

NATURAL SCIENCES - PROGRAM AND POLICY

Past Program and Proposed Future Program

Extract from agenda for
special meeting of Trustees
April 11, 1953 DR 469

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THE NATURAL SCIENCES

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The present activities of The Rockefeller Foundation in the field of the natural sciences represent interests originating in three boards and extending back over many years. During the early years the activities consisted of more or less isolated projects, chosen on account of individual interest or on account of broad relationship with accepted programs in public health or medical education. For the history prior to the reorganization of the Boards in 1929, it is useful to consider separately the activities of The Rockefeller Foundation, the International Education Board and the General Education Board. Details of appropriations are given in tables at the conclusion of this statement.

Natural Science activities in The Rockefeller Foundation
Prior to the Reorganization in 1929

In a forecast of policy given by the President of The Rockefeller Foundation on December 5, 1917, there was suggested the desirability of exchange fellowships in science as a contribution to international understanding, and of an institute of physics and chemistry as a contribution to national efficiency in the reconstruction period following the War. These proposals were studied, and in 1919 a fellowship program administered by the National Research Council was begun in physics and chemistry. This fellowship program was later extended to include biology (1923) and mathematics (1924).

At the May, 1922 meeting of the Trustees, it was stated that "experience suggests the fostering of general science education as a logical, fundamentally important, and fruitful enterprise for the Foundation". In December, 1923 the Division of Studies was created, and in February, 1925 this division was authorized "to continue to study and to make surveys of the sciences involved in

the field of human biology and to mature and to bring to The Rockefeller Foundation from time to time specific projects to be considered on their merits". Previous to this date, three projects in the biological field had been approved. Subsequent to the authorization just quoted, aid was advanced for six principal projects in the field of biology. In 1927 the Division of Studies was dissolved, but projects were later approved which were functionally within the program in human biology.

In connection with the medical program in China administered by the China Medical Board of The Rockefeller Foundation, aid was extended, beginning with 1916, to thirteen institutions in support of the premedical sciences. Local Chinese fellowships in the premedical sciences were granted as early as 1920 from general funds, and since 1929 this procedure has been regularized by annual appropriation. Similarly, Chinese predoctorate training fellowships for foreign study in the United States were granted from 1922, specific appropriations for this purpose being made since 1929. A small program of emergency aid for medical work in China was extended in 1929 to include the natural sciences, and became the present program for developmental and research aid in the medical and natural sciences.

Prior to 1929, then, the natural science activities within The Rockefeller Foundation fall into three main groups: fellowships, the projects in biology, and the aid to premedical science in China. The financial aspect of these activities is summarized in the following table.

Approximate Appropriations for Natural Science Projects in
The Rockefeller Foundation prior to the Reorganization of 1929

	<u>Approximate Appropriations</u>	<u>Per Cent</u>
Fellowships	\$1,832,500	39.
Biological Projects	1,521,000	32.
Chinese Premedical Projects	<u>1,287,000</u>	<u>29.</u>
	\$4,640,500	100.

Natural Science Activities in the International Education Board

The International Education Board was organized on February 3, 1923. Three months later a "scheme for the promotion of science on an international scale" was proposed and approved. In presenting this scheme it was stated that "all important fields of activity, from the breeding of bees to the administration of an empire, call for an understanding of the spirit and technique of modern science. Promotion of the development of science in a country is germinal; it affects the entire system of education and carries with it the remaking of a civilization". In 1924, Dr. Rose, in reporting a European trip, stated that "The journey with its abundant opportunity for helpful discussion has tended to confirm one's faith in the soundness of the schemes the Board has projected.....Science is the method of knowledge. It is the key to such dominion as man may ever exercise over his physical environment. Appreciation of its spirit and technic, moreover, determines the mental attitude of a people, affects the entire system of education, and carries with it the shaping of a civilization."

As stated in May, 1925, "The efforts of the Board.....have taken two main forms: (1) Co-operation in improving the facilities of men who have attained great distinction.....; (2) The granting of stipends to individuals to enable them to carry out specific researches." During its existence the International Education Board appropriated approximately \$16,000,000 for projects in the natural sciences, and for purposes which are summarized in the following table.

Approximate Appropriations for Natural Science Projects
in the International Education Board

<u>NATURE OF AID</u>	<u>Approximate Appropriations</u>	<u>Per Cent</u>
Aid to Institutions		
Construction and equipment	\$10,738,000	65.8
Endowment	3,579,000	22.2
Research funds	175,000	1.1
Maintenance	88,000	0.5
Fellowships and traveling		
professorships	1,511,000	9.3
Publications	180,000	1.1
	<u>\$16,271,000</u>	<u>100.0</u>
 <u>FIELD</u>		
Astronomy	\$ 6,204,000	38.1
Biology	4,362,000	26.8
Mathematics	678,000	4.3
Physics	522,000	3.3
Chemistry	507,000	3.0
Unassigned	<u>3,998,000</u>	<u>24.5</u>
	<u>\$16,271,000</u>	<u>100.0</u>

Prereorganization Natural Science Activities of the
General Education Board

The following statement occurs in the Minutes of the Meeting on
October 10-12, 1924, of the Board of Trustees of the General Education Board:

"Convinced that on the whole the progress of civilization coincides with the increase of accurate knowledge and the spread of objective and dispassionate spirit of scientific inquiry, the Board is now definitely undertaking to co-operate in the improvement in the United States of conditions favorable to the development of the physical and biological sciences."

In the Annual Report of 1925-1926 of the General Education Board, it
is stated that:

"The increase of knowledge upon which human welfare depends comes largely from the laboratories dealing in the most fundamental fashion with the physical and biological sciences. In cultivating these, universities make, therefore, a notable contribution not only to knowledge, as such, but to the art of living."

From 1924 to 1929, under the policy just indicated, the General Education Board made large contributions in support of the natural sciences in the United States. The great majority of this support took the form of grants to strong institutional centers for construction, equipment and endowment of advanced work in the basic sciences. The financial aspect of this support is summarized in tables at the end of this statement. These tables include only those interests of the General Education Board which were transferred to The Rockefeller Foundation at the time of the reorganization.

Appropriations for Natural Science Projects in the
General Education Board (Prereorganization Program)

<u>NATURE OF AID</u>	<u>Approximate Appropriations</u>	<u>Per Cent</u>
Aid to nine institutions	\$11,915,000	98.1
Research projects	138,500	1.1
Publications	105,000	0.8
	<u>\$12,158,500</u>	<u>100.0</u>
 <u>FIELD</u>		
Chemistry	\$ 2,775,000	22.7
Physics	1,737,500	14.3
Biology	641,000	5.3
Astronomy	200,000	1.6
Unassigned	<u>6,805,000</u>	<u>56.1</u>
	<u>\$12,158,500</u>	<u>100.0</u>

Natural Science Activities in The Rockefeller Foundation subsequent
to the Reorganization in 1929

In the reorganization of 1929, The Rockefeller Foundation established a division of natural sciences which took over the interests in natural sciences of the International Education Board, and that part of the similar interests of the General Education Board which related primarily to research rather than to education. The period from 1929 to date contrasts with the earlier period in three principal ways. There has been a diminishing emphasis on capital grants. There has been an increasing emphasis on support directed to special fields of

interest. There have been two practically new modes of support - fluid research grants to institutions and grants in aid of research.

Approximate Appropriations for Natural Science Projects in
The Rockefeller Foundation (Jan. 1, 1929 - Dec. 31, 1932)

<u>NATURE OF AID</u>	<u>Approximate Appropriations</u>	<u>Per Cent</u>
Aid to Institutions		
Construction and equipment	\$ 2,878,000	24.3
Endowment	2,845,000	23.9
Maintenance	627,000	5.3
Fluid Research Funds	520,000	4.4
Other Research Funds	1,107,000	9.3
Aid to Individuals		
Fellowships	1,860,000	15.7
Research Grants	368,000	3.1
Research Aid Funds	340,000	2.9
Traveling Professorships, etc. ..	39,000	0.3
Publications	417,000	3.5
Premedical Aid, China	905,000	7.3
	<u>\$11,906,000</u>	<u>100.0</u>
 <u>FIELD</u>		
Marine Biology and Oceanography ...	\$ 3,144,000	26.5
Biology	1,249,000	10.5
Physics	933,000	7.9
Anthropoid Research	750,000	6.3
Astronomy	630,000	5.3
Chemistry	357,000	3.0
Geophysics	227,000	1.9
Paleontology	172,000	1.4
Geology	115,000	1.0
Mathematics	9,000	0.1
Unassigned	<u>4,320,000</u>	<u>36.1</u>
	<u>\$11,906,000</u>	<u>100.0</u>

Summary

The stream of activity since 1929 thus represents the confluence of three separate streams, the parent stream extending back for some ten years, while the two tributaries extend back for five and six years. In actual magnitude, the tributaries, with appropriated totals of \$12,158,500 (General Education Board) and \$16,271,000 (International Education Board) are roughly three and four

times as large as the parent stream, with \$4,640,500. The following table indicates, in a very rough way, the purposes for which sums were appropriated over the entire program to January 1, 1933, for the advancement of knowledge in the natural sciences.

	<u>Approximate Appropriations</u>	<u>Per Cent</u>
Construction, Equipment, Maintenance and Endowment ...	\$33,434,000	74.3
Fellowships	5,383,000	12.0
Research Aid, etc.	3,871,000	8.6
China	1,287,000	2.9
Publications	<u>1,001,000</u>	<u>2.2</u>
	\$44,976,000	100.0

It is also interesting to note that, of the \$45,000,000 some \$32,000,000, or 71 per cent, were spent in the United States, while the remaining \$13,000,000, or 29 per cent, were spent outside the United States.

Summary of Appropriations in The Natural Sciences

This summary has been prepared to give a financial picture of the development in the various boards of the interests which in the reorganization of 1929 were taken over by The Rockefeller Foundation to form its then program in the natural sciences. In general, appropriations are listed rather than expenditures, since the former more accurately reflect current policy. Appropriations later lapsed are included, for the same reason. If, however, a later appropriation effectively replaces an earlier lapsed appropriation, only one is included. To serve best the purpose in mind, it proved desirable to use some latitude in the listing of certain items. For example, when endowment was appropriated but not paid at once, interim interest payments are not listed. Detailed explanations can be furnished, if desired.

The summary is inclusive in the case of The Rockefeller Foundation and of the International Education Board. In the case of the General Education Board, those items are included which fall within the program transferred to The Rockefeller Foundation in 1929. Here, also, clarity is given precedence over strictness. Two items are included, for example, which were appropriated in 1929 or later but which clearly belong to the prereorganization program of the General Education Board.

Approximate Appropriations for Natural Science Projects in
The Rockefeller Foundation prior to the Reorganization of 1929

FELLOWSHIPS

National Research Council - Physical Sciences ..	\$1,130,000	
National Research Council - Biological Sciences.	395,000	
Mental Hygiene	222,500	
Division of Studies	<u>85,000</u>	\$1,832,500
See also China		

BIOLOGICAL PROJECTS

(A) <u>Before formation of Division of Studies</u>			
Marine Biological Laboratory, Woods Hole ..	\$ 500,000		
Biological Abstracts	189,000		
Concilium Bibliographicum	<u>110,000</u>	\$ 799,000	
(B) <u>Under Division of Studies</u>			
Biological Research, Johns Hopkins	\$ 164,500		
Marine Biology, Pacific Grove	100,000		
Anthropology, Australia	92,950		
Brain Physiology, Iowa	62,500		
Surveys	51,000		
Anthropoid Research, Yale	<u>35,000</u>	505,950	
(C) <u>After dissolution of Division of Studies</u>			
Polynesian Anthropology, Univ. of Hawaii ..	\$ 40,000		
Visiting Professors, Japan	125,000		
Racial Biology, Bishop Museum, Hawaii	20,000		
Visiting Scientists	15,500		
Anthropological Research, China	<u>15,200</u>	<u>215,700</u>	1,520,650

PREMEDICAL AID IN CHINA

Aid to Thirteen Institutions

Yenching University	\$ 191,500	
Fukien University	163,500	
Lingnan University	169,000	
College of Yale-in-China	158,508	
National Central University (formerly National Southeastern University)	109,100	
Nankai University	107,600	
St. John's University	98,000	
Tsing Hua University	5,900	
Nanking University	42,000	
Soochow University	36,205	
Shanghai University	35,000	
(formerly Shanghai Baptist College)		
Shantung Christian University	33,700	
Ginling College	<u>25,250</u>	\$1,175,263

Miscellaneous Aid

Biological Supply Service	\$ 8,500	
Specialist in Science Teaching	10,000	
Summer Institute for Science Teachers	<u>10,500</u>	29,000
Developmental and Research Aid (Emergency Fund).		2,500
Fellowships		<u>80,000</u>
		<u>1,286,763</u>
Grand Total		<u>\$4,639,913</u>

Approximate Appropriations for Natural Science Projects in
The International Education Board

AID TO INSTITUTIONS

Construction and Equipment

California Institute of Technology	\$ 6,000,000	
Harvard-biology	2,000,000	
University of Cambridge	475,500	
Madrid-physics and chemistry	440,000	
Göttingen-mathematics and physics	350,000	
University College, London	244,000	
Edinburgh-zoology	235,000	
Jardin des Plantes	200,000	
Copenhagen-physical chemistry	132,000	
Leiden-physics	110,000	
Copenhagen-physiology	107,220	
Poincare Institute	100,000	
Tromsøe Institute	75,000	
Stockholm-biochemistry	70,000	
Upsala-physical chemistry	50,000	
Copenhagen-physics	45,000	
Bureau of Weights and Measures	40,800	
Jungfrauoch Station	38,000	
Paris-radioactivity	10,000	
Göttingen-physics	7,540	
Plymouth Biological Station	5,000	
Utrecht-physics	3,000	\$10,738,060

Endowment

University of Cambridge	\$ 1,720,000	
Harvard-biology	1,000,000	
University College, London	342,000	
Harvard African Observatory	180,000	
Poincare Institute	180,000	
Edinburgh-zoology	127,000	
Botanical Conservatory, Geneva	26,500	
Lyons Observatory	4,000	3,579,500

Research Funds

University of Virginia	175,000
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Maintenance

Naples Station	\$ 55,000	
Poincare Institute	19,300	
Vienna Radium Institute	13,500	87,800
		\$14,580,360

FELLOWSHIPS AND TRAVELING PROFESSORSHIPS 1,510,830

PUBLICATIONS

Chemical Abstracts	\$ 35,000	
Critical Tables	35,000	
London Mathematical Society	28,600	
Annual Tables	25,000	
French Biological Society	20,000	
Planetary Research Bibliography	20,000	
Italian Scientific Literature	16,225	179,825

Grand Total \$16,271,015

Approximate Appropriations for Natural Science Projects in
The International Education Board

AID TO INSTITUTIONSConstruction and Equipment

California Institute of Technology	\$ 6,000,000	
Harvard-biology	2,000,000	
University of Cambridge	475,500	
Madrid-physics and chemistry	440,000	
Göttingen-mathematics and physics	350,000	
University College, London	244,000	
Edinburgh-zoology	235,000	
Jardin des Plantes	200,000	
Copenhagen-physical chemistry	132,000	
Leiden-physics	110,000	
Copenhagen-physiology	107,220	
Poincare Institute	100,000	
Tromsøe Institute	75,000	
Stockholm-biochemistry	70,000	
Upsala-physical chemistry	50,000	
Copenhagen-physics	45,000	
Bureau of Weights and Measures	40,800	
Jungfrauoch Station	38,000	
Paris-radioactivity	10,000	
Göttingen-physics	7,540	
Plymouth Biological Station	5,000	
Utrecht-physics	3,000	\$10,738,060

Endowment

University of Cambridge	\$ 1,720,000	
Harvard-biology	1,000,000	
University College, London	342,000	
Harvard African Observatory	180,000	
Poincare Institute	180,000	
Edinburgh-zoology	127,000	
Botanical Conservatory, Geneva	26,500	
Lyons Observatory	4,000	3,579,500

Research Funds

University of Virginia	175,000
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Maintenance

Naples Station	\$ 55,000	
Poincare Institute	19,300	
Vienna Radium Institute	13,500	87,800
		\$14,580,360

FELLOWSHIPS AND TRAVELING PROFESSORSHIPS 1,510,830

PUBLICATIONS

Chemical Abstracts	\$ 35,000	
Critical Tables	35,000	
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Annual Tables	25,000	
French Biological Society	20,000	
Planetary Research Bibliography	20,000	
Italian Scientific Literature	16,225	179,825

Grand Total \$16,271,015

Approximate Appropriations for Natural Science Projects in
the General Education Board (Prereorganization Program)

AID TO INSTITUTIONS

Chicago-natural sciences	\$ 2,700,000	
California Institute of Technology-physics- chemistry	2,550,000	
Princeton-natural sciences	1,000,000	
Princeton-chemistry	1,000,000	
Cornell-natural sciences	1,500,000	
Harvard-chemistry	500,000	
Harvard-physics	400,000	
Harvard-astronomy	200,000	
University of Rochester-natural sciences	750,000	
Leland Stanford-natural sciences	750,000	
Woods Hole-biology	500,000	
University of Texas-biology	65,000	\$11,915,000

RESEARCH PROJECTS

National Academy-oceanography	\$ 76,000	
National Research Council-radiation	62,500	138,500

PUBLICATIONS

National Academy Fund	105,000	
Grand Total	<u>\$12,158,500</u>	

Approximate Appropriations for Natural Science Projects in
The Rockefeller Foundation
Since the Reorganization in 1929

AID TO INSTITUTIONSConstruction and Equipment

Woods Hole-oceanography	\$ 1,000,000	
KWG Institute-physics	435,000	
Munich Institute-zoological & physical chemistry	372,000	
Harvard-astronomy	250,000	
University of Washington-oceanography	245,000	
Leiden-astronomy	110,000	
Oslo-astrophysics	105,000	
Szeged - pure science	69,000	
Warsaw-physics	50,000	
Göttingen-chemistry	50,000	
Geneva-zoology	40,000	
Scripps Institute-oceanography	40,000	
Paris-marine biology	24,500	
Plymouth-marine biology	22,800	
Hopkins Marine Station-marine biology and oceanography	20,000	
Stockholm-biology	16,000	
Princeton-physics	16,000	
Tihany-biology	12,500	\$2,877,800

Endowment

Woods Hole-oceanography	\$ 1,000,000	
California Institute Tech.-general	500,000	
Johns Hopkins-biology	387,500	
Bristol-physics	250,000	
Harvard-astronomy	250,000	
Bermuda-marine biology & oceanography	245,000	
Davy-Faraday Research Laboratory	112,700	
Princeton-geology	100,000	2,845,200

Maintenance

Woods Hole-oceanography	\$ 500,000	
Long Island Biological Station	40,000	
University of Washington-oceanography	35,000	
Naples-biology	18,000	
Tihany-biology	12,500	
Bermuda-marine biology & oceanography	12,000	
Szeged-pure science	9,000	626,500

Fluid Research Funds

Massachusetts Institute of Technology	\$ 170,000	
University of Minnesota	150,000	
Washington University	100,000	
University of Pennsylvania	40,000	
University of North Carolina	30,000	
Iowa State College	30,000	520,000

Other funds specifically for research

Yale-anthropoid research	\$	750,000		
Chicago-biology		150,000		
Harvard-geophysics		40,000		
California Institute Tech.-physics and chemistry		40,000		
Johns Hopkins-biology		24,500		
Ohio Wesleyan-astronomy		20,000		
Field Museum-botany		15,000		
University of Minnesota-geology		15,000		
KWG Institute-physics and chemistry		13,200		
Alaska Coll. Agric. & Sch. Mines, Aurora .		10,000		
Apia Observatory-geophysics		10,000		
Vienna-liquid air		7,500		
American Society Civil Eng.-geophysics ...		6,000		
Massachusetts Inst. Tech.-aerology		6,000	\$ 1,107,200	\$ 7,976,700

AID TO INDIVIDUALSFellowships

National Research Council	\$	1,275,000		
European		585,000	\$ 1,860,000	
See also China				

Research Aid Funds

Administered from Paris	\$	120,000		
Administered by National Research Council.		220,000	\$	340,000

Research grants

D. Black, PUMC-paleontology	\$	172,000		
Conant, Harvard-chemistry		45,000		
International Comm. Polar Year-geophysics.		40,000		
Von Hevesey, Univ. of Freiburg-chemistry .		25,000		
Biltz, Hannover-chemistry		19,700		
Michelson, Chicago-physics		15,000		
Runnstrom, Stockholm-biology		12,000		
National Research Council, for Wilkins - geophysics		10,000		
Freundlich, Berlin-chemistry		7,000		
Zemplan, Royal Hung. Jos. Tech. Univ., Budapest-chemistry		5,000		
Woltereck, University of Leipzig-biology .		5,000		
Sommerfeld, Munich-physics		5,000		
Petterson, Vienna-physics		5,000		
Angstrom, University of Stockholm-physics.		1,500		
Abel, Vienna University-biology		1,000	\$	368,200
Traveling professorships and study commissions			39,000	2,607,200

PUBLICATIONS

Biological Abstracts	\$	315,000		
National Academy Fund		60,000		
Tables of Constants		18,000		
American Institute of Physics		15,000		
American Mathematical Society		9,000		417,000

PREMEDICAL AID, CHINAAid to Institutions

Yenching	\$	587,500		
Tsinghua		41,250		
Fukien		31,500		
Marine Biological Institute		3,000	\$	663,350
Research and Developmental Aid			41,625	
Fellowships			200,500	905,375
			Grand Total	\$11,906,275

NATURAL
SCIENCES -
PROPOSED
PROGRAM

(1) The unique opportunities open to The Rockefeller Foundation are not met by supporting scientific projects merely because they are science, or even because they are outstandingly good science. A highly selective procedure is necessary if the available funds are not to lose significance through scattering. In the past, this selection has consisted chiefly of a choice of scientific leaders, among both men and institutions, although there has always been some selection on the basis of fields of interest. It is proposed for the future program that interest in the fields in question be the dominant rôle in the selection process. Within the fields of interest, selection will continue to be made of leading men and institutions.

(2) This principle of functional concentration calls for three changes in emphasis. First, a considerably increased proportion of expenditures should be devoted to the development of the few selected fields. Second, capital grants for general scientific purposes should practically cease in the United States and Western Europe, and should be restricted to relatively backward countries. Thirdly, the fellowship program, and to some extent the grants-in-aid program, should be pointed toward the adopted fields of interest.

(3) The choice of fields of interest is influenced by several considerations. The field must contribute in a basic and important way to the welfare of mankind; it must be sufficiently developed to merit support, but so imperfectly developed as to need it; it should be a field in which the contributions of the Foundation will play a critical rôle in producing and stimulating development that otherwise would not occur within a reasonable time.

(4) The welfare of mankind depends in a vital way on man's understanding of himself and his physical environment. Science has made magnificent

progress in the analysis and control of inanimate forces, but science has not made equal advances in the more delicate, more difficult, and more important problem of the analysis and control of animate forces. This indicates the desirability of greatly increasing emphasis on biology and psychology, and upon those special developments in mathematics, physics and chemistry which are themselves fundamental to biology and psychology. Similarly, it is desirable to emphasize those studies of the earth, sea and air, which furnish information concerning the physical background for the development of man.

(5) No person or group of persons is sufficiently wise to specify, even for a short time, all desirable activities. The program should always be kept flexible. A small provision should be made in the budget of the program to care for unpredictable and unquestionable opportunities.

It is proposed to center the program of The Rockefeller Foundation in The Natural Sciences around two chief interests - an interest in the field of vital processes and an interest in earth science.

Vital Processes.

Biology is today in a position in some ways analogous to that occupied by physics and chemistry many years ago. It has, that is, advanced out of the stage of qualitative observation and classification and into the stage of detailed quantitative analysis. A biological institute, wishing advice as to the most fruitful field to develop, recently consulted some twenty of the outstanding experimentalists of the world in biology, biophysics, physical chemistry, etc. The nature of the replies is well indicated by three quotations. Professor Selig Hecht, biophysicist of Columbia University, said:

"I quite agree with you in believing that the future of biology will be dominated by quantitative work which will be closely linked with chemistry, physics and mathematics as tools."

Professor F.G. Donnan, a leading physical chemist of England, said:

"It gives me great pleasure to support as strongly as I can the view that the greatest possible scientific advances may be expected from a combination of biological research with mathematics, physics, and chemistry."

Dr. Otto Warburg, Nobel laureate from Berlin-Dahlem, believes

"that the most important problem in biology is to obtain an understanding in physicochemical terms of the processes - and the substances which take part in these processes - that occur in the normal living cell."

The evidence is clear that the time is ripe to stimulate most significant advances by helping to bring to bear the powerful quantitative technics of mathematics, physics and chemistry onto the basic problems of biology.

The problems of physical growth and development, of mental growth and development, and of reproduction of kind are of central importance to all individuals. Not only the well-being of present man, but to an even greater extent the well-being of future society depends upon a deeper understanding of the nature of these problems. It is proposed that research be sponsored in four closely correlated and overlapping subfields.

<u>General field</u>	<u>Subfields</u>
Vital Processes	(endocrinology
	(genetics
	(biology of reproduction
	(psychobiology

Psychobiology is included here for two sorts of reasons. Recent experimental work, of the most accurate and refined sort, on electrical phenomena associated with the conduction of nerve impulses as well as many other quantitative experimental procedures, make attack on central problems of psychology more promising than before. Furthermore, the formation of thinking and learning

patterns and the conditioning of the stream of consciousness by physicochemical factors are truly vital processes, both in the sense of fundamental importance, and in the more strict sense of being part of the basic activity associated with life.

The interest in the whole field of the biology of reproduction is not a new one to the Foundation. Under grants to the National Research Council Committee on Sex Research, work of the highest order and greatest promise has already been accomplished. This work has already entered on a stage of direct application to human problems. This interest would include research in the physiology of reproduction, in embryology, in fertility, in the neuropathology and neuropsychology of sex, and (overlapping with endocrinology) in the relation between the various ductless gland secretions and sexual phenomena.

It is hardly necessary to emphasize the importance of genetics. Our ability to pass on to a future society the advances we make in the control of our own vital processes is largely conditioned by the state of advancement of genetics. Dr. T.H. Morgan, in his presidential address before the International Genetics Congress at Ithaca, August 25, 1932, said in part:

"I have been challenged to state on this occasion what seems to be the most important problem for genetics in the immediate future. First, the physical and physiological processes involved in the growth of genes and their duplication. Second, an interpretation in physical terms of the changes that take place during and after the conjugation of the chromosomes. Third, the relation of genes to character. Fourth, the nature of the mutation process - perhaps I may say the chemicophysical changes involved when a gene changes to a new one. Fifth, the application of genetics"

Work in this subfield would be concentrated on basic cytological genetics, with primary emphasis on animal rather than plant genetics. Work in human genetics should receive special consideration as rapidly as sound

possibilities present themselves. The attack planned, however, is a basic and long-range one, and such a subject as eugenics, for example, would not be given support.

Certain phases of endocrinology have received support from the Committee on Sex Research. This support should be continued and extended to include the biochemical, physiological, neurological and psychological aspects of internal secretions in general, and to include the closely related nutritional studies. M.F. Guyer, in an article "The Internal Secretions and Human Well-Being" (Science, August 14, 1931) states,

"The secretions themselves are second in importance only to the nervous system in keeping the parts of the body in harmonious operation. They are also necessary for normal development and growth. They can stimulate or inhibit the activity of some organ or tissue in a part of the body far distant from the source of the secretion itself. While the modest achievements of the biologist, the pathologist and the biochemist toward an understanding of the nature and functions of the internal secretions do not measure up to the expectations of a public appetite fed mainly on sensationalism, still the facts, unmagnified by the imagination, are certainly both interesting and significant."

The hormones secreted by the ductless glands are known to play essential rôles in maintaining a proper balance between nutritional and growth processes, in controlling the calcium content of the blood, in affecting the elimination of wastes from the body, in affecting the heart and respiratory action, and in controlling menstruation, spermatogenesis, ovulation, conception, lactation and menopause. The effect these secretions have upon mental effectiveness and personality in general is an open but a most important question.

The opportunities for developing the field of vital processes are unquestionable. Individuals and groups now exist who are able and ready to carry on. An incomplete survey of institutional centers indicates that Chicago,

Harvard, California Institute of Technology, Johns Hopkins, and possibly Columbia are prepared to participate on a group basis, while outstanding individual workers exist at many other places such as California, Rochester, Wisconsin, Princeton and Missouri. It may be desirable to vest considerable responsibility for the development of opportunities in a national committee (or committees) such as the present Committee on Sex Research. The Foundation would, however, propose to deal directly with those group situations (notably Chicago) which are definitely past the preliminary stages of support; as well as with smaller projects which have already been fully developed under committee supervision. Grants-in-aid specifically pointed to this program would be administered by the Foundation, while it is proposed to meet the important and pressing problem of recruitment of personnel by special training fellowships supported by funds from the General Education Board. Such fellowships bear an important relationship to the program, especially since many problems in this field can only be attacked by a man trained in both the physical and biological sciences. Only with reasonable assurance of two or three years of fellowship support can physicists or chemists obtain the necessary training in biology, or a biologist receive the necessary training in the physical sciences. In conclusion, it should be emphasized that this program in vital processes will be developed in co-operation with The Medical Sciences, with whose new program this work closely connects.

Earth Science

The field of vital processes is proposed as the major future interest of The Natural Sciences. Considerably smaller support is recommended for a second field, that of earth science. During the last half century there has been great interest, throughout the physical sciences, in the very small and the very

large. It has been popular to work on the atom or on the cosmos, but there has been very little study, relatively speaking, on the less spectacular but important problems that refer directly to the earth. The situation is, in some respects, like that which obtained in astronomy before Hale emphasized the desirability of the study of the sun as the nearest and most available star. Some reaction can already be detected, and great impetus can be given by Foundation support to this relatively neglected field.

A further reason indicates the special desirability of this interest. In the whole history of thought there have been few concepts so widespread and important in implication as the concept of organic evolution, and man has no higher responsibility than that of understanding and consciously controlling the evolutionary processes. In the attack on the unsolved problems of evolution, two types of knowledge are required: knowledge of the development of individuals and knowledge of the physical background which, to so large an extent, conditions that development. A program in earth science thus forms a natural and important adjunct to the program in vital processes.

Earth science is by no means a new interest for the Foundation. Since the reorganization, in fact, sums in excess of \$2,500,000 have been spent for projects which were entirely or predominantly for oceanography; while over \$250,000 has been appropriated for geophysics. The program in oceanography is essentially completed, and it is not proposed to make further capital commitments for this purpose but only to round out by such small grants as prove necessary to maintain the values in the present program.

Under the program of earth science, support will be given to projects in geophysics, including meteorology, seismology, earth currents and magnetism, and atmospheric electricity. Support will also be given to studies in mathematics, physics, chemistry or geology which have direct application to the problems

of earth science. Of this latter type, for example, would be researches in the physical and chemical properties of matter under high pressures and temperatures; and physical, geological and mathematical studies of the thermal history of the earth. This program is too narrow and specific to include ordinary geological investigations, and support would not be given to the development of "geophysical" methods as this phrase is understood by the mining geologist.

Beside the several institutes, notably in Europe, which primarily devote themselves to such problems, there are outstanding opportunities to sponsor these studies in universities. The situation at Boston, where Harvard and Massachusetts Institute of Technology are both actively interested in such a program, is a specially important one, as well as the situation at the California Institute of Technology. It is desirable that this field be served by a fellowship program, especially since the effective research often requires extensive training in two disciplines such as, for example, geology and physics.

General Program

Beside the support which will be concentrated around the two special fields of interest in vital processes and earth science, there will continue to be general support. This is most conveniently discussed under several headings.

Institutional Support. For the United States or Western Europe no new capital institutional support is suggested other than that which will be extended under the above special programs. Second in importance to capital grants to institutions have been fluid research grants. In making these the Foundation has had two purposes in mind, both to support valuable research and to help establish the principle of direct institutional or state support for research. It is proposed to continue fluid research grants only so far as economic circumstances permit both of the above purposes to be served.

Fellowships. Three distinct purposes may be served by a fellowship program. First, recruitment, training or enriching experience may be given to outstanding men regardless of their scientific fields. That is, the first purpose is to serve science in a broad and general way. Second, recruitment and training fellowships may serve the special fields of interest. This is a concentrated and specialized support. Third, fellowships, on a necessarily lower level, may be given to men in relatively backward countries. Experience has indicated that this is a most effective way of introducing the leaven necessary for future development.

At the present time the National Research Council and the European fellowship systems serve the first purpose; the Chinese fellowships the third purpose. It is proposed to reduce considerably the "general" type of fellowship, to increase somewhat the "backward country" type, and to initiate the "special field" type.

Specifically, it is proposed gradually to reduce the support of the National Research Council fellowships in the natural sciences from the present level of \$300,000 per year to an eventual level somewhere between \$150,000 and \$200,000 a year, the figure to be determined when it becomes clear what amount of support for special fellowships will derive from the General Education Board. It is proposed to maintain the European fellowship program at nearly its present level, emphasizing in this program, for the future, the interests in vital processes and earth science. It is further proposed to recognize, on a modest and definitely budgeted level, a fellowship program for backward countries. This program will include the Chinese fellowships as in the past, but will further include Finland, Esthonia, Latvia, Lithuania as one group; Poland, Czechoslovakia, Hungary, and Spain as a second; and Rumania, Yugoslavia, and Bulgaria as a third. Slightly different procedures seem indicated for the different groups.

Grants-in-aid. Grants-in-aid, like fellowships, can serve general support, special support, or backward country support. A general program of grants-in-aid, moreover, is often of great use in an exploratory sense, uncovering and developing interests which later are included within program. The present program expends about fifty thousand a year in the United States through the National Research Council, and approximately fifty thousand yearly in Europe through the Paris Office, in each instance for general support. There is also a small sum available in China which should be classified as backward country support.

It is proposed to reduce the general grants-in-aid program at present administered by the National Research Council from approximately \$50,000 yearly to \$30,000 yearly. This reduction will more than be absorbed, however, by the grants-in-aid program to be administered by the Foundation in support of the two special fields of interest.

In Western Europe the political divisions and the individualistic character of their scientific development make group or committee procedure impractical. Negotiation must be carried out, in most cases, with single institutes or individuals. On this account, as well as on account of economic circumstances, great opportunities exist to save first-rate scientific projects, in Europe, by means of a grants-in-aid program. The officers have felt that the grants-in-aid program in Europe should be expanded, particularly during the present emergency. It is proposed, however, to reduce slightly the general (or undirected) European grants-in-aid program and to add to this a grants-in-aid program directed towards the development of the two special fields of interest.

A principal purpose in originating the European grants-in-aid program was to furnish small but sorely needed assistance to returned fellows. Practically, however, it is difficult to handle emergency grants to established leaders

and small grants to returned fellows from a single fund. A similar difficulty exists relative to the small exploratory grants which can be so effective in backward countries. It is therefore proposed that in allocating the sum for European grants-in-aid, elastic budget provision be made for general support, special support, aid to returned fellows, and aid to backward countries.

Publication. It is proposed to retire, as rapidly as is feasible, from the support of publications. Two interests, however, must be recognized and protected during this withdrawal of support. Biological Abstracts constitutes the first interest. Present authorization to appropriate covers the needs until 1936. It now seems highly probable that further support, on a diminishing basis, will be recommended. The second interest refers to the establishment of the principle that the cost of publication of research is an integral and respectable part of the cost of research itself. To advance this principle, it is proposed to continue interest in the publications of the American Institute of Physics and of the American Mathematical Society.

Special Studies. To initiate wisely the less familiar features of the two special programs, it will be advisable to provide for special surveys and reports.

Contingent Funds. In Europe, an unquestionable opportunity which does not lie within special fields of interests could be met under the above scheme through the unassigned grants-in-aid fund. The New York Office, however, will have no item of program under its direct administration other than those which fall definitely within the two special fields of interest. This is one of the prices which one pays for concentration, and it seems an unnecessarily high price. It is therefore proposed that a small, definitely budgeted amount be set aside to be used outside of program. Claims on this fund will be accumulated, and decisions made once a year, so that the various projects can compete fairly.

Financial Implications of the Proposed Program

The following illustrative budget is given in detailed form in order to indicate, as definitely as possible, the probable and proposed financial implications of the suggested program. It is not proposed that a detailed and binding budget be set up for the division. The budget here submitted is based upon annual expenditures at the level of \$1,500,000. This total was adopted on account of present indications, and is not to be regarded as an optimum sum.

SPECIAL PROGRAMS

Vital Processes

Institutional and Committee Support (U.S. & Europe)	\$500,000		
Fellowships			
U.S. (\$35,000)			
Europe	35,000		
Grants-in-aid			
U.S. \$35,000)			
Europe \$35,000)	70,000		
Studies	15,000	\$620,000	

Earth Science

Institutional Support (U.S. & Europe)	\$200,000		
Fellowships			
U.S. (\$35,000)			
Europe	10,000		
Grants-in-aid			
U.S. \$10,000)			
Europe \$20,000)	30,000	240,000	\$860,000

GENERAL PROGRAM

Fluid Research		\$ 80,000	
Fellowships			
N.R.C. \$150,000)			
Europe \$ 40,000)	190,000		
Grants-in-aid			
N.R.C. \$ 30,000)			
Europe \$ 40,000)	70,000		
Publications	90,000		
Backward Countries			
China			
Fellowships \$50,000			
Institutional 50,000			
Grants-in-aid 10,000	\$110,000)		
European			
Fellowships \$20,000			
Grants 5,000	25,000)		
		135,000	
Contingent Fund	75,000	640,000	\$1,500,000