Federal Support of Research in the Life Sciences

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Since the postwar entry of the Federal Government into the financial support of scientific research, there has been a welter of conjecture regarding the level of federal support of research in the life sciences. Many estimates have been made to suit whatever immediate purposes were at hand, so that now it is possible to find appropriate quotations supporting almost any thesis one might wish to discuss: that federal grants and contracts for research in the life sciences are too few, too many, or just about right in number, that they are concentrated in a few specialties, or that they neglect certain important fields. The National Science Foundation early realized the need to collect certain basic factual data that would indicate the extent and nature of the activities of the Federal Government in the life sciences. As a result, the foundation recently compiled and published a listing of federal grants and contracts in the life sciences for the fiscal year 1954 (1 July 1953 to 30 June 1954) (*1*).

The objectives of the compilation were to publish a guide to federal activities in the life sciences for use by science administrators and to assemble fiscal data to determine the magnitude and distribution of federal support to the various areas in the life sciences. This article endeavors to summarize some of the information obtained from the study (*2*). Since comparable but less comprehensive data are available from a study of the calendar year 1952 (*3*), some comparisons between the two periods are included.

Two somewhat similar studies have been made by Deignan and Miller (*4*). Their coverage of the federal program was less complete than that of the present report, but their data did include the program activities of the major private foundations. The classification system they used to categorize the research projects was organized around the major diseases and organ systems and was therefore mainly medical in emphasis. This study takes a different point of view. We have taken cognizance of the major basic biologic disciplines and have recognized medical and also agricultural research as major components of applied biology.

The information on which this paper is based covers the unclassified research and related activities in the life sciences supported by federal grant and contract programs. The report does not include data on research done in Government laboratories except in the rare instances of grants made by one agency to another. It does not include the federal fellowship and scholarship programs. It does not include the federal programs that support the psychological sciences except for a few projects in which the physiological emphasis was significant. The fiscal data are recorded as annual rates of support as of the end of the year reported; they are not necessarily synonymous with either obligation or expenditure data used in other types of federal reports. The 1954 study is thought to represent a coverage of at least 95 percent. It is virtually complete for the agency programs covered, but a few programs are known to have been missed. The 1952 study is probably no more than 85 percent complete.

Distribution by Agency

Table 1 gives the distribution of federal funds by agency. In fiscal year 1954 the Federal Government supported approximately 8100 projects in the life sciences at a total annual rate of $64.5 million. Allowing for the incompleteness of coverage in the 2 years, this represents an increase in funds of about 25 percent over calendar year 1952. In both years, nearly one-half of the total federal support came from the Department of Health, Education, and Welfare (DHEW). The Department of Defense (DOD) was next, accounting for approximately 20 percent. Following in descending order were the Department of Agriculture (USDA), the Atomic Energy Commission (AEC), the National Science Foundation (NSF), the Tennessee Valley Authority (TVA), the Veterans Administration (VA), and the Department of the Interior (USDI). A comparison of distribution during the two years shows that the funds for the Air Force (USAF), the Department of

Table 1. Distribution by agency of federal grants and contracts for unclassified research in the life sciences. The coverages for calendar year 1952 and fiscal year 1954 are estimated to be 85 and 95 percent, respectively.

Agency	Calendar 1952			Fiscal 1954		
	No. of projects	Annual rate (thousands of dollars)	Percentage of total funds	No. of projects	Annual rate (thousands of dollars)	Percentage of total funds
USDA						
OES	3138	9,894.0	21.2	3165	10,207.3	15.8
ARS				36	360.6	0.6
AEC*	314	5,345.0	11.5	377	6,183.5	9.6
DOD						
USA						
ACC				39	696.7	1.1
SGO	318	5,125.0	11.0	398	6,502.2	10.1
OQMG				123	1,629.9	2.5
USN†	342	3,207.0	6.9	427	3,326.4	5.2
USAF‡	77	1,398.0	3.0	142	2,371.3	3.7
DHEW§	2080	20,889.0	44.8	3091	31,249.7	48.4
USDI						
F&W				6	101.4	0.2
BuR				6	21.4	0.0
NSF	131	770.0	1.7	292	1,543.3	2.4
TVA				21	186.3	0.3
VA				21	152.9	0.2
Totals	6400	46,628.0	100.1	8144	64,532.9	100.1

* Division of Biology and Medicine. † Office of Naval Research. ‡ Human Factors Division. § National Institutes of Health.

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Health, Education, and Welfare, and the National Science Foundation increased proportionately much faster than those for the other agencies. The Air Force increase may be partially the result of better coverage for the second year, but the other two increases were real. The other agencies all showed some increase, but for the Department of Agriculture and the Navy (USN), the increase was very small.

Categories

A desire to determine the scope and diversity of federal support for the life sciences led to an analysis by the category system defined in Table 2. The system was designed so as to recognize the major basic biological disciplines and the major categories of applied research. The classification includes seven basic disciplines (a somewhat modified version of the arrangement suggested by Weiss (see Waterman, 5), four categories of applied medical research, three categories of applied agricultural research, one category of technologic research, and five interdisciplinary categories that cover activities related to research but not necessarily confined to one discipline. Categorization was done from short summaries prepared by the principal investigators except in a few cases in which only the title was available. Most of the abstracts were obtained from the Bio-Sciences Information Exchange of the Smithsonian Institution, but others, notably those of the Department of Agriculture, were made available directly by the agency. Each project was uniquely assigned to one category. Since not all research projects were easily assigned to a single category, a sizable subjective element was present in this process. It was especially difficult to distinguish between basic and applied research. The particular slant the investigator chose in preparing his abstract was in many cases the most important factor that determined the category into which the project was pigeonholed. These difficulties should be kept in mind when one draws conclusions from the present data.

The distribution of funds by category for fiscal year 1954 is presented in Table 3. The two categories that received the largest proportion of funds were regulatory biology and pathology, each accounting for approximately 19 percent of the total. Plant management, on the other hand, included a greater number of projects. Among the basic categories, systematic and structural biology received the least support. The most expensive research, on a per project basis, was in the medical sciences, particularly in pathology, therapy, and community health. This will surprise no one who

Table 2. Definitions of categories used to classify federal grants and contracts in the life sciences.

Category	Definition	Examples of pertinent disciplines
Molecular biology	Biology at the molecular level: isolation, structural analysis, synthesis, and reactivity of biological substances, and so forth	Biochemistry, biophysics, biomathematics, biokinetics
Regulatory biology	Regulation of living processes: metabolism, circulation, immunological response, photosynthesis, role and function of biocatalysts, and so forth	Biochemistry, physiology, endocrinology, pharmacology
Structural biology	Physical structure of biological units: subcellular entities, cells, tissues, organs, organ systems, and organisms	Cytology, histology, anatomy, physical anthropology
Genetic biology	Action and behavior of genes and chromosomes, nature and origin of inheritable characteristics and variations, cytoplasmic inheritance	Genetics
Developmental biology	Growth and differentiation: reproduction, fertilization, growth and reproduction of subcellular units and of cells, morphogenesis, regeneration, senescence	Embryology, experimental morphology, gerontology, oncology
Environmental biology	Interrelationships between organisms and external conditions: effects of chemical, physical, and biological factors on activities, distribution, and survival of organisms; commensalism, symbiosis	Ecology, population dynamics, gross radiation effects
Systematic biology	Kinds of organisms: description, classification, biologic relationships of categories, life cycles, evolution, and so forth	Taxonomy, paleontology, phylogeny, zoo- and phytogeography, natural history
Pathology	Description of the cause, course, and results of disease pertaining to human beings	Pathologic physiology and anatomy, medical bacteriology, immunology
Diagnosis	Recognition and identification of disease pertaining to human beings, including mental disease	Internal medicine, neurology, electroencephalography, cardiology, radiology, diagnostics, clinical testing, psychiatry
Therapy	Treatment of disease and disorders pertaining to human beings	Internal medicine, neurology, pharmacology, physical therapy, surgery, psychotherapy
Community health	Health of groups or individuals: control of contagion, pollution, food and drug supplies, occupational and military hazards; chemical, radiological, and biological warfare protection	Public health, epidemiology, sanitation, toxicology
Plant management	Breeding, cultivation, production, and use of economic plants, their diseases and pests	Plant breeding, agronomy, horticulture, plant pathology
Animal management	Breeding, production, and use of domestic animals, their diseases and pests	Animal husbandry, animal breeding, animal industry, veterinary science
Soil management	Treatment and use of soil for agricultural purposes, soil conservation	Irrigation, fertilization, soil composition, soil conservation
Technology	Application and development of scientific knowledge for practical usage	Food technology, wood technology, bioengineering, synthesis of organic chemicals
Methodology	Development of new techniques for use in life sciences	All disciplines
Equipment design	Development of new equipment for use in life sciences	All disciplines

Table 2. (*Continued*)

Category	Definition	Examples of pertinent disciplines
Training	Imparting special skills for serving the life sciences, but not fellowships or scholarships	All disciplines
Scientific information	Aids to the communication process in life sciences; surveys, publications, lectures, conferences, seminars, symposia, reviews, international travel, and so forth	All disciplines
Facilities	Development or maintenance of stations, laboratories, committees, trust funds, and so forth, dedicated to research endeavor, but not construction grants	All disciplines

is familiar with the expense of human experimentation.

The applied agricultural categories—plant, animal, and soil management—ranked lowest in funds per project. It should be remembered that these figures represent the *federal contribution* to research endeavors carried out in nonfederal institutions and supported in part by the recipient institution. The apparent low cost of the projects in the agricultural categories is largely the result of the fact that this support, which comes almost entirely from the Office of Experiment Stations (OES) of the Department of Agriculture, consists mostly of grants to state experiment stations which traditionally have been administered on a cost-sharing basis. It is estimated that in fiscal 1954 state support to experiment stations was about 5 times as great as the federal commitment.

Commitments to basic research. Taking the data of Table 3 at their face value, one can estimate the proportion of federal funds for grants and contracts in the life sciences committed to basic research. The estimated support for the seven basic categories amounted to about $26 million, which was about 40 percent of the total. It would be unwise, however, to interpret this figure too literally because of the previously mentioned difficulty of distinguishing basic from applied research.

Agency support to categories. Table 4 shows the distribution of agency funds among categories. It is clear that the research interests of the federal agencies differ widely. The Department of Agriculture supported research principally in agriculture and food technology. The interest of the Atomic Energy Commission in all aspects of the biological effects of irradiation resulted in a widespread distribution of its funds with special emphasis, however, on the molecular, genetic, and pathological effects. The Army Chemical Corps (ACC) and the Surgeon General's Office (SGO) heavily supported research in the medical sciences and in basic physiology (regulatory biology). The Army Quartermaster Corps (OQMG) was principally concerned with food technology. The Navy supported research in all fields except agriculture, but with the main emphasis on molecular and regulatory biology. The interest of the Air Force in low pressure physiology was reflected in its heavy support of regulatory biology. The Department of Health, Education, and Welfare gave substantial aid to nearly all fields except agriculture, but, as with the Army Chemical Corps and the Surgeon General's Office, its main interests were in the medical sciences and in regulatory biology. The interest of the Fish and Wildlife Service (F&W) and the Bureau of Reclamation (BuR) of the Department of the Interior in wildlife and soil conservation was shown by support of environmental biology and soil management. The National Science Foundation concentrated its efforts in the basic disciplines and in interdisciplinary categories. The Tennessee Valley Authority supported agricultural research, and the Veterans Administration supported principally medical research.

If one considers the data from the point of view of the proportion of category funds provided by each agency, it is clear that the major support for nearly all categories except for the agricultural sciences came from the Department of Health, Education, and Welfare. This pattern is largely a consequence of this department's great over-all size relative to the other agencies. However, the National Science Foundation led in the support of the categories of systematic biology and scientific information, and the Army Quartermaster Corps led in technology. In the applied agricultural sciences, the sole federal support of any consequence came from the Department of Agriculture.

Recipients

In order to obtain information concerning the distribution of federal support

Table 3. Distribution by category of federal grants and contracts for unclassified research in the life sciences for fiscal year 1954.

Category	No. of projects	Annual rate (thousands of dollars)	Average annual rate per project (thousands of dollars)	Percentage of total funds
Molecular biology	833	7,485.0	8.986	11.6
Regulatory biology	1310	12,460.6	9.512	19.3
Structural biology	123	1,027.6	8.354	1.6
Genetic biology	191	1,577.4	8.259	2.4
Developmental biology	232	1,694.0	7.302	2.6
Environmental biology	170	1,601.6	9.421	2.5
Systematic biology	78	445.6	5.713	0.7
Pathology	1000	12,238.7	12.239	19.0
Diagnosis	93	860.5	9.253	1.3
Therapy	473	6,539.6	13.826	10.1
Community health	290	4,082.7	14.078	6.3
Plant management	1454	4,114.0	2.829	6.4
Animal management	752	2,989.8	3.976	4.6
Soil management	285	1,022.7	3.588	1.6
Technology	482	3,113.5	6.459	4.8
Methodology	60	431.9	7.198	0.7
Equipment design	75	656.1	8.748	1.0
Training	12	74.3	6.192	0.1
Scientific information	87	676.4	7.775	1.0
Facilities	144	1,440.9	10.006	2.2
Total	8144	64,532.9	7.924	99.8

Table 4. Distribution by agency and category of federal grant and contract funds for unclassified research in the life sciences for fiscal year 1954. Amounts are in thousands of dollars.

Category	USDA		AEC	DOD					DHEW	USDI		NSF	TVA	VA	Total
	OES	ARS		USA			USN	USAF		F&W	BuR				
				ACC	SGO	OQMG									
Molecular biology	71.0	21.0	1416.2	64.9	369.7	111.1	639.7	26.9	4,345.1			380.7		38.7	7,485.0
Regulatory biology	287.5	17.8	824.2	195.9	1156.5	86.7	1000.7	1071.3	7,521.7	2.7		290.2		5.4	12,460.6
Structural biology	4.2		40.2		48.1	15.1	50.0	137.1	709.3			23.6			1,027.6
Genetic biology	93.2		597.3		50.9		70.8		647.8			117.4			1,577.4
Developmental biology	42.8		98.6		25.6		79.2		1,376.3			71.5			1,694.0
Environmental biology	34.3		154.4	28.6	143.8	297.4	291.6	130.6	375.2	47.7		98.0			1,601.6
Systematic biology	13.1				5.7		29.7	31.4	92.6			273.1			445.6
Pathology	8.5		2148.8	76.2	1361.8	17.1	369.6	464.7	7,724.6					67.4	12,238.7
Diagnosis			54.3		122.8		44.2	1.7	625.0					12.5	860.5
Therapy	15.1		443.4	108.6	1207.9	36.0	147.3	92.2	4,460.2					28.9	6,539.6
Community health	352.3		276.3	203.5	1236.9	165.7	119.4	144.1	1,572.1				12.4		4,082.7
Plant management	4,018.5		28.7				23.0		2.8		4.0		37.0		4,114.0
Animal management	2,820.8	40.1	24.9	9.1					92.6				2.3		2,989.8
Soil management	861.3		7.1						2.3		17.4		134.6		1,022.7
Technology	1,053.5	281.7	31.2	9.9	358.9	769.2	53.4	116.3	439.4						3,113.5
Methodology	30.4				4.3	71.3	22.8	15.6	287.5						431.9
Equipment design	82.9		13.5		140.9	36.5	68.1	28.2	223.6	51.0		11.4			656.1
Training					3.8		6.3		46.9			17.3			74.3
Scientific information	37.8		20.0		46.7	23.8	65.3	111.2	181.7			189.9			676.4
Facilities	380.1		4.4		217.9		245.3		523.0			70.2			1,440.9
Total	10,207.3	360.6	6183.5	696.7	6502.2	1629.9	3326.4	2371.3	31,249.7	101.4	21.4	1543.3	186.3	152.9	64,532.9

to various types of institutions, the recipients were grouped according to the following seven classes: (i) academic institutions; (ii) nonprofit research institutes—museums, foundations, botanical gardens, biological stations, libraries, and associations actively involved in research; (iii) hospitals, clinics, and so forth—hospitals, clinics, departments of health and sanitation, and sanitaria; (iv) nonprofit associations—academies, societies, foundations, commissions, committees, clubs, journals, and congresses not actively engaged in research; (v) federal agencies; (vi) industrial organizations—commercial research institutes and industrial associations; and (vii) individuals.

The distinction between "academic institutions," "nonprofit research institutes," and "hospitals, clinics, and so forth" was not always clear. We followed the procedure of classifying hospitals or research institutes as "academic institutions" if they were administratively responsible to an academic institution.

Table 5 shows the distribution of federal grants and contracts by class of recipient. By far the largest share of support for the life sciences went to academic institutions. However, the rate of support per project was lowest for academic institutions. This is in part the result of the inclusion in this group of the relatively small grants of the Office of Experiment Stations. If these are eliminated from consideration, the average rate for academic institutions was about $10,000, which is still lower than the average of the other groups except for grants to individuals. This figure is partly a reflection of the small size of the research projects; it is probably also a reflection of the fact that a larger share of the cost is borne by the academic institution as part of its traditional sympathy for, and support of, research.

Industrial organizations received only a small fraction of federal funds for research in the life sciences. This support was largely accounted for by funds from the Army Quartermaster Corps and the Agricultural Research Service (ARS) of the Department of Agriculture for support of research in food technology. Federal institutions also received a very small fraction of life-science research funds. Whatever support existed was largely accounted for by grants to the Smithsonian Institution for support of the Bio-Sciences Information Exchange and to the Library of Congress for special services. It included also a few grants for support of the research programs of federally employed scientists. One finds that the federal agencies made very few grants to individuals. This pattern is for the most part due to a considered policy of federal agencies, but would be largely true in any case, since modern scientists are usually affiliated with academic or research institutions that provide the elaborate facilities needed for the accomplishment of research.

Since the bulk of these federal funds are distributed to academic institutions, and since the effect of these funds on the recipient educational institutions is a matter of national concern, it seems important to estimate the magnitude of federal support to academic institutions relative to support from other outside sources. Preliminary figures collected by the National Science Foundation in a study of financial support of research in colleges and universities indicate that, in the fiscal year 1954, academic institutions received between $20 million and $30 million from industry, private foundations, fund raising organizations, and other nongovernment sources. Thus the federal support of $53 million probably represents no less than 64 and no more than 72 percent of the total external contribution to educational institutions for research in the life sciences. Whether

Table 5. Distribution by class of institution of federal grants and contracts for unclassified research in the life sciences for the fiscal year 1954.

Class of institution	No. of projects	Annual rate (thousands of dollars)	Average annual rate per project (thousands of dollars)
Academic institutions	7277	53,131.5	7.301
Nonprofit research institutes	250	3,433.3	13.733
Hospitals, clinics, and so forth	444	5,430.7	12.231
Nonprofit associations	83	1,078.0	12.988
Federal agencies	22	349.0	15.864
Industrial organizations	52	957.9	18.421
Individuals	16	152.5	9.531
Total	8144	64,532.9	7.924

one uses the smaller or the larger estimates for the contribution of nongovernment sources, federal influence on the life sciences in academic institutions through grant and contract policies may be expected to be relatively significant compared with the effect of policies of the other off-campus groups.

Total Federal Support to Science

Although the grant and contract funds reported in this paper constitute a major segment of the total funds for grant and contract research in the life sciences, they represent but a very small part of the over-all federal expenditure for research and development. For fiscal year 1954, the total federal obligations in the physical, life, and social sciences amounted to $1762 million (*6*). Of this, 87 percent was for the physical sciences, 2 percent for the social sciences, and the remaining 11 percent, or $195 million, for the life sciences. Thus, the sum of approximately $64.5 million expended for unclassified grants and contracts in fiscal year 1954 amounted to about one-third of the total federal obligation for the life sciences and about 3.7 percent of the over-all federal financial commitment for all research and development.

References and Notes

1. *Federal Grants and Contracts for Unclassified Research in the Life Sciences, Fiscal Year 1954* (National Science Foundation, Washington, D.C., 1955).
2. The data presented in this article are from official findings of the National Science Foundation. However, the conclusions whether stated or implied are those of the authors and do not necessarily reflect the views of the National Science Foundation.
3. *Federal Grants and Contracts for Unclassified Research in the Life Sciences, Fiscal Year 1952* (National Science Foundation, Washington, D.C., 1954).
4. S. L. Deignan and E. Miller, *Science* 115, 321 (1952); 119, 661 (1954).
5. A. T. Waterman, *Public Health Repts.* 69, 378 (1954).
6. *Federal Funds for Science IV. The Federal Research and Development Budget.* Fiscal years 1954, 1955, and 1956. (National Science Foundation, Washington, D.C., 1955.)

C. M. Louttit, Psychologist

The death of Chauncey McKinley Louttit on 24 May 1956 was a great loss to psychology and to the behavioral sciences. Louttit will be missed as one of psychology's more versatile and productive contributors and as the very able editor of *Psychological Abstracts*. After a brief, known illness, Louttit succumbed to leukemia. He is survived by his wife, Laura, née Talcott, two sons, Robert I. and Richard T., and a brother, Henry I. Louttit.

Louttit was born 9 October 1901 in Buffalo, New York. Following a battle in his teens with tuberculosis and subsequent work as a miner in the Southwest and as an assistant in a color physics laboratory, he spent a year in the College of Forestry at Syracuse University and then transferred to Hobart College, where he received the A.B. degree in 1925. He became a research assistant at the Training School, Vineland, New Jersey, and a graduate student at Yale University, which awarded him a Ph.D. degree in 1928. In the same year, his *Bibliography of Bibliographies on Psychology, 1900–1927* was published by the National Research Council.

Following completion of his studies at Yale, his first appointment was as research psychologist in the psychological clinic of the University of Hawaii, where for 2 years he was associated with Stanley D. Porteus in studying culture-free behavior. After a year at Ohio University as assistant professor of psychology, he went to Indiana University in 1931 as director of the psychological clinics and assistant professor of psychology, where he developed one of the earlier and better-known programs of graduate training in clinical psychology. In 1933, his *Handbook of Psychological Literature* appeared, and, in 1936, his *Clinical Psychology; A Handbook of Children's Behavior Problems*. Both of these handbooks were "firsts" in psychology. The latter was especially influential in developing the field of clinical psychology and was a significant stimulus in the field of child development.

Despite a heavy schedule of teaching, writing, and research at Indiana University, he concerned himself with psychological problems in various institutional and community settings throughout Indiana and was a very active participant in the American Association for Applied Psychology, in which he served as executive secretary (1940–42) and as president (1943). Yet, with these and many other professional and scientific concerns, he was always available to his students, who found in him an unfailing source of stimulation and encouragement.

His services during World War II were substantial and extended to many important activities. Commissioned a lieutenant commander in 1940, he was assigned to duty with the U.S. Naval Medical School, in which he served as a consultant in the development of the initial plans for the psychological aspects of psychiatric screening of recruits at naval training stations. He then became chief of the clinical psychology section, and subsequently assistant chief of the psychological division, research and analysis branch, of the Office of Coordinator of Information. He next served as coordinator and executive officer in charge of quality control for naval training schools, which led to subsequent assignments as commanding officer of the Naval Training School at Plattsburg, New York, and the Naval Training Center at Bainbridge, Maryland. He retired from active duty in the navy with the rank of captain in the latter part of 1945.

Following the war Louttit became professor of psychology and director of the psychological clinic at Ohio State University, where a community-oriented behavior clinic was established and a graduate training program in clinical psychology was developed in cooperation with the Veterans Administration. Then, beginning in the latter part of 1946, Louttit yielded to a growing interest in the field of college administration and accepted several appointments in this field during the next several years. He was, in turn, dean of the faculty at Samson College, executive dean of the Galesburg Division of the University of Illinois and assistant to the provost at the University of Illinois before he accepted his last position as professor of psychology and chairman of the department of psychology at Wayne University in 1954.

At Wayne University, Louttit, with typical enthusiasm, initiative, and a prophetic sense of values, was working toward a broadly conceived graduate training program in psychology which his friends feel will be a significant advance in graduate education.