

7. 20/68

THE
ROBERT A. WELCH
FOUNDATION
RESEARCH BULLETIN

ACADEMIC SCIENCE AND THE
FEDERAL GOVERNMENT

BY

DR. PHILIP HANDLER

BULLETIN No. 22 May, 1968

HOUSTON, TEXAS

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PRINTED IN U. S. A.

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W. O. MILLIGAN, *Editor*

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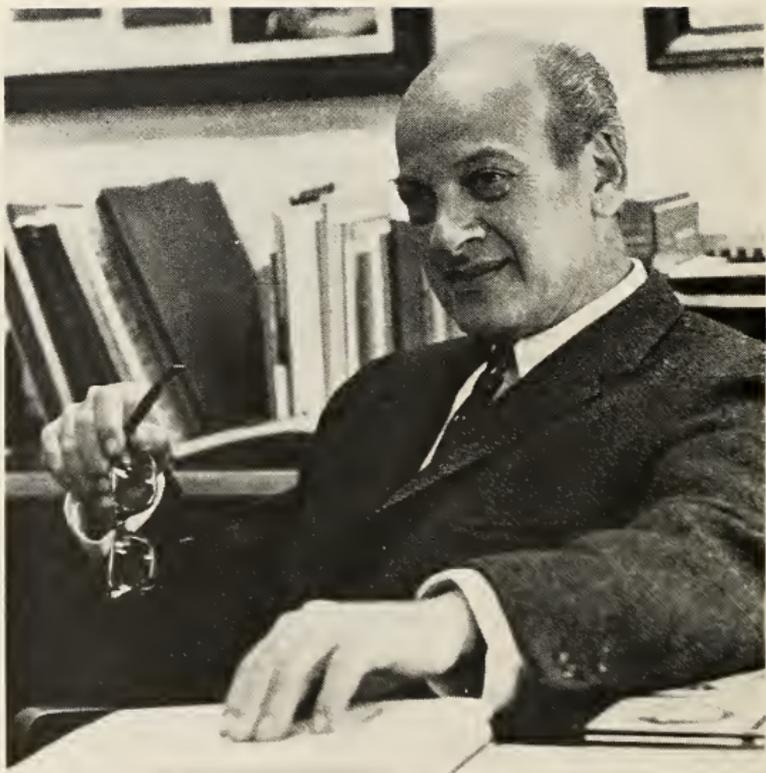
Chairman, Department of Biochemistry

Duke University School of Medicine

Chairman, National Science Board

Member, President's Science Advisory Committee

An after dinner address delivered before "The Robert A. Welch Foundation Conferences on Chemical Research. XI. Radiation and the Structure of Matter," December 5, 1967, Houston, Texas.



ACADEMIC SCIENCE AND THE FEDERAL GOVERNMENT

By

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Chairman, Department of Biochemistry

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Mr. Bullard, Dr. Milligan, Trustees of The Robert A. Welch Foundation, Distinguished Guests, Ladies and Gentlemen:

It is unlikely that this audience would take issue with the statement that the future security and prestige of the United States, its economic vitality, the health of its citizens and the general quality of American life will reflect to an evergrowing extent the successful maintenance of our national strength in science and engineering. To be sure, maintenance and development of that strength may not appear to be our most pressing or immediate domestic problem. But it is painful to contrast the front section of our newspapers which report disturbances in the cities and the plight of the disadvantaged sector of our population with the advertisements in the rear which cry for trained scientists and engineers of all types. Whereas our scientific labor force is at an all time high, so also is the disparity between supply and demand. Had we provided adequate educational opportunities for the first group we might have gone part of the way towards satisfying the second problem and to our great national advantage.

American science is strong. Indeed, it has never been stronger, more vigorous or more capable than it is today. This assembly, and the quality of the program are eloquent testimony of the intrinsic health of our effort in basic research. This research has led the world into the era of the scientific revolution. In a manner which continues to appear mysterious to economists, it has given a wondrous vitality

to our economy and it offers promise of exciting and fresh opportunities in almost all aspects of life, tomorrow.

At the heart of the enterprise which has made all this possible is the American graduate school. Collectively, our graduate schools constitute the seat of the major thrust of fundamental research in this nation while also providing the trained scientists who are to staff the universities and colleges as well as to man industrial and government laboratories while spinning off increasing numbers who are diverted from the bench and the classroom to the desk, the plant or even the board room. Created by the addition of elements of a 19th Century German university onto a base which is essentially the historical English college and, frequently, living cheek by jowl with the agricultural experiment station and the medical school, the American graduate school is an uniquely successful educational endeavor within which education and conduct of research are indistinguishable, regardless of the efforts of those who seek to separate the two for cost accounting purposes. Young scientists are given meaningful research opportunities during what may be the most productive stage of their careers and the endeavor occurs within coherent departments which are frequently of a magnitude sufficient to exceed the minimal critical intellectual mass essential for success. The enterprise nurtures not only the few highly talented young people who will become tomorrow's scientific leaders but also the much larger numbers of scientists in our educational institutions, government and industrial laboratories who permit us to take full advantage of the accomplishments of those highly talented few. Indeed, this may well be the prime basis for the technology gap between the United States and those European nations which contribute their share of effective and highly talented scientists but which fail adequately to capitalize on the contributions of the latter for lack of supporting cadres of well trained if not equally talented scientists and engineers.

The success of this endeavor seems all the more remarkable when one considers that it has been accomplished, largely, by funding mechanisms which were designed to support research qua research, rather than to support graduate education and which have been

administered by federal agencies which are charged with a diversity of practical missions inherently unrelated to the educational process.

Last year¹ in discussing the operation of this system with you, Dr. Donald Hornig, Special Assistant to the President for Science and Technology, said that "We have plainly come to a turning point." Before the American Physical Society this spring he said that "The simple fact is that science and technology, research and development, have changed from being frosting on the cake of defense expenditures, health expenditures and so on to being significant national expenditures which must compete with other claimants on national resources." In the time since, it has become evident that the entire system is entering upon a time of crisis.

Never before were there such extreme pressures for the growth of the national graduate education enterprise. Each year, an increasing fraction of high school graduates go on to college, about 45 percent this fall, and an even more rapidly growing fraction of college graduates seek entry to graduate school. Moreover, they are better prepared to do so. Our young people are increasingly aware of the almost imperative need for advanced education if they are to cope successfully and enjoy the opportunities of an increasingly technological and specialized society, just as they are also aware of the fact that graduate education, particularly graduate education in science, has proved to be the most remarkable instrumentality for effecting upward social mobility in our national history.

There are those who contemplate this situation and ask "What will our country do, tomorrow, with such greatly increased numbers of individuals with advanced training?" For my part, I seriously doubt that this is a meaningful question. There have always been those who opposed every extension of the educational process to the populace at large, and on similar grounds. And our national history provides an effective answer. I cannot believe that it is possible to overeducate the American people and in the present instance it is quite probably supply which engenders demand rather than the converse.

¹ The Robert A. Welch Foundation Research Bulletin, No. 18, March, 1966.

At the same time, as yet another aspect of the revolution of rising expectations, large regions of the nation have become aware of the fact that they have not enjoyed the advantages which can accrue to a given region by virtue of the very presence of a dynamic graduate school in its own midst. The frequently heard clamor for what is termed 'equitable distribution of federal funds for research and development' is not a demand for redistribution of wealth. It is not a demand that research funds be taken from those institutions which, by forethought or by an accident of history, are presently in the forefront of such developments. Rather, is it a reasonable statement of the aspirations of substantial segments of the nation to enjoy the full fruits of life in the twentieth century. It reflects understanding that the very conduct of scientific research, in and of itself, contributes to the tone and quality of life in the region about it, as well as the belief, however insecurely founded, that this enterprise also contributes in significant degree to the vitality, diversity and growth of the economy of that same region.

In view of these rising personal and societal expectations, it is ironic and particularly painful to note that Federal support of academic science effectively plateaued in amount for the past two fiscal years and may actually decline in the present fiscal year. That fact brings into sharp relief the nature and operation of the system whereby, as a nation, we have supported graduate education in science and its associated research.

Through a series of legislative acts in the past few years it has become explicit national policy to use the Federal tax base to strengthen and upgrade education at the primary, secondary and collegiate levels. Federal support of such activities in the current fiscal year is about 4 billion dollars. But the Federal contribution at each of these educational levels is far smaller than is the equivalent local, state or private support. And I hope that such local support will continue to be the financial pillar of education at these levels. Yet, paradoxically, there has been no equivalent, explicit statement of Federal policy or intent with respect to graduate education.

And this, despite the fact that the Federal government is today, in fact, the major single supporter of this enterprise.

This support has not been provided, however, as a deliberate, direct and understanding subvention of graduate education. In the main, it has been provided through the back door from funds which were collected or appropriated to further distinctly applied missions such as a hoped for cure of cancer or a new weapons system. In the years since WW II, although private support of research at academic institutions has indeed grown most hearteningly — a fact which we gratefully acknowledge this evening — nevertheless, the Federal government has become established as the major patron of science in our country. Funds in support of academic research are provided by such diverse agencies as the Department of Defense, the National Institutes of Health, the Atomic Energy Commission, the National Aeronautics and Space Agency, the Department of Agriculture, and smaller agencies such as the Office of Saline Water as well as by the National Science Foundation. Of these, only the latter is specifically charged with assuring the vitality of American science. Yet today appropriations to the National Science Foundation make possible only 15 percent of Federal support of research at academic institutions proper. This pluralistic pattern of support underlies not only the applied research which is clearly and specifically mission-oriented, but also that of fundamental research at the frontiers as well. This practice has been justified as a means whereby the scientists engaged in the applied missions of these agencies are enabled to remain au courant with current advanced thinking, an academic scientist may be attracted to fundamental problems whose solution bears some relation to agency mission, as well as by the argument that, since the research and development activities of these agencies draw heavily upon both the manpower and the information generated in the universities, the agencies have a financial obligation to support the system which so nourishes them.

Even the support of individual graduate students has largely been provided in bootleg form. The highly effective program of grants which support graduate education in certain departments of

biomedical institutions are termed 'research *training* grants' by the National Institutes of Health because their legislation does not permit them frankly to support education. And the largest single block of fellowships available from Federal sources is provided by the Office of Education under what is euphemistically called the National Defense Education Act.

As long as budgets continued to grow, the potential weaknesses of this system seemed inconsequential to those who, wisely, preferred not to rock the boat. And grow they did.

In the period 1953 to 1965, the National Research and Development enterprise grew at an average annual rate of 12 percent as compared to 5.3 percent for the GNP. Whereas, in 1953, 365 of each 100,000 civilian employees were research scientists or engineers, that proportion has somewhat more than doubled. The annual production of Ph.D.'s in science went from 6,400 in 1950 to 16,500 in 1965, while the total number of full-time and part-time graduate students increased from 200,000 to 550,000 necessitating retention of an ever greater fraction of the Ph.D. output as new university faculty. Meanwhile, Federal support for academic research rose to over 1.5 billion dollars. A remarkable, dedicated and highly effective bureaucracy has managed this effort, the guidelines for which have been provided variously by the Congress, the Administration, the bureaucracy itself and members of the scientific community serving in advisory capacity. But the sheer size and variety of this unplanned enterprise is now a powerful deterrent to those who wish to remedy its more patent defects.

The budgetary stringency of the moment, however serious in itself, is an episode which we will certainly survive. It has, however, also revealed the intrinsic inadequacy of the pluralistic system of support of graduate education through diverse mission-oriented Federal agencies. Quite understandably, as such agencies have confronted the problem of how best to fulfill a primary mission at reduced appropriation levels, they have been forced to decide that, since the fundamental research for which they had once undertaken responsibility is relatively remote from the current mission, it is now more readily expendable

than other aspects of the agency programs. Accordingly, the recent decrements in support of academic research by some agencies are substantially greater than a simple pro rata allocation of this year's appropriation would have demanded. And in some agencies, the underlying philosophy itself is being questioned. Were you Director of such an agency, it is entirely likely that you would behave similarly.

But there are more permanent and more serious defects in the system. Perhaps its greatest flaw has been the increasingly frequent practice of payment of faculty salaries from individual research project grants or contracts. This is an arrangement into which universities have entered because, by this means, they have been enabled to look to the Federal government for a contribution to their operating budgets at a time when their own resources are being seriously over-extended. This practice has eroded faculty loyalty, degraded the individual professor who must come to the government with his hat in his hand, engendered such truth as there may in the allegation of the so-called 'flight from teaching', while building into the university structure an inherent instability which is reflected in the inability sensibly to plan and budget for the future.

At the same time, by whatever name it be called, the instrument which defines the arrangement between the university and a mission-oriented agency is, in effect, a procurement action for the purchase of research. Accordingly, there have evolved accounting procedures which are intrinsically inappropriate to the life of the university, including the time and effort reporting which is anathema to most of the faculty. These accounting procedures put into proper perspective the limited nature of the partnership between the university and a Federal agency which may legally purchase research but, however enlightened its bureaucracy, may not, within the law, overtly accept responsibility for the educational function of the university.

Moreover, we may note that, within this system, the graduate student himself is frequently employed as a research technician whose time is purchased by a member of the faculty who, in turn, must make efficient and effective use of the public funds which have been put at his disposal so that his research may be maximally productive. Such

an arrangement simply fails to recognize that the graduate student quite properly, in his own interest, and, hence, in the national interest, may simultaneously be student, teacher of undergraduates and research colleague to the faculty, and that he should receive a stipend which assures his personal support and is not a fee for service.

Accordingly, this pause in both appropriations and graduate enrollments, occasioned by the Viet Nam episode, would appear to be the proper moment for a clear statement of national policy with respect to graduate education and research at the university. I believe that the Federal government should formally accept continuing responsibility for a major share of the total support of graduate education, a share proportionately greater than that provided at lower educational levels. Such a role for the Federal government seems appropriate on the following grounds:

Graduate institutions are national rather than local resources. The graduate student body at each institution is drawn from a wide geographic area, indeed frequently from the entire nation. The trained scientists provided by the graduate schools are highly mobile and they distribute themselves nationally as career opportunities afford. The increased understanding of man, of society, and of the universe, resulting from academic research has wide applicability and is the property of all. By virtue of its own broad programs of research and development, the Federal government, directly and indirectly, is the largest single user of the services of graduate scientists and engineers. Because of the national character of the Federal tax structure, assistance can be provided for the improvement of graduate programs across the nation, thereby benefiting communities and regions that could not, at least initially and with their own means alone, support such efforts through local funds. Please understand, that I do not propose that local, state or private financing of graduate education be reduced. Quite the contrary. But, in view of the difficult financial circumstances of most institutions of higher learning and the increasing disparity between the resources of such institutions and the expectations of American society, of the fact that graduate education will be the most rapidly growing segment of the American

educational scene during the next decade, and of the fact that, even now, Federal funds provide the major single source of support for graduate education in the sciences, the needs of the future can be met only if the Federal government will accept the role which is here proposed.

Were such a policy adopted, its implementation would require that one, or perhaps two, agencies be specifically authorized to administer support of those programs whereby the Federal government would frankly underwrite, in whatever degree, graduate education in the sciences and engineering at both public and private universities. In point of fact, I really see no reason for restricting such a program to the sciences and engineering and the recommendations with respect to specific programs which I am about to make should apply equally well to graduate education taken more broadly.

The Federal government would then be in position to establish a rational overall program consisting of five major types of grants. This program was designed by a Committee of the National Science Board and will be described in detail early next year in a Report from which many of these remarks are taken. Allow me to summarize.

1. The lead agency in this endeavor would inaugurate a program of institutional grants to be made annually to colleges and universities, *on a formula basis*, for support of their graduate programs. The funds provided should make possible payment of faculty salaries, the aggregate of which, initially, would be at least as great as the totality of such payments from all Federal agencies at the present time, as well as for those general institutional expenditures required for graduate education which are commonly included in the indirect costs formulae presently utilized in association with project grant. This combination should then permit the institution to engage in the broad programs of education and research expected of it by our society. The institution should retain full freedom to determine the detailed disposition of the funds so received.

2. A separate program would provide developmental grants, based upon national competition with respect to quality or potential quality, and which would permit strengthening of existing graduate

programs, establishment of new graduate programs in existing institutions, and even the establishment of new institutions which are intended to engage in graduate education.

With regard to the latter possibility, a few words are in order. All available indicators suggest that graduate enrollments will approximately double in the next ten years. But there is no need to create and develop new graduate universities simply to meet this pressure of student bodies. Rather does it afford opportunity to bring up to effective critical levels most of those institutions currently engaged in this enterprise. Accordingly, new institutions should be initiated only when local circumstances clearly so demand, particularly in those growing metropolitan areas which do not find themselves adequately served by existing graduate institutions. The development of new institutions and of new graduate programs should not be undertaken at such a pace or in such manner as to do damage to those institutions which are already competently engaged in the graduate education process. These must continue to progress if they are not to retrogress. As the total national graduate student body expands, increasing numbers of well qualified students will turn to the lesser institutions of the moment for their education. And it is just this which will afford the opportunity for a rational and sound, "more equitable geographic distribution of funds."

3. In the third type of award, grants would be made to disciplinary departments to assist in providing for their specific needs. Among these we may note stipends for most of the graduate students who are to receive support; communally used, relatively heavy and expensive equipment: the research needs of young investigators during the first several years of their appointment to the faculty; as well as expenditures for activities in general support of ongoing research and educational programs such as maintenance of specialized shops, animal quarters, preparation rooms, etc. Here we should note that appropriate forms of such grants could also be utilized to encourage multidisciplinary programs of research and education such as those in material sciences or neurobiology.

4. The fourth program would provide funds for acquisition of special large facilities such as libraries, laboratories, computer

centers, animal quarters, small observatories, marine laboratories, etc. In this regard, we should note that the major installations required by 'big science' should be undertaken for scientific reasons rather than primarily for education, and should be so justified. Nevertheless, once in being, they should certainly be available for the use of graduate students and faculty.

Were the present agency structure of the Federal government unaltered, I would assign responsibility for the first program to the National Science Foundation and authorize it also to engage in each of the other three. One can readily imagine the National Institutes of Health engaging in appropriate fashion in the other three programs. Several other Federal agencies could well be empowered to make awards of the fourth class.

5. Finally, we come to the research project grant, an award based upon quality competition and made to assist a member or a group of members of the faculty in conducting a specific research project. Such a grant would provide for specialized equipment, for the salaries only of those individuals employed specifically for the research proposed, for travel, publication, consumables, etc., required by the work. But note that only the immediate direct costs of such research would be included within such awards since all of the indirect expenses, as well as the related salaries and stipends of the faculty and students would be provided by the types of grants mentioned previously.

All Federal agencies, reflecting their own missions, should be authorized and encouraged to engage in a grants program of this character. And I consider it meaningless and pointless to draw a line between fundamental and applied research. Universities must accept the responsibility both to advance the frontiers of science and to engage themselves in the real problems of the society which supports them. Nevertheless, only in rare cases, however, should a mission agency look to the university for solutions to its most immediate problems. In general, these require the efforts of multidisciplinary teams, rather than the classical unit characteristic of academic research, which consists of a professor and his coterie of fellows and

students. However, these more complex research enterprises might well be managed in fully funded institutes located on or close by the university campus.

The totality of this set of five grant programs would recognize the commitment of the Federal government to graduate education, rectify the most serious defects in our present mechanism of operation, provide stability to the universities and to their faculty, generate maximal opportunity for graduate study, meet the real needs of the mission agencies, increasingly involve all regions of the nation in graduate education and research, and would permit rational construction of a Federal budget for academic science commensurate with the national need.

Perhaps the most compelling argument in favor of such a five pronged program is provided by an analysis by Dr. Lawton Hartman of the National Science Foundation of the manner and purposes for which Federal funds were actually expended at the universities in fiscal 1966. As a first approximation, of a total of 1.7 billion dollars of Federal support, 560 millions were for the purposes encompassed in the proposed institutional formula grants, 40 millions for the purposes of the proposed developmental grants, 500 millions in the departmental grants, 200 millions in the facility grants, and only 470 millions of the total would have been delivered as research project grants were the proposed system in operation. Yet almost 1.3 billions was actually transferred by way of the research project grants system as it presently operates.

But while we are delivering strictures to the Federal government, we might address a few words to universities and their faculties. In accepting research funds which arrive in consequence of seemingly private negotiations between individual professors and Federal agencies, universities have all too frequently divested themselves of any sense of responsibility for the resultant activities. Such funds are rarely managed with the care given to the university budget proper: not infrequently the university serves only as landlord or rental agent to the research endeavor. Trivial, inconsequential, poorly written, ill-defined applications arrive at Federal agencies even from

our greatest universities with no evidence of review at home. Supplements for summer salaries have been permitted to do violence to university salary scales and thus, have engendered the attitude that summer research is conducted 'for the government' and somehow differs from identical endeavors by the same member of the faculty through the balance of the academic year. And much the same situation holds when the Federal agency provides the annual salary of the investigator. This display of disinterest on the part of the university with its corresponding irresponsibility, has contributed both to the erosion of faculty loyalty and the occasional embarrassment of a Federal agency when funds have not been managed and expended with due regard for prudence and propriety.

In addition to the necessity for responsible attitudes with respect to their students, their universities and the public funds at their disposal, evident in what we have already said, to scientists at large I would address one additional charge, enjoining them to participate in every means by which the average American can be assisted in his appreciation and enjoyment of the nature of the scientific enterprise and the intellectual structure it has created. For the past two decades, the triumphs of science and its contributions to the national welfare have made for rapid and almost unquestioning growth of the scientific enterprise. That support of this enterprise is in the national interest is no longer seriously questioned by the American public or by its representatives in the Congress. But it will ever remain necessary to justify the absolute magnitude of that support. And this is no trivial or simple task. As a minimum, clearly one might hope to establish that level of funding which would be commensurate with the size of the graduate student body. Beyond that point, justification must rest on grounds which can be provided — *if* they can be provided — only by the scientific community, you who are gathered here this evening. The literature abounds with references to "the cathedral of science," to "science as the modern humanity," or even "science as the modern religion." But a religion with naught but a priesthood, no matter how enthusiastic, devoted or dedicated, yet without a laity, cannot long survive. It is not enough to point to the material benefits

to society which derive from the application of science. If this is to be truly the age of science, then all citizens must share its emotional impact, all must understand that the doing of science is an essentially aesthetic experience and participate therein. Warren Weaver, the third² dinner speaker in this series, when president of the AAAS, spoke of science as "an adventure of the human spirit . . . an artistic enterprise, stimulated largely by curiosity, served largely by a disciplined imagination and based largely on faith." And in a recent report of the Carnegie Institution, Caryl Haskins urged that the scientist "communicate by every effective means the imagination can command, the nature, the purpose, the rationale, and the intense social relevance of the scientific way." Few of us have accepted this charge and even fewer have succeeded. Yet it is a continuing task and I urge it upon you.

When the episode in Viet Nam is terminated, our nation can once again turn its energies toward domestic activities intended to insure a better tomorrow. The present pause is an opportune moment for rethinking the manner in which our nation will manage and finance the academic-scientific enterprise, the success of which will determine the quality of life for all Americans tomorrow. Now is the time to plan how we may replace the present patchwork, superbly effective though it may have been during the period of rising budgets, with a rational set of mechanisms which will assure the autonomy and integrity of the university, maximize educational opportunity for all citizens in all regions of the nation and sustain this nation in the vanguard of research in all scientific disciplines. Thank you.

² The Robert A. Welch Foundation Research Bulletin, No. 6, January, 1960.

