prophet is asked to provide concepts whereby advances in—say—extrasensory preception could be exploited, sharper forecasting methods than any now available would be needed. Should it be shown that ESP is physico-chemical in nature, an immense amount of applied research would have to precede the invention of transmitting, receiving, and translating devices. . . .

Essentially, methodical technological forecasting calls for a better, sharper image of the future then we now have. It is curious that we have today a fairly clear set of requirements for making the moon habitable, as well as many concepts of the properties and characteristics to be incorporated into moon structures; the image of the future as regards planet Earth is less well defined. Research and development might be greatly benefited by improved statements of future requirements, complemented by technological forecasts of the general course that science and technology will take to fulfill them.

MARTIN S. PETERSON
U. S. Army Natick Laboratories, Natick, Massachusetts

Congress and the Fermi Prize

The Congress is composed of elected representatives of the people and is concerned with many and weighty decisions. Science is something few of its members understand, as is frequently pointed out in your columns. The actions of the Joint Committee on Atomic Energy in connection with the Fermi Prize [see News and Comment, *Science*, 20 Mar., p. 1305] are a prime example of their ignorant dabbling. Have they so little understanding of the devotion which is being shown by the many scientists who have consented to serve on such time-consuming bodies as the General Advisory Committee of the Atomic Energy Commission? Have they really the desire to keep good physicists from serving on it so that they may not become ineligible for some recognition?

I seriously suggest that the best action the General Advisory Committee of the AEC can take is simply to cease awarding the prize. If the Joint Committee cares, itself, to make an award to someone, presumably someone who has never worked for the government, perhaps (in order to avoid any suggestion of favoritism) not to a scientist at all, I suppose it is within its legislative ingenuity to do so. But I repeat, for the GAC the only dignified and proper action is to cease making the award.

DONALD O. WALTER
Brain Research Institute, University of California Medical Center, Los Angeles 24

New High School Biology Course in the Light of Experience

In his fine review of the Biological Sciences Curriculum Study publications (*Science*, 14 Feb., p. 668), J. K. Brierley, one of Her Majesty's Inspectors of Schools, British Ministry of Education, voices some objections that others who have not actually used these books may share. We were among the high school biology teachers who evaluated the first revised Green Version textbook in their classes in 1961–62. Each of us evaluated in actual use one of the laboratory blocks (*Plant Growth and Development* and *Animal Growth and Development*). This year we have both been using the commercially prepared Green Version (*BSCS Green Version—High School Biology*, Rand McNally, Chicago, 1963), and we are currently evaluating a newly written laboratory block on *Metabolism*. We should like, in the light of this experience, to comment on some of the objections expressed in the review.

First, Brierley regards some of the concepts presented in the texts as too sophisticated and too difficult for high school students. Our experience is that all these concepts can be taught *to some extent* to all our students. The slower learners are taught them without certain refinements of detail. New aids to teaching biological concepts to the slow learner have been developed by the BSCS under the heading of "Special Materials." We have found that population dynamics, taxonomic theory, energy relationships, genetic continuity, and a host of other so-called "difficult" ideas of biology can become a part of a student's understanding even though he has reading or learning difficulties.

We think, with Jerome Bruner, that "it may be that nothing is intrinsically difficult," that "We just have to wait until the proper point of view and corresponding language for presenting it are revealed," and that "The trick is to find the medium questions that can be answered and that take you somewhere" (*The Process of Education*, Harvard Univ. Press, Cambridge, 1962, p. 40). It seems to us no disadvantage to have intricate diagrams in the textbook on which to base our questions for the more able learners; it is easy enough to ignore a diagram, a paragraph, or a whole section if it is not appropriate to the learner's ability. We are finding that it is not beyond the ability of the average student to extract and analyze chromatographically the purines and pyrimidines of yeast nucleic acids. The hydrolysis and synthesis of polysaccharides, autoradiography in photosynthesis studies, and the role of ATP in energy transfer are becoming first-hand experiences for our biology students. We have been amazed ourselves at what they have been able to do in what could reasonably be called "high level" biology.

Second, Brierley seems to misunderstand one premise of BSCS. He says that school courses should be complete in themselves and assumes that BSCS has prepared its curricula with this in mind. This is not quite true. It is true that for many students the high school course is the first and last formal presentation of biology; but to behold in the BSCS publications an effort to open and close the subject within the course of an academic year is to misunderstand our aim. The most basic attempt in science teaching is to prepare students for the great advancements that will come in the future. As a corollary, we must also rebut Brierley's conjecture that the BSCS includes too much physics and chemistry for average 15- and 16-year-olds. By and large, we find that our students are able to understand those bits and pieces of chemistry and physics that are introduced for clearer understanding of some of the biological concepts. We contend that the more relationships we can show among the natural sciences as well as among the specialties within biology, the better.

Our third comment is that the BSCS courses are *not* too difficult to teach even when one's formal education ended 20 years ago. Brierley says, "The impact of this new work on older teachers whose university courses were finished, say 20 years ago, and whose body of knowledge . . . may be largely inadequate and as obsolete as notions 'of body humors, the ether, or the impenetrable atom,' would be to break their backs and perhaps destroy the solid work they are doing in the

schools. . . ." Teachers who are doing "solid work" have kept up to date through the years by reading and by attending institutes and conferences. In this country it has been particularly easy to do so, thanks to the generous financial support given by the National Science Foundation. One of us completed his formal study of biology 30 years ago, the other 3 years ago. There is no noticeable difference in the success of our pupils as measured by standardized tests or as reported by our graduates. We would go so far as to say that the BSCS materials have come upon those teachers who are doing solid work as a quite logical and expected development, prophesied by the advances in the discipline itself. Teachers who reject BSCS, or any new curriculum, on the basis of their own insecurity may be encouraged by our faith that they have nothing to lose but their trepidation.

Fourth, we read with perplexity Brierley's statement, "I am not suggesting that it is wrong to teach about DNA coding, but it should not be taught as a proven fact." We cannot find any indication in the BSCS materials that we teach DNA as a fact any more than we teach the steps in photosynthesis, or digestion, or genetic continuity as facts. Indeed, to teach any concept in science as an unalterable fact is foreign to our understanding of the methods in science, as is clearly demonstrated in the following passage from the Green Version (p. 556):

> Biochemists have found that chromosomes contain large amounts of DNA. And all the biochemical evidence indicates that each gene is a DNA molecule or a part of one. Mutations, then, probably result from a disturbance in the structure of the DNA molecules.

This passage appears along with the explanation of replication under the proper heading "A Theory of Gene Mutations."

Fifth and last, we wish to comment on Brierley's assumption that the school teachers in the project have been forced by research scientists into accepting material in their texts. The BSCS materials grew out of writing sessions held on the campus of the University of Colorado; in these sessions, research and teaching scientists, professors of education, and high school teachers prepared the texts and laboratory manuals. Of course the research and teaching scientists were looked to for technical information when it was needed. In many cases, these scientists took over whole writing assignments, but by no means all of them. There was, no doubt, considerable argument over whether or not a certain statement or diagram should be included, but to assume that the research scientist got his way every time his opinion differed from that of the rest of the writing team is unfounded. There were, and are still, several checks set up to assure that unwarranted detail or personal predilection on the part of any individual cannot be forced into the texts.

One such check was the BSCS Evaluation Center meeting. Weekly during the evaluation years 1960–61 and 1961–62, teachers met in groups across the country to discuss the teachability of the materials. Too complex ideas and wording were weeded out, and further explanation was called for where it was needed. Written reports of the success or failure of the materials in the classroom were sent by each participating teacher to the curriculum headquarters. Final revision was made on the basis of these reports. We have been happy to see several of our own recommendations appearing in the textbook and manual as printed by Rand McNally.

The periodic testing of the students' achievement served as another check against the inclusion of unsuitable material. Results of the tests and teachers' comments on the test questions were part of the reports. Addison E. Lee, chairman of the BSCS Committee on Innovations in Laboratory Instruction, through his "project associates," themselves high school teachers, and by use in the high school laboratory, has measured the practicability of each laboratory block.

As a third check, high school teachers served as writers and center leaders. One was editor of the Green Version. We knew many of the high school teachers who were in positions of responsibility; none of them could be cowed in the way Brierley implies.

We have selected these five criticisms of Brierley's report because they are, we feel, most likely to reflect a widespread misunderstanding of our endeavor. We have not commented on certain other of his statements, such as his stand against dissections by high school students, his doubts concerning the transfer from pupil experience to theory, or his opinion that the text outruns the pupils' laboratory experiences, because we think that these are personal opinions and not those of most science educators. We think examination of certain other BSCS materials would lead Brierley to revise some of his opinions.

CHARLES BUTTERFIELD
PRESTON WHITE
Brattleboro Union High School, Brattleboro, Vermont

. . . Brierley's major criticism seems to be that the materials are generally pitched too high for the comprehension of the 15-year-old age group. He ignores the extensive testing and feedback programs which were employed to insure that the materials would be compatible with the abilities of high school sophomores. A great deal of objective evidence has been compiled in a well-designed series of tests which would not support Brierley's opinion. I would like to call his attention to *BSCS Newsletter No. 19*, which treats this matter. . . . Being a Yellow-Version teacher on the firing line daily for the past four years, I can state with confidence that these materials have been within the ability range of my students. This includes the passage on RNA from the Yellow Version quoted by the reviewer.

MANERT H. KENNEDY
Fraser High School, Fraser, Michigan

Basic Question in Chemistry

This letter is in wholehearted support of your editorial "Chemistry in the universities" (17 Apr., p. 251), in which the main thesis is, "Adequate financial support for basic research in chemistry in universities should enjoy a very high priority among the federal granting agencies. Chemistry is crucial to both science and technology."

One basic question in inorganic chemistry which this nation has never attempted to answer in a manner commensurate with its importance is: to how high a temperature can we heat substances and still contain them for substantial periods of time and thus make engineering use of them? For gases the answer is simple; they can be heated to over 50,000°K and still be contained, because of the very small energy density. The answer in regard to liquids, however, is wide open. And mastery of high temperatures is essential for our whole effort in rockets and missiles for national defense or for the peaceful conquest of space. I can think