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ABSTRACT

Planning major research programs requires accurate information about funding and personnel. Since reliable baseline data for plant biology have not been available, a study was conducted to provide such data by measuring the total plant biology effort at major doctorate-granting institutions with graduate programs in botany during fall 1982. Findings (which are national estimates based on responses from 143 of 165 major institutions) are presented in these categories: (1) research support; (2) faculty; (3) faculty vacancies; (4) postdoctorates; (5) graduate students (including women, minorities, and foreign students); (6) areas of concentration; (7) personnel supply and demand; (8) organization; (9) contrasts between land-grand and private institutions; (10) comparison of data at the 20 largest institutions; and (11) plant biology's representation in the life sciences. Among the findings are those indicating that molecular biology was the discipline most frequently cited as having a shortage of personnel, that ecology was the area of concentration that ranked highest for graduate study and faculty research, and that over 900 doctorates were awarded in academic year 1982-83. (Highlights of major findings, summary of methodology used, detailed statistical tables, copy of the survey instruments, and technical notes are included.) (JN)

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PLANT BIOLOGY PERSONNEL AND TRAINING AT DOCTORATE-GRANTING INSTITUTIONS

Charles J. Andersen

U.S. DEPARTMENT OF EDUCATION
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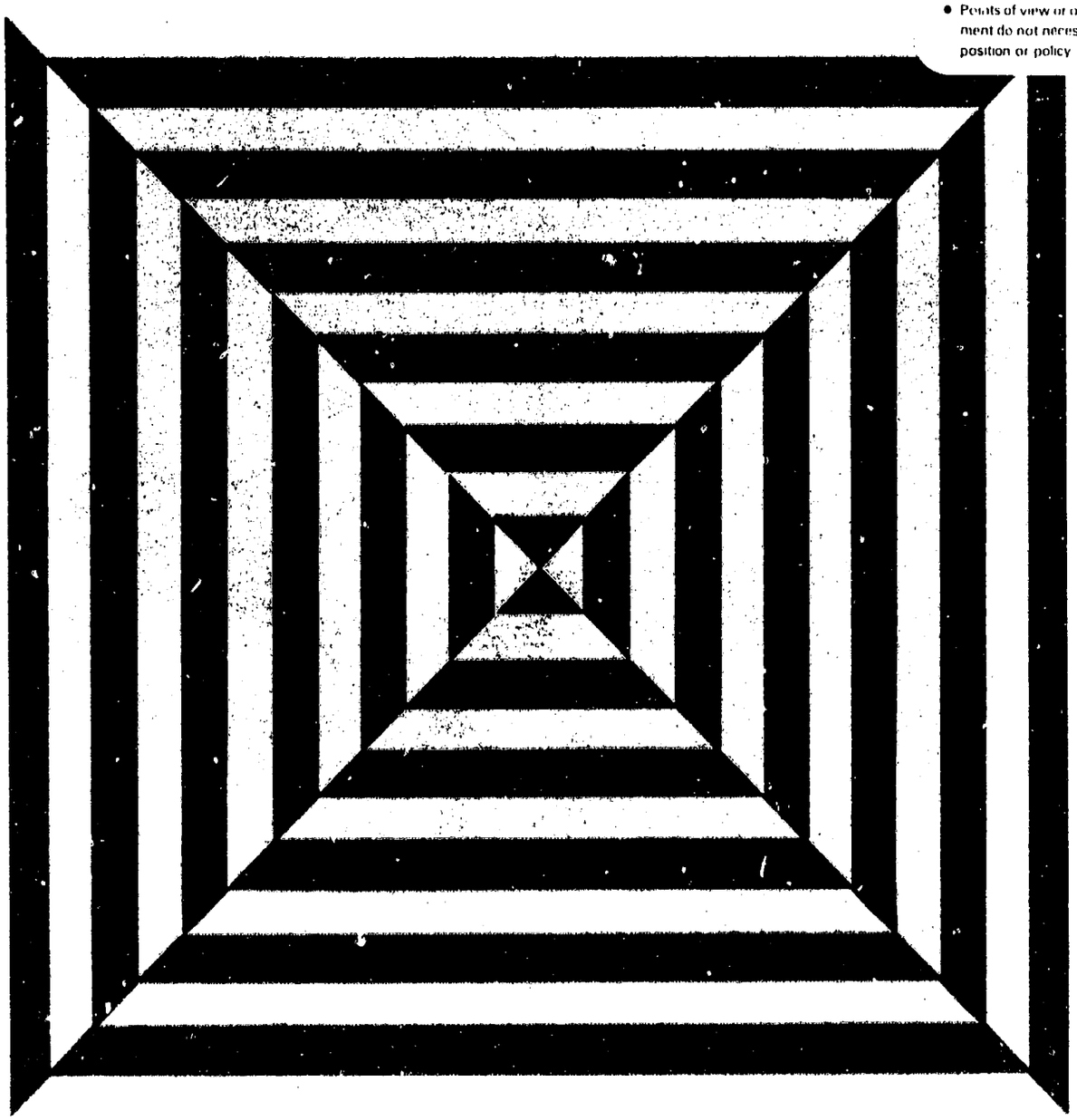

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Plant Biology Personnel and Training at Doctorate-granting Institutions

Charles J. Andersen

Higher Education Panel Reports
Number 62 November 1984

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The Higher Education Panel Advisory Committee, the Federal Advisory Board, and its Technical Advisory Committee also contributed to this study.

Special thanks go to the "plant biology coordinators" on each participating campus; they did yeoman work in pulling together from various departments and schools the data that are reported in this publication.

And, as always, we offer special recognition and thanks to each campus' Panel representative whose cooperation and coordination were vital to the success of this study.

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HIGHLIGHTS

- Research support in plant biology totaled a little more than $200 million in fiscal year 1983. The federal government provided nearly half of these funds (48 percent); the state governments, about one-third (34 percent); and industry one-tenth (10 percent).

- Molecular biology was the discipline most frequently cited as having a shortage of personnel. Ecology was most frequently identified as the specialty that had a surplus of personnel.

- Ecology was the area of concentration that ranked highest for graduate study and faculty research. Plant physiology was ranked highest for postdoctorate research and/or study.

- Land-grant institutions predominate in all areas of academic plant biology. They account for 83 percent of the research support; 80 percent of the faculty, students, and doctorates, and 72 percent of the postdoctorates.

- Over 4,700 full-time plant biology faculty were in departments involved in training graduate students in the field at the nation's principal doctorate-granting institutions.

- Just over 8,000 full-time students were in graduate plant biology programs at major doctorate-granting institutions in fall 1982.

- The primary source of support for nearly one-third of the graduate students in plant biology came from the institutions themselves. Federal sources provided the primary support for nearly one-quarter of the students, state governments for one-eighth, and industry for less than one-tenth.

- Over 900 doctorates were awarded in academic year 1982-83 in disciplines that comprised plant biology.

- One thousand postdoctorate fellows or associates were studying and/or conducting research in plant biology during the 1982-83 academic year.

  Women represented 31 percent of the graduate students, 29 percent of the postdoctorates, 21 percent of the doctorates awarded, and 7 percent of the faculty in graduate plant biology programs.

  Members of racial/ethnic minorities comprised 4 percent of the faculty in graduate plant biology programs, and 5 percent of the doctorates awarded in 1982-83. Seven percent of the U.S. graduate students and 10 percent of the postdoctorates in plant biology in 1982-83 were racial/ethnic minority group members.

  Foreign students with temporary visas represented 20 percent of the full-time graduate students and 33 percent of the postdoctorates in plant biology. Three-quarters (77 percent) of these foreign graduate students and two-fifths (39 percent) of the foreign postdoctorate fellows came from developing countries.

BACKGROUND

Various recent studies and reports have emphasized the importance of plant biology research. In 1983, the National Academy of Sciences Briefing Panel on Agricultural Research Opportunities identified plant biology specifically as a research area that is likely to return the highest scientific dividends as a result of incremental federal investments. The National Science Board is devoting special attention to plant biology since it is expected to produce the scientific discoveries essential to agricultural advances in the next century.

Planning major research programs requires accurate information about funding and personnel. Reliable baseline data for plant biology have not been available. To develop such data, the National Science Foundation asked the Higher Education Panel to measure the total plant biology effort in terms of students, faculty, researchers, and research funding at those doctorate-granting institutions with graduate programs in the field. Though much activity in plant biology occurs at the undergraduate level, in this first effort to gather basic information, the decision was to focus on the major graduate institutions, where most of tomorrow's professoriate is prepared and where most of the research is being conducted.

FINDINGS

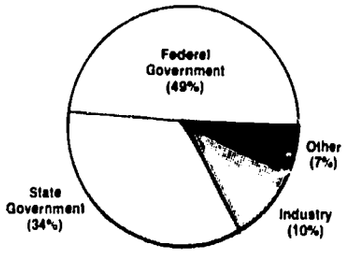
These findings are national estimates based on responses from 143 of the 165 major doctorate-granting institutions that had graduate programs in plant biology in fall, 1982. A description of the data-gathering procedure is found in the Methods Summary section, which follows these findings, and in Appendix B, Technical Notes.

Research Support

Research support totaling $201.6 million was received by the 165 doctorate-granting institutions covered by this survey. The federal government provided $98 million, or nearly half of that total. This 1983 federal contribution equals about one-twelfth of the federal research and development funds for the biological and agricultural sciences for 1982 as reported by the National Science Foundation.[1]

State governments provided just over one-third of the plant biology research support; industry provided one-tenth (see figure 1).

Figure 1
Sources of Research Support for Plant Biology, FY 1983
Total: $201 million



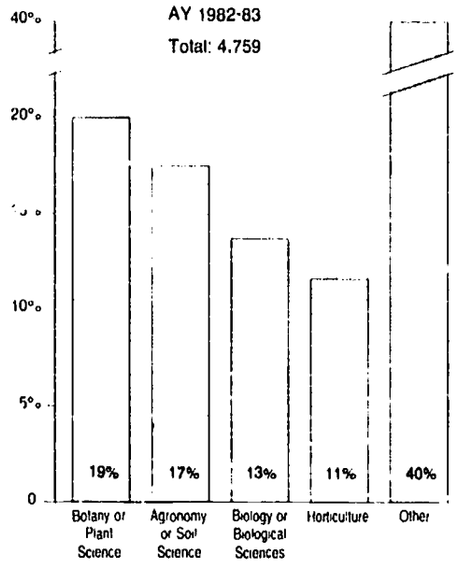
Four-fifths of these research support funds went to land-grant institutions. They received nearly all of the funds (98 percent) provided by the state governments, and three-quarters of those provided by the federal government, industry, and other sources.

Faculty

A total of 4,760 full-time plant biology faculty were in departments involved in training graduate students in the field. Nineteen percent of these faculty were in botany or plant science departments; 17 percent were in agronomy and soil science departments; 13 percent were in biology or biological science departments; and 10 percent were in horticulture departments. The remaining 40 percent of the faculty were spread among departments of plant pathology; forestry; plant and soil science; biochemistry; genetics; chemistry; marine sciences/oceanography; and other. None of these departments accounted for as much as 10 percent of the total faculty.

[1]National Science Foundation (NSF), Academic Science R&D Funds, FY 1982, Detailed Statistical Tables (Washington: NSF, 1984).

Figure 2
Plant Biology Faculty, by Department
AY 1982-83
Total: 4,759



Overall, about 8 of 10 plant biology faculty were directly involved in training graduate students. However, that proportion varied somewhat by department. In departments of botany or plant science, 83 percent of the faculty were teaching graduate students, in contrast to 71 percent in departments of plant and soil science and 73 percent in departments of horticulture and agronomy and soil science (see table A). Faculty in these departments are primarily at land-grant institutions, where research and extension are major activities.

TABLE A--Percentage of Plant Biologists Training Graduate Students, by Department, AY 1982-83

Department	Percentage Training Graduate Students at All Institutions	Percentage Training Graduate Students at Land-grant Institutions
All departments	81%	79%
Botany/plant science	83	81
Biology/biological sciences	[illegible]	81
Plant pathology	82	82
Forestry	79	79
Agronomy and soil science	73	74
Horticulture	73	73
Plant and soil science	71	69

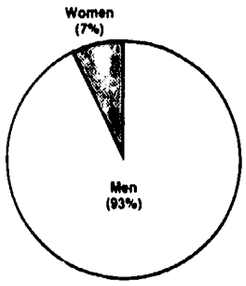
Note: Only those department names with totals of more than 150 plant biologists are listed.

Reference: Table 2A

A total of 4,610 faculty were reported in the plant biology programs conducted at the 165 institutions covered by the survey.[2] Women represented 7 percent of this faculty. Members of minority racial/ethnic groups make up 4 percent of the total.

[2]The 3 percent difference between "departmental" and the "program" counts (4,759 vs. 4,607) may be due to the elimination from the latter of plant biologists in departments that were peripheral to some institutions' formal plant biology graduate programs.

Figure 3
Plant Biology Faculty by Sex
AY 1982-83
Total: 4,759



Faculty Vacancies

Forty-one percent of the institutions reported at least one full-time faculty vacancy in their plant biology programs as of the fall of 1983. Nearly 215 vacancies were reported, or 4 percent of the departmental faculty count.

Eighteen institutions reported that molecular biology was the discipline in which the need to replace faculty was the greatest. Eight institutions identified horticulture/crop science as the neediest field; 7 noted agronomy/soil science; and 5, plant physiology. The remaining 29 institutions had faculty vacancies spread among various other disciplines, such as anatomy/ morphology; biochemistry; developmental biology; and plant pathology. None of these disciplines was cited by more than 4 institutions as being in greatest need of being filled.

Almost half of the institutions reporting vacancies identified research opportunities as being the most important reason for filling the vacancy(ies) in the discipline with the greatest need. Another one-third identified faculty retirements/ departures as the most important reason. Not known is whether institutions were using (as they sometimes do) the existence of a vacancy to take advantage of research opportunities in certain disciplines to fill a vacancy, rather than replacing a retiring faculty member in one discipline with another in the same discipline.

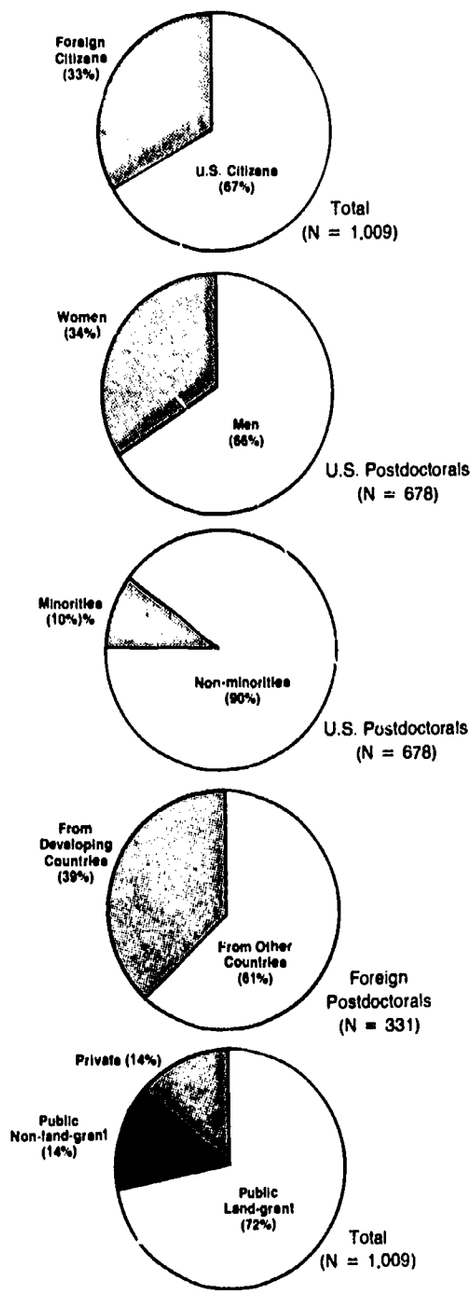
Postdoctorates

In 1982-83, postdoctoral fellows or associates in plant biology numbered just over 1,000 nationally. Essentially the same number of postdoctorates (1,020) were expected in 1983-84.

Two-thirds of the postdoctorates were U.S. citizens. Of these, 1 out of 3 was a woman; and 1 of 10 was a member of a racial/ethnic minority group.

One-third of the fellows were foreign citizens with temporary visas for the United States. Of these foreign postdoctorates, two-fifths came from developing countries.

Figure 4
Postdoctoral Fellows/Associates in Plant Biology
AY 1982-83

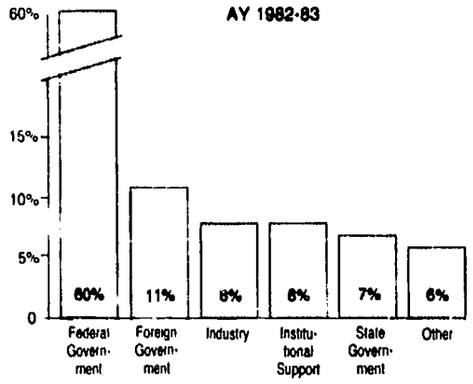


About three-quarters (72 percent) of the postdoctorates were at land-grant institutions. These colleges and universities had essentially the same share of all the foreign postdoctorates with temporary visas (75 percent) but a somewhat smaller share (65 percent) of the postdoctorates from developing countries.

Three of 5 postdoctorates in plant biology received their major support from the federal government--either through fellowship assistance or research grants. Foreign governments were the second most important source, providing support for one-tenth of all postdoctorates. If one assumes that foreign governmental assistance is confined to postdoctorates with temporary visas, then as many as a third of the foreign postdoctorates would have received their major support from foreign governments.

Industry and institutional support each provided major support to 8 percent of the postdoctorates; state governments, to 7 percent (see figure 5).

Figure 5
Sources of Major Support for Postdoctoral Fellows/Associates
AY 1982-83



Graduate Students

An estimated 8,000 graduate students were enrolled in plant biology programs in academic year 1982-83. About the same number were expected to be in these programs in the 1983-84 academic year.

U.S. citizens (and foreign nationals with permanent visas for the United States) made up four-fifths of this graduate enrollment. Two-thirds of these U.S. students were male; one-third were female; less than one-tenth were members of racial/ethnic minority groups.[3] Land-grant institutions enrolled 80 percent of all graduate students.

Twenty percent of the graduate students were foreign citizens with temporary visas. Seventy-seven percent of these were from developing countries, and 87 percent were enrolled at land-grant institutions.

The major source of support for 2,400 graduate students--30 percent of the total--came from their own institutions. Thus, institutional support predominated as the greatest source of graduate student support. The federal government--through fellowships or research grants--ranked second, providing support to 23 percent of the students.

Fourteen percent of the students were reported to derive their major support from personal funds, 12 percent from state governments, and 6 percent from industry.

Foreign governments provided the major support to 840 students, or 11 percent of the total. If one assumes all of these were foreign students, then foreign governments were the major source of support for 52 percent of all the foreign graduate students in plant biology.

Figure 6
Graduate Students in Plant Biology
AY 1982-83

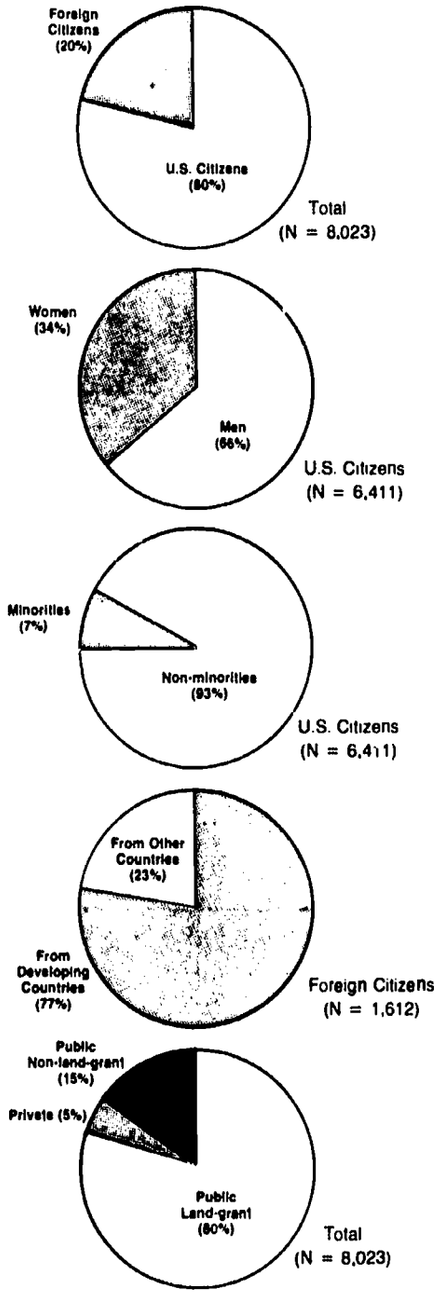
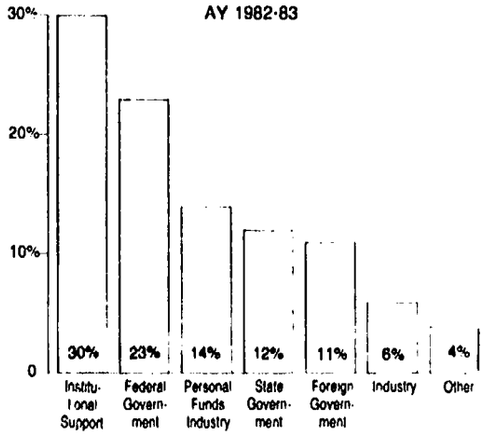


Figure 7
Sources of Major Support for Graduate Students
AY 1982-83



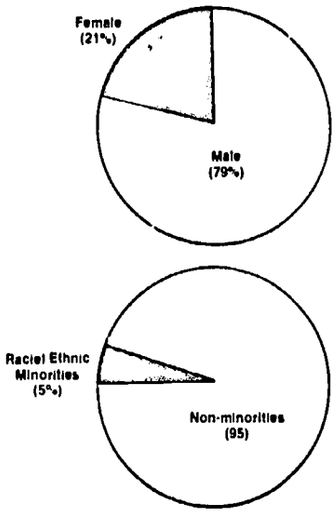
[3]The Department of Education's Office of Civil Rights (OCR) reported that racial/ethnic minorities in 1980 comprised 9 percent of the U.S. graduate students in agriculture and natural resources and the biological sciences combined. Source: Rosa M. Simmons and Susan G. Broyles, Fall Enrollment in Colleges and Universities, 1980 (Washington: Government Printing Office, 1982).

An estimated 925 men and women received doctorates in plant biology in academic year 1982-83. A 14 percent increase (to 1,050) was estimated for academic year 1983-84.

Women received 21 percent of the plant biology degrees, and members of racial/ethnic minority groups were awarded 5 percent of the total (see figure 8).[4]

Figure 8
Doctorates Awarded in Plant Biology, Academic Year 1982-83

Total: 925



Areas of Concentration

Ecology was the discipline in which there was the greatest concentration in graduate student training and faculty research. Plant physiology and systematics showed the second and third highest degrees of concentration in these two areas of academic activity.

For postdoctoral research and training, however, the results were somewhat different. Plant physiology ranked first, with biochemistry and ecology holding the second and third places, respectively.

This ranking was determined by having the respondents list, in rank order, the 3 major disciplines that best characterized the areas of greatest concentration in their plant biology program(s).

A weighted score for each discipline was calculated by assigning it a value of 3 when it ranked highest, a value of 2 when it ranked second highest, and a value of 1 when it ranked third highest. The values were summed to get a total score for each discipline. The scores were summed and percentage distributions were calculated separately for (1) graduate student training, (2) postdoctoral research and training, and (3) faculty research (see table B).

TABLE B--Highest Ranking Areas of Concentration in Plant Biology, AY 1982-83

Area of Concentration	Rank	Percent of Total Weighted Score
Graduate Student Training		
Ecology	1	20%
Plant physiology	2	16
Systematics	3	11
Agronomy and soil science	4	8
Biochemistry	5	7
Faculty Research		
Ecology	1	19%
Plant physiology	2	18
Systematics	3	10
Biochemistry	4	7
Agronomy and soil science	5	6
Postdoctoral Training and Research		
Plant physiology	1	21%
Biochemistry	2	14
Ecology	3	11
Plant pathology	4	8
Molecular biology	5	7

Note: Graduate study and research are conducted in disciplines with low (or even no) scores. The low score indicates that few institutions have made the discipline a top priority.

Reference: Table 6

Each institution was also asked to indicate, for the discipline it ranked highest for graduate student training, those fields in which students were required to take courses, or to have taken courses as undergraduates. Detailed tables series 7 presents the results in the form of cross tabulations showing the number of institutions that ranked each plant biology discipline highest for graduate student study and the number of institutions that required courses in selected fields. Table C presents those data as percentages for the 5 top-ranked disciplines.

Of the 40 institutions that reported ecology as the top-ranked discipline for graduate student training, 49 percent required courses in biochemistry; 80 percent required coursework in genetics; 73 percent required courses in plant physiology; and nearly all required courses in ecology/evolution. Of the 17 institutions that reported the greatest concentration as being in plant physiology, all required their graduate students to have coursework in biochemistry; 88 percent required courses in genetics; and 82 percent required courses in plant physiology.

[4]The Department of Education's Office of Civil Rights (OCR) reported that racial/ethnic minorities in 1981 earned 6.5 percent of the doctorates awarded in agriculture and natural resources and the biological sciences combined. Source: W. Vance Grant and Thomas D. Snyder, Digest of Education Statistics, 1983-84, (Washington: Government Printing Office, 1983).

TABLE C--Required Courses, by Selected Graduate Study Discipline, AY 1982-83

Highest-Ranked Discipline for Graduate Study	Number of Institutions	Percentage of Institutions in Column A That Required Courses In				
		Biochemistry	Genetics	Plant Structure	Ecology/ Evolution	Plant Physiology
	A	B	C	D	E	F
Ecology	40	49%	80%	61%	95%[a]	73%
Plant physiology	17	100	88	59	53	82[a]
Systematics	15	53	80	87	80	60
Agronomy/soil science	14	93	93	64	14	100
Developmental biology	10	100	100	80	60	60

[a]The expectation was that all institutions reporting ecology/evolution and plant physiology as the highest-ranked disciplines for graduate student training would require courses in those areas. However, the percentages are less than 100 because several smaller institutions indicated that they had no specific course requirements; study in each field is conducted through advanced seminars or through individually directed work.

Reference: Table 7

Personnel Supply and Demand

Shortage Disciplines. Molecular biology was the discipline most frequently identified by the surveyed institutions as having a shortage of personnel in academia, industry, and government.[5] Biochemistry and genetics were the second most frequently cited shortage areas, depending on the type of employment being considered (see table D).

At land-grant institutions, molecular biology was also the discipline most frequently identified as a shortage area. However, as shown in table D, the second-ranked shortage disciplines at these institutions differed among types of employment.

[5]Respondents were asked to assess the employment market for plant biologists in 5 categories: (1) postdoctoral training positions, (2) permanent doctoral research associate positions, (3) tenure-track faculty, (4) industrial positions, and (5) federal or state government positions. Respondents identified the disciplines with a shortage and with a surplus of personnel or indicated if there was a supply/demand balance across all fields in a given employment category.

TABLE D--Disciplines Frequently Cited as Having a Shortage of Personnel, by Employment Category, 1982-83

Employment Category	Type of Institution	Most Frequently Cited	Second Most Frequently Cited
Postdoctoral training positions	All	Molecular biology	Biochemistry
	Land-grant	Molecular biology	Biochemistry
Permanent doctoral research associate positions	All	Molecular biology	Biochemistry
	Land-grant	Molecular biology	Biochemistry; Genetics; Horticulture/crop science
Tenure-track faculty positions	All	Molecular biology	Genetics
	Land-grant	Molecular biology	Horticulture/crop science
Industrial positions	All	Molecular biology	Biochemistry; Genetics
	Land-grant	Molecular biology	Genetics; Plant pathology
Federal/state government positions	All	Molecular biology	Biochemistry
	Land-grant	Molecular biology	Agronomy/soil science

Reference: Table 9A

TABLE E--Disciplines Frequently Cited as Having a Surplus of Personnel, by Employment Category, 1982-83

Employment Category	Type of Institution	Most Frequently Cited	Second Most Frequently Cited
Postdoctoral training positions	All	Ecology	Systematics
	Land-grant	Ecology	Systematics
Permanent doctoral research associate positions	All	Ecology	Anatomy/morphology
	Land-grant	Ecology	Plant pathology
Tenure-track faculty positions	All	Ecology	Systematics
	Land-grant	Ecology	Systematics
Industrial positions	All	Ecology	Systematics
	Land-grant	Ecology	Systematics; Evolution
			Anatomy/morphology
Federal/state government positions	All	Ecology	Systematics
	Land-grant	Ecology	Evolution; Anatomy/morphology

Reference: Table 9B

Surplus Disciplines. Ecology was most frequently cited as the discipline in which there was a surplus of personnel for all employment categories. Systematics was the second most frequently cited surplus discipline in each category except for postdoctorate research positions, where it was replaced by anatomy/morphology.

At land-grant institutions, ecology was most frequently cited as a surplus field regardless of the employment category. The second most frequently cited fields were, variously, systematics, evolution, plant pathology, and anatomy/morphology.

Organization

More than half (54 percent) of the institutions reported that plant biology graduate work is concentrated in colleges of arts and sciences. Nearly one-third indicated that it was centered in colleges of agriculture, forestry, or natural resources, and one-sixth said it was focused in special colleges, institutes, or divisions such as schools of applied biology, colleges of pure and applied sciences, and divisions of biology and medicine.

However, these figures are misleading in terms of where the bulk of the activity in the field takes place. The institutions with the largest faculties and enrollments are the land-grant institutions. Nearly seven-eighths reported their plant biology efforts concentrated in colleges of agriculture, forestry, or natural resources. The land-grant colleges and universities, though representing less than one-third of the doctoral institutions engaged in graduate work in plant biology, had four-fifths of the faculty and students, awarded four-fifths of the doctorates, and received four-fifths of research support dollars in the field.

Contrasts between Land-grant and Private Institutions

In the foregoing discussion, few comparisons have been made between land-grant and private institutions because the preponderant share of plant biology activity is centered in the former. As noted above, they accounted for 80 percent of the faculty, doctorates, and graduate students in the field. The public non-land-grant institutions accounted for about 15 percent of the totals in these areas and the private institutions had the remaining 5 percent. Some variations from these patterns appear, however. Private institutions, for example, had 14 percent of all the postdoctoral fellows/associates.

A large part (70 percent) of the research support reported by private institutions came from the federal government. This contrasts with the 44 percent of federal support at land-grant institutions. Private institutions got practically no research funds from the state governments, whereas land-grant institutions received 40 percent of their support from that source. Industry and other sources together provided the private sector with about 30 percent of its research support. This was about double the percentage that those sources furnished the land-grant institutions. Note, however, that in terms of dollars, the funds received by the land-grant institutions far exceeded those received by the private colleges and universities. Land-grant colleges and universities received 8 of every 10 support dollars.

Sources of major support for graduate students also varied between the land-grant and private institutional sectors. More than half of the

Figure 9

Private Institutions Share of Plant Biology Support and Personnel

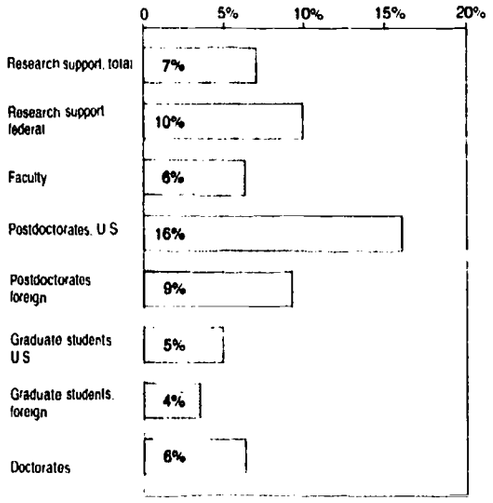
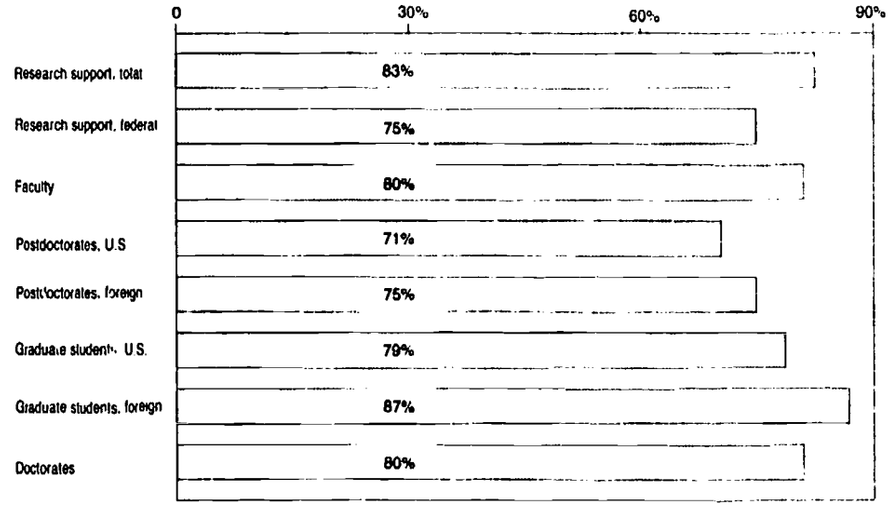


Figure 10

Land-grant Institutions' Share of Plant Biology Support and Personnel



graduate students at private institutions were reported to receive their major support from their college or university and one-third from federal government sources. At land-grant institutions, just over one-quarter received major support from their institutions; just under one-quarter received major support from the federal government.

Private institutions reported a higher proportion of minority group members among U.S. graduate students than did land-grant institutions (16 percent versus 7 percent). They also showed higher proportions of minorities on their faculties (8 percent versus 4 percent). Land-grant institutions, however, counted 42 minorities (6 percent) among their 1982-83 doctoral awards, whereas private institutions reported only one (less than 1 percent). Both types of institution reported about the same proportion (8 percent) of minorities among their U.S. postdoctorates.

The distribution of faculty among departments varied between private and land-grant institutions. At the former, over half (54 percent) of the plant biology faculty were in departments of biology. At land-grant institutions they were found in a wider range of departments, four of which--agriculture and soil science, horticulture, plant pathology, and botany--accounted for over half (56 percent) of the total.

About one-quarter of the private institutions reported faculty vacancies; this contrasts with four-fifths (81 percent) of the land-grant universities. However, because of the difference in total faculty size, the vacancies represented about one-tenth of the plant biology faculty at private institutions, but less than one-twentieth at the land-grant universities.

20 Largest Institutions

Separate tallies were made on several questionnaire items for the top 20 responding institutions that received the greatest federal life sciences research and development (R&D) support in 1982.[6] Figure 10 shows several of the survey measures (research support, faculty, postdoctorates, etc.) and the percentages accounted for by these 20 institutions. Whereas these institutions accounted for 20 percent of the federally funded research support in plant biology, they received 33 percent of federally funded R&D in the life sciences in FY 1982.

At the top 20 institutions there were 61 faculty vacancies, which represented nearly 8 percent of the plant biology faculty at these universities. That proportion was about twice the 4 percent figure registered by the remaining 145 institutions.

The principal areas of concentration for postdoctoral research and training at the top 20 institutions varied somewhat from the other colleges and universities. Molecular biology was ranked second at the 20 largest institutions; sixth at the remainder. Systematics was ranked tenth by the 20 large institutions and fifth by the remain-

[6] These 20 institutions include only 13 of the first 20 on a list prepared by the National Science Foundation (NSF) that rank-ordered institutions by the amount of federal R&D funding in the life sciences for fiscal year 1982. Seven of NSF's first 20 institutions were not included because 2 are medical schools; 2 indicated that they did not have graduate programs in plant biology; 3 did not respond to the questionnaire. To get a total of 20 respondents for this "20 largest" category, it was necessary to go down the NSF ranked list to the 33rd institution.

Shown in Appendix C are the first 50 institutions on the NSF rank-ordered list.

ing institutions. Table F compares the high-ranking disciplines at the two groups of institutions for each of the three areas of training and research. Detailed table series 6 gives a more complete picture of the rankings.

Figure 11

20 Largest Institutions' Share of Plant Biology Support and Personnel

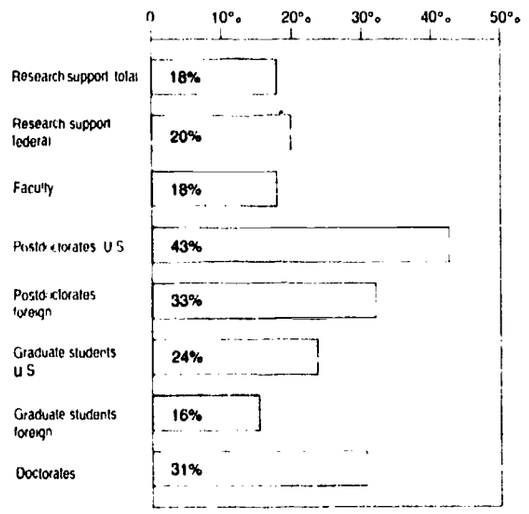


TABLE F--Comparison of Highest Ranking Areas of Concentration at the 20 Largest Institutions with All Other Institutions, AY 1982-83

20 Largest Institutions		All Other Institutions	
Rank	Discipline	Rank	Discipline
	Postdoctoral Training and Research		
1	Plant physiology	1	Plant physiology
2	Molecular biology	2	Biochemistry
3	Ecology	3	Ecology
4	Biochemistry	4	Plant pathology
5	Plant pathology	5	Systematics
	Faculty Research		
1	Ecology	1	Ecology
1	Plant physiology	2	Plant physiology
3	Molecular biology	3	Systematics
4	Biochemistry	4	Biochemistry
4	Systematics	5	Agronomy/soil science
	Graduate Student Training		
1	Ecology	1	Ecology
2	Plant physiology	2	Plant physiology
3	Molecular biology	3	Systematics
3	Biochemistry	4	Agronomy/soil science
5	Plant pathology	5	Biochemistry
5	Systematics		

Reference: Table 6

Plant Biology's Representation in the Life Sciences

As noted previously, the $98 million of federal funds for research support in plant biology was equal to 4 percent of the total federal research and development (R&D) expenditures in the life sciences for fiscal year 1982. This contrasts with the 12 percent share that plant biology graduate students represented of all graduate students in the life sciences in 1982.[7]

Faculty and postdoctorates in plant biology represented 6 percent of the 101,000 academic scientists in the life sciences at doctorate-granting institutions as reported by the National Science Foundation.[8]

The 1,000 postdoctorates in plant biology reported in this study represented 8 percent of all the postdoctorates in the life sciences at doctorate-granting institutions.[9] It should be noted that postdoctoral training in many of the life sciences, particularly the biomedical disciplines, is now considered a necessary transition between graduate training and a faculty--or faculty equivalent--position. However, that is not true in general for the agricultural sciences.

Women represented 29 percent of all the postdoctorates in plant biology; foreign citizens accounted for 33 percent. Comparable figures for all of the life sciences in 1982 were 26 percent and 30 percent, respectively.[10]

The 925 plant biology doctorates identified by this survey represented 17 percent of the life sciences doctorates reported by the National Research Council (NRC) in its annual doctorate survey.[11] Women were awarded 21 percent of the doctorates in plant biology; this compares with their 31 percent share of all doctorates in the biological sciences.

U.S. citizens who were members of racial/ethnic minorities earned 5 percent of the plant biology Ph.D.'s awarded in 1982-83. In contrast, minorities were awarded 9 percent of all the doctorates in the biological sciences and 8 percent in the agricultural sciences.

[7] National Science Foundation (NSF), Academic Science/Engineering: Graduate Enrollment and Support, Fall 1982, (Washington, NSF, 1984).

[8] National Science Foundation (NSF), Academic Science and Engineering: Scientists and Engineers, January 1983 (Washington: NSF, 1984).

[9] NSF, Academic Science/Engineering, 1982.

[10] NSF, Academic Science/Engineering, 1982.

[11] NRC, Summary Report 1983, Doctorate Recipients from United States Universities, (Washington: National Academy Press, 1983).

Foreign students represented 20 percent of all the plant biology graduate students in doctorate-granting institutions. The 840 students who received their major support from foreign governments is equal to 52 percent of this enrollment from abroad. These figures--especially the latter--contrast with the 1982 data for all of the life sciences. Foreign students represented only 14 percent of that total, and foreign support in 1982-83 aided only 29 percent of the foreign full-time graduate students.[12]

[12] NSF, Academic Science/Engineering, 1982.

METHODS SUMMARY

The foregoing findings are based on data obtained by the Higher Education Panel which forms the basis of a continuing survey research program created in 1971 by the American Council on Education. The Panel's purpose is to conduct surveys on topics of current policy interest to the higher education community and to government agencies.

The Panel is a disproportionate stratified sample of 760 colleges and universities drawn from the population of more than 3,000 institutions listed in the National Center for Education Statistics' Education Directory, Colleges and Universities. All institutions in the population are grouped according to the Panel's stratification design, which is based upon institution type (university, four-year college), control (public, private), and size (full-time-equivalent enrollment). For any given survey, either the entire Panel or an appropriate subgroup is used.

The survey is dependent upon a network of campus representatives at the Panel institutions whose presidents have agreed to participate. The representatives receive the Panel questionnaires and direct them to the most appropriate campus officials for response.

This survey involved a limited number of institutions, those that granted at least five doctorates in the the arts and sciences and engineering combined in 1980--an estimated 209 institutions. Excluded were doctorate-granting institutions that were primarily professional schools of medicine, theology, education, law, and the fine arts.

Questionnaires were sent to the selected institutions in October 1983. The survey was complicated, requiring coordination among numerous departments and, at many universities, between schools of agriculture and colleges of arts and sciences. Thus, "plant biology coordinators," who in most cases were plant biologists, were designated at many of the larger institutions to take the lead in identifying the relevant departments and data sources and in overseeing the completion of the questionnaire. Their assistance was invaluable.

A follow-up mailing was sent to nonrespondents in late November, and follow-up telephone calls were made during December 1983 and January 1984. Data gathering was cut off on January 31, 1984.

Data obtained from the questionnaires, telephone calls, and in some cases, institutions' catalogues, indicated that graduate programs in plant biology were conducted at 165 of the doctorate-granting institutions. Nearly seven-eighths of these institutions provided substantive data which were statistically adjusted by computing institutional weights based upon the ratio of respondents to the number of institutions in the population, separately for each institutional stratum.

Appendix B presents the stratification design used to produce the national estimates and a comparision of respondents and nonrespondents, according to various institutional characteristics.

Detailed Statistical Tables

TABLE 1

Number of Institutions with Graduate Training Programs in Plant Biology, by School/Division with Primary Responsibility for Training, AY 1982-83

Administrative Unit in Which Training Is Primarily Focused	All Institutions	Public		Private
		All	Land-grant	
All Institutions				
All administrative units	165	118	48	47
College/division of arts and sciences	89	56	5	33
College/school/division of agricultural/forestry/ natural resources	49	43	41	5
Other administrative unit	27	19	2	9
20 Largest Institutions[a]				
All administrative units	20	11	7	9
College/division of arts and sciences	13	6	2	7
College/school/division of agricultural/forestry/ natural resources	5	4	4	1
Other administrative unit	2	1	1	1
Institutions Other Than the 20 Largest				
All administrative units	145	107	41	38
College/division of arts and sciences	76	50	3	26
College/school/division of agricultural/forestry/ natural resources	44	39	37	4
Other administrative unit	25	18	1	8

[a]The 20 responding institutions with the largest federally financed R&D expenditures in the life sciences in FY 1982.

TABLE 2A

Number of Plant Biologists and the Percentage Training Graduate Students, by Department and by Control of Institution, AY 1982-83

All Institutions

Department[a]	All Institutions		All Public Institutions		Land-grant Institutions[b]		Private Institutions	
	Total	Faculty Training Graduate Students as a Percentage of Total	Total	Faculty Training Graduate Students as a Percentage of Total	Total	Faculty Training Graduate Students as a Percentage of Total	Total	Faculty Training Graduate Students as a Percentage of Total
All departments	4,759	81%	4,491	81%	3,802	79%	268	81%
Botany/plant science	913	83	874	83	717	81	39	87
(Botany)	(600)	(90)	(561)	(90)	(404)	(88)	(39)	(87)
(Plant science)	(313)	(72)	(313)	(72)	(313)	(72)	(-)	(nap)
Agronomy and soil science	806	73	806	73	795	74	-	nap
Biology/biological sciences	633	83	466	85	128	81	167	80
(Biology)	(428)	(82)	(284)	(84)	(74)	(80)	(144)	(76)
(Biological sciences)	(205)	(87)	(182)	(86)	(54)	(83)	(23)	(100)
Horticulture	506	73	506	73	506	73	-	nap
Plant pathology	434	82	434	82	434	82	-	nap
Forestry	246	79	230	77	206	79	16	100
Plant and soil science	195	71	195	71	181	69	-	nap
Biochemistry	109	93	106	94	100	94	3	33
Genetics	56	89	55	91	55	91	1	0
Chemistry	18	100	17	100	2	100	1	100
Marine sciences/oceanography	13	100	13	100	1	100	-	nap
All others	830	87	789	87	677	87	41	78

[a]Department names cited by 5 or more institutions.

[b]Land-grant institutions are a subset of "all public" institutions.

- Represents zero

nap Not applicable

Note: Total faculty counts shown in this table differ by 3 percent from those in the series 3 tables. This table shows counts of plant biology faculty in departments that were involved in training plant biology graduate students. The series 3 tables show counts of faculty in plant biology programs. See appendix A for a facsimile of the survey questionnaire.

TABLE 2B

Number of Plant Biologists and the Percentage Training Graduate Students, by Department and by Control of Institution, AY 1982-83

20 Largest Institutions[a]

Department[b]	All Institutions		All Public Institutions		Land-grant Institutions[b]		Private Institutions	
	Total	Faculty Training Graduate Students as a Percentage of Total	Total	Faculty Training Graduate Students as a Percentage of Total	Total	Faculty Training Graduate Students as a Percentage of Total	Total	Faculty Training Graduate Students as a Percentage of Total
All departments	863	85%	762	85%	676	83%	101	87%
Botany/plant science	118	98	101	98	72	97	17	100
(Botany)	(96)	(100)	(79)	(100)	(50)	(100)	(17)	(100)
(Plant science)	(22)	(91)	(22)	(91)	(22)	(91)	(-)	(nap)
Agronomy and soil science	52	77	52	77	52	77	-	nap
Biology/biological sciences	87	90	40	93	26	92	47	87
(Biology)	(64)	(86)	(30)	(90)	(16)	(88)	(34)	(82)
(Biological sciences)	(23)	(100)	(10)	(100)	(10)	(100)	(13)	(100)
Horticulture	99	76	99	76	99	76	-	nap
Plant pathology	80	93	80	93	80	93	-	nap
Forestry	80	79	66	74	66	74	14	100
Plant and soil science	42	45	42	45	42	45	-	nap
Biochemistry	33	100	32	100	28	100	1	100
Genetics	25	96	25	96	25	96	-	nap
Chemistry	6	100	6	100	1	100	-	nap
Marine sciences/oceanography	3	100	3	100	-	nap	-	nap
All others	238	85	216	87	185	85	22	68

[a]The 20 responding institutions with the largest federally finance R&D expenditures oin the life sciences in 1982.

[b]Department names cited by 5 or more institutions.

[c]Land-grant institutions are a subset of "all public" institutions.

- Represents zero

nap Not applicable

Note: The total faculty count shown in this table differs by 10 percent from that shown in the series 3 tables. This table shows counts of plant biology faculty in departments that were involved in training plant biology graduate students. The series 3 tables show counts of faculty in plant biology programs. See appendix A for a facsimile of the survey questionnaire.

TABLE 2C

Number of Plant Biologists and the Percentage Training Graduate Students, by Department and by Control of Institution, AY 1982-83

Institutions Other than the 20 Largest

Department[a]	All Institutions		All Public Institutions		Land-grant Institutions[b]		Private Institutions	
	Total	Faculty Training Graduate Students as a Percentage of Total	Total	Faculty Training Graduate Students as a Percentage of Total	Total	Faculty Training Graduate Students as a Percentage of Total	Total	Faculty Training Graduate Students as a Percentage of Total
All departments	3,896	80%	3,729	80%	3,126	79%	167	77%
Botany/plant science	795	81	773	81	645	79	22	77
(Botany)	(504)	(88)	(482)	(88)	(354)	(86)	(22)	(77)
(Plant science)	(291)	(70)	(291)	(70)	(291)	(70)	(-)	(nap)
Agronomy and soil science	754	73	754	73	743	73	-	nap
Biology/biological sciences	546	82	426	84	102	78	120	77
(Biology)	(364)	(81)	(254)	(84)	(58)	(78)	(110)	(75)
(Biological sciences)	(182)	(86)	(172)	(85)	(44)	(80)	(10)	(100)
Horticulture	407	72	407	72	407	72	-	nap
Plant pathology	354	80	354	80	354	80	-	nap
Forestry	166	79	164	79	140	81	2	100
Plant and soil science	153	78	153	78	139	76	-	nap
Biochemistry	76	89	74	92	72	92	2	0
Genetics	31	84	30	87	30	87	1	0
Chemistry	12	100	11	100	1	100	1	100
Marine sciences/oceanography	10	100	10	100	1	100	-	nap
All others	592	87	573	87	492	87	19	89

[a]Department names cited by 5 or more institutions.

[b]Land-grant institutions are a subset of "all public" institutions.

- Represents zero

nap Not applicable

Note: The total faculty counts shown in this table differs by 2 percent from that shown in the series 3 tables. This table shows counts of plant biology faculty in departments that were involved in training plant biology graduate students. The series 3 tables show counts of faculty in plant biology programs. See appendix A for a facsimile of the survey questionnaire.

TABLE 3

Students and Faculty in Graduate Plant Biology Programs, by Type of Institution and by Sex, AY 1982-83, with Total Estimates for AY 1983-84

Type of Student/Faculty	1982-83 Men	1982-83 Women	1982-83 Total	1983-84 Estimated Total
All Institutions				
Full-time graduate students	5,539	2,484	8,023	8,040
Ph.D. recipients	730	195	925	1,050
Postdoctoral fellows/associates	715	294	1,009	1,020
Full-time faculty	4,288	319	4,607	4,660
Public Institutions				
Full-time graduate students	5,287	2,361	7,648	7,670
Ph.D. recipients	691	177	868	970
Postdoctoral fellows/associates	630	241	871	860
Full-time faculty	4,067	277	4,344	4,400
Land-grant Institutions				
Full-time graduate students	4,568	1,874	6,442	6,500
Ph.D. recipients	600	140	740	810
Postdoctoral fellows/associates	523	208	731	730
Full-time faculty	3,467	207	3,674	3,720
Private Institutions				
Full-time graduate students	252	123	375	370
Ph.D. recipients	39	18	57	80
Postdoctoral fellows/associates	85	53	138	160
Full-time faculty	221	42	263	260
20 Largest Institutions[a]				
Full-time graduate students	1,206	562	1,768	1,750
Ph.D. recipients	226	65	291	290
Postdoctoral fellows/associates	281	117	398	400
Full-time faculty	730	54	784	800
Institutions Other Than the 20 Largest				
Full-time graduate students	4,333	1,922	6,255	6,290
Ph.D. recipients	504	130	634	760
Postdoctoral fellows/associates	434	177	611	620
Full-time faculty	3,558	265	3,823	3,860

[a]The 20 responding institutions with the largest federally financed R&D expenditures in the life sciences in FY 1982.

TABLE 4

Number of Racial/Ethnic Minority[a] Students and Faculty in Graduate Plant Biology Programs, by Type of Institution, AY 1982-83

Type of Student/Faculty	All Institutions	Public		Private
		All	Land-grant	
All Institutions				
Full-time students	459	411	359	48
1982-93 Ph.D. recipients	46	45	42	1
Postdoctoral fellows/ associates	72	63	41	9
Full-time faculty	207	185	150	22
20 Largest Institutions[b]				
Full-time students	74	65	62	9
1982-93 Ph.D. recipients	9	9	9	0
Postdoctoral fellows/ associates	17	11	10	6
Full-time faculty	18	17	15	1
Institutions Other Than the 20 Largest				
Full-time students	385	346	297	39
1982-93 Ph.D. recipients	37	36	33	1
Postdoctoral fellows/ associates	55	52	31	3
Full-time faculty	189	168	135	21

[a]Racial/ethnic groups included were: American Indian/Alaskan Native; Black, non-Hispanic; Asian or Pacific Islander; Hispanic. Racial/ethnic group data pertain to U.S. citizens and non-U.S. citizens with permanent visas only.

[b]The 20 responding institutions with the largest federally financed R&D expenditures in the life sciences in FY 1982.

TABLE 5

Number of Graduate Students and Postdoctorates in Plant Biology Programs, by Sex and Citizenship Status, AY 1982-83

Type of Individual	Total	Men	Women	From Developing Countries
All Institutions				
Total				
Full-time graduate students	8,023	5,539	2,484	na
Postdoctoral fellows/associates	1,009	715	294	na
Foreign citizens[a]				
Full-time graduate students	1,612	1,284	328	1,248
Postdoctoral fellows/associates	331	266	65	130
U.S. citizens[b]				
Full-time graduate students	6,411	4,255	2,156	na
Postdoctoral fellows/associates	678	449	229	na
Public Institutions				
Total				
Full-time graduate students	7,648	5,287	2,361	na
Postdoctoral fellows/associates	871	630	241	na
Foreign citizens[a]				
Full-time graduate students	1,543	1,235	308	1,200
Postdoctoral fellows/associates	301	242	59	119
U.S. citizens[b]				
Full-time graduate students	6,105	4,052	2,053	na
Postdoctoral fellows/associates	570	388	182	na
Land-grant Institutions				
Total				
Full-time graduate students	6,442	4,568	1,874	na
Postdoctoral fellows/associates	731	523	208	na
Foreign citizens[a]				
Full-time graduate students	1,405	1,149	256	1,098
Postdoctoral fellows/associates	247	197	50	85
U.S. citizens[b]				
Full-time graduate students	5,037	3,419	1,618	na
Postdoctoral fellows/associates	484	326	158	na

TABLE 5--Continued

Number of Graduate Students and Postdoctorates in Plant Biology Programs, by Sex and Citizenship Status, AY 1982-83

Type of Individual	Total	Men	Women	From Developing Countries
Private Institutions				
Total				
Full-time graduate students	375	252	123	na
Postdoctoral fellows/associates	138	85	53	na
Foreign citizens[a]				
Full-time graduate students	69	49	20	48
Postdoctoral fellows/associates	30	24	6	11
U.S. citizens[b]				
Full-time graduate students	306	203	103	na
Postdoctoral fellows/associates	108	61	47	na
20 Largest Institutions[c]				
Total				
Full-time graduate students	1,768	1,206	562	na
Postdoctoral fellows/associates	398	281	117	na
Foreign citizens[a]				
Full-time graduate students	250	197	53	140
Postdoctoral fellows/associates	108	89	19	33
U.S. citizens[b]				
Full-time graduate students	1,518	1,009	509	na
Postdoctoral fellows/associates	290	192	98	na
Institutions Other than the 20 Largest				
Total				
Full-time graduate students	6,255	4,333	1,922	na
Postdoctoral fellows/associates	611	434	177	na
Foreign citizens[a]				
Full-time graduate students	1,362	1,087	275	1,108
Postdoctoral fellows/associates	223	177	46	97
U.S. citizens[b]				
Full-time graduate students	4,893	3,246	1,647	na
Postdoctoral fellows/associates	388	257	131	na

[a]Individuals who are non-U.S. citizens on temporary visas.

[b]Includes non-U.S. citizens who have permanent visas.

[c]The 20 responding institutions with the largest federally financed R&D expenditures in the life sciences in FY 1982.

na Not available. Developing countries data were requested for foreign (temporary visa) individuals only.

TABLE 6

Principal Areas of Concentration in Training and Research in Plant Biology, by Discipline, AY 1982-83

Discipline	Graduate Student Training	Postdoctoral Research & Training	Faculty Research
All Institutions (N = 165)			
Total	100.0%	100.0%	100.0%
Agronomy/soil science	7.6	3.8	5.7
Anatomy/morphology	2.1	3.6	3.6
Biochemistry	7.1	14.1	7.2
Cell biology	4.1	5.0	5.2
Developmental biology	5.6	5.0	5.6
Ecology	19.5	10.9	18.5
Evolution	2.5	1.6	3.0
Forestry/natural resources	3.5	2.6	3.1
Genetics	5.1	3.2	3.7
Horticulture crop science	3.0	2.4	3.7
Molecular biology	4.2	7.2	4.2
Plant pathology	4.8	7.9	5.0
Plant physiology	15.6	21.0	17.9
Systematics	10.5	5.7	10.0
Weed science	0.4	1.7	0.5
Other	4.4	4.3	3.1
20 Largest Institutions[a] (N=20)			
Total	100.0%	100.0%	100.0%
Agronomy/soil science	1.7	2.5	0
Anatomy/morphology	0	0.8	2.5
Biochemistry	11.7	10.0	9.2
Cell biology	2.5	8.3	2.5
Developmental biology	5.8	5.0	5.0
Ecology	20.7	11.7	16.6
Evolution	5.0	0.8	6.7
Forestry/natural resources	2.5	5.8	2.5
Genetics	2.5	7.5	4.2
Horticulture crop science	5.0	0.8	7.5
Molecular biology	11.7	16.7	13.3
Plant pathology	6.7	9.2	4.2
Plant physiology	15.0	17.6	16.6
Systematics	6.7	3.3	9.2
Weed science	0	0	0
Other	2.5	0	0

TABLE 6--Continued

Principal Areas of Concentration in Training and Research in Plant Biology, by Discipline, AY 1982-83

Discipline	Graduate Student Training	Postdoctoral Research & Training	Faculty Research
Institutions Other than 20 Largest (N=145)			
Total	100.0%	100.0%	100.0%
Agronomy/soil science	8.4	4.0	6.5
Anatomy/morphology	2.4	4.0	3.7
Biochemistry	6.5	14.6	7.0
Cell biology	4.3	4.5	5.6
Developmental biology	5.6	5.0	5.7
Ecology	19.4	10.8	18.6
Evolution	2.1	1.8	2.4
Forestry/natural resources	3.6	2.1	3.2
Genetics	5.4	2.6	3.6
Horticulture crop science	2.7	2.6	3.2
Molecular biology	3.1	5.9	2.9
Plant pathology	4.5	7.7	5.2
Plant physiology	15.8	21.4	18.0
Systematics	11.0	6.1	10.2
Weed science	0.5	2.0	0.6
Other	4.7	4.9	3.6

[a]The 20 responding institutions with the largest federally financed R&D expenditures in the life sciences in FY 1982.

Note: Percentage distribution of weighted scores. Respondents indicated the first-, second-, and third-ranking disciplines for each type of training/research. These rankings were converted to scores which in turn were converted to the percentages shown here.

TABLE 7

Required Courses by Highest-Ranked Discipline

Discipline Ranked Highest for Graduate Training	Number of Institutions That Ranked Discipline Highest	Number of Institutions That Required Courses in:				
		Biochemistry	Genetics	Plant Structure	Ecology/ Evolution	Plant Physiology
All Institutions (N = 165)						
Total	165	119	138	95	103	115
Agronomy/soil science	14	13	13	9	2	14
Anatomy/morphology	2	2	2	1	2	1
Biochemistry	8	8	6	2	3	4
Cell biology	8	8	7	2	3	4
Developmental biology	10	10	10	8	6	6
Ecology	41	20	33	25	39	30
Evolution	3	1	3	1	3	1
Forestry/natural resources	4	2	1	4	4	4
Genetics	7	3	7	2	3	5
Horticulture/crop science	5	5	5	4	1	4
Molecular biology	7	7	7	1	3	5
Plant pathology	9	7	8	9	6	8
Plant physiology	17	17	15	10	9	14
Systematics	15	8	12	13	12	9
Other	9	8	9	4	7	8
No response	6	nap	nap	nap	nap	nap
Public Institutions (N=118)						
Total	118	85	103	74	76	90
Agronomy/soil science	14	13	13	9	2	14
Anatomy/morphology	2	2	2	1	2	1
Biochemistry	4	4	4	1	2	2
Cell biology	5	5	5	2	2	4
Developmental biology	5	5	5	5	5	4
Ecology	28	13	23	17	27	20
Evolution	2	-	2	1	2	1
Forestry/natural resources	4	2	1	4	4	4
Genetics	5	2	5	1	2	4
Horticulture/crop science	5	5	5	4	1	4
Molecular biology	2	2	2	-	1	2
Plant pathology	9	7	8	9	6	8
Plant physiology	12	12	11	8	6	10
Systematics	9	6	9	8	8	7
Other	8	7	8	4	6	7
No response	4	nap	nap	nap	nap	nap
Private Institutions (N=47)						
Total	47	34	35	21	27	25
Agronomy/soil science	-	-	-	-	-	-
Anatomy/morphology	-	-	-	-	-	-
Biochemistry	4	4	2	1	1	2
Cell biology	3	3	2	-	1	-
Developmental biology	5	5	5	3	1	2
Ecology	13	7	10	8	12	10
Evolution	1	1	1	-	1	-
Forestry/natural resources	-	-	-	-	-	-
Genetics	2	1	2	1	1	1
Horticulture/crop science	-	-	-	-	-	-
Molecular biology	5	5	5	1	2	3
Plant pathology	-	-	-	-	-	-
Plant physiology	5	5	4	2	3	4
Systematics	6	2	3	5	4	2
Other	1	1	1	-	1	1
No response	2	nap	nap	nap	nap	nap

- Means zero.

nap: Not applicable

TABLE 8A

Number of Institutions with Faculty Vacancies in Plant Biology and Number of Vacancies

Item	All Institutions	Public		Private	20 Largest[a] Institutions	Institutions Other than 20 Largest
		All	Land-grant			
Number of institutions with vacancy	67	54	39	13	15	52
Number of vacancies	213	190	168	23	61	152

[a]The 20 responding institutions with the largest federally financed R&D expenditures in the life sciences in FY 1982.

TABLE 8B

Number of Institutions with Faculty Vacancies, by Discipline with Greatest Need for Faculty

Discipline	All Institutions	Public		Private	20 Largest Institutions[a]	Institutions Other than 20 Largest
		All	Land-grant			
All disciplines	67	54	39	13	15	52
Molecular biology	18	12	7	6	4	14
Horticulture/crop science	8	8	8	-	-	7
Agronomy/soil science	7	7	6	-	-	7
All others	34	27	18	7	10	24

[a]The 20 responding institutions with the largest federally financed R&D expenditures in the life sciences in FY 1982.

Note: This table shows the estimated number of institutions with one or more faculty vacancies as of fall 1983 in plant biology programs. The three disciplines listed are those most frequently identified as having the greatest need for faculty.

TABLE 8C

Most Important Reason for Need to Recruit Plant Biology Faculty, by Discipline: Institutional Counts

Discipline	All Reasons	Research Opportunities	Faculty Retirements/ Departures	Increased Graduate Enrollments	Other	No Reason Given
Total	57	33	24	3	5	2
Agronomy/soil science	7	1	6	-	-	-
Anatomy/morphology	4	-	3	1	-	-
Biochemistry	4	4	-	-	-	-
Cell biology	1	1	-	-	-	-
Developmental biology	4	2	-	-	2	-
Ecology	2	-	1	-	1	-
Evolution	-	-	-	-	-	-
Forestry/natural resources	3	2	-	-	1	-
Genetics	1	-	1	-	-	-
Horticulture/crop science	8	4	4	-	-	-
Molecular biology	18	12	4	1	1	-
Plant pathology	4	3	1	-	-	-
Plant physiology	5	2	3	-	-	-
Systematics	1	-	1	-	-	-
Weed science	-	-	-	-	-	-
Other	3	2	-	1	-	-
No discipline identified	2	-	-	-	-	2

TABLE 9A

Disciplines Most Frequently Cited as Having a Shortage of Personnel, by Employment Category and Type of Institution

Employment Category	Most Frequently Cited Discipline	Second Most Frequently Cited Discipline
All Institutions		
Postdoctoral training positions	Molecular biology	Biochemistry
Permanent doctoral research associate positions	Molecular biology	Biochemistry
Tenure-track faculty positions	Molecular biology	Genetics
Industrial positions	Molecular biology	Biochemistry Genetics
Federal/state government positions	Molecular biology	Biochemistry
Public Institutions		
Postdoctoral training positions	Molecular biology	Biochemistry Plant physiology
Permanent doctoral research associate positions	Molecular biology	Biochemistry Plant physiology
Tenure-track faculty positions	Molecular biology	Genetics
Industrial positions	Molecular biology	Genetics
Federal/state government positions	Molecular biology	Agronomy/soil science
Private Institutions		
Postdoctoral training positions	Molecular biology	Biochemistry
Permanent doctoral research associate postitions	Molecular biology	Biochemistry
Tenure-track faculty positions	Molecular biology	Biochemistry
Industrial positions	Molecular biology	Biochemistry
Federal/state government positions	Molecular biology	Biochemistry
Land-grant Institutions		
Postdoctoral training positions	Molecular biology	Biochemistry
Permanent doctoral research associate postitions	Molecular biology	Biochemistry Horticulture/crop science
Tenure-track faculty positions	Molecular biology	Horticulture/crop science
Industrial positions	Molecular biology	Genetics Plant pathology
Federal/state government positions	Molecular biology	Agronomy/soil science

TABLE 9B

Disciplines Most Frequently Cited as Having a Surplus of Personnel, by Employment Category and Type of Institution

Employment Category	Most Frequently Cited Discipline	Second Most Frequently Cited Discipline
All Institutions		
Postdoctoral training positions	Ecology	Sytematics
Permanent doctoral research associate positions	Ecology	Anatomy/morphology
Tenure-track faculty positions	Ecology	Sytematics
Industrial positions	Ecology	Systematics
Federal/state government positions	Ecology	Systematics
Public Institutions		
Postdoctoral training positions	Ecology	Systematics
Permanent doctoral research associate postitions	Ecology	Anatomy/morphology
Tenure-track faculty positions	Ecology	Systematics
Industrial positions	Ecology	Systematics
Federal/state government positions	Ecology	Anatomy/morphology
Private Institutions		
Postdoctoral training positions	Ecology	Systematics
Permanent doctoral research associate postitions	Systematics	Ecology
Tenure-track faculty positions	Ecology	Systematics
Industrial positions	Ecology	Systematics
Federal/state government positions	Ecology	Systematics
Land-grant Institutions		
Postdoctoral training positions	Ecology	Systematics
Permanent doctoral research associate postitions	Ecology	Plant pathology
Tenure-track faculty positions	Ecology	Systematics
Industrial positions	Ecology	Anatomy/morphology Evolution Systematics
Federal/state government positions	Ecology	Anatomy/morphology Evolution

TABLE 10

Full-time Graduate Students and Postdoctoral Fellows in Plant Biology, by Major Source of Support, AY 1982-83

Source of Support	Full-time Graduate Students		Postdoctoral Fellows/associates	
	Number	Percent	Number	Percent
All Institutions (N = 165)				
Total	8,023	100.0	1,009	100.0
Federal fellowship	270	3.4	63	6.2
Federal research grant	1,586	19.8	545	54.0
State government	950	11.8	69	6.9
Foreign government[a]	840	10.5	107	10.6
Institutional support	2,400	29.9	75	7.5
Industry	520	6.5	84	8.3
Other non-industry non-personal support	293	3.6	58	5.7
Personal funds	1,164	14.5	8	0.8
Public Institutions (N = 118)				
Total	7,648	100.0	871	100.0
Federal fellowship	222	2.9	32	3.7
Federal research grant	1,513	19.8	492	56.4
State government	948	12.4	68	7.8
Foreign government[b]	827	10.8	93	10.7
Institutional support	2,204	28.9	61	7.0
Industry	514	6.7	74	8.5
Other non-industry non-personal support	285	3.7	45	5.2
Personal funds	1,135	14.8	6	0.7
Land-grant Institutions (N = 48)				
Total	6,442	100.0	731	100.0
Federal fellowship	187	2.9	25	3.4
Federal research grant	1,268	19.7	398	54.3
State government	807	12.5	63	8.7
Foreign government[c]	800	12.4	79	10.8
Institutional support	1,664	25.8	52	7.2
Industry	493	7.7	67	9.2
Other non-industry non-personal support	246	3.8	41	5.6
Personal funds	977	15.2	6	0.8

[a]The counts on this line represent 52 and 32 percent, respectively, of all foreign graduate students and postdoctorates in plant biology.

[b]The counts on this line represent 54 and 31 percent, respectively, of the foreign graduate students and postdoctorates in plant biology at public institutions.

[c]The counts on this line represent 57 and 32 percent, respectively, of the foreign graduate students and postdoctorates in plant biology at land-grant institutions.

TABLE 10--Continued

Full-time Graduate Students and Postdoctoral Fellows in Plant Biology, by Major Source of Support, AY 1982-83

Source of Support	Full-time Graduate Students		Postdoctoral Fellows/associates	
	Number	Percent	Number	Percent
Private Institutions (N = 47)				
Total	375	100.0	138	100.0
Federal fellowship	48	12.9	30	22.1
Federal research grant	74	19.7	54	38.8
State government	2	0.6	1	0.8
Foreign government[d]	12	3.3	14	9.8
Institutional support	195	51.9	15	10.6
Industry	7	1.7	10	7.4
Other non-industry non-personal support	8	2.1	12	8.9
Personal funds	29	7.8	2	1.6
20 Largest Institutions[e] (N = 20)				
Total	1,768	100.0	398	100.0
Federal fellowship	105	5.9	42	10.6
Federal research grant	482	27.3	201	50.5
State government	120	6.8	21	5.3
Foreign government[f]	117	6.6	34	8.5
Institutional support	515	29.1	24	6.0
Industry	156	8.8	37	9.3
Other non-industry non-personal support	81	4.6	35	8.8
Personal funds	192	10.9	4	1.0
Institutions Other Than the 20 Largest (N =145)				
Total	6,255	100.0	611	100.0
Federal fellowship	165	2.6	21	3.4
Federal research grant	1,104	17.6	344	56.3
State government	830	13.3	48	7.9
Foreign government[g]	723	11.6	73	11.9
Institutional support	1,885	30.2	51	8.3
Industry	364	5.8	47	7.7
Other non-industry non-personal support	212	3.4	23	3.8
Personal funds	972	15.5	4	0.7

[d]The counts on this line represent 17 and 47 percent, respectively, of the foreign graduate students and postdoctorates in plant biology at private institutions.

[e]The 20 responding institutions with the largest federally financed R&D expenditures in the life sciences in FY 1982.

[f]The counts on this line represent 47 and 32 percent, respectively, of the foreign graduate students and postdoctorates in plant biology at the 20 largest responding institutions.

[g]The counts on this line represent 53 and 33 percent, respectively, of the foreign graduate students and postdoctorates in plant biology at institutions other than the 20 largest responding institutions.

TABLE 11A

Amount of Research Support for Plant Biology,
by Type of Institution and Source, FY 1983

(Dollars in thousands)

Type of Institution	Total		Source of Support			
	Dollars	Percent	Federal Government	State Government	Industry	Other
(Number of Institutions)	(147)	(na)	(128)	(89)	(79)	(91)
All institutions	$201,569.6	100.0	$97,988.3	$69,023.7	$19,486.4	$15,071.2
Public institutions	186,959.5	92.8	87,774.7	69,000.1	17,243.7	12,941.0
Land-grant institutions	166,993.9	82.8	73,339.8	66,938.8	14,842.2	11,873.1
Private institutions	14,610.1	7.2	10,213.6	23.6	2,242.7	2,130.2
20 largest institutions[a]	36,923.8	18.3	19,959.9	9,506.3	4,253.4	3,204.2
Institutions other than the 20 largest	164,645.8	81.7	78,028.4	59,517.4	15,233.0	11,867.0

[a]The 20 responding institutions with the largest federally financed R&D expenditures in the life sciences in FY 1982.

TABLE 11B

Percentage Distribution of Research Support for Plant Biology,
by Type of Institution and Source, FY 1983

	All	Federal Government	State Government	Industry	Other
All institutions	100%	48.6	34.2	9.7	7.5
Public institutions	100	47.0	36.9	9.2	6.9
Land-grant institutions	100	43.9	40.1	8.9	7.1
Private institutions	100	69.8	.2	15.4	14.6
20 largest institutions[a]	100	54.1	25.7	11.5	8.7
Institutions other than the 20 largest	100	47.4	36.1	9.3	7.2

[a]The 20 responding institutions with the largest federally financed R&D expenditures in the life sciences in FY 1982.

APPENDIX A: SURVEY INSTRUMENT

AMERICAN COUNCIL ON EDUCATION
ONE DUPONT CIRCLE
WASHINGTON, D. C. 20036

HIGHER EDUCATION PANEL
(202) 833-4757

October 6, 1983

Dear Higher Education Panel Representative,

Attached is Higher Education Panel Survey #62, "Plant Biology Training and Personnel." Sponsored by the National Science Foundation, its purpose is to obtain basic data concerning this emerging discipline.

Information is urgently needed for developing federal policy concerning plant biology. But it is a field in which little baseline data exist because it is composed of many subfields for which statistics are not separately identified and published. Thus, even the number of students, faculty, post-doctorates, and researchers in the field are not collected systematically or in such a way as to be identifiable with plant biology. This survey is designed to gather such data plus information on research support and opinions on the employment prospects of people trained in the field. Our pretest indicated strong interest in the survey on the part of plant biologists themselves.

You will note that this is a complex questionnaire and will require very specific, substantive knowledge of the discipline to complete. Consequently, instead of asking the HEP representative to determine the most appropriate respondent, the Foundation has requested that a specific individual act as plant biology coordinator on your campus. At your institution, the Foundation recommends that the survey be forwarded to:

If this person is no longer on your campus or is otherwise unavailable to act as coordinator, please designate an appropriate substitute, and let us know whom you select. We have included a preaddressed postcard for this purpose.

The importance of careful coordination for this particular survey cannot be overemphasized. We request that only one questionnaire be returned, and that it contain consolidated data from all of the units involved. The temptation to merely return a questionnaire for each department would severely diminish the usefulness of the effort, inasmuch as several questions require a single overview of the entire effort at your institution. This is another reason that we are asking that the data be assembled by a specialist in the field.

Please understand that your institution's response will be protected to the maximum extent permissible by law. As with all our surveys, the data you provide will be reported in summary fashion only and will not be identifiable with your institution. This survey is authorized by the National Science Foundation Act of 1950, as amended. Although you are not required to respond, your cooperation is needed to make the results comprehensive, reliable, and timely.

Please have the completed questionnaire returned to us by October 31, 1983. A preaddressed envelope is enclosed for your convenience. If you have any questions or problems, please do not hesitate to telephone us collect at (202)833-4757.

Sincerely,

Frank J. Atelsek

Frank J. Atelsek
Panel Director

Enclosures

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550

October 6, 1983

Dear Colleague:

I am writing on behalf of the National Science Foundation because we urgently need your assistance in completing the attached survey on plant biology training and personnel. We are sending it to 210 doctorate-granting institutions in the United States; thus it is not possible to contact each person individually. We hope you will understand and agree to serve as your institutions's coordinator.

The need for the survey derived from numerous studies and reports that recommend plant biology as an area for emphasis in upcoming federal budgets. The National Academy of Sciences Briefing Panel on Agricultural Research Opportunities identified plant biology specifically as a research area that is "likely to return the highest scientific dividends as a result of incremental federal investments." However, planning for such a major emphasis requires having at hand accurate information about the numbers and specialties of faculty, postdoctorates and graduate students in plant biology, the major areas of concentration of training and research, sources of support, estimates of faculty vacancies and employment prospects of plant biologists. Very little baseline data now exist because plant biology and its various subfields are not separately identified and published by extant data sources. Therefore, we at the National Science Foundation have asked the Higher Education Panel, a survey research program operated by the American Council on Education, to conduct this survey for us. We believe that the resultant information will be useful for federal agencies that support plant biology research and also universities, industry and professional societies.

As you read the eleven questions of the questionnaire you will understand why it is essential to have a plant biologist coordinate the data collection. As a plant biologist you can readily identify the various departments and research and teaching programs that involve plant biologists at your institution. Indeed, you will know that those programs and persons may reside in more than one college or division. We realize that the questionnaire is complex and that several items will require a substantial effort. However, we believe you will understand our objectives and will spend the time required to collect and aggregate your institution's data.

It is important for you to work with the Higher Education Panel Representative at your institution who forwarded the questionnaire. It will also probably be necessary for you to work with plant biologists in other departments to produce complete and accurate data. Remember it is important for the survey to include all appropriate plant biologists not just those in your department.

Please feel free to call the Higher Education Panel staff collect at (202) 833-4757 if there are any questions or problems.

Thank you for your assistance. We believe the goal will be worth our combined efforts.

Mary E. Clutter

Mary E. Clutter
Division of Physiology, Cellular
and Molecular Biology
National Science Foundation

AMERICAN COUNCIL ON EDUCATION

OMB #3145-0009
Exp. 6 30 84

Higher Education Panel Survey No. 62

PLANT BIOLOGY TRAINING AND PERSONNEL

1. Please indicate the major administrative unit at your institution that is the primary focus for training graduate students in plant biology. *Check only one.*

   ___ a. Division/College of Arts and Sciences
   ___ b. School/College/Division of Agriculture/Forestry/Natural Resources
   ___ c. Other; specify. _____

Please complete the remainder of this questionnaire with reference to *ALL* graduate plant biology personnel and training at your institution.

2. Please list the department(s) involved in training graduate students in plant biology in 1982–83 at your institution. For each department, indicate (1) the total number of *plant biology* faculty and (2) the number of those faculty *engaged in training graduate students*. Count faculty members only once, i.e., with their major departmental affiliation.

   If more than four departments are involved in training graduate students in plant biology, please list those in excess of four in the "Supplement" section on page 5.

Rank*	Department	Number of Full-Time Plant Biology Faculty: Total	Number of Full-Time Plant Biology Faculty: Training Graduate Students
1st	_____	_____	_____
2nd	_____	_____	_____
3rd	_____	_____	_____
4th	_____	_____	_____

*As measured by the number of full-time graduate students in plant biology.

3. Please show the number of full-time graduate students, Ph.D. recipients, postdoctoral fellows/associates, and faculty in your plant biology program(s). For 1982–83, categorize the data by sex; for 1983–84, show only estimated totals. Note that the 1982–83 totals for graduate students and postdoctorates should agree with corresponding totals in question 10.

	1982–83 Total	1982–83 Males	1982–83 Females	1983–84 Total (Estimate)
a. Full-time graduate students	_____**	_____	_____	_____
b. Ph.D. recipients (degrees awarded)	_____	_____	_____	_____
c. Postdoctoral fellows/associates	_____**	_____	_____	_____
d. Full-time faculty	_____	_____	_____	_____

**These figures should agree with the corresponding totals in question 10.

4. Of the 1982–83 totals shown in the preceding question, how many were members of those racial/ethnic groups shown in "Definitions"? Include only *U.S. citizens* and non-citizens who have *permanent resident* status.

   a. Full-time graduate students ____
   b. Ph.D. recipients (degrees awarded) ____
   c. Postdoctoral fellows/associates ____
   d. Full-time faculty ____

5. How many *foreign* full-time graduate students and postdoctoral fellows/associates were in your 1982–83 plant biology program(s)? Please show men and women separately. Also show the total number of these individuals (men plus women) who were from *Developing Countries* (see "Definitions" for a list). **Count as foreign students and postdoctorates those non-U.S. citizens on temporary visas.**

	Number of Men	Number of Women	Number from Developing Countries
a. Foreign graduate students	_____	_____	_____
b. Foreign postdoctorates	_____	_____	_____

6. Indicate *in rank order* the three major disciplines that best characterize the areas of greatest concentration in your plant biology program(s) for (a) graduate students, (b) postdoctorates, and (c) faculty. Select a code from the list below and place it in the column that represents its appropriate rank.

Type of Training/research	Highest Ranking Discipline	2nd Highest Ranking Discipline	3d Highest Ranking Discipline
a. Graduate student training	_____	_____	_____
b. Postdoctoral research and training	_____	_____	_____
c. Faculty research	_____	_____	_____

DISCIPLINE CODES

A. Agronomy/soil science	G. Evolution	M. Plant physiology
B. Anatomy/morphology	H. Forestry/natural resources	N. Systematics
C. Biochemistry	I. Genetics	O. Weed science
D. Cell biology	J. Horticulture/crop science	P. Other; specify.
E. Developmental biology	K. Molecular biology	_____
F. Ecology	L. Plant pathology	_____

7. For the *discipline ranked highest for graduate student training* in the preceding question, indicate those fields shown in the list below in which students *are required* to take courses—or to have taken courses during their undergraduate study.

_____ a. Biochemistry

_____ b. Genetics

_____ c. Plant structure (anatomy/morphology)

_____ d. Ecology/evolution

_____ e. Plant physiology

8. Faculty vacancies in plant biology.
   a. How many full-time faculty vacancies (budgeted positions) exist as of fall 1983 in all of your plant biology programs? _____
   b. In which discipline is the need to fill vacancies greatest? Use a discipline code from question 6. _____

   To what do you attribute this need? Check the *single most important*.

_____ (1) Increased graduate enrollments

_____ (2) Faculty retirements/departures

_____ (3) Research opportunities

_____ (4) Other; specify. _____

9. How would you characterize the "current market" for employment in plant biology?

In column 1, for each of the employment categories, enter the code for the discipline(s) in which there is a *surplus of positions*. Use discipline codes from question 6. A surplus of positions means a condition in which there are more positions available than trained people to fill them.

In column 2, for each of the employment categories, enter the code for the discipline(s) in which there is a *shortage of positions*. A shortage of positions means that there are not enough positions for all the qualified people who are applying for them.

If, in your opinion, there is a condition of equilibrium across all fields in any of the employment categories, enter a check mark in column 3.

Employment Category	Column 1 Discipline(s) with *Surplus* of Positions	Column 2 Discipline(s) with *Shortage* of Positions	Column 3 Equilibrium Across Disciplines
a. Postdoctoral training positions	_____	_____	_____
b. Permanent doctoral research associate positions	_____	_____	_____
c. Tenure-track faculty positions	_____	_____	_____
d. Industrial positions	_____	_____	_____
e. Federal/state government positions	_____	_____	_____

10. Show the number of full-time graduate students and postdoctoral fellows/associates in your plant biology program(s) by their *major* source of support. Count each individual only once. The totals should agree with the corresponding totals in question 3.

Source	Graduate Students	Post-Doctorates
a. Federal fellowship	_____	_____
b. Federal research grant	_____	_____
c. State government	_____	_____
d. Foreign government	_____	_____
e. Institutional support	_____	_____
f. Industry	_____	_____
g. Other non-industry, non-personal support (foundations, associations etc.)	_____	_____
h. Personal funds	_____	_____
i. TOTAL	_____	_____

11. Indicate the amount of support for plant biology *research* that your institution received in FY 1982–83 from each of the sources listed below. If exact figures are not yet available, please show estimates. If a multi-year award was received in FY 1982–83, show only that portion that supported research conducted during the year.

Source	Amount
a. Federal government	$ _____
b. State government	$ _____
c. Industry	$ _____
d. Other private support (foundations, associations, etc.)	$ _____
e. TOTAL	$ _____

These totals should agree with corresponding totals in question 3.

Thank you for your assistance. Please return this form by October 31, 1983 to:

Higher Education Panel
American Council on Education
One Dupont Circle Suite 829
Washington, DC 20036

Please keep a copy of this survey for your records.
Person completing form:

Name _____

Title _____

Telephone (_____) _____

If you have any questions or problems concerning this survey, please call the HEP staff collect at (202) 833-4757.

Supplement to Question 2
Additional Departments with Plant Biology Training for Graduate Students

If your institution has more than four departments involved in training graduate students in plant biology, continue below the list that was begun in question 2. For each department, indicate (1) the total number of *plant biology* faculty and (2) the number of those faculty *engaged in training graduate students*. Count faculty members *only once*, i.e., with their major departmental affiliation.

Department	Number of Full-Time Plant Biology Faculty	
	Total	Training Graduate Students

DEFINITIONS

Developing Countries by Region

Latin America and the Caribbean: Includes Central America, Mexico, South America and the Caribbean

Far East, excluding Japan: Includes China, Burma, Thailand, the Philippines, Malaysia, Indonesia, and others

South Asia: Includes India, Afghanistan, Bangladesh, Pakistan, and Sri Lanka

Africa South of the Sahara *excluding* South Africa

Near and Middle East and North Africa: Includes Turkey, Iran, Saudi Arabia and other Middle East countries; included in North Africa are Morocco, Algeria, Tunisia, Libya, Egypt, Mauritania, Mali, Niger, Chad, and Sudan.

Racial/ethnic Groups

American Indian/Alaskan Native
Asian or Pacific Islander
Black, non-Hispanic
Hispanic

Full-time Faculty

Individuals with regular, full-time faculty appointments (both tenured and nontenured), *excluding* postdoctoral fellows/associates.

Postdoctoral Fellow/associate

Individual with a doctorate (Ph.D, Sc.D., etc.) or with a professional degree (M.D., D.D.S., D.V.M., etc.) who, under temporary appointment carrying no academic rank, devotes full-time to research activities or study, usually for a specified period.

APPENDIX B: TECHNICAL NOTES

The institutional population for this survey was defined to include institutions that had awarded five or more doctorates in 1980 in the arts and sciences and engineering combined. Excluded were doctorate-granting professional schools of medicine, allied health professions, business, law, fine and performing arts, and theology.

The questionnaire was mailed to a group of 209 institutions. Data received from returned questionnaires, supplemented by information obtained from follow-up telephone calls, degree-production records, and catalogs permitted the identification of 165 doctorate-granting institutions with graduate programs in plant biology. Of these 165 institutions, 143 responded to the survey questionnaire with substantive data, for an overall response rate of 87 percent.

At the time the survey was being initiated, the finishing touches were being put on the redesigned Higher Education Panel. Because there was a very high overlap of doctorate-granting institutions between the old and the new Panels, it was decided that the new Panel's weighting and institutional classification procedures should be used in calculating the national estimates. The following table shows the population and responses categorized according to the revised Panel stratification design.

Weighting

Data from the responding institutions were statistically adjusted to represent the population of doctorate-granting institutions with graduate plant biology programs. The weighting technique used was the standard one employed for Panel surveys. Data received from Panel members were adjusted for item and institutional nonresponse within each cell. Then institutional weights were applied to bring Panel data up to estimates representative of the national population.

Comparison of Respondents and Nonrespondents

Table B-2 compares survey respondents and nonrespondents on the basis of several variables. Higher-than-average response rates were recorded for institutions with large graduate enrollments and private institutions generally. Eastern and western institutions and those with graduate full-time-equivalent enrollments ranging from 2,000 to 5,000 students had lower-than-average response rates.

Reliability of Survey Estimates

Because the statistics presented in this report are based on a sample, they will differ somewhat from the figures which would have been obtained if a complete census had been taken using the same survey instrument, instructions, and procedures. As in any survey, the results are also subject to reporting and processing errors and errors due to nonresponse. To the extent possible, these types of errors were kept to a minimum by methods built into the survey procedures.

The standard error is primarily a measure of sampling variability--that is, the variations that might occur by chance because only a sample of the institutions is surveyed. The chances are about 90 out of 100 that an estimate from the sample would differ from a complete census by less than

Table B-1--Stratification Design

Cell	Type of Institution	All Doctoral Institutions	Institutions with Graduate Plant Biology	
			Total	Respondents
	Total	209	165	143
01	Public doctorate-granting	103	98	82
02	Private doctorate-granting	56	36	32
03	Large public comprehensive (FTE >9,000)	24	15	14
04	Large private comprehensive (FTE >9,000)	9	5	5
05	Large public specialized	1	1	1
06	Large private specialized	2	--	--
08	Public comprehensive (FTE 5,000 - 9,000)	2	2	2
09	Public comprehensive (FTE <5,000)	3	2	1
10	Private comprehensive (FTE <9,000)	7	4	4
16	Medium to small private specialized	2	2	2

Excludes institutions that awarded less than 5 doctorates in the arts and sciences and engineering combined in 1980 and doctorate-granting professional schools of medicine, allied health professions. business, law, fine and performing arts, and theology.

1.65 times the standard error; about 95 out of 100 that it would be less than 1.96 times the standard error; and about 99 out of 100 that it would be less than 2.5 times as large. Thus, knowing the standard error permits us to specify a range within which we can have a stated confidence that a given estimate would lie if a complete census, rather than a sample survey, had been conducted. As an example, refer to table B-3 to the estimated number of graduate students at all institutions--8,023. The 90 percent confidence interval for that item is plus or minus 616. Thus, chances are 90 out of 100 that a complete census would show the number of graduate students to be more than 7,407, and less than 8,639.

Table B-3 shows 90 percent confidence intervals of selected survey items for all institutions and for land-grant and private institutions separately.

Table B-2--Comparison of Respondents and Nonrespondents (In percenteges)

Institutional Characteristic	Respon-dents (N=143)	Nonrespon-dents (N=22)	Response Rate
Total	100.0	100.0	86.7
Control			
Public	69.9	81.8	84.7
Private	30.1	18.2	91.5
Region			
East	18.9	27.3	81.8
South	34.9	22.7	90.9
Midwest	25.9	18.2	90.2
West	20.3	31.8	80.6
Total graduate full-time equivalent enrollment (1980)			
Less than 1,000	28.7	18.2	91.1
1,000-1,999	33.5	27.3	88.9
2,000-4,999	30.1	50.0	79.6
5,000 and above	7.7	4.5	91.7

Table B-3--Ninety Percent Confidence Intervals for Selected Survey Estimates

Item	All Institutions		Land-grant Institutions		Private Institutions	
	Estimate	Confidence Intervals±	Estimate	Confidence Intervals±	Estimate	Confidence Intervals±
Graduate students	8,023	616	6,442	585	375	44
Ph.D.'s awarded	925	98	740	113	57	10
Postdoctorate fellows/associates	1,009	111	731	131	138	21
Full-time (program) faculty	4,607	342	3,674	328	263	18
Graduate students whose principal support came from:						
State governments	950	111	807	127	a	a
Institutional funds	2,400	169	1,664	175	195	20
Postdoctoral fellows whose principal support came from:						
State governments	69	13	63	17	a	a
Institutional funds	75	11	52	13	a	a
Research support[b]						
Total	$201,569.6	$20,221.6	$166,993.9	$22,520.1	$14,610.1	$2,122.5
Federal	97,988.3	9,567.0	73,339.8	10,965.1	10,213.6	1,678.1
State	69,023.7	9,530.1	66,938.8	11,525.8	c	c
Industry	19,486.4	2,100.6	14,842.2	2,339.6	2,242.7	486.7

a Estimate is less than 20; confidence interval not calculated.
b Estimates are in thousands of dollars.
c Estimate is less than $25,000; confidence interval not calculated.

APPENDIX C

50 Institutions with the Largest
Federally Financed Research and Development Expenditures
in the Life Sciences, FY 1982

Rank	Institution
1	University of California, San Francisco
2	Johns Hopkins University
3	University of Washington
4	University of Minnesota
5	Harvard University
6	Columbia University, Main Division
7	Yale University
8	University of Pennsylvania
9	University of Wisconsin, Madison
10	Stanford University
11	University of California, Los Angeles
12	Washington University
13	Yeshiva University
14	Cornell University
15	University of California, San Diegeo
16	University of Michigan
17	Duke University
18	University of Chicago
19	University of California, Davis
20	Baylor College of Medicine
21	New York University
22	University of Rochester
23	University of Alabama, Birmingham
24	University of North Carolina, Chapel Hill
25	University of Colorado
26	University of Iowa
27	University of Southern California
28	University of Texas Health Science Center, Dallas
29	University of California, Berkeley
30	University of Connecticut
31	University of Pittsburgh
32	Boston University
33	Michigan State University
34	University of Miami
35	University of Utah
36	University of Arizona
37	CUNY Mount Sinai School of Medicine
38	Massachusetts Institute of Technology
39	University of Florida
40	Case Western Reserve University
41	Ohio State University
42	Oregon State University
43	Pennsylvania State University
44	Virginia Commonwealth University
45	Rockefeller University
46	Northwestern University
47	Texas A & M University
48	Emory University
49	Vanderbilt University
50	University of California, Irvine

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