The Third Annual Report

of the

NATIONAL SCIENCE FOUNDATION

Year Ending June 30, 1953

The Third Annual Report

of the

NATIONAL SCIENCE FOUNDATION

Year Ending June 30, 1953

U. S. Government Printing Office, Washington, D. C.

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price 40 cents

LETTER OF TRANSMITTAL

WASHINGTON 25, D. C.,
November 1, 1953.

MY DEAR MR. PRESIDENT: I have the honor to transmit herewith the Annual Report for Fiscal Year 1953 of the National Science Foundation for submission to the Congress as required by the National Science Foundation Act of 1950.

Respectfully,

ALAN T. WATERMAN,
Director, National Science Foundation.

The Honorable
The President of the United States

CONTENTS

FOREWORD

The report of the activities of the National Science Foundation for the year ended June 30, 1953, is comprehensive and reflects in considerable detail the substantial progress made by the Director and the staff toward the accomplishment of the Foundation's mission as set forth in section 3 of the National Science Foundation Act of 1950. The National Science Board wishes to express appreciation of the efforts of the Director and staff and of the scientists and others who have served on Divisional Committees and Advisory Panels. The services of consultants play an important part in the Foundation's activities. It is with satisfaction that we record, as last year, the continued cooperation they have given the Foundation.

It is unnecessary in this Foreword to comment on details of the report. It is desirable, however, to present the point of view of the Board on certain broad problems of the Foundation. Such a statement of principles may be of general interest and it should be generally available for critical review and comment.

The Board learned with satisfaction that the Congress had amended the Act of 1950 removing the $15,000,000 ceiling upon annual appropriations to the Foundation. This action cleared the way for the Foundation to assume greater responsibility for the support of basic research—a course clearly thought to be desirable by the Administration and the Congress. More important, however, in the view of the Board, under the previous ceiling the Foundation could not have fulfilled the functions with which it is charged by the Act. The existence of a ceiling made a contradiction in the Act that appeared likely to interfere with the maintenance of competent staff and the continued cooperation and support of individuals and public and private academic institutions.

The sympathetic response to this problem by many members of the Congress was encouraging. Nevertheless, it seems clear that misunderstanding or lack of understanding of science and its methods is widespread. This is probably due, at least in part, to the great speed of scientific development in the past 50 years. In 1900 X-rays and radioactive elements had just been discovered, nuclear physics hardly begun, the nature and carriers of yellow fever and malaria only recently learned, modern genetics barely started, antibiotics unknown—the list could be expanded for pages. Progress in science almost stuns us, yet it is easy to take for granted. We fail to realize that it comes from deep devotion, hard work, sacrifices, and the popular support of our academic institutions. Wider public understanding of science, scientists, and the implications of scientific development is of vital concern not only to the National Science Foundation, but to the Federal and state governments, academic institutions, and industrial concerns.

The very rapid progress outlined above has wrought radical changes in, what I shall call, the economics of basic scientific research. Perhaps 50, certainly one hundred years ago, it was uneconomic to give general support to basic scientific research. The lag between a scientific discovery and its practical application was so great that even a large ultimate value had little present worth. The isolation of scientific discovery caused the lag. Scientific knowledge was not dense. A glance at present-day textbooks, encyclopedias, libraries, and the voluminous digests convinces one of how this has changed. There are and probably will continue to be new isolated discoveries, but for the most part new knowledge is quickly tied to old knowledge, and the inferences from the combination rapidly lead to further expansion of knowledge or new practical applications.

We ask today: How much can we afford to spend for basic research? The answer is: We cannot spend as much as would be economically advantageous. The bottleneck, I believe, will be lack of men and women who have the capacity, the interest and the willingness to pursue science. In numbers they constitute a restricted part of the population; and science is not the only profession calling for high intelligence and disciplined capabilities.

The upshot is that an economic test of basic research is now irrelevant. This does not mean that we should disregard budgetary, fiscal, and short-term administrative problems. It does mean that solutions to many current problems reside in the long-term functions of the National Science Foundation. It is the duty of the National Science Board to make this clear.

What are the relatively immediate consequences of basic research? First, the development of scientists. These are the people who by training and experience know how to use scientific knowledge, scientific techniques, and scientific instruments. Second, the production of new scientific knowledge, a high proportion of which may prove useful in ways unforeseeable today. Third, the application of the results of research to the solution of practical problems by a body of men who know how to apply scientific methods. An example is what has been called "Operations Analysis," which has for its objective not knowledge, but the best practical decisions. More and more we shall depend upon such talent for both military and industrial operations.

The National Science Foundation Act of 1950 authorizes and directs the Foundation "to develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences." Except for certain specified operating functions, the Foundation is essentially an authoritative advisory body, potentially capable of securing factual knowledge and advisory opinion, that makes its advice authentic but not determinative. Whom does it advise? Obviously, the President and the Congress; but also, through publication and consultation, other agencies and institutions, public and private, and individuals. The point to these observations is that the Foundation can neither police nor direct activities of other agencies, of academic institutions, of industrial research, or of individual scientists.

The Board believes it important to emphasize this view, because there is, on one hand, a natural tendency to utilize the Foundation for secondary purposes and immediate administrative convenience and, on the other, a fear that the interposition of government in science will lead to attempts to dominate science and thus to destroy it. The Board is aware of these dangers. It believes that its major function is to operate so as to minimize both dangers. But we realize that a new era has come when the interest of governments and of societies in the development of science is great and the need exists for large financial support to scientific research and for the development of adequate numbers of scientists.

CHESTER I. BARNARD,
Chairman, National Science Board.

SCIENCE AND PUBLIC POLICY

With increasing participation of Federal agencies in research and development activities, there has been a growing realization of the need for formulation of sound national policies with respect to science. The day-to-day operations of an agency necessarily result in policy formulation to a degree, and the several agencies supporting research have consciously sought to broaden operating policies by interagency liaison and appointment of non-Governmental advisory groups.

In the case of the National Science Foundation many decisions having policy implications have been made during the year in connection with the research support activities, the graduate fellowship program in the sciences, and other program activities; they are reported elsewhere under appropriate headings in this report.

During the year, however, numerous additional activities were carried on which were related to policy formulation but not connected with specific programs. The first two parts of a continuing series of reports were issued under the general title, *Federal Funds for Science.* Definite plans were made for a survey of the Nation's present efforts and needs in research and development. The gathering of information on several phases of the survey was well along.

On several occasions during the year the Foundation was able to provide background information and recommendations on scientific questions raised by other executive agencies and the Congress. In such advisory capacity the Foundation was able to draw upon the opinion of the scientific community in general by means of its established system of advisory committees and panels in all fields of science.

FEDERAL RESEARCH AND DEVELOPMENT BUDGET

A comprehensive report on Federal funds for research and development was issued in June 1953, entitled *The Federal Research and Development Budget, Fiscal Years 1952 and 1953.* The information in this report is not readily available in the ordinary financial reports issued by the Government, since the greater part of Federal scientific activities is budgeted and reported as an integral part of the operating responsibilities of the various agencies. Following congressional appropriation action in July 1953 the figures for fiscal year 1953 given in the report were revised and preliminary figures were given for fiscal year 1954. The revised figures as estimated by the Foundation are given below.

For fiscal year 1952 total Federal obligations for research and development activities reached $2.22 billion while actual expenditures for the same purpose totaled $1.84 billion. (See table I.)

The comparable estimated totals were $2.19 billion in obligations and $2.20 billion for expenditures in fiscal year 1953 and $2.07 billion and $2.19 billion, respectively, for fiscal 1954. Over the past several years a 9-month lag has existed between obligations and expenditures so that the downward trend in obligations in 1953 and 1954 will presumably be reflected in lower expenditures in 1954 and 1955.

TABLE I.—*Obligations and Expenditures of Federal Agencies for Scientific Research and Development in Fiscal Years 1952, 1953, and 1954*

[Millions of dollars]

Agency	Obligations			Expenditures		
	Fiscal year 1952	Fiscal year 1953	Fiscal year 1954 [1]	Fiscal year 1952	Fiscal year 1953	Fiscal year 1954 [1]
Department of Defense	1, 705	1, 650	1, 556	1, 315	1, 646	1, 636
Atomic Energy Commission	229	247	239	250	260	266
National Advisory Committee for Aeronautics	82	79	73	67	79	88
Department of Agriculture	56	57	68	57	58	63
Department of Health, Education and Welfare	53	67	63	65	74	61
Department of the Interior	36	36	32	33	37	33
Department of Commerce	31	23	17	28	24	17
Other agencies	25	28	26	24	26	24
Total, all agencies	2, 217	2, 187	2, 074	1, 839	2, 205	2, 187

[1] Estimate. Revised: August 24, 1953.

Source: National Science Foundation.

Roughly 85 percent of the total obligations and expenditures in 1952 and 1953 represent research and development operations and the remaining 15 percent went for increased research and development plant. The postwar peak in obligations for plant additions reached about $330 million in 1951; expenditures for the same purpose reached a maximum in 1953.

The Federal research and development budget is the composite financial expression of the individual programs of many agencies. Slightly less than half of all Federal agencies—24 in 1952 and 22 in 1953—obligated funds for such programs. In both years, however, the Department of Defense accounted for about 76 percent of the total and the Atomic Energy Commission for about 10 percent. Only five other agencies, the National Advisory Committee for Aeronautics, Department of Health, Education and Welfare, Department of Agriculture, Department of Interior, and Department of Commerce had research and development budgets of one percent or more of the total.

On the whole, Federal research activities heavily emphasize the practical and immediately useful. Almost 94 percent of the research and development funds go for applied research and development; only 6 percent for basic research.

Support for the physical sciences far outranked the other fields, absorbing about 90 percent of the total funds in 1952 and 1953. From 7 to 8 percent of the funds is for work in the life sciences and the remainder for work in the social sciences. The designation "social science" includes the gathering and processing of statistical data on social phenomena where the information has general utility. Although not research in a conventional sense, the collection of general-purpose statistics by the Government forms the basis for much of the research done in the social sciences, especially for population and economic studies. (See figs. 1 and 2.)

Trend in Research and Development, 1940–54

From fiscal year 1940 through fiscal year 1954, the longest period for which reasonably comparable data are available, there has been a general tendency for Federal research and development expenditures to rise. In 1940, these expenditures amounted to $97 million, while in 1953 they are estimated at $2.20 billion, a more than twentyfold increase in 13 years. The 1954 estimates show a slight decline which may continue in 1955. (See fig. 1.)

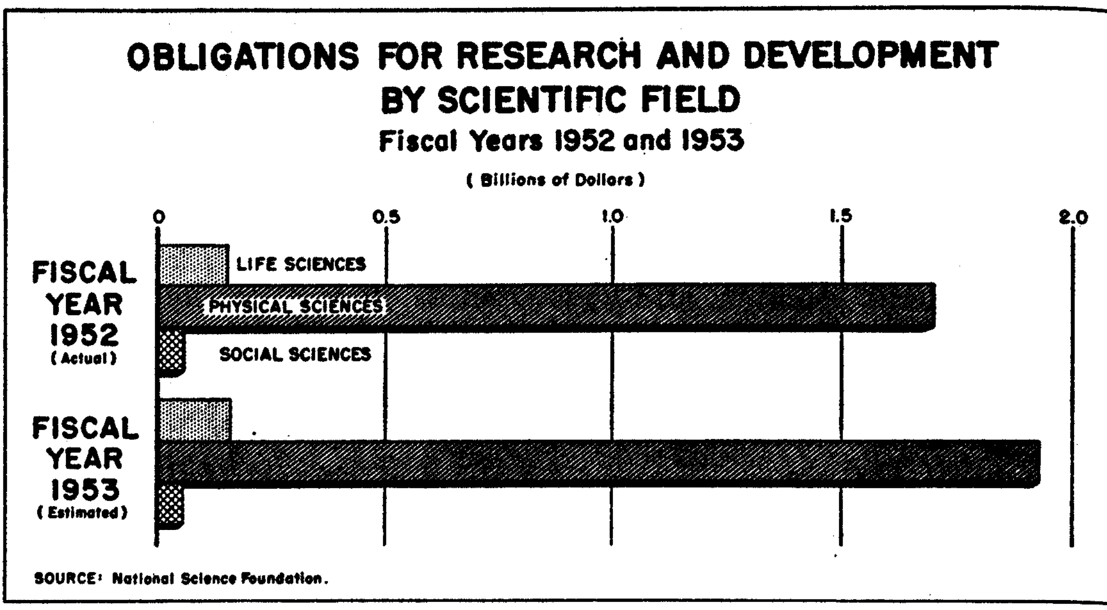

Figure 1

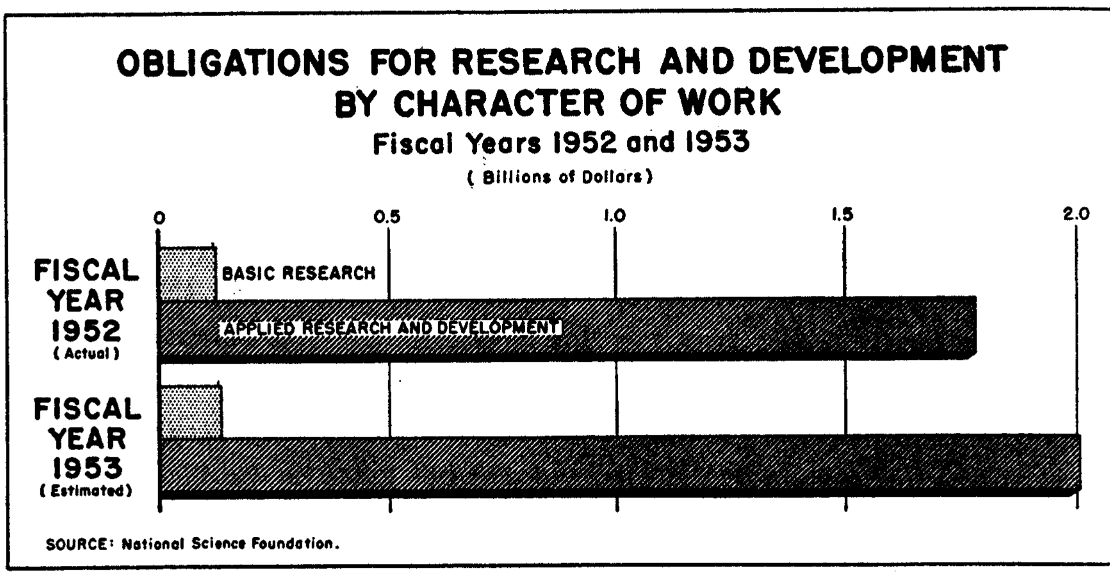

Figure 2

During this period two separate cycles of Federal research and development expenditures are discernible. The first, starting in 1940, reached its peak in 1945. About half of the total research and development expenditures during the peak period of the first cycle is directly traceable to the activities of the Manhattan Engineer District, the organization responsible for the development of the atom bomb.

The second cycle began in 1946. It appears to have reached its peak in 1953. The sharp rise beginning in 1951 was the result of heavy defense expenditures for research and development stimulated by Korean hostilities. During the same period, however, there was a general tendency for the expenditures of all agencies to increase.

Not only have expenditures for research and development increased in absolute terms, but during this period the relative proportion of the Federal budget for these purposes has increased from roughly 1 percent of the total budget in 1940–43 to about 3 percent in 1952–54.

FEDERAL FUNDS FOR SCIENCE AT NONPROFIT INSTITUTIONS

A second published study entitled *Federal Funds for Scientific Research and Development at Nonprofit Institutions, 1950–51 and 1951–52,* was issued by the Foundation during the year. This report shows that about $338 million out of total Federal research and development obligations of $2.22 billion in fiscal year 1952 financed research and development activities at nonprofit institutions. Seventeen Federal agencies administered the funds, but four agencies—the Department of Defense, the Atomic Energy Commission, the Department of Health, Education, and Welfare, and the Department of Agriculture—accounted for about $330 million (98 percent) of the total. About 1 out of every 5 dollars which went to nonprofit institutions in 1951–52 was for basic research; the other 4 went for applied research, development, and large-scale additions to the research and development plants of these institutions.

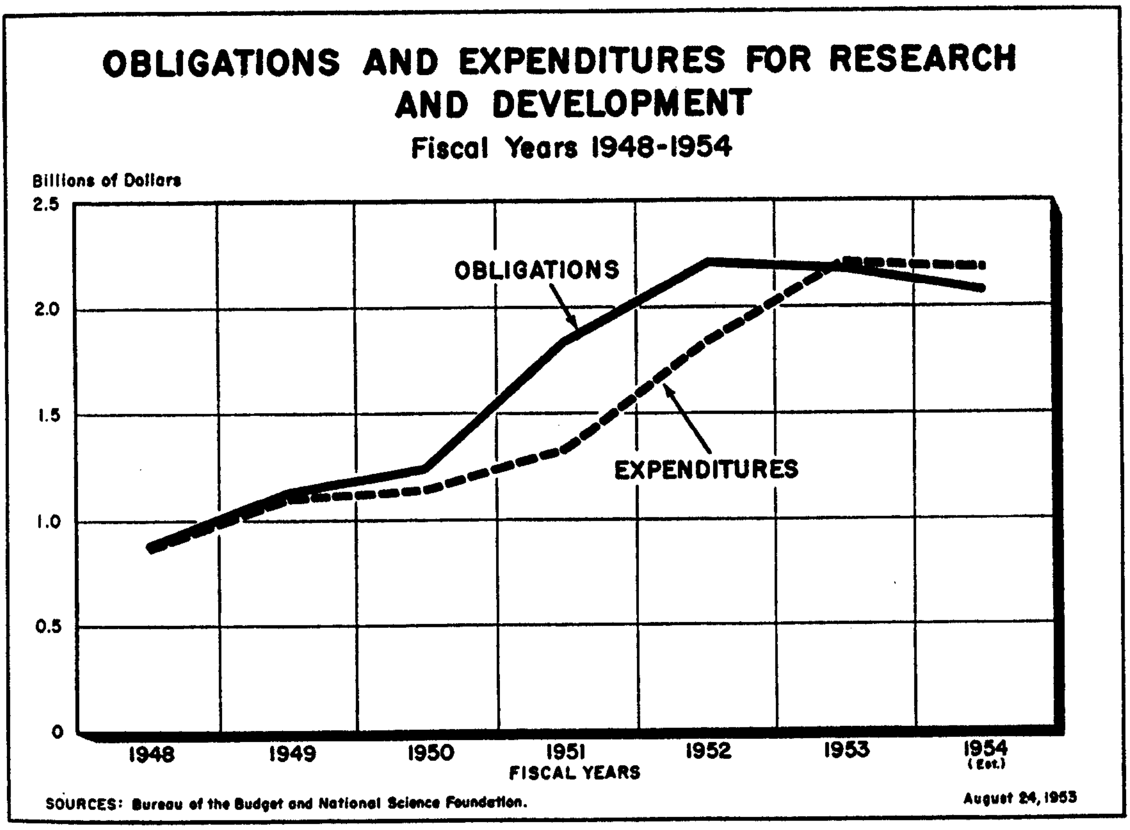

Figure 3

The report also shows that of about 700 educational institutions which appear to have immediate potential capacity for carrying out research and development, 225 received Federal funds. With research centers excluded, five of these institutions received about 29 percent of the total funds going to such institutions, the 50 getting the largest amounts receiving 83 percent of the funds. This concentration is largely accounted for by the more fully developed scientific facilities and staff of the institutions receiving the most funds and by the critical national defense needs. The capacity to do research is also concentrated geographically. The report indicates, however, that scientific resources do exist in many smaller American colleges and universities not receiving support from Federal research programs.

The report points out that the increased activities of the Government in scientific research have resulted in the establishment of "research centers" which are operated for the Government by nonprofit institutions. These centers are usually associated with educational institutions but because the primary emphasis is upon research they seldom maintain a teaching staff or engage in educational activities. In general the research centers carry out special scientific programs closely tied to the operating responsibilities of the supporting Government agency. The funds expended by the Government at these research centers amounted to $159 million, or a little less than half the funds expended at all nonprofit institutions.

In discussing Federal support of research and development at educational institutions, the report points out that about half the total—$143 million out of $295 million in 1951–52—supports research, especially applied research and development, that probably contributes little to the primary objectives of these institutions. There is apparent an increasing tendency to separate research sponsored by the Government and others from the normal functions and activities of the institutions, the report states, adding that as this trend grows, the value of sponsored research for educational purposes is lessened.

Imbalance in Research Programs at Nonprofit Institutions

The amount of money spent for applied research and development in itself is understandable since there is no question that agencies having specific responsibilities for improving our military potential or industrial and agricultural productivity must provide support for applied research and development devoted toward immediately practical ends.

An imbalance between basic and applied work is a portent of danger, however. As was pointed out in the Foundation's *Second Annual Re-*

port, "unlimited expansion of effort toward applied research and development, without corresponding support for basic research, will defeat the entire effort by limiting technological progress to minor improvements and refinements of obsolete processes and equipment."

Of some concern is the fact, brought to light in the report on nonprofit institutions, that a large part of the total Federal research support at educational institutions is devoted to applied and developmental work. This is common practice in certain fields, notably medicine, agriculture and engineering, where work in applied areas is an accepted part of the educational process. On the other hand, in the fundamental scientific areas, the educational process stresses basic research and the fundamentals of the subject, studied both in the classroom and in the laboratory, where first principles can be demonstrated. It will be desirable periodically to review the relative support furnished to basic and applied science.

RESPONSIBILITY OF THE FOUNDATION FOR BASIC RESEARCH

It has been the stated policy of the Executive branch of the Government to increase the responsibility of the National Science Foundation for Federal support of basic research. At the same time, it is desirable for other agencies to support basic research closely related to the solution of problems for which they have statutory responsibility.

The appropriation requests for fiscal year 1954 of the various agencies reflected this point of view to some extent and the pattern of distribution of Federal funds for research during the year ending June 30, 1953, indicated that the research agencies were already making adjustments in their programs.

The effort to centralize support of basic research in the Foundation is desirable from the standpoint of logical administration of Federal research support, but it will clearly work against the best interests of science in the United States unless the Foundation together with the other research agencies can provide adequate support for basic research in order to balance support given to applied research and development. The Foundation has been fully aware of this danger. In order that the Foundation might be able to carry its appropriate share of basic research support, the Congress removed the limitation in the National Science Foundation Act which restricted the appropriation in any fiscal year to $15 million.

Basic Research Needs of Operating Agencies

The Foundation is in full accord with the view that other agencies should carry on basic research programs directly related to their operating functions. There are two principal factors in support of this position. First, there is the need of an operating agency for an assured and continuing direct flow of fundamental knowledge relating to its practical problems. Second, in view of the increasing dependence of these agencies upon scientific and technical developments, it is essential that the operating personnel maintain effective contact with the scientists of the country. Conversely, it is to the advantage of the country that scientists be encouraged to be interested in fields of great potential importance to national defense and welfare. Support of basic research in areas of immediate interest to the agency provides opportunity to maintain this two-way exchange on a healthy basis.

SURVEY OF SCIENCE IN THE UNITED STATES

By June 30, 1953, the Foundation had completed preliminary plans for a survey of the Nation's present efforts and needs in research and development and was well along toward completion of several phases of the plan. The over-all survey will include six major sections, namely:

1. Research programs of the Federal Government.
2. Research in industry.
3. Research at nonprofit institutions.
4. Studies on scientific manpower.
5. Studies on the exchange of scientific information.
6. Studies on the current status of scientific progress.

Three previous overall studies of the status of research and development in the United States have been issued in the last 20 years. The earliest of these, *Research—A National Resource,* was published in 1937 by the National Resources Committee. At the close of World War II, *Science—the Endless Frontier,* prepared under the direction of Vannevar Bush, drew attention to the increasing importance of basic research to our national security and welfare and reassessed our scientific resources at that time. In 1947 the Steelman report, *Science and Public Policy,* made strong recommendations for a continuing Federal program in support of science. Many of the recommendations of the Bush and Steelman reports were incorporated into the legislation establishing the National Science Foundation in 1950. At the present time there is a clear need for a reappraisal of the status of science in this country. The survey being undertaken by the Foundation will attempt to assess relevant portions of the information now available.

COORDINATION OF FEDERAL RESEARCH

Many groups have need for current lists of research and development activities supported by Federal agencies through grant or contract. The Foundation has taken several steps toward this end. Quarterly lists of projects in psychology and human resources research and research in the social sciences are compiled and distributed to other interested agencies. The Foundation participates in the support and administration of the Biological Sciences Information Exchange for compiling project information in the biological and medical sciences. It has also encouraged the formation of informal liaison groups made up of representatives of interested agencies to review research activities in specific areas, such as high temperature research. This type of interagency cooperation and liaison is expected to continue.

One of the problems in obtaining comparable fiscal and statistical information from the several agencies is that of defining the terms used in reporting research and development work. Working definitions have been adopted for basic research, applied research and development. It is difficult to arrive at mutually satisfactory definitions of subject field categories used by the various agencies for reporting and record purposes. Complications arise since some agencies are accustomed to keep records based upon the operational goals of research and development programs while others used traditional subject categories. Agencies also differ widely in the use of such terms as project, task, and program as a unit of research and development. These differences and distinctions are gradually being worked out, or at least noted and accounted for, in the statistics being gathered.

ADVISORY COMMITTEE ON MINERALS RESEARCH

The President's Materials Policy Commission in June 1952, recommended that there be undertaken an extensive program of basic scientific research and technical development on techniques and instruments of exploration for minerals. The first step in such a program, the Commission suggested, should be the appointment of a committee under the National Science Foundation, of experts from Government, private industry, and universities, to make a full inventory of existing scientific and technical knowledge in the field, to determine the subject

278626—54——2

areas of greatest need for further research and development, to devise a coordinated program to be carried out by private groups and Federal agencies, and to estimate the cost and the extent to which the program will require supporting funds from the Government.

In line with these suggestions the Foundation has appointed a committee to assist in planning and executing research support and training programs, in studying Government programs of research and development, and in developing policies in research and training in the fields of science and technology important to exploration for minerals. This includes:

1. The formulation of a broad program of research and training oriented toward strengthening exploration and discovery of mineral resources.
2. Development of measures to finance and execute such a program through the Foundation, other Government agencies, and industry.
3. Identification and study of background data and policy questions which affect the conduct of sound research and training in this field.

The Committee gave considerable thought to the subject areas of interest and prepared a sample catalog of the problems facing the nation in the minerals research field. While recognizing the importance of Federal support of research and training in the minerals field, the Committee thought it desirable for industry to support the preponderate amount of research in this field, especially applied research and development. A list of areas of minerals research developed by the Advisory Committee on Minerals Research is given in appendix VII, page 109.

TRAVEL RESTRICTIONS ON FOREIGN SCIENTISTS

In October 1952, the Director was invited to testify before the President's Commission on Immigration and Naturalization concerning the impact of existing immigration laws upon science. In assessing the problem, he drew upon the experience of other Government agencies and of scientists themselves. Upon the basis of information available to the Foundation through these channels, it was clear that the provisions of the immigration laws governing the temporary admission of aliens to this country, and the administration of those laws, had created a problem.

The problem arose in the enlargement between 1948 and 1950 of restrictions on temporary admission of an alien visitor. These restrictions were retained in the codified law becoming effective in December 1952. In the practically unanimous opinion of scientists these restrictions have brought about deterioration in the relationships of American scientists with their opposite numbers in countries friendly to the United States, particularly in the United Kingdom and other countries in Western Europe.

In his statement, the Director called attention to the fact that creative scientific ability is not circumscribed by national boundaries. He pointed to the evidence that the observations and conclusions reached by competent scientists in any one country are invaluable to the research of scientists in other countries working on the same or similar problems. He further pointed out that in achieving the advanced technology and living standards of present day America, we have drawn heavily on the findings and accomplishments in pure science abroad. Without ready access to these foreign sources of scientific information this progress would have been impossible.

The number of foreign scientists excluding students visiting the United States in 1951 was estimated at less than 3,000, or about 1 percent of the 300,000 visitors and tourists entering the country in that year. The Director pointed out that these scientists were important to our scientific strength out of all proportion to their number, for they consist, generally speaking, of the best scientific minds of the free world outside the United States.

It appears that under existing statutes at least 50 percent of all foreign scientists who apply to enter the United States meet difficulties or serious delays. The number of actual refusals of permission to enter is much less, but the principal damage to our international relationships appears to occur in a small number of cases involving refusals to outstanding persons which are difficult for the public to understand on the basis of the published facts, coupled with the tedious, cumbersome, and uncertain process experienced by those who do pass through the screen.

Recommendations

In closing his comment on the visitor visa problem, the Director made four specific recommendations for improving the law and its administration. In so doing he recognized that rigorous and effective security measures are required under present world conditions to preserve the integrity of our Government and our country. It is believed, however, that the recommendations will achieve better balance between security by isolation and security by technological achievement. The recommendations may be summarized as follows:

1. That a distinction be made in the statute between procedures and criteria for temporary admission of a nonimmigrant alien and require-

ments for admission of an alien who intends to become a permanent resident of the United States. Complicated administrative procedures, extensive security checks, exhaustive questionnaires and careful interrogations are acceptable as part of an application for permanent entrance and ultimate citizenship in the United States. The need for the same administrative procedures and criteria is less apparent in the case of an application for a visit of a few weeks or months. It is implicit in this suggestion, of course, that strict measures be employed to screen out foreign agents, saboteurs, and secret couriers.

2. That the criterion requiring exclusion of an alien visitor might rationally become *present, sympathetic* association with a foreign subversive organization rather than, as now, affiliation, in an extremely broad sense of the word, at any time in the past with such an organization. The Congress has already taken a step in this direction by providing exceptions for persons who in the past were so affiliated but who have terminated such affiliation and for five years prior to the date of application for a visa have been actively opposed to the program of subversive organizations.

3. That consideration be given to providing for selective audit from time to time of applications for temporary admission, by a competent, reliable and distinterested group with appropriate experience both inside and outside of Government. This suggestion grows out of recognition that our Government has been accumulating a wealth of experience with security programs in which a balance must be struck between security by isolation and security by technological achievement.

4. That, particularly if the other suggestions prove to be impracticable, a separate section of the immigration law be established, which would create a much-simplified and expeditious system for admitting "students, trainees, teachers, guest researchers, professors and leaders in fields of specialized knowledge or skill," who have applied for admission to this country for a purpose directly related to the activities of a Government agency, an accredited institution of higher learning or a scheduled meeting of an accredited international professional organization.

LEGISLATION ON WEATHER CONTROL

At the invitation of the House Committee on Interstate and Foreign Commerce, the Foundation in July 1953, presented comment on pending legislation relating to weather control and modification. The Foundation's recommendations were favorable to several alternate bills in view of the close correspondence of most of their provisions. Subsequent action of the Congress was in accord with these recommendations and a bill was approved in August 1953, as Public Law 256, first session, Eighty-third Congress. The National Science Foundation was included as a member of the interagency advisory committee established under the law.

The bills had a common objective of establishing an advisory committee to make a complete study and evaluation of public and private experiments in weather control, for the purpose of determining the extent to which the Federal Government should experiment with, engage in, or regulate activities designed to control weather conditions.

In endorsing the principal objective of these bills, the statement of the Foundation presented a brief review of the present status of knowledge regarding artificial weather modification as follows:

> Developments in the study of cloud nucleation and in experimental seeding of clouds have indicated that significant artificial modifications of weather may be possible. Current studies, as supplemented by field experiments, do not afford a satisfactory basis for belief that widespread practical applications of weather modification efforts are feasible at the present time. Present knowledge is inadequate for formation of definitive conclusions as to the nature and extent of possible modifications, the means by which they may best be accomplished and the conditions and circumstances required for successful and beneficial effects. Because of the lack of necessary basic data, much current cloud-seeding activity appears to represent inefficient expenditure and perhaps actual waste of energy and funds.
>
> The greatest need at the present time is for additional basic research in cloud nucleation processes. Such basic research should go forward both in the laboratory, to gain an understanding of the nucleation processes, and in the field, to investigate natural processes of cloud nucleation. Controlled field experimentation, applying the knowledge thus gained to more effective understanding and practical use of cloud nucleation, is also necessary and desirable.
>
> Insofar as the Federal Government is concerned, these recent scientific developments present issues and problems which deserve attention. Further knowledge of mechanisms underlying possible modifications of the weather and the potentialities of practical application is a matter of broad interest and significance to several departments and agencies including the Foundation. The nature, extent and distribution of Federal research activities in nucleation processes also require careful consideration and are of special interest to the National Science Foundation.

A further problem is presented by the possible need for Federal regulation of weather modification operations. Current operations have prompted several States to enact regulatory legislation. The potential interstate and possibly international effects of such operations, the need to avoid indiscriminate or wasteful seeding and the further need to prevent interference with soundly conceived and significant field experimentation are factors which may ultimately impel some exercise of Federal authority. Until more evidence of the practicality of weather modification is available, however, Federal regulation seems premature. Informal liaison with State regulatory agencies and private operators would perhaps be useful, and would seem to be sufficient to protect Federal interests at the present time.

SURVEY OF THE STATUS OF THE SCIENCES OF HUMAN SOCIAL BEHAVIOR

During the year ending June 30, 1952, Federal agencies obligated over $53 million for research and development in the social sciences. These activities were highly weighted in the direction of collection of statistics and applied and development work, with slightly more than $3 million for basic research studies.

In view of these data, the Foundation undertook in March 1953 a systematic and continuing study of the present status of the sciences of human social behavior to determine its own position with respect to research in the field. The Foundation is following with interest the programs of the private foundations in the behavioral sciences.

The term "behavioral sciences" covers a wide range of activities. These may be thought of in terms of a continuum. At one end lie the hard-core scientific studies of human social behavior—the use of experimental techniques, controlled experiments, laboratory studies, statistical and mathematical methods, survey design techniques, development of measurement devices and instruments such as standardized tests and scales, empirical testing of hypotheses and concepts, and other characteristic features of scientific research. At the other end of the continuum lie the philosophical, ethical and political studies and interpretations of human social conduct.

In its current survey of the status of research in this broad area, the Foundation will seek to identify the hard-core scientific end of the continuum. Of particular interest are certain interdisciplinary areas of convergence of the natural and social sciences. These include such areas, for example, as anthropology, human ecology, statistical and experimental design, and demography.

SPECIAL STUDIES ON THE CURRENT STATUS OF SCIENCE

The Foundation is interested both in the long-range development of knowledge in broad fields of science and in short-range studies of science, urgent from the standpoint of national defense, the general welfare, or progress in science itself.

In considering the subject matter and progress of science as opposed to its organization, financing, and manpower utilization, the Foundation believes that the scientists themselves must make the major contribution. There are dangers in self-analysis but these can be guarded against. An evaluation of the development and status of a domain of science attempted by individuals unfamiliar with the current state of knowledge in that science would be of little value.

To test the merits of self-appraisal the Foundation has supported three general long-range surveys of fields of science—physiology, psychology, and applied mathematics. As presently planned these studies will require up to three years to complete. None has been completed to date but the progress reports below show the methods of attack that have been decided upon.

SURVEY OF PHYSIOLOGY

The survey of physiological science, being conducted by the American Physiological Society, is under the general direction of a central committee of physiologists representative of the several subdisciplines of physiology. Specific segments of the survey are guided by subcommittees of physiologists who will evaluate those data pertinent to their special areas of cognizance and, on the basis of these data, will formulate individual reports and conclusions. The subcommittees, with the central committee, will then prepare the final report which is expected to be published during the autumn of 1954.

One of the most important information gathering phases of the study is the use of questionnaires, supplemented by data from existing rosters of the scientific population. The information will be checked by a limited number of interviews. The questionnaire, to be submitted to all American physiologists (estimated to number between 4,000 and 5,000) is designed to obtain information about the profession of physiology, of what and whom it is constituted, why persons enter and leave the field, what are the motivations and the attitudes of these persons toward the profession and the problems encountered in practicing it. Information is being obtained about research, teaching, and administrative activities. The educational, social, economic, and geographic backgrounds of physiologists will be investigated.

Another part of the study has to do with the function of scientific literature in physiological science. Analysis of the data will show past and present interests in physiological science, the interweaving of other disciplines into physiological research, the development of concepts and the effects thereof on progress in the field.

Correlative studies are being made of college course offerings, content of such courses and methods used in teaching them, textbook and monograph analyses, student populations and factors related to recruiting of physiologists. Special studies designed to evaluate the presentation of physiological science to the lay public are also being made. An evaluation of the usefulness of physiology and of its contributions to society and the general welfare are being undertaken. For comparative purposes, a brief examination of the general status of physiology in selected foreign countries is being made.

The effects of the physiological survey are already being felt. As a result of discussion surrounding the formulation and development of the survey and also as a result of several meetings held by the survey at national scientific meetings, it is apparent that physiologists are individually and collectively beginning to take an introspective look at themselves, their relation to society and the contributions they and their science are making to our culture and well-being.

DEVELOPMENT AND STATUS OF PSYCHOLOGY

On October 1, 1952, the American Psychological Association entered into a contract with the National Science Foundation to conduct a study of the development and status of psychology in the United States. The need for such a study was perhaps more acute in psychology than in some older sciences. Psychology in recent years has shown a very rapid rate of change and increasing diversity of functions. Spanning the broad gap between the natural and social sciences, its relations with other sciences are growing in volume and in complexity. Such relationships are not limited to the strictly scientific domain. During and since World

War II the various fields of applied psychology have undergone rapid expansion. This has led to closer relationships with other professions in the fields of health, welfare, education, industry, military service, and Government.

The study of the development and status of psychology has been divided into two major parts:

Project A, an evaluation of the status of psychological knowledge with special reference to general scientific methodology, development of theory, and dependence upon empirical laws.

Project B, an analysis of occupations in psychology, including supply, demand, and utilization of scientific manpower in the various branches of the science. This part of the study is oriented toward the individual psychologist, his characteristics, interests, values, and social origins, the nature of his training, his output, and the cultural factors that influence him in his research and professional work.

APPLIED MATHEMATICS SURVEY

The survey of applied mathematics is being conducted under the direction of the National Research Council Committee on Training and Research in Applied Mathematics in cooperation with the Defense Department. A questionnaire has been sent to approximately fifty university departments with interest in applied mathematics to obtain factual data. Two national meetings were also scheduled for the fall of 1953 in conjunction with regular meetings of the American Mathematical Society. The first was devoted to the philosophy of and the training in applied mathematics, and the second to selected topics in applied mathematics.

Fifty years ago applied mathematics consisted essentially of the treatment of physical problems involving calculus and analysis. Today, quantum mechanics, statistical mechanics, numerical analysis, and the creation of biological and economic models have advanced applied mathematics to a state far beyond conventional analysis. Although this specialization is taking place on the pure side of mathematics as well as the applied, there is considerable risk of a drifting apart between the two categories of mathematicians. Practical techniques must be found for encouraging and facilitating cooperation between pure and applied mathematicians. Periodic revision of undergraduate curricula to take advantage of both empiricism and postulational mathematics is a possible approach to the problem.

The final report of the survey group will attempt to chart the principal factors involved in the training for and practice of applied mathematics. One fact is already clear. The applied mathematicians of the future will need deeper understanding of pure mathematics as well as an open mind toward the experimental sciences.

CONFERENCES IN SUPPORT OF SCIENCE

One of the significant programs undertaken by the Foundation has been the sponsorship of conferences and symposia to review current scientific advances in special areas of science. The conferences have drawn together leading scientists from this country and abroad to exchange information on latest research findings, to develop improvements in theory and procedures, and to lay plans for future research. As a rule the subjects discussed are at the frontiers of knowledge where ideas are in a state of flux and the participants attempt to resolve theoretical differences and explain the known facts.

During the year ending June 30, 1953, a total of eight conferences were sponsored by the National Science Foundation, jointly with universities, scientific societies and other Government agencies. (See table II.)

Brief notes on these conferences are given below. In general, the request for support of conferences originates with the scientists doing active research in the field under review. Proceedings and papers are usually published at the conclusion of the conference so that the value extends well beyond that to the actual participants.

In addition to the listed conferences devoted to discussion of special areas of science, numerous other conferences, symposia and meetings were sponsored by the Foundation for other purposes. These included four summer institutes attended by college science teachers (p. 53); a Conference on Physics Research in Colleges (p. 37); a Symposium on Education in Physiological Science, sponsored by the Foundation-financed Survey of Physiological Science and held in conjunction with the St. Louis meeting of the American Association for the Advancement of Science; a Workshop on the Production and Use of Technical Reports, jointly sponsored by the Foundation, the Catholic University of America, the American Chemical Society, American Documentation Institute and Special Libraries Association; and a number of *ad hoc* advisory conferences held in Washington to which were invited specialists in various fields of scientific research and education.

TABLE II.—*Conferences Supported by the National Science Foundation in Year Ending June 30, 1953*

Subject	*Sponsoring institution*	*Chairman*	*Date*
Astrophysics	University of Michigan	W. Baade	June 29–July 24, 1952.
Photosynthesis	Committee on Photobiology of National Research Council; Office of Naval Research; National Institutes of Health; Atomic Energy Commission.	S. Hendricks	Oct. 29–Nov. 1, 1952.
Abundance of Elements	University of Chicago	H. C. Urey	Nov. 6–8, 1952.
High Energy Physics	University of Rochester, certain industrial firms of Rochester.	R. E. Marshak	Dec. 18–20, 1952.
Fiber Bundles and Differential Geometry.	Cornell University	R. J. Walker	May 3–7, 1953.
Methods of Determination of Steroids in Blood and Urine.	Worcester Foundation for Experimental Biology.	G. Pincus	May 31–June 4, 1953.
Specificity in Development	Society for the Study of Development and Growth; National Cancer Institute; American Cancer Society; University of New Hampshire.	E. J. Boell	June 19–22, 1953.
Lie Groups and Lie Algebras	American Mathematical Society, Colby College.	E. G. Begle	June 20–July 31, 1953.

ASTROPHYSICS

The 4-week Symposium on Astrophysics conducted at the University of Michigan consisted of lectures and discussions on subjects of current interest in the field, including the composition and structure of galaxies; the origin, evolution, and age of the stars and galaxies; and the problem of turbulence as it applies to stars and nebulae. Discussion leaders included W. Baade, G. K. Batchelor, G. Gamov, G. Keller, G. P. Kuiper, D. Osterbrock, E. E. Salpeter, and A. Sandage.

PHOTOSYNTHESIS

Sunlight as a continuing source of energy far surpasses coal and oil and even atomic fuel. On an average day the sunlight falling on the United States equals in energy some 40 tons of coal for each man, woman, and child in the country. Plants and plant life have been our principal means for tapping this abundant energy source, although wind and waterpower are converted forms of solar energy independent of the plant cycle.

The Conference on Photosynthesis at Gatlinburg was of primary interest to biologists working on the problem of how plants convert the energy of sunlight into food and fuel. The Conference was administered by the Committee on Photobiology of the National Research Council with support of the Foundation, the Office of Naval Research, the National Institutes of Health, and the Atomic Energy Commission.

Sunlight consists of a countless number of small energy-carrying packets, called photons. Altogether the energy thus transported is enormous. The quantum of energy represented by the individual photon, however, is almost incredibly small. This gives rise to one of the major theoretical problems in the study of photosynthesis. What is the nature of the chemical reaction that can be activated by the energy in a single photon? Apparently the process takes place in steps, the energy for each step being supplied quantum by quantum from the absorbed photons of light. Although some of the intermediate products have been identified, scientists have not determined conclusively the number of steps and the number of quanta required in the total reaction. Solution of this problem will be an important key to the commercial utilization of photosynthesis. It was the major topic of interest at the Gatlinburg meeting.

ABUNDANCE OF ELEMENTS

The University of Chicago-National Science Foundation Conference on the Abundance of Elements at the Yerkes Observatory was particularly notable for bringing together scientists of several disciplines to discuss a common problem. More than 50 physicists, chemists, geologists, and astronomers met to discuss the present status of knowledge of the abundance and distribution of chemical elements, both on earth and in the universe as a whole.

Information on the relative abundance of the elements provides the key to many puzzling and important scientific problems. For example, the sun and the stars are great natural laboratories operating at temperatures and pressures unattainable to the scientist on earth, even with the most powerful instruments now available. Accurate estimates of the ratio of the various elements in a star aid in understanding the origin and nature of the reactions that are taking place. These estimates are also used by scientists to calculate the age of the earth and the universe and trace the decline of dying stars. They also give the theoretical limits of our material resources.

HIGH-ENERGY PHYSICS

Over 100 representatives from 45 physics laboratories in the United States and eight foreign countries attended the Third Annual Rochester Conference on High-Energy Physics sponsored jointly by the Foundation, the University of Rochester, and a group of Rochester industrial concerns. Nuclear physicists at the present time are faced with the problem of formulating a suitable theoretical explanation of the massive forces within the nuclei of atoms. Well over 99 percent of all the energy in the universe is locked within atomic nuclei. Indeed, atomic fission, the basic physical process in atomic bombs, releases only about one-tenth of 1 percent of the total energy available in the uranium nucleus.

Several years ago physicists appeared to be on the threshold of reaching a complete and reliable theory of nuclear forces. The theory involved the assumption of an unknown entity called the *meson,* which in the nucleus appeared to bind the nuclear particles together but at the instant of destruction of a nucleus would be observed as a new type of particle. Shortly thereafter such particles were actually found—first in cosmic ray collisions, then in the laboratory. It now appears, however, that there are many meson-like particles having various masses and electrical charges. As a result, previous theories of nuclear forces have had to be revised, and nuclear physicists are in need of a unifying principle that will account for the vast array of new experimental data now available. The Rochester Conference was devoted to the discussion of such problems. The proceedings of the conference have been published.

FIBER BUNDLES AND DIFFERENTIAL GEOMETRY

Some 17 years ago Hassler Whitney of Harvard University developed the concept of fiber bundle in mathematics and noted the possible application of algebraic topology to other branches of geometry. The Conference on Fiber Bundles and Differential Geometry at Cornell University constituted a survey of the very extensive developments of this concept during the post-war years. The first half of the program was devoted to the problems within topology itself resulting from the use of fiber space techniques. The second half reviewed the applications to Lie groups, differential geometry, complex analytic manifolds, and algebraic geometry. The most striking feature of the conference was the frequent use of the same mathematical treatment of problems in two or more widely separated disciplines. This strongly suggested that some unification of geometry at a higher level than now exists will probably be developed in the future. The discussions were marked by the presentation of numerous unsolved problems. These were recorded. A report on the conference is now being prepared for publication.

METHODS OF DETERMINATION OF STEROIDS

Steroid hormones, of which cortisone is a well-known example, are highly important factors in the regulation of many body functions. They are closely involved in growth, deposition of proteins, utilization of carbohydrates as energy sources, response to physical and mental stress, and regulation of reproductive processes in both male and female. The steroid hormones are often used by physicians to treat arthritic diseases, allergic conditions, a few types of malignant growth, and disorders of the reproductive systems. Despite their widespread clinical uses, however, exact knowledge of their function and sites of action is incomplete.

One of the remarkable properties of steroid hormones is their great potency. Small amounts will produce extraordinarily large effects. Thus, it is highly important in research and therapy to have reliable means for measuring minute quantities of steroid hormones and related products in blood, excreta and other body fluids and tissues.

The Conference on Methods for Determination of Steroids in Blood and Urine was organized to review recent progress in this field and to discuss the validity of present methods. It was a further goal of this conference to stimulate research for the development of better methods. The proceedings of the conference will appear in published form available to all investigators in the field.

SPECIFICITY IN DEVELOPMENT

The Twelfth Growth Symposium on Specificity in Development was supported jointly by the Foundation, the National Cancer Institute, and the American Cancer Society, under the direction of the Society for the Study of Development and Growth. About 150 persons attended the Symposium at Durham, N. H. Speakers were drawn from all parts of the United States and Europe.

The Conference was mainly interested in the biochemical differences in species, individuals, and the various parts of a single organism. These chemical differences are the basis for the more readily recognizable physical and physiological differences. Biological specificity of form and action is one of the basic problems before biologists at present. It has to do with such matters as the biochemical differences between the sexes, the immunity reactions, blood groups, and the origin of the different parts of an embryo.

Typical questions discussed at the conference were the following: What is the relation in the adult of the nucleus and cytoplasm in the cell? What are the biochemical factors that cause tissue antagonism preventing transplanting of tissue between different individuals? Why can a parasite exist in one organism and not in another?

LIE GROUPS AND LIE ALGEBRAS

The Summer Institute of Mathematics, sponsored by the American Mathematical Society and the Foundation at Colby College, brought together about 30 mathematicians for 8 weeks to discuss one of the foremost problem areas in present-day mathematics. The group contained specialists from Europe, the Far East and the Middle East as well as from the United States.

The work of the Institute was devoted to exploring the present status and lines of future development of Lie Groups and Lie Algebras. These topics are closely associated with differential geometry. Last year when Deane Montgomery of the Institute for Advanced Study, Princeton, and Leo Zippin of Queens College, New York, solved Hilbert's Fifth Problem—one of a famous list of problems which has been of active interest to the mathematical world for forty years—it became apparent that Lie Groups also were of interest in topology, and would serve as a bridge between topology and differential geometry.

The scientific results of the Summer Institute will appear in the mathematical journals and in a volume to be published by the American Mathematical Society.

278626—54——3

SCIENTIFIC MANPOWER STUDIES

The Government, industry, and the educational and scientific institutions, all have a vital stake in the supply of scientific manpower. Their various needs must be understood if serious shortages and conflicting demands are to be avoided.

The Office of Defense Mobilization has the responsibility, among others, for coordinating activities of Federal departments and agencies looking toward the development of programs to assure that our manpower resoures keep pace with our probable needs at any level of mobilization. Since scientific and technical manpower is clearly a most important segment of the whole, the ODM has established an advisory Committee on Specialized Personnel dealing specifically with questions relating to scientific, engineering and other specialized manpower. The Committee is made up of representatives from government, industry, labor, and education.

A number of private organizations have also evinced interest in problems relating to the supply and utilization of scientific manpower. Of these groups, one of the most active is the National Manpower Council which has compiled a sizeable volume of information and opinion on these problems, and within recent months has issued *A Policy for Scientific and Professional Manpower*.

During the past year the Foundation began to accumulate and disseminate information on scientific manpower in accordance with its clearinghouse function. The program is in three parts:

1. Operation of the National Register of Scientific and Technical Personnel as a means of collecting information on individual scientists and assembling available statistics concerning manpower resources.

2. Dissemination, by bulletins and studies, of analyses of information gathered in (1).

3. Manpower studies on the characteristics, utilization, supply and demand for scientific and technical personnel.

NATIONAL REGISTER OF SCIENTIFIC AND TECHNICAL PERSONNEL

On January 1, 1953, responsibility for maintaining a register of scientific and technical personnel in the United States was transferred from the Office of Education to the Foundation. Under the operating plan developed by the Foundation, the compilation and maintenance of the registration data will be done by professional societies in the various scientific disciplines. Compilation of data regarding members of their professions is a normal function of these societies. With some modification of present procedures, they can obtain the additional data needed for national registration of scientists and technical personnel.

Some 10 to 12 scientific societies, with financial assistance from the Foundation, are setting up comprehensive registers to provide essential information on scientists and engineers in the United States. Registration of about 100,000 scientists and engineers is expected by June 1954. According to the present schedule, registers will have been established by June 1955 for all major fields of science. Meanwhile information previously collected is being analyzed and reports prepared on specific scientific fields. In case of war, registration information now being collected will facilitate the mobilization of scientists and the establishment of manpower controls.

Four societies are already well along in the work of compiling their registers: American Geological Institute, American Institute of Biological Sciences, American Veterinary Medical Association, Federation of American Societies for Experimental Biology. Other societies which will participate on the program include the American Mathematical Society, American Institute of Physics, American Chemical Society, the American Meteorological Society, and the Engineers Joint Council.

Each society will be responsible for compilation and maintenance of its respective register, registration of both members and nonmembers alike, and furnishing the supervisory, administrative, and clerical services required. The Foundation will receive duplicates of the cards produced on each register, including replacement cards as the registrants' records are brought up to date. The Foundation will not use the file for placement purposes.

The Foundation will furnish the societies with record cards, codes, coding materials, and records from previous registers in order to insure as complete and uniform registration as possible.

MANPOWER STUDIES

As registration data become available, it will be possible to continue analysis of information on the professional characteristics, training, and employment of scientists by field and to follow trends in the utilization of trained scientists and engineers. A series of reports on chemists, physicists, chemical engineers, psychologists, geologists, and sanitary engineers was issued by the National Scientific Register, Office of Education. Major studies were made in two of these fields—physics and chemistry—for the Register by the Bureau of Labor Statistics. Funds have been provided to the Bureau of Labor Statistics to produce reports from register data in mathematics, the earth sciences, and the agricultural and biological sciences. These reports will be published jointly by the Foundation and the Bureau of Labor Statistics within the next few months.

Support has been provided for the continuation of the *Studies of Doctoral Degrees* which has been made annually for a number of years by the National Research Council and financed by the Office of Naval Research. This study will provide a continuing flow of information about the recipients of degrees at the doctoral level in all fields. Reports similar to *The Baccalaureate Origins of the Science Doctorates Awarded in the United States, 1936–45*, will be published periodically.

Characteristics of Scientific Manpower

The analysis of 1951 registration data compiled by the National Scientific Register deals with the professional characteristics of American scientists. The rate of expansion of various fields is shown by the age of scientists in those fields. (See table III.) The chemical engineers were the youngest group, possibly indicating the most rapid rate of expansion in a scientific manpower sense.

Statistics on type of employment of scientists (table IV) reveals that industry hires the majority of chemical engineers, chemists, and geologists, about 40 percent of the physicists, and but relatively few mathematicians and psychologists.

Income statistics (table V) show that industrial scientists command the highest salaries with Government scientists next. There is a marked differential in income depending upon educational attainment. The median annual salary of scientists with doctor of philosophy degrees is from $1,600 to $2,000 greater than those with master's degrees and from $1,800 to $2,500 greater than those with bachelor's degrees.

TABLE III.—*Median Age of Scientists, in Selected Fields, 1951*

	Doctor of Philosophy	Master's	Bachelor's
Chemical engineering	37	32	31
Chemistry	39	36	33
Physics	39	35	32
Mathematics	41	34	

Source: National Scientific Register, Office of Education.

TABLE IV.—*Type of Employment of American Scientists, 1951*

Degree held	*Number reporting*	*Educational institutions (percent)*	*Government (percent)*	*Industry (percent)*
	MATHEMATICS			
Doctor of philosophy	1, 320	88. 0	6. 1	5. 9
Other	700	76. 7	11. 4	11. 9
	CHEMISTRY			
Doctor of philosophy	11, 568	32. 5	7. 4	60. 1
Master's	7, 857	20. 8	9. 4	69. 8
Bachelor's	25, 086	4. 8	8. 6	86. 6
	CHEMICAL ENGINEERING			
Doctor of philosophy	854	30. 1	2. 7	67. 2
Master's	2, 329	5. 5	3. 8	90. 7
Bachelor's	8, 251	. 7	4. 1	95. 2
	PHYSICS			
Doctor of philosophy	2, 784	58. 4	10. 7	30. 9
Master's	1, 620	50. 2	15. 4	34. 4
Bachelor's	1, 365	21. 4	23. 9	54. 7
	GEOLOGY			
Total	6, 089	13. 6	13. 0	73. 4
	PSYCHOLOGY			
Total	5, 399	55. 4	25. 6	19. 0

Source: National Scientific Register, Office of Education.

TABLE V.—*Median Annual Salary of American Scientists, 1951*

Degree held	*Colleges and universities*	*Government*	*Industry*	*Total*
	MATHEMATICS			
Doctor of philosophy	5, 900	7, 600	9, 100	6, 200
Other	4, 100	4, 900	5, 500	4, 400
	CHEMISTRY			
Doctor of philosophy	5, 600	6, 700	7, 900	7, 000
Master's	4, 000	5, 100	5, 900	5, 400
Bachelor's	3, 400	4, 400	5, 100	4, 900
	CHEMICAL ENGINEERING			
Doctor of philosophy	....	....	....	7, 900
Master's	....	....	....	5, 900
Bachelor's	....	....	....	5, 400
	PHYSICS			
Doctor of philosophy	6, 400	8, 000	8, 000	7, 100
Master's	4, 500	6, 000	6, 400	5, 300
Bachelor's	4, 000	5, 000	5, 800	5, 100
	PSYCHOLOGY			
Doctor of philosophy	6, 300	6, 700	7, 600	6, 500
Master's, Bachelor's	4, 500	5, 000	4, 800	
Master's				4, 800
Bachelor's				4, 700

Source: National Scientific Register, Office of Education.

SURVEY OF JUNE 1951 COLLEGE GRADUATES

Another important area in which more complete information is needed is in the relationship between undergraduate and graduate specialization in terms of "college majors" as well as between college and university specialization and subsequent employment. The Foundation supported a study under the direction of the National Scientific Register, Office of Education, to gather data on a sample of graduates who received bachelor's and master's degrees in June 1951.

The survey of 1951 graduates was conducted about one year after the recipients received their degrees. It was conducted by questionnaires addressed to a third of those who had received master's or second professional degrees and one out of five who had been granted bachelor's or first professional degrees and included graduates in all major subjects from all degree-granting institutes in the United States. Nearly 50,000 graduates returned usable questionnaires.

One year after receiving their degrees, 61 percent of the men with bachelor's degrees and 77 percent of those with master's degrees were employed; 16 percent of bachelors and 12 percent of masters were full-time graduate students; and 21 percent of the bachelors and 8 percent of the masters were on active military duty. Of the women 74 percent with bachelor's and 84 percent with master's degrees were employed, 13 percent of bachelors and 9 percent of masters were housewives, and 8 percent and 3.5 percent, respectively, were continuing graduate studies.

While the relationship between college specialization and employment is probably not a true measure of the effectiveness of the educational system, such information is of importance in estimating changes in the supply of specialized manpower.

Table VI shows the types of employment reported by graduates who specialized in various areas of study. Of employed persons with bachelor's degrees specializing in health fields during college, 96 percent report that they are employed in the same fields. At the other extreme only 7 percent of the employed individuals who majored in psychology report that they are now working in this field. In the case of those receiving master's degrees, there is in general a closer correlation between the field of employment specialization and the field of college specialization.

TABLE VI.—*Field of employment entered by 1951 college graduates by field of specialization in college*

[In percent of total graduates in each field of college specialization]

Field of specialization in college	Field of employment at time of survey										
	Natural Science	Engineering	Psychology	Applied Biology	Health Fields	Social Sciences	Humanities	Education	Business and Commerce	Other [2]	Total [3]
BACHELOR'S DEGREES											
Natural sciences	46	10	....	1	6	1	(1)	21	14	1	100
Engineering	3	93	....	(1)	(1)	(1)	(1)	(1)	3	(1)	100
Psychology	2	2	7	(1)	2	5	2	21	52	7	100
Applied biology	3	1	....	40	1	1	(1)	34	19	1	100
Health fields	1	(1)	....	(1)	96	(1)	(1)	(1)	2	(1)	100
Social sciences	1	2	(1)	1	1	6	4	24	53	8	100
Humanities	1	1	(1)	(1)	(1)	1	14	43	34	5	100
Education	1	2	(1)	2	1	1	6	77	11	1	100
Business and commerce	(1)	3	....	1	(1)	2	(1)	4	89	1	100
Other [2]	2	3	....	1	1	3	3	7	23	57	100

MASTER'S DEGREES

Natural sciences	69	7	....	1	2	1	([1])	14	5	1	100
Engineering	3	93	....	([1])	....	([1])	....	2	1	([1])	100
Psychology	3	([1])	44	([1])	1	4	1	23	23	1	100
Applied biology	4	1	....	63	1	2	....	19	8	1	100
Health	7	2	([1])	....	87	....	....	2	2	....	100
Social sciences	1	2	1	2	([1])	23	4	30	26	11	100
Humanities	1	([1])	([1])	([1])	....	1	38	41	13	5	100
Education	1	([1])	2	1	1	2	6	79	6	1	100
Business and commerce	1	6	([1])	....	....	4	1	9	78	1	100
Other [2]	....	2	....	([1])	....	2	1	4	4	87	100

[1] Less than 0.5 percent.
[2] Includes social work, library science, law, architecture, journalism, and statistics.
[3] The total percent of professionally employed graduates from each field of college specialization equals 100.

Source: Commission on Human Resources and Advanced Training.

SUPPORT OF BASIC RESEARCH IN THE SCIENCES

During the year ending June 30, 1953, 173 grants totaling $1,698,150 were made for the support of basic research in the natural sciences. These funds were distributed for research in the biological, medical, mathematical, physical, and engineering sciences to 85 institutions in 37 States, the District of Columbia, and Hawaii. During the previous year 96 grants totaling $1,053,762 were made for the support of basic research. The average research grant for both years was $10,300 to run for 1.9 years, or about $5,400 per year.

Table VII below gives a summary statement of the research support program for fiscal years 1952 and 1953 by broad subject categories. A detailed list of the grants, showing institution, principal scientist, title of project, duration, and amount is given in appendix II, page 72.

RESEARCH AND TRAINING

Research conducted in a college or university campus stimulates more effective teaching and teaching in turn stimulates research. Graduate and undergraduate students participating in research see the basic information they have acquired put to use in pushing back scientific frontiers. Good research enriches the educational process in ways not measurable in dollars or in the availability of equipment.

In addition, therefore, to the award of fellowships, the support of conferences for college science teachers, and similar efforts to strengthen science education described elsewhere in this report, the Foundation sees in the distribution of research support among the several types of educational institutions in various sections of the country another opportunity to strengthen the teaching of science.

Generally speaking, Federal funds in support of research at universities and colleges have been concentrated in a relatively small number of institutions. However, in evaluating this institutional concentration of funds, one factor must be kept in mind. The Department of Defense, the Atomic Energy Commission, and other agencies which have supplied the greater part of Federal research funds at educational institutions, mainly sponsor research related to the operating functions of the agencies. These agencies need and expect results which further their over-all programs and, therefore, place research contracts and grants in large, well-equipped and well-staffed institutions. Regardless of the long-term national gains to be obtained through broader institutional support of research, these agencies on the whole dare not risk any substantial proportion of their research support effort in institutions which cannot quickly and effectively meet their operating needs.

The Foundation has made some progress in broadening the distribution of its research support funds, but the relatively small amount of funds available and the great number of pressing and outstanding proposals have reduced the effectiveness of its efforts in this direction.

TABLE VII.—*National Science Foundation Research Grants By Fields of Science*

	Fiscal year 1952		Fiscal year 1953	
	Number of grants	Amount	Number of grants	Amount
Biological and medical sciences:				
Developmental biology	9	$66, 975	4	$39, 600
Environmental biology	4	25, 060	2	7, 500
Genetic biology	5	86, 800	7	100, 700
Microbiology	9	83, 687	9	107, 600
Molecular biology	9	114, 500	11	134, 800
Psychobiology	2	15, 400	8	101, 000
Regulatory biology	15	173, 800	14	177, 900
Systematic biology	11	106, 480	15	99, 700
General	4	72, 760	2	30, 000
Total	68	745, 462	72	798, 800
Mathematical, physical, and engineering sciences:				
Astronomy	1	8, 000	7	81, 000
Chemistry	12	143, 800	28	206, 500
Earth sciences	3	23, 700	6	66, 150
Engineering sciences	3	41, 900	18	145, 300
Mathematics	1	19, 300	19	85, 200
Physics	8	71, 600	22	282, 400
Total	28	308, 300	100	866, 550
General	0	0	1	32, 800
Total	96	1, 053, 762	173	1, 698, 150

CONFERENCE ON PHYSICS RESEARCH IN COLLEGES

In early May 1953 a conference jointly supported by Amherst College and the National Science Foundation brought together 25 college teachers of physics with an active interest in physics research. The participants were chosen so as to represent various types of colleges and regions of the country. The outcome of the Amherst Conference and similar meetings planned by the Foundation in other fields may be an important factor in developing a suitable program designed both for support of research and the strengthening of college science teaching, particularly at the undergraduate level.

The conference agenda contained several major items for discussion: (1) the probable benefits of a college research grant program from the point of view of its contribution to scientific knowledge, the capacity of the small college for conduct of basic research, and the benefits to the faculty member, the student, and the college; (2) the possible dangers of such a program to an institution in which education is the prime objective; and (3) the problems which arise in administering such a program and in evaluating requests for grants.

The discussion indicated a potential need for several types of college research grants, for example, grants in which payment for summer salary of the principal investigator is made, grants permitting the investigator up to a full year to work on research free of teaching assignments, or grants which relieve part, generally not greater than one-third, of the faculty member's formal teaching load during the academic year.

Recommendations

In connection with the administration of programs of this kind, the conference recommended that in addition to evaluating the significance of the proposed research for its own sake, the evaluation criteria should place equal emphasis upon the probable contribution of the proposal to the educational work of the institution. Four other additional considerations were suggested in the evaluation of proposals:

1. Projects which involve student participation should be strongly encouraged.
2. The promise and ability of the principal investigator should be given weight at least equal to that assigned to the scientific merit of the project.

3. An attitude sympathetic to research in the department and institution is highly desirable.
4. Experts appraising research proposals should be cognizant of the fact that they are judging proposals under the college program.

The full report and recommendations of the Amherst Conference are given in appendix VI, page 104.

WHAT IS BASIC RESEARCH?

A worker in basic scientific research is motivated by a driving curiosity about the unknown. When his explorations yield new knowledge, he experiences the satisfaction of those who first attain the summit of a mountain or the upper reaches of a river flowing through unmapped territory. Discovery of truth and understanding of nature are his objectives. His professional standing among his fellows depends upon the originality and soundness of his work. Creativeness in science is of a cloth with that of the poet or painter.

Vannevar Bush, in *Science the Endless Frontier,* says with great authority and validity:

> Basic research is performed without thought of practical ends. It results in general knowledge and understanding of nature and its laws. The general knowledge provides the means of answering a large number of important practical problems, though it may not give a complete specific answer to any one of them. The function of applied research is to provide such complete answers. The scientist doing basic research may not be at all interested in the practical applications of his work, yet the further progress of industrial development would eventually stagnate if basic research were long neglected.
>
> One of the peculiarities of basic science is the variety of paths which lead to productive advance. Many of the most important discoveries have come as a result of experiments undertaken with very different purposes in mind. Statistically it is certain that important and highly useful discoveries will result from some fraction of the undertakings in basic science; but the results of any one particular investigation cannot be predicted with accuracy.
>
> Basic research leads to new knowledge. It provides scientific capital. It creates the fund from which the practical applications of knowledge must be drawn. . . .
>
> Today it is truer than ever that basic research is the pacemaker of technological progress. . . .

Despite this apparent unconcern for practical ends every great scientist has a profound faith that knowledge is an essential value of life. He believes that greater understanding will lead to the greater well-being of mankind. Time and again this faith has been justified. The history of science affirms the fact that basic research, though seeking no practical ends, is by no means "impractical" research.

Basic research, in terms of its immediate utility, is a game of chance. In the search for oil, many a dry hole is drilled, but statistically the eventual output far out-weighs the cost. So it is with research.

From another point of view, basic research is an investment in which, if wisely planned, the proceeds from a small portion not identifiable in advance more than pay for the total outlay.

The essential difference between basic and applied research lies in the freedom permitted the scientist. In applied work his problem is defined and he looks for the best possible solution meeting these conditions. In basic research he is released of such restrictions; he is confined only by his own imagination and creative ability. His findings form part of the steady advance in fundamental science, with always the chance of a discovery of great significance.

In our colleges and universities basic research is a necessary ingredient in the training of scientists. One of the primary missions of the National Science Foundation is to support basic research both in the cause of progress in science and of the training of scientists. But what of organizations looking for practical utilization of science, such as technical industries and many Federal agencies? For them extension of knowledge and new ideas in a special area of science may often be critically needed for a particular development. It follows that the support of basic research by an organization with practical goals is justifiable and important in areas of science closely related to the operations of the agency.

SCIENTIFIC METHODOLOGY

Many students of science and human affairs have studied the methods and procedures found effective in scientific research. It is questionable whether there is a unique, all-purpose method for attacking research problems. Different problems and different investigators require different approaches. Several observations about the working habits of scientists, however, are of interest.

One of the outstanding characteristics of science is the objectivity of its findings. Each individual researcher is trained to observe, to experiment and to analyze in as objective a manner as possible. Wishful thinking has no place in his work. He realizes that his findings will not become a permanent part of the structure of science until they have been challenged and confirmed by other investigators. Thus, science is a highly democratic process. Anyone can question a "law" of science and if he can establish his objection by proof convincing to his colleagues, it will stand. The strength of science and its power rests therefore largely upon the thorough testing of its structure at all points, and upon an interesting combination of collaboration and competition on the part of its workers, upon their independence and their integrity.

The term research covers many activities. The following paragraphs will describe some of the common activities of scientists in making their inquiries. These will be illustrated by examples taken from the research currently supported by the Foundation.

OBSERVATION AND DESCRIPTION

Careful observation and description of an event is required at an early stage in understanding and explaining it. The point seems too obvious to dwell upon, yet for hundreds of years science failed to advance because men did not see what took place before their eyes. They described nature as they thought it should behave and not as it did behave. In 1543 the publication of an atlas of anatomy by Vesalius proved a milestone in scientific thought because Vesalius based his anatomical studies upon actual dissections of human bodies. The Greeks had also done this, but for a millennium and a half the practice was discontinued and almost no further advance was made in knowledge of the human body and in the competence of surgeons. Careful observation is still a vital scientific requirement.

For example, the patient exploration, collection, classification, and description of the hundreds of thousands of species of plants and animals is the bedrock upon which our present knowledge of life and living forms is built. Two centuries ago such studies revealed the wonder and diversity of nature and sharpened man's desire to know and understand the world around him. They led directly to the formulation of important biological theories, such as those of evolution and genetics. Moreover, the practical implications of systematic biology rival the purely scientific. New plants contribute to progress in agriculture and medicine. The relationship of plants and animals to environment, soils, and climate, particularly in little known regions, anticipates extension of agriculture into such regions and the successful management of forest reserves, grasslands, and watersheds.

New York Botanical Garden

Bassett Maguire of the New York Botanical Garden has a Foundation grant to explore the botanical resources of the Guayana Highland of British Guiana. The geographic isolation of the area makes it an excellent natural laboratory in which plant evolution may be studied on a grand scale.

University of Utah

Stephen D. Durrant of the University of Utah has undertaken with Foundation support a study of mammals on the Aquarius Plateau and in the Henry and Abajo Mountains of Southern Utah. Many of the animals in this remote, isolated area are unlike related species in other localities and there is little chance for crossbreeding with species outside the immediate area. The animal populations are relatively small. Nature has in effect provided ideal conditions for experiments in evolution and the development of species. Under these unique circumstances the scientists hope to learn much about the rate and amount of change that can take place in a population in a few generations.

University of California at Los Angeles

Another type of exploratory research is being undertaken by Theodore H. Bullock of the University of California at Los Angeles. He is studying the pit organ of pit vipers, a class of poisonous snakes including rattlesnakes, copperheads, and water moccasins. The pit organ, located between the eye and the nostril, is unusually sensitive to infrared or heat radiation. The mechanism is perhaps similar to that of the heat sensitive receptors in human skin, but it is far more highly developed, both for sensitivity and rapidity of response. One of the interesting characteristics of the pit organ is its resemblance to certain man-made electronic mechanisms. The nerve fibers connecting the pit organ to the central nervous system carry a steady stream of relatively constant impulses. The impulses to the brain are modulated by changing temperatures, somewhat as a radio carrier current is modulated by sound.

American Museum of Natural History

Human behavior is probably determined in part by the instinct or the biology of the individual and in part by his training or experiences after birth. Not all psychologists agree, however, upon the relative importance of instinct as against experience, nor upon the aspects of behavior for which each is primarily responsible. A great deal can be

278626—54——4

learned from painstaking observation of lower animals for which controlled conditions can be established.

T. C. Schneirla of the American Museum of Natural History has a Foundation grant to study the development of behavior patterns in lower animals. He is particularly interested in those aspects of behavior resulting from the relationships between mother and young as well as between litter mates from the time of birth to young adulthood. A series of studies will be conducted on the behavioral development of young cats raised with normal access to the mother. The results will be compared with the behavior of animals raised in isolation from birth.

TOOLS AND INSTRUMENTS

One of the outstanding achievements of modern science lies in the extension of the powers of observation by the development of better tools and instruments. Although micro-organisms were postulated in ancient times, they became observable biological entities only with the invention of the microscope. Physical theories are based upon the restricted range that has been observed. It is dangerous to try to use them beyond the range of observation without testing them experimentally. The classical theory of moving fluids, for example, worked very well at speeds up to the speed of sound. At that point and beyond no theory existed. Further theoretical development, needed to describe jet and rocket behavior, required improved instruments and facilities, such as the highspeed camera and the transonic and supersonic wind tunnel.

Illinois Institute of Technology

Max Jakob of the Illinois Institute of Technology received a Foundation grant to study bubble formation, heat flow and other aspects of boiling. By means of a highspeed camera, he slows down the action permitting detailed observations and measurements to be made of bubble area and frequency which will in turn enable him to estimate heat flow characteristics of boiling liquids at the heating surface and the bubble surface.

Pennsylvania State College

At the Ionosphere Research Laboratory at Pennsylvania State College, J. J. Gibbons, A. H. Waymack and their colleagues are exploring the upper atmosphere. In this case radio waves are used to probe the unknown. For more than a quarter of a century the existence of ionized or electrified layers of particles in the upper atmosphere has been established. They are known to have a great deal to do with long-distance radio transmission and possibly with weather. The Heaviside layer—first to be discovered—ranges from about 8 to 12 miles above sea level. Many other higher layers have since been discovered. Within the past year, working on a Foundation grant, Dr. Gibbons has announced the discovery of a very high, heretofore unknown ionized layer more than 500 miles above the surface of the earth.

Harvard College Observatory

The Foundation has provided partial support to the Harvard College Observatory for construction and operation of a radio telescope, under the direction of Bart J. Bok. Radio astronomy is a comparatively recent field of study which deals with short wave radio waves generated by the stars or other heavenly bodies. Such studies promise to reveal much new information about the Milky Way, the galaxy to which the solar system belongs. Very little is known about several important sections of our galaxy, the Milky Way, because visible light from distant stars has apparently been absorbed by the "dark nebulae," immense clouds of gaseous material in between. The Harvard radio telescope will be used for a systematic study of the range of frequencies from 300 to 1650 megacycles per second. This range is of particular interest because it will provide a means of identification of hydrogen and deuterium and yield information about the temperature, densities and turbulence of these gases in interstellar space.

MEASUREMENT

Measurement is another step in research. Many scientific problems are well along toward solution when a scientist knows what to measure and how to measure it. This was expressed emphatically by Lord Kelvin:

> When you can measure what you are speaking about and express it in numbers, you know something about it, and when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind.

The development of physics from the time of Galileo is one of the great achievements of mankind. Much of the progress of physics has been due to its success in finding the proper things to measure. Mechanics progressed hand in hand with the recognition of the measurable concepts of momentum, acceleration, and energy, and the advance in thermodynamics awaited the discovery of measureable ideas like pressure, temperature, and heat. As measurements become more precise, discrepancies previously hidden come to light and suggest the need for better physical theories. The complexity of living organisms and social organizations has prevented the easy formulation of measurable concepts in these areas which in turn has hampered biologists and social scientists. What metric does one use for aging, for example, or insanity, or happiness?

Of the projects supported by the Foundation a number are concerned primarily with precision measurements and quantitative studies in both the physical and biological sciences.

University of New Mexico

On the experimental side many scientists are engaged in observing the behavior of nuclear particles and in making precise measurements of them. Cosmic ray studies are of particular value in this regard since the energy of many of the primary particles in cosmic rays far exceed energies that can be attained in particle accelerators.

V. H. Regener and John R. Green of the University of New Mexico, working on a Foundation grant, have been investigating an uncharged component of cosmic radiation called N-rays, believed to be mostly high-energy neutrons. They have been measuring the penetrating power of N-rays passing through ordinary water and heavy water by measuring the distance that the N-rays travel on the average before colliding with a nucleus in the water. Since water consists of hydrogen and oxygen, collision may occur with either type of nucleus. In the case of heavy water, heavy hydrogen replaces ordinary hydrogen but the oxygen atoms remain the same so that any observed difference in the distance of penetration should be due to the difference in the two types of hydrogen. Actually the observed difference was less than the uncertainty in the measurements. On the other hand, in both cases the penetrating power of N-rays was about four times the distance that would have been expected under the conditions of the experiment. This experimental fact has not yet been satisfactorily explained.

Duke University

Martin M. Block and Harold Lewis, of Duke University, are also investigating the action of cosmic ray particles, in this case charged particles. The analysis is complicated by the fact that the charged component of cosmic rays is a mixture of several kinds of particles and the first problem to be attacked is the separation of the various factors. This is done by measuring the mass and momentum of the particles. The problem is further complicated because some of the particles to be observed have a very short lifetime of the order of a billionth of a second.

USE OF MODELS OR ANALOGUE SYSTEMS

Creation of models or simplified systems imitating natural processes has greatly aided scientific inquiry. Some models may involve actual construction for measurement and operational studies. The testing of air-frame designs in a wind tunnel is an example. Here, measurements made on the actual model answer questions too complicated to handle mathematically. Other models, however, may be purely abstract and mathematical. They simplify the analysis and enable scientists to use the powerful tools developed by mathematicians.

Several research projects supported by the Foundation involve the design of suitable models for dealing with difficult problems.

Yale University

Wolf Vishniac of Yale University is one of a group of biochemists trying to unravel the mystery of photosynthesis, the chemical process by which plants convert the energy of sunlight into energy-containing foods and fuels. In essence, the process turns low energy compounds such as water and carbon dioxide into high energy compounds such as sugar and cellulose. The radiant energy of light is transformed into stored chemical energy. Chlorophyll, the green coloring material in plants, plays an important part in this energy transformation.

For a long time scientists tried to design a laboratory model of the process. Several investigators, including Vishniac, had successfully converted a solution of organic compounds into compounds of higher energy in the presence of light, but they could do it only when natural particles of plant material containing chlorophyll were added. During the past year Dr. Vishniac has been able to duplicate essential features of the process by exposing to sunlight a chemical solution to which pure chlorophyll was added. This development of a working model may be an important forward step in research on photosynthesis.

By controlled modification of the conditions of the experiment biochemists can now test and measure the effects of many hypotheses concerning the reaction. It is now possible to visualize production line or continuous flow processes in which high energy materials useful for food and fuel are created through the action of sunlight.

Johns Hopkins University

W. D. McElroy, of the Pratt-McCollum Institute of Johns Hopkins University, has received Foundation support for research into the nature of the biochemical reactions responsible for the luminescence of fireflies. As in the case of photosynthesis, luminescence is the result of a complicated chain of reactions, all but the last of which take place in the dark. Firefly luminescence is known as "cold light" because of the small amount of heat released in the reaction.

The light-making process of the firefly requires a fluorescent compound (luciferin), an enzyme (luciferase), a metallic ion such as magnesium or cobalt, oxygen, and a high-energy phosphate containing compound. Dr. McElroy is primarily concerned with the method by which luciferin is formed and with the role of the phosphate in the reaction. Much of his experimental material is obtained through purification of crude extracts of tissues from fireflies.

DEVELOPMENT OF CONCEPTS

One of the most difficult as well as one of the most creative aspects of research is the development of meaningful concepts. Much has been written about the creative process by which the mind working upon the raw materials of experience distills out the essences and recombines them into new, more revealing insights about the physical world. In this respect creativeness in science appears to differ little from creativeness in art or any other branch of thought.

In large part the intellectual excitement of science derives from the scope and boldness of its concepts. Their impact can be revolutionary as was the case with the germ theory concept formulated by Pasteur and Koch in which specific infectious diseases are traced to the action of specific organisms. Such a sweeping conceptual generalization not only clarifies our understanding of a host of observed natural phenomena but suggests a course of action—in this case methods for treating individual patients or for preventing epidemics.

University of Chicago

During the year the Foundation provided support for the work of Rudolph Carnap, a mathematician and logician from the University of Chicago, who is attempting to develop a new conceptual basis for probability. Probability may be defined as a measure of the likelihood of an event's occurring; but careful analysis reveals that the term actually covers two very different concepts. Both aspects of probability are highly useful in practice, and many persons feel that the two forms are closely related.

One type of probability may be called statistical or actuarial. In this case the probability assigned to an event's occurring is based upon the frequency with which it has been observed to have occurred in the past. The vast insurance business is largely built upon this concept as are many of the statistical techniques based on frequency counts.

The second type of probability is more theoretical in that an attempt is made to assign on purely theoretical grounds a measure of the probability of an event's occurring. Games of chance furnish the most obvious example. Assuming the wheel is true, the odds on roulette can be calculated. Of course, the calculated odds can then be tested by experience and if there is marked disagreement the careful player will re-examine his initial assumptions. The uses of this type of probability extend far beyond games. It has been applied by physicists to the kinetic theory of gases and by communications engineers to problems in telephone traffic.

Rational decision-making in any field is largely a matter of estimating the odds as to the possible outcomes of the decision. Depending upon the case at hand, we normally, as a basis for estimate, use one or the other of the two types of probability listed above. Carnap hopes to develop a single logical system incorporating the valuable features of both.

TESTING OF CONCEPTS

In order for science to be effective in helping us understand nature, it must be able to meet the test of experience. The testing of scientific ideas and concepts, therefore, is an important and essential research activity. It often requires great thought and ingenuity to devise suitable tests and to set up appropriate experiments.

University of Illinois

Among the fascinating mysteries of nature is the ability of living things to repair or regrow damaged tissue. In some lower animals the amount of damage that can be repaired is extraordinary. The salamander apparently can lose its tail with impunity because it is able to grow a new one. If a leg is lost, however, it is not so fortunate; it cannot normally grow a new leg. Biologists can induce growth of a new tail-like organ on the leg stump by transplanting tissue from the tail. Conversely, a tissue graft from the leg grafted to the tail stump will prevent growth of a new tail.

Evidence of this nature suggests that there are two types of tissue cells—youthful cells capable of growth and adult cells in which further growth is prevented. It further suggests that the difference in the two types of cells might be of a chemical nature and that the adult cells produce a growth-inhibiting substance. S. Meryl Rose of the University of Illinois has a Foundation grant to study regeneration of tissue and particularly to attempt to find a growth-inhibiting substance in the adult tissue. For his experiments Dr. Rose uses the hydroid, a simple animal related to jellyfishes, that lives in the sea. If one of the tentacles of the hydroid is lost, another will quickly grow out to take its place. An area of tissue near the mouth of the hydroid contains cells which inhibit the regrowth of the tentacles when transplanted to the stump. As a matter of fact growth can be prevented if large quantities of the growth inhibiting tissue is simply placed in the sea water in which the injured hydroid lives. Having obtained these results Dr. Rose is now attempting to isolate and identify the growth inhibiting factor.

Columbia University

Over the past decade the radioactive clock, developed by Willard Libby at the University of Chicago, has proved a most valuable tool for historians and archeologists. Scientists have long known that nitrogen atoms turn into radioactive carbon when bombarded by cosmic radiation in the upper atmosphere. The radioactive carbon mixes rapidly with ordinary carbon in carbon dioxide in the air and hence becomes a component part of all living plants and animals. With the death of the plant or animal, however, the mixing process stops and the radioactive carbon slowly decays while the ordinary carbon stays fixed. From the ratio of radiocarbon to ordinary carbon a scientist can estimate the age of the material being examined. Archeologists have used this method to assign dates to the remains and artifacts of early men. The radioactive clock is useful for dating organic material up to about 30,000 years old. Beyond that the amount of radioactive carbon remaining is too small to measure.

In order for the radioactive clock to be useful, however, it must run on time. This means that radioactive carbon must have been formed in the atmosphere at a constant rate over the past 30,000 years, which in turn means that the cosmic radiation has been constant for the same period. Scientists have generally assumed this, but during the past year J. Laurence Kulp, of the Lamont Geological Observatory of Columbia University, found a way to test the assumption. Dr. Kulp received a grant from the Foundation to measure the radioactive carbon content in sediments at the bottom of the ocean. In testing the assumption of cosmic ray constancy he compared the time-scale of radioactive carbon with that of ionium, another radioactive material found in ocean sediments. Since the presence of ionium has no connection with cosmic ray activity, the comparison was fair. Dr. Kulp showed that the two radioactive timescales have agreed for at least 30,000 years, and on other grounds he has reason to believe that cosmic radiation may have been constant for the past 500 million years.

EDUCATION IN THE SCIENCES

During fiscal 1953, the Foundation pushed ahead on two important programs designed to increase the national supply of trained scientific manpower:

1. A Fellowship Program to provide predoctoral and postdoctoral training for a limited number of research scientists.
2. Encouragement of efforts to improve education in the various fields of science through the support of experimental conferences for college teachers of science.

FELLOWSHIP AWARDS FOR 1953–54

The Foundation conducted its second graduate fellowship program in the sciences during the year. A total of 557 fellowships were awarded for the academic year 1953–54 as compared with 624 for the previous year. At the same time the Foundation received more applications, about 3,300 as against 3,000 in the previous year.

Of the total number of fellowships awarded, 515 went to predoctoral candidates and 42 to postdoctoral candidates. Of the total 175 fellows were also recipients of last year's awards.

In view of the fact that the limitation upon funds precluded the possibility of making awards to all highly qualified applicants, the Foundation published an Honorable Mention List of 1,274 applicants. The circulation of this list among deans of graduate schools has resulted in better communication between departments and potential students in the award of fellowships from other sources and the placing of a number of applicants in teaching assistantships.

Continuing the policy of emphasizing the first year of graduate study, the Foundation awarded 180 fellowships to first year graduate students. A total of 166 awards was made to graduate students in the intermediate years, 169 to terminal year predoctoral students.

The largest group of fellowships (129) was awarded in chemistry, and the second largest in physics and astronomy (115). In other fields the numbers of awards were: engineering 63, mathematics 56, zoology

38, biochemistry 35, geosciences 26, botany 19, microbiology 18, geophysics 14, medical sciences 14, genetics 11, psychology and anthropology 10, agriculture 9.

Stipends for fellows in the first year of graduate study are $1,400; those for the intermediate years are $1,600; those for the terminal year of graduate study are $1,800; postdoctoral fellows receive $3,400. Additional allowances for dependents, tuition, and other normal expenses are provided.

Applicants for both new fellowships and renewals are evaluated at the same time by the same screening panels, and the awards are made irrespective of whether an applicant has previously held a National Science Foundation fellowship. Of the National Science Foundation fellows who applied for renewal, 44 percent were awarded fellowships for an additional year.

Fellowship awards are made on the basis of ability only and are distributed among candidates of substantially equal ability on a geographical basis. For the first 2 years there has been a good correspondence between college student population density and the geographical distribution of fellows.

The National Science Foundation Act specifies that fellows shall have free choice of selection among accredited institutions of higher learning.

Distribution by Field of Study

The Foundation has distributed fellowship awards among scientific fields in proportion to the number of qualified applicants in each field. No attempt has yet been made to award greater numbers of fellowships in fields where shortages appear to be acute. At present there are no sufficiently reliable data about existing or potential requirements for scientists to justify such action.

In 1952 the Foundation awarded 38 first year fellowships in physics and 43 in 1953. During the 1951–52 academic year the Office of Education estimates that there were in all about 1,860 first year graduate students in physics in the United States. Thus, the first-year fellowship holders in physics constituted only about 2 percent of the total number of all students in this category. The ratios in other scientific fields are similar.

Departmental Duties

The Foundation believes that experience in teaching and in other departmental duties contributes to graduate training. Requests from fellows to undertake definite duties in addition to normal work and research will be approved provided the fellow, his scientific advisor, and the Foundation agree in advance that such duties are clearly and primarily needed for the student's education. A fellow who undertakes such additional duties may not accept remuneration for these services.

ATTRITION RATE IN SCHOOLS AND COLLEGES

If the Nation's scientific and technical manpower is to be maintained in adequate numbers and proficiency, there must be an adequate flow of students with aptitudes in these fields up through the secondary schools and colleges. The Commission on Human Resources and Advanced Training has analyzed the intelligence distribution of high school and college graduates in order to determine the fraction of the student population capable of completing advanced training.

The findings indicate that 89 percent of our young people having at least the average intelligence of college graduates finish high school in the United States. Of these 38 percent enter college, and 25 percent graduate from college. These figures make clear that a large loss of potential college graduates occurs between high school and college, and that a second substantial loss occurs during the college years.

In the same study estimates were made of the number of bachelor's degrees and doctor's degrees awarded for the 5-year period 1948–52 and for the estimated period 1953–57. For the earlier period the total number of individuals receiving bachelor's degrees in science, engineering, and agriculture totaled about 95,000 per year. The comparable estimate for 1953–57 is 66,800 per year, a decline of nearly 30 percent. For the earlier period the number of doctor's degrees granted in the same fields averaged about 4,660 per year, compared with an estimated 5,420 per year for the period 1953–57. Since a 3- to 4-year lag exists the decline in doctorate awards will not appear for several years, but after 1956 the number of doctor's degrees awarded will reflect the same downward trend noted above for bachelors degrees. This is further shown by statistics indicating that the total graduate enrollment at the first year level in all fields of science dropped from approximately 12,000 in 1951–52 to approximately 8,000 in 1952–53.

Interpretation of the figures is complicated by a number of factors, which prevent easy generalization. The decline in the number of graduates in science and engineering is in part due to the effects of the reduced birthrate in the United States during the 1930's. It also coincides with the termination of large-scale Federal support for education under the GI bill.

These factors may explain the situation, but the statistics themselves indicate that inadequate numbers of capable young persons are receiving advanced training in the sciences. They raise two questions: (1) how can the total college population, and hence the number of students majoring in science, be increased; and (2) how can the total number of graduate students in all fields of science be increased.

Corrective Measures

The possible solutions are numerous and complex and not all of the possibilities within the purview of the National Science Foundation. One solution which immediately suggests itself is a large-scale scholarship program which would assist students who now fail to enter college for economic reasons. Thus far, the Foundation has not asked Congress for funds to support a scholarship program.

Students do not enter college for many reasons other than lack of funds. Dr. Byron Hollinshead, in a recent book *Who Should Go To College,* points out that only 13 percent of the top quarter ability high school graduates fail to enter college because of inadequate finances. Approximately 30 percent of the graduates in the top group would probably—under any set of conditions—continue to leave school either to enter the work force or, in the case of girls, to be married and become homemakers.

The National Research Council reports that 46 percent of students who received doctor's degrees in the sciences from 1936 to 1945 received their undergraduate training at institutions which did not award the doctor's degree in any field of science. Over half of the 46 percent received their training in only 118 of the 900 4-year colleges which do not grant the doctor's degree. The potential capacity of many smaller schools for interesting students in science careers may not be fully realized.

There is reason to believe that the major difference between the colleges, whether large or small, which are productive of scientific talent and those which are not, lies in the ability of science teachers to inspire, as well as properly teach, potential scientists. Teachers in the productive colleges have shown an active interest in research and ability to convert this interest into better teaching programs. The Foundation is attempting to increase the supply of young scientists by improving the teaching of science.

INSTITUTES FOR COLLEGE SCIENCE TEACHERS

During the past year the Foundation sponsored four summer institutes to assist college science teachers in learning more about recent developments in their own and allied fields. These included:

1. Colloquium on College Physics, State University of Iowa, June 17–20, 1953.
2. Conference on College Mathematics, University of Colorado, June 15 through August 8, 1953.
3. Conference on College Biology, University of Oklahoma, June 15–19, 1953.
4. Institute for College Teachers of Physics, University of Minnesota, June 15 to July 18, 1953.

The 4 institutes were attended by a total of 250 teachers from small colleges. The participants came largely from the surrounding regional areas, although in the case of the mathematics conference at the University of Colorado all sections of the country were represented.

The Colloquium on College Physics, an annual event now in its 15th year, was developed by G. W. Stewart, head of the Physics Department (retired), State University of Iowa. The Colloquium consisted of a series of lectures by leading scientists, followed by discussion periods. A feature of the program was the exhibition of experimental teaching devices created by members of the Colloquium.

The purpose and organization of the Conference on College Biology at the University of Oklahoma were similar. Lectures were given throughout the week by specialists in several fields of modern biology, followed by audience participation and discussion.

The Conference on Collegiate Mathematics at the University of Colorado and the Institute for College Teachers of Physics at the University of Minnesota were of longer duration. At Colorado lectures were given daily throughout the conference by two outstanding mathematicians. These were supplemented by lectures from a series of visiting scientists who covered special phases of modern mathematics. A feature of this institute was the spontaneous organization, by members of the conference, of an informal group for discussion of problems of mutual interest, including curricula, methods of teaching, and new textbooks.

SCIENCE ACTIVITIES AT SECONDARY SCHOOL LEVEL

The need for effective science teaching at the secondary school level is also acute since it is at the high school age that many students begin to show an interest in careers in science. It is hoped that ways and means can be found through the science teachers at the secondary school level to identify and motivate toward science those students who should become scientists.

During the past year a grant from the Foundation was awarded to Science Service, Inc., for the support of Science Clubs of America. This aid has strengthened materially the programs of the science clubs and science fairs during the year. In 14 new areas local science fairs were held and their finalists were able to participate in the Fourth National Science Fair held at Oak Ridge, Tenn., in May 1953. In all the Fourth National Science Fair had exhibitors from 29 local fairs. During the coming year the grant will assist in promoting science fairs in about 20 additional localities. Part of the grant was used to finance the compilation and publication of a booklet, *Thousands of Science Projects,* prepared to give students and teachers ideas for science projects that can be undertaken. It is estimated that activities under the grant benefited over 300,000 members of Science Clubs of America.

EXCHANGE OF SCIENTIFIC INFORMATION

During the year, activities in the exchange of scientific information included a number of inquiries into various problem areas, limited support of scientific publication and the dissemination of scientific information, and continuation of the program to encourage attendance of American scientists at international scientific meetings. An Advisory Panel on Scientific Information was established by the Foundation with the first meeting scheduled for October 1953.

INFORMATION PROBLEMS

Since the war an increasingly significant body of information has appeared in scientific and technical reports submitted by recipients of Federal support for research and development. Normally, such reports are available only to scientists and other persons associated with Government-sponsored research projects.

When research is classified for security reasons, no other system of dissemination of scientific information appears practicable. Any limitation upon distribution of information can be detrimental to scientific progress, however, in the case of unclassified research, where the widest possible dissemination is desirable. During the year the Foundation undertook a small-scale study to learn whether the amount of information thus buried represents an appreciable problem.

Authors of 95 unclassified reports submitted to defense agencies were asked if the information contained in the reports had been published in the open literature. If so, bibliographical references were requested. Of the 83 replies received, 33 indicated reports had been published in full, 13 partially published, 13 either in press or in preparation for publication, and 5 listed as easily available to the public in other forms. Information in 19 reports had not been and apparently will not be published. These papers were evaluated and only 1 of the 19 seemed to be of sufficient general interest to warrant publication.

These preliminary results suggest strongly that the most important information in unclassified research reports does reach scientists through established publication channels. If further investigation bears out these findings, it may be possible to modify present procedures for distributing Government reports at considerable savings in effort and cost.

At the request of the Armed Services Technical Information Agency and the Office of Technical Services, Department of Commerce, the Foundation is currently reviewing the present program for getting research and development information from defense projects to scientists, particularly those in industrial laboratories. The present program provides for public distribution of only about 30 percent of the 12,000 reports annually produced in this area. An attempt is being made to evaluate the remaining 70 percent to determine their potential value to science and industry.

SCIENTIFIC PERIODICALS

The scientific journals are, of course, the principal media for exchange of scientific information and the primary reference tools both for research and education in the sciences. The number of scientific journals published in the world is in the tens of thousands. The individual scientist depends to a large extent upon abstracting services for wide coverage of the literature in his field of interest, but such services face formidable difficulties in keeping track of new and discontinued publications and publications in other countries, even where no political or security barriers are erected to limit the flow of information.

To assist in this situation a project at the Library of Congress has been supported for the compilation of current lists of scientific periodicals published in the United States and the Soviet Union. They will be published and made available to scientists and scientific services having need for the information. The list for the United States, now being edited for publication, includes some 8,000 periodicals and other scientific and technical serial titles.

DISSEMINATION OF INFORMATION ORIGINATING ABROAD

During the year, the Russian science group at Columbia University received support for compilation of a preliminary edition of a *Russian-English Dictionary of Metallurgical Terms.* Copies were distributed to Federal agencies and a limited number of private individuals working in the field. These persons were asked to submit corrections and suggested revisions which will be needed in preparing a final version.

The Columbia group has also undertaken to translate approximately 1,000 pages of current Russian research reports in physics over the next year. Limited numbers of the completed translations are printed at the facilities maintained at Oak Ridge, Tenn., by the United States Atomic Energy Commission. Copies are distributed to Federal agencies interested in the material and to some 40 depository libraries throughout the country. The translations may also be purchased for a nominal charge at the Office of Technical Services, Department of Commerce.

In the course of preparing translations the Columbia group is compiling files of new or unusual Russian terms in physics and related sciences as the basis for an improved Russian-English glossary of terms in the physical sciences.

TRANSLATIONS CENTER

A center for holding and photoduplicating foreign scientific translations has been established by the Foundation in the Science Division of the Library of Congress. Partial support for the project has been contributed by the Atomic Energy Commission.

Scientific translations for the center are being collected from many sources, including Government agencies, scientific societies, industrial laboratories, and universities. Initially, the center has put major emphasis upon translations from Russian scientific journals, although it is hoped eventually to add material from other languages for more comprehensive coverage of the world's scientific literature. Monthly lists of translations issued by the center include notices of translations that are available by direct purchase from commercial translating services, but the center will not supply photocopies of such material. The new service has attracted widespread interest, particularly among Federal agencies and industrial concerns.

AMERICAN SCIENTISTS ATTENDING MEETINGS ABROAD

During the year the Foundation provided assistance to 54 American scientists, which enabled them to attend important scientific meetings abroad. This program fosters the exchange of scientific information for the mutual benefit of all participating nations and provides United States scientists with direct contact with foreign research activities and personnel. The benefits from attendance at these meetings accrue to this country not only in terms of the increased competence of our scientists, but also in terms of the international good will, both scientific and cultural, which is created.

278626—54——5

Applications are evaluated and travel grants awarded on the basis of the scientific competence of the applicant, the nature of the meeting to be attended, and the potential benefits which will accrue to the scientist, his sponsoring institution, and the meeting as a result of his attendance.

ADMINISTRATION

During the year the National Science Board met 7 times with an average attendance of 17 members. James B. Conant, an original member and first chairman of the National Science Board, resigned from the Board upon his appointment by the President as United States High Commissioner for Germany. In early September 1953 the vacancy created by Dr. Conant's resignation was filled by the recess appointment to the Board of Laurence M. Gould, geologist and president of Carleton College, Northfield, Minn.

The gradual expansion of activity in all programs, necessitated the addition of 27 employees to the staff, making a total of 113 on duty by June 30, 1953. Due to this increase the Foundation moved from 2144 California Street NW., to larger quarters in the old Cosmos Club at 1520 H Street NW. In addition to staff personnel the Foundation also utilized the services of 177 scientists as consultants and members of Divisional Committees.

The members of the National Science Board, Divisional Committees, and advisory panels, and members of the Director's staff are listed in appendix I, page 61.

FINANCE

In fiscal year 1953 the Foundation operated with an appropriation of $4,750,000, an increase of $1,250,000 over 1952. In addition there was available a carry-over of $34,000 from 1952 making a total of $4,784,000 available for obligation in 1953. The Foundation's financial report for fiscal year 1953 appears in appendix V, page 102.

Funds totaling $300,000 were reserved from 1953 funds for the conduct in 1954 of national science policy studies.

For fiscal year 1954 the Congress appropriated $8,000,000 for the Foundation, which together with the carry-over from fiscal year 1953 makes a total of $8,360,385 available for obligation in 1954. The gradual increase in Foundation activity since its inception in 1951 is shown in the table below.

Table VII.—*National Science Foundation Appropriation, Fiscal Years 1951–54*

Fiscal year:	*Appropriation*	Fiscal year:	*Appropriation*
1951	$225, 000	1953	4, 750, 000
1952	3, 500, 000	1954	8, 000, 000

APPENDIX I

NATIONAL SCIENCE BOARD, STAFF, DIVISIONAL COMMITTEES AND ADVISORY PANELS

NATIONAL SCIENCE BOARD

Terms Expire May 10, 1954

LEE A. DUBRIDGE, President, California Institute of Technology, Pasadena, Calif.

DONALD H. MCLAUGHLIN, President, Homestake Mining Co., San Francisco Calif.

GEORGE W. MERCK, Chairman of the Board, Merck & Co., Inc., New York, N. Y.

JOSEPH C. MORRIS,[1] Head, Physics Department and Vice-President, Tulane University, New Orleans, La.

MARSTON MORSE, Professor of Mathematics, The Institute for Advanced Study, Princeton, N. J.

JAMES A. REYNIERS,[1] Director, LOBUND Institute, University of Notre Dame, Notre Dame, Ind.

E. C. STAKMAN,[1] Division of Plant Pathology and Botany, University of Minnesota, St. Paul, Minn.

PATRICK H. YANCEY, S. J., Professor of Biology, Spring Hill College, Mobile, Spring Hill Branch, Ala.

Terms Expire May 10, 1956

JOHN W. DAVIS, Director, U. S. Operations Mission to Liberia, American Embassy, Monrovia, Liberia.

EDWIN B. FRED, Vice Chairman of the National Science Board, President, University of Wisconsin, Madison, Wis.

LAURENCE M. GOULD,[2] President, Carleton College, Northfield, Minn.

PAUL M. GROSS, Vice-President and Dean of Duke University, Duke University, Durham, N. C.

GEORGE D. HUMPHREY, President, The University of Wyoming, Laramie, Wyo.

O. W. HYMAN, Vice-President, University. of Tennessee, Memphis, Tenn.

---

[1] Members of the Executive Committee.

[2] Appointed September 1953, to fill unexpired term of James B. Conant.

FREDERICK A. MIDDLEBUSH, President, University of Missouri, Columbia, Mo.

EARL P. STEVENSON, President, Arthur D. Little, Inc., Cambridge, Mass.

Terms Expire May 10, 1958

SOPHIE D. ABERLE,[1] Special Research Director, University of New Mexico, Albuquerque, N. Mex.

CHESTER I. BARNARD.[1] Chairman of the National Science Board, New York, N. Y.

ROBERT P. BARNES, Professor of Chemistry, Department of Chemistry, Howard University, Washington, D. C.

DETLEV W. BRONK,[1] Chairman of the Executive Committee of the Board, President, National Academy of Sciences, Washington, D. C.

GERTY T. CORI, Professor of Biological Chemistry, School of Medicine, Washington University, St. Louis, Mo.

CHARLES DOLLARD, President, Carnegie Corp. of New York, New York, N. Y.

ROBERT F. LOEB,[1] Bard Professor of Medicine, College of Physicians and Surgeons, Columbia University, New York, N. Y.

ANDREY A. POTTER, Dean Emeritus of Engineering, Purdue University, Lafayette, Ind.

Ex Officio Member

ALAN T. WATERMAN,[1] Director, National Science Foundation, Washington, D. C.

STAFF

Director	ALAN T. WATERMAN.
Deputy Director	C. E. SUNDERLIN.
Special Assistant to the Director	NEIL CAROTHERS.
Secretary to the National Science Board	VERNICE ANDERSON.
Associate Director	PAUL E. KLOPSTEG.
General Counsel	WILLIAM JAY HOFF.
Assistant Director for Mathematical, Physical, and Engineering Sciences.	RAYMOND J. SEEGER (acting).
Program Director for:	
Chemistry	WALTER R. KIRNER.
Earth Sciences	H. KIRK STEPHENSON.
Engineering Sciences	RALPH A. MORGEN.
Mathematical Sciences	LEON W. COHEN.
Physics and Astronomy	J. HOWARD MCMILLEN (acting).

[1] Members of the Executive Committee.

Assistant Director for Biological and Medical Sciences.	H. BURR STEINBACH.
Program Director for:	
Developmental, Environmental, and Systematic Biology.	HUBERT B. GOODRICH.
Molecular Biology	WILLIAM V. CONSOLAZIO.
Psychobiology	JOHN T. WILSON.
Regulatory Biology	LOUIS LEVIN.
Anthropological and Related Sciences	HARRY ALPERT.
Assistant Director for Scientific Personnel and Education.	HARRY C. KELLY.
Program Director for:	
Fellowships	BOWEN C. DEES.
Scientific Manpower	THOMAS J. MILLS.
Assistant Director for Program Analysis	RAYMOND H. EWELL.
Study Director for:	
Government Research	CHARLES G. GANT.
Nonprofit Institutions	RICHARD G. AXT.
Social Science Research	HARRY ALPERT.
Assistant Director for Administration	WILSON F. HARWOOD.
Head, Office of Scientific Information	ROBERT TUMBLESON.
Fiscal Officer	FRANKLIN C. SHEPPARD.
Grants Administrator	FRANKLIN J. CALLENDER.
Administrative Officer	T. MARL HEMPHILL.
Personnel Officer	LELAND P. DECK.

DIVISIONAL COMMITTEES

Divisional Committee for Biological Sciences

MARSTON BATES, Researcher, Department of Zoology, University of Michigan, Ann Arbor, Mich.

GEORGE W. BEADLE, Director, The Kerckhoff Biological Laboratories, California Institute of Technology, Pasadena, Calif.

DONALD P. COSTELLO, Chairman, Department of Zoology, University of North Carolina, Chapel Hill, N. C.

WALLACE O. FENN, School of Medicine and Dentistry, University of Rochester, Rochester, N. Y.

JACKSON FOSTER, Professor of Bacteriology, University of Texas, Austin, Tex.

FRANK A. GELDARD, Psychological Laboratory, University of Virginia, Charlottesville, Va.

THEODOR JUST, Chief Curator, Department of Botany, Chicago Natural History Museum, Chicago, Ill.

JOHN S. NICHOLAS, Director and Chairman, Osborn Zoological Laboratory, Yale University, New Haven, Conn.

HUBERT B. VICKERY, Director, Connecticut Agricultural Experiment Station, New Haven, Conn.

DOUGLAS M. WHITAKER, Provost, Stanford University, Stanford, Calif.

Divisional Committee for Mathematical, Physical, and Engineering Sciences

A. ADRIAN ALBERT, Department of Mathematics, The University of Chicago, Chicago, Ill.

JESSE W. BEAMS, Chairman, School of Physics, University of Virginia, Charlottesville, Va.

W. L. EVERITT, Dean, College of Engineering, University of Illinois, Urbana, Ill.

LEO GOLDBERG, Department of Astronomy, University of Michigan, Ann Arbor, Mich.

MORROUGH P. O'BRIEN, Chairman, Department of Engineering, University of California, Berkeley, Calif.

GEORGE B. PEGRAM, Department of Physics, Columbia University, New York, N. Y.

CHARLES C. PRICE, Department of Chemistry, University of Notre Dame, Notre Dame, Ind.

WILLIAM W. RUBEY, Principal Geologist, U. S. Geological Survey, Washington 25, D. C.

CYRIL STANLEY SMITH, Director, Institute for the Study of Metals, The University of Chicago, Chicago, Ill.

SAMUEL S. WILKS, Princeton University, Princeton, N. J.

E. BRIGHT WILSON, Jr., Department of Chemistry, Harvard University, Cambridge, Mass.

Divisional Committee for Medical Research

FRANK BRINK, JR., Department of Biophysics, Johns Hopkins University, Baltimore, Md.

BERNARD D. DAVIS, U. S. Public Health Service, Tuberculosis Research Laboratory, New York, N. Y.

EDWARD W. DEMPSEY, Head, Department of Anatomy, Washington University, St. Louis, Mo.

ERNEST GOODPASTURE, School of Medicine, Vanderbilt University, Nashville, Tenn.

SEVERO OCHOA, College of Medicine, New York University, New York, N. Y.

DICKINSON W. RICHARDS, Director, First (Columbia) Medical Division, Bellevue Hospital, New York, N. Y.

GEORGE WALD, the Biological Laboratories, Harvard University, Cambridge, Mass.

ARNOLD D. WELCH, School of Medicine, Yale University, New Haven, Conn.

Divisional Committee for Scientific Personnel and Education

JOEL H. HILDEBRAND, Professor Emeritus of Chemistry, University of California, Berkeley, Calif.

KATHARINE MCBRIDE, President, Bryn Mawr College, Bryn Mawr, Pa.

HAROLD W. STOKE, Dean of the Graduate School, University of Washington, Seattle, Wash.

RALPH W. TYLER, Dean of Social Sciences, University of Chicago, Chicago, Ill.

FRANK J. WELCH, Dean and Director, College of Agriculture and Home Economics, Agricultural Experiment Station, University of Kentucky, Lexington, Ky.

DOUGLAS WHITAKER, Provost, Stanford University, Stanford, Calif.

HARRY A. WINNE, Vice President—Engineering, General Electric Company, Schenectady, N. Y.

ADVISORY PANELS

Advisory Panel for Astronomy

LAURENCE H. ALLER, Professor of Astrophysics, The Observatory of the University of Michigan, Ann Arbor, Mich.

DIRK BROUWER, Professor of Astronomy, Yale University, New Haven, Conn.

JESSE L. GREENSTEIN, California Institute of Technology, Pasadena, Calif.

GERARD P. KUIPER, Professor of Astronomy, Yerkes Observatory, Williams Bay, Wis.

MARTIN SCHWARZSCHILD, Princeton University, Princeton, N. J.

K. A. STRAND, Northwestern University, Evanston, Ill.

OTTO STRIVE, University of California, Berkeley, Calif.

FRED L. WHIPPLE, Professor of Astronomy, Harvard University, Cambridge, Mass.

A. E. WHITFORD, University of Wisconsin, Madison, Wis.

Advisory Panel for Chemistry

PAUL D. BARTLETT, Chemistry Department, Harvard University, Cambridge, Mass.

FARRINGTON DANIELS, Department of Chemistry, University of Wisconsin, Madison, Wis.

HENRY EYRING, Chemistry Department, University of Utah, Salt Lake City, Utah.

NATHAN H. FURMAN, Department of Chemistry, Princeton University, Princeton, N. J.

JOEL H. HILDEBRAND, Professor of Chemistry, University of California, Berkeley, Calif.

WILLIAM S. JOHNSON, Department of Chemistry, University of Wisconsin, Madison, Wis.

JOSEPH W. KENNEDY, Department of Chemistry, Washington University, St. Louis, Mo.

CARL S. MARVEL, Chemistry Department, University of Illinois, Urbana, Ill.

FREDERICK A. MATSEN, Department of Chemistry, University of Texas, Austin, Tex.

FREDERICK D. ROSSINI, Department of Chemistry, Carnegie Institute of Technology, Pittsburgh, Pa.

HERMAN I. SCHLESINGER, University of Chicago, Evanston, Ill.

ERNEST H. SWIFT, California Institute of Technology, Pasadena, Calif.

Advisory Panel for Developmental, Environmental, and Systematic Biology

ELMER G. BUTLER, Professor of Biology, Princeton University, Princeton, N. J.

RALPH E. CLELAND, Dean, Graduate School, Indiana University, Bloomington, Ind.

H. J. COOLIDGE, Executive Director, Pacific Science Board, NRC, Washington, D. C.

ALFRED E. EMERSON, Professor of Zoology, University of Chicago, Chicago, Ill.

RICHARD H. GOODWIN, Professor of Botany, Connecticut College, New London, Conn.

REMINGTON KELLOGG, Director, U. S. National Museum, Washington, D. C.

G. E. MACGINITIE, Professor of Biology, California Institute of Technology, Pasadena, Calif.

DOUGLAS A. MARSLAND, Professor of Biology, New York University, New York, N. Y.

ARTHUR W. MARTIN, Jr., Professor of Zoology, University of Washington, Seattle, Wash.

ERNST MAYR, Professor of Zoology, Harvard University, Cambridge, Mass.

DANIEL MERRIMAN, Director, Bingham Oceanographic Laboratory, Yale University, New Haven, Conn.

A. S. PEARSE, Professor of Zoology, Duke, University, Durham, N. C.

C. LADD PROSSER, Professor of Zoology, University of Illinois, Urbana, Ill.

DON M. REES, Professor of Zoology, University of Utah, Salt Lake City, Utah.

WILLIAM J. ROBBINS, Director, New York Botanical Garden, New York, N. Y.

CARL C. SPEIDEL, Professor of Anatomy, University of Virginia, Charlottesville, Va.

B. W. WELLS, Professor of Botany, North Carolina State College, Raleigh, N. C.

R. H. WETMORE, Professor of Botany, Harvard University, Cambridge, Mass.

Advisory Panel for Earth Sciences

HUGO BENIOFF, Seismological Laboratory, Pasadena, Calif.

JAMES GILLULY, U. S. Geological Survey, Denver, Colo.

M. KING HUBBERT, Shell Oil Company, Houston, Tex.

LUNA B. LEOPOLD, U. S. Geological Survey, Washington 25, D. C.

WALTER MUNK, Scripps Institution of Oceanography, La Jolla, Calif.

ELBURT F. OSBORN, Pennsylvania State College, State College, Pa.

WILLIAM T. PECORA, U. S. Geological Survey, Washington 25, D. C.

SVERRE PETTERSSEN, University of Chicago, Chicago, Ill.

RICHARD J. RUSSELL, Louisiana State University, Baton Rouge, La.

PHILIP J. SHENON, Consulting Geologist, 1339 3rd Avenue, Salt Lake City, Utah.

GEORGE G. SIMPSON, American Museum of Natural History, New York, N. Y.

C. W. THORNTHWAITE, Johns Hopkins Laboratory of Climatology, Seabrook, N. J.

Advisory Panel for Engineering

THOMAS J. DOLAN, Research Professor of Theoretical and Applied Mechanics, University of Illinois, Urbana, Ill.

GEORGE W. GLEESON, Oregon State College, Corvallis, Oreg.

LINTON E. GRINTER, Dean of the Graduate School, University of Florida, Gainesville, Fla.

GEORGE ANDREW HAWKINS, Associate Dean, College of Engineering, Purdue University, Lafayette, Ind.

N. J. HOFF, Professor of Aeronautical Engineering, Polytechnic Institute of Brooklyn, New York, N. Y.

ROBERT F. MEHL, Director, Metals Research Laboratory, Carnegie Institute of Technology, Pittsburgh, Pa.

HUNTER ROUSE, State University of Iowa, Iowa City, Iowa.

THORNDIKE SAVILLE, Dean, College of Engineering, New York University, New York, N. Y.

THOMAS K. SHERWOOD, Professor of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

ERIC A. WALKER, Dean of Engineering, Pennsylvania State College, State College, Pa.

KURT F. WENDT, Associate Director, Engineering Experiment Station, University of Wisconsin, Madison, Wis.

W. R. WOOLRICH, Dean of Engineering, University of Texas, Austin, Tex.

Advisory Panel for Genetics

T. DOBZHANSKY, Department of Zoology, Columbia University, New York, N. Y.

JOSHUA LEDERBERG, Department of Genetics, University of Wisconsin, Madison, Wis.

M. M. RHOADES, Department of Botany, University of Illinois, Urbana, Ill.

FRANZ SCHRADER, Department of Zoology, Columbia University, New York, N. Y.

TRACY SONNEBORN, Department of Zoology, University of Indiana, Bloomington, Ind.

L. STEBBINS, Department of Botany, University of California, Berkeley, Calif.

CURT STERN, Department of Zoology, University of California, Berkeley, Calif.

Advisory Panel for High Temperature Research

W. P. ALLIS, Massachusetts Institute of Technology, Cambridge, Mass.

LEO BREWER, University of California, Berkeley, Calif.

F. G. BRICKWEDDE, National Bureau of Standards, Washington, D. C.

C. HERRING, Bell Telephone Laboratory, Murray Hill, N. J.

J. O. HIRSCHFELDER, University of Wisconsin, Madison, Wis.

J. H. HOLLOMON, General Electric Company, Schenectady, N. Y.

Advisory Panel for Low Temperature Research

JOHN BARDEEN, Professor of Physics, University of Illinois, Urbana, Ill.

S. C. COLLINS, Massachusetts Institute of Technology, Cambridge, Mass.

J. G. DAUNT, Professor of Physics, Ohio State University, Columbus, Ohio.

C. T. LANE, Professor of Physics, Yale University, New Haven, Conn.

EARL ALBERT LONG, Director of Cryogenics Laboratory, University of Chicago, Chicago, Ill.

C. F. SQUIRE, the Rice Institute, Houston, Tex.

Advisory Panel for Mathematical Sciences

S. BOCHNER, Professor of Mathematics, Princeton University, Princeton, N. J.

K. O. FRIEDRICHS, Professor of Applied Mathematics, New York University, New York, N. Y.

HAROLD HOTELLING, Associate Director of Research, University of North Carolina, Chapel Hill, N. C.

D. H. LEHMER, Director of Research, National Bureau of Standards, Los Angeles, Calif.

SAUNDERS MACLANE, Professor of Mathematics, University of Chicago, Chicago, Ill.

ERIC REISSNER, Professor of Mathematics, Massachusetts Institute of Technology, Cambridge, Mass.

HASSLER WHITNEY, Professor of Mathematics, Institute for Advanced Study, Princeton, N. J.

Advisory Panel for Molecular Biology

BRITTON CHANCE, University of Pennsylvania, Philadelphia, Pa.

WALDO COHN, Oak Ridge National Laboratory, Oak Ridge, Tenn.

JOHN EDSALL, Harvard Medical School, Cambridge, Mass.

DAVID GODDARD, University of Pennsylvania, Philadelphia, Pa.

STERLING HENDRICKS, Bureau of Plant Industry, United States Department of Agriculture, Beltsville, Md.

FRANK H. JOHNSON, Princeton University, Princeton, N. J.

DAVID RITTENBERG, Columbia University, New York, N. Y.

HOWARD SCHACHMAN, University of California, Berkeley, Calif.

SOL SPIEGELMAN, University of Illinois, Urbana, Ill.

Advisory Panel for Physics

SAMUEL K. ALLISON, University of Chicago, Evanston, Ill.

CARL D. ANDERSON, Department of Physics, California Institute of Technology, Pasadena, Calif.

HARVEY FLETCHER, Brigham Young University, Provo, Utah.

GAYLORD P. HARNWELL, University of Pennsylvania, Philadelphia, Pa.

KARL F. HERZFELD, Catholic University of America, Washington, D. C.

WILLIAM V. HOUSTON, The Rice Institute, Houston, Tex.

JOSEPH KAPLAN, University of California, Los Angeles, Calif.

ALFRED O. NIER, University of Minnesota, Minneapolis, Minn.

EDWARD M. PURCELL, Harvard University, Cambridge, Mass.

BRUNO P. ROSSI, Massachusetts Institute of Technology, Cambridge, Mass.

FREDERICK SEITZ, University of Illinois, Urbana, Ill.

EUGENE P. WIGNER, Princeton University, Princeton, N. J.

Advisory Panel for Psychobiology

FRANK A. BEACH, Professor of Psychology, Yale University, New Haven, Conn.

LYLE HICKS LANIER, Professor of Psychology, University of Illinois, Urbana, Ill.

DONALD B. LINDSLEY, Professor of Psychology, University of California, Los Angeles, Calif.

QUINN MCNEMAR, Professor of Psychology, Stanford University, Stanford, Calif.

DONALD G. MARQUIS, Professor of Psychology, University of Michigan, Ann Arbor, Mich.

Advisory Panel for Regulatory Biology

H. ALBERT BARKER, Professor of Plant Biochemistry, University of California, Berkeley, Calif.

R. H. BARNES, Associate Director of Research, Sharp and Dohme, West Point, Pa.

R. H. BURRIS, Professor of Biochemistry, School of Agriculture, University of Wisconsin, Madison, Wis.

I. C. GUNSALUS, Professor of Bacteriology, University of Illinois, Urbana, Ill.

FRITZ A. LIPMANN, Professor of Biological Chemistry, Harvard University, School of Medicine, Boston, Mass.

C. N. H. LONG, Professor of Physiology, Yale University School of Medicine, New Haven, Conn.

A. M. PAPPENHEIMER, Professor Microbiology, New York University, College of Medicine, New York, N. Y.

ESMOND E. SNELL, Professor of Chemistry, University of Texas, Austin, Tex.

ALFRED E. WILHELMI, Professor of Biochemistry, Emory University, Ga.

Advisory Panel for Scientific Information

CURTIS BENJAMIN, President, McGraw-Hill Book Co., New York, N. Y.

BERNARD BERELSON, Director, Behavioral Sciences Division, Ford Foundation, 655 Madison Avenue, New York, N. Y.

VERNER CLAPP, Chief Assistant Librarian, Library of Congress, Washington, D. C.

GAYLORD HARNWELL, President, University of Pennsylvania, Philadelphia 4, Pa.

G. E. HUTCHINSON, Director of Graduate Studies in Zoology, Yale University, New Haven, Conn.

W. A. NOYES, JR., Chairman, Department of Chemistry, University of Rochester, Rochester, N. Y.

Advisory Panel for Social Sciences

CLARK KERR, Chancellor, University of California, Berkeley, Cal.

CLYDE R. KLUCKHOHN, Harvard University, Cambridge, Mass.

DON K. PRICE, Associate Director, Ford Foundation, New York, N. Y.

DONALD R. YOUNG, Russell Sage Foundation, New York, N. Y.

Advisory Committee for Minerals Research

ALLEN V. ASTIN, Director, National Bureau of Standards, Washington 25, D. C.

JOHN G. BARTRAM, Consulting Geologist, Stanolind Oil & Gas Company, Tulsa, Okla.

ALAN BATEMAN, Yale University, New Haven, Conn.

JAMES BOYD, Exploration Manager, Kennecott Copper Company, New York, N. Y.

ARTHUR H. BUNKER, President, Climax Molybdenum Company, New York, N. Y.

GORDON L. DAVIS, Geophysicist, Geophysical Laboratory, Washington 25, D. C.

MAURICE EWING, Department of Geology, Columbia University, New York, N. Y.

PAUL D. FOOTE, Executive Vice President, Gulf Research & Development Company, Pittsburgh, Pa.

L. C. GRATON, Harvard University, Cambridge, Mass.

JOHN GUSTAFSON, M. A. Hanna Company, Cleveland, Ohio.

THOMAS NOLAN, Assistant Director, U. S. Geological Survey, Washington 25, D. C.

WILLIAM W. RUBEY, Chairman, National Research Council, Washington 25, D. C.

LOUIS SLICHTER, University of California at Los Angeles, Calif.

JOHN VANDERWILT, President, Colorado School of Mines, Golden, Colo.

CLYDE E. WILLIAMS, Battelle Memorial Institute, Columbus, Ohio.

WILLIAM WRATHER, Director, U. S. Geological Survey, Washington 25, D. C.

PAUL ZINNER, Chief, Minerals Division, Bureau of Mines, Washington 25, D.C.

APPENDIX II

Research Support Program

BASIC RESEARCH GRANTS AWARDED IN FISCAL YEAR 1958

Astronomy

UNIVERSITY OF CHICAGO, Chicago, Ill.; W. W. Morgan and B. Stromgren, Yerkes Observatory; *Interstellar Hydrogen Emission Regions;* 18 months; $7,300.

UNIVERSITY OF CINCINNATI, Cincinnati, Ohio; P. Herget, Cincinnati Observatory; *Orbits of the Minor Planets;* 1 year; $5,500.

HARVARD UNIVERSITY, Cambridge, Mass.; B. J. Bok, Harvard College Observatory; *Radio Astronomy in the Microwave Region;* 2 years; $32,000.

VANDERBILT UNIVERSITY, Nashville, Tenn.; C. K. Seyfert, Barnard Observatory; *Galactic Structures and Eclipsing Variable Stars;* 2 years; $12,000.

UNIVERSITY OF VIRGINIA, Charlottesville, Va.; H. L. Alden, Leander McCormick Observatory; *Astrometric Studies of Selected Stars;* 2 years; $10,000.

UNIVERSITY OF WISCONSIN, Madison, Wis.; A. E. Whitford, Washburn Observatory; *Structure of the Southern Milky Way as Outlined by O and B Stars;* 1 year; $10,000.

YALE UNIVERSITY, New Haven, Conn.; R. Wildt, Yale University Observatory; *Solid Hydrogen in the Planets;* 18 months; $4,200.

Chemistry

UNIVERSITY OF CALIFORNIA, Berkeley, Calif.; W. G. Young, Department of Chemistry; *Displacement Reactions Involving Allylic Systems;* 2 years; $14,000.

UNIVERSITY OF SOUTHERN CALIFORNIA, Los Angeles, Calif.; N. Kharasch, Department of Chemistry; *Free Radical Reactions of Sulfenyl Halides;* 1 year; $2,500.

UNIVERSITY OF COLORADO, Boulder, Colo.; R. N. Keller, Department of Chemistry; *Low Count-Rate Techniques in Radiocarbon Dating;* 1 year; $9,000.

CORNELL UNIVERSITY, Ithaca, N. Y.; D. F. De Tar, Department of Chemistry; *Mechanism of Reactions of Aromatic Rings with Free Radical Intermediates;* 1 year; $8,000.

UNIVERSITY OF DELAWARE, Newark, Del.; E. Dyer, Department of Chemistry; *Effect of Oxygen on Vinyl Compounds in the Presence of Free Radicals;* 1 year; $6,400.

DUKE UNIVERSITY, Durham, N. C.; F. London, Department of Chemistry; *Theoretical Investigations of Low Temperature Phenomena;* 18 months; $4,500.

HARVARD UNIVERSITY, Cambridge, Mass.; F. C. Uhle, Department of Pharmacology; *Chemistry of Ergot Alkaloids;* 1 year; $12,000.

HOWARD UNIVERSITY, Washington, D. C.; L. N. Ferguson, Department of Chemistry; *Study of Aromatic Bromination;* 1 year; $6,100.

UNIVERSITY OF ILLINOIS, Urbana, Ill.; J. C. Bailar, Jr., Department of Chemistry; *Metal Complexes in Resolution of Optically Active Organic Substances;* 1 year; $5,000.

UNIVERSITY OF ILLINOIS, Urbana, Ill.; H. A. Laitinen, Department of Chemistry; *Adsorption Processes at Electrode Surfaces;* 1 year; $5,000.

UNIVERSITY OF ILLINOIS, Urbana, Ill.; H. R. Snyder, Department of Chemistry; *Alkaloids of Haplophyton Cimicidum;* 1 year; $9,500.

JOHNS HOPKINS UNIVERSITY, Baltimore, Md.; A. H. Corwin, Department of Chemistry; *Synthetic Studies on Chlorophyll;* 2 years; $13,200.

KANSAS STATE COLLEGE OF AGRICULTURE AND APPLIED SCIENCES, Manhattan, Kans.; S. Searles, Jr., Department of Chemistry; *Reactions of Some Substituted Trimethylene Oxides;* 3 years; $8,100.

MICHIGAN STATE COLLEGE, East Lansing, Mich.; K. G. Stone, Department of Chemistry; *Quantitative Oxidation-Reduction in Non-Aqueous Media;* 1 year; $3,100.

MISSISSIPPI STATE COLLEGE, State College, Miss.; L. C. Behr, Department of Chemistry; *Position Isomerism in the Azoxybenzenes;* 1 year; $3,000.

MOUNT HOLYOKE COLLEGE, South Hadley, Mass.; L. W. Pickett, Department of Chemistry; *Vacuum Ultraviolet Spectra of Selected Organic Compounds;* 1 year; $7,400.

UNIVERSITY OF NORTH DAKOTA, Grand Forks, N. Dak.; R. G. Severson, Department of Chemistry; *Preparation and Properties of Certain Substituted Organosilanes;* 1 year; $3,300.

NORTHWESTERN UNIVERSITY, Evanston, Ill.; R. L. Burwell, Jr., Department of Chemistry; *Relative Reactivities of Various Radicals by Cleavage Reactions of Ethers;* 2 years; $7,000.

NORTHWESTERN UNIVERSITY, Evanston, Ill.; A. A. Frost, Department of Chemistry; *Molecular Potential Energies;* 2 years; $13,000.

RENSSELAER POLYTECHNIC INSTITUTE, Troy, N. Y.; S. Ross, Department of Chemistry; *Adsorption of Pure Hydrocarbons on Ionic Crystal Surfaces;* 1 year; $4,800.

ST. JOHN'S UNIVERSITY, Brooklyn, N. Y.; H. A. Horan and J. A. Skarulis, Department of Chemistry; *Correlation of Structures and Properties of Some Alums;* 1 year; $3,800.

SMITH COLLEGE, Northampton, Mass.; M. D. Soffer, Department of Chemistry; *Synthetic and Structural Investigations in the Sesquiterpene Series;* 2 years; $8,800.

UNIVERSITY OF SOUTH CAROLINA, Columbia, S. C.; H. W. Davis, Department of Chemistry; *Decomposition of Benzoyl Peroxide in 1,4-Epoxycyclohexane;* 6 months; $2,400.

UNIVERSITY OF UTAH, Salt Lake City, Utah; H. Eyring, Department of Chemistry; *Theory of Reaction Rates;* 2 years; $18,000.

WASHINGTON UNIVERSITY, St. Louis, Mo.; A. C. Wahl, Department of Chemistry; *Kinetic Studies of Oxidation-Reduction Reactions;* 1 year; $9,500.

WAYNE UNIVERSITY, Detroit, Mich.; C. Djerassi, Department of Chemistry; *Application of Rotatory Dispersion to Steroids;* 18 months; $9,500.

WEST VIRGINIA UNIVERSITY, Morgantown, W. Va.; J. B. Hickman, Department of Chemistry; *Binary Liquid Mixtures of Fluorocarbons, Halides and Hydrocarbons;* 1 year; $3,600.

UNIVERSITY OF WISCONSIN, Madison, Wis.; W. S. Johnson, Department of Chemistry; *Synthesis of Structures Related to the Steroids;* 18 months; $6,000.

Developmental Biology

UNIVERSITY OF CHICAGO, Chicago, Ill.; E. C. Olson, Department of Geology; *Biometrical Study of Evolution;* 3 years; $25,200.

UNIVERSITY OF CHICAGO, Chicago, Ill.; S. L. Washburn, Department of Anthropology; *Growth of the Brain Case;* 1 year; $3,900

278626—54——6

University of Virginia, Charlottesville, Va.; M. S. McKeehan, Department of Medicine; *Growth and Differentiation in the Developing Lens of the Chick Embryo;* 2 years; $5,400.

Yale University, New Haven, Conn.; J. P. Trinkaus, Osborn Zoological Laboratory; *Tissue Differentiation and Transformation;* 2 years $5,100.

Earth Sciences

Columbia University, New York, N. Y.; J. L. Kulp, Lamont Geological Observatory; *Carbon 14 Measurements of Ocean Floor Sediments;* 1 year; $16,000.

University of Miami, Coral Gables, Fla.; I. Hela, Marine Laboratory; *Ocean Currents in the Cape Hatteras-Bermuda-Bahamas Area;* 6 months; $1,450.

Ohio Department of Natural Resources, Columbus, Ohio; G. N. Cady, Division of Geological Survey; *Petrographic Constitution of Ohio Coals;* 2 years; $24,000.

Temple University, Philadelphia, Pa.; A. V. Grosse, Research Institute of Temple University; *Investigation of Natural Tritium Content in Various Waters;* 1 year; $10,300.

Washington University, St. Louis, Mo.; H. N. Andrews, Jr., School of Botany; *Studies of Coal Ball Floras from the Central Coal Fields of the United States;* 1 year; $2,700.

University of Washington, Seattle, Wash.; T. J. Chow and T. G. Thompson, Department of Oceanography; *Distribution of Some Minor Constituents of Sea Water;* 2 years; $11,700.

Engineering

University of California, Berkeley, Calif.; F. E. Romie, Department of Engineering; *Heat Transfer to Fluids in Pulsating Flow;* 18 months; $8,400.

Clarkson College of Technology, Potsdam, N. Y.; H. L. Shulman, Department of Chemical Engineering; *Determination of Interfacial Area in Packed Absorption and Distillation Columns;* 15 months; $10,200.

George Washington University, Washington, D. C.; B. D. Greenshields, Department of Civil Engineering; *Mathematical Models for Traffic Patterns;* 18 months; $8,000.

Illinois Institute of Technology, Chicago, Ill.; M. Jakob, Department of Mechanical Engineering; *Fundamental Studies in Boiling;* 1 year; $9,000.

Lehigh University, Bethlehem, Pa.; A. C. Zettlemoyer, Department of Chemistry; *A Study of Mixed Vapor Adsorption;* 1 year; $5,600.

Louisiana State College, Baton Rouge, La.; J. Coates, Engineering Experiment Station; *Thermal Conductivity of Pure Liquids and Solutions as a Function of Temperature;* 1 year; $10,500.

Massachusetts Institute of Technology, Cambridge, Mass.; M. C. Shaw, Mechanical Engineering; *An Investigation of the Stress and Energy Characteristics of Brittle Materials During Comminution;* 1 year; $5,500.

Massachusetts Institute of Technology, Cambridge, Mass.; T. K. Sherwood, Department of Chemical Engineering; *Mechanism of Mass Transfer With Chemical Reaction;* 18 months; $4,600.

University of Minnesota, Minneapolis, Minn.; H. S. Isbin, Department of Chemical Engineering; *Natural Convection Studies in Regions of Maximum Fluid Densities;* 18 months; $5,000.

Northwestern University, Evanston, Ill.; A. B. Bronwell, Department of Electrical Engineering; *Theoretical and Experimental Studies of a New Type of Microwave Detector;* 1 year; $11,000.

Pennsylvania State College, State College, Pa.; A. Rose, Department of Chemical Engineering; *Mass Transfer in Simple Two-Phase Systems;* 1 year; $8,800.

PURDUE RESEARCH FOUNDATION, Lafayette, Ind.; J. E. Goldberg, Engineering Experiment Station; *Relation of Residual Stresses to the Compressive Strength of Structural Steel Columns;* 1 year; $9,000.

PURDUE RESEARCH FOUNDATION, Lafayette, Ind.; W. L. Sibbitt and G. A. Hawkins, Department of Mechanical Engineering; *Experimental Determination of Viscosity of Steam over Wide Ranges of Temperatures and Pressures;* 1 year; $9,000.

RENSSELAER POLYTECHNIC INSTITUTE, Troy, N. Y.; J. O. Hougen, Department of Chemical Engineering; *Kinetic Research in the Field of Reduction of Tungsten Oxide with Hydrogen;* 18 months; $4,000.

UNIVERSITY OF TENNESSEE, Knoxville, Tenn.; H. J. Garber and F. N. Peebles, Department of Engineering; *Mass Transfer in Liquid-Gas Bubble Systems;* 2 years; $6,700.

WASHINGTON UNIVERSITY, St. Louis, Mo.; M. Stippes, Department of Applied Mechanics; *Large Deflections of Flat Plates;* 18 months; $6,000.

UNIVERSITY OF WISCONSIN, Madison, Wis.; O. A. Hougen and W. R. Marshall, Department of Chemical Engineering; *Transport Properties of Fluids Related to the Separation Processes of Chemical Engineering;* 2 years; $16,000.

UNIVERSITY OF WYOMING, Laramie, Wyo.; H. S. Sweet, Department of Civil Engineering; *Application of Nuclear Radiations to Properties of Engineering Materials;* 18 months; $8,000.

Environmental Biology

CATHOLIC UNIVERSITY OF AMERICA, Washington, D. C.; M. Gusinde, Department of Anthropology; *Demography and Physiology of South African Bushmen;* 1 year; $4,500.

WOODS HOLE OCEANOGRAPHIC INSTITUTION, Woods Hole, Mass.; J. H. Ryther; *Etiology of Plankton Blooms;* 1 year; $3,000.

Genetic Biology

UNIVERSITY OF CHICAGO, Chicago, Ill.; J. R. Raper and J. P. San Antonio, Department of Botany; *Naturally Occurring Filtrable Mutagens in Schizophyllum;* 2 years; $11,000.

STATE UNIVERSITY OF IOWA, Iowa City, Iowa; E. Witschi, Department of Zoology; *Natural Causes of Teratogenesis;* 3 years; $34,500.

UNIVERSITY OF MARYLAND, College Park, Md.; D. T. Morgan, Jr. and R. D. Rappleye, Department of Botany; *Effect of X-Ray on Embryonic Development in Plants;* 3 years; $12,000.

UNIVERSITY OF MICHIGAN, Ann Arbor, Mich.; D. L. Nanney, Department of Zoology; *Protozoan Genetics;* 3 years; $10,000.

UNIVERSITY OF PENNSYLVANIA, Philadelphia, Pa.; J. R. Preer, Jr., Department of Zoology; *Genetic Cytoplasmic Factors in Paramecium;* 1 year; $4,600.

STANFORD UNIVERSITY, Stanford, Calif.; W. C. Steere, Department of Biological Sciences; *Cytology of Bryophytes;* 3 years; $10,600.

UNIVERSITY OF TEXAS, Austin, Tex.; W. F. Blair, Department of Zoology; *Interbreeding of Vertebrate Populations;* 3 years; $18,000.

Mathematics

BROWN UNIVERSITY, Providence, R. I.; H. Federer, Department of Mathematics; *Investigations into the Theory of Measure and Area;* 1 year; $3,500.

BROWN UNIVERSITY, Providence, R. I.; D. Gale, Department of Mathematics; *Mathematical Theory of Economic Models and Related Topics;* 1 year; $2,800.

BROWN UNIVERSITY, Providence, R. I.; B. Jonsson, Department of Mathematics; *Free Lattices and Decision Problems for Modular Lattices;* 1 year; $3,000.

UNIVERSITY OF CHICAGO, Chicago, Ill.; R. Carnap, Department of Philosophy; *Development of a New Theory of Probability;* 1 year; $6,400.

COLUMBIA UNIVERSITY, New York, N. Y.; C. Chevalley, Department of Mathematics; *Methods of Laurent Schwartz in the Theory of Distributions;* 1 year; $4,100.

COLUMBIA UNIVERSITY, New York, N. Y.; E. R. Kolchin, Department of Mathematics; *Topics in the Galois Theory of Differential Fields;* 1 year; $5,100.

CORNELL UNIVERSITY, Ithaca, N. Y.; P. Olum, Department of Mathematics; *Homotopy Types of Topological Spaces;* 1 year; $5,000.

UNIVERSITY OF ILLINOIS, Urbana, Ill.; P. T. Bateman, Department of Mathematics; *Goldbach Problem in Algebraic Number Fields;* 1 year; $5,100.

UNIVERSITY OF ILLINOIS, Urbana, Ill.; J. Mitchell, Department of Mathematics; *Research in the Geometry of Matrices;* 1 year; $3,000.

STATE UNIVERSITY OF IOWA, Iowa City, Iowa; H. T. Muhly, Department of Mathematics; *Numerical Characters of Local Rings and Some Relative Invariants of Algebraic Surfaces;* 8 months; $1,700.

UNIVERSITY OF MICHIGAN, Ann Arbor, Mich.; W. Kaplan, Department of Mathematics; *Investigation of Problems in Theory of Functions of a Complex Variable;* 18 months; $5,400.

UNIVERSITY OF PENNSYLVANIA, Philadelphia, Pa.; R. D. Schafer, Department of Mathematics; *Non-Associative Algebras;* 1 year: $4,200.

PRINCETON UNIVERSITY, Princeton, N. J.; N. E. Steenrod, Department of Mathematics; *Homology Groups of the Symmetric Groups;* 6 months; $3,000.

UNIVERSITY OF SOUTHERN CALIFORNIA, Los Angeles, Calif.; L. A. Henkin, Department of Mathematics; *Formal Systems and Their Mathematical Models;* 1 year, $4,000.

UNIVERSITY OF VIRGINIA, Charlottesville, Va.; E. J. McShane, Department of Mathematics; *Partially Ordered Spaces;* 6 months; $7,600.

UNIVERSITY OF WASHINGTON, Seattle, Wash.; F. H. Brownell, Department of Mathematics; *A General Theory of Operators with Applications to Partial Differential Equations and Potential Theory;* 1 year; $9,600.

WASHINGTON UNIVERSITY, St. Louis, Mo.; H. M. Elliott, Department of Mathematics; *Approximation by Rational Functions to Harmonic and Analytic Functions;* 1 year; $2,900.

UNIVERSITY OF WISCONSIN, Madison, Wis.; R. H. Bing, Department of Mathematics; *Imbedding Sets in Manifolds;* 10 months; $3,100.

UNIVERSITY OF WISCONSIN, Madison, Wis.; L. C. Young, Department of Mathematics; *Existence of Solutions in the Calculus of Variations;* 1 year $5,700.

Microbiology

UNIVERSITY OF CALIFORNIA, Berkeley, Calif.; D. M. Reynolds, Department of Bacteriology; *Microbiological Aspects of Chitin Decomposition;* 2 years; $7,000.

UNIVERSITY OF ILLINOIS, Urbana, Ill.; W. A. Wood, Department of Dairy Science; *Pathways of Carbohydrate Oxidation in Aerobic Bacteria;* 3 years; $17,500.

INDIANA UNIVERSITY, Bloomington, Ind.; E. D. Weinberg, Department of Bacteriology; *Nutritional Basis of Antibiotic Action;* 2 years; $4,500.

UNIVERSITY OF NORTH CAROLINA, Chapel Hill, N. C.; V. M. Cutter, Jr., Department of Biology, The Woman's College at Greensboro, N. C.; *Isolation and Culture of Plant Rusts;* 3 years; $9,300.

UNIVERSITY OF PENNSYLVANIA, Philadelphia, Pa.; D. J. O'Kane, Department of Botany; *Enzymes in Metabolism of Microorganisms;* 3 years; $24,000.

ST. JOHN'S UNIVERSITY, Brooklyn, N. Y.; D. M. Lilly, Department of Biology; *Nutrition and Growth of Suctorian Protozoa;* 1 year; $4,000.

UNIVERSITY OF TEXAS, Austin, Tex.; J. Meyers, Department of Zoology; *Physiology of Blue-Green Algae;* 2 years; $10,000.

STATE COLLEGE OF WASHINGTON, Pullman, Wash.; R. E. Hungate, Department of Bacteriology and Public Health; *Microbiology and Biochemistry of the Rumen;* 3 years; $17,800.

YALE UNIVERSITY, New Haven, Conn.; H. P. Treffers, Department of Microbiology; *Microbial Resistance to Drugs and Antibiotics;* 2 years; $13,500.

Molecular Biology

UNIVERSITY OF CALIFORNIA, Berkeley, Calif.; A. L. Black, School of Veterinary Medicine, College of Agriculture; *Biosynthesis of Amino Acids in Dairy Cows;* 2 years; $6,900.

CONNECTICUT AGRICULTURAL EXPERIMENT STATION, New Haven, Conn.; H. B. Vickery, *Metabolism of Organic Acids of Leaves;* 3 years; $24,500.

HARVARD UNIVERSITY, Cambridge, Mass.; F. H. Westheimer, Department of Chemistry; *Chemical Models of Enzyme Systems;* 15 months; $6,000.

STATE UNIVERSITY OF IOWA, Iowa City, Iowa; C. Tanford, Department of Chemistry and Chemical Engineering; *Physico-Chemical Investigation of Protein Molecules;* 2 years; $9,000.

STATE UNIVERSITY OF NEW YORK, Albany, N. Y.; R. A. Turner, Department of Biochemistry, College of Medicine, Brooklyn, N. Y.; *Chemical Structure of Peptides and Proteins;* 3 years; $15,000.

RETINA FOUNDATION, Boston, Mass.; M. A. Jakus, *Fibrous Components of the Eye;* 2 years; $8,000.

UNIVERSITY OF TENNESSEE, Knoxville, Tenn.; R. E. Koeppe, School of Biological Sciences; *Precursors of the Carbons of Glutamic Acid;* 2 years; $8,000.

TUFTS COLLEGE, Medford, Mass.; H. Z. Sable, Tufts College Medical School; *Intermediary Metabolism of Nucleic Acid Fragments;* 1 year; $5,700.

YALE UNIVERSITY, New Haven, Conn.; J. S. Fruton, Department of Ph siological Chemistry; *Hydroxyamino Acids in Protein Structure;* 3 years; $30,000.

YALE UNIVERSITY, New Haven, Conn.; G. E. Hutchinson, Department of Zoology; *Amino Acids in Lake Waters, Organisms and Sediments;* 1 year; $1,000.

YALE UNIVERSITY, New Haven, Conn.; J. M. Sturtevant, Department of Chemistry; *Calorimetric Investigations of Proteins;* 3 years; $20,700.

Physics

BRIGHAM YOUNG UNIVERSITY, Provo, Utah; H. Fletcher, Department of Physics; *Research in Musical Acoustics;* 1 year; $10,000.

UNIVERSITY OF CALIFORNIA, Berkeley, Calif.; L. B. Loeb, Department of Physics; *Research in the Field of Gaseous Electronics;* 1 year; $4,000.

CARNEGIE INSTITUTE OF TECHNOLOGY, Pittsburgh, Pa.; S. DeBenedetti and R. Siegel, Department of Physics; *Electronic States in Solids and in Chemical Compounds with the Method of Observations on Positron Annihilation Radiations;* 1 year; $10,000.

UNIVERSITY OF CHICAGO, Chicago Ill.; M. G. Inghram, Department of Physics; *Mass Spectrometric Investigations;* 1 year; $20,000.

UNIVERSITY OF COLORADO, Boulder, Colo; W. B. Pietenpol, Department of Physics; *Solar Radiation in 2100 Angstrom Region;* 1 year; $6,900.

COLUMBIA UNIVERSITY, New York, N. Y.; H. M. Foley, Department of Physics; *Theoretical Analysis of Hyperfine Structure Problems;* 1 year; $10,100.

DUKE UNIVERSITY, Durham, N. C.; M. M. Block, Department of Physics; *Mass and Momentum Spectra and Interactions of Charged Cosmic-Ray Particles;* 2 years; $15,000.

FLORIDA STATE UNIVERSITY, Tallahassee, Fla.; G. Schwarz and G. Rogosa, Department of Physics; *Anomalous Transmission of Radiation Through Single Crystals at the Bragg Angle;* 2 years; $16,800.

GEORGIA INSTITUTE OF TECHNOLOGY, Atlanta, Ga.; L. D. Wyly, Department of Physics; *Augular Correlation Between Nuclear Radiations;* 1 year; $7,000.

UNIVERSITY OF ILLINOIS, Urbana, Ill.; R. Maurer, Department of Physics; *Low Temperature Electronic Phenomena in Solids;* 2 years; $9,200.

INDIANA UNIVERSITY, Bloomington, Ind.; E. J. Konopinski, Department of Physics; *Theory and Interpretation of the Interaction of Elementary Particles;* 2 years; $30,000.

LEHIGH UNIVERSITY, Bethlehem, Pa.; P. Havas, Department of Physics; *Theoretical Study Concerning the Nature and Interaction of Fundamental Particles;* 1 year; $4,300.

LOUISIANA STATE UNIVERSITY, Baton Rouge, La.; J. M. Reynolds, Department of Physics; *Measurements on the Hall Effect and Magneto-Resistance of Graphite and Bismuth;* 1 year; $11,800.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Cambridge, Mass.; B. E. Warren, Department of Physics; *Elastic Spectrum of Solids by the Measurement of the Temperature Diffuse Scattering of X-Rays;* 2 years; $12,400.

UNIVERSITY OF MINNESOTA, Minneapolis, Minn.; A. O. C. Nier, Department of Physics; *Atomic Mass Determinations with Double-Focusing Mass Spectrometer;* 2 years; $45,000.

NORTHWESTERN UNIVERSITY, Evanston, Ill.; J. A. Marcus, Department of Physics; *Investigation of the Hall Effect in Metal Single Crystals at Low Temperatures;* 1 year; $9,000.

OHIO STATE UNIVERSITY, Columbus, Ohio; A. N. Dingle, Department of Physics; *Physics of Natural and Artificial Precipitation;* 2 years; $14,900.

UNIVERSITY OF OREGON, Eugene, Oreg.; S. Y. Ch'en, Department of Physics; *Shift and Broadening of Spectral Lines Under High Pressures of Foreign Gases;* 3 years; $18,900.

UNIVERSITY OF PENNSYLVANIA, Philadelphia, Pa.; B. Chance, Johnson Foundation; *Physical Methods for the Measurement of Biological Phenomena;* 3 years; $8,800.

UNIVERSITY OF PITTSBURGH, Pittsburgh, Pa.; P. M. Stehle, Department of Physics; *Theoretical Study of Positron Annihilation in Matter;* 1 year; $5,900.

ST. LOUIS UNIVERSITY, St. Louis, Mo.; H. U. Rhoads, Department of Physics; *Structure of Evaporated Metal Films as a Function of Film Thickness;* 1 year; $2,900.

WESTERN RESERVE UNIVERSITY, Cleveland, Ohio; R. G. Winter, Department of Physics; *Double Beta Decay;* 1 year; $9,500.

Psychobiology

BROWN UNIVERSITY, Providence, R. I.; C. Pfaffmann, Department of Psychology; *Psychophysiology of the Chemical Senses;* 3 years; $16,300.

CORNELL UNIVERSITY, Ithaca, N. Y.; H. E. Evans, Department of Entomology; *Behavior Patterns of Solitary Hymenoptera;* 3 years; $7,900.

UNIVERSITY OF KANSAS, Lawrence, Kans.; C. D. Michener, Department of Entomology; *Origin and Evolution of Caste Behavior Among Certain Bees;* 2 years; $13,500.

UNIVERSITY OF MICHIGAN, Ann Arbor, Mich.; E. L. Walker, Department of Psychology; *Comparison of Conditioning Techniques in Learining;* 2 years; $14,000.

STANFORD UNIVERSITY, Stanford, Calif.; C. P. Stone, Department of Psychology; *Behavior of Hypophysectomized Rats;* 2 years; $7,400.

STATE COLLEGE OF WASHINGTON, Pullman, Wash.; D. Ehrenfreund, Department of Psychology; *Role of Drive-Reward Interaction in Learning;* 2 years; $11,300.

YALE UNIVERSITY, New Haven, Conn.; F. A. Logan, Department of Psychology; *Stimulus Conditions in Learning;* 1 year; $5,000.

YALE UNIVERSITY, New Haven, Conn.; H. E. Rosvold, Department of Psychiatry; *Brain Functions in the Behavior of Infra-Human Primates;* 2 years; $25,600.

Regulatory Biology

ANTIOCH COLLEGE, Yellow Springs, Ohio; P. Feigelson, Department of Biochemistry; *Adaptive Enzyme Formation in Mammals;* 2 years; $8,500.

CALIFORNIA INSTITUTE OF TECHNOLOGY, Pasadena, Calif.; A. W. Galston, Division of Biology; *Light Controlled Growth Reactions in Plants;* 2 years; $11,000.

UNIVERSITY OF CALIFORNIA, Berkeley, Calif.; T. H. Bullock, Department of Zoology; *Neurological Study of Animal Responses to Infrared Radiation;* 3 years; $15,000.

UNIVERSITY OF CALIFORNIA, Berkeley, Calif.; C. H. Sawyer, Department of Anatomy, School of Medicine, Los Angeles, Calif.; *Hormonal Control of Enzymal Synthesis;* 1 year; $7,000.

INDIANA UNIVERSITY, Bloomington, Ind.; W. R. Breneman, Department of Zoology; *Reciprocal Endocrine Interactions in the Chick;* 3 years; $14,000.

HARVARD UNIVERSITY, Cambridge, Mass.; L. R. Cleveland, Biological Laboratories; *Molting Hormone and its Effect on Cells;* 3 years; $23,500.

HARVARD UNIVERSITY, Cambridge, Mass.; K. V. Thimann and R. H. Wetmore, Biological Laboratories; *Growth and Differentiation in Plants;* 3 years; $34,700.

UNIVERSITY OF MARYLAND, College Park, Md.; M. J. Pelczar, Jr., Department of Bacteriology; *Microbiological Degradation of Lignin;* 1 year; $5,000.

UNIVERSITY OF MINNESOTA, Minneapolis, Minn.; P. D. Boyer, Division of Agricultural Biochemistry; *Function of Sulfrydryl Groups in Enzymes;* 3 years; $18,200.

UNIVERSITY OF PENNSYLVANIA, Philadelphia, Pa.; H. Borei, Department of Zoology; *Biochemistry and Biophysics of the Fertilization Process;* 1 year; $8,000.

UNIVERSITY OF PENNSYLVANIA, Philadelphia, Pa.; J. R. Brobeck, Department of Physiology, School of Medicine; *Regulation of Food Intake by the Central Nervous System;* 3 years; $14,500.

PURDUE RESEARCH FOUNDATION, Lafayette, Ind.; H. Beevers, Department of Biological Sciences; *Fat Metabolism in Seeds and Seedlings;* 2 years; $5,000.

VANDERBILT UNIVERSITY, Nashville, Tenn.; F. R. Blood, Department of Biochemistry, School of Medicine; *Biochemistry and Nutrition of the Bat;* 2 years; $9,500.

WOODS HOLE OCEANOGRAPHIC INSTITUTION, Woods Hole, Mass.; P. F. Scholander; *Mechanism of Buoyancy Control of Fish;* 1 year; $4,000.

Systematic Biology

F. HARPER, Mt. Holly, N. J.; *Study of Nueltin Lake, Keewatin;* 1M years; $7,000.

W. H. HODGE, Silver Spring, Md.; *Flora of Dominica, B. W. I.,* 1 year; $1,700.

ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA, Philadelphia, Pa.; R. Patrick, Curator of Limnology; *Fresh-Water Diatoms of the United States;* 3 years; $31,500.

UNIVERSITY OF ARIZONA, Tucson, Ariz.; E. L. Cockrum, Department of Zoology; *Mammals of Arizona;* 3 years; $5,000.

BERNICE P. BISHOP MUSEUM, Honolulu, T. H.; J. L. Gressitt, Department of Entomology; *Insects of Micronesia;* 18 months; $15,200.

BRIGHAM YOUNG UNIVERSITY, Provo, Utah; V. M. Tanner, Department of Zoology; *Weevils of Western United States;* 1 year; $2,400.

DARTMOUTH COLLEGE, Hanover, N. H.; H. Croasdale, Department of Zoology; *Fresh-water Algae of Alaska;* 1 year; $2,500.

COLLEGE OF NEW ROCHELLE, New Rochelle, N. Y.; M. D. Rogick, Department of Biology; *Bryozoa of the Antarctic;* 1 year; $2,300.

PURDUE RESEARCH FOUNDATION, Lafayette, Ind.; J. S. Karling, Department of Biological Sciences; *Taxonomy of the Genus Synchytrium;* 3 years; $7,500.

SMITHSONIAN INSTITUTION, Washington, D. C.; A. C. Smith, Division of Phanerogams; *Descriptive Flora of the Fiji Islands;* 1 year; $5,000.

SOUTH DAKOTA SCHOOL OF MINES AND TECHNOLOGY, Rapid City, S. Dak.; J. R. Macdonald, Museum of Geology; *Study of the North American Anthrocotheres;* 1 year; $2,100.

STANFORD UNIVERSITY, Stanford, Calif; W. C. Steere, Department of Biological Sciences; *Bryophytes in Arctic Alaska;* 1 year; $3,500.

UNIVERSITY OF TENNESSEE, Knoxville, Tenn.; L. R. Hesler, Department of Botany; *Southern Appalachian Fungi, with Special Reference to the Basidiomycetes;* 2 years; $5,000.

UTAH STATE AGRICULTURAL COLLEGE, Logan, Utah; A. H. Holmgren, Curator, Intermountain Herbarium; *Intermountain Flora;* 2 years; $4,000.

UNIVERSITY OF UTAH, Salt Lake City, Utah; S. D. Durrant, Department of Vertebrate Zoology; *Mammals of Isolated Mountains of Southern Utah;* 2 years; $5,000.

General

UNIVERSITY OF CALIFORNIA, Berkeley, Calif., S. F. Cook and N. Pace, Department of Physiology, School of Medicine; *Operating Expenses of the White Mountain High Altitude Research Station;* 3 years; $32,800.

MARINE BIOLOGICAL LABORATORY, Woods Hole, Mass.; P. B. Armstrong; *Research in Marine Biology;* 2 years; $20,000.

WORCESTER FOUNDATION FOR EXPERIMENTAL BIOLOGY, Shrewsbury, Mass.; G. Pincus, Director of Laboratories; *Analysis of Steroids by Ultra-Violet Spectroscopy;* $10,000.

APPENDIX III

Contracts and Grants Other Than Research Awarded in Fiscal Year 1953

Studies in Science

Amherst College, Amherst, Mass.; *Conference on Physics Research in Colleges;* $3,765.

University of Chicago, Chicago, Ill.; H. C. Urey, Institute for Nuclear Studies; *Conference on Abundance of the Elements;* $4,000.

Columbia University, New York, N. Y.; *Symposium on the Biochemical and Physiological Interrelationships of Glutathione;* $8,200.

Duke University, Durham, N. C.; *Conference on Cosmic Rays;* $8,500.

University of Michigan, Ann Arbor, Mich.; *Symposium on Astrophysics;* $5,500.

University of New Mexico, Albuquerque, N. Mex.; *Conference on Motions in the Upper Atmosphere;* $5,000.

Rice Institute, Houston, Tex.; W. V. Houston, Department of Physics; *Third International Conference on Low Temperature Physics;* $8,000.

University of Rochester, Rochester, N. Y.; R. E. Marshak, Department of Physics; *Third Annual Conference on High Energy Physics;* $3,200.

University of Rochester, Rochester N. Y.; *Fourth Annual Conference on High Energy Nuclear Physics;* $3,000.

Simmons College, Boston, Mass.; J. L. Solinger, Department of Biology; *Survey of the Subject Matter of Introductory Biology Courses;* 1 year; $2,000.

University of Wisconsin, Madison, Wis.; *Symposium on Utilization of Solar Energy;* $6,000.

Worcester Foundation for Experimental Biology, Shrewsbury, Mass.; G. Pincus; *Conference on Methods of Determination of Steroids of Blood and Urine;* $8,900.

American Mathematical Society, Providence, R. I.; *Summer Mathematical Institute;* $20,000.

American Psychological Association, Washington, D. C.; *Study of the Development and Status of Psychology;* 11 months; $40,000.

Cornell University, Ithaca, N. Y.; *Conference on Fiber Bundles and Differential Geometry;* $2,200.

National Academy of Sciences, Washington, D. C.; *Committee on Photobiology;* 1 year; $10,000.

National Academy of Sciences, Washington, D. C.; J. Kaplan and W. W. Atwood, Jr.; *Support of the U. S. National Committee for the Third Geophysical Year;* 6 months; $5,000.

Northwestern University, Evanston, Ill.; *Conference on Problems in Astrometry;* $7,400.

Society for the Study of Development and Growth, New Haven, Conn.; *Symposium on Specificity in Development;* $1,500.

Colloquium of Astronomers, Lowell Observatory, Flagstaff, Ariz.; $4,885.

Education in the Sciences

UNIVERSITY OF COLORADO, Boulder, Colo.; B. W. Jones, Department of Mathematics; *Summer Conference in Collegiate Mathematics;* 8 weeks; $12,750.

STATE UNIVERSITY OF IOWA, Iowa City, Iowa; G. W. Stewart, Department of Physics; *Colloquium of College Physicists;* 3 years; $4,100.

UNIVERSITY OF MINNESOTA, Minneapolis, Minn.; J. W. Buchta, Department of Physics; *Summer Institute for College Teachers of Physics;* 5 weeks; $9,500.

UNIVERSITY OF OKLAHOMA, Norman, Okla.; H. Harvey, Department of Biological Sciences; *Summer Conference in Collegiate Biology;* $5,500.

SCIENCE SERVICE, INC., Washington, D. C.; *Support of Science Clubs of America;* 1 year; $10,000.

SOCIETY OF SYSTEMATIC ZOOLOGY; R. E. Blackwelder, Secretary; *Discussion Panels on Basic Concepts in Zoology;* $1,000.

Scientific Personnel Information

AMERICAN COUNCIL OF LEARNED SOCIETIES, Washington, D. C.; J. F. WELLEMEYER, Jr., Staff Adviser; *Publication of the Combined Coding and Classification Systems used in National Registration;* 3 months; $800.

AMERICAN MATHEMATICAL SOCIETY, Providence, Rhode Island; E. G. Begle, Secretary; *Survey to Determine Operating Procedures to be Followed in Compilation and Maintenance of a, Register of Mathematicians;* 3 months; $650.

AMERICAN VETERINARY MEDICAL ASSOCIATION, Chicago, Illinois; J. G. Hardenbaugh Executive Secretary; *Establishing a Register of Veterinarians;* 3 months; $2,600.

FEDERATION OF AMERICAN SOCIETIES FOR EXPERIMENTAL BIOLOGY, Washington, D. C.; M. O. Lee, Executive Secretary; *Establishing a Register of Experimental Biologists;* 1 year; $11,400.

NATIONAL ACADEMY OF SCIENCES, Washington, D. C.; R. W. Webb, Executive Director, American Geological Institute; *Establishing a Register of Scientific and Technical Personnel in the Earth Sciences;* 1 year; $11,500.

Training in the Sciences

EDUCATIONAL TESTING SERVICE, Princeton, N. J.; *Testing Candidates for Academic Year 1953–54 Fellowship Program;* 1 year; $47,500.

NATIONAL ACADEMY OF SCIENCES, Washington, D. C.; *Evaluation of NSF Fellowship Applicants for Academic Year 1953–54, and Analysis of Fellowship Programs;* 14 months; $65,000.

Exchange of Scientific Information

AMERICAN ASSOCIATION OF PHYSICS TEACHERS, Lexington, Ky.; T. H. Osgood, Dean School of Graduate Studies, Michigan State College, East Lansing, Mich.; *Compilation and Publication of a Twenty-Year Cumulative Index for the American Journal of Physics;* 1 year; $3,600.

AMERICAN ASTRONOMICAL SOCIETY, Madison, Wis.; C. M. Huffner, Secretary, Washburn Observatory, Madison, Wis.; *Publication of a Supplement to the Astrophysics Journal and an Annual Issue of the Astronomical Journal;* 2 years; $9,200.

AMERICAN MATHEMATICAL SOCIETY, Providence, R. I.; H. M. MacNeille, Executive Director; *Experimental Project to Explore the Possibilities of Reducing the Costs of Publication and Distribution of the Results of Research in the Field of Mathematics;* 1 year; $6,300.

ASTRONOMICAL SOCIETY OF THE PACIFIC, San Francisco, Calif.; S. B. Nicholson, Chairman, Publications Committee; *Compilation and Publication of a Fifteen-Year Cumulative Index to the Publications of the Society;* 2 years; $2,500.

BIOLOGICAL ABSTRACTS, INC., Philadelphia, Pa.; *Emergency Support of Biological Abstracts;* 2 years; $25,000.

COLUMBIA UNIVERSITY, New York, N. Y.; E. J. Simmons, Head, Department of Slavic Languages; *Translation of Certain Scientific Papers from the Russian and Compilation of a Russian-English Card-file Glossary in Science;* 1 year; $40,000.

THE LIBRARY OF CONGRESS, Washington 25, D. C.; R. L. Zwemer, Chief, Science Division; *Compilation of Lists of Scientific and Technical Serial Publications;* 9 months; $25,000.

NATIONAL ACADEMY OF SCIENCES, Washington, D. C.; *Preparation of a Glossary of Terms Used in Geology and Related Sciences;* 2 years; $7,500.

UNIVERSITY OF PENNSYLVANIA, Philadelphia, Pa.; F. B. Wood, Department of Astronomy; *Compilation and Publication of a Finding List for Observers of Eclipsing Variables;* 1 year; $2,000.

SMITHSONIAN INSTITUTION, Washington, D. C.; *Support of The Program for Foreign Exchange of Scientific Literary and Governmental Reports;* 6 months; $6,000.

International Travel Grants

H. L. ALDEN, University of Virginia, Charlottesville, Va., to Rome, Italy.
O. N. ALLEN, University of Wisconsin, Madison, Wis., to Rome, Italy.
R. S. ANDERSON, University of South Dakota, Vermillion, S. Dak., to Cambridge, England.
L. BINNENDIJK, Carleton College, Northfield, Minn., to Rome, Italy.
D. BLISS, Harvard University, Cambridge, Mass., to Naples, Italy.
R. H. BOLT, Massachusetts Institute of Technology, Cambridge, Mass., to Europe.
B. J. BOK, Harvard University, Cambridge, Mass., to Groningen, Netherlands.
S. E. BRANHAM, National Institutes of Health, Bethesda, Md., to Rome, Italy.
M. S. BROWN, Texas Agricultural Experiment Station, College Station, Tex., to Bellagio, Italy.
H. L. CARSON, Washington University, St. Louis, Mo., to Bellagio, Italy.
E. CASPARI, Wesleyan University, Middletown, Conn., to Bellagio, Italy.
R. V. DIPPEL, University of Indiana, Bloomington, Ind., to Bellagio, Italy.
J. T. EDSALL, Harvard University, Cambridge, Mass., to Stockholm, Sweden.
P. J. FLORY, Cornell University, Ithaca, N. Y., to Kyoto, Japan.
A. S. FOX, Ohio State University, Columbus, Ohio, to Bellagio, Italy.
J. P. FOX, Tulane University, New Orleans, La., to Rome, Italy.
H. I. EWEN, Harvard University, Cambridge, Mass., to Sydney, Australia.
J. G. GALL, University of Minnesota, Minneapolis, Minn., to Bellagio, Italy.
E. J. GARDNER, Utah State Agricultural College, Logan, Utah, to Bellagio, Italy.
R. B. GOLDSCHMIDT, University of California, Berkeley, Calif., to Bellagio, Italy.
M. M. GREEN, University of California, Davis, Calif., to Bellagio, Italy.
R. A. HELLIWELL, Stanford University, Stanford, Calif., to Sydney, Australia.
I. M. KOLTHOFF, University of Minnesota, Minneapolis, Minn., to Oxford, England.
L. H. KLEINHOLZ, Reed College, Portland, Oregon, to Naples, Italy.
G. P. KUIPER, University of Chicago, Chicago, Ill., to Rome, Italy.
R. P. LEVINE, Amherst College, Amherst, Mass., to Bellagio, Italy.
L. A. MANNING, Stanford University, Stanford, Calif., to Sydney, Australia.
R. E. MARSHAK, University of Rochester, Rochester, N. Y., to Kyoto, Japan.

M. W. MAYALL, Harvard University, Cambridge, Mass., to Rome, Italy.
J. E. MAYER, University of Chicago, Chicago, Ill., to Kyoto, Japan.
M. G. MELLON, Purdue University, Lafayette, Ind., to Oxford, England.
M. G. MORGAN, Dartmouth College, Hanover, N. H., to Sydney, Australia.
W. W. MORGAN, University of Chicago, Chicago, Ill., to Groningen, Netherlands.
C. P. OLIVER, University of Texas, Austin, Tex., to Bellagio, Italy.
J. R. OPPENHEIMER, Institute for Advanced Study, Princeton, N. J., to Kyoto, Japan.
R. R. OVERMAN, University of Tennessee, Memphis, Tenn., to Istanbul, Turkey.
I. I. RABI, Columbia University, New York, N. Y., to Kyoto, Japan.
G. T. REYNOLDS, Princeton University, Princeton, N. J., to Bagneres de Bigorre, France.
R. SAGER, Rockefeller Institute for Medical Research, New York, N. Y., to Rome, Italy.
M. SCHWARZSCHILD, Princeton University, Princeton, N. J., to Rome. Italy.
S. SILVER, University of California, Berkeley, Calif., to Sydney, Australia.
G. W. SINCLAIR, Ohio Wesleyan University, Delaware, Ohio, to Copenhagen, Denmark.
J. C. SLATER, Massachusetts Institute of Technology, Cambridge, Mass., to Kyoto, Japan.
A. H. SPARROW, Brookhaven National Laboratory, Upton, N. Y., to Bellagio, Italy.
K. F. STEIN, Mt. Holyoke College, South Hadley, Mass., to Bellagio, Italy.
M. SWANN, Texas State College for Women, Denton, Tex., to Bellagio, Italy.
W. SZYBALSKI, Biological Laboratory, Cold Spring Harbor, N. Y., to Rome, Italy.
R. L. USINGER, University of California, Berkeley, Calif., to Copenhagen, Denmark.
B. WALLACE, Biological Laboratory, Cold Spring Harbor, N. Y., to Bellagio, Italy.
J. A. WHEELER, Princeton University, Princeton, N. J., to Kyoto, Japan.
E. P. WIGNER, Princeton University, Princeton, N. J., to Kyoto, Japan.
C. M. WILLIAMS, Harvard University, Cambridge, Mass., to Copenhagen, Denmark.
M. L. WOLFROM, Ohio State University, Columbus, Ohio, to Stockholm, Sweden.
J. H. YOE, University of Virginia, Charlottesville, Va., to Oxford, England.

APPENDIX IV

Graduate Fellowship Program

Distribution of NSF Fellowships by State of Residence for the Academic Year 1953–54

Region and State	*Applications received*	*Awards made*
NORTHEAST		
Connecticut	87	11
Maine	6	2
Massachusetts	170	25
New Hampshire	13	1
New Jersey	144	22
New York	619	83
Pennsylvania	257	35
Rhode Island	16	3
Vermont	6	1
SOUTH		
Alabama	26	1
Arkansas	8	0
Delaware	9	2
District of Columbia	39	6
Florida	36	8
Georgia	40	3
Kentucky	23	4
Louisiana	19	2
Maryland	58	10
Mississippi	11	2
North Carolina	54	7
Oklahoma	29	8
South Carolina	10	1
Tennessee	36	6
Texas	86	15
Virginia	54	9
West Virginia	16	1

Region and State	*Applications received*	*Awards made*
NORTH CENTRAL		
Illinois	261	47
Indiana	92	15
Iowa	47	12
Kansas	44	11
Michigan	95	18
Minnesota	57	12
Missouri	55	15
Nebraska	15	5
North Dakota	11	3
Ohio	118	32
South Dakota	11	2
Wisconsin	77	15
WEST		
Arizona	10	1
California	312	59
Colorado	36	8
Idaho	13	2
Montana	10	3
Nevada	3	1
New Mexico	15	3
Oregon	34	6
Utah	26	5
Washington	62	10
Wyoming	7	2
POSSESSIONS		
Hawaii	10	2
Puerto Rico	2	0
Other	3	0

Distribution of NSF Fellowships by Year of Study and Field for the Academic Year 1953–1954

Field	Predoctoral			Post-doctoral	Total
	First year	Inter-mediate	Terminal year		
Life sciences	33	55	62	18	168
Chemistry	46	40	36	7	129
Engineering	27	15	20	1	63
Geology	10	8	7	1	26
Mathematics	21	16	12	7	56
Physics and astronomy	43	32	32	8	115
Total	180	166	169	42	557

Names, Residence and Field of Study of Persons Awarded National Science Foundation Fellowships for Fiscal Year 1953

ALABAMA

PRIESTLEY TOULMIN, Birmingham, Geosciences.

ARIZONA

BRADLEY D. BUCHER, Phoenix, Mathematics.

CALIFORNIA

DANA LEROY ABELL, Fresno, Zoology.

ELIHU ABRAHAMS,[1] Berkeley, Physics.

CHARLES F. ANDREWS, Pasadena, Chemistry.

DOUGLAS EINAR APPLEQUIST, Berkeley, Chemistry.

LYLE CHOLWELL BACON, Pasadena, Physics.

IVAN STANLEY BJORKLUND, Los Angeles, Engineering.

DON LOUIS BUNKER, Simi, Chemistry.

KENTON LEE CHAMBERS, Paso Robles, Botany.

ROBERT SCOTT CREELY, San Francisco, Geosciences.

RAYMOND FREDERIC DASMANN, Berkeley, Zoology.

DONALD DE FREMERY, Oakland, Biochemistry.

BERNARD ELSPAS, Palo Alto, Engineering.

MARTIN EMIL FULLER, Hawthorne, Chemistry.

DAVID GARFINKEL, Berkeley, Biochemistry.

ROY WALTER GOULD,[1] Pasadena, Physics.

DALE WALTER GRANT,[1] Gustine, Microbiology.

JOHN WILLIAM HAMPTON, Berkeley, Chemistry.

BILLY J. HARTZ, Albany, Engineering.

RICHARD H. HELM, Mountain View, Physics.

CLIFFORD ANDRAE HOPSON, Mill Valley, Geosciences.

JOHN CHARLES HUBBS, Berkeley, Physics.

LIONEL FRANCIS JAFFE,[1] Pasadena, Zoology.

THOMAS LLEWELLYN JENKINS, Berkeley, Physics.

CLIFFE DAVID JOEL, Vista, Biochemistry.

ARNOLD HERBERT KAHN, Berkeley, Physics.

ROBERT PAUL KRAFT, Albany, Astronomy.

RUSSELL SHERMAN LEHMAN, Menlo Park, Mathematics.

JAMES ARTHUR LOCKHART, Los Angeles, Botany.

JOHN WARREN LUCAS, Ontario, Engineering.

JOSEPH INGLES MACGEE, Berkeley, Microbiology.

[1] Declined.

JON MATHEWS, Hollywood, Physics.
PAUL CECIL MARTIN, Los Angeles, Physics.
ERNEST ALAN MEYER, Berkeley, Microbiology.
ARTHUR MILLER, Pasadena, Chemistry.
STANLEY LLOYD MILLER, Oakland, Chemistry.
IRA KELLY MILLS, San Pedro, Botany.
JAMES DAWSON MOHLER, Berkeley, Genetics.
JAMES GREGORY MOORE, Palo Alto, Geosciences.
LLOYD N. MORRISETT, JR., Los Angeles, Psychology.
BRUCE C. MURRAY, Los Angeles, Geosciences.
ROBERT ALLEN NORRIS, Berkeley, Zoology.
WHEELER JAMES NORTH, La Jolla, Zoology.
DALLAS LYNN PECK, San Gabriel, Geosciences.
PETER MARTIN RAY, Saratoga, Botany.
ROBERT CHARLES REMPEL, Stanford, Physics.
ELMER GLEN RICHARDS, Fontana, Biochemistry.
WILLIAM GLENN SLY, Lakeside, Chemistry.
FELIX TEISSEIRE SMITH, San Francisco, Chemistry.
RONALD DEAN SMITH, Oakland, Chemistry.
ERNST SNAPPER, Los Angeles, Mathematics.
ROBERT JAMES STANTON, JR., Glendale, Geosciences.
MORTIMER PAUL STARR,[1] Davis, Microbiology.
ROBERT FRANCIS STEIDEL, Berkeley, Engineering.
EDWARD ABRAHAM STERN, Los Angeles, Physics.
RICHARD BARTLETT TAYLOR, Claremont, Geosciences.
GEORGE HENRY TRILLING, Los Angeles, Physics.
MILTON DENMAN VAN DYKE,[1] Los Altos, Mathematics.
VICTOR ANTON VAN LINT, Pasadena, Physics.
ARTHUR EDWIN WENNSTROM, Los Angeles, Engineering.

COLORADO

ERIK KAUFFMANN BONDE, Longmont, Botany.
DAVID MARION CHASE, Denver, Physics.
WILLIAM GEORGE HOEKSTRA, Golden, Biochemistry.
CHARLES WILLIAM LINDENMEIER,[1] Fort Collins, Physics.
BRUCE HARRY MORGAN, Denver, Physics.
CARL FREDERICK PRENZLOW, Englewood, Chemistry.
JOHN LEONARD WESTLEY, Denver, Biochemistry.
DAVID JAMES WILSON,[1] Fort Collins, Chemistry.

CONNECTICUT

WILLIAM THOMAS DOYLE, New Haven, Physics.
DONALD LAWRENCE GILMAN, Storrs, Geosciences.
CLARENCE LESLIE GREGORY, Greenwich, Engineering.
WILLIAM SERMOLINO HILLMAN, Westport, Botany.
PAUL MERLE LAFLAMME, Hartford, Biochemistry.
JOSEPHINE OWEN MEINHART, New Haven, Biochemistry.
HARRY DOWD PECK, Middletown, Microbiology.
FREDERIC M. RICHARDS,[1] Wilton, Biochemistry.
ZEVI WALTER SALSBURG,[1] Hartford, Chemistry.
MAXINE FRANK SINGER, New Haven, Biochemistry.
ETHEL STOLZENBERG TESSMAN, New Haven, Biophysics.

DELAWARE

KENNETH JOHN BELL, Newark, Engineering.
RICHARD EUGENE EMMERT, Newark, Engineering.

DISTRICT OF COLUMBIA

NORMAN CASTLEMAN CRAIG, Chemistry.
DAVID HIRSCH EZEKIEL, Microbiology.
ROYAL BRUCE KELLOGG, Mathematics.
FRANCIS LINCOLN LAMBERT, Zoology.
LEON JOSEPH SCHKOLNICK, Physics.
JEROME SPANIER, Mathematics.

[1] Declined.

FLORIDA

ALEXANDER TROY COLE, De Land, Geosciences.
PAUL S. HUBBARD, Jr., St. Petersburg, Physics.
HARRY WILLIAM JOHNSON, Jr., WAVERLY, Chemistry.
DEAN FRANCIS KELLEY, Tallahassee, Chemistry.
EARL WELLS McKISSON, Gainesville, Chemistry.
JACOB SHAPIRA, Tallahassee, Biochemistry.
WILLIS WOODBURY TYRRELL, Pensacola, Geosciences.
THOMAS HAMIL WOOD,[1] Tallahassee, Biophysics.

GEORGIA

ARTHUR WILLIAM FORT, Americus, Chemistry.
JOHN ELDON PIPPIN, Atlanta, Engineering.
HUGH GETTYS ROBINSON, Atlanta, Physics.

IDAHO

MALCOLM THOMAS JOLLIE, Moscow, Zoology.
LAVERNE EUGENE RUBY, Caldwell, Mathematics.

ILLINOIS

JAMES STUART AAGAARD, Chicago, Engineering.
FRANK LLUBERAS ALLEN, Chicago, Biophysics.
GEORGE EDWARD BACKUS, Chicago, Physics.
ROBERT ELI BARON, Chicago, Physics.
HUGH NEEDHAM BROWN, Urbana, Physics.
BERNARD CENTURY, Chicago, Medical Sciences.
LORENCE GENE COLLINS, Champaign, Geosciences.
WILLIAM EDWARD COOLEY, Champaign, Chemistry.
RICHARD EARL DICKERSON, Charleston, Chemistry.
DOUGLAS AMBROSE EGGEN, Chicago, Biophysics.
JEREMIAH PATRIC FREEMAN,[1] Urbana, Chemistry.
DONALD SHEPARD GAGE, Palatin, Engineering.
ROBERT BRUCE GARLAND, Elgin, Chemistry.
DAVID MELVILLE GELLER, Oak Park, Biochemistry.
RICHARD WILLIAM GLADE, Champaign, Zoology.
NATHANIEL ROY GOODMAN, Chicago, Mathematics.
JACQUE EDGAR HANLON, Chicago, Physics.
DANIEL D. HENDLEY, Chicago, Biochemistry.
DALE RICHARD HOFF, Galesburg, Chemistry.
WILLIAM THOMAS KABISCH, Chicago, Medical Sciences.
MALVIN HOWARD KALOS,[1] Urbana, Physics.
CARL WILLIAM KAMMEYER, Washington, Chemistry.
WILLIAM E. M. LANDS, Urbana, Biochemistry.
WILLIAM LEWIS LICHTEN, Chicago, Physics.
ANDREW DAVID LIEHR, Chicago, Physics.
ROBERT LEE METZENBERG, JR., Highland Park, Biochemistry.
ROBERT EUGENE MEYER, Bellewood, Chemistry.
ROBERT HARBISON MOUNTJOY, Chicago, Mathematics.
JOHN LUDWIG MUERLE,[1] Springfield, Engineering.
JOSEPH EDWARD NELSON, Chicago, Mathematics.
CLIFFORD SHELDON PATLAK, Chicago, Zoology.
RICHARD EUGENE PRIEST, Urbana, Mathematics.
ALFRED GUILLOU REDFIELD, Urbana, Physics.
ARTHUR HINTON ROSENFELD, Chicago, Physics.
WILLARD NELS ROSINE, Galesburg, Zoology.
THEODORE DAVID SCHULTZ, Glencoe, Physics.
DONALD ARTHUR SPEER, Morton Grove, Chemistry.
EDWARD OTTO STEJSKAL, Berwyn, Chemistry.
GENE STRULL, Chicago, Engineering.

[1] Declined.

WILLIAM JUNKICHI TAKEI, Chicago, Chemistry.
ROBERT E. TAYLOR, Chicago, Medical Sciences.
RICHARD SANBORN THOMAS, Champaign, Biophysics.
ROBERT BENJAMIN URETZ, Chicago, Biophysics.
ROBERT ALLAN SWANSON, Chicago, Physics.
WILLIAM GEORGE VAN DER KLOOT,[1] Chicago, Medical Sciences.
JOHN PATTESON WEHRENBERG, West Springfield, Geosciences.
JAMES WILLIAM WILT, Chicago, Chemistry.

INDIANA

WILLIAM WALLACE CLELAND, Bloomington, Biochemistry.
ROBERT LOUIS CONNER, Marion, Biochemistry.
ROGER ESTLICK GERKIN, South Bend, Chemistry.
THEODORE MORGAN HALLMAN, West Lafayette, Engineering.
EARL DORCHESTER HANSON, Bloomington, Genetics.
JOSEPH DAVID HARRIS, West Lafayette, Biophysics.
JOHN BURNETT HEMWALL, West Lafayette, Agriculture.
RICHARD ROWLS HIATT, Indianapolis, Chemistry.
DONALD JOSEPH MASON, Kokomo, Microbiology.
THOMAS ROBERT MERTENS, St. Joe, Genetics.
ROBERT RAMSAY SEANEY, Fort Wayne, Agriculture.
MICHAEL EDWARD SENKO, Crown Point, Chemistry.
JAMES RICHARD TROYER, Elkhart, Botany.
STEPHEN A. WAINWRIGHT,[1] Indianapolis, Zoology.
EDWARD OSBORNE WILSON,[1] Jeffersonville, Zoology.

IOWA

JOHN CRAVEN BELSHE,[1] Emmetsburg, Geosciences.
JOHN BERNARD CARLSON, Ames, Botany.
MARVIN EMERSON EBEL, Waterloo, Physics.
GORDON GRANT, Cedar Falls, Astronomy.
JOSEPH BRUCE GRIFFING,[1] Ames, Genetics.
ROGER WAYNE HANSON, Rake, Zoology.
THERESE MARIE KELLEHER, Des Moines, Botany.
JUDSON ULERY MCGUIRE, Ames, Zoology.
WILLARD DALE ROTH, Waterloo, Zoology.
TRAVIS EDWARD STEVENS, Ames, Chemistry.
GEORGE ROWLAND WHITE, Ames, Physics.
HUGH DAVID YOUNG, Osage, Physics.

KANSAS

SYDNEY ANDERSON, Lawrence, Zoology.
NORMAN PAUL BAUMANN, Sylvan Grove, Physics.
JIM ENOCH DALE, Osawatomie, Agriculture.
VIRGINIA ROGERS FERRIS, Abilene, Botany.
CHARLES CULLEN GRIMES, Chanute, Physics.
EDWIN DALE HORNBAKER, Louisburg, Chemistry.
JOHN LEROY KELLEY, Lawrence, Mathematics.
ARTHUR HERMAN KRUSE, Wichita, Mathematics.
KENNETH ROBERT LUCAS, Lawrence, Mathematics.
DAVID WARREN MCCALL, Wichita, Chemistry.
FRANCIS WARE PROSSER, Lawrence, Physics.

KENTUCKY

WILLIAM WALLACE HUNT, JR., Franklin, Chemistry.
JOEL WILLIAM MCCLURE, JR., Lexington, Physics.
JAMES MERRILL MARTIN, Lamasco, Physics.
THOMAS WILSON MULLIKIN, Georgetown, Mathematics.

LOUISIANA

ALAN HERBERT CHEETHAM, Shreveport, Geosciences.
PIERRE EUCLIDE J. CONNER, Lafayette, Mathematics.

MAINE

DAVID CHARLES MAUZERALL, Sanford, Chemistry.
DAVID BENJAMIN STEWART, East Sumner, Geosciences.

---

[1] Declined.

278626—54——7

MARYLAND

ROBERT HARRY GILPIN, Cumberland, Microbiology.
JUDSON HARDY, JR., Silver Spring, Physics.
RICHARD LAMOND IRWIN, Baltimore, Chemistry.
ROLF WERNER JUHLE,[1] Ironsides, Geosciences.
WILLIAM JOHN LEVEDAHL, Kensington, Engineering.
FREDERICK WIESNER LIPPS, JR., Baltimore, Physics.
THEODORE FRANK MARIANI, Cottage City, Engineering.
SIDNEY RANKIN, Baltimore, Engineering.
L. EDWARD SCRIVEN, Elkton, Engineering.
PETER FALLON STEHLE, Baltimore, Chemistry.

MASSACHUSETTS

JOLANE PRUDENCE BAUMGARTEN, Cambridge, Medical Sciences.
EDITH CONSTANCE CLARKE, Concord, Biochemistry.
ELMON LEE COE, Boston, Biochemistry.
LLOYD ARTHUR CURRIE, Somerville, Chemistry.
BRUCE SIGMUND FISHER, Cambridge, Chemistry.
RICHARD M. FRANKLIN, Dorchester, Biophysics.
RALPH CLIVE GREENOUGH, Medford, Chemistry.
WILLIAM BRUCE HAWKINS, JR., Springfield, Physics.
JACK HILIBRAND, Cambridge, Engineering.
LLOYD GEORGE HYMAN, Boston, Physics.
MARTIN KARPLUS, West Newton, Chemistry.
JOSHUA KURLAND KOPP, Dorechester, Physics.
ELLIOTT HERSHEL LIEB, Brighton, Physics.
CAROLINE STUART LITTLEJOHN, Cambridge, Physics.
DONALD MORE MAYNARD, Jr.,[1] West Newton, Zoology.
JOHN COLEMAN MOORE, Belmont, Mathematics.
RICHARD SHELDON PALAIS, Brookline, Mathematics.
JOHN WINSOR PRATT, Concord, Mathematics.
CARL ARTHUR PRICE, Cambridge, Biochemistry.
PHILLIPS WESLEY ROBBINS, Leominster, Biochemistry.
ROBERT HORTON ROMER, Cambridge, Physics.
ROBERT DAVID STOLOW, Brookline, Chemistry.
PETER PAUL VAUGHN, Cambridge, Zoology.
PETER HANS VON HIPPEL, Weston, Biophysics.
ROBERT CULBERTSON WEST, Boston, Chemistry.

MICHIGAN

EDWIN HALL BATTLEY, Port Huron, Microbiology.
JAMES LEE BURKHARDT, Birmingham, Physics.
I. THOMAS CUNDIFF, Jr., Kalamazoo, Mathematics.
HOWARD MELVIN DESS, Ann Arbor, Chemistry.
GEORGE WILLARD FORD, Troy, Physics.
JOHN MITCHELL GARY, Kalamazoo, Mathematics.
ROBERT HOWARD GOOD, Ann Arbor, Physics.
RICHARD LOUIS HAUKE, Detroit, Botany.
ROBERT RICHARDS LEWIS, Jr., Ann Arbor, Physics.
DAVID MILLARD LOCKE, Escanaba, Chemistry.
CHARLES BRIAN MAGEE, Detroit, Chemistry.
KNUT JONSON NORSTOG, Willow Run, Botany.
HERBERT BOWEN PAHL, Ann Arbor, Biochemistry.
RICHARD HOUGHTON PRATT, Mount Pleasant, Physics.
ETHEL MARGARET AUGHEY REID, Royal Oak, Chemistry.
WILLIAM DAVID SLAWSON, Grand Rapids, Physics.
JOSEPH CHARLES STEVENS, Grand Rapids, Psychology.
GEORGE ALEXANDER VIDAVER, Detroit, Biochemistry.

[1] Declined.

MINNESOTA

William Thomas Battin, Minneapolis, Zoology.
John Amerpohl Davison, Minneapolis, Zoology.
Duane Gordon Erickson, Minneapolis, Zoology.
William Clarence Erickson, Duluth, Physics.
John Robert Holum, Minneapolis, Chemistry.
Nahmin Horwitz, Minneapolis, Physics.
Kirk Warren McVoy, Minneapolis, Physics.
Paul Chadwick Royce, Brainerd, Medical Sciences.
Evalyn F. Segal, Minneapolis, Psychology.
Richard Myron Straw, St. Paul, Zoology.
Warren Freyschlag Wade, Minneapolis, Engineering.
Richard Anthony Zemlin, Minneapolis. Mathematics.

MISSISSIPPI

Jesse Lane Fletcher, State College, Agriculture.
Edward Everett Grace, Corinth, Mathematics.

MISSOURI

Sterling Gaylen Bradley, Springfield, Microbiology.
Herbert Conrad de Staebler, Kirkwood, Physics.
Lise Gruen, Kansas City, Chemistry.
William Terril Higdon, Independence, Agriculture.
Edwin Ray Hiller, Jr., Glendale, Engineering.
Richard Thomas Keller, St. Joseph, Chemistry.
Leonard Sol Kisslinger, St. Louis, Physics.
Lester Herman Krone, Jr., Jennings, Engineering.
Theodore Alfred Long, Seneca, Agriculture.
Kenneth Lloyd Rinehart, Chillicothe, Chemistry.
William Arthur Steele, St. Louis, Chemistry.
George Hubert Stout, St. Louis, Chemistry.
John McConkle Teem, Springfield, Physics.
Louis Joseph Tichacek, St. Louis, Engineering.
Edgar William Warnhoff,[1] St. Louis, Chemistry.

MONTANA

Edwin Harold Eylar, Butte, Biochemistry.
Loris Donald Hamlin, Hardin, Microbiology.
John Clancey Powers, Jr., Billings, Chemistry.

NEBRASKA

Joan Finkle de Pena, Lincoln, Anthropology.
Richard Charles Dove, Fairbury, Engineering.
Ralph Wolfgang Kilb, Lincoln, Chemistry.
David Carter McGarvey, Omaha, Physics.
James Raymond Munkres, Broadwater, Mathematics.

NEVADA

Joseph William Weihe, Reno, Mathematics.

NEW HAMPSHIRE

Walter Joseph Bernard, Manchester, Chemistry.

NEW JERSEY

Laurence C. Bonar, Morris Plains, Biochemistry.
Ronald C. Breslow, Rahway, Chemistry.
Richard M. Chrenko, Stirling, Physics.
Robert Lee Christensen, Summit, Physics.
Thomas N. K. Godfrey, Princeton, Physics.
John Thomas Harding, Jr., Trenton, Physics.
Standish Chard Hartman, Flemington, Biochemistry.
Fred Peter Hauck, Bloomfield, Chemistry.

[1] Declined

Bentz Buell Howard, Jr., Plainfield, Chemistry.

Sol Krongelb, Jersey City, Physics.

John Williams Lamperti, Upper Montclair, Physics.

David Nelson Limber, Morris Plains, Astronomy.

Dan Leslie Lindsley, Princeton, Genetics.

Robert Marc Mazo, Camden, Chemistry.

Joshua Elihu Neimark, Elberon, Engineering.

Kenneth William Powers,[1] Ridgewood, Engineering.

Burton Richter, Paterson, Physics.

John Van Alstyne Sharp, Leonia, Geology.

John Alan Strother, Princeton, Engineering.

Lawrence Wilets, Princeton, Physics.

Peter Joseph Wojtowicz, Linden, Chemistry.

William Garfield Zoellner, East Orange, Chemistry.

NEW MEXICO

Calvin Wayne Moon, Los Alamos, Engineering.

James Charles Phillips, Albuquerque, Physics.

Charles Bryan Reynolds, Albuquerque, Geosciences.

NEW YORK

Edward Lawrence Aiello, Woodside, Zoology.

Hudson Robbins Ansley, Salamanca, Zoology.

Michael Klaus Bach, Flushing, Biochemistry.

Leonard Esau Baum, Brooklyn, Mathematics.

Arnold Mixon Benson, New York, Engineering.

Paul Walter Berg,[1] New York, Mathematics.

Samuel David Berkowitz, New York, Mathematics.

Alan Fredric Berndt, New York, Chemistry.

Seymour Michael Blinder, New York, Chemistry.

William Patrick Cain, New York, Chemistry.

Garrett Conde Clough, Newburgh, Zoology.

Rane Locke Curl, Staten Island, Engineering.

Morris A. Cynkin, Brooklyn, Microbiology.

Robert Arnold Darrow, Solvay, Biochemistry.

John William Dean, Jr., Kew Gardens, Chemistry.

Richard J. Drachman, Brooklyn, Physics.

Vera Rada Demerec Dyson-Hudson, Coldspring Harbor, Zoology.

George Edward Ericksen, New York, Geosciences.

Gerald Feinberg, New York, Physics.

Gary Felsenfeld, New York, Chemistry.

Marshall Leonard Freimer, Brooklyn, Mathematics.

Aaron Judah Friedland, New York, Engineering.

Bernard Friedland, Brooklyn, Engineering.

Gertrude Elizabeth Garbers, New York, Microbiology.

Donald Allen Geffen, Brooklyn, Physics.

James Monroe Gere, Syracuse, Engineering.

Walter Gilbert, New York, Physics.

Alan Joseph Goldman, Brooklyn, Mathematics.

Paul Greengard, Forest Hills, Medical Sciences.

Alvin Hausner, Brooklyn, Mathematics.

David Hertzig, Brooklyn, Mathematics.

Leonard Arthur Herzenberg, Brooklyn, Biochemistry.

Richard Allan Holroyd, Jamestown, Chemistry.

Paul Horowicz, New York, Biophysics.

Jack Horowitz, New York, Biochemistry.

Allen Isaacson, Brooklyn, Biophysics.

James J. Keavney, Brooklyn, Chemistry.

Roger Gordon Ketcham, New Hartford, Chemistry.

Joseph John Kohn, New York, Mathematics.

Bertram Kostant, Brooklyn, Mathematics.

[1] Declined.

Alvin Isaac Krasna, Brooklyn, Biochemistry.
Paul Harriman Kydd, Brooklyn, Chemistry.
Henry Jacob Landau, New York, Mathematics.
Leon Fred Landovitz, Brooklyn, Physics.
Norman Lazaroff, Brooklyn, Microbiology.
Richard Charles Lewontin, Flushing, Genetics.
Yale Jay Lubkin, Brooklyn, Engineering.
David Blodgett Ludlum, Rockville Center, Chemistry.
Arthur Paul Mattuck, Brooklyn, Mathematics.
Ronald Max Mayrbaurl, Brooklyn, Engineering.
Elliott Mendelson, Brooklyn, Mathematics.
Henri Emmanuel Mitler, New York, Physics.
Mark Samuel Nelkin, Ithaca, Physics.
Martha Mount Nicely, Mt. Kisco, Zoology.
John Melvin Olson, Niagara Falls, Biophysics.
John Francis Pardo, New York, Engineering.
Edward Charles Posner, Brooklyn, Mathematics.
Kenneth Sidney Rawson, Ithaca, Zoology.
Frank Albert Raymond, Syracuse, Mathematics.
Gerhard Rayna, New York, Mathematics.
Alexander H. Reisner, New Rochelle, Genetics.
Walter George Rosen, Forest Hills, Botany.
Mary Margaret Schreiner, Brooklyn, Microbiology.
Jack Schwartz, New York, Physics.
Melvin Schwartz, New York, Physics.
Richard Alan Schwarz, Jamaica, Engineering.
Silvan Samuel Schweber, Brooklyn, Physics.
George Benham Seligman, Attica, Mathematics.
Andrew Mariehoff Sessler, Jamaica, Physics.
Elias M. Stein, New York, Mathematics.
Robert Carrington Stein, New Hyde Park, Zoology.
William Allan Steward, Eggertsville, Engineering.
George Walter Sutton, Brooklyn, Engineering.
John Joseph Taylor, Levittown, Medical Sciences.
Philip Teitelbaum, Brooklyn, Psychology.
Ursula Vivian Victor, Pleasantville, Biochemistry.
Lillian K. Wainwright, Brooklyn, Genetics.
Edel Wasserman, Brooklyn, Chemistry.
Roger Weinberg, New York, Genetics.
William North White,[1] Walton, Chemistry.
Grosvenor Searles Wich, Herkimer, Chemistry.
Michael B. Yarmolinsky, New York, Biochemistry.
Ariel Charles Zemach, New York, Physics.

NORTH CAROLINA

Frederick Phillips Brooks, Jr., Greenville, Physics.
Wesley Osborne Doggett, Brown Summit, Engineering.
Francis Clark Howell,[1] Asheville, Anthropology.
Peter Michael Lang, Greensboro, Engineering.
Jackson Ramsaur Mauney, Jr., Kings Mountain, Botany.
Charles Ellis, Winslow, Jr., Raleigh, Engineering.
William Vaughn Wright, Wilson, Engineering.

NORTH DAKOTA

Wallace Edmond Laberge, Grafton, Zoology.
Robert Dean Lundberg, Valley City, Chemistry.
Paul Emery Thomas, Fargo, Mathematics.

OHIO

Norman Andrew Bates, Cleveland, Chemistry.

[1] Declined.

George Edward Briggs, Jr., Briggsdale, Psychology.
Richard Louis Deininger, Dayton, Psychology.
Marshall Paul Ernstene, Cleveland, Physics.
Doyle Owen Etter, Columbus, Engineering.
Alvin Eli Fein, Cleveland Heights, Physics.
Pat W. K. Flanagan, Dayton, Chemistry.
Roger Harold Geeslin, Cincinnati, Mathematics.
John Edward Gordon, Columbus, Chemistry.
Casimer Thaddeus Grabowski, Cleveland, Zoology.
Robert Carl Griffis, Euclid, Chemistry.
Wayne Bassett Hadley, Farmdale, Chemistry.
Walter Ashley Harrison, Toledo, Physics.
Karl Gordon Henize, Cincinnati, Astronomy.
Edward Orson Hill, Cincinnati, Microbiology.
Fred Donald Hoerger, Wadsworth, Chemistry.
Herbert Otis House,[1] Willoughby, Chemistry.
William Henry Kasner, Killbuck, Physics.
David Ronald Krieg, Lorain, Biophysics.
Daniel Lednicer, Columbus, Chemistry.
Martin Shelling Longmire, Glendale, Physics.
Stewart Henry Merrill, Andover, Chemistry.
James Thomas Morse, Mentor, Mathematics.
George Raymond Murray, Jr. Dayton, Chemistry.
Robert Kenyon Nesbet, Lakewood, Chemistry.
Richard Edwin Prange, Berea, Physics.
Kenneth Harvey Sauer, East Cleveland, Chemistry.
Robert Sundal Schutz, Columbus, Chemistry.
Robert Llewellyn Stoffer, Columbus, Chemistry.
Andrew Albert Weaver, Wooster, Zoology.
Robert Bruce Weiser, Columbus, Engineering.
Edward Zajac, Cleveland, Engineering.

OKLAHOMA

Leslie Catron Case, Tulsa, Engineering.
Robert Jacob Dunham, Perry, Geosciences.
Jack Houston Esslinger, Oklahoma City, Medical Sciences.
Edward Ambrose Flinn, Tulsa, Geosciences.
Jospeh Poyer Deyo Hull, Jr., Tulsa, Geosciences.
Harold Joseph Kidd, Red Rock, Botany.
Paul Baker McCay, Muskogee, Medical Sciences.
John David Sorrels, Poteau, Physics.

OREGON

Richard Leroy Baird, Portland, Chemistry.
Bertram Gale Dick, Portland Physics.
Margery Pearl Gray, Eugene, Anthropology.
Charles Poling Luehr, Corvallis, Chemistry.
Roy Norman Peacock, Springfield, Physics.
Richard Clarence Thomas, Corvallis, Chemistry.

PENNSYLVANIA

Igor Alexeff, Pittsburgh, Physics.
Walter Lewis Baily, Jr., Waynesburg, Mathematics.
Paul Booth Barton, Jr., Pittsburgh, Geosciences.
Robert Hamilton Boyer,[1] Johnstown, Physics.
Mark Munroe Chamberlain, Pittsburgh, Chemistry.
Victor Hugo Cohn, Reading, Medical Sciences.
Donald John Denney, Glenolden, Chemistry.
Raymond Edwin Dessy, Blawnox, Chemistry.
Jacob Feldman, Philadelphia, Mathematics.

[1] Declined.

Nathan Jacob Fine, Philadelphia, Mathematics.
H. Newton Garber, Philadelphia, Engineering.
Paul Randolph Gross, Philadelphia, Zoology.
Geneva Eitel Grosz, Philadedphia, Mathematics.
John Russell Hughes, Brookville, Psychology.
Neil Raymond Johnson, McKeesport, Engineering.
Robert John Lavfer, Pittsburgh, Chemistry.
Theodor Arthur Liss, Temple, Chemistry.
James Paul McHugh, Pittsburgh, Chemistry.
John Edward Meyer,[1] Pittsburgh, Engineering.
Robert Kenneth Miller, Harrisburg, Chemistry.
Charles William Misner, Pittsburgh, Physics.
Frederick Carl Neidhardt, Penns Park, Medical Sciences.
John Stanley Nodvik, Canonsburg, Physics.
Arthur S. Obermayer, Philadelphia, Chemistry.
Charles Arthur Plantz, Pittsburgh, Chemistry.
James Russell Powell, Bradford Woods, Engineering.
Herbert Scarf, Philadelphia, Mathematics.
Lloyd Robert Schissler, Alburtis, Engineering.
Frank Vanloon Shallcross, Philadelphia, Chemistry.
Lawrence Clement Snyder, Uniontown, Chemistry.
Raymond Andrew Sorenson, Pittsburgh, Physics.
Joan Ruth Spector, Philadelphia, Chemistry.
Paul Herman Squires, Ambridge, Engineering.
Werner B. Teutsch, Philadelphia, Physics.
John William Woll, Jr., Newton, Mathematics.

[1] Declined.

RHODE ISLAND

Paul Robert Chagnon, Woonsocket, Physics.
Lincoln Ekstrom, Providence, Chemistry.
Robert Hermann, Kingston, Mathematics.

SOUTH CAROLINA

Forrest Eugene Cookson, Jr., Clemson, Physics.

SOUTH DAKOTA

Edmund Guenthner, Bridgewater, Agriculture.
Melvin Hugo Rice, Sisseton, Physics.

TENNESSEE

William Perry Flatt, Newbern, Agriculture.
Wendell Gene Holladay, Huntingdon, Physics.
Clarence Lindenmeyer, Oak Ridge, Geosciences.
James Cullen Martin, Dover, Chemistry.
Robert Guy Parrish,[1] Franklin, Chemistry.
Thomas Jefferson Walker, Dyersburg, Zoology.

TEXAS

Calvin Larue Barker, Austin, Engineering.
Rue Linn Belford, La Porte, Chemistry.
Paul Leighton Donoho, Houston, Physics.
Martin Dworkin, Austin, Microbiology.
Daniel O'Connell Etter, Fort Worth, Mathematics.
James Franklin Gibbons, Texarkana, Engineering.
Frederick H. Kasten, Austin, Genetics.
Leon Kraintz, Houston, Medical Sciences.
Lloyd Stanton Lockingen, Houston, Biophysics.
Ellington McFall Magee, Austin, Chemistry.
John Samuel Mathis, Dallas, Physics.
John Stephen Mecham, Austin, Zoology.
Ulrich Merten, Houston, Chemistry.
Grady Linder Webster, Jr., Cedar Valley, Botany.

James Cammack Wilhoit, Jr.,[1] Houston, Engineering.

UTAH

David Ralph Bennion, Salt Lake City, Engineering.

Jerald Nelson Christiansen, Logan, Engineering.

Don Wynn Esplin, Cedar City, Medical Sciences.

Charles Edward Jacob,[1] Salt Lake City, Geosciences.

Richard Lewis Snow, Salt Lake City, Chemistry.

VERMONT

Robert Cummings Woodworth, Bennington, Chemistry.

VIRGINIA

Richard Lawson Bernard, Williamsburg, Agriculture.

Henry Gabriel Blosser, Harrisonburg, Physics.

Kent Combs Brannock, Independence, Chemistry.

Joseph Callaway, Alexandria, Physics.

Robert Ernest Cunningham, Charlottesville, Chemistry.

Hugh Everett, III, Alexandria, Physics.

James Thomas Kofron, Jr., Petersburg, Chemistry.

Harris Edward Petree, Arlington, Chemistry.

Howard Ensign Simmons, Norfolk, Chemistry.

WASHINGTON

Charles Ballantine, Seattle, Mathematics.

Jean Julian Comita,[1] Seattle, Zoology.

Glenn Arthur Crosby, Seattle, Chemistry.

Philip Alexander Cruickshank, Blaine, Chemistry.

Jack Wayne Culvahouse, Richland, Physics.

Richard Wayne Eppley, Spokane, Botany.

Paul Amos Johnson, Seattle, Engineering.

Wilbur Vance Johnson, Seattle, Chemistry.

Winston Glenn Walker,[1] Seattle, Engineering.

Sefton Robert Wellings, Poulsbo, Zoology.

WEST VIRGINIA

Richard Louis Tallman, Wheeling Chemistry.

WISCONSIN

Robert James Blattner,[1] Milwaukee, Mathematics.

James William Brault, New London, Physics.

Phillip Herbert Geil, Milwaukee, Physics.

Arthur Haltner, Jr., Milwaukee, Chemistry.

Barbara Jean Hamilton, Manitowoc, Botany.

Alan Edwin Johnsrud, Manitowoc, Physics.

Peggy Jean Kossow, Sturgeon Bay, Mathematics.

Charles Corbett Laing, Milwaukee, Botany.

Wayne Edward Magee, Madison, Biochemistry.

Melvin Laurance Morse, Madison, Genetics.

Leonard Earl Mortenson, Madison, Microbiology.

Donald Francis Root, Madison, Engineering.

Paul Woodward Schmidt, Madison, Physics.

Michael Tinkham, Ripon, Physics.

Donald B. Wetlaufer, Madison, Biochemistry.

WYOMING

James Edwin Banks, Cheyenne, Chemistry.

John Maurice Birmingham, Hyattville, Chemistry.

TERRITORY OF HAWAII

Alfred S. Hu, Honolulu, Zoology.

William Charles Peterson, Honolulu, Engineering.

[1] Declined.

INSTITUTIONS ATTENDED BY NATIONAL SCIENCE FOUNDATION FELLOWS AS UNDERGRADUATES AND GRADUATE STUDENTS

Institution and location	Number of fellows attending: As undergraduates	Number of fellows attending: As graduate students
Abraham Baldwin Agricultural College, Tifton, Ga	1	......
Amherst College, Amherst, Mass	6	......
Antioch College, Yellow Springs, Ohio	4	......
Arlington State College, Arlington, Tex	1	......
Ashland College, Ashland, Ohio	1	......
Augustana College, Rock Island, Ill	2	......
Baker University, Baldwin City, Kans	1	......
Baldwin-Wallace College, Berea, Ohio	1	......
Ball State Teachers College, Muncie, Ind	1	......
Bethany College, Bethany, W. Va	1	......
Bethel College, McKenzie, Tenn	1	......
Boise Junior College, Boise, Idaho	1	......
Bowdoin College, Brunswick, Maine	1	......
Brooklyn College, Brooklyn, N. Y	7	......
Brooklyn Polytechnic Institute, Brooklyn, N. Y	2	......
Brown University, Providence, R. I	4	3
Bryn Mawr College, Bryn Mawr, Pa	2	......
California Institute of Technology, Pasadena, Calif.	12	32
Calvin College, Grand Rapids, Mich	1	......
Cambridge University, Cambridge, England	......	4
Capital University, Columbus, Ohio	1	......
Carleton College, Northfield, Minn	4	......
Carnegie Institute of Technology, Pittsburgh, Pa	10	8
Carnegie Institution of Washington, Department of Genetics, Cold Spring Harbor, N. Y	......	1
Carthage College, Carthage, Ill	1	......
Case Institute of Technology, Cleveland, Ohio	5	......
Catholic University, Washington, D. C	1	1
Central College, Fayette, Mo	1	......
Chaffey Junior College, Ontario, Calif	2	......
Chariton Junior College, Chariton, Iowa	1	......
City College of San Francisco, San Francisco, Calif.	1	......
Claremont Graduate School, Claremont, Calif	......	1
College of the City of New York, New York, N. Y	15	......
College of Idaho, Caldwell, Idaho	1	......
College of the Pacific, Stockton, Calif	1	......
College of William and Mary, Williamsburg, Va	1	......
College of Wooster, Wooster, Ohio	5	......
Clemson Agricultural College, Clemson, S. C	1	......
Colby College, Waterville, Maine	1	......
Colorado State College of Education, Greeley, Colo.	1	......
Colorado A and M, Fort Collins, Colo	2	......
Columbia University, New York, N. Y	13	28
Cooper Union, School of Engineering New York, N. Y	2	......
Cornell University, Ithaca, N. Y	9	19

INSTITUTIONS ATTENDED BY NATIONAL SCIENCE FOUNDATION FELLOWS AS UNDERGRADUATES AND GRADUATE STUDENTS—Continued

Institution and location	*Number of fellows attending* — *As under-graduates*	*As graduate students*
Deep Springs Junior College, Deep Springs, Calif	1	......
Dennison University, Granville, Ohio	1	......
De Pauw University, Greencastle, Ind	2	......
Drew University, Madison, N. J	1	......
Duke University, Durham, N. C	4	1
Duquesne University, Pittsburgh, Pa	1	......
East Tennessee State College, Johnson City, Tenn	1	......
Eastern Kentucky State College, Richmond, Ky	1	......
Eidgenoessische Technische Hochschule, Zurich, Switzerland	......	1
El Camino Junior College, El Camino College, Calif	1	......
Emory University, Emory University, Ga	1	1
Fairbury Junior College, Fairbury, Nebr	1	......
Florida State University, Tallahassee, Fla	1	5
Fordham University, New York, N. Y	3	1
Franklin and Marshall College, Lancaster, Pa	2	......
Fresno State College, Fresno, Calif	1	......
Fritz-Haber Institute, Berlin-Dahlem, Germany	......	1
George Washington University, Washington, D. C	4	2
Georgia Institute of Technology, Atlanta, Ga	1	1
Graceland College, Lamoni, Iowa	1	......
Hamilton College, Clinton, N. Y	2	......
Harvard University, Cambridge, Mass	31	58
Haverford College, Haverford, Pa	3	......
Heidelberg College, Tiffin, Ohio		
Herzl Branch, Chicago City Junior College, Chicago,	1	......
Ill	1	......
Hofstra College, Hempstead, N. Y	1	......
Holy Cross College, Worcester, Mass	1	......
Hunter College, New York, N. Y	2	......
Illinois Ins itute of Technology, Chicago, Ill	3	1
Indiana University, Bloomington, Ind	4	9
Institute for Advanced Study, Princeton, N. J	......	2
Institute of Agriculture, Vienna, Austria	......	1
Institute for Theoretical Physics, Copenhagen, Denmark	......	1
Iowa State College, Ames, Iowa	7	11
Iowa State Teachers College, Cedar Falls, Iowa	1	......
Iowa State University, Iowa City, Iowa	3	1
Johns Hopkins University, Baltimore, Md	3	14
Kansas City Junior College, Kansas City, Mo	1	......
Kalamazoo College, Kalamazoo, Mich	1	......
Kansas State Teachers College, Emporia, Kans	1	......
Kenyon College, Gambier, Ohio	3	......
Knox College, Galesburg, Ill	1	......
Lassen Junior College, Susanville, Calif	1	......
Lebanon Valley College, Annville, Pa	1	......
Lehigh University, Bethlehem, Pa	3	1

Long Island Biological Association, Cold Spring Harbor, N. Y	......	1
Los Angeles City College, Los Angeles, Calif	2	......
Los Angeles State College of Applied Arts and Sciences, Los Angeles, Calif	1	......
Louisiana State University, Baton Rouge, La	......	1
Loyola College, Baltimore, Md	1	......
Luther College, Decorah, Iowa	1	......
Marine Biological Laboratory, Woods Hole, Mass	......	5
Mars Hill College, Mars Hill, N. C	1	......
Massachusetts Institute of Technology, Cambridge, Mass	35	52
Medical College of Alabama, Birmingham, Ala	......	1
Miami University, Oxford, Ohio	1	......
Michigan State College, East Lansing, Mich	1	2
Middlebury College, Middlebury, Vt	1	......
Mississippi State College, State College, Miss	......	1
Missouri School of Mines and Metallurgy, Rolla, Mo	1	......
Montana State College, Bozeman, Mont	2	1
Montana State University, Missoula, Mont	1	......
Morton Junior College, Cicero, Ill	1	......
Mount Union College, Alliance, Ohio	1	......
Nebraska State Teachers College, Wayne, Nebr	1	......
Nebraska Wesleyan University, Lincoln, Nebr	1	......
New Mexico School of Mines, Socorro, N. Mex	1	......
New York University, New York, N. Y	7	3
North Carolina State College of Agriculture and Engineering, Raleigh, N. C	2	3
Northeastern Oklahoma Agriculture and Mechanical College, Miami, Okla	1	......
Northeastern University, Boston, Mass	1	......
Northern Oklahoma Junior College, Tonkawa, Okla	2	......
Northwestern University, Evanston, Ill	6	5
Northwestern State College of Louisiana, Natchitoches, La	1	......
Norwich University, Northfield, Vt	2	......
Oberlin College, Oberlin, Ohio	7	......
Ohio State University, Columbus, Ohio	9	15
Oklahoma A and M, Stillwater, Okla	3	2
Olympic Junior College, Bremerton, Wash	2	......
Oregon State College, Corvallis, Oreg	2	4
Oxford University, Oxford, England	2	6
Palomar Junior College, San Marcos, Calif	1	......
Pasadena City College, Pasadena, Calif	2	......
Pennsylvania State College, State College, Pa	1	1
Plymouth Teachers College, Plymouth, N. H	1	......
Pomona College, Claremont, Calif	7	......
Princeton University, Princeton, N. J	4	35
Purdue University, Lafayette, Ind	6	9
Queens College of the City of New York, Flushing, Long Island, N. Y	1	......
Radcliffe College, Cambridge, Mass	1	3
Reed College, Portland, Oreg	2	......
Rensselaer Polytechnic Institute, Troy, N. Y	4	2
Rheinisch-Westfälische Technische Hochschule, Aschen, Germany	......	1
Rice Institute, Houston, Tex	1	3
Ripon College, Ripon, Wis	1	......
Rutgers University, New Brunswick, N. J	4	......
St. Louis University, St. Louis, Mo	1	......
St. Michael's College, Winooski Park, Vt	1	......
St. Olaf College, Northfield, Minn	3	......
St. Peter's College, Jersey City, N. J	1	......

INSTITUTIONS ATTENDED BY NATIONAL SCIENCE FOUNDATION FELLOWS AS UNDERGRADUATES AND GRADUATE STUDENTS—Continued

	Number of fellows attending	
	As undergraduates	As graduate students
St. Thomas College, St. Paul, Minn	1	......
Sampson College, Sampson, N. Y	1	......
San Diego State College, San Diego, Calif	2	......
San Francisco State College, San Francisco, Calif	1	......
San Jose State College, San Jose, Calif	1	......
Seton Hall University, Seton Hall, N. J	1	......
Seton Hill College, Greensburg, Pa	1	......
Sheffield University, Sheffield, England	......	1
Smith College, Northampton, Mass	1	......
South Dakota School of Mines and Technology, Rapid City, S. Dak	1	......
South Dakota State College of Agriculture and Mechanic Arts, Brookings, S. Dak	1	......
Southwest Missouri State College, Springfield, Mo	2	......
Southwestern at Memphis, Memphis, Tenn	1	......
Southwestern Louisiana Institute, Lafayette, La	1	......
Springfield Junior College, Springfield, Ill	2	......
Stanford University, Stanford, Calif	10	21
State Teachers College, Valley City, N. Dak	1	......
Sullins College, Bristol, Va	1	......
Swarthmore College, Swarthmore, Pa	10	......
Syracuse University, Syracuse, N. Y	3	1
Teachers College of Connecticut, New Britain, Conn	1	......
Temple University, Philadelphia, Pa	2	......
Texas A and M, College Station, Tex	1	1
Texas Christian University, Fort Worth, Tex	1	1
Trinity College, Hartford, Conn	1	......
Tufts College, Medford, Mass	1	......
Tulane University, New Orleans, La	2	2
Union College, Albany, N. Y	1	......
Union Junior College, Cranford, N. J	1	......
University of Amsterdam, Amsterdam, The Netherlands	1	1
University of Arkansas Medical School, Fayetteville, Ark	1	......
University of Bern, Bern, Switzerland	......	1
University of Birmingham, Birmingham, England	......	1
University of California, Berkeley, Calif	15	32
University of California, Los Angeles, Calif	5	11
University of Chicago, Chicago, Ill	23	45
University of Cincinnati, Cincinnati, Ohio	2	......
University of Colorado, Boulder, Colo	4	4
University of Copenhagen, Copenhagen, Denmark	......	2
University of Delaware, Newark, Del	......	5
University of Detroit, Detroit, Mich	1	......
University of Florida, Gainesville, Fla	3	2
University of Georgia, Athens, Ga	1	1
University of Göttingen, Göttingen, Germany	......	2
University of Hawaii, Honolulu, T. H	1	1
University of Houston, Houston, Tex	2	1
University of Illinois, Urbana, Ill	15	27
University of Kansas, Lawrence, Kans	6	6
University of Kansas City, Kansas City, Mo	1	......
University of Kentucky, Lexington, Ky	3	3

University of London, London, England	......	1
University of Maine, Orono, Maine	1	......
University of Maryland, College Park, Md	2	1
University of Miami, Miami, Fla	1	......
University of Michigan, Ann Arbor, Mich	8	11
University of Minnesota, Minneapolis, Minn	8	11
University of Missouri, Columbia, Mo	3	3
University of Nebraska, Lincoln, Nebr	2	2
University of Nevada, Reno, Nev	1	1
University of New Hampshire, Durham, N. H	2	1
University of New Mexico, Albuquerque, N. Mex	2	3
University of North Carolina, Chapel Hill, N. C.	2	3
University of North Dakota, Grand Forks, N. Dak.	1	1
University of Notre Dame, Notre Dame, Ind	2	......
University of Oklahoma, Norman, Okla	5	2
University of Oregon, Eugene, Oreg	2	3
University of Paris, Paris, France	1	2
University of Pennsylvania, Philadelphia, Pa	9	7
University of Pittsburgh, Pittsburgh, Pa	1	3
University of Rhode Island, Kingston, R. I	1	......
University of Richmond, Richmond, Va	......	1
University of Rochester, Rochester, N. Y	3	4
University of Southern California, Los Angeles, Calif.	1	......
University of Tennessee, Knoxville, Tenn	3	2
University of Texas, Austin, Tex	5	6
University of the South, Sewanee, Tenn	1	......
University of Utah, Salt Lake City, Utah	3	2
University of Vermont, Burlington, Vt	1	......
University of Virginia, Charlottesville, Va	2	5
University of Washington, Seattle, Wash	7	8
University of Wichita, Wichita, Kans	1	......
University of Wisconsin, Madison, Wis	10	27
University of Wyoming, Laramie, Wyo	1	......
Utah State Agricultural College, Logan, Utah	3	1
Valparaiso University, Valparaiso, Ind	1	......
Vanderbilt University, Nashville, Tenn	4	3
Vanport Extension Center, Portland, Oreg	1	......
Vassar College, Poughkeepsie, N. Y	1	......
Virginia Junior College, Virginia, Minn	1	......
Virginia Military Institute, Lexington, Va	1	......
Virginia Polytechnic Institute, Blacksburg, Va	4	1
Washburn Municipal University of Topeka, Topeka, Kans	1	......
Washington State College, Pullman, Wash	2	1
Washington and Lee University, Lexington, Va	1	......
Washington University, St. Louis, Mo	6	5
Waynesburg College, Waynesburg, Pa	1	......
Wellesley College, Wellesley, Mass	1	......
Wesleyan University, Middletown, Conn	4	1
Western Kentucky State Teachers College, Bowling Green, Ky	2	......
Western Michigan College of Education, Kalamazoo, Mich	1	......
Western Reserve University, Cleveland, Ohio	6	3
Western Washington College of Education, Bellingham, Wash	1	......
Whittier College, Whittier, Calif	1	......
Williams College, Williamstown, Mass	1	......
Wilmington College, Wilmington, Ohio	1	......
Wisconsin State College, Milwaukee, Wis	1	......
Wisconsin State College, Oshkosh, Wis	1	......
Wright Branch, Chicago City Junior College, Chicago, Ill	2	......
Yale University, New Haven, Conn	4	18
Yeshiva University, New York, N. Y	1	......

APPENDIX V

Financial Report for Fiscal Year 1953

APPROPRIATED FUNDS

Status of Appropriation From the Congress to the National Science Foundation as of June 30, 1953

RECEIPTS

Appropriation for fiscal year 1953		$4,750,000
Unobligated balance from fiscal year 1952		34,000
Total funds available		4,784,000

OBLIGATIONS

National Science Policy Studies		
Subtotal	$207,167	
Support of Science		
Grants for support of research:		
Biological and medical sciences	830,586	
Mathematical, physical, and engineering sciences	982,715	
Grants for training of scientific manpower:		
Graduate fellowships	1,366,344	
Education in the sciences	40,844	
Review of research and training programs	432,022	
Subtotal	3,652,511	
Scientific Information Exchange		
Dissemination of scientific information	[1] 158,654	
Attendance at international scientific meetings	33,565	
Subtotal	192,219	
Executive Direction and Management		
Subtotal	355,746	
Support of Interdepartmental Committee on Scientific Research and Development		
Subtotal	23,272	
Total obligations		4,430,915
Unobligated reserve for additional national science policy studies		353,085

[1] Includes $7,300 transferred to the Library of Congress, but not obligated by the Library of Congress at June 30, 1953.

WORKING FUNDS

Status of Funds Transferred From Federal Agencies to the National Science Foundation as of June 30, 1953

RECEIPTS

Atomic Energy Commission	$15,000	
Department of Defense:		
Department of the Air Force	10,000	
Surgeon General	5,000	
Department of Health, Education, and Welfare	5,000	
Total receipts		$35,000

OBLIGATIONS

Dissemination of scientific information	25,000
Unobligated balance carried forward	10,000

TRUST FUND

Status of Funds Donated From Private Sources to the National Science Foundation as of June 30, 1953

RECEIPTS

Unobligated balance from prior years	$1,047	
Donations received during fiscal year 1953	372	
Total receipts		$1,419

OBLIGATIONS

Services	63
Unobligated balance carried forward	1,356

APPENDIX VI

Report of the National Science Foundation—Amherst Conference on Physics Research in Colleges

I. Purpose

On May 4–6, 1953, a conference was held at Amherst College to discuss the status of physics research in colleges. The conference was jointly sponsored by Amherst College and the National Science Foundation. A committee under the chairmanship of T. Soller directed the meeting. The committee was composed of the following members:

Theodore Soller, Amherst College, Chairman.

Walter C. Michels, Bryn Mawr College.

Karl S. Van Dyke, Wesleyan University, Connecticut.

Mildred Allen, Mount Holyoke College.

Charles A. Fowler, Pomona College.

R. Ronald Palmer, Beloit College.

J. Howard McMillen, National Science Foundation.

Twenty-five college teachers of physics with an active interest in physics research were assembled. They were chosen so as to represent various types of colleges and regions of the country.[1]

II. Major Recommendations

The conferees agree that the instruction and intellectual development of students is the fundamental task of college teachers. They conclude, nevertheless, that this task not only is entirely compatible with the simultaneous pursuit of scientific research, but also that it is greatly aided thereby.

The liberal arts colleges of this country can make significant contributions to the national output of research; this activity will benefit both the teacher and the students, it can aid in attracting able young scientists into college teaching and generally raise the scientific maturity of our college communities.

The undergraduate colleges have played a major role in the development of physics in the United States, both by the research carried on in their laboratories and through the early training of a large proportion of working physicists. During the postwar expansion of research facilities, the potentialities of many colleges have been neglected by the granting and contracting agencies of the Federal government, by industry and by the colleges themselves. This conference believes that it would be in the national interest to correct this situation.

The conference discussed the problems which would arise in administering a grant program and in evaluating requests for grants. It also discussed the advantages and the dangers of the program, from the point of view of colleges which must consider education to be their prime objective. Following this discussion *the conference makes the following recommendations:*

1. THE FEDERAL GOVERNMENT, THROUGH APPROPRIATE AGENCIES, SHOULD ESTABLISH A SPECIAL PROGRAM FOR AWARDING GRANTS OR CONTRACTS FOR THE ENCOURAGEMENT OF PHYSICS RESEARCH IN COLLEGES NOT CONNECTED WITH LARGE GRADUATE SCHOOLS.
2. GRANTS OR CONTRACTS AWARDED UNDER THIS PROGRAM SHOULD HAVE AS PRIMARY OBJECTIVES BOTH THE ENCOURAGEMENT OF SIGNIFICANT RESEARCH, AND THE IMPROVEMENT OF THE EDUCATION OF PHYSICISTS WHO WILL BE AVAILABLE TO STRENGTHEN SCIENCE IN THE UNITED STATES.

[1] The list of those attending the conference is contained at the end of the report.

III. Benefits of Grant Program

The conference calls attention to the following advantages and benefits to result from the recommended program. In assessing the benefits of research in colleges to the national research program, attention should be given not only to the published results of these efforts but also to their effect on increasing the number and quality of physics majors that the colleges furnish to our graduate schools. This should enhance the level of sciences throughout the country. While this section outlines the potentialities of research in small colleges, an adequate program of research is not possible at the present time because of financial limitations.

Contributions to Scientific Knowledge. The national output of research can be enhanced by the contributions of the colleges.

(a) The output of the colleges can in the aggregate be large because of the large number of physicists involved.
(b) Physicists in the small colleges and in the large university have received the same training and both can make contributions despite the larger teaching load of the former.
(c) Research in small colleges can advance the frontiers of science.
(d) Important basic research can even today be carried out by individuals; neither large teams nor large budgets are a vital necessity for the making of significant contributions.

Advantages of the Small College for Research. There are definite advantages of the small colleges as a place for some types of basic research:

(a) The opportunity for the individual's independent choice of problem and of line of attack can be more easily provided for in small colleges.
(b) The administrative procedure is usually simplified.
(c) The pressure for results is usually less and consequently there should be more time for contemplation of problems.

Benefits to the Faculty Member. The individual faculty member derives substantial benefit from such a research program in the following manner:

(a) His research should be a continued stimulus to his intellectual growth.
(b) His research offers one of the best means of broadening the scientific basis from which his fundamental work of teaching proceeds. This assumes that administrative arrangements permit an adequate allocation of time for the teaching function while research is pursued.
(c) His professional prestige, his independence, and his self-esteem are enhanced, as he continues to be a creative physicist.
(d) His income may be increased by regular summer employment.

Benefits to Students. Students in a department which is actively engaged in research may realize the following benefits:

(a) The active work of professors is reflected in more vital teaching.
(b) The student's concept of the science and of its importance is made more realistic by this contact with creative work.
(c) Students may participate directly in research at an earlier stage in their development than is usually possible in a university.
(d) Senior projects or theses may be related to the larger program, and may be significant contributions in themselves.
(e) Part-time remuneration for research assistance is sometimes available.
(f) Undergraduate research experience leads to better graduate school opportunities.

Benefits to the Colleges. The colleges will benefit from research in a number of ways:

(a) They will be able to attract and to hold better qualified men as physics teachers if their continued research activity is made practicable.
(b) Student participation in research will stimulate the better students and attract more good students, thus improving the quality and the number of physics majors.
(c) The intellectual development of the faculty members will lead to better

278626—54——8

teaching and hence to a better college.

(d) The publication of the results of research will have prestige value to the college.

(e) The continuance of the research activity of the younger teacher fresh from graduate school may provide a means for revitalizing in research and in the live science the older teacher whose contacts with the changing fields of physics have become second hand.

IV. Kinds of Research Suitable to Colleges

Inasmuch as almost any type of research in which a college teacher is sincerely interested and well qualified can contribute to the dual objectives of contribution to scientific knowledge and contribution to the educational work of the institution, the conference considers it unwise to prescribe limitations as to particular research fields. However, there are certain criteria which seem applicable to the selection of suitable problems for the typical small colleges. The more important factions include:

(1) The investigator should have experience that is relevant to the project proposed.

(2) The research should be of such a nature as to allow understanding participation by serious undergraduate students.

(3) The project should have modest equipment and space requirements. In the event that little or no capital equipment is available, the investigator should endeavor to keep the equipment requirements within reason.

(4) The small college is in a particularly favorable position to make a significant contribution in certain areas which are better suited to individual and independent research than to large projects existing in the universities.

Some additional considerations of lesser importance may enter into the choice of a research problem:

(1) It is often wise to choose a field of investigation that is not too fast-moving or competitive, since full-time effort toward research, except during the summer, is rarely possible for the college teacher.

(2) Where possible, it would seem desirable that two or more members of a department collaborate on a single project.

(3) Problems which combine the efforts of scientists in more than one field should be encouraged.

Some of the areas in which small colleges are at present doing significant work (under grants from NSF, ONR, AEC, OOR, OSR, Research Corp., etc.) include: (*a*) solid state, especially semi-conductors, magnetism, and thin-film studies; (*b*) high energy particle study, especially investigations using nuclear emulsions; (*c*) gas and spark discharge experiments; (*d*) certain areas of electronics, such as transistor circuit development, and (*e*) important work in optics, thermodynamics, acoustics, electrodynamics, and other fields of fundamental physics which have been neglected in favor of more exciting frontier fields.

Examples of current projects are illustrative of several patterns which have been successful in small colleges. At one college, a photosynthesis project supported by a private foundation involves the cooperation of staff and students from the chemistry, physics, and biology departments. At another, each of the five physics teachers is working half-time on research. At still another college, three teachers are working cooperatively on low-temperature research. A fourth pattern is represented by a recent program calling for collaboration between individuals in different colleges and a group in a large research center.

V. Most Suitable Grants Program

The discussion during the conference indicated that a wide variety of needs exists in the colleges. The previously outlined objectives can be achieved best if the program is a very flexible one. Grants should generally make provision for financial assistance to the faculty member and to the college as well as for equipment, supplies, travel, technical assistance, etc.

The conference recommends that this assistance be accomplished by grants of the type in which the payment of summer salary is made, by grants permitting an occasional provision of a year free of teaching assignments, or by grants which relieve a small part (generally not greater than one-third) of the faculty member's formal teaching load during the year.

THE CONFERENCE RECOMMENDS THAT SPECIAL ADVISORY PANELS BE USED TO ASSIST IN THE ADMINISTRATION OF PROGRAMS OF THIS KIND.

Such panels should consist of individuals each of whom has the following qualifications:

(1) He shall have contributed to the progress of physics through his research.
(2) He shall have demonstrated superior ability as a teacher at the undergraduate level.
(3) He shall be acquainted through present or recent association with institutions of the type involved in the program.

Grants or contracts should be made under this program only when it appears probable that the project will be significant for its own sake and that it will contribute to the educational work of the institution. It is suggested that the advisory panels in evaluating proposals, take into account some or all of the following considerations:

(1) Projects which involve student participation should be strongly encouraged.
(2) The promise and ability of the principal investigator should be given weight at least equal to that assigned to the scientific merit of project.
(3) An attitude sympathetic to research in the department and in the institution is highly desirable.
(4) The value of the research may be judged after consultation with experts in the field, but these experts should be cognizant of the fact that they are judging proposals under the college program.

Because of small administrative staffs in colleges, the conference recommends that administrative procedures connected with such grants be kept to a minimum.

VI. The Problem of Stimulation to the College Research Worker

A serious handicap to the progress of a college research program is the isolation of many college investigators. The awarding of a grant or contract in itself tends to reduce this isolation. Factors which may be helpful in overcoming the effects of isolation are the following:

(1) In certain cases advice of an expert may be helpful in getting research started.
(2) Arrangements may be made for consultations during the course of a project with experts in the field of the research undertaken.
(3) Grants may include provision for travel expense for attending scientific meetings and for visiting other laboratories.
(4) Grants may be provided for occasional summer work at other institutions. Industries should be encouraged to support summer projects.
(5) Leaves of absence help relieve isolation.
(6) Group efforts of the various sorts mentioned in the previous section promote a stimulating exchange of ideas.
(7) The informal exchange of prepublication results among various investigators in a field is recommended.

VII. Non-Federal Support for Research in Colleges

The conference recognizes the importance of the encouragement of basic physics research by private, industrial, and other nongovernmental groups. *It is recommended that college administrators actively solicit aid from such sources under conditions that will maintain the coordination between research and teaching that has been emphasized above.*

It is further recommended that the American Association of Physics Teachers set up a com-

mittee which, working in cooperation with the American Institute of Physics, will investigate ways and means of promoting the support of basic physics research in colleges.

Appendix

Participants in the conference are listed below. The number was limited to 25 in order to give adequate representation without endangering the efficiency of the operations of the conference. The sponsors realize that many colleges of recognized achievement in the research and education field were not included in the conference; unfortunately the limitation of conferees to 25 made this unavoidable. It was felt, however, that the participants, chosen as they were from so many different types of colleges, truly represented the cross section of physicists in American colleges.

MILDRED ALLEN, Mount Holyoke College, Mass.

IAN G. BARBOUR, Kalamazoo College, Mich.

LAURENCE R. BICKFORD, New York College of Ceramics, N. Y.

P. E. BOUCHER, Colorado College, Colo.

W. W. DOLAN, Linfield College, Oreg.

W. C. ELMORE, Swarthmore College, Pa.

CHARLES A. FOWLER, Pomona College, Calif.

GRANT O. GALE, Grinnell College Iowa.

THOMAS E. GILMER, Hampden-Sydney College, Va.

LORENZ D. HUFF, Clemson, S. C.

HAROLD C. JENSEN, Lake Forest College, Ill.

THURSTON E. MANNING, Oberlin College, Ohio.

WALTER C. MICHELS, Bryn Mawr College, Pa.

DOROTHY D. MONTGOMERY, Hollins College, Va.

GWILYM E. OWEN, Antioch College, Ohio.

R. RONALD PALMER, Beloit College, Wis.

WILLIAM L. PARKER, Reed College, Oreg.

PAUL B. PICKAR, Loyola University, La.

THEODORE SOLLER, Amherst College, Mass.

REGINALD J. STEPHENSON, Wooster College, Ohio.

T. H. TAYLOR, Morgan State College, Md.

FRANCIS E. THROW, Wabash College, Ind.

FRANK VERBRUGGE, Carleton College, Minn.

KARL S. VAN DYKE, Wesleyan University, Conn.

JOHN XAN, Howard College, Ala.

APPENDIX VII

Important Areas of Minerals Research Compiled by the National Science Foundation Advisory Committee on Minerals Research

This outline has been prepared by the Advisory Committee on Minerals Research both as a guide to division of effort among its subcommittees and as a sample catalogue of the kinds of important problems facing the Nation in the minerals research field. It is recognized that items D, E, and F are not basic research areas for which direct financial support by the Foundation is appropriate. They are included, however, since they are of great importance to its evaluation and policy-making functions. They are also likely areas for activity to be financed from resources of other Federal agencies and industry.

A. *Fundamental Geologic Research:*

1. Background and fundamental research into the environments of ore deposition.
   a. Age relationships.
   b. Structural features.
   c. Quantitative mineralogic studies—(Composition of different deposits; total amount of material emplaced and inference as to size of igneous source, if any; zoning within ore bodies and districts, etc.).
   d. Halos around ore districts—trace elements.
   e. Geologic thermometry of ore.
2. Reassessment of geologic theories relating to ore deposition and on which theories of ore deposition are based.
   a. Why are some igneous areas productive of ore deposits, others not?
   b. Reexamination of theories of evolution of the earth's crust having a bearing on ore depositions.
   c. Relationship of major geologic structures to ore deposits.
   d. Migration and concentration of elements in geologic time.
3. Study of why some metallogenetic provinces are dominantly copper, others silver-lead, etc.
4. Restudy of some principal ore districts (combined geological-geophysical-geochemical-geobotanical approach).
5. Favorability of one rock type for ore deposition over another—library research, statistical study, etc.

B. *Fundamental Geochemical Research:*

1. Physical-chemical relationships in evolution of the earth's crust in relation to ore deposition.
2. Physical-chemistry of ore deposition.
3. Trace elements in sedimentary, igneous, and metamorphic rocks.
4. Study of pressures and temperatures of ore deposition.
5. Chemistry of wall-rock alteration—dolomitization, sericitekaolin alteration, etc.
6. Compilation of a new and up-to-date *Data of Geochemistry.*
7. Mass spectrograph determinations of isotopes of elements in ore deposit.

C. *Fundamental Geophysical Research:*

1. Behavior and movement of fluids under high temperatures and pressures and their movement in different kinds of rocks and openings.
2. Physical characteristics of the earth's crust and substrata.
3. Measurement of electrical, magnetic, seismic, and other phenomena in structures of ore deposits.
4. Interpretation of geophysical data in ore districts where geology is known.

C. *Fundamental Geophysical Research*—Con.

5. Global physical characteristics of the earth's crust and substructure, e. g.:
   a. Comprehensive investigation and study of electrical ground currents (both telluric and those from spontaneous polarization) should be made in order to increase our knowledge of their relationship to regional and local geology and geologic conditions.
   b. Comprehensive geothermal studies as in (a).
   c. Comprehensive geomagnetic studies as in (a), etc.
6. Further research of the transmission of seismic energy in nonhomogeneous media is needed, as mining geology does not deal with homogeneous media as in oil.
7. Instrumentation [see also D (2)].
   a. Background noise.
   b. New types of instruments.
   c. Applications of high-speed computers.
8. Physical properties of rocks and minerals.

D. *Applied Research on Methods of Exploration:*

1. Better drilling methods—correlation with American Petroleum Institute.
2. Improvement of geophysical instruments and techniques.
   a. What else can be put in automobiles or airplanes?
   b. Drill hole instruments and techniques.
   c. Method for detecting disseminated sulphide deposits.
   d. Quick, cheap, reliable method for determining depth of overburden.
3. Improvement of quick, accurate field methods of chemical analysis—mass spectrometry.

E. *Other Applied Research Applicable to Conserving Raw Material:*

1. Ground water studies in ore districts.
2. Deep mining problems.
   a. Rock bursts.
   b. Supports.
   c. Refrigeration—ventilation.

F. *Appraising Ore Yet to Be Found, cf., Wallace Pratt Survey for Oil:*

1. Below present mining depth.
2. Under gravel covered in grabens of basin-range province.
3. Etc.

G. *Supply, Demand for and Training of Scientific and Technical Manpower.*

O