NSF Library Copy

Fourth Annual Report

NATIONAL SCIENCE FOUNDATION

Year ending June 30, 1954

NSB LIBRARY

NATIONAL SCIENCE FOUNDATION

FOURTH ANNUAL REPORT FOR THE FISCAL YEAR ENDING JUNE 30, 1954

U. S. GOVERNMENT PRINTING OFFICE : WASHINGTON, D. C.

Letter of Transmittal

WASHINGTON 25, D. C.,
November 1, 1954.

MY DEAR MR. PRESIDENT: I have the honor to transmit herewith the Annual Report for Fiscal Year 1954 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.

For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. — Price 50 cents

Contents

NOTE ON ILLUSTRATIONS

The illustrations facing pages 22, 23, 54, and 55 were carefully selected to typify the variety of scientific research studies currently receiving support from the National Science Foundation. In all cases the photographs were supplied by the public information offices of the institutions represented. The National Science Foundation is grateful for their assistance and cooperation.

Foreword

The following *Fourth Annual Report* of the National Science Foundation gives a view of what has been accomplished and what inquiries are in progress. It calls attention to certain broad problems of national interest in scientific development that have become evident in the past year. The kind of report now submitted would not have been possible at an earlier date, because of the early limitations of funds, the emphasis upon recruiting of staffs and committees and organizing of the work, and the need for experience in carrying on one of the more recently recognized functions of government.

I believe that those who read this report will readily recognize the wisdom of the Congress in establishing the Foundation and in specifying its duties, and of the President in clarifying its functions in relation to those of other government departments and agencies. The national interest, whether for defense or for the improvement of the level of living and of employment, requires comprehensive understanding of our scientific resources in men, facilities and organization, a matured judgment of present and future needs, and perspective about the relation of science to the rest of the economy and culture. For the future our ability to defend ourselves, to develop usable energy, to conserve resources, to protect against old and newly evolving diseases of men, animals, and plants, will no doubt depend upon much more than what we now call science; but it is clear that science has been highly successful and, indeed, essential in the recent past and that it will continue to be indispensable.

It is the function of the National Science Foundation to furnish leadership—not to direct—in the broad effort to promote science and to assess the situation and the need. This it will do through factual inquiry and the mobilization of the judgments of those most competent, including those in the various fields of science and of education. Neither the colleges and universities nor the private foundations could perform, or accept responsibility for this function. It is a function that would have had little meaning fifty years ago and probably none a century ago. Today, it is clear that responsible, continuing and comprehensive appraisal of our scientific resources, needs and opportunities is an essential element of public policy.

The recognition that this function is of primary concern to the Federal Government might lead some to believe that government can and should direct the course of scientific development in this country. It is clearly the view of the members of the National Science Board that neither the National Science Foundation nor any other agency of the Government should attempt to direct the course of scientific development and that such an attempt would fail. Cultivation, not control, is the feasible and appropriate process here. Both individuals and institutions require public knowledge concerning science that they may continue to act, autonomously but more effectively, in the public interest.

The futility of central control of science arises in part because science is essentially non-national in character, being concerned with natural phenomena rather than polity, but also because pioneering into the unknown calls for imagination and novelty of conception and of method—abilities that are stifled by control and specific direction. This must be conceded to the scientists—not merely because they say so and because the history of science thus far confirms their view—but because it is true also of the application of science and of the management of affairs, public, private, industrial, social or military, though often in much less degree.

The promotion or cultivation of science in the United States is the central task of the National Science Foundation. Performance of the task still depends upon scientists, academic institutions, industry and the professional societies, not less, but more, than heretofore. Indeed, the Foundation, its staff, its Board, and its advisory Committees and panels are made up of personnel drawn chiefly from the roster of scientists and from their institutions.

In fostering scientific progress, we must henceforth be conscious of a multitude of interests—separate administratively perhaps, but nevertheless related and interdependent—such as general and technical education, financial support of schools, colleges, universities, and public and private laboratories, recruitment of talent, conduct of research, provision of physical facilities, and the relationships between governments, educational and scientific institutions and industry. This is not the time nor the place to indulge in comprehensive discusson of these matters. Many are touched upon in the present report. Here, I attempt only to note a few aspects of our general concern.

The first of these is the matter of incentives. It seems certain that the public interest requires for the future more scientists and other technically trained men in closely related fields than will be forthcoming at present rates. Not a large proportion of the population has both the intellectual capacity and the essential interest to become scientists and it is evident that much potential talent is now being lost. Thus, as never before, the matter of incentives for the pursuit of scientific careers becomes an important social problem.

The primary and indispensable incentive is a deep, personal, and indefatigable interest in scientific discovery. To find ways to promote that interest is of first importance and leads directly to the quality of the teaching in the secondary schools and the early college years. But this does not imply that relative freedom, adequate monetary remuneration, and public recognition and appreciation can be neglected.

The increase in government contract work, security considerations, and the necessity for large-scale cooperation and team research may be limiting conditions on scientific freedom and in many cases impose a discouraging degree of anonymity upon individuals. The tendency of these conditions to restrict initiative, imagination, and persistence is a matter of real concern. The problem cannot be dissipated simply by the lavish and indiscriminate expenditure of money.

Scholarship and fellowship programs wisely administered are useful means for inducing and supporting the development of scientists. However, not merely financial assistance but the recognition and prestige that are conferred by the process of careful selection are required.

Scientific development also requires money for basic research. Abundant funds are necessary in many types of inquiries for physical equipment, energy, and personal services, for chemical materials, for biological specimens, and for travel and gear for field work. It is sometimes thought that such expenditures are solely for the acquisition of knowledge. This view misses the point. Mere accumulation of knowledge is not understanding, which is a human attribute. Scientific knowledge without scientists would be nearly useless, and scientists are made and acquire understanding by practicing science. Research is the school in which this is done. Financial support for research serves a double purpose—acquisition of scientific knowledge and development of scientists.

CHESTER I. BARNARD,
Chairman, National Science Board.

PART I

Current Aspects of American Science

The Year in Review

Scientific activity in the United States during the past year has continued at a high rate. Among significant findings reported in all fields of science the following selected items may be considered representative:

The announcement by Marcel Schein, University of Chicago, and Bruno Rossi, Massachusetts Institute of Technology, of cosmic ray events of very high energy, suggestive of super protons or perhaps nuclei with negative charges. If corroborated by further research, these discoveries may lead to new concepts regarding the origin of cosmic rays and the constitution of the universe.

The first actual glimpse of the internal electrical structure of atomic nuclei was reported by Robert Hofstadter and colleagues of Stanford University. According to the laws of optics, in order to "see" or measure an object, the wave length of the radiation—whether light, X-rays, or electron beams—must be at least as short as the distances to be measured. Hofstadter, using ultrahigh energy electrons with wavelengths of the order of intranuclear distances found that the charge of the nucleus was not uniformly distributed throughout the nuclear volume.

The model of desoxyribonucleic acid—the basic material of which genes and viruses are made—proposed by J. D. Watson, California Institute of Technology, and F. H. C. Crick, Cambridge University. This model has proved helpful in attempts to explain such diverse biological actions as chromosome division and virus activity.

The complete synthesis of morphine, which has eluded organic chemists for decades, announced by M. D. Gates, University of Rochester.

James D. Ebert, Indiana University, continuing the work of Paul Weiss, implanted kidney, liver and spleen tissue in chick embryos and noted greatly increased rates of growth in the respective embryonic organs. Apparently, the growing organ can utilize specific organic components almost intact without first breaking them down into simpler building blocks. His experiments also revealed the effectiveness of the growth regulating mechanism. Although the growth of the treated organs for a time outstrips that of the rest of the embryo, the accelerated growth stops when it reaches the normal adult stage.

Further progress was reported in explaining physiological and psychological actions in terms of biochemistry or biophysics. George Wald, Harvard University, traced the chemical steps taken by the eye in adapting to light or darkness. W. S. McCulloch, Massachusetts Institute of Technology, W. H. Mosberg, Illinois State Hospital for Mental Diseases, and their colleagues, reported temporary relief for schizophrenia by injecting appropriate chemotherapeutic compounds directly into the brain. Wilder Penfield of McGill University, Montreal, and Maitland Baldwin and his associates at the National Institute of Neurology and Blindness have shown how memory responds to electric and mechanical stimulation.

The mass antipolio inoculation with the vaccine developed by J. E. Salk, University of Pittsburgh, was an outstanding development of research in the field of preventive medicine.

As in other recent years well over half of the support for scientific research was supplied by the Federal Government. The President issued an Executive order designed to strengthen and increase the effectiveness of Federal participation in scientific activities. In so doing he called particular attention to the importance of greater support for basic research.

He wrote:

> In 1940, the Federal Government spent about $100 million in supporting research and development. The budget which I have just transmitted to the Congress calls for expenditures for these purposes in the next fiscal year of over $2 billion. This is convincing evidence of the important role of science and technology in our national affairs * * * more than 90 percent of this Federal support is presently going into applied research and development. This is the practical application of basic knowledge to a variety of products and devices. However, only a small fraction of the Federal funds is being used to stimulate and support the vital basic research which makes possible our practical scientific progress. I believe strongly that this Nation must extend its support of research in basic science.

The United States took steps to join with more than 30 other nations in the International Geophysical Year (1957–58)—one of the largest and most significant international scientific undertakings ever attempted. Dozens of scientific groups and thousands of scientists throughout the world will engage in this concerted effort to observe and measure important natural phenomena associated with geophysics, meteorology, oceanography and upper atmosphere research.

The President's A-bank proposal for joint international participation in the development and use of atomic energy for peaceful purposes captured the imagination of the citizens of many nations.

The research support programs of the Defense Department research agencies, the Atomic Energy Commission, the National Institutes of Health, the Department of Agriculture, National Advisory Committee for Aeronautics, and the National Science Foundation continued at a vigorous pace.

The Foundation was well along in its overall survey of scientific activities and the likely future requirements for trained scientists and research facilities. For the third successive year the Foundation conducted a graduate fellowship program under which some 700 talented young scientists are provided support for graduate study. In addition many hundreds of graduate students receive assistance through the Federal research support programs.

Thus, outwardly at least, American science was thriving. Nevertheless, there was evidence of an underlying uneasiness on the part of many citizens about the aims and values of science and its role in a free society.

This in part stemmed from the increasingly esoteric and abstract nature of scientific thought, especially at the frontiers of knowledge. It was difficult for scientists to communicate their ideas not only to nonscientists but to colleagues in other scientific fields. Although he clearly saw the operational effectiveness of these ideas, the nonspecialist had no base in ordinary experience from which to gain understanding of present day scientific thought. In the absence of a clear understanding of what science is about, the average citizen more and more was required to accept or reject science uncritically and on faith.

The laws of nature take no sides on the question of how the power of science should be directed—whether toward good or evil. The control of such power rests with men and calls for ceaseless vigilance and firmness on the part of all men of good will. A generation that had witnessed two world wars and innumerable lesser crises felt natural resentment against the continuing stress and tension. Rightly or wrongly, some of the blame attached to science.

But although the laws of nature might be unbiased as to the ends to which they were put, scientists were not. They had responded loyally and with devotion to the urgent national call for their services. In so doing they set aside some of the traditional satisfactions to be gained from scientific pursuits. For the foreseeable future they would occupy a central place in the Nation's defense and technological development. They were in process of adjusting to their new status but it was a trying and critical experience.

Further uncertainty was felt by many citizens, scientist and nonscientist alike, in attempting to reconcile the demands of technological and military secrecy with basic democratic freedoms. L. V. Berkner at Ann Arbor described the point of view of many scientists on this conflict in the following terms:

> Scientific greatness always rises from diversity of thought, never from conformity. Since the security procedures that support technological secrecy inevitably put a premium on conformity, they tend to prevent our Nation's realization of the very greatness that we seek. Technological secrecy tends to obscure the essential dependence of democracy on diversity of thought and opinion. * * * The strength of democracy lies in the perspective and proportion that the diversity of public opinion provides for the guidance of our public officers. This guidance is now entirely lacking with respect to our most critical problem, because information is either restricted, or because public opinion is influenced by "leaks" to the press of information that supports some special interest or point of view. * * *
>
> But beyond its direct effect on the formulation of public policy, technological secrecy has an even greater impact on the public adjustment to the new environment produced by technology. As technology emerging from science becomes more and more a major part of our living fabrics, just so will its control become more and more a major factor in shaping our whole society and political

structure. Therefore, the decisions that direct the application of technology for man's benefit should not be reserved to any class, creed, political party, or individuals—whether they be scientists or churchmen, military strategists or statesmen, for the concept of "benefit" may be viewed differently by different groups. This responsibility for the application of technological development to man's benefit must rest with the whole of society, of which science is only one part, and in which each man, on the basis of his peculiar experience, partakes of the decision. For deep comprehension and intelligent action by society can be achieved only after all implications of scientific discovery are fully disclosed, explored and evaluated.

Perhaps the most hopeful note was found in the fact that so many thoughtful Americans, of every class and interest, were aware of these problems and had the will to face up to them.

National Science Policy

On March 17, 1954, President Eisenhower issued an Executive order concerning Government scientific research and the responsibilities of the National Science Foundation and other Federal agencies engaged in research and development. The text of the Order 10521 is given in Appendix V, p. 118.

The Executive order clarified and helped to define areas of interest of the several agencies with a view toward conservation of fiscal and manpower resources in the conduct of research. It made clear that agencies having operating missions depending upon research for their proper execution should continue to conduct and support basic research in areas closely related to their missions. At the same time, it stated that the National Science Foundation should be increasingly responsible for providing Federal support for general-purpose basic research.

The order called for the establishment of effective working arrangements between the Foundation and other agencies in arriving at mutually agreeable policies concerning the support of basic research. Each agency is charged with the responsibility for making continuous review and evaluation of its applied research and development programs with a view to maximizing efficiency and economy. Among the factors to be considered in such review are the status of basic research underlying development work, the relative priority of various development programs, project costs, and availability of manpower and facilities.

To the extent consistent with national security the order requires increased attention to the reporting and dissemination within the Federal Government of reports on the nature and progress of research projects undertaken by the various agencies. To facilitate this exchange of research information, the Foundation in cooperation with other agencies is directed to develop improved methods of classification and reporting. Other provisions of the order require the establishment of an inventory of major scientific facilities and equipment to facilitate the joint use and exchange of such items. This is under the primary supervision of the Interdepartmental Committee on Scientific Research and Development.

SURVEYS OF NATIONAL SCIENTIFIC ACTIVITIES

Several sections of the Executive order have to do with developing and encouraging the pursuit of an appropriate and effective national policy for the promotion of basic research and education in the sciences. This is of major concern to the National Science Foundation. In carrying out such responsibilities the Foundation is directed to recommend to the President policies for the Federal Government which will strengthen the national scientific effort and furnish guidance toward defining the proper role of the Federal Government in the conduct and support of scientific research.

During the past 2 years the Foundation has been engaged in making studies of the scientific resources of this country and of the manner in which they are being used to promote the national security, health, and economic welfare. This has involved the review and study of scientific research and training activities of the Government, industry, universities, and other public and private institutions. The order confirms the desirability and need for such studies.

The National Science Foundation Act of 1950 specifically authorizes and directs the Foundation to appraise the impact of research upon industrial development and upon the general welfare. The new order makes clear that this directive extends to the study of the effects upon educational institutions of Federal policies and administration of support programs for scientific research and development. In December the Foundation announced the appointment of an Advisory Committee on Government-University Relationships. It is the intention of the Committee to consider Federal policies and procedures which will promote general national research objectives and realization of Federal research needs while safeguarding the strength and independence of the Nation's institutions of learning.

By the close of the fiscal year, the Foundation had started several cooperative studies of Federal agencies, educational institutions, and industrial groups engaged in research and development.

RESEARCH AT EDUCATIONAL AND OTHER NONPROFIT INSTITUTIONS

During the year, an extended study was made of the type of information needed for analysis of scientific research and training activities at educational institutions. Questionnaires for obtaining such information were pretested at selected representative universities. Following the pretest a modified questionnaire-schedule was sent to over 400 universities and colleges which offer graduate study at least through the master's degree level.

The initial survey will provide statistics on the current enrollment of graduate students in the natural and social sciences, as well as in the humanities and most professional fields, and on the amount of financial support that is now available to graduate students in various fields.

Other segments of the study of nonprofit institutional research will be concerned with the analysis of sources of support for research at universities and colleges, the nature of such research, and the effect of research upon the teaching programs of the institutions. In order to define possible trends in research, case studies will be made of the research experience of some 30 selected institutions throughout the United States.

A separate project on the effects of outside research support on the development of an educational institution is being conducted at one leading university noted for its long and successful research experience. This analysis will cover research undertaken in the biological sciences department of the institution over the past 25 years. Among the factors to be considered are the relationship of research support to the professional development of individual investigators, the fate of research proposals that fail to attract nonuniversity support, the interplay of factors which influence the level and frequency of research support, and the influence of research support on education. This study will supplement the more general studies in appraising the impact of the type and quantity of support available for research upon scientific education and scientific productivity.

RESEARCH PROGRAMS OF FEDERAL AND STATE GOVERNMENTS

A second broad area of study of research activity in the United States is centered on current programs of Federal agencies in support of research in the natural and social sciences. The past year has been devoted to the development, with the advice and cooperation of the interested agencies, of a series of questionnaires to obtain comparable information on funds for research, scientific manpower resources, research programs, and related activities. At the present time the following information is being compiled:

Agency organization for science.—This is designed to develop a "map" of the organizational structure of units in Government performing scientific functions. It will eventually be reduced to an organizational directory of Government science for both Federal officials and private groups.

Personnel engaged in scientific activities.—This will provide information on the supply and distribution of scientific and supporting technical personnel in Government. The Government is the largest user of scientific and specialized personnel in the United States, either directly in its own laboratories or indirectly in industry or academic institutions working on Government contracts or grants.

Government scientific installations.—This in effect will be a descriptive inventory of Federal scientific installations, facilities, and other capital items for conduct of research and development. Under Executive Order 10521 the Interdepartmental Committee for Scientific Research and Development is directed to maintain a continuing inventory of large-scale research equipment owned and operated by Federal agencies.

Funds for scientific activities.—This will continue the fiscal analyses of Federal research and development activities of the type previously reported in the Foundation's published report series, *Federal Funds for Science.*

Preparation of a history of the activities of the Federal Government in science from 1789 to 1940 is being supported by the Foundation at the American Academy of Arts and Sciences. This historical account will supply important background information.

A survey of research activities of State governments is being done in two parts: (1) By the Bureau of the Census, Department of Commerce, and (2) by the Institute for Research in Social Science, University of North Carolina, Chapel Hill. The Census Bureau will analyze pertinent information now available in its extensive files and will determine in what respects additional investigations are necessary to study State-financed and State-controlled research activities throughout the country. The Institute at North Carolina will participate in the initial analysis and will conduct the followup investigations. Information will be gathered on research costs, manpower, research administration, and research content of State-supported programs.

RESEARCH ACTIVITIES OF INDUSTRY AND OTHER PRIVATE GROUPS

The National Science Foundation has started four studies of industrial and other private research activities by outside survey groups to round out its broad investigation of science in the United States. These studies, supported by the Foundation under contract, are as follows:

Survey of industrial research and development.—The preliminary phase of this study is being conducted for the Foundation by the Bureau of Labor Statistics, Department of Labor, under the direction of a steering committee composed of staff members of the two agencies. Plans were developed in consultation with the research committee of the National Association of Manufacturers, the Industrial Research Institute, and other industry groups. The study includes a review of available information from previous studies, a questionnaire survey of a carefully selected sample of about 12,000 companies in the United States, and intensive interviews with representatives of about 200 selected large corporations.

Estimates will be obtained on a nationwide basis of the amounts spent for the conduct of research by size of companies and by industry groups; of the source of these funds by major economic sectors; and of the amount spent by companies to purchase research conducted elsewhere, for example, in universities and research institutes.

The information will also permit the estimation by groups of companies, of ratios of research expenditures to capital expenditures, to sales, to research and development personnel, and to other relevant measures. In addition to dollar figures, the questionnaires will furnish in considerable detail information on the use of scientific and technical manpower in industrial research and development.

In the interviews an attempt will be made to ascertain the opinion of industrial leaders with respect to policies which might strengthen the scientific research effort of the United States. The interviews will also provide clues to specific bottlenecks faced by industry in planning its research. Some estimates may be obtained of the economic payoff of research.

Finally a historical analysis of selected companies will be carried out in an attempt to reconstruct the gross pattern of industry research over the past two or three decades. It is hoped that this will assist in the estimation of manpower and capital requirements that are likely to confront the Nation's economy in the near future.

Survey of research by trade associations and similar organizations.—This study is being conducted by the Battelle Memorial Institute, Columbus, Ohio. There are about 16,000 trade associations in the United States, of which 200 to 400 conduct or support research programs in the natural sciences. A somewhat larger number have research programs in economics and other social science fields. The study will also include other types of cooperative industrial research organizations and certain professional societies which conduct research programs, largely supported by industry.

Survey of research at nonprofit institutes and commercial laboratories.—This study is being conducted by the Maxwell Research Center, Syracuse University, Syracuse, N. Y. It is planned to explore the research programs of the 50 to 100 independent nonprofit research institutes and the estimated 250 to 400 commercial research laboratories in the United States. In many instances these organizations are concerned with research of interest to industry, but they differ from industrial laboratories in that the primary emphasis is upon research, and production, if any, is secondary.

Status of research in fermentation.—This study, undertaken as a case history in industry-government research relationships, is being conducted by the Roger Williams Technical and Economic Services, Inc., of New York. The field of fermentation was selected for such a pilot study for a number of reasons: (1) It involves both basic and applied research by industry, government, universities, and commercial laboratories; (2) it cuts across disciplinary lines, since both physical and biological research is required; (3) it is of interest to several important industries, including distilling, brewing, chemicals, food, and pharmaceuticals; and (4) the problem of security, such as would be encountered in the field of electronics, for example, is minimal.

RESEARCH PROJECT INFORMATION COORDINATION

The need for improved exchange of research information among Federal agencies has been stressed frequently. During the past year the Foundation has expanded its program of compiling and publishing unclassified lists of Federal research projects in various fields of science. The previously announced quarterly and semiannual lists of projects in psychology and the social sciences have been continued.

Preparation of the first annual list of extramural projects in the life sciences supported by Federal agencies has been completed and issued to the interested agencies for comment and suggestions for improving coverage in subsequent editions. The information on projects in the life sciences covers nearly 6,400 grants and contracts totaling almost $47 million for the calendar year 1952, or about 80 percent of the estimated Federal expenditures for research in biology, medicine, and agriculture for that year. The following seven Federal agencies having major research programs in the life sciences cooperated in the study: The Office of Naval Research, Office of Surgeon General of the Department of the Army, the Department of the Air Force, the Department of Agriculture, the Department of Health, Education, and Welfare, the Atomic Energy Commission, and the National Science Foundation. The analysis does not include research on human resources problems or psychology, nor does it include biological and medical research supported by the Atomic Energy Commission at its operating laboratories, such as the Oak Ridge, Brookhaven, and Argonne National Laboratories.

The Foundation is one of seven Federal agencies supporting the Biological Sciences Information Exchange, a cooperative enterprise administered by the Smithsonian Institution for the exchange of research information among scientific administrators of the contributing agencies.

Parallel activities in mathematics and the physical sciences are being carried on by means of compilations of projects in various fields and by informal liaison among program directors of the interested agencies.

International Geophysical Year

During 1957–58 for the third time in a century scientists of many countries will join in a critical examination of the ever-changing aspects of man's immediate physical environment.

The International Geophysical Year (IGY) is a major research undertaking in the earth sciences, including astrogeophysical measurements, meteorology, oceanography, glaciology, ionospheric physics, aurora and airglow, geomagnetism, cosmic rays, and rocket exploration of the upper atmosphere. The undertaking must be conducted on an international scale, for the problems are global in character. Each field of study requires observations and measurements on a worldwide basis. Moreover, these scientific fields are closely interrelated, so that maximum progress can be made only if the technical work in all fields is performed simultaneously.

Much effort has already gone into planning the program. Scientists from many countries have worked together in laying out the necessary scientific projects and activities, both on a national and international scale. In this sense, the IGY has already begun. Activity will increase during the next 2 years, culminating in intensive studies during calendar years 1957 and 1958. The years 1957–58 were selected for the observation period to take advantage of a period of maximum solar activity and of concurrent eclipses.

That geophysical problems could benefit from international cooperation was recognized in 1882–83 when the First Polar Year was launched, and again in 1932–33 during the Second Polar Year. These previous ventures were more limited in scope. Geographically, the areas of interest were restricted to regions about the North Pole, in contrast to the current worldwide program. Nevertheless, studies of the ionosphere during the Second Polar Year, by techniques then recently developed, gave rise to communications information that proved to be worth hundreds of millions of dollars.

INTERNATIONAL BACKGROUND

The proposal for the present international geophysical research effort originated in the International Council of Scientific Unions (ICSU), the central organization representing the several specialized international scientific unions. Toward the end of 1952, ICSU began planning for the IGY program. ICSU established a special committee for planning at an international level, and associated scientific groups in various nations were asked to set up national committees for planning and undertaking their national programs. The affiliated body in the United States is the National Academy of Sciences-National Research Council, which established a national committee for the preparation of the United States program.

As of November 1, 38 nations had signified that they would participate in the program:

ARGENTINA	ICELAND	SPAIN
AUSTRALIA	INDIA	SWEDEN
AUSTRIA	IRELAND	SWITZERLAND
BELGIUM	ISRAEL	THAILAND
BRAZIL	ITALY	TUNISIA
BURMA	JAPAN	UNION OF SOUTH AFRICA
CANADA	MEXICO	UNION OF SOVIET SOCIALIST REPUBLICS
CZECHOSLOVAKIA	MOROCCO	UNITED KINGDOM
DENMARK	NETHERLANDS	UNITED STATES
FINLAND	NEW ZEALAND	YUGOSLAVIA
FRANCE	NORWAY	
GERMANY, EAST	PAKISTAN	
GERMANY, WEST	PERU	
GREECE	PHILIPPINES	

Details of the technical and fiscal plans of other nations during the International Geophysical Year were not available at the time of writing, but the final plans were to be formulated at a general meeting of the IGY Committee held in Rome in September 1954.

THE UNITED STATES PROGRAM

Many agencies and institutions assisted in planning the United States program. Within the Government, the program is of most immediate concern to the Departments of Commerce, Defense, State, and the National Science Foundation. In response to the request of the United States National Committee, the National Science Foundation has undertaken to coordinate various Federal interests. The Foundation will also handle the administrative and fiscal planning for the United States Government. Many universities, private foundations, observatories, and laboratories have specific interests. In the formulation of the program, several hundred scientists from Federal and private agencies and research institutions have contributed their services. Execution of this program will involve the continuing cooperation of all of these groups.

The United States program includes activities in several geographical regions of importance to this country: (1) The Arctic and sub-Arctic regions; (2) the middle latitudes of the Northern and Southern Hemispheres, including the United States, Central America, South America, and adjacent stretches of the Atlantic and Pacific Oceans; and (3) the Antarctic and sub-Antarctic regions. In each region the type of program to be pursued will depend on present geophysical activities in the region. Existing activities provide a substantial base for the total endeavor, but the proposed program will stress specific areas of research in geophysics for which existing programs are inadequate or lacking altogether. A more detailed summary of the United States program is given in Appendix VII, p. 123.

In many fields little additional activity need be carried on within the continental United States, since normal operations provide the necessary information. For example, the planned meteorology program calls for observations from only a few additional South American and Antarctic stations. Data from these regions, added to those gathered at existing Weather Bureau stations in the United States and the Arctic, will give adequate weather coverage for the Western Hemisphere. Similarly, the ionospheric, auroral, and geomagnetic programs stress the northern and southern latitudes. The planned Antarctic activity will require a major expedition.

In a letter to the Chairman of the National Science Board, President Eisenhower gave the International Geophysical Year strong endorsement calling particular attention to the value of scientific cooperation among nations. The President wrote:

> I am glad to support this undertaking. It is a striking example of the opportunities which exist for cooperative action among the peoples of the world. * * * Under especially favorable conditions, scientists of many nations will work together in extending man's knowledge of the universe. The findings of this research will be widely disseminated throughout the world, aiding in the further development of telecommunications, aviation, navigation, and weather forecasting. It is doubtful whether any single nation could undertake such a program. Acting in concert, each participating nation, contributing within its means, secures the benefits of the program. The United States has become strong through its diligence in expanding the frontiers of scientific knowledge. Our technology is built upon a solid foundation of basic scientific inquiry, which must be continuously enriched if we are to make further progress. The International Geophysical Year is a unique opportunity to advance science, while at the same time it holds the promise of greater technological gains both for ourselves and for other nations. I am sure that our participation in this far-reaching effort will very materially strengthen our bonds with the many

cooperating nations and make a constructive contribution toward the solution of mutual problems.

The budget request for support of the International Geophysical Year was submitted to the Congress in June 1954, and an expenditure of $2 million was authorized for the initial phase of the program. It is estimated that an additional $11 million will be required to complete the United States program.

Utilization and Training of American Scientists

THE INCREASE IN TECHNICALLY TRAINED PERSONNEL

In 1870, the population of the United States totaled nearly 40 million persons. Of every thousand persons in the population, 325 were gainfully employed. Only about 12,000 individuals in all, or 1 in 1,000 workers, were employed in science and technology. During the next three-quarters of a century these figures changed rapidly. By 1950 the population exceeded 150 million, and 400 persons out of every thousand were at that time in the labor force. The number of scientific and technical employed had passed the million mark, so that 1 in every 60 individuals in the labor force was a scientist, engineer, or other type of technologist (fig. 1).

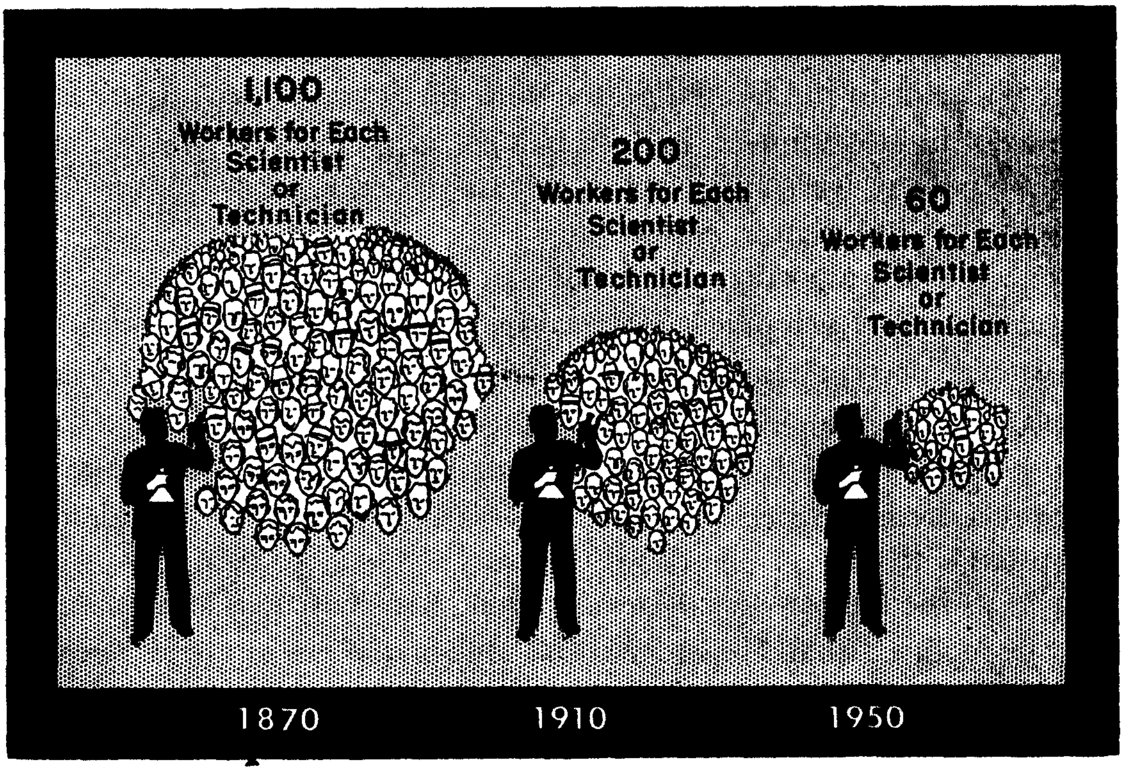


FIGURE 1. *Ratio of scientific and technical workers to total labor force in 1870, 1910 and 1950.*

Another indication of the trend toward technology is seen in the changing ratio of farm to nonfarm workers in the labor force. In 1820, some 72 percent of the labor force was classified as agricultural workers; by 1870 this proportion had fallen to 53 percent; and in 1950 less than 12 percent was so classified.

The term "scientists and engineers" is limited here to those who have at least a bachelor's degree, or its equivalent in professional experience, and who are employed in recognized branches of the natural sciences, engineering, or mathematics. By 1953, the population of scientists and engineers meeting this definition was estimated at 400,000 to 500,000 engineers and 200,000 scientists. About half of the scientists were chemists, a fourth were biologists or agricultural scientists, and the remaining fourth were earth scientists, physicists, mathematicians, and other scientific specialists.

According to the 1950 Census of Population, about 24 percent of the engineers in the United States were in civil engineering, 21 percent in mechanical engineering, and 20 percent in electrical engineering. The remaining 35 percent were distributed among chemical, industrial, aeronautical, mining and metallurgical engineering, and other engineering fields.

UTILIZATION OF SCIENTISTS AND ENGINEERS

In 1951, the Bureau of Labor Statistics estimated that about 48 percent of the scientists in the United States were employed in private industry, 26 percent in Government, and 26 percent in education. Of the engineers, 75 percent were employed in private industry, 22 percent in Government and 3 percent in education.

In 1951 the proportion of scientists actually engaged in research, as contrasted with development work and other professional activities, was highest (58 percent) in geology, which includes field exploration, and lowest (13 percent) in psychology. Nearly half of the physicists and chemists listed research as their primary activity. Eighty percent of the mathematicians reported principal professional activity as teaching, as contrasted with only 11 percent of chemists and geologists.

In 1953 the Research and Development Board of the Department of Defense reported that 17 percent of scientists and engineers in research and development were employed in Federal Government, 68 percent in private industry, and 15 percent in educational and other nonprofit institutions.

Although figures are available on the number of college graduates receiving degrees in science, less is known about the number who actually enter scientific professions after graduation. The National Science Foundation has obtained some information on this point from a study of persons graduating from college in June 1951 (fig. 2).

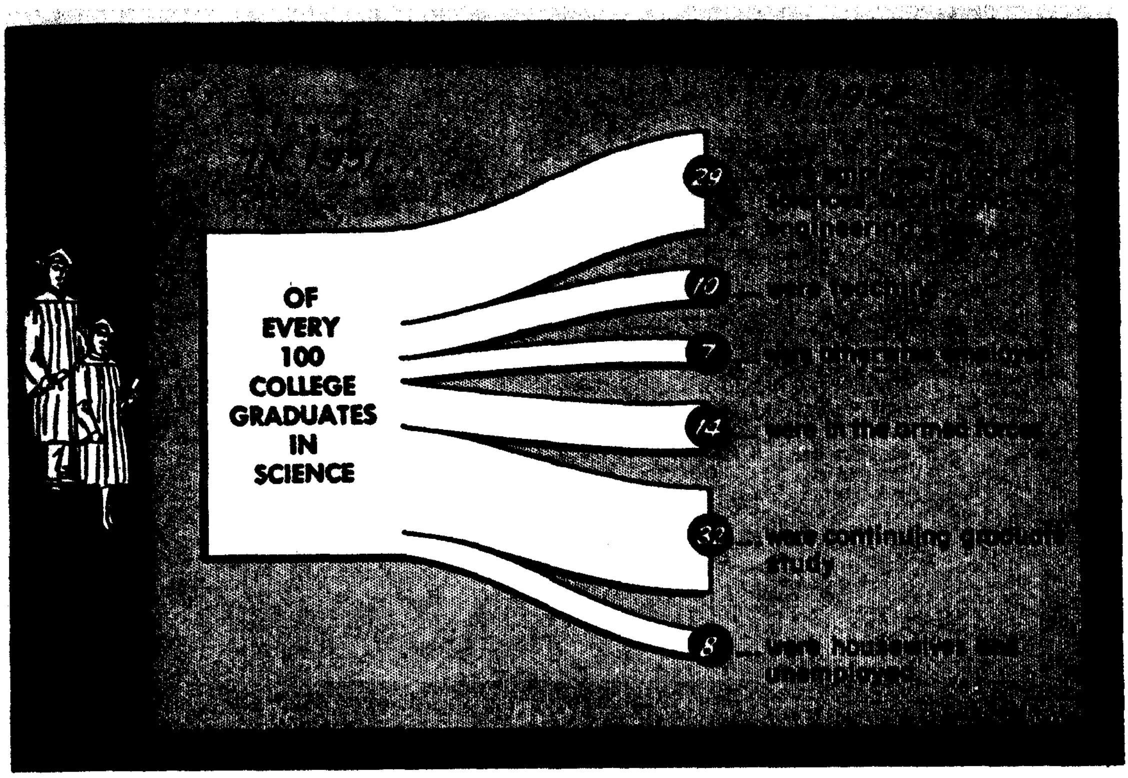


FIGURE 2. *Employment status of 1951 college graduates in science, 1 year following graduation.*

Approximately 1 year after graduation, 32 percent of the science graduates were continuing their education in graduate studies—40 percent in science, 45 percent in health fields including medicine, and the remainder in other fields. Fourteen percent of the total were in the Armed Forces, another 46 percent were professionally employed, and the remaining 8 percent were mainly women graduates who had married and become housewives. Of those professionally employed, 46 percent were working in the natural sciences, 21 percent in education, 15 percent in business and commerce, 10 percent in engineering, 6 percent in health fields, and 3 percent in occupations not elsewhere classified.

UNIVERSITY OUTPUT OF SCIENTISTS

The Commission on Human Resources and Advanced Training estimates that about 44,000 of the 200,000 scientists have doctors' degrees. Of this number about 55 percent are in physical sciences, 39 percent in agricultural and biological sciences, and 6 percent in the earth sciences.

Since 1900, the number of doctoral degrees granted annually in science by American universities has approximately doubled every 10 years. In 1900, 102 degrees were reported, and 4,631 in 1953. This increase, however, conceals a serious loss in the output of science doctorates during the years 1942–49. The low point of recent years was reached at 833 in 1945. Figure 3 shows the number of such degrees granted since 1920.

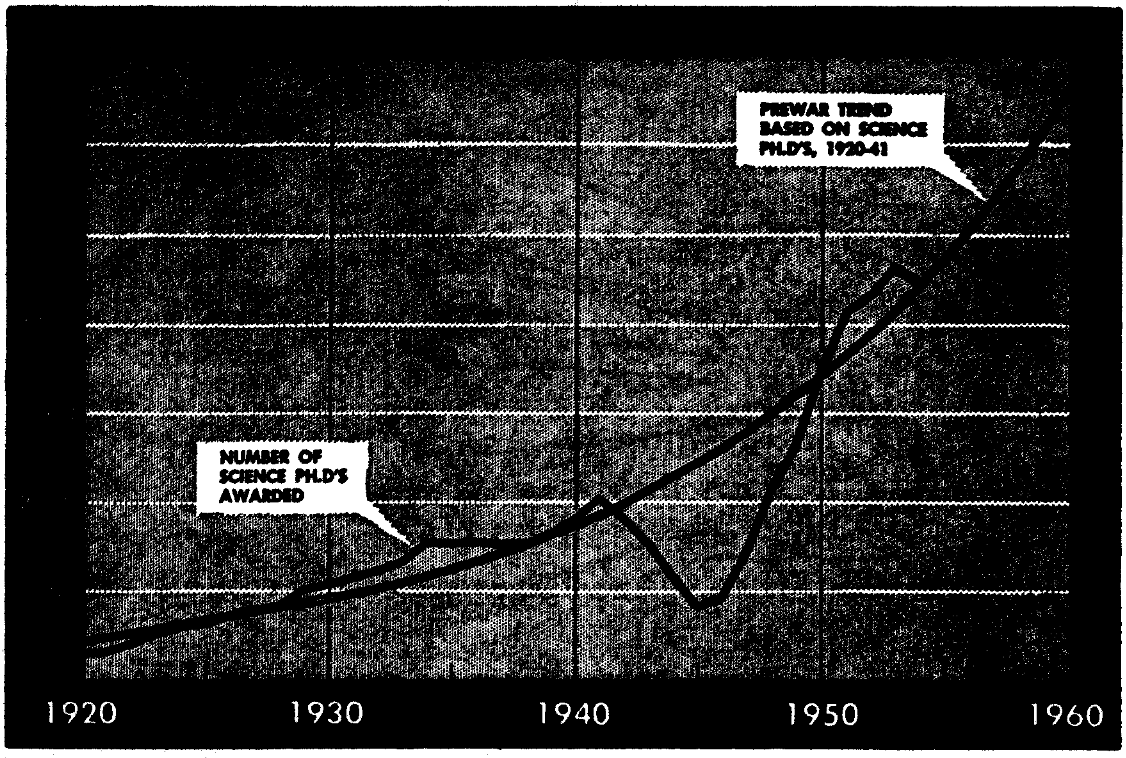


FIGURE 3. *Ph. D. degrees in science awarded in the United States, 1920–54, with prewar trend through 1960.*

The loss of science doctorates during 1942–49 is attributable in large part to military requirements which sharply reduced the college student population in both graduate and undergraduate training. A secondary factor, operating importantly during at least part of the period, was the great number of employment opportunities which made graduate study less attractive. The loss of science doctorates during this period may be estimated at about 9,000 on the basis of the prewar trend.

The downward trend in bachelors' degrees awarded in science and lower undergraduate enrollments of recent years will be followed by a smaller number of doctorates in 1954 and the next few years, or until the youth of the higher birthrate years of the 1940's appear in the graduate schools. There is no present indication that the loss of 1942–49 will be made up.

The highpoint of bachelors' degrees awarded in science and engineering occurred in 1950 largely as the result of the GI bill and the return to the colleges of the youth whose education was interrupted by the war. In that year, 57,000 bachelors' degrees in science and 52,000 in engineering were reported. By 1953, bachelors' degrees in science numbered 34,000 and in engineering 24,000. The low point was probably reached in 1954. Thereafter, the larger first-year college classes of the past few years should result in increased numbers of science graduates. Significant increases are in prospect for the early 1960's.

SHORTAGES OF SCIENCE TEACHERS

Little that is definitive can be said on the present requirements and shortages of scientists and engineers. The Committee on Manpower Resources for National Security of the Office of Defense Mobilization in its review of the situation in 1953 pointed to current shortages in engineering, to needs for advanced degree holders in the physical sciences, in medicine, and in teaching. Shortages in engineering and physical science fields are shown by recruiting difficulties and the increase in entrance salaries. The shortage of qualified science teachers in the secondary schools is well known. The shortage of teachers may be expected to extend to the colleges as the student population bulge advances to that point.

Enrollments in elementary schools in the United States were estimated at about 18 million in 1919–20. There was a slight increase during the next 30 years to about 20 million in 1949–50. The high birthrates of the war and postwar years have led the Commission on Human Resources and Advanced Training to estimate that elementary school enrollments will reach nearly 32 million by 1964–65.

The increase in secondary school enrollments will be proportionately greater. In 1919–20 there were an estimated 2.5 million students in high school, compared with 7 million in 1949–50 and an estimate of 12.7 million in 1964–65.

According to information in the Biennial Survey of Education in the United States, 1948–50, the Office of Education reports that the student-teacher ratio in colleges was 14 to 1 in 1950 as contrasted to 18 to 1 in secondary schools and 33 to 1 in the elementary schools. In order to maintain a reasonable student-teacher ratio in the secondary schools many thousands of newly trained teachers are needed each year to provide for the increasing enrollments and to replace those leaving teaching. The National Education Association estimates the need for new high school science teachers over the next decade as increasing from 7,700 per year in 1954–55 to about 10,000 per year in 1965–66.

While high school enrollments go steadily upward, the proportion of college graduates who qualify to teach high school subjects continues to decrease. The situation is particularly critical in the case of graduates qualifying to teach high school science and mathematics. Between 1950 and 1954, the total number of bachelors' degrees granted dropped by 34 percent. During this same period, according to the National Education Association, the number of college graduates meeting certification requirements to teach in high school dropped 42 percent, and the number qualified to teach mathematics and science dropped 51 and 56 percent, respectively.

More serious still is the fact that many college graduates who qualify to teach high-school science subjects actually find employment in other fields. A recent study of 1953 college graduates in teacher preparation programs showed that only 40 percent of those qualified to teach science and mathematics were actually teaching in November 1953. These percentages compare with 70 percent for home economics, 62 percent for English, and 53 percent for commercial subjects.

LOSS OF POTENTIAL SCIENTIFIC AND TECHNICAL PERSONNEL

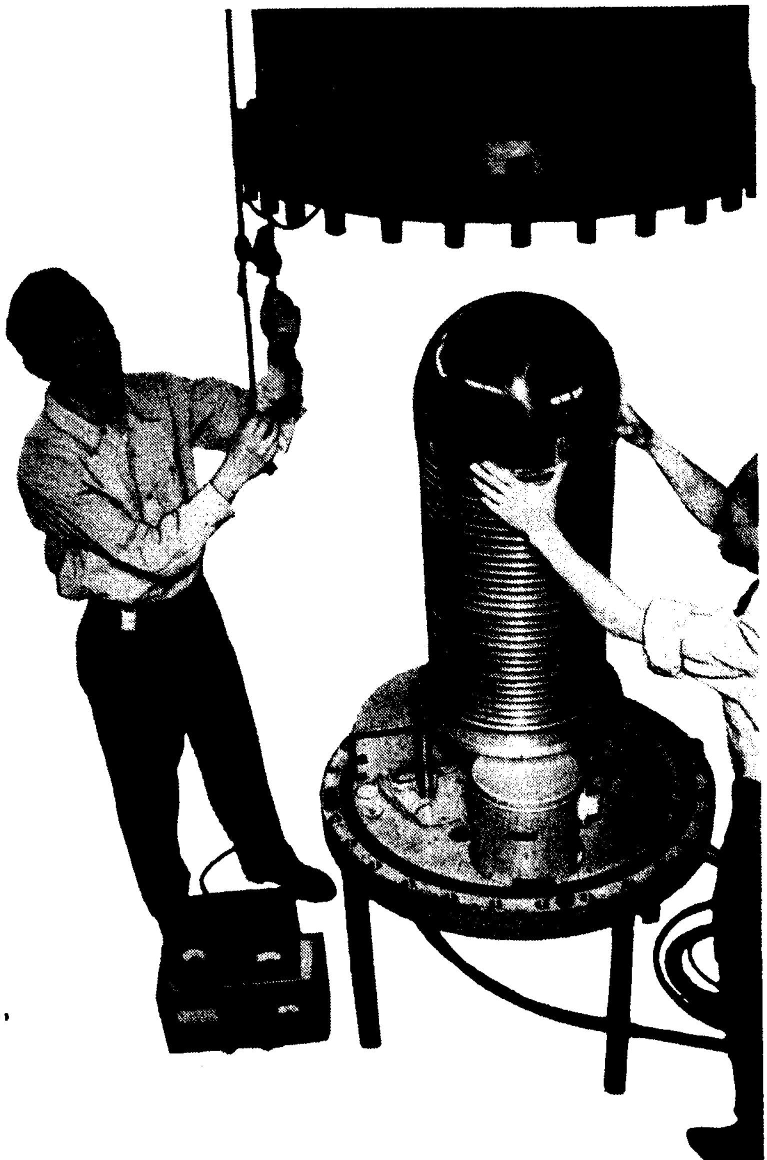
It is generally agreed that successful pursuit of a professional career in science requires a high level of mental ability. The Commission on Human Resources and Advanced Training has attempted to relate the distribution of intelligence in a population group to levels of education. The resulting data show the average ability rating of high school graduates to be about 110 and of college graduates to be about 120, in comparison with 100 for the general population of the same age group.

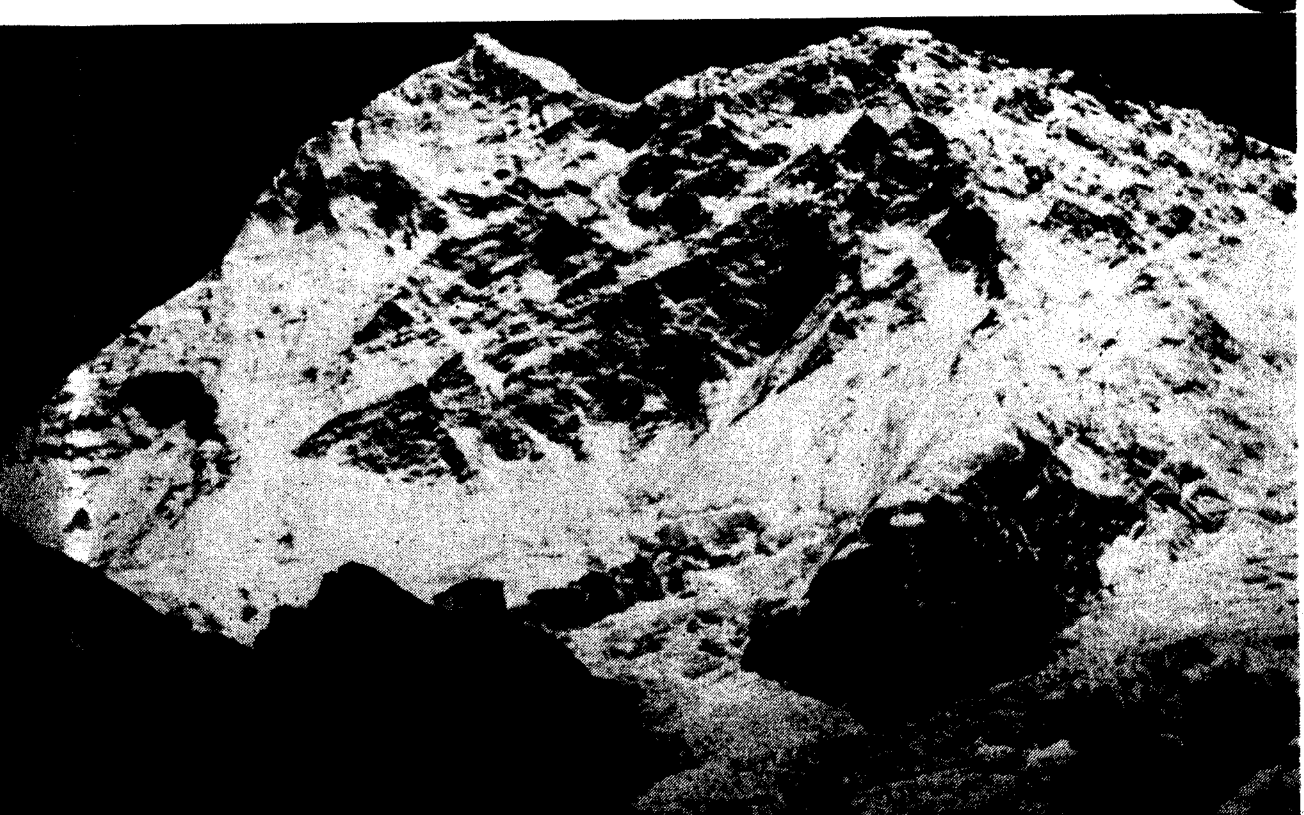
About 13 percent or 1 out of 8 of an age group possesses a rating of 120 or more, equivalent to that of the average college graduate. This is the group from which intellectual leadership not only in science but in all fields must be sought. Presumably, this relatively small group contains most of the individuals who are capable of benefiting from advanced training and who, in turn, will be best able to benefit society as a result of such training. The extent to which this group continues its formal education is a measure of our success in training up to our potential manpower resources.

Nearly all of this potentially productive group now finishes high school, with only about 1 percent loss reported by the Commission. However, 47 percent fail to continue formal education beyond this point, and another 13 percent drop out before completing college. Thus, about 60 percent of the group with the greatest potential fail to complete a college education. Only 2 percent of all college graduates, or one quarter of 1 percent of the total age group, continue their education through the Ph.D. level.

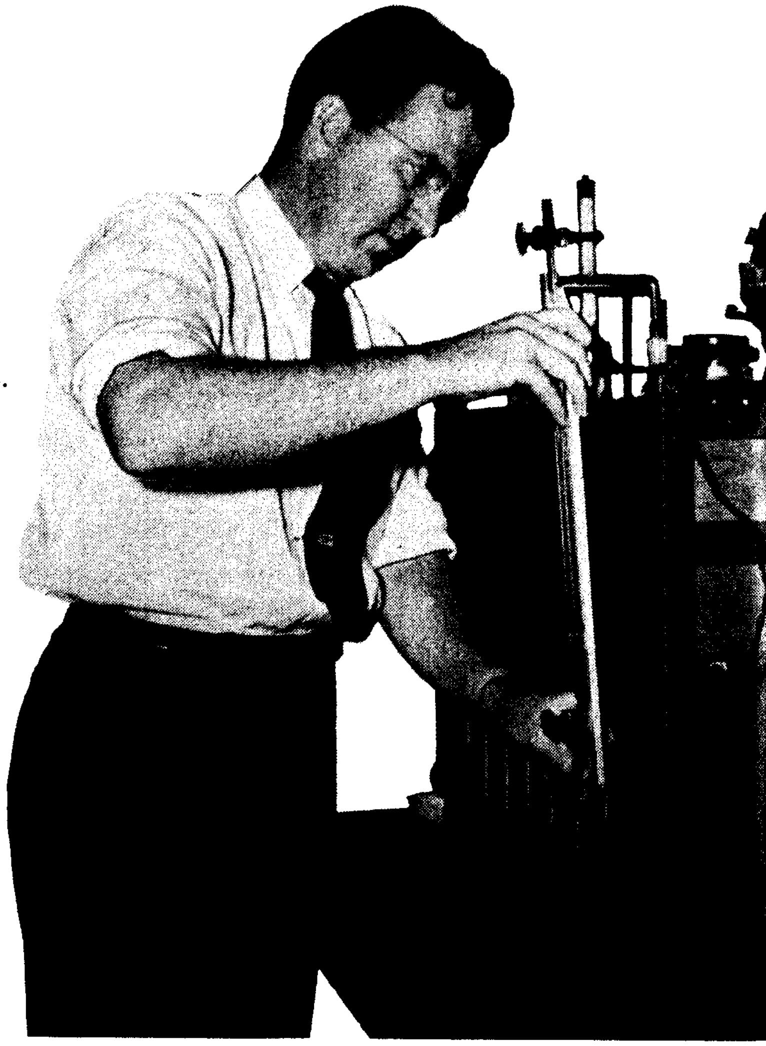
Economic and cultural factors have an important bearing on the failure of large numbers of the more talented youth to continue their education. The high cost of a college education, a traditional independence from family support at about college age, competing interests in employment, early marriages, and lack of interest and knowledge of opportunities available to college graduates are other important fac-

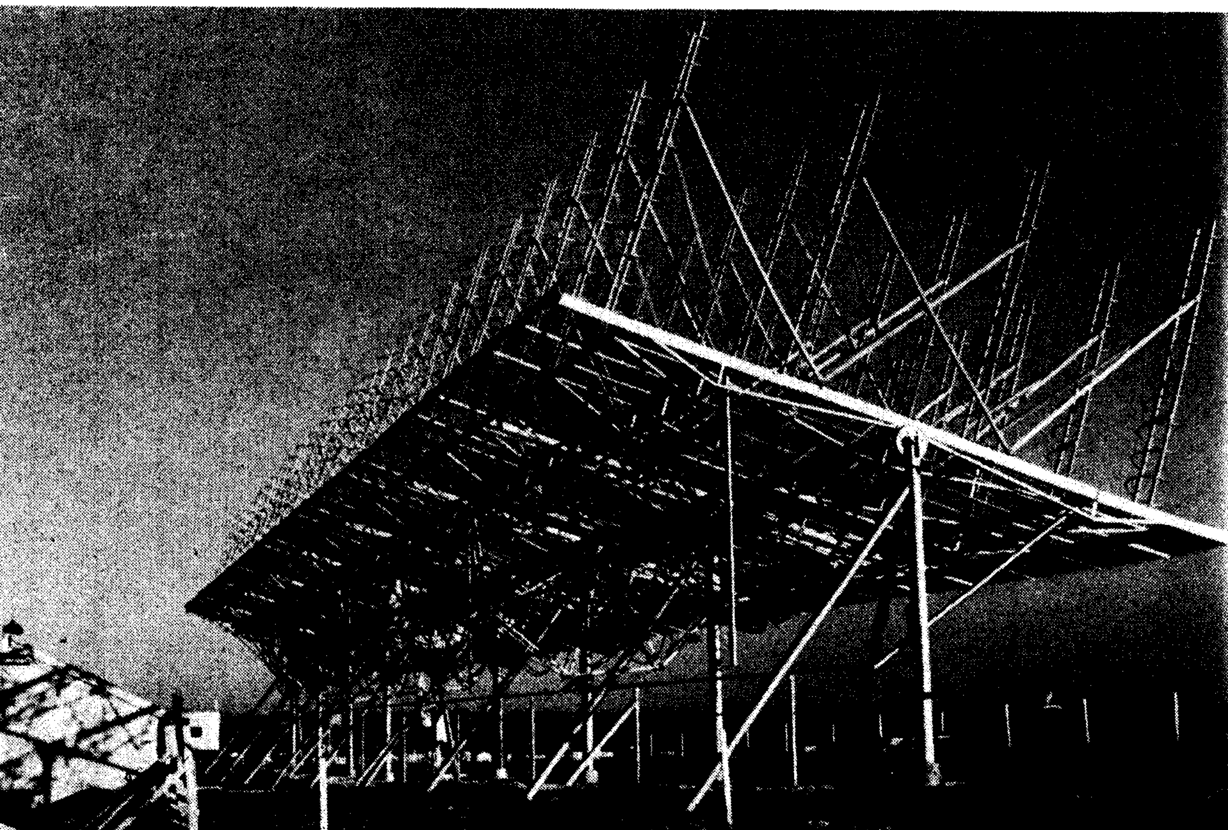
Graduate assistants (right) at Massachusetts Institute of Technology, adjust terminal of 2-million-volt Van de Graaf accelerator, used to study electron emission from metals under high-energy bombardment. John G. Trump directs research. Makalu (below) world's 4th highest peak, rises to 27,790 feet near Nepal-Tibet border. California-Himalayan Expedition in April 1954 reached 23,000 feet, highest point yet attained on Makalu's frigid, wind-swept slopes. NSF support enabled Nello Pace, University of California physiologist, to study human body changes at high altitudes. Lawrence Swan, biologist on 10-man team, found native spiders at 20,000 feet, "the highest animal level in the world."





Daniel J. O'Kane (right),
microbiologist,
at the University of Pennsylvania,
is studying the enzymes
that produces energy from food.
The Warburg respirometer
measures small gas changes
from "breathing" of microorganisms.
John D. Kraus (below),
of Ohio State University,
is shown with an unusual type
of radio telescope.
It has 96 helical (corkscrew)
beam antennas mounted on
a pivoted 160-foot steel frame.
The antenna picks up weak radio
waves from celestial objects.
The Ohio State radio telescope
has located over 200 spots
of radiation in the sky.
Most of these "radio stars"
are not associated with
any known visible object.
Kraus is now making a radio map
of all sky visible from Columbus.





tors. A positive decision to attend college is related to the socio-economic status and such additional factors as parental education, books in the home, and the counsel of teachers and friends.

There are no simple solutions to the problem of increasing our potential of highly trained scientific and technical manpower. They may include greater public support of education in order to reduce the financial burden of attending college, at least in those fields where policy dictates that increases are essential. The motivation to undertake science training can be increased by stressing the national importance and the personal satisfactions and rewards of careers in science and technology.

A summary of the Foundation's efforts to increase the Nation's competence by encouraging policies to increase the quality and number of young people trained in science is given in later sections of this report.

820814—55——3

Research in Colleges

A conference on physics research in colleges held at Amherst College in May 1953 (See *Third Annual Report,* p. 36) was the first of a series of conferences sponsored by the Foundation on the subject of research in colleges, as distinguished from universities. During the past year conferences of this type were held on research in geology, Beloit College, October 1953; biology, Bryn Mawr College, April 1954; astronomy, Swarthmore College, April 1954; and chemistry, Washington and Lee University, May 1954.

The conferences were called to consider problems associated with the conduct of research in colleges or small university departments, to assess the value of research as an adjunct to teaching in such institutions, and to determine the desirability of increasing the research activities in the normal undergraduate schedule.

The participating institutions were selected so as to represent various regions and types of institutions. Altogether, 92 institutions were represented, of which 63 may be classified as strictly liberal arts colleges. (See Appendix VI, p. 120.) The average attendance at the conferences was about 30. Some colleges were represented at more than one meeting.

THE PLACE OF RESEARCH IN THE COLLEGES

The participants noted that many colleges, although operating under stringent financial limitations which preclude research programs, are sending students on to careers as scientists. It was generally felt that undue pressure to undertake research might unbalance the programs of these institutions and should be avoided. On the other hand there was general agreement that carefully conceived plans of research aid, administered with appreciation of the special role of colleges in our educational system, could further enhance the service they render.

Although the majority of the participants were active in research, it was clearly the consensus of opinion that the primary function of the liberal arts college is teaching. If not overemphasized, research was considered a desirable activity for the college teacher and essential in realizing most completely the fundamental aims of the college. It was generally felt that a scientist engaged in research, even on a small scale, is likely thereby to be better equipped to present his subject in dynamic fashion. Excellent teaching has clearly been shown as one of the best means to stimulate undergraduates to enter careers in science.

The conference delegates agreed that student participation in research can be highly effective in motivating the students toward careers in science. Furthermore, the experience produces mental maturity of value for all students, including those who do not enter research careers. Several conference participants pointed out that the greater freedom from pressures and the simplicity of administration in small institutions provide an environment suited for creative work in basic science. While the total output of research in the small colleges cannot be expected to approach that of the universities, many notable investigations have been and are being carried out in smaller institutions.

UNDERGRADUATE PARTICIPATION IN RESEARCH

Undergraduate participation in research was considered at all the meetings, but it was the special topic of the conference on chemistry. Undergraduate participation is carried out under a variety of curricular devices, such as honors work, special study programs, and paid assistance in faculty research. The conferees felt that in general research experience tends to develop enthusiasm among students. As one delegate stated: "The student becomes alive when he finds he can produce." Other values noted included the added stimulation to faculty research and the help in selecting students fitted for graduate work.

Undergraduate participation in research creates certain administrative problems, such as increasing the amount of time expended by the instructor. Moreover, a research-minded faculty is essential in carrying out such a program. In geology and biology, where the summer is a peculiarly suitable and often the only possible time for certain kinds of research, scholarships covering travel and other expenses may be required.

CONCLUSIONS AND RECOMMENDATIONS

Conference recommendations for encouraging research were necessarily related to the differing needs of the various scientific fields and to local institutional situations that may interfere with the conduct of research. The major difficulties appear to be (1) inadequate faculty time because of heavy teaching schedules and administrative and other duties, and (2) inadequate salaries. The conferees recognized that the basic responsibility for removing these difficulties lies with the colleges.

This is particularly true in regard to relieving the teaching load, but some help may properly be given by outside agencies to provide for assistants or partial salary for additional personnel, thus permitting the institution to schedule more research time for an able investigator.

Low salaries militate against the use of summers for carrying out research, as it is frequently necessary for a faculty member to seek supplementary employment during the summer. This situation may be met by providing summer salaries so that competent scientists may undertake or continue research activities. In geology and biology, where much field work is carried out, assistance may be provided for attendance at summer stations or laboratories. In the physical sciences, there are analogous opportunities for summer attendance at universities, participation in research programs at astronomical observatories, exchange of staff members between large and small institutions, and leaves of absence.

The National Science Foundation has experimented along these lines by approving grants to research stations which in turn provide aid to college teachers. The summer institute or conference, which brings otherwise isolated teachers in small colleges in contact with recent scientific developments, has also proved successful.

It was noted that frequently a college may be unable to supply scientific instruments. The conferees felt that small grants of $100 or less might be of real help in furnishing research supplies and small pieces of equipment in such cases.

In discussing research support from Federal agencies or private foundations the conferees generally agreed that a proportion of the total available research funds should be reserved for research at small colleges. Moreover, it was felt that the point of view of the college teacher should be considered by the panels and project review boards which advise agencies in the distribution of research funds. In support of this position several conference participants cited the record of the Carnegie Foundation for the Advancement of Teaching during its 5-year program operating in the Southeast from 1948 through 1952. Grants to colleges made under this program appear to have been extraordinarily successful in stimulating research as well as in revitalizing teaching.

There was some discussion of appropriate procedures for awarding small grants. Although no definite administrative device was recommended, it seemed clear that one of the major requirements of such a program was an intimate knowledge of existing local problems.

PART II

Program Activities of the National Science Foundation

Conferences in Support of Science

During the year ending June 30, 1954, the National Science Foundation sponsored and provided partial support for a total of 19 conferences in special areas of science. In all cases sponsorship was shared with one or more private or public agencies, including universities and scientific societies. (See Table 1.)

Such conferences frequently provide a unique forum for the exchange and full discussion of new ideas and recent experimental findings on rapidly developing scientific fronts. Through support of conferences the Foundation is able to encourage research in areas of science of potential national interest but for which industrial support is not available. Leading foreign scientists attend many of these meetings, and at times the subject matter may be of an interdisciplinary nature of interest to scientists in several fields of science.

Brief notes on these conferences are given below. Normally, the request for support of conferences originates with the scientists working in the field under review. Proceedings and papers are frequently published by the scientific sponsors at the conclusion of the meetings.

ASTRONOMICAL RESEARCH AND PHOTOELECTRIC TECHNIQUES

During the past 20 years astronomers have relied more and more on photoelectric devices for making accurate measurements of the color and brightness of stars and other celestial bodies. The starlight falls upon a surface coated with an active material which releases a stream of electrons proportional to the intensity of the light. Such devices can "see" and measure the color and intensity of light over a range of wave lengths far broader than can be detected by the human eye.

In August 1953 the National Science Foundation and the Lowell Observatory sponsored a conference on Photoelectric Problems, Techniques, and Instrumentation for Astronomy Research. It was held at the Lowell Observatory, Flagstaff, Ariz. Astronomers, physicists, and electronic engineers discussed extension of the use of photoelectric techniques in their research. Among the problems benefiting from use of this type of equipment are measurement of the colors and magnitudes of star clusters and the study of double stars, eclipsing stars, and the Cepheids or pulsating stars. It is expected that work on these problems will clarify current views on stellar populations, stellar dimensions and masses, and the nature of stellar pulsations.

One of the important outcomes of the conference was the unanimous recommendation for a new telescope fully equipped for photoelectric methods in astronomical research and available to scientists from all parts of the country. The Foundation has established an advisory panel to consider all aspects of a cooperative National Astronomical Observatory.

Scientific Conferences Supported by the National Science Foundation in Year Ending June 30, 1954

Subject	*Sponsoring Organizations*	*Chairman*
Astronomical Research and Photoelectric Techniques.	Lowell Observatory	A. E. Whitford.
Problems in Astrometry	Northwestern University	G. M. Clemence.
Utilization of Solar Energy	University of Wisconsin	F. Daniels.
Nuclear Processes in Geologic Settings.	University of Chicago	L. T. Aldrich.
Role of Proteins in the Transport of Ions Across Membranes.	Columbia University	D. Nachmansohn.
Glutathione Research	Columbia University and Office of Naval Research.	D. Schwarz.
Cosmic Rays	Duke University	Bruno Rossi.
Low Temperature Physics and Chemistry.	Rice Institute and International Union of Pure and Applied Physics.	W. V. Houston.
Validation of Scientific Theories.	American Academy of Arts and Sciencies, Institute for the Unity of Science, and the American Association for the Advancement of Science.	P. Frank.
Radio Astronomy	Carnegie Institution of Washington and California Institute of Technology.	M. A. Tuve.
Luminescence of Biological Systems.	Committee on Photobiology of the National Research Council.	S. B. Hendricks.
Problem-Solving Behavior	New York University	H. H. Kendler.
High-Speed Computing in Meteorology and Oceanography.	University of California at Los Angeles.	J. von Neumann.
Physiological Development of the Mammalian Fetus.	Long Island Biological Association.	M. Demerec.
Multidimensional Analysis in Psychological Research.	University of Michigan	C. H. Coombs.
Problems in Human Communication and Control.	Massachusetts Institute of Technology.	J. C. R. Licklider.
Fundamental Problems of Perception.	Cornell University	J. J. Gibson.
Acoustics and the Structure of Liquids.	Brown University	R. B. Lindsay.
Growth and Development	National Institutes of Health, Society for the Study of Development and Growth and Dartmouth College.	David R. Goddard.

PROBLEMS IN ASTROMETRY

Participants from this country and abroad met in September 1953 at Northwestern University, Evanston, Ill., to discuss the present status of position measurements of celestial bodies. During the course of the 3-day meeting the conferees agreed on a number of recommendations for extending present work in astrometry. These included: (1) Making a third observation of all stars included in the *Astronomische Gesellschaft* zones; (2) extension to the southern hemisphere of the astrometric program now in progress at the Lick Observatory; (3) relating positions and proper motions of stars to those of galaxies; (4) installation of a meridian circle in the southern hemisphere; and (5) reduction of systematic errors in star positions by improvement of techniques.

UTILIZATION OF SOLAR ENERGY

A Symposium on Utilization of Solar Energy was sponsored jointly by the National Science Foundation and the University of Wisconsin at Madison in September 1953. The general purpose of the meeting was to assess progress in nonbiological aspects of solar energy research and to consider promising unexplored areas in which further research effort would appear to be desirable. The participants discussed the potential utilization of solar energy as a source of power from two viewpoints: (1) The possible use of solar energy in the relatively near future when it might be competitive with present low-cost fuels and (2) from the long-range viewpoint after existing low-cost fuel supplies will have been depleted and the sun's current output of energy may be the principal available energy source.

NUCLEAR PROCESSES IN GEOLOGICAL SETTINGS

Many of the processes of nuclear physics—including fission of uranium, production of plutonium, generation of neutrons, and the decay of radioactive elements—occur in nature on a small but detectable scale. Careful analysis and measurement of such events provide scientists with a method for attacking such problems as estimating the age of the earth and of meteorites, revealing the geological history of the earth, and locating the sources of trace elements in the atmosphere. There are marked differences in the relative abundances of isotopes in various regions on the surface of the earth. Knowledge of these differences and the general nature of geochemical processes permits the reconstruction of some of the more important events that took place from time to time during the long history of the earth.

Some 30 specialists in physics, geology, geophysics, and geochemistry attended the Conference on Nuclear Processes in Geological Settings at Williams Bay, Wis., in September 1953. The conference, cosponsored with the University of Chicago, called particular attention to the need for better standardization and correlation of measurements which are being made at dozens of laboratories in the world. It recommended that a single laboratory in the United States be designated to assume the responsibility for maintaining records and standardizing measurements of interest to scientists in this country.

ROLE OF PROTEINS IN THE TRANSPORT OF IONS ACROSS MEMBRANES

Investigation of nerve action is one of the active fields in physiological research at the present time. Neurophysiologists know that the mechanism depends on electrical currents set up at the cellular level. It involves the movement of charged organic particles or ions across cell walls and other biological membranes normally impervious to charged particles. It also appears that protein substances in the cell have much to do with the passage of the ions across the membranes. Similar problems arise in the passage of nutrient or waste products across cell walls.

Despite the obvious importance of the subject, very little is known about the interaction between proteins and ions. In October 1953 a conference on the subject supported by the Foundation at Columbia University made it possible for leading neurophysiologists and physical chemists from the United States and abroad to review recent research findings and to suggest promising areas for future study. The complete proceedings of the conference will be published.

GLUTATHIONE RESEARCH

Glutathione is a sulfur-containing component of body cells related to the proteins. It participates in many basic biochemical reactions and is probably a factor both in the storage and utilization of body energy. Available evidence points strongly to the importance of glutathione in the synthesis of protein, a major factor in body growth and repair. Apparently, it also helps to activate certain enzymes which perform vital functions, such as the transformation of food into tissue and energy. Thus, while it is clear that glutathione is essential to life, biological and medical scientists are still puzzled about the manner in which it acts.

In November 1953 a Symposium on Glutathione Research was sponsored jointly by the National Science Foundation and the Office of Naval Research and administered by Columbia University. Discussion sessions were held on the organic chemistry of sulfhydryl components and glutathione, biosynthesis of glutathione and its role in peptide synthesis, methods for determination of glutathione, glutathione as a coenzyme, and the relation of glutathione to metabolism and digestion. The proceedings of the conference will be published.

COSMIC RAYS

An international Conference on Cosmic Rays, sponsored jointly by the National Science Foundation and Duke University, was held at Durham, N. C., in November 1953. The aim of the conference was to assess the present status of cosmic ray research, particularly in the light of new high-energy accelerators, and to discuss possible future studies which will contribute most effectively to the solution of pressing problems on the physical nature of our universe.

The introductory discussion of nuclear interactions at very high energies centered on meson production in nucleon-nucleon or meson-nucleon collisions. A number of observations were reported of new unstable particles—hyperons, or particles having masses greater than neutrons, and heavy mesons. Other problems discussed were the origin of cosmic rays, the primary cosmic radiation, propagation in the atmosphere and time fluctuations. In many instances the conference failed to achieve unanimity of opinion, thus emphasizing the state of flux of many of the fundamental ideas in this field and the need for continuing rapid exchange of information about new findings and hypotheses.

LOW TEMPERATURE PHYSICS AND CHEMISTRY

In December 1953 the Third International Conference on Low Temperature Physics and Chemistry was held at the Rice Institute, Houston, Tex. The conference was sponsored jointly by the Institute, the National Science Foundation, and the International Union of Pure and Applied Physics. About 250 scientists participated in the discussion of recent research developments at temperatures in the vicinity of absolute zero. Delegates were present from leading laboratories in Australia, Belgium, Canada, France, Germany, Great Britain, the Netherlands, and the United States.

Particular attention was given to the different properties of the helium isotopes, three and four, in the liquid state. Several theories of the superfluid state were discussed. Steady progress was reported in research on the magnetic properties of matter at low temperatures, and a new magnetic cycle refrigerator capable of maintaining a constant temperature of 0.2° K. was described.

Ample time was provided for informal discussions of special problems by groups of from 2 to 10 people. This mechanism of informal exchange of information is highly productive in eliminating unnecessary duplication among the large number of research workers in this rapidly developing field.

VALIDATION OF SCIENTIFIC THEORIES

The criteria for validity of scientific theories vary from science to science. In physics and chemistry, for example, theories may frequently be tested experimentally in the laboratory. In other disciplines—human biology, geology, astrophysics, mathematics—direct experimental tests are seldom possible, and indirect tests, such as those involving statistical methods, may be uncertain and subject to conflicting interpretations.

At the annual meeting of the American Association for the Advancement of Science, December 1953, the Foundation, in cooperation with the American Academy of Arts and Sciences and the Institute for the Unity of Science, sponsored a conference on the Validation of Scientific Theories.

The chairman, Philipp Frank of Harvard University, stressed at the outset that the acceptance of scientific theories involves far more than agreement upon the observed results of research and the drawing of logical conclusions. Subjective factors often enter in, manifesting themselves as philosophical and sociological creeds, or even political ideologies, which may influence the course of science.

Scholars from various fields of science discussed the following topics: The present state of operationalism; psychoanalysis and the scientific method; organism and machine; science as a social and historical phenomenon; and the general principles of social physics. The papers and discussions are being published in full in the *Scientific Monthly.*

RADIO ASTRONOMY

The Carnegie Institution of Washington, the California Institute of Technology, and the National Science Foundation sponsored jointly a conference on radio astronomy at Washington, D. C., in January 1954. The conference was attended by many actively engaged in radio astronomy throughout the world, plus a group of other United States astronomers, physicists, electronics engineers, and a number of young research men especially interested in this exciting new field of research. An effort was made to present a comprehensive survey of current research and facility development, to examine in detail the most critical problems now evident in both these areas, and to indicate, as far as possible, some of the directions for profitable future activity.

At the conclusion of the conference a group of American scientists recommended that the National Science Foundation establish a permanent panel to promote understanding and development of radio astronomy in the United States. The advisory panel subsequently appointed is comprised of astronomers, engineers and physicists.

LUMINESCENCE OF BIOLOGICAL SYSTEMS

Bioluminescence is the process by which fireflies and many other animals and plants produce light by biochemical means. The process evolves very little heat so that the light production is high in relation to energy expended. The study of "cold light" is of interest to biochemists and biophysicists, not only per se but also because it gives insight into life processes in general. The amount of light given off by a plant or an animal may indicate the effect of drugs, heat or pressure on such body functions as respiration, growth, and muscle action.

A Conference on Luminescence of Biological Systems sponsored by the Foundation was arranged by the Committee on Photobiology of the National Research Council and held at Pacific Grove, Calif., in March 1954. The range of subjects discussed included chemical luminescence and fluorescence, spectroscopic investigation of bioluminescence, and the physiology of luminescence in specific plants and animals. The proceedings of the conference will be published.

PROBLEM-SOLVING BEHAVIOR

The behavior of human beings in solving problems is highly complex and progress in the study of such behavior has been relatively slow. Research workers are often faced with apparently contradictory findings and only a small part of the work done has actually been reported in publications. For this reason individual scientists in the field are often poorly informed about current studies in laboratories other than their own. A Symposium on Problem-Solving Behavior was held in April 1954 primarily to enable investigators working in the field to exchange ideas and to evaluate current progress. The meeting was jointly supported by New York University and the National Science Foundation.

HIGH-SPEED COMPUTING IN METEOROLOGY AND OCEANOGRAPHY

Many of the theoretical problems associated with weather forecasting have been solved but the computational effort required has prevented the widespread use of such theory in actual forecasting. The weather had long since come and gone by the time scientists using ordinary methods had analyzed and organized thousands of individual observations on air temperatures, wind currents, and velocities. Oceanographers are also faced with complicated, many variable problems in fluid dynamics. With the advent of high-speed computing machines a new and powerful tool is available for rapid analysis of data and prediction of events.

In May 1954 the National Science Foundation and the University of California at Los Angeles sponsored a Conference on High-Speed Computing in Meteorology and Oceanography. About 40 meteorologists, oceanographers, mathematicians and fluid dynamicists met to review recent accomplishments of high-speed computing in fluid dynamics and to discuss some of the problems to which application of computers might be feasible in meteorology and oceanography. Scientists from England, France, and Norway attended the meeting.

Numerical weather forecasting using modern computing equipment is already an object of extensive study, particularly in the United States and the United Kingdom. In this country the work has been supported in large part by Federal agencies. From known meteorological conditions over the United States, the general flow pattern of the atmosphere for a large part of the country can now be determined one or two days ahead. With slight further development predictions of large-scale flow patterns will soon be possible on a routine basis. The next step will be to modify this overall flow pattern by introducing small-scale air motions and humidity and temperature fields in order to predict weather on a local basis.

One of the most interesting sessions was devoted to the problems of air pollution in an industrial area, with particular emphasis upon smog conditions in the Los Angeles area. Here again high-speed computing methods may make possible the application of physical laws to the solution of a complex problem. The meteorologists will be able to determine the distribution of contaminants originating at each of the sources of pollution of the area. Such atmospheric pollution studies will become even more important with the widespread development of atomic energy, which will create problems in radioactive contamination.

PHYSIOLOGICAL DEVELOPMENT OF THE MAMMALIAN FETUS

A number of conferences in recent years have dealt with aspects of embryonic development but usually from the viewpoint of abnormal development. The Symposium on Physiological Development of the Mammalian Fetus held in June 1954 was devoted to discussion of the normal mechanisms and functions of the developing embryo.

Participants were interested mostly in those functions which are critical during the period of adjustment immediately before and after birth. These include circulation, respiration, and the complex of kidney-endocrine-body water-electrolyte functions, as well as certain mechanisms, such as temperature regulation. Any major advance in understanding these factors may have immediate practical value in the evaluation of current practices in the clinical management of newborn and premature infants.

The Symposium was held at Cold Spring Harbor, Long Island, under the sponsorship of the Long Island Biological Association and the National Science Foundation. About 20 of the 50 participants were from laboratories in foreign countries. The complete proceedings of the Symposium will be published.

MULTIDIMENSIONAL ANALYSIS IN PSYCHOLOGICAL RESEARCH

From an interdisciplinary point of view one of the major conferences held during the year was devoted to multidimensional analysis in psychological research. This was held at the University of Michigan in June 1954 with support from the National Science Foundation and brought together interested people from the fields of psychology, sociology, mathematics, and statistics. The conference followed the Fourteenth International Congress of Psychology so that many individuals from other countries were able to attend.

The development of useful measurement techniques and mathematical models is a problem of central importance in psychological research. Of the methods currently employed the most useful are multiple factor analysis, multiple correlation, and latent structure analysis. Some recent modifications in these models and some entirely new ones have been suggested, but these are not yet widely known or used. Further progess will require the close collaboration of psychologists and mathematicians in the basic formulation of new models and the additional collaboration of psychologists, mathematicians, and statisticians in testing their validity.

ACOUSTICS AND THE STRUCTURE OF LIQUIDS

The structure of matter in the liquid state is more complex and difficult to understand than matter in either the solid or gaseous states. Scientists have learned that acoustics, and in particular ultrasonics, provides a unique tool for investigation of the liquid state. This conference of physicists, physical chemists and acoustical engineers, including several from abroad, met in June 1954 at Brown University, Providence, R. I., to review present-day theories of liquids and to plan for the further utilization of acoustical methods in studies of liquids.

Among the subjects covered at the conference were: (1) Shear and compressibility characteristics of liquids as revealed by the behavior of acoustic waves, (2) the character of chemical reactions affected by acoustic waves, (3) the dispersion and velocity of acoustic waves as they depend on liquid structure, and (4) the effect of gas nuclei on the formation of cavitation bubbles.

PROBLEMS IN HUMAN COMMUNICATION AND CONTROL

During the last two decades, the theory of communication developed by Norbert Wiener of the Massachusetts Institute of Technology, Claude Shannon of the Bell Telephone Laboratories, and others, has undergone vigorous development. The potential value of this theory for understanding human behavior and the action of the nervous system were apparent from the beginning. It has taken some time, however, for the influence of the formal theory upon experimental psychology to extend beyond superficial analogy.

The Wiener-Shannon concepts for quantifying information flow have recently served in the analyses of behavioral data, inasmuch as they are capable of handling transmissions from a multiplicity of sources to a multiplicity of destinations taking interactions into account. The concepts of "coding" and "context" as defined in communications theory are making possible new insights into perception, language, and learning. The techniques of time-series analysis and spectrum analysis are being used in studies on psychomotor control.

In June 1954 the Conference on Problems in Human Communication and Control sponsored by the Foundation and the Massachusetts Institute of Technology brought together experimental psychologists, physicists, engineers, and mathematicians for discussions of mutual benefit. The discussions brought out several facts that pointed up the timeliness of the conference: (1) That despite strong and widespread interest in the topic, formal channels for interdisciplinary exchange of information have not been adequate; (2) that there are independent and parallel developments in England and the United States that would profit from mutual exchange of ideas; and (3) that the give-and-take of technical discussion could not fail to assist in the solution of several basic research problems.

FUNDAMENTAL PROBLEMS OF PERCEPTION

Over the past quarter of a century psychologists have been confronted with two different theories of sensory perception. The empiricist position, widely accepted for many decades, held that perception of depth, space, form, etc., is primarily a learning process built up from a few simple elements of sensation. This view was challenged some years ago by the Gestalt psychologists, who believe that perception is directly determined by the physiology of the sensory and nerve structures involved. Adherents of both viewpoints have been able to marshal hypotheses and experimental data, which appear to support their respective positions.

The Conference on Fundamental Problems of Perception sponsored jointly by Cornell University and the National Science Foundation was one of a series of four psychological conferences held in conjunction with the Fourteenth International Congress of Psychology in June 1954.

During the conference five specific problems were discussed in an attempt to evaluate and reconcile the apparently conflicting experimental results arising from the two differing theories of perception. These included: (1) Past experience and learning in perception; (2) the perception of motion, change, and complex events; (3) the status of perceptual trace theories; (4) the effects and after effects of protracted presentations; and (5) the status of Gestalt psychology after 30 years.

DEVELOPMENT AND GROWTH

For the second year the National Science Foundation contributed to the support of the annual Symposium on Development and Growth. Other sponsors included the Society for the Study of Development and Growth and the National Institutes of Health. The Symposium was held at Dartmouth College in June 1954.

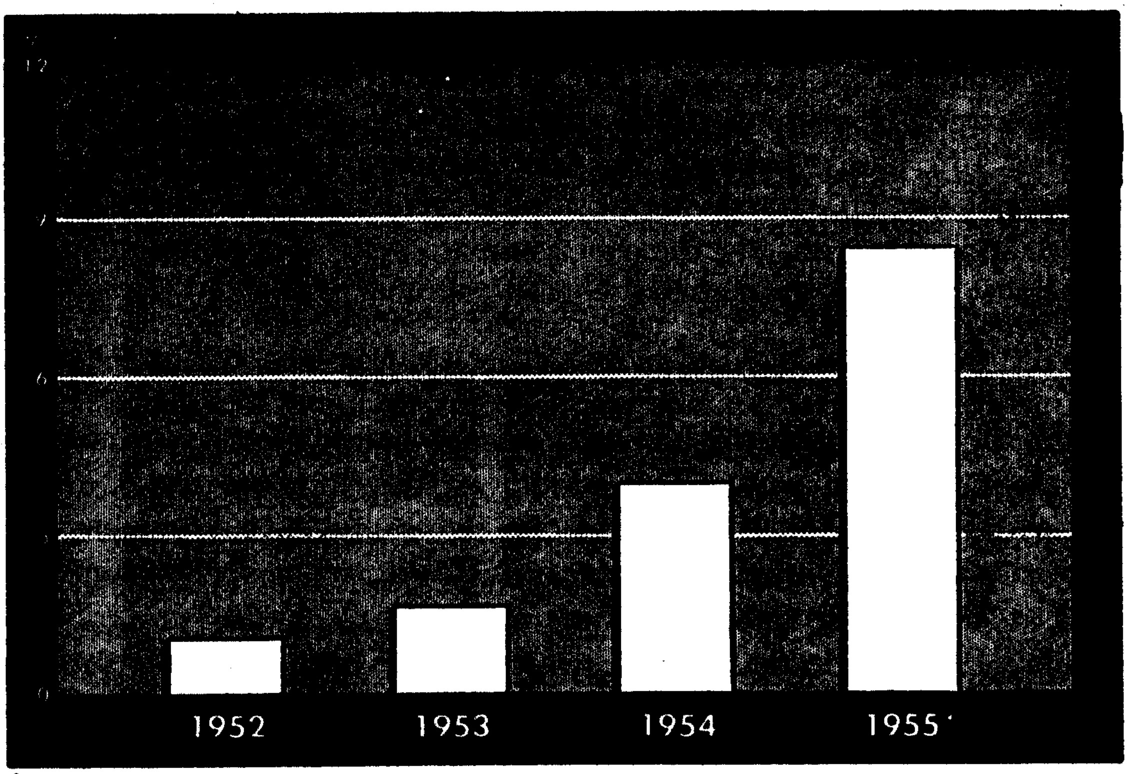
Since 1936 the annual growth symposia have been unusually successful in bringing together research investigators in the field of growth for the free exchange of concepts and principles common to both animal and plant growth and to normal and abnormal growth.

320814—55——4

Support of Basic Research in the Sciences

During the year ending June 30, 1954, 374 grants totaling $3,888,220 were made by the Foundation for the support of basic research in the natural sciences. This compares with 269 grants totaling $2,751,912 made during the previous 2 years.

These funds were distributed in the biological, medical, mathematical, physical, and engineering sciences to 170 institutions in 43 States, the District of Columbia, Hawaii, and Bermuda. The average research grant for fiscal year 1954 was $11,100, to run for 2.5 years, or about $4,400 per year.



* Estimated

FIGURE 4. *National Science Foundation obligations for support of research, fiscal years 1952 through 1955.*

The table below summarizes the research support program 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.

Over the past year the Foundation has assumed primary responsibility for Federal support of several important fields of basic research, including astronomy, pure mathematics, low temperature research, systematic biology, and ecology. This is in line with Executive Order 10521 stat-

National Science Foundation Research Grants by Fields of Study

Field	Fiscal years 1952–53		Fiscal year 1954	
	Number of grants	Amounts	Number of grants	Amount
Biological and medical sciences:				
Developmental biology	15	$116, 462	13	$110, 520
Environmental biology	6	32, 560	7	43, 200
Genetic biology	13	201, 000	13	156, 900
Molecular biology	21	273, 300	32	458, 000
Psychobiology	10	116, 400	27	293, 450
Regulatory biology	41	482, 000	41	464, 800
Systematic biology	27	209, 780	32	238, 500
General	7	112, 760	12	164, 100
Total	140	1, 544, 262	177	1, 929, 470
Mathematical, physical and engineering sciences:				
Astronomy	8	89, 000	19	147, 900
Chemistry	40	350, 300	47	477, 400
Earth sciences	9	89, 850	27	282, 800
Engineering	21	187, 200	42	390, 900
Mathematics	20	104, 500	21	173, 950
Physics	30	354, 000	41	485, 800
Total	128	1, 174, 850	197	1, 958, 750
General	1	32, 800	....	....
Total	269	2, 751, 912	374	3, 888, 220

ing that the Foundation should be increasingly responsible for providing Federal support for general-purpose basic research.

The subject matter of research is clearly of much more interest and importance than the administrative details. In a program so large and so varied however, it is impossible to describe the plans, methodology, and current activities of each of the scientists supported. Instead, in the paragraphs that follow certain research areas of unusual current interest have been selected and a brief description is given of the general status of research in these areas with notes concerning some of the related research supported by the Foundation.

RADIO ASTRONOMY

Radio astronomy is one of the youngest sciences, only slightly more than 20 years old. It was born when Karl G. Jansky of the Bell Telephone Laboratories found the first faint evidence of natural radio signals reaching the earth from outer space. The exploration of the universe by radio started some 5 years later, when another American engineer, Grote Reber of Wheaton, Ill., began systematic scientific studies with his privately constructed equipment. Radiation in the radio frequency bands was first detected from the sun by Reber 12 years ago.

The United States can take pride in the fact that American engineers made the basic discoveries that opened up this wholly new approach to the study of the sun, the stars and the universe. The United States did not, however, stay in the lead in the young science. Since the war, Great Britain, Australia, and Holland have moved ahead while this country has lagged behind. American efforts in the field have been relatively small although significant programs are under way at the United States Naval Research Laboratory, the United States National Bureau of Standards, the Department of Terrestrial Magnetism of the Carnegie Institution, and a number of educational institutions.

Radio astronomy is a field of research in which astronomers, physicists, and engineers can benefit by working together. Research in radio astronomy has important scientific values in the realm of pure astronomy and physics. Moreover, it leads to development of new techniques of great practical value in such electronic engineering fields as noise suppression and antenna and tube development.

In undertaking to promote a greater United States effort in radio astronomy, the Foundation brought together about 80 scientists to discuss the current status of this branch of science. (See Conferences in Support of Sciences, p. 29.) Subsequently the Foundation established an Advisory Panel on Radio Astronomy to assist in developing a national program.

At Harvard University, where the radiation from interstellar hydrogen gas was first detected in 1951, Bart J. Bok and Harold I. Ewen have built, with the aid of a Foundation grant and private support, a 24-foot radio telescope at the Agassiz Station. It is now being used for a survey of the hydrogen clouds of the Milky Way. Radio waves from cosmic hydrogen are able to penetrate the cosmic gas of interstellar space, somewhat as radar is able to penetrate atmospheric clouds. Thus, radio radiation enables us to "see" parts of the Milky Way that could not be observed with optical telescopes. Correlation of radio and optical observations will permit estimates to be made of the temperatures inside dark nebulae and the ratio between gas and dust in interstellar space.

John D. Kraus' program at Ohio State involved the construction of special receiving antennas of novel design. With this low-cost equipment

Kraus and his associates have studied the radiation from the remote parts of the Milky Way system and have further recorded radiation associated with distant groups of galaxies.

The work at Cornell under C. R. Burrows is primarily concerned with solar research and with radio problems of the earth's upper atmosphere. At Penn State, A. H. Waynick is conducting research on electronic instrumentation related to radio astronomy.

UNCONVENTIONAL SOURCES OF POWER

For many generations improvement in man's ability to convert energy into work has been closely linked to his rising standard of living. The great advance occurred when he learned to use fossil fuels—coal, oil, and gas—to meet his major power needs. The world supply of low-cost fossil fuels is limited, however, and at the present rate of consumption, it may be a matter of survival for man to develop alternative power sources.

The two unconventional sources of power that now seem most promising are the energy of the atomic nucleus and solar energy. Energy from either or both sources may eventually be available for heating and for the production of power. In either case the time scale depends in part upon economic factors and in part upon advances in basic knowledge.

From a scientific point of view the problems involved in utilizing energy from these two sources are quite different. In the fission or fusion of atomic nuclei the rate of energy production per unit volume is very high which means that the temperature level is far above that normally used in production of power. A basic problem, therefore, is that of the management and control of energy at high temperatures.

The problem in utilizing solar energy lies at the other extreme. Solar energy is widely diffused—the rate of production per unit volume and, hence, the temperature is too low to be converted into power by known methods. The intermittent nature of solar energy from night to day, winter and summer at any point on the earth's surface adds to the complexity of the problem.

High temperature energy utilization.—A basic engineering problem in high temperature energy utilization is to conduct heat rapidly from its production source into the mechanisms for converting it into usable power. Its solution involves basic studies on the nature of heat transfer, whether by solids, liquids, or gases. Research now being conducted under several Foundation grants may yield useful basic information in this area. Jesse M. Coates and Byron L. Sakiadis of Louisiana State University are doing research on heat capacities of pure liquids and solutions. Edward W. Commings and his students at Purdue University are investigating heat transfer of gases at high pressures.

The physical properties and behavior of materials at high temperatures is another aspect of high-level energy utilization. New construction materials to handle hot gases, liquids, and solids are important. Most familiar materials fail or become useless because of corrosion at such extreme temperatures. The materials must also be able to withstand intense bombardment of nuclear radiation. In this area, the Foundation has provided a grant for study of the effect of nuclear radiations on engineering materials at the University of Wyoming under the direction of Harold Sweet.

Low level energy utilization.—The Foundation is supporting a direct attack on the solar power problem at the University of Wisconsin as an outgrowth of the Symposium on the Utilization of Solar Energy held there. This program involves research in the fields of chemistry, physics, biology, and engineering under the leadership of John A. Duffie.

The storage of solar energy may in principle be accomplished chemically, electrically or mechanically, or perhaps in some other less apparent form. This problem is currently being attacked at the basic level through the use of chemicals which can be converted into a different form by sunlight and then reconverted in off hours. In effect, this would be a storage battery charged by sunlight.

More information on the origin of fossil fuels also may provide a clue to the rapid conversion of solar energy to fuels. Wayne Kube at the University of North Dakota is attacking this phase of the general problem.

The biological conversion of solar energy into forms utilizable by man proceeds on a tremendous scale by green plants in the process known as photosynthesis. The process requires small chlorophyll-containing particles in the leaves, called chloroplasts, and the intervention of complex enzyme systems. Scientists are attacking the problem from many points of view in attempting to understand the quantitative relationships between absorbed radiant energy and the converted chemical energy, in isolating and identifying enzyme systems involved in the process, and in probing into the relationship of growth hormones to utilization of radiant energy.

Among the investigators who are pursuing these problems with the aid of National Science Foundation grants are Robert Emerson, of the University of Illinois, who is determining the quantitative energy relationships between radiant energy absorbed and the newly synthesized carbohydrate molecules. Wolfe Vishniac, of Yale University, has successfully obtained photosynthetic reactions under the influence of light in cell free systems. He is now attempting to learn more about the enzyme systems involved in this chain of reactions.

At the California Institute of Technology, Arthur Galston is studying the manner in which light affects the metabolism and activity of the plant growth hormone, auxin. His studies indicate that plants contain an enzyme system, activated by light, which destroys auxin and therefore inhibits growth during the period of illumination, causing it to proceed mainly during the periods of darkness. Dr. Galston has some evidence indicating that the receptor pigment for this enzymatic reaction is a flavoprotein. Jack Myers of the University of Texas, is studying the photosynthetic activity in microorganisms in order to obtain information concerning the gradual evolution of the photosynthetic process from the primitive single-celled forms to the higher plants. Such studies may lead to the possible utilization of microorganisms in mass culture as a source of food or fuel.

MESON PHYSICS

At the present time understanding of the interaction of mesons with atomic nuclei is a basic problem of nuclear physics. Mesons are nuclear particles, heavier than electrons and lighter than protons, that have a brief, observable existence arising from certain nuclear reactions. They may be produced in laboratories by high energy accelerators and they are found as products of cosmic ray activity. Mesons leave visible evidence on photographic plates of the forces that hold the atomic nucleus together.

For several years the major support for high energy physics research has come from the Atomic Energy Commission and the Office of Naval Research. Recently the Foundation has also been able to contribute to meson research in the United States in several ways. The annual Rochester conference on high energy physics is one example. From such meetings, it is clear that a great deal of progress is being made in the experimental study of mesons but that the theoretical interpretation and explanation of the experimental findings is lagging.

One of the most useful methods for studying a complicated subject such as meson physics is to devise a simple model that has a few of the characteristics of the real thing. In attempting to explain the observed absorption and scattering of mesons by atomic nuclei a group of theorists at Indiana University suggested a model of a temporary "compound meson-nucleon state." This model has proved quite useful in interpreting some of the experimental observations. The Foundation is supporting further research of the group under the direction of E. J. Konopinski.

In the absence of adequate meson theory, progress in this challenging field will continue to depend largely on experimental work in which high energy accelerators are required. The Foundation is supporting research in accelerator design problems at the Midwest Study Group, which consists of physicists from seven leading universities in the Midwest. This group is investigating such subjects as the effect of nonlinear force terms on the orbits of accelerated particles.

During the past year the Foundation established an *ad hoc* Advisory Panel on Ultra High Energy Nuclear Accelerators, to assist the Foundation and other governmental and private groups in planning research support programs involving accelerators.

HILBERT SPACE

One of the extraordinary examples of scientific collaboration in the history of science has been that of the geometers and physicists. As knowledge of physics has increased, the dimensions and characteristics of physical "space" have created a need for more profound geometrical analysis. Classical Newtonian physics was embedded in Euclidean space. The non-Euclidean geometers prepared the ground for relativity and the four dimensional space-time concept. In our day another deepening of geometrical concepts is playing a basic role in the theory of quantum mechanics.

This development, brought to the fore by Hilbert in the early years of this century, extends the ideas of Euclid and Descartes to space of infinitely many dimensions. Such a geometry appears to be appropriate in describing a physical system—the hydrogen atom, for example—which may exist in an indefinite number of orbital or energy states, each having a characteristic probability and geometrical configuration.

The mathematical structure of Hilbert space has permitted precise formulation of many of the ideas of quantum mechanics. The geometry of Hilbert space and the algebra of linear transformations acting upon it have been significant factors in studying atomic processes. Further progress in this direction, however, awaits further development in Hilbert space of many common geometrical concepts and operations. One of the pressing problems is that of defining volume in Hilbert space so that it is a natural extension of the volume concept in spaces of finite dimensions. Until this is done little headway can be made in developing a theory of integration. A solution of this problem is basic to a complete theory of quantum mechanics, and hence to an adequate theoretical understanding of atomic energy relations.

The Foundation is encouraging research in this important area. For example, it is sponsoring research of E. R. Lorch of Columbia University, who recently formulated some definitions of volume and integration in Hilbert space.

LUMINESCENCE

Luminescence is a broad term involving all forms of "cold light." Physical and chemical research have made possible such familiar examples as fluorescent lights, phosphorescent paints and tapes, television screens, and other practical applications of growing importance in everyday life. The luminescence that accompanies certain biological processes has long been known. Familiar examples include the flashing of fireflies, the phosphorescence of the sea, and the light seen emanating from moldy wood and leaves or from certain types of bacteria that thrive on dead fish and meat. Natural luminescence has excited the curiosity of casual observers and has aroused the active interest of such scientists as Aristotle and Robert Boyle. Only recently, however, have scientists become fully aware of the scientific importance of luminescence in biology. A few widely scattered groups of contemporary scientists, principally in the United States, Holland, England, and Japan, are concentrating their efforts on research in this field.

Biological luminescence is of fundamental interest since it provides a unique and efficient "tool" for investigating the influence of various substances and factors—chemotherapeutic compounds, narcotics, temperature, high pressure, and others—on the rates of life processes. Luminescence is virtually the only process in living organisms endowed with a natural, instantaneous, and measurable indicator of its own reaction velocity: the brightness of the light emitted is proportional to the rate of the underlying chemical reactions. From studies of bacterial luminescence as a research tool, new concepts have emerged in regard to basic mechanisms that control reaction rates in organisms; concepts that apply as well to more familiar processes, such as digestion, growth, muscle contraction, and nerve activity.

Within the past year, luminescence has been obtained, after years of futile attempts, in extracts of bacterial cells, and major components of this light-emitting system have been biochemically identified. In part, these components are related to the B vitamins which are universally involved in releasing the energy on which life depends. Moreover, the luminescence of bacterial extracts in a test tube has the same basic characteristics, and responds to various factors in fundamentally the same way, as the luminescence of the living organisms.

In extracts of fireflies, adenosine triphosphate has been identified as a substance necessary for luminescence. The same substance is intimately involved in muscle contraction, in the synthesis of living matter, in the utilization of foods, and in other life processes. Other studies have shown that a chemical luminescence is also associated with photosynthesis, the biological process on which the total food supply of the world ultimately depends. An understanding of the significance of luminescence in these processes is clearly prerequisite to a full understanding of the processes themselves.

Two Foundation grants have been awarded to specialists in this field. E. Newton Harvey, of the Department of Biology, Princeton University, is engaged in a 3-year laboratory program during which he hopes to describe more precisely the chemical constituents of luciferin and luciferase, principle components in the process. Such research may establish the basis for the eventual synthesis of these substances. William D. McElroy of the McCollum-Pratt Institute, Johns Hopkins University, also has a grant for the study of the mechanism by which chemical energy is converted into light energy by biological systems. Professor McElroy and others have noted that the light-emitting components in the process are not merely caused by the release of excess energy from excited molecules but also depend upon certain dark reactions which occur prior to light emission. At present his research centers upon the study of reactions of known enzymes upon purified luciferin extracted from fireflies.

STEROID CHEMISTRY

The steroids are a group of naturally occurring compounds derived from the hydrocarbon cyclopentanoperhydrophenanthrene. Among the common steroids are cholesterol, vitamin D, bile acids, heart poisons, such as digitoxin, toad poisons, sex hormones, and adrenal cortical hormones, such as cortisone.

While the complicated analysis of certain sterols and heart and toad poisons was started over a century ago, the major advances have been made during the past few decades and represent one of the outstanding achievements of modern organic chemistry. The structural chemistry of the sex hormones and the adrenal cortical hormones was solved in still more recent years.

Because of the remarkable biological properties and therapeutic value of certain of these compounds a search is being made for suitable methods and improved starting materials for their large scale preparation. Many are found in limited quantities in nature and are very expensive. The total synthesis of a few individual compounds in this series, for example, cortisone, has already been accomplished, largely because of basic research on the spatial arrangement of the atoms into molecules. Further work will undoubtedly suggest new approaches to the problem in which more readily available starting materials may be used, the number of synthetic steps reduced and simplified, and the final yield increased.

The National Science Foundation is supporting the research of William S. Johnson and A. L. Wilds of the University of Wisconsin, who are working on the total synthesis of the nonaromatic steroids, their stereochemistry and the development of new synthetic approaches. The most significant advance made in this research has been the total synthesis of epiandrosterone, related to the male sex hormone, adrosterone, and the discovery of androgenic activity in certain intermediates with a structure similar to that of the sex hormone. Some of the compounds being studied are of current interest in cancer research.

Richard B. Turner of the Rice Institute, Houston, is working on the total synthesis of the adrenal cortical hormones and intermediates which lead to them. Carl Djerassi of Wayne University, Detroit, is studying a new method for the identification and characterization of steroids.

ARCHEOLOGY

Archeology contributes to our knowledge of the species, man (*Homo sapiens*), by reclaiming and interpreting the material remains of his past. It has advanced from an art which attracted amateur diggers in search of curios to a well-defined science. Archeologists are currently attempting to isolate and identify the characteristic features of early human technology and the physical, biological, and environmental forces which effected the change from one stage of development to another.

The record of these changes and the appearance of civilization is buried in prehistory. No written records describe how and why civilization first appeared. The only source materials available are those which can be directly excavated from the prehistoric levels of archeological sites. The effective analysis of these materials is an interdisciplinary task. The techniques of the archeologist must be supplemented with those of the paleontologist, botanist, ceramicist, engineer, and geologist in order to understand prehistoric finds in the full perspective of all aspects of the early environment.

Two studies supported by the National Science Foundation will contribute to better understanding of the beginnings and evolution of civilization. One group, under Robert J. Braidwood of the University of Chicago, is investigating the zoological, demographic, and environmental aspects of the variegated human populations that have lived and died in the Fertile Crescent. This area encompasses modern Iraq, lowland Turkey, Syria, Palestine, and Trans-Jordan. Here occurred the earliest transition from a food-gathering to a food-producing economy in human history.

To understand and explain this great change, the archeologist relies on both artifactual and nonartifactual materials. The artifacts—villages, dwellings, pottery, tools, weapons, objects of decoration and the like—are the familiar subjects of archeological attention. The study of artifacts sheds some light on *how* civilization evolved.

The nonartifactual materials are as important as the artifacts. These materials include the utilized but unworked materials and refuse from an ancient site: animal bones, remnants of burned grain or seeds, bits of unworked stone or metal, and the skeletons of men themselves. In the study of nonartifactual materials, the natural scientists play the greatest role in archeological expeditions. It is essential to understand the physical environment in which the changeover from nomadic food-gathering to settled food-producing and village life came about. Study of the ecological situation helps to answer the *why* of cultural evolution.

The Foundation's contribution to the Fertile Crescent expedition will enable a zoologist and a ceramic technologist to join an agronomist, geneticist, physical anthropologist, ecologist, and archeologist in a cooperative effort to understand the environment at the time the foundations of civilization were laid. It is hoped that their participation will develop the natural history of animal domestication and will establish an appropriate time-scale for the appearance of new technologies and their economic consequences. Through such coordinated interdisciplinary teams of specialists, understanding and knowledge can be advanced most effectively.

A second project being supported by the Foundation focuses attention on another important problem in prehistoric archeology. For over a century we have known about and marveled at the artistic and intellectual achievements of the Mayas of ancient Mexico as shown in their architecture, sculpture, and hieroglyphic systems. Their great civilization arose, flourished for some 600 years, and then declined. The reasons behind this cultural decline, disruption, and abandonment of important centers are not known.

Gordon R. Willey of Harvard University has proposed a new and significant approach to the problem. He is studying the prehistoric settlement patterns in the Mayan area. Although many persons have studied the spectacular artifacts of the Mayas, little is known of the prehistoric Mayan dwellings, the number and arrangement of these dwellings, and how they were distributed over the landscape. The nature of a settlement reflects not only the natural environment but the way in which that environment was exploited to maintain a society. The physical form of a community reveals the technology of the society and offers insights into the social, political, and religious characteristics of the people. By plotting dwelling sites and dating them from their potsherd contents, Dr. Willey hopes to relate dwellings to the temple centers, establish population data and relate population to the physical setting.

Other Foundation-supported studies, directly related to geologic and minerals research, were indirectly of help to the archeologist in the investigation of ancient man and his environment. These included research on radiocarbon dating by J. L. Kulp, Lamont Geological Observatory; W. F. Libby, University of Chicago; and R. N. Keller, University of Colorado.

HISTORY, PHILOSOPHY, AND SOCIOLOGY OF SCIENCE

In any period of history scientific thought is an integral part of the culture of the period. In measuring the progress and impact of science, the pursuit of subject matter research is not enough. It becomes necessary to study the historical, philosophical and sociological aspects of the cultural setting as well.

Development of a worthwhile program of study in these fields is difficult, however, since the area of interest is not well defined. During the coming year the Foundation plans to sponsor a conference to consider appropriate programs for further investigation and support.

The Foundation has made a research grant to Philipp Frank of Harvard University to undertake an historical analysis of the validating grounds of scientific theories together with the social and psychological atmosphere in which theoretical ideas originate, develop, and become accepted, rejected or modified. This investigation is aimed at clarifying the relations and interactions of various fields of science on each other and in demonstrating what influences have contributed to the progress of modern science.

Another project in this area is under the direction of Henry Margenau of Yale University, who is reexamining the basic concepts, definitions, and laws employed in the physical sciences. The two components of scientific definitions—the operational and the logical—are being examined in the fields of classical mechanics and thermodynamics. A reappraisal of the underlying philosophical theories may aid in establishing common ground leading to increased communication and understanding among the scientific disciplines.

Education in the Sciences

GRADUATE FELLOWSHIP PROGRAM

Late in March the Foundation announced the award of 657 predoctoral graduate fellowships and 79 postdoctoral fellowships for advanced study in the natural sciences for the academic year 1954–55. This was the third year in which such awards were made. The distribution of fellowship awards by field of study and comparative figures for the previous programs are summarized in figure 5. A table giving the number of applicants and awards by state and region, a complete list of fellowship holders, and a list of institutions attended by the fellowship holders as undergraduates and graduate students is given in Appendix IV, p. 96.

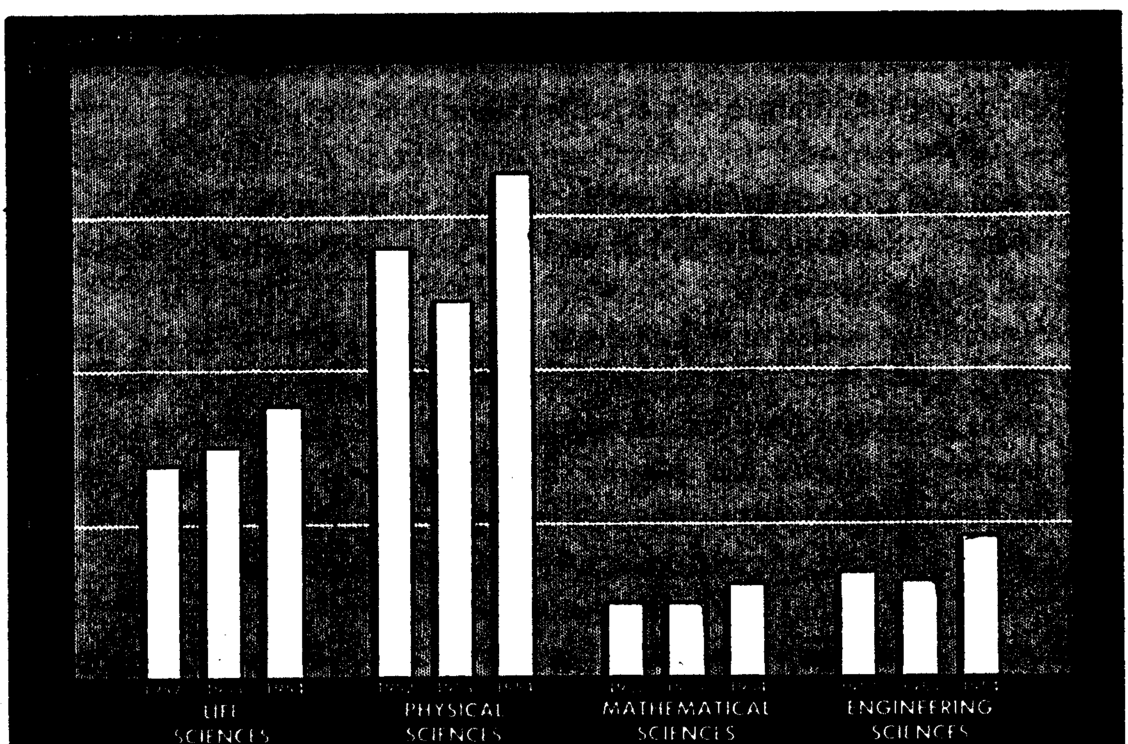


FIGURE 5. *Predoctoral graduate fellowships awarded by National Science Foundation by field of science, 1952–54.*

FELLOWSHIP SELECTION PROCEDURES

The National Science Foundation Act states that fellowships must be awarded solely on the basis of ability. In setting up screening and selection procedures for its fellowship program, the Foundation drew heavily upon the experience of other groups whose programs have operated successfully for several decades. The excellence of the selection methods used by the National Research Council and the Rockefeller Foundation, for example, has been shown by followup studies of the later scientific careers of successful applicants.

In the system used for selection of National Science Foundation Fellows, the National Research Council, which administers the rating program, appoints rating panels of leading scientists in each of the fields for which awards are made. Each panel evaluates the records of candidates in its respective field. The ratings are then submitted to the Foundation which makes the final selection.

The record of each predoctoral applicant from which the evaluation is made consists of three parts: (1) Test scores on verbal ability, quantitative ability, and scientific aptitude in chosen field; (2) previous scholastic record; and (3) confidential evaluation reports of faculty advisers.

Figure 6 shows the distribution of scores on the Quantitative Aptitude Test of all 1954 first year applicants for Foundation fellowships compared with the standard distribution of scores. Only 7 percent of the fellowship

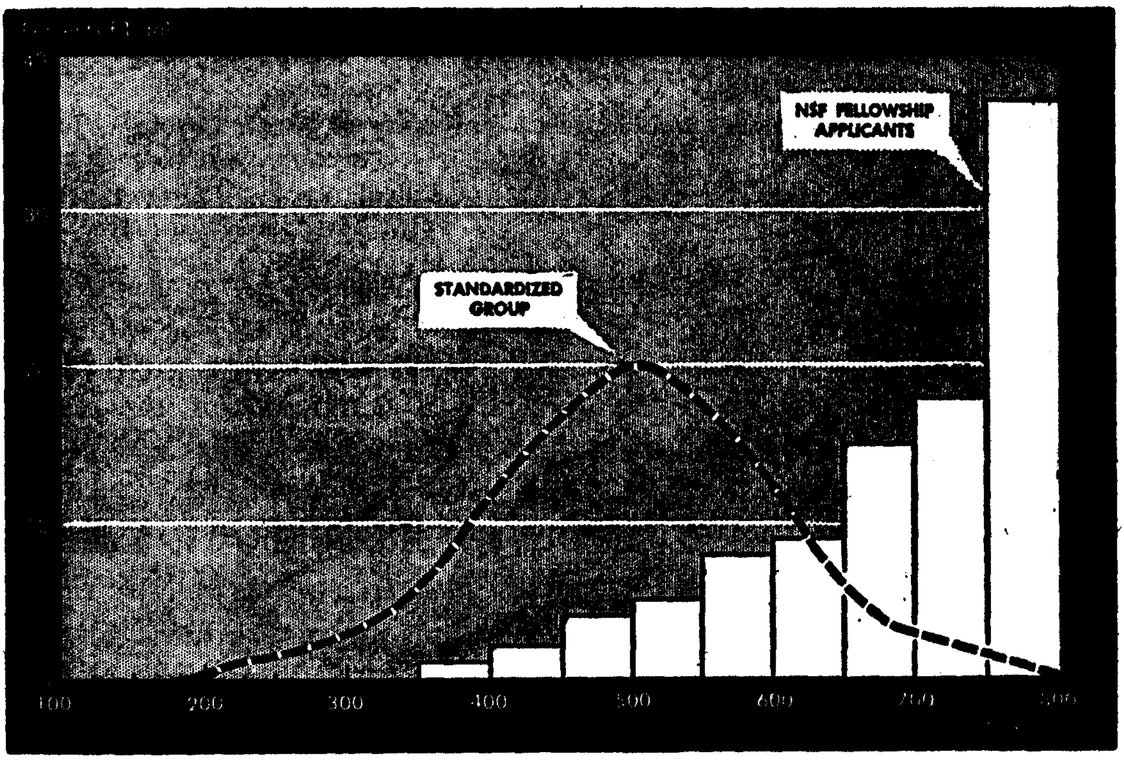


FIGURE 6. *Distribution of quantitative aptitude test scores of applicants for National Science Foundation predoctoral fellowships compared with distribution for standard group.*

applicants have test scores below the median for the standard group. There is little doubt that a powerful preselection factor is at work, in that only the highest ranking students in their classes apply for Foundation fellowships.

While considerable intellectual capacity is a prerequisite to success in scientific research, it is not the sole factor involved. However, very little progress has been made to date in isolating and defining other mental, personality, and physiological factors that may be required for scientific creativity and achievement. The Foundation believes this to be an important area for further research and during the year it has supported studies on fellowship selection techniques administered by the Office of Scientific Personnel, National Research Council, under the direction of C. W. Taylor. In connection with this program two conferences on fellowship selection techniques and criteria of scientific achievement have been held.

INSTITUTES FOR COLLEGE SCIENCE TEACHERS

The success of the regional summer institutes and conferences for college teachers of science, begun on an experimental basis by the Foundation during fiscal year 1953, resulted in the extension of this program during the summer of 1954. These conferences are designed primarily to assist science teachers in small colleges with limited research activities to keep abreast of recent research in their own and allied fields. Four summer conferences were held:

Colloquium on Collegiate Mathematics, University of North Carolina, June 15–August 6, 1954.

Conference on Collegiate Mathematics, University of Oregon, June 21–August 13, 1954.

First Chemistry Institute, sponsored by the American Chemical Society, University of Wyoming, July 19–August 20, 1954.

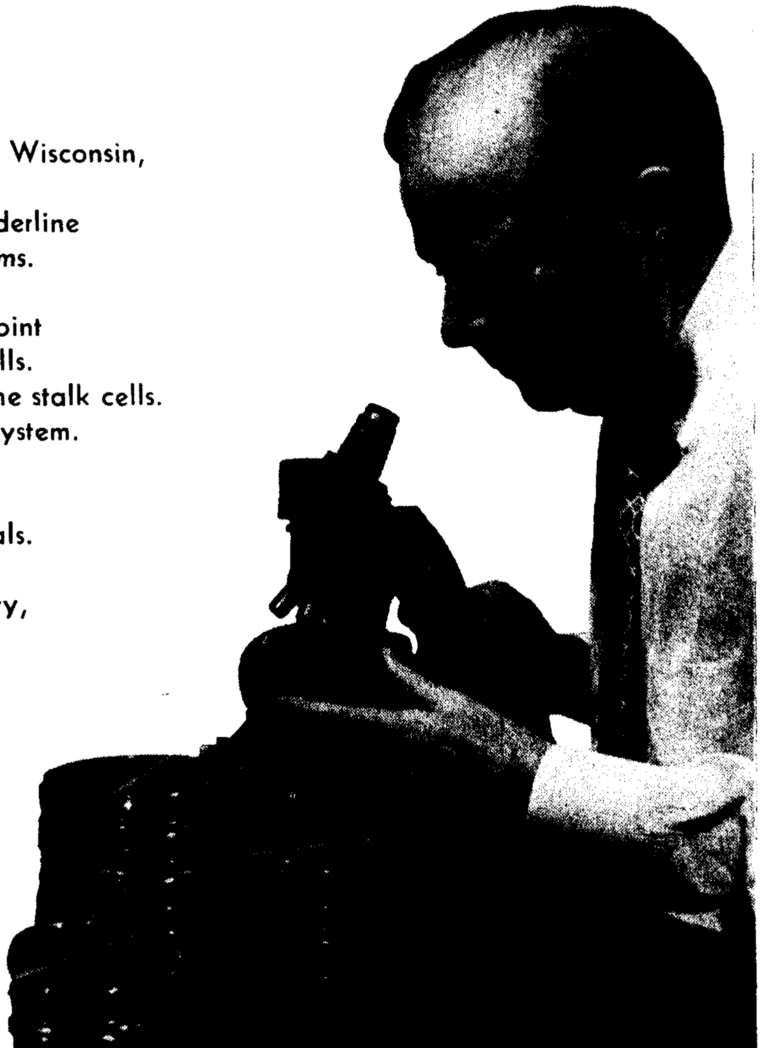
Colloquium of College Physicists, State University of Iowa, June 16–19, 1954.

The conferences are attended normally by teachers from the regions in which the institutes are held. The programs are built around outstanding research leaders who serve as lecturers and seminar directors. The direct contact with active scientists has been beneficial in improving teaching and curricula, which in turn stimulates students at the undergraduate level, making them more aware of current scientific progress at an early stage in their training and encouraging them to undertake careers in research.

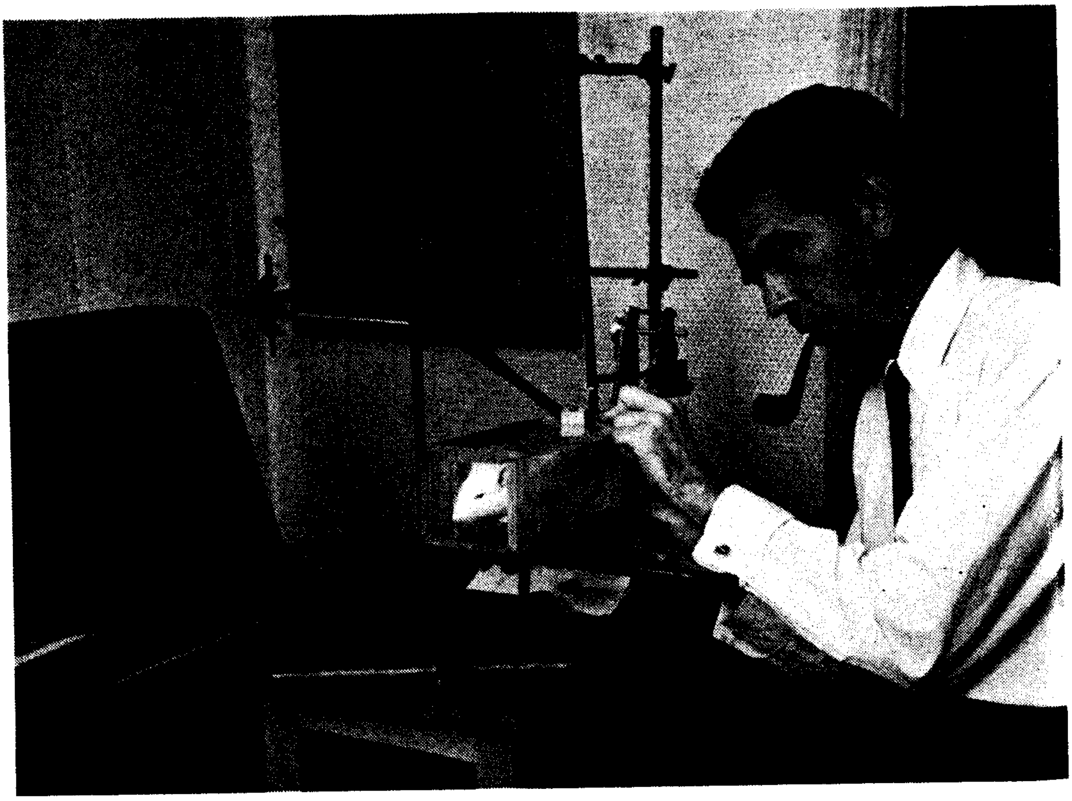
CONFERENCES IN ENGINEERING SCIENCES

During the past few years, engineering educators have realized that engineering education is in a transitory stage. At this time there is, first, an increasing emphasis on the inclusion of engineering subjects in the undergraduate curriculum and, secondly, an increase in the need for a larger number of students to obtain advanced degrees in engineering. A

Kenneth B. Raper (right), University of Wisconsin,
Madison, studies slime molds.
These curious creatures are on the borderline
between the plant and animal kingdoms.
At a certain stage in their life cycle,
individual cells migrate to a central point
where they join hundreds of similar cells.
Then the cells combine. Some become stalk cells.
Others become parts of reproductive system.
Study of these lifeforms may reveal
how cells become specialized
for particular jobs in plants and animals.
David B. Erickson (below),
of the Lamont Geological Observatory,
Columbia University,
inspects ocean-bottom cores
in the "core library" at Lamont.
Study of such cores reveals
how and at what rate sediments
were laid down on the ocean floor
The amount of radiocarbon
in the sediment tells its age.
This radioactive clock is accurate
for estimating ages of deposits
up to about 30,000 years old.



Graduate students in geophysics (left) at the Pennsylvania State University study the generation of seismic waves. The 70-lb. weight is dropped to the ground and vibrations are measured. The research is directed by Benjamin J. Howell, third from left. (Below) Edward L. Walker of the University of Michigan uses white rats and electric shock in experimental study of learning behavior. The rat learns to avoid mild electric shocks on its tail by hunching forward when a tone sounds. This acquired "avoidance" habit persists long after the need for it has passed. Dr. Walker is exploring the psychological problems of "unlearning" or eliminating such rigid acquired habits—a situation that arises in treatment of some types of pathological human behavior.



third important factor is the need for inclusion of some of the more recent advances of science into the engineering curriculum so that the engineers will be able to apply these new principles as rapidly as possible.

Several groups interested in these problems have asked the Foundation to assist educational authorities in the "pure science" fields to meet with responsible leaders in engineering education in an attempt to resolve the problem. The American Society for Engineering Education selected two specific areas for such conferences: (1) Solid State Physics in Engineering Education, and (2) Nuclear Physics in Engineering Education. In each subject a double conference composed of physicists and engineers was held with Foundation support. The first conference was composed of persons who were conversant with the problems in the area under discussion. The conferees spent 3 days discussing such subjects as (*a*) the status of the basic science areas, (*b*) the most important areas to be included in the engineering curricula, and (*c*) how these added materials can be introduced into an overcrowded curriculum.

Following the initial conference, a program was prepared for a larger open conference in each case, and all interested members of the staffs of all engineering institutions were invited to attend the open meetings.

The first double conference of this type was the invitational conference in the field of Solid State Physics in Engineering Education, held at Allerton House at the University of Illinois in March 1954. During three fruitful days of discussion a picture developed of the need for the inclusion of solid state physics in the regular engineering curriculum. The recommendations of this conference were published in summary form so that participants in the second conference held at Carnegie Institute of Technology in June 1954 would be advised of the background before attendance at the meeting. The proceedings of the entire double conference will be published so that the information will be available to engineering educators generally.

The initial session of the conference on Nuclear Physics in Engineering Education was held at Columbia University in April 1954. At this conference it was generally agreed that it was desirable for information on nuclear processes to be included in the standard engineering curricula and that the development of specialized curricula in nuclear engineering should be undertaken with considerable caution. The decision on how much and in what way such material should be incorporated in the standard engineering curricula, is of importance. The conferees reached some tentative conclusions which were presented to a larger audience at the open conference at Northwestern University held in September 1954.

320814—55——5

In this instance again, a publication of the proceedings of the conferences will be prepared for wide distribution.

This experience suggests that the double conference technique has certain advantages. It permits a small group well versed in the problems under discussion to come to some tentative conclusions and arrive at a meaningful agenda. The larger group is then in a position to examine critically and revise the tentative conclusions in light of their more general background.

SCIENCE TEACHING IN THE SECONDARY SCHOOLS

The quality of science teaching at the secondary school level is of the utmost importance, for it is normally at the high school level that students first exhibit interest in scientific careers. More important, decisions are made at this time in selection of course work, such as mathematics, which is prerequisite to continuing scientific training in later years. Many organizations, both private and public, have studied the problem and generally agree that the high school science teacher has a unique opportunity to recognize talent early and to stimulate students toward more intensive science training at college and postgraduate levels. The teacher needs guidance and assistance, however, in carrying out this responsibility.

During the past year the Foundation has continued to support Science Service, Inc., which administers the Science Clubs of America and science fairs on a local and national basis. This program provides a practical outlet for the scientific enterprise and imagination of young students and encourages and rewards them for their early scientific achievement. Science clubs are located in many of the States of the country and receive strong support from many community groups. The membership, now estimated at 300,000, continues to grow.

The Foundation also sponsored an experimental Summer Conference for High School Mathematics Teachers at the University of Washington, Seattle, July 26–August 20, 1954. This conference, somewhat similar to the college institutes, was aimed at the high school teaching level and emphasized modern viewpoints in the teaching of algebra and geometry.

Exchange of Science Information

In the interest of scientific progress American scientists must be informed on research developments throughout the world. At this particular time, however, the most acute need is for more widespread knowledge in the United States of the status of Russian science, and the National Science Foundation has turned its attention to this problem.

The American Institute of Physics at the request of the Foundation has undertaken to develop a plan for improving the comprehensive coverage, abstracting, and translation of important current reports on physics research in the Soviet Union. During the course of this study the Institute questioned over 600 members of the American Physical Society to determine the limits of such a program and to pinpoint those areas of most immediate interest. In their replies the American physicists urged that complete English translations of Soviet physics journals be made available for two principal reasons:

1. Because of the technical value of the research now in progress in the U. S. S. R.

2. Because of the national danger of underestimating the strength of the U. S. S. R., particularly as far as scientific advances are concerned.

Among the specific areas listed in which the Russians have shown unusual competence and originality were molecular spectroscopy, magnetism, low temperature physics, underwater sound and related applied acoustics, solid state physics, nonlinear mechanics and differential equations.

During the year the Foundation provided support to the American Mathematical Society to continue its program of translating about 1,000 pages a year of the most significant Russian mathematical papers.[1]

The Scientific Translation Center of the Library of Congress established under the sponsorship of the Foundation and the Atomic Energy Commission has collected, catalogued, and listed over 2,000 recent scientific translations from Russian journals. The translations are collected from many sources, including Government agencies, scientific societies, industrial laboratories, and universities. The Center issues a monthly *Bibliography of Translations from Russian Scientific and Technical Literature* from which scientists can order microfilms or enlarged

[1] Copies of these translations may be obtained directly from the American Mathematical Society, 80 Waterman Street, Providence, R. I.

photocopies. The response to this service, particularly among scientists from Government and industrial laboratories, has definitely shown its value. Translations are collected on mathematics, astronomy, physics, chemistry, earth sciences, biological sciences, agriculture, medicine, engineering and technology.

SUPPORT OF SCIENTIFIC PUBLICATION

In its initial statement of policy regarding the support of research the National Science Foundation adopted the principle that publication of the results was an essential element of good research. In pursuing this policy the Foundation has approved inclusion of publication costs in its grants for research support, and from time to time grants have been made solely for support of scientific publications. At the same time, however, the Foundation has maintained that direct Federal subsidy of private scientific publications is neither necessary nor desirable at this time. In order to reconcile these two policies, it seemed appropriate to establish criteria for use by the Foundation in evaluating requests for financial assistance to publications.

During the year with the advice and assistance of the Advisory Panel on Scientific Information tentative criteria were developed. These criteria, which take account of both scientific and economic factors, are:

> The publication should have an adequate referee system to insure that only material of high quality is published.
>
> Only publications covering original basic research in the sciences, including monographs and secondary publications, such as index, abstract and review journals, should be considered for support. It was felt that except for historical material, manuscript collections, and other unique or scarce materials, scientific bibliographies should not in general be supported.
>
> Foundation support should be primarily of an emergency nature and it should be clear that the publication is taking steps to become self-supporting within a reasonable time.
>
> Highly specialized or "splinter" journals should not be supported if it is feasible to publish the material more economically in a journal or journals of broader coverage.
>
> Federal support of scientific publication is undesirable if it is used so that the published material is priced at an artificially low level.
>
> Alternative methods of publishing the material in question should be considered, for the Foundation's primary interest lies in making the information available rather than in supporting any established publication or reference service.
>
> Federal support should not normally be given local publications or services of interest primarily to scientists in a particular geographic locality.
>
> In considering requests for support for publication of books and monographs, all methods of printing should be investigated to determine how the work can be published in the most economical way.

INTERNATIONAL INFORMATION EXCHANGE

During the year the Foundation approved individual travel grants to 101 American scientists to permit them to participate in 25 of the approximately 250 international scientific meetings held during the year. In order to insure the maximum benefit to science and to the Nation, the meetings for which travel grants are awarded are carefully selected. Individual scientists are selected with the assistance of panels of consultants, scientific societies, or the appropriate committees of the National Academy of Sciences.

One of the most important international meetings held on the North American Continent during 1954 was the Fourteenth International Psychological Congress at Montreal, sponsored jointly by the American Psychological Association and the Canadian Psychological Association. The Foundation approved a grant to defray part of the costs of the Congress and it also sponsored four individual conferences on special areas in which leading scientists attending the Congress participated. The special conferences are described in a previous section of this report. The total attendance at the Montreal meeting was 1,500, including some 250 scientists from abroad.

Outstanding foreign scientists in many other fields were able to participate in Foundation-sponsored conferences held during the year. The Foundation has encouraged such meetings in the belief that personal contact with leading scientists of other countries stimulates exchange of scientific information in a way that cannot be done by any other means of communication.

APPENDIX I

National Science Board, Staff, Divisional Committees and Advisory Panels

NATIONAL SCIENCE BOARD

Terms Expire May 10, 1956

John W. Davis, President (ret.), West Virginia State College, Englewood, N. J.

Edwin B. Fred, President, the University of Wisconsin, Madison, Wis.

Laurence M. Gould, President, Carleton College, Northfield, Minn.

Paul M. Gross,[1] 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, the University of Tennessee, Memphis, Tenn.

Frederick A. Middlebush,[1] President Emeritus, University of Missouri, Columbia, Mo.

Earl P. Stevenson,[1] President, Arthur D. Little, Inc., Cambridge, Mass.

Terms Expire May 10, 1958

Sophie D. Aberle,[1] Special Research Director, the University of New Mexico, Albuquerque, N. Mex.

Chester I. Barnard,[1] Chairman of the Board, President (ret.), Rockefeller Foundation, New York, N. Y.

Robert P. Barnes, Professor of Chemistry, Howard University, Washington, D. C.

Detlev W. Bronk,[1] Vice Chairman of the Board and Chairman of the Executive Committee, President, National Academy of Sciences, Washington, D. C., and President, Rockefeller Institute for Medical Research, New York, N. Y.

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.

Terms Expire May 10, 1960

Roger Adams, Department of Chemistry and Chemical Engineering, University of Illinois, Urbana, Ill.

THEODORE M. HESBURGH, C. S. C., President, University of Notre Dame, Notre Dame, Ind.

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

JAMES B. MACELWANE, S. J., Dean, Institute of Technology, St. Louis University, St. Louis, Mo.

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

GEORGE W. MERCK,[1] Chairman of the Board, Merck & Co., Inc., New York, N. Y.

JOSEPH C. MORRIS,[1] Vice President, Tulane University, New Orleans, La.

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

Ex-Officio Member

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

STAFF

Director	ALAN T. WATERMAN.
Deputy Director	C. E. SUNDERLIN.
Associate Director	PAUL E. KLOPSTEG.
General Counsel	WILLIAM J. HOFF.
Special Assistant to the Director	NEIL CAROTHERS III.
Secretary to the National Science Board	VERNICE ANDERSON.
Assistant Director for Mathematical, Physical, and Engineering Sciences	RAYMOND J. SEEGER (acting).
Program Director for:	
Astronomy	PETER VAN DE KAMP
Chemistry	WALTER R. KIRNER.
Earth Sciences	H. KIRK STEPHENSON.
Engineering Sciences	GEORGE H. HICKOX.
Mathematical Sciences	LEON W. COHEN.
Physics	J. HOWARD MCMILLEN (acting).
Assistant Director for Biological and Medical Sciences	LAWRENCE R. BLINKS.
Program Director for:	
Environmental Biology	GEORGE SPRUGEL, JR.
Genetic and Developmental Biology	MARGARET C. GREEN.
Molecular Biology	WILLIAM V. CONSOLAZIO.
Psychobiology	JOHN T. WILSON.
Regulatory Biology	LOUIS LEVIN.
Systematic Biology	WILLIAM C. STEERE.
Anthropological and Related Sciences	HARRY ALPERT.

[1] Member of the Executive Committee.

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	John C. Honey.
Industrial Research	Herbert E. Striner (acting).
Institutional Research	Richard G. Axt.
Social Science Research	Harry Alpert.
Assistant Director for Administration	Wilson F. Harwood.
Fiscal Officer	Franklin C. Sheppard.
Grants Administrator	Franklin J. Callender.
Personnel Officer	Leland P. Deck.
Head, Office of Scientific Information	Robert Tumbleson.
Program Director for:	
Foreign Science Information	Norman Ball.
Scientific Documentation	Helen L. Brownson.
Executive Secretary, Interdepartmental Committee for Research and Development	Norman Ball.

DIVISIONAL COMMITTEES

Divisional Committee for Mathematical, Physical, and Engineering Sciences

Jesse W. Beams, Chairman, School of Physics, University of Virginia, Charlottesville, Va.

Carey Croneis, Provost and Wiess Professor of Geology, Rice Institute, Houston, Tex.

William L. Everitt, Dean, College of Engineering, University of Illinois, Urbana, Ill.

Leo Goldberg, Department of Astronomy, University of Michigan, Ann Arbor, Mich.

Einar Hille, Department of Mathematics, Yale University, New Haven, Conn.

Alfred O. C. Nier, Department of Physics, University of Minnesota, Minneapolis, Minn.

Charles C. Price, Department of Chemistry, University of Pennsylvania, Philadelphia, Pa.

Frederick D. Rossini, Chemistry Department, Carnegie Institute of Technology, Pittsburgh, Pa.

William W. Rubey, Principal Geologist, United States Geological Survey, Washington, D. C.

Thomas K. Sherwood, Department of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Otto Struve, Department of Astronomy, University of California, Berkeley, Calif.

Samuel S. Wilks, Department of Mathematics, Princeton University, Princeton, N. J.

Divisional Committee for Biological and Medical Sciences

Edgar Anderson, Director, Missouri Botanical Garden, St. Louis, Mo.

Marston Bates, Department of Zoology, University of Michigan, Ann Arbor, Mich.

Frank Brink, Rockefeller Institute for Medical Research, New York, N. Y.

Bernard D. Davis, Department of Pharmacology, Bellevue Medical Center, New York University, New York, N. Y.

Jackson W. Foster, Professor of Bacteriology, University of Texas, Austin, Tex.

Frank A. Geldard, Psychological Laboratory, University of Virginia, Charlottesville, Va.

Ernest W. Goodpasture, School of Medicine, Vanderbilt University, Nashville, Tenn.

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.

Katherine E. McBride, President, Bryn Mawr College, Bryn Mawr, Pa.

Harold W. Stoke, Dean of the Graduate School, University of Washington, Seattle, Wash.

George W. Thom, Peter Bent Brigham Hospital, Boston, Mass.

Ralph W. Tyler, Center for Advanced Studies, Behavioral Sciences, Stanford, Calif.

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

Harry A. Winne, Vice President for Engineering (ret.), General Electric Co., Redford, N. Y.

ADVISORY PANELS

Advisory Panel for Anthropological and Related Sciences

Marston Bates, Department of Zoology, University of Michigan, Ann Arbor, Mich.

Luther S. Cressman, Department of Anthropology, University of Oregon, Eugene, Oreg.

William W. Howells, Department of Sociology and Anthropology, University of Wisconsin, Madison, Wis.

CLYDE KLUCKHOHN, Professor of Anthropology, Harvard University, Cambridge, Mass.

RUPERT B. VANCE, Kenan Professor of Sociology, University of North Carolina, Chapel Hill, N. C.

S. L. WASHBURN, Department of Anthropology, University of Chicago, Chicago, Ill.

Advisory Panel for Astronomy

JESSE L. GREENSTEIN, Mount Wilson and Palomar Observatories, California Institute of Technology Pasadena, Calif.

PAUL HERGET, Cincinnati Observatory, Cincinnati, Ohio.

GEOFFREY KELLER, Perkins Observatory, Delaware, Ohio.

GERARD P. KUIPER, Yerkes Observatory, Williams Bay, Wis.

NICHOLAS U. MAYALL, Hick Observatory, Mount Hamilton, Calif.

LYMAN SPITZER, Jr., Princeton University, Princeton, N. J.

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

FRED L. WHIPPLE, Harvard University, Cambridge, Mass.

A. E. WHITFORD, Director, Washburn Observatory, University of Wisconsin, Madison, Wis.

Advisory Panel for Chemistry

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

PAUL C. CROSS, University of Washington, Seattle, Wash.

NATHANIEL H. FURMAN, Princeton University, Princeton, N. J.

L. P. HAMMETT, Columbia University, New York, N. Y.

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

JOSEPH KENNEDY, Washington University, St. Louis, Mo.

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

FREDERICK MATSEN, University of Texas, Austin, Tex.

K. S. PITZER, University of California, Berkeley, Calif.

HERMANN I. SCHLESINGER, University of Chicago, Chicago, Ill.

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

W. G. YOUNG, University of California, Los Angeles, Calif.

Advisory Panel for Developmental, Environmental, and Systematic Biology

WILLIAM D. BILLINGS, Department of Botany, Duke University, Durham, N. C.

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

GEORGE H. CLARKE, Harvard University, Cambridge, Mass.

WILLIAM A. DAYTON, U. S. Forest Service, U. S. Department of Agriculture, Washington, D. C.

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

DAVID D. KECK, New York, Botanical Garden, New York, N. Y.

REMINGTON KELLOGG, Director, United States National Museum, Washington, D. C.
ERNST MAYR, Professor of Zoology, Harvard University, Cambridge, Mass.
SAMUEL H. MEYER, Department of Botany, Florida State University, Tallahassee, Fla.
C. LADD PROSSER, Professor of Zoology, University of Illinois, Urbana, Ill.
A. C. SMITH, U. S. National Museum, Washington, D. C.

Advisory Panel for Earth Sciences

HUGO BENIOFF, California Institute of Technology, Pasadena, Calif.
JAMES GILLULY, United States Geological Survey, Denver, Colo.
M. KING HUBBERT, Shell Oil Co., Houston, Tex.
LUNA LEOPOLD, United States Geological Survey, Denver, Colo.
WALTER H. MUNK, Scripps Institute of Oceanography, La Jolla, Calif.
ELBURT F. OSBORN, Pennsylvania State University, State College, Pa.
WILLIAM T. PECORA, United States Geological Survey, Denver, Colo.
SVERRE PETTERSSEN, University of Chicago, Chicago, Ill.
RICHARD J. RUSSELL, Louisiana State University, Baton Rouge, La.
PHILIP J. SHENON, Salt Lake City, Utah.
GEORGE G. SIMPSON, American Museum of Natural History, New York, N. Y.
CHARLES W. THORNTHWAITE, Johns Hopkins Laboratory of Climatology, Seabrook, N. J.

Advisory Panel for Engineering Sciences

ALLAN P. COLBURN, Department of Chemical Engineering, University of Delaware, Newark, Del.
THOMAS J. DOLAN, Department of Theoretical and Applied Mechanics, University of Illinois, Urbana, Ill.
RALPH E. FADUM, Department of Civil Engineering, North Carolina State College, Raleigh, N. C.
GEORGE W. GLEESON, School of Engineering and Industrial Arts, Oregon State College, Corvallis, Oreg.
GEORGE A. HAWKINS, Office of the Dean of Engineering, Purdue University, Lafayette, Ind.
VERNON P. JENSEN, C. F. Braun and Co., Alhambra, Calif.
R. C. JORDAN, Department of Mechanical Engineering, University of Minnesota, Minneapolis, Minn.
ROBERT F. MEHL, Carnegie Institute of Technology, Pittsburgh, Pa.
HUNTER ROUSE, Director, Iowa Institute of Hydraulic Research, State University of Iowa, Iowa City, Iowa.
THORNDYKE SAVILLE, College of Engineering, New York University, University Heights, New York, N. Y.
ERIC A. WALKER, Pennsylvania State University, State College, Pa.

KURT F. WENDT, College of Engineering, University of Wisconsin, Madison, Wis.

Advisory Panel on Foreign Scientific Literature

IVER IGELSRUD, Librarian, Battelle Memorial Institute, Columbus, Ohio.

VLADIMIR ROJANSKY, Department of Physics, Union College, Schenectady, N. Y.

JOHN TURKEVICH, Department of Chemistry, Princeton University, Princeton, N. J.

Advisory Panel for Genetic Biology

ASBERT W. BRIGGS, Lankenau Hospital Research Institute, Philadelphia, Pa.

R. H. GOODWIN, Department of Botany, Connecticut College, New London, Conn.

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

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

CLIFFORD GROBSTEIN, National Cancer Institute, Bethesda, Md.

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

PAUL B. WEISZ, Department of Biology, Brown University, Providence, R. I.

Advisory Panel for Low Temperature Research

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

S. G. COLLINS, Massachusetts Instiute of Technology, Cambridge, Mass.

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

E. A. LONG, University of Chicago, Chicago, Ill.

C. F. SQUIRE, Department of Physics, Rice Institute, Houston, Tex.

Advisory Panel for Mathematical Sciences

DAVID BLACKWELL, Howard University, Washington, D. C.

RALPH P. BOAS, Jr., Northwestern University, Evanston, Ill.

SOLOMON BOCHNER, Statistical Laboratory, University of California, Berkeley, Calif.

KURT O. FREIDRICHS, New York University, New York, N. Y.

DERRICK H. LEHMER, University of California, Berkeley, Calif.

SAUNDERS MACLANE, University of Chicago, Chicago, Ill.

E. J. MCSHANE, University of Virginia, Charlottesville, Va.

PAUL C. ROSENBLOOM, University of Minnesota, Minneapolis, Minn.

HASSLER WHITNEY, Institute for Advanced Study, Princeton, N. J.

Advisory Panel for Molecular Biology

ALLAN H. BROWN, Department of Botany, University of Minnesota, Minneapolis, Minn.
BRITTON CHANCE, University of Pennsylvania, Philadelphia, Pa.
WALDO E. COHN, Oak Ridge National Laboratory, Oak Ridge, Tenn.
JOHN T. EDSALL, Biological Laboratories, Harvard University, Cambridge, Mass.
STERLING B. HENDRICKS, Agricultural Research Service, United States Department of Agriculture, Beltsville, Md.
FRANK H. JOHNSON, Princeton University, Princeton, N. J.
HENRY A. LARDY, Enzyme Institute, University of Wisconsin, Madison, Wis.
HOWARD K. SCHACHMAN, University of California, Berkeley, Calif.
DAVID SHEMIN, Department of Biochemistry, Columbia University, New York, N. Y.

Advisory Panel for National Astronomical Observatory

IRA SPRAGUE BOWEN, Mount Wilson and Palomar Observatories, California Institute of Technology, Pasadena, Calif.
ROBERT R. MCMATH, McMath-Hulbert Obervatory, University of Michigan, Pontiac, Mich.
BENGT G. D. STROMGREN, Director, Yerkes and McDonald Observatories, University of Chicago, Williams Bay, Wis.
OTTO STRUVE, Department of Astronomy, University of California, Berkeley, Calif.
ALBERT E. WHITFORD, Director, Washburn Observatory, University of Wisconsin, Madison, Wis.

Advisory Panel for Physics

SAMUEL K. ALLISON, University of Chicago, Chicago, Ill.
CARL D. ANDERSON, California Institute of Technology, Pasadena, Calif.
R. B. BRODE, University of California, Berkeley, Calif.
GAYLORD P. HARNWELL, University of Pennsylvania, Philadelphia, Pa.
KARL F. HERZFELD, Catholic University of America, Washington, D. C.
JOSEPH KAPLAN, University of California, Los Angeles, Calif.
C. T. LANE, Yale University, New Haven, Conn.
W. K. H. PANOFSKY, Stanford University, Stanford, Calif.
EDWARD M. PURCELL, Harvard University, Cambridge, Mass.
FREDERICK SEITZ, University of Illinois, Urbana, Ill.
JOHN SLATER, Massachusetts Institute of Technology, Cambridge, Mass.
EUGENE P. WIGNER, Princeton University, Princeton, N. J.

Advisory Panel for Psychology

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

CARL I. HOVLAND, Professor of Psychology, Yale University, New Haven, Conn.

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

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

W. D. NEFF, Department of Psychology, University of Chicago, Chicago, Ill.

BENTON J. UNDERWOOD, Department of Psychology, Northwestern University, Evanston, Ill.

Advisory Panel for Radio Astronomy

BART J. BOK, Harvard College Observatory, Cambridge, Mass.

JESSE L. GREENSTEIN, Mount Wilson and Palomar Observatories, California Institute of Technology, Pasadena, Calif.

JOHN PETER HAGEN, Naval Research Laboratory, Washington, D. C.

JOHN D. KRAUS, Ohio State University, Columbus, Ohio.

RUDOLPH L. B. MINKOWSKI, Mount Wilson and Palomar Observatories, Pasadena, Calif.

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

M. A. TUVE, Carnegie Institution, Washington, D. C.

Advisory Committee for Regulatory Biology

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

RICHARD H. BARNES, Associate Director of Research, Sharpe and Dohme, West Point, Pa.

R. H. BURRIS, Professor of Bacteriology, Department of Agriculture, University of Wisconsin, Madison, Wis.

IRWIN 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.

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

FOLKE SKOOG, Botany Department, University of Wisconsin, Madison, Wis.

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

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

Advisory Panel on Scientific Information

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

BERNARD R. BERELSON, Director, Behavioral Sciences Division, Ford Foundation, New York, N. Y.

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

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

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

WILLIAM A. NOYES, Jr., Chairman, Department of Chemistry, Universitv of Rochester, Rochester, N. Y.

Advisory Panel on Scientific Manpower Data

JAMES W. COLE, Jr., Department of Chemistry, University of Virginia, Charlottesville, Va.

HAROLD GOLDSTEIN, Bureau of Labor Statistics, United States Department of Labor, Washington, D. C.

CHARLES V. KIDD, Director, Research Planning Branch, National Institute of Health, Bethesda, Md.

JAMES M. MITCHELL, Deputy Assistant Secretary of Defense (Manpower and Personnel), Washington, D. C.

JAMES C. O'BRIEN, Director of Personnel, Department of Health, Education, and Welfare, Washington, D. C.

PHILIP N. POWERS, Executive Administrator, Atomic Electric Project, Monsanto Chemical Co., St. Louis, Mo.

MERRIAM H. TRYTTEN, Director, Office of Scientific Personnel, National Research Council, Washington, D. C.

JOHN F. WELLEMEYER, Staff Advisor on Personnel Studies, American Council of Learned Societies, Washington, D. C.

DAEL L. WOLFLE, Administrative Secretary, American Association for the Advancement of Science, Washington, D. C.

Advisory Panel for Social Science Research

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

CLYDE KLUCKHOHN, Professor of Anthropology, Harvard University, Cambridge, Mass.

DONALD MARQUIS, Department of Psychology, University of Michigan, Ann Arbor, Mich.

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

SAMUEL S. WILKS, Professor of Mathematics, Princeton University, Princeton, N. J.

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

ADVISORY COMMITTEES

Advisory Committee on Government-University Relationships

ARTHUR S. ADAMS, President, American Council on Education, Washington, D. C.

VANNEVAR BUSH, President, Carnegie Institution of Washington, Washington, D. C.

JAMES S. COLES, President, Bowdoin College, Brunswick, Maine.

HAROLD W. DODDS, President, Princeton University, Princeton, N. J.

CONRAD A. ELVEHJEM, Dean, Graduate School, University of Wisconsin, Madison, Wis.

KEITH T. GLENNAN, President, Case Institute of Technology, Cleveland, Ohio.

VIRGIL M. HANCHER, President, State University of Iowa, Iowa City, Iowa.

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

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

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

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

JULIUS A. STRATTON, Provost, Massachusetts Institute of Technology, Cambridge, Mass.

HARRY A. WINNE, Vice President for Engineering (ret.), General Electric Co., Redford, N. Y.

Advisory Committee on Minerals Research

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

JOHN G. BARTRAM, Stanolind Oil & Gas Co., Tulsa, Okla.

ALAN M. BATEMAN, Yale University, New Haven, Conn.

JAMES BOYD, Kennecott Copper Co., New York, N. Y.

ARTHUR H. BUNKER, Climax Molybdenum Co., New York, N. Y.

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

W. MAURICE EWING, Lamont Geological Observatory, Palisades, N. Y.

PAUL D. FOOTE, Gulf Research & Development Co., Pittsburgh, Pa.

LOUIS C. GRATON, Cambridge, Mass.

JOHN K. GUSTAFSON, M. A. Hanna Co., Cleveland, Ohio.

C. K. LEITH, National Research Council, Washington, D. C.

THOMAS B. NOLAN, United States Geological Survey, Washington, D. C.

WILLIAM W. RUBEY, United States Geological Survey, Washington, D. C.

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

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

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

WILLIAM E. WRATHER, United States Geological Survey, Washington, D. C.

PAUL ZINNER, Bureau of Mines, Washington, D. C.

Subcommittee on Geologic Research

C. A. Anderson, United States Geological Survey, Washington, D. C.
Charles H. Behre, Jr., Columbia University, New York, N. Y.
A. F. Buddington, Princeton University, Princeton, N. J.
W. S. Burbank, United States Geological Survey, Washington, D. C.
Carl E. Dutton, United States Geological Survey, Madison, Wis.
R. N. Hunt, United States Smelting, Refining and Mining Co., Salt Lake City, Utah.
T. S. Lovering, United States Geological Survey, Denver, Colo.
Hugh E. McKinstry, Harvard University, Cambridge, Mass.
Charles Meyer, University of California, Berkeley, Calif.
Thomas G. Moore, American Metal Co., Ltd., New York, N. Y.
James A. Noble, California Institute of Technology, Pasadena, Calif.
V. D. Perry, Anaconda Copper Mining Co., Salt Lake City, Utah.
G. M. Schwartz, University of Minnesota, Minneapolis, Minn.
F. S. Turneaure, University of Michigan, Ann Arbor, Mich.

Subcommittee on Geochemical Research

Robert M. Garrels, United States Geological Survey, Washington, D. C.
Earl Ingerson, United States Geological Survey, Washington, D. C.
J. L. Kulp, Columbia University, New York, N. Y.
Konrad Krauskopf, Stanford University, Palo Alto, Calif.
T. S. Lovering, United States Geological Survey, Denver, Colo.
Edwin Roedder, University of Utah, Salt Lake City, Utah.

Subcommittee on Geophysical Research

J. R. Balsley, United States Geological Survey, Washington, D. C.
Arthur A. Brant, Newmont Exploration Ltd., Jerome, Ariz.
A. F. Birch, Harvard University, Cambridge, Mass.
Henry Faul, United States Geological Survey, Washington, D. C.
Sigmund Hammer, Gulf Research and Development Co., Pittsburgh, Pa.
C. A. Heiland, Heiland Research Corp., Denver, Colo.
B. F. Howell, Jr., Pennsylvania State University, State College, Pa.
Patrick M. Hurley, Massachusetts Institute of Technology, Cambridge, Mass.
J. A. Noble, California Institute of Technology, Pasadena, Calif.

Subcommittee on Scientific Manpower

Charles B. Hunt, American Geological Institute, National Research Council, Washington, D. C.
Howard A. Meyerhoff, Scientific Manpower Commission, Washington, D. C.

320814—55——6

APPENDIX II

Research Support Program

BASIC RESEARCH GRANTS AWARDED IN FISCAL YEAR 1954

Astronomy

The American Association of Variable Star Observers, Harvard University, Cambridge, Mass.; W. Myall; *The Light Variations of More than 500 Variable Stars;* 1 year; $10,000.

University of Chicago, Chicago, Ill.; W. A. Hiltner, Department of Astronomy; *Interstellar Polarization;* 2 years; $10,900.

University of Chicago, Chicago, Ill.; G. P. Kuiper, Department of Astronomy; *Physical and Statistical Study of the Asteroids;* 2 years; $23,000.

University of Chicago, Chicago, Ill.; G. van Biesbroeck, Yerkes Observatory; *Astrometric Observations;* 1 year; $4,400.

University of Florida, Gainesville, Fla.; D. Duke, Department of Astronomy; *Photographic Studies of Close Binaries;* 1 year; $1,200.

Harvard University, Cambridge, Mass.; B. J. Bok and H. I. Ewen, Harvard College Observatory; *Radio Astronomy in the Microwave Region;* 1 year; $17,000.

Harvard University, Cambridge, Mass.; D. Hoffleit, Harvard College Observatory; *Variable Stars in the Milky Way;* 2 years; $5,500.

Harvard University, Cambridge, Mass.; H. Shapley, Department of Astronomy; *The Stellar Corona Surrounding our Discoidal Galactic System;* 1 year; $3,800.

University of Illinois, Urbana, Ill.; G. C. McVittie, Department of Astronomy; *Classical and Relativistic Gas-Dynamics by the Method of Einstein's Equations;* 2 years; $11,400.

Indiana University, Bloomington, Ind.; F. K. Edmondson, Department of Astronomy; *Observations of Asteroids;* 1 year; $5,000.

Louisiana State University, Baton Rouge, La.; K. Yoss, Department of Physics and Astronomy; *Relative Frequencies of Galactic Star Populations;* 2 years; $2,700.

University of Michigan, Ann Arbor, Mich.; L. H. Aller, Department of Astronomy; *Abundances of Light Metals in Stars and Nebulae;* 2 years; $11,000.

Mount Holyoke College, South Hadley, Mass.; A. H. Farnsworth, Department of Astronomy; *Study of a Milky Way Field;* 3 years; $1,500.

Northwestern University, Evanston, Ill.; K. Aa. Strand, Department of Astronomy; *Photographic Observation of Double Stars;* 2 years; $6,500.

Ohio State University, Columbus, Ohio; P. C. Keenan, Department of Physics and Astronomy; *Spectroscopic Study of Luminosity and Composition of S-Type and Related Stars;* 2 years; $3,700.

Ohio State University, Columbus, Ohio; A. Slettebak, Department of Physics and Astronomy; *Line Broadening in Early-Type Supergiant Stars;* 1 year; $2,700.

Princeton University, Princeton, N. J.; M. Schwarzschild, Department of Astronomy; *Advanced Stages of Stellar Evolution;* 2 years; $12,600.

University of Virginia, Charlottesville, Va.; A. N. Vyssotsky, Department of Astronomy; *Spectra of Faint Stars;* 1 year; $3,500.

Yale University, New Haven, Conn.; D. Brouwer, Department of Astronomy; *Systems of Fundamental Catalogues from Observations of Selected Minor Planets;* 2 years; $11,500.

Chemistry

BOSTON UNIVERSITY, Boston, Mass.; N. N. Lichtin, Department of Chemistry; *Ionic Dissociation Equilibria in Solutions in Liquid Sulfur Dioxide;* 2 years; $12,900.

BRANDEIS UNIVERSITY, Waltham, Mass.; S. G. Cohen, Department of Chemistry; *Chemistry of Free Radicals;* 3 years; $18,000.

BRIGHAM YOUNG UNIVERSITY, Provo, Utah; J. R. Goates, Department of Chemistry; *Mechanism of Adsorption of Ions by Silicate Minerals;* 1 year; $4,400.

UNIVERSITY OF CALIFORNIA, Berkeley, Calif.; T. L. Allen, Department of Chemistry; *Dissociation Equilibria of Metallic Halides at High Temperatures;* 3 years; $9,000.

UNIVERSITY OF CALIFORNIA, Berkeley, Calif.; D. W. Mitchell, Institute of Engineering Research; *A Study of the Structure of Molten Silicates by Measurements of Partial Molar Volumes;* 1 year; $3,000.

UNIVERSITY OF CALIFORNIA, Los Angeles, Calif.; R. L. Scott, Department of Chemistry; *Molecular Complexes Involving Halogens;* 3 years; $14,800.

CARNEGIE INSTITUTE OF TECHNOLOGY, Pittsburgh, Pa.; P. Fugassi, Department of Chemistry; *Chemical Nature of Coal Hydrogenation Products;* 3 years; $12,000.

CENTRAL STATE COLLEGE, Wilberforce, Ohio; E. O. Woolfolk, Department of Chemistry; *P-Phenylazo-Benzoyl Chloride for Identification and Separation of Alcohols, Amines, and Phenols;* 2 years; $3,100.

UNIVERSITY OF COLORADO, Boulder, Colo.; R. N. Keller, Department of Chemistry; *Low Count-Rate Techniques in Radiocarbon Dating;* 2 years; $10,000.

COLUMBIA UNIVERSITY, New York, N. Y.; G. Stork, Department of Chemistry; *Synthesis of the Polycyclic Di- and Tri-Terpenes;* 2 years; $13,300.

UNIVERSITY OF DELAWARE, Newark, Del.; E. Dyer, Department of Chemistry; *Effect of Oxygen on Vinyl Compounds in the presence of Free Radicals;* 18 months; $10,000.

UNIVERSITY OF FLORIDA, Gainesville, Fla; G. A. Greathouse, Engineering and Industrial Experiment Station; *Mechanism of Synthesis and Degradation of Specifically Labeled C^{14} Celluose;* 2 years, $6,500.

GEORGIA INSTITUTE OF TECHNOLOGY, Atlanta, Ga.; J. Hine, Department of Chemistry; *Effect of Halogen Atoms on Reactivity of Other Halogen Atoms in the Same Molecule;* 2 years; $10,000.

HOWARD UNIVERSITY, Washington, D. C.; M. D. Taylor, Department of Chemistry; *Action of Simple and Complex Hydrides on Rare Earth Compounds;* 2 years; $12,000.

ILLINOIS INSTITUTE OF TECHNOLOGY, Chicago, Ill.; S. E. Wood, Department of Chemistry; *Properties of Nonelectrolytic Solutions;* 3 years; $24,000.

UNIVERSITY OF ILLINOIS, Urbana, Ill.; H. A. Laitinen, Department of Chemistry and Chemical Engineering; *Adsorption Processes at Electrode Surfaces;* 2 years; $11,800.

UNIVERSITY OF ILLINOIS, Urbana, Ill.; B. R. Ray, Department of Chemistry; *Transference Numbers of Salts in Non-Aqueous Solvents;* 1 year; $5,300.

UNIVERSITY OF ILLINOIS, Urbana, Ill.; H. R. Snyder, Department of Chemistry; *Alkaloids of Haplophyton Cimicidum;* 3 years; $29,600.

UNIVERSITY OF ILLINOIS, Urbana, Ill.; E. C. Taylor, Jr., Department of Chemistry; *An Investigation of the Pyridinopyrimidines;* 2 years; $5,000.

KENYON COLLEGE, Gambier, Ohio; B. M. Norton, Department of Chemistry; *Liquid Phase Photochemical Reactions;* 3 years; $4,600.

UNIVERSITY OF LOUISVILLE, Louisville, Ky.; J. P. Phillips, Department of Chemistry; *Analytical Reagents Related to 8-Quinolinol;* 2 years; 5,100.

UNIVERSITY OF MARYLAND, College Park, Md.; G. Brown, Department of Chemistry; *X-Ray Analysis of Organic Crystal Structures;* 2 years; $10,400.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Cambridge, Mass.; G. Swain, Department of Chemistry; *Quantitive Correlation of Relatives Rates of Polar Displacement Reactions;* 3 years; $13,000.

UNIVERSITY OF MISSISSIPPI, University, Miss.; W. L. Nobles, School of Pharmacy; *Studies Involving the Mannich Reaction;* 2 years; $4,100.

MONMOUTH COLLEGE, Monmouth, Ill.; G. W. Thiessen, Department of Chemistry; *Benzenoid Inhibition of the Kolbe Electrolysis;* 1 year; $5,000.

MOUNT HOLYOKE COLLEGE, South Hadley, Mass.; L. W. Pickett, Department of Chemistry; *Vacuum Ultraviolet Spectra of Selected Organic Compounds;* 2 years $11,000.

STATE UNIVERSITY OF NEW YORK, Albany, N. Y.; M. Szwarc, Department of Chemistry, School of Forestry, Syracuse, N. Y.; *Heats of Formation of Radicals and of Bond Dissociation Energies;* 2 years; $16,000.

UNIVERSITY OF NOTRE DAME, Notre Dame, Ind.; C. Curran, Department of Chemistry; *Localized and Nonlocalized Hydrogen Bonding;* 2 years; $6,100.

OHIO STATE UNIVERSITY, Columbus, Ohio; M. L. Wolfrom, Department of Chemistry; *Determination of Polysaccharide Structure by Degradative Methods;* 3 years; $25,000.

PENNSYLVANIA STATE UNIVERSIY, State College, Pa.; N. C. Deno, Department of Chemistry; *Factors Governing Stability of Carbonium Ions;* 2 years; $4,600.

REED COLLEGE, Portland, Oreg.; A. F. Scott, Department of Chemistry; *Chemical Determination of Atomic Weights;* 2 years; $8,000.

RENSSELAER POLYTECHNIC INSTITUTE, Troy, N. Y.; S. Ross, Department of Chemistry; *Two-Dimensional Condensation of Adsorbed Vapors on Solid Surfaces;* 1 year; $5,000.

RICE INSTITUTE, Houston, Tex.; R. B. Turner, Department of Chemistry; *Total Synthesis in the Steroid Series;* 2 years; $16,300.

UNIVERSITY OF SOUTH CAROLINA, Columbia, S. C.; D. F. De Tar, Department of Chemistry; *Intramolecular Reactions of Free Radicals;* 2 years; $13,100.

UNIVERSITY OF SOUTHERN CALIFORNIA, Los Angeles, Calif.; W. K. Wilmarth, Department of Chemistry; *Chemistry of Aromatic Free Radicals;* 2 years, $6,300.

TUFTS COLLEGE, Medford, Mass.; C. E. Messer, Department of Chemistry; *Solid Solution Formation and Solid-Liquid Phase Equilibria in Systems of Aromatic Ring Compounds;* 1 year; $5,000.

UNIVERSITY OF UTAH, Salt Lake City, Utah; R. E. Hamm, Department of Chemistry; *Solution Chemistry of Complex Ions;* 2 years; $9,700.

VANDERBILT UNIVERSITY, Nashville, Tenn.; D. E. Pearson, Department of Chemistry; *Mechanisms of Electrophylic Reactions;* 2 years; $9,200.

UNIVERSITY OF VIRGINIA, Charlottesville, Va.; R. E. Lutz, Department of Chemistry; *Stereochemistry and Effectiveness of Conjugation in Chalcones and Related Systems;* 2 years; $6,600.

STATE COLLEGE OF WASHINGTON, Pullman, Wash; G. W. Stacy, Department of Chemistry; *Addition of Thiols to Schiff Base Systems;* 1 year; $4,100.

UNIVERSITY OF WASHINGTON, Seattle, Wash.; W. M. Schubert, Department of Chemistry; *Aromatic Electrophilic Substitution by Hydrogen;* 3 years; $6,500.

UNIVERSITY OF WASHINGTON, Seattle, Wash.; B. S. Rabinovitch, Department of Chemistry; *Kinetics of Homogeneous Unimolecular Isomerization Reaction;* 2 years; $12,400.

WASHINGTON UNIVERSITY, St. Louis, Mo.; A. C. Wahl, Department of Chemistry; *Kinetic Studies of Oxidation-Reduction Reactions;* 2 years; $17,700.

WESTERN RESERVE UNIVERSITY, Cleveland, Ohio; E. L. Pace, Department of Chemistry; *Thermodynamics and Molecular Structure of Simple Fluorine Compounds;* 2 years; $10,500.

UNIVERSITY OF WISCONSIN, Madison, Wis.; W. S. Johnson, Department of Chemistry; *Synthesis of Structures Related to the Steroids;* 2 years; $15,000.

UNIVERSITY OF WISCONSIN, Madison, Wis.; A. L. Wilds, Department of Chemistry; *Total Synthesis of Nonaromatic Steroids;* 1 year; $8,600.

YALE UNIVERSITY, New Haven, Conn.; B. Owen, Department of Chemistry; *The Dielectric Constants of Liquids at High Pressures;* 1 year; $3,800.

Developmental Biology

ATLANTA UNIVERSITY, Atlanta, Ga.; M. L. Reddick, Department of Biology; *Pattern of Outgrowth of Cells from Chick Medulla Grown in Vitro;* 2 years; $4,600.

UNIVERSITY OF CALIFORNIA, Berkeley, Calif.; R. Y. Stainer, Department of Bacteriology; *Physiology and Photosynthetic Bacteria;* 3 years; $20,700.

UNIVERSITY OF COLORADO, Boulder, Colo.; H. Herrmann, Department of Pediatrics, School of Medicine; *Embryonic Development and Maturation of Muscle Tissue;* 1 year; $7,500.

FLORIDA STATE UNIVERSITY, Tallahassee, Fla; C. B. Metz, Department of Zoology; *The Nature and Role of Specific Substances in Fertilizin;* 2 years; $8,100.

GRINNELL COLLEGE, Grinnell, Iowa; G. Mendoza, Department of Biology; *Yolk Nucleus of the Teleost Ova;* 1 year; $500.

STATE UNIVERSITY OF IOWA, Iowa City, Iowa; R. B. Wylie, Department of Botany; *New Methods in Leaf Research;* 15 months; $5,400.

MACALESTER COLLEGE, St. Paul, Minn.; W. S. Glock, Department of Geology; *Tree Growth and Climate;* 3 years; $13,000.

UNIVERSITY OF PENNSYLVANIA, Philadelphia, Pa.; C. E. Wilde, School of Dentistry; *Embryogenesis of the Vertebrate Head;* 2 years; $10,800.

RICE INSTITUTE, Houston, Tex.; R. V. Talmadge, Department of Biology; *Hormonal Basis for Implantation of Blastocyst in Armadillo;* 2 years; $13,000.

ST. AMBROSE COLLEGE, Davenport, Iowa; W. F. Lynch, Department of Biology; *Factors Inducing Metamorphosis in Bugula;* 1 year: $450.

UNIVERSITY OF WASHINGTON, Seattle, Wash.; W. S. Hsu, Department of Zoology; *Bdelloid Cytology;* 2 years; $3,200.

UNIVERSITY OF WISCONSIN, Madison, Wis.; H. W. Mossman, Department of Anatomy; *Uterine Vascular System in the Hamster;* 1 year; $4,370.

UNIVERSITY OF WISCONSIN, Madison Wis.; K. B. Raper, Department of Botany; *Speciation in Simple Slime Molds;* 3 years; $18,900.

Earth Sciences

UNIVERSITY OF ALASKA, College, Alaska; C. T. Elvey, Director, Geophysical Institute; *Ionospheric Research Using Both Radio Waves of Extraterrestrial Origin and from Controlled Transmitters;* 2 years; $20,000.

AMERICAN MUSEUM OF NATURAL HISTORY, New York, N. Y.; N. D. Newell, Curator of Historical Geology and Fossil Invertebrates; *Phylogenetic Studies of Pelecypoda;* 1 year; $3,100.

BROWN UNIVERSITY, Providence, R. I.; R. B. Montgomery, Visiting Professor of Oceanography; *Analysis of Serial Oceanographic Observations;* 2 years; $12,200.

UNIVERSITY OF CALIFORNIA, Los Angeles, Calif.; D. I. Axelrod, Department of Geology; *Pliocene Floras of Western Nevada;* 3 years; $13,800.

UNIVERSITY OF CALIFORNIA, Berkeley, Calif.; C. Meyer, Department of Geological Sciences; *Hydrothermal Alteration Studies of Micas, Mica-Like Clays and Related Minerals;* 2 years; $19,500.

UNIVERSITY OF CALIFORNIA, Berkeley, Calif.; C. A. Nelson, Department of Geology; *Cambrian Strata of the Inyo Mountains, California;* 3 years; $8,600.

UNIVERSITY OF CALIFORNIA, Los Angeles, Calif.; G. Tunell, Department of Geology; *Geochemistry of Mercury Ores;* 2 years; $17,700.

UNIVERSITY OF CHICAGO, Chicago, Ill.; H. C. Urey, Institute for Nuclear Studies; *Isotopic Abundances Relating to Geochemical Research;* 1 year; $21,400.

COLUMBIA UNIVERSITY, New York, N. Y.; W. H. Bucher, Department of Geology; *Geologic Investigation of the Tectonic Settling of Land Masses Adjacent to the Puerto Rican Trench;* 1 year; $14,000.

COLUMBIA UNIVERSITY, New York, N. Y.; D. B. Ericson, Iamont Geological Observatory; *Lithological and Micropaleontological Investigation of Atlantic Ocean Sediment Cores;* 2 years; $18,000.

COLUMBIA UNIVERSITY, New York, N. Y.; J. L. Kulp, Department of Geology; *Time Relations of Ocean Floor Sediments;* 1 year; $13,000.

HIGH ALTITUDE OBSERVATORY OF HARVARD UNIVERSITY AND THE UNIVERSITY OF COLORADO, Boulder, Colo.; W. O. Roberts, Director, High Altitude Observatory; *Observational Studies of Solar Activity;* 1 year; $10,000.

UNIVERSITY OF ILLINOIS, Urbana, Ill.; G. W. White, Department of Geology; *Properties of Glacial Tills;* 15 months; $11,800.

UNIVERSITY OF MIAMI, Coral Gables, Fla.; R. N. Ginsburg, Marine Laboratory; *Geological Role of Some Blue-Green Algae;* 6 months; $3,300.

UNIVERSITY OF NEBRASKA, Lincoln, Nebr.; R. L. Threet, Department of Geology; *Structures of the Colorado Plateau Margin in Southwestern Utah;* 2 years; $4,400.

NORTH DAKOTA AGRICULTURAL COLLEGE, Fargo, N. Dak.; P. Tasch, Department of Geology; *Fauna and Paleoecology of the Depauperate Zone of the Maquoketa Shale of Iowa;* 1 year; $1,000.

OBERLIN COLLEGE, Oberlin, Ohio; P. B. Sears, K. Clisby, and F. Foreman; *Continuous History of Vegetation, Climate and Sediments Extending into the Pleistocene;* 1 year; $9,000.

PALEONTOLOGICAL RESEARCH INSTITUTION, Ithaca, N. Y.; J. D. McLean, Jr.; *Foraminifera of the Yorktown Formation;* 1 year; $5,200.

PENNSYLVANIA STATE UNIVERSITY, State College, Pa.; B. F. Howell, Jr., Department of Earth Sciences; *Formation of Seismic Pulses;* 2 years; $12,100.

PENNSYLVANIA STATE UNIVERSITY, State College, Pa.; M. L. Keith, Department of Earth Sciences; *Fractionation of Stable Isotopes in Geologic Processes;* 2 years; $15,100.

PENNSYLVANIA STATE UNIVERSITY, State College, Pa.; O. F. Tuttle, Department of Earth Sciences; *Stability Relations of Silicate-Carbonates at Elevated Temperatures and Pressures;* 1 year; $5,500.

PRINCETON UNIVERSITY, Princeton, N. J.; J. C. Maxwell, Department of Geology; *Compaction and Cementation of Sediments;* 2 years; $10,800.

PRINCETON UNIVERSITY, Princeton, N. J., W. T. Thom, Jr., Department of Geological Engineering; *Crustal Deformation in Portions of the Great Plains and Cordilleran Regions;* 1 year; $8,700.

UNIVERSITY OF UTAH, Salt Lake City, Utah; E. Roedder, Department of Mineralogy; *Phase Equilibrium Relations in the System* K_2O–FeO–Al_2O_3–SiO_2; 2 years; $13,400.

WASHINGTON UNIVERSITY, St. Louis, Mo.; J. C. Brice, Department of Geology; *Pleistocene Geology of Northeastern Missouri;* 2 years; $3,500.

WAYNE UNIVERSITY, Detroit, Mich.; W. H. Parsons, Department of Geology; *Igneous Geology in the Beartooth Mountain Area, Wyoming-Montana;* 6 months; $4,000.

WAYNE UNIVERSITY, Detroit, Mich.; W. H. Parsons, Department of Geology; *Problems of Igneous Geology in the Beartooth Mountain Area, Wyoming-Montana;* 1 year; $3,700.

Engineering Sciences

UNIVERSITY OF ARIZONA, Tucson, Ariz.; T. L. Martin, Jr. and C. R. Hausenbauer, Department of Electrical Engineering; *Thermionic Ion Generation in Contaminated Air and Other Gases;* 2 years; $10,000.

POLYTECHNIC INSTITUTE OF BROOKLYN, Brooklyn, N. Y.; J. C. Chu, Department of Chemical Engineering; *Drying with Superheated Vapors;* 2 years; $3,500.

UNIVERSITY OF CALIFORNIA, Berkeley, Calif.; W. T. Thomson, Department of Engineering; *Wave Propogation Through Hydrocarbons;* 2 years; $9,600.

CARNEGIE INSTITUTE OF TECHNOLOGY, Pittsburgh, Pa.; C. L. McCabe, Department of Metallurgical Engineering; *Determination of Activity of Silicon in Liquid Silicate Systems;* 18 months; $11,000.

CASE INSTITUTE OF TECHNOLOGY, Cleveland, Ohio; W. L. Bryan, Mechanical Engineering Department; *Heat Transfer to Boiling Liquids Flowing in Horizontal Tubes;* 1 year; $5,700.

COLORADO AGRICULTURAL AND MECHANICAL COLLEGE, Fort Collins, Colo.; M. L. Albertson, Department of Civil Engineering; *Resistance to Flow in Open Channels;* 30 months; $12,500.

UNIVERSITY OF DELAWARE, Newark, Del.; A. B. Metzner, Department of Chemical Engineering; *Engineering Reaction Kinetics of Ethylene Oxide Hydration;* 18 months; $9,000.

UNIVERSITY OF DETROIT, Detroit, Mich.; R. H. McCormack, Department of Chemical Engineering; *Solubility of Hydrogen Chloride and Ammonia in Water and Organic Solvents;* 18 months; $2,300.

GEORGIA INSTITUTE OF TECHNOLOGY, Atlanta, Ga.; W. T. Ziegler, Department of Chemical Engineering; *Studies of Compounds for Superconductivity;* 2 years; $13,000.

UNIVERSITY OF ILLINOIS, Urbana, Ill.; J. W. Westwater, Division of Chemical Engineering; *Metastable Boiling;* 2 years; $13,500.

STATE UNIVERSITY OF IOWA, Iowa City, Iowa; J. O. Osburn, Division of Chemical Engineering; *Supersaturation in Liquid Solutions;* 1 year; $8,000.

JOHNS HOPKINS UNIVERSITY, Baltimore, Md.; H. E. Hoelscher, Department of Chemical Engineering; *Kinetics of Reactions in Three-Phase Systems;* 2 years; $9,000.

KANSAS STATE COLLEGE, Manhattan, Kans.; D. R. Carver, Applied Mechanics Department; *Stability of Rings and Circular Arches under Arbitrary Loading;* 2 years; $10,000.

UNIVERSITY OF KENTUCKY, Lexington, Ky.; C. S. Crouse and J. P. Hammond, Department of Mining and Metallurgical Engineering; *Effect of Deformation Temperature on the Rolling Textures of Metals;* 1 Year; $9,000.

LEHIGH UNIVERSITY, Bethlehem, Pa.; L. S. Beedle, Department of Civil Engineering; *The Influence of Residual Stress on Column Strength;* 3 years; $15,000.

LEHIGH UNIVERSITY, Bethlehem, Pa.; A. C. Zettlemoyer, Department of Chemistry; *Mixed Vapor Adsorption;* 2 years; $6,200.

LOUISIANA STATE UNIVERSITY, Baton Rouge, La.; J. Coates, Department of Chemical Engineering; *Thermal Conductivity of Liquids and Solutions as a Function of Temperature;* 2 years; $13,800.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY; Cambridge, Mass.; M. C. Shaw, Department of Mechanical Engineering; *Stress and Energy Characteristics of Brittle Materials During Comminution;* 1 year; $6,000.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY; Cambridge, Mass,; J. Wulff, Department of Metallurgy; *Adsorption of Gases on Solid Metals;* 1 year; $8,600.

UNIVERSITY OF MINNESOTA, Minneapolis, Minn.; E. L. Piret, Department of Chemical Engineering; *Reaction and Dislocation Kinetics of Crushing and Grinding;* 2 years; $15,000.

MISSISSIPPI STATE COLLEGE, State College, Miss.; D. M. McCain, Department of Civil Engineering; *Stress-Strain Relations in Plain Concrete Under Simulated Beam Action*; 1 year; $5,500.

MONTANA SCHOOL OF MINES; Butte, Mont.; D. W. McGlashan, Department of Mining Engineering; *Effects of Progressive Change of Position on the Surface Reactivity of Aliphatic Derivatives;* 2 years; $13,000.

NEW YORK UNIVERSITY, New York, N. Y.; Y. C. Liu, Department of Metallurgy; *Effect of Crystal Orientation in Cold-Rolled and Recrystallized Textures of Copper;* 18 months; $6,000.

NEW YORK UNIVERSITY, New York, N. Y.; R. E. Treybal, Department of Chemical Engineering; *Mass Transfer to and from Solid Spheres Immersed in a Flowing Fluid;* 30 months; $7,000.

NORTH CAROLINA STATE COLLEGE, Raleigh, N. C.; N. L. Memerow, Department of Engineering Research; *Mechanism of Biochemical Oxidation of Organic Matter;* 1 year; $7,000.

UNIVERSITY OF NORTH DAKOTA, Grand Forks, N. Dak.; W. R. Kube, Department of Chemical Engineering; *Sorption of Water Vapor by Thermally Treated Lignite;* 18 months; $3,400.

NORTHWESTERN UNIVERSITY, Evanston, Ill.; A. B. Bronwell, Department of Electrical Engineering; *Microwave Conversion and Detection;* 1 year; $5,000.

NORTHWESTERN UNIVERSITY, Evanston, Ill.; G. Thodos, Department of Chemical Engineering; *Vapor Liquid Equilibrium Studies in Multicomponent Systems;* 2 years; $10,000.

OHIO STATE UNIVERSITY, Columbus, Ohio; J. D. Kraus, Department of Electrical Engineering; *Positions and Characteristics of Discrete Radio Sources;* 2 years; $9,800.

OREGON STATE COLLEGE, Corvallis, Oreg.; J. G. Knudsen, Department of Chemical Engineering; *Heat Transfer Coefficients in Baffled Tubular Heat Exchanges;* 2 years; $7,200.

PENNSYLVANIA STATE UNIVERSITY, State College, Pa., L. W. Hu and J. Marin, Department of Engineering; *Creep Stress-Strain-Time Relations for Combined Stresses;* 2 years; $13,000.

PENNSYLVANIA STATE UNIVERSITY, State College, Pa., A. H. Waynick, Department of Electrical Engineering; *Detecting Solar and Upper Atmosphere Phenomena by Long-Wave Radio Methods;* 1 year; $12,000.

UNIVERSITY OF PENNSYLVANIA, Philadelphia, Pa.; F. J. Dunkerley, Department of Metallurgical Engineering; *Thermodynamic Properties of Sulphur and Oxygen in Liquid Iron Alloys;* 2 years; $20,000.

UNIVERSITY OF PENNSYLVANIA, Philadelphia, Pa.; F. F. Hagerty, Department of Chemical Engineering; *Fixed Bed Problem with a Nonlinear Equilibrium Relationship;* 1 year; $5,000.

PRATT INSTITUTE, Brooklyn, N. Y.; G. B. Diamond, Department of Chemical Engineering; *Selective Electrolytic Reduction of Carbocyclic Unsaturated Compounds;* 2 years; $10,000.

PURDUE UNIVERSITY, Lafayette, Ind.; E. W. Comings, School of Chemical and Metallurgical Engineering; *Properties of Gases at High Pressures;* 2 years; $14,000.

RENSSELAER POLYTECHNIC INSTITUTE, Troy, N. Y.; J. O. Hougen, Department of Chemical Engineering; *Reduction of Metallic Oxides with Hydrogen;* 1 year; $4,300.

SOUTH DAKOTA SCHOOL OF MINES AND TECHNOLOGY, Rapid City, S. Dak.; W. A. Hixson, Department of Electrical Engineering; *Observable Failures of Electrically Stressed Transformer Oil;* 2 years; $3,500.

SWARTHMORE COLLEGE, Swarthmore, Pa.; C. Barus, Department of Electrical Engineering; *Electronic Instrumentation in Neurophysiology;* 1 year; $8,500.

UNIVERSITY OF TEXAS, Austin, Tex.; W. L. Moore, Department of Civil Engineering; *Diffusion of a Two-Dimensional Submerged Jet;* 1 year; $10,000.

UNIVERSITY OF UTAH, Salt Lake City, Utah; J. H. Hamilton and J. R. Lewis, Department of Metallurgical Engineering; *Kinetics of the Removal of Carbon from Molten Metal-Carbon Mixtures by Reaction with Carbon Dioxide;* 3 years; $13,000.

UNIVERSITY OF WISCONSIN, Madison, Wis.; J. A. Duffie, Engineering Experiment Station; *Solar Energy Research;* 3 years; $13,000.

Environmental Biology

UNIVERSITY OF ARIZONA, Tucson, Ariz.; A. R. Mead, Department of Zoology; *Population Decline of the Giant African Snail;* 1 year; $8,300.

EMORY UNIVERSITY, Emory University, Ga.; F. H. Bormann, Department of Biology; *Ecology of Southern Pine;* 2 years; $4,200.

UNIVERSITY OF MIAMI, Coral Gables, Fla.; H. B. Moore, Assistant Director, Marine Laboratory; *Reactions of the Copepods of the Florida Current;* 2 years; $11,600.

MICHIGAN STATE COLLEGE, East Lansing, Mich.; G. W. Prescott, Department of Botany; *Alpine and Arctic Algae;* 1 year; $2,200.

ST. LOUIS UNIVERSITY, St. Louis, Mo.; B. J. Luyet, Institute of Biophysics; *Survival of Vitrified and Dried Organisms;* 1 year; $4,500.

STANFORD UNIVERSITY, Palo Alto, Calif.; D. P. Abbott and R. L. Bolin, Hopkins Marine Station; *Populations of Marine Organisms;* 1 year; $7,100.

VASSAR COLLEGE, Poughkeepsie, N. Y.; G. E. Baker, Plant Science Department; *Microorganisms in Lake Water;* 3 years; $5,300.

Genetic Biology

ALABAMA POLYTECHNIC INSTITUTE, Auburn, Ala.; C. D. Squiers and L. E. Gregory, Department of Animal Husbandry and Nutrition; *Fertility, Viability, and Growth in the Rat;* 3 years; $18,000.

UNIVERSITY OF CALIFORNIA, Berkeley, Calif.; C. M. Rick, Department of Vegetable Crops; *Cytogenetic Studies in the Genus Lycoperiscon;* 3 years; $7,000.

UNIVERSITY OF DETROIT, Detroit, Mich.; P. F. Forsthoefel, Department of Zoology; *The Developemental Genetics of Luxoid, A New Skeletal Variation in the House Mouse;* 2 years; $7,900.

HARVARD UNIVERSITY, Cambridge, Mass.; J. R. Raper, Professor of Botany; *Naturally Occurring Filtrable Mutagens in Schizophyllum;* 1 year; $5,500.

MISSOURI BOTANICAL GARDEN, St. Louis, Mo.; E. Anderson, Genetics; *Introgression in Natural Populations;* 3 years; $19,000.

UNIVERSITY OF NORTH CAROLINA, Chapel Hall, N. C.; D. U. Gerstel, Department of Agronomy, North Carolina State College, Raleigh, N. C.; *Segregation in Artificial Amphidiploids in Genus Gossypium;* 3 years; $12,500.

PURDUE UNIVERSITY, Lafayette, Ind.; D. C. Warren and A. E. Bell, Department of Poultry Husbandry, Agricultural Experiment Station; *Heterosis in Drosophila Melanogaster;* 3 years; $18,400.

RADFORD COLLEGE, Radford, Va.; V. L. House, Department of Biology; *Genetic Control of Venation in Drosophila;* 2 years; $7,500.

RANCHO SANTA ANA BOTANICAL GARDEN, Claremont, Calif.; V. Grant, Biosystematist; *Genetics of the Genus Gilia;* 3 years; $7,700.

UNIVERSITY OF ROCHESTER, Rochester, N. Y.; K. W. Cooper, Department of Biology; *Patterns of Chromosome Segregation;* 3 years; $24,000.

SMITH COLLEGE, Northampton, Mass.; A. F. Blakeslee, Director, Genetics Experiment Station; *Evolution and Life Processes in Plants;* 2 years; $14,000.

TEXAS AGRICULTURAL EXPERIMENT STATION, College Station, Tex.; H. H. Hadley, Department of Genetics; *Cytogenetic Relationships Among Sorghums;* 3 years; $3,900.

WASHINGTON UNIVERSITY, St. Louis, Mo.; H. L. Carson and H. D. Stalker, Department of Zoology; *Investigation of Drosophila and Diptera;* 3 years; $11,500.

Mathematical Sciences

ALABAMA POLYTECHNIC INSTITUTE, Auburn, Ala.; Hsien-Chung Wang; *Subgroups of Complex Lie Groups and Groups of Holomorphic Homeomorphisms;* 1 year; $8,900.

AMERICAN MATHEMATICAL SOCIETY, Providence, R. I.; *Summer Mathematical Institute for the Study of Functions of Several Complex Variables;* $25,000.

BROWN UNIVERSITY, Providence, R. I.; H. Federer, Department of Mathematics; *Theory of Measure and Area;* 1 year; $7,000.

BROWN UNIVERSITY, Providence, R. I.; B. Jonsson, Department of Mathematics; *Problems in Modular Lattices;* 1 year; $3,400.

COLUMBIA UNIVERSITY, New York, N. Y.; E. R. Lorch, Department of Mathematics; *Volume in Hilbert Space;* 1 year; $5,700.

HAVERFORD COLLEGE, Haverford, Pa.; R. C. James, Department of Mathematics; *Implications of the Existence of Banach Spaces;* 1 year; $2,500.

ILLINOIS INSTITUTE OF TECHNOLOGY, Chicago, Ill.; L. R. Wilcox, Department of Mathematics, *Imbedding Theorems and Topologies for Lattices;* 1 year; $7,000.

INSTITUTE FOR ADVANCED STUDY, Princeton, N. J.; H. Samelson, School of Mathematics; *Topology of Lie Groups and Spaces of Paths;* 1 year; $9,200.

INSTITUTE FOR ADVANCED STUDY, Princeton, N. J.; Shing-Shen Chern, Department of Mathematics; *Pseudo Groups with Emphasis on Complex and Symplectic Manifolds;* 1 year; $3,450.

LEHIGH UNIVERSITY, Bethlehem, Pa.; E. A. Pitcher, Department of Mathematics; *Problems in Critical Point Theory;* 1 year; $3,000.

UNIVERSITY OF MICHIGAN, Ann Arbor, Mich.; W. Kaplan, Department of Mathematics; *Problems in the Theory of Functions of a Complex Variable;* 6 months; $1,600.

NORTHWESTERN UNIVERSITY, Evanston, Ill.; A. Rosenberg and D. Zelinsky, Department of Mathematics; *Galois Theory of Rings;* 1 year; $6,800.

OHIO STATE UNIVERSITY, Columbus, Ohio; M. Hall, Jr., Department of Mathematics; *Combinatorial Problems;* 18 months; $10,400.

PENNSYLVANIA STATE UNIVERSITY, State College, Pa.; H. B. Curry, Department of Mathematics; *Combinatory Logic;* 1 year; $9,400.

PRINCETON UNIVERSITY, Princeton, N. J.; A. Church, Department of Mathematics; *Preparation of Results of Basic Research Entitled "Introduction to Mathematical Logic, Volumes I and II";* 1 year; $5,600.

PURDUE RESEARCH FOUNDATION, Lafayette, Ind.; C. R. Putnam, Department of Mathematics; *Investigation of Singular Boundary Value Problems and Operators in Hilbert Space;* 2 years; $12,000.

QUEENS COLLEGE, Flushing, N. Y.; L. Zippin, Department of Mathematics; *Topological Groups Acting as Transformation Groups;* 1 year; $7,700.

UNIVERSITY OF VIRGINIA, Charlottesville, Va.; E. J. McShane, School of Mathematics; *Convergence Problems in Partially Ordered Spaces;* 1 year; $1,700.

WAYNE UNIVERSITY, Detroit, Mich.; C. Goffman, Department of Mathematics; *Lower Semicontinuous Functionals and Surface Area;* 1 year; $8,200.

UNIVERSITY OF WASHINGTON, Seattle, Wash.; E. Hewitt, Department of Mathematics; *Investigations in Functional Analysis;* 21 months; $30,000.

UNIVERSITY OF WISCONSIN, Madison, Wis.; R. H. Bing, Department of Mathemathics; *Imbedding Sets in Manifolds;* 1 year; $5,400.

Molecular Biology

UNIVERSITY OF ALABAMA, Birmingham, Ala.; W. Pigman, Department of Biochemistry; *Biologically Significant Reactions and Interactions of Nitrogenous Carbohydrates and Related Substances;* 3 years; $13,000.

UNIVERSITY OF CALIFORNIA, Berkeley, Calif.; G. Mackinney, Department of Food Technology; *Carotenoid Biosynthesis;* 2 years; $16,000.

UNIVERSITY OF CALIFORNIA, Berkeley, Calif.; H. K. Schachman and C. A. Dekker, Virus Laboratory; *Mechanisms of Enzymatic Breakdown of Proteins and Nucleic Acids;* 3 years; $25,000.

CHICAGO MEDICAL SCHOOL, Chicago, Ill.; A. R. Goldfarb, Department of Biochemistry; *Structure and Reactions of the Peptide Bond in Aqueous Solution as Indicated by Ultraviolet Absorption Spectra;* 1 year; $8,000.

UNIVERSITY OF CHICAGO, Chicago, Ill.; L. Bogorad, Department of Botany; *Enzymatic Synthesis of Porphyrins from Porphobilinogen;* 2 years; $12,000.

CORNELL UNIVERSITY, Ithaca, N. Y.; H. A. Scheraga, Department of Chemistry; *Hydrodynamic Properties of Proteins;* 3 years; $15,500.

DUQUESNE UNIVERSITY, Pittsburgh, Pa.; N. C. Li, Department of Chemistry; *Metal-Protein Interactions;* 2 years; $13,000.

FORDHAM UNIVERSITY, New York City, N. Y.; F. F. Nord, Department of Organic Chemistry; *Structural, Biochemical and Physicochemical Studies of Lignin;* 3 years; $21,000.

HARVARD UNIVERSITY, Cambridge, Mass.; J. T. Edsall, Biological Laboratories; *Physical Chemistry of Amino Acids, Peptides, and Proteins with Special Reference to Raman Spectra;* 3 years; $30,000.

HARVARD UNIVERSITY, Cambridge Mass.; L. F. Fieser, Department of Chemistry; *Role of Sterols in Health and Disease;* 3 years; $30,000.

HARVARD UNIVERSITY, Cambridge, Mass.; A. F. Riggs, Biological Laboratories; *Biochemistry of Hemoglobin;* 2 years; $3,500.

UNIVERSITY OF ILLINOIS, Urbana, Ill.; I. C. Gunsalus, Department of Bacteriology; *Biosynthesis and Function of Microbial Chromoproteins;* 2 years; $11,000.

STATE UNIVERSITY OF IOWA, Iowa City, Iowa; R. Benesch, Department of Biochemistry; *The Reactivity of Sulfhydryl Groups in Peptides and Proteins;* 2 years; $12,000.

JOHNS HOPKINS UNIVERSITY, Baltimore, Md.; W. L. Hughes, McCollum-Pratt Institute; *Nature of the Hemoglobin Linkage;* 3 years; $18,000.

JOHNS HOPKINS UNIVERSITY, Baltimore, Md.; W. C. McElroy, McCollum-Pratt Institute; *Biological Conversion of Chemical Energy to Light;* 3 years; $15,000.

University of Michigan, Ann Arbor, Mich.; A. G. Norman, Department of Botany; *Interrelationships Between Plant Cell Wall Polysaccharides;* 2 years; $16,000.

Montana State College, Bozeman, Mont.; R. H. McBee, Department of Botany and Bacteriology; *Bacterial Cellulose Decomposition;* 3 years; $12,000.

Montana State College, Bozeman, Mont.; J. H. Pepper, Department of Zoology and Entomology, and L. H. Johnson, Department of Chemistry Research; *The Composition and Structure of the Cuticular Components of the Exoskeleton of the Mormon Cricket;* 2 years; $10,000.

University of Nebraska, Lincoln, Nebr.; H. Jehle, Department of Physics; *Specific Interactions of Biological Significance;* 2 years; $10,000.

University of Nebraska, Lincoln, Nebr.; J. N. Pazur, Department of Biochemistry and Nutrition, Agricultural Experiment Station; *Enzymatic Synthesis of Glucosyl Carbohydrates;* 2 years; $10,500.

New York University, New York, N. Y.; M. Levy, Medical Center, College of Medicine, Department of Chemistry; *Chemical Structure of Proteins;* 3 years; $18,000.

University of Pennsylvania, Philadelphia, Pa.; M. J. Coon, Department of Physiological Chemistry, School of Medicine; *Amino Acid Metabolism;* 3 years; $25,000.

University of Pennsylvania, Philadelphia, Pa.; S. D. Rodenberg, Laboratory of Microbiology; *Biosynthesis of Proteins Associated with Microbial Cells;* 2 years; $2,200.

University of Pittsburgh, Pittsburgh, Pa.; M. A. Lauffer, Department of Biophysics; *Biophysical Studies on Plant Viruses;* 2 years; $16,000.

Princeton University, Princeton, N. J.; E. N. Harvey, Department of Biology; *The Biochemistry of Light Production in the Ostracod Crustacean, Cypridina Hilgendorfii;* 3 years; $19,000.

Vanderbilt University, Nashville, Tenn.; O. Touster, Department of Biochemistry; *The Origin and Metabolic Fate of L-Xylulose;* 2 years; $8,000.

Washington University, St. Louis, Mo.; M. Cohn, Department of Biological Chemistry; *Mechanism of Phosphorylation and Phosphate Transfer Reactions;* 3 years; $18,000.

Western Reserve University, Cleveland Ohio; H. Z. Sable, Department of Biochemistry; *Intermediary Metabolism of Nucleic Acid Fragments;* 2 years; $10,000.

Western Reserve University, Cleveland Ohio; J. B. Wittenberg, Department of Biochemistry; *The In Vitro Synthesis of Sphingosine;* 2 years; $3,500.

University of Wisconsin, Madison, Wis.; R. A. Alberty and R. M. Bock, Department of Chemistry; *Investigation of Enzyme Fumarase;* 2 years; $15,000.

Woods Hole Oceanographic Institution, Woods Hole, Mass.; F. A. Richards; *Significance of Chlorophyll C;* 2 years; $8,000.

R. W. G. Wyckoff, Science Attaché, U. S. Embassy, London, England; *Eleotron Microscopic Study of the Structure of Biological Tissues;* 1 year; $3,000.

Yale University, New Haven, Conn.; E. C. Pollard and F. Hutchinson, Department of Physics; *X-Ray Studies of Viruses;* 2 years; $13,000.

Physics

University of Alabama, University, Ala.; A. E. Ruark, Department of Physics; *A Cloud Chamber Search for Free Magnetic Poles;* 3 years; $14,300.

Antioch College, Yellow Springs, Ohio; A. B. Stewart and G. E. Owen, Department of Physics; *Glow Discharge Oscillations;* 2 years; $10,000.

Bowdoin College, Brunswick, Maine; M. A. Jeppesen, Department of Physics; *Optical Studies of Surface and Body Properties of Crystalline and Amorphous Solids;* 2 years; $14,100.

BRIGHAM YOUNG UNIVERSITY, Provo, Utah; H. Fletcher, Department of Physics; *Definitive Physical Characteristics of Tones;* 2 years; $11,100.

BRYN MAWR COLLEGE, Bryn Mawr, Pa.; J. R. Pruett, Department of Physics; *Direction Correlations and Forbidden Beta-Spectra;* 2 years; $8,000.

UNIVERSITY OF CALIFORNIA, Berkeley, Calif.; C. Kittel, Department of Physics; *Interaction of Fundamental Particles with Solid State Systems;* 2 years; $11,800.

CASE INSTITUTE OF TECHNOLOGY, Cleveland, Ohio; L. L. Foldy and M. J. Klein, Department of Physics; *Theoretical Research in Nuclear and Solid State Physics;* 2 years; $15,600.

UNIVERSITY OF CHICAGO, Chicago, Ill.; M. G. Inghram, Department of Physics; *Mass Spectrometric Investigations;* 2 years; $20,000.

UNIVERSITY OF COLORADO, Boulder, Colo.; W. A. Rense, Department of Physics; *Polarization Measurements of the Zodiacal Light During Total Solar Eclipse of June '54;* 6 months; $1,700.

COLUMBIA UNIVERSITY, New York, N. Y.; H. M. Foley Department of Physics; *Theory of Nuclear Quadrupole Effects;* 18 months; $11,300.

UNIVERSITY OF CONNECTICUT, Storrs, Conn.; C. A. Reynolds, Department of Physics; *Hydrodynamics of Liquid Helium II;* 1 year; $8,400.

CORNELL UNIVERSITY, Ithaca, N. Y.; R. L. Sproull, Department of Physics; *Thermal Conductivity and Crystal Imperfections;* 3 years; $15,000.

DUKE UNIVERSITY, Durham, N. C.; L. W. Nordheim and E. Greuling, Department of Physics; *Theory of Nuclear Shell Structure;* 2 years; $20,600.

UNIVERSITY OF ILLINOIS, Urbana, Ill.; D. W. Kerst, Department of Physics; *Photo Production of Pi-Mesons;* 2 years; $12,000.

JOHNS HOPKINS UNIVERSITY, Baltimore, Md.; H. Meissner, Department of Physics; *Intermediate State of Superconductivity;* 2 years; $6,000.

KENT STATE UNIVERSITY, Kent, Ohio; A. A. Silvidi, Department of Physics; *Continuous Cloud Chambers;* 1 year; $3,000.

LOUISIANA STATE UNIVERSITY, Baton Rouge, La.; J. S. Levinger, Department of Physics; *Theory of Photonuclear Reactions;* 2 years; $8,700.

LOUISIANA STATE UNIVERSITY, Baton Rouge, La.; J. M. Reynolds, Department of Physics; *Electric and Magnetic Measurements on Bismuth at Low Temperatures;* 1 year; $9,800.

MARQUETTE UNIVERSITY, Milwaukee, Wis.; A. G. Barkow, Department of Physics; *Elementary Particle Reactions in Photographic Emulsions;* 2 years; $5,500.

UNIVERSITY OF MARYLAND, College Park, Md.; S. F. Singer; *Origin of Ultrahigh Energy Cosmic Rays;* 2 years; $15,800.

UNIVERSITY OF MICHIGAN, Ann Arbor, Mich.; D. A. Glaser, Department of Physics; *Use of Bubble Chambers in the Study of High Energy Nuclear Interactions;* 2 years; $12,600.

MICHIGAN STATE COLLEGE, East Lansing, Mich.; E. A. Hiedemann, Department of Physics; *Light Diffraction and Ultrasonic Waves;* 2 years; $10,600.

UNIVERSITY OF MINNESOTA, Minneapolis, Minn.; A. O. C. Nier, Department of Physics; *Atomic Mass Determinations;* 2 years; $15,500.

UNIVERSITY OF NEBRASKA, Lincoln, Nebr.; D. C. Moore, Department of Physics; *Half-Life of Positrons in Condensed Matter;* 2 years; $10,000.

UNIVERSITY OF NEW MEXICO, Albuquerque, N. Mex.; J. R. Green and V. H. Regener, Department of Physics; *Collision Cross-Sections for Cosmic Ray Showers;* 2 years; $8,900.

NEW YORK UNIVERSITY, New York, N. Y.; A. Beiser, Department of Physics; *Time Sensitivity in Nuclear Emulsions;* 1 year; $7,200.

UNIVERSITY OF NORTH CAROLINA, Chapel Hill, N. C.; J. W. Straley, Department of Physics; *The Intensities of Infrared Absorption Bands;* 3 years; $11,700.

NORTHWESTERN UNIVERSITY, Evanston, Ill.; J. A. Marcus, Department of Physics; *Hall Effect in Single Crystals at Low Temperatures;* 2 years; $11,100.

OHIO STATE UNIVERSITY, Columbus, Ohio; J. G. Daunt and P. S. Jastram, Department of Physics; *Nuclear Orientation at Low Temperatures;* 2 years; $17,000.

UNIVERSITY OF OKLAHOMA, Norman, Okla.; J. R. Nielsen, Department of Physics; *Vibrational Spectra of Compounds in Different States of Aggregation;* 3 years; $21,200.

UNIVERSITY OF PUERTO RICO, Rio Piedras, Puerto Rico; A. Cobas, Department of Physics; *Zenith Angle Variation of Cosmic Rays;* 1 year; $6,600.

PURDUE RESEARCH FOUNDATION, Lafayette, Ind.; F. J. Belinfante, Department of Physics; *Elementary Particles and Field Theory;* 2 years; $6,000.

REED COLLEGE, Portland, Oreg.; F. C. Brown, Department of Physics; *Conduction and Trapping in Ionic Crystals;* 2 years; $8,500.

RENSSELAER POLYTECHNIC INSTITUTE, Troy, N. Y.; P. J. Bray, Department of Physics; *Molecular and Crystalline Structure by a Nuclear Resonance Absorption Technique;* 2 years; $17,200.

RICE INSTITUTE, Houston, Tex.; C. F. Squire, Department of Physics; *Studies in Solid State Physics;* 1 year; $14,300.

SOUTHWESTERN AT MEMPHIS, Memphis, Tenn.; D. E. Matthews, Department of Physics; *Critical Energy for Secondary Electron Research;* 1 year; $9,400.

UNIVERSITY OF VIRGINIA, Charlottesville, Va.; J. W. Beams, Department of Physics; *Ultracentrifuge Research on Molecular Weights;* 2 years; $9,800.

WESTERN RESERVE UNIVERSITY, Cleveland, Ohio; R. G. Winter, Department of Physics; *Double Beta Decay;* 1 year; $7,600.

WISCONSIN ALUMNI RESEARCH FOUNDATION, Madison, Wis.; D. W. Kerst, Department of Physics, University of Illinois; *High-Energy Accelerator Problems;* 9 months; $53,300.

YALE UNIVERSITY, New Haven, Conn.; H. Margenau, Department of Physics; *Definition and Law in the Physical Sciences;* 2 years; $4,600.

Psychobiology

AMERICAN MUSEUM OF NATURAL HISTORY, New York, N. Y.; T. C. Schneirla, Department of Animal Behavior; *Development of Behavior Patterns in Lower Mammals;* 2 years; $16,500.

BOSTON UNIVERSITY, Boston, Mass.; J. M. Harrison, Department of Psychology; *The Relation Between the Hippocampus and Sensory Hyperasthesia;* 2 years; $9,400.

UNIVERSITY OF CALIFORNIA, Berkeley, Calif.; D. A. Riley, Department of Psychology; *Research in Rote Learning;* 1 year; $3,400.

DUKE UNIVERSITY, Durham, N. C.; G. A. Kimble, Department of Psychology; *Research in Avoidance Learning;* 2 years; $6,100.

DUKE UNIVERSITY, Durham, N. C.; K. Zener, Department of Psychology; *Visual Perception of Spatial Relationships;* 2 years; $11,800.

FLORIDA STATE UNIVERSITY, Tallahassee, Fla.; W. N. Kellogg, Oceanographic Institute; *Echolocation in the Dolphin;* 1 year; $7,000.

GEORGE WASHINGTON UNIVERSITY, Washington, D. C.; B. H. Fox, Department of Psychology; *Research on Vision;* 1 year; $5,900.

STATE UNIVERSITY OF IOWA, Iowa City, Iowa; D. Lewis, Department of Psychology; *Research on Perceptual-Motor Tasks;* 2 years; $11,700.

JOHN HOPKINS UNIVERSITY, Baltimore, Md.; E. F. MacNichol, Jr., Department of Biophysics; *Visual Research;* 3 years; $9,800.

UNIVERSITY OF MISSOURI, Columbia, Mo.; M. H. Marx, Department of Psychology; *Experimental Analysis of Food Hoarding Behavior;* 2 years; $8,400.

MOUNT HOLYOKE COLLEGE, South Hadley, Mass.; J. Volkmann, Department of Psychology; *Research in Visual Perception;* 2 years; $9,800.

NEW YORK UNIVERSITY, New York, N. Y.; H. H. and T. S. Kendler, Department of Psychology; *Research on Problem-Solving Behavior;* 2 years; $14,100.

UNIVERSITY OF NORTH CAROLINA, Chapel Hill, N. C.; L. L. Thurstone, The Psychometric Laboratory; *Research in Multiple Factor Analysis;* 2 years; $17,700.

NORTHWESTERN UNIVERSITY, Evanston, Ill.; A. L. Diamond, Department of Psychology; *The Psycho-Physiology of Vision: Simultaneous Brightness Contrast;* 2 years; $9,000.

PENNSYLVANIA STATE UNIVERSITY, State College, Pa.; J. H. Grosslight, Department of Psychology; *The Role of Reinforcement in Learning;* 2 years; $7,600.

PRINCETON UNIVERSITY, Princeton, N. J.; H. Gulliksen, Department of Psychology; *Mathematical Techniques in Psychology;* 3 years; $24,400.

RUTGERS UNIVERSITY, New Brunswick, N. J.; D. S. Lehrman, Department of Psychology; *The Physiological Basis of Incubation Behavior in the Ring Dove;* 2 years; $9,500.

UNIVERSITY OF SOUTHERN CALIFORNIA, Los Angeles, Calif.; W. W. Grings, Department of Psychology; *Studies of Stimulus Patterning in Learning;* 3 years; $9,400.

SYRACUSE UNIVERSITY, Syracuse, N. Y.; W. R. and D. E. McAllister, Department of Psychology; *Eyelid Conditioning and Generalization of the Conditioned Eyelid Response;* 2 years; $12,300.

UNIVERSITY OF UTAH, Salt Lake City, Utah; F. B. Porter, Department of Psychology; *Psychological Effects of Antimetabolites;* 2 years; $10,000.

STATE COLLEGE OF WASHINGTON, Pullman, Wash.; F. A. Young, Department of Psychology; *A Systematic Investigation of Pupillary Conditioning;* 2 years; $11,400.

UNIVERSITY OF WASHINGTON, Seattle, Wash.; A. F. Ax, Department of Psychiatry; *Investigations of Human Reactions to Stress;* 3 years; $17,200.

UNIVERSITY OF WISCONSIN, Madison, Wis.; W. J. Brogden, Department of Psychology; *Verbal Factors in the Learning of Motor Skill;* 3 years; $15,100.

UNIVERSITY OF WISCONSIN, Madison, Wis.; K. U. Smith, Department of Psychology; *The Role of Perception in Patterned Motion;* 2 years; $7,800.

YALE UNIVERSITY, New Haven, Conn.; F. A. Logan, Department of Psychology; *Conditions of Reinforcement;* 1 year; $5,200.

YALE UNIVERSITY, New Haven, Conn.; K. C. Montgomery, Department of Psychology; *Exploratory and Fear Behavior in Lower Mammals;* 2 years; $11,400.

YALE UNIVERSITY, New Haven, Conn.; F. D. Scheffield, Department of Psychology; *A Comparison of Autonomic Conditioning and Skeletal Instrumental Learning;* 3 years; $11,550.

Regulatory Biology

UNIVERSITY OF CALIFORNIA, Berkeley, Calif.; C. H. Sawyer, Department of Anatomy, School of Medicine; *The Hormonal Control of Enzyme Synthesis;* 3 years; $6,000.

UNIVERSITY OF CALIFORNIA, Berkeley, Calif.; P. K. Stumpf, Department of Plant Biochemistry; *The Oxidation of Short Chain Fatty Acids by Plant Extracts;* 1 year; $1,050.

CALIFORNIA INSTITUTE OF TECHNOLOGY, Pasadena, Calif.; J. Bonner, Division of Biology; *Energetic Coupling in Plant Systems;* 1 year; $8,500.

COLUMBIA UNIVERSITY, New York City, N. Y.; H. Elftman, Department of Anatomy, School of Physicians and Surgeons; *The Cytochemical Investigation of Phospholipids;* 2 years; $9,300.

EMORY UNIVERSITY, Emory University, Ga.; F. W. Fales, Department of Biochemistry; *Alkali-Insoluble Reserve Carbohydrate of Yeast Cells;* 2 years; $9,100.

HASKINS LABORATORIES, New York, N. Y.; L. Provasoli; *Nutritional Requirements of Marine Algae;* 3 years; $9,000.

INDIANA UNIVERSITY, Bloomington, Ind.; W. J. van Wagtendonk, Department of Zoology; *Role of Steroids in the Metabolism of Paramecium Aurelia;* 2 years; $14,000.

JEFFERSON MEDICAL COLLEGE OF PHILADELPHIA, Philadelphia, Pa.; B. W. Koft, Department of Bacteriology; *Growth Factor to Replace P-Aminobenzoic and Folic Acids;* 2 years, $5,100.

KAISER FOUNDATION, Oakland, Calif.; E. C. Dougherty, Department of Internal Medicine; *Nutrition of Free-Living Nematodes;* 2 years; $13,400.

UNIVERSITY OF KANSAS, Lawrence, Kans.; J. Jensen and A. Werder, Department of Medical Microbiology, School of Medicine; *Host-Parasite Relationships Between Viruses, Helminths and Protozoa;* 3 years; $14,500.

MASSACHUSETTS GENERAL HOSPITAL, Boston, Mass.; A. Leaf, Department of Medicine; *Mode of Action of the Antidiuretic Hormone;* 1 year; $1,000.

MICHIGAN STATE COLLEGE, East Lansing, Mich.; H. M. Sell, Department of Agricultural Chemistry; *The Biochemistry of Growth Substances in Corn Pollen;* 2 years; $6,900.

NORTHWESTERN UNIVERSITY, Evanston, Ill.; C. L. Turner, Department of Biology; *Hormonal Control of Growth and Differentiation of Regenerating Tissue;* 2 years; $9,000.

OKLAHOMA AGRICULTURAL AND MECHANICAL COLLEGE, Stillwater, Okla.; R. J. Sirny, Department of Agricultural Chemistry Research; *Sodium and Potassium Requirements of Lactic Acid;* 2 years; $7,900.

OREGON STATE COLLEGE, Corvallis, Oreg.; V. H. Cheldelin, Department of Chemistry; *Nutrition and Metabolism of Insects;* 2 years; $15,000.

UNIVERSITY OF PITTSBURGH, Pittsburgh, Pa.; R. Bentley, Department of Biochemistry and Nutrition; *Carbohydrate Metabolism in Molds;* 3 years; $16,500.

PRINCETON UNIVERSITY, Princeton, N. J.; J. T. Bonner, Department of Biology; *Differentiation of the Amoeboid Slime Molds;* 3 years; $8,800.

PRINCETON UNIVERSITY, Princeton, N. J.; W. P. Jacobs, Department of Biology; *Internal Factors Limiting Differentiation of Plant Cells;* 3 years; $15,400.

PRINCETON UNIVERSITY, Princeton, N. J.; W. W. Swingle, Department of Biology; *The Isolation, Physiological Properties and Bioassay of the Amorphous Fraction of Adrenal Cortical Extracts;* 2 years, $11,500.

RESEARCH FOUNDATION OF CHILDREN'S HOSPITAL, Washington, D. C.; S. P. Bessman; *Low Energy Transacylation in Animal Tissues;* 2 years; $15,000.

UNIVERSITY OF ROCHESTER, Rochester, N. Y.; E. F. Adolph, School of Medicine and Dentistry; *Physiological Development of Regulatory Functions;* 3 years; $24,000.

ST. JOHN'S UNIVERSITY, Brooklyn, N. Y.; D. M. Lilly, Department of Biology; *Nutritional Factors in Growth of Carnivorous Protozoa;* 2 years; $7,600.

UNIVERSITY OF TENNESSEE, Memphis, Tenn.; J. S. Davis, Division of Anatomy, Medical Units Division; *The Effects of Accessory Nutritional Factors on the Nucleic Acids of Uterine Tissue;* 2 years, $9,000.

UNIVERSITY OF TENNESSEE, Knoxville, Tenn.; D. F. Holtman, Department of Bacteriology; *Role of Amino Acids in the Host-Parasite Relationship;* 2 years; $8,300.

VANDERBILT UNIVERSITY, Nashville, Tenn.; C. R. Park, Department of Physiology, School of Medicine; *Factors Influencing Glucose Penetration into Cells;* 2 years; $16,000.

WABASH COLLEGE, Crawfordsville, Ind.; W. H. Johnson, Department of Biology; *Nutritive Requirements of Paramecium Multimicronucleatum;* 2 years; $3,000.

VIRGINIA POLYTECHNIC INSTITUTE, Blacksburg, Virginia; K. W. King, Department of Biology; *The Mechanism of Cellulose Decomposition by Aerobic Bacteria;* 2 years; $6,000.

UNIVERSITY OF WASHINGTON, Seattle, Wash.; E. C. Roosen-Runge, Department of Anatomy, School of Medicine; *Mammalian Spermatogenesis;* 2 years; $10,000.

WASHINGTON UNIVERSITY, St. Louis, Mo.; M. Cohn, Department of Microbiology, School of Medicine; *Induced Enzyme and Antibody Synthesis;* 3 years; $22,500.

WASHINGTON UNIVERSITY, St. Louis, Mo.; A. Kronberg, Department of Microbiology, School of Medicine; *Enzymatic Mechanisms in Nucleic Acid Synthesis;* 3 years; $26,000.

WESTERN RESERVE UNIVERSITY, Cleveland, Ohio; E. W. Sutherland, Department of Pharmacology; *The Mechanism of Action of Epinephrine and Related Synpathomimetic Amines;* 3 years; $22,750.

UNIVERSITY OF WISCONSIN, Madison, Wis.; G. W. Keitt, Department of Plant Pathology, College of Agriculture; *The Nature of Parasitism and Disease Resistance;* 2 years; $15,000.

UNIVERSITY OF WISCONSIN, Madison, Wis.; F. M. Strong, Department of Biochemistry; *The Chemistry and Metabolism of Biologically Active Substances;* 3 years; $15,700.

WOODS HOLE OCEANOGRAPHIC INSTITUTION, Woods Hole, Mass.; P. F. Scholander, Physiologist; *The Mechanism of Gas Secretion in Fishes;* 2 years; $8,500.

WORCESTER FOUNDATION FOR EXPERIMENTAL BIOLOGY, Shewsbury, Mass.; R. I. Dorfman, Associate Director of Laboratories; *Metabolism of Steroid Hormones by the Guinea Pig;* 3 years; $20,000.

YALE UNIVERSITY, New Haven, Conn.; M. Foster, Osborn Zoological Laboratory; *Inherited Pigmentary Variations;* 2 years; $5,800.

YALE UNIVERSITY, New Haven, Conn.; G. E. Pickford, The Bingham Oceanographic Laboratory; *Pituitary Hormones of Fish;* 3 years; $14,400.

YALE UNIVERSITY, New Haven, Conn.; W. Vishniac, Department of Microbiology; *Enzymatic Reactions in Photosynthesis and Chemosynthesis;* 3 years; $10,000.

Systematic Biology

ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA, Philadelphia, Pa.; J. A. G. Rehn, Curator, Department of Insects; *Orthoptera of North America;* 2 years; $16,000.

BERNICE P. BISHOP MUSEUM, Honolulu, Hawaii; J. L. Gressitt; *Insects of Micronesia;* 3 years; $30,000.

UNIVERSITY OF CALIFORNIA, Berkeley, Calif.; G. F. Papenfuss, Department of Botany; *Marine Algal Flora of South Africa;* 3 years; $12,250.

UNIVERSITY OF CALIFORNIA, *Berkeley, Calif.;* A. E. Pritchard, Department of Entomology and Parasitology; *The Tetranychoid Acarids of Europe;* 1 year; $6,500.

CHICAGO NATURAL HISTORY MUSEUM, Chicago, Ill.; C. C. Sanborn, Curator of Mammals; *A Catalog of the Microchiroptera;* 5 years; $10,000.

DUKE UNIVERSITY, Durham, N. C.; L. E. Anderson, Department of Botany; *Bryophytes of the Ozarks;* 18 months; $4,600.

DUKE UNIVERSITY, Durham, N. C.; R. M. Schuster, Department of Botany; *The Hepaticae of Eastern North America;* 2 years; $7,200.

UNIVERSITY OF FLORIDA, Gainesville, Fla.; J. C. Dickinson, Jr., Department of Biology; *Biological Survey of Flint-Chattahoochee-Appalachicola Drainage Basins;* 3 years; $5,200.

FRANCIS HARPER, MOUNT HOLLY, N. J., *Flora and Fauna of the Central Labrador Peninsula;* 2 years, $10,300.

UNIVERSITY OF HAWAII, Honolulu, Hawaii; D. E. Hardy, College of Agriculture, Department of Entomology; *Diptera of Hawaii;* 1 year; $2,000.

HOLLINS COLLEGE, VIRGINIA; P. M. Patterson, Department of Biology; *Bryophyte Flora of Virginia;* 1 year; $1,000.

320814—55——7

University of Idaho, Moscow, Idaho; H. A. Imshaug, Department of Biological Sciences; *Alpine Lichens of Western America;* 2 years; $3,500.

Michigan State College, East Lansing, Mich.; I. W. Knobloch, Department of Natural Sciences; *The Flora of the Barranca Del Cobre Region;* 1 year; $1,700.

University of Minnesota, Minneapolis, Minn.; J. W. Hall, Department of Botany; *Coal Ball Floras;* 2 years; $2,600.

University of New Hampshire, Durham, N. H.; M. H. Pettibone, Department of Zoology; *The Polychaete Annelids of New England;* 2 years; $11,500.

New Mexico Highlands University, Las Vegas, N. Mex.; L. M. Shields, Department of Biology; *Nitrogen Sources and Nitrogen Content of Plants in Gypsum, Lava, and Alkali Deserts;* 2 years; $3,450.

College of New Rochelle, N. Y.; M. D. Rogick, Department of Biology; *Bryozoa of the Antarctic;* 2 years; $3,900.

State University of New Yory, Albany, N. Y.; J. L. Lowe, College of Forestry, Syracuse, N. Y.; *Polyporaceae of North America;* 1 year; $1,200.

New York Botanical Garden, New York, N. Y.; B. Maguire, Curator; *The Flora of the Guayana Highland;* 2 years; $12,400.

University of North Carolina, Chapel Hill, N. C.; J. N. Couch, Department of Botany; *The Genus Actinoplanes;* 3 years; $15,300.

University of North Carolina, Chapel Hill, N. C.; Z. P. Metcalf, Division of Biological Sciences; *Catalogue of World Homoptera;* 2 years; $16,000.

University of Pennsylvania, Philadelphia, Pa.; J. M. Fogg, Jr., Department of Botany; *The Flora of Pennsylvania;* 1 year; $4,600.

Roosevelt College, Chicago, Ill.; C. H. Seevers, Department of Biology; *Systematics and Evolution of Staphylinidae;* 3 years; $8,400.

Texas Agriculture and Mechanics Research Foundation, College Station, Tex.; S. O. Brown, Department of Biology, Texas Agriculture and Mechanics College; *Microscopic Structure of Fossil Bone;* 1 years; $2,650.

Tulane University, New Orleans, La.; G. H. Penn, Department of Zoology; *Speciation in Crawfish;* 2 years; $5,200.

United States Geological Survey, Washington, D. C.; P. E. Cloud, Jr., Paleontology and Stratigraphy Branch; *Marine Mollusks of Reefs of the Pacific Ocean;* 1 year; $3,000.

University of Washington, Seattle, Wash.; P. L. Illg, Department of Zoology; *Systematics of North American Copepods;* 3 years; $5,900.

State College of Washington, Pullman, Wash.; G. W. Fischer, Department of Plant Pathology; *Revision of the Genus Tilletia;* 2 years; $6,500.

University of Wisconsin, Madison, Wis.; E. V. Morse, Department of Veterinary Science, and E. McCoy, Department of Bacteriology; *Speciation of Animal Pathogens of the Genus Vibrio;* 2 years; $9,550.

University of Wisconsin, Madison, Wis.; J. T. Medler and S. D. Beck, Department of Entomology; *Nutrition of Plant-Sucking Hemiptera;* 2 years; $6,500.

Woods Hole Oceanographic Institution, Woods Hole, Mass.; G. L. Clarke, Marine Biologist; *The Penetration of Light Into the Sea and its Effect on Aquatic Organisms;* 1 year; $6,200.

Woods Hole Oceanographic Institution, Woods Hole, Mass.; J. H. Ryther; *Basic Biological Productivity of Offshore Waters;* 3 years; $6,700.

Yale University, New Haven, Conn.; S. D. Ripley, Peabody Museum of Natural History; *Speciation in Bird Fauna of the Eastern Moluccan Islands;* 1 year; $1,700.

General

American Type Culture Collection, Washington, D. C.; F. Weiss, Curator; *A Collection of Bacteriophages* (Bacterial Viruses); 2 years; $11,000.

BERMUDA BIOLOGICAL STATION FOR RESEARCH, INC., St. George's, Bermuda; *Biological Research at the Bermuda Biological Station for Research;* 5 years; $10,000.

UNIVERSITY OF CHICAGO, Chicago, Ill.; R. J. Braidwood, Department of Anthropology; *Human Population Studies in the Fertile Crescent;* 3 years; $23,500.

DUKE UNIVERSITY, Durham, N. C.; *Biological Research at the Duke University Marine Laboratory;* 3 years; $12,000.

UNIVERSITY OF GEORGIA, Athens, Ga.; P. R. Burkholder, Department of Bacteriology; *Development of National Culture Collection of Algae;* 2 years; $7,500.

HARVARD UNIVERSITY, Cambridge, Mass.; P. Doty, Department of Chemistry; *Physico-Chemical Properties and Characterization of Polymer Molecules;* 3 years; $16,000.

HARVARD UNIVERSITY, Cambridge, Mass.; G. R. Willey, Peabody Museum of Archaeology and Ethnology; *Prehistoric Settlement Patterns in the Maya Area;* 1 year; $11,500.

UNIVERSITY OF ILLINOIS, Urbana, Ill.; L. M. Black, Department of Botany; *Isolation and Characterization of Plant Viruses;* 3 years; $5,500.

UNIVERSITY OF MINNESOTA, Minneapolis, Minn.; *Biological Research at the Itasca Biological Station;* 1 year; $3,000.

MOUNT DESERT ISLAND BIOLOGICAL LABORATORY, Salisbury Cove, Maine; W. F. Sheldon; *Investigations in General and Comparative Physiology;* 3 years; $26,000.

NATIONAL ACADEMY OF SCIENCES, Washington, D. C.; *Operating Expenses of the Pacific Science Board;* 3 years; $39,000.

NATIONAL ACADEMY OF SCIENCES, Washington, D. C.; *U. S. National Committee for the International Geophysical Year 1957–1958;* $22,000.

SIERRA CLUB, San Francisco, Calif.; *California Himalayan Expedition Committee;* 1 year; $5,000.

WASHINGTON UNIVERSITY, St. Louis, Mo.; *Summer Research by Medical Students;* 3 years; $6,900.

APPENDIX III

Contracts and Grants Other Than Research Awarded in Fiscal Year 1954

Conferences in Support of Science

American Academy of Arts and Sciences, Boston, Mass.; *The Validation of Scientific Theories;* $5,000.

American Psychological Association, Washington, D. C.; *Fourteenth International Congress of Psychology;* $10,000.

Beloit College, Beloit, Wis.; *Geology Research in Small Colleges;* $7,000.

Brown University, Providence, R. I.; *Liquid Structure and Acoustics;* $7,000.

Bryn Mawr College, Bryn Mawr, Pa.; *The Place of Biological Research in the Liberal Arts College;* $7,000.

University of California, Berkeley, Calif.; *Anomalous Magnetization of Rocks;* $7,400.

University of California, Los Angeles, Calif.; *The Significance and Possibilities of High Speed Computing in Meteorology;* $6,000.

Carnegie Institution of Washington, Washington, D. C.; *Radio Astronomy;* $8,500.

University of Chicago, Chicago, Ill.; *Nuclear Processes in Geological Settings;* $4,800.

Columbia University, New York, N. Y.; *Role of Proteins in the Transport of Ions Across Membranes;* $4,100.

Columbia University, New York, N. Y.; *The Crust of the Earth;* $6,000.

Cornell University, Ithaca, N. Y.; *Fundamental Problems of Perception;* $4,500.

Harvard University, Cambridge, Mass.; *Problems in Comparative Behavoir;* $6,300.

Indiana University, Bloomington, Ind.; *Stellar Atmospheres;* $3,300.

University of Kansas, Lawrence, Kans.; *Genetic, Psychological, and Hormonal Factors in the Regulation of Patterns of Sexual Behavoir in Mammals;* $5,000.

Long Island Biological Association, Cold Spring Harbor, N. Y.; *The Mammalian Fetus—Physiological Aspects of Development;* $6,500.

Massachusetts Institute of Technology, Cambridge, Mass.; *Problems in Human Communication and Control;* $5,200.

Massachusetts Institute of Technology, Cambridge, Mass.; *Mathematical Tables;* $4,700.

University of Michigan, Ann Arbor, Mich.; *Multidimensional Analysis;* $5,300.

National Academy of Sciences, Washington, D. C.; *Radiation Biochemistry;* $3,100.

New York University, New York, N. Y.; *Problem Solving Behavior;* $5,700.

Society for the Study of Development and Growth, University of Pennsylvania, Philadelphia, Pa.; *Thirteenth Symposium on Development and Growth;* $1,500.

Swarthmore College, Swarthmore, Pa.; *Astronomy Research in Colleges;* $5,000.

Studies in Science

American Academy of Arts and Sciences, Boston, Mass.; A. H. Dupree; *History of Activities of the Federal Government in Science;* 2 years; $29,400.

American Psychological Association, Washington, D. C.; *Study of the Development and Status of Psychology;* $45,000.

BATTELLE MEMORIAL INSTITUTE, Chicago, Ill.; *Study of Research Activities of Trade Associations, Cooperative Industrial Research Organizations, and Industry Supported Research Activities of Professional Societies and Associations;* $42,331.

UNIVERSITY OF CHICAGO, Chicago, Ill.; I. Veith, Department of Medicine and Division of the Biological Sciences; *Study of Endowed and Grant Supported Research in the Division of Biological Sciences of the University of Chicago Over the Past Twenty-five Years;* 3 years; $12,500.

HARVARD UNIVERSITY, Cambridge, Mass.; P. G. Frank, Department of Physics; *Study of "Reasons for Acceptance of Scientific Theories";* 1 year; $11,600.

ROGER WILLIAMS TECHNICAL AND ECONOMIC SERVICES, INC., New York, N. Y.; *Pilot Study of Industry—Government Relationships in Research by Survey of Present Status of Basic and Applied Research Bearing on Industrial Fermentation Processes;* $15,000.

SYRACUSE UNIVERSITY, Syracuse, N. Y.; *Survey of Past History and Present Status of Research Activities of Independent and Quasi-Independent Nonprofit Research Institutes and of Commercial Research Laboratories;* $32,000.

Education in the Sciences

UNIVERSITY OF CALIFORNIA, Berkeley, Calif.; *Summer Conference for Teachers of Astronomy;* 4 weeks; $8,750.

CITY COLLEGE, New York, N. Y.; *Preliminary Survey of the Teaching of Biochemistry;* $500.

COLUMBIA UNIVERSITY, New York, N. Y.; *Conference on Nuclear Physics in Engineering Education;* 10 days; $8,200.

UNIVERSITY OF ILLINOIS, Urbana, Ill.; *Conference on Solid State Physics in Engineering Education;* 10 days; $7,000.

MATHEMATICAL ASSOCIATION OF AMERICA, University of Buffalo, Buffalo, N. Y.; *Program of Visiting Scientists;* 1 year; $15,000.

NATIONAL ACADEMY OF SCIENCES, Washington, D. C.; *Committee on Educational Policies in the Division of Biology and Agriculture of the National Research Council;* $1,725.

NATIONAL ASSOCIATION OF BIOLOGY TEACHERS, Crystal Lake, Ill.; *Southeast Conference on Training in Biology;* $15,000.

UNIVERSITY OF NORTH CAROLINA, Chapel Hill, N. C.; *Summer Conference in Collegiate Mathematics;* 8 weeks; $15,000.

NORTHWESTERN UNIVERSITY, Evanston, Ill.; *Conference on the Training of Laboratory Assistants in Physics;* $2,220.

UNIVERSITY OF OREGON, Eugene, Oreg.; *Summer Conference in Collegiate Mathematics;* 8 weeks; $15,000.

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

UNIVERSITY OF WASHINGTON, Seattle, Wash.; *Summer Conference for High School Mathematics Teachers;* 4 weeks; $10,000.

WASHINGTON AND LEE UNIVERSITY, Lexington, Va.; *Conference on Undergraduate Research in Chemistry;* 3 days; $5,700.

UNIVERSITY OF WYOMING, Laramie, Wyo.; *Summer Conference in Collegiate Chemistry;* 5 weeks; $10,500.

Scientific Manpower

AMERICAN CHEMICAL SOCIETY, Washington, D. C.; *Register of Scientific and Technical Personnel in the Field of Chemistry;* $69,000.

AMERICAN INSTITUTE OF PHYSICS, New York, N. Y.; H. A. Barton, Director; *Register of Scientific and Technical Personnel in the Field of Physics;* 1 year; $14,500.

AMERICAN MATHEMATICAL SOCIETY, Providence, R. I.; *Register of Scientific and Technical Personnel in Field of Mathematical Sciences;* 1 year; $13,800.

AMERICAN METEOROLOGICAL SOCIETY, Boston, Mass.; K. C. Spengler, Executive Secretary; *Register of Scientific and Technical Personnel in the Field of Meteorology;* 1 year; $9,000.

AMERICAN PSYCHOLOGICAL ASSOCIATION, Washington, D. C.; *Register of Scientific and Technical Personnel in the Field of Psychology;* 1 year; $11,600.

ENGINEERS JOINT COUNCIL, New York, N. Y.; *Register of Scientific and Technical Personnel in Engineering;* $25,000.

UNIVERSITY OF MINNESOTA, Minneapolis, Minn.; *The Loss of Talent Through Educational Drop-Out at High School Graduation: A Followup Study of Talented High School Graduates Who Did Not Attend College;* $8,250.

NATIONAL ACADEMY OF SCIENCES, Washington, D. C.; American Geological Institute; *Register of Scientific and Technical Personnel in the Earth Sciences;* $5,500.

NATIONAL ACADEMY OF SCIENCES, Washington, D. C.; American Institute of Biological Sciences; *Register of Scientific and Technical Personnel in the Field of Biology;* 1 year; $19,200.

NATIONAL ACADEMY OF SCIENCES, Washington, D. C.; M. H. Trytten, Office of Scientific Personnel, National Research Council; *Studies on Doctoral Degrees;* 1 year; $12,000.

NATIONAL BUREAU OF ECONOMIC RESEARCH, INC., New York, N. Y.; *A Technical Study of Methods for Determining Demand and Supply of Specialized Personnel;* 1 year; $25,000.

International Travel Grants

A. A. ALBERT, University of Chicago, Chicago, Ill., to Amsterdam, Netherlands.

L. W. ALVAREZ, University of California, Berkeley, Calif., to Canberra, Australia.

N. C. BAENZIGER, State University of Iowa, Iowa City, Iowa, to Paris, France.

E. BALL, North Carolina State College, Raleigh, N. C., to Paris, France.

S. S. BALLARD, Santa Monica, Calif., to Parma, Italy.

J. J. BIESELE, Sloan-Kettering Institute for Cancer Research, New York, N. Y., to Leiden, Netherlands.

J. E. BIRREN, National Institutes of Health, Bethesda, Md., to London, England.

J. BJERKNES, University of California, Los Angeles, Calif., to Rome, Italy.

H. F. BLANEY, Agricultural Research Service, Los Angeles, Calif., to Rome, Italy.

R. M. BLOUCH, Colorado A. and M. College, Fort Collins, Colo., to Paris, France.

W. BLUM, Washington, D. C., to London, England.

R. BRAUER, Harvard University, Cambridge, Mass., to Amsterdam, Netherlands.

W. R. BRENEMAN, Indiana University, Bloomington, Ind., to London, England.

D. BROUWER, Yale University, New Haven, Conn., to Leningrad, Russia.

J. E. CANRIGHT, Indiana University, Bloomington, Ind., to Paris, France.

E. C. CANTINO, University of Pennsylvania, Philadelphia, Pa., to Paris, France.

A. J. CARLSON, University of Chicago, Chicago, Ill., to London, England.

E. CHARGAFF, Columbia University, New York, N. Y., to London, England.

L. C. COCHRAN, University of California, Riverside, Calif., to Paris, France.

A. L. COHEN, Oglethorpe University, Oglethorpe University, Ga., to Paris, France.

H. B. CREIGHTON, Wellesley College, Wellesley, Mass., to Paris, France.

A. T. CROSS, West Virginia University, Morgantown, W. Pa., to Paris, France.

K. K. DARROW, Bell Telephone Laboratory, New York, N. Y., to London, England.

E. W. DEMPSEY, Washington University, St. Louis, Mo., to London, England.

J. D. H. DONNAY, Johns Hopkins University, Baltimore, Md., to Paris, France.

J. D. DWYER, St. Louis University, St. Louis, Mo., to Paris, France.

J. D. EBERT, Indiana University, Bloomington, Ind., to Leiden, Netherlands.

A. Erdelyi, California Institute of Technology, Pasadena, Calif., to Amsterdam, Netherlands.
H. I. Ewen, Harvard University, Cambridge, Mass., to Amsterdam, Netherlands.
I. Fankuchen, Polytechnic Institute of Brooklyn, Brooklyn, N. Y., to Paris, France.
H. Feigl, University of Minnesota, Minneapolis, Minn., to Zurich, Switzerland.
M. Gell-Mann, University of Chicago, Chicago, Ill., to Glasgow, Scotland.
A. Gorbman, Columbia University, New York, N. Y., to London, England.
C. S. Greene, Howard University, Washington, D. C., to Lisbon, Portugal.
R. O. Greep, Harvard University, Boston, Mass., to London, England.
C. Grobstein, National Cancer Institute, Bethesda, Md., to Leiden, Netherlands.
J. E. Gunckel, Rutgers University, New Brunswick, N. J., to Paris, France.
P. L. Halmos, University of Chicago, Chicago, Ill., to Amsterdam, Netherlands.
R. R. Heinrich, St. Louis University, St. Louis, Mo., to Rome, Italy.
A. C. Helmholz, University of California, Berkeley, Calif., to Glasgow, Scotland.
J. H. M. Henderson, Tuskegee Institute, Tuskegee Institute, Ala., to Paris, France.
L. Henkin, University of California, Berkeley, Calif., to Amsterdam, Netherlands.
E. Hewitt, University of Washington, Seattle, Wash., to Amsterdam, Netherlands.
E. Hille, Yale University, New Haven, Conn., to The Hague, Netherlands.
F. L. Hisaw, Harvard University, Cambridge, Mass., to London, England.
F. G. Hoffman, Columbia University, New York, N. Y., to London, England.
A. S. Holt, University of Illinois, Urbana, Ill., to Paris, France.
V. H. Jones, University of Michigan, Ann Arbor, Mich., to Paris, France.
E. C. Jordan, University of Illinois, Urbana, Ill., to Amsterdam, Netherlands.
O. J. Kaplan, San Diego State College, San Diego, Calif., to London, England.
M. C. Kik, University of Arkansas, Fayetteville, Ark., to Quezon City, Philippines.
I. M. Kolthoff, University of Minnesota, Minneapolis, Minn., to Birmingham, England.
P. J. Kramer, Duke University, Durham, N. C., to Paris, France.
W. D. Lambert, Canaan, Conn., to Rome, Italy.
J. H. Leathem, Rutgers University, New Brunswick, N. J., to London, England.
W. A. Lewis, Illinois Institute of Technology, Chicago, Ill., to Rio de Janeiro, Brazil.
G. O. G. Lof, Denver, Colo., to Rio de Janeiro, Brazil.
G. H. Lowery, Jr., Louisiana State University, Baton Rouge, La., to Basel, Switzerland.
G. S. S. Ludford, University of Maryland, College Park, Md., to Amsterdam, Netherlands.
S. MacLane, University of Chicago, Chicago, Ill., to The Hague, Netherlands.
W. Magnus, New York University, New York, N. Y., to The Hague and Amsterdam, Netherlands.
H. Margenau, Yale University, New Haven, Conn., to Zurich, Switzerland.
L. Marton, National Bureau of Standards, Washington, D. C., to London, England.
S. L. Meyer, Florida State University, Tallahassee, Fla., to Paris, France.
E. E. Moise, University of Michigan, Ann Arbor, Mich., to Amsterdam, Netherlands.
M. G. Morgan, Dartmouth College, Hanover, N. H., to Amsterdam, Netherlands.
R. S. Mulliken, University of Chicago, Chicago, Ill., to Lund, Sweden.
M. R. Murray, Columbia University, New York, N. Y., to Leiden, Netherlands.
J. J. Nassau, Case Institute of Technology, Cleveland, Ohio, to Leningrad, Russia.
A. H. Norris, Baltimore City Hospital, Baltimore, Md., to London, England.
L. S. Olive, Columbia University, New York, N. Y., to Paris, France.
I. I. Oster, Institute of Animal Genetics, Edinburgh, Scotland, to Leiden, Netherlands.
R. G. Pearson, Northwestern University, Evanston, Ill., to Birmingham, England.
J. M. Pettit, Stanford University, Stanford, Calif., to Amsterdam, Netherlands.

E. A. Phillips, Pomona College, Claremont, Calif., to Paris, France.
C. M. Pomerat, University of Texas, Galveston, Tex., to Leiden, Netherlands.
H. Ris, University of Wisconsin, Madison, Wisc., to Leiden, Netherlands.
V. H. Rumsey, Ohio State University, Columbus, Ohio, to Amsterdam, Netherlands.
W. H. Sawyer, New York University, New York, N. Y., to London, England.
A. M. Schechtman, University of California, Los Angeles, Calif., to Leiden, Netherlands.
M. O. Schmidt, University of Illinois, Urbana, Ill., to Rome, Italy.
L. P. Schultz, Takoma Park, Md., to Quezon City, Philippines.
W. G. Shepherd, University of Minnesota, Minneapolis, Minn., to Amsterdam, Netherlands.
C. G. Sibley, Cornell University, Ithaca, N. Y., to Basel, Switzerland.
P. C. Silva, University of Illinois, Urbana, Ill., to Paris, France.
S. Silver, University of California, Berkeley, Calif., to Amsterdam, Netherlands.
W. E. Smith, American Geophysical Union, Washington, D. C., to Rome, Italy.
R. Smoluchowski, Carnegie Institute of Technology, Pittsburgh, Pa., to London, England.
R. W. Storer, University of Michigan, Ann Arbor, Mich., to Basel, Switzerland.
A. W. Sullivan, University of Florida, Gainesville, Fla., to Amsterdam, Netherlands.
A. Tarski, University of California, Berkeley, Calif., to Amsterdam, Netherlands.
R. H. Thompson, University of Kansas, Lawrence, Kans., to Paris, France.
J. Thorp, Earlham College, Richmond, Ind., to Quezon City, Philippines.
R. M. Tryon, Missouri Botanical Garden, St. Louis, Mo., to Paris, France.
D. F. Tuttle, Stanford University, Stanford, Calif., to Amsterdam, Netherlands.
C. Vaurie, American Museum of Natural History, New York, N. Y., to Basel, Switzerland.
B. E. Warren, Massachusetts Institute of Technology, Cambridge, Mass., to Paris, France.
P. Weiss, National Research Council, Washington, D. C., to Europe.
J. A. Wheeler, Princeton University, Princeton, N. J., to London, England.
G. T. Whyburn, University of Virginia, Charlottesville, Va., to Amsterdam, Netherlands.
R. L. Wilder, University of Michigan, Ann Arbor, Mich., to Amsterdam, Netherlands.
H. G. Wiln, State University of New York, Syracuse, N. Y., to Rome, Italy.
E. Witschi, State University of Iowa, Iowa City, Iowa, to London, England.
Chien-Shiung Wu, Columbia University, New York, N. Y., to Glasgow, Scotland.
W. H. Zachariasen, University of Chicago, Chicago, Ill., to Paris, France.
L. Zippin, Queens College, Flushing, N. Y., to Amsterdam, Netherlands.

Scientific Information Exchange

American Institute of Physics, New York, N. Y.; *A Study of a Comprehensive Russian-English Translating Service in the Field of Physics;* $3,300.

American Mathematical Society, Providence, R. I.; *Preparation and Distribution of Selected Translations of Russian Mathematics Articles;* 1 year; $14,500.

University of California, Berkeley, Calif.; *Preparation of a Punched Card File of Double Star Measures;* $15,500.

University of Chicago, Chicago, Ill.; S. Polyak, Department of Anatomy; *Publishing Results of Basic Research Entitled "The Vertebrate Visual System";* 4 years; $13,300.

Documentation, Inc., Washington, D. C.; *Semi-Mechanized System for Indexing and Retrieving Scientific Information;* $8,000.

University of Hawaii, Honolulu, Hawaii; *Exchange of Biological Research Information at the Hawaii Marine Laboratory;* $6,000.

LIBRARY OF CONGRESS, Washington, D. C.; *Compilation of Lists of Current Biological Periodicals;* $8,800.

LIBRARY OF CONGRESS, Washington, D. C.; *Compilation of Lists of Scientific and Technical Serial Publications;* 6 months; $6,500.

LIBRARY OF CONGRESS, Washington, D. C.; R. L. Zwemer, Chief, Science Division; *Establishing and Operating a Center for Recording, Reporting, Duplicating, and Distributing Translations of Scientific Literature;* 1 year; $29,500.

LIBRARY OF CONGRESS, Washington, D. C.; D. E. Gray, Chief, Technical Information Division; *Study of Publications Stemming from Defense-Related Technical Reports;* 1 year; $4,000.

MARINE BIOLOGICAL LABORATORY, Woods Hole, Mass.; *Participation in the Exchange of Scientific Information at the Marine Biological Laboratory, Woods Hole, Mass.;* $1,800.

MINERALOGICAL SOCIETY OF AMERICA, Washington, D. C.; *Publishing an Expanded Issue of "The American Mineralogist";* 1 year; $1,100.

NATIONAL ACADEMY OF SCIENCES, Washington, D. C.; *Preparation of a Monograph on the Training of Scientists and Engineers in Russia;* $1,900.

NEW YORK UNIVERSITY, New York, N. Y.; S. A. Korff, Department of Physics; *Survey of High Altitude Cosmic Ray Stations;* 2 years; $1,000.

UNIVERSITY OF PENNSYLVANIA, Philadelphia, Pa.; L. V. Heilbrunn, Zoological Laboratory; *Assistance in Editing an International Treatise on Protoplasm Entitled "Protoplasmatologia";* $1,000.

SMITHSONIAN INSTITUTION, Washington, D. C.; S. L. Deignan; *Partial Support of "Biological Sciences Information Exchange";* 1 year; $22,000.

THE TORREY BOTANICAL CLUB, New York, N. Y.; E. Lawton, Treasurer; *Publishing a "75-year Index of the Bulletin of the Torrey Botanical Club";* 3 years; $5,000.

UNITED STATES DEPARTMENT OF AGRICULTURE GRADUATE SCHOOL, Washington, D. C.; R. R. Shaw, Librarian; *Investigation of the Effectiveness of Information Sources Available to American Scientists;* 1 year; $20,700.

WAYNE UNIVERSITY, Detroit, Mich.; *Human Biology, A Quarterly Journal of Research;* $3,250.

APPENDIX IV

Graduate Fellowship Program

Distribution of NSF Fellowships by State of Residence for the Academic Year 1954–55

Region and State	*Applications received*	*Awards made*
NORTHEAST		
Connecticut	81	18
Maine	9	2
Massachusetts	169	38
New Hampshire	11	3
New Jersey	157	28
New York	602	99
Pennsylvania	221	56
Rhode Island	21	4
Vermont	6	2
SOUTH		
Alabama	33	4
Arkansas	16	1
Delaware	4	0
District of Columbia	39	7
Florida	59	9
Georgia	31	3
Kentucky	16	3
Louisiana	26	3
Maryland	63	15
Mississippi	20	7
North Carolina	47	4
Oklahoma	42	17
South Carolina	17	1
Tennessee	43	7
Texas	84	19
Virginia	46	6
West Virginia	19	0

Region and State	*Applications received*	*Awards made*
NORTH CENTRAL		
Illinois	250	50
Indiana	72	23
Iowa	51	17
Kansas	46	11
Michigan	107	23
Minnesota	68	21
Missouri	66	24
Nebraska	26	8
North Dakota	10	4
Ohio	121	35
South Dakota	9	2
Wisconsin	70	26
WEST		
Arizona	18	3
California	304	85
Colorado	61	9
Idaho	5	0
Montana	15	4
Nevada	9	3
New Mexico	15	4
Oregon	40	9
Utah	18	5
Washington	43	12
Wyoming	8	1
POSSESSIONS		
Alaska	1	0
Hawaii	7	1
Puerto Rico	4	0

Distribution of NSF Fellowships by Year of Study and Field for the Academic Year 1954–55

Field	Predoctoral			Post-doctoral	Total
	First year	Inter-mediate	Terminal year		
Life sciences	40	81	56	36	213
Chemistry	59	54	43	15	171
Engineering	41	22	28	1	92
Earth sciences	8	15	8	2	33
Mathematics	20	21	19	12	72
Physics and astronomy	52	47	43	13	155
Total	220	240	197	79	736

Names, Residences, and Fields of Study of Individuals Awarded National Science Foundation Graduate Fellowships for Fiscal Year 1954

Predoctoral Fellows

ALABAMA

Roy Ronald Odom, Fairfield, Chemistry.

Charles M. Steinberg, Montgomery, Biophysics.

Priestly Toulmin III, Birmingham, Earth Sceinces.

ARIZONA

Donald G. Bryant, Tucson, Earth Sciences.

Bradley Dean Bucher, Phoenix, Mathematics.

ARKANSAS

James Fred Hays,[1] Little Rock, Earth Sciences.

CALIFORNIA

Dana LeRoy Abell, Fresno, Zoology.

Edward McIntosh Acton, Morgan Hill, Chemistry.

Douglas E. Applequist, Berkeley, Chemistry.

Jon Barr Applequist,[1] Berkeley, Chemistry.

[1] Declined.

George Allen Baker, Jr.,[1] Davis, Physics.

Allan Marion Barnes, Richmond, Zoology.

Edwin DeMuth Becker, Berkeley, Chemistry.

David Ralph Bennion, Los Altos, Engineering.

Ivan Stanley Bjorklund, Los Angeles, Engineering.

Albert Thomas Bottini, Petaluma, Chemistry.

John Doyle Britton, Los Angeles, Chemistry.

Michael Edwin Browne, Long Beach, Physics.

Don Louis Bunker, Simi, Chemistry.

Sherwin John Carlquist, San Marino, Botany.

John Arthur Carlson, Pasadena, Engineering.

Mark Cher, Los Angeles, Chemistry.

John William Crump, Sebastopol, Chemistry.

Noel Howard De Nevers,[1] San Francisco, Engineering.

William Edwin Dibble, Glendale, Biophysics.

[1] Declined.

Lowell Ralph Doherty, San Diego, Physics.
Walter John Downhower, Altadena, Engineering.
Robert Louis Dressler, Inglewood, Botany.
Walter Pasold Eatherly, Temple City, Physics.
Shelden D. Elliott, Jr., Independence, Physics.
Ronald Fuchs, Altadena, Physics.
Robert Howard Good, Berkeley, Physics.
Andrew L. Gram III, San Marino, Engineering.
Bruno Harris, Arcadia, Mathematics.
Billy J. Hartz, Albany, Engineering.
Robert Shaw Hoffman, Albany, Zoology.
Clifford Andre Hopson, Mill Valley, Earth Sciences.
Mary Lawrence Houston, San Francisco, Zoology.
Cliffe David Joel, Vista, Biochemistry.
Robert Eugene Jones, Watsonville, Engineering.
Glenn Howard Keitel, Palo Alto, Engineering.
John Harvey Kennedy, Los Angeles, Chemistry.
Robert P. Kraft, Albany, Physics.
Robert Edmond Levin, Santa Ana, Engineering.
John Clayton Little, Stockton, Chemistry.
Jon Mathews, Sierra Madre, Physics.
Donald S. Matteson, Berkeley, Chemistry.
Ernest Alan Meyer, Berkeley, Microbiology.
Jerry Charles Mitchell, Van Nuys, Chemistry.
James Dawson Mohler, Berkeley, Genetics.
James Edward Monson, Palo Alto, Engineering.
Lloyd N. Morrisett, Jr., Los Angeles, Psychology.
Allen Parducci, Berkeley, Psychology.
Peter Martin Ray, Saratoga, Botany.
Walter Barclay Ray, Saratoga, Earth Sciences.
Richard Allen Reeves, Los Angeles, Chemistry.
John Hall Richards, Berkeley, Chemistry.
Lorenzo W. Richards, Riverside, Chemistry.
Kenneth W. Robinson, Los Angeles, Physics.
Willard N. Runquist, Green Valley Lake, Psychology.
Jack Sandweiss, Berkeley, Physics.
Ronald Lee Shreve, Bishop, Earth Sciences.
Jerome William Sidman,[1] Berkeley, Chemistry.
Harold King Sinclair, Los Angeles, Chemistry.
Felix Teisseire Smith, San Francisco, Chemistry.
Ronald Dean Smith, Oakland, Chemistry.
Edward Abraham Stern, Los Angeles, Physics.
Robert W. Tankersley, Jr., Stanford, Microbiology.
Richard B. Taylor, Claremont, Earth Sciences.
John Bowman Thomas, Stanford, Engineering.
Walter Rollier Thorson, Los Angeles, Chemistry.
Edward Oakley Thorp, Los Angeles, Physics.
Walter M. Walsh, Los Angeles, Physics.
Harold Weitzner, San Francisco, Physics.
Arthur Edwin Wennstrom,[1] Los Angeles, Engineering.

COLORADO

Arnold Benson, Boulder, Zoology.
Alfred Danti, Colorado Springs, Chemistry.
Robert C. Gunning, Longmont, Mathematics.
Vance Clifford Kennedy, Denver, Earth Sciences.
Fred Barrows Knight, Fort Collins, Agriculture.
John A. Laswick, Boulder, Chemistry.
John Robert Nazy, Denver, Chemistry.
Lewis Todd Reynolds, Denver, Chemistry.

---

[1] Declined.

CONNECTICUT

NORMAND CONRAD BLAIS, New Haven, Physics.
FRANCIS GERALD CAREY, Rockville, Zoology.
WILLIAM THOMAS DOYLE, New Haven, Physics.
GEORGE BROOKS FIELD, Pomfret, Physics.
DONALD LAWRENCE GILMAN, Storrs, Earth Sciences.
CAROL LOUISE KILBOURNE, Woodmont, Chemistry.
FRANK BRYANT MALLORY, New Haven, Chemistry.
HARRY DOWD PECK, JR., Middletown, Microbiology.
WALTER RALPH REITMAN, Middletown, Psychology.
MAXINE FRANK SINGER, New Haven, Biochemistry.
WILLIAM GRANT TIFFT, Seymour, Physics.
JAMES V. TRUMBULL, Stonington, Earth Sciences.
CHARLES F. WILCOX, Cos Cob, Chemistry.

DISTRICT OF COLUMBIA

THOMAS ALBERT FARLEY, Washington, Physics.
ROYAL BRUCE KELLOGG, Washington, Mathematics
FRANCIS L. LAMBERT, Washington, Zoology.
PATRICIA C. REYNOLDS, Washington, Chemistry.
LEO BLASE SCHLEGEL,[1] Washington, Mathematics.
JEROME SPANIER, Washington, Mathematics.

FLORIDA

HERBERT CHARLES CURL, Tallahassee, General Biology.
DAVID JAMES FOULIS, South Miami, Mathematics.
IRIS MABEL KIEM, Miami, Microbiology.
ARTHUR R. MARSHALL, Miami, General Biology.
RALPH DAVID MCWILLIAMS, Fort Myers, Mathematics.
WALLACE A. MOSER, Bradenton, Physics.
R. CHARD C. PILGER, West Palm Beach, Chemistry.
ROBERT SIDNEY SILAS, Gainesville, Chemistry.

GEORGIA

WILLIAM ARCHER HAGINS, Oliver, Medical Sciences.
ZELVIN LEVINE, Savannah, Engineering.
ARTHUR HOMER NEAL, Atlanta, Chemistry.

ILLINOIS

JAMES STUART AAGAARD, Chicago, Engineering.
GEORGE EDWARD BACKUS, Chicago, Physics.
ROBERT ELI BARON, Chicago, Physics.
CHARLES EARL BARR, Elmwood Park, Botany.
WALTER SCOTT BARTKY, Chicago, Mathematics.
ALAN HERBERT CROMER, Chicago, Physics.
DARWIN DARRELL DAVIS, Salem, Chemistry.
DAVID HIRSCH EZEKIEL, Urbana, Microbiology.
RICHARD WARREN FULMER, Champaign, Chemistry.
DONALD SHEPARD GAGE, Palatine, Engineering.
ROBERT BRUCE GARLAND, Elgin, Chemistry.
DAVID MELVILLE GELLER, Oak Park, Biochemistry.
JAMES W. GEWARTOWSKI, Chicago, Engineering.
RICHARD WILLIAM GLADE, Urbana, Zoology.
RAMON DON HAMILTON, Colfax, Microbiology.
ROBERT JUNIOR HARDER, Gibson City, Chemistry.
ROBERT HAROLD HARDIN, Champaign, Engineering.
HARRIS DALE HARTZLER, Downers Grove, Chemistry.
ALFRED HELLER, Chicago, Medical Sciences.
DALE RICHARD HOFF, Galesburg, Chemistry.
DELBERT LEROY JOHNSON, Monmouth, Engineering.
GEORGE J. KACEK, JR., Berwyn, Engineering.

[1] Declined.

Miles Vincent Klein, Highland Park, Physics.

Arthur A. Krawetz, Evanston, Chemistry.

John Harold Law, Jr., Park Forest, Biochemistry.

Seymour Lederberg, Urbana, Microbiology.

Andrew David Liehr, Chicago, Physics.

Theodore Dean Little, Marissa, Engineering.

Harvey Monroe Loux, St. Joseph, Chemistry.

Lois W. Mednick, Chicago, Anthropology.

Robert Lee Metzenberg, Highland Park, Biochemistry.

Robert Lee Mieher, Waverly, Engineering.

Franklin Paul Peterson, Naperville, Mathematics.

Wesley John Peterson,[1] Chicago, Zoology.

Lionel Israel Rebhun, Chicago, Biochemistry.

Franco Scardiglia, Chicago, Chemistry.

Theodore David Schultz, Glencoe, Physics.

Justin Isabel Simon, Wheaton, Chemistry.

Donald Arthur Speer, Morton Grove, Chemistry.

Edward Otto Stejskal, Berwyn, Chemistry.

Robert Allan Swanson, Chicago, Physics.

Richard Sanborn Thomas, Champaign, Biochemistry.

Hal Richard Waite, Chicago, Chemistry.

James William Wilt, Chicago, Chemistry.

John Widmer Winchester, Western Spring, Chemistry.

INDIANA

Ila Glover Carroll, West Lafayette, Microbiology.

John Polk Chesick, New Castle, Chemistry.

William W. Cleland, Bloomington, Biochemistry.

[1] Declined.

William Robert Frazer, Indianapolis, Physics.

Roger Estlick Gerkin, South Bend, Chemistry.

Theodore M. Hallman,[1] West Lafayette, Engineering.

Joseph David Harris, West Lafayette, Biophysics.

John Burnett Hemwall, West Lafayette, Agriculture.

Margaret Marie Hiatt, Indianapolis, Microbiology.

Lewis Milton Horger, West Lafayette, Zoology.

Kenneth Alan Johnson, Hobart, Physics.

J. Johanna Jones, Indianapolis, Botany.

Robert Paul Kaiser, South Bend, Engineering.

William Charles Lordan, Gary, Mathematics.

Donald Joseph Mason, Cutler, Microbiology.

Thomas Robert Mertens, St. Joe, Genetics.

David John Meschi, Hammond, Chemistry.

Joseph P. Mutschlecner, Fort Wayne, Physics.

Michael Edward Senko, Crown Point, Chemistry.

William Danks Shephard, Gary, Physics.

Frank Samuel Stephens, Wabash, Chemistry.

Thomas Lee Swihart, Elkhart, Physics.

IOWA

James Robert Anderson, Ames, Physics.

George Edwin Collins, Adel, Mathematics.

Sperry Eugene Darden, Sioux City, Physics.

Daniel Hartz Hug, Davenport, Microbiology.

James Stewart Hyde, Des Moines, Physics.

Claude G. King, Jr., Cedar Rapids, Engineering.

Bruce Owen Nolf, Iowa City, Earth Sciences.

[1] Declined.

William David Ohlsen, Ames, Physics.
John Frederick Pauls, Washington, Mathematics.
Laura Maurer Roth, Waterloo, Physics.
William W. Rozeboom, Ottumwa, Psychology.
Richard Mark Sanders, Waterloo, Physics.
Ronald Lewis Sass, Davenport, Chemistry.
Charles F. Schumacher, Ames, Psychology.
Travis E. Stevens, Ames, Chemistry.
Hugh David Young, Osage, Physics.

KANSAS

Norman Paul Baumann, Sylvan Grove, Physics.
Robert Rex Brownlee, Zenith, Physics.
T. M. Burford, Wichita, Engineering.
Richard Huntley Capps, Wichita, Physics.
Howard Brittok Hamilton, Wichita, Engineering.
Edwin Dale Hornbaker, Louisburg, Chemistry
Forrest Earl Ladd, Jr., Lawrence, Psychology.
Allen Jay Lundeen, Fowler, Chemistry.
Francis Ware Prosser, Lawrence, Physics.
Robert Warren Rydjord, Wichita, Psychology.
Robert Lynn Shaffer, Kinsley, Botany.

KENTUCKY

Joe Wood Cable, Murray, Chemistry.
Alan Stanley Horowitz,[1] Ashland, Earth Sciences.
William Wallace Hunt, Franklin, Chemistry.

LOUISIANA

Paula Jean Beaver, New Orleans, Microbiology.
Pierre Euclide Conner, Lafayette, Mathematics.
Robert Edgar Weaver, New Orleans, Engineering.

[1] Declined.

MAINE

Reginald A. Deering, Brooks, Biophysics.
David Benjamin Stewart, East Sumner, Earth Sciences.

MARYLAND

Robert Wauchope Bass, Baltimore, Mathematics.
Fernand Denis Bedard, Baltimore, Physics.
Alvin L. Berman, Baltimore, Zoology.
Paul Andrew Cook, Baltimore, Engineering.
Albert William Currier, West Annapolis, Mathematics.
Robert Harry Gilpin, Cumberland, Botany.
John Joseph Hopfield,[1] Bethesda, Physics.
Eskin Huff, Bethesda, Biochemistry.
John Edward Laynor, Bethesda, Engineering.
Hirsch I. Mandelberg, Baltimore, Physics.
Leonard Sidney Rodberg, Baltimore, Physics.
L. Edward Scriven II, Elkton, Engineering.
Thomas Darrah Thomas, Chevy Chase, Chemistry.
Carroll Vance Truss, Baltimore, Psychology.

MASSACHUSETTS

Margaret Stuart Bryan, Cambridge, Botany.
Edith Constance Clarke, Concord, Biochemistry.
Lloyd Arthur Currie, Somerville, Chemistry.
Louis Selig Harris, Brookline, Medical Sciences.
Richard J. Herrnstein, Newton, Psychology.
Winborne Terry Jenkins, Cambridge, Biochemistry.
Harold Melvin Kaplan, Northampton, Mathematics.

[1] Declined.

Francis Thomas Kenney, Springfield, Biochemistry.
Thomas Bulkley Knapp, Newton, Mathematics.
Joshua Kurland Kopp, Dorchester, Physics.
Ann Matthews Lacy, Newton Center, Genetics.
Elliott Hershel Lieb, Boston, Physics.
Robert Mandel Lurie, Cambridge, Engineering.
Gerald E. Mahoney, Norwood, Mathematics.
Robert Bruce Marr, West Bridgewater, Physics.
Edward James Ofengand, Taunton, Biochemistry.
Richard Sheldon Palais, Brookline, Mathematics.
John Winsor Pratt, Concord, Mathematics.
Stuart Alan Rice,[1] Cambridge, Chemistry.
Phillips W. Robbins, Leominster, Biochemistry.
Robert Horton Romer, Cambridge, Physics.
Franklin William Stahl, Needham, Genetics.
Robert David Stolow, Brookline, Chemistry.
Robert W. Thrasher, Greenfield, Physics.
Beatrice Tugendhat, Webster, Psychology.
Peter Hans Von Hippel, Weston, Biophysics.
Edwin Snell Weaver, Andover, Chemistry.
Charles Allen Whitney, Cambridge, Physics.

MICHIGAN

Arden Leroy Albee, Mount Clemens, Earth Sciences.
James William Albrecht, Detroit, Physics.
Sam Allan Brady, South Haven, Chemistry.
Gerald Walter Camiener, Detroit, Microbiology.
Mary Ruth Dawson, Ferndale, Earth Sciences.

[1] Declined.

Howard Melvin Dess, Ann Arbor, Chemistry.
John Mitchell Gary, Kalamazoo, Mathematics.
David Marvin Green, Ann Arbor, Psychology.
Robert Arthur J. Hefner, Ann Arbor, Psychology.
William S. Jewell, Detroit, Engineering.
Lloyd Edward Kaechele, Allegen, Engineering.
Duane Francis Morrow, Detroit, Chemistry.
Morton E. Munk, Detroit, Chemistry.
Edward H. Poindexter, Lansing, Physics.
Garry Lee Schott, Huntington Woods, Chemistry.
Owen James Sexton, Pinckney, Zoology.
Anthony Edward Siegman, Pontiac, Engineering.
David Slawson William,[1] Grand Rapids, Physics.
Hugh Latimer Smith, Ann Arbor, Engineering.
George A. Vidaver, Detroit, Biochemistry.
Thomas Frank Waters, East Lansing, Zoology.
Andre M. Weitzenhoffer, Ann Arbor, Psychology.

MINNESOTA

Norman Henry Anderson, Minneapolis, Psychology.
Theodore E. Dickelman, Minneapolis, Chemistry.
Morton Albert Eliason, Moorhead, Chemistry.
William C. Erickson, Duluth, Physics.
Mark Stanley Fawcett, Winona, Chemistry.
Clayton Frederic Giese, Minneapolis, Physics.
Richard Evans Grant, St. Paul, Earth Sciences.
John Carl Holmes, South St. Paul, Zoology.
Nahmin Horwitz, Minneapolis, Physics.
Frank Jeremiah Lyon, Minneapolis, Engineering.

[1] Declined.

ROBERT L. NICKELSON, Minneapolis, Engineering.

ALLEN EUGENE OGARD, Ada, Chemistry.

JAMES HARLAND OSBORN, Winona, Chemistry.

JOHN FETSCH READY, Minneapolis, Physics.

PAUL CHADWICK ROYCE,[1] Brainerd, Zoology.

RICHARD MYRON STRAW, St. Paul, Botany.

JEROME DOUGLAS SWALEN, Minneapolis, Chemistry.

WARREN FREYSCHLAG WADE, Minneapolis, Engineering.

NORMAN MALTBY WOLCOTT, St. Paul, Physics.

MISSISSIPPI

JOHN BALLARD BREAZEALE, Brandon, Physics.

CHARLES JULIAN BROWN, Utica, Chemistry.

JOHN FREDERIC GARST, Jackson, Chemistry.

EDWARD EVERETT GRACE, Corinth, Mathematics.

ALAN B. GROSSBERG, Gulfport, Chemistry.

JOHN FINCHER HOWELL, Cleveland, Microbiology.

NORMAN CHARLES MERWINE, Leakesville, Agriculture.

MISSOURI

ELIZABETH BECKER, Williamsville, Chemistry.

ROBERT LOUIS BECKER, Kirkwood, Physics.

JOSEPH HAROLD BELL, Ferguson, Engineering.

ROBERT EARL LEE BLACK, Harrisonville, Zoology.

ARTHUR MAR BOLSTERLI, St. Louis, Physics.

ROBERT MURRAY CANTWELL, St. Louis, Physics.

GERALD ALLEN COHEN, University City, Engineering.

ALONZO J. FAIRBANKS, St. Louis, Biophysics.

LISE GRUEN, Kansas City, Chemistry.

PHILIP GEORGE HALLOF, Kirkwood, Earth Sciences.

[1] Declined.

320814—55——8

JOHN HOWER, JR., St. Louis, Earth Sciences.

LEONARD S. KISSLINGER, St. Louis, Physics.

LESTER HERMAN KRONE, JR., Jennings, Engineering.

DAVID EDGAR LEVENTHAL, St. Louis, Biochemistry.

CHESTER ALDEN MEAD, Webster Groves, Chemistry.

RALPH MOON MOBERLY, JR., Ferguson, Earth Sciences.

JOE MANFORD PARKS, Clinton, Chemistry.

JOSEPH W. RITTENHOUSE,[1] Rolla, Engineering.

BYRON PAUL ROE, St. Louis, Physics.

GEORGE HUBERT STOUT, St. Louis, Chemistry.

LOUIS JOSEPH TICHACEK, St. Louis, Engineering.

KENNETH GENE WERNICKE, Kansas City, Engineering.

MONTANA

MARVIN THEODORE BEATTY, Bozeman, Agriculture.

JOHN E. BUTCHER, Albion, Agriculture.

JOSEPH CONRAD CLIFFORD, Great Falls, Engineering.

JOHN ANTHONY POIRIER, Harlowton, Physics.

NEBRASKA

HARRY LAWRENCE GOLDING, Omaha, Biochemistry.

RALPH WOLFGANG KILB, Lincoln, Chemistry.

DAVID CARTER McGARVEY, Omaha, Mathematics.

JAMES RAYMOND MUNKRES, Broadwater, Mathematics.

RUSSELL L. SCHELKOPF, Shickley, Agriculture.

WILLIAM F. VOGELSANG, Lincoln, Physics.

JERROLD MOORE YOS, Lincoln, Physics.

NEVADA

IRVING POPE CRAWFORD, Reno, Microbiology.

FREDERICK R. JENSEN, Reno, Chemistry.

ROBERT DEAN SMYTH, Reno, Zoology.

[1] Declined.

NEW HAMPSHIRE

Donald Dennis Fitts, Keene, Chemistry.
William F. Hoffmann, Manchester, Physics.
Frederic Allan Johnson, Concord, Chemistry.

NEW JERSEY

Ralph Raymond Berggren, Short Hills, Physics.
Ronald Charles Breslow, Rahway, Chemistry.
Stephen Urban Chase, Princeton, Mathematics.
George A. Condouris, Passaic, Medical Sciences.
Rudolph John Dietz, New Brunswick, Chemistry.
Phyllis B. Eveleth, Neptune City, Anthropology.
Paul Edward Gray, Livingston, Engineering.
Oscar W. Greenberg, Newark, Physics.
Peter Harold Greene, East Orange, General Biology.
Nellie Robbins Harris, Port Norris, Medical Sciences.
Robert Hobart, Jr., Ramsey, Physics.
Bentz Buell Howard, Jr., Plainfield, Chemistry.
Daniel Kleitman, Morristown, Physics.
Philip Charles Laris, Perth Amboy, Zoology.
Robert Marc Mazo, Camden, Physics.
Victor Kenneth Pare, Woodbury, Physics.
Willard Van Tuyl Rusch, Lambertville, Engineering.
Joseph A. Shropshire, New Gretna, Chemistry.
Malcolm Saul Steinberg, Highland Park, Zoology.
Richard Gordon Swan, Boonton, Mathematics.
Peter James Warter, Jr., Trenton, Engineering.
Henry Oscar Werntz, Margate, Zoology.
Peter Joseph Wojtowicz, Linden, Chemistry.
William G. Zoellner, East Orange, Chemistry.

NEW MEXICO

Lewis Edgar Agnew, Jr., Los Alamos, Physics.
Walter Reilly Kane, Los Alamos, Physics.
George W. Lecompte, Los Alamos, Engineering.
James Charles Phillips, Albuquerque, Physics.

NEW YORK

Lee Richard Abramson, New York, Mathematics.
Ernest A. Allton, Bronx, Physics.
Michael Klaux Bach, Flushing, Biochemistry.
Robert J. Ballengee, New Rochelle, Engineering.
Emanuel Baskir, Rochester, Physics.
Leonard E. Baum, Brooklyn, Mathematics.
Robert Gordon Beard, Oswego, Zoology.
Arnold Mixon Benson, New York, Engineering.
Joan Berkowitz, Brooklyn, Chemistry.
Samuel David Berkowitz, Bronx, Mathematics.
Martin Barry Brilliant, Brooklyn, Engineering.
William Browder, Yonkers, Mathematics.
Edward Reynolds Byrne, Kenmore, Engineering.
Frank Vincent Caccavo, Upton, Engineering.
Morton Irving Cohen, New York, Zoology.
Paul J. Cohen, Brooklyn, Mathematics.
William Charles Cohen, Brooklyn, Engineering.
Morris A. Cynkin, Brooklyn, Microbiology.
Daniel Frank De Santo, New Rochelle, Engineering.
Robert W. Detenbeck, Kenmore, Physics.
George Howard Dinsmore, Ridgewood, Mathematics.
Richard J. Drachman, Brooklyn, Physics.
Paul Raymond Drouilhet, Poughkeepsie, Engineering.

GERALD DUDEK, Binghamton, Chemistry.
HERBERT LEO ENNIS, Brooklyn, Microbiology.
DAVID S. FALK, Long Island City, Physics.
GERALD FEINBERG, New York, Physics.
MAY FELDMAN, Brooklyn, Psychology.
DUNCAN GRAHAM FOSTER, Ithaca, Physics.
MARSHALL L. FREIMER, Brooklyn, Mathematics.
AARON JUDAH FRIEDLAND, Bronx, Engineering.
WALTER GILBERT, New York, Physics.
MELVIN J. GOLDSTEIN, New York, Chemistry.
MALCOLM STEPHEN GORDON, Brooklyn, Zoology.
JOHN MORGAN GREENE, Rochester, Physics.
ROSEMARY HAMMER, Franklin Square, Microbiology.
RICHARD HECHT, Bronx, Physics.
JULIAN P. HEICKLEN, Rochester, Chemistry.
DAVID HERTZIG, Brooklyn, Mathematics.
LEONARD A. HERZENBERG, Brooklyn, Biochemistry.
RICHARD H. HILLSLEY, Larchmont, Engineering.
PAUL HOROWICZ, New York, Zoology.
SONJA KRAUSE, New York, Chemistry.
ARTHUR F. KUCKES, Yonkers, Physics.
AIMLEE D. LADERMAN, New York, Zoology.
HENRY JACOB LANDAU, New York, Mathematics.
DAVID B. LEWIN,[1] New York, Mathematics.
MICHAEL LITT, New Rochelle, Biochemistry.
JAMES DUANE LIVINGSTON, Brooklyn, Physics.
ROBERT GERALD LOOMIS, Mount Vernon. Mathematics.
IRVING JACK LOWE, Brooklyn, Physics.
ELIHU LUBKIN, Brooklyn, Physics.
DAVID WILLIAM LYNCH, Ithaca, Physics.
DEAN EVERETT MCCUMBER, Rochester, Engineering.
ELLIOTT MENDELSON, Brooklyn, Mathematics.

[1] Declined.

JOHN JACOB METZNER, Long Island, Engineering.
JOHN DAVIS MUSA, Farmingdale, Engineering.
JACK NACHMIAS, Brooklyn, Psychology.
MARSHALL IRA NATHAN, New York, Physics.
NORMAN PAUL NEUREITER, Genesco, Chemistry.
MARTHA MOUNT NICELY, Mount Kisco, Zoology.
DONALD SAMUEL ORNSTEIN, Harrison, Mathematics.
ROBERT PEARLMAN, Long Beach, Mathematics.
THERON STANDISH PIPER, Elmira, Chemistry.
EDWARD CHARLES POSNER, Brooklyn, Mathematics.
DAVID PRATT, Ithaca, Agriculture.
LAWRENCE ROSLER, Brooklyn, Physics.
DAVID ROTHMAN, Bronx, Mathematics.
JEROME LEO SACKMAN,[1] Rome, Engineering.
PHILIP EUGENE SARACHIK, Flushing, Engineering.
RICHARD M. SCRIBNER, Snyder, Chemistry.
HENRY SEIWATZ, Ithaca, Biophysics.
RUTH FRIEDLAND SEIWATZ, Ithaca, Biophysics.
CHARLES M. SOMMERFIELD, Brooklyn, Physics.
DAVID SPIELBERG, Richmond Hill, Physics.
ELIAS M. STEIN, New York, Mathematics.
SIDNEY STEIN, New York, Engineering.
WILLIAM JOHN STEIN, Flushing, Engineering.
LISA AMELIA STEINER, Kew Gardens, Mathematics.
SAUL HERBERT STERNBERG,[1] Bronx, Mathematics.
MENASHA JOSEPH TAUSNER, Bronx, Physics.
DAVID ANDREW TREFFS, South Schroon, Engineering.
URSULA VIVIAN VICTOR, Pleasantville, Genetics.
ALLEN W. WACHTEL, Irvington, Zoology.
ROSELIN S. WAGNER, Jackson Heights, Chemistry.

[1] Declined.

WALTER D. WALES, Oneonta, Physics.
EDEL WASSERMAN, Brooklyn, Chemistry.
STEVEN WEINBERG, New York, Physics.
DONALD EARL WILCOX, Farmingdale, Engineering.
LOUIS MARSHALL WINER, Spring Valley, Mathematics.
ERIC WOLMAN, Rye, Mathematics.
ARIEL CHARLES ZEMACH, New York, Physics.

NORTH CAROLINA

ALBERT RICH ERWIN, JR., Concord, Physics.
ROBERT WINSHIP HEATH, Chapel Hill, Mathematics.
KATHERINE RONDTHALER, Ocracoke Island, Botany.
WILLIAM VAUGHN WRIGHT, Wilson, Mathematics.

NORTH DAKOTA

JULIUS ADLER, GRAND FORKS, Biochemistry.
WILLIAM PATRICK BROWN, Stanley, Engineering.
DAVID JOHN PARKER,[1] Fargo, Chemistry.
PAUL EMERY THOMAS, Fargo, Mathematics.

OHIO

JAMES NOEL BAPTIST, Olmsted Falls, Biochemistry.
NORMAN ANDREW BATES, Cleveland, Biochemistry.
EDWARD GEORGE DANIELS, Lorain, Biochemistry.
RICHARD L. DEININGER, Dayton, Psychology.
HARMON CRAIG DUNATHAN, St. Marys, Chemistry.
MARSHALL PAUL ERNSTENE, Cleveland, Physics.
ALVIN ELI FEIN, University Heights, Physics.
PAT W. K. FLANAGAN, Dayton, Chemistry.
EDWARD LEE GARWIN, Cleveland, Physics.
JOHN EDWARD GORDON, Columbus, Chemistry.
WALTER ASHLEY HARRISON, Toledo, Physics.

[1] Declined.

HENRY ORVILLE HEISEY, Louisville, Biochemistry.
ROBERT TWEED HERSH, Cleveland Heights, Biochemistry.
FRED DONALD HOERGER, Wadsworth, Chemistry.
JOSEPH H. HOLLOWAY, Shaker Heights, Physics.
REED ANDERSON HOWALD, Perrysburg, Chemistry.
WILLIAM HENRY KASNER, Killbuck, Physics.
DAVID RONALD KREIG, Lorain, Genetics.
LOIS CAROLYN LAWRENCE, Cincinnati, Psychology.
DANIEL LEDNICER, Columbus, Chemistry.
WALTER LESLIE MEYER, Oak Harbor, Chemistry.
JAMES THOMAS MORSE, Mentor, Mathematics.
GEORGE RAYMOND MURRAY, Dayton, Chemistry.
GLEN ANDERSON REBKA, JR., Cincinnati, Physics.
CARL FREDERICK ROTHE,[1] Lima, Zoology.
DAVID RYEBURN, Goshen, Mathematics.
DAVID ALAN SLOUGH, Findlay, Earth Sciences.
DAVID ARTHUR STRANG, Girard, Engineering.
ANDREW ALBERT WEAVER, Wooster, Zoology.
PETER NORD WOLFE, Columbus, Physics.

OKLAHOMA

REAGAN HOWARD BRADFORD, Lawton, Biochemistry.
LEON JAMES BRUNER, Ponca City, Physics.
RODNEY JEAN COOPER, Mutual, Agriculture.
CHARLES RUSSELL CRANE, Barnsdall, Biochemistry.
JACK H. ESSLINGER, Oklahoma City, Medical Sciences.
JOSEPH POYER DEYO HULL, Tulsa, Earth Sciences.
HAROLD JOSEPH KIDD, Red Rock, Genetics.
EARL BUDDY KILPATRICK, Durant, Zoology.
OMER KIRCHER, Fairland, Engineering.

[1] Declined.

Carroll Field Knutson,[1] Ponca City, Earth Sciences.
James Elliott McCune, Tulsa, Engineering.
Mark Aldridge Melton, Norman, Earth Sciences.
Gordon Leon Nelson, Stillwater, Engineering.
James Vernon Parcher, Stillwater, Engineering.
Charles William Reich, Oklahoma City, Physics.
Richard Lewis Willham, Stillwater, Agriculture.

OREGON

Richard Leroy Baird, Portland, Chemistry.
John William Daly, Portland, Biochemistry.
Bertram Gale Dick, Jr., Portland, Physics.
Douglas O. Geymer, Clackamas, Chemistry.
Margery Pearl Gray, Eugene, Anthropology.
Barbara Lee Manley, Medford, Zoology.
Ira Kelly Mills, Corvallis, Botany.
Edwin Norbeck, Milwaukie, Physics.
Douglas L. Van Fleet, Portland, Biochemistry.

PENNSYLVANIA

Walter Lewis Bailey, Jr., Waynesburg, Mathematics.
Paul Booth Barton, Jr., Pittsburgh, Earth Sciences.
Joanne Marie Bridges, McKees Rocks, Chemistry.
Arthur Jerry Buslik, Philadelphia, Physics.
Kalman Joseph Cohen, Pittsburgh, Mathematics.
Victor Hugo Cohn, Jr., Reading, Medical Sciences.
Richard Bertram Curtis, Ardmore, Physics.
Richard Todd Denton,[1] State College, Engineering.

[1] Declined.

Robert Hemphill Depue,[1] Rutledge, Biochemistry.
Raymond Edwin Dessy, Blawnox, Chemistry.
Thomas McKeown Devlin, Philadelphia, Biochemistry.
Joseph Engelberg, Philadelphia, Biophysics.
Bruce Sigmund Fisher, Philadelphia, Chemistry.
Robert T. Folk, Allentown, Physics.
H. Newton Garber, Philadelphia, Engineering.
Alvin Malcolm Goodman, Philadelphia, Engineering.
Martin Paul Gouterman, Philadelphia, Biophysics.
Paul Barnett Green, Bala Cynwyd, Botany.
Joseph John Higgins, Philadelphia, Physics.
Frank Scanland Houck, Newville, Chemistry.
Paul Mitchell Hurst, Jr., Hellam, Psychology.
Neil Raymond Johnson, McKeesport, Engineering.
Theodore Arthur Liss, Temple, Chemistry.
William Alfred Love, Pittsburgh, Physics.
Lewis Nelson Lukens, Philadelphia, Biochemistry.
Paul Schultz Martin, West Chester, Zoology.
Thomas Joseph Mathia, Strabane, Chemistry.
John Edward Meyer,[1] Pittsburgh, Engineering.
Robert Kenneth Miller, Harrisburg, Chemistry.
James Okey Montague, Pittsburgh, Physics.
Joseph T. Mullhaupt, Warren, Chemistry.
Frederick C. Neidhardt, Bucks County, Microbiology.
Robert Clark Newman, State College, Engineering.
Charles Joseph Noel, Philadelphia, Chemistry.

[1] Declined.

RICHARD EYRE NORTON, Philadelphia, Physics.
ARTHUR S. OBERMAYER, Philadelphia, Chemistry.
JOHN MELVIN OLSON, Philadelphia, Biophysics.
CHARLES ARTHUR PLANTZ, Pittsburgh, Chemistry.
JAMES RUSSELL POWELL, Bradford Woods, Engineering
HARRY ELMER REIFF, Allentown, Chemistry.
KURT REIBEL, Philadelphia, Physics.
JUDITH A. RICHMAN, Philadelphia, Mathematics.
JOHN ALBERT ROMBERGER, Hershey, Botany.
RONALD RAYMOND SAUERS, Irwin, Chemistry.
RAYMOND FRANCIS SAWYER, Bethlehem, Physics.
LLOYD ROBERT SCHISSLER, Alburtis, Engineering.
ALBIN EUGENE SCHRAEDER, Nanticoke, Physics.
DOROTHY ANN SEMENOW, Pittsburgh, Chemistry.
FRANK V. SHALLCROSS, Philadelphia, Chemistry.
PAUL HERMAN SQUIRES, Ambridge, Engineering.
WERNER TEUTSCH, Philadelphia, Physics.
KURT FALKE WISSBRUN, Philadelphia, Chemistry.
JOHN WILLIAM WOLL, JR., Newtown, Mathematics.

RHODE ISLAND

PAUL ROBERT CHAGNON, Woonsocket, Physics.
LINCOLN EKSTROM, Providence, Chemistry.
ROBERT HERMANN, Kingston, Mathematics.
JOSEPH N. PALMIERI, Providence, Physics.

SOUTH CAROLINA

VICTOR WILLIAM LAURIE, Columbia, Chemistry.

SOUTH DAKOTA

KERMIT MARC BANDT, Revillo, Earth Sciences.
RODNEY RAYMOND RANKIN, Draper, Earth Sciences.

TENNESSEE

JAMES REED COX, JR., Nashville, Chemistry.
LOYAL DURAND III, Knoxville, Physics.
WILLIAM PERRY FLATT, Newbern, Agriculture.
FREDERICK REDWINE, Chattanooga, Engineering.
JOHN CHARLES STEWART, Sewanee, Physics.
ANNE STOCKELL, Nashville, Biochemistry.
SAMUEL GUY TAYLOR, JR., Memphis, Earth Sciences.

TEXAS

WILLIAM C. AGOSTA, Dallas, Chemistry.
DAVID LEONARD AMSBURY, Houston, Earth Sciences.
CALVIN LARUE BARKER, Dallas, Engineering.
R. LINN BELFORD, Laporte, Chemistry.
JAMES ERWIN COOPER III, Waxahachie, Chemistry.
JAMES WATSON CRONIN, Dallas, Physics.
ROBERT FLOYD CURL, JR., San Antonio, Chemistry.
PAUL LEIGHTON DONOHO, Houston, Physics.
MARTIN DWORKIN, Austin, Microbiology.
JAMES FRANKLIN GIBBONS, Texarkana, Engineering.
WILLIAM CECIL HERNDON, El Paso, Chemistry.
LLOYD S. LOCKINGEN, Austin, Biophysics.
ELLINGTON MCFALL MAGEE, San Augustine, Chemistry.
JERRY BASCERVIL MARION, Houston, Physics.
JOHN STEPHEN MECHAM, Austin, Zoology.
PAUL EUGENE PETERSON, Denison, Chemistry.

IDE PEEBLES TROTTER, JR., Bryan, Engineering.

GEORGE ROWLAND WHITE, Abilene, Physics.

UTAH

DAVID ALAN BRODIE, Salt Lake City, Medical Sciences.

ROBERT VAN NOY DAVIS, Provo, Microbiology.

DON W. ESPLIN, Salt Lake City, Medical Sciences.

DAVID MORRIS GRANT, Salt Lake City, Chemistry.

RICHARD LEWIS SNOW, Salt Lake City, Chemistry.

VERMONT

NORMAN A. FRIGERIO, Lyndonville, Biochemistry.

ROBERT C. WOODWORTH, Bennington, Chemistry.

VIRGINIA

JAMES HARRISON BOYDEN, Wytheville, Physics.

KENT COMBS BRANNOCK, Independence, Chemistry.

CHARLES EUGENE COFFEY, Bristol, Chemistry.

HUGH EVERETT 3d, Alexandria, Physics.

MELVIN MORDECAI LEVINE, Charlottesville, Physics.

WAYLAND WALDEN RENNIE, Richmond, Agriculture.

WASHINGTON

LOWELL L. ANDERSON, Spokane, Biophysics.

CHARLES BALLANTINE, Seattle, Mathematics.

DENNIS MARTIN FAHEY, Walla Walla, Chemistry.

MARK PHILLIPS FREEMAN, Seattle, Chemistry.

PAUL AMOS JOHNSON, Seattle, Engineering.

DOUGLAS BRUCE MASSON, Pullman, Chemistry.

DAVID DOLPH NYBERG, Camas, Chemistry.

ROBERT ALLEN OLSON, Pullman, Microbiology.

DON LEE PETERSON, Seattle, Chemistry.

CHARLES JACK SMILEY, Mt. Vernon, Earth Sciences.

LAURENCE EDWARD WILSON, Mt. Vernon, Chemistry.

WISCONSIN

MARTIN ALEXANDER, Madison, Microbiology.

WILLIAM F. BATTIG, Wauwatosa, Psychology.

ROBERT JAMES BLATTNER, Milwaukee, Mathematics.

FREDERICK GRAMM BROWN, Madison, Psychology.

STEPHEN DEZIEL DARLING, Appleton, Chemistry.

STEVEN CLARK FRAUTSCHI,[1] Madison, Physics.

BARBARA JEAN HAMILTON, Manitowoc, Botany.

ROBERT N. HAZELWOOD, Milwaukee, Biophysics.

RICHARD JACOB HOLL, Madison, Physics.

JOHN WARREN HUMBERT, Kohler, Engineering.

WAYNE EDWARD MAGEE, Madison, Biochemistry.

RICHARD JAMES PLANO, Merrill, Physics.

JOHN EDWARD QUINLAN, Milwaukee, Chemistry.

JEROME WILLIAM RIESE, Kaukauna, Physics.

DONALD FRANCIS ROOT, Madison, Engineering.

JOHN HOKE SCHNEIDER, Madison, Medical Sciences.

ERNEST F. SILVERSMITH, Madison, Chemistry.

RICHARD ALLEN SNEEN, Menomonie, Chemistry.

EDWARD CARL THIEL, Wausau, Earth Sciences.

JOHN DIRK WALECKA, Wauwatosa, Chemistry.

HAWAII

ALFRED S. L. HU, Honolulu, Zoology.

POSTDOCTORAL FELLOWS

ALABAMA

JOSEPH CHARLES O'KELLEY, Tuscaloosa. Botany.

ARIZONA

WENDELL V. F. BROOKS, Tucson, Chemistry.

CALIFORNIA

RICHARD CHARLES BLANCHFIELD,[1] South Pasadena, Mathematical Sciences.

MELVIN JOSEPH COHEN, Los Angeles, Zoology.

J. WYATT DURHAM,[1] Berkeley, Earth Sciences.

RICHARD E. GLICK,[1] Sherman Oaks, Chemistry.

DONALD LEONARD GLUSKER, Santa Monica, Chemistry.

RICHARD FRED HECK, Los Angeles, Chemistry.

JAMES ARTHUR IBERS, Pasadena, Chemistry.

LIONEL FRANCIS JAFFE, Pacific Grove, Botany.

JAMES ARTHUR LOCKHART, Los Angeles, Botany.

PAUL CECIL MARTIN,[1] Los Angeles, Physics.

LAWRENCE ORDIN, Berkeley, Botany.

DAVID DEXTER PERKINS, Stanford, Genetics.

DAVID MARSHALL PRESCOTT,[1] Berkeley, Zoology.

EDGAR REICH, Santa Monica, Mathematical Sciences.

WILLIAM GLENN SLY, Lakeside, Chemistry.

MILTON DENMAN VAN DYKE,[1] Los Altos, Engineering.

COLORADO

JOHN LEONARD WESTLEY, Denver, Genetics.

CONNECTICUT

HOWARD MARVIN DINTZIS, New Haven, Biochemistry.

WILLIAM SERMOLINO HILLMAN, Westport, Botany.

WILLIAM CHARLES G. ORTEL, New Haven, Physics.

FREDERIC M. RICHARDS, Wilton, Biochemistry.

IRWIN TESSMAN, New Haven, Physics.

[1] Declined.

DISTRICT OF COLUMBIA

FRANK SLAGLE HAM,[1] Washington, Physics.

FLORIDA

EUGENE FLOYD COX, Bradenton, Chemistry.

ILLINOIS

VERNON ROBERT DORJAHN, Evanston, Anthropology.

WILLIAM E. M. LANDS, Urbana, Biochemistry.

ROBERT WILLIAM LICHTWARDT, Champaign, Botany.

EARL ROBERT RICH, Chicago, General Biology.

JONATHAN GEORGE WEGENER,[1] Chicago, Psychology.

INDIANA

WILLIAM MARTIN HUEBSCH, South Bend, Mathematical Sciences.

IOWA

WALLACE HERMAN ORGELL, Hubbard, Botany.

MARYLAND

HENRY LEROY PLAINE,[1] Baltimore, Genetics.

MASSACHUSETTS

PHILIP STANLEY CHEN, JR., South Lancaster, Medical Sciences.

THEODORE DELEVORYAS,[1] Chicopee Falls, Botany.

WILLIAM BRUCE HAWKINS, JR., Springfield, Physics.

MARTIN KARPLUS, West Newton, Chemistry.

HENRY WAY KENDALL, Sharon, Physics.

JOHN HERMAN LUFT,[1] Boston, Zoology.

DONALD MORE MAYNARD, JR., West Newton, Zoology.

JOHN COLEMAN MOORE, Belmont, Mathematical Sciences.

ANTHONY G. OETTINGER, Cambridge, Mathematics.

BRUCE BERNOT STOWE, Cambridge, Botany.

LAWRENCE WILETS, Auburn, Physics.

[1] Declined.

MICHIGAN

Edwin Weiss, Ann Arbor, Mathematical Sciences.

MINNESOTA

Glen Earl Baxter,[1] Minneapolis, Mathematical Sciences.
David Thoreson Lykken, Minneapolis, Psychology.

MISSOURI

S. Gaylen Bradley,[2] Springfield, Microbiology.
Kenneth L. Rinehart, Jr.,[1] Chillicothe, Chemistry.

NEBRASKA

William L. Bade,[1] Omaha, Physics.
Marshall Flynn Ruchte, Lincoln, Mathematical Sciences.

NEW JERSEY

George Lee Bate, Bergenfield, Earth Sciences.
Gerald Sanford Bernstein, Trenton, Biochemistry.
David Alvin Buchsbaum, Princeton, Mathematical Sciences.
Victor Lenard Shapiro, University Heights, New Brunswick, Mathematical Sciences.

NEW YORK

Leon N. Cooper, Great Neck, Physics.
Gerard F. Endres,[1] Brooklyn, Chemistry.
Gary Felsenfeld, New York, Chemistry.
Richard C. Lewontin,[1] Flushing, Genetics.
Arthur Paul Mattuck, Brooklyn, Mathematical Sciences.
Arthur Roberts,[1] Rochester, Physics.
Dexter Rogers, Buffalo, Biochemistry.

OHIO

George Edward Briggs,[1] Briggsdale, Psychology.

[1] Declined.
[2] Withdrew.

Kenneth Taylor Brown, Yellow Springs, Psychology.
James Briggs Hendrickson,[1] Toledo, Chemistry.
Karl Gordon Henize,[1] Cincinnati, Astronomy.
Charles Henry Southwick, Wooster, Zoology.

OKLAHOMA

Walter Clark Hamilton, Stillwater, Chemistry.

PENNSYLVANIA

Laroy Northrop Castor, Jr.,[1] Philadelphia, Zoology.
Jacob Feldman, Philadelphia, Mathematical Sciences.
Wade Lanford Fite, Jenkintown, Physics.
Stuart Harvey Mudd, Haverford, Medical Sciences.

TEXAS

Grady Linder Webster, Cedar Valley, Botany.

WASHINGTON

Byron Adams Campbell, Seattle, Psychology.

WISCONSIN

William Louis Culberson, Madison, Botany.
Charles Whittlesey Curtis,[1] Madison, Mathematical Sciences.
James Frederick Hornig, Milwaukee, Chemistry.
Robert Ellsworth Ireland, Madison, Chemistry.
Waldo E. Johnson, Osseo, Zoology.
Michael Tinkham, Ripon, Physics.

WYOMING

Richard Edwin Cutkosky, Cheyenne, Physics.

[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
Amherst College, Amherst, Mass	8	......
Antioch College, Yellow Springs, Ohio	3	......
Augustana College, Rock Island, Ill	1	......
Baldwin-Wallace College, Berea, Ohio	1	......
Ball State Teachers College, Muncie, Ind	1	......
Bard College, Annandale-on-Hudson, N. Y	1	......
Bethany Peniel College, Bethany, Okla	1	......
Bethel College, McKenzie, Tenn	1	......
Birmingham-Southern College, Birmingham, Ala	4	......
Black Mountain College, Black Mountain, N. C	1	......
Bob Jones University, Greenville, S. C	1	......
Boston University, Boston, Mass	1	1
Bowdoin College, Brunswick, Me	1	......
Bowling Green State University, Bowling Green, Ohio	1	......
Brigham Young University, Provo, Utah	1	1
Brookhaven National Laboratory, Upton, Long Island, N. Y	......	2
Brooklyn College, Brooklyn, N. Y	6	......
Brown University, Providence, R. I	4	8
Bryn Mawr College, Bryn Mawr, Pa	1	......
Butler University, Indianapolis, Ind	1	......
California Institute of Technology, Pasadena, Calif.	18	47
Cameron State Agricultural College, Lawton, Okla.	1	......
Canisius College, Buffalo, N. Y	1	......
Carleton College, Northfield, Minn	4	......
Carnegie Institute of Technology, Pittsburgh, Pa	14	11
Carnegie Institution of Washington, Biological Laboratory, Cold Spring Harbor, N. Y	......	1
Case Institute of Technology, Cleveland, Ohio	7	......
Catholic University, Washington, D. C	2	1
Central College, Pella, Iowa	1	......
Chaffey Junior College, Ontario, Calif	1	......
City College of New York, N. Y	12	......
Claremont Graduate School, Claremont, Calif	......	1
Clark University, Worcester, Mass	1	......
Colby College, Waterville, Maine	1	......
College of Great Falls, Great Falls, Mont	1	......
College of William and Mary, Williamsburg, Va	1	......
College of Wooster, Wooster, Ohio	4	......
Colorado College, Colorado Springs, Colo	1	......
Columbia University, New York, N. Y	15	27
Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia	......	1
Concordia College, Moorhead, Minn	1	......
Cooper Union, School of Engineering, New York, N. Y	2	......
Cornell University, Ithaca, N. Y	24	25
Dartmouth College, Hanover, N. H	1	1
Deep Springs Junior College, Deep Springs, Calif	1	......

Delta State Teachers College, Cleveland, Miss	1	......
DePauw University, Greencastle, Ind	3	......
Drexel Institute of Technology, Philadelphia, Pa	1	......
Dickinson College, Carlisle, Pa	1	......
Duke University, Durham, N. C	2	4
Eau Claire State Teachers College, Eau Claire, Wis	1	......
Edinburgh University, Edinburgh, Scotland	......	1
Eidgenössiche Technische Hochshule, Zürich, Switzerland	......	2
El Camino College, El Camino College, Calif	1	......
Emory University, Emory University, Ga	......	2
Eureka College, Eureka, Ill	1	......
Florida State University, Tallahassee, Fla	1	5
Fordham University, New York, N. Y	1	......
Fresno State College, Fresno, Calif	1	......
Georg August University, Goettingen, Germany	......	1
George Washington University, Washington, D. C	3	2
Georgia Institute of Technology, Atlanta, Ga	2	3
Gettysburg College, Gettysburg, Pa	1	......
Hamline University, St. Paul, Minn	1	......
Hamilton College, Clinton, N. Y	1	......
Hanover College, Hanover, Ind	1	......
Harvard University, Cambridge, Mass	40	74
Haverford College, Haverford, Pa	3	......
Heidelberg College, Tiffin, Ohio	1	......
Hershey Junior College, Hershey, Pa	1	......
Hinds Junior College, Raymond, Miss	1	......
Hofstra College, Hempstead, N. Y	1	......
Holy Cross College, Worcester, Mass	1	......
Hopkins Marine Station, Pacific Grove, Calif	......	3
Illinois Institute of Technology, Chicago, Ill	7	1
Indiana University, Bloomington, Ind	6	8
Institute for Advanced Study, Princeton, N. J	......	6
Iowa State College, Ames, Iowa	8	13
Iowa State University, Iowa City, Iowa	4	1
John Muir College, Pasadena, Calif	2	......
Johns Hopkins University, Baltimore, Md	6	13
Junior College, Kansas City, Mo	1	......
Kalamazoo College, Kalamazoo, Mich	1	......
Kansas State College of Agriculture and Applied Science, Manhattan, Kans	1	1
Kenyon College, Gambier, Ohio	2	......
King's College, Bristol, Tenn	1	......
Knox College, Galesburg, Ill	1	......
Lebanon Valley College, Annville, Pa	1	......
Lehigh University, Bethlehem, Pa	7	2
Lewis and Clark College, Portland, Oreg	1	......
Los Angeles City College, Los Angeles, Calif	1	......
Los Angeles State College of Applied Arts and Sciences, Los Angeles, Calif	1	......
Louisiana State University, Baton Rouge, La	......	1
Loyola University, Chicago, Ill	1	......
Lyons Township Junior College, La Grange, Ill	1	......
Manchester College, Manchester, Ind	1	......
Manhattan College, New York, N. Y	1	......
Marine Biological Laboratory, Woods Hole, Mass	......	4
Marquette University, Milwaukee, Wis	2	1
Mars Hill College, Mars Hill, N. C	1	......
Massachusetts Institute of Technology, Cambridge, Mass	29	60
McNeese State College, Lake Charles, La	1	......
Messiah Junior College, Grantham, Pa	1	......
Miami University, Oxford, Ohio	4	1
Michigan State College, East Lansing, Mich	5	2

Institutions attended by National Science Foundation Fellows as Undergraduates and Graduate Students—Continued

Institution and location	Number of fellows attending: As undergraduates	As graduate students
Middlebury College, Middlebury, Vt	1	......
Milligan College, Milligan College, Tenn	1	......
Millsaps College, Jackson, Miss	1	......
Minot State Teachers College, Minot, N. Dak	1	......
Mississippi College, Clinton, Miss	1	......
Mississippi State College, State College, Miss	1	1
Missouri School of Mines and Metallurgy, Rolla, Mo.	2	......
Montana State College, Bozeman, Mont	3	2
Montana State University, Missoula, Mont	2	......
Morton Junior College, Cicero, Ill	1	......
Mount Holyoke College, South Hadley, Mass	1	......
Murray State College, Murray, Ky	1	......
Nebraska Wesleyan University, Lincoln, Nebr	3	......
Newcomb College, New Orleans, La	1	......
New Jersey State Teachers College, Upper Montclair, N. J	1	......
New York State Maritime College, Bronx, N. Y	1	......
New York University, New York, N. Y	7	5
North Carolina State College of Agriculture and Engineering, Raleigh, N. C	1	......
North Dakota Agricultural College, Fargo, N. Dak.	1	......
Northeastern Oklahoma Agriculture and Mechanical College, Miami, Okla	1	......
Northern Oklahoma Junior College, Tonkawa, Okla.	2	......
North Texas State College, Denton, Tex	2	2
Northwestern University, Evanston, Ill	13	11
Oak Ridge School of Reactor Technology, Oak Ridge, Tenn	......	1
Oberlin College, Oberlin, Ohio	11	......
Ohio State University, Columbus, Ohio	7	11
Ohio Wesleyan University, Delaware, Ohio	2	......
Oklahoma Agricultural and Mechanical College, Stillwater, Okla	6	4
Oregon State College, Corvallis, Oreg	2	5
Oxford University, Oxford, England	3	9
Palomar College, Vista, Calif	1	......
Pembroke College, Providence, R. I	1	......
Pennsylvania College for Women, Pittsburgh, Pa	1	......
Pennsylvania State University, State College, Pa	5	7
Philadelphia College of Pharmacy and Science, Philadelphia, Pa	1	......
Phillips University, Marburg, Germany	......	1
Polytechnic Institute of Brooklyn, New York	3	1
Pomono College, Claremont, Calif	3	......
Portland State Extension Center, Portland, Oreg	1	......
Pratt Institute, Brooklyn, N. Y	1	......
Princeton University, Princeton, N. J	7	36
Purdue University, Lafayette, Ind	6	11
Queens College of the City of New York, Flushing, Long Island, N. Y	3	......

Radcliffe College, Cambridge, Mass	3	5
Reed College, Portland, Oreg	6	......
Regis College, Denver, Colo	1	......
Rensselaer Polytechnic Institute, Troy, N. Y	3	1
Rice Institute, Houston, Tex	3	6
Ripon College, Ripon, Wis	1	......
Roosevelt College, Chicago, Ill	1	......
Royal Veterinary College, Stockholm, Sweden	......	1
Rutgers University, New Brunswick, N. J	7	......
St. Louis University, St. Louis, Mo	2	......
St. Michael's College, Winooski Park, Vt	1	......
St. Olaf College, Northfield, Minn	3	......
St. Thomas College, St. Paul, Minn	1	......
Sampson College, Sampson, N. Y	1	......
San Diego State College, San Diego, Calif	2	......
Santa Ana College, Santa Ana, Calif	1	......
Santa Rosa Junior College, Santa Rosa, Calif	2	......
Smith College, Northampton, Mass	1	......
South Dakota School of Mines and Technology, Rapid City, S. Dak	2	......
Southeastern State College, Durant, Okla	......	1
Southern Illinois University, Carbondale, Ill	2	......
Southern Methodist University, Dallas, Tex	1	......
Southwestern College, Winfield, Kans	1	......
Stanford University, Stanford, Calif	11	27
Sterling College, Sterling, Kans	1	......
Stockton College, Stockton, Calif	1	......
Sul Ross State College, Alpine, Tex	1	......
Swarthmore College, Swarthmore, Pa	15	1
Syracuse University, Syracuse, N. Y	1	1
Technische Hochschule, Munich, Germany	......	1
Temple University, Philadelphia, Pa	2	......
Texas Agricultural and Mechanical College, College Station, Tex	2	......
Trinity College, Hartford, Conn	1	......
Tufts College, Medford, Mass	1	......
Tulane University, New Orleans, La	2	3
Union College, Schenectady, N. Y	1	1
University College of North Wales, Bangor, Wales	......	1
University of Alabama, University Post Office, Ala	1	1
University of Arizona, Tucson, Ariz	1	......
University of Arkansas, Fayetteville, Ark	......	1
University of Bern, Bern, Switzerland	......	1
University of Birmingham, Birmingham, England	......	1
University of California, Berkeley, Calif	22	39
University of California, Davis, Calif	......	1
University of California, Los Angeles, Calif	9	15
University of Cambridge, Cambridge, England	2	6
University of Chattanooga, Chattanooga, Tenn	1	......
University of Chicago, Chicago, Ill	23	51
University of Cincinnati, Cincinnati, Ohio	2	......
University of Colorado, Boulder, Colo	3	3
University of Connecticut, Hartford, Conn	1	......
University of Copenhagen, Copenhagen, Denmark	......	6
University of Delaware, Newark, Del	......	3
University of Detroit, Detroit, Mich	3	......
University of Florida, Gainesville, Fla	2	2
University of Glasgow, Glasgow, Scotland	......	1
University of Grenoble, Grenoble, France	......	1
University of Hawaii, Honolulu, T. H	1	......
University of Houston, Houston, Tex	1	1
University of Illinois, Urbana, Ill	14	44
University of Kansas, Lawrence, Kans	7	6
University of London, London, England	......	2

Institutions attended by National Science Foundation Fellows as Undergraduates and Graduate Students—Continued

Institution and location	Number of fellows attending: As undergraduates	Number of fellows attending: As graduate students
University of Maine, Orono, Maine	2	......
University of Maryland, College Park, Md	4	......
University of Massachusetts, Amherst, Mass	......	1
University of Miami, Coral Gables, Fla	2	5
University of Michigan, Ann Arbor, Mich	13	19
University of Minnesota, Minneapolis, Minn	13	19
University of Missouri, Columbia, Mo	3	1
University of Nebraska, Lincoln, Nebr	3	3
University of Nevada, Reno, Nev	3	2
University of New Hampshire, Durham, N. H	1	1
University of New Mexico, Albuquerque, N. Mex	......	2
University of North Carolina, Chapel Hill, N. C	3	6
University of Notre Dame, Notre Dame, Ind	4	5
University of Oklahoma, Norman, Okla	10	5
University of Omaha, Omaha, Nebr	2	......
University of Oregon, Eugene, Oreg	3	2
University of Paris, Paris, France	......	6
University of Pennsylvania, Philadelphia, Pa	12	13
University of Pittsburgh, Pittsburgh, Pa	1	4
University of Portland, Portland, Oreg	1	......
University of Redlands, Redlands, Calif	1	......
University of Rochester, Rochester, N. Y	5	8
University of the South, Sewanee, Tenn	1	......
University of South Carolina, Columbia, S. C	2	......
University of Southern California, Los Angeles, Calif.	2	2
University of Strasbourg, Strasbourg, France	......	1
University of Tennessee, Knoxville, Tenn	2	2
University of Texas, Austin, Tex	5	7
University of Utah, Salt Lake City, Utah	4	5
University of Vermont, Burlington, Vt	1	......
University of Virginia, Charlottesville, Va	......	3
University of Washington, Seattle, Wash	8	10
University of Wichita, Wichita, Kans	1	1
University of Wisconsin, Madison, Wis	13	46
U. S. Naval Academy Postgraduate School, Annapolis, Md	......	1
USAF Institute of Technology, Wright-Patterson Air Force Base, Ohio	1	......
Utah State Agricultural College, Logan, Utah	2	1
Vanderbilt University, Nashville, Tenn	4	3
Vanport College, Portland, Oreg	1	......
Villanova College, Villanova, Pa	1	......
Virginia Polytechnic Institute, Blacksburg, Va	2	......
Wagner College, Staten Island, N. Y	1	......
Washington and Jefferson College, Washington, Pa.	1	......
Washington and Lee University, Lexington, Va	1	......
Washington State College, Pullman, Wash	4	2
Washington University, St. Louis, Mo	6	9
Wayne State Teachers College, Wayne, Nebr	1	......
Wayne University, Detroit, Mich	2	1

Wellesley College, Wellesley, Mass.	1	......	Whitman College, Walla Walla, Wash.	1	......
Wesleyan University, Middletown, Conn.	5	2	Whitworth College, Spokane, Wash.	1	......
Western Kentucky State Teachers College, Bowling Green, Ky.	1	......	Willamette University, Salem, Oreg.	1	......
Western Michigan College of Education, Kalamazoo, Mich.	2	......	William Jewell College, Liberty, Mo.	1	......
Western Reserve University, Cleveland, Ohio	3	3	Williams College, Williamstown, Mass.	2	......
Western Washington College of Education, Bellingham, Wash.	2	......	Wilson Junior College, Chicago, Ill.	2	......
Wheaton College, Wheaton, Ill.	3	......	Winona State Teachers College, Winona, Minn.	2	......
			Wright Junior College, Chicago, Ill.	2	......
			Yale University, New Haven, Conn.	9	31
			Yeshiva University, New York, N. Y.	1	......

APPENDIX V

Executive Order Concerning Government Scientific Research

TITLE 3—THE PRESIDENT

Executive Order 10521

Administration of Scientific Research by Agencies of the Federal Government

Whereas the security and welfare of the United States depend increasingly upon the advancement of knowledge in the sciences; and

Whereas useful applications of science to defense, humanitarian, and other purposes in the Nation require a strong foundation in basic scientific knowledge and trained scientific manpower; and

Whereas the administration of Federal scientific research programs affecting institutions of learning must be consistent with the preservation of the strength, vitality, and independence of higher education in the United States; and

Whereas, in order to conserve fiscal and manpower resources, it is necessary that Federal scientific research programs be administered with all practicable efficiency and economy; and

Whereas the National Science Foundation has been established by law for the purpose, among others, of developing and encouraging the pursuit of an appropriate and effective national policy for the promotion of basic research and education in the sciences:

Now, therefore, by virtue of the authority vested in me as President of the United States, it is hereby ordered as follows:

Section 1. The National Science Foundation (hereinafter referred to as the Foundation) shall from time to time recommend to the President policies for the Federal Government which will strengthen the national scientific effort and furnish guidance toward defining the responsibilities of the Federal Government in the conduct and support of scientific research.

Sec. 2. The Foundation shall continue to make comprehensive studies and recommendations regarding the Nation's scientific research effort and its resources for scientific activities, including facilities and scientific personnel, and its foreseeable scientific needs, with particular attention to the extent of the Federal Government's activities and the resulting effects upon trained scientific personnel. In making such studies, the Foundation shall make full use of existing sources of information and research facilities within the Federal Government.

Sec. 3. The Foundation, in concert with each Federal agency concerned, shall review the scientific research programs and activities of the Federal Government in order, among other purposes, to formulate methods for strengthening the administration of such programs and activities by the responsible agencies, and to study areas of basic research where gaps or undesirable overlapping of support may exist, and shall recommend to the heads of agencies concerning the support given to basic research.

Sec. 4. As now or hereafter authorized or permitted by law, the Foundation shall be increasingly responsible for providing support by the Federal Government for general-purpose basic research through contracts and grants. The conduct and support by other Federal agencies of basic research in areas which are closely related to their missions is recognized as important and desirable, especially in response to current national needs, and shall continue.

Sec. 5. The Foundation, in consultation with educational institutions, the heads of Federal agencies, and the Commissioner of Education of the Department of Health, Education, and Welfare, shall study the effects upon educational institutions of Federal policies and administration of contracts and grants for scientific research and development, and shall recommend policies and procedures which will promote the attainment of general national research objectives and realization of the research needs of Federal agencies while safeguarding the strength and independence of the Nation's institutions of learning.

SEC. 6. The head of each Federal agency engaged in scientifiic research shall make certain that effective executive, organizational, and fiscal practices exist to ensure (a) that the Foundation is consulted on policies concerning the support of basic research, (b) that approved scientific research programs conducted by the agency are reviewed continuously in order to preserve priorities in research efforts and to adjust programs to meet changing conditions without imposing unnecessary added burdens on budgetary and other resources, (c) that applied research and development shall be undertaken with sufficient consideration of the underlying basic research and such other factors as relative urgency, project costs, and availability of manpower and facilities, and (d) that, subject to considerations of security and applicable law, adequate dissemination shall be made within the Federal Government of reports on the nature and progress of research projects as an aid to the efficiency and economy of the overall Federal scientific research program.

SEC. 7. Federal agencies supporting or engaging in scientific research shall, with the assistance of the Foundation, cooperate in an effort to improve the methods of classification and reporting of scentific research projects and activities, subject to the requirements of security information.

SEC. 8. To facilitate the efficient use of scientific research equipment and facilities held by Federal agencies:

(a) the head of each such agency engaged in scientific research shall, to the extent practicable, encourage and facilitate the sharing with other Federal agencies of major equipment and facilities;

(b) a Federal agency shall procure new major equipment or facilities for scientific research purposes only after taking suitable steps to ascertain that the need cannot be met adequately from existing inventories or facilities of its own or of other agencies; and

(c) the Interdepartmental Committee on Scientific Research and Development shall take necessary steps to ensure that each Federal agency engaged directly in scientific research is kept informed of selected major equipment and facilities which could serve the needs of more than one agency. Each Federal agency possessing such equipment and facilities shall maintain appropriate records to assist other agencies in arranging for their joint use or exchange.

SEC. 9. The heads of the respective Federal agencies shall make such reports concerning activities within the purview of this order as may be required by the President.

DWIGHT D. EISENHOWER.

THE WHITE HOUSE,
March 17, 1954.

820814—54——9

APPENDIX VI

Institutions Represented at the Conferences on Research in Small Colleges

Institution	Biology	Chemistry	Geology	Physics	Astronomy
Abilene Christian College, Abilene, Tex.	x				
Agnes Scott College, Decatur, Ga.					x
Alaska, University of, College, Alaska			x		
Allegheny College, Meadville, Pa.	x				
Amherst College, Amherst, Mass.	x	x		x	x
Antioch College, Yellow Springs, Ohio	x			x	
Arizona, University of, Tucson, Ariz.					x
Augustana College, Rock Island, Ill.			x		
Beloit College, Beloit, Wis.			x	x	
Bryn Mawr College, Bryn Mawr, Pa.	x	x		x	
Bowdoin College, Brunswick, Maine		x			
California, University of, Riverside, Calif.					
Carleton College, Northfield, Minn.	x	x	x	x	
Case Institute of Technology, Cleveland, Ohio					x
City College of New York, New York, N. Y.					x
Clemson College, Clemson, S. C.				x	
Colby College, Waterville, Maine	x				
Colorado College, Colorado Springs, Colo.	x		x	x	
Dartmouth College, Hanover, N. H.		x			x
Davidson College, Davidson, N. C.		x			
Dillard University, New Orleans, La.	x				
Duke University, Durham, N. C.			x		
Earlham College, Richmond, Ind.			x		
Emory University, Atlanta, Ga.		x			
Florida State University, Tallahassee, Fla.			x		
Franklin and Marshall College, Lancaster, Pa.			x		
Fresno State College, Fresno, Calif.			x		
Furman University, Greenville, S. C.		x			
Georgetown University, Washington, D. C.					x
Grinnell College, Grinnel, Iowa		x		x	
Hampden-Sydney College, Hampden-Sydney, Va.				x	
Harpur College, Endicott, N. Y.			x		
Haverford College, Haverford, Pa.		x			x
Hofstra College, Hempstead, N. Y.	x				
Hollins College, Hollins College, Va.	x			x	
Hope College, Holland, Mich.	x	x			
Howard College, Birmingham, Ala.				x	
Illinois, University of, Urbana, Ill.		x			x
Kalamazoo College, Kalamazoo, Mich.	x			x	
Knox College, Galesburg, Ill.	x				

INSTITUTIONS REPRESENTED AT THE CONFERENCES ON RESEARCH IN SMALL COLLEGES—Continued

Institution	Biology	Chemistry	Geology	Physics	Astronomy
Lafayette College, Easton, Pa			x		
Lake Forest College, Ill				x	
Lawrence College, Appleton, Wis		x	x		
Linfield College, McMinnville, Oreg	x			x	
Louisiana State University, Baton Rouge, La					x
Loyola University, New Orleans, La				x	
Maine, University of, Orono, Maine			x		
Michigan, University of, Ann Arbor, Mich					x
Middlebury College, Middlebury, Vt		x			
Mississippi Southern College, Hattiesburg, Miss			x		
Monmouth College, Monmouth, Ill		x			
Montana School of Mines, Butte, Mont			x		
Morehouse College, Atlanta, Ga	x				
Morgan State College, Baltimore, Md				x	
Minnesota, University of, Minneapolis, Minn					x
Mt. Holyoke College, South Hadley, Mass		x		x	x
New York College of Ceramics, N. Y				x	
North Carolina, University of, Chapel Hill, N. C		x			
North Dakota Agricultural College, Fargo, N. Dak			x		
North Texas State College, Denton, Tex		x			
Notre Dame, University of, Notre Dame, Ind			x		
Oberlin College, Oberlin, Ohio	x	x		x	
Oklahoma, University of, Norman, Okla					x
Ohio Wesleyan University, Delaware, Ohio					x
Pennsylvania State College, State College, Pa					x
Pittsburgh, University of, Pittsburgh, Pa					x
Pomona College, Claremont, Calif	x	x	x	x	
Principia College, Elsah, Ill			x		
Randolph-Macon College, Ashland, Va					x
Reed College, Portland, Oreg	x	x		x	
Santa Barbara College, Santa Barbara, Calif	x				
Seton Hill College, Greensburg, Pa	x				
Smith College, Northampton, Mass			x		x
Swarthmore College, Swarthmore, Pa	x			x	x
Toronto, University of, Toronto, Ontario					x
Union College, Schenectady, N. Y	x				
Utah State Agricultural College, Logan, Utah			x		

INSTITUTIONS REPRESENTED AT THE CONFERENCES ON RESEARCH IN SMALL COLLEGES—Continued

Institution	Biology	Chemistry	Geology	Physics	Astronomy
Vanderbilt University, Nashville, Tenn	....	....	x	....	x
Vassar College, Poughkeepsie, N. Y	....	x	....	....	x
Wabash College, Crawfordville, Ind	x	x	....	x	....
Washington, State College of, Pullman, Wash	....	....	x	....	....
Washington and Lee University, Lexington, Va	....	x	x	....	....
Washington, University of, Seattle, Wash	....	....	....	....	x
Wellesley College, Wellesley, Mass	x	....	....	....	x
Wesleyan College, Macon, Ga	x	....	....	....	....
Wesleyan University, Middletown, Conn	x	x	x	x	x
Whitman College, Walla Walla, Wash	x	x	....	....	....
Wichita, University of, Wichita, Kans	....	....	x	....	....
William Jewel College, Liberty, Mo	....	x	....	....	....
William and Mary, College of, Williamsburg, Va	x	....	....	....	....
Wooster, College of, Wooster, Ohio	x	....	....	x	....

APPENDIX VII

The International Geophysical Year—Proposed United States Program

The United States program for the International Geophysical year is described by fields below. It envisages activities in several geographical regions of concern to the Nation: (1) The Arctic and sub-Arctic regions; (2) the middle latitudes of the Northern and Southern Hemispheres, including the United States, Central America, South America, and adjacent stretches of the Atlantic and Pacific Oceans; and (3) the Antarctic and sub-Antarctic regions. The effort in these regions varies with present, sustained geophysical activities in each region and with technical needs. Existing activities of the former kind, whose results will be made available in the program, afford a substantial base for the total endeavor, and the proposed program represents those added efforts which are required for advances in geophysics expected from a major United States activity, in combination with similar special and expanded investigations by other nations.

Emphasis of much of the program is upon the Arctic and sub-Arctic, Antarctic and sub-Antarctic, a few zones in South America, and the Atlantic and Pacific Oceans. It is not necessary, in many of the programs, to add much activity within the United States, for normal operations provide this data. For example, the meteorology program includes only a few South American stations and work in the Antarctic. The data from these regions, added to those from existing Weather Bureau stations in the United States and in the North Pole regions, will provide adequate coverage for the crucial experiments planned in the Western Hemisphere. Similarly, the ionospheric, auroral, and geomagnetic programs stress the northern and southern latitudes.

ASTROGEOPHYSICAL MEASUREMENTS

Many of the most practical and everyday activities of man and society are affected and determined by astronomical phenomena. Surveying, whether of continental coast lines or real estate lots, mapping and charting of land and sea, tidal currents, magnetic compass and radio navigation, travel and commerce over land, sea, or air, radio communications, typhoons, duststorms and rainless regions are typical of the activities and phenomena that are closely linked to the sun, moon, and stars.

The sun, in particular, dominates events and activities on the earth. The sun's radiation—electromagnetic and particle—is the major source of energy for the earth's atmosphere and indirectly for all types of life on this planet. Some solar effects are obvious to the layman—the gross diurnal variations in weather phenomena, the weather changes by seasons, the temperature differences between the equator and the poles. Solar variations are not particularly important in these connections. Less obvious but of equally great significance to modern civilization are the effects of solar activity on the upper atmosphere. Unusual solar radiation, either in intensity or in kind, strongly influences the upper atmosphere and, indirectly, not only weather phenomena but radio communications, radio navigational systems, and many other civilian and military activities.

Solar activity has several time scales: Overall activity, measured in a number of ways, grows and subsides alternately in about 11 years—the "sunspot cycle." Individual active regions on the sun, sometimes marked by sunspots, have lifetimes of a few days to a few months, changing rather gradually during that time. Spurts of activity, occasionally during "sunspot minimum" but common during the high activity stages of the 11-year cycle, occur in some individual solar regions and last a few hours or a few days, with individual outbursts or flares lasting only 10 to 30 minutes or so.

Variation in solar activity on each of these time scales have been shown to be associated with terrestrial phenomena. Many details of these correlations, however, remain hazy because of the many interruptions in the record of solar activity observations. Further correlations of broad implications to science and civilization require detailed and comprehensive records of solar activity. The chief aim of the solar activity work during the IGY is to achieve this record by systematic observations of the sun, through improved coordination of the observing programs of the solar observatories of the world, and through more detailed, speedy and meaningful compilation of observations by coordinated reduction with workers in the relevant fields of geophysics.

Solar activity—solar flares, coronal and chromospheric activity, and sun spots—will be observed as part of the overall geophysical program. In particular, solar flares will be studied in order to correlate them with changes in cosmic rays, ionospheric and auroral disturbances, and meteorological phenomena. One of the immediate uses to which flare data will be put during the IGY has to do with the "Warning Service" program (see below). While regularly planned measurements will go on during the IGY, it is especially important that experiments be conducted simultaneously throughout the world during periods of unusual activity of the sun. The Warning Service will collect data from all fields, as well as solar activity, and will broadcast the imminence, onset or presence of unusual geophysical effects, such as solar flares, magnetic storms, ionospheric fadeouts and blackouts, signaling the observers to proceed with their special preestablished study programs.

The IGY also affords an opportunity to achieve a marked advance in longitude and latitude measurements. There are two kinds of longitude and latitude: Geographic and astronomical. Geographic coordinates must be used in mapping and can only be obtained for the earth as a whole by observing the moon or by measurements of gravity all over the earth, which have never been adequately obtained. Astronomical coordinates can be determined accurately only by observing the stars. While these are not useful for making maps, their high precision makes them useful for detecting a possible shift in the distance between two land masses.

The longitudes and latitudes of numerous points in all civilized countries have been accurately measured so that accurate maps of large regions have been possible. But it has not been possible to extend the surveys across the oceans because they are too wide: There are not islands enough to use as stepping stones, nor has it been possible to connect the separate networks of longitudes and latitudes with each other more accurately than 200 or 300 feet, and the location of some islands is uncertain by a mile. The moon, however, can be used as a stepping stone across oceans, using a new photographic technique that makes it possible to observe the moon with the necessary precision whenever it can be seen at night. This makes it possible to accomplish as much in a single year as could be done in a century by the older methods, provided a sufficient number of observatories, well distributed geographically, are included in the program. The observational technique consists of direct photography of the moon, the camera being specially devised to hold the image of the moon stationary among the stars while the exposure is being made. The probable error of a single observation is about 0.15 second of arc, corresponding in general to about 900 feet on the earth. Thus, 200 observations at each of 2 stations should give the distance between them with a probable error of about 90 feet. The new technique adds greatly to the precision with which changes in the speed of rotation of the earth can be measured, and the observational material obtained for this geodetic program may be expected to shed new light on the inner constitution of the earth.

METEOROLOGY

The atmosphere is the working fluid of an enormous engine which picks up heat in the tropics and discharges it in the polar regions. In the course of this complex thermodynamic process, the atmosphere creates winds and weather. Measurements of temperatures, pressures, humidities, and winds from the few hundred such stations in the Northern Hemisphere are assembled into a picture of the current state of the atmosphere, and are used to explain the existing weather patterns and to predict their changes. In spite of the large increase in number of these sounding-balloon observations in recent decades, there exist vast volumes of the atmosphere still unexplored. The relatively known portion of the atmosphere is largely limited to the lower reaches of the atmosphere in the Northern Hemisphere: The air masses of the Southern Hemisphere and of the whole upper atmosphere remain largely unknown. No marked advance in meteorology appears likely without a major international cooperative effort in this field and the related fields of geophysics.

The proposed United States program in meteorology will provide significant data in three areas: The lower atmosphere in the Northern Hemisphere, where there exist a number of stations in norcal operation; the Southern Hemisphere where strategic, temporary new stations are proposed in order to understand this largely unknown region; and the upper atmosphere from which data will be obtained in the rocket-exploration program.

The North and South Poles will be connected with a line of weather stations equipped with sounding balloons capable of going to heights of 100,000 feet or more. Stations are to be established along three pole-to-pole world lines. The data obtained thereby should provide clues as to whether southern hemispheric weather changes precede and control those in the Northern Hemisphere, or whether both these are controlled by upper atmospheric conditions (perhaps brought about by changes in solar radiation). The world line which the United States is most interested in is the 80th meridian, west of Greenwich, passing through the eastern portions of North America and the west coast of South America, making use of existing stations in the Northern Hemisphere. The northern terminus of this line is Eureka, N. W. T. at 80° N., completely equipped with weather instruments and sounding balloons. The line then passes through the joint Canadian-United States operated Arctic weather stations in the Canadian Archipelago and the Canadian stations in the Hudson Bay area, entering the United States at Buffalo. It hops along a series of United States stations, crosses over to stations in the Caribbean, and reaches the Pacific Ocean at Balboa. There the presently existing line comes to an end, well north of the equator.

It is proposed to extend this line to the South Pole by establishing eight additional weather stations—the minimum needed for scientific analysis. Five of these stations would be located along the west coast of South America and the remaining 3 in Antarctica. The only presently existing station of this kind in South America, Port Stanley (Falkland Islands), would be incorporated in the line.

Four of the proposed five new stations for South America would be located at sites already recommended for weather-aviation purposes by the International Civil Aeronautics Organization (ICAO) and endorsed by the World Meteorological Organization (WMO). These four stations are Guayaquil, Ecuador; Lima, Peru; Santiago, Chile; and San Carlos de Bariloche, Argentina. It is proposed that the United States furnish the technical guidance and specialized weather equipment, and that the respective South American countries furnish the 16 observers necessary to man the 4 stations. The fifth South American station would be located at the Smithsonian Institution solar station at Montezuma, Chile. Existing facilities and part-time assistance by resident observers there would be used to reduce the cost of maintaining this fifth station.

In Antarctica, three stations would be established: At Little America, at a point near 80° S., 120° W., and at the South Pole. These stations would complete the pole-to-pole line. The Little America station would also permit comparison with meteorological observations made by previous expeditions.

The data from this line of stations will be used in the study of various transport problems, e. g., heat, momentum, energy, and water vapor. Equally important uses will be the determination of the location, strength, and movement of the various jet streams, the study of the possible interdependence of circulations of both hemispheres, and the addition of the Southern Hemisphere circulation to our knowledge. The Antarctic observations will also shed further light on the reported differences in the wintertime structure of the upper troposphere and of the lower stratosphere between the Arctic and Antarctic regions, leading to a better understanding of the general circulation of the atmosphere.

The proposed Antarctic station near 80° S., 120° W., which introduces a slight "dog-leg" in the pole-to-pole line of stations, is chosen to permit the study of a phenomenon uncovered from weather observations made by the Ross Expedition nearly 50 years ago. Study of these records revealed the existence of air pressure waves or "surges" spreading outward from the neighborhood of 80° S., 120° W. Since the atmosphere over Antartica is known to be the coldest in the world, both winter and summer, and also has in its Ross Sea area the most persistent low atmospheric pressure belt found anywhere, it is possible that the effect of Antartica on world weather may be proportionately much greater than indicated by its size. The proposed three stations in the Antarctic, particularly that at the supposed point of origin of the waves, plus the Antarctic stations to be established by other countries will provide the needed Antarctic meteorological data.

OCEANOGRAPHY AND GLACIOLOGY

Water in one form or another covers some four-fifths of the earth's surface. Of the earth's 197 million square miles of surface, the oceans account for some 147 millions; ice sheets, ice caps, and glaciers account for another 10 million or so. The oceans are superficially well known as avenues of travel and commerce and as reservoirs of food and dissolved minerals. Glaciers are less well known—largely and simply as ice masses associated with high mountain ranges. Yet these two major features of our earth-surface environment play a critical part in man's existence and being. Both oceanography and glaciology are linked to atmospheric events. The relationship between these fields and meteorology and solar activity is particularly close. Oceanography is intimately related to weather, and there is an interplay between atmospheric and oceanic temperatures and water content. Glaciology is closely related to climatology—the longer-range changes in weather. Both are tied together in their roles as depositories of the global water budget.

Oceanography.—As in the other fields of geophysics, the study of oceanography requires the conduct of many experiments and the taking of many measurements if major problems are to be solved. These problems have to do with the nature of oceanic currents, temperature, composition and levels, and total water content. A major problem is the study of the annual cycle in sea level and the global water budget of the oceans. Although all available tide gauge and temperature data have been studied, the problem remains unsolved—because a minimum of 20 years of tide observations at a station are required to give a meaningful average, so that values in one area can be compared with values in another area taken at a different time. As much or more could be learned by synchronous measurements during one specific year. Simultaneous measurements of fluctuations in sea level are probably the most effective and the least expensive means of studying the "weather" of the oceans—i. e., the fluctuations in ocean currents with time. To be of value, these observations must extend over vast ocean areas.

In low latitudes the recorded seasonal changes in sea level are about what can be inferred from observed changes in temperature of the superficial layers, indicating a change in specific volume rather than in mass. In high latitudes, there is also a change in mass. If these changes are associated with changes in currents, the currents at mid-latitude may be essentially confined to superficial layers, whereas at high latitudes they may extend to the very bottom and are therefore not measurable by present standard techniques. Moreover recorded sea level is lower by about one-half foot in the Northern Hemisphere in northern spring and in the Southern Hemisphere in southern spring than in the respective fall seasons. From present data it cannot be determined whether this involves flow of water across the Equator or between the fringes of the ocean basins (where nearly all tide stations are located) and the central portions (where observations are inadequate).

Such problems are analogous in oceanography to those in the meteorologic program involving measurements of air flow across a meridian and across the Equator. Similarly, the solution requires synchronous global measurements, which include (*a*) observations and reduction of data from existing tide stations; (*b*) temporary tide gages or surge recorders at some 40 stations with emphasis on islands and the Southern Hemisphere, particularly the Antarctic; and (*c*) weekly temperature readings to depths of about 1,000 feet offshore from as many tide gage stations as possible. In addition to these tide and surge observations, a major study will be undertaken of the sub-Antarctic oceans. The structure and dynamics of currents and other oceanic phenomena of this region, which is little known but of great importance in several fields of geophysics, will be explored intensively.

Glaciology.—Glacier studies have given clear indications that we are now in a cycle of warming which began about 1900. It is estimated that if the indicated warming continues for another 25 to 50 years, the ice will melt out of the Arctic Ocean in the summer, making it navigable. In addition, the warming cycle, if continued, may melt enough ice now tied up in glaciers to add to the sea level sufficiently to affect the lives of millions of people living along low coastal lands. Whether this actually happens or not, the slow change of climate has already begun to show a change of storm paths and redistribution of rainfall, rendering some areas previously well-watered more arid and, in turn, bringing water to arid regions.

The objectives of the United States glaciological efforts in the IGY program will be twofold: (1) To extend the studies of glaciers on a worldwide basis in conjunction with similar efforts of other countries and (2) to coordinate the existing observations of glaciers with the varied worldwide efforts in other fields of geophysics in order to establish quantitative and qualitative indications of long-term climatic variations affecting the world as a whole. The plan includes: (1) Assembly of all available data on the variations of glaciers; (2) analysis of the data obtained to determine the extent to which glacier variations are caused by climatic change; (3) study of the hydrological economy of specific glaciers with respect to meteorological factors; and (4) studies to establish, correlate, and trace climatic trends of the past and to improve future predictions by combining these findings with those of solar and atmospheric physics.

Two major efforts are planned in the Northern Hemisphere: (*a*) Alaska. One study region will be concentrated in the vicinity of the American Geographical Society's Juneau Ice Field project. Because of the significance of data already collected in the region, conduct of the study during the IGY will be unusually valuable. (*b*) Greenland. Intensive glacial studies of portions of the Ice Cap and fringe area in Greenland will be undertaken in cooperation with Danish scientists associated with IGY. Two Antarctic studies are also planned: (*a*) Little America. The Ross Shelf is the largest sheet glacier of its type in the world and has been studied in part by American expeditions of the past. Much quantitative information is still lacking, and considerably more can be supplied by this effort. Among the major tasks will be the survey of the 400-mile front of this glacier feature for estimates of quantitative changes. Maps and aerial photographs of this region are available; and the IGY efforts, taking advantage of this prior work, should provide a major indication of the rates of snow accumulation and wastage over a large segment of the continent. In addition, the Bay of Whales area provides a vast laboratory of glacial phenomena fundamental to the understanding of glacial mechanics. (b) Satellite stations. Descriptions of the glacial conditions and snow accumulation on the high polar plateau indicate that the South Pole station affords a unique opportunity to obtain glaciological data not now known. A glacial team of three observers will be stationed at this substation. Similar work will be carried out at the station at latitude 80° S., longitude 120° W. Operation of three stations will permit direct correlation with one another as well as with the IGY glacial studies of other nations in the Antarctic.

IONOSPHERIC PHYSICS

The ionosphere is a region of rarified, ionized gas between 50 and 250 miles above the surface of the earth. Somewhat as a mirror reflects light, the ionosphere reflects radio waves and thus makes possible long-range radio communications, radio telephony, and radio navigation. The analogy between the ionosphere and a mirror holds roughly true only in terms of this reflective property, for the ionosphere is a complex, vast region of the atmosphere, fluctuating in height and depth, varying in its ionization, and importantly affected by solar activity, geomagnetic disturbances, the aurora, and perhaps by meteors and thunderstorms.

A study of the ionosphere also inherently involves a study of geomagnetism, the aurora, and solar activity. While the "normal" (i. e., closely predictable) ionosphere is maintained by solar radiation, the occurrences of disturbed ionic layers are associated with disturbances on the sun. A solar flare may be immediately followed by a sudden ionospheric disturbance. The growth of active sunspots may be followed within a few days by geomagnetic storminess and violent auroral displays. These displays, which occur in high latitudes of the Northern and Southern Hemispheres, are frequently accompanied by radio blackouts which may completely paralyze communications in these regions. Isolated meteorological or other observing stations find that although they may use radar locally, weather and associated information cannot be transmitted to central coordinating sites. This problem is one of immediate concern to the United States, particularly since the northern auroral zone lies more over North America than over any other continent.

Radio blackouts affect radio contact not only in the Arctic but in middle latitudes as well. Radio waves propagating between any two points follow the great circle distance between these points. Because of the location of centers of population in the Northern Hemisphere, most radio communication paths from points in the United States to Great Britain, Europe and Asia penetrate or come close to the auroral zone; these communication channels are also subjected to absorption and radio blackouts, and other communication paths must be sought.

Solar activity changes greatly during the 11-year sunspot cycle. During periods of sunspot minimum, the sun is quiet; the ionosphere is then relatively normal and badly disturbed radio conditions are rare. During the several years, however, when sunspot activity is high, communications are often erratic over most regions of the globe. The period chosen for the IGY coincides with a period of maximum solar activity.

Predicting the future state of the ionosphere is one of the major problems in ionospheric physics. The prediction must indicate whether or not direct radio contact will be possible, the frequencies to be employed if the possibility is good, and the alternative "radio routes" and frequencies if the probability for direct contact is low. With regard to the Arctic, the problems are many and complex, and it is equally possible to have a failure in an ionospheric prediction as in a weather forecast. Improvement in radio prognostication requires, among other things, additional observing stations in the Arctic regions, not only for the ionosphere but also for geomagnetism and for the aurora.

An intensive coordinated study and observational program in each of these fields is required. A study of the ionosphere can scarcely be undertaken from observations made in only one nation or in one portion of the world. A national network is insufficient for the prediction of conditions either over extensive geographic areas or over extended time periods. While attempts at extrapolation may be made over the "silent areas," the accuracies are quite low.

While meteorological observations at a single site are confined to the weather parameters in the general vicinity of the station, new techniques in ionospheric observations make it possible to gain information about the ionosphere thousands of miles away. This is accomplished by oblique-incidence, back-scatter probings, which in one form of the experiment can be rotated in azimuth so as to provide information in 1 or 2 circular zones whose radii may be about 600 and 1,200 miles, respectively. This new technique greatly increases the flexibility of the observational network, but a clear interpretation of the results still requires extensive comparison with the usual type of vertical incidence probings. The latter observations provide ionospheric information only in the immediate locale of the station. The use of the oblique-incidence stations capitalizes on this new observational technique and will contribute to improvements in ionospheric predictions. More intensive study, especially of the Arctic atmosphere (by ionospheric, auroral, and geomagnetic observations), will provide a new dimension for the improvement of radio forecasts.

The ionospheric physics program consists of three principal sets of investigations, involving Arctic and Antarctic regions as well as central zones in the Northern and Southern Hemispheres: (1) A series of vertical incidence soundings whereby the ionosphere is probed by radar pulses, (2) a series of scatter soundings whereby broad areas of the ionosphere are swept by radio energy of fixed and multiple frequencies, and (3) some studies of basic properties of the ionosphere layers having to do with the mechanical and atomic dynamics of the ionospheric atmosphere.

Vertical soundings.—Vertical sounding measurements of the ionosphere provide data on the vertical height of the ionosphere layers and on the critical radio frequencies. Because the ionosphere varies in space and in time, information is needed over the surface of the earth, taken regularly throughout the day and night. Automatic ionospheric instruments are used to probe the ionosphere at frequent intervals, using radar techniques. The radar pulses are transmitted vertically up and their reflections are picked up by the same device, which measures the round-trip transit time and thus permits the determination of the distance to the ionosphere.

These data from many stations over the earth are needed for an understanding of the ionosphere as a whole, for insight into the behavior of radio waves over the frequency range from 1 megacycle to 25 megacycles, and for use in the prediction of frequencies that can be used in long-range radio communications. At the present time, reasonably adequate coverage is available in the United States through its chain of stations, while excellent coverage is available in Canada, which proportionately, has a denser network of stations. Major gaps of interest to the United States exist in the Arctic, South America, Antarctic, and North Atlantic; gaps in other parts of the world, of most direct interest to other nations, will be covered by the latter; and the combined data will be invaluable in advancing basic ionospheric knowledge and improving radio communications. The United States program in vertical soundings consists of four parts: (1) Arctic and South America, (2) Antarctic, (3) North Atlantic, and (4) Data Quality Control.

Scatter soundings.—Vertical soundings provide specific data on ionospheric height in the limited region immediately over the station. Ideally, to map the ionosphere adequately would require a dense network—literally thousands in the United States alone as against the present four. To provide data over large regions, scatter sounding is used giving oblique incidence data over a large area as the antenna is rotated, actually or in effect to scan the ionosphere. Two types of scatter sounding studies are needed: Fixed frequency and multifrequency.

Ionospheric dynamics.—More data are needed on the specific properties of the ionosphere as well as on its overall behavior as a whole. The behavior of molecules and electrons in the ionosphere—in particular, molecular and electron collisions and motions—can reveal the radiowave absorption properties and temperature of the ionospheric layers. In addition to individual particle motions, there are motions of patches of ionized particles. These motions constitute ionospheric winds, whose dynamics need to be explored for basic and applied reasons. Two investigations are to be undertaken in this area: (1) Ionospheric winds and (2) cross modulation experiments.

AURORA AND AIRGLOW

The bombardment of the earth's atmosphere by electrically charged particles produces four major effects. One effect is characterized by very high speed particles which produce cosmic rays. The other three come from relatively low speed particles. Their manifestations are: (*a*) Magnetic storms, (*b*) ionospheric storms, and (*c*) the aurora, which is the luminous trace of the charged particles in the atmosphere. All three of these phenomena give us an insight into the effects of the bombardment of the atmosphere by charged particles. Comprehensive studies of these subjects not only tell us the nature of the upper atmosphere and the action of the bombarding particles, but also provide us with the knowledge needed to predict the amount and kind of disruption of radio communications, how best to circumvent it, or actually how to utilize the aurora as a means of propagating radio waves. The disruption of radio communications is felt mostly in the Arctic and sub-Arctic regions and corresponding areas in the Southern Hemisphere. Yet it is in these frozen and desolate regions that the maintenance of satisfactory radio communications is even more important than almost anywhere else—in terms both of communications and of safety.

The ionized sheets and rays directly associated with the visible aurora are directly responsible for many of the anomalous effects observed in radio propagation. For example, the density of ionization gets so large that very high frequency radio waves may be picked up at distances far beyond expectation. Thus one radio station may provide unwanted interferences to another distant one during an auroral display. But more important, at present, are the interfering effects on radio waves which cause messages to be unintelligible, or the absorption of radio waves which may be so great that no message gets through at all. The paths of the charged particles in the atmosphere may be traced through observation of aurora. Spectroscopic and photometric analyses of aurora show us not only the composition of the atmosphere at this level but also the temperature of that portion of the atmosphere and the energies of the bombarding particles.

The North American Continent is an area ideally situated to study the aurora since it is possible to have access across the auroral zone and far to the north of it on continental land masses. There are already a number of stations in North America working on auroral and airglow problems that could be integrated with a few new stations into a very efficient network to investigate these problems. In general, the network required for this phase of the program will fit well into stations required for other phases of the IGY programs. The establishment of a main base and two satellite bases on the Antarctic continent will be a major step toward the establishment of a reasonably satisfactory network of stations in the Southern Hemisphere. Two of the likely stations in the southern zone network are of particular interest. The first is MacQuarie Island, between Australia and Antarctica, which is on the same geomagnetic field line as College, Alaska. A second is a point within a few hundred kilometers of Little America that is paired similarly with Chesterfield, Baker Lake, Canada. The establishment of auroral observations at both pairs of stations is essential.

The program, requiring an orderly and well placed network of cooperating stations, is concerned with large-scale airglow and auroral phenomena. In this field there are four main problems: (1) Airglow latitude intensity profile, (2) aurora latitude spectrum and frequency profile, (3) auroral longitude spectrum, frequency, and continuity profile, and (4) Northern-Southern Hemisphere correlations. The program has 5 major aspects: Visual and special observations, radar-type observations, spectrographic patrol, photometric observations, and data reductions and analysis.

GEOMAGNETISM

Geomagetism has various important relations and implications cutting across almost all areas of study in the physics of the atmosphere. In addition to its own specific uses in surveying, navigation (including missile guidance), and exploration for minerals and petroleum, geomagnetism has broad and basic implications in the study of the ionosphere, radio wave propagation, aurora, cosmic rays, as well as other fields of science.

While the main portion of the earth's geomagnetic field originates in the solid core of the earth, practically all the fluctuations and variations of the field originate in electric currents which flow in the atmosphere. These current systems flow within the altitude range 50–240 miles, with especilly strong current over the polar caps. The interaction of the magnetic field developed by these sheet currents with the normal geomagnetic field produces the innumerable variations so pronounced at high latitudes. In addition to currents flowing around portions of the earth within ionic layers, a current is hypothesized which flows around the earth at a distance of about 20,000 miles. The magnetic field of this ring current also affects the local field and introduces further transients which also cause variations in the geomagnetic field. Because of these effects, geomagnetic records display complex fluctuations whose nature is incompletely understood.

Changes in the earth's magnetic field are closely linked to ionospheric and auroral displays. A geomagnetic storm frequently occurs simultaneously with a strong aurora and a radio blackout. To gain better insight into the physical mechanism which causes both the geomagnetic storminess and the ionospheric disturbances, it is essential to obtain more information on the interdependence between the two. More geomagnetic data must be collected, particularly at the higher latitudes. In addition to its correlation with radio blackouts in the auroral zone, the geomagnetic field portrays constant irregular fluctuations. Some thought has been given to the possibility that at least some of these rapid fluctuations are caused by the penetration of meteors through the atmosphere.

The primary objective of the geomagnetic program during IGY is to shed new light on the conditions responsible for magnetic storms and other little-understood transient effects. Almost all features of the proposed program are directed to this end, the minor exceptions being (1) exploratory rocket observations at great heights, (2) a station at Jarvis Island to shed light on certain unexplained effects of possibly great importance in equatorial regions, and (3) exploration of the practically unknown field of high-frequency magnetic fluctuations. The proposed investigations bear upon the fundamental problems of atmospheric physics.

Two new temporary observatories will be established in Alaska at Big Delta and McKinley Park, which together with the existing observatory at College will form a tripartite array for the recording of unique data bearing on the electric currents characteristic of the north polar auroral zone. Two outpost stations will be established a few miles from the College observatory for the recording and analysis of magnetic field gradients at times of magnetic disturbance. Special rapid-run equipment will be installed and operated at seven observatories. Two magnetic observatories will be established and operated at Little America and at the important, and unique South Pole site. A semiautomatic magnetic observatory at Jarvis Island in the Pacific will be established and operated for the study of daily magnetic changes peculiar to the equatorial region. Jarvis Island is near the junction of the magnetic and geographic equators. Special apparatus will be installed at four high latitude observatories, including College, for the study of magnetic oscillations in the range of 1–10,000 cycles per second, and visible-type magnetic recorders will be installed at six sites of ionospheric and auroral observations.

COSMIC RAYS

The existence of cosmic rays has been known for 50 years, but our knowledge of them is elementary. The problem is one of major importance in understanding our universe, involved as it is in both astrophysics and in understanding the structure of the atomic nucleus. Implications of the latter are highly practical matters, for cosmic ray energies are literally millions of times greater than the energies which the largest atomic accelerators can produce.

Cosmic rays are known to consist of streams of electrically charged particles—mostly protons (the positive particles of atomic nuclei) but also the atomic nuclei of heavy elements. These particles bombard the earth all the time, and they come from every direction. Their origin appears to be interstellar space, but whether the source is the sun, the stars, or some phenomenon or process of interstellar space is unknown. There are clear connections between cosmic rays and solar activity, and the earth's magnetic field and magnetic storms also affect cosmic rays.

The magnetic field of the earth is the chief instrument for analyzing the energy of cosmic rays. The cosmic rays are bent in this field in such a way that the low-energy rays cannot arrive at equatorial latitudes but tend to come in chiefly near the magnetic poles; the high-energy components arrive at all latitudes. To study the high-energy portion, observations are made near the equator. To study the low-energy portion, observations should be made in the Arctic and Antarctic regions. The connections between solar effects and cosmic rays are generally most conspicuous for the low-energy cosmic rays; thus observations in the Far North and Far South may unravel the fundamental facts of the origin of cosmic rays. Another cosmic-ray phenomenon is the large decrease in cosmic radiation often associated with magnetic storms. It appears that these storms alter the magnetic conditions in the vicinity of the earth, and that these changed conditions may either deflect or decelerate cosmic radiation. This means that cosmic rays represent a powerful tool with which to study magnetic phenomena many thousands of miles from the earth.

Perhaps the most spectacular phenomena observed in cosmic radiations have been the rapid and very large increases which sometimes occur simultaneously with eruptions of gas on the solar disc. These coincide with disturbances in the ionosphere, which may be so severe as to black out radio communications. Such violent solar flares are generally followed by magnetic storms, which can be observed by violent changes in the earth's magnetic field and which can adversely affect communication circuits. Detailed knowledge of cosmic rays requires simultaneous investigations of flares, sun spots, and chromospheric eruptions.

The question of the origin of cosmic rays remains the outstanding basic problem in this field. The particles are related to solar phenomena—in particular, to the large increases of radiation accompanying some solar outbreaks. Perhaps conditions at the surface of the sun and in the outer solar atmosphere may be such as to accelerate nuclear particles to cosmic ray energies. In other words, the sun may well behave like a giant cyclotron, vastly more powerful than any man-made reactor. The principles that nature uses in such an accelerator are unknown; the study of the origin of cosmic rays may give us the answer. Most of the basic discoveries of the short-lived mesons and other energy particles have come from studies of cosmic radiation. Such studies have blazed the trail in our understanding of nuclear forces, furnishing the impetus to the construction of large accelerators which are now being used for more detailed investigations in this low-energy range.

The program calls for investigations of three problems: (1) Exploration of the variations in mass and energy of primary cosmic radiation, (2) exploration of the variations in cosmic radiation with both altitude and latitude, and (3) investigations of the long-time fluctuations in the neutron component of cosmic rays. These studies require simultaneous measurements widely made over the earth, including the Arctic and Antarctic regions as well as the temperate and equatorial zones; they also require parallel studies of solar activity, geomagnetism, aurora, and ionospheric physics in view of the complex interrelationships of events in these fields.

ROCKET EXPLORATION OF THE UPPER ATMOSPHERE

One of the principal problems in the investigation of atmospheric phenomena has been the general difficulty of obtaining direct measurements. Until relatively recent years the maximum height attainable by sounding balloons has been some 10 to 15 miles; within the last few years this range has increased to about 24 miles. Studies in meteorology and cosmic rays have made extensive use of such balloons. However, the upper atmosphere has not been open to direct observation by these techniques, which has meant that no direct data have been available in auroral or ionospheric physics, and the only direct data in solar studies, meteorology, and cosmic rays have been restricted to the lower atmosphere.

The development of rockets during and after World War II has provided a method of penetrating many times higher into the atmosphere. Rockoons, balloon-borne small rockets that are fired once the balloon has reached its maximum altitude, have a range of 60 miles. Aerobees or ground-launched rockets, have a range of 144 miles. Somewhat comparable rockets have been developed by other nations and are to be used for similar purposes in the IGY program.

Both types of measurement, direct and indirect, are needed. Conventional measurements, which can be made readily, inexpensively and extensively, provide the large bodies of "indirect" data upon which ultimate solutions of major geophysical problems depend. Rocket measurements, which are relatively costly and difficult, provide intensive sets of "direct" data for a short period of time, and this information can be used to "calibrate" indirect data. This, in effect, permits the conversion of large bodies of indirect data into direct data. At the same time, new discoveries are possible by rocket techniques.

Some of the types of results attained by rocket explorations are the following: (1) Solar radiation of the shorter wave lengths, which are absorbed in the upper atmosphere and hence never reach the earth, has been successfully studied—for example, a rocket measurement led to the discovery of X-rays in one of the ionospheric layers. (2) Solar ultraviolet light measurements from rockets have established the variation of the ozone with heights up to an altitude of 42 miles. (3) Electric charge densities in the ionosphere and collision frequencies of the air particles have been measured directly. (4) What are believed to be auroral particles have been detected in rocket-borne Geiger counters.

The program calls for the launching of 37 rockoons and 36 Aerobees from sites in New Mexico, Greenland, Canada, and Alaska. United States firings will be coordinated with those of other nations, particularly at those crucial times of unusual solar activity. Each rocket will carry instrumentation within the very severe weight limitations, to measure several quantities: atmospheric pressure, temperature and density; the earth's magnetic field, especially during auroral displays; night and day airglow; solar and ultraviolet light and X-rays; auroral particles; ozone distribution; ionospheric charge densities; and cosmic radiation. The results of these investigations will be integrated with the results of simultaneous measurements made in each of the major fields of geophysics that represent aspects of or directly involve the atmosphere.

APPENDIX VIII

Financial Report for Fiscal Year 1954

APPROPRIATED FUNDS

Status of Appropriation from the Congress to the National Science Foundations as of June 30, 1954

RECEIPTS

Appropriation for fiscal year 1954	$8, 000, 000	
Unobligated balance from fiscal year 1953	353, 085	
Appropriation reimbursement	866	
Total		$8, 353, 951

OBLIGATIONS

National science policy studies:		
Subtotal	$800, 121	
Support of science:		
Grants for support of research:		
Biological and medical sciences	1, 971, 789	
Mathematical, physical, and engineering sciences	2, 032, 780	
Grants for training of scientific manpower:		
Graduate fellowships	1, 865, 978	
Education in the sciences	160, 790	
Review of research and training programs	412, 414	
Subtotal	6, 443, 751	
Scientific information exchange:		
Dissemination of scientific information	238, 300	
Attendance at international scientific meetings	53, 058	
Subtotal	291, 358	
Executive direction and management:		
Subtotal	426, 301	
Total obligations		7, 961, 531
Unobligated balance carried forward to 1955		392, 420

WORKING FUNDS

Status of Funds Transferred from Federal Agencies to the National Science Foundation as of June 30, 1954

RECEIPTS

Atomic Energy Commission	$25, 000	
Department of Defense:		
Department of the Air Force	10, 000	
Surgeon General	5, 000	
Office of Naval Research	4, 000	
Department of Health, Education, and Welfare	5. 000	
Total receipts		$49, 000

OBLIGATIONS

Dissemination of scientific information	$45,000	
Grants for support of science	4,000	
Total obligations		$49,000

TRUST FUND

Status of Funds Donated from Private Sources to the National Science Foundation as of June 30, 1954

RECEIPTS

Unobligated balance from prior years	$1,356

OBLIGATIONS

Unobligated balance carried forward	$1,356

APPENDIX IX

Publications of the National Science Foundation

ANNUAL REPORTS

In January of each year the National Science Foundation issues an annual report of activities covering the previous fiscal year ending on June 30. The annual reports are made available to the public through the Superintendent of Documents, Government Printing Office, Washington 25, D. C., at the prices shown.

First Annual Report. Fiscal year ending June 30, 1951., 20 cents.

Second Annual Report. Fiscal year ending June 30, 1952. 30 cents.

Third Annual Report. Fiscal year ending June 30, 1953. 40 cents.

Fourth Annual Report. Fiscal year ending June 30, 1954. 50 cents.

FEDERAL FUNDS FOR SCIENCE SERIES

These reports contain information on the Federal research and development budget. Such information is compiled on a current basis by the National Science Foundation with the cooperation of other Federal agencies having research and development programs. The reports may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

I. Federal Funds for Scientific Research and Development at Non-Profit Institutions, 1950–1951 and 1951–1952. 30 cents.

II. The Federal Research and Development Budget, Fiscal Years 1952 and 1953. Out of print.

III. The Federal Research and Development Budget, Fiscal Years 1953, 1954, and 1955. 30 cents.

SCIENTIFIC MANPOWER SERIES

The Scientific Manpower Series consists of reports on the supply and characteristics of scientific and technological manpower in various fields of science. The reports were based originally upon data developed through the registration program of the National Scientific Register, which functioned under the policy and fiscal direction of the National Science Foundation and was operated by the Federal Security Agency, Office of Education. Following the transfer of registration operations to the Foundation the reports were continued in cooperation with the United States Department of Labor, Bureau of Labor Statistics. These reports may be purchased from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

Research and Development Personnel in Industrial Laboratories 1950. 15 cents.

The Composition of the Sanitary Engineering Profession. 15 cents.

Manpower Resources in Physics 1951. 20 cents.

Manpower Resources in Chemistry and Chemical Engineering. 50 cents.

Manpower Resources in Mathematics. 20 cents.

Manpower Resources in the Earth Sciences. — cents.

SCIENTIFIC MANPOWER BULLETINS

This series of four-page leaflets was also established as a means for releasing scientific manpower information gathered in connection with the scientific registration program. Copies of *Bulletins* still in print may be obtained upon request from the Division of Scientific Personnel and Education, National Science Foundation, Washington 25, D. C.

Manpower Resources in Chemistry, 1951.

Manpower Resources in Physics, 1951.

Manpower Resources in Chemical Engineering, 1951.

Military Status and Selective Service Classification of June 1951 College Graduates.

Manpower Resources in Geology, 1951.

Manpower Resources in Psychology, 1951.

Manpower Resources in Mathematics, 1951.

Highlights of a Survey of June 1951 College Graduates.

Manpower Resources in the Geophysical Sciences.

Manpower Resources in Meteorology, 1951.

PROCEEDINGS OF CONFERENCES ON SCIENTIFIC MANPOWER

Since December 1951, the National Science Foundation has sponsored an annual conference on scientific manpower in conjunction with the anual meetings of the American Association for the Advancement of Science. In view of the widespread interest in meetings a limited number of processed copies of the *Proceedings* have been issued. Copies of *Proceedings* still in print may be obtained upon request from the Division of Scientific Personnel and Education, National Science Foundation, Washington 25, D. C.

I. Philadelphia, December 1951.

II. St. Louis, December 1952.

III. Boston, December 1953.

SCIENCE INFORMATION EXCHANGE

In connection with its program for exchange of scientific information the National Science Foundation has published or sponsored the publication of material of interest to American scientists and scientific librarians.

List of International and Foreign Scientific and Technical Meetings. Quarterly. May be ordered from Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription price: 75 cents per year, domestic; $1 per year, foreign. Single copy price: 20 cents.

Bibliography of Translations from Russian Scientific and Technical Literature. Monthly. May be ordered from the Card Division, Library of Congress, Washington 25, D. C. Subscription price: $3 per year. Single copy price: 25 cents.

Scientific and Technical Serial Publications. United States, 1950–53. Compiled by Library of Congress. May be ordered from Superintendent of Documents, Government Printing Office, Washington 25, D. C. $1.25.

Scientific and Technical Serial Publications. Soviet Union, 1945–1953. Compiled by Library of Congress. May be ordered from Superintendent of Documents, Government Printing Office, Washington 25, D. C. 60 cents.

Soviet Science. A symposium presented on December 27, 1951, at the Philadelphia meeting of the American Association for the Advancement of Science. May be ordered from American Association for the Advancement of Science, 1515 Massachusetts Avenue NW., Washington 5, D. C. $1.

O