Government Support of Research

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IT IS INTERESTING and significant to find government support of research so much under discussion recently. It is interesting because there has been for the past few years a great deal more support from government, and therefore at least the edge of the need has been dulled. It is interesting also because, contrary to the attitude before and immediately after the war, there are few institutions now that are unwilling to entertain the idea of government support. It is significant because we are now in the position, not only of establishing the need for support of research, but also of considering how much support is necessary and prudent and how it should be provided. The value of discussion at the present time lies in the fact that we are now able to evaluate what has been accomplished, at least to some extent, and thus more realistically to consider plans or proposals for the future.

The subject "Government Support of Research" as considered here is limited to support by the federal government to scientific research outside its own establishments. No attempt will be made to discuss support of research by state and city governments, which is a different kind of problem.

It is hardly necessary to review the reasons for government support of research. It may be recalled that before the war there was little or no interest in support of general basic research by the federal government, although there was demand for support in particular areas of research and to some extent for general and higher education. Nevertheless, awareness of need for support had its origin at that time in the concern with which educational and industrial institutions viewed lack of capital, low returns from investments, rising taxes, and hard times generally. But there were few then who advocated federal support.

It is probably salutary to recall that, historically, research has always required a patron; it has never been regarded as self-supporting. We have become so accustomed to the idea of pure research conducted in universities that we tend to forget this fact. Actually, the universities have become the patrons. Research foundations, which operate more frankly in the older tradition, and certain industries have to some extent also assumed this role. If the funds from these sources begin to fail or the demand for research increases it is not surprising to find a search for ways to add to the traditional means of support. As a matter of fact, both conditions have been operative.

This parasitic view of research should not be regarded as humiliating; it puts research in the class with the creative arts, along with literature, music, painting, and sculpture. It may be that the time will come when it is generally realized that pure scientific research does in fact more than pay its way. Certainly a strong case can be made. But we should be careful not to fall into the error of assuming that great discoveries can be bought or that research in certain fields will never be profitable. I doubt whether any such practical justification of pure science will ever come about through the efforts of scientists themselves. There will always be too many among us who regard with apprehension or resentment the motivation of utility. This is probably as it should be, but we must admit that it is a source of misunderstanding when we ask for money.

Much has been said and written of the effect of the war on the need for scientific research. It is true that we drew heavily on our stockpile of scientific knowledge. It is true that most European science, which had long led us in fundamental research, came to a standstill. But other factors were also at work. Academic scientists learned what industry already knew—the advantages of teamwork on scientific problems. Also, notably in nuclear physics and fluid mechanics, large scale and costly installations proved necessary, but beyond the reach of single institutions. We must add to this the urge among many of the scientific fraternity to return to the pursuit of knowledge with a deep sigh of relief after their strenuous years of applied research and development.

It was in this atmosphere that a National Science Foundation was proposed. There are many who feel it a misfortune that the first bill for a National Science Foundation and those subsequently proposed have failed of enactment. However, it is some consolation to realize that we all now know a lot more about the problem than we did, both as a result of the discussion provoked by rival legislation and as a result of experience with such federal support as has been available. This at least is good, and should be helpful in making a National Science Foundation more effective if established.

In the atmosphere just following the war it is not surprising that the military establishment took the

lead in sponsorship of research. Everyone was convinced of the importance of science, and research in particular, to national defense. In 1946 General Eisenhower put forth a strong statement to this effect, and the Navy went into action by securing authorization for a special Office of Naval Research, through farsighted planning led by such men as Robert D. Conrad, Luis de Florez, Harold Bowen, and James Forrestal. It was necessary for the military to act quickly, since their peacetime plans had to be made at once and geared to a much lower level of operation. Besides, many felt that much of the Office of Scientific Research and Development had permanent value and should be retained. In this connection it is interesting to note a statement made in 1885 by the then Secretary of the Navy, William C. Whitney:

> The rapid advance of the art of naval warfare and the singular fertility of human genius in devising new and more formidable implements of destruction are rendering this branch of public service more complicated and difficult. . . .
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> A naval vessel at the present moment is a product of science. Taking the world over it will be found that each part of her—her armor, her armament, her power, and the distribution of her parts or characteristics—each of these features of the completed vessel is absorbing from year to year the exclusive study of a class of scientific men. And as men of science throughout the world are continually stimulated to new discoveries and inventions, no vessel that can be built can be considered a finality in any particular.
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> It is of little service to a nation to have any Navy at all unless it is a fair expression of the highest scientific resources of its day. The destructive power of the modern implements has become so great as to dominate in actual warfare. The bravest and best commander is helpless without them.

Just how broad is the need for support of research? Does industry require or want government support of research? Should *all* colleges aim to do a fair proportion of research? If so, should all receive government support? If not, to which should support go? Should support be given to the institution as a whole, to particular schools or departments, or to qualified or promising individuals? Or should it be on a different basis—support in certain fields of apparent promise or of interest to the donor? Whatever the answer, one has to reckon with the fact of limited government appropriations for the purpose.

And what of the problem of scientific manpower? If we grant the desirability or even the urgency of increased support of research, have we actually an adequate number of scientists and engineers for the job we need to do? It is commonly supposed that we have not, and that no considerable expansion in support of research can be started at once without serious dislocation of existing programs. But this statement is only partly true, and, like all part-truths, can prove a serious obstacle to proper action. It is true that the need for competent scientists in industry and in government is great and that the available supply is low, and the same can be said with even more force with respect to the teaching of science at the more elementary levels. But the operations of the ONR have produced conclusive evidence that there is still abundant room for support of research in colleges and universities, and this may take place with little if any detriment to existing programs for combined research and development. Furthermore, by application of increased support along this avenue we should at the same time take the most direct step toward alleviation of the shortage of highly trained scientific manpower. This research is almost entirely basic in character, and is, consequently, universal in availability to all. Although assistance in this direction could not be counted on to produce immediate practical benefits, the by-products would in many cases lead to important applications. From straight content alone, the outcome would merely add to our store of scientific knowledge. But ideas beget ideas and we should thereby greatly enhance the likelihood of turning up untold treasures, still in the rough.

One may properly ask how it is possible that this situation may exist—an unfilled demand for research scientists and yet an unfilled capacity for accomplishment of research. The answer is evidently that there are many competent scientists who prefer the academic environment and who cannot be induced to leave it. Among them are good research scientists who can, with help of a graduate student or two and funds for equipment and materials, turn out good research without interfering seriously with their present share of educational work.

One consequence of the support now provided is an expressed need by the heads of educational institutions for general funds to restore the balance disturbed by support in special fields.

Questions like these should really be considered by a general agency like the proposed National Science Foundation, or, failing that, by a special commission if the matter is urgent enough. There are other matters, too, which should be more the concern of such an agency than any existing one, such as support of fellowships, underwriting scientific publications, dissemination of scientific information, exchange of scientists, aid to foreign science, and finally, firsthand scientific advice to the executive and the legislative branches of the government.

These are some of the reasons why the ONR should not be regarded as a competitor of the proposed National Science Foundation. For purposes of our pres-

ent discussion, the function of the ONR is to follow and coordinate the research performed by the rest of the Navy and to supplement this by support of research externally and within its two major field laboratories, the Naval Research Laboratory and the Special Devices Center. The ONR interprets this part of its function as justification for backing a limited program of basic research in scientific areas which offer the chance of ultimate important effect upon developments in weapons, devices, and techniques of warfare.

There are other advantages too. As stated by a former chairman, Detlev W. Bronk, of our Naval Research Advisory Committee:

> We feel that there are many important practical needs of the Navy which derive from fundamental research which cannot be immediately identified. We also have faith that there are very important results which are going to issue from research undertakings which cannot, at this present moment, be identified as having outstanding practical value; secondly, we feel that it is of great importance to the Navy that there should be outstanding civilian scientists who are associated with the Navy through their ONR contracts. We feel this is a source of good will, expert advice, and guidance, and one which would not be as available to the Navy if there were not these direct contractual relationships between the Navy and scientists; and finally, we feel that it would be extremely undesirable if all of the support for fundamental research were to be derived from just one agency. This is necessarily a type of support which involves exploration, adventure, and gambling and we think it is sounder, as a basis of operation, if the support be derived from various individuals and various agencies concerned.
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> And furthermore, related to this there will be special needs of different agencies which will be best supported if all of the research support is not derived from just one foundation or one organization.

The ONR research program has been built by selection of research projects proposed by scientists with the endorsement of their institutions. This selection is based upon many factors, such as the scientific value of the research, the capability of the proposing group and their facilities, the degree of support by the institution, both financial and policywise, the probability of ultimate usefulness to the Navy, the relation of the research to that elsewhere in the Department of Defense, and last but not least, the state of the budget. The ONR grants no fellowships, it constructs no buildings for its contractors, nor does it give grants-in-aid. Its means of furnishing support is by nonprofit contracts with the institutions concerned. Much care and thought have been spent on setting up procedures which would leave the investigators free to attack their proposed research in their own way. Supervision by the government, necessary by law, takes the form of close supervision of the program, with the help of consulting panels of experts in each field of research, supervision projectwise over expenditures, and full discussion and decision in the case of change in aim or scope of a project. Almost all this external research with universities is free from security classification. Publication in scientific journals is encouraged, as are conferences and symposia. The ONR reserves the right, however, to discuss immediately any result which requires classification and to obtain agreement to remove the classified portion to some military laboratory or set up adequate safeguards in case the university and the Navy jointly wish to continue the work in the existing location.

Why is federal support of research a problem? There are three standard answers to this question: government support implies government control, it involves administrative red tape and confusion, it is erratic and uncertain. These objections must be met by such safeguards as can be managed in the arrangement set up.

At the risk of oversimplification, let me suggest that for our immediate purpose, federal support of research is a problem for two main reasons, which may be illustrated by two additional questions:

1. Is federal support of research justified? The government requires a satisfactory answer to this.

2. What will be the consequences of extensive federal support? The answer to this is a matter of concern to science, to scientists, and to scientific and educational institutions.

To the former of these two questions the majority of scientists would probably answer that federal support of research is justified provided the values inherent in the traditional environment of research, such as continuity, initiative, and freedom of communication and publication, can be maintained. In other words, most scientists would give an affirmative answer to the former question provided the answers to the latter may be satisfactory.

Let us remind ourselves at this point that Uncle Sam is properly a realist. He may believe in charitable donations for some of the people all the time, for all the people some of the time, but not for all the people all the time. In general he expects to pay only for services rendered. Thus the federal government does not provide financial support unless a need can be established, and when such support is provided it must be expected to show some return to the taxpayer.

As a quick answer to our first question, then, intelligent support of research should be able to accomplish the following:

1. Raise the productive level of research, with the many attendant benefits sure to follow;

2. Increase the output of young research men and women and thus fill the needs of industry, government, and academic institutions.

But let me turn at once to my second question: What may we expect to be the consequences of extensive federal support of research? As mentioned earlier, I shall consider only the case of support in institutions external to the government, and especially in nonprofit institutions such as universities, technical institutions, and colleges. I shall confine my remarks to support given on broad, comprehensive lines, and so not mention the support furnished by agencies with special fields in view—as for example the excellent work done by such agencies as the Public Health Service and the Department of Agriculture.

In the first place, if we are to be realistic we must at once admit that extensive government support of research will have consequences beyond the important and beneficial ones of stimulating research output and supply of future scientists. It is a commonly observed fact that any attempt to change some factor in a situation is accompanied by effects other than those intended. Indeed experimental science knows that it is only by careful planning and painstaking attention to techniques that these spurious effects may be kept in the background.

For one thing, increased support of research in universities has been accompanied by an increased number of graduate students. What effect will this have upon the quality of the doctor's or graduate engineer's degree? It may be that by increasing graduate school enrollments we shall succeed in turning out no larger number of potential research leaders but shall actually lower the average competence of the total output, by dilution and by congestion. Perhaps increased demand for trained research men and women and for research administrators may to some extent justify such a tendency, but the situation should be watched.

Research institutions generally are apprehensive of possible dictation or control over their research by a supporting agency. The independence of an institution is threatened if pressure can be applied toward the acceptance of undesired work. This may be minimized by the policy of basing support on proposals initiated from the institution, by the avoidance of permanent construction owned by the supporting agency, and by a cooperative program of joint support. For a given institution, any danger of control may be balanced to some extent by internal adjustment and by the existence of a number of sources of support. Objectionable control with respect to progress on individual problems can certainly be avoided by intelligent management. Nevertheless, even though no pressure is intended, it is undeniably true that the mere selection of research for support by an outside agency is itself a form of control.

A subtle form of this influence may be expected to manifest itself in varying degrees by the tendency of an existing research group to perpetuate support from the same source, and the attempt of other groups to slant their program in the direction of probable areas of support. This tendency should be recognized and any instances identified both by the institution and by the supporting agency.

A prospect may exist, especially among universities, which is of more fundamental concern to the cause of basic research. As already mentioned, the government quite properly invests its money in areas which will bring a return to the taxpayer—that is, in activities which promote the national welfare or security. This implies an emphasis upon short-term tangible and practical results, and this is foreign to the nature of pure or basic research. Will we therefore see in government support a verification of the truth first pointed out by Vannevar Bush in "Science—The Endless Frontier," that applied research tends to drive out basic? This would indeed be tragic. All the elements that go to make up our high standard of living, in fact a very large part of the world's thought and progress, have come about through pure or basic research in the broad sense, that is, creative work in the arts and sciences. The great discoveries cannot in general be predicted nor can they be made to order. There is no need to give examples—history is eloquent on this score. This is admittedly a troublesome point. I believe it must be met by an insistence upon support of basic research in its own right. If a practical justification is required, let us call it a necessary investment for the future. It will be dangerous for basic research to compete for funds with applied research and development, which can cite probable practical accomplishments. This difficulty might be handled in the federal budget by general agreement that every agency should have a limited sum or a limited fraction of its budget set aside for research, and that this sum should not require detailed budget defense in advance. Instead, the results of the research program should be subject to periodic review.

A quite different consequence of support of research by contract follows from the amount of administrative detail required of the institution and the supporting agency. Many academic institutions, not accustomed to this degree of administrative detail, have found it advisable to set up a special office and staff for research administration, particularly where there is a considerable volume of industry- and government-supported research. This is of course an advantage in that it takes many administrative details off the shoulders of the chief investigators and the scientific

departments concerned. It is obviously important to centralize this function within the institution. The growth and strengthening of these administrative offices is a consequence of support by contract. However, there is an aspect of this development which may bear watching, namely, the possible tendency of a strong administrative office to dominate the research program of the institution. In fact, an aggressive office is in position to exercise pressure upon the research staff of the institution itself. Or it may tend to insulate the scientist from his opposite number in the supporting agency.

Another movement, which may be related to the one just mentioned, is the establishment or the strengthening of research institutes or foundations, attached to a university but separated to a greater or less degree from the academic or educational plant. Such organizational units have advantages from the standpoint of handling externally supported contracts and of increasing the research business of the institutions. They can accept support for applied research or development with less fear of upsetting the balance between education, basic research, and applied research. They can more readily go in for group research and more extensive programs. To some extent they can protect the university from sudden fluctuations in financial support. They can more readily accommodate confidential work, either from industry or government. But such a unit may run into rather troublesome situations, such as a salary differential between its staff and faculty members not connected with it. For another thing, if it goes in strongly for applied research and development and is ready to accept projects upon request, it may come into competition with commercial research agencies. This competition may be regarded as unfair if the unit takes advantage of its nonprofit and tax-exempt status to quote lower costs for research or development undertaken. It is of course early to say, but it is possible that, unless great care is exercised, the advantages gained by this separation of research from education may be offset by deterioration in fundamental research.

These are some of the consequences which may be anticipated from government support of research. They are of course bound up with the mission of the sponsoring agency and also the policy and procedures established by this agency. These are to a certain extent dictated by governmental limitations, both as to allowable procedures and as to mission. In this connection, I should like to return to a point mentioned earlier, namely, the importance of a government agency's having the authority and opportunity to pursue basic research. Let me illustrate by the case of the ONR as a typical example. This office has as its aim the sponsorship of research for the Navy Department. Since the Navy's mission is national defense, it is clear that the money spent by the department should be directly related to national security. Insofar as national security implies scientific strength in the country as a whole there is justification for wide support of science, provided the country's science is felt to require assistance. This was admittedly the case immediately following the war. The question then arises whether the department should continue to give widespread support to science if and when a stage shall have been reached of a strong, stable scientific effort in the nation. It is the considered judgment of the ONR—and this is fully endorsed by its Naval Research Advisory Committee—that the Department of the Navy is still justified in continuing support of basic research in outside institutions, provided the level of this operation is definitely limited and is appropriate to Navy needs. The reasons for the interest of the ONR in basic research may be expressed as follows: The Navy's interest lies in end results, whether weapons, devices, or techniques; very many of such end items have their origin in science. Now, progress toward these end items occurs in the following sequence: basic research, applied research, development, test, and production. Note that this chain of events begins with basic research. This beginning may be found in scientific literature or in current research.

One of the most promising avenues toward accomplishment, then, is to expedite this sequence. Sometimes progress may be held up for lack of basic research; again there is apt to be serious delay between the basic research stage and that of applied research, or between the development and production. The ONR conceives as one of its most important functions the speeding up of the research end of this sequence. Any progress along this road can be an untold asset for national security. It should be clear that real effectiveness in such a mission can be accomplished only when the agency concerned has responsibility for support of basic research, for quickly seeing promising applications and for assistance in initiating appropriate action within its department. In the long run this job cannot be handled adequately if left entirely to some other agency. This was a mistake made by the military establishment prior to World War II. It is certainly true that a second-hand method of providing this service is also second-best, and this is hardly justifiable when we are dealing with national security. The case is, in fact, quite similar to that of the technical industries, which have long recognized the necessity of supporting research.

It should not be forgotten that there are areas in basic research which are of the greatest importance

to a particular agency such as the Department of Defense or the Department of Commerce, but where no general research agency like a National Science Foundation would be expected to provide adequate support. In these areas the government department can hardly expect adequate and timely support from a foundation where the work has to compete with the latter's own mission and with outside requests. Furthermore, at any given time specific areas in basic research can be identified as bottlenecks to existing developmental programs. Again the operating agency critically needs authority to pursue these on its own initiative. Quite apart from these considerations, it is my personal belief that no one should question the right of an operating agency to place a limited fraction of its support in extremely pure or fundamental research in the major fields of science. This appears to me completely justifiable in many ways. For example, there is the opportunity of uncovering a radically new discovery of significance chiefly to the agency, ties are thus established by the agency with up-to-date scientific thinking, barriers between science in government and outside science are destroyed, the morale of scientists at work for the agency is improved, and competition in pure research serves as a stimulus. Finally, I believe it is the opinion of most scientists that research should never become the monopoly of any agency, government or otherwise.

I have remarked earlier that the government expects practical results from the support of research, and that in basic research the investigator should be as free as possible to work out his ideas. These ideas usually have nothing to do with possible application, and in fact any practical consequences are generally regarded as irrelevant to the investigation. How are we to reconcile these apparently opposing points of view? The answer is clear. In general, we must consider the practical application of ideas from basic research to be the responsibility of the supporting agency and not that of the investigator. This recognizes a well-known fact that many research men have no particular aptitude for applied research or, if they have, do not make use of this aptitude except in solving their own research problems. Thus a research investigator may show a high degree of ingenuity in devising a piece of his apparatus to perform a special, practical function, but he regards this ability as important only to the accomplishment of his main purpose, the solution of his problem. If his attention to his chosen goal is deflected the probability of his making a creative contribution is considerably reduced. It is the integrated total of such accomplishments that form the backbone of true scientific progress.

On the other hand, the supporting agency should choose its staff to include scientists of a more practical turn of mind who by association with the needs of the agency are in the best possible position to spot possible applications and to carry them forward in the hands of the proper group in their department. If this policy is followed, there should be minimum difficulty in insuring proper environment for the sponsored research and, at the same time, satisfactory output of practical suggestions. What is more, the tendency toward improper pressure on the research worker or his institution is eased thereby.

In order to arrive at adequate safeguards to insure reasonably effective operation of external research programs supported by a government agency, it may be profitable, at least for purposes of discussion, to attempt to lay down a few guiding principles. I propose the following:

1. In selection of items for support, emphasis should be placed upon the field of interest of the agency and upon the caliber of the investigator, with final selection made from specific problems proposed by interested research scientists and accompanied by endorsement of their institutions.

2. Every effort should be made to insure that the working conditions are appropriate to research. These mean freedom in performance of research and freedom to publish and to exchange information with colleagues.

3. Administrative details should be handled as fully as possible by the respective administrative staffs of the institution and the supporting agency. However, the initial arrangements and any subsequent changes should be reviewed by the interested scientists on both sides.

4. The supporting agency should possess a scientific staff with full authority regarding approval of research projects and it should have committees of experts to guide it in formulation of its program.

5. The scientific staff of the supporting agency should be composed of scientists with research experience who know from personal background the conditions that should be maintained. This staff should be competent to discuss the work intelligently and intimately with the working research groups. It should also be competent administratively and organization-wise to deal effectively with administrative and service units in the agency and also with other agencies with which the work should be coordinated.

While the success of any plan for government support of research obviously depends on the administration of the supporting agency, it must at all times be remembered that no charter, no administrative setup, and no staff can succeed in this relatively uncharted area without full cooperation from the institutions supported. It is impossible to solve many questions on a unilateral basis. A common misap-

prehension is that administrative questions arising in a research program may be solved apart from scientific matters or vice versa. In point of fact, the two are apt to be inextricably mingled. In the negotiation and administration of supported research there are and should be four groups involved: the research group at the institution, the scientific staff of the agency, and the administrative offices of both the institution and the agency. It is also desirable that the policy of the supporting agency be flexible enough to adjust to the policy of the institution, within limits. Above all, I wish to emphasize the great importance of a cooperative interest on the part of the research investigators in the program supported by the government agency. This cooperation should be kept extremely close, in order that the agency may meet or even anticipate the needs of the research group, and in order that it may plan effectively. A successfully organized program should have the weight of approval of all its constituents. If this is achieved, government support of research will be abundantly justified.

Technical Papers

Fluorometric Determination of Serum Aureomycin Levels

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In view of the difficulties associated with the bacteriologic assay of serum aureomycin concentrations, a method was developed of determining these concentrations by adsorbing the aureomycin on small columns of silica gel and observing the yellow fluorescence at the top of the column. A fluorometric method of measuring high concentrations of aureomycin has been reported by Kelsey and Goldman (*1*), but their procedure is not applicable to determining the low concentrations found in clinical material.

It was observed that aureomycin had an intense yellow fluorescence in an acid or neutral medium and that after several minutes in an alkaline medium it began to be altered to a compound with a blue fluorescence. Inasmuch as yellow fluorescing compounds are a great deal more uncommon in body fluids and among medications than blue fluorescing compounds, it was felt that a test depending on yellow fluorescence would be less subject to interference than one depending on blue fluorescence. Hence, only neutral solutions were used.

Two-hundred-mesh activated silica gel (Davison) was backwashed with distilled water at 100 ml/min on a column 50 mm × 1 m for 3 hr. This removed the very small particles and gave a suspension of particles of fairly uniform size. To a 20-cm length of 6-mm glass tubing constricted at one end and packed with glass wool, there was added, by means of a capillary pipette, enough of a slurry of the prepared silica gel to form a packed column 3 cm long. Packing was achieved by repeated tapping of the column until no further settling occurred. One ml of serum containing aureomycin was allowed to filter through the silica gel column without vacuum or pressure being applied. The serum was followed by 1 ml of isotonic saline and 1 ml of 95 or 100% ethyl alcohol. The saline served to wash out the serum, and the alcohol intensified the fluorescence. At no time was the surface of the silica gel column allowed to dry out or be mechanically disturbed by the addition of fluids. Standards were prepared, in the same manner, with sera to which 20, 10, 5, 3, 2, 1, 0.5, 0.2, and 0.1 μg of aureomycin hydrochloride[2] had been added. The aureomycin was diluted to the appropriate concentration in distilled water and 0.1 ml of the dilution added to 0.9 ml of serum. The unknowns were visually compared to the standards, after dark adaptation, in a darkened room with the focused light from an 85-watt argon-mercury lamp filtered to remove all wavelengths above 400 mμ. The fluorescence appeared at the top of the column as a yellow band, which varied in width and intensity according to the concentration of aureomycin. Standards must be prepared every day or two, since the fluorescent color tends to fade. The success of this procedure depends in large measure on obtaining uniform silica gel particles and in uniformly packing these particles into a column free of bubbles.

The procedure may be modified to determine aureomycin in urine, spinal fluid, and other media. These modifications and the preparation of permanent standards will be reported elsewhere.

The fluorometric test was checked against bacteriologically determined levels on two healthy subjects who took, respectively, 9.3 and 10.4 mg/kg of aureomycin orally, and on patients who had received a single intravenous dose of aureomycin. The results are recorded in Table 1.

A test for interfering substances was made by adding aureomycin to the sera[3] of patients receiving other medi-

[1] The authors wish to thank Dr. Eleanor Bliss, of The Johns Hopkins Medical School, for her stimulating suggestions and encouragement.

[2] The aureomycin hydrochloride used in these experiments was supplied by the Lederle Laboratories Division of American Cyanamid Company, through the Antibiotics Study Section of the National Institutes of Health.

[3] These sera were obtained through the kind cooperation of the members of the House Staff of The Johns Hopkins Hospital.