]											
a. Total	50,620	n/a	55,031	n/a	62,332	n/a	68,806	n/a	71,423	4.4%	1.9%
b. Academic (excl. postdocs.)	28,332	n/a	30,384	n/a	33,566	n/a	36,482	n/a	36,963	3.4%	0.7%
c. Industry	6,662	n/a	6,893	n/a	8,455	n/a	9,928	n/a	11,819	7.4%	9.1%
d. Government	4,517	n/a	4,568	n/a	5,000	n/a	5,398	n/a	5,988	3.6%	5.3%
e. Hospitals/clinics	1,940	n/a	2,297	n/a	2,726	n/a	2,799	n/a	2,946	5.3%	2.6%
f. Nonprofit	1,232	n/a	1,543	n/a	1,858	n/a	2,088	n/a	2,102	6.9%	0.3%
g. Self-employed	840	n/a	862	n/a	1,185	n/a	1,857	n/a	1,910	10.8%	1.4%
h. Other (incl. postdocs.)[c]	6,557	n/a	7,687	n/a	8,786	n/a	9,487	n/a	8,743	3.7%	−4.0%
i. Unemployed and seeking	532	n/a	797	n/a	676	n/a	767	n/a	952	7.5%	11.4%
4. BIOMEDICAL ENROLLMENTS:											
a. Total biomedical graduate and undergraduate enrollments	538,000	556,000	545,000	532,000	506,000	497,000	493,000	n/a	n/a	−1.4%	−0.8%
b. Estimated undergraduate[d]	425,000	440,000	426,000	406,000	378,000	368,000	362,000	n/a	n/a	−2.6%	−1.6%
c. Medical and dental schools	74,222	77,011	79,279	81,934	84,761	86,502	88,254	89,105	89,121	2.3%	0.02%
d. Graduate	38,314	39,322	39,260	43,922	43,529	43,135	42,381	41,773	41,191	0.9%	−1.4%
e. First-year graduate[e]	9,382	9,918	9,763	9,612	8,836	8,348	8,279	8,105	8,043	−1.9%	−0.8%

[a] Ratio of academically employed Ph.D.s to a weighted average of total graduate and undergraduate enrollments (WS), where $(WS)_t = 0.25(US)_t + 0.75(GS)_t$, $(US)_t = 1/3(U_t + U_{t-1} + U_{t-2})$, and $(GS)_t = 1/3(G_t + G_{t-1} + G_{t-2})$.

[b] Since labor force data are not available for 1982, latest annual change represents average annual growth rate from 1981–83.

[c] Also includes FFRDC laboratories.

[d] Estimated by the formula $U_t = (A_{t+2}/B_{t+2})C_t$ where U_t = biomedical science undergraduate enrollment in year t; A_{t+2} = biomedical science baccalaureate degrees awarded in year t+2 (excluding health professions); B_{t+2} = total baccalaureate degrees awarded in year t+2; C_t = total undergraduate degree-credit enrollment in year t (excluding first professional). The FY 1981 figure is a preliminary estimate.

[e] Represents full-time students in doctorate-granting institutions only.

SOURCES: AAMC (1972–85, special tabulations of 4/8/82, 5/17/82, 6/15/83, 7/10/84, and 2/5/85); ADA (1969–84); AMA (1960-84); NIH (1966–84); NRC (1958–85, 1973–84); NSF (1973–85a, 1975–85); U.S. Department of Education (1948–81, 1948–84, 1959–79, 1961–84a, 1961–84b, 1973–82, 1974–83).

Ph.D. Production (Table 3.1, line 1a and Figure 3.1)

The annual number of Ph.D. degrees awarded in the biomedical fields, which has been increasing gradually since the mid-1970s, reached an all-time high in 1982 before dropping in 1983 to 3,775. As was pointed out in the committee's 1983 report (IOM, 1983b, pp. 64-65), the peak production in 1982 and subsequent decline was an expected result of corresponding patterns of first-year graduate enrollments 6 years earlier. These enrollments peaked around 1976 and have continued to decline each year since then through 1983 (Figure 3.1). If the past relationship between first-year graduate enrollments and Ph.D. production prevails, we would expect Ph.D. production to continue to decline for the rest of the 1980 decade at least.

Of course the rate of decline is critically important, and at this point, we are not sure just how fast the drop will be. If Ph.D. production is in fact closely tied to first-year graduate enrollments, then the data would indicate a drop of about 3 percent per year for the next several years. This would bring the level of biomedical Ph.D. production in 1990 to about 3,050, which is below the 1970 level. Whether or not this would lead to serious shortages depends, of course, on what happens to the demand for biomedical Ph.D.s. The committee's estimate of demand in turn depends on what assumptions are made about trends in total graduate and undergraduate enrollments and R and D funding for the next few years. These assumptions and projections are presented in the Market Outlook section of this chapter.

Postdoctoral Appointments (Table 3.1, line 1c and Figure 3.1)

The number of biomedical scientists serving on postdoctoral appointments apparently declined slightly in 1983 for the first time in over 10 years, perhaps as a consequence of the drop in Ph.D. production in that year.

Throughout the 1960s, the postdoctoral pool tracked quite closely with Ph.D. production. But in the 1970s, the postdoctoral pool continued to grow while Ph.D. production leveled off. The committee noted this disparity in its 1983 report (IOM, 1983b, p. 57) and presented evidence showing that it was due to slower absorption of postdoctoral trainees into more permanent jobs in the academic sector. The fact is that employment of bioscientists in the academic sector slowed dramatically in the mid-1970s after a long period of rapid expansion since 1960 (see Appendix Table B5). Between 1960 and 1973, academic employment of biomedical Ph.D.s increased by more than 9 percent per year on the average, but only at 4.5 percent per year between 1973 and 1981. This slowdown caused some pressure to build up in the system which has manifested itself by the bulge in the postdoctoral pool. Continued expansion of employment in the industrial sector is apparently helping to relieve some of that pressure.

About 31 percent of bioscience postdoctoral appointees in FY 1983 were foreign citizens, the same percentage as in FY 1982 and up slightly from the 28 percent in FY 1980 (NSF 1973-85a).

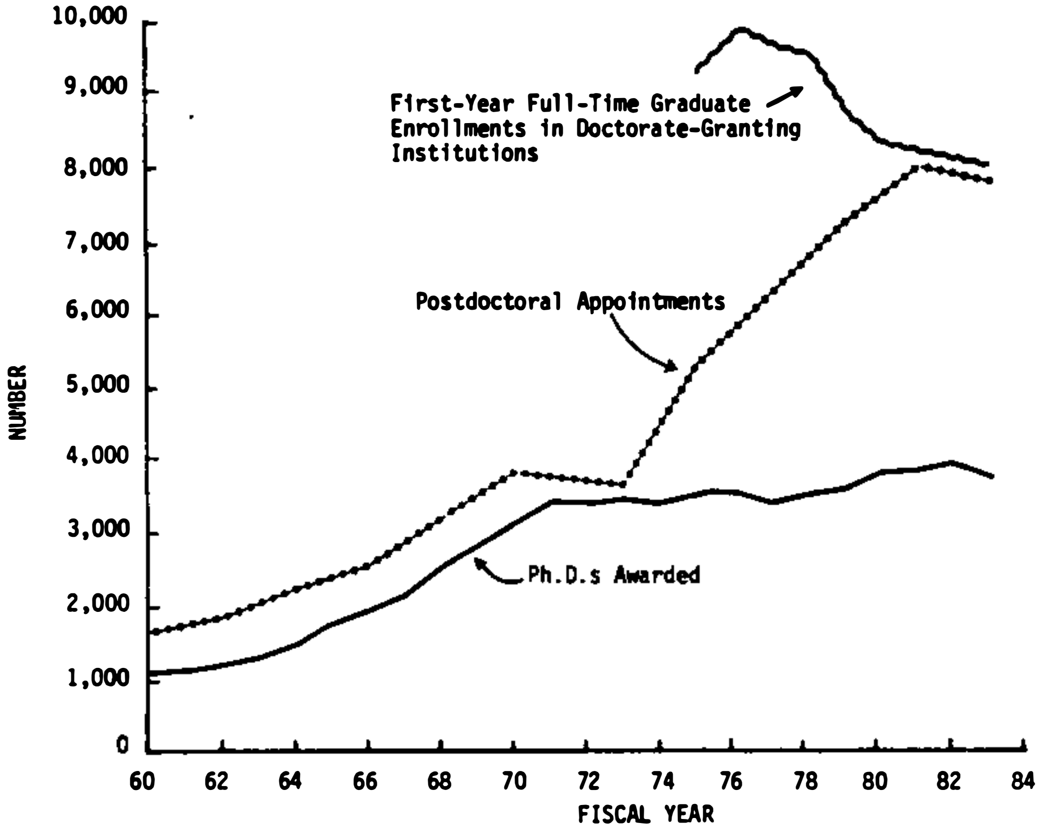

FIGURE 3.1 Ph.D. production, postdoctoral appointments, and first-year graduate enrollments in doctorate-granting institutions in basic biomedical science fields, 1960-83. See Appendix Tables B2 and B3.

Bachelor's Degrees (Table 3.1, line 1d and Figure 3.2)

After a long period of sustained growth from the early 1960s through 1976, the number of bachelor's degrees granted in the biomedical sciences has declined for 6 straight years. The biosciences are not alone in this regard--many fields have experienced similar patterns, with the notable exceptions of business, engineering, and computer sciences. These occupationally-oriented fields have proven to be very popular with students lately. Business, and management in particular, has had exceptionally strong growth in B.A.s since the mid-1960s. Currently more than 200,000 business B.A.s are produced annually, far above the second most popular field, education.

The ratio of biomedical bachelor's degrees to total bachelor's degrees awarded annually has fallen to its lowest level since 1960 (Appendix Table B4). This has an ominous implication for future Ph.D. production and also affects our estimate of undergraduate enrollment in bioscience fields as explained in the next section.

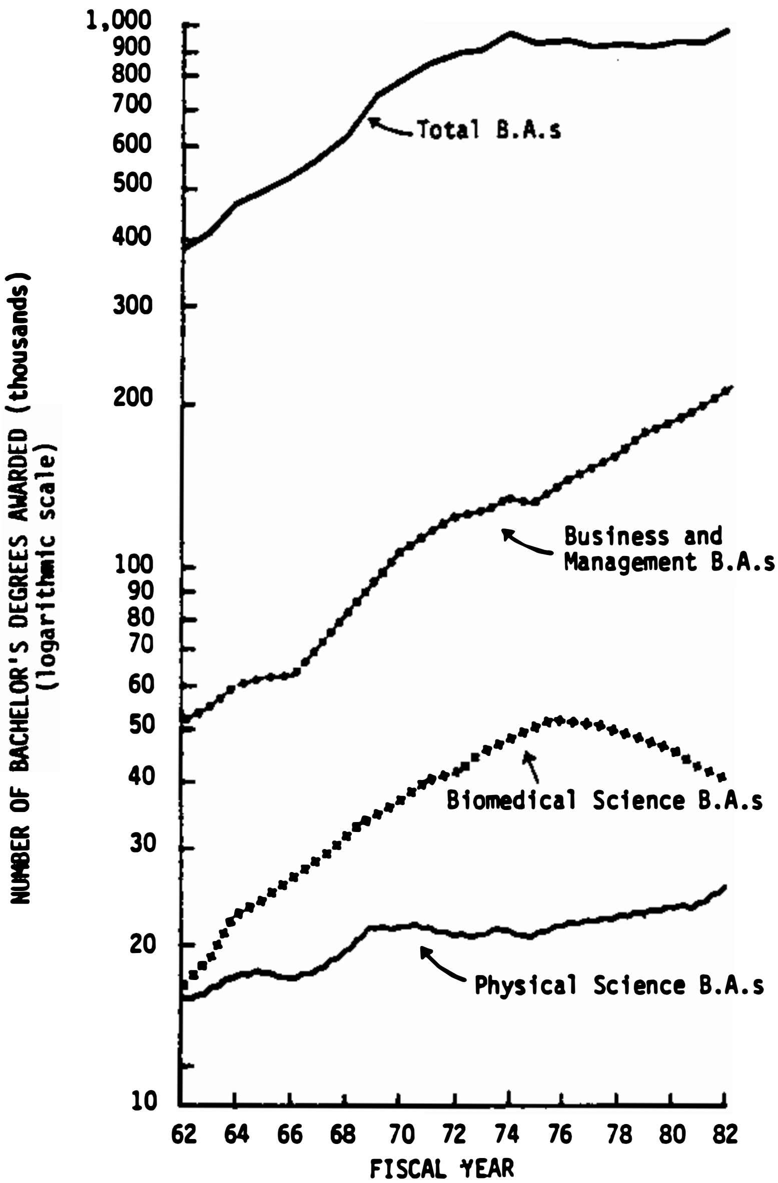

FIGURE 3.2 Bachelor's degrees awarded in biomedical science fields compared to other fields, 1962-82. See Appendix Tables B3 and B4. Business and management and physical sciences degrees are from the U.S. Department of Education (1948-84).

Enrollments (Table 3.1, line 4 and Figure 3.3)

For purposes of this study, it is necessary to have an estimate of undergraduate enrollment in bioscience fields, mainly because such enrollment helps to determine the demand for bioscience Ph.D.s in the academic sector. Yet the U.S. Department of Education, whose surveys collect most of the country's data on enrollments and degrees, does not provide undergraduate enrollment figures by such detailed fields. Therefore, we have developed a procedure for estimating bioscience undergraduate enrollment from the ratio of bioscience bachelor's degrees to total bachelor's degrees (B_b/B_t). This ratio in year t is multiplied by total undergraduate enrollment in year t-2 to provide an estimate of bioscience enrollment in year t-2.

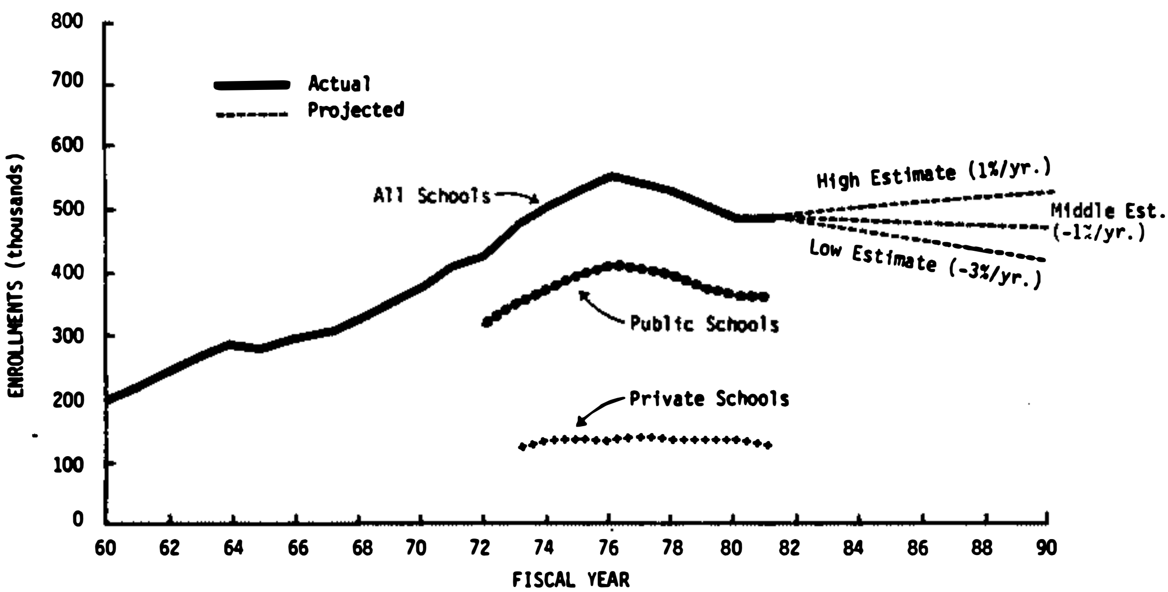

FIGURE 3.3 Total biomedical science undergraduate and graduate enrollments in colleges and universities, by control of institution, 1960-81, with projections to 1990. See Appendix Table B1.

As noted in the previous section, the ratio B_b/B_t has been falling since 1976, and so even though total undergraduate enrollment has increased almost without interruption since 1960 and reached an all-time high in 1983, estimated bioscience undergraduate enrollment has been declining since 1976. The latest estimate for 1981 is almost 1 percent below the 1980 level.

Since we cannot measure bioscience undergraduate enrollment directly, there is some uncertainty that our estimating procedure is detecting the trends accurately. Yet there is also some corroborating evidence from graduate enrollment to support our estimates. Graduate enrollment in bioscience fields (which is measured directly by the National Science Foundation) reflects the pattern shown by estimated bioscience undergraduate enrollment--it reached a peak in 1978 and has been falling steadily since then through 1983 (Table 3.1, line 4a).

Although enrollments in medical and dental schools have leveled out, as of 1983 they had not fallen (Table 3.1, line 4b). But the 1983 increase over 1982 was only 16 students, and it is anticipated that 1984-85 data will show the first yearly decline in these enrollments in more than 20 years.

Overall, total graduate and undergraduate enrollment in bioscience fields, as best we can estimate it, reached an all-time high in 1976 and has declined steadily through 1981. This pattern is illustrated in Figure 3.3 along with the committee's projections through 1990.

R and D Funding (Table 3.1, line 2 and Figure 3.4)

Biomedical science R and D expenditures at colleges and universities are generally following the pattern anticipated by the committee. These funds increased by 2 percent in 1983 after adjusting for inflation. The committee expects these funds to grow at about 1.5 percent per year in real terms through 1990 as shown in Figure 3.4.

NIH research grant expenditures rose substantially in 1983 after successive real declines in 1981 and 1982 (Table 3.1, line 2c).

Labor Force (Table 3.1, line 3)

The labor force of Ph.D.s employed in biomedical science fields totaled more than 71,000 in 1983. Slightly more than half of these scientists are employed in academic institutions, but there was almost no growth of this sector between 1981 and 1983. It would appear that declining bioscience enrollments and slower growth in R and D expenditures are diminishing academic demand for biomedical scientists. Industrial employment of biomedical Ph.D.s is increasing rapidly but this sector is still small relative to the academic sector. The distribution of the labor force has shifted somewhat toward the industrial sector since 1975--it has increased from 13.2 percent of the biomedical Ph.D. labor force in 1975 to 16.5 percent in 1983. At the same time, academic employment has declined from 56 percent to about 52 percent of the labor force. The remaining sectors have generally retained their respective shares.

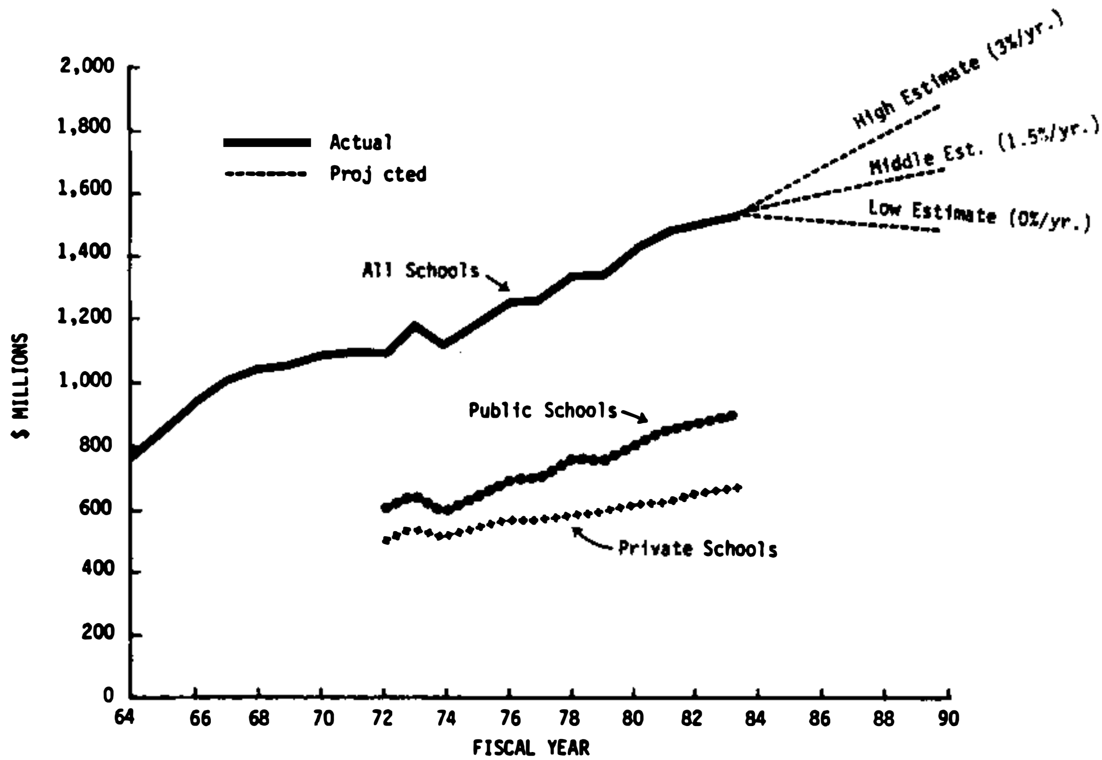

FIGURE 3.4 Biomedical science R and D expenditures in colleges and universities, by control of institution, 1964-83, with projections to 1990 (1972 $, millions). See Appendix Table B9.

Within the academic sector there is a rapid diffusion of new concepts and techniques from basic research to agriculture and clinical disciplines. This transfer of knowledge has been facilitated by the large postdoctoral group of scientists through which new ideas and techniques are quite easily transmitted. Thus, there is widespread enthusiasm for the opportunities created by recent advances in this fast moving field of science.

SURVEY OF BIOTECHNOLOGY FIRMS

In 1983, this committee collaborated with the Congressional Office of Technology Assessment in a joint effort to collect information about employment of biomedical scientists in the developing biotechnology industry. That survey of 265 firms obtained responses from 138, of which 20 said they were not engaged in biotechnology as defined on the questionnaire (the application of novel biological strategies such as rDNA, cell fusion or immobilized cells or enzymes, for biochemical processing). The results--described more fully in the committee's 1983 report--showed that most of the firms were formed after 1977, and in 1983 employed about 12 biomedical Ph.D.s per firm. Total employment in the industry is difficult to estimate because there are no precise data on the actual number of biotechnology firms. The Office of Technology Assessment (OTA) estimates that about 5,000 scientists were employed by 219 biotechnology firms in 1983 (OTA, 1984). Probably half of these scientists were Ph.D.s.

This survey was repeated in 1985 as a joint effort of the committee and the American Society for Microbiology. A total of 336 potential biotechnology firms were contacted. Responses were received from 168 firms (50 percent) and 27 indicated that they were not engaged in biotechnology activities, leaving 141 usable responses. The questionnaire and a summary of responses are presented in Appendix E.

There are some signs that the formation of new firms has slowed from the rapid pace of the 1970s. The peak was reached in 1981 when 26 of the respondents started operations in biotechnology (Figure 3.5). Since then there has been a pronounced fall off, with 17 firms starting in 1982 and only 4 each in 1983 and 1984. Although there appear to be more firms in the industry in 1985 than there were in 1983, we don't know the extent to which the apparent expansion is real or simply due to better identification of biotechnology firms.

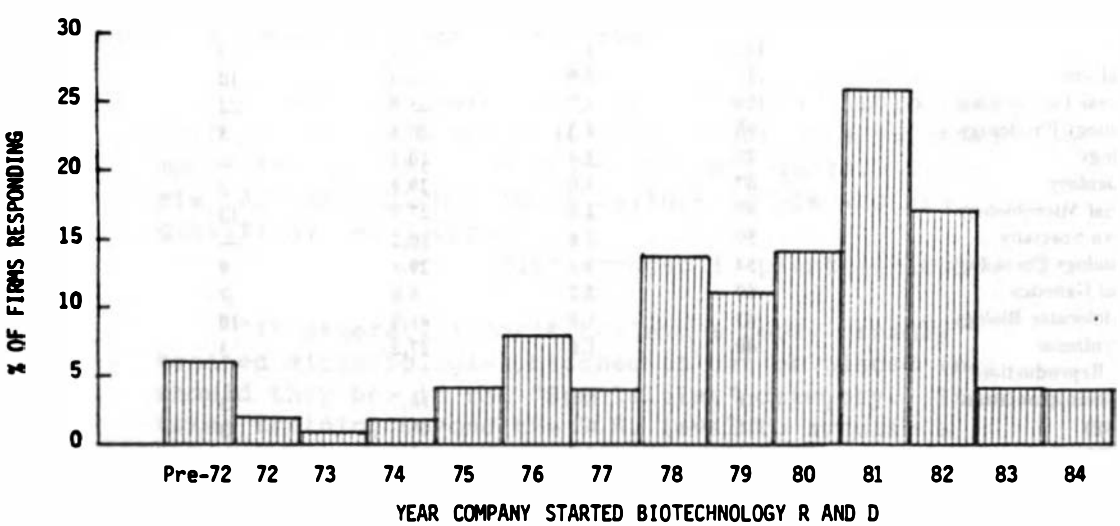

FIGURE 3.5 Percentage distribution of the year of firms' initiation of operations in the biotechnology industry. Data are from the Committee/ASM survey, 1985.

As in 1983, the most frequent area of application mentioned by the 1985 respondents was human diagnostics, followed by pharmaceuticals and fine chemicals. Among the miscellaneous applications cited were vaccines, food products, and biocosmetics.

The 1985 results indicate a substantial increase in the number of scientists employed in the biotechnology industry since 1983 (Table 3.2) despite some well-publicized layoffs and consolidations. The 141 respondents to the 1985 survey reported employment of almost 6,000 scientists of which about 38 percent held Ph.D.s, 18 percent held master's degrees, and 44 percent held bachelor's degrees. The 141 respondent firms employed 2,266 Ph.D. scientists in 1985 for an average of over 16 per firm, up from the 12 per firm reported in 1983. Based on a response rate of 50 percent, we estimate a total employment of about 12,000 scientists in the biotechnology industry in 1985, about 4,000-5,000 of which were Ph.D.s.

The top three specialties in terms of employment of Ph.D.s were recombinant DNA/molecular genetics, general biochemistry, and hybridomas/monoclonal antibodies (Table 3.2). These were also the top

TABLE 3.2 Biomedical Ph.D.s Employed by Biotechnology Firms Responding to Survey

Employment Specialties (listed in order of number of Ph.D.s employed)	Ph.D.s Employed by 141 Responding Firms		Increase Expected in 18 Months	Number of Respondents Indicating a Shortage[a]	
	N	%	%	N	%
1. Recombinant DNA/Molecular Genetics	465	20.5	26.0	26	13.8
2. Biochemistry, General	286	12.6	16.1	9	4.8
3. Hybridomas/Monoclonal Antibodies	182	8.0	35.7	16	8.5
4. Other Biotechnology Specialties	144	6.4	28.5	18	9.6
5. Microbiology. General	136	6.0	19.1	8	4.3
6. Analytic Biochemistry	128	5.6	15.6	6	3.2
7. Enzymology/Immobilized Systems	112	4.9	23.2	11	5.9
8. Cell Culture	110	4.9	16.3	10	5.3
9. Bioprocess Engineering	106	4.7	25.5	22	11.7
10. Cell Biology/Physiology	98	4.3	20.4	5	2.7
11. Toxicology	77	3.4	10.4	3	1.6
12. Pharmacology	67	3.0	29.9	3	1.6
13. Industrial Microbiology	65	2.9	27.7	13	6.9
14. Unknown Specialty	59	2.6	10.2	—	—
15. Plant Biology/Physiology	54	2.4	29.6	9	4.8
16. Classical Genetics	50	2.2	8.0	7	3.7
17. Plant Molecular Biology	43	1.9	41.9	10	5.3
18. Gene Synthesis	40	1.8	27.5	3	1.6
19. Animal Reproduction/ Embryotransplantation	18	0.8	16.7	3	1.6
20. Physiology	15	0.7	46.7	3	1.6
21. Cell Fusion	11	0.5	18.1	3	1.6
TOTAL	2,266	100.0	23.2	188	100.0

[a] Each respondent could indicate multiple shortage categories. Therefore, the number of responses in this column total more than the 83 firms reporting a shortage.

SOURCE: Committee/ASM Survey of Biotechnology Firms (1985).

three in 1983. However, the rankings of the remaining specialties have shifted somewhat since 1983. Those that have moved up in rank are other biotechnology specialties (from 8th to 4th); analytic biochemistry (from 10th to 6th); cell biology/physiology (from 14th to 10th); and toxicology (from 13th to 11th).

Among the specialties that have moved down in rank are general microbiology (from 4th to 5th); enzymology/immobilized systems (from 5th to 7th); and plant molecular biology (from 12th to 17th).

The respondent firms expect to increase their staff of Ph.D.s by more than 23 percent over the next 18 months, down from the 39 percent increase that was expected in the 1983 survey. Large increases are expected in the specialties of plant molecular biology and hybridomas/monoclonal antibodies.

From firms responding to both the 1983 and the 1985 surveys, it is possible to compare their actual hiring experience with their expectations. There were 48 such firms, and in 1983 they expected to increase their staff of Ph.D.s by over 42 percent. The actual increase was just under 20 percent.

Shortages of Specialists

More firms reported shortages of specialists in 1985 than in 1983. Almost 47 percent of the respondents said there were shortages of Ph.D.s in one or more biotechnology specialties in 1985. In 1983, only about one-third of the respondents indicated shortages of Ph.D.s.

The most frequently cited shortage category in 1985 was recombinant DNA/molecular genetics which moved up from second place in 1983 (Table 3.2). Bioprocess engineering was the second most frequently cited shortage category in 1985, followed by the category of other biotechnology specialties, within which were mentioned organic chemistry, immunodiagnostics, fermentation, microbial physiology, pharmaceutics, and teratology.

Some respondents submitted additional comments on the question of shortages. A sampling of these follows:

> "There are near zero plant molecular biologists that are really qualified. All of ours are retreaded mammalian or bacterial molecular biologists. There are near zero plant tissue culture people who are qualified. We import."
>
> A firm engaged in plant agriculture.

> "In general, I don't believe a good, broadly trained microbiologist/biochemist can be placed (nor should they be) in the "Specialties" category. It takes training beyond the B.S. level to acquire a specialty, whether it be graduate education or on-the-job experience.
>
> There is definitely a shortage of what I consider to be Ph.D. industrial microbiologists--i.e., sound microbiology background, strong in microbial physiology and some biochemical engineering savvy."
>
> A firm involved in human diagnostics and enzyme manufacturing.

"We are a developmental company just emerging as a commercial enterprise. I don't believe we can help you in your demand estimates; we share, however, a sense that growth will occur and will be rapid.

So far, people have not been our problem; money has."

A monoclonal antibody firm.

"The areas in which the plant biotechnology industry is experiencing the most difficulty in recruiting personnel is in the area of plant genetics. There is a need for scientists with a background in clinical plant genetics and breeding combined with a secondary discipline; i.e., tissue culture, cell biology, molecular biology, recombinant DNA technology, etc."

A medium size firm engaged in fine chemicals and plant agriculture.

"We are not experiencing shortages and do not anticipate staff expansion in near future. We will probably recruit about 6 Ph.D.s and 6 M.S./B.S. level staff--but specialties are not known at this time."

A large firm engaged in pharmaceuticals, animal growth hormones, human diagnostics and therapeutics.

The biotechnology industry continues to look to the academic sector as the principal supplier of trained scientists. In both the 1983 and 1985 surveys, most of the respondent firms with plans to increase their staffs over the next 18 months expected to do so by hiring from academia rather than from industry or by retraining current staff.

THE MARKET OUTLOOK

For its analysis of the academic sector, the committee has relied on a model which estimates academic demand for biomedical Ph.D.s on the basis of enrollments and R and D expenditures in colleges and universities. This follows from the knowledge that the demand for bioscience Ph.D.s in colleges and universities derives mainly from their teaching and research activities. The available data, covering the period from 1960 to 1983, suggest that academic employment is related linearly to enrollments and nonlinearly to R and D expenditures. Empirical evidence also shows a generally increasing ratio of faculty to enrollment in biomedical fields.

These observations have led to a model used in past reports in which the faculty/student ratio is specified to depend on R and D expenditures. But there are now indications that academic institutions are finding ways to compensate partially for declining enrollments which might alter previous relationships between faculty and students.

The main issue is the extent to which the future size of biomedical faculties will depend on enrollments, as we have assumed in past reports. There are various views on this issue ranging from one extreme which holds that faculty size is completely independent of enrollments, to another position which states that faculty size depends on enrollments as well as financial factors such as the availability of R and D funds. If enrollment growth is related to faculty growth, the relationship is likely to be a long-term one in that faculty size generally will not result from year-to-year changes in enrollment.

In between these extremes is the view that graduate and undergraduate enrollments may have different impacts on faculty size in the biomedical fields. Since graduate education is more faculty-intensive than undergraduate education, changes in graduate enrollment may have a greater effect on faculty size than would corresponding changes in undergraduate enrollment. The empirical evidence on the relationship between faculty size and enrollments favors the latter point of view. Faculty and undergraduate enrollments rose concurrently up to 1975, but from that point on they diverged--faculty continued to increase while undergraduate enrollments decreased (Figure 3.6a). The overall correlation between them from 1962 to 1981 is 0.898.

On the other hand, faculty and graduate enrollments are highly correlated throughout the period ($r = 0.998$, see Figure 3.6b). With only 10 observations, these two correlation values are not significantly different in a statistical sense, but the pattern shown by the time series suggests that graduate enrollments will provide a better fit as more data become available.

It is understood, of course, that correlation does not prove causation. These high correlation values merely indicate the relative strengths of the relationships over the period covered by the data.

The data appear to lend support to the proposition that biomedical Ph.D. faculty size might be more strongly related to graduate than to undergraduate enrollments. If that is the case, then a modification to our model is in order. One possibility is to give more weight to graduate students in the denominator of the faculty/student ratio. A weighting factor of three for graduate enrollments seems a reasonable approximation under the assumption that a graduate student requires three times as much faculty time as an undergraduate student. Applying this factor results in the pattern of points shown in Figure 3.7. The pattern is nonlinear and we assume that a growth curve of the Gompertz type is applicable. Thus, we have the following description of our revised model for academic demand for biomedical Ph.D.s:

$$F/WS = (K-C)\exp(-e^{a-bM}) + C$$

where: F = Ph.D.s employed by academic institutions in biomedical fields (excluding postdoctoral trainees)

WS = 0.25 US + 0.75 GS

US = 3-yr. moving average of undergraduate enrollments $= 1/3(U_t+U_{t-1}+U_{t-2})$

GS = 3-yr. moving average of graduate enrollments $= 1/3(G_t+G_{t-1}+G_{t-2})$

M = 3-yr. weighted average of R and D expenditures i.e. $M = 1/4(RD_t+2RD_{t-1}+RD_{t-2})$

K = asymptote: i.e., $F/WS \rightarrow K$ as $M \rightarrow \inf.$

C = scaling constant

a, b = parameters.

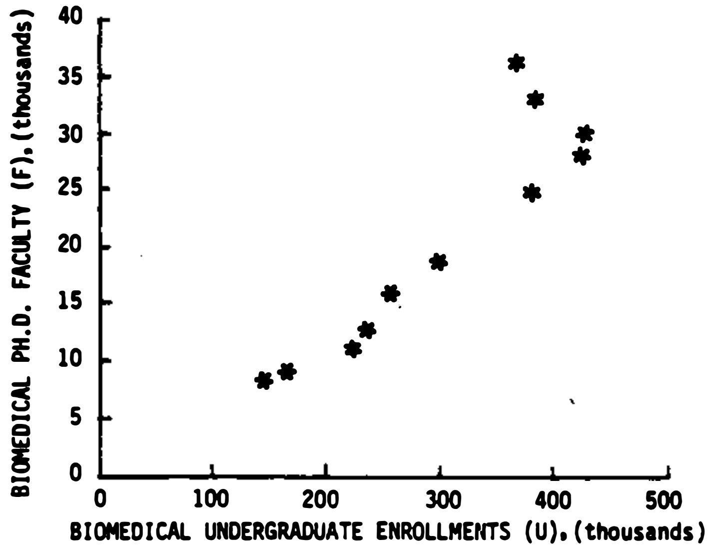

FIGURE 3.6a Biomedical science Ph.D. faculty (F) vs. biomedical undergraduate enrollments (U). Based on 11 annual observations, 1960-81. See Appendix Tables B1 and B5.

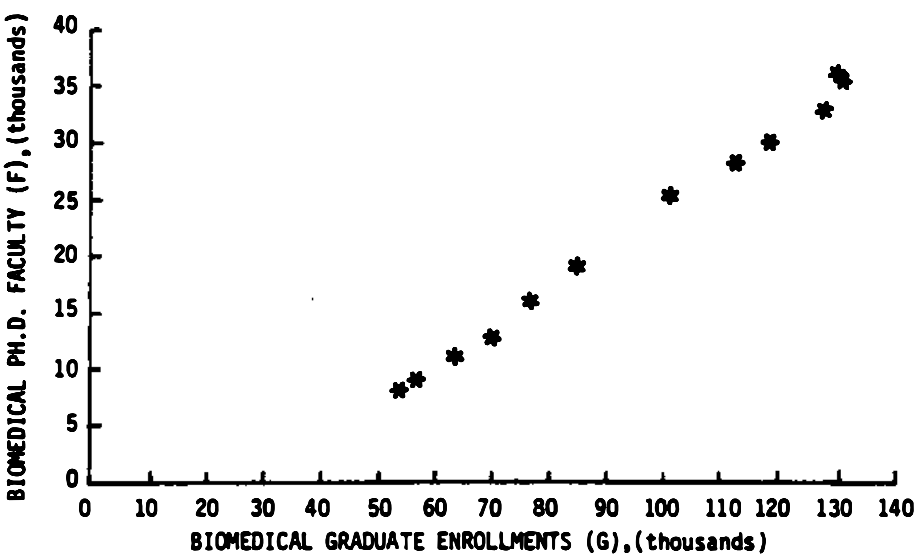

FIGURE 3.6b Biomedical science Ph.D. faculty (F) vs. biomedical graduate enrollments (G). Based on 12 annual observations, 1960-83. See Appendix Tables B1 and B5.

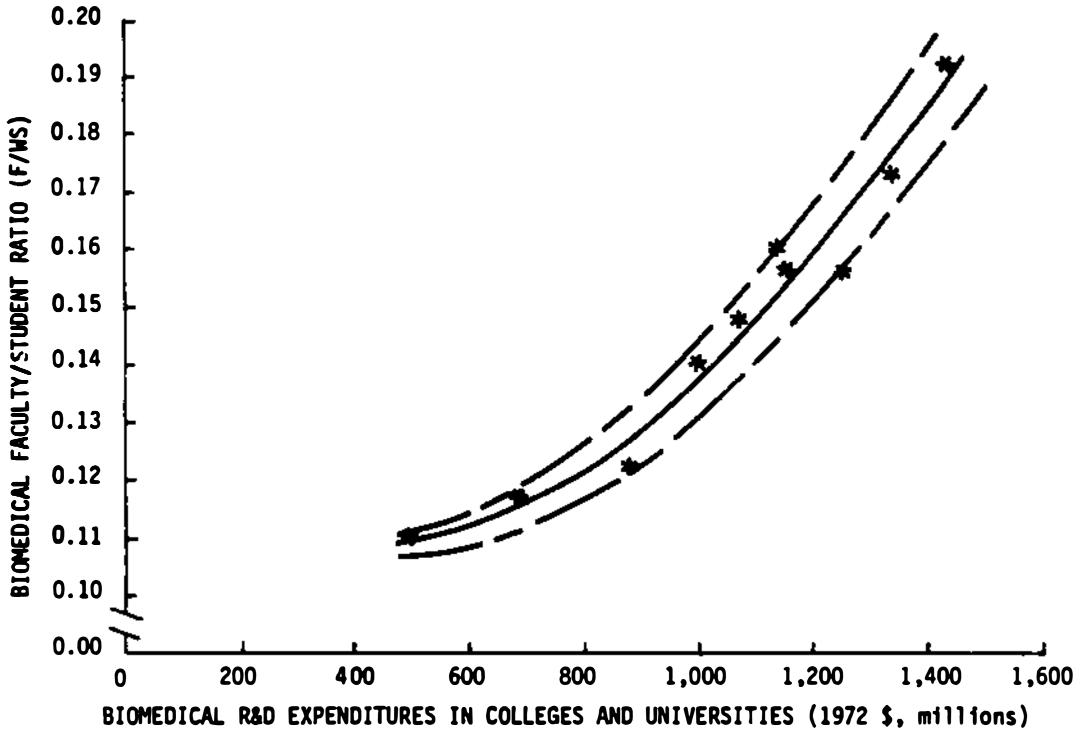

FIGURE 3.7 Biomedical Ph.D. faculty/student ratio (F/WS) vs. biomedical R and D expenditures in colleges and universities (M). The F/WS ratio is defined as the number of academically employed bioscience Ph.D.s relative to a weighted average of bioscience graduate and undergraduate enrollments (WS), where WS = 0.25 (US) + 0.75 (GS), and $(US)_t$ = 3-year moving average of undergraduate enrollments = $1/3(U_t + U_{t-1} + U_{t-2})$, and $(GS)_t$ = 3-year moving average of graduate enrollments = $1/3(G_t + G_{t-1} + G_{t-2})$. M is a 3-year weighted average of R and D expenditures, $M_t = 1/4(R_t + 2R_{t-1} + R_{t-2})$. Solid line represents a growth curve of the form $Y = (K\text{-}C)\exp(-e^{a-bx}) + C$ fitted to the data for 1962-81. Broken lines represent 95% confidence intervals on the estimated curve. See Appendix Tables B1, B5, and B9.

Fitting this model to the data from 1962-81 yields the following parameter estimates: K = 0.5, C = 0.105, a = 2.0127, b = 0.0011144. R^2 = 0.9708, inflection point at M = $1,806 (millions).

Projections of Academic Demand for Biomedical Ph.D.s

The committee's expected growth in enrollments and R and D expenditures in constant dollars through 1990 are outlined below:

	High	Middle	Low
Total bioscience enrollments	1%/yr.	-0.5%/yr.	-2%/yr.
Bioscience R and D expenditures in colleges & universities	3%/yr.	1.5%/yr.	0

Applying these growth rates to the latest data, we derive the 1990 levels under the above assumptions:

	High	Middle	Low
S = total bioscience enrollments (492,900 in 1981)	523,180	471,160	423,630
US = 3-yr. moving average of undergraduate enrollments (369,100 in 1981)	384,300	346,080	311,170
GS = 3-yr. moving average of graduate enrollments (130,800 in 1983)	140,250	126,300	113,560
RD = bioscience R and D expenditures ($1,514 mil. in 1982)	$1,890	$1,705	$1,536
M = 3 yr. weighted average of R and D ($1,477 mil. in 1982)	$1,835	$1,680	$1,536
WS = 0.25 US + 0.75 GS (189,600 in 1981)	199,274	182,160	166,313

Using these projections as input to the model, we now derive estimates of the annual number of faculty positions expected to become available each year during the period 1983-90 from expansion and attrition due to death, retirement, and other causes (field-switching and job changes). First we estimate demand created by expansion of faculty (Figure 3.8). To that we add demand created by attrition. Our attrition estimates are based on data from the Survey of Doctorate Recipients conducted every 2 years by the Office of Scientific and Engineering Personnel of the National Research Council (Table 3.3), augmented by a detailed study of faculty attrition rates by the committee on Continuity in Academic Research Performance (NRC, 1979b). Attrition rates shown in Table 3.3 are 6 percent per year for all causes in the 1981-83 period. This is up sharply from the 4.1 percent rate of the 1979-81 period (IOM, 1983b, p. 77).

Most college and university faculties expanded rapidly in the 1960s to accommodate the surge in enrollments. Growth during the 1970s and 1980s has been slower. As a result, faculty age distributions have shifted upward. In the biosciences, the proportion of academically employed Ph.D.s over age 60 has increased from 6.7 percent in 1977 to 8.6 percent in 1983 (see Appendix Table B18). Our projections indicate that this proportion will be over 12 percent by 1991. One implication of this trend is that faculty attrition rates will be higher in the late 1980s.

For projections to 1990, attrition of academically employed Ph.D.s is estimated at 1.5 percent per year due to death and retirement. In

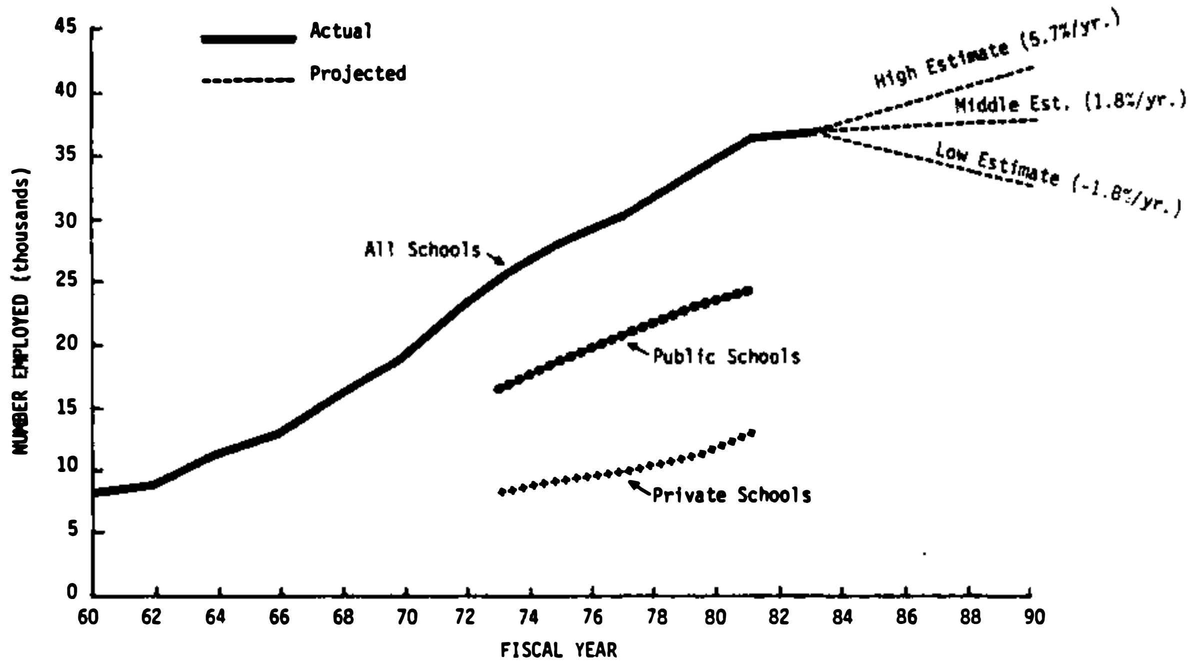

FIGURE 3.8 Ph.D.s employed in the biomedical sciences at colleges and universities, by control of institution, 1960-83, with projections to 1990. See Appendix Table B5.

the case of attrition due to other causes, we use high, middle, and low estimates of 4 percent, 3.5 percent, and 3 percent, respectively.[1]

These computations are shown in Table 3.4. The three assumptions about enrollment growth together with the three assumptions about R and D expenditures give nine combinations of assumptions to be used as input to the model.

Under the most optimistic assumptions, bioscience R and D expenditures at academic institutions would grow by 3 percent per year through 1990 (assumption I of Table 3.4), driving the F/WS ratio to 0.254.[2]

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[1]These are higher than the 1 percent and 3 percent estimates used for projections to 1988 in the last report.

[2]The 95 percent confidence limits on this estimate are 0.274 and 0.236, respectively. Since the most optimistic assumptions attempt to define an upper limit on our projections, we use the upper 95 percent confidence limit on the F/WS ratio (0.274) as the most optimistic estimate.

TABLE 3.3 Inflows and Outflows from Academic Employment for Biomedical Science Ph.D.s, 1981–83

I. *Average Annual Attrition from Academic Employment in the Biomedical Sciences 1981–83*
1. Total biomedical Ph.D.s employed in academia in 1981: 36,482
2. Leaving academic employment in the biomedical sciences each year to:

	N	% of Academic Employment
a. nonacademic sectors	904	2.5
b. postdoctoral appointments	152	0.4
c. death and retirement	432	1.2
d. unemployed	212	0.6
e. other fields[a]	462	1.3
f. total attrition	2,162	6.0

II. *Average Annual Accessions to Academic Employment in the Biomedical Sciences 1981-83*
1. Total biomedical Ph.D.s employed in academia in 1983: 36,963
2. Entering academic employment in the biomedical sciences each year from:

	N	% of Total Accessions
a. nonacademic sectors	527	21.9
b. postdoctoral appointments	1,197	49.8
c. unemployed	110	4.6
d. Ph.D. recipients 1981–82[b]	569	23.7
e. total annual accessions	2,403	100.0

III. *Balancing:* 1981 academic employment − attrition + accessions = 1983 academic employment
36,482 − 2(2,162) + 2(2,403) = 36,964[c]

[a] These individuals were all academically employed in 1981 and 1983. The number shown represents the estimated *net* outflow from biomedical fields to other fields.
[b] Based on postdoctoral plans of Ph.D. recipients, it is estimated that 70% of these new Ph.D. cohorts took a postdoctoral appointment before taking an academic position.
[c] Does not agree with line II.1 because of rounding.

SOURCES: National Research Council (1958–85, 1973–84).

We project academic demand by using the most optimistic estimate of enrollment growth--1 percent per year (assumption A in Table 3.4)--together with the estimated F/WS ratio. This produces an upper estimate of faculty size of 54,700 bioscience Ph.D.s in 1990, for a faculty growth rate of 5.7 percent per year. About 2,530 positions per year would be created by faculty expansion, 690 per year would be generated by attrition due to death and retirement, and 1,830 per year would be generated by other attrition. The total number of academic positions that would become available each year under these high growth conditions is 5,050.

TABLE 3.4 Projected Growth in Biomedical Science Ph.D. Faculty, 1983–90, 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 (493,000 students in 1981)		Assumptions about Real R&D Expenditures (in constant 1972 dollars[b]) in the Biomedical Sciences in Colleges and Universities ($1.5 billion in 1982)		
		I	II	III
		Will grow at 3%/year to $1.9 billion in 1990	Will grow at 1.5%/year to $1.7 billion in 1990	Will remain at current level ($1.5 billion) through 1990
A. Will grow at 1%/yr., reaching 523,000 students by 1990	Expected size of biomedical Ph.D. faculty (F) in 1990	54,700	45,800	38,900
	Annual growth rate in F from 1983 to 1990	5.7%	3.1%	0.7%
	Average annual increment due to faculty expansion	2,530	1,270	270
	Annual replacement needs due to:			
	death and retirement[c]	690	620	570
	other attrition[d]	1,830	1,450	1,140
	Expected number of academic positions to become available annually for biomedical Ph.D.s	5,050	3,340	1,980
B. Will decline by 0.5%/yr. to 471,000 students by 1990	Expected size of biomedical Ph.D. faculty (F) in 1990	50,000	41,900	35,500
	Annual growth rate in F from 1983 to 1990	4.4%	1.8%	−0.6%
	Average annual increment due to faculty expansion	1,860	700	−200
	Annual replacement needs due to:			
	death and retirement[c]	650	590	540
	other attrition[d]	1,740	1,380	1,090
	Expected number of academic positions to become available annually for biomedical Ph.D.s	4,250	2,670	1,430
C. Will decline by 2%/yr. to 424,000 students by 1990	Expected size of biomedical Ph.D. faculty (F) in 1990	45,600	38,200	32,400
	Annual growth rate in F from 1983 to 1990	3.0%	0.5%	−1.8%
	Average annual increment due to faculty expansion	1,240	180	−650
	Annual replacement needs due to:			
	death and retirement[c]	620	560	520
	other attrition[d]	1,650	1,320	1,040
	Expected number of academic positions to become available annually for biomedical Ph.D.s	3,510	2,060	920

[a] Faculty is defined in this table as all academically employed Ph.D.s in biomedical fields, excluding postdoctoral appointees. These projections are based on the following relationship:

$(F/WS)_t = 0.395\,[\exp(-\exp(2.013 - 0.001114M))] + 0.05$, where F = faculty; WS = weighted average of last 3 years of enrollments, i.e., $(WS)_t = 0.25(US)_t + 0.75(GS)_t$, where $(US)_t$ = 3-year moving average of bioscience undergraduate enrollments and $(GS)_t$ = 3-year moving average of bioscience graduate enrollments; M = weighted average of last 3 years of biomedical science R and D expenditures in colleges and universities, i.e., $M_t = \frac{1}{4}(R_t + 2R_{t-1} + R_{t-2})$. See Appendix Tables B1, B6, and B9.

[b] Deflated by the Implicit GNP Price Deflator, 1972 = 100.0. See Appendix Table B7.

[c] Based on an estimated replacement rate of 1.5% annually due to death and retirement.

[d] Based on high, middle, and low attrition rates of 4%, 3.5%, and 3%, respectively.

Under the middle or best-guess assumptions (II-B in Table 3.4), bioscience R and D expenditures at academic institutions would grow by 1.5 percent per year through 1990--yielding an F/WS ratio of 0.230--and bioscience enrollment would decline by 0.5 percent per year to 471,000 students by 1990. The best estimate of bioscience Ph.D. faculty size under these assumptions is 41,900, an increase of 700 positions or 1.8 percent per year over the 1983 level. Attrition would add another 1,970 positions to give a total annual academic demand of about 2,670 positions.

Under the low growth assumptions (III-C in Table 3.4), bioscience R and D expenditures at academic institutions would remain at the 1982 level through 1990 and consequently the bioscience F/WS ratio would also remain at the 1982 level of 0.207.[8] Bioscience enrollment would decline by 2 percent per year, yielding a Ph.D. faculty size in 1990 of 32,400. That represents a drop of 650 positions per year, but attrition would add 1,560, for a net demand of 920 per year.

ESTIMATING PREDOCTORAL AND POSTDOCTORAL SUPPORT LEVELS UNDER NRSA PROGRAMS

Having obtained an estimate of the size of the academic market for biomedical Ph.D.s through 1990, we are now in a position to assess the level of predoctoral and postdoctoral training needed to satisfy that demand. For this, we must consider how the system works at several crucial stages of the process by which biomedical scientists are trained and absorbed into career positions.

Postdoctoral Training Levels

The features of the postdoctoral training system which must be considered in addition to the projections of faculty growth are as follows:

1. the number of accessions to faculty positions who have (or should have) postdoctoral research training,
2. the appropriate length of the postdoctoral research training period,
3. the proportion of individuals in the postdoctoral research training pipeline who are expected to choose academic careers,
4. the proportion of support to the total pool of postdoctoral research trainees that should be provided by the federal government.

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[8]The 95 percent confidence limits on this estimate are 0.220-0.195. We use the lower limit of 0.195 to represent the most pessimistic estimate of F/WS.

It will be noted that some of these features reflect decisions by individuals regarding career choice, and in that sense they are independent of the system. However, there are other features--such as the proportion of the total support for the postdoctoral pool that should be assumed by the federal government--that can be controlled by policy and program decisions.

Using the projections of academic demand derived in Table 3.4 and the same set of conditions specified in the 1981 and 1983 reports, we calculate in Table 3.5 the range of basic biomedical science postdoctoral trainees that should be supported by NRSA programs under the specified conditions.

Line 1 of Table 3.5 is a summary of the projections of academic demand for the extreme cases and the best-guess estimate derived in Table 3.4.

Line 2 shows the number of academic positions to be filled by individuals with postdoctoral research training experience. From the data on inflows and outflows from academic employment in the biosciences between 1981 and 1983 shown in Table 3.3, we estimate that 70 percent of all vacancies will be filled by former postdoctoral trainees. In the best-guess case, this number is estimated to be 1,870 per year between 1983 and 1990.

Line 3 indicates the size of the biomedical postdoctoral pool required to supply the necessary number of individuals with postdoctoral training under certain assumptions about the length of the postdoctoral training period and the proportion of the pool seeking academic employment. Currently, bioscience Ph.D.s are typically spending about 3 years in postdoctoral appointments, up from 2 years in the early 1970s.

If the appropriate length of postdoctoral training is assumed to be 3 years, then the pool size needed to produce 1,870 trained scientists each year is three times 1,870 or 5,610. Further, if 60 percent of the trainees seek academic appointments after completing their training, then the necessary pool size must be 9,350.

Line 4 shows the estimated number of biomedical science postdoctoral trainees that should be supported annually by NRSA programs under different assumptions about the proportion of total support provided by that source. The resulting range is between 1,100 under the lowest set of assumptions, and 5,890 under the highest set. The best-guess assumptions yield a range of 3,200-4,670 postdoctoral trainees.

Predoctoral Training Levels

A similar procedure can be used to estimate the level of predoctoral training to be supplied under NRSA programs. Starting with the number of postdoctoral trainees needed under the most likely projections (Table 3.5, line 3--middle estimate), we may determine in turn the number of Ph.D.s to be produced each year, the level of graduate enrollments needed, and finally the number of predoctoral trainees that should be in the pipeline. The calculations are shown in Table 3.6. They depend on certain parameters that describe how the

TABLE 3.5 Estimated Number of Basic Biomedical Science Postdoctoral Trainees Needed to Meet Expected Academic Demand Through 1990 Under Various Conditions

	Projected 1983–90			Annual
	High Estimate	Middle Estimate	Low Estimate	Average 1981–83
1. Academic demand for biomedical Ph.D.s—annual average:	5,050	2,670	920	2,400
a. due to expansion of faculty	2,530	700	−640	240
b. due to death and retirement[a]	690	590	520	430
c. due to other attrition[b]	1,830	1,380	1,040	1,730
2. Total accession with postdoctoral research training—annual average (assuming 70% of all accessions have postdoctoral research training)	3,535	1.870	640	1,200–1,600[c]
3. Size of biomedical postdoctoral pool—annual average Size needed to meet academic demand assuming a 3-yr. training period and portion of trainees seeking academic positions is:				7,920
a. 60%	11,780	9,350	3,200	
b. 70%	10,100	8,010	2,740	
4. Annual number of biomedical postdoctoral trainees to be supported under NRSA programs:				2,855 (1981–82)
a. If 40% of pool is supported under NSRA	4,040–4,710	3.200–3,740	1,100–1,280	
b. If 50% of pool is supported under NSRA	5,050–5,890	4,000–4,670	1.370–1,600	

[a] Assumes an attrition rate due to death and retirement of 1.5% per year.
[b] Assumes replacement demand created by other attrition under the high, middle, and low estimates will be 4%, 3.5%, and 3%, respectively.
[c] Assumes that 70% of the 1981–82 Ph.D. cohorts took a postdoctoral appointment before taking an academic position. See Table 3.3.

SOURCES: Tables 3.3 and 3.4.

system works in the biomedical fields. For example, it is known that almost 70 percent of each biomedical Ph.D. cohort plans to take a postdoctoral appointment after graduation (Table 3.6, line 3). Our data also show that about 9 or 10 percent of all bioscience graduate students complete the Ph.D. program each year (Table 3.6, line 4), and that NRSA programs recently have provided support for 5 to 10 percent of bioscience predoctoral students.

Applying these system parameters, we derive the estimated number of NRSA predoctoral trainees that should be in the pipeline, given our projections of academic demand and the current status of the training system (Table 3.6, line 5). The result is a range of about 1,900-5,780 predoctoral trainees per year in the biosciences during the period 1983-90.

TABLE 3.6 Estimated Number of Basic Biomedical Science Predoctoral Trainees to be Supported Under NRSA Programs

	Projected 1983–90	Actual 1983
1. Estimated number of postdoctoral trainees needed to satisfy demand under the committee's most likely estimate (from Table 3.5)	8,010–9,350	7,827
2. Annual attrition from postdoctoral pool if average length of appointment is 3 years	2,670–3,120	2,609
3. Number of Ph.D.s needed each year to maintain postdoctoral pool level if percentage of Ph.D.s seeking a postdoctoral appointment is:		
a. 60%	4,450–5,200	3,775
b. 70%	3,810–4,460	
4. Average graduate enrollment needed to produce the required number of Ph.D.s if annual completion rate is:[a]		
a. 9%	42,330–57,780	41,532
b. 10%	38,100–52,000	
5. Number of NRSA predoctoral traineeships needed if percentage of graduate students to be supported under NRSA programs is:		
a. 5%	1,900–2,890	3,673 (1982)
b. 10%	3,810–5,780	

[a] The completion rate is defined here as the ratio of Ph.D.s awarded in any year to graduate enrollments in the same year. This ratio has varied in a narrow range generally between 0.09 and 0.1 since 1960. It is likely that many graduate students in this field are candidates for the M.A. rather than the Ph.D. degree. See Appendix Tables B1 and B3.

SOURCES: Table 3.5, Appendix Tables B1 and B3.

SUMMARY

The committee's determination of the appropriate number of trainees to be supported under NRSA programs in the basic biomedical sciences has been based on estimates of academic demand and certain assumptions about how the training system operates. Projections of demand are derived from a model in which faculty size is dependent upon enrollment and research funding. Graduate enrollment is thought to have more influence on faculty demand than undergraduate enrollment, so the previous model has been modified in this report to allocate more weight to graduate enrollment.

The resulting projections show a somewhat higher annual academic demand through 1990 compared to previous projections through 1988. This is true despite the fact that enrollment and research funding assumptions are lower than previous ones. One reason is that the most recent data for 1983 show that biomedical Ph.D. faculty has continued to grow moderately even though enrollments are declining. Therefore, the faculty/student ratio shows sharp increases in recent years, and this has the effect of raising the projections of faculty size in 1990. However, the outlook is heavily dependent on the last few data points and could change drastically with the next one or two observations.

Another reason is the increase in attrition that is expected in the late 1980s. Based on the faculty age distribution and data from another study, we now estimate attrition due to death and retirement at 1.5 percent per year through 1990, and 3.5 percent per year for other reasons. These are up from the 1.0 percent per year and 3.0 percent, respectively, that we had projected through 1988.

Finally, there is the question of predoctoral support and how to assess it in terms of national need. This task is made even more difficult by the fact that the time horizon involved in predoctoral training is longer than in postdoctoral training. Also, since practically all predoctoral support comes from training grants rather than fellowships, the issue of institutional support becomes another factor to consider along with enrollment trends, Ph.D. production, the postdoctoral pool size, alternate sources of support, and the long-term outlook. Using the parameters of the current system as guides, and with stability of the system as an important criterion, we have estimated the level of predoctoral support that NRSA programs should provide.

EVALUATION OF THE MARC HONORS UNDERGRADUATE RESEARCH TRAINING PROGRAM

The Minority Access to Research Careers (MARC) program was created by the National Institute of General Medical Sciences (NIGMS) to increase the number of biomedical scientists from minority groups. The largest component of the MARC program is the Honors Undergraduate Research Training Program. Trainees (junior and senior level honors students at schools with enrollments drawn substantially from minority groups) receive tuition and stipend support and participate in a specially structured curriculum. Exposure to ongoing research in the biomedical sciences is a central component of the training experience.

The MARC Honors program has as its principal objective the encouragement of minority students in the pursuit of graduate training leading to the Ph.D. degree. It began in 1977 with 74 trainees at 12 participating schools. By 1984, there were 389 undergraduate trainees at 52 programs involving 56 undergraduate institutions. As of August 1984, there were nearly 800 program alumni.

At the suggestion of NIGMS, this committee has undertaken an evaluation of the Honors Undergraduate Research Training Program. A complete report describing that evaluation will be published separately. The central findings of the MARC Honors Evaluation are described below.

The MARC Honors program was established in response to the small number of minority group members holding research doctorates in the biomedical sciences. Examination of the most current data on scientific employment and training demonstrates that minority group members are still underrepresented at all stages of the scientific career. While some reduction of the minority/nonminority disparity has taken place, substantial underrepresentation of minorities remains the rule.

Site visits to five MARC Honors training programs reveal a diverse array of program activities adapted to the needs of the recipient institutions and their students. The program (often working in conjunction with another NIH program, the Minority Biomedical Research Support Program) brings guest speakers to campus, develops new courses, purchases laboratory equipment, and fosters institutional connections between program schools and major research centers. Most of these activities benefit the entire scientific community on campus.

Individual trainees receive stipends and work closely with faculty members on laboratory research projects. As part of their training, they also attend scientific seminars, conferences, and meetings. A summer research project (usually at a major research university) is a significant part of the MARC Honors experience. Trainees report that the laboratory exposure and close contact with faculty members is an important part of their academic and professional development. Many credit these experiences with shaping their decision to pursue research careers.

Faculty members report high levels of motivation among the MARC Honors students and note several examples of published research by undergraduate trainees. At almost every institution, the faculty members identified highly talented students who might not have been able to finish school without the availability of MARC stipends.

Two important issues emerged from the site visits. There seems to be some disagreement over the optimal location of the trainees' summer research experience. Some MARC faculty members feel that the student is best served by continuing a research project at the home institution. Others find the benefits of external placement (personal growth as well as broader research experience) to be significant. Emphasis on external placement varies within and across program institutions.

A second issue concerns the selection of trainees. The MARC Honors program was designed explicitly to prepare students for research careers, yet many talented undergraduate science majors plan to pursue professional (but not necessarily research) careers. The question of how to treat students with professional career plans is a crucial issue in the selection of MARC Honors applicants.

A questionnaire inquiring about educational and occupational status was sent to all MARC Honors program alumni. Sixty-five percent of the 821 former trainees in the study population returned the questionnaires. Survey results show that 76.1 percent of the former trainees have enrolled in graduate programs at some point. As of November 12, 1984 (the survey reference date), 43.5 percent of the former trainees were enrolled in doctorate programs (128 in M.D. or D.D.S. programs, 86 in Ph.D. programs and 3 in M.D./Ph.D. programs). Another 15.1 percent were enrolled in master's degree programs. Since the first MARC Honors cohort graduated in 1978 (and the first full, two-year trainee cohort in 1979), there has been limited time in which to complete work on a Ph.D. degree. By the fall of 1984, 22 people from the first 3 trainee cohorts (21.2 percent) had earned doctorate degrees. Of the completed doctorates, the vast majority were M.D.s; only one respondent had completed a Ph.D. at the time of the survey. Most of the former trainees who were no longer in school were employed in science or engineering fields (62.4 percent). The unemployment rate of former trainees was 9.2 percent and was concentrated among those without graduate degrees. While exact comparisons cannot be made, the rates of graduate school attendance and employment in science fields for the former MARC Honors trainees are above the levels found in the most closely comparable national data.

Overall, 35.7 percent of the respondents expected to be in research careers by the time they are 35 years old. Among those planning careers in the health professions, a smaller fraction (13.0 percent) expected to be doing research at age 35. Only a small fraction of the former trainees (7.4 percent) expect to be in jobs unrelated to science or engineering.

The survey did not reveal any serious deficiencies in the MARC Honors program. While some students left graduate or professional programs before receiving a degree (22.2 percent), nearly half are currently enrolled in another graduate program. More students withdrew from master's degree programs than from doctorate programs. Students reported a high level of satisfaction with the MARC Honors program in general and with the research component in particular.

In an attempt to gauge the institutional impact of the MARC Honors program, the percentage of graduates majoring in biology was examined at MARC and nonMARC institutions. The percentage of biology majors has remained level since the late 1970s for minority students and has decreased for white students. At MARC schools, however, the percentage of biology majors increased (especially among minority students). Both the size and the length of the programs were associated with higher rates of degrees earned in biology. These effects persisted after the impact of other institutional characteristics were taken into consideration.

A FOLLOW-UP STUDY OF FORMER NIH POSTDOCTORAL TRAINEES AND FELLOWS

A study of the career achievements of NIH postdoctoral trainees and fellows is currently being conducted. The employment, grant, and publication activity of biomedical scientists with NIH postdoctoral appointments is being compared to that of biomedical scientists without NIH postdoctoral appointments. Due to the differences in career patterns and sources of data, separate analyses will be conducted for M.D. and Ph.D. scientists.

For Ph.D.s, the NIH group will be divided into trainees and fellows based on the terms of the most recent NIH appointment. The non-NIH group will be subdivided according to their plans for postdoctoral training at the time they completed their Ph.D.

It is expected that this follow-up study will be completed in 1986 and a separate report on it will be published by the committee.

4. Behavioral Sciences

Abstract

The academic labor market for behavioral science Ph.D.s continues to expand at a moderate rate of growth. Academic employment of Ph.D.s and post-doctoral training increased in 1983 and are higher than they were in the mid-1970s. Most of the growth has occurred in the field of clinical psychology. Behavioral Ph.D. production rebounded in 1983 from the decline in 1982, but the number of new doctorate recipients is only a slight fraction above the level recorded in the late 1970s. Concurrent with the continued expansion of the academic labor market are continuing declines in R and D funding, undergraduate enrollments, and first-year graduate enrollments. Recently, total graduate enrollments in the behavioral sciences have begun to fall. However, there appears to be a substantial amount of behavioral science courses being taught to graduate students at professional schools--public health, law, medicine, and business--which tends to increase the demand for behavioral scientists.

The shift toward clinical psychology that began in the mid-1970s is continuing. In 1977, clinical psychology became the dominant behavioral science Ph.D. employment field and now accounts for about 45 percent of the behavioral Ph.D. labor force, up from 38 percent in 1975.

INTRODUCTION AND OVERVIEW

Within the behavioral science fields, it is evident that a strong movement into clinical psychology has occurred in recent years. There has been an increase, both absolute and relative to other areas, in the number of Ph.D.s who identify themselves as clinical psychologists and in the number of new Ph.D. degrees being granted in that field. From the standpoint of the federal government's research program in the behavioral sciences, this trend is cause for some concern since most clinical psychologists work outside the academic sector and many do not contribute to the research effort. Even within the academic sector, clinical psychologists are more likely than other psychologists to be involved in the provision of services and other non-research activities. One of the principal purposes of the government's research training programs is to provide an adequate supply of scientists with current knowledge of their fields who can be relied on to carry out the agencies' research agenda competently and productively. Practically all of this research is done by Ph.D. scientists in colleges and universities, so we are especially concerned in this study about the career prospects and opportunities in the academic sector. Academic employment of behavioral science Ph.D.s has increased without interruption since the early 1960s (which is as far back as our data go). However, this growth has not been uniform throughout the behavioral sciences. Academic positions in nonclinical fields of psychology have decreased since 1981. Since the bulk of psychological research has been carried out in the academic sector by nonclinical psychologists, this trend is of some possible significance for future research. In this chapter we will examine these trends more closely and make some projections of academic demand and training needs through 1990.

As a result of suggestions made at public hearings and in private communications, the data on behavioral scientists are disaggregated in this report to a greater degree than has been done in the past. In the early work of this committee, the behavioral sciences--psychology, sociology, anthropology, and speech and hearing sciences--were treated as a single group. In 1978 the behavioral sciences were divided into clinical and nonclinical fields. This disaggregation proved helpful because it enabled the identification of divergent market trends within the behavioral sciences. In the current report we carry the disaggregation one step further and divide the nonclinical fields into nonclinical psychology and other behavioral sciences. This yields three behavioral science subdivisions:

--clinical psychology;
--nonclinical psychology; and
--other behavioral science fields (sociology, anthropology, and speech pathology/audiology).[1]

CURRENT SUPPLY/DEMAND INDICATORS

With this additional level of disaggregation, substantial differences among disciplines and education levels (graduate and undergraduate) begin to emerge. For example, undergraduate enrollments in psychology have not been subject to the decline experienced by the other behavioral fields. Here are some other highlights:

[1]The nomenclature used in the NRC surveys was changed in 1983. Speech pathology/audiology replaced speech and hearing sciences. This field is more clinically oriented than either sociology or anthropology but it is not part of clinical psychology, and is too small (113 Ph.D.s awarded in 1983) to be considered separately.

- Graduate enrollments in the behavioral sciences have been less susceptible to attrition than have undergraduate enrollments. Enrollments at the graduate level rose every year from 1978 through 1981 and only in 1983 did enrollments fall by more than a fraction of a percentage point. In 1983 graduate enrollments in psychology declined less than those in other behavioral science fields.
- R and D funding for behavioral science research decreased in 1983. Research funding for psychology did not decline, however. It remained at its 1982 level which (after adjusting for inflation) was about equal to the 1975 funding levels. The decline in R and D funding occurred in behavioral fields outside of psychology.
- Employment in the behavioral sciences continued to grow along the same lines observed in earlier reports. The self-employment and business sectors were the most rapidly expanding areas. These patterns were general across all subdivisions of the behavioral sciences. Academic employment continued to grow in 1983, but the increases were concentrated in the fields outside of psychology: sociology, anthropology, and speech pathology/audiology.
- The number of behavioral scientists on postdoctoral appointments rose in 1983. Clinical psychology had the greatest increase followed by large increases for the combined category of sociology, anthropology and speech pathology/audiology. Nonclinical psychology had fewer postdoctoral appointments in 1983 than in 1981. The number of nonclinical psychologists with postdoctoral appointments fell to its lowest level since the committee began monitoring these data. While some of these shifts may be due to sampling fluctuations,[2] the change could signal an imporant decline in research potential. Clinical psychologists on postdoctoral appointments are often being trained in clinical skills; nonclinical psychologists on postdoctoral appointments are more likely to augment the pool of researchers in the behavioral sciences.

In the following sections the supply and demand outlook for behavioral scientists is examined in greater detail.

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[2]The data on the Ph.D. labor force came from a 16 percent sample of the doctorate population. See NRC, 1985 for a discussion of sampling error.

Enrollments (Tables 4.1-4.3 and Figure 4.1)

Total enrollments in the behavioral sciences (graduate and undergraduate) declined steadily from 1976 through 1980 (Table 4.1, line 4a).[3] In 1981, the downward trend was halted and behavioral science enrollments rose for the first time since the early 1970s. The long-term decline in enrollments is due exclusively to trends for undergraduate majors. Graduate enrollments in the behavioral sciences increased during the late 1970s and have remained stable (near 64,000) since 1978. Only in 1983 was there a non-trivial decline in behavioral science graduate enrollments.

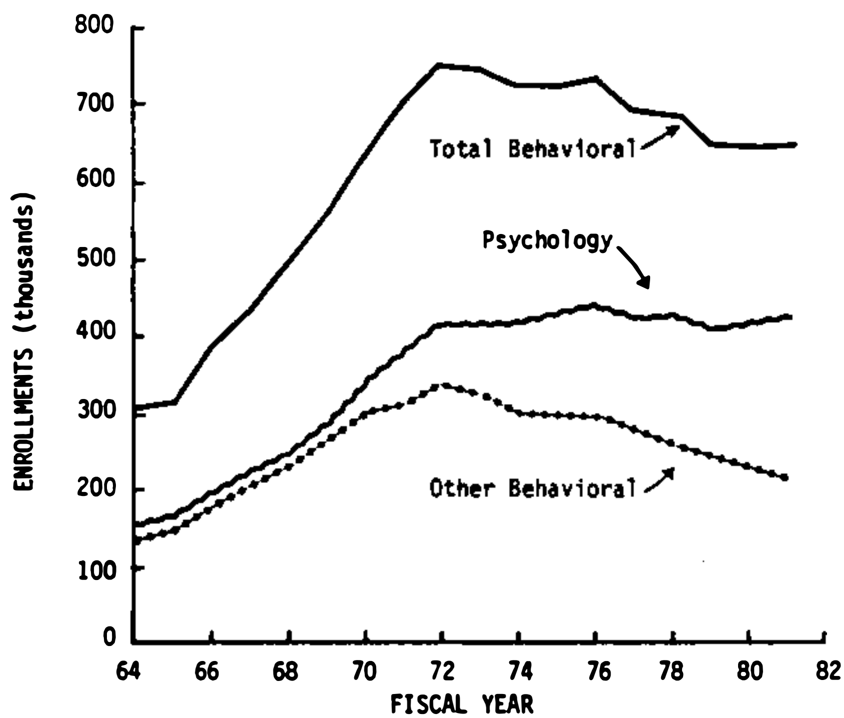

FIGURE 4.1 Behavioral science undergraduate and graduate enrollments in colleges and universities, 1964-81. See Appendix Tables C1, C4-C8.

[3]The enrollment data in Tables 4.1 through 4.3 come from two sources. Undergraduate enrollments are estimated from U.S. Department of Education Higher Education General Information Surveys (HEGIS). Graduate enrollments are from National Science Foundation Surveys of Graduate Students and Postdoctorals.

TABLE 4.1 Current Trends in Supply/Demand Indicators for Behavorial Science Ph.D.s[a]

	Fiscal Year 1975	1976	1977	1978	1979	1980	1981	1982	1983	Growth Rate from 1975 to Latest Year	Latest Annual Change
1. SUPPLY INDICATORS (New Entrants):											
a. Ph.D. production	3,938	4,190	4,246	4,207	4,245	4,192	4,472	4,188	4,318	1.2%	3.1%
b. % of Ph.D.s without specific employment prospects at graduation	13.3%	15.0%	15.6%	16.7%	15.5%	14.9%	14.6%	16.5%	18.4%	4.1%	11.5%
c. Postdoctoral appointments	705	n/a	997	n/a	1,111	n/a	972	n/a	1,039	5.0%	3.4%
d. B.A. degrees awarded	92,609	87,446	81,491	75,899	71,109	68,859	65,733	64,386	n/a	−5.1%	−2.1%
2. DEMAND INDICATORS:											
a. Behavioral science R and D expenditures in colleges and universities (1972 $, mil.)	117.2	107.6	103.8	103.0	105.7	111.9	114.6	102.1	99.3	−2.1%	−2.7%
b. Ph.D. faculty/student ratio[b]	0.032	n/a	0.036	n/a	0.039	n/a	0.043	n/a	n/a	5.0%	5.0%
3. LABOR FORCE:[c]											
Ph.D.s employed in behavioral science fields:											
a. Total	38,737	n/a	44,283	n/a	49,322	n/a	53,815	n/a	58,811	5.4%	4.5%
b. Academic (excl. postdocs.)	23,624	n/a	25,582	n/a	26,896	n/a	28,235	n/a	29,776	2.9%	2.7%
c. Business	1,404	n/a	1,793	n/a	1,901	n/a	2,764	n/a	3,390	11.6%	10.7%
d. Government[d]	2,632	n/a	2,931	n/a	3,288	n/a	3,351	n/a	3,559	3.8%	3.1%
e. Hospitals/clinics	4,936	n/a	5,595	n/a	6,157	n/a	6,481	n/a	6,584	3.7%	0.8%
f. Nonprofit	1,161	n/a	1,487	n/a	2,164	n/a	2,120	n/a	1,865	6.1%	−6.2%
g. Self-employed	2,748	n/a	3,725	n/a	5,209	n/a	7,352	n/a	9,707	17.1%	14.9%
h. Other (incl. postdocs.)	1,843	n/a	2,416	n/a	2,958	n/a	2,780	n/a	3,017	6.4%	4.2%
i. Unemployed and seeking	389	n/a	754	n/a	749	n/a	732	n/a	913	11.3%	11.7%
4. BEHAVIORAL SCIENCE ENROLLMENTS:											
a. Total undergraduate and graduate enrollments	723,000	731,000	693,000	684,000	651,000	645,000	647,000	n/a	n/a	−1.8%	0.3%
b. Est. undergraduate[e]	668,000	672,000	635,000	620,000	587,000	581,000	583,000	n/a	n/a	−2.2%	0.3%
c. Total graduate	55,383	59,056	58,289	63,780	63,801	63,820	64,780	64,331	63,108	1.6%	−1.9%
d. First-year graduate[f]	12,028	11,821	11,606	11,695	10,390	9,938	10,227	9,846	9,650	−2.7%	−2.0%

[a] Behavioral sciences include anthropology, sociology, psychology, and speech pathology/audiology. Numbers in the report may differ from previous reports because of taxonomy changes. Speech pathology/audiology was excluded in the committee's 1983 report, but is included here. See footnote 1 to this chapter.

[b] Ratio of academically employed Ph.D.s to a 4-year weighted average of total graduate and undergraduate enrollments (WS), where $(WS)_i = \frac{1}{6}(S_i + 2S_{i-1} + 2S_{i-2} + S_{i-3})$.

[c] Since labor force data are not available for 1982, latest annual change represents average annual growth rate from 1981–83.

[d] Also includes FFRDC laboratories.

[e] Estimated by the formula $U_i = (A_{i+2}/B_{i+2})C_i$, where U_i = behavioral science undergraduate enrollment 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 enrollment in year i. The FY 1981 figure is a preliminary estimate.

[f] Represents full-time students in doctorate-granting insitutions only.

SOURCES: NRC (1958–85, 1973–84); NSF (1973–85a, 1975–85); U.S. Department of Education (1948–81, 1948–84, 1959–79, 1961–84a, 1961–84b, 1973–82, 1974–83).

TABLE 4.2 Current Trends in Supply/Demand Indicators for Clinical and Nonclinical Psychology Ph.D.s

	Fiscal Year									Growth Rate from 1975 to Latest Year	Latest Annual Change
	1975	1976	1977	1978	1979	1980	1981	1982	1983		
1. SUPPLY INDICATORS (New Entrants):											
Nonclinical Psychology:											
a. Ph.D. production	1,607	1,590	1,637	1,591	1,582	1,517	1,615	1,477	1,545	−0.5%	4.6%
b. % of Ph.D.s without specific employment prospects at graduation	13.1%	16.3%	15.5%	16.3%	14.6%	13.1%	12.2%	15.6%	16.3%	2.8%	4.5%
c. Postdoctoral appointments	398	n/a	394	n/a	527	n/a	511	n/a	302	−4.4%	−23.1%
Clinical Psychology:											
d. Ph.D. production	1,144	1,293	1,353	1,464	1,509	1,581	1,743	1,681	1,762	5.5%	4.8%
e. % of Ph.D.s without specific employment prospects at graduation	14.7%	14.8%	16.0%	17.6%	16.3%	14.6%	14.8%	15.7%	16.9%	1.8%	7.6%
f. Postdoctoral appointments	156	n/a	357	n/a	302	n/a	262	n/a	466	14.7%	33.4%
2. DEMAND INDICATOR:											
a. Psychology R&D at colleges and universities (1972 $, mil.)	63.1	58.2	60.1	59.0	60.7	62.3	65.9	63.7	63.6	0.1%	−0.2%
3. LABOR FORCE:[a]											
Ph.D.s employed in nonclinical psychology fields:											
a. Total	15,387	n/a	16,102	n/a	16,688	n/a	18,791	n/a	19,431	3.0%	1.7%
b. Academic (excl. postdocs.)	10,863	n/a	10,905	n/a	11,538	n/a	12,586	n/a	12,404	1.7%	−0.7%
c. Business	1,218	n/a	1,344	n/a	1,355	n/a	1,827	n/a	2,258	8.0%	11.2%
d. Government[b]	1,170	n/a	1,404	n/a	1,164	n/a	1,235	n/a	1,320	1.5%	3.4%
e. Hospitals/clinics	470	n/a	447	n/a	401	n/a	905	n/a	1,328	13.9%	21.1%
f. Nonprofit	560	n/a	519	n/a	574	n/a	507	n/a	629	1.5%	11.4%
g. Self-employed	401	n/a	443	n/a	321	n/a	631	n/a	451	1.5%	−15.5%
h. Other (incl. postdocs.)	527	n/a	649	n/a	961	n/a	806	n/a	635	2.4%	−11.2%
i. Unemployed and seeking	178	n/a	391	n/a	374	n/a	294	n/a	406	10.9%	17.5%
Ph.D.s employed in clinical psychology fields:											
j. Total	14,846	n/a	17,578	n/a	21,268	n/a	23,775	n/a	26,285	7.4%	5.1%
k. Academic (excl. postdocs.)	5,140	n/a	5,438	n/a	5,790	n/a	6,172	n/a	6,370	2.7%	1.6%
l. Business	165	n/a	409	n/a	417	n/a	880	n/a	1,004	25.3%	6.8%
m. Government[b]	1,252	n/a	1,216	n/a	1,671	n/a	1,653	n/a	1,854	5.0%	5.9%
n. Hospitals/clinics	4,425	n/a	5,102	n/a	5,702	n/a	5,937	n/a	5,737	3.3%	−1.7%
o. Nonprofit	363	n/a	662	n/a	1,093	n/a	1,032	n/a	1,165	15.7%	6.2%
p. Self-employed	2,292	n/a	3,201	n/a	4,785	n/a	6,264	n/a	7,999	16.9%	13.0%
q. Other (incl. postdocs.)	1,151	n/a	1,468	n/a	1,674	n/a	1,629	n/a	1,995	7.1%	10.7%
r. Unemployed and seeking	58	n/a	82	n/a	136	n/a	208	n/a	161	13.6%	−12.0%
4. PSYCHOLOGY ENROLLMENTS:											
a. Total undergraduate and graduate	425,000	434,000	419,000	422,000	408,000	415,000	426,000	n/a	n/a	0.04%	2.7%
b. Est. undergraduate[c]	392,000	399,000	384,000	383,000	369,000	375,000	385,000	n/a	n/a	−0.3%	2.7%
c. Total graduate	32,794	35,318	35,363	38,628	39,207	39,786	40,636	40,691	40,098	2.5%	−1.5%
d. Est. nonclinical graduate	17,954	18,393	18,099	18,915	18,856	18,608	18,985	19,039	18,761	0.6%	−1.5%
e. Est. clinical graduate	14,840	16,925	17,264	19,713	20,351	21,178	21,651	21,652	21,337	4.6%	−1.5%

[a] Since labor force data are not available for 1982, latest annual change represents average annual growth rate from 1981–83.
[b] Also includes FFRDC laboratories.
[c] Estimated by the formula $U_i = (A_{i+2}/B_{i+2})C_i$, where U_i = psychology undergraduate enrollment in year i; A_{i+2} = psychology B.A. degrees awarded in year i+2; B_{i+2} = total B.A. degrees awarded in year i+2; C_i = total undergraduate enrollment in year i. The FY 1981 figure is a preliminary estimate.

SOURCES: NRC (1958–85, 1973–84); NSF (1973–85a, 1975–85); U.S. Department of Education (1948–81, 1948–84, 1959–79, 1961–84a, 1961–84b, 1973–82, 1974–83).

TABLE 4.3 Current Trends in Supply/Demand Indicators for Other Behavorial Science Ph.D.s (Sociology, Anthropology, Speech Pathology/Audiology)

	Fiscal Year									Growth Rate from 1975 to Latest Year	Latest Annual Change
	1975	1976	1977	1978	1979	1980	1981	1982	1983		
1. SUPPLY INDICATORS (New Entrants):											
a. Ph.D. production	1,187	1,307	1,256	1,152	1,154	1,094	1,114	1,030	1,011	−2.0%	−1.8%
b. % of Ph.D.s without specific employment prospects at graduation	12.3%	13.3%	15.3%	16.3%	15.7%	17.3%	17.7%	19.2%	23.9%	8.7%	24.5%
c. Postdoctoral appointments	151	n/a	246	n/a	282	n/a	199	n/a	271	7.6%	16.7%
d. B.A. degrees awarded	3,732	3,925	3,864	3,551	3,554	3,576	3,445	3,446	n/a	−1.1%	0.03%
2. DEMAND INDICATOR:											
a. Sociology R and D expenditures in colleges and universities (1972 $, mil.)	54.0	49.5	43.7	44.0	45.0	49.6	48.7	38.3	35.6	−5.1%	−7.1%
3. LABOR FORCE:[a] Ph.D.s employed in other behavioral science fields:											
a. Total	8,504	n/a	10,603	n/a	11,366	n/a	11,249	n/a	13,095	5.5%	7.9%
b. Academic (excl. postdocs.)	7,621	n/a	9,239	n/a	9,568	n/a	9,477	n/a	11,002	4.7%	7.7%
c. Business	21	n/a	40	n/a	129	n/a	57	n/a	128	25.3%	49.9%
d. Government[b]	210	n/a	311	n/a	453	n/a	463	n/a	385	7.9%	−8.8%
e. Hospitals/clinics	41	n/a	46	n/a	54	n/a	37	n/a	218	23.2%	142.7%
f. Nonprofit	238	n/a	306	n/a	497	n/a	457	n/a	249	0.6%	−26.2%
g. Self-employed	55	n/a	81	n/a	103	n/a	183	n/a	380	27.3%	44.1%
h. Other (incl. postdocs.)	165	n/a	299	n/a	323	n/a	345	n/a	387	11.2%	5.9%
i. Unemployed and seeking	153	n/a	281	n/a	239	n/a	230	n/a	346	10.7%	22.7%
4. OTHER BEHAVIORAL SCIENCE ENROLLMENTS:											
a. Total undergraduate and graduate enrollments	299,000	297,000	274,000	262,000	243,000	230,000	221,000	n/a	n/a	−4.9%	−3.9%
b. Est. undergraduate[c]	276,000	273,000	251,000	237,000	218,000	206,000	197,000	n/a	n/a	−5.5%	−4.4%
c. Graduate	22,589	23,738	22,926	25,152	24,594	24,034	24,144	23,640	23,010	0.2%	−2.7%

[a] Since labor force data are not available for 1982, latest annual change represents average annual growth rate from 1981–83.

[b] Also includes FFRDC laboratories.

[c] Estimated by the formula $U_i = (A_{i+2}/B_{i+2})C_i$, where U_i = other behavioral science undergraduate enrollment in year i; A_{i+2} = other 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 enrollment in year i. The FY 1981 figure is a preliminary estimate.

SOURCES: NRC (1958–85, 1973–84); NSF (1973–85a, 1975–85); U.S. Department of Education (1948–81, 1948–84, 1959–79, 1961–84a, 1961–84b, 1973–82, 1974–83).

Psychology Enrollments

Most of the decrease in behavioral science enrollments is found in disciplines other than psychology. Psychology enrollments have been very stable since 1975 while enrollments in the other behavioral sciences have declined (Figure 4.1). Total psychology enrollment (graduate and undergraduate combined) was approximately 425,000 in 1975 and approximately 426,000 in 1981 (Table 4.2, line 4a). Undergraduate psychology enrollments declined in 1977, 1978, and 1979 and rose again in 1980 and 1981. At the same time that undergraduate enrollments were declining, graduate enrollments in psychology rose. The number of psychology graduate students grew rapidly from 1975 through 1978 and smaller gains in enrollments continued through 1982. Only in 1983 did the graduate enrollments in psychology decline.

Almost all of the growth in psychology graduate enrollments was due to students in clinical specialties. The clinical fields grew each year from 1975 through 1982. During this period the average growth rate for clinical psychology enrollments was 5.6 percent (Table 4.2, line 4e). In more recent years the clinical growth rate has slowed. Nonclinical psychology graduate enrollments have been extremely stable, rising from 17,954 in 1975 to 19,039 in 1982 (Table 4.2, line 4d). In 1983 both clinical and nonclinical psychology graduate enrollments fell by 1.5 percent.

Other Behavioral Science Enrollments

Total graduate and undergraduate enrollments in behavioral science disciplines other than psychology have declined steadily since 1975. The rate of decline in recent years is only slightly smaller than the average decline over the entire period (Table 4.3, line 4a). Most of the decline is due to trends in undergraduate enrollments which fell from 276,000 in 1975 to 197,000 in 1981. Graduate enrollments in these behavioral science fields rose at the end of the 1970s and have begun to fall in 1982 and 1983. Over the entire 1975 to 1983 period, the average growth rate for other behavioral science graduate enrollments has been 0.2 percent (Table 4.3, line 4c).

In summary, the trends in behavioral science enrollments vary by field and by educational level. Undergraduate enrollments have fallen. This decline is less pronounced in psychology and more concentrated in the other behavioral science fields. Graduate enrollments increased in the late 1970s and have not declined appreciably in recent years. Most of the expansion in graduate enrollments has been due to the growing number of graduate students in clinical psychology.

Reliability of Behavioral Science Undergraduate Enrollment Estimates

In the preceding discussion, the estimates of undergraduate enrollments were based on earned baccalaureate degrees and thus tend to measure the number of students majoring in behavioral sciences. Some observers have suggested that the role of the behavioral sciences in undergraduate education may be underestimated by relying on number of majors rather than on number of course enrollments. The argument is based on the view that behavioral science courses are frequently taken as requirements or electives by non-majors. Thus, the proportion of students in behavioral science courses may exceed the proportion of behavioral science majors and it is possible that the committee's estimates of enrollments in these fields underestimate the true teaching loads. We have undertaken an examination of that possibility.

Course enrollment data are not collected in a systematic and comprehensive manner by federal agencies. However, a 1982 survey by the American Council on Education (ACE) collected course enrollment data in science, engineering, and the humanities for the fall of 1980 (Atelsek and Anderson, 1982). The ACE data were obtained from a stratified sample of 698 institutions, of which 498 (71 percent) provided usable responses.

The hypothesis that the number of behavioral science majors is not a good estimator of teaching loads in these fields can be tested by comparing course enrollments with the number of B.A. degrees granted in each field. If the service load is heavy, course enrollments in a field--expressed as a percentage of total course enrollments--should be greater than B.A. degrees in the field--expressed as a percentage of total B.A. degrees. In other words, one would expect that for fields with heavy service loads:

$$\frac{CE_i}{CE_T} > \frac{BA_i}{BA_T}$$

where:

CE_i = course enrollments in field i
CE_T = total course enrollments in all fields
BA_i = B.A. degrees awarded in field i
BA_T = total B.A. degrees awarded.

The relevant data are shown in Table 4.4. Course enrollment data are shown for fall 1980 and B.A. degrees are shown for 1982. Note that in math and English, fields known for high service loads, the shares of undergraduate course enrollments are much higher than the shares of bachelor's degrees. In the behavioral fields that is not the case.

TABLE 4.4 Course Enrollments and B.A. Degrees in Science and Humanities Fields

	Undergraduate Student Credit Hours, Fall 1980[a] (thousands)						B.A. Degrees Awarded in 1982	
	Total		Lower Division		Upper Division			
	N	%	N	%	N	%	N	%
TOTAL	69,931	100.0	56,481	100.0	13,450	100.0	388,080	100.0
Subtotal for Science and Engineering Fields	48,967	70.0	38,226	67.7	10,741	79.9	321,785	82.9
Chemistry	3,503	5.0	2,957	5.2	547	4.1	11,055	2.8
Computer Science	2,670	3.8	2,204	3.9	466	3.5	20,267	5.2
Earth Sciences	1,567	2.2	1,280	2.3	287	2.1	6,688	1.7
Engineering	3,361	4.8	1,233	2.2	2,128	15.8	66,513	17.1
Engineering Technology	1,615	2.3	1,366	2.4	249	1.8	12,984	3.3
Life Sciences	6,745	9.6	5,109	9.0	1,637	12.2	59,081	15.2
Mathematical Sciences	9,834	14.1	8,959	15.9	876	6.5	11,599	3.0
Physics/Astronomy	2,656	3.8	2,322	4.1	334	2.5	6,302	1.6
Psychology	5,835	8.3	4,432	7.8	1,403	10.4	40,950	10.6
Social Sciences (Basic)	11,179	16.0	8,364	14.8	2,815	20.9	86,346	22.2
Subtotal for Four Humanities Fields	20,965	30.0	18,256	32.3	2,709	20.1	66,295	17.1
English & Amer. Lit.	11,267	16.1	10,166	18.0	1,101	8.2	36,768	9.5
History	4,538	6.5	3,738	6.6	800	5.9	17,146	4.4
Modern Languages	3,289	4.7	2,822	5.0	467	3.5	8,990	2.3
Philosophy	1,871	2.7	1,529	2.7	341	2.5	3,391	0.9

[a] Defined as the credit value of a course multiplied by the number of students registered for that course.

SOURCES: Atelsek and Anderson (1982); U.S. Department of Education (1948–84).

In psychology, $\frac{CE_i}{CE_T} = 8.3\%$ and $\frac{BA_i}{BA_T} = 10.6\%$

In the social sciences,* $\frac{CE_i}{CE_T} = 16.0\%$ compared to $\frac{BA_i}{BA_T} = 22.2\%$

These data do not seem to support the hypothesis that the service load in behavioral fields when measured by course enrollments is greater than when measured by majors. However, more conclusive evidence may be needed. The data cover only a single year and perhaps the relationships have been changing over time.

At the graduate level, the situation may be different. There appears to be a substantial number of behavioral sciences courses being offered to graduate students in professional schools such as public health, law, medicine, and business. In schools of public health, for example, the accreditation rules require behavioral science courses to be included in the core curriculum. In business schools, courses are offered in marketing and industrial psychology, and sociology of organizations. Law students may take courses in research on jury selection, and medical students are offered courses in psychopathology, death and dying, and public health.

Ph.D. Production (Tables 4.1-4.3 and Figure 4.2)

In 1983, 4,318 Ph.D.s were granted in the behavioral sciences (Table 4.1, line 1a). This represents an increase of 3.1 percent over the 1982 level. All of the growth in behavioral science Ph.D. production is due to the rising number of psychology Ph.D.s (Table 4.2, lines 1a and 1d). The number of new Ph.D.s in clinical psychology rose by 4.8 percent in 1983; the rate of increase for nonclinical psychology Ph.D.s was only slightly lower (4.6 percent). In both cases the 1983 gains reversed the drop in Ph.D. production observed in 1982. It is only when long-term growth--e.g., 1975 to present--is considered that a difference between clinical and nonclinical psychology Ph.D. production is found (Figure 4.2). The number of new doctorates in clinical psychology had a growth rate of 5.5 percent, while in nonclinical areas of psychology the rate of growth was -0.5 percent.

In the behavioral science fields other than psychology there was a decline in Ph.D. production in 1983. The number of new Ph.D.s fell from 1,030 in 1982 to 1,011 in 1983 (Table 4.3, line 1a). This decline of 1.8 percent is roughly equivalent to the annual rate of change from 1975 through 1983.

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*The following fields were included in the social sciences in the ACE survey: agricultural economics, anthropology, archeology, economics, geography, history of science, linguistics, political science, and sociology.

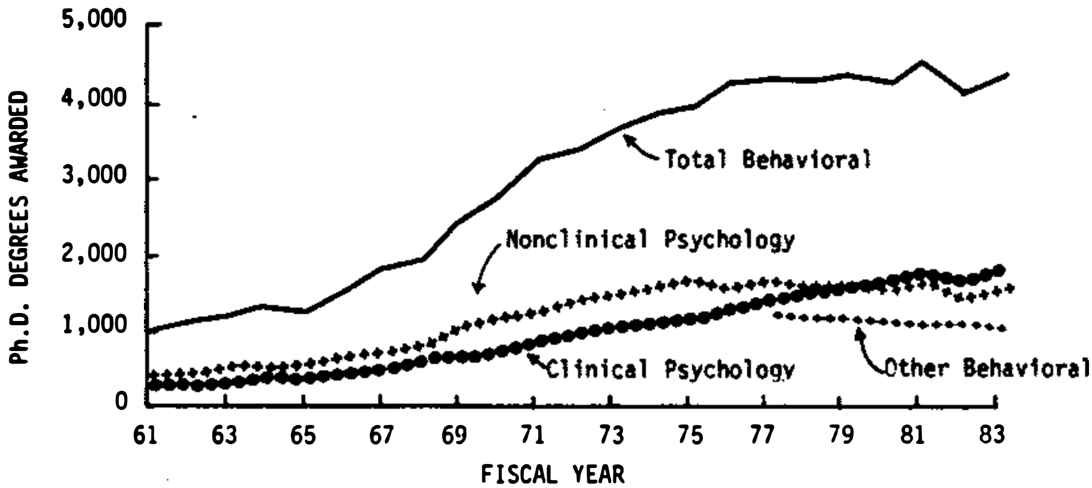

FIGURE 4.2 Ph.D. degrees awarded in behavioral science fields, 1961-83. See Appendix Table C10.

The estimation of the supply of behavioral researchers is further complicated by the rise of autonomous (so called "professional") schools of psychology. As research training is not generally a focus of the curricula of these schools, it seems reasonable to assume that they contribute to the number of individuals seeking employment in psychological service, and add little or nothing to the supply of research scientists in psychology. A report published in 1982 counted 43 schools of professional psychology. Nineteen offer the Ph.D. degree, 21 offer the Psy.D. (Doctor of Psychology), and 3 offer both degrees (McNett, 1982). Only Ph.D. recipients are included in the present discussion of trends in the behavioral sciences. As a result, our figures will not be the same as those which include Psy.D. degree holders.

The exclusion of Psy.D. degree holders does not completely eliminate the graduates of these schools of professonal psychology from our tabulation of psychologists. All schools granting the Ph.D. degree are included in our figures. Four large professional schools offering the Ph.D. degree produced 148 clinical psychology Ph.D.s in 1984 and 6 nonclinical Ph.D.s. The 148 clinical psychology Ph.D.s represent 8.6 percent of all Ph.D.s granted during the year. Other unidentified schools of professional psychology also add to the supply of clinical Ph.D.s. Thus, the number of researchers in psychology included in our data on the Ph.D. labor force may be overestimated due to the presence of Ph.D. holders from schools whose curriculum has little research emphasis.

Postdoctoral Appointments (Tables 4.1-4.3 and Figure 4.3)

The number of behavioral scientists on postdoctoral appointments rose from 1981 to 1983, reversing the pattern of the previous two-year period. In 1981, there were 972 behavioral science postdoctoral appointments. By 1983 this number reached 1,039, an increase of 3.4 percent (Table 4.1, line 1c). The growth rate for postdoctoral appointments during the 1975 to 1983 period was 5 percent, over four times the rate of growth for behavioral science Ph.D.s.

As was the case with graduate enrollments and Ph.D. production, the greatest growth in postdoctoral appointments is found in clinical psychology (Figure 4.3). The number of clinical psychologists on postdoctoral appointments rose from 262 in 1981 to 466 in 1983 (Table 4.2, line 1f). This rapid rate of postdoctoral growth (33.4 percent) outstripped the growth rate for new Ph.D.s. in clinical psychology. These new Ph.D.s, it may be assumed, contribute mainly to the supply of clinical service providers and add less to the supply of research scientists.

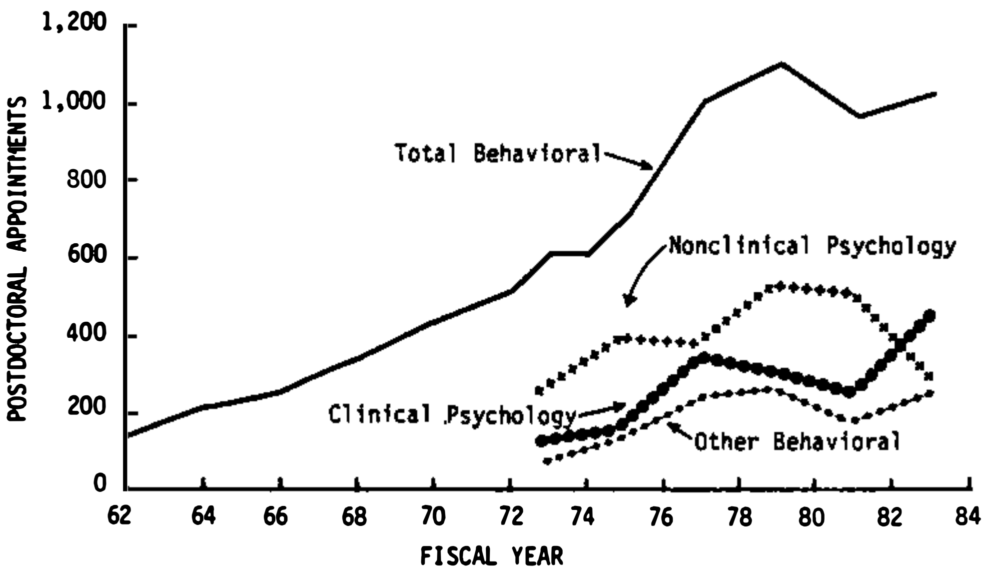

FIGURE 4.3 Postdoctoral appointments in behavioral science fields, 1962-83. See Appendix Table C3.

The number of nonclinical psychologists on postdoctoral appointments fell from 511 in 1981 to 302 in 1983 (Table 4.2, line 1c). The decline in postdoctoral appointments was far greater than the decline in Ph.D. production for the same time period. In 1975 the majority of the psychologists on postdoctoral appointments were from nonclinical fields. By 1983, there were more clinical than nonclinical psychologists holding postdoctoral appointments, a reversal of the 1975 pattern.

In the other behavioral sciences, the number of postdoctoral appointments rose sharply during the 1981-83 period while the number of new Ph.D.s declined. The growth rate for postdoctoral appointments was 16.7 percent while the number of Ph.D.s produced dropped by 2 percent.

R and D Expenditures (Tables 4.1-4.3 and Figure 4.4)

Behavioral science research and development expenditures at colleges and universities declined in 1983 by 2.7 percent from the 1982 level. This represents a smaller decline than the one recorded in the previous year (Table 4.1, line 2a). Behavioral science R and D expenditures declined in the late 1970s (from $117.2 million in 1975 to $103.0 million[5] in 1978), rose in 1979, 1980, and 1981, before dropping again in 1982 and 1983 (Figure 4.4). The 1981 funding level ($99.3 million) is below the 1975 funding level after adjusting for inflation.

Research and development expenditures for psychology show little change between 1982 and 1983 (Table 4.2, line 2a). The $63.6 million (in constant 1972 dollars) that universities spent on psychology R and D in 1983 is just $.5 million above the 1975 level. While there were some fluctuations during the intervening years, the growth rate from 1975 to 1983 was 0.1 percent.

R and D expenditures in sociology have declined during the same period. Funding declined from $38.3 million in 1981 to $35.6 million in 1983, a loss of 7.1 percent. The 1983 R and D figure is well below the $54.0 million reported in 1975 (Table 4.3, line 2a). Sociology R and D expenditures declined in 1976 and 1977, rose in 1979 and 1980, and then declined again (1981 through 1983). Over the entire period the average annual decline in funding was 5.1 percent.

Employment Sectors (Tables 4.1-4.3)

For the total behavioral science population (regardless of field), the number of Ph.D.s increased during 1983 in every employment sector except nonprofit corporations (Table 4.1, lines 3a-i). The largest gains over 1981 were in self-employment (up 14.9 percent) and business

[5]These and all other R and D expenditure figures refer to constant 1972 dollars.

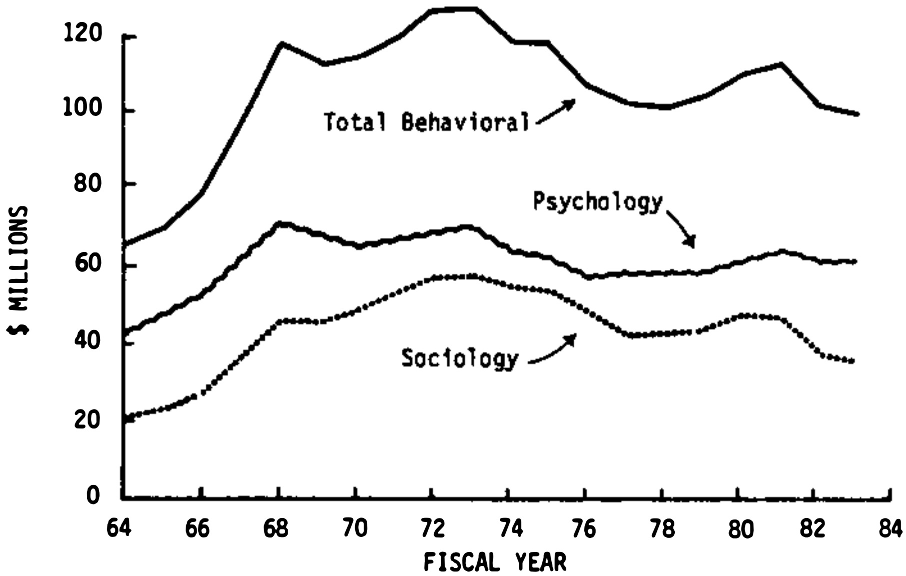

FIGURE 4.4 Behavioral science R and D expenditures in colleges and universities, 1964-83 (1972 $, millions). See Appendix Tables C18-C21.

employment (up 10.7 percent). Unemployment also grew in 1983 (but here the percentage change figures are misleading because of the small numbers of unemployed persons). Academic employment of behavioral scientists rose 2.7 percent in 1983. These changes are continuations of longer trends observable since 1975. The only major shift in behavioral science employment patterns is the decreased level of employment in nonprofit corporations. This reverses a longer term pattern of expanding employment in this sector.

Some important variations were found when the behavioral science Ph.D. population is disaggregated. Nonclinical psychologists had increased employment in hospitals and businesses in 1983, continuing trends that have been present since the 1970s (Table 4.2, lines 3a-3i). Employment in nonprofit corporations increased in 1983. Academic employment of nonclinical psychologists showed a small decrease from the 1981 level. Since 1975, the growth rate for academic employment has been 1.7 percent. Unemployment among nonclinical psychologists also rose in 1983.

For clinical psychologists, the largest gains in 1983 were in the self-employed category. The number of clinical psychologists reporting self-employment rose 13.0 percent above the 1981 level (Table 4.2, lines 3j-3r). The next largest gains (10.7 percent) were for "other" employment, the category that includes postdoctoral appointments. Gains in self-employment and "other" employment followed long-term employment trends for clinical psychologists. In 1983 there was a reduction in the number of clinical psychologists unemployed and seeking work. Employment in businesses showed smaller growth in 1983 (6.8 percent) than had been the case in the period from 1975 to 1981.

In the other behavioral sciences, employment in hospitals, businesses, and self-employment continued to grow in 1983, but at a much higher rate than before (Table 4.3, lines 3a-3i). Academic employment also rose for this group at a level slightly greater than the average growth rate for the 1975 to 1983 period. Fewer persons were employed by government and nonprofit corporations and (like nonclinical psychologists) unemployment rose in 1983 for other behavioral scientists. Similar trends are reported by Huber (1985), who examined the employment patterns of sociologist separately from those of other behavioral scientists.

Since 1973 there has been only slight growth in the academic employment of behavioral scientists. Areas of rapid growth have been in the nonacademic sectors. The changing employment distribution of behavioral scientists (favoring clinical and other nonacademic settings) may have important implications for the future of behavioral science research. Psychologists in human service settings devote a much smaller portion of their time to research than do psychologists in academic settings (Pion and Lipsey, 1984). The shifting employment picture has had a subsequent effect on academic departments. Pion and Lipsey report that the percentage of "academic" programs in psychology has decreased while the percentage of clinical and counseling programs has increased.

The Behavioral Ph.D. Faculty/Student Ratio

In the biomedical and clinical fields, faculty/student ratios have had a strong positive correlation with R and D expenditures, but no such relationship can be found for the behavioral sciences--faculty/student ratios have continued to rise while R and D expenditures and enrollments have declined (Figure 4.5).

In its 1983 report, the committee speculated on the reasons for these apparently conflicting trends. Several possibilities were considered--enrichment of faculty by Ph.D.s, graduate enrollment trends, increasing part-time employment, and inaccurate enrollment estimates. Evidence has accumulated on each of these considerations, and we are now in a better position to assess the significance of each of these potential factors.

Part-time Employment

Part-time academic employment of behavioral science Ph.D.s has been increasing much more rapidly than full-time employment since 1973. However, it still constitutes only a very minor portion of total employment and does not seem to be an important factor in the growth of Ph.D. faculty.

Academically Employed Behavioral Science Ph.D.s

FY	Total	Full-time	Part-Time	% Part-Time
1973	19,928	19,220	708	3.6
1983	29,776	28,091	1,685	5.7

SOURCE: Appendix Table C17.

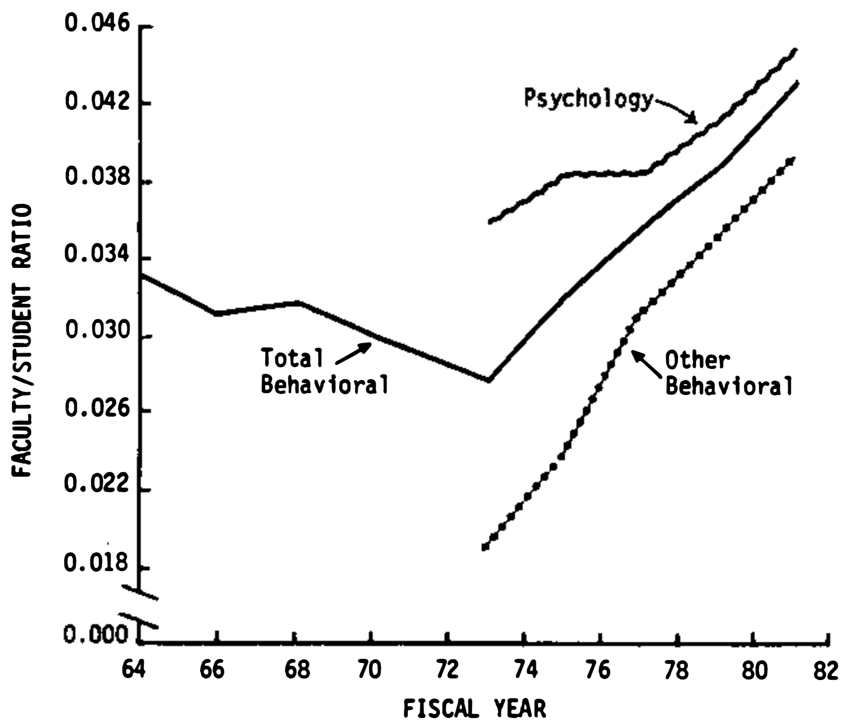

FIGURE 4.5 Behavioral science Ph.D. faculty/student ratio, 1964-81. See Appendix Table C16.

Accuracy of Enrollment Estimates

The argument that the committee's data on behavioral science majors underestimates the behavioral science undergraduate course enrollment was discussed earlier. From the examination of enrollment data for 1984, it appears that the use of data on majors as an approximation for enrollments does not underestimate the share of the undergraduate teaching load attributed to the behavioral sciences.

Enrichment

As the number of behavioral scientists employed by colleges and universities has expanded over the past 20 years, an increasing proportion of them have been Ph.D.s. This process is known as enrichment. It occurs as Ph.D.s replace non-Ph.D.s on the faculty, or as non-Ph.D. faculty members receive Ph.D. degrees. Much of the increase of Ph.D.s on behavioral science faculties in recent years can be explained by this process. In 1966 only 57 percent of the academically employed behavioral scientists had Ph.D.s; by 1983, the figure had risen to 79 percent (Table 4.5). More importantly, the Ph.D. component has continued to increase since 1977 even though total academic employment of behavioral scientists has declined.

Enrichment is likely to have had its greatest impact at colleges and universities without doctoral programs. Doctorate-granting universities have had a high percentage of Ph.D.s on their faculty for several decades. However, some of the increase in the proportion of Ph.D. faculty could be due to changes in the timing of entry into the academic labor market. During the period of rapidly rising behavioral science enrollments, young scholars frequently took faculty positions without having completed their dissertation. Data from the Doctorate Records File indicate that 24.1 percent of the new behavioral science Ph.D.s in 1972 had been employed on college or university faculties during the year prior to receipt of their doctorate degree. As they finished their degrees, the number of Ph.D. faculty members rose. With the passing of the period of high enrollments and the onset of a much more competitive market, the employment of scholars without completed degrees became steadily less common. Only 10.2 percent of the 1982 behavioral science Ph.D. recipients reported faculty employment in the year prior to the receipt of their doctorate. This would also serve to increase the proportion of faculty members with Ph.D.s.

Graduate Enrollment Trends

Behavioral science graduate enrollments have only recently begun to decline after growing steadily throughout the 1970s. The table below shows that the graduate component has almost doubled in size relative to total behavioral science enrollments since 1970.

Behavioral Science Enrollments

FY	Total Behavioral Enrollments	Graduate Behavioral Enrollments #	Graduate Behavioral Enrollments % of Total
1970	637,000	36,500	5.7
1975	723,000	55,400	7.7
1980	645,000	64,200	10.0
1981	648,000	65,200	10.1

TABLE 4.5 Behavioral Scientists Employed in Colleges and Universities, 1961–83

Fiscal Year	Total[a] N	Total[a] %	Ph.D.s[b] N	Ph.D.s[b] %	Non-Ph.D.s[c] N	Non-Ph.D.s[c] %
1961	13,700	100.0				
1962	n/a		5,339			
1963	n/a		n/a			
1964	n/a		8,143			
1965	15,691	100.0	n/a			
1966	17,304[d]	100.0	9,783	56.5	7,521	43.5
1967	18,916	100.0	n/a		n/a	
1968	21,574[d]	100.0	12,915	59.9	8,659	40.1
1969	24,231	100.0	n/a		n/a	
1970	26,180[d]	100.0	16,175	61.8	10,005	38.2
1971	28,129	100.0	n/a		n/a	
1972	29,744[d]	100.0	n/a		n/a	
1973	31,359	100.0	19,928	63.1	11,572	36.9
1974	32,980	100.0	n/a		n/a	
1975	35,883	100.0	23,624	65.9	12,252	34.1
1976	38,121	100.0	n/a		n/a	
1977	39,237	100.0	25,582	65.2	13,655	34.8
1978	39,159	100.0	n/a		n/a	
1979	38,458[d]	100.0	26,896	69.9	11,562	30.1
1980	37,758	100.0	n/a		n/a	
1981	38,074	100.0	28,235	74.5	9,839	25.5
1982	38,335	100.0	n/a		n/a	
1983	37,875	100.0	29,776	78.6	8,099	21.4

[a] Includes psychologists and sociologists only.
[b] Includes psychologists, sociologists, anthropologists, and speech pathologists/audiologists.
[c] Obtained by subtracting number of Ph.D.s from total behavioral scientists employed in colleges and universities.
[d] Interpolated.

SOURCES: NRC (1973–84); NSF (1965–84).

Since graduate education traditionally puts greater demands on Ph.D. faculty members than does undergraduate education, it seems reasonable to conclude that the relative growth of graduate enrollments has helped to maintain the growth of behavioral science Ph.D. faculty.

The best explanation for the steady growth in behavioral science Ph.D.s employed at colleges and universities is that it is due mainly to the enrichment process. The growing importance of graduate education in the behavioral sciences, and its more intensive demands on faculty time, can also be seen as a contributing factor.

THE MARKET OUTLOOK

Projections of Academic Demand for Behavioral Ph.D.s

The number of behavioral science Ph.D.s employed in the academic sector from 1962 to 1983 forms a typical growth pattern--rapidly increasing in the early stages and slowly increasing in the later ones (Figure 4.6). To obtain projections of academic demand, a Gompertz-type curve has been fitted to the time series from 1962 to 1983, and extrapolated to 1990 as shown in Figure 4.6. This provides estimates of the size of the Ph.D. faculty in 1990 from which we can estimate the average annual demand due to expansion of faculty. The 95 percent confidence limits are used as the upper and lower bounds on this estimate.

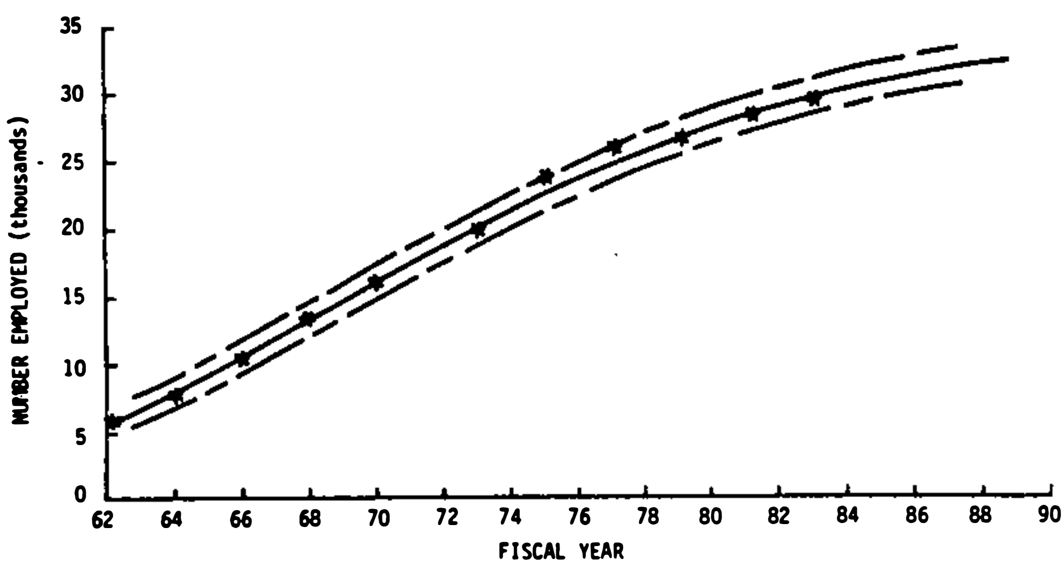

FIGURE 4.6 Behavioral science Ph.D.s employed in colleges and universities, 1962-83. Solid line represents a growth curve of the form: $Y = (K-C)\exp(-e^{a-bt}) + C$ fitted to the data for 1962-83. Parameters derived from these 11 observations are: K = 35,000; C = 2,500; a = 1.73314; b = 0.12466; R^2 = 0.997. Curve has an inflection point at 1968. Broken lines represent 95% confidence limits on the estimated curve. See Appendix Table C12.

Additional demand is generated by attrition due to death, retirement, field-switching, and job changes. Estimates for these attrition rates are derived from the National Research Council's biennial Survey of Doctorate Recipients and are shown in Table 4.6. Because of expected increases in the age distribution of academically employed behavioral Ph.D.s in the next few years (Appendix Table C24), we expect faculty attrition rates to increase. Previously we have assumed a 1 percent per year attrition rate due to death and retirement through 1988. For projections to 1990, we use an attrition rate of 1.5 percent per year for death and retirement, and 3.5 percent per year (±0.5 percent) for other causes as suggested by the data in Table 4.6. The calculations are shown in Table 4.7.

TABLE 4.6 Inflows and Outflows from Academic Employment for Behavioral Science Ph.D.s, 1981–83

I. *Average Annual Attrition from Academic Employment in the Behavioral Sciences 1981–83*

1. Total behavioral science Ph.D.s employed in academia in 1981: 28,235
2. Leaving academic employment in the behavioral sciences each year to:

	N	% of Academic Employment
a. nonacademic sectors	875	3.1
b. postdoctoral appointments	53	0.2
c. death and retirement	338	1.2
d. unemployed	205	0.7
e. total attrition	1,471	5.2

II. *Average Annual Accessions to Academic Employment in the Behavioral Sciences 1981–83*

1. Total behavioral science Ph.D.s employed in academia in 1983: 29,776
2. Entering academic employment in the behavioral sciences each year from:

	N	% of Total Accessions
a. nonacademic sectors	601	26.8
b. postdoctoral appointments	107	4.8
c. unemployed	151	6.7
d. Ph.D. recipients 1981–82[a]	1,164	51.9
e. other fields[b]	219	9.8
f. total annual accessions	2,242	100.0

III. *Balancing:* 1981 academic employment − attrition + accessions = 1983 academic employment
28,235 − 2(1,471) + 2(2,242) = 29,777[c]

[a] Based on postdoctoral plans of Ph.D. recipients, it is estimated that 15% of these new Ph.D. cohorts took a postdoctoral appointment before taking an academic position.
[b] These individuals were all academically employed in 1981 and 1983. The number shown represents the net number switching from nonbehavioral to behavioral fields.
[c] Does not agree with line II.1 because of rounding.

SOURCES: National Research Council (1958–85, 1973–84).

TABLE 4.7 Projected Growth in Behavioral Science Ph.D. Faculty, 1983–90[a]

	I High Estimate	II Middle Estimate	III Low Estimate
Expected size of behavioral science Ph.D. faculty (F) in 1990	32,930	32,740	32,530
Annual growth rate in F from 1983 to 1990	1.45%	1.36%	1.26%
Average annual increment due to faculty expansion	450	420	390
Annual replacement needs due to:			
death and retirement[b]	470	470	470
other attrition[c]	1,250	1,090	930
Expected number of academic positions to become available annually for behavioral science Ph.D.s	2,170	1,980	1,790

[a] Faculty in this table is defined as all academically employed Ph.D.s, excluding postdoctoral appointees, regardless of tenure status. These projections are based on the following relationship:

$(F)_t = (32{,}500)\exp(-e^{1.73314-0.012466t}) + 2{,}500$, where F = size of behavioral faculty in year t. See Appendix Table C12.

[b] Based on an estimated annual replacement rate of 1.5% due to death and retirement.

[c] Based on high, middle, and low attrition rates of 4%, 3.5%, and 3%, respectively.

The best estimate of behavioral science Ph.D. faculty size in 1990 is 32,740, an increase of 420 positions per year from the 1983 level of 29,780. Attrition due to death and retirement would add 470 positions, and other attrition would add another 1,090. Total annual demand expected under these assumptions is 1,980 positions. An upper bound 2,170 is derived from using attrition rates of 4.0 percent per year for "other causes." A lower bound of 1,790 is computed using an attrition rate of 3.0 percent per year for "other causes."

ESTIMATING PREDOCTORAL AND POSTDOCTORAL SUPPORT LEVELS UNDER NRSA PROGRAMS

The next step in our quantitative analysis of the market is to attempt to translate the projections of academic demand into recommended levels of postdoctoral training under NRSA programs. This step requires certain additional assumptions about how the system has functioned in recent years with regard to postdoctoral training and its sources of support.

Postdoctoral Training Levels

The features of the postdoctoral training system which must be considered in addition to the projections of faculty growth and attrition are shown in Table 4.8 and are described as follows:

1) The number of accessions to academic positions who have (or should have) postdoctoral research training, (line 2). We estimate that 20 percent of all vacancies will be filled by former postdoctoral trainees. In the best-guess case, this number is estimated to be about 400.

TABLE 4.8 Estimated Number of Behavioral Science Postdoctoral Trainees Needed to Meet Expected Academic Demand Through 1990 Under Various Conditions

	Projected 1983-90			Annual
	High Estimate	Middle Estimate	Low Estimate	Average 1981–83
1. Academic demand for behavioral science Ph.D.s—annual average:	2,170	1,980	1,790	2,241
a. due to expansion of faculty	450	420	390	770
b. due to death and retirement[a]	470	470	470	338
c. due to other attrition[b]	1,250	1,090	930	1,133
2. Total vacancies filled by individuals with postdoctoral research training—annual average:[c]	430	400	360	110–285[d]
3. Size of behavioral science postdoctoral pool—annual average				
Size needed to meet academic demand assuming a 2-yr. training period and portion of trainees seeking academic positions is:				1,005
a. 60%	1,430	1,330	1,200	
b. 70%	1,230	1,140	1,030	
4. Annual number of behavioral science postdoctoral trainees to be supported under NRSA programs:				365 (1981–82)
a. if 40% of pool is supported under NRSA	490–570	460–530	410–480	
b. if 50% of pool is supported under NRSA	620–720	570–670	520–600	
c. if 60% of pool is supported under NRSA	740–860	680–800	620–720	

[a] Assumes annual attrition rate due to death and retirement of 1.5%.
[b] Assumes high, middle, and low annual attrition rates due to other causes of 4%, 3.5%, and 3%, respectively.
[c] Assumes that 20% of all vacancies will be filled by individuals with postdoctoral research training in the behavioral sciences.
[d] Assumes that 15% of the 1981-82 Ph.D. cohorts took a postdoctoral appointment before taking an academic position. See Table 4.6.

SOURCES: Tables 4.6 and 4.7.

2) The appropriate length of the postdoctoral research training period and the proportion of trainees who aspire to research careers (line 3). If the appropriate length is 2 years, then the pool size needed to produce 400 trained scientists each year would be 800. If only 60 percent of the trainees seek academic appointments after completing their training, then the necessary pool size must be 1,330.

3) The proportion of support of the total pool of behavioral science postdoctoral appointments that should be provided by the federal government (line 4). We are assuming a range between 40 and 60 percent. The resulting range of NRSA postdoctoral trainees is between 410 under the lowest set of assumptions, and 860 under the highest set. The best-guess assumptions yield a range of 460-800 postdoctoral trainees in the behavioral sciences.

Predoctoral Training Levels

This analysis of the training system may also be extended to graduate education in the behavioral sciences and the level of predoctoral support under NRSA programs. The size of the postdoctoral pool needed to satisfy academic demand under specified conditions was computed in Table 4.8 (line 3) to be between 1,140 and 1,330 in the best-guess case. This becomes the basis for estimating NRSA predoctoral support levels as shown in Table 4.9.

If the training system requires a postdoctoral appointment of two years duration, then between 570 and 665 postdoctoral trainees would be expected to leave the pool each year (Table 4.9, line 2). To maintain a stable system, the number of Ph.D.s entering the postdoctoral pool each year would have to equal the attrition. And if the number of Ph.D.s who seek postdoctoral appointments is between 14 and 16 percent of each cohort, then the annual Ph.D. production rate must be between 3,560 and 4,750 (line 3).

The ratio of Ph.D.s granted to graduate enrollments in behavioral fields has varied in a narrow range between 6 and 8 percent since 1960. If this ratio holds for the next few years, graduate enrollments would have to be between 44,500 and 79,200 (line 4).

The percentage of graduate enrollments that receives predoctoral support from NRSA programs is small--currently around 1 percent. To maintain the system at this level, 450 to 790 predoctoral trainees in the behavioral sciences would be needed each year (line 5).

TABLE 4.9 Estimated Number of Behavioral Science Predoctoral Trainees to be Supported Under NRSA Programs

	Projected 1983–90	Actual 1983
1. Estimated number of postdoctoral trainees needed to satisfy demand under the committee's most likely estimate (from Table 4.8)	1,140–1,330	1,039
2. Annual attrition from postdoctoral pool if average length of appointment is 2 years	570–665	520
3. Number of Ph.D.s needed each year to maintain postdoctoral pool level if percentage of Ph.D.s seeking a postdoctoral appointment is:		
a. 14%	4,070–4,750	4,318
b. 16%	3,560–4,160	
4. Average graduate enrollment needed to produce the required number of Ph.D.s if annual completion rate is:[a]		
a. 6%	59,300–79,200	63,500
b. 8%	44,500–59,400	
5. Annual number of NRSA predoctoral traineeships needed if 1% of graduate students are supported under NRSA programs	450–790	516 (1982)

[a] The completion rate is defined here as the ratio of Ph.D.s awarded to graduate enrollments in a given year. This ratio has varied in a narrow range generally between 0.06 and 0.08 since 1960. See Appendix Tables C1 and C10.

SOURCES: Table 4.7, Appendix Tables C1 and C10.

SUMMARY

Apart from nonclinical psychology, in which there has been a small reduction, behavioral science Ph.D. faculty size has continued to increase throughout the 1970s and early 1980s. This is not due to a general increase in faculty size--total behavioral science faculty (including non-Ph.D.s) leveled off around 1977--but to an increase in the Ph.D. portion at the expense of those without doctorate degrees. The percentage of behavioral science faculty with doctorate degrees increased from 57 percent in 1966 to 79 percent in 1983.

Projections to 1990 indicate that this growth in Ph.D. faculty positions will continue, but at a slower pace. Judging from the age distribution of the faculty, attrition due to death, retirement, and other reasons is expected to accelerate toward the end of this decade. A portion of the vacancies created by expansion and replacement should be filled by behavioral scientists with some postdoctoral training experience. The fraction of faculty accessions with such experience is currently small, but the committee has recommended that it be increased. If we assume that 20 percent of newly hired behavioral science faculty members should have post-doctoral training, then the appropriate level of NRSA postdoctoral training in the behavioral sciences for the 1988-90 period should be in the range of 460-800 trainees and fellows annually. The committee's last recommendations for postdoctoral training in the behavioral sciences were for 440 trainees in 1985, rising to 540 in 1987.

Similarly, to maintain the current structure of the system, a number of predoctoral awards should be provided. Currently in the behavioral science fields about 1 percent of graduate students receive support from NRSA programs. If the system is maintained at this level, 450-790 predoctoral training awards should be made available annually during the period 1988-1990.

5. Health Services Research

Abstract

Health services researchers have contributed to the understanding of factors affecting the effectiveness of health care, including methodological advances in the measurement of health status and in the conceptual underpinnings of cost-benefit and cost-effectiveness analysis. These efforts at quantification are relevant to the problems of constraining the rapid growth of health care costs and assessing the consequences of new forms of health care delivery.

Support for health services research comes from diverse private, as well as government, sources. Philanthropic foundations have been a major source since the 1920s when the Committee on the Costs of Medical Care conducted studies of the incidence of disease, family expenditures for health services, incomes of physicians, and facilities for the provision of health services. Foundations with major health activities such as Robert Wood Johnson, Kaiser Family, Kellogg, and Hartford continue to provide support for the field. Research activities also are supported by professional societies and private business. Federal support of health services research has its principal focus in the National Center for Health Services Research and Health Care Technology Assessment, the Office of Research and Demonstrations of the Health Care Financing Administration, and the Veterans Administration. However, research programs and projects whose substance is health services research, but that are not identified as such, occur in NIH, the Department of Defense, and elsewhere in the federal government. State agencies for health and social services use the methodologies of health services research or contract with consultants and university-based researchers to evaluate health care practices within their jurisdiction. Efforts are needed to obtain systematic information on all public and private funds supporting health services research. Total federal expenditures were estimated to be $183 million in 1985; these expenditures are increasing but remain small relative to federal expenditures for biomedical R and D.

Unlike the behavioral, biomedical, and clinical sciences, data are not available that permit the committee to make quantitative estimates of the current supply of health services research personnel nor that support projections of future supply or demand. A much better base of knowledge is needed on the training, employment, and research activities of health services researchers, and on the funding of health services research.

DEFINITION AND EXAMPLES OF CURRENT HEALTH SERVICES RESEARCH

Health services research is a field of inquiry that addresses the structure and functioning of the health care delivery system. It is not a discipline in the sense of biochemistry or psychology, but rather a problem area in which are applied the theories and methods of the social and behavioral sciences, epidemiology, economics, biostatistics, and operations research. Some health services research is directly relevant to the evaluation of health programs and the development of health policy. Other research is focused on technology assessment or more theoretical studies addressing such issues as the optimal organization of health care delivery systems. Still other research has the aim of developing and improving data and methods for studying health services delivery.

Investigators in this field employ a variety of research methods. Depending on the disciplinary background of the investigator and the aims of the research, a project might utilize, e.g., case analysis and randomized trials (medicine), interviews or questionnaire surveys (social sciences), observation studies (anthropology), empirical testing of theoretical models (economics), or experimental or quasi-experimental studies (behavioral sciences). Analytic techniques are drawn from biostatistics, epidemiology, econometrics, and statistics. Health services researchers also have developed research methods, of which health status measures (discussed below) constitutes an important example, and have made significant contributions to the development of cost-benefit and cost-effectiveness analysis.

Health services researchers examine the influence of health care organization, methods of delivery, and health care financing on the quality, costs, and accessibility of health services. They also examine the development and deployment of health manpower. Ultimately their concern is with problems involved in the financing and provision of health services and with improving the effectiveness of those services as measured by improved treatment outcomes.

Such lines of inquiry take on special importance during periods of major change in health care. The past two years have witnessed rapid and profound changes such as the institution of prospective payments for hospital payments by Medicare, the rapid growth of for-profit health care, the adoption of business-oriented goals by many health care providers, and the limitation of Medicaid patients' choices of providers by some states. Major employers such as General Motors have drastically changed their employee health insurance benefits to encourage prudent use of health care resources. Physicians have started to form Preferred Provider Organizations and to enter other new organizational arrangements such as free-standing surgical centers. These changes have occurred within a context of the continued proliferation of medical technology, a greatly enlarged physician supply, and the increasing rate of growth in the nation's elderly population.

Investigators in this field have made significant contributions to knowledge about the structure and function of the health system and have developed research tools to assess its effectiveness. Over the past 20 years, for example, substantial progress has been made in the development of measures and indices of health status.[1] Investigators gators have developed aggregate indexes based on population mortality and morbidity. They also have developed measures that combine morbidity and mortality to construct a quality-adjusted life expectancy. These measures provide the means for monitoring health status in local, regional, or national populations. As an adjunct to economic measures such as per capita income or unemployment rates, health status measures provide indicators of population well-being.

Individual health status measures also have been developed. For example, Katz and his colleagues at the Benjamin Rose Hospital developed the index of Activities of Daily Living (ADL), a measure of patients' functional independence or dependence designed to study results of treatment and prognosis in the elderly and chronically ill (Benjamin Rose Hospital Staff, 1959). More recently, investigators have developed measures that encompass a much broader range of physical, social, and psychological functioning (Brook, et al., 1979). Even more subtle measures of health status are being introduced with the concept of individual preferences for specific health states or health outcomes (Lipscomb, 1982). Such measures are essential to the evaluation of health programs, the assessment of the effectiveness of alternative delivery modes, and the analysis of the outcomes of medical practice. This area of research continues to be important as the federal government, the states, and the private sector act to constrain the rate of growth in health care expenditures and new forms of health care delivery emerge that increase the need for tools with which to analyze the consequences.

Health Maintenance Organizations and Health Care Costs

Since the 1950s, health services researchers have made extensive study of Health Maintenance Organizations (HMOs)[2] to test the

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[1]This discussion draws heavily on Bergner (1985) and Ware (1985).

[2]The Health Maintenance Organization (HMO) provides a range of services to a defined population for a fixed annual or monthly payment. This form of medical care delivery, in contrast to fee-for-service, contains financial incentives to perform fewer services and to emphasize health promotion and disease prevention. Its proponents argue that, because of these incentives, the HMO offers the possibility for substantial cost savings in health care delivery (Luft, 1978). Since 1973, the federal government has encouraged the development of HMOs with the dual objectives of (a) reducing costs through the widespread enrollment of a substantial fraction of the population in prepaid plans and (b) lowering costs more generally by competing with conventional insurers and providers (Luft, 1985).

hypothesis that HMOs offer care at lower cost and to identify the sources of cost differences between HMOs and other providers. Much of this work has found lower per capita costs in HMOs than under conventional health insurance, although the evidence is much stronger for group-practice HMOs than for independent practice associations (IPAs)[3] (Luft, 1985). Lower hospital utilization has been shown to account for most of the difference. Enrollees in group practice HMOs have hospital utilization rates (days/1,000) about 30 percent less than those of comparison groups. The lower rates are due to fewer admissions rather than shorter lengths of stay (Luft, 1978, p. 1339). However, the possibility that healthier individuals choose HMOs could not be ruled out on the basis of these nonexperimental studies. This issue of self-selection has been addressed in two studies. A 1976 study compared the costs of providing services to members of a St. Louis HMO and a matched group who received care under fee-for-service and found similar rates of surgical utilization, significantly lower rates of non-surgical and overall utilization, and much higher rates of ambulatory utilization in the HMO members (Perkoff, 1976). More recently, investigators at the Rand Corporation compared utilization among persons in Seattle who were randomly assigned to one of three health plans: a free fee-for-service plan, a fee-for-service plan with copayments, and free care in the Group Health Cooperative of Puget Sound (GHC). A random sample of voluntarily-enrolled GHC patients also was analyzed. The assigned GHC group had a somewhat higher rate of hospital utilization than the GHC control group (49 days per 100 compared with 38 days per 100); however, imputed annual expenditures per enrollee were very similar for these two groups (Manning, et al., 1984). Whether assigned or voluntary, GHC enrollees had a rate of hospital admissions that was 40 percent less than the randomly assigned fee-for-service group. These findings suggest that self-selection has not markedly biased the results of earlier, nonexperimental studies and lend support to the group-practice model HMO as a lower-cost alternative to traditional methods of health care delivery.

Health Status and Medical Care Utilization

Expenditures for health care have grown enormously over the past 20 years. Between 1965 and 1983, current dollar expenditures grew almost tenfold. Adjusting for inflation, they more than doubled. Since the 1970s Victor Fuchs and others have called into question whether this increase has translated into better health for the American people. Not only have mortality and morbidity rates appeared not to be declining commensurate with the growth in national health care expenditures, but age-specific mortality rates in this country have compared unfavorably with other developed countries with lower per capita health expenditures. A major theme of Fuchs' book Who

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[3]In an IPA, a physician group is paid on a capitation basis, but individual physicians are paid fee-for-service.

Shall Live was that--except for the very poor--"life-style" factors such as diet, exercise, smoking, and automobile driving were the major determinants of health and that therefore the marginal benefit from an additional dollar spent on health care was very small (Fuchs, 1974).

Investigations in the field of health services research have attempted to estimate statistically the relative contributions to health status made by health care and other factors. This issue is of great importance to policy deliberations because there is a range of strategies available for improving health--e.g., increasing the availability and accessibility of health services, encouraging health-enhancing behaviors (or discouraging health-detracting behaviors), improving environmental quality, and increasing job safety--and resources are constrained. In a 1969 study using state data, researchers found that a 1 percent increase in medical care expenditures per capita was associated with a small (0.1 percent) decrease in age-sex-adjusted mortality for whites (Auster, et al., 1969). Subsequent research (Silver, 1972) also suggested that medical care utilization exercised a negligible effect on mortality rates. However, a recent major study of small areas found higher health expenditures per capita to be associated with significantly lower mortality (Hadley, 1982).

SOURCES OF FUNDING FOR HEALTH SERVICES RESEARCH

Non-government Sources

From its inception in the 1920s, the field of health services research has received significant support from the private sector. Eight philanthropic foundations* supported the landmark work of the Committee on the Costs of Medical Care (1927-1932), which can be considered the principal origin of health services research in this country. The work of this committee included community surveys and other field studies aimed at producing a comprehensive picture of the incidence of disease and disability in the population, family expenditures for health services, the numbers and incomes of physicians and other service providers, and existing facilities for the provision of health services. This was the first time that such an ambitious attempt was made to establish a factual base for a broad consideration of health policy (Anderson, 1967, p. 19).

Foundations such as the Robert Wood Johnson Foundation, the Kaiser Family Foundation, the Hartford and Kellogg Foundations, continue to play an important role in the support of health services research. They have funded the work of major commissions whose work has included original research. They also have supported innovative health care programs as well as evaluation research to assess their effectiveness.

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*The Carnegie Corporation, Josiah Macy, Jr. Foundation, Milbank Memorial Fund, New York Foundation, Rockefeller Foundation, Julius Rosenwald Fund, Russell Sage Foundation, and the Twentieth Century Fund.

They have funded pioneering investigations in medical care at universities and provider organizations. In 1976, the contribution of foundations to health service research was estimated at over $26 million.

Major professional associations support health services research in several ways; they collect, process, and disseminate data on their members which then serves as a resource for research by their own research staff members and by academic investigators. Major examples are the American Medical Association's Physician Masterfile and the data on hospital characteristics maintained by the American Hospital Association. Medical specialty societies have undertaken research on medical care quality and methods of assessing medical care. The American College of Surgeons (ACS), for example, developed a system for evaluating hospital surgical programs as early as 1918 (Flook, 1973, p. 100). More recently, the ACS and the American Surgical Association jointly conducted a major study of surgical services and surgical manpower in the United States. The well-known SOSSUS study documented, among other things, the large number of non-surgeons performing surgery and the excessive numbers of physicians choosing surgical residencies (ACS and ASA, 1975, pp. 83-85). In another instance, the American College of Radiology, with the support of NCHSR, conducted a pioneering study (1977) assessing the extent to which diagnostic radiologic procedures influenced medical decision-making.

Industry involvement in health services research is increasing. The Blue Cross-Blue Shield Association, for example, supports research on health services utilization and financing. Large investor-owned health care firms such as the Hospital Corporation of America are providing funding for research in health care administration.

Government Sources

Significant involvement in health services research by the federal government dates from the 1930s. The first Health Interview Survey, covering over 700,000 households, was conducted by the Public Health Service in the winter of 1935-1936. Data from this survey, which continues to the present, were used by PHS staff to study aspects of the organization, financing, and evaluation of health services over a decade (Flook, 1973, p. 103). Several researchers who served on the staff of the Committee on the Costs of Medical Care subsequently joined the Social Security Administration's Office of Research and Statistics (Fox, 1979, p. 29).[5] This office developed estimates of national expenditures for health and became the principal locus for intramural and extramural research on the economics of health care.

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[5]Agnes Brewster, I. S. Falk, Margaret Klem, and Louis Reed. This activity was first headed by Ida C. Merriam, the Assistant Commissioner for Research and Statistics.

The National Center for Health Services Research and Health Care Technology Assessment

The National Center for Health Services Research was established in 1968 with an explicit mandate to support health services research and research training.[6] Since its inception, the center has maintained an extensive program of extramural and intramural research and supported the training of researchers. Through these programs the Center "...seeks to create new knowledge and better understanding of the processes by which health services are made available and how they may be provided more efficiently, more effectively, and at lower cost" (NCHSR and HCFA, 1985). NCHSR is the primary source of federal support for research on problems related to the quality and delivery of health services.

The NCHSR extramural program provides support for investigator-initiated projects in health services research conducted at universities, nonprofit organizations and institutions, and by industry. Priority areas for 1985 include:

(1) Health promotion and disease prevention: health status measurement, organization, and provider studies, analysis of public and private program interventions, and methods to increase consumer knowledge and change health attitudes and behavior.

(2) Technology assessment: studies of the safety, efficacy, effectiveness, and cost effectiveness of specific technologies, development of new methods for evaluating medical technologies, and diffusion of medical technology.

(3) The role of market forces in the delivery of health care: market and industry structure, expenditure studies, strategies to enhance cost consciousness, and productivity studies.

(4) Primary care: development and testing of better designs, measures, and analytic techniques to improve primary care research; evaluation and surveillance techniques to assess the quality of care and the effectiveness of health promotion and disease prevention efforts, studies of the medical decision-making process; and systematic evaluations of the effectiveness and costs of clinical care.

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[6]Section 304 of the Partnership for Health Amendments of 1967 authorized support for research, experiments, and demonstrations related to the "Development, utilization, quality, organization, and financing of services, facilities, and resources" (Sanazaro, 1973, p. 152).

(5) State and local health problems: improving data and methods for projecting the demand for service and related supply requirements, and forecasting health expenditures, studies to develop and evaluate decision models for allocating health care resources at various jurisdictional levels and among various programs in a cost-effective manner; and techniques to assess and project the impact of changes in health expenditures (NCHSR, 1984b).

In its intramural research program the Center emphasizes four major health care issues. The Hospital Studies Program examines how competition, reimbursement systems, and various types of regulation influence the use and costs of hospital care. The Health Services for the Aged Studies Program evaluates the impact of different reimbursement approaches on the admission practices and services of nursing homes, the feasibility of private, long-term care insurance, and the contribution of informal support systems for the elderly. The National Health Care Expenditures Study, using information from a large national survey, examines how Americans use and pay for health care services. The Health Status and Health Promotion Studies Program focuses on measuring the level of health and on evaluating strategies to modify behavioral practices that have an adverse impact on health status.

The National Medical Care Expenditure Survey, conducted in 1977, has provided a rich source of data yielding significant findings on the utilization of health care and how families finance their health care. This survey included interviews in approximately 14,000 households, complemented by additional surveys of physicians and health care facilities providing care to household members during 1977 and of employers and insurance companies about their insurance coverage. On the basis of data from the survey it has been estimated that three of every 10 dollars spent for health care are accounted for by persons whose activities are limited by chronic conditions, although these persons represent only 10 percent of the population. The Medicare and Medicaid programs pay a large share of their health care costs, including about half of their hospital care (NCHSR, 1984a). These data also have been used to estimate the proportion of the insured population that is underinsured, that is, that could face significant out-of-pocket expenses over and above their insurance coverage. For approximately five percent of the privately insured population under age 65, expected out-of-pocket expenses could exceed three percent of income (Farley, 1984). These estimates highlight the large number of Americans who face substantial financial risk because they are uninsured for all or part of a year, or because their health insurance is not sufficient to cover certain expenses for which there is an appreciable statistical expectation.

Center-funded research also has made significant contributions to the knowledge base for the design, implementation, and evaluation of Medicare prospective payment, including early support of efforts by Yale researchers to develop diagnostic groups that are homogeneous with respect to hospital resource use and continued efforts to improve measures of case mix/case severity. Research funded by NCHSR also addresses the effects of DRG-based prospective payment on the quality of care and access to care.

Annual research appropriations for the Center have leveled at approximately $15 million after declining for a number of years (Table 5.1). In real terms, this represents a decline of 67 percent since 1976. A small amount is allocated for the support of dissertation research. Between 10 and 20 grants of up to $20,000 are made annually to promising students whose dissertation topics are within Center priority areas. At present the Center has no other program for training of health services research personnel.

TABLE 5.1 Annual Research Appropriations for the National Center for Health Services Research, FY 1976–86 ($ millions)

Fiscal Year	Research Appropriations: Current $	Research Appropriations: 1972 $	Implicit GNP Price Deflator[a] (1972 = 100.0)
1976	$26.0	$19.4	133.90
1977	24.0	16.9	141.70
1978	26.1	17.2	152.05
1979	26.1	15.8	165.46
1980	22.4	12.6	178.42
1981	21.5	11.0	195.14
1982	14.3	6.9	206.88
1983	14.6	6.8	215.63
1984	15.7	7.0	223.43
1985	14.8	6.4	232.29
1986 (proposed)	14.7	n/a	n/a

[a] From the U.S. Bureau of the Census. The deflator for 1985 represents the third quarter.

SOURCE: National Center for Health Services Research.

Health Care Financing Administration (HCFA)

As the agency responsible for managing Medicare, Medicaid, the End Stage Renal Disease Program, professional review, and their accompanying statistical and monitoring activities, HCFA, through its Office of Research and Demonstrations (ORD), supports research and demonstrations related to these responsibilities. Research areas include hospital payment, physician payment, long-term care, home health care, and alternative payment systems. In addition, this office supports program analysis and evaluation, including the development and analysis of program data and data from major health surveys, review of state Medicaid programs' management information needs, and the compilation and dissemination of state health activities (HCFA, 1984).

To support and extend the activities of HCFA, it supports two health policy centers. The Brandeis University Health Policy Research Consortium, which includes the Boston University School of Medicine, the Center for Health Economics Research, and the Urban Institute conducts a broad array of analytic activities and recently has assisted the Office of Research in responding to a Congressional mandate for reports on the Medicare prospective payment system (P.L. 98-21). A second center at The Rand Corporation/University of California, Los Angeles, primarily is providing expert consultation to ORD in planning, implementing, and evaluating demonstrations and experiments. This center also is supporting the analytic activities of the Office of Research in response to Congress.

The enactment of prospective payment for hospital services represented a radical departure from historical methods of paying for hospital care. However, this legislation (P.L. 98-21) was based on research, demonstrations, and evaluations over a period of more than ten years. Most of this painstaking work was supported by HCFA. In the late 1970's ORD funded the development by researchers at Yale of Diagnosis-Related Groups, a classification scheme comprised of subgroups of patients that have similar clinical attributes and resource utilization patterns (Fetter, et al., 1980). The algorithm that was developed grouped patients in a manner that minimized within-group variation in length of stay while keeping the number of groups to a manageable level. HCFA also funded a demonstration of the use of per-case payment for hospital care under Medicare in the state of New Jersey using DRG's to define cases. All general acute care hospitals in the state were phased into the demonstration, starting in 1980. All hospital patients in the state and all third-party payers were included (HCFA, 1984). Preliminary results from this demonstration formed the basis for a 1982 report to Congress on prospective payment under Medicare that led to the adoption of prospective payment in 1983. The ORD budget for research and demonstrations was $34 million in 1985 (Table 5.2), approximately evenly divided between research and demonstrations. In enacting prospective payment Congress called for HCFA to conduct studies and deliver a number of reports on the implementation and effects of this major change in payment for hospital services, as well as a report on the advisability and feasibility of incorporating physician payments into prospective payment. Fulfilling these Congressional mandates currently occupies about 30 to 40 percent of HCFA's research and demonstration resources.

National Institutes of Health

While NIH does not separately identify grants for health services research, such research activity can be found in a number of institutes, primarily in comprehensive centers and control programs for cancer, diabetes, arthritis, and cardiovascular and pulmonary diseases (IOM, 1979). The NIH biennially compiles information on federal obligations for the conduct of health research and development

TABLE 5.2 Research and Demonstrations Budget for the Health Care Financing Administration, FY 1979–86 ($ millions)

Fiscal Year	Budget: Current $	Budget: 1972 $[a]
1979	$32.5	$19.6
1980	46.8	26.2
1981	38.9	19.9
1982	29.5	14.3
1983	30.0	13.9
1984	33.1	14.8
1985	34.0	14.6
1986 (proposed)	34.0	n/a

[a] Deflated by the GNP Price Deflator, 1972 = 100.0. See Table 5.1.

SOURCE: Office of the Director, Office of Research and Demonstrations, HCFA.

(biomedical R and D, health services R and D, and other health-related R and D) that are reported in NIH publications and to Congress (NIH, 1983b).[7] In developing the information on its own health services research activities, NIH employs a keyword analysis of its computer-based CRISP system. For FY 1985, NIH obligations for health services research were estimated at $42.3 million (Table 5.3). This amount has risen steadily since 1979.

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[7]The instructions for reporting that are provided to federal agencies employ the following definition for health services R and D:

> The structure, processes, and effects of health services, and development and use of health resources. Examples of areas to be included are: (a) analysis of the organization, delivery, and impact of health promotion and disease prevention activities; (b) analysis of the factors underlying the increase in health care costs and the structural reforms and incentives which might modify these; (c) analysis of the implications of various health insurance and financing initiatives; (d) analysis of health manpower, such as education, requirements, distribution, utilization, and development (but excluding the actual training of such manpower); (e) analysis of technology-based approaches to modify the organization and delivery of health care services, with special emphasis on the uses of computer science and medical and information systems (excluding research on the effectiveness of diagnostic and therapeutic technologies); (f) relationship between the health services provided, and the health of the population; (g) analysis of emergency medical service system; (h) R and D on portable field units for emergency care, including adaptation of design and instruments for specific use; (i) analysis of long-term care services; (j) evaluation of health services R and D.

TABLE 5.3 NIH Obligations for Health Services Research and Development, FY 1977–85[a] ($ millions)

Fiscal Year	Obligations	
	Current $	1972 $[b]
1977	$ 7.4	$ 5.2
1978	11.6	7.6
1979	30.3	18.3
1980	32.3	18.1
1981	37.3	19.1
1982	37.3	18.0
1983	39.7	18.4
1984	41.0	18.4
1985	42.3	18.2

[a] See footnote 7 for definition of Health Services R&D. The FY 1985 figure is based on President's budget request.
[b] Deflated by the GNP Price Deflator, 1972 = 100.0. See Table 5.1.

SOURCE: National Institutes of Health.

Other Federal Sources

The National Center for Health Statistics, the primary agency for the production of national general purpose health statistics, conducts surveys and inventories that form the basis of both descriptive and analytic studies. The center also conducts research to enhance the quality of survey data and improve estimation methods. Other agencies of DHHS that fund health services research are the Alcohol, Drug Abuse and Mental Health Administration, the Health Resources and Services Administration, the Office of the Assistant Secretary for Health, and the Office of the Assistant Secretary for Planning and Evaluation. Outside DHHS, health services research is funded by the Department of Defense, the Department of Education, the International Development Cooperation Agency (AID), and the Veterans Administration. Estimated total federal obligations for health services research for 1985 were $183 million[8] (Table 5.4).

As the information presented above indicates, a diversity of sources fund health services research, including foundations and industry as well as government. The major focal points for health services research in the federal government are the National Center for Health Services Research and the Office of Research and Demonstrations of the Health Care Financing Administration. The Veterans Administration also conducts a small health services research program. However, programs whose substance is health services research --but which are not called health services research--occur in other government offices and agencies. In order that this committee and others can properly assess historical trends in funding for health services research and to assess the outlook for its future funding,

[8]In comparison, biomedical R and D obligations were over $5.6 billion.

TABLE 5.4 Federal Obligations for Health R and D, by Agency and Type of Research, FY 1985 ($ thousands)

Agency	Total	Biomedical R&D	Health Services R&D	Other Health-Related R&D
TOTAL, All Agencies	6,274,776	5,615,477	183,177	476,122
Dept. of Health and Human Services, Total	4,930,294	4,720,833	128,166	81,295
National Institutes of Health	4,345,429	4,303,159	42,270	—
Other Public Health Service Agencies, Total	541,865	417,674	43,191	81,000
Alcohol, Drug Abuse, and Mental Health Admin.	355,563	332,792	22,771	—
Centers for Disease Control	83,982	83,982	—	—
Food and Drug Admin.	81,000	—	—	81,000
Health Resources and Services Admin.	3,920	900	3,020	—
Office of the Assistant Secretary for Health (including NCHS and NCHSR)	17,400	—	17,400	—
Other DHHS, Total	43,000	—	42,705	295
Health Care Financing Admin.	35,000	—	35,000	—
Office of the Secretary	8,000	—	7,705	295
Other Agencies, Total	1,344,482	894,644	55,011	394,827
Dept. of Agriculture	147,558	27,417	296	119,845
Dept. of Commerce	4,073	733	—	3,340
Dept. of Defense, Total	473,059	410,351	13,340	49,368
Dept. of the Army	332,499	273,396	12,016	47,087
Dept. of the Navy	69,570	67,113	176	2,281
Dept. of the Air Force	50,059	50,059	—	—
Defense Agencies and Service Schools	19,383	19,383	—	—
Other DOD	1,548	400	1,148	—
Dept. of Education	30,821	—	30,821	—
Dept. of Energy	178,116	106,942	—	71,174
Dept. of the Interior	16,977	—	—	16,977
Dept. of Labor	5,075	—	—	5,075
Dept. of Transportation	7,924	7,268	—	656
Consumer Product Safety Commission	709	466	—	243
Environmental Protection Agency	51,295	30,777	—	20,518
International Development Cooperation Agency (AID)	36,992	32,451	4,541	—
National Aeronautics & Space Admin.	113,883	34,951	—	78,932
National Science Foundation	83,500	68,804	—	14,696
Veterans Admin.	194,500	174,484	6,013	14,003

SOURCE: National Institutes of Health.

these government bodies are encouraged to identify those programs and projects that are health services research. Efforts also should be made to develop an approach for systematically obtaining information on health services research funding by private industry, foundations, and state governments.

THE MARKET OUTLOOK FOR HEALTH SERVICES RESEARCH PERSONNEL

Data are not available that would allow the committee to make quantitative estimates of the current supply of health services research personnel, nor that would support projections of future supply or demand. This situation is markedly different from that in the biomedical, behavioral, and clinical sciences. In those areas, (a) the participants fall into distinct disciplines which enable them to be identified and counted, (b) data on sources of funds supporting research are routinely available, (c) employment of researchers is concentrated in well-defined academic departments. In addition, the federal government and organizations such as the AAMC and APA have made major investments to develop data on research personnel and the institutions that employ them. The committee has been fortunate to be able to draw on these data sources in order to analyze supply and demand for these fields.

The committee encourages the development of a base of knowledge on the training, employment, and research activities of health services researchers, and on the funding of health services research. Such data are necessary for the quantitative assessment of the market for these investigators by this committee and others, and also could contribute to a qualitative assessment of the "match" between the problems addressed by health services researchers and the qualifications of members of the field. The research agenda will of necessity have to take into account the diversity of training among health services research personnel, the multiple sources of research funding for the field, and the nature of employment that includes government and private industry as well as academia. These characteristics set health services research apart from the other fields for which this committee makes recommendations and greatly complicate the development of systematic information. At the same time, they are characteristics that are not unique to health services research but are common to applied, multidisciplinary areas such as area studies, urban studies, and population studies.

The research agenda should be developed with the participation of a broad representation of interested organizations such as the major federal funding sources for health services research (NCHSR, HCFA, NIH, VA), private foundations that have provided significant support for the field, academic and non-academic employers of health services researchers including health services research centers, the Association for Health Services Research, and other relevant professional organizations. The research agenda can draw upon the past work of this committee's health services research panel, which gave considerable thought to the merits of various approaches for improving the information base in health services research.

Health Services Research Centers

In some universities, a center serves as the focal point for health services research. In 1984 there were 38 academic health services research centers[9] according to the Association for Health Services

[9]Defined as "an organization or entity whose primary mission is the conduct of health services and policy research by a multidisciplinary staff, which is either based in or formally affiliated with an academic institution" (AHSR, 1983).

Research (Table 5.5). These centers vary widely in size, organizational location, sources of funding, and training capabilities. Anecdotal evidence suggests the need for an assessment of center funding and study of the factors characterizing effective centers. Of particular concern is support of research which has a long-range orientation, especially research on methods and concepts and research that illuminates fundamental health-related behaviors of institutions and individuals.

Individual investigators as well as enclaves of health services researchers are found in departments of political science, social and behavioral science, economics, epidemiology, biostatistics, operations research, nursing, medicine, and surgery. They are also found in departments of community medicine, maternal and child health, health education, health policy and management, and health administration, departments that often are multidisciplinary and may share characteristics in common with centers.

TABLE 5.5 Characteristics of Health Services Research Centers, 1983

Number of Centers	38
Number of Full-Time Employees	3–71
Budget[a]	$120,000–$5.5 million
Organizational Location	
Office of the President, Chancellor, or Vice President	6
Graduate School of Business, Management, Public Administration, Social Welfare	5
School of Medicine	9
School of Public Health	8
Other	10
Sources of Funding	
Federal Government	28
State/Local Government	12
Private Foundation	27
Corporation	18
Parent University	16
Endowment Income	6
Other	3
Training Capability	
None	12
Internships	9
Predoctoral fellows	13
Postdoctoral fellows	15
Other	7

[a] Based on 36 centers reporting.

SOURCE: Association for Health Services Research (1983).

The committee applauds the survey of investigators associated with academic health services research centers that is being conducted by the Association for Health Services Research. This survey represents a significant step in that not only will it provide a picture of a very important subpopulation of health services researchers, but also be invaluable in the development of a broader research strategy. The data from this survey should become available in 1986.

Training for Health Services Research

As this committee stated in its 1983 report, "A competent principal investigator in health services research must have two sets of qualifications. The first is an adequate grasp of a discipline or profession[10] [and] the second...is an understanding of...the delivery and financing of health care and a mastery of suitable research methods (IOM, 1983b, p. 121)."

An indication of the diversity of disciplines/professions among health services researchers can be gleaned from the results of the 1978 survey of former principal investigators on NCHSR research grants (Table 5.6) and NCHSR trainees (Table 5.7). The distribution of health services researchers by discipline probably would be different today. Too, these data did not represent investigators who received support from HCFA, ADAMHA, NIH, or other sources. Based on the 1985 estimate (Table 5.4) of $183 million in federal obligations for health services research, NCHSR support represents approximately 8 percent of the total.

The second set of qualifications can be acquired (1) through formal coursework and research experience during predoctoral training, including dissertation research, (2) through formal postdoctoral training, or (3) informally, through research experience gained after completing graduate training. Early contributors to health services research came from this latter group, "switching" to health services research from clinical medicine, public health, or the social sciences. On the basis of the committee's 1978 survey of health services researchers, it appears that newer entrants to the field are more likely to have had formal training in it. Part of a research agenda on health services research personnel should be an assessment of the appropriateness of training.

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[10]The committee listed as examples anthropology, sociology, psychology, economics, political science, biomedical and clinical sciences, public health, epidemiology, biostatistics, operations research, health administration, health education and public administration.

TABLE 5.6 Field of Highest Degree Reported by NCHSR Principal Investigators, FY 1978

Field of Highest Degree	Number of Individuals[a]
TOTAL	398
Total Behavioral Sciences	60
Anthropology	3
Psychology	14
Sociology	43
Total Social Sciences	41
Economics/Econometrics	30
Political Science	5
Other	6
Total Biomedical Sciences	20
Biometrics/Biostatistics	13
Other	7
Total Medical Sciences	36
Public Health and Epidemiology	11
Nursing	7
Other	18
Total Other Fields	108
Bioengineering	0
Operations Research	2
Public Administration	2
Other	104
Total Medical Doctorates	133

[a]Excludes full-time degree candidates.

SOURCE: National Research Council (1977a).

The committee reaffirms its position that health services research is an important field that offers significant potential for increasing understanding of health care. The field's importance is even greater in this time of rapid and profound changes in the organization and financing of health care and the proliferation of medical technology. To maintain an adequate pool of qualified investigators to address questions of the quality, cost, and effectiveness of health care in the future, the committee recommends that NRSA awards be made specifically and explicitly for health services research training at levels of support set out in Chapter 1.

In the early 1970s, the federal government provided support to over 800 health services research trainees and fellows (NRC, 1975-81). By 1981, this number had dwindled to zero--neither the NIH, ADAMHA, nor the HRSA was supporting any extramural training in health services research. This committee has recommended that these training programs be restored to about the 1976 level. In addition, the committee continues to endorse the dissertation grant program of NCHSR as an effective means for increasing the pool of health services research personnel.

TABLE 5.7 Field of Highest Degree Reported by NCHSR Trainees, FY 1978

Field of Highest Degree	Number of Individuals[a]
TOTAL	565
Total Behavioral Sciences	236
Anthropology	18
Psychology	32
Sociology	186
Total Social Sciences	76
Economics/Econometrics	36
Political Science	16
Other	24
Total Biomedical Sciences	21
Biometrics/Biostatistics	20
Other	1
Total Medical Sciences	131
Public Health and Epidemiology	45
Nursing	10
Other	76
Total Other Fields	101
Bioengineering	1
Operations Research	6
Public Administration	5
Other	89

[a] Excludes full-time degree candidates.

SOURCE: National Research Council (1977a).

6. Nursing Research

Abstract

The Division of Nursing of the Health Resources and Services Administration currently provides the major portion of funds for nursing research supported by the federal government. About $9 million in research grants and contracts was awarded by this agency in FY 1984. A substantial amount of nursing research is also sponsored by the NIH, the Veterans Administration, and private organizations such as the American Nurses Foundation and the Robert Wood Johnson Foundation. Funds provided by these organizations have supported recent studies on the health and care of premature infants which have shown how they respond to specific nursing interventions. Other studies have focused on care and prevention of disability in the elderly.

In most but not all of these studies, the principal investigator is a nurse with a doctorate degree. Although the annual production of nurses with doctorate degrees is increasing, only about 8 percent of nurses serving as full-time faculty members held doctorate degrees in 1982. The lack of nurses with doctorates to serve as faculty exercises a qualitative, as well as quantitative constraint on the continued growth of doctoral programs in nursing. There does not appear to be any substantial amount of support available for training in nursing research other than that provided by the Division of Nursing, HRSA, under the NRSA program.

According to a recent statement by the American Nurses' Association:

> Nursing research generates knowledge about health and health promotion in individuals and families and knowledge about the influence of social and physical environments on health. Nursing research also addresses the care of persons who are acutely or chronically ill, disabled, or dying, as well as the care of their families. In addition, nursing research studies therapeutic actions that minimize the negative

effects of illness by enhancing the abilities of individuals and families to respond to actual or potential health problems. Nursing research also emphasizes the generation of knowledge about (a) systems that effectively and efficiently deliver health care, (b) the profession and its historical development, (c) ethical guidelines for the delivery of nursing services, and (d) systems that effectively and efficiently prepare nurses to fulfill the profession's current and future social mandate.

Nursing research complements biomedical research, which is primarily concerned with causes and treatments of disease. In its attention to the study of nursing interventions, procedures, and methods of patient care it also complements clinical research by members of other health professions. And, in its attention to the costs and outcomes of different types of procedures, settings, and providers of care, it contains a large component of health services research.

The Division of Nursing, HRSA, classifies nursing research into six categories:

1. Fundamental research, which establishes a foundation for further investigations rather than contributing to the solution of specific health problems. It may use human or animal subjects to investigate the ways in which human beings and human systems function and behave, and the ways in which humans think, feel, act, and interact, e.g., studies of the interaction of mothers or fathers with their new infants;

2. Nursing practice research, which directly addresses nursing practice problems, often by assessing the effectiveness of nursing procedures, techniques, and methods, either physical, psychosocial, or cultural. Dependent variables usually involve client outcomes, and studies often employ experimental methods;

3. Nursing profession research, which addresses the nurse as a professional, with studies of cognitive, attitudinal, and behavioral characteristics of nurses which may influence nursing practice;

4. Nursing services administration research, which investigates the structure in which nursing care is provided as well as the physical and social environment in which nurses and clients interact;

5. Nursing education research, which is concerned with the educational process, including studies of the curriculum and student-faculty interaction; and

6. Utilization of research findings, which includes studies of the utilizatiion of research findings in practice and education.

EXAMPLES OF NURSING RESEARCH

An important step in the maturation of nursing research came in 1983 with the publication of the first Annual Review of Nursing Research (Werley and Fitzpatrick, eds.). This publication provides an overview of the field, highlighting significant advances and suggesting areas where additional research is needed.

Nursing researchers have made important advances in the study of the health care of infants, young children, and the elderly. Nurse investigators, for example, "have been concerned with questions about how premature infants respond to extrauterine living and how nursing action influences the response and well-being of premature infants" (Barnard, 1984, p. 4). In one clinical study, premature infants were given finger sucking opportunities twice a day, which appeared to promote neuromuscular coordination, alert activity, alert inactivity, and deep sleep (Anderson and Vidyasagar, 1979, cited in Barnard, 1984). Another study showed that sucking during and after tube feedings advanced premature infants' readiness for bottle feeding by several days. These infants gained weight faster and left the hospital four days earlier than comparison infants not on the sucking protocol (Measal and Anderson, 1979, cited in Barnard, 1984). The role of sucking as a regulator of infants' physiological and behavioral responses is an important area for research. Other significant nursing research is addressing the effects of various stimuli (tactile, auditory, kinesthetic, and visual) on preterm infants' neurological and mental development, and weight gain (Barnard, 1984). This research has significant implications for the effectiveness and cost of neonatal nursing care. The average cost of initial neonatal intensive care is estimated to exceed $13,000 (Institute of Medicine, 1985, p. 229), and almost 7 percent of newborns in the U.S. are at risk because of low birthweight.

Nurse researchers also have addressed important questions in clinical geriatric nursing: the maintenance of health, prevention of illness and disability, and care of the ill elderly. This research is of great importance as life expectancy increases; data from the 1980 census show that 1.5 percent of persons age 65-74 were in nursing homes; the percentage rises to 6.6 percent for persons 75-84, and 22.7 percent for persons 85 and over. In 1983, almost $29 billion was spent on nursing home care (Gibson et al., 1984). Two issues in the clinical care of the ill elderly that are being addressed by nursing researchers are (1) the prevention and treatment of decubitus ulcers and (2) the prevention or reduction in the frequency of incontinence. Gerber and Van Ort (1979, cited in Wolanin, 1984), for example, tested the use of topical insulin in treating decubiti with good results. Catanzaro (1981, cited in Wolanin, 1984) conducted a qualitative study of the perceptions of the elderly regarding incontinence; other, experimental studies have employed behavior modification techniques to control incontinence (Wolanin, 1984).

As these examples illustrate, the nature of problems studied by nurses is influenced strongly by the nature of problems they encounter in the clinical setting. While these problems might be studied by investigators from other health professions, they generally are not.

SOURCES OF SUPPORT FOR NURSING RESEARCH AND TRAINING

Division of Nursing, HRSA

Nursing Research

The Division of Nursing of the Health Resources and Services Administration (PHS, DHHS) is the primary source of funding for nursing research and research training in the federal government. Since January 1985, the Nursing Research Grants Program has been administered by a Center for Nursing Research. Replacing the research component of the former Nursing Research and Analysis Branch, the Center is intended to provide increased visibility to nursing research in DHHS. In establishing the Center, no additional budget allocation was made by the Secretary.

The Division supports five types of grants under its Nursing Research Grants Program, as described below.

NURSING RESEARCH PROJECT GRANTS support discrete, specified, circumscribed projects in an area representing the investigator's interest and competencies.

NURSING RESEARCH PROGRAM GRANTS support clusters of at least three studies focused upon a single theme.

NEW INVESTIGATOR NURSING RESEARCH AWARDS (NINRA) support small studies of high quality carried out by new investigators.

UTILIZATION OF RESEARCH IN NURSING AWARDS (URNA) support projects to bridge the gap between the generation of knowledge through research and the utilization of such knowledge in nursing practice, nursing education, or nursing services administration.

NURSING RESEARCH EMPHASIS GRANTS FOR DOCTORAL PROGRAMS IN NURSING (NRE/DPN) stimulate nursing research in areas that emphasize special health needs of the nation, and advance the research efforts and resources of faculty in schools of nursing offering doctoral programs.

The stated purpose of the Nursing Research Grants Program is "to enlarge the body of scientific knowledge that underlies nursing practice, nursing education, and nursing services administration; and to strengthen these areas through the utilization of such knowledge." Principal investigators need not be nurses. The NRS/DPN projects, however, are specifically designed for schools of nursing that offer doctoral programs. Applications for all five types of grants are submitted to the Division of Research Grants of the National Institutes of Health; they are then assigned to the Division of Nursing on the basis of nursing relevance, where they are subject to interdisciplinary peer review.

Grants are awarded in a number of content areas (Table 6.1). As shown, most projects in recent years have been in the areas of fundamental research and research on nursing practice. Fundamental research provides basic knowledge about the person before intervention; nursing practice research looks at the interaction between the nurse and the patient. Examples of some recent projects include "Models of Newborn Nursing Services," "Stress Response: Assessment and Change," and "Acute Confusional States in Elderly Patients."

Table 6.2 shows the earned doctorates of principal investigators (PIs) working under research grants from the Division of Nursing. Nurses have represented between 75 percent and 85 percent of the awardees in each year since 1974. The proportion of nurse PIs holding doctorates has increased from about 50 percent in 1974 to 96 percent in 1983. Nearly all of the non-nurse PIs have held doctorates.

TABLE 6.1 Nursing Research Grants Active at End of Fiscal Years 1969–83, by Content Category[a]

		Fiscal Year														
Content Category		1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
A	Fundamental	5	6	9	7	9	10	12	9	10	11	8	10	11	9	12
B	Nursing Practice	6	6	4	7	11	9	9	6	9	14	20	25	23	16	19
C	Nursing Profession	6	6	6	6	7	4	2	1	6	7	4	3	3	3	7
D	Delivery of Nursing Services	9	6	6	4	5	6	4	2	1	1	1	1	2	2	5
E	Nursing Education	4	4	1	3	2	1	1	1	1	1	0	0	0	0	1
F	Research Conferences	3	3	3	5	5	0	0	0	0	0	0	0	0	0	0
G1,2	(Faculty) Research Development	16	17	14	16	13	15	11	9	12	10	9	4	0	0	0
G3	Program Grants	0	0	0	0	0	0	0	0	0	0	0	4	6	5	3
G4	NRE/DPN Grants	0	0	0	0	0	0	0	0	0	0	0	10	13	13	14
H	Utilization of Research Findings	0	0	0	0	0	0	1	1[c]	1[c]	1[c]	1[c]	1[c]	0	0	0
4[b]	Development of Methodology, Tools	5	4	1	1	2	2	4	4	5	8	8	n/a	n/a	n/a	n/a
	TOTAL	54	52	44	49	54	47	44	33	45	53	51	58	58	48	61

[a] Count includes projects which were extended without receiving funds during the fiscal year under consideration.
[b] Category 4 was in the classification system used until 1979.
[c] Also G2.

SOURCE: Division of Nursing, HRSA.

TABLE 6.2 Doctoral Degree Status of Principal Investigators on Active Research Grants from the Division of Nursing, 1974–83

Fiscal Year of Grant	Nurses with Doctorates		Nurses without Doctorates		Non-Nurses with Doctorates		Non-Nurses without Doctorates		Total
	N	%	N	%	N	%	N	%	N
1974	17	37	18	39	11	24	•	•	46
1975	23	52	10	23	11	25	•	•	44
1976	19	58	7	21	7	21	•	•	33
1977	29	64	5	11	10	23	1	2	45
1978	32	60	8	15	12	23	1	2	53
1979	30	59	10	20	11	21	0	0	51
1980	40	69	10	17	8	14	0	0	58
1981	38	66	7	12	13	22	0	0	58
1982	34	71	4	8	10	21	0	0	48
1983	49	80	2	3	9	15	1	2	61

SOURCE: Division of Nursing, HRSA.

Table 6.3 shows the amount of money appropriated and awarded to nursing research grants and contracts from 1956 through 1984. In 1956, $498,000 was awarded. This amount has increased since then, reaching a plateau of $5 million in the late 1970s and early 1980s; it was increased to $9 million for FY 1984. Figure 6.1 shows this history from 1969 on, in constant 1972 dollars.

Training for Nursing Research

In FY 1984, 117 students were being supported under the NRSA awards funded through the Division of Nursing, for a total of $955,487 (Table 6.4). Two million dollars have been appropriated for FY 1985 and about 170 trainees and fellows are expected to be supported. To be eligible under the predoctoral and postdoctoral Nurse Fellowship Program, applicants must be registered professional nurses with an active license and a degree in nursing at the appropriate level. Predoctoral stipends are $6,552 per year; postdoctoral stipends begin at $15,996. Institutions can receive $3,000 for each predoctoral trainee and $5,000 for each postdoctoral trainee annually.

Support of research training by the Division of Nursing is primarily at the predoctoral level. In FY 1984, for example, of 102 applications received, just 5 were from postdoctoral applicants; 2 of these were approved (Table 6.5).

TABLE 6.3 Nursing Research Grants and Contracts Awarded, FY 1956–84 ($ thousands)

Fiscal Year	Amount Appropriated	Amount Awarded	New Grants N	New Grants $	Renewal Grants N	Renewal Grants $	Continuation Grants N	Continuation Grants $	T&(S) Grants[a] N	T&(S) Grants[a] $	Contracts N	Contracts $
1956		$ 498										
1957		525										
1958		725										
1959		976										
1960		1,208										
1961		1,449										
1962		1,476										
1963		1,814										
1964	$1,999	1,999										
1965	1,953	1,952										
1966	2,170	2,166										
1967	2,230	2,087										
1968	2,655	2,593	22	$ 744	4	$266	32	$1,475	2+(3)	$108	0	$ 0
1969	2,593	2,593	16	642	4	158	33	1,720	(4)	73	0	0
1970	2,625	2,155	10	524	1	76	28	1,390	(6)	165	0	0
1971	2,455	1,955	11	781	3	92	18	1,039	(4)	43	0	0
1972	2,455	2,439	18	865	1	56	21	1,283	(9)	99	1	136
1973	2,455	2,454	9	519	1	61	27	1,704	(8)	98	1	72
1974	2,660[b]	2,631	13	877	2	161	19	1,378	(10)	99	1	116
1975	1,200	3,374[c]	11	962	8	783	20	1,307	1+(4)	204	1	118
1976	2,804	2,801	1	80	0	0	29	2,617	(1)	11	1	93
1977	5,000	4,991	25	2,674	5	327	7	954	3+(7)	484	3	553
1978	5,000[d]	4,979	15	1,413	1	103	31	3,447	(1)	16	0	0
1979	5,000[e]	4,944	10	929	3	366	30	3,514	2+(1)	135	0	0
1980	5,000[f]	4,986	26	2,882	4	465	16	1,580	(4)	58	0	0
1981	5,000[g]	4,950	16	1,592	1	98	29	3,066	2+(1)	195	0	0
1982	3,400[h]	3,376[j]	3	184	1	84	37	3,001	2+(0)	107	0	0
1983	5,000[i]	4,995	30	3,030[k]	8	717	14	1,245	0+(1)	2	0	0
1984	9,000[l]	8,986	45	4,591[m]	2	269	31	3,097	1+(1)	80	3	868

[a] Transfers and supplements. A "transfer" is a change of grantee institution; a "supplement" refers to additional funds provided to a funded project.
[b] Funds reprogrammed.
[c] Includes $2,412,000 from Nursing Special Projects Funds.
[d] Minus $17,000 retained for BHM evaluation activities.
[e] Minus $50,000 retained for BHM evaluation activities.
[f] Minus $13,000 retained for BHPr evaluation activities.
[g] Minus $50,000 retained for BHPr evaluation activities.
[h] Minus $24,000 retained for BHPr evaluation activities.
[i] Includes $1,000,000 appropriated for the Nursing Research Grants Program in urgent supplemental appropriation.
[j] Minus $4,355 retained for BHPr evaluation activities.
[k] Includes $197,094 transferred to NCHSR for one cooperatively funded project.
[l] Minus $90,000 retained for BHPr evaluation activities.
[m] Includes $747,376 transferred to NIA for 4 cooperatively funded projects.

SOURCE: Division of Nursing, HRSA.

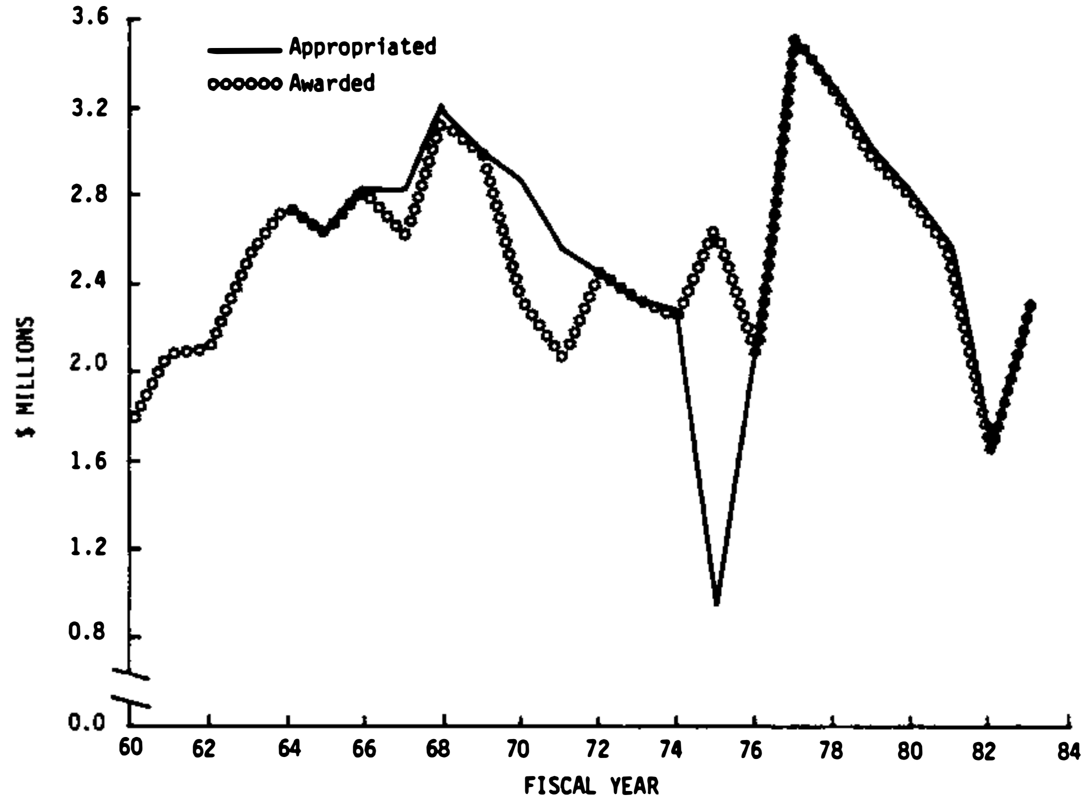

FIGURE 6.1 Funding for nursing research grants and contracts, 1960-83 (1972 $, millions). Data are from the Division of Nursing, HRSA.

TABLE 6.4 National Research Service Awards in Nursing, FY 1982–84[a]

	Predoctoral		Postdoctoral		Total	
	N	$	N	$	N	$
1982						
New	56		2		58	492,400
Continuing	62		0		62	467,110
Total	118		2		120	959,510
1983						
New	43	354,231	3	58,548	46	412,779
Continuing	64	513,562	2	33,590	66	547,152
Total	107	867,793	5	92,138	112	959,931
1984						
New	47	389,724	2	45,952	49	435,676
Continuing	66	496,786	2	23,025	68	519,811
Total	113	886,510	4	68,977	117	955,487

[a] All awards represent fellowships.

SOURCE: Division of Nursing, HRSA.

TABLE 6.5 NRSA Applications Reviewed by Scientific Review Groups, by Status of Application, FY 1984

Date of Review	Total Applications	Number Approved	Number Disapproved	Number Deferred
October 13-14, 1984	34	23	10	1
February 2-3, 1984	20	13	6	1
May 10-11, 1984	48	31	16	1
TOTAL APPLICATIONS	102	67	32	3
Predoctoral Applications	96	64	29	3
Postdoctoral Applications	5	2	3	0
Institutional Training Grants	1	1	0	0

SOURCE: Division of Nursing, HRSA.

Most of the applicants and trainees sponsored through the division are doing work in nursing (Table 6.6). Of approved applicants in 1984, 66 percent were in the nursing discipline. Among the stated research interests of 1984 awardees were "Coping with Spinal Cord Injuries and Rehabilitation," "Psychometric Methods for Nursing Research," "Nursing Care Delivery Systems in Rural Areas," and "Nursing Strategies in Infection Prevention of Cancer Patients."

It is estimated that approximately 1,000 individuals have received training grants in the area of nursing since the inception of the NRSA awards.

TABLE 6.6 Disciplines of NRSA Applicants, by Status of Application, FY 1984

Discipline	Total Applications	Number Approved	Number Disapproved	Number Deferred	Number Withdrawn
Nursing	64	44	18	1	1
Human Development	4	1	2	1	
Physiology	4	3	1		
Epidemiology	1	1	1		
Anthropology	3	2	1		
Psychology	1	1			
Sociology	2	1	1		
Social Psychology	5	2	3		
Education	2	1	1		
Educational Psychology	1	1			
Health Services	6	3	3		
Public/Community	2	2			
Health	1	1			
History	2	2			
Rehabilitation Education	2	2			
Policy/Ethics	2		2	1	
TOTAL	102	67	32	3	1

SOURCE: Division of Nursing, HRSA.

National Institutes of Health

In December 1984, an NIH Task Force on Nursing Research delivered its report to the NIH Director. The report focused primarily on the support of nursing research by NIH in fiscal year 1983. The report uses a working definition of nursing research at NIH: research conducted by the nurse principal investigator (PI); or nursing care research.[1] The task force was able to classify 108 extramural activities funded by NIH in FY 1983 as nursing research or as having components of nursing research. A total of $6.6 million was awarded to the nursing portions of these activities. The awards were made through 14 types of activities in the extramural program (Table 6.7). Table 6.8 shows which unit of NIH supported the activities. Seventy percent of the total funding came from either the National Cancer Institute or the National Institute on Aging.

A major program of the National Cancer Institute involving nursing research is the Clinical Cooperative Group Program. The 15 cooperative groups support oncology nursing or nursing research subcommittees. Activities of nurses in the clinical research effort include participation in protocol development (with particular emphasis on the potential impact of different treatment options on patient compliance), facilitation of the informed consent process, development of nursing care and patient education approaches to dealing with side effects of therapy, data management, attendance at scientific meetings, and presentation and publication of research results.

The individual units were asked to classify their projects into one of five focus areas. These areas were defined as follows:

1. Research--scientific inquiry in the cause, diagnosis, and prevention of diseases, in the promotion of health, in the processes of human growth and development and in the biological effects of environmental contaminants. The principal investigator is a nurse.

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[1]The full definition follows: 1. Research conducted by the nurse principal investigator: scientific inquiry in the causes, diagnosis, and prevention of diseases; in the promotion of health; in the processes of human growth and development; and in the biological effects of environmental contaminants. 2. Nursing care research: research directed to understanding the nursing care of individuals and groups and the biological, physiological, social, behavioral, and environmental mechanisms influencing health and disease which are relevant to nursing care. Nursing research develops knowledge about health and the promotion of health over the full lifespan, care of persons with health problems and disabilities, and nursing actions to enhance the ability of individuals to respond effectively to actual or potential health problems (Task Force Report, p. 1).

TABLE 6.7 Activities of NIH Grants with Nursing Research Components, FY 1983

Activity (Code)	Number of Awards
Research Project (R01)	21
Research Demonstration and Dissemination (R18)	20
Comprehensive Center (P60)	19
Biomedical Research Support Grant (S07)	15
Specialized Center (P50)	8
Research Program Projects (P01)	7
Academic Teacher Award (K07)	5
General Clinical Research Center (M01)	5
Research and Development Contracts (N01)	2
Contracts (unspecified)	2
New Investigator Research Award (R23)	1
Intragency Agreement (Y01)	1
Small Grants (R03)	1
Small Business Innovation Research (R43)	1
TOTAL	108

SOURCE: NIH Task Force on Nursing Research, December 1984.

TABLE 6.8 NIH-Funded Extramural Projects in Nursing Research or with Nursing Research Components, by Supporting Unit, FY 1983

Institute/Division	Number of Awards	$ Funded	% of Total $
Nat'l. Cancer Institute	30	2,641,012	40
Nat'l. Institute on Aging	22	2,025,456	30
Division of Research Resources	20	173,133	3
Nat'l. Institute of Arthritis, Diabetes, and Digestive and Kidney Diseases	13	194,645	3
Nat'l. Heart, Lung, and Blood Institute	11	713,726	11
Nat'l. Institute of General Medical Sciences	6	156,359	2
Nat'l. Institute of Allergy and Infectious Diseases	3	84,342	1
Nat'l. Institute of Neurological and Communicative Disorders and Stroke	3	658,000	10
TOTAL	108	6,646,682	100

SOURCE: NIH Task Force on Nursing Research, December 1984.

2. Nursing Care Research--research directed to understanding the nursing care of individuals and groups and the biological, physiological, social, behavioral, and environmental mechanisms influencing health and disease which are relevant to nursing care. Nursing research develops knowledge about health and the promotion of health over the full lifespan, care of persons with health problems and disabilities, and nursing actions to enhance the ability of individuals to respond effectively to actual or potential health problems.

3. Clinical Training--activities directed to the improvement or expansion of education and training of nursing students and practitioners.

4. Development of Researchers--activities directed to assisting or extending training of individuals preparing for research.

5. Other--activities that are supportive of the research process or basic or applied research that involves nursing but where the project is not headed by a nurse principal investigator.

Table 6.9 breaks down the total by the investigator (nurse or non-nurse) and by the focus of the award. In contrast to the Division of Nursing, the majority of projects funded by NIH in the area of nursing research did not have nurses as principal investigators. About 26 percent of the projects were headed by PIs who were nurses; this accounts for about 21 percent of the total money awarded to nursing activities. An example of a project headed by a PI who is a nurse is a project on sickle cell anemia sponsored by the National Heart, Lung, and Blood Institute. The study focuses on consolidating and strengthening programs which provide screening, education, counseling, and patient care to persons with sickle cell anemia. Most of the funding, 62 percent overall, was classified as nursing care research. In the "Development of Researchers" category, there was one project, accounting for 6 percent of the total amount awarded.

TABLE 6.9 NIH-Funded Extramural Projects in Nursing Research or with Nursing Research Components, by Focus of Award and Type of Investigator, FY 1983

	All Principal Investigators			Nurse Principal Investigators			Non-Nurse Principal Investigators		
Focus of Award	N	$ Funded	% of Total $	N	$ Funded	% of Total $	N	$ Funded	% of Total $
Research	6	63,930	1	6	63,930	4	—	—	—
Nursing Care	54	4,130,813	62	13	694,658	50	41	3,436,155	66
Clinical Training	21	448,224	7	3	237,659	17	18	210,585	4
Development of Researchers	1	386,000	6	1	386,000	27	—	—	—
Other	26	1,617,695	24	5	29,078	2	21	1,588,617	30
TOTAL	108	6,646,682 (100%)	100	28	1,411,325 (21%)	100	80	5,235,357 (79%)	100

SOURCE: NIH Task Force on Nursing Research, December 1984.

The task force report does not analyze the awards for 1984. It does indicate, however, that there were 64 applications in 1984 from schools, departments, or colleges of nursing; that the total request from these applications was for $6.4 million; and that the total award was $1.5 million.

The report states that there are 20 current intramural projects with nurse researchers as participants, through the Department of Nursing's Nursing Research Committee at the Clinical Center of NIH.

Veterans Administration

The Veterans Administration (VA) supports nursing research in several areas. Nurses within the VA can receive support from the research components of the VA for medical research, health services research, and rehabilitation research. Researchers compete for awards with others in the VA. VA nurses seek and receive outside support as well; sources include HHS's Division of Nursing, the American Nurses' Foundation, Sigma Theta Tau, and various pharmaceutical companies.

Research responsibilities appear as a component of job descriptions for nurses in the VA for the intermediate grades and above. Research positions for nurses in VA Medical Centers include Associate Chief Nurse for Research, for which a doctorate is needed, and Nurse Researcher, requiring a master's or a Ph.D. The VA also has a trainee program for chief nurses, including both research and administrative training.

The VA lists 190 approved research projects with nurses as principal investigators for FY 1984. They are broken down by position of research and area of research as shown in Table 6.10. Of these projects, nearly 80 percent are in the clinical area, and the VA reports that this proportion has been growing over the past several years. The clinical projects are further broken down into the areas of nursing procedures (25), quality of life (19), patient education (17), patient experience (14), nursing intervention (13), nutrition (13), quality of care (10), patient behavior (8), injection (6), rest/exercise (6), incontinence (6), pain (3), and miscellaneous (11).

The Gerontologic Nurse Fellowship Program provides salary and dissertation support for doctoral nursing students for a two-year period. Two fellows are chosen each fiscal year; during the fellowship period, each participant is based at one of the 172 VA Medical Centers. The VA anticipates that at least half of those who complete the program will be hired by the VA.

American Nurses' Foundation

The American Nurses' Foundation, a body of the American Nurses' Association, awards grants to nurses through its Competitive Extramural Grants Program. The program is funded by corporate and individual contributions to the foundation. Proposals are evaluated by the Foundation's Research Review Committee, made up of experienced researchers holding doctorates. In 1981, 10 of 69 applications were funded; in 1982, 12 of 86; in 1983, 25 of 109; and in 1984, 34 of 119.

TABLE 6.10 V.A. Research Projects with Nurse Principal Investigators, by Position of Principal Investigator and Area of Research, FY 1984

Position of Principal Investigator	Area of Research: Clinical	Administration	Education	Total
Staff Nurse	24	4	1	29
Head Nurse	12	—	—	12
Instructor	6	—	5	11
ACNS/E	—	3	2	5
Nurse Practitioner	5	1	—	6
Infection Control Nurse	12	1	—	13
Clinical Specialist	27	3	4	34
Supervisor/Coordinator	7	2	1	10
ACNS	—	3	—	3
Nurse Researcher	6	1	1	8
ACNS/Researcher	14	6	—	20
Other	38		1	39
TOTAL	151	24	15	190

SOURCE: Veterans Administration.

The grants program supports nursing research directed by a registered nurse. It is designed primarily for beginning nurse researchers, but experienced researchers entering a new area of investigation are also considered for awards. From 1955 through 1984, the program awarded 206 grants for a total of more than $1 million. In 1985, 32 grants of up to $2,500 each are expected to be awarded.

Robert Wood Johnson Foundation

The Robert Wood Johnson Foundation supports nursing research through its grants program and through its relatively new Clinical Nurse Scholars Program. Since 1982, the Foundation has supported, or is supporting, 17 projects in the area of nursing research, for a total commitment of $3.5 million. Research subjects have included "Increasing Communication Ability in Stroke Patients," "Program to Improve Health Outcomes for Teenage Mothers and Their Infants," "Survey of the Role of Nurse Midwives in United States Health Care," and "Sources of Nurse Satisfaction and Nursing Shortages in Hospitals."

The Clinical Nurse Scholars Program supports individual researchers during two-year postdoctoral fellowships for advanced, in-hospital clinical practice and research. Scholars are based at the academic health centers of one of three institutions: the University of California, San Francisco; the University of Pennsylvania; or the University of Rochester. The first group of nine scholars received awards for 1983-85, and nine additional scholars were funded for 1984-85 and for 1985-86. Up to nine awards may be made each year.

The goal of the program is to prepare a group of nursing faculty and clinicians who can place renewed emphasis on clinical teaching, practice, and research at their own institutions. Applicants must be registered nurses with earned doctorate degrees. Most recipients take a leave of absence from their employing institutions in order to accept the fellowship; stipends are based on the recipient's current salary level. A total of $3.3 million has been allocated to this program thus far; much of this amount was in start-up and administrative costs.

Sigma Theta Tau

Sigma Theta Tau, the national honor society of nursing has awarded a small number of nursing research grants each year since 1936. The purpose of its grant program is "to encourage qualified nurses to contribute to the advancement of nursing through research." Applicants must be registered nurses holding a master's degree or a doctorate. The maximum award is for $3,000. In 1984, the program received 33 applications. Ten were funded, for a total of $27,532. Local chapters of Sigma Theta Tau commonly make a small number of research awards each year, usually not exceeding $1,000, to their members.

NURSES WITH DOCTORAL DEGREES

Doctorate Degrees Awarded

The number of nurses receiving doctorates each year has been accelerating since 1978 (Figure 6.2). Data from the National League for Nursing show that 31 doctorates were awarded to nurses in academic year 1964-65; by 1981-82 that number had increased to 204.

Many nurses earn doctorates in fields other than nursing, however. According to the American Nurses' Association,[4] before 1950 nurses earned the Ph.D. and the Ed.D. in equal numbers; between 1950 and 1964, more than half received Ed.D. degrees; but since 1965, the Ph.D. has been the most prevalent of doctoral degrees earned by nurses. The nursing science doctorates, D.N.S. and D.N.Sc., have been awarded only since the 1960's, but their numbers have been increasing. Of the 3,648 nurses with doctorates surveyed by ANA in its 1984 study, 53.9 percent held the Ph.D., 32.5 percent the Ed.D., and 7 percent the D.N.S./D.N.Sc. The remaining 6.6 percent had other doctoral degrees.

The ANA's 1984 survey also collected data on the major area of the degree awarded. Respondents reported that 37 percent of the degrees were in education, 12 percent in nursing, 3 percent in public health, and 4 percent in the biomedical sciences. The remainder had a variety of major areas or did not report a major area.

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[4]For its 1980 survey, the ANA identified 2,348 U.S. nurses with earned doctorates. Of these, 1,964 completed and returned the questionnaires (83.6 percent response).

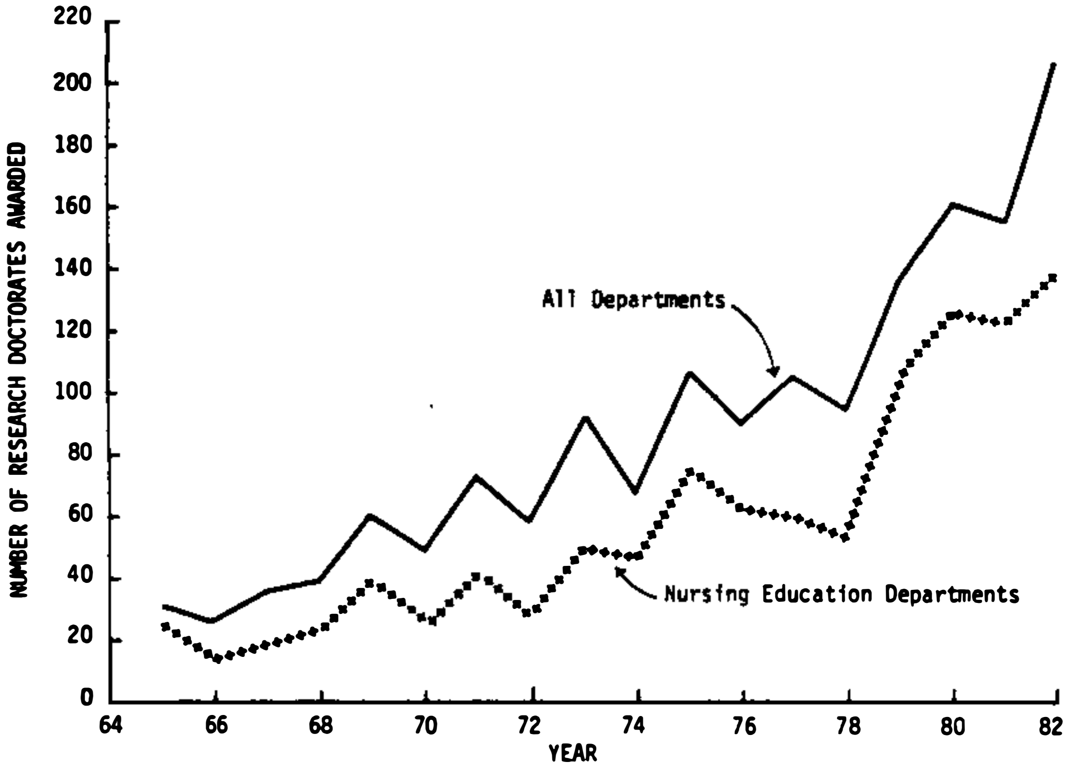

FIGURE 6.2 Research doctorates awarded to nurses, 1965-82 (academic years). Data are from the National League for Nursing (1981-84).

The federal government has been the most common source of support for nurses during doctoral study. Since 1950 more than 40 percent of the nurses with doctorates who had outside support while studying for the degree received that support from a federal grant for training or research (ANA, 1981, p. 37).

Doctoral Programs in Nursing

The number of doctoral programs in nursing also has been increasing steadily over the past 20 years (Figure 6.3). According to the NLN, in 1962-63 there were four programs in nursing schools or departments that awarded doctorates. In 1983-84 there were 30 such programs. Of that number, 21 granted the Ph.D. degree, 8 awarded a nursing science degree, and 1 awarded the Ed.D. (Table 6.11).

The enrollment of nurses in doctoral programs has been increasing as well (Figure 6.4). The NLN reports that much of this increase is due to the rising number of part-time students.

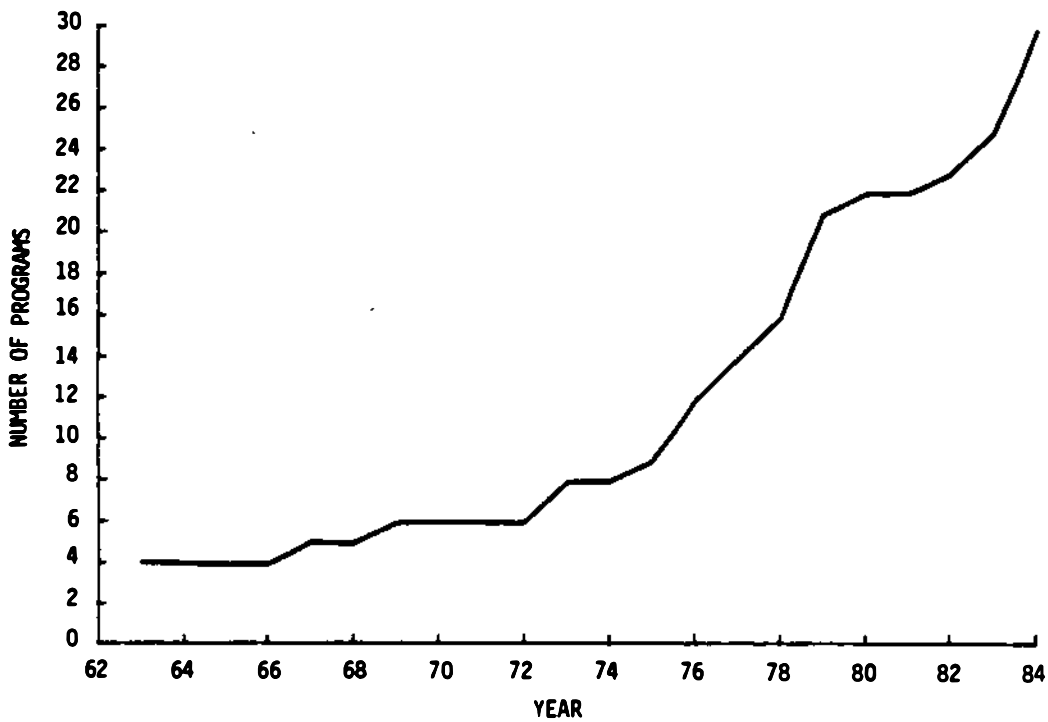

FIGURE 6.3 Research doctoral programs administered by schools or departments of nursing, 1963-84 (academic years). Data are from the National League for Nursing (1981-84).

TABLE 6.11 Doctoral Programs in Nursing, 1983–84

Degree Granted	Number of Programs
Ph.D.	21
D.N.Sc.	3
D.N.S.	2
D.S.N.	2
D.N.	1
Ed.D.	1
TOTAL	30

SOURCE: Sigma Theta Tau (1984a).

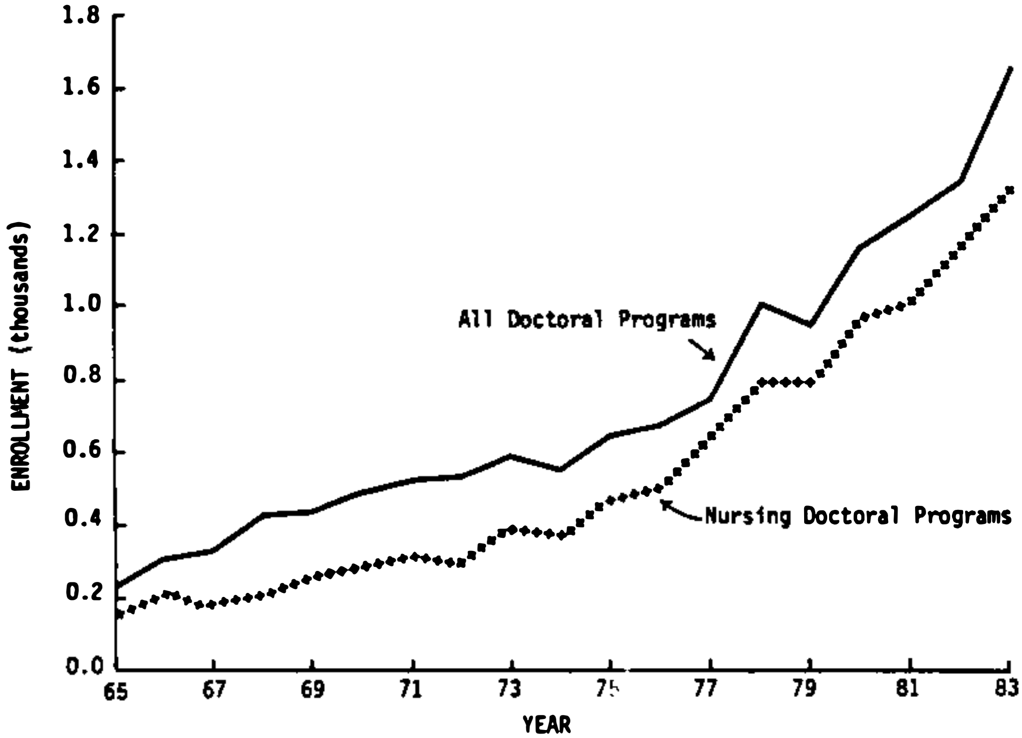

FIGURE 6.4 Nurses enrolled in research doctoral programs, 1965-83 (academic years). Data are from the National League for Nursing (1981-84).

Nurse Faculty with Doctorates

In nursing education programs, the number of faculty members who hold doctorates has been increasing but still is a small proportion of the total faculty (Figure 6.5). In 1982, only 8.4 percent of all full-time nurse-faculty members held doctorates; 16.1 percent of those employed in programs offering the baccalaureate and higher degrees held the doctorate. The NLN reports that of the 1,657 full-time nurse faculty holding doctorates, 92 percent were employed in programs offering the baccalaureate and higher degrees.

Employment of Nurses with Doctorates

In 1980, 91 percent of the nurses with doctorates were employed, most (88 percent) full-time (ANA, 1981). Approximately 6 percent were retired, and approximately 2 percent were in temporary positions. Only about 1 percent were reported to be unemployed and seeking employment.

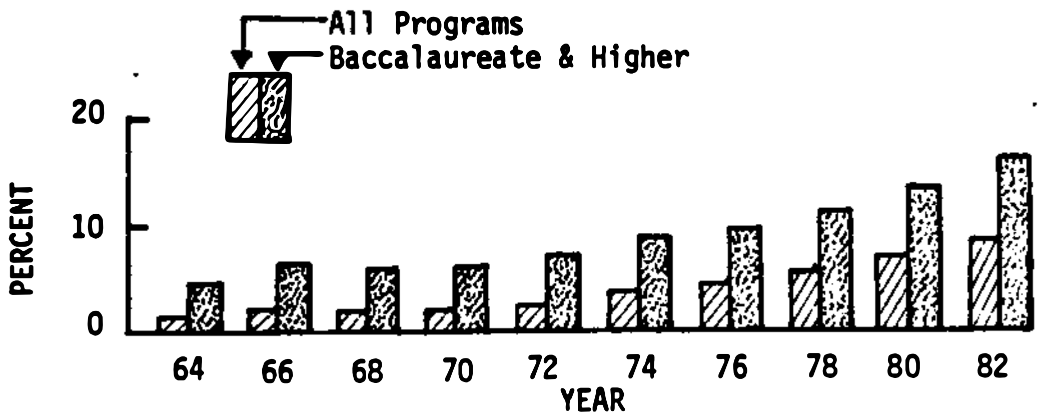

FIGURE 6.5 Percentage of full-time nurse faculty who hold research doctorate degrees, 1964-82 (academic years). Data are from the National League for Nursing (1981-84).

By far the largest proportion of all nurses with doctorates (61 percent) were employed in schools of nursing offering the baccalaureate and higher degrees; 4 percent worked in schools of nursing offering less than the baccalaureate. Another 6 percent were faculty members in other departments of educational institutions. Government agencies (4 percent), hospitals (2 percent), and public health settings (1 percent) accounted for the other specified employment settings of nurses with doctorates.

In institutions having both baccalaureate and higher degree programs in 1982, about 20 percent of full-time nurse faculty were assigned exclusively to the graduate programs, and another 18 percent were assigned part-time to graduate programs and part-time to baccalaureate programs. The remainder spent full-time with the undergraduate programs.

As indicated in Table 6.12, 4.6 percent of nurses with doctorates reported that their major function was research. This percentage was highest (18.1 percent) for those employed by government agencies. When broken down by degree (Table 6.13), the percentage was highest for those whose doctorate was in the biomedical sciences.

Table 6.14 shows the responses of nurses with doctorates as to what percentage of time is spent on research (ANA, 1981). Nurses in health professions schools other than nursing reported spending almost 30 percent of their time on research. Those in nursing programs at the baccalaureate and higher level spent only about 12 percent of their time on research.

TABLE 6.12 Registered Nurses with Doctoral Degrees, by Major Area of Degree and Major Function, 1980[a]

			Major Area of Degree															
	Total		Nursing		Public Health		Other		Biomedical		Education		Humanities		Social-Behavioral		Not Reported
Major Function	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N
Administration	550	28.0	120	28.0	20	23.5	7	10.6	8	10.8	285	34.6	4	23.5	106	22.8	—
Clinical Practice	42	2.1	12	2.8	1	1.2	6	9.1	2	2.7	4	0.5	3	17.6	14	3.0	—
Consultation	34	1.7	6	1.4	4	4.7	1	1.5	—	—	16	1.9	—	—	7	1.5	—
Research	91	4.6	15	3.5	6	7.1	2	3.0	11	14.9	21	2.5	2	11.8	34	7.3	—
Teaching	598	30.4	153	35.7	27	31.8	7	10.6	28	37.8	216	26.2	3	17.6	162	34.8	2
Multiple Functions[b]	250	12.7	48	11.2	8	9.4	9	13.6	16	21.6	108	13.1	2	11.8	58	12.5	1
Other	79	4.0	14	3.3	7	8.2	14	21.2	2	2.7	27	3.3	—	—	15	3.2	—
Not Reported[c]	320	16.3	61	14.2	12	14.1	20	30.3	7	9.5	147	17.8	3	17.6	69	14.8	1
TOTAL	1,964	100.0	429	100.0	85	100.0	66	100.0	74	100.0	824	100.0	17	100.0	465	100.0	4

[a] Percents may not add to 100.0 due to rounding.

[b] Includes nurses who have a combination of functions, e.g. teaching, administration, and research.

[c] Includes nurses not employed.

SOURCE: American Nurses' Association, Center for Research, Statistics and Data Analysis Unit, a special tabulation from a study of nurses with doctoral degrees, 1980. Unpublished data.

TABLE 6.13 Registered Nurses with Doctoral Degrees, by Employment Setting and Major Function, 1980[a]

	Employment Setting																	
			School of Nursing															
	Total		Baccalaureate or Higher		Less than Baccalaureate		Other School/ Department		Hospital		Public Health		Government Agency		Other		Not Reported	
Major Function	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Administration	550	28.0	378	31.5	34	43.0	33	27.0	29	59.2	10	52.6	29	34.9	26	16.3	11	4.3
Clinical Practice	42	2.1	4	0.3	—	—	2	1.6	3	6.1	5	26.3	2	2.4	25	15.6	1	0.4
Consultation	34	1.7	2	0.2	1	1.3	1	0.8	1	2.0	1	5.3	13	15.7	14	8.8	1	0.4
Research	91	4.6	50	4.2	—	—	5	4.1	6	12.2	1	5.3	15	18.1	14	8.8	—	—
Teaching	598	30.4	514	42.9	29	36.7	42	34.4	2	4.1	—	—	1	1.2	3	1.9	7	2.8
Multiple Functions[b]	250	12.7	166	13.8	10	12.7	23	18.9	4	8.2	1	5.3	12	14.5	31	19.4	3	1.2
Other	79	4.0	36	3.0	1	1.3	8	6.6	1	2.0	—	—	5	6.0	24	15.0	4	1.6
Not Reported[c]	320	16.3	49	4.1	4	5.1	8	6.6	3	6.1	1	5.3	6	7.2	23	14.4	226	89.3
TOTAL	1,964	100.0	1,199	100.0	79	100.0	122	100.0	49	100.0	19	100.0	83	100.0	160	100.0	253	100.0

[a] Percents may not add to 100.0 due to rounding.

[b] Includes nurses who have a combination of functions, e.g. teaching, administration, and research.

[c] Includes nurses not employed.

SOURCE: American Nurses' Association, Center for Research, Statistics and Data Analysis Unit, a special tabulation from a study of nurses with doctoral degrees, 1980. Unpublished data.

TABLE 6.14 Average Percentage of Time Spent in Research by Work Setting and Percentage of Nurses with Doctorates, 1980

Setting	% Time in Research	% of Nurses with Doctorates
School of Nursing (Baccalaureate and Higher)	11.8	70.1
School of Nursing (Hospital)	0.8	
School of Nursing (Associate Degree)	2.3	4.6
Other Health Professional School	28.4	
Other Department or School	11.1	7.1
Hospital in Service	11.5	
Hospital Nursing Administration Work	12.3	2.9
Public/Community Health Agency	4.0	
Federal/State/Local Government	20.6	6.0
Other	14.3	9.3
		100.0

SOURCE: American Nurses' Association (1981).

SUMMARY

In 1983, an Institute of Medicine committee (IOM, 1983a, p. 149) concluded that:

> Unlike the situation with respect to the basic supply of generalist nurses, where we have found the likelihood of a general balance between supply and demand in 1990, the committee concludes that there is both a serious current and probable 1990 shortage of nurses educationally prepared for administration, teaching, research, and advanced clinical nursing specialties. ... there is such an obvious gap between the present supply ... and even conservative estimates of future advanced positions required ... that existing program capacity and sources of student support at the graduate level should be expanded.

We agree with these findings. The low rate of unemployment of nurses with doctorates, the low percentage of nurse faculty members with doctorates, and the rapid growth in the number of doctoral programs in nursing lead the committee to conclude, even in the absence of numerical projections, that there is and will continue to be unfilled demand for researchers in this area.

There is also a growing need for training support in nursing research. In FY 1985, appropriations for NRSA programs of the Division of Nursing more than doubled from the previous year to $2 million, and the number of trainees and fellows increased to 168. Applications for fellowships increased by about 50 percent in FY 1985 and are expected to increase by another 30 percent in FY 1986.

NRSA fellowships and traineeships constitute one of the principal sources of support for nurses pursuing predoctoral and postdoctoral research training. However, the committee notes that funding levels, although increasing, have not been sufficient to allow programs to reach the levels it has recommended in the past. The importance of the problems addressed in nursing research, the continued demand for nurse faculty with research training, and the growing pool of fellowship applicants all indicate that nursing research is a rapidly developing area. Research training levels should be raised from the current number (168 in FY 1985) to about 320 in 1990.

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APPENDIX A
Medical and Dental School Data

APPENDIX A (cont'd.)
Medical and Dental School Data

APPENDIX TABLE A1 Students in U.S. Medical Schools, by Control of Institution, 1961-84[a]

	All Schools				Public Schools				Private Schools			
Fiscal Year	Total	Medical Students	Interns & Residents	Clinical Fellows	Total	Medical Students	Interns & Residents[b]	Clinical Fellows[b]	Total	Medical Students	Interns & Residents	Clinical Fellows
1961	49,899	30,688	16,970	2,241	25,115	15,954	8,362	799	24,784	14,734	8,608	1,442
1962	52,014	31,077	17,362	3,575	26,412	16,211	8,237	1,964	25,602	14,866	9,125	1,611
1963	52,219	31,238	17,380	3,601	26,198	16,432	8,292	1,474	26,021	14,806	9,088	2,127
1964	54,181	32,001	17,956	4,224	27,292	17,012	8,408	1,872	26,889	14,989	9,548	2,352
1965	55,170	32,106	18,991	4,073	27,561	17,116	8,999	1,446	27,609	14,990	9,992	2,627
1966	56,101	32,482	19,950	3,669	28,610	17,406	9,959	1,245	27,491	15,076	9,991	2,424
1967	57,618	33,142	20,290	4,186	29,358	17,906	9,932	1,520	28,260	15,236	10,358	2,666
1968	61,684	34,318	22,044	5,322	32,308	18,631	11,330	2,347	29,376	15,687	10,714	2,975
1969	63,530	35,102	23,462	4,966	33,153	19,024	11,930	2,199	30,377	16,078	11,532	2,767
1970	67,785	37,978	27,003	2,804	35,309	21,082	12,848	1,379	32,476	16,896	14,155	1,425
1971	71,500	40,476	27,440	3,584	37,733	22,616	13,956	1,161	33,767	17,860	13,484	2,423
1972	81,564	43,576	31,722	6,266	44,169	24,500	16,657	3,012[c]	37,395	19,076	15,065	3,254[b]
1973	86,914	47,523	33,117	6,274	47,429	26,830	16,954	3,645[c]	39,485	20,693	16,163	2,629[b]
1974	91,515	50,242	35,644	5,629	50,230	28,753	18,808	2,669[d]	41,285	21,489	16,836	2,960[c]
1975	95,273	54,076	36,213	4,984	51,677	30,826	19,159	1,692	43,596	23,250	17,054	3,292
1976	100,152	56,244	38,370	5,538	55,561	32,417	20,625	2,519	44,591	23,827	17,745	3,019
1977	103,061	58,266	39,431	5,364	57,364	33,932	21,141	2,291	45,697	24,334	18,290	3,073
1978	106,868	60,424	41,222	5,222	59,880	35,633	21,992	2,255	46,988	24,791	19,230	2,967
1979	112,770	62,582	44,951	5,237	64,024	37,265	24,219	2,540	48,746	25,317	20,732	2,697
1980	116,511	64,020	46,775	5,716	66,335	38,234	25,170	2,931	50,176	25,786	21,605	2,785
1981	118,283	65,412	46,577	6,294	67,091	39,425	24,628	3,038	51,192	25,987	21,949	3,256
1982	123,988	66,484	50,381	7,123	70,601	40,132	26,791	3,678	53,387	26,352	23,590	3,445
1983	126,024	66,886	51,704	7,434	71,323	40,410	27,178	3,735	54,701	26,476	24,526	3,699
1984	127,879	67,437	53,297	7,145	73,251	40,795	28,835	3,621	54,628	26,642	24,462	3,524

a/Figures were obtained from the Association of American Medical Colleges (1972-85, special tabulations of 4/8/82, 5/17/82, 6/15/83, 7/10/84 and 2/5/85). Because AAMC data were incomplete, figures for all items in 1962 and for clinical fellows in 1969 were obtained from the American Medical Association (1960-84).

b/Includes only individuals in accredited programs affiliated with medical schools.

c/Includes graduate students.

d/Interpolated.

APPENDIX TABLE A2 Faculty in U.S. Medical Schools, by Control of Institution, 1961-84

	Full-Time[a]									Part-Time[b]			Volunteer[b]		
	All Schools			Public Schools			Private Schools								
Fiscal Year	Total	Basic Sci. Depts.	Clin. Depts.	Total	Basic Sci. Depts.	Clin. Depts.	Total	Basic Sci. Depts.	Clin. Depts.	Total	Basic Sci. Depts.	Clin. Depts.	Total	Basic Sci. Depts.	Clin. Depts.
1961	11,224	4,023	7,201	5,054	1,849	3,205	6,170	2,174	3,996	n/a	n/a	n/a	n/a	n/a	n/a
1962	12,040	4,342	7,698	5,448	2,011	3,437	6,592	2,331	4,261	n/a	n/a	n/a	n/a	n/a	n/a
1963	13,602	4,693	8,909	6,190	2,202	3,988	7,412	2,491	4,921	n/a	n/a	n/a	n/a	n/a	n/a
1964	15,015	5,541	9,474	7,099	2,705	4,390	7,916	2,832	5,084	n/a	n/a	n/a	n/a	n/a	n/a
1965	15,882	5,233	10,649	7,609	2,452	5,157	8,273	2,781	5,492	n/a	n/a	n/a	n/a	n/a	n/a
1966	17,118	5,671	11,447	8,220	2,666	5,552	8,898	3,003	5,895	n/a	n/a	n/a	n/a	n/a	n/a
1967	19,297	5,877	13,420	9,268	2,907	6,361	10,029	2,970	7,059	n/a	n/a	n/a	n/a	n/a	n/a
1968	22,293	6,639	15,654	11,066	3,364	7,702	11,227	3,275	7,952	n/a	n/a	n/a	n/a	n/a	n/a
1969	23,034	7,048	15,986	11,126	3,567	7,559	11,908	3,481	8,427	n/a	n/a	n/a	n/a	n/a	n/a
1970	24,093	7,287	16,806	11,870	3,778	8,092	12,223	3,509	8,714	n/a	n/a	n/a	n/a	n/a	n/a
1971	27,539	8,283	19,256	13,385	4,300	9,085	14,154	3,983	10,171	7,792		n/a	49,928	n/a	n/a
1972	30,170	8,714	21,456	14,588	4,642	9,946	15,582	4,072	11,510	7,403	925	6,478	56,732	3,499	53,233
1973	33,265	9,381	23,884	15,455	4,790	10,665	17,810	4,591	13,219	6,870	880	5,990	61,895	2,817	59,078
1974	34,878	9,928	24,950	16,307	5,238	11,069	18,571	4,690	13,881	7,616	793	6,823	62,115	3,946	58,169
1975	37,010	10,164	26,846	17,820	5,488	12,332	19,190	4,676	14,514	10,011	1,027	8,984	64,393	3,896	60,497
1976	39,346	10,743	28,603	19,690	5,944	13,746	19,656	4,799	14,857	7,824	800	7,024	70,453	4,405	66,048
1977	41,650	11,301	30,349	20,819	6,383	14,436	20,831	4,918	15,913	7,738	685	7,053	74,193	4,473	69,720
1978	44,358	11,736	32,622	23,240	6,766	16,474	21,118	4,970	16,148	7,268	749	6,519	78,986	4,649	74,337
1979	46,662	12,605	34,057	24,406	7,164	17,242	22,256	5,441	16,815	9,692	922	8,770	86,096	5,353	80,743
1980	49,446	12,831	36,665	26,444	7,461	18,983	23,052	5,370	17,682	9,052	919	8,133	82,635	4,876	77,759
1981	50,532	12,816	37,716	26,555	7,471	19,084	23,977	5,345	18,632	9,550	1,017	8,533.	89,077	5,100	83,977
1982	53,371	13,223	40,148	27,572	7,707	19,865	25,799	5,516	20,283	10,451	1,043	9,408	93,099	5,517	87,582
1983	55,525	13,587	41,938	29,160	7,963	21,197	26,365	5,624	20,741	8,997	975	8,022	105,590	5,779	99,811
1984	57,003	13,560	43,443	29,274	7,782	21,492	27,729	5,778	21,951	9,864	917	8,947	104,240	5,947	98,293

[a]Figures were obtained from the Association of American Medical Colleges (1972-85, special tabulations of 4/8/82, 5/17/82, 6/15/83, 7/10/84, and 2/5/85). Because AAMC data were incomplete, total full-time faculty figures for 1962 were obtained from the American Medical Association (1960-84); public and private figures for 1962 were estimated by the committee.

[b]From the American Medical Association (1960-84).

APPENDIX TABLE A3 Clinical Sciences Faculty/Student Ratio, by Control of Institution, 1963-84[a]

Fiscal Year	All Schools: Clinical Faculty (CF)	All Schools: 4-Yr. Weighted Avg. Enrollment (WS)	All Schools: Clinical Faculty/Student Ratio (CF/WS)	Public Schools: Clinical Faculty (CF)	Public Schools: 4-Yr. Weighted Avg. Enrollment (WS)	Public Schools: Clinical Faculty/Student Ratio (CF/WS)	Private Schools: Clinical Faculty (CF)	Private Schools: 4-Yr. Weighted Avg. Enrollment (WS)	Private Schools: Clinical Fac./Student Ratio (CF/WS)
1963	8,909	51,209	0.174[b]	3,988	25,850	0.154[b]	4,921	25,359	0.194[b]
1964	9,474	52,091	0.182	4,390	26,271	0.167	5,084	25,820	0.197
1965	10,649	53,331	0.200	5,157	26,826	0.192	5,492	26,505	0.207
1966	11,447	54,504	0.210	5,552	27,419	0.202	5,895	27,085	0.218
1967	13,420	55,724	0.241	6,361	28,165	0.226	7,059	27,558	0.256
1968	15,654	57,382	0.273	7,702	29,301	0.263	7,952	28,081	0.283
1969	15,986	59,706	0.268	7,559	30,849	0.245	8,427	28,827	0.292
1970	16,806	62,639	0.268	8,092	32,598	0.248	8,714	30,010	0.290
1971	19,256	65,969	0.292	9,085	34,494	0.263	10,171	31,475	0.323
1972	21,456	70,611	0.304	9,946	37,234	0.267	11,510	33,376	0.345
1973	23,884	76,805	0.311	10,665	41,090	0.260	13,219	35,714	0.370
1974	24,950	83,329	0.299	11,069	45,193	0.245	13,881	38,135	0.364
1975	26,846	88,949	0.302	12,332	48,527	0.254	14,514	40,422	0.359
1976	28,603	93,440	0.306	13,746	51,134	0.269	14,857	42,306	0.351
1977	30,349	97,571	0.311	14,436	53,678	0.269	15,913	43,893	0.363
1978	32,622	101,428	0.322	16,474	56,235	0.293	16,148	45,193	0.357
1979	34,057	105,463	0.323	17,242	59,012	0.292	16,815	46,451	0.362
1980	36,665	109,808	0.334	18,983	61,918	0.307	17,682	47,890	0.369
1981	37,716	113,952	0.331	19,084	64,615	0.295	18,632	49,337	0.378
1982	40,148	117,724	0.341	19,865	66,913	0.297	20,283	50,812	0.399
1983	41,938	121,180	0.346	21,197	68,840	0.308	20,741	52,339	0.396
1984	43,443	124,364	0.349	21,492	70,698	0.304	21,951	53,666	0.409

[a] Faculty is defined as all full-time faculty employed in clinical science departments of U.S. medical schools. Students are defined as a 4-year weighted average of enrollments, i.e., $(WS)_t = 1/6(S_t + 2S_{t-1} + 2S_{t-2} + S_{t-3})$, where S = total enrollments of medical students, interns, residents, and clinical fellows. Totals may not sum due to rounding. See Appendix Table A1 for suppo ting data.

[b] Estimated by the committee.

APPENDIX TABLE A4 M.D. Graduates of U.S. Medical Schools, by Control of Institution, 1961-84

Fiscal Year	M.D. Graduates[a]			Number of Medical Schools[b]		
	Total	Public	Private	Total	Public	Private
1961	6,994	n/a	n/a	86	44	42
1962	7,168	n/a	n/a	86	44	42
1963	7,264	n/a	n/a	87	44	43
1964	7,336	n/a	n/a	88	45	43
1965	7,409	n/a	n/a	88	45	43
1966	7,574	n/a	n/a	91	48	43
1967	7,743	n/a	n/a	96	53	43
1968	7,973	n/a	n/a	98	54	44
1969	8,059	n/a	n/a	100	56	44
1970	8,367	n/a	n/a	102	58	44
1971	9,005	4,891	4,114	107	62	45
1972	9,558	5,295	4,263	110	64	46
1973	10,396	5,884	4,512	113	66	47
1974	11,365	6,441	4,924	113	66	47
1975	12,716	7,175	5,541	113	66	47
1976	13,634	7,534	6,100	115	68	47
1977	13,614	7,698	5,916	119	72	47
1978	14,391	8,284	6,107	123	74	49
1979	14,966	8,852	6,114	125	74	51
1980	15,135	8,840	6,295	126	75	51
1981	15,673	9,243	6,430	126	75	51
1982	15,985	9,545	6,440	127	75	52
1983	15,801	9,411	6,390	127	75	52
1984	16,369	9,792	6,577	127	75	52

[a] Figures for 1961-1970 were obtained from the American Medical Association (1960-84). Figures for 1971-84 were obtained from the Association of American Medical Colleges (1972-85, special tabulations of 10/21/82, 6/15/83, 7/10/84, and 2/5/85). The 1983 figure for private schools includes an estimate from Columbia University.

[b] From the Association of American Medical Colleges (1972-85, special tabulations of 10/27/82, 6/15/83, 7/10/84, and 2/5/85).

APPENDIX TABLE A5 Full-Time Budgeted Vacancies on U.S. Medical School Faculties, by Control of Institution, 1961-84[a]

Fiscal Year	All Departments			Basic Science Departments			Clinical Science Departments		
	Total	Public	Private	Total	Public	Private	Total	Public	Private
1961	784	n/a	n/a	305	n/a	n/a	515	n/a	n/a
1962	836	n/a	n/a	348	n/a	n/a	488	n/a	n/a
1963	826	n/a	n/a	350	n/a	n/a	476	n/a	n/a
1964	915	n/a	n/a	401	n/a	n/a	514	n/a	n/a
1965	955	n/a	n/a	376	n/a	n/a	579	n/a	n/a
1966	1,115	n/a	n/a	443	n/a	n/a	672	n/a	n/a
1967	1,374	n/a	n/a	520	n/a	n/a	854	n/a	n/a
1968	1,585	n/a	n/a	570	n/a	n/a	1,015	n/a	n/a
1969	1,691	n/a	n/a	579	n/a	n/a	1,112	n/a	n/a
1970	1,634	n/a	n/a	541	n/a	n/a	1,093	n/a	n/a
1971	1,522	856	666	518	296	222	1,004	560	444
1972	1,757	1,111	646	511	328	183	1,246	783	463
1973	1,857	1,144	713	550	361	189	1,307	783	524
1974	2,079	1,339	740	601	388	213	1,478	951	527
1975	2,250	1,505	745	618	415	203	1,632	1,090	542
1976	2,446	1,588	858	664	467	197	1,782	1,121	661
1977	2,503	1,599	904	638	416	222	1,865	1,183	682
1978	2,697	1,782	915	697	484	213	2,000	1,298	702
1979	2,821	1,811	1,010	721	467	254	2,100	1,344	756
1980	3,055	1,971	1,084	776	489	287	2,279	1,482	797
1981	2,887	1,978	909	656	425	231	2,231	1,553	678
1982	2,932	1,931	1,001	668	432	236	2,264	1,499	765
1983	2,941	1,857	1,084	671	419	252	2,270	1,438	832
1984	3,107	1,890	1,217	705	443	262	2,402	1,447	955

[a] Figures for 1961-70 were obtained from the American Medical Association (1960-84). Figures for 1971-84 were obtained from the Association of American Medical Colleges (1972-85, special tabulations of 10/21/82, 6/15/83, 7/10/84, and 2/5/85).

APPENDIX TABLE A6 Primary Activity of Physicians in the U.S., 1963-83[a]

Fiscal Year	Total Active[b]		Patient Care		Teaching		Admin.		Research		Other		Unclassified and Unknown Address	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
1963	263,063	100.0	246,951	93.9	8,190	3.1	3,332	1.3	3,255	1.2	n/a	-	1,335	0.5
1964	270,885	100.0	253,543	93.6	8,869	3.3	3,512	1.3	3,627	1.3	n/a	-	1,333	0.5
1965	278,809	100.0	259,418	93.0	9,794	3.5	4,057	1.5	4,306	1.5	n/a	-	1,234	0.4
1966	287,163	100.0	266,766	92.9	10,503	3.7	4,143	1.4	4,445	1.5	n/a	-	1,306	0.5
1967	295,732	100.0	274,190	92.7	11,166	3.8	4,121	1.4	4,595	1.6	n/a	-	1,660	0.6
1968[c]	298,401	100.0	261,722	87.7	5,051	1.7	11,715	3.9	15,441[d]	5.2	2,383	0.8	2,089	0.7
1969	305,047	100.0	270,737	88.8	5,149	1.7	12,107	4.0	12,375	4.1	2,598	0.9	5,865	1.9
1970	314,407	100.0	278,535	88.6	5,588	1.8	12,158	3.9	11,929	3.8	2,635	0.8	3,562	1.1
1971	325,435	100.0	287,248	88.3	5,844	1.8	12,076	3.7	10,898	3.3	2,633	0.8	6,736	2.1
1972	336,424	100.0	292,210	86.9	5,836	1.7	11,074	3.3	9,290	2.8	2,693	0.8	15,521	4.6
1973	343,755	100.0	295,257	85.9	6,183	1.8	11,959	3.5	8,332	2.4	2,636	0.8	19,388	5.6
1974	358,134	100.0	301,238	84.1	6,464	1.8	11,739	3.3	8,159	2.2	2,666	0.7	27,868	7.8
1975	372,293	100.0	311,937	83.8	6,445	1.7	11,161	3.0	7,944	2.1	2,793	0.8	32,013	8.6
1976	387,329	100.0	318,412	82.2	6,935	1.8	11,689	3.0	8,514	2.2	2,893	0.7	38,886	10.0
1977	392,913	100.0	332,393	84.6	6,673	1.7	11,954	3.0	9,786	2.5	2,813	0.7	29,296	7.5
1978	410,655	100.0	342,714	83.6	7,025	1.7	11,858	2.9	11,437	2.8	2,777	0.7	34,844	8.5
1979	426,226	100.0	356,783	83.7	7,523	1.8	12,118	2.8	14,515	3.4	2,790	0.7	32,497	7.6
1980	441,935	100.0	376,512	85.2	7,942	1.8	12,209	2.8	15,377	3.5	2,876	0.7	27,019	6.1
1981	450,112	100.0	389,369	86.5	7,202	1.6	13,250	2.9	17,901	4.0	3,023	0.7	19,367	4.3
1982	466,268	100.0	408,663	87.6	7,505	1.6	13,408	2 9	16,743	3.6	3,070	0.7	16,879	3.6
1983	482,635	100.0	423,361	87.7	7,783	1.6	13,828	2.9	18,535	3.8	3,290	0.7	15,838	3.3

[a] From the American Medical Association (1963-85).

[b] Excludes temporary foreign; includes unknown address and unclassified.

[c] In 1968 the AMA revised its procedures for classifying physicians, making comparisons with early years extremely difficult. One effect was to drastically reduce the Teaching category and to increase the Administration and Research categories.

[d] Includes 8,029 fellows formerly included in the Patient Care category.

APPENDIX TABLE A7 R and D Expenditures in U.S. Medical Schools, by Control of Institution, 1962-84 ($ thousands)

Fiscal Year	Total R and D Expenditures: Current Dollars[a] Total	Public	Private	1972 Dollars Total	Public	Private	Implicit GNP Price Deflator[b] (1972 = 100.00)	NIH Clinical Research as a % of Total Research Obligations[c]	Estimated Clinical R and D[d] 1972 Dollars Total	Public	Private
1962	208,573	85,491	123,082	295,848	121,264	174,584	70.50	12.0	35,502	14,552	20,950
1963	264,418	106,000	158,400	369,299	148,045	221,229	71.60	13.5	49,855	19,986	29,866
1964	310,412	128,710	181,702	426,977	177,043	249,934	72.70	15.0	64,047	26,556	37,490
1965	344,787	143,627	201,160	464,047	193,307	270,740	74.30	16.5	76,568	31,896	44,672
1966	377,027	155,960	221,068	490,921	203,073	287,849	76.80	18.0	88,366	36,553	51,813
1967	422,467	178,881	243,586	534,768	226,432	308,337	79.00	20.0	106,954	45,286	61,667
1968	470,958	202,440	268,518	570,167	245,085	325,082	82.60	22.5	128,288	55,144	73,143
1969	489,314	196,800	292,500	564,376	226,990	337,370	86.70	25.0	141,094	56,748	84,343
1970	498,066	205,962	292,104	544,930	225,341	319,589	91.40	28.0	152,580	63,095	89,485
1971	499,841	207,346	292,495	520,668	215,985	304,682	96.00	30.0	156,200	64,796	91,405
1972	558,120	227,638	330,482	558,120	227,638	330,482	100.00	32.0	178,598	72,844	105,754
1973	606,921	264,808	342,113	573,649	250,291	323,358	105.80	34.0	195,041	85,099	109,942
1974	657,287	300,479	356,808	566,627	259,034	307,593	116.00	34.0	192,653	88,072	104,582
1975	784,537	363,893	420,644	616,774	286,079	330,695	127.20	39.0	240,542	111,571	128,971
1976	839,170	385,857	453,313	626,714	288,168	338,546	133.90	37.0	231,884	106,622	125,262
1977	973,827	449,709	524,118	687,246	317,367	369,879	141.70	39.0	268,026	123,773	144,253
1978	1,046,121	490,029	556,092	688,011	322,281	365,730	152.05	41.0	282,085	132,135	149,949
1979	1,190,689	585,488	605,201	719,623	353,855	365,769	165.46	38.0	273,457	134,469	138,977
1980	1,352,409	677,085	675,324	757,992	379,489	378,502	178.42	39.0	295,617	148,001	147,616
1981	1,477,919	766,565	711,354	757,363	392,828	364,535	195.14	38.0	287,798	149,275	138,523
1982	1,605,585	828,954	776,631	776,095	400,693	375,402	206.88	38.0	294,916	152,263	142,653
1983[e]	1,787,532	937,510	850,022	828,981	434,777	394,204	215.63	38.0	315,013	165,215	149,798
1984	1,997,317	1,065,607	931,710	893,934	476,931	417,003	223.43	38.0	339,695	181,234	158,461

a/Figures were obtained from the Association of American Medical Colleges (1972-85, special tabulations generated annually from 1982-85). Because AAMC data were incomplete, figures for 1963 and 1969 were obtained from the American Medical Association (1960-84). Items may not sum to totals due to rounding.

b/From the U.S. Bureau of the Census.

c/Estimates for 1962-75 were derived from data supplied by John James, Division of Research Grants, NIH. Other years were estimated by the committee.

d/See note to this table on next page.

e/Financial data from the University of Washington and Mayo Medical School were included for the first time in 1983.

NOTE TO APPENDIX TABLE A7:

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 best data we can obtain from the AAMC are on total R and D expenditures in medical schools. This is the variable used in our demand models. Data on clinical R and D expenditures, however, are not available.

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 1984, this proportion has increased by 52 percent as shown below.

Clinical Research as Percent of NIH Obligations (NIH, 1975; NSF, 1960-84)

1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
25%	28%	30%	32%	34%	34%	39%	37%	39%	41%	38%	39%	38%	38%	38%	38%

In the absence of any direct measurements, the above percentages offer the best available means of estimating clinical R & D expenditures in medical schools. Accordingly, they have been used to produce the data shown in Table 2.1.

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.

APPENDIX TABLE A8 Professional Service Income in U.S. Medical Schools, by Control of Institution, 1962-84 ($ thousands)

Fiscal Year	Current Dollars[a]			1972 Dollars[b]		
	Total	Public	Private	Total	Public	Private
1962	15,500	7,453	8,047	21,986	10,572	11,414
1963	16,681	8,624	8,056	23,297	12,045	11,251
1964	18,576	9,124	9,452	25,552	12,550	13,001
1965	21,840	11,534	10,305	29,394	15,524	13,869
1966	25,203	13,369	11,834	32,816	17,408	15,409
1967	30,252	16,407	13,845	38,294	20,768	17,525
1968	47,406	28,096	19,310	57,392	34,015	23,378
1969	65,304	37,600	27,700	75,322	43,368	31,949
1970	90,057	52,232	37,825	98,531	57,147	41,384
1971	115,883	68,379	47,504	120,711	71,228	49,483
1972	138,197	75,466	62,731	138,197	75,466	62,731
1973	158,984	87,763	71,221	150,268	82,952	67,317
1974	201,642	121,842	79,800	173,829	105,036	68,793
1975	305,331	168,798	136,533	240,040	132,703	107,337
1976	409,877	218,905	190,972	306,107	163,484	142,623
1977	553,664	263,965	289,699	390,730	186,285	204,445
1978	616,971	296,219	320,752	405,768	194,817	210,952
1979	729,439	361,104	368,335	440,855	218,242	222,613
1980	880,335	436,567	443,768	493,406	244,685	248,721
1981	1,026,296	500,402	525,894	525,928	256,432	269,496
1982	1,265,146	597,484	667,662	611,536	288,807	322,729
1983[c]	1,595,165	771,330	823,835	739,770	357,710	382,060
1984	1,800,954	868,772	932,182	806,048	388,834	417,214

[a] This is income under control of school. An unknown amount is not under control of school and is not reported here. Figures were obtained from the Association of American Medical Colleges (1972-85, special tabulations generated annually from 1982-85). Because AAMC data were incomplete, figures for 1969 were obtained from the American Medical Association (1960-84). Items may not sum to totals due to rounding.

[b] 1972 dollars were obtained by using the Implicit GNP Price Deflator (U.S. Bureau of the Census--see Appendix Table A7).

[c] Financial data from the University of Washington and Mayo Medical School were included for the first time in 1983.

APPENDIX TABLE A9 Average Clinical R and D Expenditures and Professional Service Income per U.S. Medical School, by Control of Institution, 1962-84[a] (1972 $, thousands)

Fiscal Year	Clinical R and D Expenditures						Professional Service Income						Sum of Average Clinical R & D + Professional Service Income per School		
	Average per School			Number of Schools Reporting[b]			Average per School			Number of Schools Reporting[b]					
	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total	Public	Private
1962	413	331	499	86	44	42	733	587	951	30	18	12	1,146	918	1,450
1963	573	444	711	87	45	42	752	669	863	31	18	13	1,325	1,113	1,574
1964	745	604	893	86	44	42	824	738	929	31	17	14	1,569	1,342	1,822
1965	880	709	1,064	87	45	42	891	817	991	33	19	14	1,771	1,526	2,055
1966	993	778	1,234	89	47	42	994	967	1,027	33	18	15	1,987	1,745	2,261
1967	1,114	854	1,434	96	53	43	891	865	922	43	24	19	2,005	1,719	2,356
1968	1,323	1,003	1,742	97	55	42	1,025	1,031	1,016	56	33	23	2,348	2,034	2,758
1969	1,550	1,091	2,163	91	52	39	1,321	1,314	1,331	57	33	24	2,871	2,405	3,494
1970	1,526	1,088	2,130	100	58	42	1,388	1,361	1,427	71	42	29	2,914	2,449	3,557
1971	1,531	1,080	2,176	102	60	42	1,724	1,656	1,833	70	43	27	3,255	2,736	4,009
1972	1,734	1,235	2,404	103	59	44	1,946	1,841	2,091	71	41	30	3,680	3,076	4,495
1973	1,894	1,418	2,557	103	60	43	2,147	2,127	2,172	70	39	31	4,041	3,545	4,729
1974	1,736	1,334	2,324	111	66	45	2,381	2,283	2,548	73	46	27	4,117	3,617	4,872
1975	2,167	1,665	2,931	111	67	44	3,077	2,765	3,578	78	48	30	5,244	4,430	6,509
1976	2,070	1,591	2,784	112	67	45	3,644	3,270	4,195	84	50	34	5,714	4,861	6,979
1977	2,311	1,768	3,136	116	70	46	4,390	3,450	5,841	89	54	35	6,701	5,218	8,977
1978	2,351	1,835	3,124	120	72	48	4,363	3,479	5,701	93	56	37	6,714	5,314	8,825
1979	2,260	1,842	2,896	121	73	48	4,740	3,829	6,184	93	57	36	7,000	5,671	9,079
1980	2,443	2,000	3,141	121	74	47	5,140	4,078	6,909	96	60	36	7,583	6,078	10,050
1981	2,398	2,045	2,947	120	73	47	5,259	4,136	7,092	100	62	38	7,657	6,181	10,039
1982	2,398	2,058	2,911	123	74	49	5,995	4,658	8,068	102	62	40	8,393	6,716	10,979
1983[c]	2,561	2,233	3,057	123	74	49	6,914	5,420	9,319	107	66	41	9,475	7,653	12,376
1984	2,739	2,449	3,169	124	74	50	7,533	5,891	10,176	107	66	41	10,272	8,340	13,345

[a] See Appendix Tables A7 and A8 for supporting data.

[b] From the Association of American Medical Colleges (1972-85, special tabulations generated annually from 1982-85). Figures for 1969 were estimated by the committee.

[c] Financial data from the University of Washington and Mayo Medical School were included for the first time in 1983.

APPENDIX TABLE A10 Clinical R and D Expenditures + Professional Service Income in U.S. Medical Schools, by Control of Institution, 1962-84[a]
(1972 $, thousands)

Fiscal Year	Sum of Clinical R and D Expenditures + Professional Service Income: Current Dollars			Sum of Clinical R and D Expenditures + Professional Service Income: 1972 Dollars			Weighted Sum of Clinical R and D + Professional Service Income in Last 3 Years[b]			Weighted Sum of Average Clinical R and D + Professional Service Income per School in Last 3 Years[b]		
	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total	Public	Private
1962	40,529	17,712	22,817	57,488	25,123	32,364.						
1963	52,377	22,934	29,440	73,153	32,031	41,117						
1964	65,138	28,430	36,707	89,598	39,107	50,491	73,348	32,073	41,273	1,341	1,122	1,606
1965	78,730	35,232	43,496	105,962	47,419	58,542	89,578	39,416	50,160	1,558	1,331	1,818
1966	93,068	41,442	51,626	121,182	53,961	67,222	105,676	46,976	58,699	1,774	1,535	2,048
1967	114,745	52,183	62,562	145,247	66,055	79,193	123,393	55,349	68,044	1,938	1,684	2,233
1968	153,372	73,645	79,727	185,680	89,159	96,521	149,339	68,807	80,532	2,086	1,804	2,433
1969	187,633	86,800	100,825	216,416	100,115	116,292	183,256	86,122	97,132	2,393	2,048	2,842
1970	229,515	109,901	119,614	251,111	120,242	130,869	217,406	102,408	114,993	2,751	2,323	3,326
1971	265,835	130,583	135,252	276,912	136,024	140,888	248,887	119,156	129,729	2,989	2,510	3,655
1972	316,795	148,310	168,485	316,795	148,310	168,485	280,432	135,150	145,282	3,276	2,749	4,018
1973	365,337	177,798	187,539	345,309	168,051	177,258	313,953	150,174	163,779	3,664	3,108	4,432
1974	425,120	224,005	201,115	366,482	193,108	173,375	343,474	169,380	174,094	3,969	3,446	4,706
1975	611,300	310,716	300,584	480,582	244,274	263,308	389,714	199,635	190,079	4,380	3,803	5,245
1976	720,370	361,672	358,698	537,991	270,106	267,885	466,409	237,940	228,469	5,080	4,335	6,217
1977	933,457	439,352	494,105	658,756	310,058	348,698	553,830	273,636	280,194	5,844	4,842	7,361
1978	1,045,881	497,131	548,750	687,853	326,952	360,901	635,839	304,293	331,545	6,457	5,153	8,440
1979	1,181,900	583,589	598,311	714,312	352,707	361,605	687,193	329,167	358,026	6,782	5,379	8,927
1980	1,407,774	700,630	707,144	789,023	392,686	396,337	726,375	356,263	370,112	7,074	5,684	9,258
1981	1,587,904	791,698	796,208	813,726	405,707	408,019	776,521	385,947	390,574	7,456	6,002	9,805
1982	1,875,269	912,487	962,781	906,452	441,070	465,382	830,732	411,293	419,439	7,823	6,289	10,277
1983[c]	2,274,429	1,127,583	1,146,845	1,054,783	522,925	531,858	920,353	452,693	467,660	8,480	6,817	11,093
1984	2,559,934	1,273,703	1,286,231	1,145,743	570,068	575,675	1,040,440	514,247	526,193	9,404	7,591	12,269

[a] See Appendix Tables A7, A8, and A9 for supporting data.

[b] Computed by the formula $D_i = 1/4(S_i + 2S_{i-1} + S_{i-2})$, where D_i = a weighted average; S_i = sum of clinical R and D expenditures + professional service income in medical schools in year i.

[c] Financial data from the University of Washington and Mayo Medical School were included for the first time in 1983.

APPENDIX TABLE A11.1 Sources of Revenue in U.S. Medical Schools, 1959-83[a] (current $, millions)

	Total Revenue									Number of Schools Reporting		
Fiscal Year	All Schools	Public Schools	Private Schools	Federal Research	Other Federal	State/ Local Govt.	Tuition Revenue	Prof. Service Income	Other Revenue	All Schools	Public Schools	Private Schools
1959	319						24					
1960	371						26	11		87		
1961	433	191	242				28			87	44	43
1962	515	239	276				30			87	44	43
1963	603	279	324				32			87	44	43
1964	696	323	372				35			87	44	43
1965	779	363	416				39			87	44	43
1966	882	409	473				41			88	44	44
1967	1,010	483	527				44			88	44	44
1968	1,175	549	627				48			89	45	44
1969	1,366	635	731				52			92	47	45
1970	1,550	702	848				56			93	48	45
1971	1,713	815	898	438	322	323	63	209	358	92	48	44
1972	1,945	916	1,030				78			95	51	44
1973	2,181	1,070	1,111				92			96	53	43
1974	2,524	1,321	1,204				112			107	62	45
1975	3,046	1,634	1,412				130			108	63	45
1976	3,389	1,819	1,570	823	398	808	156	609	595	111	65	46
1977	3,940	2,078	1,862				194			112	65	47
1978	4,316	2,338	1,978				231			112	66	46
1979	4,906	2,705	2,201				265			112	66	46
1980	5,701	3,178	2,523				308			119	73	46
1981	6,425	3,628	2,797	1,446	396	1,452	346	1,850	935	119	73	46
1982	7,216	3,995	3,221	1,578	415	1,617	413	2,140	1,054	121	74	47
1983[b]	8,179	4,531	3,647	1,655	415	1,784	482	2,626	1,216	124	75	49

[a] From the American Medical Association (1960-84). Numbers may not sum to totals due to rounding.

[b] Financial data from the University of Washington and Mayo Medical school were included for the first time in 1983. These two schools account for three percent of all revenue in U.S. medical schools.

APPENDIX TABLE A11.2 Sources of Revenue in U.S. Medical Schools, 1959-83[a] (1972 $, millions)

Fiscal Year	Total Revenue: All Schools	Total Revenue: Public Schools	Total Revenue: Private Schools	Federal Research	Other Federal	State/ Local Govt.	Tuition Revenue	Prof. Service Income	Other Revenue	Number of Schools Reporting: All Schools	Number of Schools Reporting: Public Schools	Number of Schools Reporting: Private Schools	Implicit GNP Price Deflator[b] (1972=100.00)
1959	473						36						67.50
1960	540						38	16		87			68.70
1961	625	276	349				40			87	44	43	69.30
1962	730	339	391				43			87	44	43	70.50
1963	842	390	453				45			87	44	43	71.60
1964	957	444	512				48			87	44	43	72.70
1965	1,048	489	560				52			87	44	43	74.30
1966	1,148	533	616				53			88	44	44	76.80
1967	1,278	611	667				56			88	44	44	79.00
1968	1,423	665	759				58			89	45	44	82.60
1969	1,576	732	843				60			92	47	45	86.70
1970	1,696	768	928				61			93	48	45	91.40
1971	1,784	849	935	456	335	336	66	218	373	92	48	44	96.00
1972	1,945	916	1,030				78			95	51	44	100.00
1973	2,061	1,011	1,050				87			96	53	43	105.80
1974	2,176	1,139	1,038				97			107	62	45	116.00
1975	2,395	1,285	1,110				102			108	63	45	127.20
1976	2,531	1,358	1,173	615	297	603	117	455	444	111	65	46	133.90
1977	2,781	1,466	1,314				137			112	65	47	141.70
1978	2,839	1,538	1,301				152			112	66	46	152.05
1979	2,965	1,635	1,330				160			112	66	46	165.46
1980	3,195	1,781	1,414				173			119	73	46	178.42
1981	3,293	1,859	1,433	741	203	744	177	948	479	119	73	46	195.14
1982	3,488	1,931	1,557	763	201	782	200	1,034	509	121	74	47	206.88
1983[c]	3,793	2,101	1,691	768	192	827	224	1,218	564	124	75	49	215.63

[a]From the American Medical Association (1960-84). Numbers may not sum to totals due to rounding.

[b]From the U.S. Bureau of Census.

[c]Financial data from the University of Washington and Mayo Medical school were included for the first time in 1983. These two schools account for three percent of all revenue in U.S. medical schools.

APPENDIX TABLE A12 Students in U.S. Dental Schools, by Control of Institution, 1961-84[a]

Fiscal Year	Predoctoral Enrollment			Graduates			Advanced Specialty Enrollment[b]			Number of Schools		
	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total	Public	Private
1961	13,580	6,135	7,445	3,253	1,564	1,689	n/a	n/a	n/a	47	n/a	n/a
1962	13,513	6,121	7,392	3,290	n/a	n/a	n/a	n/a	n/a	47	n/a	n/a
1963	13,576	6,237	7,339	3,207	n/a	n/a	n/a	n/a	n/a	48	n/a	n/a
1964	13,691	6,333	7,358	3,233	n/a	n/a	n/a	n/a	n/a	48	n/a	n/a
1965	13,876	6,524	7,352	3,213	n/a	n/a	n/a	n/a	n/a	49	n/a	n/a
1966	14,020	6,601	7,419	3,181	1,602	1,579	n/a	n/a	n/a	49	n/a	n/a
1967	14,421	6,452	7,969	3,198	n/a	n/a	n/a	n/a	n/a	49	n/a	n/a
1968	14,955	7,108	7,847	3,360	n/a	n/a	1,374	653	721	50	25	25
1969	15,408	7,425	7,983	3,457	n/a	n/a	1,728	833	895	52	28	24
1970	16,008	7,430	8,578	3,433	1,759	1,674	1,851	859	992	53	20	24
1971	16,553	8,338	8,215	3,749	1,996	1,753	1,966	990	976	53	29	24
1972	17,305	8,865	8,440	3,775	1,924	1,851	2,171	1,112	1,059	52	29	23
1973	18,376	9,445	8,931	3,961	1,992	1,969	2,045	1,051	994	56	32	24
1974	19,369	10,217	9,152	4,230	2,147	2,083	2,024	1,068	956	58	34	24
1975	20,146	10,817	9,329	4,515	2,331	2,184	2,062	1,107	955	58	34	24
1976	20,767	11,413	9,354	4,969	2,463	2,506	2,022	1,111	911	59	35	24
1977	21,013	11,628	9,385	5,336	2,920	2,416	2,009	1,112	897	59	35	24
1978	21,510	12,004	9,506	5,177	2,796	2,381	2,054	1,146	908	59	35	24
1979	22,179	12,319	9,860	5,324	2,899	2,425	2,101	1,167	934	60	35	25
1980	22,482	12,523	9,959	5,424	2,964	2,460	2,127	1,185	942	60	35	25
1981	22,842	12,709	10,133	5,256	2,874	2,382	2,169	1,207	962	60	35	25
1982	22,621	13,429	9,192	5,550	3,004	2,546	2,188	1,299	889	60	35	25
1983	22,235	13,019	9,216	5,371	2,941	2,430	2,128	1,246	882	60	35	25
1984	21,428	12,299	9,129	5,274	3,207	2,549	2,159	1,239	920	60	35	25

[a]From the American Dental Association (1969-84).

[b]Public and private numbers were estimated from the total by using the same percentages as in predoctoral enrollments.

APPENDIX TABLE A13 Faculty in U.S. Dental Schools, by Control of Institution, 1969-84[a]

	Full-Time									Part-Time (Full-time Equivalent)[b]		
	All Schools			Public Schools			Private Schools			Clinical Departments		
Fiscal Year	Total	Basic Sci. Depts.	Clin. Depts.	Total	Basic Sci. Depts.	Clin. Depts.	Total	Basic Sci. Depts.	Clin. Depts.	All Schools	Public Schools	Private Schools
1969	2,810	1,167	1,643	1,611	650	961	1,199	517	682	926.8	335.6	591.2
1970	3,329	1,389	1,940	1,982	821	1,161	1,347	568	779	1,060.2	422.2	638.0
1971	3,197	1,096	2,101	1,927	647	1,280	1,270	449	821	1,011.3	448.6	562.7
1972	3,351	1,088	2,263	2,041	627	1,414	1,310	461	849	1,129.7	507.4	622.3
1973	3,711	1,269	2,442	2,309	768	1,541	1,402	501	901	1,283.0	654.3	628.7
1974	3,927	1,255	2,672	2,473	764	1,709	1,454	491	963	1,355.3	624.4	730.8
1975	4,373	1,402	2,971	2,766	850	1,916	1,607	552	1,055	1,517.5	746.4	771.1
1976	4,885	1,646	3,239	3,149	1,050	2,099	1,736	596	1,140	1,341.8	664.1	677.7
1977	5,145	1,761	3,384	3,358	1,145	2,213	1,787	616	1,171	1,277.9	618.1	659.7
1978	5,108	1,696	3,412	3,314	1,096	2,218	1,794	600	1,194	1,318.9	648.2	670.7
1979	5,338	1,794	3,544	3,417	1,138	2,279	1,921	656	1,265	1,385.6	654.4	731.2
1980	5,521	1,856	3,665	3,472	1,174	2,298	2,049	682	1,367	1,429.1	684.5	744.6
1981	5,647	1,901	3,746	3,527	1,167	2,360	2,120	734	1,386	1,442.5	691.9	750.6
1982	5,706	1,917	3,789	3,561	1,152	2,409	2,145	765	1,380	1,391.2	694.5	696.7
1983	5,635	1,849	3,786	3,583	1,174	2,409	2,052	675	1,377	1,458.4	686.6	771.8
1984	5,478	1,790	3,688	3,441	1,100	2,341	2,037	690	1,347	1,392.7	661.3	731.4

[a] From the American Dental Association (1969-84).

[b] Part-time faculty positions expressed as full-time equivalents are available for clinical departments only.

APPENDIX TABLE A14 Research and Development Revenue and Expenditures in U.S. Dental Schools, by Control of Institution, 1968-83[a] ($ thousands)

R&D Revenue[b] (no. of schools reporting is shown in parentheses)

Fiscal Year	Current Dollars Total	Current Dollars Public	Current Dollars Private	1972 Dollars[c] Total	1972 Dollars[c] Public	1972 Dollars[c] Private
1968	14,019 (46)	8,667 (23)	5,352 (23)	16,972	10,493	6,479
1969	14,019 (47)	9,193 (24)	4,826 (23)	16,169	10,603	5,566
1970	14,869 (47)	8,443 (24)	6,426 (23)	16,268	9,237	7,031
1971	15,634 (47)	10,035 (25)	5,599 (22)	16,285	10,453	5,832
1972	17,155 (48)	12,153 (27)	5,002 (21)	17,155	12,153	5,002
1973	18,969 (49)	13,250 (27)	5,720 (22)	17,929	12,524	5,406
1974	20,718 (50)	14,787 (28)	5,931 (22)	17,860	12,747	5,113
1975	21,197 (49)	14,930 (28)	6,266 (21)	16,664	11,737	4,926
1976	23,975 (50)	16,135 (28)	7,840 (22)	17,904	12,050	5,855
1977	26,586 (54)	18,250 (32)	8,337 (22)	18,762	12,879	5,884
1978	28,500 (56)	19,565 (33)	8,935 (23)	18,744	12,868	5,876
1979	30,935 (56)	21,112 (33)	9,824 (23)	18,696	12,760	5,937
1980	33,960 (57)	23,645 (34)	10,315 (23)	19,148	13,332	5,816
1981	42,318 (55)	29,010 (33)	13,308 (22)	21,861	14,986	6,875
1982	46,706 (57)	31,804 (34)	14,902 (23)	22,547	15,353	7,194
1983	47,843 (57)	31,934 (34)	15,908 (23)	22,187	14,810	7,378

Clinical R&D Expenditures (no. of schools reporting is shown in parentheses); Avg. R&D Revenue per School

Fiscal Year	Clinical Current Dollars Total	Clinical Current Dollars Public	Clinical Current Dollars Private	Clinical 1972 Dollars[c] Tot.	Clinical 1972 Dollars[c] Pub.	Clinical 1972 Dollars[c] Priv.	Avg. Current Dollars Tot.	Avg. Current Dollars Pub.	Avg. Current Dollars Priv.	Avg. 1972 Dollars[c] Tot.	Avg. 1972 Dollars[c] Pub.	Avg. 1972 Dollars[c] Priv.
1968	n/a	n/a	n/a	n/a	n/a	n/a	305	377	233	369	456	282
1969	n/a	n/a	n/a	n/a	n/a	n/a	298	383	210	344	442	242
1970	n/a	n/a	n/a	n/a	n/a	n/a	316	352	279	346	385	306
1971	n/a	n/a	n/a	n/a	n/a	n/a	333	401	255	346	418	265
1972	n/a	n/a	n/a	n/a	n/a	n/a	357	450	238	357	450	238
1973	n/a	n/a	n/a	n/a	n/a	n/a	387	491	260	366	464	246
1974	10,133 (39)	7,460 (23)	2,673 (16)	8,735	6,431	2,304	414	528	270	357	455	232
1975	10,512 (43)	8,157 (27)	2,354 (15)	8,264	6,413	1,851	433	533	298	340	419	235
1976	12,266 (42)	8,223 (27)	4,043 (15)	9,161	6,141	3,019	480	576	356	358	430	266
1977	11,369 (45)	8,451 (28)	2,918 (17)	8,023	5,964	2,059	492	570	379	347	402	267
1978	13,389 (47)	9,939 (28)	3,450 (19)	8,806	6,537	2,269	509	593	389	335	390	256
1979	12,602 (42)	9,893 (27)	2,710 (15)	7,616	5,979	1,638	552	640	427	334	387	258
1980	15,100 (42)	12,838 (28)	2,262 (14)	8,514	7,238	1,275	596	695	449	336	392	253
1981	19,025 (41)	15,176 (27)	3,849 (14)	9,828	7,840	1,988	769	879	605	398	454	312
1982	24,121 (42)	18,847 (27)	5,274 (15)	11,644	9,098	2,546	819	935	648	396	452	313
1983	22,328 (43)	17,442 (27)	4,886 (16)	10,355	8,089	2,266	839	939	692	389	436	321

[a]/From the American Dental Association (1969-84).

[b]/Excludes indirect cost allowances.

[c]/1972 dollars were obtained by using the implicit GNP Price Deflator (U.S. Bureau of the Census--See Appendix Table A7).

APPENDIX TABLE A15 Dental Clinic Revenue in U.S. Dental Schools, by Control of Institution, 1968-83[a] ($ thousands)

	Dental Clinic Revenue (no. of schools reporting is shown in parentheses)						Average Dental Clinical Revenue per School					
	Current Dollars			1972 Dollars[b]			Current Dollars			1972 Dollars[b]		
Fiscal Year	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total	Public	Private
1968	12,563 (46)	5,182 (23)	7,381 (23)	15,209	6,274	8,936	273	225	321	331	273	388
1969	14,004 (47)	5,871 (24)	8,133 (23)	16,152	6,772	9,381	298	245	354	344	282	408
1970	16,023 (47)	6,272 (24)	9,751 (23)	17,531	6,862	10,669	341	261	424	373	286	464
1971	18,490 (47)	7,521 (25)	10,969 (22)	19,260	7,834	11,426	393	301	499	410	313	519
1972	20,566 (49)	8,858 (27)	11,709 (22)	20,566	8,858	11,709	420	328	532	420	328	532
1973	21,787 (48)	9,481 (25)	12,306 (23)	20,593	8,961	11,631	454	379	535	429	358	506
1974	27,510 (51)	12,809 (28)	14,701 (23)	23,716	11,042	12,673	539	458	639	465	394	551
1975	32,193 (50)	14,724 (27)	17,469 (23)	25,309	11,576	13,733	644	545	760	506	429	597
1976	38,656 (52)	17,939 (28)	20,716 (24)	28,869	13,397	15,471	743	641	863	555	479	645
1977	43,989 (55)	21,010 (31)	22,979 (24)	31,044	14,827	16,217	800	678	958	564	478	676
1978	47,588 (57)	21,946 (33)	25,642 (24)	31,298	14,433	16,746	835	665	1,061	549	437	698
1979	57,980 (59)	29,065 (35)	28,914 (24)	35,042	17,566	17,475	983	830	1,205	564	502	728
1980	63,500 (59)	31,912 (35)	31,587 (24)	35,803	17,993	17,810	1,076	912	1,316	607	514	742
1981	74,141 (58)	38,321 (34)	35,820 (24)	38,300	19,796	18,504	1,278	1,127	1,493	660	582	771
1982	82,312 (59)	42,099 (34)	40,212 (25)	39,736	20,323	19,412	1,395	1,238	1,609	674	598	776
1983	94,272 (60)	49,524 (35)	44,748 (25)	43,719	22,967	20,752	1,571	1,415	1,790	729	656	830

[a]From the American Dental Association (1969-84).

[b]1972 dollars were obtained by using the Implicit GNP Price Deflator (U.S. Bureau of the Census--See Appendix Table A7).

APPENDIX TABLE A16 Dental School Tuition Revenue, by Control of Institution, 1968-83[a] ($ thousands)

	Dental School Tuition Revenue (no. of schools reporting is shown in parentheses)						Average Tuition Revenue per School					
	Current Dollars			1972 Dollars[b]			Current Dollars			1972 Dollars[b]		
Fiscal Year	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total	Public	Private
1968	20,282 (46)	6,239 (23)	14,043 (23)	24,554	7,553	17,001	441	271	611	534	328	739
1969	22,994 (47)	6,622 (24)	16,372 (23)	26,521	7,638	18,884	489	276	712	564	318	821
1970	26,367 (47)	6,882 (24)	19,210 (23)	28,848	7,530	21,018	561	287	835	613	314	914
1971	28,793 (47)	7,836 (24)	20,957 (23)	29,993	8,163	21,830	613	327	911	638	340	949
1972	36,278 (48)	10,511 (26)	25,767 (22)	36,278	10,511	25,767	756	404	1,171	756	404	1,171
1973	41,129 (49)	12,003 (26)	29,125 (23)	38,874	11,345	27,528	839	462	1,266	793	436	1,197
1974	46,197 (51)	13,911 (28)	32,286 (23)	39,825	11,992	27,833	906	497	1,404	781	428	1,210
1975	51,648 (51)	15,209 (28)	36,440 (23)	40,604	11,957	28,648	1,013	543	1,584	796	427	1,246
1976	58,266 (53)	16,623 (29)	41,643 (24)	43,515	12,414	31,100	1,099	573	1,735	821	428	1,296
1977	67,818 (56)	19,872 (32)	47,946 (24)	47,860	14,024	33,836	1,211	621	1,998	855	438	1,410
1978	78,930 (57)	23,266 (33)	55,664 (24)	51,911	15,302	36,609	1,385	705	2,319	911	464	1,525
1979	94,394 (59)	26,860 (35)	67,534 (24)	57,049	16,234	40,816	1,600	767	2,814	967	464	1,701
1980	108,341 (59)	29,069 (35)	79,273 (24)	61,085	16,390	44,696	1,836	831	3,303	1,035	468	1,862
1981	115,668 (59)	32,716 (35)	82,897 (24)	59,752	16,901	42,823	1,961	935	3,454	1,013	483	1,784
1982	147,308 (60)	39,690 (35)	107,618 (25)	71,112	19,160	51,952	2,455	1,134	4,305	1,185	547	2,078
1983	164,990 (60)	46,018 (35)	118,972 (25)	76,515	21,341	55,174	2,750	1,315	4,759	1,275	610	2,207

[a]From the American Dental Association (1969-84).

[b]1972 dollars were obtained by using the Implicit GNP Price Deflator (U.S. Bureau of the Census--See Appendix Table A7).

APPENDIX TABLE A17 Revenue from State and Local Governments in U.S. Dental Schools, by Control of Institution, 1968-83[a]
($ thousands)

Fiscal Year	Revenue from State/Local Governments[b] (no. of schools reporting is shown in parentheses): Current Dollars, Total	Current Dollars, Public	Current Dollars, Private	1972 Dollars[c], Total	1972 Dollars[c], Public	1972 Dollars[c], Private	Average State/Local Govt. Revenue per School: Current Dollars, Total	Current Dollars, Public	Current Dollars, Private	1972 Dollars[c], Total	1972 Dollars[c], Public	1972 Dollars[c], Private
1968	27,130 (23)	27,130 (23)	-	32,845	32,845	0	590	1,180	0	714	1,428	0
1969	32,980 (24)	32,980 (24)	-	38,039	38,039	0	702	1,374	0	809	1,585	0
1970	40,488 (24)	40,488 (24)	-	44,298	44,298	0	861	1,687	0	942	1,846	0
1971	34,545 (24)	33,418 (20)	1,127 (04)	35,984	34,810	1,174	720	1,337	49	750	1,392	51
1972	68,206 (40)	62,084 (27)	6,123 (13)	68,206	62,084	6,123	1,392	2,299	278	1,392	2,299	278
1973	85,874 (40)	78,321 (27)	7,553 (13)	81,166	74,027	7,139	1,718	2,901	328	1,623	2,742	310
1974	99,707 (43)	87,857 (28)	11,851 (15)	85,954	75,739	10,216	1,955	3,138	515	1,685	2,705	444
1975	117,582 (43)	102,656 (28)	14,906 (15)	92,439	80,720	11,719	2,306	3,667	648	1,812	2,883	510
1976	142,735 (46)	122,968 (29)	19,767 (17)	106,598	91,836	14,763	2,693	4,240	824	2,011	3,167	615
1977	175,927 (51)	151,564 (32)	24,363 (19)	124,155	106,961	17,193	3,142	4,736	1,015	2,217	3,343	716
1978	205,975 (52)	177,737 (33)	28,237 (19)	135,465	116,894	18,571	3,614	5,386	1,177	2,377	3,542	774
1979	225,763 (54)	195,132 (35)	30,630 (19)	136,446	117,933	18,512	3,827	5,575	1,276	2,313	3,370	771
1980	253,433 (53)	217,464 (35)	35,968 (18)	142,892	122,612	20,280	4,296	6,213	1,499	2,422	3,503	845
1981	280,176 (59)	243,719 (35)	36,457 (24)	144,734	125,901	18,833	4,749	6,963	1,519	2,453	3,597	785
1982	306,572 (54)	268,196 (35)	38,375 (19)	147,995	129,469	18,525	5,110	7,663	1,535	2,467	3,699	741
1983	318,326 (54)	278,307 (35)	40,019 (19)	147,626	129,067	18,559	5,305	7,952	1,601	2,460	3,688	742

[a] From the American Dental Association (1969-84).

[b] Excludes sponsored research and education programs, and indirect cost allowances.

[c] 1972 dollars were obtained by using the Implicit GNP Price Deflator (U.S. Bureau of the Census--See Appendix Table A7).

APPENDIX TABLE A18 Total Revenue in U.S. Dental Schools, by Control of Institution, 1968-83[a] ($ thousands)

	Total Dental School Revenue (no. of schools reporting is shown in parentheses)						Total Revenue per School					
	Current Dollars			1972 Dollars[b]			Current Dollars			1972 Dollars[b]		
Fiscal Year	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total	Public	Private
1968	108,649 (46)	65,164 (23)	43,485 (23)	131,536	78,891	52,645	2,362	2,833	1,891	2,860	3,430	2,289
1969	127,076 (47)	76,126 (24)	50,950 (23)	146,570	47,804	58,766	2,704	3,172	2,215	3,119	3,658	2,555
1970[c]	141,960 (47)	85,290 (24)	56,670 (23)	155,317	93,315	62,002	3,020	3,554	2,464	3,305	3,888	2,696
1971	167,141 (48)	94,453 (25)	72,688 (23)	174,105	98,389	75,717	3,482	3,778	3,160	3,627	3,935	3,292
1972	195,625 (49)	116,467 (27)	79,157 (22)	195,625	116,467	79,157	3,992	4,314	3,598	3,992	4,316	3,598
1973	238,210 (50)	147,124 (27)	91,086 (23)	225,152	139,059	86,093	4,764	5,449	3,960	4,503	5,150	3,743
1974	270,705 (51)	170,496 (28)	100,209 (23)	233,366	146,979	86,387	5,308	6,089	4,357	4,576	5,249	3,756
1975	310,388 (51)	191,518 (28)	118,869 (23)	244,016	150,565	93,451	6,086	6,840	5,168	4,785	5,377	4,063
1976	347,804 (53)	216,421 (29)	131,383 (24)	259,749	161,629	98,120	6,562	7,463	5,474	4,901	5,573	4,088
1977	394,938 (56)	251,414 (32)	143,524 (24)	278,714	177,427	101,287	7,053	7,857	5,980	4,977	5,545	4,220
1978	441,075 (57)	281,661 (33)	159,414 (24)	290,086	185,242	104,843	7,738	8,535	6,642	5,089	5,613	4,368
1979	489,932 (59)	311,643 (35)	178,289 (24)	296,103	188,350	107,754	8,304	8,904	7,429	5,013	5,381	4,490
1980	541,413 (59)	341,357 (35)	200,057 (24)	305,262	192,466	112,797	9,177	9,753	8,336	5,174	5,499	4,700
1981	607,113 (59)	380,828 (35)	226,284 (24)	313,624	196,729	116,894	10,290	10,881	9,429	5,316	5,621	4,871
1982	665,168 (60)	415,991 (35)	249,177 (25)	321,105	200,816	120,288	11,086	11,886	9,967	5,352	5,738	4,812
1983	699,811 (60)	434,584 (35)	265,227 (25)	324,543	201,542	123,001	11,664	12,417	10,609	5,409	5,758	4,920

[a]From the American Dental Association (1969-84).

[b]1972 dollars were obtained by using the Implicit GNP Price Deflator (U.S. Bureau of the Census--See Appendix Table A7).

[c]Public figures for 1970 are interpolated.

APPENDIX TABLE A19 Full-Time Budgeted Vacancies on U.S. Dental School Faculties, by Control of Institution, 1969-84[a]

Fiscal Year	All Departments			Basic Science Depts.			Clinical Science Depts.		
	Total	Public	Private	Total	Public	Private	Total	Public	Private
1969	293	223	70	110	79	31	183	144	39
1970	201	101	100	60	23	37	141	78	63
1971	167	102	65	51	26	25	116	76	40
1972	160	102	58	42	22	20	118	80	38
1973	268	189	79	79	51	28	189	138	51
1974	278	176	102	76	50	26	202	126	76
1975	224	147	77	45	33	12	179	114	65
1976	203	132	71	43	24	19	160	108	52
1977	179	116	63	37	24	13	142	92	50
1978	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1979	193	105	88	49	19	30	144	86	58
1980	191	113	78	39	19	20	152	94	58
1981	161	94	67	34	20	14	127	74	53
1982	174	87	87	37	25	12	137	62	75
1983	192	120	72	49	36	13	143	84	59
1984	238	158	80	50	33	17	188	125	63

[a] From the American Dental Association (1969-84).

APPENDIX TABLE A20 NIH Trainees and Fellows in Clinical Dental Research, 1977-84[a]

Fiscal Year	Total			Trainees			Fellows		
	Total	Predoc	Postdoc	Total	Predoc	Postdoc	Total	Predoc	Postdoc
1977	182	24	158	159	24	135	23	0	23
1978	187	33	154	166	33	133	21	0	21
1979	166	25	141	134	25	109	32	0	32
1980	217	93	124	192	93	99	25	0	25
1981	157	25	132	114	25	89	43	0	43
1982	126	26	100	107	26	81	19	0	19
1983	111	20	91	102	20	82	9	0	9
1984	101	20	81	101	20	81	0	0	0

[a]Figures were obtained from the Division of Research Grants, NIH.

182

APPENDIX B
Biomedical Sciences Data

APPENDIX B (cont'd.)
Biomedical Sciences Data

APPENDIX TABLE B1 Biomedical Science Enrollments in Colleges and Universities, by Control of Institution, 1960-84 a/

Fiscal Year	Total Undergraduate and Graduate Enrollment			Estimated Undergraduate Enrollment b/			Graduate Enrollment: Total Medical, Dental, and Biomed. Sci. Graduate			Graduate Enrollment: Medical and Dental c/			Graduate Enrollment: Biomedical Science Graduate d/		
	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total	Public	Private
1960	197,419	n/a	n/a	143,037	n/a	n/a	54,382	n/a	n/a	43,665	n/a	n/a	10,717	6,516	4,201
1961	217,711	n/a	n/a	161,236	n/a	n/a	56,475	n/a	n/a	44,268	n/a	n/a	12,207	7,768	4,439
1962	241,945	n/a	n/a	183,890	n/a	n/a	58,055	n/a	n/a	44,590	n/a	n/a	13,465	8,841	4,624
1963	265,534	n/a	n/a	205,839	n/a	n/a	59,695	n/a	n/a	44,814	n/a	n/a	14,881	9,827	5,054
1964	286,169	n/a	n/a	223,002	n/a	n/a	63,167	n/a	n/a	45,692	n/a	n/a	17,475	n/a	n/a
1965	279,371	n/a	n/a	213,042	n/a	n/a	66,329	n/a	n/a	45,982	n/a	n/a	20,347	n/a	n/a
1966	301,921	n/a	n/a	231,977	n/a	n/a	69,944	n/a	n/a	46,512	n/a	n/a	23,432	n/a	n/a
1967	311,635	n/a	n/a	239,725	161,555	78,170	71,910	n/a	n/a	47,563	n/a	n/a	24,347	n/a	n/a
1968	327,940	n/a	n/a	251,170	173,606	77,564	76,770	n/a	n/a	49,273	n/a	n/a	27,497	n/a	n/a
1969	358,186	n/a	n/a	279,180	200,825	78,335	79,006	n/a	n/a	50,510	n/a	n/a	28,496	n/a	n/a
1970	384,362	n/a	n/a	299,553	220,073	79,480	84,829	n/a	n/a	53,986	n/a	n/a	30,843	n/a	n/a
1971	414,650	n/a	n/a	325,018	242,058	82,960	89,632	n/a	n/a	57,029	n/a	n/a	32,603	n/a	n/a
1972	438,671	318,900	119,771	343,587	259,492	84,095	95,084	59,408	35,676	60,881	34,369	26,512	34,203	25,039	9,164
1973	480,055	350,954	124,101	379,268	288,109	91,159	100,787	62,845	32,942	65,899	37,390	28,509	34,888	25,455	9,433
1974	510,603	376,292	134,311	404,881	309,900	94,981	105,722	66,392	39,330	69,611	40,021	29,590	36,111	26,371	9,740
1975	537,075	399,593	137,482	424,539	328,697	95,842	112,536	70,896	41,640	74,222	42,731	31,491	38,314	28,165	10,149
1976	556,279	417,055	139,223	439,946	343,184	96,762	116,333	73,872	42,461	77,011	44,949	32,062	39,322	28,923	10,399
1977	544,402	408,393	136,009	425,863	332,770	93,093	118,539	75,623	42,916	79,279	46,657	32,622	39,260	28,966	10,294
1978	532,229	396,376	135,053	406,373	316,281	90,092	125,856	80,095	45,761	81,934	48,730	33,204	43,922	31,365	12,557
1979	505,841	374,599	131,242	377,551	292,901	84,650	128,290	81,698	46,592	84,761	50,681	34,080	43,529	31,017	12,512
1980	497,342	367,566	129,776	367,705	285,068	82,637	129,637	82,498	47,139	86,502	51,830	34,672	43,135	30,668	12,467
1981	492,688	364,613	128,075	362,053	281,136	80,917	130,635	83,477	47,158	88,254	53,194	35,060	42,381	30,283	12,098
1982	n/a	n/a	n/a	n/a	n/a	n/a	130,878	83,484	47,394	89,105	53,693	35,412	41,773	29,791	11,982
1983	n/a	n/a	n/a	n/a	n/a	n/a	130,312	82,580	47,732	89,121	53,609	35,512	41,191	28,971	12,220
1984	n/a	n/a	n/a	n/a	n/a	n/a	130,385	82,883	47,502	88,865	53,339	35,526	41,520	29,544	11,976

a/ Biomedical science undergraduate, graduate, and dental student enrollments for Temple University and the University of Pittsburgh were counted as public; medical school enrollments were counted as private. The Association of American Medical Colleges, which provided the medical school data, was the only data source which considered those universities to be privately controlled.

b/ Estimated by the formula $U_i = (A_{i+2}/B_{i+2})C_i$, where U_i = biomedical science undergraduate enrollment in year i; A_{i+2} = biomedical science baccalaureate degrees awarded in year i+2 (excluding health professions); B_{i+2} = total baccalaureate degrees awarded in year i+2; C_i = total undergraduate degree-credit enrollment in year i (excluding first professional). Public and private estimates were based on enrollment ratios. See Appendix Tables B3 and B4 for supporting data.

c/ Medical school enrollment figures were obtained from the Association of American Medical Colleges (1972-84, special tabulations of 4/8/82, 5/17/82, 6/15/83, 7/10/84, and 2/5/85) and the American Medical Association (1960-84). Dental school enrollment figures were obtained from the American Dental Association (1969-84).

d/ Figures for 1960-77 were obtained from the U.S. Department of Education (1959-79). Figures for 1978-84 were obtained from the National Science Foundation (1973-85a) except for the 1979 figure which was interpolated. Because of differences in taxonomy, NSF numbers for 1978-84 total biomedical science graduate students may be slightly higher than numbers that would have been obtained from the Department of Education had data been collected for those years. For the year 1977, NSF reported 42,495 graduate students enrolled in the biomedical sciences; in comparison, the Department of Education reported a somewhat lower figure of 39,260 (as shown in this table).

APPENDIX TABLE B2 First-Year Graduate Enrollment in the Biomedical Sciences, 1960-84

Fiscal Year	Total First-Year Graduate Enrollment[a]	First-Year, Full-Time Graduate Enrollment in Doctorate-Granting Institutions[b]
1960	5,370	n/a
1961	6,025	n/a
1962	6,642	n/a
1963	7,137	n/a
1964	8,542	n/a
1965	10,430	n/a
1966	12,034	n/a
1967	12,511	n/a
1968	13,301	n/a
1969	13,343	n/a
1970	14,835	n/a
1971	15,845	n/a
1972	16,722	n/a
1973	17,511	n/a
1974	17,538	n/a
1975	18,876	9,382
1976	18,756	9,918
1977	18,073	9,763
1978	n/a	9,612
1979	n/a	8,836
1980	n/a	8,348
1981	n/a	8,279
1982	n/a	8,105
1983	n/a	8,043
1984	n/a	8,334

a/From the U.S. Department of Education (1959-79).

b/From the National Science Foundation (1973-85a).

APPENDIX TABLE B3 Biomedical Science Degrees Awarded in Colleges and Universities, by Control of Institution, and Postdoctoral Appointments in All Employment Sectors, 1960-84

Fiscal Year	B.A. Degrees Awarded[a] (excluding first professional)			Ph.D. Degrees Awarded[b]			Postdoctoral Appointments[c]				
								Academic[d]			
	Total	Public	Private	Total	Public	Private	Total	Total	Public	Private	Nonacademic
1960	n/a	n/a	n/a	1,096	n/a	n/a	1,639	n/a	n/a	n/a	n/a
1961	15,588	n/a	n/a	1,136	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1962	16,424	n/a	n/a	1,272	n/a	n/a	1,827	n/a	n/a	n/a	n/a
1963	18,704	n/a	n/a	1,341	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1964	22,207	n/a	n/a	1,552	n/a	n/a	2,259	n/a	n/a	n/a	n/a
1965	24,612	n/a	n/a	1,753	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1966	26,336	n/a	n/a	1,961	n/a	n/a	2,570	n/a	n/a	n/a	n/a
1967	28,157	n/a	n/a	2,181	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1968	31,221	n/a	n/a	2,545	n/a	n/a	3,224	n/a	n/a	n/a	n/a
1969	34,795	20,338	14,457	2,854	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1970	36,868	22,382	14,486	3,171	n/a	n/a	3,837	n/a	n/a	n/a	n/a
1971	40,000	24,611	15,389	3,482	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1972	42,000	26,208	15,792	3,460	2,385	1,075	n/a	n/a	n/a	n/a	n/a
1973	45,000	28,236	16,764	3,520	2,466	1,054	3,607	2,883	1,636	1,247	724
1974	47,434	29,881	17,553	3,417	2,327	1,090	n/a	n/a	n/a	n/a	n/a
1975	50,493	31,841	18,652	3,515	2,401	1,114	5,369	4,361	2,530	1,831	1,008
1976	52,642	33,244	19,398	3,578	2,447	1,131	n/a	n/a	n/a	n/a	n/a
1977	51,783	32,789	18,994	3,465	2,386	1,079	6,312	5,211	2,836	2,375	1,101
1978	49,701	30,968	18,733	3,516	2,438	1,078	n/a	n/a	n/a	n/a	n/a
1979	47,717	29,241	18,476	3,644	2,466	1,178	7,268	5,974	3,543	2,431	1,294
1980	45,106	27,279	17,827	3,822	2,631	1,191	n/a	n/a	n/a	n/a	n/a
1981	42,297	25,380	16,917	3,842	2,595	1,247	8,026	6,740	4,064	2,676	1,286
1982	40,750	24,167	16,583	3,960	2,665	1,295	n/a	n/a	n/a	n/a	n/a
1983	n/a	n/a	n/a	3,775	2,609	1,166	7,827	6,208	3,287	2,921	1,619
1984	n/a	n/a	n/a	3,894	n/a	n/a	n/a	n/a	n/a	n/a	n/a

a/Figures for 1961-68 were obtained from the U.S. Department of Education (1948-81; those for 1969-82 from the U.S. Department of Education (1948-84). Figures for 1971-73 were estimated by the committee in order to remove the distortion produced in the series by a change in the survey taxonomy in 1971. Health professions are not included.

b/From the National Research Council (1958-85). Foreign nationals who received doctorates from U.S. institutions are included.

c/Figures for 1960-70 were estimated by the committee. Figures for 1973-83 are based on the most recent data available from the National Research Council (1973-84). Foreign nationals who received doctorates from U.S. institutions are included.

d/Public and private figures were adjusted by the committee to include a small number of individuals for whom control of institution could not be determined.

APPENDIX TABLE B4 Total Undergraduate Degree-Credit Enrollment, Total B.A. Degrees Awarded, and Ratio of Biomedical Science B.A.s to Total B.A.s, by Control of Institution, 1960-83

Fiscal Year	Total Undergraduate Degree-Credit Enrollment (thousands) — Including First Professional[a]			Excluding First Professional[b]			Total B.A. Degrees Awarded[c] (excluding first professional)			Ratio of Biomed. Sci. B.A.s to Total B.A.s[d]
	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total
1960	3,402	n/a	n/a	3,334	n/a	n/a	n/a	n/a	n/a	n/a
1961	3,610	n/a	n/a	3,538	n/a	n/a	365,337	n/a	n/a	0.0427
1962	3,891	n/a	n/a	3,813	n/a	n/a	382,822	n/a	n/a	0.0429
1963	4,207	n/a	n/a	4,123	n/a	n/a	410,421	n/a	n/a	0.0456
1964	4,529	n/a	n/a	4,438	n/a	n/a	460,467	n/a	n/a	0.0482
1965	4,342	2,802	1,541	4,255	n/a	n/a	492,984	n/a	n/a	0.0499
1966	4,829	3,184	1,645	4,732	n/a	n/a	524,117	n/a	n/a	0.0502
1967	5,160	3,451	1,709	5,057	3,408	1,649	562,369	n/a	n/a	0.0501
1968	5,557	3,810	1,747	5,437	3,758	1,679	636,863	n/a	n/a	0.0490
1969	6,043	4,308	1,735	5,905	4,248	1,657	734,002	466,133	267,869	0.0474
1970	6,529	4,749	1,780	6,377	4,685	1,692	798,070	523,442	274,628	0.0462
1971	6,889	5,076	1,813	6,719	5,004	1,715	846,110	562,345	283,765	0.0473
1972	7,104	5,302	1,802	6,913	5,221	1,692	894,110	604,471	289,639	0.0470
1973	7,199	5,401	1,799	6,998	5,316	1,682	930,272	636,378	293,894	0.0484
1974	7,396	5,589	1,807	7,187	5,501	1,686	954,376	657,455	296,921	0.0497
1975	7,833	5,986	1,847	7,610	5,892	1,718	931,663	640,524	291,139	0.0542
1976	8,468	6,520	1,948	8,234	6,423	1,811	934,443	640,799	293,644	0.0563
1977	8,559	6,595	1,964	8,312	6,495	1,817	928,228	635,909	292,319	0.0558
1978	8,722	6,696	2,026	8,471	6,593	1,878	930,201	633,183	297,018	0.0534
1979	8,709	6,662	2,047	8,452	6,557	1,895	931,340	627,084	304,256	0.0512
1980	8,962	6,850	2,112	8,699	6,744	1,955	940,251	629,338	310,913	0.0480
1981	9,354	7,162	2,192	9,074	7,046	2,028	946,877	632,168	314,709	0.0447
1982	9,341	7,132	2,209	9,066	7,020	2,046	964,043	641,751	322,292	0.0423
1983	9,398	7,184	2,214	9,120	7,071	2,049	n/a	n/a	n/a	0.0399 (est.)

[a] Figures for 1960-64 were obtained from the U.S. Department of Education (1961-84a), those for 1965-75 from the U.S. Department of Education (1973-82), and the one for 1976 from the U.S. Department of Education (1974-83). Figures for 1977-81 were obtained by subtracting enrollment for master's and doctor's degrees from total degree-credit enrollment (U.S. Department of Education 1974-83). Figures for 1982-83 were obtained by adding first professional enrollment to total undergraduate degree-credit enrollment excluding first professional. First professonal enrollment data were obtained from the U.S. Department of Education (1961-84b). See footnote [b] for source of undergraduate degree-credit enrollment for 1982-83.

[b] Figures for 1960-66 were estimated at 98% of total undergraduate degree-credit enrollment (including first professional). Those for 1967-81 were obtained by subtracting first professional enrollment from total degree-credit undergraduate enrollment (including first professional). First professional enrollment data for 1967-77 were obtained from the U.S. Department of Education (1959-79), data for 1978-81 from the U.S. Department of Education (1961-84a). Figures for 1982-83 were derived from total undergraduate enrollment (including nondegree-credit) data obtained from the U.S. Department of Education (1961-84b). These data have been adjusted with the percentages used by the U.S. Department of Education to estimate degree-credit enrollments for 1977-80.

[c] Figures for 1961-68 were obtained from the U.S. Department of Education (1948-81), those for 1969-82 from the U.S. Department of Education (1948-84).

[d] See Appendix Table B3 for number of baccalaureate degrees awarded in the biomedical sciences.

APPENDIX TABLE B5 Ph.D.s Employed in the Biomedical Sciences, 1960-83[a]

Fiscal Year	Total Labor Force	Academia (excluding postdocs.)[b] Total	Public	Private	Postdoc. Appts.	Business	Gov't.	FFRDC Labs	Hospitals/ Clinics	Non-Profit	Self-Employed	Other	Unemployed and Seeking
1960	16,067	8,194	n/a	n/a	1,639	2,799	2,360	n/a	n/a	n/a	n/a	1,046	29
1961	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1962	17,862	9,140	n/a	n/a	1,827	2,831	2,886	n/a	n/a	n/a	n/a	1,129	49
1963	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1964	20,930	11,300	n/a	n/a	2,259	3,212	2,866	n/a	n/a	n/a	n/a	1,255	38
1965	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1966	23,870	12,870	n/a	n/a	2,570	3,691	3,370	n/a	n/a	n/a	n/a	1,304	65
1967	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1968	28,962	16,122	n/a	n/a	3,224	4,212	3,829	n/a	n/a	n/a	n/a	1,470	105
1969	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1970	34,151	19,181	n/a	n/a	3,837	4,832	4,284	n/a	n/a	n/a	n/a	1,771	246
1971	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1972	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1973	43,688	25,471	16,911	8,560	3,607	5,369	4,338	1,031	1,431	1,293	518	186	444
1974	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1975	50,620	28,332	18,987	9,345	5,369	6,662	4,517	994	1,948	1,232	840	194	532
1976	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1977	55,031	30,384	20,688	9,696	6,312	6,893	4,568	1,040	2,297	1,543	862	335	797
1978	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1979	62,332	33,566	22,700	10,866	7,268	8,455	5,080	1,079	2,726	1,858	1,185	439	676
1980	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1981	68,806	36,482	23,882	12,600	8,026	9,928	5,398	1,236	2,799	2,088	1,857	225	767
1982	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1983	71,423	36,963	25,108	11,855	7,827	11,819	5,988	661	2,946	2,102	1,910	255	952

a/Figures for 1960-70 were estimated by the committee. Figures for 1973-83 are based on the most recent data available from the National Research Council (1973-84). Foreign nationals who received doctorates from U.S. institutions are included.

b/Public and private figures were adjusted by the committee to include a small number of academically employed individuals for whom control of institution could not be determined.

APPENDIX TABLE B6 Three-Year Moving Average of Biomedical Science Undergraduate and Graduate Enrollments, 1962-83

Fiscal Year	3-Yr. Moving Average of Undergraduate Enrollments[a] (US)	3-Yr. Moving Average of Graduate Enrollments[b] (GS)	Weighted Sum of US + GS (WS=0.25US + 0.75GS)	Faculty[c] (F)	Ph.D. Faculty/ Student Ratio (F/WS)
1962	162,711	56,304	82,908	9,140	0.1102
1963	183,655	58,075	89,470	n/a	n/a
1964	204,244	60,306	96,291	11,300	0.1174
1965	213,961	63,066	100,790	n/a	n/a
1966	222,674	66,480	105,529	12,870	0.1220
1967	228,248	69,394	109,108	n/a	n/a
1968	240,957	72,875	114,895	16,122	0.1403
1969	256,692	75,895	121,094	n/a	n/a
1970	276,634	80,202	129,311	19,181	0.1483
1971	301,250	84,489	138,680	n/a	n/a
1972	322,719	89,848	148,066	n/a	n/a
1973	349,291	95,168	158,699	25,471	0.1605
1974	375,912	100,531	169,376	n/a	n/a
1975	402,896	106,348	180,485	28,332	0.1569
1976	423,122	111,530	189,429	n/a	n/a
1977	430,116	115,803	194,381	30,384	0.1563
1978	424,061	120,298	196,239	n/a	n/a
1979	403,262	124,354	194,082	33,566	0.1729
1980	383,876	128,139	192,073	n/a	n/a
1981	369,103	129,747	189,586	36,482	0.1924
1982	n/a	130,559	n/a	n/a	n/a
1983	n/a	130,813	n/a	36,963	n/a

a/Defined by the formula $(US)_t = 1/3(U_t + U_{t-1} + U_{t-2})$, where U = undergraduate enrollments in the biomedical sciences. See Appendix Table B1 for supporting data.

b/Defined by the formula $(GS)_t = 1/3(G_t + G_{t-1} + G_{t-2})$, where G = graduate enrollments in the biomedical sciences. See Appendix Table B1 for supporting data.

c/Defined as all Ph.D.s academically employed in the biomedical sciences (excluding postdoctoral appointments).

APPENDIX TABLE B7 National Expenditures for Health-Related R and D, 1960-84[a] ($ millions)

Fiscal Year	Current Dollars: Total	Current Dollars: Federal	Current Dollars: Private Industry	Current Dollars: Other	1972 Dollars: Total	1972 Dollars: Federal	1972 Dollars: Private Industry	1972 Dollars: Other	Implicit Price Deflator[b] (1972 = 100.0)
1960	886	448	253	185	1,290	652	368	269	68.70
1961	1,087	574	312	201	1,569	828	450	290	69.30
1962	1,333	782	336	215	1,891	1,109	477	305	70.50
1963	1,526	919	375	232	2,131	1,284	524	324	71.60
1964	1,698	1,049	400	249	2,336	1,443	550	343	72.70
1965	1,890	1,174	450	266	2,544	1,580	606	358	74.30
1966	2,111	1,316	510	285	2,749	1,714	664	371	76.80
1967	2,345	1,459	580	306	2,968	1,847	734	387	79.00
1968	2,568	1,582	661	325	3,109	1,915	800	393	82.60
1969	2,785	1,674	754	357	3,212	1,931	870	412	86.70
1970	2,847	1,667	795	385	3,115	1,824	870	421	91.40
1971	3,168	1,877	860	431	3,300	1,955	896	449	96.00
1972	3,536	2,147	934	455	3,536	2,147	934	455	100.00
1973	3,750	2,225	1,048	477	3,544	2,103	991	451	105.80
1974	4,443	2,754	1,183	506	3,830	2,374	1,020	436	116.00
1975	4,701	2,832	1,319	550	3,696	2,226	1,037	432	127.20
1976	5,107	3,059	1,469	579	3,814	2,285	1,097	432	133.90
1977	5,606	3,396	1,614	596	3,956	2,397	1,139	421	141.70
1978	6,264	3,811	1,800	653	4,120	2,506	1,184	429	152.05
1979	7,113	4,321	2,093	699	4,299	2,612	1,265	422	165.46
1980	7,914	4,723	2,456	735	4,436	2,647	1,377	412	178.42
1981	8,540	4,848	2,875	817	4,376	2,484	1,473	419	195.14
1982	9,239	4,970	3,373	896	4,466	2,402	1,630	433	206.88
1983 (prelim.)	10,208	5,399	3,887	922	4,734	2,504	1,803	428	215.63
1984 (est.)	11,538	6,087	4,486	965	5,164	2,724	2,008	432	223.43

a/From NIH (special tabulations, 6/7/82, 6/8/82, 5/3/84 and 7/5/85). Items may not sum to totals due to rounding.

b/From the U.S. Bureau of the Census.

APPENDIX TABLE B8 NIH Research Grant Expenditures, 1965-84[a] ($ millions)

Fiscal Year	Total NIH Research Grant Expenditures		NIH Research Grant Expenditures in U.S. Colleges and Universities					
			Current Dollars			1972 Dollars[b]		
	Current Dollars	1972 Dollars	Total	Public	Private	Total	Public	Private
1965	492.1	662.3	n/a	n/a	n/a	n/a	n/a	n/a
1966	551.2	717.7	n/a	n/a	n/a	n/a	n/a	n/a
1967	618.4	782.8	n/a	n/a	n/a	n/a	n/a	n/a
1968	647.0	783.3	n/a	n/a	n/a	n/a	n/a	n/a
1969	649.1	748.7	n/a	n/a	n/a	n/a	n/a	n/a
1970	624.3	683.0	n/a	n/a	n/a	n/a	n/a	n/a
1971	699.7	728.9	n/a	n/a	n/a	n/a	n/a	n/a
1972	826.5	826.5	676.7	339.7	337.0	676.7	339.7	337.0
1973	838.5	792.5	680.7	332.2	348.5	643.4	314.0	329.4
1974	1,100.8	949.0	885.0	448.7	436.3	762.9	386.8	376.1
1975	1,148.0	902.5	927.3	469.1	458.2	729.0	368.8	360.2
1976	1,275.8	952.8	1,025.4	516.1	509.3	765.8	385.4	380.4
1977	1,435.7	1,013.2	1,148.8	577.5	571.3	810.7	407.6	403.2
1978	1,638.0	1,077.3	1,322.4	668.4	654.0	869.7	439.6	430.1
1979	1,951.7	1,179.6	1,579.7	808.6	771.1	954.7	488.7	466.0
1980	2,161.1	1,211.2	1,742.6	893.2	849.5	976.7	500.6	476.1
1981	2,331.4	1,194.7	1,882.6	963.7	918.9	964.7	493.9	470.9
1982	2,407.7	1,163.8	1,937.8	991.2	946.6	936.7	479.1	457.6
1983	2,702.3	1,253.2	2,175.7	1,097.4	1,078.3	1,009.0	508.9	500.1
1984	3,087.0	1,381.8	2,472.8	1,254.9	1,217.9	1,106.9	561.7	545.2

a/From NIH (1966-84; special tabulations, 6/7/82, 6/8/82, 5/2/84, and 4/12/85). Items may not sum to totals due to rounding.

b/1972 dollars were obtained by using the Implicit GNP Price Deflator (U.S. Bureau of the Census--see Appendix Table B7). Items may not sum to totals due to rounding.

APPENDIX TABLE B9 Biomedical Science R and D Expenditures in Colleges and Universities, by Control of Institution, 1960-83 ($ millions)

Fiscal Year	Current Dollars[a] Total	Current Dollars[a] Public	Current Dollars[a] Private	1972 Dollars[b] Total	1972 Dollars[b] Public	1972 Dollars[b] Private	Weighted Sum of Biomed. Sci. R and D Expend. in Last 3 Yrs.[c] (Total, 1972 Dollars)
1960	287.4	n/a	n/a	418.3	n/a	n/a	363.5
1961	339.4	n/a	n/a	489.8	n/a	n/a	422.6
1962	402.2	n/a	n/a	570.5	n/a	n/a	492.1
1963	480.9	n/a	n/a	671.7	n/a	n/a	575.6
1964	565.7	n/a	n/a	778.2	n/a	n/a	673.0
1965	638.0	n/a	n/a	858.7	n/a	n/a	771.7
1966	724.0	n/a	n/a	942.8	n/a	n/a	859.6
1967	795.0	n/a	n/a	1,006.4	n/a	n/a	937.6
1968	860.7	n/a	n/a	1,042.1	n/a	n/a	999.4
1969	917.3	n/a	n/a	1,058.0	n/a	n/a	1,037.1
1970	991.2	n/a	n/a	1,084.5	n/a	n/a	1,060.6
1971	1,054.7	n/a	n/a	1,098.7	n/a	n/a	1,081.4
1972	1,102.2	600.5	501.7	1,102.2	600.5	501.7	1,096.0
1973	1,252.9	691.2	561.8	1,184.3	653.3	531.0	1,121.9
1974	1,284.3	691.4	592.8	1,107.1	596.1	511.1	1,144.5
1975	1,517.0	825.5	691.5	1,192.6	649.0	543.6	1,147.8
1976	1,688.8	937.9	750.9	1,261.3	700.5	560.8	1,188.4
1977	1,798.2	1,002.3	795.9	1,269.0	707.3	561.7	1,246.0
1978	2,038.8	1,158.3	880.5	1,340.9	761.8	579.1	1,285.0
1979	2,227.7	1,237.3	990.4	1,346.4	747.8	598.6	1,324.3
1980	2,538.5	1,433.4	1,105.1	1,422.7	803.4	619.4	1,364.1
1981	2,901.1	1,663.1	1,238.0	1,486.7	852.2	634.4	1,419.6
1982	3,132.7	1,790.8	1,341.9	1,514.3	865.6	648.6	1,477.6
1983	3,316.8	1,911.7	1,405.1	1,538.2	886.6	651.6	1,513.3

[a] Figures for 1972-83 were obtained from the National Science Foundation (1975-85). The 1978 figures are NSF estimates. Figures for other years were estimated by the committee. Items may not sum to totals due to rounding.

[b] 1972 dollars were obtained by using the Implicit GNP Price Deflator (U.S. Bureau of the Census--see Appendix Table B7). Items may not sum to totals due to rounding.

[c] Computed by the formula $1/4(R_t + 2R_{t-1} + R_{t-2})$, where R = total biomedical science R and D expenditures (1972 dollars).

APPENDIX TABLE B10 Average Biomedical Science R and D Expenditures per School in Colleges and Universities, by Control of Institution, 1972-83[a] (1972 $, thousands)

Fiscal Year	Average R and D Expenditures			Number of Schools Reporting[b]		
	Total	Public	Private	Total	Public	Private
1972	1,865	1,793	1,960	591	335	256
1973	2,004	1,950	2,074	591	335	256
1974	1,858	1,774	1,966	596	336	260
1975	2,225	2,009	2,552	536	323	213
1976	2,357	2,175	2,633	535	322	213
1977	2,368	2,197	2,625	536	322	214
1978	2,386	2,301	2,507	562	331	231
1979	2,383	2,252	2,569	565	332	233
1980	2,527	2,420	2,681	563	332	231
1981	2,640	2,566	2,746	563	332	231
1982	2,689	2,606	2,807	563	332	231
1983	2,737	2,679	2,821	562	331	231

[a] See Appendix Table B9 for supporting data.

[b] From the National Science Foundation. For 1978, the number of doctorate-granting institutions was obtained from NSF; the number of master's-granting institutions was estimated by the committee.

APPENDIX TABLE B11 Indirect Costs of NIH-Sponsored Research Grants at Institutions of Higher Education, 1970-83[a]

Fiscal Year	All Institutions of Higher Ed.		Public Schools		Private Schools	
	% of Direct Costs	% of Total Costs	% of Direct Costs	% of Total Costs	% of Direct Costs	% of Total Costs
1970	25.7	20.5	26.6	21.0	24.9	19.9
1971	27.2	21.4	28.2	22.0	26.3	20.8
1972	28.7	22.3	28.9	22.4	28.5	22.2
1973	30.0	23.1	29.6	22.8	30.4	23.3
1974	31.8	24.1	30.4	23.3	33.2	24.9
1975	32.4	24.5	30.2	23.2	34.8	25.8
1976	34.6	25.7	31.7	24.1	37.6	27.4
1977	35.0	25.9	31.4	23.9	38.9	28.0
1978	36.0	26.5	31.7	24.1	40.7	28.9
1979	37.5	27.3	32.9	24.8	42.7	29.9
1980	39.2	28.2	33.3	25.0	46.0	31.5
1981	40.4	28.8	34.1	25.4	47.6	32.2
1982	41.0	29.1	34.4	25.6	48.8	32.8
1983	43.5	30.3	36.1	26.5	51.8	34.1
Average Annual Growth Rate 1970-83	4.1%	3.1%	2.4%	1.8%	5.8%	4.2%

[a] From NIH (1966-84).

APPENDIX TABLE B12 Ph.D.s Academically Employed in the Biomedical Sciences, by Employment Status and Type of Institution, 1973-83[a/]

Fiscal Year	Employment Status	Type of Institution Total	4-Year	2-Year
1973	Total	25,471	24,960	511
	Full-Time	24,724	24,241	483
	Part-Time	747	719	28
1975	Total	28,332	27,709	623
	Full-Time	27,487	26,919	568
	Part-Time	845	790	55
1977	Total	30,384	29,604	780
	Full-Time	29,473	28,768	705
	Part-Time	911	836	75
1979	Total	33,566	32,744	822
	Full-Time	32,550	31,802	749
	Part-Time	1,015	942	73
1981	Total	36,482	35,644	838
	Full-Time	35,462	34,701	761
	Part-Time	1,020	943	77
1983	Total	36,963	35,973	990
	Full-Time	35,781	34,884	897
	Part-Time	1,182	1,089	93
Average Annual Growth Rate from 1973-83	Total	3.8	3.7	6.8
	Full-Time	3.8	3.7	6.4
	Part-Time	4.7	4.2	12.8

[a/]Based on the most recent data available from the National Research Council (1973-84). Foreign nationals who received doctorates from U.S. institutions are included. Individuals on postdoctoral appointments are excluded.

APPENDIX TABLE B13 Faculty Attrition Rates at U.S. Medical Schools, by Department and Degree Type, 1970-81[a]

Fiscal Year	All Departments				Clinical Departments				Basic Science Departments			
	Total	M.D.s	Ph.D.s	Other	Total	M.D.s	Ph.D.s	Other	Total	M.D.s	Ph.D.s	Other
1970	6.3	6.5	4.6	9.6	7.1	6.8	7.3	9.7	4.8	5.1	3.3	4.3
1971	6.5	6.9	4.5	8.8	7.3	7.2	6.4	9.7	4.7	5.3	3.6	7.6
1972	7.8	7.7	6.3	12.2	8.2	7.9	7.7	11.8	6.8	6.3	5.5	12.7
1973	7.2	7.0	5.2	13.4	7.8	7.1	6.9	15.3	5.8	6.2	4.3	10.7
1974	6.5	6.4	4.9	11.1	7.0	6.6	6.7	10.9	5.3	5.3	3.9	11.4
1975	6.7	6.5	5.4	11.6	7.1	6.7	6.8	10.8	5.9	5.4	4.6	12.7
1976	7.5	7.4	5.8	13.1	8.2	7.7	7.5	13.7	6.0	5.6	4.9	12.2
1977	7.7	7.7	6.0	12.0	8.2	8.0	7.5	11.6	6.3	5.9	5.2	12.4
1978	6.5	6.6	4.9	11.0	7.1	6.8	6.5	11.3	5.2	5.1	4.1	10.4
1979	6.3	6.3	5.1	10.8	6.9	6.6	7.1	10.3	5.0	4.1	4.0	11.4
1980	5.9	6.0	4.8	8.6	6.4	6.2	5.9	9.0	4.7	4.1	4.2	8.1
1981	5.8	5.8	4.7	9.8	6.1	6.0	5.6	8.6	5.1	4.3	4.2	11.5
Average 1970-81	6.7	6.7	5.2	11.0	7.3	7.0	6.8	11.0	5.5	5.2	4.3	10.4

[a] From Sherman and Bowden (1982). Based on the Medical School Faculty Roster. Figures represent percent of full-time faculty leaving each year for retirement, death, and other reasons.

APPENDIX TABLE B14 Postdoctoral Research Training of New Faculty Hires in U.S. Medical Schools, by Department and Degree Type, 1970-81[a]

Fiscal Year	All Departments		Clinical Departments		Basic Science Departments	
	M.D.s	Ph.D.s	M.D.s	Ph.D.s	M.D.s	Ph.D.s
1970	28.2	29.6	27.7	20.1	31.7	39.2
1971	26.1	32.5	25.0	22.5	35.6	43.4
1972	25.8	39.3	24.6	28.5	36.6	49.4
1973	22.9	41.0	22.7	26.9	25.1	54.1
1974	25.0	44.2	24.3	31.0	33.9	57.3
1975	22.5	41.7	21.7	29.9	31.1	55.9
1976	23.4	49.9	22.8	37.9	30.4	62.2
1977	23.7	50.7	22.7	38.3	37.4	64.5
1978	23.5	56.0	23.2	43.8	28.4	72.7
1979	20.0	55.8	19.4	41.4	29.4	72.2
1980	22.2	55.3	21.6	38.2	30.4	71.8
1981	25.3	55.7	24.0	42.0	42.4	71.6
Average 1970-81	24.0	46.0	23.4	33.4	32.7	59.5

[a] From Sherman and Bowden (1982). Based on Medical School Faculty Roster. Figures represent percent of new full-time faculty with postdoctoral research training.

APPENDIX TABLE B15 Graduate School Attrition Rates in the Biomedical Sciences, 1960-71

Fiscal Year of Graduate School Entry	First-Year Graduate Enrollment in the Biomed. Sci.[a]	Number of FY 1958-84 Biomedical Sci. Ph.D.s Entering Grad. School[b]	Ph.D. Completion Rate (%)[c]	Graduate School Attrition Rate (%)[c]
1960	5,370	1,932	36.0	64.0
1961	6,025	2,178	36.1	63.9
1962	6,642	2,369	35.7	64.3
1963	7,137	2,548	35.7	64.3
1964	8,542	3,047	35.7	64.3
1965	10,430	3,400	32.6	
1966	12,034	3,746	31.1	
1967	12,511	3,695	29.5	
1968	13,301	3,484	26.2	
1969	13,343	3,335	25.0	
1970	14,835	3,428	23.1	
1971	15,845	3,478	22.0	
Pre-1960		12,986		
Post-1971		24,319		

[a]From the U.S. Department of Education (1959-79).
[b]From the National Research Council (1958-85).
[c]The Ph.D. completion rate represents the percentage of first-year graduate students in a given year who earned a Ph.D. between 1958 and 1984 (column 2/column 1). The attrition rate is obtained by subtracting the Ph.D. completion rate for a given year from 100.0%. The rates for 1960-64 are relatively constant, indicating that most individuals entering graduate school during that period had either received a Ph.D. or dropped out of graduate school by 1984. For 1965-71, however, the Ph.D. completion rates decline with each year. The attrition rates for these years undoubtedly include students who are still enrolled in graduate school but who had not earned a Ph.D. by 1984, as well as those who had actually dropped out of graduate school. The Ph.D. completion rates will most likely increase and the attrition rates decrease once 1985 Ph.D.s are added to the calculations, and should continue to do so with the inclusion of each additional year of Ph.D.s. For this reason, we have not calculated the attrition rates after 1964.

APPENDIX TABLE B16 Percent of the Postdoctoral Population in the Biomedical Sciences Who Had Earned Their Doctorates More Than 2, 3, or 4 Years Earlier, 1973-83[a]

		Number of Years Since Ph.D.					
		>2 Years		>3 Years		>4 Years	
Fiscal Year	Total Postdocs	N	%	N	%	N	%
1973	3,607	1,123	31.1	577	16.0	343	9.5
1975	5,369	2,239	41.7	1,334	24.8	843	15.7
1977	6,312	2,782	44.1	1,715	27.2	1,051	16.7
1979	7,268	3,530	48.6	2,345	32.3	1,532	21.1
1981	8,026	3,695	46.0	2,369	29.5	1,544	19.2
1983	7,827	3,503	44.8	2,309	29.5	1,432	18.3

[a]From the National Research Council (1973-84).

APPENDIX TABLE B17 Projected Combined Death and Retirement Rates as Percent of Total Faculty, by Broad Field of Science and Engineering, 1976-2000[a]

Year	Mathematics	Physical Sciences	Engineering	Life Sciences	Sciences
1976	1.06	1.11	1.07	1.27	1.20
1977	0.94	1.41	0.79	1.28	1.21
1978	0.93	1.22	0.61	1.35	1.26
1979	0.71	1.13	0.61	1.21	1.23
1980	0.69	1.05	0.72	1.22	1.34
1981	0.67	1.03	0.80	1.21	1.31
1982	0.76	1.16	0.80	1.22	1.24
1983	0.81	1.30	0.96	1.40	1.48
1984	1.12	1.38	0.98	1.44	1.64
1985	1.04	1.49	1.29	1.44	1.73
1986	0.98	1.49	1.40	1.74	1.97
1987	1.02	1.88	1.48	1.68	2.21
1988	1.57	2.15	1.55	2.08	2.19
1989	1.45	1.97	1.67	1.97	2.30
1990	1.43	2.14	1.90	1.98	2.45
1991	1.58	1.96	1.78	2.18	2.71
1992	1.53	2.24	2.28	2.05	2.73
1993	1.96	2.50	2.13	2.23	2.80
1994	2.06	2.46	2.05	2.52	2.98
1995	1.98	2.53	2.33	2.45	2.90
1996	2.07	2.64	2.22	2.47	3.00
1997	2.32	2.58	2.34	2.70	3.24
1998	2.44	2.98	2.63	2.70	3.08
1999	2.57	2.95	2.54	2.60	3.16
2000	2.84	3.03	2.50	2.55	3.12

[a]From special tabulations prepared by Charlotte Kuh, based on the Radner-Kuh projection model and data from the National Research Council (1973-84).

APPENDIX TABLE B1B Actual and Projected Age Distribution of Academically Employed Biomedical Science Ph.D.s[a]

	Actual Age Distribution												Projected Age Distribution							
	1977			1979			1981			1983			1985		1987		1989		1991	
Age	#	%	2-Yr. Attrition Rate (1977-79)	#	%	2-Yr. Attrition Rate (1979-81)	#	%	2-Yr. Attrition Rate (1981-83)	#	%	Expected 2-Yr. Attrition Rate (1983-85)	#	%	#	%	#	%	#	%
TOTAL	30,384	100.0		33,566	100.0		36,482	100.0		36,963	100.0		38,500	100.0	39,500	100.0	41,000	100.0	42,500	100.0
45 and under	19,516	64.2	-	21,698	64.6	-	22,837	62.6	-	22,631	61.2	-	23,145	60.1	23,195	58.7	23,760	58.0	24,395	57.4
46-47	1,514	5.0	-	1,698	5.1	-	1,828	5.0	4.1	1,937	5.2	2.0	1,925	5.0	1,975	5.0	2,050	5.0	2,125	5.0
48-49	1,667	5.5	3.8	1,541	4.6	3.8	1,749	4.8	-	1,753	4.7	2.0	1,900	4.9	1,890	4.8	1,940	4.7	2,010	4.7
50-51	1,483	4.9	0.8	1,604	4.8	0.3	1,482	4.1	2.8	1,775	4.8	2.0	1,720	4.5	1,860	4.7	1,850	4.5	1,900	4.5
52-53	1,440	4.7	8.2	1,471	4.4	-	1,599	4.4	9.4	1,441	3.9	3.0	1,740	4.5	1,690	4.3	1,820	4.4	1,810	4.3
54-55	1,052	3.5	4.7	1,322	3.9	-	1,581	4.3	5.9	1,449	3.9	3.0	1,400	3.6	1,690	4.3	1,640	4.0	1,770	4.2
56-57	872	2.9	5.5	1,003	3.0	-	1,362	3.7	2.6	1,487	4.0	3.0	1,410	3.7	1,360	3.4	1,640	4.0	1,590	3.7
58-59	742	2.4	7.7	824	2.5	2.1	1,068	2.9	14.2	1,327	3.6	4.0	1,440	3.7	1,370	3.5	1,320	3.2	1,590	3.7
60-61	594	2.0	7.7	686	2.0	-	807	2.2	-	916	2.5	5.0	1,270	3.3	1,380	3.5	1,320	3.2	1,270	3.0
62-63	522	1.7	-	548	1.6	4.0	833	2.3	34.1	817	2.2	10.0	870	2.3	1,210	3.1	1,310	3.2	1,250	2.9
64-65	528	1.7	36.7	549	1.6	14.9	526	1.4	30.0	549	1.5	20.0	740	1.9	780	2.0	1,090	2.7	1,180	2.8
66-67	218	0.7	37.2	334	1.0	32.0	467	1.3	37.9	368	1.0	35.0	440	1.1	590	1.5	620	1.5	870	2.0
68-69	141	0.5	-	137	0.4	16.8	227	0.6	7.9	290	0.8	10.0	240	0.6	290	0.7	380	1.0	400	0.9
70+	86	0.3	-	145	0.4	-	114	0.3	-	209	0.6	-	260	0.7	220	0.6	260	0.6	340	0.8
Unknown	9	-	-	9	-	-	2	-	-	14	-	-								

a/The data for 1977-83 were obtained from the National Research Council (1973-84). Projections were computed by the committee.

APPENDIX C
Behavioral Sciences Data

APPENDIX C (cont'd.)
Behavioral Sciences Data

APPENDIX TABLE C1 Behavorial Science Enrollments in Colleges and Universities, by Control of Institution, 1960-84[a]

Fiscal Year	Total Undergraduate and Graduate Enrollment			Estimated Undergraduate Enrollment[b]			Graduate[c]		
	Total	Public	Private	Total	Public	Private	Total	Public	Private
1960	172,976	n/a	n/a	160,228	n/a	n/a	12,748	n/a	n/a
1961	194,799	n/a	n/a	179,839	n/a	n/a	14,960	n/a	n/a
1962	225,475	n/a	n/a	210,099	n/a	n/a	15,376	n/a	n/a
1963	257,638	n/a	n/a	241,032	n/a	n/a	16,606	n/a	n/a
1964	304,375	n/a	n/a	285,593	n/a	n/a	18,782	n/a	n/a
1965	316,575	n/a	n/a	295,626	n/a	n/a	20,949	n/a	n/a
1966	382,904	n/a	n/a	358,840	n/a	n/a	24,064	n/a	n/a
1967	431,820	n/a	n/a	406,763	n/a	n/a	25,057	n/a	n/a
1968	495,958	n/a	n/a	466,075	n/a	n/a	29,883	n/a	n/a
1969	565,817	n/a	n/a	531,814	n/a	n/a	34,003	n/a	n/a
1970	637,063	n/a	n/a	600,555	n/a	n/a	36,508	n/a	n/a
1971	706,924	n/a	n/a	666,568	496,429	170,139	40,356	n/a	n/a
1972	750,453	563,722	186,731	705,746	533,011	172,735	44,707	30,711	13,996
1973	743,829	561,782	182,047	695,613	528,419	167,194	48,216	33,363	14,853
1974	724,277	550,163	174,114	672,565	514,787	157,778	51,712	35,376	16,336
1975	723,479	554,594	168,885	668,096	517,270	150,826	55,383	37,324	18,059
1976	730,900	564,051	166,849	671,844	524,078	147,766	59,056	39,973	19,083
1977	692,920	534,577	158,343	634,631	495,901	138,730	58,289	38,676	19,613
1978	684,149	525,988	158,161	620,369	482,835	137,534	63,780	43,153	20,627
1979	650,543	497,901	152,642	586,742	455,191	131,551	63,801	42,710	21,091
1980	644,803	492,677	152,126	580,983	450,413	130,570	63,820	42,264	21,556
1981	647,331	494,346	152,985	582,551	452,353	130,198	64,780	41,993	22,787
1982	n/a	n/a	n/a	n/a	n/a	n/a	64,331	41,701	22,630
1983	n/a	n/a	n/a	n/a	n/a	n/a	63,108	40,965	22,143
1984	n/a	n/a	n/a	n/a	n/a	n/a	63,811	41,501	22,310

a/Behavioral sciences include psychology, sociology, anthropology, and speech pathology/audiology. Figures are higher than those presented in the 1983 Report because speech pathology/audiology is now included in the taxonomy.

b/Sum of estimated undergraduate enrollments in psychology, sociology, anthropology, and speech pathology/audiology. See Appendix Tables C4-6 and C8 for supporting data.

c/Figures for 1960-77 were obtained from the U.S. Department of Education (1959-79). Figures for 1978-84 were obtained from the National Science Foundation (1973-85a) except for the 1979 figure, which was interpolated. Due to differences in taxonomy, NSF numbers for 1978-84 may be slightly higher than numbers that would have been obtained from the Department of Education had data been collected for those years. For the year 1977, NSF reported 62,699 graduate students enrolled in the behavioral sciences; in comparison, the Department of Education reported a somewhat lower figure of 58,289 (as shown in this table).

APPENDIX TABLE C2 Graduate Enrollment in Clinical Psychology, Nonclinical Psychology, and Other Behavorial Sciences, and Ratio of Clinical Psychology Ph.D.s to Total Psychology Ph.D.s, by Control of Institution, 1960-84

Fiscal Year	Graduate Enrollment[a/]									Ratio of Clinical Psychology Ph.D.s to Total Psychology Ph.D.s[d/]
	Clinical Psychology[b/]			Nonclinical Psychology[b/]			Other Behavioral Sciences[c/]			
	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total
1960	3,788	1,962	1,826	5,169	2,677	2,492	3,791	1,977	1,814	0.4067
1961	4,403	2,301	2,102	6,274	3,279	2,995	4,283	2,401	1,882	0.4646
1962	4,978	2,638	2,340	5,773	3,060	2,713	4,625	2,595	2,030	0.4229
1963	4,733	2,655	2,078	6,611	3,708	2,903	5,262	3,093	2,169	0.4124
1964	4,866	n/a	n/a	7,761	n/a	n/a	6,155	n/a	n/a	0.4630
1965	5,610	n/a	n/a	8,123	n/a	n/a	7,216	n/a	n/a	0.4172
1966	6,511	n/a	n/a	9,040	n/a	n/a	8,513	n/a	n/a	0.3854
1967	5,949	n/a	n/a	9,736	n/a	n/a	9,372	n/a	n/a	0.4085
1968	7,139	n/a	n/a	11,925	n/a	n/a	10,819	n/a	n/a	0.4187
1969	8,525	n/a	n/a	13,118	n/a	n/a	12,360	n/a	n/a	0.3793
1970	9,172	n/a	n/a	13,554	n/a	n/a	13,782	n/a	n/a	0.3745
1971	10,882	n/a	n/a	14,460	n/a	n/a	15,014	n/a	n/a	0.3939
1972	10,909	7,268	3,641	15,803	10,528	5,275	17,995	12,915	5,080	0.4031
1973	12,125	8,179	3,946	17,032	11,490	5,542	19,059	13,694	5,365	0.4292
1974	13,858	9,067	4,791	17,041	11,149	5,892	20,813	15,160	5,653	0.4084
1975	14,840	9,462	5,378	17,954	11,448	6,506	22,589	16,414	6,175	0.4158
1976	16,925	10,576	6,349	18,393	11,493	6,900	23,738	17,904	5,834	0.4485
1977	17,264	10,444	6,820	18,099	10,949	7,150	22,926	17,283	5,643	0.4525
1978	19,713	12,285	7,428	18,915	11,787	7,128	25,152	19,081	6,071	0.4792
1979	20,351	12,473	7,878	18,856	11,557	7,299	24,594	18,680	5,914	0.4882
1980	21,178	12,769	8,409	18,608	11,219	7,389	24,034	18,276	5,758	0.5103
1981	21,651	12,671	8,980	18,985	11,110	7,875	24,144	18,212	5,932	0.5191
1982	21,652	12,699	8,953	19,039	11,166	7,873	23,640	17,836	5,804	0.5323
1983	21,337	12,447	8,890	18,761	10,945	7,816	23,010	17,573	5,437	0.5328
1984	n/a	n/a	n/a	n/a	n/a	n/a	22,677	17,331	5,346	0.5321

a/ Figures for 1960-77 were obtained from the U.S. Department of Education (1959-79). Figures for 1978-84 were obtained from the National Science Foundation (1973-85a) except for the 1979 figure, which was interpolated. NSF numbers for 1978-84 may be slightly higher than numbers that would have been obtained from the Department of Education had data been collected for those years.

b/ Total graduate enrollment in clinical psychology was estimated by the formula $CG_i=(CP_{i+2}/TP_{i+2})E_i$, where CG_i = clinical psychology graduate enrollment in year i; CP_{i+2} = clinical psychology Ph.D. degrees awarded in year i+2; TP_{i+2} = total psychology Ph.D. degrees awarded in year i+2; E_i = psychology graduate enrollment in year i. Public and private estimates were based on enrollment ratios. Nonclinical psychology graduate enrollment represents the difference between total psychology and clinical psychology graduate enrollments. The figures for 1983 are preliminary estimates. See Appendix Tables C4 and C10 for supporting data.

c/ Includes sociology, anthropology, and speech pathology/audiology.

d/ See Appendix Table C10 for number of Ph.D.s.

APPENDIX TABLE C3 First-Year Graduate Enrollment in the Behavioral Sciences, 1960-84[a]

Fiscal Year	Total First-Year Graduate Enrollment[b]					First-Year Full-Time Graduate Enrollment in Doctorate-Granting Institutions[c]					
	All Behav. Sci.	Psych.	Sociol.	Anthro.	Spch.Path./ Audiology	All Behav. Sci.	Psych.	Sociol.	Anthro.	Sociol/ Anthro.	Spch.Path./ Audiology
1960	6,188	4,366	1,486	336	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1961	7,732	5,470	1,805	457	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1962	8,038	5,655	1,861	522	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1963	8,739	6,169	2,020	550	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1964	9,288	5,928	2,625	735	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1965	11,832	7,673	3,137	1,022	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1966	13,659	8,765	3,645	1,249	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1967	13,659	8,459	3,793	1,407	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1968	15,966	10,190	4,290	1,486	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1969	16,831	10,645	4,584	1,602	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1970	19,501	12,200	5,456	1,845	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1971	22,709	14,262	6,033	2,414	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1972	24,607	14,754	5,484	2,366	2,003	n/a	n/a	n/a	n/a	n/a	n/a
1973	26,269	15,678	5,642	2,525	2,424	n/a	n/a	n/a	n/a	n/a	n/a
1974	27,636	16,219	5,404	2,515	3,498	n/a	n/a	n/a	n/a	n/a	n/a
1975	29,376	17,270	5,257	2,554	4,295	12,028	5,872	1,930	1,368	338	2,520
1976	31,545	18,510	5,012	2,748	5,275	11,821	5,737	1,852	1,276	398	2,558
1977	29,778	17,565	4,461	2,525	5,227	11,606	5,983	1,706	1,335	259	2,323
1978	n/a	n/a	n/a	n/a	n/a	11,695	6,063	1,678	1,326	273	2,355
1979	n/a	n/a	n/a	n/a	n/a	10,390	5,569	1,371	1,141	218	2,091
1980	n/a	n/a	n/a	n/a	n/a	9,938	5,468	1,286	1,110	227	1,847
1981	n/a	n/a	n/a	n/a	n/a	10,227	5,697	1,314	966	203	2,047
1982	n/a	n/a	n/a	n/a	n/a	9,846	5,564	1,229	928	153	1,972
1983	n/a	n/a	n/a	n/a	n/a	9,650	5,474	1,130	896	200	1,950
1984	n/a	n/a	n/a	n/a	n/a	9,406	5,392	1,129	836	159	1,890

a/Figures are higher than those presented in the 1983 Report because speech pathology/audiology is now included in the taxonomy.

b/From the U.S. Department of Education (1959-79).

c/From the National Science Foundation (1973-85a).

APPENDIX TABLE C4 Psychology Enrollments in Colleges and Universities, B.A. Degrees Awarded in Psychology, and Ratio of Psychology B.A.s to Total B.A.s, by Control of Institution, 1960-84

	Enrollments												Ratio of Psych. B.A.s to Total B.A.s d/
	Total Undergraduate and Graduate Enrollment			Estimated Undergraduate Enrollment a/			Graduate b/			B.A. Degrees Awarded c/			
Fiscal Year	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total
1960	92,894	n/a	n/a	83,937	n/a	n/a	8,957	4,639	4,318	8,111	n/a	n/a	n/a
1961	106,036	n/a	n/a	95,359	n/a	n/a	10,677	5,580	5,097	8,524	n/a	n/a	0.0233
1962	121,373	n/a	n/a	110,622	n/a	n/a	10,751	5,698	5,053	9,638	n/a	n/a	0.0252
1963	134,461	n/a	n/a	123,117	n/a	n/a	11,344	6,363	4,981	11,062	n/a	n/a	0.0270
1964	156,762	n/a	n/a	144,135	n/a	n/a	12,627	n/a	n/a	13,359	n/a	n/a	0.0290
1965	161,244	n/a	n/a	147,511	n/a	n/a	13,733	n/a	n/a	14,721	n/a	n/a	0.0299
1966	193,667	n/a	n/a	178,116	n/a	n/a	15,551	n/a	n/a	17,022	n/a	n/a	0.0325
1967	218,894	n/a	n/a	203,209	136,946	66,263	15,685	n/a	n/a	19,496	n/a	n/a	0.0347
1968	249,700	n/a	n/a	230,636	159,413	71,223	19,064	n/a	n/a	23,972	n/a	n/a	0.0376
1969	287,920	n/a	n/a	266,277	191,557	74,720	21,643	n/a	n/a	29,495	16,609	12,886	0.0402
1970	332,414	n/a	n/a	309,688	227,519	82,169	22,726	n/a	n/a	33,854	19,819	14,035	0.0424
1971	372,721	n/a	n/a	347,379	258,712	88,667	25,342	n/a	n/a	38,154	22,696	15,458	0.0451
1972	405,227	303,667	101,560	378,515	285,871	92,644	26,712	17,796	8,916	43,421	26,312	17,109	0.0486
1973	415,508	313,159	102,349	386,351	293,490	92,861	29,157	19,669	9,488	48,096	29,410	18,686	0.0517
1974	418,251	316,699	101,552	387,352	296,483	90,869	30,899	20,216	10,683	52,256	33,007	19,249	0.0548
1975	424,629	324,286	100,343	391,835	303,376	88,459	32,794	20,910	11,884	51,436	32,751	18,685	0.0552
1976	434,156	333,186	100,970	398,838	311,117	87,721	35,318	22,069	13,249	50,363	32,662	17,701	0.0539
1977	419,235	321,351	97,884	383,872	299,958	83,914	35,363	21,393	13,970	47,794	31,005	16,789	0.0515
1978	421,640	322,171	99,469	383,012	298,099	84,913	38,628	24,072	14,556	45,057	28,698	16,359	0.0484
1979	408,429	310,470	97,959	369,222	286,440	82,782	39,207	24,030	15,177	43,012	26,969	16,043	0.0462
1980	414,611	314,575	100,036	374,825	290,587	84,238	39,786	23,988	15,798	42,513	26,254	16,259	0.0452
1981	426,281	323,236	103,045	385,645	299,455	86,190	40,636	23,781	16,855	41,364	25,592	15,772	0.0437
1982	n/a	n/a	n/a	n/a	n/a	n/a	40,691	23,865	16,826	41,539	25,758	15,781	0.0431
1983	n/a	n/a	n/a	n/a	n/a	n/a	40,098	23,392	16,706	n/a	n/a	n/a	0.0425 (est.)
1984	n/a	n/a	n/a	n/a	n/a	n/a	41,134	24,170	16,964	n/a	n/a	n/a	n/a

a/ Estimated by the formula $U_i=(A_{i+2}/B_{i+2})C_i$, where U_i = psychology undergraduate enrollment in year i; A_{i+2} = psychology 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 professional). Public and private estimates were based on enrollment ratios. See Appendix Table C9 for supporting data.

b/ Figures for 1960-77 were obtained from the U.S. Department of Education (1959-79). Figures for 1978-84 were obtained from the National Science Foundation (1973-85a) except for the 1979 figure, which was interpolated. Due to differences in taxonomy, NSF numbers for 1978-84 may be slightly higher than numbers that would have been obtained from the Department of Education had data been collected for those years. For the year 1977, NSF reported 37,427 graduate students enrolled in psychology; in comparison, the Department of Education reported a somewhat lower figure of 35,363 (as shown in this table).

c/ Figures for 1960-68 were obtained from the U.S. Department of Education (1948-81), those for 1969-82 from the U.S. Department of Education (1948-84).

d/ See Appendix Table C9 for total B.A.s.

208

APPENDIX TABLE C5 Sociology Enrollments in Colleges and Universities, B.A. Degrees Awarded in Sociology, and Ratio of Sociology B.A.s to Total B.A.s, by Control of Institution, 1960-84

	Enrollments												Ratio of Sociol. B.A.s to Total B.A.s[d]
	Total Undergraduate and Graduate Enrollment			Estimated Undergraduate Enrollment[a]			Graduate[b]			B.A. Degrees Awarded[c]			
Fiscal Year	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total
1960	74,195	n/a	n/a	71,266	n/a	n/a	2,929	1,540	1,389	7,182	n/a	n/a	n/a
1961	81,326	n/a	n/a	78,049	n/a	n/a	3,277	1,863	1,414	7,519	n/a	n/a	0.0206
1962	94,982	n/a	n/a	91,494	n/a	n/a	3,488	1,975	1,513	8,183	n/a	n/a	0.0214
1963	111,778	n/a	n/a	107,854	n/a	n/a	3,924	2,328	1,596	9,054	n/a	n/a	0.0221
1964	133,335	n/a	n/a	128,732	n/a	n/a	4,603	n/a	n/a	11,049	n/a	n/a	0.0240
1965	139,652	n/a	n/a	134,307	n/a	n/a	5,345	n/a	n/a	12,896	n/a	n/a	0.0262
1966	170,114	n/a	n/a	163,924	n/a	n/a	6,190	n/a	n/a	15,203	n/a	n/a	0.0290
1967	189,642	n/a	n/a	182,954	123,296	59,658	6,688	n/a	n/a	17,751	n/a	n/a	0.0316
1968	217,927	n/a	n/a	210,157	145,258	64,899	7,770	n/a	n/a	22,062	n/a	n/a	0.0346
1969	243,609	n/a	n/a	234,927	169,004	65,923	8,682	n/a	n/a	26,555	14,604	11,951	0.0362
1970	263,958	n/a	n/a	254,093	186,675	67,418	9,865	n/a	n/a	30,848	17,820	13,028	0.0387
1971	270,294	n/a	n/a	259,971	193,614	66,357	10,323	n/a	n/a	33,662	19,992	13,670	0.0398
1972	270,184	203,360	66,824	260,012	196,372	63,640	10,172	6,988	3,184	35,626	21,783	13,843	0.0398
1973	249,429	188,734	60,695	238,987	181,545	57,442	10,442	7,189	3,253	35,994	22,780	13,214	0.0387
1974	225,615	172,021	53,594	215,123	164,657	50,466	10,492	7,364	3,128	35,896	23,387	12,509	0.0376
1975	215,344	166,070	49,274	204,870	158,619	46,251	10,474	7,451	3,023	31,817	20,790	11,027	0.0342
1976	213,928	166,275	47,653	203,512	158,751	44,761	10,416	7,524	2,892	27,970	18,506	9,464	0.0299
1977	193,033	150,147	42,886	183,359	143,277	40,082	9,674	6,870	2,804	24,989	16,569	8,420	0.0269
1978	181,517	140,598	40,919	172,653	134,376	38,277	8,864	6,222	2,642	22,991	15,324	7,667	0.0247
1979	165,452	127,751	37,701	156,940	121,753	35,187	8,512	5,998	2,514	20,545	13,531	7,014	0.0221
1980	155,457	119,968	35,489	147,298	114,194	33,104	8,159	5,774	2,385	19,164	12,494	6,670	0.0204
1981	145,926	112,673	33,253	137,925	107,099	30,826	8,001	5,574	2,427	17,582	11,371	6,211	0.0186
1982	n/a	n/a	n/a	n/a	n/a	n/a	7,816	5,461	2,355	16,324	10,574	5,750	0.0169
1983	n/a	n/a	n/a	n/a	n/a	n/a	7,246	5,168	2,078	n/a	n/a	n/a	0.0152 (est.)
1984	n/a	n/a	n/a	n/a	n/a	n/a	6,951	5,029	1,922	n/a	n/a	n/a	n/a

a/ Estimated by the formula $U_i=(A_{i+2}/B_{i+2})C_i$, where U_i = sociology undergraduate enrollment in year i; A_{i+2} = sociology 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 professional). Public and private estimates were based on enrollment ratios. See Appendix Table C9 for supporting data.

b/ Figures for 1960-77 were obtained from the U.S. Department of Education (1959-79). Figures for 1978-84 were obtained from the National Science Foundation (1973-85a) except for the 1979 figure, which was interpolated. Due to differences in taxonomy, NSF numbers for 1978-84 may be slightly higher than numbers that would have been obtained from the Department of Education had data been collected for those years. For the year 1977, NSF reported 9,686 graduate students enrolled in sociology (with an additional 1,239 enrolled in sociology/anthropology); in comparison, the Department of Education reported a somewhat lower figure of 9,674 (as shown in this table). Graduate enrollments in the interdisciplinary field of sociology/anthropology are not included in this table, but are presented in Appendix Table C7.

c/ Figures for 1960-68 were obtained from the U.S. Department of Education (1948-81), those for 1969-82 from the U.S. Department of Education (1948-84).

d/ See Appendix Table C9 for total B.A.s.

APPENDIX TABLE C6 Anthropology Enrollments in Colleges and Universities, B.A. Degrees Awarded in Anthropology, and Ratio of Anthropology B.A.s to Total B.A.s, by Control of Institution, 1960-84

	Enrollments												
	Total Undergraduate and Graduate Enrollment			Estimated Undergraduate Enrollment[a]			Graduate[b]			B.A. Degrees Awarded[c]			Ratio of Anthro B.A.s to Total B.A.s[d]
Fiscal Year	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total
1960	5,887	n/a	n/a	5,025	n/a	n/a	862	437	425	413	n/a	n/a	n/a
1961	7,437	n/a	n/a	6,431	n/a	n/a	1,006	538	468	484	n/a	n/a	0.0013
1962	9,120	n/a	n/a	7,983	n/a	n/a	1,137	620	517	577	n/a	n/a	0.0015
1963	11,399	n/a	n/a	10,061	n/a	n/a	1,338	765	573	746	n/a	n/a	0.0018
1964	14,278	n/a	n/a	12,726	n/a	n/a	1,552	n/a	n/a	964	n/a	n/a	0.0021
1965	15,679	n/a	n/a	13,808	n/a	n/a	1,871	n/a	n/a	1,203	n/a	n/a	0.0024
1966	19,123	n/a	n/a	16,800	n/a	n/a	2,323	n/a	n/a	1,503	n/a	n/a	0.0029
1967	23,284	n/a	n/a	20,600	13,883	6,717	2,684	n/a	n/a	1,825	n/a	n/a	0.0032
1968	28,331	n/a	n/a	25,282	17,475	7,807	3,049	n/a	n/a	2,261	n/a	n/a	0.0036
1969	34,288	n/a	n/a	30,610	22,021	8,589	3,678	n/a	n/a	2,990	2,321	669	0.0041
1970	40,691	n/a	n/a	36,774	27,017	9,757	3,917	n/a	n/a	3,711	2,894	817	0.0046
1971	45,318	n/a	n/a	40,627	30,257	10,370	4,691	n/a	n/a	4,386	3,417	969	0.0052
1972	48,476	36,443	12,033	43,475	32,834	10,641	5,001	3,609	1,392	5,156	4,034	1,122	0.0058
1973	47,477	36,001	11,476	42,243	32,090	10,153	5,234	3,911	1,323	5,625	4,397	1,228	0.0060
1974	45,472	34,589	10,883	39,902	30,541	9,361	5,570	4,048	1,522	6,002	4,756	1,246	0.0063
1975	45,481	34,940	10,541	39,713	30,748	8,965	5,768	4,192	1,576	5,624	4,430	1,194	0.0060
1976	44,124	34,183	9,941	38,062	29,691	8,371	6,062	4,492	1,570	5,188	4,081	1,107	0.0056
1977	41,625	32,328	9,297	35,681	27,881	7,800	5,944	4,447	1,497	4,844	3,816	1,028	0.0052
1978	39,215	30,275	8,940	32,487	25,285	7,202	6,728	4,990	1,738	4,300	3,353	947	0.0046
1979	36,366	28,022	8,344	29,830	23,142	6,688	6,536	4,880	1,656	3,998	3,018	980	0.0043
1980	34,108	26,294	7,814	27,765	21,525	6,240	6,343	4,769	1,574	3,606	2,773	833	0.0038
1981	32,637	25,084	7,553	26,315	20,434	5,881	6,322	4,650	1,672	3,342	2,465	877	0.0035
1982	n/a	n/a	n/a	n/a	n/a	n/a	6,118	4,442	1,676	3,077	2,281	796	0.0032
1983	n/a	n/a	n/a	n/a	n/a	n/a	5,948	4,293	1,655	n/a	n/a	n/a	0.0029 (est.)
1984	n/a	n/a	n/a	n/a	n/a	n/a	5,693	4,110	1,583	n/a	n/a	n/a	n/a

[a] Estimated by the formula $U_i=(A_{i+2}/B_{i+2})C_i$, where U_i = anthropology undergraduate enrollment in year i; A_{i+2} = anthropology 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 professional). Public and private estimates were based on enrollment ratios. See Appendix Table C9 for supporting data.

[b] Figures for 1960-77 were obtained from the U.S. Department of Education (1959-79). Figures for 1978-84 were obtained from the National Science Foundation (1973-85a) except for the 1979 figure, which was interpolated. Due to differences in taxonomy, NSF numbers for 1978-84 may be slightly higher than numbers that would have been obtained from the Department of Education had data been collected for those years. For the year 1977, NSF reported 6,622 graduate students enrolled in anthropology (with an additional 1,239 enrolled in sociology/anthropology); in comparison, the Department of Education reported a somewhat lower figure of 5,944 (as shown in this table). Graduate enrollments in the interdisciplinary field of sociology/anthropology are not included in this table, but are presented in Appendix Table C7.

[c] Figures for 1960-68 were obtained from the U.S. Department of Education (1948-81), those for 1969-82 from the U.S. Department of Education (1948-84).

[d] See Appendix Table C9 for total B.A.s.

APPENDIX TABLE C7 Graduate Enrollment in Sociology/Anthropology (Interdisciplinary), by Control of Institution, 1978-84[a]

Fiscal Year	Total	Public	Private
1978	1,398	864	534
1979	1,317	794	523
1980	1,236	723	513
1981	1,206	722	484
1982	1,110	634	476
1983	1,133	638	495
1984	1,182	610	572

[a]From the National Science Foundation (1973-85a). The figures for 1979 were interpolated. The NSF taxonomy includes the interdisciplinary field of sociology/anthropology as well as the separate fields of sociology and anthropology. Sociology/anthropology is included in the total graduate enrollment data presented in Appendix Table C1. It is not included in Appendix Tables C5 and C6 which present graduate enrollments in sociology and anthropology.

APPENDIX TABLE C8 Speech Pathology/Audiology Enrollments in Colleges and Universities, B.A. Degrees Awarded in Speech Pathology/Audiology, and Ratio of Speech Pathology/Audiology B.A.s to Total B.A.s, by Control of Institution, 1971-84

Fiscal Year	Enrollments: Total Undergraduate and Graduate Enrollment			Estimated Undergraduate Enrollment[a]			Graduate[b]			B.A. Degrees Awarded[c]			Ratio of Speech Path./Audiol. B.A.s to Total B.A.s[d]
	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total
1971	n/a	n/a	n/a	18,591	13,846	4,745	n/a	n/a	n/a	1,427	1,070	357	0.0017
1972	26,566	20,251	6,315	23,744	17,933	5,811	2,822	2,318	504	1,863	1,489	374	0.0021
1973	31,415	23,888	7,527	28,032	21,294	6,738	3,383	2,594	789	2,574	2,117	457	0.0028
1974	34,939	26,854	8,085	30,188	23,106	7,082	4,751	3,748	1,003	3,278	2,713	565	0.0034
1975	38,025	29,298	8,727	31,678	24,527	7,151	6,347	4,771	1,576	3,732	3,172	560	0.0040
1976	38,692	30,407	8,285	31,432	24,519	6,913	7,260	5,888	1,372	3,925	3,360	565	0.0042
1977	39,027	30,751	8,276	31,719	24,785	6,934	7,308	5,966	1,342	3,864	3,295	569	0.0042
1978	40,480	32,068	8,412	32,217	25,075	7,142	8,162	7,005	1,157	3,551	2,842	709	0.0038
1979	39,081	30,851	8,230	30,750	23,856	6,894	8,229	7,008	1,221	3,554	2,967	587	0.0038
1980	39,493	31,104	8,389	31,095	24,107	6,988	8,296	7,010	1,286	3,576	2,954	622	0.0038
1981	41,401	32,627	8,774	32,666	25,365	7,301	8,615	7,266	1,349	3,445	2,906	539	0.0036
1982	n/a	n/a	n/a	n/a	n/a	n/a	8,596	7,299	1,297	3,446	2,963	483	0.0036
1983	n/a	n/a	n/a	n/a	n/a	n/a	8,683	7,474	1,209	n/a	n/a	n/a	0.0036 (est.)
1984	n/a	n/a	n/a	n/a	n/a	n/a	8,851	7,582	1,269	n/a	n/a	n/a	n/a

[a]Estimated by the formula $U_i=(A_{i+2}/B_{i+2})C_i$, where U_i = speech pathology/audiology undergraduate enrollment in year i; A_{i+2} = speech pathology/audiology 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 professional). Public and private estimates were based on enrollment ratios. See Appendix Table C9 for supporting data.

[b]Figures for 1971-77 were obtained from the U.S. Department of Education (1959-79). Figures for 1978-84 were obtained from the National Science Foundation (1973-85a) except for the 1979 figure, which was interpolated. Due to differences in taxonomy, NSF numbers for 1978-84 may be slightly higher than numbers that would have been obtained from the Department of Education had data been collected for those years. For the year 1977, NSF reported 7,725 graduate students enrolled in speech pathology/audiology; in comparison, the Department of Education reported a somewhat lower figure of 7,308 (as shown in this table).

[c]Figures for 1971-83 were obtained from the U.S. Department of Education (1948-83).

[d]See Appendix Table C9 for total B.A.s.

APPENDIX TABLE C9 Total Undergraduate Degree-Credit Enrollment, Total B.A. Degrees, and B.A. Degrees Awarded in the Behavioral Sciences, by Control of Institution, 1960-83

Fiscal Year	Total Undergraduate Degree-Credit Enrollment (thousands): Including First Professional[a]			Excluding First Professional[b]			Total B.A. Degrees Awarded (excluding first professional)[c]			B.A. Degrees Awarded in Behavioral Sciences[c]		
	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total	Public	Private
1960	3,402	n/a	n/a	3,334	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1961	3,610	n/a	n/a	3,538	n/a	n/a	365,337	n/a	n/a	16,527	n/a	n/a
1962	3,891	n/a	n/a	3,813	n/a	n/a	382,822	n/a	n/a	18,398	n/a	n/a
1963	4,207	n/a	n/a	4,123	n/a	n/a	410,421	n/a	n/a	20,862	n/a	n/a
1964	4,529	n/a	n/a	4,438	n/a	n/a	460,467	n/a	n/a	25,372	n/a	n/a
1965	4,342	2,802	1,541	4,255	n/a	n/a	492,984	n/a	n/a	28,820	n/a	n/a
1966	4,829	3,184	1,645	4,732	n/a	n/a	524,117	n/a	n/a	33,728	n/a	n/a
1967	5,160	3,451	1,709	5,057	3,408	1,649	562,369	n/a	n/a	39,072	n/a	n/a
1968	5,557	3,810	1,747	5,437	3,758	1,679	636,863	n/a	n/a	48,295	n/a	n/a
1969	6,043	4,308	1,735	5,905	4,248	1,657	734,002	466,133	267,869	59,040	33,534	25,506
1970	6,529	4,749	1,780	6,377	4,685	1,692	798,070	523,442	274,628	68,413	40,533	27,880
1971	6,889	5,076	1,813	6,719	5,004	1,715	846,110	562,345	283,765	77,629	47,175	30,454
1972	7,104	5,302	1,802	6,913	5,221	1,692	894,110	604,471	289,639	86,066	53,618	32,448
1973	7,199	5,401	1,799	6,998	5,316	1,682	930,272	636,378	293,894	92,289	58,704	33,585
1974	7,396	5,589	1,807	7,187	5,501	1,686	954,376	657,455	296,921	97,432	63,863	33,569
1975	7,833	5,986	1,847	7,610	5,892	1,718	931,663	640,524	291,139	92,609	61,143	31,466
1976	8,468	6,520	1,948	8,234	6,423	1,811	934,443	640,799	293,644	87,446	58,609	28,837
1977	8,559	6,595	1,964	8,312	6,495	1,817	928,228	635,909	292,319	81,491	54,685	26,806
1978	8,722	6,696	2,026	8,471	6,593	1,878	930,201	633,183	297,018	75,899	50,217	25,682
1979	8,709	6,662	2,047	8,452	6,557	1,895	931,340	627,084	304,256	71,109	46,485	24,624
1980	8,962	6,850	2,112	8,699	6,744	1,955	940,251	629,338	310,913	68,859	44,475	24,384
1981	9,354	7,162	2,192	9,074	7,046	2,028	946,877	632,168	314,709	65,733	42,334	23,399
1982	9,341	7,132	2,209	9,066	7,020	2,046	964,043	641,751	322,292	64,386	41,576	22,810
1983	9,398	7,184	2,214	9,120	7,071	2,049	n/a	n/a	n/a	n/a	n/a	n/a

[a]Figures for 1960-64 were obtained from the U.S. Department of Education (1961-84a), those for 1965-75 from the U.S. Department of Education (1973-82), and the one for 1976 from the U.S. Department of Education (1974-83). Figures for 1977-81 were obtained by subtracting enrollment for master's and doctor's degrees from total degree-credit enrollment (U.S. Department of Education, 1974-83). Figures for 1982-83 were obtained by adding first professional enrollment to total undergraduate degree-credit enrollment excluding first professional. First professional enrollment data were obtained from the U.S. Department of Education (1961-84b). See footnote b/ for source of undergraduate degree-credit enrollment for 1982-83.

[b]Figures for 1960-66 were estimated at 98% of total undergraduate degree-credit enrollment (including first professional). Those for 1967-81 were obtained by subtracting first professional enrollment from total degree-credit undergraduate enrollment (including first professional). First professional enrollment data for 1967-77 were obtained from the U.S. Department of Education (1959-79), data for 1978-81 from the U.S. Department of Education (1961-84a). Figures for 1982-83 were derived from total undergraduate enrollment (including nondegree-credit) data obtained from the U.S. Department of Education (1961-84b). These data have been adjusted with the percentages used by the U.S. Department of Education to estimate degree-credit enrollments for 1977-80.

[c]Figures for 1961-68 were obtained from the U.S. Department of Education (1948-81), those for 1969-82 from the U.S. Department of Education (1948-84). Behavioral science B.A.s include psychology, sociology, anthropology, and speech pathology/audiology. Figures are higher than those presented in the 1983 Report because speech pathology/audiology is now included in the taxonomy.

APPENDIX TABLE C10 Behavioral Science Ph.D. Degrees Awarded in Colleges and Universities, by Control of Institution, 1961-84[a]

Fiscal Year	Total Behavioral Sciences			Total Psychology (Clinical & Nonclinical)			Clinical Psychology[b]			Nonclinical Psychology		
	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total	Public	Private
1961	1,042	n/a	n/a	820	n/a	n/a	381	n/a	n/a	439	n/a	n/a
1962	1,121	n/a	n/a	856	n/a	n/a	362	n/a	n/a	494	n/a	n/a
1963	1,184	n/a	n/a	890	n/a	n/a	367	n/a	n/a	523	n/a	n/a
1964	1,297	n/a	n/a	1,013	n/a	n/a	469	n/a	n/a	544	n/a	n/a
1965	1,275	n/a	n/a	954	n/a	n/a	398	n/a	n/a	556	n/a	n/a
1966	1,496	n/a	n/a	1,139	n/a	n/a	439	n/a	n/a	700	n/a	n/a
1967	1,773	n/a	n/a	1,295	n/a	n/a	529	n/a	n/a	766	n/a	n/a
1968	1,970	n/a	n/a	1,464	n/a	n/a	613	n/a	n/a	851	n/a	n/a
1969	2,408	n/a	n/a	1,756	n/a	n/a	666	n/a	n/a	1,090	n/a	n/a
1970	2,726	n/a	n/a	1,888	n/a	n/a	707	n/a	n/a	1,181	n/a	n/a
1971	3,148	n/a	n/a	2,130	n/a	n/a	839	n/a	n/a	1,291	n/a	n/a
1972	3,310	2,121	1,189	2,280	1,490	790	919	633	286	1,361	857	504
1973	3,542	2,245	1,297	2,458	1,541	917	1,055	673	382	1,403	868	535
1974	3,750	2,358	1,392	2,598	1,626	972	1,061	653	408	1,537	973	564
1975	3,938	2,552	1,386	2,751	1,783	968	1,144	771	373	1,607	1,012	595
1976	4,190	2,673	1,517	2,883	1,807	1,076	1,293	805	488	1,590	1,002	588
1977	4,246	2,685	1,561	2,990	1,864	1,126	1,353	858	495	1,637	1,006	631
1978	4,207	2,632	1,575	3,055	1,853	1,202	1,464	880	584	1,591	973	618
1979	4,245	2,698	1,547	3,091	1,918	1,173	1,509	923	586	1,582	995	587
1980	4,192	2,517	1,675	3,098	1,787	1,311	1,581	896	685	1,517	891	626
1981	4,472	2,727	1,745	3,358	1,965	1,393	1,743	962	781	1,615	1,003	612
1982	4,188	2,541	1,647	3,158	1,830	1,328	1,681	957	724	1,477	873	604
1983	4,318	2,626	1,692	3,307	1,951	1,356	1,762	981	781	1,545	970	575
1984	4,177	n/a	n/a	3,223	n/a	n/a	1,715	n/a	n/a	1,508	n/a	n/a

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APPENDIX TABLE C10 (Continued)

Fiscal Year	Total Other Behavioral Sci. (Socio., Anthro., Spch./Audio.)			Sociology			Anthropology			Speech Pathology/Audiology		
	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total	Public	Private
1961	222	n/a	n/a	167	n/a	n/a	55	n/a	n/a	n/a	n/a	n/a
1962	265	n/a	n/a	184	n/a	n/a	81	n/a	n/a	n/a	n/a	n/a
1963	293	n/a	n/a	211	n/a	n/a	82	n/a	n/a	n/a	n/a	n/a
1964	284	n/a	n/a	201	n/a	n/a	83	n/a	n/a	n/a	n/a	n/a
1965	321	n/a	n/a	239	n/a	n/a	82	n/a	n/a	n/a	n/a	n/a
1966	357	n/a	n/a	260	n/a	n/a	97	n/a	n/a	n/a	n/a	n/a
1967	478	n/a	n/a	331	n/a	n/a	147	n/a	n/a	n/a	n/a	n/a
1968	506	n/a	n/a	369	n/a	n/a	137	n/a	n/a	n/a	n/a	n/a
1969	652	n/a	n/a	408	n/a	n/a	180	n/a	n/a	64	n/a	n/a
1970	838	n/a	n/a	505	n/a	n/a	217	n/a	n/a	116	n/a	n/a
1971	1,018	n/a	n/a	586	n/a	n/a	239	n/a	n/a	193	n/a	n/a
1972	1,030	631	399	639	374	265	260	155	105	131	102	29
1973	1,084	704	380	599	369	230	326	211	115	159	124	35
1974	1,152	732	420	645	390	255	379	238	141	128	104	24
1975	1,187	769	418	680	418	262	386	260	126	121	91	30
1976	1,307	866	441	734	459	275	428	283	145	145	124	21
1977	1,256	821	435	725	452	273	385	254	131	146	115	31
1978	1,152	779	373	610	399	211	399	270	129	143	110	33
1979	1,154	780	374	632	407	225	383	258	125	139	115	24
1980	1,094	730	364	601	382	219	370	255	115	123	93	30
1981	1,114	762	352	605	407	198	369	238	131	140	117	23
1982	1,030	711	319	568	372	196	333	230	103	129	109	20
1983	1,011	675	336	525	338	187	373	246	127	113	91	22
1984	954	n/a	n/a	515	n/a	n/a	335	n/a	n/a	104	n/a	n/a

a/From the National Research Council (1958-85). Foreign nationals who received doctorates from U.S. institutions are included.

b/Includes clinical and school psychology, counseling, and guidance.

APPENDIX TABLE C11 Behavioral Science Postdoctoral Appointments, 1962-83[a/]

Fiscal Year	All Behavioral Fields Total	Academic[b/] Total	Public	Private	Nonacademic	Clinical Psychology Total	Academic[b/] Total	Public	Private	Nonacademic
1962	137	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1963	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1964	209	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1965	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1966	251	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1967	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1968	331	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1969	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1970	415	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1971	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1972	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1973	482	320	195	125	162	125	46	28	18	79
1974	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1975	705	556	355	201	149	156	79	57	22	77
1976	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1977	997	736	416	320	261	357	186	96	90	171
1978	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1979	1,111	795	380	415	316	302	182	59	123	120
1980	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1981	972	705	395	310	267	262	160	99	61	102
1982	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1983	1,039	652	493	159	387	466	179	142	37	287

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APPENDIX TABLE C11 (Continued)

Fiscal Year	Nonclinical Psychology					Other Behavioral Sciences				
		Academic[b]					Academic[b]			
	Total	Total	Public	Private	Nonacademic	Total	Total	Public	Private	Nonacademic
1962	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1963	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1964	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1965	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1966	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1967	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1968	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1969	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1970	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1971	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1972	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1973	259	197	127	70	62	98	77	40	37	21
1974	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1975	398	368	258	110	30	151	109	40	69	42
1976	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1977	394	344	218	126	50	246	206	102	104	40
1978	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1979	527	359	173	186	168	282	254	148	106	28
1980	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1981	511	379	174	205	132	199	166	122	44	33
1982	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1983	302	249	173	76	53	271	224	178	46	47

[a] Clinical psychology includes clinical and school psychology, counseling, and guidance. All other psychology fields are considered nonclinical. Other behavioral sciences include anthropology, sociology, and speech pathology/audiology. Figures for 1962-70 were estimated by the committee. Figures for 1973-83 are based on the most recent data available from the National Research Council (1973-84). Foreign nationals who received doctorates from U.S. institutions are included.

[b] Public and private figures were adjusted by the committee to include a small number of individuals for whom control of institution could not be determined.

APPENDIX TABLE C12 Ph.D.s Employed in All Behavioral Science Fields, 1962-83[a]

Fiscal Year	Total Labor Force	Academia (excluding postdocs.)[b] Total	Public	Private	Postdoc. Appts.	Business	Gov't.[c]	Hospitals/ Clinics	Non-Profit	Self-Employed	Other	Unemployed and Seeking
1962	11,240	5,339	n/a	n/a	137	n/a	n/a	n/a	n/a	n/a	5,730	34
1963	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1964	13,606	8,143	n/a	n/a	209	n/a	n/a	n/a	n/a	n/a	5,227	27
1965	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1966	15,746	9,783	n/a	n/a	251	n/a	n/a	n/a	n/a	n/a	5,681	31
1967	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1968	19,953	12,915	n/a	n/a	331	n/a	n/a	n/a	n/a	n/a	6,667	40
1969	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1970	24,253	16,175	n/a	n/a	415	n/a	n/a	n/a	n/a	n/a	7,566	97
1971	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1972	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1973	31,699	19,928	13,807	6,121	482	1,142	2,845	2,698	1,246	1,895	1,075	388
1974	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1975	38,737	23,624	16,091	7,533	705	1,404	2,632	4,936	1,161	2,748	1,138	389
1976	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1977	44,283	25,582	17,726	7,856	997	1,793	2,931	5,595	1,487	3,725	1,419	754
1978	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1979	49,322	26,896	18,275	8,621	1,111	1,901	3,288	6,157	2,164	5,209	1,847	749
1980	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1981	53,815	28,235	19,023	9,212	972	2,764	3,351	6,481	2,120	7,352	1,808	732
1982	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1983	58,811	29,776	19,890	9,886	1,039	3,390	3,559	6,584	1,865	9,707	1,978	913

a/Behavioral sciences include anthropology, sociology, psychology, and speech pathology/audiology. Figures for 1962-70 were estimated by the committee. Figures for 1973-81 are based on the most recent data available from the National Research Council (1973-84). Foreign nationals who received doctorates from U.S. institutions are included.

b/Public and private figures were adjusted by the committee to include a small number of academically employed individuals for whom control of institution could not be determined.

c/Includes FFRDC laboratories for 1973-83. For other years, FFRDC laboratories may be included in any category.

APPENDIX TABLE C13 Ph.D.s Employed in Clinical Psychology, 1973-83[a]

Fiscal Year	Total Labor Force	Academia (excluding postdocs.)[b]			Postdoc. Appts.	Business	Gov't.[c]	Hospitals/ Clinics	Non-Profit	Self-Employed	Other	Unemployed and Seeking
		Total	Public	Private								
1973	11,574	4,341	3,266	1,075	125	101	1,641	2,417	497	1,520	821	111
1974	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1975	14,846	5,140	3,731	1,409	156	165	1,252	4,425	363	2,292	995	58
1976	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1977	17,578	5,438	4,117	1,321	357	409	1,216	5,102	662	3,201	1,111	82
1978	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1979	21,268	5,790	3,972	1,818	302	417	1,671	5,702	1,093	4,785	1,372	136
1980	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1981	23,775	6,172	4,346	1,826	262	880	1,653	5,937	1,032	6,264	1,367	208
1982	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1983	26,285	6,370	4,316	2,054	466	1,004	1,854	5,737	1,165	7,999	1,529	161

a/Clinical psychology includes clinical and school psychology, counseling, and guidance. Figures are based on the most recent data available from the National Research Council (1973-84). Foreign nationals who received doctorates from U.S. institutions are included.

b/Public and private figures were adjusted by the committee to include a small number of academically employed individuals for whom control of institution could not be determined.

c/Includes FFRDC laboratories.

APPENDIX TABLE C14 Ph.D.s Employed in Nonclinical Psychology, 1973-83[a]

Fiscal Year	Total Labor Force	Academia (excluding postdocs.)[b]			Postdoc. Appts.	Business	Gov't.[c]	Hospitals/ Clinics	Non-Profit	Self-Employed	Other	Unemployed and Seeking
		Total	Public	Private								
1973	13,340	9,452	6,429	3,023	259	999	1,083	269	562	323	212	181
1974	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1975	15,387	10,863	7,204	3,659	398	1,218	1,170	470	560	401	129	178
1976	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1977	16,102	10,905	7,287	3,618	394	1,344	1,404	447	519	443	255	391
1978	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1979	16,688	11,538	7,551	3,987	527	1,355	1,164	401	574	321	434	374
1980	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1981	18,791	12,586	8,239	4,347	511	1,827	1,235	507	631	905	295	294
1982	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1983	19,431	12,404	8,008	4,396	302	2,258	1,320	629	451	1,328	333	406

[a]Nonclinical psychology includes all psychology fields except clinical and school psychology, counseling, and guidance. Figures are based on the most recent data available from the National Research Council (1973-84). Foreign nationals who received doctorates from U.S. institutions are included.

[b]Public and private figures were adjusted by the committee to include a small number of academically employed individuals for whom control of institution could not be determined.

[c]Includes FFRDC laboratories.

APPENDIX TABLE C15 Ph.D.s Employed in Other Behavioral Sciences, 1973-83[a]

Fiscal Year	Total Labor Force	Academia (excluding postdocs.)[b]			Postdoc. Appts.	Business	Gov't.[c]	Hospitals/ Clinics	Non-Profit	Self-Employed	Other	Unemployed and Seeking
		Total	Public	Private								
1973	6,785	6,135	4,112	2,023	98	42	121	12	187	52	42	96
1974	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1975	8,504	7,621	5,156	2,465	151	21	210	41	238	55	14	153
1976	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1977	10,603	9,239	6,322	2,917	246	40	311	46	306	81	53	281
1978	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1979	11,366	9,568	6,752	2,816	282	129	453	54	497	103	41	239
1980	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1981	11,249	9,477	6,438	3,039	199	57	463	37	457	183	146	230
1982	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1983	13,095	11,002	7,566	3,436	271	128	385	218	249	380	116	346

[a]Other behavioral sciences include sociology, anthropology, and speech pathology/audiology. Figures are based on the most recent data available from the National Research Council (1973-84). Foreign nationals who received doctorates from U.S. institutions are included.

[b]Public and private figures were adjusted by the committee to include a small number of academically employed individuals for whom control of institution could not be determined.

[c]Includes FFRDC laboratories.

APPENDIX TABLE C16 Behavioral Sciences Faculty/Student Ratios, 1962-81[a]

	All Behavioral Sciences			Psychology (Clinical and Nonclinical)			Other Behavioral Sciences (Sociology, Anthropology, Speech Pathology/Audiology)		
Fiscal Year	Faculty (F)	4-Yr. Weighted Avg. Enrollment (WS)	Ph.D. Faculty/ Student Ratio (F/WS)	Faculty (F)	4-Yr. Weighted Avg. Enrollment (WS)	Ph.D. Faculty/ Student Ratio (F/WS)	Faculty (F)	4-Yr. Weighted Avg. Enrollment (WS)	Ph.D. Faculty/ Student Ratio (F/WS)
1962	5,339	192,205[b]	0.0278[b]	n/a	n/a	n/a	n/a	n/a	n/a
1963	n/a	211,860	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1964	8,143	244,233	0.0333	n/a	n/a	n/a	n/a	n/a	n/a
1965	n/a	277,679	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1966	9,783	313,740	0.0312	n/a	n/a	n/a	n/a	n/a	n/a
1967	n/a	355,859	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1968	12,915	406,997	0.0317	n/a	n/a	n/a	n/a	n/a	n/a
1969	n/a	467,380	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1970	16,175	532,072	0.0304	n/a	n/a	n/a	n/a	n/a	n/a
1971	n/a	601,440	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1972	n/a	667,374	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1973	19,928	715,941	0.0278	13,793	383,970	0.0359	6,135	325,774	0.0188
1974	n/a	736,628	n/a	n/a	405,407	n/a	n/a	328,122	n/a
1975	23,624	735,024	0.0321	16,003	416,229	0.0384	7,621	318,795	0.0239
1976	n/a	728,374	n/a	n/a	422,571	n/a	n/a	305,803	n/a
1977	25,582	720,993	0.0355	16,343	425,843	0.0384	9,239	295,150	0.0313
1978	n/a	709,212	n/a	n/a	425,509	n/a	n/a	283,703	n/a
1979	26,896	689,264	0.0390	17,328	420,723	0.0412	9,568	268,541	0.0356
1980	n/a	667,851	n/a	n/a	415,664	n/a	n/a	252,187	n/a
1981	28,235	653,696	0.0432	18,758	415,667	0.0451	9,477	238,029	0.0398

[a]Faculty is defined as all Ph.D.s academically employed in the behavioral science area (excluding postdoctoral appointments). Students are defined as a 4-year weighted average of enrollments, i.e., $(WS)_t = 1/6(S_t + 2S_{t-1} + 2S_{t-2} + S_{t-3})$, where S = total graduate and undergraduate enrollments in the behavioral science area. See Appendix Tables C1, C4-6, and C8 for supporting data.

[b]Estimated by the committee.

222

APPENDIX TABLE C17 Ph.D.s Academically Employed in the Behavioral Sciences, by Employment Status and Type of Institution, 1973-83[a]

Fiscal Year	Employment Status	All Behavioral Fields			Clinical Psychology			Nonclinical Psychology			Other Behavioral Sci.		
		Type of Institution			Type of Institution			Type of Institution			Type of Institution		
		Total	4-Year	2-Year	Total	4-Year	2-Year	Total	4-Year	2-Year	Total	4-Year	2-Year
1973	Total	19,928	19,361	567	4,341	4,155	186	9,452	9,144	308	6,135	6,062	73
	Full-Time	19,220	18,710	510	4,159	3,977	182	9,164	8,909	255	5,897	5,824	73
	Part-Time	708	651	57	182	178	4	288	235	53	238	238	0
1975	Total	23,624	22,923	701	5,140	4,946	194	10,863	10,528	335	7,621	7,449	172
	Full-Time	22,887	22,255	632	4,965	4,778	187	10,511	10,210	301	7,413	7,269	144
	Part-Time	737	668	69	175	168	7	352	318	34	208	180	28
1977	Total	25,582	24,706	876	5,438	5,272	166	10,905	10,438	467	9,239	8,996	243
	Full-Time	24,736	23,970	766	5,233	5,074	159	10,505	10,124	381	8,998	8,772	226
	Part-Time	846	736	110	205	198	7	400	314	86	241	224	17
1979	Total	26,896	26,003	893	5,790	5,621	169	11,538	11,090	448	9,568	9,292	276
	Full-Time	25,566	24,836	730	5,463	5,318	145	10,966	10,619	347	9,137	8,898	239
	Part-Time	1,330	1,167	163	327	303	24	572	471	101	431	394	37
1981	Total	28,235	27,062	1,173	6,172	5,806	366	12,586	12,062	524	9,477	9,194	283
	Full-Time	27,098	26,065	1,033	5,802	5,464	338	12,181	11,744	437	9,111	8,854	257
	Part-Time	1,137	997	140	370	342	28	405	318	87	366	340	26
1983	Total	29,776	28,487	1,289	6,370	6,151	219	12,404	11,772	632	11,002	10,564	438
	Full-Time	28,091	26,964	1,127	5,903	5,684	219	11,871	11,315	556	10,317	9,964	353
	Part-Time	1,685	1,523	162	467	467	0	533	457	76	685	600	85
Average Annual Growth Rate from 1973-81	Total	4.1	3.9	8.6	3.9	4.0	1.6	2.8	2.6	7.5	6.0	5.7	19.6
	Full-Time	3.9	3.7	8.3	3.6	3.6	1.9	2.6	2.4	8.1	5.8	5.5	17.1
	Part-Time	9.1	8.9	11.0	9.9	10.1	-	6.3	6.9	3.7	11.2	9.7	-

[a]Clinical psychology includes clinical and school psychology, counseling, and guidance. All other psychology fields are considered nonclinical. Other behavioral sciences include anthropology, sociology, and speech pathology/audiology. Figures are based on the most recent data available from the National Research Council (1973-84). Foreign nationals who received doctorates from U.S. institutions are included. Individuals on postdoctoral appointments are excluded.

APPENDIX TABLE C18 Behavioral Science R and D Expenditures in Colleges and Universities, by Control of Institution, 1960-83 ($ millions)

Fiscal Year	Current Dollars[a]			1972 Dollars			Implicit GNP Price Deflator[b] (1972 = 100.0)
	Total	Public	Private	Total	Public	Private	
1960	23.6	n/a	n/a	34.3	n/a	n/a	68.70
1961	27.9	n/a	n/a	40.2	n/a	n/a	69.30
1962	33.0	n/a	n/a	46.8	n/a	n/a	70.50
1963	39.5	n/a	n/a	55.1	n/a	n/a	71.60
1964	46.6	n/a	n/a	64.1	n/a	n/a	72.70
1965	52.4	n/a	n/a	70.5	n/a	n/a	74.30
1966	60.1	n/a	n/a	78.3	n/a	n/a	76.80
1967	77.4	n/a	n/a	98.0	n/a	n/a	79.00
1968	97.9	n/a	n/a	118.5	n/a	n/a	82.60
1969	98.2	n/a	n/a	113.3	n/a	n/a	86.70
1970	103.6	n/a	n/a	113.4	n/a	n/a	91.40
1971	115.9	n/a	n/a	120.7	n/a	n/a	96.00
1972	127.6	84.3	43.4	127.6	84.3	43.4	100.00
1973	135.3	92.6	42.7	127.8	87.5	40.3	105.80
1974	137.7	95.0	42.7	118.7	81.9	36.8	116.00
1975	149.1	103.4	45.7	117.2	81.3	35.9	127.20
1976	144.1	99.6	44.5	107.6	74.4	33.3	133.90
1977	147.1	99.2	47.8	103.8	70.0	33.7	141.70
1978	156.6	107.3	49.3	103.0	70.6	32.4	152.05
1979	174.9	120.5	54.4	105.7	72.8	32.9	165.46
1980	199.7	137.9	61.8	111.9	77.3	34.6	178.42
1981	223.5	155.4	68.2	114.6	79.6	34.9	195.14
1982	211.2	137.3	73.9	102.1	66.4	35.7	206.88
1983	214.0	142.9	71.1	99.3	66.3	33.0	215.63

a/ Figures for even years from 1964-70 and for all years from 1972-83 were obtained from the National Science Foundation (1975-85). The 1978 figures are NSF estimates. Those for other years were estimated by the committee. Items may not sum to totals due to rounding.

b/ From the U.S. Bureau of the Census.

224

APPENDIX TABLE C19 Average Behavioral Science R and D Expenditures per School in Colleges and Universities, by Control of Institution, 1972-83[a]
(1972 $, thousands)

Fiscal Year	Average R and D Expenditures			Number of Schools Reporting[b]		
	Total	Public	Private	Total	Public	Private
1972	216	251	169	591	335	256
1973	216	261	158	591	335	256
1974	199	244	142	596	336	260
1975	219	252	169	536	323	213
1976	201	231	156	535	322	213
1977	194	217	158	536	322	214
1978	183	213	140	562	331	231
1979	187	219	141	565	332	233
1980	199	233	150	563	332	231
1981	203	240	151	563	332	231
1982	181	200	155	563	332	231
1983	177	200	143	562	331	231

[a] See Appendix Table C18 for supporting data.

[b] From the National Science Foundation. For 1978 the number of doctorate-granting institutions was obtained from NSF; the number of master's-granting institutions was estimated by the committee.

APPENDIX TABLE C20 Psychology R and D Expenditures in Colleges and Universities, by Control of Institution, 1960-83

Fiscal Year	Current Dollars (millions)[a]			1972 Dollars (millions)[b]			Average R and D Expenditures per School (1972 $, thousands)[c]		
	Total	Public	Private	Total	Public	Private	Total	Public	Private
1960	16.160	n/a	n/a	23.523	n/a	n/a	n/a	n/a	n/a
1961	19.075	n/a	n/a	27.525	n/a	n/a	n/a	n/a	n/a
1962	22.600	n/a	n/a	32.057	n/a	n/a	n/a	n/a	n/a
1963	27.025	n/a	n/a	37.744	n/a	n/a	n/a	n/a	n/a
1964	31.904	n/a	n/a	43.884	n/a	n/a	n/a	n/a	n/a
1965	35.376	n/a	n/a	47.612	n/a	n/a	n/a	n/a	n/a
1966	40.143	n/a	n/a	52.270	n/a	n/a	n/a	n/a	n/a
1967	48.986	n/a	n/a	62.008	n/a	n/a	n/a	n/a	n/a
1968	59.286	n/a	n/a	71.775	n/a	n/a	n/a	n/a	n/a
1969	59.296	n/a	n/a	68.392	n/a	n/a	n/a	n/a	n/a
1970	59.250	n/a	n/a	64.825	n/a	n/a	n/a	n/a	n/a
1971	64.500	n/a	n/a	67.188	n/a	n/a	n/a	n/a	n/a
1972	69.025	46.015	23.010	69.025	46.015	23.010	117	137	90
1973	73.742	47.503	26.239	69.699	44.899	24.801	118	134	97
1974	74.236	48.920	25.316	63.997	42.172	21.824	107	126	84
1975	80.322	55.416	24.906	63.146	43.566	19.580	118	135	92
1976	77.883	51.871	26.012	58.165	38.739	19.426	109	120	91
1977	85.129	55.011	30.118	60.077	38.822	21.255	112	121	99
1978	89.664	57.453	32.211	58.970	37.786	21.184	105	114	92
1979	100.386	63.839	36.547	60.671	38.583	22.088	107	116	95
1980	111.177	71.981	39.196	62.312	40.344	21.968	111	122	95
1981	128.560	85.548	43.012	65.881	43.839	22.042	117	132	95
1982	131.883	86.119	45.764	63.749	41.628	22.121	113	125	96
1983	137.170	90.712	46.458	63.614	42.068	21.545	113	127	93

[a] Figures for even years from 1964-70 and for all years from 1972-83 were obtained from the National Science Foundation (1975-85). The 1978 figures are NSF estimates. Those for other years were estimated by the committee. Items may not sum to totals due to rounding.

[b] 1972 dollars were obtained by using the Implicit GNP Price Deflator (U.S. Bureau of the Census--see Appendix Table C18). Items may not sum to totals due to rounding.

[c] See Appendix Table C19 for number of schools reporting.

APPENDIX TABLE C21 Sociology R and D Expenditures in Colleges and Universities, by Control of Institution, 1960-83

Fiscal Year	Current Dollars (millions)[a]			1972 Dollars (millions)[b]			Average R and D Expenditures per School (1972 $, thousands)[c]		
	Total	Public	Private	Total	Public	Private	Total	Public	Private
1960	7.429	n/a	n/a	10.814	n/a	n/a	n/a	n/a	n/a
1961	8.775	n/a	n/a	12.662	n/a	n/a	n/a	n/a	n/a
1962	10.396	n/a	n/a	14.746	n/a	n/a	n/a	n/a	n/a
1963	12.432	n/a	n/a	17.363	n/a	n/a	n/a	n/a	n/a
1964	14.664	n/a	n/a	20.171	n/a	n/a	n/a	n/a	n/a
1965	17.025	n/a	n/a	22.914	n/a	n/a	n/a	n/a	n/a
1966	20.000	n/a	n/a	26.042	n/a	n/a	n/a	n/a	n/a
1967	28.431	n/a	n/a	35.989	n/a	n/a	n/a	n/a	n/a
1968	38.587	n/a	n/a	46.715	n/a	n/a	n/a	n/a	n/a
1969	38.938	n/a	n/a	44.911	n/a	n/a	n/a	n/a	n/a
1970	44.383	n/a	n/a	48.559	n/a	n/a	n/a	n/a	n/a
1971	51.375	n/a	n/a	53.516	n/a	n/a	n/a	n/a	n/a
1972	57.983	37.822	20.161	57.983	37.822	20.161	98	113	79
1973	61.514	45.072	16.442	58.142	42.601	15.541	98	127	61
1974	63.447	46.054	17.393	54.696	39.702	14.994	92	118	58
1975	68.749	47.960	20.789	54.048	37.704	16.344	101	117	77
1976	66.239	47.720	18.519	49.469	35.639	13.830	92	111	65
1977	61.922	44.225	17.697	43.699	31.210	12.489	82	97	58
1978	66.900	49.857	17.043	43.999	32.790	11.209	78	99	49
1979	74.464	56.638	17.826	45.004	34.231	10.774	80	103	46
1980	88.548	65.966	22.582	49.629	36.972	12.657	88	111	55
1981	94.986	69.818	25.168	48.676	35.778	12.897	86	108	56
1982	79.335	51.189	28.146	38.348	24.743	13.605	68	75	59
1983	76.869	52.225	24.644	35.649	24.220	11.429	63	73	49

[a] Figures for even years from 1964-70 and for all years from 1972-83 were obtained from the National Science Foundation (1975-85). The 1978 figures are NSF estimates. Those for other years were estimated by the committee. Items may not sum to totals due to rounding.

[b] 1972 dollars were obtained by using the Implicit GNP Price Deflator (U.S. Bureau of the Census--see Appendix Table C18). Items may not sum to totals due to rounding.

[c] See Appendix Table C19 for number of schools reporting.

APPENDIX TABLE C22 Graduate Enrollment in the Behavioral Sciences, by Sex, 1967-84 (percent of field total)[a]

Fiscal Year	All Behav. Sci.		Psychology		Sociology		Anthropology		Socio./Anthro.		Spch.Path./Audio.	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
1967	68.4	31.6	70.2	29.8	66.8	33.2	62.3	37.7				
1968	67.0	33.0	67.6	32.4	67.6	32.4	61.6	38.4				
1969	64.9	35.1	66.2	33.8	64.4	35.6	58.6	41.4				
1970	64.1	35.9	65.6	34.4	63.4	36.6	57.2	42.8				
1971	62.6	37.4	63.5	36.5	62.6	37.4	57.8	42.2				
1972	59.9	40.1	63.4	36.6	61.9	38.1	58.3	41.7			22.6	77.4
1973	58.0	42.0	61.6	38.4	60.4	39.6	56.9	43.1			21.3	78.7
1974	55.8	44.2	60.1	40.0	59.6	40.4	54.0	46.0			20.8	79.2
1975	52.4	47.6	57.4	42.6	58.0	42.0	52.9	47.1			16.8	83.2
1976	50.3	49.7	55.2	44.8	56.4	43.6	52.9	47.1			15.6	84.4
1977	47.8	52.2	52.8	47.2	54.1	45.9	50.0	50.0			13.2	86.8
1978	49.4	50.6	53.1	46.9	54.5	45.5	50.3	49.7	64.4	35.6	23.0	77.0
1979	47.3	52.7	50.9	49.1	53.3	46.7	49.6	50.4	59.3	40.7	19.9	80.1
1980	45.2	54.8	48.8	51.2	52.0	48.0	48.9	51.1	53.6	46.4	16.9	83.1
1981	43.2	56.8	46.8	53.2	49.8	50.2	47.6	52.4	53.7	46.3	15.3	84.7
1982	40.7	59.3	44.0	56.0	48.4	51.6	45.6	54.4	49.0	51.0	13.8	86.2
1983	39.3	60.7	42.3	57.7	46.6	53.4	45.0	55.0	48.8	51.2	14.1	85.9
1984	37.9	62.1	40.6	59.4	47.0	53.0	43.3	56.7	49.3	50.7	13.5	86.5

[a]Percents for 1967-77 are based on figures from the U.S. Department of Education (1959-79). Those for 1978-84 are based on figures from the National Science Foundation (1973-85a). See Appendix Tables C1 and C4-8 for supporting data.

[b]This interdisciplinary field is reported separately from sociology and anthropology by the National Science Foundation.

APPENDIX TABLE C23 Graduate School Attrition Rates in the Behavioral Sciences, 1960-71

Fiscal Year of Graduate School Entry	First-Year Graduate Enrollment in the Behavl. Sci.[a]	Number of FY1958-84 Behavioral Sci. Ph.D.s Entering Grad. School[b]	Ph.D. Completion Rate (%)[c]	Graduate School Attrition Rate (%)[c]
1960	6,188	1,766	28.5	71.5
1961	7,732	2,017	26.1	73.9
1962	8,038	2,147	26.7	73.3
1963	8,739	2,393	27.4	72.6
1964	9,288	2,853	30.7	69.3
1965	11,832	3,275	27.7	72.3
1966	13,659	3,692	27.0	73.0
1967	13,659	3,907	28.6	71.4
1968	15,966	3,840	24.1	
1969	16,831	3,849	22.9	
1970	19,501	4,297	22.0	
1971	22,709	4,398	19.4	
Pre-1960		13,416		
Post-1971		23,363		

[a] From the U.S. Department of Education (1959-79).
[b] From the National Research Council (1958-85).
[c] The Ph.D. completion rate represents the percentage of first-year graduate students in a given year who earned a Ph.D. between 1958 and 1984 (column 2/column 1). The attrition rate is obtained by subtracting the Ph.D. completion rate for a given year from 100.0%. The rates for 1960-67 show little variation, indicating that most individuals entering graduate school during that period had either received a Ph.D. or dropped out of graduate school by 1984. For 1968-71, however, the Ph.D. completion rates decline with each year. The attrition rates for these years undoubtedly include students who are still enrolled in graduate school but who had not earned a Ph.D. by 1984, as well as those who had actually dropped out of graduate school. The Ph.D. completion rates will most likely increase and the attrition rates decrease once 1985 Ph.D.s are added to the calculations, and should continue to do so with the inclusion of each additional year of Ph.D.s. For this reason, we have not calculated the attrition rates after 1967.

APPENDIX TABLE C24 Actual and Projected Age Distribution of Academically Employed Behavorial Science Ph.D.s[a]

Age	Actual Age Distribution 1977 #	1977 %	2-Yr. Attrition Rate (1977-79)	1979 #	1979 %	2-Yr. Attrition Rate (1979-81)	1981 #	1981 %	2-Yr. Attrition Rate (1981-83)	1983 #	1983 %	Expected 2-Yr. Attrition Rate (1983-85)	Projected Age Distribution 1985 #	1985 %	1987 #	1987 %	1989 #	1989 %	1991 #	1991 %
TOTAL	25,582	100.0		26,896	100.0		28,235			29,776			31,000	100.0	32,000	100.0	32,500	100.0	33,000	100.0
45 and under	16,537	64.6	-	17,085	63.5	-	17,649	62.5	-	17,704	59.5	-	18,300	59.0	18,680	58.3	18,640	57.4	18,680	56.6
46-47	1,201	4.7	4.8	1,308	4.9	6.0	1,359	4.8	-	1,624	5.5	3.0	1,550	5.0	1,600	5.0	1,630	5.0	1,650	5.0
48-49	1,364	5.3	2.0	1,143	4.2	10.0	1,230	4.4	-	1,440	4.8	3.0	1,570	5.1	1,500	4.7	1,550	4.8	1,580	4.8
50-51	1,309	5.1	-	1,337	5.0	4.5	1,027	3.6	-	1,248	4.2	3.0	1,400	4.5	1,520	4.8	1,460	4.5	1,500	4.5
52-53	1,104	4.3	7.7	1,346	5.0	2.0	1,275	4.5	-	1,151	3.9	3.0	1,210	3.9	1,360	4.3	1,470	4.5	1,420	4.3
54-55	855	3.3	7.5	1,073	4.0	-	1,320	4.7	1.0	1,464	4.9	3.0	1,120	3.6	1,170	3.7	1,320	4.1	1,430	4.3
56-57	984	3.8	9.2	791	2.9	-	1,216	4.3	1.8	1,307	4.4	3.0	1,420	4.6	1,090	3.4	1,130	3.5	1,280	3.9
58-59	603	2.4	13.3	894	3.3	5.3	795	2.8	-	1,195	4.0	4.0	1,270	4.1	1,380	4.3	1,060	3.3	1,100	3.3
60-61	551	2.2	11.4	523	1.9	13.3	846	3.0	11.8	812	2.7	12.0	1,150	3.7	1,220	3.8	1,320	4.1	1,020	3.1
62-63	392	1.5	14.3	489	1.8	5.4	464	1.6	10.0	746	2.5	10.0	710	2.3	1,010	3.2	1,070	3.3	1,160	3.5
64-65	341	1.3	11.5	332	1.2	48.0	463	1.6	37.3	420	1.4	30.0	670	2.2	640	2.0	910	2.8	960	2.9
66-67	159	0.6	49.5	301	1.1	25.0	239	0.8	75.9	291	1.0	30.0	290	0.9	470	1.5	450	1.4	640	1.9
68-69	86	0.3	-	80	0.3	-	226	0.8	19.0	177	0.6	20.0	200	0.6	200	0.6	330	1.0	320	1.0
70+	70	0.3	-	186	0.7	-	126	0.4	-	183	0.6	-	140	0.4	160	0.5	160	0.5	260	0.8
Unknown	26	0.1	-	8	-	-	0	-	-	14	-	-								

[a] The data for 1977-83 were obtained from the National Research Council (1973-84). Projections were computed by the committee.

APPENDIX D
Miscellaneous Data

APPENDIX TABLE D1 Estimates of the Total Population of the United States, by Age Group, 1971-2081[a]

Fiscal Year	Age Group 15-19 Years	20-24 Years	25-29 Years
1971	19,333	17,202	13,736
1972	19,789	18,159	14,041
1973	20,296	18,153	15,240
1974	20,719	18,521	15,786
1975	21,042	18,975	16,521
1976	21,285	19,527	17,280
1977	21,534	19,986	18,274
1978	21,540	20,499	18,277
1979	21,496	20,946	18,683
1980	21,402	21,297	19,178
1981	21,123	21,605	19,763
1982	20,433	21,938	20,173
1983	19,845	21,935	20,769
(Projected - Middle Series)			
1984	19,180	21,871	21,170
1985	18,658	21,706	21,527
1986	18,416	21,301	21,838
1987	18,419	20,600	22,166
1988	18,192	19,999	22,151
1989	17,934	19,338	22,088
1990	17,465	18,820	21,925
1991	16,968	18,580	21,522
1996	16,968	17,142	18,822
2001	18,943	17,145	17,396
2006	19,689	19,113	17,403
2011	19,114	19,857	19,362
2016	18,133	19,285	20,102
2021	17,958	18,308	19,533
2026	18,481	18,135	18,562
2031	18,948	18,654	18,389
2036	18,863	19,120	18,906
2041	18,465	19,035	19,370
2046	18,205	18,640	19,286
2051	18,251	18,381	18,892
2056	18,393	18,426	18,635
2061	18,377	18,568	18,681
2066	18,177	18,552	18,822
2071	17,985	18,353	18,806
2076	17,926	18,162	18,608
2081	17,940	18,103	18,418

[a]From the U.S. Bureau of the Census (1965-84). Includes armed forces overseas.

APPENDIX TABLE D2 NIH/ADAMHA/HRSA Expenditures for Research Training Programs, 1971-83 ($ millions)

	Total NIH/ADAMHA/HRSA						NIH[a]					ADAMHA[b]					HRSA, Division of Nursing[c]				
	Total Amount		Fellowships		Training Grants		Total Amount	Fellowships		Training Grants		Total Amount	Fellowships		Training Grants		Total Amount	Fellowships		Training Grants	
Fiscal Year	Constant 1972 $[d]	Current $	#	Amt.	#	Amt.	Current $	#	Amt.	#	Amt.	Current $	#	Amt.	#	Amt.	Current $	#	Amt.	#	Amt.
1971	178.6	171.5	-	-	-	-	152.9	2,718	23.8	2,111	129.1	16.7	n/a	n/a	n/a	n/a	1.9	183	0.9	9	1.0
1972	178.1	178.1	-	-	-	-	157.6	2,264	21.5	2,024	136.1	19.2	n/a	n/a	n/a	n/a	1.3	146	0.6	9	0.7
1973	120.2	127.2	-	-	-	-	115.3	1,233	12.2	1,696	103.1	10.3	n/a	n/a	n/a	n/a	1.6	136	0.6	10	1.0
1974	179.2	207.9	-	-	-	-	186.5	2,267	30.6	2,922	155.9	20.1	n/a	n/a	n/a	n/a	1.3	115	0.6	9	0.7
1975	139.2	177.1	2,657	34.1	1,979	143.0	156.8	2,056	27.8	1,739	129.0	19.7	570	6.1	232	13.6	0.6	31	0.2	8	0.4
1976	105.7	141.6	2,107	27.9	1,570	113.7	122.0	1,652	23.2	1,339	98.8	19.4	414	4.6	230	14.8	0.16	41	0.08	1	0.08
1977	105.4	149.4	2,389	31.2	1,426	118.2	130.4	1,975	27.3	1,200	103.1	18.2	318	3.3	223	14.9	0.8	96	0.6	3	0.2
1978	108.6	165.1	2,423	32.8	1,551	132.2	147.2	2,070	29.7	1,321	117.4	16.9	231	2.3	227	14.6	1.0	122	0.8	3	0.2
1979	100.4	166.2	2,539	34.9	1,466	131.2	148.0	2,208	31.8	1,256	116.1	17.2	219	2.3	207	14.9	1.0	112	0.8	3	0.2
1980	113.9	202.1	2,258	42.4	1,718	159.7	181.1	1,973	38.9	1,505	142.2	20.0	190	2.8	210	17.2	0.99	95	0.7	3	0.3
1981	104.5	202.2	2,072	39.4	1,560	162.8	180.4	1,752	35.5	1,359	144.9	20.8	205	3.0	200	17.8	0.99	115	0.9	1	0.1
1982	83.9	173.6	1,997	34.3	1,465	139.2	155.4	1,726	31.2	1,285	124.2	17.2	151	2.1	180	15.0	0.96	120	0.9	0	0.0
1983	87.4	188.5	2,023	37.7	1,511	150.8	170.4	1,756	34.4	1,331	136.0	17.1	155	2.3	180	14.8	0.96	112	0.9	0	0.0

a/From NIH (1966-84, 1984 edition, p. 17). Includes MARC Honors Undergraduate trainees.

b/Figures for 1971-74 were obtained from ADAMHA (1978-81, 1980 edition, p. 33); figures for 1975-83 were from special tabulations prepared annually by ADAMHA, Office of the Administrator. Includes MARC Honors Undergraduate trainees.

c/From HRSA, Division of Nursing. Figures for 1971-76 represent Special Nurse Research Fellowship and Nurse Scientist Training Grant Programs. Figures for 1977-83 were obtained from HRSA, Division of Nursing. Authority for NRSA research training programs in the Division of Nursing began in FY 1977.

d/Obtained by using the Implicit GNP Price Deflator (U.S. Bureau of the Census--see Appendix Table B7).

APPENDIX TABLE D3 NRSA Training Expenditures as a Percentage of NIH/ADAMHA/HRSA Research Obligations, 1971-83 ($ millions)a/

	Total NIH/ADAMHA/HRSA			NIHb/			ADAMHAc/			HRSA, Division of Nursingd/		
Fiscal Year	Research $	Training $	% of Research $	Research $	Training $	% of Research $	Research $	Training $	% of Research $	Research $	Training $	% of Research $
1971	960.7	171.5	17.9	842.7	152.9	18.1	116.0	16.7	14.4	2.0	1.9	95.0
1972	1,173.8	178.1	15.2	1,041.1	157.6	15.1	130.3	19.2	14.7	2.4	1.3	54.2
1973	1,205.6	127.2	10.6	1,081.4	115.3	10.7	121.7	10.3	8.5	2.5	1.6	64.0
1974	1,607.2	207.9	12.9	1,449.3	186.5	12.9	155.3	20.1	12.9	2.6	1.3	50.0
1975	1,679.4	177.1	10.5	1,536.9	156.8	10.2	139.1	19.7	14.2	3.4	0.6	17.6
1976	1,854.2	141.6	7.6	1,678.2	122.0	7.3	173.2	19.4	11.2	2.8	0.16	5.7
1977	2,011.2	148.6	7.4	1,853.4	130.4	7.0	152.8	18.2	11.5	5.0	0.8	16.0
1978	2,244.9	164.1	7.3	2,078.6	147.2	7.1	161.3	16.9	10.5	5.0	1.0	20.0
1979	2,613.9	165.2	6.3	2,413.0	148.0	6.1	196.0	17.2	8.8	4.9	1.0	20.4
1980	2,796.0	201.1	7.2	2,579.3	181.1	7.0	211.7	20.0	9.4	5.0	1.0	20.0
1981	2,897.8	201.2	6.9	2,686.1	180.4	6.7	206.7	20.8	10.1	5.0	1.0	20.0
1982	2,959.4	173.6	5.9	2,753.5	155.4	5.6	202.5	17.2	8.5	3.4	1.0	29.4
1983	3,297.0	188.5	5.7	3,058.8	170.4	5.6	233.2	17.1	7.3	5.0	1.0	20.0

a/Research obligations represent grants and contracts.

b/From NIH (1966-84, 1982-84 editions).

c/From ADAMHA (1978-83, FY 1980-83 editions).

d/Extracted from annual reports provided by HRSA, Division of Nursing.

APPENDIX TABLE D4 Classifications of Fields

NIH[a]

BIOMEDICAL SCIENCES

General Medical and Biological Sciences

- •Anatomy
- •Biochemistry
- •Biophysics
- •Microbiology
- •Pathology
- •Pharmacology
- •Physiology
- Multidisciplinary[b]
- Radiation, Nonclinical
- Entomology
- •Genetics
- •Nutrition
- Hydrobiology
- Ecology
- •Cell Biology
- •Zoology
- Botany
- •Biology NEC
- •Other Gen. Med. and Bio. Sci.
- •Environmental Sciences
- •Toxicology

Mathematics, Physical Sciences, Engineering, Other

- Mathematics
- Chemistry
- Physics
- Earth and Related Sciences
- Agricultural Fields
- Engineering
- Engineering, Health-Related

Other Health-Related Fields

- •Biostatistics
- •Epidemiology

Community and Environmental Health

- Accident Prevention
- Disease Prevention and Control
- Maternal and Child Health
- Dental Public Health
- Mental Health
- Hospital and Medical Care
- Other Community Health
- Radiological Health
- Water Pollution Control
- Air Pollution
- Environmental Engineering
- Food Protection
- Occupational Health
- Health Administration
- Social Work
- Pharmacy
- Other Health-Related Professions
- Other Environmental Health Fields

ADAMHA[c]

BIOMEDICAL SCIENCES

•Anatomy

- Anatomy
- Histology
- Pathology
- Experimental Pathology
- Cell Biology
- Embryology

•Biology

- Radiobiology
- Entomology
- Nutrition
- Molecular Biology
- Zoology
- Botany
- Biology
- Developmental Biology
- Neurobiology
- Teratology
- Aging Process
- Oral Biology

•Genetics

- Genetics
- Mutagenesis

•Microbiology/Immunology

- Microbiology
- Bacteriology
- Immunology
- Mycology
- Parasitology
- Virology

•Pharmacology

- Pharmacology

•Physiology

- Physiology
- Reproductive Physiology
- Endocrinology
- Communicative Sciences
- Physiological Optics

•Toxicology

- Toxicology
- Aquatic
- Environmental
- Forensic
- Inhalation
- Occupational/Safety

Mathematics, Physical Sciences, Engineering, Other

Chemistry

- Biochemistry
- Biomaterials
- Chemistry
- Polymer Chemistry
- Medicinal Chemistry
- Organic Chemistry
- Physical Chemistry
- Inorganic Chemistry

Physics/Engineering

- Biophysics
- Radiation Physics
- Biomedical Engineering
- Environmental Engineering
- Physics
- Engineering

Other Health-Related Fields

Statistics/Epidemiology/Computer Sciences

- •Biostatistics
- •Epidemiology
- Information Sciences
- Mathematics
- Statistics
- Computer Sciences

NAS[d]

•BASIC BIOMEDICAL SCIENCES

- Anatomy
- Embryology
- Human and Animal Physiology
- Biochemistry
- Molecular Biology
- Biomathematics
- Biometrics and Biostatistics
- Biomedical Engineering
- Biophysics
- Environmental Sciences
- Environmental Health
- General Biological Sciences
- Human and Animal Genetics
- Immunology
- Parasitology
- Microbiology
- Bacteriology
- Neurosciences
- Human and Animal Pathology
- Pharmaceutical Chemistry
- Human and Animal Pharmacology
- Pharmacy
- Public Health
- Epidemiology
- Hospital Administration
- Veterinary Medicine
- Zoology
- Cell Biology/Cytology
- Nutritional Sciences/Dietetics
- Food Science and Technology
- Endocrinology
- Toxicology
- Other Biological Sciences
- Medicine and Surgery
- Dentistry
- Optometry, Ophthalmology
- General Health, Medical Sciences
- Other Health/Medical Sciences

APPENDIX TABLE D4 Classifications of Fields (Continued)

NIH[a]	ADAMHA[c]	NAS[d]
BEHAVIORAL SCIENCES	*BEHAVIORAL SCIENCES*	*BEHAVIORAL SCIENCES*
Psychology	*Psychology*	*Psychology*
General and Experimental	Experimental and General	General
Comparative and Animal	Psychophysics	Clinical
Physiological	Physiological Psychology and Psychobiology	Cognitive
Developmental	Developmental and Child	Counseling and Guidance
Personality	Personality	Developmental and Gerontological
Social–Psychological Aspects	Social	Educational
Abnormal	Community and Ecological	School
Clinical		Experimental
Education, Counseling, and Guidance	*Other Behavioral Sciences*	Comparative
Other Psychological	Health Administration and Public Health	Physiological
	Education and Guidance	Psychometrics
Other Behavioral Sciences	Sociology	Quantitative
Sociology	Demography or Population Dynamics	Social
Social Psychology–Sociological Aspects	Anthropology	Industrial and Organizational
Anthropology	Linguistics	Personality
Social Sciences and Related Disciplines	Social Sciences and Related Disciplines	Human Engineering
Other Fields	Economics	Behavior/Ethology
	Political Science	Other Psychology
CLINICAL SCIENCES	Bioethics	
Internal Medicine	Social/Behavioral Sciences	*Other Behavioral Sciences*
Allergy		Anthropology
Pediatrics	*CLINICAL SCIENCES*	Sociology
Geriatrics	Psychiatry	Audiology and Speech Pathology
Obstetrics-Gynecology	Other Clinical Medicine	
Radiology	Nursing	
Surgery	Social Work	
Otorhinolaryngology	Clinical Psychology	
Ophthalmology		
Anesthesiology		
Neuropsychiatry		
Neurology		
Psychiatry		
Preventive Medicine		
Other Clinical Medicine		
Veterinary Medicine		
Clinical Dentistry		
NURSING RESEARCH		

• These fields correspond to those defined by the committee as the Basic Biomedical Sciences. See NRC (1975–81, 1977 Report, p. 29).

[a] Since 1962, NIH has used a classification scheme called the Discipline/Specialty/Field Code (DSF) to classify areas of training for its trainees and fellows. The major categories of that scheme are shown in this table. They have been grouped into 4 broad areas of research that the committee has established for purposes of this study.

[b] Most of the trainees in the Medical Scientist Training Program are classified in this category.

[c] These fields represent the lexicon established by ADAMHA to classify areas of training for its NRSA trainees and fellows.

[d] These fields are used by the National Research Council's Survey of Doctorates and Survey of Doctorate Recipients to identify fields of Ph.D. specialization and fields of employment.

APPENDIX E
Biotechnology Survey Questionnaire and Summary of Responses

Dear Colleague:

The Congress has asked the National Academy of Sciences (NAS) to determine the nation's need for research personnel in the biomedical and behavioral fields. As a member of the NAS' Committee on National Needs for Biomedical and Behavioral Research Personnel, I am particularly concerned that there be an adequate number of people trained in areas of the new biotechnology.

In collaboration with the American Society for Microbiology (ASM), I am writing to ask your assistance in collecting some information on this issue. You could help us greatly in our efforts to get a profile of current employment opportunities and a sense of future demand in biotechnology and related industries by responding to the three questions on the attached page. To be useful in our report to the Congress, we need your answers as soon as possible. The tabulated data from the questionnaire will be published. Only ASM and the NAS Committee will have access to the individual responses.

If you have additional comments or suggestions that you think would assist us, please include them with your response. A self-addressed envelope is enclosed. Also, if you have any questions concerning the questionnaire, don't hesitate to call me at (607) 256-2364.

With thanks for your help.

Yours sincerely,

Robert Barker, Ph.D.
Provost
Cornell University

Enc.

SUMMARY OF RESULTS FROM 141 RESPONDING FIRMS

COMPANY NAME AND ADDRESS:

____

____

____

____

PERSON COMPLETING THIS FORM:
Name:

Phone Number:

For the purpose of this questionnaire, Biotechnology is defined as the application of novel biological strategies (rDNA, cell-fusion, mobilized cells or enzymes) for biochemical processing.

PLEASE INCLUDE ANY COMMENTS ON REVERSE

1. Is your company currently involved in any aspect of biotechnology as defined above? Yes 141 No 27. If yes, please indicate the year started in biotechnology, complete this questionnaire, and return in the self-addressed enveloped. Year biotechnology activities started ______. If not, indicate above and return the uncompleted form.

2. Please check all areas of biotechnology application in which your company is involved:

a) 48 fine chemicals	e) 27 biomass conversion	i) 18 pollution control
b) 25 bulk chemicals	f) 68 human diagnostics	j) 10 enhanced oil recovery
c) 60 pharmaceuticals	g) 39 plant agriculture	k) 45 other; specify ______
d) 43 animal agriculture	h) 7 mineral leaching & mining	

3.

Specialties	(1) Check if you are experiencing personnel shortages in any of these specialties: Ph.D.	MS	BS	Total	(2) No. scientists currently on staff (list each employee only once): Ph.D.	MS	BS	Total	(3) Expected No. of scientists to be hired in next 18 months: Ph.D.	MS	BS	Total	(4) For vacant positions, do you expect to: Hire from Industry (Check applic. boxes)	Hire from Academia	Retrain current Staff	Total
a) recombinant DNA/molecular genetics	26	12	11	49	465	259	337	1,061	121	57	79	257	66	54	6	126
b) hybridomas/monoclonalantibodies/immunology	16	6	10	22	182	91	265	538	65	39	90	194	27	38	7	72
c) cell culture	10	6	10	26	110	54	176	340	18	10	31	59	15	23	2	40
d) cell fusion	3	1	4	8	11	9	20	40	2	1	4	7	1	5	1	7
e) animal reproduction/embryo transplantation	3	1	1	5	18	4	20	42	3	1	3	7	2	6	0	8
f) classical genetics	7	0	1	8	50	10	35	95	4	5	6	15	7	8	1	16
g) gene synthesis	3	2	2	7	40	19	76	135	11	8	14	33	8	11	1	20
h) enzymology/immobilized systems	11	5	5	21	112	50	99	261	26	21	26	73	16	20	4	40
i) microbiology, general	8	1	4	13	136	72	172	380	26	8	30	64	18	19	1	38
j) industrial microbiology	13	2	0	15	65	33	72	170	18	12	18	48	19	13	1	33
k) bioprocess engineering	22	14	7	43	106	72	143	321	27	29	30	86	27	21	4	52
l) analytical biochemistry	6	7	4	17	128	51	212	391	20	15	21	56	13	10	3	26
m) biochemistry, general	9	8	7	24	286	121	282	689	46	32	58	136	21	31	2	54
n) cell biology/physiology	5	1	2	8	98	21	88	207	20	9	18	47	4	11	1	16
o) plant molecular biology	10	3	3	16	43	19	35	97	18	7	15	40	4	8	0	12
p) plant biology/physiology	9	1	3	13	54	19	19	92	16	3	8	27	5	10	1	16
q) pharmacology	3	0	1	4	67	28	93	188	20	9	30	59	7	6	1	14
r) toxicology	3	0	0	3	77	36	175	288	8	1	33	42	5	6	0	11
s) physiology	3	0	1	4	15	6	10	31	7	0	5	12	2	6	0	8
t) other biotechnology specialties (specify)	18	12	8	38	144	65	199	408	41	19	63	123	20	25	4	49
unknown					59	28	78	165	6	6	6	18	1	1	0	2
TOTAL	188	82	84	354	2,266	1,067	2,606	5,939	525	294	590	1,409	288	332	40	660

APPENDIX F
Summary of Public Meeting, May 10, 1984

The committee held a public meeting on May 10, 1984 to receive comments from the scientific community on issues discussed in the 1983 report. Fifteen witnesses presented statements. Their names and those of the organizations they represented are listed below in order of appearance:

Speaker	Organization
1. Elizabeth Short	Association of American Medical Colleges
2. Stanley Hazen	American Association for Dental Research
3. Emanuel Donchin	Federation of Behavioral, Psychological and Cognitive Sciences
4. Michael Pallak	American Psychological Association
5. Robert Carson	Council of Graduate Departments of Psychology
6. Myron Genel	Association of Program Directors, General Clinical Research Centers
7. William McGivney	American Medical Association
8. Barbara Redman	American Association of Colleges of Nursing
9. Gerald D. Shockman	American Society for Microbiology
10. David Rabin	Association of Teachers of Preventive Medicine
11. Gordon Kaye	Association of Anatomy Chairmen
12. George Bohrnstedt	Professor and Chairman of Sociology, Indiana University
13. Matthew J. Freund and Donald W. Light	American Association of Colleges of Osteopathic Medicine
14. William Jolly	American Institute of Biological Sciences
15. John Marshall	National Center for Health Services Research

Summaries of each presentation are provided below. The complete statement of each speaker is available upon request to the committee.

Elizabeth Short, M.D.

1. The appropriateness of a market model for estimating demand for researchers requires no justification. It is regrettable, however, that personnel requirements cannot be defined realistically to reflect revolutionary opportunities in biomedical science.

2. The market for basic scientists in clinical departments of medical schools should continue to be monitored closely by the committee.

3. NIH-supported post M.D. trainees/fellows who have not sought faculty positions may be involved in formal clinical trials, and hence, may not have been lost to research. This may account in part for the consistent increase of physician-researchers reported by AMA since 1975.

4. It will become more difficult to project practice income in medical schools, owing to the uncertain impact of the DRG-based prospective pricing system and its extension to non-Medicare beneficiaries.

5. In estimating needs for trainees in the clinical sciences, why not, as a parameter, substitute for the 35 percent of M.D. faculty accessions who have had postdoctoral research training the 63 percent of M.D. faculty shown by the Faculty Roster to be doing at least some (10 percent or more of professional time) research?

6. The committee's suggestions for monitoring the clinical investigator pool,. . . i.e. establishment of a computerized roster. . . seem worthwhile.

7. The use of a 2-year postdoctoral research training period for physicians-scientists in estimating the recommended number of clinical sciences trainees should be reexamined for the 1985 Report. The increasing sophistication of biomedical research would seem to demand a longer apprenticeship.

Stanley Hazen, D.D.S.

Dr. Hazen lauded the committee's current concern with training needs in dental research. He urged that special consideration be given to the following issues:

1. Extension of eligibility to dental schools to participate in the MST program.

2. Increase of stipends for dental and medical trainees in short-term research training (T-35) programs.

3. Permitting dental students to spread 3-month short-term research training over an entire academic year.

4. Establishment of a 5-year training program to produce dentist-scientists.

Emanuel Donchin, Ph.D.

1. The committee's recommendation that the erosion of predoctoral training be halted was strongly endorsed.

2. The Federation hoped that the committee, in the development of future recommendations, would extend the interpretation of its charge beyond a market analysis of the availability of jobs. That emphasis consecrates the status quo, and it provides a poor guide for planning an educational enterprise whose time constant is measured in decades.

3. The committee was asked to undertake a close examination of alternate data bases, with specific emphasis on disaggregating data in order to determine the state of affairs in different disciplines and across different classes of institutions. With respect to levels of quality, he noted that the data on hand aggregate the statistics for all Ph.D.-granting institutions, whereas the bulk of active researchers in the behavioral sciences have been trained in a relatively small number of institutions.

4. The committee should consider the consequences of its recommendations as a critical aspect of its work. Response by NIH/ADAMHA to the recommendations should be carefully monitored. In addition, the agencies, the public, and Congress should be alerted to dangerous trends that may occur as the unintended results of a rigid and inadequately funded implementation of its reports. The Federation pledges its readiness to cooperate in assessing the impact of various training support policies.

Michael S. Pallak, Ph.D.

1. The Association believes that the committee's charge includes a responsibility to inform Congress explicitly regarding the implications for research training inherent in levels of funding below those needed to implement NAS recommendations.

2. Some seven months after release of the 1983 report, the agencies appear to have taken no steps in the direction of making available the 650 predoctoral and 540 postdoctoral awards recommended by the committee in the behavioral sciences field.

3. The estimated number of predoctoral awards available for 1983 was 475, which is far short of the actual number in 1981 (639) and the number recommended for 1987 (650). The 475 awards, however, include about 100 awards to undergraduate students, which should not be equated with support for predoctoral research training in behavioral sciences. The committee should request that agency data on predoctoral awards be broken down by graduate and undergraduate categories.

4. It was suggested that postdoctoral data provided to the committee by NIH/ADAMHA be arrayed by length of award. An undetermined number of the postdoctoral awardees in 1983 were short-term trainees...i.e., support for a period of three months.

5. Except for the foregoing concerns about implementation, the Association fully supports the committee's 1983 recommendations.

Robert Carson, Ph.D.

Dr. Carson lauded the committee's recommendation for a return to the 1981 level of predoctoral trainees. He suggested the following:

1. Against the certainty of insufficient funds to achieve NAS target figures, the committee nevertheless should set a priority on an immediate increase in predoctoral awards.

2. The Council disparages the committee's reliance on market analysis. Preferably, the committee should attempt to assess personnel needs necessary to exploit knowledge gains in areas that will be important in the future.

3. There is justification for considering psychology separately from other behavioral science disciplines in the committee's analyses and recommendations.

4. Incentives should be provided for Ph.D.s to pursue medical training through a program similar to that of the new Physician Scientist Award. Provision of clinical training for Ph.D.s with backgrounds in behavioral science also merits consideration.

5. Regardless of changes in the number of undergraduate psychology majors, enrollment in psychology courses remains constant. Moreover, the reported decline in majors can be ascribed to the choice of a date for baseline. For example, psychology majors were at an all-time high during the early to mid-70s, owing to "an excessively romanticized humanism" in that era.

Myron Genel, M.D.

1. The committee should pay particular attention to the unique problems and patterns of research and training that pertain to "true" clinical research....i.e., first two categories in the Landau typology.

2. The committee's recommendations should be interpreted with an awareness that the NIH-IMPAC classification of research with human subjects does not distinguish the subset involving a significant "hands on" physician-subject interaction.

3. The Cuca study in the October 1983 issue of Clinical Research, which deals with difficulties in obtaining grant support for human subjects research underscores the need for more rigorous training of young physicians embarking upon a research career. The GCRC's Clinical Associate Physician program was described as response to that need.

4. Also needed are more innovative approaches to research training. For example, programs should incorporate a core curriculum in experimental design, data analysis, computer science, and basic laboratory methods applicable to human subjects studies of almost any kind and subspecialty interest.

5. Also meriting attention in this connection is a new training program at Yale, which is funded by NIADDK and NICHHD. The committee should also monitor the pilot programs at the University of Michigan's School of of Public Health and the Mayo Graduate School of Medicine.

6. The Association will be pleased to share with the committee the conclusions and recommendations emerging from its November 1984 conference on training and sustaining clinical investigators. Among the participants will be Dr. William N. Kelley and Dr. James B. Wyngaarden.

William McGivney, Ph.D.

Representing the American Medical Association, Mr. McGivney extolled the 1983 Report. He expressed agreement with the recommendations for the basic biomedical and clinical sciences fields, including the committee's observations on employment of bioscientists in the nonacademic sectors. He stressed the role of adequate and long-range federal support as a means of influencing the selection of biomedical research career paths by young scientists.

Barbara Redman, Ph.D.

1. Commends the committee for a comprehensive and useful report.

2. Only a tiny proportion of national expenditures for biomedical research and training is dedicated to research on nursing problems.

3. Nursing research deals with sleep disruption, pain reduction, and stress management among other things, and has produced findings that have improved patient care while effecting significant savings.

4. Hospital acquired infections are a substantial health problem. Infection control practitioners (75 percent of whom are nurses) were proven effective in decreasing the occurence of these infections in a recent study.

5. Support for nursing doctoral education is crucial to nursing research. A recent study showed an unmet need for 1,623 doctorally prepared nurse faculty.

6. The number of NRSA fellowships in nursing research should be increased to 500 per year, the number of traineeships for graduate nursing students should be increased, and grants for nursing research should be increased to a comparable level with other types of research.

Gerald D. Shockman, Ph.D.

1. Demand data from the survey of the biotechnology industry, cosponsored by the IOM committee and the Congressional Office of Technology Assessment, taken together with NSF data on manpower supply, demonstrate a "current shortage of certain types of biomedical scientists." The same data also justify concern that the shortage will worsen, unless remedial steps are quickly taken.

2. In addition to microbiology/immunology, similar market forces relevant to the new biotechnology are observable in several other biomedical science disciplines..., i.e., cell biology, genetics, biochemistry.

3. The shortages foreshadow harm to research and graduate education in the biomedical sciences, and will ultimately erode the U.S. position in international biotechnology competition. The quality and quantity of faculty required to train a competent work force are points of particular vulnerability.

4. Aside from increases in trainees/fellows at the predoctoral and postdoctoral levels, a major push is called for to enhance the prestige and rewards of academic employment in these fields. Competition for the best minds is not only with the medical schools, but increasingly with industry.

5. Anecdotal "data" suggest that the anticipated demand for appropriate B.S. and M.S. degree holders already equals or exceeds that for Ph.D.s in microbiology/immunology and related areas. The lure of higher salary in industry may be drawing off candidates for doctoral training, including some who have completed one or more years of graduate study.

David L. Rabin, M.D.

Dr. Rabin appeared on behalf of the Association of Teachers of Preventive Medicine, an organization of 700 M.D. and Ph.D. faculty in schools of medicine and public health. The Association is concerned with quantity and quality of personnel trained for prevention practice, as well as prevention and public health research, biostatistics, epidemiology, environmental health, and behavioral sciences. He alluded to the shortages of clinical prevention specialists that were projected by GMENAC and to the essentiality of federal support for residency programs. On the basis of data from the National Health Service of Scotland, he pointed to a need for 8,000 medically trained epidemiologists, as against a current supply of 1,000 epidemiologists, less than half of whom are medically trained. While the need for biostatisticians and epidemiologists has been recognized in previous reports of the committee, training support continues to be inadequate. He recommended that a national study be undertaken to define clinical and research needs to attain prevention goals. The results of such a study would facilitate the committee's setting priorities for research training.

Gordon Kaye, Ph.D.

Dr. Kaye described a continuing shortfall of personnel to fill faculty positions in departments of anatomy. He cited data since 1973, derived largely from the Association's biennial manpower survey, on the disparity between "job seekers" and "available positions." For the remainder of his presentation, he made the following observations.

1. Onerous teaching demands make it difficult for established faculty to keep up to date on research developments and to attract external funds. At the same time, it is difficult to find faculty candidates proficient in cell and molecular biology, who can also teach any of the subjects traditionally taught in anatomy departments.

2. In a related vein, teaching for anatomy faculty in medical schools is no longer restricted to the first year, but now includes electives in the 3rd and 4th years. Also, the development of CAT and NMR scanning, ultrasonic lithotomy, etc., have made teaching in anatomy essential for house staff and clinical faculty.

3. In addition to categorical--predoctoral and postdoctoral--training grants, there is need for advanced postdoctoral support to permit middle-level faculty to renew their technical armamentarium. A similar support program should be instituted to re-attract individuals, such as women with Ph.D.s, who have left academic employment.

4. Funds should be made available for underwriting a year of full-time research training as part of the residency, rather than merely cutting the number of residency positions in response to changes in the financing of hospital care. The presence of such trainees in basic science departments could notably improve the likelihood of their participation in research, but also would enhance the scope of research in these departments.

George W. Bohrnstedt, Ph.D.

1. My concern is that continued cutbacks being made in what are called "teaching costs" associated with training are begining to have a serious negative effect on our ability to do quality research training. In the past five years, the allowance for teaching costs on my training grant has declined from $30,000 to $10,000 per year, with no reduction in number of fellows and faculty participating in the program.

2. The term "teaching funds" is somewhat of a misnomer. These funds are used primarily for research needs of the trainees, e.g., the purchase of computer time, data entry costs, manuscript preparation, travel expenses for consultants, etc.

3. Sponsoring agencies should be advised that the reduction of these funds is likely to have an effect on the quality of research training we are all trying to provide. I believe we should return to a model that allows the applicant to provide and justify a teaching budget that is commensurate with a given research training program's needs.

Matthew Freund, Ph.D.

Dr. Freund spoke for the American Association of Colleges of Osteopathic Medicine. The 15 member-schools were the locus in 1982 for research totalling $9 million in support (including $6 million in federal funds). In addition, two D.O./Ph.D. training programs and two student summer research fellowship programs are currently active. He recommended that the committee's data base be extended to include information relevant to osteopathic medical schoools, and that representatives from their faculties and administration be considered for future committee and Panel appointments.

Donald W. Light, Ph.D.

1. The committee's projections should transcend the marketplace constraints, particularly with respect to training personnel for health services research. For that field, 2 percent of recommended traineeship/fellowship awards could more reasonably approximate 7 percent.

2. It is important through NRSA to encourage the training of researchers with more <u>applied</u> interests in the clinical and behavioral sciences (underlining supplied).

3. The scope of behavioral science should extend beyond psychology, and the training of behavorial scientists should in many cases take place directly in departments of the primary care specialties.

4. Post-Ph.D. training should increasingly be based on research which involves collaboration with clinicians.

5. In line with trends described in chapter 2, some 12 Ph.D. researchers have been "seeded" in all the major clinical departments of his institution.

William Jolly, Ph.D.

1. Inasmuch as undergraduate degrees and graduate enrollment in the biomedical sciences are declining, recruitment of predoctoral trainees should be stepped up, while maintaining current levels of NRSA postdoctoral support.

2. The persistently low unemployment rate for Ph.D. biomedical scientists should be regarded as an indication of continuing demand, despite market shifts between the academic and industrial sectors and among specialties within the two sectors.

3. Manpower shortages in bioprocess engineering are likely to have an important influence on the future development, commercialization, and adoption of biotechnology.

4. In light of the glamour of biotechnology, special efforts will be needed to avert shortages in other biomedical science areas.

5. Overall biomedical Ph.D. production will continue to be closely tied to federal research support levels.

John Marshall, Ph.D.

1. The decline in grant support available from the National Center for Health Services Research is not indicative of a decline in the needs for health services research. The staggering growth in the nation's health costs generates a need for conceptual models, technology assessment, innovative methodology, and strategic data collection.

2. The capacity of the health services community to devise effective ways to assess technology, not only clinically, but in terms of costs and relative benefits is in a primitive state. Where will we find the young investigator with apporpriate skills?

3. We are hopeful that the NCHSR will once again be able to sponsor centers of health services research with the aim of bringing together multidisciplinary skills and encouraging new approaches to policy-relevant areas like technology assessment.

4. The NCHSR has endeavored to maintain its dissertation grant program and expects to continue to fund at least 20 grants per year.

5. Hard data on health services research personnel are probably among the most difficult to obtain in the health sector. The formation of the Association for Health Services Research provides a focal point for collection of such data.