are pertinent to the controversial material. These questions should be so phrased that they require definite answers, such as "yes," "no," or "possibly true." When a consultant answers in the negative, he is asked to present evidence to support his contrary opinion. The discussion of consultants may be rounded out further by including their opinions of the paper as a whole and stating their approval or disapproval.

The number of consultants necessary to present a good discussion varies. Usually 5 or 6 are sufficient, although the discussion concerning a generally held misconception may require as many as 15 or 20 consultants. After conference with the author, consultants are selected by the editor of the periodical in which the article is to be published. If the author selected as consultants only those whose views agreed with his, he would defeat his purpose. He must consider authorities of contrary opinion a well as those in agreement with him. It is clear that the opinion of the readers will depend greatly on the previously published views of the consultants. The principal purpose of consultant articles is to ascertain whether or not the available evidence is sufficient to convince those men who, in the past, have held contrary views.

When all consultants have submitted their discussions, the author has the privilege of answering their criticisms. He often finds this opportunity highly instructive. The author may note that (1) a certain phase of his evidence is not quite as conclusive as he believed; (2) the evidence was unknown to some consultants; (3) some of his statements have been misinterpreted by consultants due to lack of clarity; (4) photomicrographs, charts, graphs, or other material used as evidence supporting his findings were insufficient in number or not sufficiently clear to gain conviction. All of these data may be discussed by the author in order to interpret and correlate all opinions. The closing discussion should be brief, yet sufficiently comprehensive to allow the busy reader to glean from this concluding statement an idea of the status of this controversial subject.

Past experience has shown that consultant articles can be made highly authoritative and instructive. By means of cooperation between the leaders in specialized fields, obsolete material may be eliminated more rapidly and the value of new hypotheses tested, resulting in the more rapid progress of science.

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Research Service Laboratories

As research grows more specialized the methods used become more complex, and progress in one field is increasingly dependent on advances in knowledge and techniques in other fields. Scientists find it increasingly difficult, however, to keep informed concerning current developments in their own fields, and practically impossible to keep up with advances in other fields. Thus, it seems that just at the time when our dependence on other fields is increasing, our ignorance of them is heightening. This situation emphasizes the importance of cooperation and consultation between departments. The advantages of being able to consult with competent advisers concerning the planning of efficient experiments and the construction of reliable apparatus are obvious to all who have ever developed research programs. Much time and money are wasted trying to improvise apparatus because no expert is available to give advice or to build reliable apparatus. Probably even more time and money are wasted on poorly designed projects which yield inadequate and inconclusive results, but which, if properly planned, would have yielded satisfactory results with the expenditure of less time and money.

While we usually find our colleagues in other departments willing to advise us, we generally consult them with some reluctance because we know that they could spend their time more profitably on their own problems. This situation might be remedied by the establishment of what Klopsteg calls "laboratories of instrumentology" to assist investigators in developing better methods and apparatus for research (*Science*, 1945, **101**, 569). The program proposed by Klopsteg is too elaborate and too expensive for any but the largest universities, but much can be done to increase the efficiency of research in institutions of moderate size by supplying a few of the more essential services.

Perhaps the most useful service is an adequately equipped instrument shop, supervised by an ingenious and cooperative instrument maker. In view of the increasing use of electronics and electrical instruments of all sorts, a consulting physicist with special training in electricity and electronics is highly desirable. The services of a glass blower are often needed, but individual conditions would determine whether or not an institution of moderate size can afford a full-time man. One solution is for two adjacent institutions to cooperate by sending all their work to a shop maintained by one of them. Another essential service is a statistical laboratory in charge of an expert in the design of experiments and the analysis and interpretation of data. Such a consultant can add greatly to the efficiency of research by eliminating the waste of time and money resulting from poorly planned experiments. While most investigators have a fair knowledge of experimental techniques, few have had adequate training in planning experiments and evaluating the reliability of data. Various other forms of service can be developed to fit the needs of research in particular institutions.

Probably most institutions have some of the services mentioned, but in only a few instances are they specifically organized to serve investigators in all departments. Service laboratories should ordinarily be administered by the departments to which they are naturally related. Investigators using them should be charged for the time and materials used on their projects. Free services are never as much appreciated as those which must be paid for, and a charge prevents a few self-centered individuals from completely monopolizing the services of a laboratory.

It should be emphasized that the success of such laboratories depends largely on the training and personality of the men in charge. Not only must they be well informed in their own fields, but they must have broad interests, ingenuity, curiosity, and a real desire to cooperate with their colleagues in other fields in solving a wide variety of problems.

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On Introductory Biology Courses

In the recent discussion of the nature of the elementary course in biology reported by Dr. Hamburger (*Science*, 1945, 102, 511–513), consideration was given to the problem of whether a single course in general biology should be given for all students, general and professional, or whether a special course should be set up for the latter. At Stanford University both methods have been tried, and the author has taught under both plans. The staff has been sufficiently large to allow two introductory courses, so the choice has depended upon the performance of the students. Our plan and experience might therefore be of interest to others.

Stanford was one of the pioneers in giving a general biology course designed primarily for the liberal arts student and organized along lines quite different from the classical courses in botany and zoology (L. L. Burlingame and E. G. Martin, *Science*, 1920, 51, 452–455). This course and its successors have used the principles of biology and their corollaries as the basis of organization. Thus, the broader concepts of biology are emphasized as the basis of an understanding of the functioning of the human body and the place of man in nature as one of the animals in a community of organisms.

On the other hand, such a course, while excellent for the liberal arts student, may not necessarily be the best beginning for the person who, by virtue of high school training or a strong interest in organisms awakened in some other way, already has a fair understanding of the general concepts and is anxious to begin directly on his professional training. In two attempts to put all students together—majors in biology, premedical and liberal arts students—we have had this brought to our attention strikingly. The pace necessary for the newcomer is too slow for the student already introduced to biology. The repetition of the same material as he had in high school is not most stimulating to him. On the other hand, accelerating the course or making it more intensive soon carries it beyond the ability of the newcomer. Segregation of the majors and premedical students into a special advanced laboratory section helps but does not solve the problem, for the lectures are still aimed mainly at one group. As a result of these experiences the professional and premedical students were allowed to elect plant and animal biology instead of general biology. This most of them did, although some, feeling the need of orientation, took general biology. Both routes are allowed to serve as an introduction to the advanced professional courses.

In the introductory plant and animal biology courses the plan has been to introduce the student to the major plant and animal groups, their behavior, nutrition, structure (gross and histological), life cycles, and evolution. In so far as is feasible, principles of adaptation, distribution, homology, recapitulation, evolution, and heredity are considered when the material favors their discussion, and the cell theory serves as a unifying principle throughout.

The professional and premedical student does not receive adequate training in all the principles of biology in his introductory plant and animal biology courses, since time is inadequate for this purpose. On the other hand, by the time he finishes a good advanced sequence in his professional field he will have been introduced to all the principles of biology, each strongly reinforced by a body of data far in excess of that possible in the general biology course. If he still needs a general treatment of the principles of biology and their application to man, a course on the senior level, encouraging him to focus his attention on the principles and to weld these into a philosophy of biology, might serve his needs far better than time taken out at the elementary level.

Such a double entry into biology may require more staff, and it taxes the type of adviser who wishes to rubber-stamp all college entrants. Inasmuch as the entrants are diverse in ability, background, and training, why not recognize and take advantage of this diversity as well as of the differences in objectives and subsequent training an individual is to receive? While all members of our own staff are not in complete agreement on this arrangement, practice has borne it out as preferable under local conditions. It would be interesting to know the experience of others in this regard.

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Support of Scientific Research

In reading the various interesting and stimulating discussions of different aspects of the proposed national legislation for the support of scientific research, there is one phase of the problem that seems to me to have been largely, if not entirely, overlooked. This is the educational value to a democracy derived from the individual support of such work. There has been a well-organized effort in this country to emasculate the emotional and participative factors in individual charity and philanthropy.

Community chests with pooled and budgeted objectives are undoubtedly, on paper, an efficient method of giving. By the conduct of a single campaign covering many needs it effectively obviates the necessity of the donor investigating and considering the individual needs. It is a soporific to individual responsibility and tries to make giving an easy and comfortable process devoid of any unpleasant realities that make the donor even temporarily uncomfortable. It kills thought and, with