Changing Postdoctoral Career Patterns for Biomedical Scientists

Porter E. Coggeshall, John C. Norvell,
Lawrence Bogorad, Robert M. Bock

Summary. Between 1973 and 1977 the total number of Ph.D.'s holding postdoctoral appointments in the biomedical sciences increased at a rate of more than 550 individuals (12.5 percent) per year. During this same period the total number of doctorates awarded each year in these disciplines showed very little change. The postdoctoral growth can be attributed to substantial increases in both the numbers of recent graduates taking postdoctorals and the length of stay on these appointments. The lack of alternative employment opportunities has contributed heavily to the postdoctoral buildup. Continued growth is likely to have important consequences for biomedical research and research training.

In the late 1950's the federal government substantially increased its investment in health-related research. During the subsequent years research in all areas of biomedical science flourished to a degree that few could have foreseen. The rapid growth in research on life processes in normal and diseased tissues led to an immediate need for large numbers of highly skilled and creative investigators. To meet this need, federal programs for the support of graduate and postgraduate research training were quickly expanded. The success of these programs is unquestioned. More than 30,000 Ph.D.'s were trained for research careers in a broad spectrum of biomedical areas (*1*). In recent years, growth in federal expenditures for health-related research has slowed considerably, and permanent academic research positions have become harder to find for the large numbers of young investigators still being produced by graduate schools.

As a result of this, Congress asked the National Academy of Sciences to assess the need for research personnel in the various health-related areas and to determine to what extent the federal government should continue to provide support for biomedical research training. Under the auspices of the National Research Council, the Committee on a Study of National Needs for Biomedical and Behavioral Research Personnel was appointed to carry out this task, with financial support from the National Institutes of Health. The committee has now published three annual reports (*2–4*). In its most recent report the committee and its advisory panel for the basic biomedical sciences made a detailed examination of the employment situations of recent Ph.D.'s in the biomedical sciences and found the vast majority of these graduates to be employed in positions—either permanent or temporary—in which they were able to utilize their research training. They also found a rapid growth in the number of Ph.D.'s on temporary postdoctoral appointments and were concerned that this might signify that there was already a shortage of permanent employment opportunities for the many graduates who now hold these temporary positions. In this article we examine the postdoctoral buildup and its implications for the Ph.D. candidate planning a career in a biomedical field. (Postdoctoral training for recipients of M.D., D.V.M., D.D.S., and other professional doctorates will not be considered here.) Our purpose is not to describe the nature of the postdoctoral appointment or the contributions those holding such appointments make to research and graduate education beyond the brief description that follows.

The postdoctoral appointment has traditionally offered recent recipients of the Ph.D. degree an opportunity for the advanced training considered important, if not essential, for a career in biomedical research. The published research results from this period of intensive investigation afford important credentials needed to compete for the best permanent employment positions. The appointment typically is held for a 1- to 3-year period and allows the young investigator to concentrate on research activities without the burden of teaching and administrative responsibilities usually given to a faculty member. While holding this position the postdoctoral appointee functions as a valuable member of the research team who may bring a fresh approach to the laboratory problem being examined. In addition, the postdoctoral appointment frequently is used as a temporary buffer for those unable to find permanent positions after receipt of the doctorate. Consequently, changes in the total number and average length of these appointments are sensitive indicators of the balance between the supply of and demand for Ph.D. scientists to fill permanent positions in the biomedical sciences.

Over the past two decades there have been significant increases in the number of biomedical Ph.D.'s planning postdoctoral study after graduation. During this same period there has also been considerable growth in the number of graduates in physics, chemistry, and engineering who take postdoctorals (see Fig. 1). However, the increases in the biomedical sciences, unlike those in the other fields, have continued. One explanation for this is that the number of Ph.D. degrees awarded annually in the biomedical sciences did not start to decline in the early 1970's as it did in physics, chemistry, and engineering. Nearly 3000 graduates per year received doctoral degrees in biomedical disciplines between 1971 and 1975 (see Fig. 2), and more and more of these individuals have sought postdoctoral appointments. The resultant increase in the size of the postdoctoral group raises two questions:

1) To what extent does the continuing increase in postdoctorals reflect a current shortage of permanent positions available for young biomedical scientists?

2) How many of those now on postdoctoral appointments will be able to find employment which utilizes their training?

In this article we examine both of these questions.

Mr. Coggeshall and Dr. Norvell are staff members of the Committee on National Needs for Biomedical and Behavioral Research Personnel of the Commission on Human Resources, National Research Council, Washington, D.C. 20418. Dr. Bogorad is chairman of the committee's Advisory Panel on Basic Biomedical Sciences and professor of biology, Harvard University, Cambridge, Massachusetts 02138. Dr. Bock is a member of the committee and dean of the Graduate School, University of Wisconsin–Madison, Madison 53706.

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Earlier Studies

The first major national study of the postdoctoral scene was undertaken by a National Research Council committee whose staff was under the direction of Richard B. Curtis. A report, *The Invisible University*, was published in 1969 (*5*). It focused on the sociology of postdoctoral education in all fields of learning and has served as a valuable benchmark for later studies. Findings and recommendations were based on extensive visits to universities, government laboratories, and industry as well as on national surveys of postdoctoral appointees and other young Ph.D.'s, university administrators, department chairmen, and senior mentors. Although no specific recommendations were made concerning the appropriate sizes of postdoctoral populations in different fields, the report concluded that "the total number of postdoctoral opportunities of all kinds should have some relationship to the number of people with postdoctoral backgrounds required by universities, by specialized industries, and by government laboratories and to the number of doctorate-holders who would benefit by the experience" (*5*, p. 247).

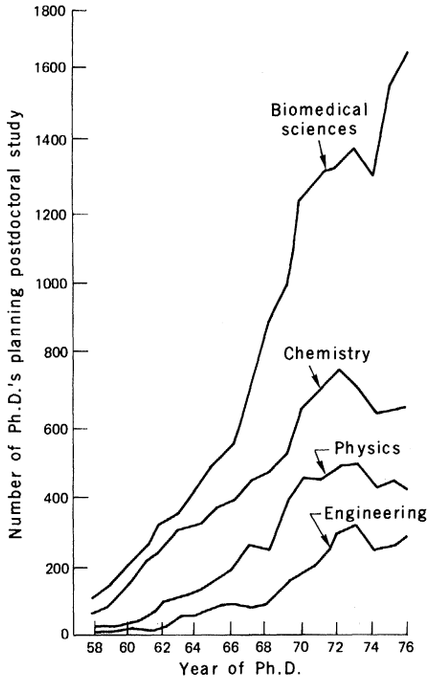

Fig. 1. The number of 1958 to 1976 Ph.D. recipients in chemistry, physics, engineering, and the biomedical sciences who had definite plans for postdoctoral study after graduation. [Data from (*11*)]

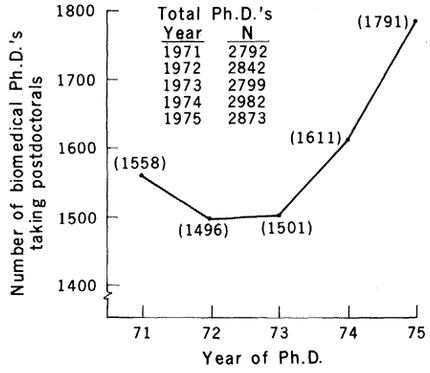

Fig. 2. The number of 1971 to 1975 biomedical Ph.D. recipients who have taken postdoctoral appointments within a year after receiving their doctorates. [Data from (*10*)]

Two National Research Council studies sponsored by the National Institutes of Health (NIH) compared the career patterns of biomedical scientists with postdoctoral training and those without such training. The reports (*1*, *6*) concluded that those with postdoctoral experience have been much more likely to pursue careers in research and that the careers of former postdoctoral appointees were more successful, as measured by publication and citation indices. However, from these studies it was not possible to differentiate the career outcomes attributable to the postdoctoral training experience from those attributable to a variety of factors operative in the selection process, either of which alone might have explained the findings.

In a paper presented at a meeting of the Council of Graduate Schools, Grodzins (*7*) raised some questions concerning the future viability of postdoctoral training. He cited anecdotal information that suggested "the postdoctoral is being increasingly used to switch to fields of greater unemployment potential or as a haven till an acceptable position becomes available" (*7*, p. 1). Grodzins underscored the urgent need for data to examine these and other changes in the postdoctoral scene, and in this article we address many of the questions he raised.

Shull (*8*) has proposed that controlled expansion and contraction of the postdoctoral population can serve as a buffer for short-term imbalances between the supply and demand for Ph.D. scientists. The consequences of using the postdoctoral in this fashion are not fully understood. On the one hand, expansion of the postdoctoral population may provide research opportunities for recent graduates who could not otherwise utilize their training in the present job market. On the other hand, this expansion may delay feedback on the job market situation to students making career choices involving graduate study, and eventually result in an even greater imbalance. The present job market situation in the biomedical sciences can serve as a trial for the postdoctoral buffering phenomenon.

All four authors of this article have participated in the National Research Council Study of National Needs for Biomedical and Behavioral Research Personnel. In its 1976 and 1977 reports (*2*, *3*) the committee on this study, faced with indications (*9*) of diminishing employment opportunities for young biomedical scientists, called for a 30 percent reduction in NIH support for predoctoral training over a 4-year period. A more drastic cutback was considered, but the committee recognized that these training programs supported by federal funds "make a major contribution to the vigor and quality of American biomedical sciences" (*2*, vol. 1, p. 60). The committee was not certain that a reduction in federal training funds would result in a proportional decline in the number of Ph.D. degrees awarded in the future, but was persuaded that a sharp reduction could have a detrimental effect on the quality of the whole enterprise. It was urged that

Table 1. The numbers and percentages of 1971 to 1975 Ph.D. recipients in biomedical specialties who have taken postdoctoral appointments within a year after receiving their doctorates. [From (*10*)]

Ph.D. specialty field	1971 to 1975 Ph.D.'s	Ph.D.'s taking postdoctorals	
	N	*N*	%
Total biomedical sciences	14,288	7,957	55.7
Biochemistry and molecular biology	3,616	2,836	78.4
Biophysics	604	458	75.8
Virology	282	203	72.0
Neurobiology	375	262	69.9
Cell biology	505	337	66.7
Immunology	502	325	64.7
Developmental biology	392	243	62.0
Microbiology	1,395	773	55.4
Physiology	1,445	789	54.6
Genetics	579	304	52.5
Pharmacology	1,170	504	43.1
Evolutionary biology	184	79	42.9
Nutrition and food science	206	67	32.5
Morphological science	435	139	32.0
Animal sciences	126	40	31.7
Pathology	265	72	27.2
General biology	703	188	26.7
Biomedical engineering	289	75	26.0
Environmental health	240	58	24.2
Epidemiology	108	13	12.0
Public health	198	19	9.6
Biomathematics and biostatistics	221	15	6.8
Other biomedical sciences	448	158	35.3

information gathered about important changes in the employment situations of young biomedical scientists be disseminated to all those involved in graduate education and those considering entering doctoral programs in this field. This article is intended to serve that purpose.

Data Sources

Most of the findings we describe are drawn from a 1976 survey of recent recipients of biomedical science doctorates (*10*). Responses were obtained from 72 percent of the 7784 persons surveyed. A careful analysis of nonrespondents revealed no apparent biases (*2*, vol. 2, appendix C1). Data reported in the tables that follow represent weighted estimates of a total survey population of 14,288 persons. Included in this population are all persons receiving U.S. biomedical Ph.D.'s between 1971 and 1975 except those who were employed outside the country.

Other data reported herein come from an annual survey of new Ph.D. recipients in all fields of learning (*11*), and a biennial survey of a 20 percent sample of doctoral scientists and engineers currently active in the U.S. labor force (*12*). Data from the latter source are available from 1972 to date.

For the purposes of this article, a postdoctoral appointment is defined as:

> . . . a temporary appointment, the primary purpose of which is to provide for continued education or experience in research usually, though not necessarily, under the supervision of a senior mentor. Included are appointments in government and industrial laboratories which resemble in their character and objectives postdoctoral appointments in universities (*10*).

Data from the survey of 1971 to 1975 Ph.D.'s are consistent with this definition. The other surveys do not provide as specific a definition of the postdoctoral appointment (*13*). In some of the data presented here the term "immediate postdoctoral" is used to designate an appointment which has been undertaken within a year after receipt of the Ph.D. degree. The term "permanent employment" refers to tenure-track positions in the academic setting and to all nontraining positions in other sectors.

Increase in Postdoctoral Appointees

Increases in the numbers of biomedical Ph.D.'s planning advanced research training after graduation are by no means a recent phenomenon (Fig. 1). Throughout the 1960's, interest in the postdoctoral appointment grew along with the complexities of approaches to research. By 1970 more than half of the graduates in the biomedical sciences said they intended to pursue postdoctoral training (*14*). Data from the survey of 1971 to 1975 Ph.D.'s (Fig. 2) indicate that the numbers who actually took postdoctoral appointments within a year after receipt of their degree declined slightly in the early 1970's—in part, a consequence of the impoundment of federal funds for research and research training. After this, the number going on to advanced research training grew once again. By 1975, nearly 1800 doctoral graduates were taking postdoctoral appointments.

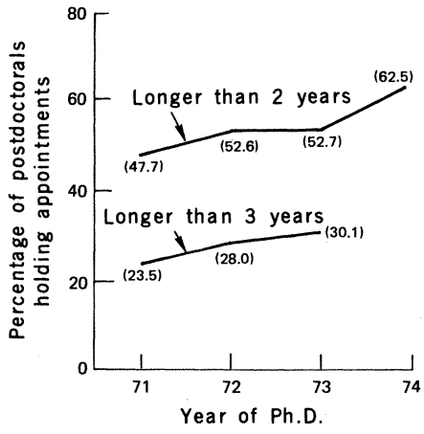

Fig. 3. The percentages of 1971 to 1975 biomedical Ph.D. recipients with immediate postdoctoral appointments who have held these appointments longer than 2 and 3 years. [Data from (*10*)]

What is most unusual about the large growth in immediate postdoctoral appointments is that it occurred during a period when the annual number of individuals earning biomedical Ph.D.'s did not change significantly. Figure 2 shows that from 1971 to 1975 the total doctoral degrees awarded each year in the biomedical fields has remained between approximately 2800 and 3000. In contrast, data from other sources (*2*) indicate that from 1958 to 1970 there were appreciable increases in the total number of biomedical doctorates awarded annually as well as in the number of graduates planning postdoctoral study.

The recent growth in the number of Ph.D.'s taking appointments within a year after graduation can be attributed almost entirely to a significant increase in the fraction of graduates deciding to take postdoctorals. More than 62 percent of the 1975 biomedical Ph.D.'s took postdoctoral appointments after graduation compared to less than 53 percent of 1972 graduates.

This heavy participation in postdoctoral training has not been shared by graduates in all of the biomedical disciplines. In some of the more applied specialties such as biostatistics, public health, and epidemiology (*15*), very few graduates have taken postdoctoral appointments (Table 1). On the other hand, more than three-fourths of the 1971 to 1975 Ph.D.'s in biochemistry and biophysics have gone on to advanced research training. It is not clear to what extent these differences are related to the availability of permanent positions in a particular specialty, the complexity of research techniques required in that specialty, the length of time spent in graduate study, or other factors. Nonetheless, in interpretating the aggregate data for the biomedical sciences reported herein, one must keep in mind that the fraction and numbers of graduates who have taken postdoctoral appointments differ substantially among disciplines. For example, more than half of those with advanced research training earned their Ph.D. degrees in three disciplines—biochemistry, physiology, or microbiology.

Table 2. The numbers and percentages of 1971 to 1975 biomedical Ph.D. recipients from the 20 highest rated and other universities who have taken postdoctoral appointments within a year after receiving their doctorates. [From (*10*)]

Institution awarding Ph.D.	Year of Ph.D.				
	1971	1972	1973	1974	1975
20 highest-rated universities*					
Total number of Ph.D.'s	726	889	751	795	808
Ph.D.'s taking postdoctorals					
Number	418	577	440	515	524
Percentage	57.6	64.9	58.6	64.8	64.9
Other universities					
Total number of Ph.D.'s	2066	1953	2048	2187	2065
Ph.D.'s taking postdoctorals					
Number	1140	919	1061	1096	1267
Percentage	55.2	47.1	51.8	50.1	61.4

*Results from a study by Roose and Andersen (*16*) were used to identify the 20 universities with the highest average ratings for biomedical departments.

Table 3. The percentages of 1971 to 1975 biomedical Ph.D. recipients on postdoctoral appointments in October 1976 who indicated they had prolonged their postdoctoral study because of difficulty in finding suitable employment. [From (*10*)]

Time on postdoctoral appointments	Percentage who prolonged study because no job
Total	43.7
Less than 25 months	24.4
From 25 to 36 months	46.5
More than 36 months	72.2

Grodzins (*7*, p. 22) speculated that "the less promising" graduates in fields with diminishing employment opportunities might be expected to take postdoctorals more frequently, with the hope of eventually obtaining better job offers. With this hypothesis in mind, we examined the increases in numbers of biomedical Ph.D.'s taking postdoctoral appointments as a function of a reputation rating of the university they attended for graduate studies. If indeed there has been a shortage of permanent jobs in recent years, we might expect a shrinking fraction of the new postdoctoral appointees to have graduated from the reputedly best universities. It is impossible, of course, to obtain a universally accepted ranking of graduate schools. For the purpose of this analysis we have used results from a 1969 study by Roose and Andersen (*16*) to identify 20 universities with the highest average reputation ratings for all biomedical departments. Although the ratings are based on subjective criteria and are several years out of date, the 20 schools included, we believe, would be considered by most readers to have outstanding graduate programs in the biomedical sciences (*17*).

The results of our analysis are inconclusive. During 1971 to 1975 there was an increase in postdoctoral appointments taken by graduates of both the 20 highest rated universities and the other institutions (Table 2). Although the differences were not large, the Ph.D. recipients from the "top 20" were consistently more likely to undertake advanced research training than other graduates. It is not evident from these findings that the growing interest in postdoctoral training can be primarily attributed to a hypothesized shortage of employment positions for the less promising biomedical Ph.D.'s as Grodzins suggested.

However, there is other evidence to suggest that those taking postdoctoral appointments have encountered increasing difficulty in finding permanent employment. Survey findings document a substantial increase in the length of postdoctoral training (Fig. 3). More than 62 percent of the 1974 graduates taking immediate postdoctorals continued their training longer than 2 years, whereas less than 47 percent of 1971 graduates held postdoctorals that long. Similar trends were found for those remaining in postdoctoral appointments longer than 3 years. Although it can be argued that longer training periods are required as technologies and concepts in biomedical research become more complex, we are convinced that most of the observed increase in the length of postdoctoral appointments can be attributed to diminishing research and teaching employment opportunities. Other survey results reveal that nearly half of the 1971 to 1975 Ph.D.'s who held postdoctorals prolonged their appointments because of difficulty in finding suitable employment (Table 3). Furthermore, nearly three-fourths of those who held postdoctoral appointments longer than 3 years indicated they had extended their period of training for this same reason. Many will argue that the additional training may benefit both the individual and the overall quality of biomedical research. We will not address that issue here. Rather, our purpose is to call attention to an indication of impending employment difficulties for young biomedical scientists.

Using findings from a national survey of scientists and engineers (*12*), we now examine the total number of individuals in postdoctoral training at any given time. Since this total is primarily a function of the numbers taking postdoctorals from each previous class of Ph.D.'s and the average length of these appointments, it is not surprising to find substantial growth in the postdoctoral population. Between 1972 and 1977 the total number of biomedical postdoctoral appointees increased from an estimated 3521 to 6339, representing an annual rate of growth of 12.5 percent (Fig. 4). Thus, during this period in which the annual number of Ph.D.'s awarded grew very little, approximately 550 more individuals started postdoctoral training than completed it each year. Except for the low estimate in 1974, which probably reflects the impoundment of federal funds, the growth in the postdoctoral population has been remarkably steady. How much longer will these increases continue? The availability of federal funds and other sources of support undoubtedly will be a key factor. Nevertheless, we see no reason to expect an immediate change in recent trends of some of the primary factors underlying this postdoctoral expansion. Over a long time

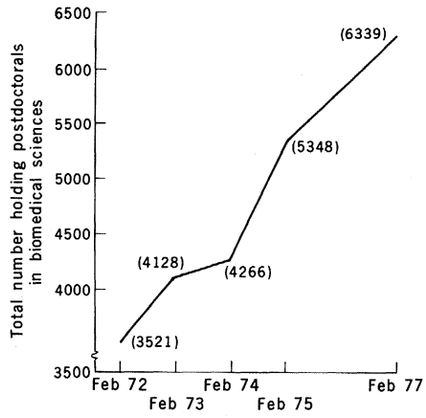

Fig. 4. The estimated total number of Ph.D.'s holding postdoctoral appointments in biomedical specialty fields. [Estimates derived from data from (*11*) and (*12*)]

span, the faculty openings available as a result of retirements and labor market changes may influence the rate of production of new graduates. In the meantime, however, as the population of biomedical Ph.D.'s grows, fresh Ph.D.'s with no postdoctoral training are likely to find it more difficult to compete successfully for permanent positions. Similarly, as the competition for permanent jobs among those holding temporary appointments intensifies, more Ph.D.'s will be forced to prolong their period of training. It is not foreseen that many new employment opportunities in other fields of science will open up for biomedical Ph.D.'s. In fact, more than 20 percent of those recently in postdoctoral training in the biomedical sciences had previously completed graduate programs in other fields such as physics and chemistry (*18*).

Alternative Career Paths

What employment alternatives have been available to the recent biomedical graduates who have chosen not to pursue postdoctoral training? Survey data describing the 1976 employment situations of graduates who received Ph.D.'s in 1975 and who did not take postdoctoral appointments show that more than half held positions in academia (Fig. 5). Most of those employed in colleges and universities considered teaching to be their primary work activity, whereas almost half of those employed in medical and other professional schools designated research as their primary activity. An additional 28 percent of the 1975 graduates not taking postdoctoral appointments found positions in government and business; of these, more than half were primarily involved in research. Very few graduates were unemployed

and seeking jobs. However, these findings may present a somewhat misleading picture of the long-term career prospects for biomedical Ph.D.'s without postdoctoral training. Survey results (*2*, vol. 1, p. 42) indicate that among the 1975 graduates who were employed in the academic sector and had not received postdoctoral training, as many as one-third held positions not considered to be in the regular tenure track. Most of these individuals, like the postdoctoral appointees, will be seeking permanent positions in the next few years.

One of the questions raised by Grodzins (*7*, p. 2) and others is whether or not advanced research training has come to be generally regarded as a prerequisite for young biomedical scientists planning an academic career. The answer to this question may be different for the various biomedical specialties. In some of the more traditional disciplines such as biochemistry, a very large fraction of all graduates (irrespective of intended employment) have had at least some postdoctoral training (see Table 1). In other areas such as biostatistics and epidemiology, the majority of graduates have entered academic employment without having held postdoctorals. To some extent these differences can be explained by the nature of the work graduates are expected to engage in. More than 65 percent of the 1971 to 1975 Ph.D.'s who indicated that they hoped to pursue academic careers with research as their primary activity have had postdoctoral training, compared with approximately 35 percent of those planning other academic careers (Table 4). Similar results were obtained for those who desired careers outside the academic sector. In fact, more than half of the 1971 to 1975 Ph.D.'s who indicated that they wanted research careers in government and industry have held postdoctoral appointments. These findings suggest that advanced research training has been important to biomedical Ph.D.'s planning research careers, regardless of whether they preferred academic or nonacademic employment. However, we find it somewhat puzzling that as many as one-third of those preferring careers in activities other than research have had postdoctoral training. Have these individuals been forced to take postdoctorals because they could not find permanent employment positions? Many of these biomedical graduates may have preferred careers with only part-time involvement in research, for which their postdoctoral training would be useful nevertheless. Others may have wished to devote their full energies to research for a brief period before beginning a career in teaching, administration, or some other activities not directly related to research. In trying to interpret these findings the reader is reminded that there are probably differences in the early career patterns of Ph.D. recipients in various biomedical specialty fields. These differences cannot be distinguished by means of the aggregate data presented.

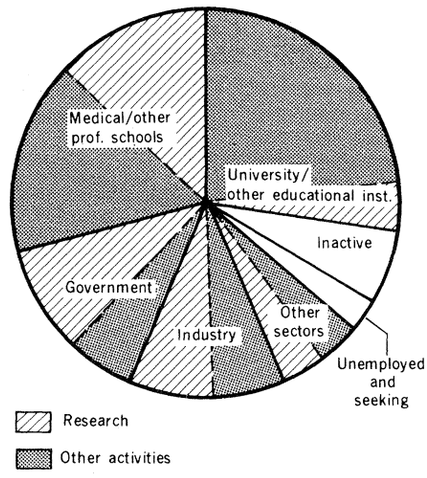

Fig. 5. The type of employer and primary work activity of 1975 biomedical Ph.D. recipients who have not held postdoctoral appointments since receiving their doctorates. [Data from (*10*)]

Subsequent Careers

How successful have the recent biomedical graduates taking postdoctoral appointments been in finding subsequent employment in research? Results from earlier studies (*1*, *6*) of NIH postdoctoral trainees and fellows indicate that these individuals have been much more likely to pursue research careers than other graduates who have not had any postdoctoral training. Our own analysis confirms these findings. Data in Table 5 compare the 1976 employment setting and primary work activity of 1971 to 1972 Ph.D.'s who have held postdoctoral appointments with the employment situations of other 1971 to 1972 Ph.D.'s. Of the 2851 graduates with some postdoctoral experience a total of more than 65 percent held research positions, whereas only 35 percent of the other 2410 graduates designated research as their primary activity (*19*). The employment settings of these two groups, on the other hand, were quite similar. Approximately 60 percent of each group were employed in the academic sector.

Other differences were found between those who have had postdoctoral training and those who have not. The latter group was much less likely to be employed in the 20 universities with the highest-rated biomedical departments (Table 6). However, a total of almost 45 percent of the 1971 to 1972 Ph.D.'s without postdoctoral study experience already held tenured positions in 1976, compared with only 8 percent of those with postdoctoral training. Much of this difference, of course, can be explained by the fact that most of those without any postdoctoral training have held academic positions leading to tenure for a longer period of time and consequently may have been eligible for tenure sooner. Also, it is likely that many of those who had acquired tenure were in those biomedical fields in which post-

Table 4. The numbers and percentages of 1971 to 1975 biomedical Ph.D. recipients taking postdoctoral appointments within a year after receiving their doctorates by desired employment setting and primary work activity. [From (*10*)]

Desired employment setting and primary work activity	1971 to 1975 Ph.D.'s	Ph.D.'s taking postdoctorals	
	N	*N*	%
Total	14,288	7,957	55.7
University or 4-year college			
Research	3,433	2,347	68.4
Other activities	1,487	516	34.7
Medical or other professional school			
Research	4,858	3,132	64.5
Other activities	1,561	575	36.8
Government			
Research	750	420	56.0
Other activities	273	83	30.4
Industry			
Research	720	347	48.2
Other activities	472	167	35.4
Other employers			
Research	423	266	62.9
Other activities	311	104	33.4

doctoral training has traditionally not been a requirement for faculty positions. Nonetheless, it is remarkable that so many graduates had acquired tenure within 4 or 5 years after receiving their doctorates. Whether or not more recent graduates not taking postdoctoral appointments will be as successful remains to be seen. Anecdotal evidence suggests that most available faculty positions in the biomedical sciences now require applicants to have had some advanced research training experience. A follow-up study of more recent postdoctoral appointees will be needed to determine the validity of this observation in each biomedical specialty field.

A comparison of median salaries of 1971 to 1972 Ph.D.'s with and without postdoctoral study experience is shown in Table 7. The salaries of individuals either on postdoctoral appointments or not employed full-time were excluded in calculating medians. As expected, those employed in government and industry had higher salaries than those in universities and colleges. However, we are surprised to learn that, in every sector of employment, graduates with no postdoctoral training were earning more than graduates with this training. The largest salary difference between these two groups was reported by scientists working in medical and other professional schools. Those who had completed postdoctoral training were earning an estimated $2550 less than other 1971 to 1972 graduates employed in professional schools. One interpretation that can be drawn from these findings is that job seniority has outweighed advanced research training experience in the determination of salary levels for biomedical scientists in the early stages of their careers (as may be the case for tenure as well). It is not known whether the salaries of those with postdoctoral training will eventually overtake other graduates' salaries at later career stages.

Table 5. The 1976 employment setting and primary work activity of 1971 to 1972 biomedical Ph.D. recipients with and without postdoctoral training. Figures exclude individuals on postdoctoral appointments at the time of the survey. [From (*10*)]

Employment setting and primary work activity in 1976	Postdoctoral study			
	Some		None	
	N	%	*N*	%
Total	2851	100.0	2410	100.0
Unemployed and seeking	41	1.4	65	2.7
Inactive	85	3.0	58	2.4
Medical or other professional school				
Research	872	30.6	318	13.2
Other activity	203	7.1	369	15.3
University or other educational institution				
Research	480	16.8	152	6.3
Other activity	369	12.9	583	24.2
Government				
Research	204	7.2	128	5.3
Other activity	63	2.2	166	6.9
Industry				
Research	206	7.2	191	7.9
Other activity	132	4.6	174	7.2
Other sectors				
Research	123	4.3	68	2.8
Other activity	73	2.6	138	5.7

Table 6. Academic employment situation in 1976 of 1971 to 1972 biomedical Ph.D. recipients with and without postdoctoral training. [From (*10*)]

Academic position	Postdoctoral study			
	Some		None	
	N	%	*N*	%
Total in academia	1924	100.0	1422	100.0
At 20 highest-rated universities*	365	19.0	135	9.5
Tenured position	22	1.1	45	3.2
Tenure track	193	10.0	47	3.3
Other position	150	7.8	43	3.1
At other universities	1559	81.0	1287	90.5
Tenured position	137	7.1	589	41.4
Tenure track	1027	53.4	507	35.7
Other position	395	20.6	191	13.4

*Results from a study by Roose and Andersen (*16*) were used to identify the 20 universities with the highest average ratings for biomedical departments.

Conclusions

The substantial increases in both the numbers of recent graduates taking postdoctorals and the length of these appointments support the notion of a developing shortage of permanent employment positions. Furthermore, data indicate that many Ph.D.'s who had taken postdoctoral appointments in the last few years prolonged their period of training specifically because of difficulty in finding permanent jobs. Undoubtedly other factors have also contributed to the rapid growth of the postdoctoral population. In fact, the recent increases in the fraction of biomedical graduates going on to postdoctoral study are a continuation of a trend that originated in the late 1950's, a trend that may be viewed by some as a natural consequence of the advancement of scientific knowledge and techniques. Indeed, the expansion in postdoctoral training is believed to have made an important contribution both to the quality of biomedical research now being done and to the qualifications of personnel who will carry on future research.

In some biomedical fields there are more postdoctoral appointments available than can be filled, and at the same time there appears to be a shortage of permanent employment opportunities. Almost 90 percent of the 1971 to 1972 Ph.D.'s who took postdoctoral appointments have completed their training, and most of them have been employed in research positions in the academic sector as well as in government and industry. However, more than one-fourth of those in academia held positions not considered to be in the regular tenure track. In some biomedical disciplines a large fraction of recent graduates have still been able to obtain faculty and other academic jobs for which advanced research training is not required.

One cannot project with certainty the employment situation in the next few years. An analysis of recent trends in federal research expenditures and graduate enrollments (*2*, chap. 3) suggests that jobs for new faculty will not be as abundant as they have been in the past. At the same time there is no indication that the new supply of biomedical Ph.D.'s

will decline significantly in the near future. With these prospects in mind, we ask:

1) How much more will the postdoctoral training population expand?

2) Will postdoctoral appointments still be considered the most propitious route for young biomedical scientists planning to pursue careers in research?

The future growth of the postdoctoral training population will depend, to a large extent, on the availability of federal funding for research and research training in the biomedical sciences. In 1976 an estimated 58 percent of the support for postdoctoral appointments came from federal training grant and fellowship funds; another 22 percent came from federal research grant and contract funds (*2*, vol. 2, p. 29). The impact of any significant change in the support levels of these sources cannot be reliably predicted from information now available. For example, a substantial cutback in either training or research support may remove a large number of temporary research positions—with untold consequences for young biomedical scientists not already holding permanent jobs. The productivity of the national biomedical research enterprise may also be impaired by a cutback in training funds. On the other hand, increases in federal support for postdoctoral training may encourage the training of many young biomedical scientists for whom permanent positions will not be available in the future. The National Research Council committee that is studying training needs has recommended that for the next few years federal support for postdoctoral training in the biomedical fields be kept at its current level (*2*, vol. 1, pp. 67–69). However, the committee has not ascertained to what extent changes in the available support have contributed to the rapid expansion of the postdoctoral training population in the last 5 years. Whether the growing postdoctoral pool influences the awarding and expenditure of limited research funds for graduate assistants, technicians (*20*), foreign postdoctorals, or other researchers would require further analysis.

We also find it difficult to assess the influence that continued expansion in postdoctoral training will have on the career decisions of potential biomedical investigators. In many biomedical specialty fields the postdoctoral appointment is considered the only route for graduates planning careers in research. Nonetheless, some students, when faced with the prospect of a minimum of 2 or 3 years of postdoctoral training and with no assurance of permanent positions after completing their training, may choose other biomedical careers not requiring advanced research training. Other students may decide on careers outside the biomedical sciences. These decisions will depend, of course, on the availability and attractiveness of competing career alternatives. A continued monitoring of the career choices made by young biomedical scientists now in graduate and postdoctoral training is needed to identify policy actions that might be initiated by federal agencies and universities. A study of the policy implications of the changing roles of postdoctorals in all fields of science has been undertaken by another National Research Council committee (*21*), and an interim report outlining policy issues and data requirements has been submitted to the National Science Foundation.

Table 7. Median 1976 salaries of 1971 to 1972 biomedical Ph.D. recipients with and without postdoctoral training. [From (*10*)]

Employment setting	Postdoctoral study	
	Some	None
Total	$19,950	$21,950
Medical or professional school	$19,950	$22,500
University or other educational institution	$17,900	$19,600
Government	$21,850	$22,750
Industry	$22,600	$22,900
Other sectors	$21,000	$22,650

References and Notes

1. National Research Council, *Research Training and Career Patterns of Bioscientists: The Training Programs of the National Institutes of Health* (Government Printing Office, Washington, D.C., 1976), pp. 107–108.
2. ———, *Personnel Needs and Training for Biomedical and Behavioral Research: 1977 Report* (Government Printing Office, Washington, D.C., 1977).
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6. ———, *Postdoctoral Training in the Biomedical Sciences* (Government Printing Office, Washington D.C., 1974).
7. L. Grodzins, paper presented at the meeting of Council of Graduate Schools, 8 to 10 December, Denver, Colo.
8. H. Shull, in *The National Research Council in 1978: Current Issues and Studies* (National Academy of Sciences, Washington, D.C., 1978), pp. 149–163.
9. In their deliberations the committee and basic biomedical panel examined recent trends in graduate enrollments, awards of doctorates, and federal research expenditures as well as the rapid growth in postdoctoral appointments.
10. National Research Council, *Survey of Biomedical and Behavioral Scientists* (Government Printing Office, Washington, D.C., 1976).
11. ———, *Survey of Earned Doctorates* (Government Printing Office, Washington, D.C., 1957 to 1976).
12. ———, *Survey of Doctorate Recipients* (Government Printing Office, Washington, D.C., 1973 to 1977).
13. In these surveys the postdoctoral appointment is described as a fellowship, traineeship, research associateship, or other study appointment.
14. This finding is based on unpublished data describing the employment plans of respondents to the *Survey of Earned Doctorates* (*11*).
15. Since all survey information reported in this article deals only with recipients of Ph.D.'s or equivalent research degrees, M.D. epidemiologists are not included.
16. D. Roose and C. J. Andersen, *A Rating of Graduate Programs* (American Council on Education, Washington, D.C., 1970).
17. Included in the group of 20 highest-rated institutions are the following: Brandeis University, University of California–Berkeley, University of California–Davis, University of California–Los Angeles, University of California–San Diego, California Institute of Technology, University of Chicago, Cornell University, Duke University, Harvard University, University of Illinois, Johns Hopkins University, Massachusetts Institute of Technology, University of Michigan, Princeton University, Rockefeller University, Stanford University, University of Washington, University of Wisconsin, and Yale University.
18. Data from the *Survey of Doctorate Recipients* (*12*) indicate that approximately 23 percent of those on biomedical postdoctorals in each year between 1972 and 1977 had received doctorates in other fields.
19. Graduates who may be actively involved in research, but do not consider it to be their primary activity, are not included in this figure.
20. B. L. R. Smith and J. J. Karlesky, *The State of Academic Science* (Change Magazine Press, New York, 1977), p. 236.
21. The Committee on Postdoctorals and Doctoral Research Staff is chaired by L. Grodzins and falls under the aegis of the Commission on Human Resources within the National Research Council. A report is expected to be completed by the committee by mid-1980.

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