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ABSTRACT

The purpose of this document is to establish the nation's overall need for biomedical and behavioral research personnel. Dealing with a limited analysis of the current situation rather than with projections, the document provides data, observations, statements of principle and recommendations. Chapter two described training programs -- their development, current levels and estimated levels in FY 1976, and what is known about the utilization of training by former fellows and trainees. Chapter three deals with a number of principles that have guided the Committee. A number of problems emerge when these principles are applied. These problems include; the costs of imbalance of supply and demand; market studies and their limitation; fellowships versus training grants; training grant funds to institutions and to trainees; and the postdoctoral pool. In Chapter four, some significant trends concerning the development and utilization of biomedical and behavioral research personnel are presented, including: graduate enrollments and student support; Ph.D. output 1961-74; research and development expenditures; current number of active researchers. Chapter five provides a brief summary of important points. Appendices contain lists of committees and members; legislative and administrative history of training authorities; some data sources and studies; and a bibliography. (Author/KE)

Personnel Needs and Training for Biomedical and Behavioral Research

The 1975 Report of the
Committee on a Study of National Needs for Biomedical and Behavioral Research Personnel

COMMISSION ON HUMAN RESOURCES
NATIONAL RESEARCH COUNCIL

PERSONNEL NEEDS AND TRAINING FOR BIOMEDICAL AND BEHAVIORAL RESEARCH

THE 1975 REPORT

of the

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

COMMISSION ON HUMAN RESOURCES

NATIONAL RESEARCH COUNCIL

National Academy of Sciences
Washington, D. C.

June 11, 1975

NOTICE: The project which is the subject of this report was approved by the Governing Board of the National Research Council, acting in behalf of the National Academy of Sciences. Such approval reflects the Board's judgment that the project is of national importance and appropriate with respect to both the purposes and resources of the National Research Council.

The members of the committee selected to undertake this project and prepare this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. Responsibility for the detailed aspects of this report rests with that committee.

Each report issuing from a study committee of the National Research Council is reviewed by an independent group of qualified individuals according to procedures established and monitored by the Report Review Committee of the National Academy of Sciences. Distribution of the report is approved, by the President of the Academy, upon satisfactory completion of the review process.

The work on which this publication is based was performed pursuant to Contract No. NO1-OD-5-2109 with the National Institutes of Health of the Department of Health, Education and Welfare.

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NATIONAL ACADEMY OF SCIENCES

OFFICE OF THE PRESIDENT
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WASHINGTON, D. C. 20418

June 16, 1975

The Honorable Caspar W. Weinberger
Secretary of Health, Education, and Welfare
Washington, D. C. 20201

My dear Mr. Secretary:

I am pleased to present to the Department of Health, Education, and Welfare the 1975 report of the Committee on a Study of National Needs for Biomedical and Behavioral Research Personnel. This continuing study has been undertaken by the National Research Council pursuant to Title I of the National Research Act of 1974 (PL 93-348). It responds to your request of September 16, 1974 that the National Academy of Sciences make such a study and follows my letter of March 6, 1975 indicating that the Academy would accept this task. The work has been supported under Contract NO1 OD 5 2109 with the National Institutes of Health.

The Act states (Section 473 (a)) that the purposes of the study are to: "(1) establish (A) the Nation's overall need for biomedical and behavioral research personnel, (B) the subject areas in which such personnel are needed and the number of such personnel needed in each such area, and (C) the kinds and extent of training which should be provided such personnel; (2) assess (A) current training programs available for the training of biomedical and behavioral research personnel which are conducted under this Act at or through institutes under the National Institutes of Health and the Alcohol, Drug Abuse, and Mental Health Administration, and (B) other current training programs available for the training of such personnel; (3) identify the kinds of research positions available to and held by individuals completing such programs; (4) determine, to the extent feasible, whether the programs referred to in clause (b) of paragraph (2) would be adequate to meet the needs established

under paragraph (1) if the programs referred to in clause (A) of paragraph (2) were terminated; and 5) determine what modifications in the programs referred to in paragraph (2) are required to meet the needs established under paragraph (1)."

The present document, submitted in order to meet the requirement for a report in FY 1975, was prepared little more than three months after commencement of the study, hence, it cannot respond fully to the broad and difficult requirements set by the Act. But a beginning has been made. I trust that our reports in 1976 and thereafter will deal in a more detailed and meaningful way with the significant problem you have brought to us.

We shall be glad to discuss this report for 1975 with you and your staff.

Sincerely yours,

Philip Handler
President

P R E F A C E

This is the first of the annual reports in the continuing study required under provisions of the National Research Service Award Act of 1974. In approaching this initial task, the Committee on a Study of National Needs for Biomedical and Behavioral Research Personnel examined critically a large and diverse body of available data. The picture emerging from that scrutiny did not permit a clear distinction between transitory developments and long-range trends even though there is ample reason to believe that we are in a period of transition. Limitations in the data base were anticipated in the preceding feasibility study and in the event proved all too true. It is not surprising, therefore, that the present report deals with a limited analysis of the current situation rather than with projections.

The report has been prepared under the most formidable time constraints. Approximately 90 days elapsed from the authorization to proceed with the study to the Committee's final review of the report. There has been a grossly inadequate opportunity to weigh broad policy questions that have been the subject of continuing debate. Nor has it been possible to deal at length with all the administrative, resource, and organizational issues that fall within the purview of the continuing study. Consequently, this report should be regarded as a preliminary response to the Congressional request contained in the Act. With enhancement of the data base and refinement of methodology, which can be expected in the coming year, future annual reports can be looked to for realization of the full potential of the continuing study.

Completion of the report for 1975 would not have been possible without help from many quarters. The Committee is indebted to its Panels for advice on data analysis, disciplinary classification, and the status of science in the various fields. Vincent Price of the National Institutes of Health, David Kefauver of the Alcohol, Drug Abuse, and Mental Health Administration, and Daniel Fox of the Health Resources Administration provided data and helpful interpretation of administrative procedures in the training programs. Robert A. Alberty, Chairman of the Commission on Human Resources, and William C. Kelly, its Executive Director, were a source of constant support through their understanding of the complexities of scientific manpower studies. Robert Lindee of The Henry J. Kaiser Family

Foundation provided valuable advice and assistance. Several consultants—Richard B. Freeman of Harvard University, Samuel S. Herman of Temple University, Robert G. Snyder, full-time consultant to this project, and Robert K. Weatherall of the Massachusetts Institute of Technology—conducted studies at the Committee's request and provided much helpful assistance. Finally, it is a pleasure to acknowledge the competence and industry of the entire staff—especially Prudence Brown, Porter Coggeshall, Lindsey Harmon, Kay Harris, and Allen Singer, who served as Acting Staff Director—in responding to the demands of this first phase of the continuing study.

Robert J. Glaser, M.D.
Chairman

June 11, 1975

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FOR BIOMEDICAL AND BEHAVIORAL RESEARCH PERSONNEL

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LIST OF ABBREVIATIONS

AAMC	Association of American Medical Colleges
Academy	National Academy of Sciences
Act	National Research Service Award Act
ADAMHA	Alcohol, Drug Abuse, and Mental Health Administration
CDC	Center for Disease Control
CR	Comprehensive Roster of Doctoral Scientists and Engineers
DOL	Department of Labor
DRF	Doctorate Records File
FDA	Food and Drug Administration
FY	Fiscal Year
GNP	Gross National Product
HEW	Department of Health, Education and Welfare
HRA	Health Resources Administration
HSA	Health Services Administration
HSMHA	Health Services and Mental Health Administration
ISI	Institute for Scientific Information
NCHS	National Center for Health Statistics
NCHSR	National Center for Health Services Research
NCI	National Cancer Institute
NEI	National Eye Institute
NHLI	National Heart and Lung Institute
NIA	National Institute of Aging
NIAID	National Institute of Allergy and Infectious Diseases
NIAMDD	National Institute of Arthritis, Metabolism, and Digestive Diseases
NICHD	National Institute of Child Health and Human Development
NIDR	National Institute of Dental Research
NIEHS	National Institute of Environmental Health Science
NIGMS	National Institute of General Medical Sciences
NIH	National Institutes of Health
NIMH	National Institute of Mental Health
NINCDS	National Institute of Neurological and Communicative Disorders and Stroke
NRC	National Research Council
NSF	National Science Foundation
OE	Office of Education
PHS Act	Public Health Service Act
PL 93-348	Public Law 93-348
R and D	Research and Development
Academies-Institute-Council	National Academy of Sciences/National Academy of Engineering-Institute of Medicine-National Research Council

CONTENTS

RECOMMENDATIONS

In developing its recommendations, the Committee was guided by the principles described on pages 37 through 40 and its experience with biomedical and behavioral training. The available quantitative data were studied, but at the present time it is not possible to derive needed training levels (numbers of people to be trained) simply from quantitative information. More can, and will, be done to improve the data base and its interpretation. Some directions that this effort will take are described in the last two sections of this chapter and in Appendix D. In addition, the Committee is looking forward in the year ahead to obtaining information about recommended future levels of biomedical and behavioral research support from the report of the President's Panel on Biomedical Research.

In the view of the Committee, the most important principle underlying its recommendations concerning training is the importance of maintaining or increasing the quality of biomedical and behavioral research. It is important to attract able people into these research fields and to make it possible for the most promising to obtain the best possible education and research experience at pre- and postdoctoral levels, independent of their own personal resources. In order to maintain high-quality training environments, it is also necessary for the universities, as well as the students, to have sufficient stability to make sound plans. The country also has a large stake in the quality of the postdoctorals in the pool, supported as trainees and fellows, and must be careful in developing plans that would alter the nature and size of this pool.

A. TRAINING RECOMMENDATIONS

The Committee recommends that federal training support be maintained in FY 1976 across the fields of the biomedical and behavioral sciences at the levels that prevailed in them in FY 1975. By "levels" we mean numbers of people to be trained. Points 1-8 deal with the special requirements for training in the four broad fields, by predoctoral and postdoctoral categories. Point 9 summarizes the Committee's understanding of the numbers of trainees and fellows that its general recommendation calls for. Point 10 concerns the division of support between fellowships and training grants.[1]

[1] See page 20 for definitions of such terms as "fellowship," "training grant," etc.

1. Predoctoral training in the basic biomedical sciences

Since the training of graduate students adds to the nation's stock of basic bioscience research personnel, the Committee has addressed the question of the appropriate rate of training of doctoral candidates in these fields. The demand for additional doctoral scientists is going to depend upon the research programs of the National Institutes of Health and other government agencies, expansion of research in industry, the development of government programs for improvement of the environment, and personnel requirements related to quality standards on food, drugs, water, and medical treatment. Some guidance as to appropriate levels will come from the recommendations of the President's Panel on Biomedical Research concerning future levels of biomedical research. However, it appears now that unless there is significant expansion of biomedical research supported by government and industry and significant rates of departure of individuals from biomedical research into teaching, administration, and other non-research activities, future predoctoral training levels may need to be reduced from current levels in some of the basic bioscience fields.

The Committee does not feel that it can make specific recommendations about predoctoral training levels in specific fields of the basic biosciences until these matters have been studied in greater detail during the next year. It does not believe that the aggregate predoctoral training levels in these fields should be increased above the levels of FY 1975, although there may be need for flexibility in adjusting among subfields. Some subfields may need somewhat higher levels of training, to be compensated by somewhat lower levels in the other subfields.

The NIH Medical Scientist Program, under which support is given to persons who wish to acquire both M.D. and Ph.D. training in preparation for medical research, deserves special note. Although this is still a relatively small program, it gives evidence of being an important component of the training spectrum. The program provides an important "middle ground" in the training spectrum. The Committee believes that support for this program should be maintained and the feasibility of its expansion, under present high standards of excellence, should be explored by NIH so that that possibility can be considered by the Committee in preparation for the 1976 report.

2. Postdoctoral training in the basic biomedical sciences

The Committee emphasizes the importance of postdoctoral training support in the basic biomedical sciences. Postdoctoral training for Ph.D's is essential for the quality of the present and future biomedical

research enterprise. Support of postdoctorals does not increase the manpower pool, but provides for its improvement and for diversification into more applied areas of special importance. In many of the basic biomedical sciences, long training experience is required for those who will make significant contributions in specialized fields, and for others, postdoctoral training provides the breadth needed for research in more applied areas. In particular, this mechanism provides a way of supporting neglected or emerging fields which may, in fact, have great potential for new approaches to the solution of important recalcitrant medical problems.

Postdoctoral training for M.D.'s provides them the opportunity to enter areas of basic bioscience research with the perspective of a medical education and health-care experience. Predoctoral training in the basic biosciences usually lasts about seven years, but postdoctorals often achieve their training goals in two years. Thus postdoctoral training programs provide the means for preparing researchers more rapidly for emerging and recently recognized priority areas. In addition, postdoctorals do research and add to knowledge in their fields.

3. Predoctoral training in the behavioral sciences

NIH and ADAMHA training grant programs have a relatively modest effect on the total numbers of research doctorates produced each year in psychology and other behavioral sciences because only a small percentage of the current doctoral candidates are supported in this way. However, NIH and ADAMHA training grants support a large fraction of the doctoral candidates in certain areas of the behavioral sciences——such as anthropology, behavior/ethology, and sociology—that are of special interest for the objectives of certain programs of NIH, ADAMHA, and HRA. The needs for federal research training support in the behavioral sciences should therefore be judged in relation to the requirements for behavioral research in areas relevant to current national health objectives.

In order to have strong national research programs in areas such as drug abuse, alcoholism, and mental health, predoctoral training should be provided in areas that are especially important for these national programs. In addition, there should be training for the purpose of increasing the application of behavioral science methodology to general medical problem areas and the delivery of health care as more emphasis is directed properly to long-term degenerative processes and to effective societal adjustment. Such training grants can attract able students into basic areas that are important for future research on this class of national problems.

4. Postdoctoral training in the behavioral sciences

Postdoctoral training provides the opportunity to attract Ph.D's and

M.D.'s into behavioral research basic to improving mental health and attacking effectively problems of drug abuse and alcoholism, and to give training in applied or problem-oriented research to basic behavioral scientists. Further studies will be made of the needs for behavioral scientists in research programs of interest to NIH and ADAMHA.

5. Predoctoral training in the clinical sciences

This is a small and rather specialized form of training but provides an opportunity to involve pre-Ph.D. as well as pre-M.D. students in work on clinical research problems. Because of difficulties of classification, this area of predoctoral research training is not clearly separable from predoctoral basic biomedical science research training and so will not be considered separately here.

6. Postdoctoral training in the clinical sciences

The National Research Service Award Act is designed primarily to provide training for research and is not intended for the specialty training of clinicians for the practice of medicine. This limitation may make it possible to reduce the number of trainees in this area, but the facts are not yet sufficiently clear to the Committee that it can feel confident of specific recommendations for reductions. At the present time, medical students are showing increased interest in medical practice rather than careers in research; and so current programs for research training in clinical sciences may be undersubscribed as compared with recent past training levels, and there may be no need for deliberate restraining action. There is a common misconception that the number of M.D. researchers is excessively large; the Committee can find no evidence to support this notion.

In view of the importance of clinical research and the need to attract capable M.D.'s into the field, the Committee is not prepared to suggest specific reductions at this time.

7. Predoctoral training in health services research

This relatively new area,[2] represented primarily but not exclusively by the HRA, has special importance for national health policy. It involves

[2] Improving Health Care through Research and Development. A report of the Panel on Health Services Research and Development of the President's Science Advisory Committee, Office of Science and Technology. U. S. Government Printing Office, March 1972.

economics, sociology, statistics, and other disciplines, but the needs for predoctoral training programs cannot be judged simply in terms of the annual doctorate productions in these fields. Health services research necessarily requires a multidisciplinary approach. In order to assure that training in this area is of high quality, there is a need for a limited number of predoctoral training programs. Since this is a new area of recognized national need, there is the temptation to build up programs too rapidly. The Committee suggests that training programs emphasize postdoctoral training somewhat more than predoctoral until the future demands for such research personnel become clearer.

This is not a single field, and a wide diversity of training grant programs needs to be developed. HRA and professionals in this area have an obligation to develop plans and objectives which can be examined in terms of needs for training programs.

8. Postdoctoral training in health services research

Postdoctoral training programs offer the opportunity for attracting Ph.D.'s from areas such as sociology, psychology, economics, and anthropology into research on the quality and efficiency of health services. Since postdoctorals can be trained in less time than doctoral candidates, postdoctoral programs offer a special opportunity for the development of this field without overstimulating the production of new doctorates. The Committee's present impression, based on incomplete data, is that there are a few fields in health services research that are in short supply.

9. Numerical recommendations

Applied to the eight broad training areas, the recommendations given above yield approximate numbers of full-time trainees and fellows for support in FY 1976. The reader is reminded that these numbers are based on estimates of training levels in FY 1975 (TABLE 3) and are not independently derived. The numbers are as follows:

	Predoctoral	Postdoctoral	Total
- Basic Biomedical Sciences	5,700	3,100	8,800
- Behavioral Sciences	1,800	260	2,060
- Clinical Sciences	140	3,200	3,340
- Health Services Research	640	90	730
Total	8,280	6,650	14,930

These numerical recommendations, according to the information available to the Committee, approximate the numbers of awards made in these fields in FY 1975. The recommendations are made subject to the following conditions:

a) The distribution of federal training support should be divided among NIH, ADAMHA, and HRA according to the FY 1975 pattern.

b) Distribution of the above numbers among subfields of the four broad training fields should approximate the distribution that prevailed in FY 1975. Pages 23-24 contain a list of the subfields that the Committee, for the purposes of the present report, considers to be associated with these broad training areas. The taxonomy is far from satisfactory, however, and will be the subject of further study in preparation for the 1976 report.

c) The Medical Scientist Program should be supported at its FY 1975 level of approximately 450 persons.

d) A somewhat greater emphasis should be placed on postdoctoral training than on predoctoral in the behavioral sciences and especially in health services research over the next several years—not a marked discontinuity, but a gradual shift toward postdoctoral training. The proposed reduction in postdoctoral awards in health services research in the President's FY 1976 budget (see TABLE 3) seems unwise in view of the need to support the training of those who wish to transfer to this field.

This simple classification of all NIH, ADAMHA, and HRA research training programs in the biomedical and behavioral sciences is not intended to inhibit innovation of new types of training grant and fellowship support or of new areas or concepts of training. Interdisciplinary fields are often important for developments which are relevant for health problems and should be encouraged. No classification scheme is rigorously and invariably applicable.

10. Training grants versus fellowships

The National Research Service Award Act specifies that not less than 25 percent of the training funds should be used for awards to individuals. The Committee, in general, favors training grants to institutions over fellowships awarded to individual students. Training grants have the advantage that they provide for the development of a training environment in which a group of faculty members, graduate students, and postdoctorals work together toward a common objective. The Committee recommends, while recognizing the importance of predoctoral fellowships in certain instances, that predoctoral training of NIH, ADAMHA, and HRA be supported through training grants.

At the postdoctoral level there is more need for fellowships because of the much wider variety of fields and the fact that some of the postdoctorals need the opportunity to seek training in smaller departments, laboratories, or institutes that might not be able to sustain training programs. The percentage specified in the Act as a lower limit for awards to individuals may be an appropriate upper limit as well for postdoctoral awards through fellowships to individuals. Until the Committee has had an opportunity to examine the situation more carefully, it recommends that the proportion of postdoctoral training given in the form of fellowships be essentially similar in FY 1976 to what it was in FY 1975. Further study will be given in the year ahead to this important issue. Such further study may lead to recommendations for changes in this aspect of the Act.

B. RECOMMENDATIONS CONCERNING DATA AND METHODOLOGY[3]

1. Data

The Committee recommends that the NIH, ADAMHA, and HRA work with the Committee's own staff, the Panel on Data and Studies, and other organizations to remedy deficiencies in data as a matter of high priority. Specifically:

a) The field structure used in the Doctorate Records File (DRF) and the Comprehensive Roster of Doctoral Scientists and Engineers (CR) of the Commission on Human Resources

[3] See also Appendix D.

to describe the biomedical and behavioral fields should be reconsidered to see whether it can be made to meet the requirements of this study more adequately. Efforts to achieve a common field structure should at the same time be pursued elsewhere.

b) Information items in the DRF and CR concerning the extent of research involvement of individuals should be made more precise. It is necessary not only that persons whose research activities are a major function be separated from those who are less directly involved in research, but that the percentage of time each person spends in research be specified.

c) The sample used in the CR to obtain information about biomedical and behavioral fields should be suitably augmented to give greater statistical validity to the data in the more specialized data cells.

d) Lack of comprehensive data about M.D. researchers is a major deficiency in understanding the personnel supply in the biomedical and behavioral research fields. The Committee recommends that steps be taken in cooperation with the Association of American Medical Colleges to extend the coverage of the AAMC's Roster of Medical School Faculties to include M.D.'s conducting research in research institutes, industrial laboratories, and the NIH Intramural Program and other government agencies. Other appropriate steps should also be taken so that complete data on individuals in this group will be available.

e) The Alcohol, Drug Abuse, and Mental Health Administration and the Health Resources Administration should create from administrative records a comprehensive, computerized data bank concerning all persons who have been given support in their fellowship and training programs, both predoctoral and postdoctoral, from the inception of the programs to the present, and should keep these files current in the future. Such a file has been created for the National Institutes of Health and serves an essential purpose in the administration of NIH training programs and in studies such as those of this Committee. In order to achieve this, ADAMHA and HRA should be given additional authority to collect the needed data from training-programs directors and others.

f) Data sources on modes of student support other than the training and fellowship programs addressed by the National Research Service Award Act——i.e., teaching assistantships and research assistantships supported by state or institutional funds, research assistantships and postdoctoral associateships supported by federal research contracts, student loans, and private funds——need to be developed and made available to the Committee on a more systematic basis. (See Appendix D.)

g) Consideration should be given to employer surveys and other data sources for evaluating future demands for biomedical and behavioral research personnel. The cooperation of professional societies can be especially helpful in this connection.

h) Program data on the probable effects of new administrative procedures, budgetary provisions, and other level-determining factors need to be made available to the Committee by NIH, ADAMHA, and HRA on a continuing basis.

2. Methodology

The Committee joins other organizations, such as the National Science Board, in urging that greater attention be given to the development of more adequate techniques for projecting supply and utilization of personnel in these fields. Specifically, the Committee recommends that consideration be given to the market model, which attempts to incorporate behavioral characteristics of employers, training institutions, and individual students and scientists, as well as to the "fixed-coefficient" methods of projection used in the past.

C. RECOMMENDATIONS CONCERNING THE SYSTEM OF RESEARCH TRAINING AND UTILIZATION

During the year ahead, the Committee will examine in greater detail the complex problems of the system with which the National Research Service Award Act is concerned. Maintenance of excellence of training, assuring the stability of the system and forestalling wide swings in the

personnel supply, and avoiding the dangers of stagnation of the research cadre will all concern the Committee. Meanwhile, the Committee recommends:

1. Innovative approaches to research training, such as the new program in the National Heart and Lung Institute, need to be instituted and evaluated.

2. The turnover rate of the cadre of biomedical and behavioral researchers needs special attention in an era of stasis in faculty growth and limitations on alternative opportunities for people who want to leave research for other activities. New mechanisms will be needed to make it possible for outflow at the "top," inflow of new talent, and exchange with other fields of endeavor throughout the normal work span. The Committee will discuss these matters in the year ahead. It urges other organizations to do so also and to share their findings with it.

I. ORIGINS AND ORGANIZATION OF THE STUDY

The present report presents the findings and recommendations of the Committee on a Study of National Needs for Biomedical and Behavioral Research Personnel, as the first of the annual reports in a continuing study called for in the National Research Act of 1974 (PL 93-348).

SUMMARY OF PROVISIONS [4]

Approved on July 12, 1974, the Act amends the Public Health Service Act "to establish a program of National Research Service Awards to assure the continued excellence [emphasis added] of biomedical and behavioral research." Title I is called the National Research Service Award Act and will be referred to in this report as the Act. It repeals existing research training and fellowship authorities of the National Institutes of Health (NIH) and the Alcohol, Drug Abuse, and Mental Health Administration (ADAMHA). Research training activities of these agencies will henceforth be carried out under a consolidated authority contained in the new law. The Act concerns research training primarily, although clinical training is also addressed. It is not completely clear how the Act affects authority available elsewhere in the Public Health Service Act under which the Secretary may enter into contracts with public and private entities and individuals for health services resesarch and health statistics training.

The Act is a clear signal of Congressional concern regarding an important sector of the nation's human resources. The Committee regards its enactment as a positive step in which the Congress calls on the responsible agencies of the Executive Branch, its own committees, and the biomedical and behavioral research communities to examine national personnel requirements in an area that has contributed much to the national well-being in the past and that has much to offer in the future.

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[4] See Appendix C for further information about legislative authorities for training, including portions of the text of Title I of the Act.

The Act authorizes awards for predoctoral and postdoctoral research training both to individuals and to nonfederal public or nonprofit institutions (which will select individuals for such awards). Not less than 25 percent of the amount appropriated must be made available directly to individuals. Each award recipient must give assurance that he or she will meet a service requirement—engage in health research or teaching or, alternatively, (1) serve as a member of the National Health Service Corps, (2) serve in his or her specialty in a geographic shortage area in that specialty or in a health maintenance organization which offers care in a medically underserved area, or (3) serve in an approved health-related activity. Guidelines now under review specify the period of time within which repayment may be made, the type of research and teaching which qualify as payback, and other matters relating to service payback. Recipients who fail to comply with the service requirement must repay the amount of their awards plus interest, less proportionate credit for half of the months they actually served.

Effective July 1, 1975, awards under the Act may be made for research training only in those subject areas in which there is need for personnel, as determined by a continuing study which the Secretary is to request the National Academy of Sciences to conduct. The Act states that the purposes of the study are to:

> 1) establish (A) the Nation's overall need for biomedical and behavioral research personnel, (B) the subject areas in which such personnel are needed and the number of such personnel needed in each such area, and (C) the kinds and extent of training which should be provided such personnel; 2) assess (A) current training programs available for the training of biomedical and behavioral research personnel which are conducted under this Act at or through institutes under the National Institutes of Health and the Alcohol, Drug Abuse, and Mental Health Administration, and (B) other current training programs available for the training of such personnel; 3) identify the kinds of research positions available to and held by individuals completing such programs; 4) determine, to the extent feasible, whether the programs referred to in clause (B) of paragraph (2) would be adequate to meet the needs established under paragraph (1) if the programs referred to in clause (A) of paragraph (2) were terminated; and 5) determine what modifications in the programs referred to in paragraph (2) are required to meet the needs established under paragraph (1).

FEASIBILITY STUDY

Pursuant to this requirement, the Secretary requested the Academy on September 16, 1974, to conduct the study. The NIH was designated the lead agency within the federal government, but it was understood that the study would also require assistance from ADAMHA. Since the National Research Council is the operating arm of the Academy, the Chairman of the National Research Council (NRC) asked the Commission on Human Resources to take a central responsibility within NRC, with the understanding that other NRC units—especially the Assembly of Behavioral and Social Sciences, the Assembly of Life Sciences, and the Institute of Medicine—would also participate.

On September 21, 1974, the Governing Board approved the establishment of a committee by the Commission on Human Resources to examine the feasibility of the continuing study called for in the Act. Funds were provided by the NIH to carry out the feasibility study. NIH, ADAMHA, and HRA also provided data and other information upon request and consulted with the committee about the requirements for the continuing study.

The committee on a Feasibility Study of National Needs for Biomedical and Behavioral Research Personnel met three times under a very tight schedule to complete its task as early in 1975 as possible. Five panels in disciplinary areas (Basic Medical Sciences, Basic and Applied Biology, Behavioral Sciences, Clinical Sciences, and Health Services Research and Evaluation) and three panels in methodological areas (Supporting Studies, Data and Analyses, and Impacts of Training) assisted the committee in reviewing the adequacy of data and methodology for estimating national personnel needs in the biomedical and behavioral research fields and in considering some possible approaches to the tasks set by the Congress.

The chairmen of the Commission and committee and members of the staff consulted widely concerning ways of responding to the Congressional mandate. Within the NRC—in addition to the Commission itself—the following units were kept informed and invited to contribute: Assembly of Behavioral and Social Sciences, Assembly of Life Sciences, and Institute of Medicine. The chairmen of related sections of the National Academy of Sciences were invited to express their views. Outside the Academies-Institute-Council complex, a number of groups were consulted: the staff of related Congressional committees, NIH/ADAMHA/HRA, the Office of Management and Budget, the Office of the Assistant Secretary/HEW-Health, and a number of scientific and professional societies and educational organizations.

The committee's report on feasibility was completed early in February and submitted to the NRC Governing Board on February 21, 1975.[5] It recommended that the National Academy of Sciences, operating through the NRC's Commission on Human Resources, accept the Secretary's invitation to conduct the continuing study, but stated a number of conditions and caveats. The committee viewed the task as difficult, but necessary and --in a suitably long time frame--feasible. The report discussed the reasons for this belief, but necessarily left a number of important questions to be answered in the continuing study. In response, the Governing Board approved the first phase of the continuing study to June 30, 1975. The Chairman of the National Research Council replied to this effect to the Secretary on March 6, 1975, transmitting a copy of the committee's report.

SCOPE OF THE FIRST REPORT

The legislative date for the annual submission of a report to the Congress by the Academy through the Secretary was March 31. It was agreed, however, that the first report could not be provided before June 1, 1975, because of the need to make preparations for the task ahead. The feasibility report made it clear that this task would indeed be complex and difficult:

> Assaying quality [of personnel] is a difficult problem. There are at present only rough methods for taking this attribute into account, such as assuming that the quality of institutions or departments can be measured, and that on the whole institutional quality is related to the quality of those who are awarded degrees.
>
> The results of attempts to produce supply and demand forecasts by field and discipline have been spotty. Sizeable differences between projected estimates and actuality are not uncommon....
>
> One of the central problems of projections is the difficulty of formulating generally acceptable concepts of underemployment....

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[5] National Research Council, Report of the Committee on a Feasibility Study on National Needs for Biomedical and Behavioral Research Personnel, Commission on Human Resources, 1975.

> In addition to methodologic complexity and data shortcomings that plague the projector, there is the well-known fact that published projections are viewed as predictions by the public and the market moves to defeat the predictions. Employers and prospective employees note where "shortages" or "overages" are forecast and shape their strategies accordingly.

In spite of these problems ahead, the committee on the feasibility study thought that a beginning could be made. Its first recommendation was:

> The committee recommends that the National Academy of Sciences accept the invitation of the Secretary to conduct the continuing study mandated by Title I of the National Research Act. The recommendation is based on the belief: (1) that within the methodologic limitations outlined in this report a productive start can be made during the current fiscal year toward meeting the requirements specified in the law; (2) that improvements can be expected in ability to gather and utilize needed information as experience is gained over the next several years; and (3) that the National Research Council through the experience of its Commission on Human Resources and its ability to call upon the skills of the scientific community is the most appropriate agency to conduct the continuing study. The recommendation further assumes that sufficient agreement can be reached on the conditions for the study as outlined below.

The feasibility report went on to describe these conditions, some of which could be readily established, others of which (improvement of the data base, development of more sophisticated methodologies) would be realizable only in a period of several years. The 1975 report, it was clear, to be prepared within a period of about 90 days, could not be more than a preliminary response to the Congressional request—the result of an effort to bring readily available data and professional judgment to bear on the study requirements. The committee for the feasibility report looked to the reports of 1976 and beyond to provide the basis on which the efficacy of the continuing study should be judged.

A concurrent development of great significance to the task ahead was the Presidential appointment late in 1974 of the Panel on Biomedical Research, chaired by Franklin Murphy. It is the Panel's task to assess the federal programs for the support of biomedical research, identify areas of future research need, and—around the end of FY 1976—submit recommendations for federal funding. The committee for the feasibility study pointed out that personnel requirements and federal research support in these fields were very closely related to each other. Several studies had shown that the numbers of research doctorates awarded—suitably lagged to allow for the training period—were substantially determined in a correlational sense by federal R and D funds in the biomedical fields. The federal government, through its system of research grants and contracts and training programs, is the major supporter of biomedical research personnel and—to a lesser extent—behavioral research personnel. Federal decisions to increase or decrease research funds exercise a compelling influence on the labor market in these fields. It would clearly be necessary for the continuing study of personnel to be kept apprised of the development of the Panel's study and to follow trends in R and D support.

THE COMMITTEE

Appointed by the Chairman of the Commission on Human Resources with the approval of the Chairman of the National Research Council, the Committee on a Study of National Needs for Biomedical and Behavioral Research Personnel (Appendix A) has the overall supervisory responsibility for the study and for the annual reports issuing from it. The Committee is a multidisciplinary group, bringing experience from the biomedical and behavioral research communities, academia and industry, different institutional types, and various areas of expertise in studies. Two thirds of the members also served as members of the committee for the feasibility study. Although the Committee is associated with a Commission within the NRC structure and submits its reports in accord with NRC report-review procedures, the contents, findings, and recommendations of the annual reports are those of the Committee alone. The Committee has held four meetings in the period February 28 to June 1, 1975.

THE PANELS

To assist the Committee with its tasks in various areas of specialization, five Panels have been appointed (Appendix B). Four of them are in disciplinary areas related to national research personnel needs and training: Basic Biomedical Sciences, Behavioral Sciences, Clinical Sciences, and Health Services Research. One of them—Data and Studies—is concerned with the methodology and information sources to be used. About 60 percent of the Panel members took part in the feasibility study. The findings and recommendations of the Panels are transmitted to the Committee for its consideration in arriving at its own judgments. Queries and suggestions from the Committee provide many of the Panel agenda, but the Panels have the prerogative of initiating inquiries on their own. The Panel on Data and Studies has held two meetings in the period February 28 to June 1, 1975, and the Panel on Basic Biomedical Sciences and the Panel on Behavioral Sciences have met once in that period. Members of the Panels in disciplinary areas have submitted individual estimates of the needs for personnel in their areas. Members of all the Panels have reviewed a draft of the present report and have had an opportunity to comment on it.

NIH, ADAMHA, AND HRA

Although NIH has been designated the lead agency for the study and provides financial support for it, ADAMHA and possibly the Health Resources Administration (HRA) also are affected by the provisions of the Act. All three agencies have an interest in the study. They have provided program data, interpretations of administrative policies and procedures, and other kinds of assistance to the Committee. In turn, the Committee, through its staff, has kept the agencies informed about the progress of the study. To facilitate the exchange of program data and related information, two working groups are being established: (1) Data and Administrative Procedures and (2) Coordination of Studies. Representatives of the NIH/ADAMHA/HRA staffs and Committee staff will serve as members of the groups, which will meet monthly.

OTHER ORGANIZATIONS

Interest in the study and concern about the problems it addresses are widespread throughout the academic community. The Committee has endeavored to provide information about its work to the several interested publics through a variety of means: news releases, distribution of copies of the feasibility report, interviews, meetings with representatives of professional societies, correspondence with interested persons, and specific queries and requests for information

to individuals and organizations. Many of the members of the Committee and its Panels are active in the affairs of the scientific and professional societies in the biomedical and behavioral sciences and have served as information links.

STAFF AND CONSULTANTS

The committee for the feasibility study recommended that adequate resources be provided to assist the Committee in carrying out the demanding tasks called for in the Act, envisioning a steady-state budgetary level of almost $1 million annually and a staff of about 25 persons. It was recognized at the same time that it would not be possible to reach this level immediately and that indeed some quite different level might seem more suitable upon closer examination of the work ahead.

During the period February 28 to June 1, 1975, the Committee has had the assistance of five professional staff members, seconded from the staff of the Commission on Human Resources, and an administrative and secretarial staff of three. It has also received effective assistance from five consultants, who provided specialized services in several areas of concern to the Committee.

ORGANIZATION OF THIS REPORT

The Committee provides in this first report some data, observations, and statements of principle that are relevant to its recommendations, as well as the recommendations themselves. The latter were presented in the front of this report and include not only numerical recommendations of training levels, but also—and importantly—recommendations to ensure that a high quality of predoctoral and postdoctoral training will be maintained in each of four broad disciplinary areas. Chapter II describes the training programs--their development, current levels, and estimated levels in FY 1976. Included is a brief summary of what is known about the utilization of training by former fellows and trainees. Chapter III deals with a number of principles that have guided the Committee in its thinking about the purposes of research training and the effective allocation of training resources. A number of problems come to the fore in the application of these principles and are described in the second half of this chapter. In Chapter IV, some significant trends concerning the development and utilization of biomedical and behavioral research personnel, selected from a great variety of staff studies, are presented to provide some indication of the way the complex training/utilization system seems to be moving. Estimates of the size of the pool of biomedical and behavioral researchers conclude this section.

The discussion in Chapter V provides a brief summary of important points.

In preparing this report, the Committee has been selective rather than comprehensive. Many additional data were analyzed, but are not included either because the Committee was dissatisfied with the quality of the data base or because the studies could not be pursued to a definitive conclusion within the available time. Much of this preliminary work will be of use in writing later reports.[6]

[6]See Appendix D for a discussion of data sources and planned studies.

II. THE TRAINING PROGRAMS

RELATION TO RESEARCH AND BETTER HEALTH CARE FOR THE NATION

The primary purposes of the research training programs sponsored by the NIH, ADAMHA, and HRA are, first, to ensure the quality of the research training effort and, secondly, to provide a cadre of highly trained individuals to conduct research in the biomedical and behavioral fields. Ample evidence has been cited in other sources[7] to show that research advances made in bioscience and behavioral science have improved our health-care system. Of great long-range concern to the Committee is the question of the cost to the nation from inadequate expansion of knowledge upon which reduction of illness and disease ultimately depends. Such research requires a continuing supply of trained biomedical/behavioral research personnel. Training programs have helped to establish in universities and medical schools a mechanism for bringing together scientists from diverse backgrounds and disciplines into programs which can provide important interdisciplinary training for the trainees and from which emerge significant new fields and specialties. Evidence of the effects of the NIH training programs on the career patterns of bioscientists has been examined in a study recently completed by a committee[8] of the National Research Council. This chapter provides a brief description of those aspects of the training programs that are especially relevant to the purposes of this report.

DEFINITIONS

This section is devoted to the definition of terms used throughout the report and to a list of disciplinary categories. Most of these will

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[7] Scientific and Educational Basis for Improving Health, Report of the Panel on Biological and Medical Science of the President's Science Advisory Committee, Executive Office of the President, Office of Science and Technology, Washington, D.C., 1972.

[8] The Impact of the NIH Training Programs on the Career Patterns of Bioscientists, National Research Council, in press.

be well-known to those familiar with biomedical/behavioral research personnel issues, but we define them here for ready reference and for the benefit of the general reader.

1. Training Mechanisms

The federal training programs have consisted of fellowships awarded to individuals and training grants which provide support to individuals and institutions for graduate and postdoctoral education in the biomedical/behavioral fields.

Predoctoral and postdoctoral. In predoctoral training, emphasis is placed on the acquisition of fundamentals; comprehension of basic disciplines is essential to do research. The predoctoral student needs the breadth and integration provided by departmental programs. The postdoctoral scientist, however, while continuing to acquire fundamental experience, tends to specialize his efforts under the guidance of a senior mentor. Although most postdoctorals work in major research centers, some have been trained well in outstanding laboratories of principal investigators in small institutions. It is in postdoctoral work that the cancer researcher, neurobiologist, or clinical statistician, focuses on his or her field of emphasis. It should also be noted that concomitantly with his or her further training, the postdoctoral accomplishes research also and thereby adds to knowledge in that field.

Fellowships are awarded to individuals applying through institutions in nationwide competitions administered by the sponsoring agencies. The successful applicants are provided with stipends geared to the individual's level of education and experience, plus allowances for tuition, dependents, travel, and supplies. The fellowship has been awarded at three levels:[9]

1. Predoctoral - granted to students whose goal is the Ph.D. degree and to medical students pursuing research on a part-time basis. (This program was phased out beginning in 1970.)

2. Postdoctoral - granted to holders of the Ph.D. or the M.D. who are seeking additional research training.

[9] Throughout this report, the term "Ph.D." refers to all research doctorates (Ph.D., D.Sc., D.P.H., D. Eng., etc.) and "M.D." is the generic term used for all professional doctorates (M.D., D.V.M., D.D.S., D.O., etc.)

3. Special Fellowships - granted to scientists with some training or experience to allow for a period of additional training, generally at the post-doctoral level.

Training grants are awarded to one or more departments of a university, medical school, or research institution upon application to strengthen an existing program for training predoctoral and/or postdoctoral trainees in a specified discipline. The awards are made after external peer review in national competition, and contain funds for trainee stipends and tuition, and for partial support of the academic environment (faculty salaries, equipment, supplies, etc.) in the department in which the training takes place. Trainees under the grant are appointed by the department, which then assumes the responsibility for providing a high-quality training program subject to peer review for extension. The training grant can provide support to any mixture of predoctoral and postdoctoral trainees.

Full-time - refers to a training period equivalent to at least one academic year.

Research Assistants - usually predoctoral or postdoctoral students supported by funds from a research grant or contract.

Teaching Assistants - predoctoral or postdoctoral students may be supported by their institutions as teaching assistants because of their contributions to teaching programs. These teaching assignments are usually at the undergraduate level and are available generally at institutions with large undergraduate teaching responsibilities.

2. Research Fields Referred to in This Report

The fields in which biomedical and behavioral research is carried out cover a very wide spectrum of the sciences. There is no standard system of classification of fields used by the various organizations that collect manpower data. The Office of Education, the National Science Foundation, the National Research Council, the National Institutes of Health, and the Association of American Medical Colleges all use taxonomies that are perhaps suitable to their own purposes but differ from the others in important respects.

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The purpose of this document is to establish the Nation's overall need for biomedical and behavioral research personnel. Dealing with a limited analysis of the current situation rather than with projections, the document provides data, observations, statements of principle and recommendations. Chapter two describes training programs--their development, current levels and estimated levels in FY 1976, and what is known about the utilization of training by former fellows and trainees. Chapter three deals with a number of principles that have guided the Committee. A number of problems emerge when these principles are applied. These problems include: the costs of imbalance of supply and demand; market studies and their limitation; fellowships versus training grants; training grant funds to institutions and to trainees; and the postdoctoral pool. In Chapter five some significant trends concerning the development and utilization of biomedical and behavioral research personnel are presented, including: graduate enrollments and student support; Ph.D. output 1961-74; research and development expenditures; current number of active researchers. Chapter four provides a brief summary of important points. Appendices contain lists of committees and members; legislative and administrative history of training authorities; some data sources and studies; and a bibliography. (Author/KE)

*Higher Education; *Behavioral Research; *Medical Research; *Doctoral Education; *Postdoctoral Education; Program Planning; Training Objectives; Student Characteristics; Federal Role; Grants; Fellowships; Enrollment Trends; Educational Supply; Manpower Ulitization; Costs

Although any scheme developed by one organization will probably not satisfy all the requirements of another, it has been necessary in this study to begin to establish a taxonomy for biomedical/behavioral manpower. This has been done by utilizing the departmental classification scheme of the Doctorate Records File maintained by the NRC, augmented in the clinical sciences by the discipline/field/specialties list used by the NIH. An important consideration in establishing this classification scheme is that many of the data required for this study are collected using either the Doctorate Records File or the NIH structure. For purposes of this report, a tentative taxonomy has been established which consists of four broad fields, within each of which a number of subfields are included. These are as follows:

Basic Biomedical Sciences

- Anatomy
- Biochemistry
- Biomathematics
- Biomedical Engineering
- Biophysics
- Cytology
- Embryology
- Genetics
- Immunology
- Microbiology/Bacteriology
- Molecular Biology
- Parasitology
- Pathology
- Pharmacology
- Physiology
- Basic Biomedical Sciences, Other

Other Fields Included with Basic Biomedical Sciences[10]

- Botany
- Ecology
- Entomology
- Environmental Sciences
- Hydrobiology
- Nutrition/Food Science
- Pharmaceutical Sciences
- Zoology

Behavioral Sciences

- Anthropology
- Behavior/Ethology
- Clinical Psychology
- Comparative Psychology
- Counseling & Guidance
- Developmental Psychology
- Educational Psychology
- Experimental Psychology
- Gerontological Psychology
- Human Engineering
- Industrial & Personnel Psychology
- Personality Psychology
- Physiological Psychology
- Psychometrics
- School Psychology
- Social Psychology
- Social Statistics
- Sociology
- Psychology, Other

[10]Certain specialties within these rather large fields are a part of the basic biomedical sciences, but others are only marginally related. For this reason, these subfields are put in a special category.

Clinical Sciences

- Dentistry
- Medicine & Surgery
  - Allergy
  - Anesthesiology
  - Geriatrics
  - Internal Medicine
    - Cardiovascular Diseases
    - Clinical Nutrition
    - Connective Tissue Diseases
    - Dermatology/Syphilology
    - Diabetes
    - Endocrinology
    - Gastroenterology
    - Hematology
    - Infectious Diseases
    - Liver Diseases
    - Metabolic Diseases
    - Nuclear Medicine
    - Oncology
    - Renal Diseases
    - Tropical Medicine
    - Internal Medicine, Other
  - Neurology
  - Obstetrics/Gynecology
  - Ophthalmology/Optometry
  - Otorhinolaryngology
  - Pediatrics
  - Preventive Medicine
  - Psychiatry
  - Radiology
  - Surgery
- Veterinary Medicine
- Clinical Sciences, Other

Health Services Research

- Biometrics/Biostatistics
- Epidemiology
- Health Economics
- Hospital Administration
- Public Health

There is no intent in this report to restrict training to those subfields explicitly shown in the above list. The Committee recognizes that a number of subfields important to biomedical and behavioral research, currently supported by the NIH/ADAMHA/HRA—such as orthopedics, osteopathy, pulmonary diseases, urology, neurosurgery, and systems analysis—are not shown in this taxonomy, which was constructed from the classification schemes mentioned above mainly as an aid to the organization and collection of data. Although this report is concerned primarily with recommendations for the four broad categories, the allocation of training support to each subfield within a more detailed classification scheme will be discussed in the next report under the continuing study.

GROWTH OF TRAINING

Although the first fellowships were awarded in 1938[11], the training programs did not begin to grow significantly until late in the 1950's. Up to that time, the programs were providing support to a few hundred postdoctoral fellows annually at funding levels not exceeding $10 million per year. After 1955, the training grant became firmly established as a support mechanism, and under it, the predoctoral program emerged and began to take on added importance as an NIH training component. Federal funds for scientific research grew from less than $1 billion in 1958 to over $5 billion in 1966.[12] The physical sciences and engineering received most of the increase, but the life sciences also received a large share. The research training programs of the NIH and the NIMH grew even more rapidly than the research budgets from $18 million in 1958 to $157 million in 1966 (TABLE 1). It was during this period that the support of predoctorals on training grants became numerically the largest single component of the NIH programs. About 10 percent of all the NIH trainees and fellows who started training during 1956-60 were pre-Ph.D. students. During the period 1966-72, this figure was about 40 percent.[13] Another significant component contributing to the growth was the post-M.D. trainee group which went from less than 500 new starts (5 percent of all new starts) during the 1956-60 period, to over 10,000 new starts (23 percent of all new starts) during 1966-72. By contrast, the post-Ph.D.'s constituted 10 percent of new starts during 1956-60 and only 8 percent during the 1966-72 period.

Around 1968, the training programs began the transition from a period of growth to a period of consolidation. As FIGURE 1 and TABLE 1 show, the growth rate of the NIH/ADAMHA research training programs in actual dollars was about 11 percent per year from 1960 to 1968. From 1968 to 1974, there has been considerable apparent variation from year to year in the level of expenditures for these programs; the growth rate varies quite widely depending on how it is calculated. In 1974, the obligation level was at a record high primarily because funds impounded in FY 1973 were released in FY 1974. Therefore, the actual change from 1968 to 1974 shows an increase. But a more realistic way of calculating the growth during this period is by using a least-squares smoothing process. When this is done, as in FIGURE 1, the series exhibits a

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[11] See Appendix C for the legislative and administrative history of the training programs.

[12] Federal Funds for Research Development and Other Scientific Activities, National Science Foundation, Washington, D. C., Volume XVIII, 1969.

[13] These data were derived from the Master File of NIH Trainees and Fellows developed for NIH in 1974 by the Commission on Human Resources of the National Research Council. See TABLE 2.

TABLE 1 NIH/ADAMHA Obligations for Research Training Grants and Fellowships, 1960-74

Fiscal Year	NIH obligations for research training excluding NIMH		ADAMHA		NIH/ADAMHA			Consumers Price Index	NIH/ADAMHA
	TG	F	TG (Research only)	F	TG	F	TG & F	1967=100	TG & F Constant $
	Millions of dollars								
1960	45.9	12.9	1.9	1.9	47.8	14.8	62.6	88.6	70.7
1961	68.5	14.9	2.5	2.0	71.0	16.9	87.9	89.6	98.1
1962	76.5	15.8	3.8	2.9	80.3	18.7	99.0	90.6	109.3
1963	90.2	17.9	5.1	4.1	95.3	22.0	117.3	91.7	127.9
1964	96.9	17.2	6.7	4.9	103.6	22.1	125.7	92.9	135.3
1965	108.3	19.3	8.0	5.1	116.3	24.4	140.7	94.5	148.9
1966	120.8	21.5	9.5	5.1	130.3	26.6	156.9	97.2	161.4
1967	131.7	25.3	11.2	5.6	142.9	30.9	173.8	100.0	173.8
1968	132.9	27.7	12.3	5.6	145.2	33.3	178.5	104.2	171.3
1969	139.6	29.8	14.6	5.9	154.2	35.7	189.9	109.8	173.0
1970	128.9	22.7	13.0	5.7	141.9	28.4	170.3	116.3	146.4
1971	130.1	23.9	13.0	3.7	143.1	27.6	170.7	121.3	140.7
1972	137.2	21.6	13.7	3.5	150.9	25.1	176.0	125.3	140.5
1973-74[1]	122.2	30.6	13.7	1.5	135.9	32.2	168.0	140.4	119.7

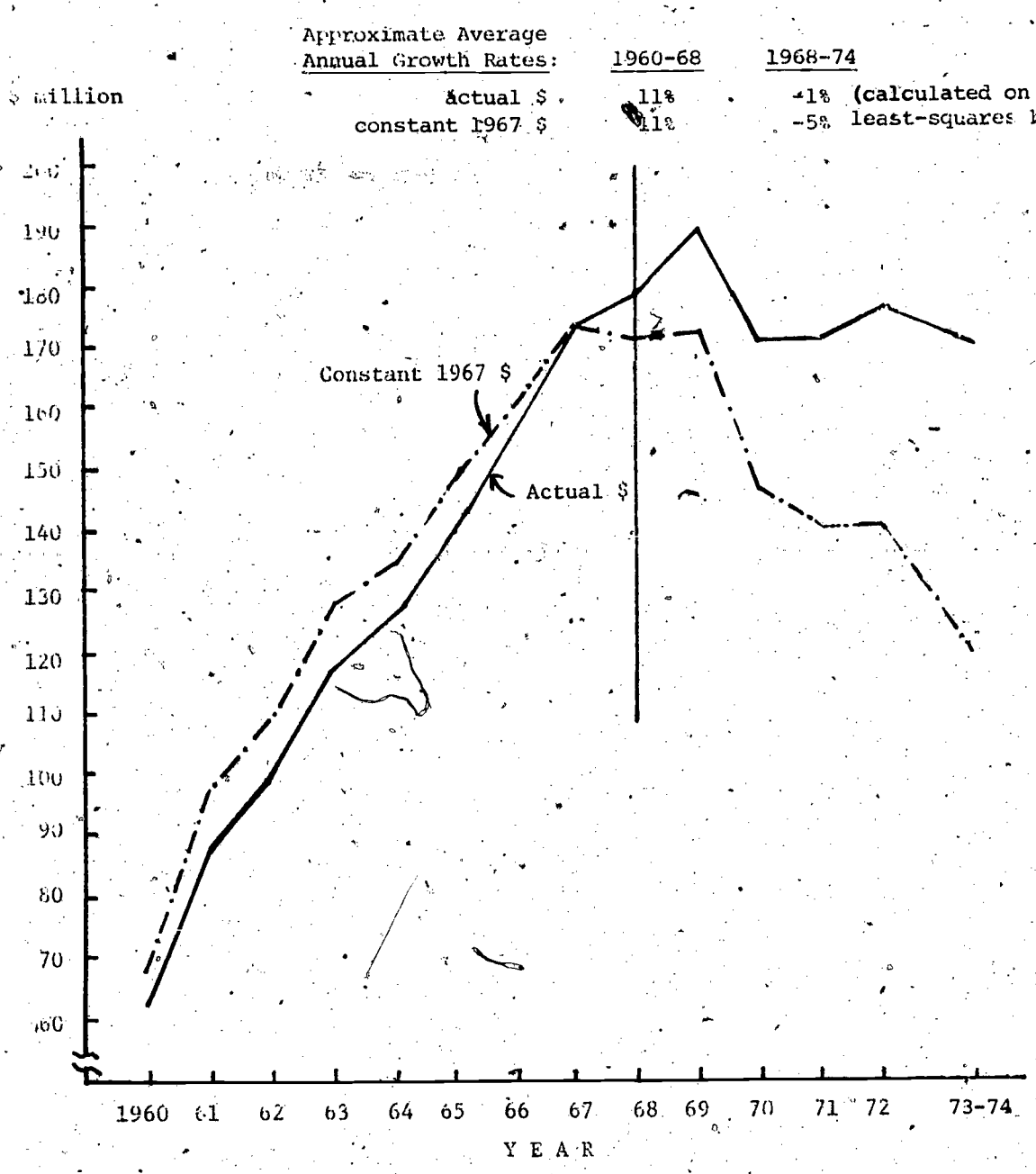
TG = Training grants

F = Fellowships (excludes Research Career Awards)

Source: Training grant data derived from Basic Data Relating to NIH, 1974, p. 22, adjusted to reflect NIH research training only by subtracting out NIMH data supplied by the Special Projects Branch, Office of Legislative Analysis/Office of the Director of NIH for 1960-66. The NIMH data tabulated by NIH include clinical training grants and research training grants. The ADAMHA data for 1960-69, which were prepared by the Manpower Analytic Studies Branch, ADAMHA, 3/19/75, contain only research training grants. ADAMHA data for 1970-74 were supplied by the Office of the Assistant Administrator for Extramural Programs, 5/6/75.

[1]Some training funds were impounded in FY 1973 and released in FY 1974. To smooth out the erratic fluctuations caused by these actions, 1973 and 1974 data have been averaged. The actual total for NIH/ADAMHA was $126.4 million in 1973 and $209.6 million in 1974.

FIGURE 1 NIH/ADAMHA Obligations for Research Training Grants and Fellowships, 1960-74



Source: TABLE 1

TABLE 2 Number of Persons Trained in the Research Training Programs of NIH by Program Type, Year of Training, Academic Level at First Award, and Full-time/Part-time Status, 1938-72

YEAR TRAINING STARTED	ACADEMIC LEVEL AT FIRST AWARD	PROGRAM TYPE: TRAINEES FT	TRAINEES PT	TRAINEES UNK	TRAINEES TOTAL	FELLOWS FT	FELLOWS PT	FELLOWS UNK	FELLOWS TOTAL	TOTAL INCLUDING UNKNOWN PROGRAM FT	TOTAL INCLUDING UNKNOWN PROGRAM PT	TOTAL INCLUDING UNKNOWN PROGRAM UNK	TOTAL INCLUDING UNKNOWN PROGRAM TOTAL
1938-45	PRE-PHD	---	---	---	---	---	---	---	---	---	---	---	---
	POST-PHD	---	---	---	---	20	---	---	20	20	---	---	20
	PRE-MD	---	---	---	---	---	---	---	---	---	---	---	---
	POST-MD	---	---	---	---	10	2	---	12	10	2	---	12
	POST-MD/PHD	---	---	---	---	---	---	---	---	---	---	---	---
	POST-MD/PRE-PHD	---	---	---	---	---	---	---	---	---	---	---	---
	OTHER & UNKNOWN	---	---	---	---	89	7	1	97	89	7	1	97
	TOTAL	---	---	---	---	119	9	1	129	119	9	1	129
1946-50	PRE-PHD	---	---	---	---	---	---	---	(a)	---	---	---	---
	POST-PHD	1	---	---	1	121	11	---	132	122	11	---	133
	PRE-MD	---	---	---	---	---	---	---	---	---	---	---	---
	POST-MD	---	---	---	---	316	13	---	329	316	13	---	329
	POST-MD/PHD	---	---	---	---	13	1	---	14	13	1	---	14
	POST-MD/PRE-PHD	---	---	---	---	---	---	---	---	---	---	---	---
	OTHER & UNKNOWN	---	---	---	---	583	32	1	616	583	32	1	616
	TOTAL	1	---	---	1	1033	57	1	1091	1034	57	1	1092
1951-55	PRE-PHD	---	---	---	---	---	---	---	(a)	---	---	---	---
	POST-PHD	1	---	---	1	298	14	---	312	299	14	---	313
	PRE-MD	---	---	---	---	---	---	---	---	---	---	---	---
	POST-MD	---	---	---	---	394	16	3	413	394	16	3	413
	POST-MD/PHD	---	---	---	---	9	1	---	10	9	1	---	10
	POST-MD/PRE-PHD	---	---	---	---	---	---	---	---	---	---	---	---
	OTHER & UNKNOWN	1	---	1	2	1317	74	3	1394	1318	74	4	1396
	TOTAL	2	---	1	3	2018	105	6	2129	2020	105	7	2132
1956-60	PRE-PHD	724	128	4	856	100	22	1	123	824	150	5	979
	POST-PHD	120	38	---	158	607	130	3	740	727	168	3	898
	PRE-MD	248	240	2	490	2	6	---	8	250	246	2	498
	POST-MD	403	75	1	479	2293	309	8	2610	2697	385	9	3091
	POST-MD/PHD	14	2	---	16	76	14	---	90	90	16	---	106
	POST-MD/PRE-PHD	45	---	---	45	40	3	---	43	85	3	---	88
	OTHER & UNKNOWN	387	101	3	491	2890	1148	18	4056	3282	1257	22	4561
	TOTAL	1941	584	10	2535	6008	1632	30	7670	7955	2225	41	10221

FT = Full-time (equivalent of one academic year of training regardless of the percentage of time spent in training during the year.)
PT = Part-time
UNK = Unknown (data not available.)

TABLE 2 - continued

YEAR TRAINING STARTED	ACADEMIC LEVEL AT FIRST AWARD	PROGRAM TYPE: TRAINEES FT	TRAINEES PT	TRAINEES UNK	TRAINEES TOTAL	FELLOWS FT	FELLOWS PT	FELLOWS UNK	FELLOWS TOTAL	TOTAL INCLUDING UNKNOWN PROGRAM[1] FT	PT	UNK	TOTAL
1961-65	PRE-PHD	7458	1331	67	8883	1580	173	20	1773	9072	1512	87	10671
	POST-PHD	196	274	4	1074	913	94	4	1011	1709	368	8	2085
	PRE-MD	1944	3837	14	5795	71	252	---	323	2019	4093	14	6126
	POST-MD	5613	645	16	6274	2681	389	4	3074	8303	1038	20	9361
	POST-MD/PHD	174	24	---	198	113	15	---	128	288	39	---	327
	POST-MD/PRE-PHD	499	39	2	540	148	11	1	160	647	50	3	700
	OTHER & UNKNOWN	1045	1468	2	2515	919	241	3	1163	1969	1715	5	3689
	TOTAL	17556	7618	105	25279	6425	1175	32	7632	24007	8815	137	32959
1966-72	PRE-PHD	15071	2379	68	17517	1414	9	9	1432	16484	2388	77	18949
	POST-PHD	1637	446	24	2107	1534	77	14	1625	3171	523	38	3732
	PRE-MD	1233	6378	59	7669	12	81	---	93	1245	6459	59	7763
	POST-MD	9172	1203	174	10549	1004	21	11	1036	10176	1224	185	11585
	POST-MD/PHD	131	9	4	144	49	3	---	52	180	12	4	196
	POST-MD/PRE-PHD	686	67	7	760	140	3	4	147	826	70	11	907
	OTHER & UNKNOWN	506	2038	24	2568	1108	17	5	1130	1614	2055	29	3698
	TOTAL	28435	12520	360	41315	5261	211	43	5515	33696	12731	403	46830
UNKNOWN	PRE-PHD	20	4	5	29	21	1	59	81	41	5	64	110
	POST-PHD	1	---	1	2	198	6	40	244	199	6	41	246
	PRE-MD	1	---	4	5	---	---	1	1	1	---	5	6
	POST-MD	5	2	11	18	95	1	57	153	100	3	68	171
	POST-MD/PHD	---	---	---	---	6	1	2	9	6	1	2	9
	POST-MD/PRE-PHD	---	---	---	---	10	---	1	11	10	---	1	11
	OTHER & UNKNOWN	3	1	14	18	7	1	81	89	10	2	95	107
	TOTAL	30	7	35	72	337	10	241	588	367	17	276	660
TOTAL ALL YEARS	PRE-PHD	23299	3842	144	27285	3115	250	89	3409	26421	4055	233	30709
	POST-PHD	2556	758	29	3343	3691	332	61	4084	6247	1090	90	7427
	PRE-MD	3426	10455	79	13960	85	339	1	425	3515	10798	80	14393
	POST-MD	15193	1925	202	17329	6793	751	83	7625	21996	2681	285	24959
	POST-MD/PHD	319	35	4	358	266	35	2	303	586	70	6	662
	POST-MD/PRE-PHD	1230	106	9	1346	338	17	6	363	1568	123	15	1709
	OTHER & UNKNOWN	1942	3608	44	5594	6913	1520	112	8545	8865	5142	157	14164
	TOTAL	47965	20729	511	69205	21201	3199	354	24754	69198	23959	866	94023

(a) A few predoctoral fellowships were awarded beginning in 1946. The records of these fellows had to be reconstructed from scanty data so it was not possible in all cases to identify the academic levels. Most of the early predoctoral awardees are counted in the "other and unknown" academic level category.

1 64 individuals with unknown program types are included in the total.

Source: NIH Roster of Trainees and Fellows, Summary File B, 6/5/74, National Academy of Sciences, National Research Council, Commission on Human Resources.

decline of about 1 percent per year in actual dollars. Taking inflation into account, the decline is almost 5 percent per year in real terms. The deflator used in this case was the consumer's price index, 1967=100.

Information about the level of expenditures for pre- and post-doctoral programs separately is not available and cannot easily be estimated. The reason is that although both pre- and postdoctoral trainees are supported on training grants, the agencies do not break out these funds by academic level. It may be possible in the future to derive a reasonable estimate based on the number of trainees in each academic level, but this calculation has not yet been made.[14]

Over 94,000 people had participated in the NIH training programs through 1972,[15] about half of them in the basic biomedical sciences. The most heavily supported fields were biochemistry, microbiology, and physiology. The clinical sciences were next largest with about 30 percent of all trainees, and the balance was distributed among other health-related fields, the physical sciences, and psychology.

About two thirds of the people supported by NIH have started on training grants, one third on fellowships.

The proportion of graduate students in the biosciences supported by NIH reached a peak of 28 percent in 1964 and has gradually declined since then to about 18 percent in 1971. In the health professions, the 1967 peak of 16 percent has declined to about 10 percent in 1971.

SOME CHARACTERISTICS OF NIH TRAINEES AND FELLOWS [16]

The length of support provided by the NIH depends on the academic level of the trainee. Those who were seeking a Ph.D. were supported for a longer period than others because of the more extensive study required to attain the Ph.D. The typical pre-Ph.D. received 22 months of support from the NIH while the typical post-Ph.D. received about 16 months of support.

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[14] See also TABLE 5 for information about support of training in these fields by other agencies.

[15] The data cited here are given in more detail in the report The Impact of the NIH Training Programs on the Career Patterns of Bioscientists, loc. cit.

[16] The data cited in this section do not include ADAMHA or HRA trainees and fellows.

Since these figures describe the average experience of all trainees and fellows supported by the NIH during the period 1938 through 1972, it is to be expected that considerable variation exists in the data. About 19 percent of all pre-Ph.D. trainees have had more than four years of support, while 39 percent have had only one year or less, including those who complete the program and those who drop out. In many cases, teaching and research assistantships have supplemented the funds provided by the NIH.

For the 1966-70 period, the total cost to NIH for a typical pre-Ph.D. fellow during the course of his training averaged about $8,100; for a post-Ph.D fellow, it was about $11,500. These figures include the stipend and dependency allowances, which go to the fellow, and allowances for tuition and supplies, which go to the institution. The amount of support has increased irregularly at an average rate of about 4 percent per year, just about the same as the increase in the cost of university education.

Pre-Ph.D. trainees in the 1960's began their supported training on an average of 2.5 years after the B.A. Post-Ph.D. support typically began between one and two years after the Ph.D. Post-M.D.'s received their first support generally after the residency, about 4.5 years beyond the M.D.

In the biological and physical sciences, those individuals with predoctoral traineeships or fellowships attained the Ph.D. more frequently and in less time than those without such support. Differences in ability, however, may account for some or all of the differences in Ph.D. attainment rates and in the shorter time lapse from B.A. to Ph.D.

The pre-Ph.D. trainees supported by NIH in the biosciences between 1956 and 1965 had a Ph.D. attainment rate of 66 percent compared to 42 percent for the nonsupported group during the same period. NIH pre-Ph.D. fellows had an attainment rate of 91 percent in the biosciences. The fellows do somewhat better than the trainees in terms of Ph.D. attainment, partly because they are a more highly selected group, and partly because they have received their fellowships at a later stage in their education. On the average, the pre-Ph.D. trainees received their first support two and one-half years after the B.A. while the fellows received theirs three and one-half years after the B.A.

ACTIVITIES OF FORMER NIH TRAINEES AND FELLOWS

One of the tasks set by the National Research Service Award Act for the continuing study is to "identify the kinds of research positions available to and held by individuals completing such [training] programs." The Committee will deal with this subject in greater depth in the course of later studies, but presents here some of the facts now known about how former NIH trainees and fellows use their training.

A little more than 70 percent of former NIH post-Ph.D.'s whose employment was known listed research as their primary work activity during 1968-70. Another 24 percent of this group listed teaching as the primary activity. This compares with postdoctorals not supported by the NIH who were split 45 percent into research and 46 percent into teaching, and with Ph.D.'s without postdoctoral support, of whom 41 percent were primarily in research and 36 percent primarily in teaching.

The M.D.'s who have received NIH support do not have as high a rate of participation in research as the NIH-supported Ph.D.'s, but the M.D.'s tend to remain in research longer whereas the Ph.D.'s tend to move sooner into other activities, principally teaching and administration. Of the M.D.'s who formerly had received post-M.D. support from NIH, about 22 percent listed research and development as their primary work activity during 1968-70, and about 10 percent listed teaching. For the oldest cohort of this group (those whose B.A. was prior to 1941), 26 percent reported research as their primary activitity in 1968-70. For the younger cohort (those whose B. A. was during 1951-60), this figure was about 21 percent.

For M.D.'s, the attainment of the Ph.D. degree is also an important factor in career outcomes. Only 20 percent of the M.D.'s with NIH post-M.D. support prior to 1972, but no Ph.D., were engaged primarily in research in 1968-70, whereas almost 50 percent of those with NIH post-M.D. support and the Ph.D. were so engaged.

Over all years of experience and at almost all degree levels, research and teaching were less highly paid in 1970 than the alternative work activities of management, administration, or professional services to individuals. Given the same number of years of experience, the median salary of M.D.'s in research was about 30 percent higher than that of Ph.D.'s in research. In teaching, M.D.'s were paid about 60 percent more than Ph.D.'s. This in a sense is a measure of the premium in the form of salary differentials and of the incentives such as training support that must be paid in order to attract M. D.'s into research or teaching careers. Scientists who worked for educational institutions in 1970

were paid considerably less on the average than those who worked in private industry or government or were self-employed.

PRESENT LEVELS OF TRAINING—NIH, ADAMHA, AND HRA

The current number of people participating in the research training programs of NIH, ADAMHA, and HRA are shown in TABLE 3. The 1974 data can be taken as reasonably accurate, 1975 figures are estimates, and 1976 figures are projections based on administration budget requests.

There are two special circumstances concerning the administration of the training programs that must be noted. The first is that training grants are "forward financed," which means that trainees on duty in a fiscal year are supported from funds obligated in the previous year. Thus, variations in the funding of the training grants have a delayed reaction on the number of trainees supported. Secondly, successful fellowship applicants are allowed up to one year after they receive the award to activate the fellowship. The result of this is that the number of awards given in a fiscal year is not necessarily the same as the number of fellows on tenure in that year, although the two are usually approximately equal.

Except for ADAMHA, the data in TABLE 3 were derived from the numbers of trainees on tenure in a given fiscal year, and the number of fellowship awards made in that fiscal year. In other words, the table shows the approximate number of trainees and fellows on tenure in each fiscal year for NIH and HRA. For ADAMHA, it was not possible to provide exactly comparable data. What the agency has provided instead is the number of trainees funded in each year, which is the best available estimate although not the same as the number on tenure in that year.

TRAINING LEVELS IN THE PRESIDENT'S FY 1976 BUDGET

Recent trends in the reduction of funds for health research training programs are continued in the administration's proposed budget for FY 1976. The budget proposes allocations of approximately $124 million to NIH for research training, down from roughly $156 million in FY 1975. For ADAMHA, $16 million is proposed (down from $22 million to previous fiscal year) with no provision for new starts. For HRA, the FY 1976 proposal contains no funds for new starts and $900,000 for continuations.

Just as important as the absolute dollar amounts are the proposed changes in the type and level of support provided. In NIH, all predoctoral training support is scheduled for phaseout, and only 1,000 new postdoctoral trainees are being proposed in the FY 1976 budget. In the

TABLE 3 Approximate Number of Full-time NIH/ADAMHA/HRA Trainees and Fellows on Duty, Current and Projected through 1976

Agency	Fiscal Year of Support	Academic Level	Basic Biomedical Sciences	Behavioral Sciences	Clinical Sciences	Health Services Research	Total
NIH[1]	1972	Predoctoral	4696	617	811	522	6646
		Postdoctoral	2834	196	2933	199	6162
		Total	7530	813	3744	721	12808
	1973	Predoctoral	4636	581	695	453	6365
		Postdoctoral	2097	84	2749	108	5038
		Total	6733	665	3444	561	11403
	1974	Predoctoral	4403	505	115	196	5219
		Postdoctoral	2575	148	2856	63	5642
		Total	6978	653	2971	259	10861
	1975*	Predoctoral	5484	629	143	244	6500
		Postdoctoral	2905	167	3223	71	6366[2]
		Total	8389	796	3366	315	12866[3]
	1976*	Predoctoral	4598	527	120	205	5450
		Postdoctoral	2727	157	3025	66	5975
		Total	7325	684	3145	271	11425[4]
ADAMHA[5]	1974	Predoctoral	267	1281	0	160	1708
		Postdoctoral	223	130	0	73	426
		Total	490	1411	0	233	2134
	1975*	Predoctoral	244	1166	0	96	1506
		Postdoctoral	171	91	0	10	272
		Total	415	1257	0	106	1778
	1976*	Predoctoral	181	863	0	71	1115
		Postdoctoral	127	67	0	7	201
		Total	308	930	0	78	1316
HRA[6]	1974	Predoctoral	0	0	0	338	338
		Postdoctoral	0	0	0	28	28
		Total	0	0	0	366	366
	1975*	Predoctoral	0	0	0	300	300
		Postdoctoral	0	0	0	12	12
		Total	0	0	0	312	312
	1976*	Predoctoral	0	0	0	215	215
		Postdoctoral	0	0	0	6	6
		Total	0	0	0	221	221
GRAND TOTAL NIH/ ADAMHA/ HRA	1974	Predoctoral	4670	1786	115	694	7265
		Postdoctoral	2798	278	2856	164	6096
		Total	7468	2064	2971	858	13361
	1975*	Predoctoral	5728	1795	143	640	8306
		Postdoctoral	3076	258	3223	93	6650
		Total	8804	2053	3366	733	14956
	1976*	Predoctoral	4779	1390	120	491	6780
		Postdoctoral	2854	224	3025	79	6182
		Total	7633	1614	3145	570	12962

*FY 1975 and 1976 figures are estimates.

NOTES TO TABLE 3

[1]NIH data represent trainees on duty and fellowships awarded in each fiscal year.

[2]Assumes all fellowships are postdoctoral.

[3]The total of 12866 is composed of 11000 trainees and 1866 fellows of which 1179 are continuations and 687 are new starts under the assumption that 25 percent of new funds totaling $41.2 million are allocated to fellowships and 75 percent to training grants. The Committee is aware that changes in this ratio may still be instituted, but regards the data cited as the most probable estimates as of the date of preparing this report.

[4]The total of 11425 is composed of 9800 trainees and 1625 fellows of which 1010 are continuations and 615 are new starts. These figures are based on the assumption that 25 percent of new starts and continuation funds will be allocated to fellowships and 75 percent to training grants. The continuation budget in FY 1976 is estimated at $25.4 million, and the FY 1976 competing budget is estimated at $11.3 million.

[5]ADAMHA data represent trainees funded and fellowships awarded in the fiscal years shown. ADAMHA does not have data on trainees on duty in each fiscal year. FY 1975 data were based on estimated obligations of $21.8 million including $2.0 million in FY 1973 funds recently released; FY 1976 data were based on the administration's budget request of $16.2 million (continuations only, no new awards).

ADAMHA does provide support for the research training of M.D.'s and other personnel with a clinical sciences background (clinical psychologist, social workers, etc.) but such trainees are included in disciplinary areas other than clinical science in the above table.

[6]HRA data represent trainees on duty and fellowships awarded in the fiscal years shown. The 1975 data are based on the actual awards made in that year; the 1976 data are estimates based on the administration's 1976 budget request of about $900,000 for continuations, and no new starts.

SOURCE: Data taken from special tabulations prepared by each agency:

NIH: Office of Research Manpower, Division of Research Grants, Table 1, 5/1/75

ADAMHA: Office of the Assistant Administrator of Extramural Programs, Table 1, 5/7/75

HRA: Office of Academic and Intergovernmental Affairs, NCHSR, table dated 4/24/75

behavioral science, training for which has been traditionally concentrated at the predoctoral level, elimination of ADAMHA support will sharply curtail training support.

For NIH and ADAMHA, the import of these policy and funding changes is that most FY 1976 funds will go toward supporting continuing trainees, i.e., those who had begun their training in prior years. Only $14 million out of the proposed $124 million for NIH is targeted toward new starts.

It should be noted, too, that the type of support recommended differs from that of previous years. According to administrative guidelines, the portion of the training grant that can be utilized for program expenditures has been cut back from an average of 45 percent of the training grant (including indirect costs) to approximately 33 percent, with the result that a larger portion of the training grants are being allocated to trainee costs.

The impact of these changes on the number of fellows and trainees supported is difficult to assess given the uncertainties in the distribution of funds between fellowships and training grants, predoctoral and postdoctoral awards, and the portion of training grants devoted to trainee costs. What does seem certain, given the President's FY 1976 budget proposal, is 1) an overall decline in fellowship and training grant support; 2) a sharp reduction in predoctoral support; and 3) a concentration in fellowships rather than in training grants.

III. PRINCIPLES AND PROBLEMS

PRINCIPLES

In responding to the requirements of the continuing study called for in the National Research Service Award Act, the Committee has been guided by certain general principles. Although several of these were stated in the report of the feasibility study, they deserve emphasis and are repeated here.

A. Numbers

Numbers and forecasts must be kept in perspective and not stretched beyond the narrow ranges of validity. In contrast to the problem of forecasting aggregate manpower in large fields, estimating needs by fine fields is exceedingly difficult. Boundaries between disciplines have become less distinct with the increase in emphasis on study of biological phenomena at the molecular level. Titles of narrow disciplinary fields have therefore lost some meaning for the purposes of forecasting. The problem is compounded by the difficulty of predicting major scientific developments and their impact on manpower requirements. Moreover, many aspects of the dynamics of the manpower pool are not clearly understood, and hence, any supply/demand model that can be developed will have limitations for determining the need for disciplinary specialists. These limitations, the Committee believes, are offset largely by the breadth of training and the adaptability of biomedical/behavioral scientists and their capacity for mobility within and across fields. This is especially true for transfers from more fundamental to applied fields. Further, postdoctoral training often makes possible a transfer to a related field where shortages may exist. As noted in The Life Sciences,[17] a report published by the National Academy of Sciences, a large percentage of those

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[17] The Life Sciences, Report of the Committee on Research in the Life Sciences of the Committee on Science and Public Policy, National Academy of Sciences, Washington, D. C., 1970.

pursuing postdoctoral training seek this experience in a discipline other than that in which they received their graduate education. Moreover, most do so in laboratories other than those of their original research mentors, engaging in fields of research distinctly different from those in which they had been trained in the first instance. These facts underscore the importance of postdoctoral study as a mechanism for responding to new opportunities and reinforce the caveat stated at the beginning of this section.

B. High Quality and Stability

In addition to a concern for adequate numbers of personnel, NIH/ADAMHA/HRA must play a pivotal role in helping to maintain high-quality training programs. This dual role, the importance of which is underscored in the declaration of purpose for Title I of the law, requires continuity of support for its proper fulfillment. Since it takes many years to complete the training of an individual—seven or more years of post-baccalaureate training for Ph.D.'s working in the basic biomedical and behavioral sciences—the process cannot be turned on and off abruptly without damage to quality and training capability. Persistence of the stop/start pattern of support that has occurred in recent years could lead to erosion in the quality of the training structure.

C. Flexibility

It will continue to be important to foster flexibility in the organization of training activities to ensure responsiveness to the changing character of the research scene. By "stability," the Committee does not mean "no change." Change must not only be permitted but encouraged to allow appropriate response to the dynamic character of biomedical/behavioral research and its changing manpower requirements. Within funding levels tied to specific fields and numbers, how are resources to be mobilized to allow ready responsiveness to emerging opportunities? This is a key question requiring the development of a sensitive monitoring system, as well as the introduction of modifications and the design of experimental training programs.

Flexibility in this context has implications which the Committee believes merit further consideration. Individuals must be prepared to change fields as research opportunities present themselves. A further key issue relates to the capability of institutions to adjust their resources—faculty, students, and facilities—to a changing manpower outlook, as in the case of fields approaching a point of saturation.

D. Concern for Excellence

The new law assigns to the continuing study the task of assessing NIH/ADAMHA/HRA training programs—a further indication of the concern for excellence. It will be necessary to evaluate the impact of training programs on the total scientific environment of institutions. Basic approaches to implementing this responsibility will be to identify areas of program success for retrospective examination of effects, such as encouragement of programs that cut across traditional departmental lines; stimulation of interaction of faculty, trainees, and persons from other departments and institutions; and increase in the quality of advanced courses. Other questions warrant investigation. Is quality more effectively fostered by concentration on a limited number of programs than by providing broad support for training? Is it possible without NIH/ADAMHA/HRA support to build the types of curricula that permit quality training in special fields? How effective have these programs been in attracting superior personnel into areas lacking a tradition of research?

E. Shared Responsibility

Though it should be a truism, the point merits repetition that NIH/ADAMHA/HRA are not—and should not be—responsible for the support of all biomedical and behavioral research training. That responsibility is shared with other elements of American society—the States, industry, the foundations, private donors, and the universities themselves—which will continue to make their individual contributions. NIH/ADAMHA are indeed responsible, as affirmed by the new law, for providing sufficient support to ensure that the overall training effort will produce the numbers and quality of research scientists which may be required in the future. This presupposes that NIH/ADAMHA/HRA will continue to bear a substantial share of the costs of graduate education in the biomedical/behavioral sciences with provision for adjustment in the face of evidence of excessive or insufficient training effort. Other agencies, however, also provide training support in these fields, particularly through support of students via research grants, but also, to a minor extent, via direct fellowship and traineeship support.

F. Recognition of Systems Aspects

The complex of training programs, training institutions, and employing organizations forms a system whose parts continuously interact. Adequate adjustment of training support levels requires a view over time, from undergraduate to postdoctoral levels, on into employment and across

disciplines and employer categories. An overall systems view is essential. It is not possible to change one portion without some effect on the other parts. Such a systems approach needs to be developed so that the effect of changing one parameter on the other parts of the system and on the system as a whole can be anticipated.

PROBLEMS

Certain problems arise in the application of these principles and in the operation of the training/utilization system. Although the Committee has not considered them in depth, it believes they must be noted to provide perspective in thinking about research training.

A. The Costs of Imbalance of Supply and Demand

Supply and demand are seldom, if ever, in perfect balance. Imbalance is the rule, and attention should be directed toward relative costs rather than toward the establishment of a fictitious "balance." Research personnel may be produced in overabundance, may be too few, or may closely match in numbers the demand for their services. The costs of oversupply, undersupply, and even of a too-close balance should be appraised in considering recommendations for numbers of persons to be supported in training. An oversupply can result in a serious degree of frustration and personal hardship for the redundant individuals and dislocation of individual lives when people graduate from training programs only to find that the expected jobs are not available. An undersupply of properly qualified persons results in the inability of research institutions to meet national needs. Shortages of highly-skilled personnel result in a failure to exploit emerging leads regarding health-related research and thus delay or diminish the impact of research findings that may aid the nation's health. Too tight a coupling of supply and demand results in a lack of mobility within the system.

B. Market Studies and Their Limitations[18]

Several approaches are possible in considering the impact of the market. There are short-term and long-term projections, and attempts have been made to incorporate into projections of supply and demand the response of individuals and institutions to observed supply/demand imbalances. Further development of such market-response models is regarded by the Committee as important to improvement in projection techniques. Some other approaches deserve comment.

[18] See also Appendix D.

One method of projecting supply makes use of "fixed coefficient" models, in which a certain percentage of the graduates of any given stage of the pipeline are expected to go on to the next stage, from high school to college to graduate school to employment in research. These coefficients are, in some models, varied according to observed time trends, but for any particular model, they are fixed at a given point in the projection process. Such models fail to take into consideration the response of students and employers to changes in the market. While this method is useful for some short-run applications, its forecasting accuracy has not been such as to recommend it for important long-term decisions.

Short-term estimates of the market may be made by assembling the judgments of persons closely associated with a given field or by surveying employers as to their intentions over a given time perspective. For the preparation of this report, the first method was explored, but without conclusive results.

Actuarial data on the employment situation have been assembled at various times. The Survey of Doctoral Scientists and Engineers, conducted by the National Research Council in 1973, showed that the unemployment rate for bioscientists in 1973 was 1.0 percent; for behavioral scientists, 1.1 percent. In other fields the rates varied above and below these amounts, for a total of all fields of 1.2 percent. The data indicated that there was not, as of 1973, a serious excess of supply; the unemployment rates are near a "frictional" minimum. A 1975 survey is now under way. It is not expected that the 1975 rates will be substantially different, although the general state of the economy suggests that they may drift marginally higher this year. Unemployment rates for Ph.D.'s are not completely informative. Underemployment must also be considered.

Traditionally, the majority of Ph.D.'s and of physician-scientists have been employed in academic institutions—universities and medical schools in the case of the biomedical scientists. Studies of the important academic sector, made by Allan M. Cartter and others, indicated this situation is changing. A diminishing proportion of new Ph.D.'s and M.D.'s can expect to find employment in the universities. The nonacademic market must be expected, in the future, to absorb an increasing fraction of the new researchers—business and industry, government at all levels, nonprofit organizations, etc. Data are not yet available to permit an accurate assessment of the proportions of the market which each of these sectors may absorb. It obviously will depend in part on government decisions regarding environmental protection and improvement, drug testing, product safety, and so on.

An important problem associated with this changing perspective concerns the attitude of the students, and their professors, toward career patterns. Flexibility of attitude—toward changing tasks, employers, or fields, or all three—is likely to be more important in the future. This kind of market shifting is one which students should be prepared to face and to cope with in the future. A related problem is providing accurate and timely market information to guide career decisions.

C. Fellowships Versus Training Grants

Training support has gone directly from agencies to (nationally selected) individuals in the form of fellowships (predoctoral and postdoctoral) and to institutions in the form of training grants that provide support both to (locally selected) individuals and to the training elements provided by the institution. The Act continues support to individuals through the fellowship mechanism, but the principle of division of funds between fellowships and training grants requires reexamination. Fellowships recognize individual excellence but carry more limited support of the training environment. Training grants recognize and enhance the excellence of training environments. Fellowships require a somewhat more elaborate administrative procedure for the review of many individual applications at the national level—a procedure that seems appropriate at the postdoctoral level, but less so at the predoctoral level if more than a small number of prestige awards are to be made. Fellowships allow the individual to pick the training institution. Training grant proposals must also be administratively processed, to be sure. The grants provide stipends and institutional funds at both predoctoral and postdoctoral levels. They require that institutions think through their total training effort and design programs suited to local needs. Both fellowships and training grants are useful, but their differences should be noted and used perceptively to enhance the return on the training investment.

D. Training Grant Funds to Institutions and to Trainees

The proportion of the funds in any training grant that goes to the students as stipends and to the institution for salaries, supplies, equipment, etc. is not fixed. It varies according to the terms of each training grant. It is important that both functions of the training grant funds be recognized, as it is impossible to provide a high-quality training program without funds for the specialized curriculum and resources to accomplish this. These funds must come from some source. Yet the major purpose of training grants is for student support. Increasing emphasis has been placed in recent years on increasing the

stipend proportion, particularly since the major department-building era of the 1960's is past. Whether the shift toward greater allocation of funds for stipends has gone far enough is another problem of concern to the Committee.

E. Postdoctoral Pool

Postdoctoral fellowships and traineeships have long been an important component of the federal program of support of the biomedical and behavioral research fields. Such appointments serve to provide research experience for M.D.'s, to complete the research preparation of new Ph.D.'s, especially in the interdisciplinary and transdisciplinary fields characteristic of these areas of science, and also to provide field-switching opportunities for more experienced scientists. The historical trend over several decades [19] has been for a greater percentage of biomedical and behavioral research scientists to undertake postdoctoral training.

Since about 1970, a new aspect of postdoctoral involvement and support has appeared. This is the so-called "holding pattern," in which new Ph.D.'s who have been unable to find postgraduation jobs and older Ph.D.'s who have held postdoctoral appointments but have been unable to find permanent positions are continued in postdoctoral slots beyond the normal term of such appointments. The extent of this phenomenon in the biomedical and behavioral research fields seems to fall within reasonable bounds at present, but the Committee is concerned about the future. Monitoring the size of the pool and finding out what happens to people who have been a part of it will be tasks for the year ahead. The holding pattern may turn out to serve a useful function, providing a flexible resource to cushion inevitable fluctuations in supply and demand.

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[19] The Invisible University, National Research Council, Washington, D. C., 1969.

IV. SOME TRENDS IN TRAINING AND UTILIZATION

The Committee's staff and consultants have launched a number of studies, following the recommendations made in the report of the feasibility study. It has not been possible for the Committee and its Panels to review these studies more than briefly, much less to assess their significance and assimilate the results into their work. Such fuller development must be left to the next stage of the continuing study. Nevertheless, data on trends in training and utilization in biomedical and behavioral research areas have already emerged and seem significant enough to be included here.

GRADUATE ENROLLMENTS AND STUDENT SUPPORT

First-year graduate enrollments in the biomedical and behavioral sciences rose from roughly 15,000 in 1960 to 47,000 in 1974, an average annual growth rate of 8.6 percent (TABLE 4).

Each broad field has exhibited different growth patterns. The basic biomedical sciences have shown the steadiest growth of all the fields, rising from 7,000 to 22,000 students from 1960 to 1974. However, its annual growth has slowed. In the years from 1968 to the present, the annual average rate of growth was 7.0 percent compared to 9.9 percent in earlier years.

The changes in growth rates in the behavioral sciences are much more pronounced than in the basic biomedical sciences. Here the average annual growth rate was 12.4 percent from 1960 to 1968 and only 3.6 percent thereafter. Furthermore, there were absolute declines in first-year enrollments from 1970 through 1973 in the disciplines of anthropology, sociology, and psychology (except in 1970-71).

It is difficult to find reliable data for the clinical sciences and health services research. Because most researchers in the clinical sciences are M.D.'s with postdoctoral training, enrollments in graduate programs are a poor and misleading indicator of clinical researchers in training. In health services research, most graduate enrollments are in terminal masters programs, e.g., in public health and hospital

TABLE 4 First-Year Graduate Enrollments[2] In All Graduate Departments, by Selective Field, 1960-1973

(1,000's)

Year[3]	Basic Biomedical Science	Behavioral Science
1960	7.0	7.7
1961	7.7	8.0
1962	8.2	8.7
1963	9.7	10.4
1964	11.8	11.8
1965	12.7	13.0
1966	14.2	15.2
1967	14.9	17.9
1968	14.9	19.6
1969	16.3	22.2
1970	17.2	26.3
1971	18.3	25.5
1972[1]	18.8	24.0
1973[1]	19.5	22.4
1974[1]	22.4	24.2
	Annual Average Rates of Growth	
1960-74	8.7	8.6
1960-68	9.9	12.4
1968-74	7.0	3.6

[1]Estimates based on NSF data for 1971-74.
[2]Both full-time and part-time students.
[3]Fall enrollment for that academic year.

Source: U. S. Department of Health, Education and Welfare, National Center for Education Statistics, Students Enrolled for Advanced Degrees, Annual Reports 1960-71.

administration. Hence, enrollments in this area are also unrepresentative of those being trained for research careers. For these reasons, enrollments in these areas are not included here.

There are also significant field differences in the pattern of federal support of graduate students. Of the 164,000 graduate students in the 1973 survey of the sciences and engineering by the National Science Foundation, over 65,000 were in the basic biomedical, behavioral, and clinical sciences. As one might expect, the basic biomedical and clinical sciences rely more heavily upon federal support (30 percent and 41 percent, respectively) than the behavioral sciences (22 percent), and in fact their reliance exceeds that for all fields (26 percent) (TABLE 5). Of the federal sources, HEW and its components, NIH/ADAMHA,[20] are clearly predominant, with HEW accounting for 18 percent of all science students supported (i.e., providing their major source of support) and 65 percent of all science students supported by federal funds.

Support for graduate students in these areas is quite diverse, however. Non-federal support still makes up the largest share (over 70 percent) of major sources of support. Institutional support accounts for roughly 40 percent of all students in these fields.[21] Self-support, including students' own funds, loans, and family support, is also substantial as a percentage of major sources of support. It is highest for the behavioral sciences (32 percent), apparently compensating for the lesser volume of federal support in this area.

It should be noted, however, that while federal support makes up the lesser part of total support in the biomedical and behavioral sciences, it is of greater importance to the development of the most talented research personnel. Research fellowships, traineeships, and assistantships are heavily subsidized by the federal government. Hence, the fact that teaching assistantships, largely concentrated in state universities, and self support make up the greater part of overall support should not cloud the importance of the federal role in training research manpower.

The support of basic biomedical and behavioral science graduate students is further elucidated by noting the type of support or kind of

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[20] ADAMHA is not included in NIH data in TABLE 5. This explains why the percentage of support for behavioral sciences may look low under NIH. It is included within total HEW support.

[21] It should be kept in mind, however, that much institutional support is actually unrestricted state aid to public institutions.

TABLE 5 Full-time Graduate Students in all Graduate Science Departments, by Source of Major Support and Selected Field, Fall 1973

(1,000's)

	Grand Total	U. S. Government Sources						Non-U.S. Government Sources				
		Total U. S. Government	DOD	TOTAL HEW	NIH(b)	NSF	Other U.S. Government	Total Non-U.S. Government	Institutional	Foreign	Other	Self
Total, All Sci. Fields	164.3	43.2	4.7	15.8	10.2	9.7	13.0	121.1	68.4	3.7	10.1	39.9
Basic Biomed. Sci.	35.6	10.6	0.1	6.7	5.9	1.2	2.6	25.0	14.7	1.0	2.1	7.2
Behav. Sci.	26.7	6.1	0.1	3.9	1.5	0.7	1.4	20.6	10.2	0.2	1.7	8.5
Clinical Sci.	4.6	1.9	(a)	1.5	0.9	(a)	0.4	2.7	1.7	(a)	0.2	0.7
Percent of Total												
Total, All Sci. Field	100.0	26.2	2.8	9.6	6.2	5.9	7.9	73.7	41.6	2.2	6.1	24.2
Basic Biomed. Sci.	100.0	29.7	0.2	18.8	16.5	3.3	7.3	70.2	41.2	2.8	5.8	20.2
Behav. Sci.	100.0	22.8	0.3	14.6	5.6	2.6	5.2	77.1	38.2	0.7	6.3	31.8
Clinical Sci.	100.0	41.3	(a)	32.6	19.5	(a)	8.6	58.6	36.9	(a)	4.3	15.2

SOURCE: National Science Foundation, Graduate Science Education Student Support, and Postdoctorals, Fall 1973. Detailed Statistical Tables, Appendix III.

(a) Less than 50 students or less than .05 percent.
(b) Does not include NIMH which is included in total HEW.

appointment received as the major source of support. All of the fields related to this study have a high concentration of fellowships and traineeships relative to all fields. Over 25 percent of the basic biomedical and behavioral science students are supported by fellowships and traineeships (TABLE 6). A substantial number of basic biomedical students also receive their support in the form of research assistantships; however, behavioral and clinical science students receive much less of their support in this form (12 percent and 9 percent). The importance of federal support for both fellowships and traineeships, and especially for research assistantships, explains the high concentration of federal support in the basic biomedical sciences. Conversely, the much smaller amount of federal research done in the behavioral sciences explains their lesser volume of research assistantships and federal support.

The overwhelming concentration of the clinical sciences support in fellowships and traineeships—especially postdoctoral—opposed to minor support for participation in research assistantships may be explained by the historically greater utilization of the training mechanism in clinically oriented programs. Further, the absence of undergraduate clinical programs means that proportionately fewer such students are engaged as teaching assistants although clinical science fellows and trainees do engage to a considerable extent in bedside teaching. Basic biomedical and behavioral sciences, on the other hand, have undergraduate courses and, thus, their graduate students are actively engaged in teaching undergraduates.[22]

The "other types of support" category, which is to a considerable extent composed of self-support, is also a major source of support to a substantial number of students—over 30 percent—in the basic biomedical and behavioral sciences. As one would suspect, the behavioral sciences have the highest concentration in this area due to lesser access to federal support.

Ph.D. OUTPUT 1961-74

In this section, we examine the trends in the production of biomedical/behavioral Ph.D.'s. Since these Ph.D.'s constitute most of the pool of basic biomedical/behavioral researchers (the others are M.D.'s), the trends in Ph.D. production have important implications for future trends in the supply. Not all Ph.D.'s become researchers; many perform

[22] It should be noted that public institutions, through state funds, offer more teaching assistantships than do private institutions.

TABLE 6 Full-time Graduate Students in all Graduate Science Departments by Type of Major Support and Selective Fields, Fall 1973[1]

(1,000's)

	Total		Fellowships & Traineeships		Research Assistantships		Teaching Assistantships		Other Types of Support[2]	
	No.	%	No.	Percent of Total	No.	Percent of Total	No.	Percent of Total	No.	Percent of Total
Total, All Sci. Fields	164.3	100.0	34.1	20.8	36.1	22.0	43.4	26.4	50.7	30.8
Basic Biomed. Science	35.6	100.0	9.1	25.5	9.1	25.5	8.5	23.8	8.9	25.0
Behavioral Science	26.7	100.0	6.8	25.4	3.2	11.9	6.0	22.4	10.7	40.0
Clinical Science	4.6	100.0	2.5	54.3	0.4	8.6	0.5	10.8	1.8	39.1

[1]Includes support from all sources.
[2]Includes, for example, self, family, spouse.

SOURCE: National Science Foundation, Graduate Science Education Student Support and Postdoctorals, Fall 1973

teaching and administrative duties exclusively, while with others research is a secondary activity. As expected, the number of Ph.D.'s entering research depends on the amount of funds allocated to research and development activities. As the growth in R and D funds slows, fewer research positions become available to the new Ph.D.'s, who therefore seek other jobs. Conversely, increases in R and D funds generate additional positions for researchers.

The pool size cannot be increased quickly. Ph.D. output responds slowly to changes in demand because of the average time lag of seven years from the B.A. to the Ph.D. It is questionable how effectively the supply can be increased by drawing from the pool of nonactive researchers. Those who have not done research for a few years may quickly lose contact with the latest techniques and developments and may find it difficult to become proficient researchers again without retraining. Here postdoctoral training plays an important role, but response again is not instantaneous.

From 1961 to 1971, the output of Ph.D.'s in the biomedical/behavioral fields increased at a rate of approximately 12 percent per year (FIGURE 2, TABLE 7). Since 1971, the growth rate has slowed considerably. In 1974, there was no growth over the previous year. This was largely due to the fact that Ph.D. output in the basic biomedical sciences actually declined from 1973 to 1974—the first time this has happened in over 15 years.

The behavioral sciences exhibit a pattern of growth very similar to the basic biomedical sciences, increasing at a rate of 12 percent up to 1971 and 6 percent from 1971 to 1974. But unlike the basic biomedical sciences, behavioral science Ph.D. production continued to grow in 1974.

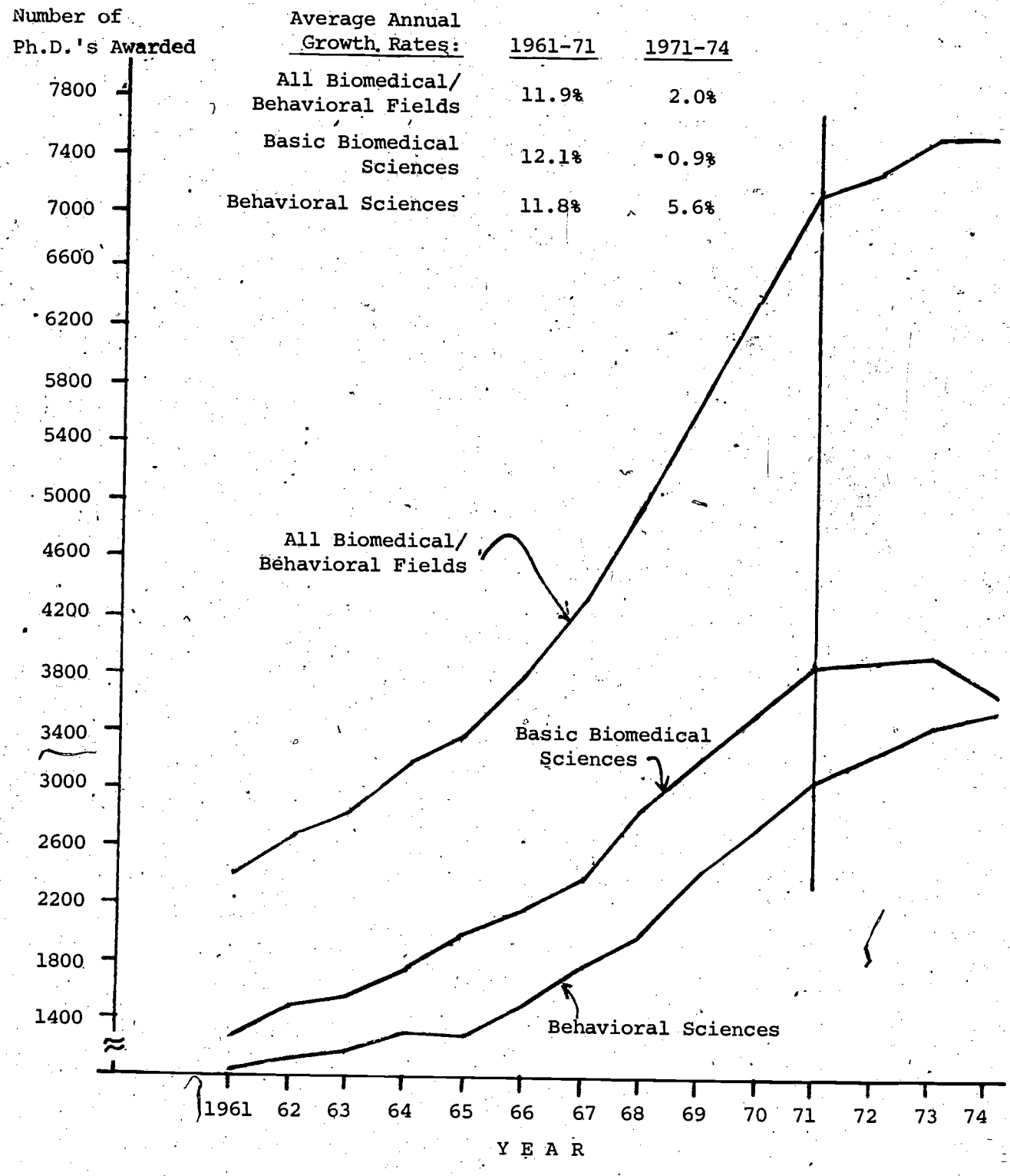
The health services research field has had erratic but generally continuous growth since 1961 at an annual growth rate of about 13 percent per year through 1974.

The number of Ph.D.'s given annually in the clinical sciences is very small. It reached a peak of 55 Ph.D.'s in 1966 and has declined steadily since then to 38 in 1974.

RESEARCH AND DEVELOPMENT EXPENDITURES

The demand for biomedical/behavioral researchers is strongly influenced by the amount of expenditures, both public and private, for biomedical research and development. Since 1957, these expenditures have grown rapidly, as have those for R and D in practically all other fields. From 1961 to 1964, the growth in actual dollars was about 9 percent per year (FIGURE 3, TABLE 8). But in 1968, inflation began to take its toll

FIGURE 2 Annual Production of Ph.D.'s in the Biomedical/Behavioral Fields



Source: TABLE 7

TABLE 7 Production of Ph.D.'s in the Biomedical/Behavioral Fields, 1961-74

Fiscal Year of Ph.D.	Basic Biomedical Sciences	Behavioral Sciences	Clinical[1] Sciences	Health Services Research	Total
1961	1266	1042	39	39	2386
1962	1441	1123	31	34	2629
1963	1538	1185	35	38	2796
1964	1736	1297	46	64	3143
1965	1993	1276	49	61	3379
1966	2163	1489	55	79	3786
1967	2378	1788	54	83	4303
1968	2871	1970	47	86	4974
1969	3206	2406	46	85	5743
1970	3526	2727	53	116[2]	6422
1971	3873	3072	51	129	7125
1972	3897	3245	48	111	7301
1973	3943	3429	35	130	7537
1974	3744	3612	38	143	7537

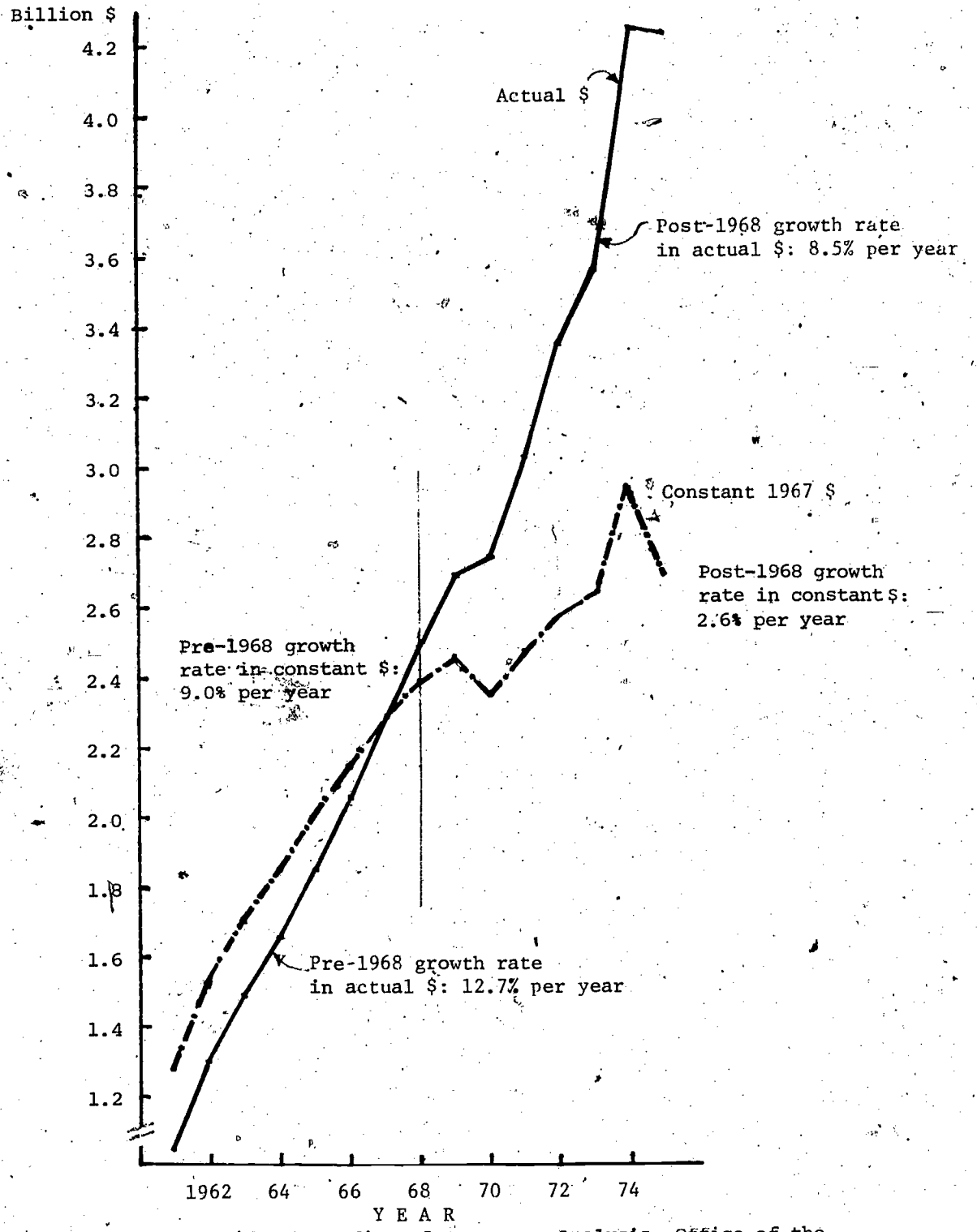
[1]The clinical science Ph.D.'s are only a small portion of the total number of researchers in the biomedical field—over two thirds are M.D.'s. However, as can be seen in this table, a few Ph.D.'s are granted in clinical sciences each year. Some, but by no means all of these are also M.D.'s. The clinical science fields in the DRF are limited to medicine and surgery, dentistry, veterinary medicine, optometry and ophthalmology.

[2]The large increase in Ph.D.'s awarded in the health services research field from 1969 to 1970 may have been due to a reclassification of field codes in the DRF during that period.

SOURCES: Doctorate Recipients from United States Universities, 1958-66: Sciences, Humanities, Professions, Arts, Office of Scientific Personnel, NAS/NRC, 1967.

Doctorate Recipients from United States Universities, Summary Reports, Office of Scientific Personnel, NAS/NRC, 1967-73.

FIGURE 3 National Support for Medical and Health Related Research



SOURCE: Basic data provided by Office of Resources Analysis, Office of the Director, National Institutes of Health. Growth rates calculated by Commission on Human Resources, NAS/NRC.

TABLE 8 National Support for Medical and Health-Related Research

Year	Actual Dollars				Constant 1967 Dollars				R and D Price Index[1] (1967=100)
	Total	Federal ($ billions)	Private Industry	Other	Total	Federal ($ billions)	Private Industry	Other	
1952	0.197	0.103	0.052	0.042					
1953	0.214	0.107	0.058	0.049					
1954	0.237	0.119	0.061	0.057					
1955	0.261	0.139	0.062	0.060					
1956	0.312	0.162	0.079	0.071					
1957	0.440	0.229	0.126	0.085					
1958	0.543	0.279	0.170	0.094					
1959	0.648	0.351	0.190	0.107					
1960	0.845	0.448	0.253	0.144					
1961	1.045	0.574	0.312	0.159	1.267	0.695	0.378	0.192	82.5
1962	1.290	0.782	0.336	0.172	1.516	0.918	0.394	0.202	85.1
1963	1.486	0.919	0.375	0.192	1.698	1.050	0.428	0.219	87.5
1964	1.652	1.049	0.400	0.203	1.840	1.168	0.445	0.226	89.8
1965	1.841	1.174	0.450	0.217	1.986	1.266	0.485	0.234	92.7
1966	2.056	1.316	0.510	0.230	2.144	1.372	0.531	0.239	95.9
1967	2.280	1.458	0.580	0.242	2.280	1.458	0.580	0.242	100.0
1968	2.497	1.582	0.661	0.254	2.383	1.509	0.630	0.242	104.8
1969	2.691	1.674	0.754	0.263	2.446	1.521	0.685	0.239	110.0
1970	2.731	1.667	0.795	0.269	2.354	1.437	0.685	0.231	116.0
1971	3.023	1.977	0.860	0.286	2.468	1.532	0.702	0.233	122.5
1972	3.354	2.147	0.925	0.282	2.578	1.650	0.711	0.216	130.1
1973	3.563	2.225	1.033	0.305	2.619	1.636	0.759	0.224	136.0
1974	4.249	2.753	1.180	0.316	2.948	1.910	0.818	0.219	144.1
1975(est)	4.220	2.609	1.280	0.331	2.686	1.660	0.814	0.210	157.1

[1] A Price Index for Deflation of Academic R and D Expenditures, NSF 72-310, Government Printing Office, Washington, D. C., May 1972.

SOURCE: Biomedical Research Manpower for the Eighties, Resources for Medical Research Report #11, Office of Resources Analysis, NIH, HEW, Washington, D. C., December 1968, and unpublished data.

TABLE 9 Federal Biomedical/Behavioral R and D Funds

Year	Biomedical & Health-Related Sciences (all life sciences, except clinical)		Clinical Sciences		Behavioral Sciences (psychology, anthropology, sociology)		Total	
	($ millions)	%	($ millions)	%	($ millions)	%	($ millions)	%
1971	1159	60.8	514	27.0	233	12.2	1906	100.0
1972	1414	63.2	568	25.4	257	11.5	2239	100.0
1973	1398	61.1	661	28.9	229	10.0	2288	100.0
1974(est.)	1658	61.6	808	30.0	224	8.3	2690	100.0
1975(est.)	1585	61.4	778	30.2	217	8.4	2580	100.0

SOURCE: Federal Funds for Research, Development and Other Scientific Activities, Table C-13, National Science Foundation, Washington, D. C., various years.

as R and D costs escalated. The NSF has compiled an index of academic R and D costs[23] which shows that 1974 costs for such activities were 57 percent higher than in 1967. As a result, although total national funds for health-related research have continued to expand at almost 9 percent per year in actual dollars, the real growth in constant dollars since 1968 has been about 3 percent per year. During the past five years, about 60 percent of federal R and D funds for biomedical/behavioral research went to the basic biomedical and health-related sciences, 30 percent to the clinical sciences, and the remaining 10 percent to the behavioral sciences (TABLE 9).

CURRENT NUMBER OF ACTIVE RESEARCHERS

Reliable data on the size of the pool of biomedical/behavioral researchers as a function of time are hard to come by. The Committee examined longitudinal data obtained from the several National Registers of Scientific and Technical Personnel, but found them erratic and inconclusive. Further analysis may make it possible to use these data, which cover a span of almost two decades, but there was insufficient time for this to be done for the present report. The Committee has relied instaad on data derived from the 1973 Survey of Doctoral Scientists and Engineers and the 1975 Faculty Profile compiled by the Association of American Medical Colleges (Appendix D).

Data on the Ph.D. (or equivalent) component come from the Survey of Doctoral Scientists and Engineers. Individuals counted on the following table are employed in biomedical and behavioral fields and have indicated that research or the management of research activities is their primary work activity.

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[23] A Price Index for Deflation of Academic R and D Expenditures, NSF 72-310, Government Printing Office, Washington, D. C., May 1972.

Field	Number of Active Ph.D. Researchers[1] (1973)
Basic Biomedical Sciences, Total	17,800
Anatomy	347
Biochemistry	5,317
Biomathematics	151
Biomedical Engineering	577
Biophysics	907
Cytology	340
Embryology	163
Genetics	1,056
Immunology	983
Microbiology/Bacteriology	1,930
Molecular Biology	1,388
Parasitology	215
Pathology	411
Pharmacology	1,624
Physiology, Animal	1,769
Physiology, Plant	622
Other Biomedical Sciences, Total	7,955
Botany	332
Ecology	551
Entomology	1,272
Environmental Sciences	1,424
Hydrobiology	90
Nutrition/Food Science	307
Pharmaceutical Sciences	297
Zoology	248
Biomedical Sciences, Other	3,434
Behavioral Sciences, Total	6,914
Anthropology	263
Behavior/Ethology	78
Clinical Psychology	776
Comparative Psychology	99
Counseling and Guidance	115
Developmental/Gerontological	333
Educational Psychology	574
Exper/Compar/Physiol Psychology	5
Experimental Psychology	797
Industrial/Personnel Psychology	468
Personality Psychology	77
Physiological Psychology	509
Psychometrics	196
School Psychology	86
Social Psychology	563
Social Statistics	110
Sociology	1,067
Psychology, Other	798

[1]The numbers of individuals shown in the above table do not necessarily reflect the numbers that have been supported by NIH/ADAMHA/HRA training programs.

Field	Number of Active Ph.D. Researchers (1973)
Clinical Sciences, Total	503
Dentistry	--
Medicine & Surgery	291
Veterinary Medicine	212
Health Services Research, Total	704
Biometrics/Biostatistics	342
Hospital Administration	30
Public Health	332
Total	33876

The American Medical Association estimates that about 8,400 M.D.'s were engaged in research activities in 1974. This appears to be the best estimate available of the current size of the total pool of M.D. researchers.

The Association of American Medical Colleges has supplied data on the number of M.D. (or equivalent) researchers on medical school faculties in each sub-field. Under the assumption that this same distribution applies to the total pool of M.D. researchers, we have computed estimates of the size of the pool in each subfield. These are presented in TABLE 10 along with a summary of the Ph.D. pool updated to 1975.

In summary, the pool in 1975 is estimated to be composed of approximately 47,000 biomedical/behavioral researchers.

TABLE 10 Estimated Number of Active Biomedical and Behavioral Researchers in 1975

	M.D.'s[a]	Ph.D.'s[b]	Total
Basic Biomedical Sciences	1,400	29,500	30,900
Behavioral Sciences	--[c]	7,900	7,900
Clinical Sciences	6,800	600	7,400
Health Services Research	200	800	1,000
TOTAL	8,400	38,800	47,200

[a]The estimated total of 8,400 M.D.'s in research was derived from Profile of Medical Practice, American Medical Association, Chicago, Illinois, 1974. The number in each subfield was estimated from data supplied by the Association of American Medical Colleges, Washington, D. C.

[b]Ph.D. data were derived from the 1973 Comprehensive Survey of Doctoral Scientists and Engineers, Commission on Human Resources, NAS/NRC, Washington, D. C., and updated to 1975 on the basis of a 7 percent per annum increment.

[c]The number of behavioral science M.D. researchers is small and hence difficult to estimate. The best available information gives less than ten M.D.'s in this category.

V. SUMMARY

We recapitulate some points of the earlier discussion:

1. Federal support of research training contributes to the continuing vitality of biomedical and behavioral research, and, thus, contributes a vital buttress to health care in the United States. The federal presence brings with it national standards. The peer-review system ensures that the standards will be uniformly applied to recognize excellence. Biomedical research training itself (a) aids in selecting the next generation of research leaders, (b) accelerates their graduate education, (c) gives M.D.'s essential research tools and Ph.D.'s essential contact with medical problems, (d) makes it possible for postdoctoral scientists to move into undersupplied fields of specialization, (e) stimulates the development of new fields of research, and (f) provides opportunity for the most able students to have access to biomedical and behavioral graduate education, independent of their private resources.

2. The competitively awarded research training grant is a unique and versatile mechanism that offers advantages beyond those of supplying trained personnel. Among them are: (a) maintenance of a complete training environment, (b) encouragement of existing interdisciplinary linkages and of new interaction of disciplines, and (c) recognition of excellence of training environments in the same way that fellowships recognize excellence of individual performance.

3. Largely due to training efforts of the last decade, a cadre of about 47,000 biomedical and behavioral researchers exists in the United States. About 70 percent of them conduct research in the basic biomedical sciences, 14 percent in the behavioral sciences, 14 percent in the clinical sciences, and 2 percent in health services studies. Seventeen percent hold M.D. degrees, and 83 percent hold Ph.D.'s.

4. Essentially full employment currently exists for doctoral scientists in these fields of research. Unemployment in 1973 was at the "frictional" level of about 1.2 percent for all fields and age groups combined, but may be higher now—perhaps 2 percent overall with somewhat higher rates for some fields and for the most recent recipients of the Ph.D. In a few fields—health services research is an example—personnel shortages exist. The commonly used market indicators, such as trends in relative salaries, suggest that, overall, no serious disequilibrium exists at the moment.

5. There is reason, however, to be concerned about future oversupply in some of the fields and about the costs thereof. Graduate enrollments have been growing strongly, indicating a plentiful supply

of graduating Ph.D.'s over the next five years. The cadre of established research workers is relatively young, and attrition will be relatively low. Research and development funds are stabilizing, and demand for personnel will stabilize accordingly. Although M.D. researchers can turn to private practice for alternative careers, similar opportunities will be more limited for Ph.D.'s. The demographic facts suggest there will be relatively few new appointments to faculties in the 1980's. Some caution is needed, and the Committee is not prepared on the basis of its limited studies to urge significant further growth of research training.

6. The training "pipeline" is long—seven years on the average from baccalaureate to Ph.D., 10 years from the baccalaureate to the M.D. researcher. The flow cannot be rapidly turned on or off. Time is required to set up high-quality training programs, and stability is necessary for an efficient and high-quality system. In this regard, the federal-budget decision not to include any funds for new starts in training at the predoctoral level in FY 1976 causes the Committee great concern.

7. Certain structural and administrative problems connected with research training have emerged. In the past, some two thirds of postdoctoral M.D. trainees and fellows in these programs entered medical practice soon after completion of training. This result was expected in an earlier period of the training programs when program goals included the training of clinical specialists in shortage fields. Now, however, this goal has essentially been met, and there seems to be little reason to maintain training for clinical practice in the future. A second issue, almost as old as the training programs themselves, concerns the percentage of training-grant funds allotted to various forms of institutional support—faculty salaries, salaries of supporting staffs, equipment purchases, library and computer costs, purchase of supplies, and so on. The Committee believes there should be a limit on the percentage of training funds used for these purposes, but notes that the matter is complex. The strength of the training-grant mechanism resides in large part in its ability to create a strong and vital total environment for training. Stipends for trainees are an essential requirement for training, but so are a strong faculty, adequate equipment and supplies, and other training elements.

8. The difficult problem of proliferation of programs that results in excess training capacity cannot easily be disposed of. The decade of the 1960's witnessed a rapid growth of training programs in response to perceptions of national needs. Now that some of those needs have been met, the situation is changing. The Committee urges upon agencies of government and training institutions a readiness for change in both the character and the magnitudes of the training programs. Legitimate aspirations of institutions and departments can best be accommodated within an adaptive mechanism that recognizes new needs, establishes excellence as the governing criterion, and sets a high priority on flexible response.

9. We have found existing data and field taxonomies insufficient for our task of forecasting personnel needs and the adequacy of the supply. The recommendations in this report are limited by that consideration to statements about immediate training requirements in broad fields. In the course of the year ahead, we expect to acquire more satisfactory data about the training pipeline, the research-personnel pool and the mobility of persons in it, and the components of demand. We also expect to develop a more adequate list of the training and research specialties in these areas.

APPENDIX A

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

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APPENDIX B

COMMITTEE ON A STUDY OF NATIONAL NEEDS FOR
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APPENDIX C

LEGISLATIVE AND ADMINISTRATIVE HISTORY OF TRAINING AUTHORITIES OF NIH, ADAMHA, AND HRA

LEGISLATION

The original legislative authorization for training comes from the National Cancer Act of 1937 which established the National Cancer Institute within the Public Health Service and authorized it to establish training facilities and award fellowships to outstanding individuals for studies relating to the causes and treatment of cancer. The first NIH fellowships were awarded in 1938 to 17 individuals in cancer research fields such as biochemistry, physiology, and genetics. Training in areas other than cancer research was made possible in 1944 with passage of the Public Health Service (PHS) Act which provided NIH with general authority to support research and research training. Subsequent legislation and executive action gradually added to the number of institutes at NIH with authority for categorical research training. Listed below are the 11 institutes of NIH and the year established.

NCI	National Cancer Institute	1937
NIAMDD	National Institute of Arthritis, Metabolism, and Digestive Diseases	1947[1]
NIAID	National Institute of Allergy and Infectious Diseases	1948[2]
NIDR	National Institute of Dental Research	1948[3]
NHLI	National Heart and Lung Institute	1948
NINCDS	National Institute of Neurological and Communicative Disorders and Stroke	1950
NICHD	National Institute of Child Health and Human Development	1963
NIGMS	National Institute of General Medical Sciences	1963[4]

[1]Established originally as the Experimental Biology and Medicine Institute, it became the National Institute of Arthritis and Metabolic Diseases in 1950 and the National Institute of Arthritis, Metabolism, and Digestive Diseases in 1972.

[2]Established in 1948 as the National Microbiological Institute, it became the National Institute of Allergy and Infectious Diseases in 1955.

[3]The Dental Hygiene Unit of NIH was created in 1931 and in 1948 became the NIDR.

[4]NIGMS existed as a division of NIH beginning in 1958, but was not established as an Institute until 1963.

NEI	National Eye Institute	1968
NIEHS	National Institute of Environmental Health Science	1969[5]
NIA	National Institute of Aging	1974

The National Institute of Mental Health was established in 1948. It remained within the NIH until 1967 when it became an independent bureau of the Public Health Service. In April 1968, another reorganization created the Health Services and Mental Health Administration (HSMHA) which absorbed the NIMH along with other service and manpower training programs. On July 1, 1973, as part of a reorganization of the health components of DHEW, the HSMHA was abolished. While two new agencies were created at that time—the Health Services Administration (HSA) and the Health Resources Administration (HRA)—NIMH was transferred on an interim basis to NIH. Following further study and issuance of a report on NIMH, the Department announced the formation of the Alcohol, Drug Abuse and Mental Health Administration (ADAMHA), effective September 25, 1973. This new agency is comprised of NIMH and the National Institute on Alcohol Abuse and Alcoholism, both of which were existing Institutes as well as the National Institute on Drug Abuse which was newly established as part of the reorganization. The administratively created ADAMHA was subsequently established legislatively through enactment of PL 93-282 on May 14, 1974.

HRA became a component of the Public Health Service, equal in status to the five other major agencies of the Public Health Service—NIH, ADAMHA, HSA, the Food and Drug Administration (FDA), and the Center for Disease Control (CDC). Under the HRA are the National Center for Health Services Research (NCHSR), the National Center for Health Statistics (NCHS), the Bureau of Health Manpower and the Bureau of Health Planning and Resources Development.

In recent years, the legislative authority for research training of both NIH and ADAMHA in relation to the causes and prevention of disease was contained in Section 301 of the Public Health Service Act. This authority has been replaced by Section 473 of the National Research Service Award Act of 1974 under which research training is authorized upon certification of need as a result of a continuing study.

With regard to clinical training supported by ADAMHA, the previous authority was contained in Section 303 of the Public Health Service Act which provided for training and instruction to individuals and for investigations and studies relating to the care, treatment and rehabilitation of the mentally ill.

That authority has been continued in the conforming amendments section of the NRSAA and perhaps made even more explicit by the language which now reads:

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[5]NIEHS existed as a division of NIH beginning in 1966, but was not established as an Institute until 1969.

To provide clinical training and instruction and to establish and maintain clinical traineeships (with such stipends and allowances—including travel and subsistence expenses and dependency allowances—for the trainees as the Secretary may deem necessary).

The authority for research training within HRA was previously provided by Section 304 of the Public Health Service Act which authorized such training in relation to the development or evaluation of health services and resources. This authority was amended by PL 93-353, entitled the "Health Services Research, Health Statistics, and Medical Libraries Act of 1974," enacted on July 23, 1974. The provisions of this act broadened the training authority in the area of health services research and evaluation[6] to include the NCHS and other units of HEW designated by the Secretary.

Some sections of the National Research Act pertinent to this study are presented below.

FINDINGS AND DECLARATION OF PURPOSE

Sec. 102. (a) Congress finds and declares that—

(1) the success and continued viability of the Federal biomedical and behavioral research effort depends on the availability of excellent scientists and a network of institutions of excellence capable of producing superior research personnel;

(2) direct support of the training of scientists for careers in biomedical and behavioral research is an appropriate and necessary role for the Federal Government; and

(3) graduate research assistance programs should be the key elements in the training programs of the institutes of the National Institutes of Health and the Alcohol, Drug Abuse, and Mental Health Administration.

(b) It is the purpose of this title to increase the capability of the institutes of the National Institutes of Health and the Alcohol, Drug Abuse, and Mental Health Administration to carry out their responsibility of maintaining a superior national program of research into the physical and mental diseases and impairments of man....

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[6]Section 304 of the PHS Act from which the HRA training authority is derived was not amended by the National Research Act (NRA) of July 12, 1974. It is not clear that HRA training is covered by the provisions of Title I of the NRA. HRA has participated in this study under the assumption that a clarification of the legislation would make their training authority also subject to Title I of the NRA. No appropriation for HRA training has been requested in the administration budget for FY 1976.

(3) Effective July 1, 1975, National Research Service Awards may be made for research or research training in only those subject areas for which, as determined under section 473, there is a need for personnel....

STUDIES RESPECTING BIOMEDICAL AND BEHAVIORAL RESEARCH PERSONNEL

Sec. 473. (a) The Secretary shall, in accordance with subsection (b), arrange for the conduct of a continuing study to—

(1) establish (A) the Nation's overall need for biomedical and behavioral research personnel, (B) the subject areas in which such personnel are needed and the number of such personnel needed in each such areas, and (C) the kinds and extent of training which should be provided such personnel;

(2) assess (A) current training programs available for the training of biomedical and behavioral research personnel which are conducted under this Act at or through institutes under the National Institutes of Health and the Alcohol, Drug Abuse, and Mental Health Administration, and (B) other current training programs available for the training of such personnel;

(3) identify the kinds of research positions available to and held by individuals completing such programs;

(4) determine, to the extent feasible, whether the programs referred to in clause (B) of paragraph (2) would be adequate to meet the needs established under paragraph (1) if the programs referred to in clause (A) of paragraph (2) were terminated; and

(5) determine what modifications in the programs referred to in paragraph (2) are required to meet the needs established under paragraph (1).

(b)(1) The Secretary shall request the National Academy of Sciences to conduct the study required by subsection (a) under an arrangement under which the actual expenses incurred by such Academy in conducting such study will be paid by the Secretary. If the National Academy of Sciences is willing to do so, the Secretary shall enter into such as arrangement with such Academy for the conduct of such study.

(2) If the National Academy of Sciences is unwilling to conduct such study under such an arrangement, then the Secretary shall enter into a similar arrangement with other appropriate nonprofit private groups or associations under which such groups or associations will conduct such study and prepare and submit the reports thereon as provided in subsection (c).

(c) A report on the results of such study shall be submitted by the Secretary to the Committee on Interstate and Foreign Commerce of the House of Representatives and the Committee on Labor and Public Welfare of the Senate not later than March 31 of each year....

ADMINISTRATION

Under the training authorities discussed in the previous section, NIH and ADAMHA have provided support both for students in the health professions interested in clinical practice and also for those interested in a research or teaching career. This distinction between clinical practice and research has not always been clearly made and is a source of confusion when discussing the programs and interpreting the data. Certain divisions of NIH, such as the Bureau of Health Resources Development (formerly the Bureau of Health Manpower Education and now part of HRA), have had programs intended primarily to support those interested in clinical practice. Medical and dental students, nurses, and other health professionals have been supported under these programs. However, most of the training programs of the Institutes of NIH were intended for the support of people interested in research or teaching careers. These are called the research training programs to distinguish them from those offering clinical training. It is these research training programs that are the subject of the National Research Service Award Act and also of this report.

In ADAMHA, the situation is different. Most of their training funds (about 80 percent) have been for clinical training rather than research training. Many of the psychiatrists and clinical psychologists supported by fellowships and traineeships of ADAMHA have received clinical training.

Most of the published data from NIH/ADAMHA do not show separate totals for clinical and research training. Both are generally subsumed under the heading of Training Grants and Fellowships. As a consequence, one must exercise great care in trying to relate data published elsewhere to those covered in this report, which refer only to the research training programs of NIH/ADAMHA.

Another important distinction between NIH and ADAMHA concerns the academic level of their trainees. The NIH programs in recent years have been fairly evenly divided between pre- and postdoctoral research training. On the other hand, the ADAMHA research training programs are almost exclusively at the predoctoral level.

APPENDIX D

SOME DATA SOURCES AND STUDIES

DATA SOURCES

Both aggregate and individual data are required for a comprehensive study of the national needs for biomedical and behavioral research personnel. For any supply/demand analysis undertaken, trends in undergraduate and graduate enrollments, baccalaureate and doctoral degrees awarded, predoctoral and postdoctoral levels of support, research and development spending, and salary scales must be considered. Much of this aggregate information has been collected by the National Institutes of Health (NIH), the National Science Foundation (NSF), the Office of Education (OE), the Department of Labor (DOL), and the National Research Council (NRC).[1] For a micro-study of career patterns, longitudinal data on type of employer, work activity, field-switching, relative salaries, and publication and citation indices are important. These data are needed for biomedical and behavioral specialties as well as for broad fields if shortage and surplus estimates are to be made for disciplinary areas. Information on the careers of Ph.D. (or equivalent) recipients is contained in five files of data concerning the education and work experience of individuals maintained by the National Research Council. Some data on the careers of M.D. and other professional doctorate recipients are available from a file maintained by the Association of American Medical Colleges (AAMC). These six data sources are briefly described below.

1. Comprehensive Roster of Doctoral Scientists and Engineers (NRC)

Contained in this file are records on all 1930-72 U.S. doctorate (Ph.D. or equivalent) recipients in science and engineering, 1930-72 U.S. doctorate recipients in other fields who were identified from the NSF National Register surveys (see below) as employed in science and engineering, and recipients of 1930-72 foreign-earned doctorates who were similarly identified. This population includes approximately 272,200 individuals—10,400 with foreign-earned doctorates and 9,700 with nonscience-nonengineering doctorates. Biographic and degree information

[1] See the bibliography (Appendix E) for specific references.

is available on the whole population. Detailed 1972 and 1973 employment data on 44,000 respondents to a sample survey accurately describe the current employment situation for Ph.D. recipients. Survey data on 1974-75 employment activities should be available in December of this year.

2. Doctorate Records File (NRC)

This file contains biographic and degree information on 471,000 individuals who earned U.S. doctorates (Ph.D. or equivalent) between 1920 and 1974. Information on sources of graduate support and employment plans (after earning the doctorate) are also included in this file.

3. National Registers of Scientific and Technical Personnel (NSF)

Employment data on 171,000 doctoral scientists working in the United States have been compiled from the 1960-70 surveys under the National Register of Scientific and Technical Personnel. Inconsistent coverage from year to year and from field to field has restricted the use of this file as a source of longitudinal information. However, an attempt to derive reliable population statistics, using the Doctorate Records File as a base, is now being made. When this effort is completed and the file is combined with the Comprehensive File, detailed information should be available on the careers of Ph.D. scientists from 1960-75.

4. NIH File of Trainees and Fellows (NIH)

This file includes biographic and detailed training program data on 94,000 individuals supported by NIH 1961-71 training grants and 1938-72 fellowships. Training records for 1972-73 funded trainees and 1973-74 funded fellows will be added shortly. This file has been collated with the above data sources so that training support can be considered in conjunction with biographic characteristics and career information.

5. Institute for Scientific Information (ISI)

Included in this file are records on 1,180,000 individuals who have published articles in world scientific literature during the period 1961-72 and records on 1,841,000 individuals who have been cited in this literature. These records have been collated with some of the data files above, adding a valuable outcome measure to other career pattern data.

6. Medical Faculty Profile (AAMC)

This file contains biographic and employment data on 23,000 recipients of the M.D. and other professional doctorates who were members of medical school faculties in 1975. Plans are now being undertaken to construct 1971-74 data in this file so that longitudinal studies relating to the employment of medical faculty members can be made.

Although the collation of the above files, on one hand, is useful in presenting a comprehensive picture of the career patterns of biomedical and behavioral research personnel, it also raises some serious problems in taxonomy. Differences in field classification schemes used in the NRC, NSF, NIH, and AAMC files make it impossible to find a consistent definition of supply in the biomedical and behavioral fields—especially in the clinical sciences. Differences in work-activity questions in the AAMC and NRC surveys raise some doubt about the comparability of the numbers of M.D.'s and Ph.D.'s who indicate that they are engaged in research. More detailed analyses of these data sources should result in a more consistent definition of the biomedical and behavioral research pool.

While the coverage of the Ph.D. component of supply is reasonably complete, M.D. researchers not associated with medical schools cannot be satisfactorily and comprehensively identified at the present time. It is hoped that M.D.'s employed by the federal government and industry will be included in future AAMC surveys. The Ph.D. sample used in future NRC employment surveys will also have to be augmented—especially in the behavioral fields—in order to be able to report with confidence market trends in subfields.

Reliable data on the demand for biomedical and behavioral research personnel are not available at the present time. A survey of a sample of employers of bioscience doctorate recipients is now being conducted by Westat, Inc. (for NIH). A survey covering the behavioral fields—and perhaps an augmentation of the biomedical sample—will also be necessary. Also, a computerized data file with the program data on individuals supported by ADAMHA and HRA must be generated and collated with the data sources mentioned above so that individuals supported by these agencies can be identified in career pattern analyses. Information on support from other sources, especially at the postdoctoral level, would also be useful, although no systematic means of collecting such data is apparent.

STUDIES

1. Studies by Professional Societies

Professional societies are a logical source for manpower studies. A few examples can be cited. A joint committee of the American Thoracic Society and the American College of Chest Physicians, for example, has completed a study of professional manpower in the field of pulmonary diseases for the period 1971-72. The findings include data on a full-time equivalence basis for physician faculty and trainees engaged in pulmonary research, the number of budgeted vacancies, and estimates of additional personnel needed to meet the requirements of medical school programs. The findings of that study have been compared with data for 1974-75 obtained by an ad hoc committee of the American Thoracic Society to determine supply and demand for physicians and scientists involved in teaching and research related to pulmonary disease in Departments of Medicine and Pediatrics. A comprehensive data base on surgical manpower will soon become available with publication of a study sponsored by the American College of Surgeons and the American Surgical Association. Using 1945-1970 as a base period, the study will provide estimates of future supply and forecasts of utilization rates for the various sectors of surgical manpower. Other studies, more circumscribed in scope, have been undertaken in recent years under the aegis of the American Society of Hematology, the American Academy of Dermatology, and the Arthritis Foundation.

A very recent study by the American Society for Pharmacology and Experimental Therapeutics describes the demographic characteristics and the employment of pharmacologists and highlights the role that federal support has played in training this manpower.

A 1971 report of the National Program for Dermatology concludes that the training grant has had a major influence on the growth of research programs in dermatology and on the overall growth and development of dermatology units.

2. Staff Studies

During the past three months several members of the Committee's staff have begun quantitative analyses related to supply/demand for biomedical and behavioral research personnel, using published data and data available from the sources described above. Included among these preliminary and exploratory analyses are a longitudinal study of several

supply components in the research pool, an evaluation of the future demand for research personnel in academia, industry, and the federal government, and the development of an alternative approach for estimating the need for research personnel. Although none of these analyses has been completed, useful information has already been compiled. Pertinent portions of this information have been incorporated into Chapter IV of this report. During the next year, further development from these analyses are expected to lead to a better understanding of the factors influencing the need for biomedical and behavioral research personnel and will enable the Committee to provide more specific recommendations concerning future levels of training.

3. Econometric Model

During the past two months an attempt has been made under the present study by Richard Freeman, a Harvard economist serving as a consultant to the Committee, to develop a "market model" for the biological sciences. Unlike standard requirement projections, market models take into consideration the adaptation of the science manpower system to changing circumstances, including changes in research and development, stipends, and other factors. Freeman has in the past constructed such models for the physical sciences and engineering. A preliminary model for the biological sciences has been developed by Freeman and his coworkers at Harvard from published aggregate data on educational and career decisions of individuals and on demand factors such as the cost of employment, relative salaries, and the market value of the "final product". Tentative findings indicate that the market for biological scientists, unlike the market for other scientists, did not collapse in the last five years. Relative salaries, numbers employed in the field, R and D funding, and private spending by drug and medicine firms all seem to be increasing in the biosciences. On the supply side, enrollments and numbers of degree recipients have been increasing, in contrast to significant decreases in the physical sciences. As for market conditions in the late 1970's/early 1980's, this preliminary analysis suggests the possibility of a significant oversupply of manpower in the bioscience area—particularly if the recent growth in graduate enrollments continues.

Much work remains before the factors influencing the bioscience market are fully understood. Data from the files available to the National Research Council (described above) have not yet been used for this preliminary model. These data will provide valuable information about the market conditions in bioscience specialties and about the mobility of individuals in these specialties.

4. Supply Studies

During the past few months, the Committee and staff have made a first attempt to identify longitudinal trends in components of the biomedical and behavioral research pool. Since the new doctorate-recipients have been, by far, the largest component of supply entries in recent years, particular attention is being paid to trends in enrollment and degree production. Attention is also being given to the field mobility of biomedical and behavioral scientists (i.e., the ability of these scientists to move both to other specialties within their broad field and to other science fields). Factors that enhance or inhibit mobility must be analyzed in detail. There is some indication that scientists have in the past been able to transfer to other fields and other employment sectors in response to market demand. Whether biomedical and behavioral scientists will be mobile enough to meet future demands and whether extensive training will be necessary are important issues to be investigated. The value of the postdoctoral appointment as a tool for retraining is a related issue to be considered.

In order to project the size of the biomedical and behavioral research pool, it is necessary, of course, to analyze trends in the proportion of the supply defined above who are engaged in research. The length of the research career, the subsequent employment, and other factors related to career patterns must be investigated. All of the above analyses depend on the availability of reliable longitudinal data. It is hoped that data from the 1960-70 National Register surveys, weighted by appropriate statistics, can be used in conjunction with 1972-75 data from the Surveys of Doctoral Scientists and Engineers to examine 15-year trends in the Ph.D. supply. For the M.D. supply, only 1971-75 data from the AAMC Faculty Profile have been collected so far.

5. Demand Studies

Estimating the future demand for biomedical and behavioral scientists is a very difficult matter that has just begun to be explored by the Committee. The approach underlying the recent NSF projections[2] divides the demand market into three components: academia, the non-academic research and development sector, and the other-employment sector. Projections of the demand for biomedical and behavioral scientists in academia can be made with some confidence by examining trends in enrollments, faculty attrition, and enrichment (as Allan Cartter has has done[3]). Trends in the growth of R and D as a percentage of GNP

[2]National Science Foundation, Projections of Science and Engineering Doctorate Supply and Utilization, 1980 and 1985, February 1975.
[3]Allan M. Cartter, "Scientific Manpower for 1970-1985," Science, vol. 172, April 9, 1971.

(or of other indices) can be used to estimate future demand in the non-academic R and D sector. However, abrupt changes in R and D levels in the recent past suggest that such estimates are not reliable. Very little is known about the demand for biomedical and behavioral scientists in the third sector (nonacademic/non-R and D). Studies of the career patterns of individuals who have entered this sector in the past should be undertaken to determine the requirements and capacity of the sector.

In a very preliminary and exploratory effort Robert Weatherall, Director of Placement at MIT and a consultant to the Committee, has surveyed a few representatives of industry and professional societies about their perceptions of the future labor market for biomedical and behavioral scientists. The usefulness of demand surveys made in the past is very much open to question, however, and the Committee intends to proceed cautiously in this part of its task.

6. Alternative Approaches

Other approaches to the determination of national need for biomedical and behavioral research personnel are being investigated. One such approach uses the total investment required to reduce national expenditures for disease and disability in order to estimate the need for biomedical and behavioral research. The level of research expenditures then determines the number of personnel required. The basic assumption underlying this approach is that biomedical and behavioral research is the primary long-term process by which disease and disability are reduced and that a prudent policy of investment in research in these areas will pay off within a given time. The data required for this study include total annual direct expenditures for illness, the annual rates of biomedical/behavioral training and research expenditures, the average annual research cost per researcher, and the size of the current manpower pool. The manpower pool size can be estimated from data in NRC and AAMC files mentioned earlier; training and research expenditures are available from the federal agencies. The Social Security Administration is now updating its 1963 estimates of the direct cost of certain disease categories. An assumption must be made about the pay-off rate of the research investment. Alternative estimates of the need for biomedical and behavioral research personnel can be made by using alternative assumptions about this rate.

APPENDIX E

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