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SCIENCE

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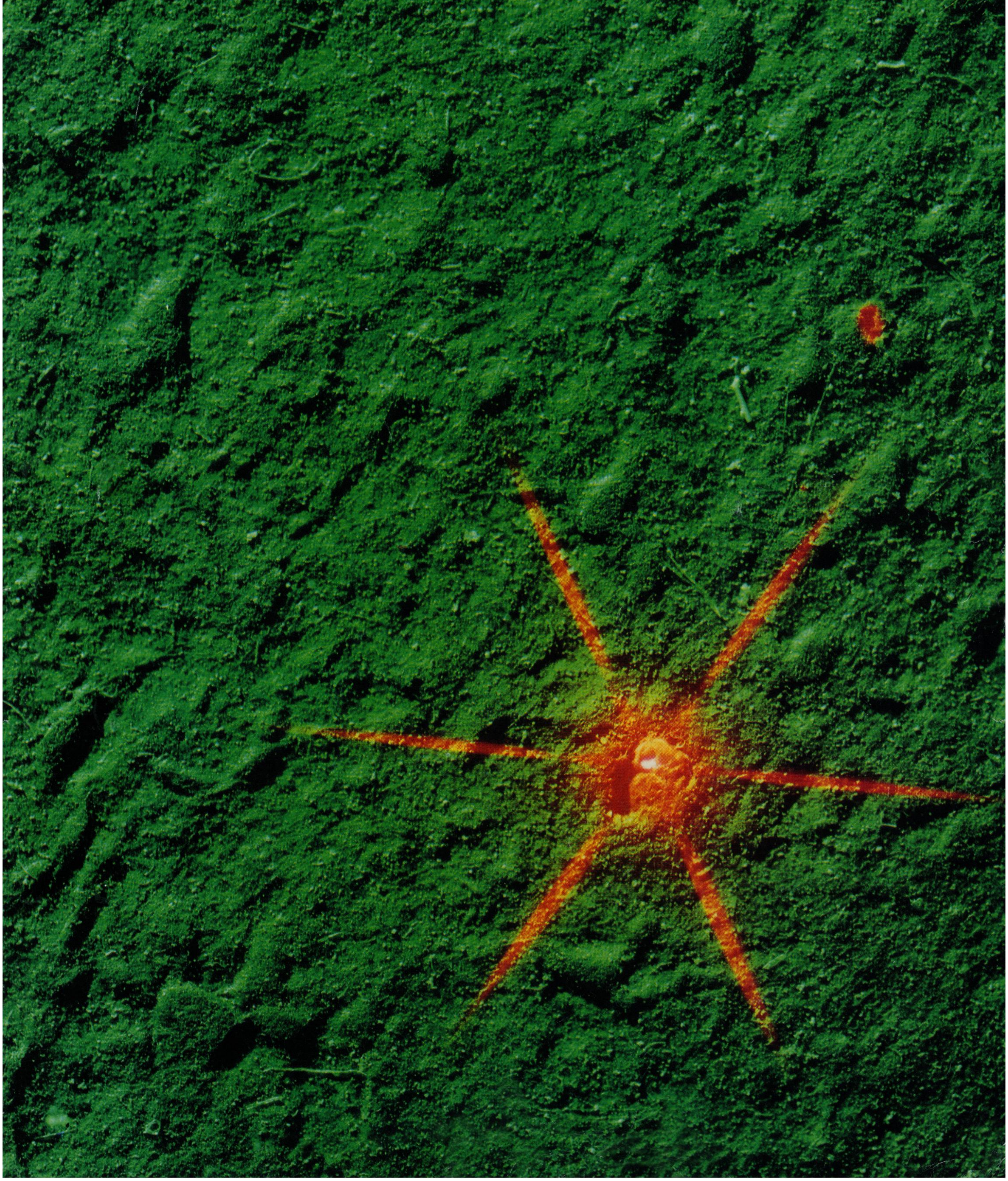

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COVER

Colloidal platinum precipitated onto photosynthetic membranes and entrapped on filter paper viewed in reflected and transmitted light (about ×8). This moistened material is capable of the simultaneous photoevolution of hydrogen and oxygen when irradiated at any wavelength in the chlorophyll absorption spectrum. The bright orange spots are punctures used to drain excess fluid from the clogged filter paper. See page 1373. [B. K. Norris and J. P. Eubanks, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831]


LIGHT
LAP/RESET COUNT/START·STOP
STOP
CITIZEN
WATER RESIST

Fluid bed technology dormant no longer

Burning coal for generating electricity and heat and catalytic conversion of methanol to gasoline can be accomplished efficiently on an industrial scale with fluid bed reactor technology (page 1329). Fluid bed reactors, first designed in the 1920's, consist of particles that are levitated, caused to boil, and thus "fluidized" by a rising current of gases. The particles, ranging from coarse to fine, are catalysts and sometimes reactants for conversion of solid and gaseous materials to energy or gasoline. Squires *et al.* expect fluid bed reactors to replace most pulverized coal boilers (over which they have advantages: lower emissions of pollutants, lower likelihood of explosion, quicker start-up time, and lower construction costs) and many fixed bed reactors for catalytic conversion of gases. Although fluid bed reactors are not expected to explode, the technology is about to—both for burning coal and for converting low-grade fuels (municipals waste, peat, and wood) ecologically to needed energy.

Prenatal diagnosis for sickle cell anemia

With perhaps as little as 20 nanograms of DNA, prenatal screening for sickle cell anemia can now be accomplished in a matter of hours (page 1350). In sickle cell anemia, unusual hemoglobin molecules in red blood cells cause the cells to take on a sickle shape, become leaky and inflexible, and occlude vessels. As a result, severe abdominal pains, leg ulcers, and arthritic symptoms occur. Normal and sickle cell molecules of globin (the protein portion of hemoglobin) differ only by a single amino acid in one of two protein chains, and this difference derives from a single base substitution in the corresponding gene. The technique developed by Saiki *et al.* combines amplification of the globin gene sequences in cells (yielding hundreds of thousands of identical copies of the globin DNA) with analysis of the gene sequence by hybridization and digestion processes that distinguish normal from abnormal genes. In a Research News article, Marx discusses the mode of inheritance of sickle cell anemia, the power of the new procedures to expedite testing for this disease (and for others that are heritable), and the new technique's applicability to general problems in molecular biology (page 1365).

Steroids stop growth of capillaries

A function has been recognized for a class of steroid metabolites for which none was known (page 1375). The unusual steroids inhibit the important process of angiogenesis or growth of new capillaries. Inhibition depends on exposing capillary beds to both steroids and heparin (or a non-anticoagulant fragment of it) and does not occur when either is tested alone. Crum, Szabo, and Folkman defined—by removing or adding substituents to the basic steroid four-ring structure—the minimum structure effective in inhibiting angiogenesis. Because substances with other variations on the basic steroidal structure can be synthesized, angiostatic steroids even more potent than the naturally occurring and synthetic ones identified to date may eventually be available for clinical use for treating diseases in which angiogenesis contributes to the pathologic process.

Crystals of a DNA-protein complex

A piece of DNA (the lambda operator site) and the protein molecule that binds to it to regulate gene activity (the lambda repressor protein) have been co-crystallized (page 1383). Jordan *et al.* describe the variables explored—including systematic variations in the length of the DNA molecules—in the search that led to the right experimental conditions under which co-crystals reproducibly formed. The best co-crystals diffracted to high resolution. They are expected to provide detailed molecular data on how the two molecules recognize and interact with each other, the types of conformation changes that occur as the complex forms, and the role of water in the complex—all data that may be applicable generally to DNA-protein interactions.

Brain and other growth factors alike

Growth-promoting substances made by brain tissue and other sources have significant structural homologies (page 1385). Gimenez-Gallego *et al.* determined the complete amino acid sequence of a growth factor from bovine brain (aFGF) and compared the data with data from other growth promoters. Sequence homology with interleukin-1 was particularly striking, fitting well with the earlier observation that these two molecules share certain three-dimensional features. Both factors can stimulate fibroblasts to divide. A stretch of ten amino acids within aFGF had sequence homology with several biologically active neuropeptides, some of which also stimulate cell division. This likeness among growth factors illustrates how, in nature, structures that work may appear more than once, perhaps packaged each time in a slightly different way.

3-D model of fibrinogen

A three-dimensional model of fibrinogen has been generated from data obtained from electron microscopic images and low resolution x-ray crystallography (page 1388). Fibrinogen is the protein in blood that forms a fibrin clot when cleaved by thrombin. Although native fibrinogen does not crystallize, crystals retaining most structural features of the native molecule form after limited enzymatic cleavage. Weisel *et al.* used computer technology to integrate new data from old; the resulting 3-D model accounts for the folding of the protein chains of fibrinogen into major domains (globular regions) and for the molecular interactions that result in clot formation.

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20 December 1985, Volume 230, Number 4732

SCIENCE

1986: A Vintage Year for Space Science

If all goes as planned, it appears that the coming year will be an extraordinarily good one for space science. In addition to the ongoing program of space research, a number of major space events that were started years ago will, largely by chance, all come together during 1986.

Mankind's first encounter with the planet Uranus will take place on 24 January. The Voyager 2 spacecraft, now 3 billion kilometers into its grand tour of the solar system, will pass within about three planetary radii of the Uranus cloud tops. Various telescopic observations show remarkable things happening at Uranus. The planet is tipped on its side with its south pole now pointing toward the sun; it is surrounded by a series of threadlike rings that demonstrate a surprising stability; and Uranus fluctuates brightly in ultraviolet light by means of a power source that is not understood. Our experience with Jupiter and Saturn has convincingly demonstrated both the inadequacy of research limited to observations from Earth and the superiority of nature's imagination over that of even the more inventive researcher. We may see another such demonstration at Uranus.

The next major event is a flyby of Comet Halley by six spacecraft from four nations. Although the spacecraft were launched months apart, all but one will pass Halley during an 8-day interval in March. The Soviet spacecraft Vega 1 will pass close to the comet on Thursday, 6 March. On Saturday, Suisei, the first of two Japanese spacecraft arrives. The second Vega will fly by on Sunday. The week continues with a distant encounter on Tuesday by Sakigake, the second Japanese spacecraft. Then, on Thursday, 23 March, the European probe Giotto will make a daring attempt to pass close to Halley's nucleus. The International Comet Explorer, an American spacecraft and veteran comet chaser that 6 months earlier flew through the tail of Comet Giacobini-Zinner, is the last. Because it arrives 2 weeks later than the others, it will pass only in the distant vicinity of Halley. Comet Halley will also be observed from Earth orbit by the Astro 1 telescope assembly and by the Spartan-Halley experiment. Although Halley's comet may well disappoint the general population, most of whom will not even be able to find it in their night sky, space scientists look forward to this brief period in March with justified anticipation.

Launches of several important new spacecraft are scheduled for 1986. These hold the promise of years of fruitful data acquisition for whole communities of space scientists. In May, there are two: the first is Ulysses, which will first go to Jupiter and then roam through the as yet unexplored regions over the poles of the sun. The second is Galileo, which will go to Jupiter, there to split into two spacecraft. One section will plunge through the clouds to explore Jupiter's dense atmosphere below, while the other section orbits the planet to examine in detail its moons, planetary magnetic field, and radiation belts. On its way to Jupiter, Galileo may be sent near the asteroid Amphritrite in December, thus closing the year with a first close-up look at one of the large bodies in the asteroid belt.

In terms of its potential scientific value, the launch of the Hubble Space Telescope by the space shuttle is perhaps the grand event of the year. The space telescope is expected to be the most influential astronomical instrument ever put into space. It will operate for years, examining selected portions of the universe with such clarity and precision that it is regarded by some astronomers as an advance rivaling Galileo's first use of the telescope for astronomy nearly 400 years ago.

The science of space is still in an early phase in which much of the solar system is yet to be explored and understood. We have not reached a level of predictive understanding that enables us to solve distant astrophysical mysteries by application of knowledge obtained from solar-system research. Our capability to generalize and extrapolate in space science is bound to be improved by the events of 1986.—A. J. DESSLER, *Director, Space Science Laboratory, NASA Marshall Space Flight Center, Huntsville, Alabama 35812*

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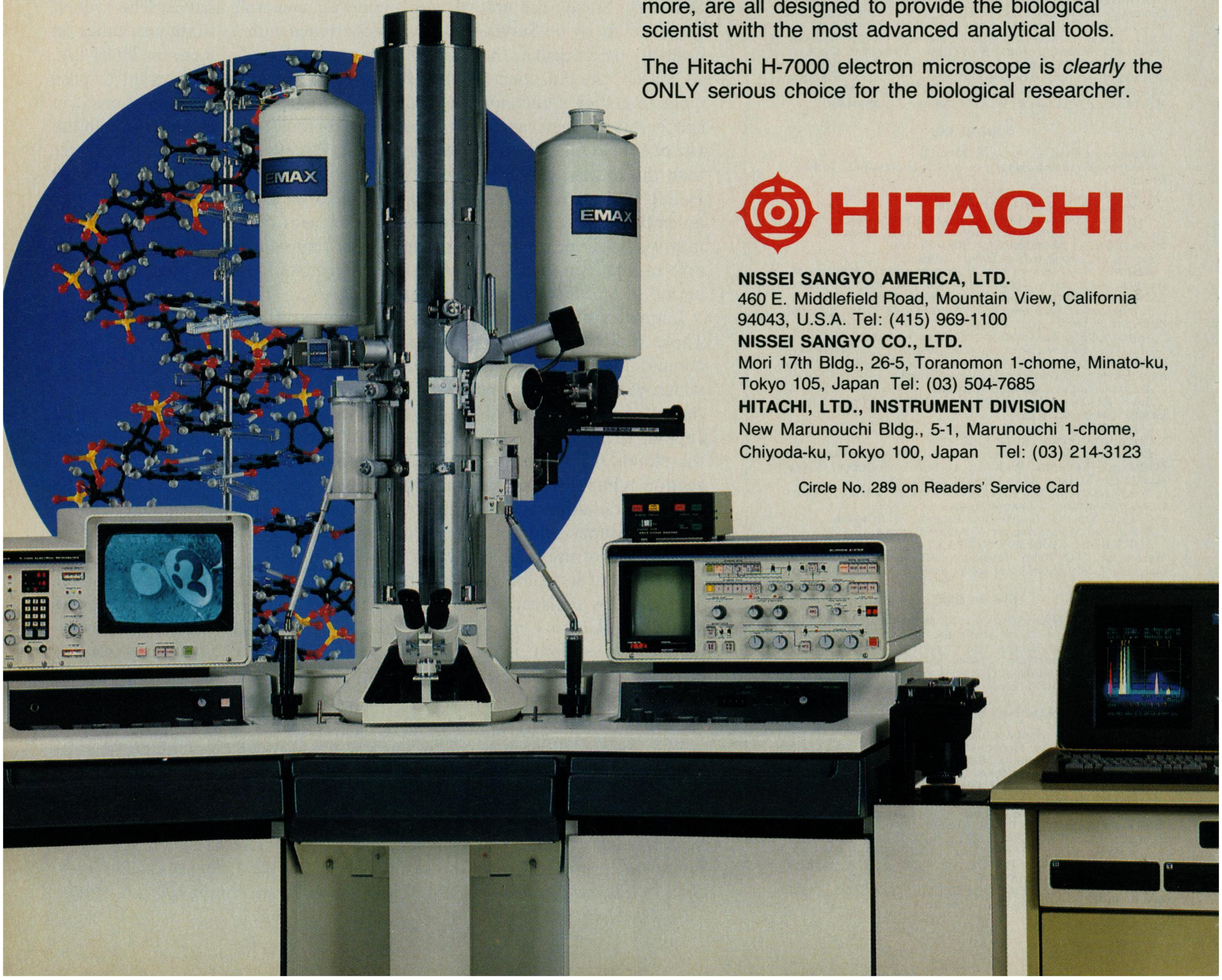

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(Continued from page 1326)

pendent scientific experts and any professional unit that oversees the work of the panel. It was the judgment of these reviewers that the RDA panel's suggestions for modifying the recommended levels for certain nutrients were not justified by the scientific evidence presented. The panel was apprised of these detailed criticisms—over 130 pages in all. However, the panel's responses satisfied neither its parent unit—the Food and Nutrition Board—nor the officers of the National Research Council.

Regrettably, the flexibility claimed in Kamin's letter was not apparent during lengthy discussions between him and various representatives of the Research Council in intensive efforts to resolve certain differences of scientific opinion. The suggestion that the RDA's for vitamins A and C were the pivotal points for my decision is misleading. At one stage, focus was indeed placed on vitamins A and C on the *assumption* that all other major issues had been resolved. Resolution of the RDA's on vitamins A and C was part of a series of major subjects that needed attention to bring the draft up to the standards considered acceptable for NRC reports. The crux of the matter is not whether the RDA's proposed by the panel were higher or lower than the current ones, but whether these proposals were based on strong scientific evidence and sound logic. It was the latter that gave the Research Council and its reviewers serious cause for concern.

Robert Olson was neither a part of the panel nor party to the review process. His letter contains unverified assertions about the NRC's decision, selective citations, faulty characterization of the review process, and unjustified attacks on members of the Food and Nutrition Board. All Research Council professional units are periodically examined for balance of expertise and viewpoints. The current Food and Nutrition Board is a broadly constituted, well-balanced group of experts from academia and the public and private sectors.

Kamin, Olson, and others who take issue with the Research Council's process of decision-making appear to reject the most basic tenet of American science—the peer review process. Despite months of deliberation and discussion, the panel's draft did not pass the scientific peer review and achieve the standards expected of Research Council reports. Under these circumstances, it is in the best interest of the scientific community and the public for the Research Council to establish a new panel charged with producing a report that can, like all our reports, withstand a rigorous scientific review.

Frank Press
Office of the Chairman, National Research Council, National Academy of Sciences, 2101 Constitution Avenue, NW, Washington, D.C. 20418

Understanding Science

Daniel E. Koshland Jr.'s eloquent call for "Scientific literacy" (Editorial, 25 Oct., p. 391) is testimony that the AAAS has not done enough with the old *Scientific Monthly*, the new *Science 85*, the radio broadcasts, the internship program with the media, the congressional fellowships, the museum displays, and so forth. Why not try organizing and financing a cadre of retired scientists and educators to advance the understanding of the scientific enterprise? There are many willing and able to capture attention and motivate and sustain interest. They are ready; working scientists are probably too busy.

Morris Goran
Roosevelt University, 430 South Michigan Avenue, Chicago, Illinois 60605

The scientific illiteracy described so cogently by Koshland in his 25 October editorial is really a general and massive failure of our public education system. An adequate understanding of logical thinking and methods of inquiry does not require specialized scientific and mathematical training per se. The concepts of the scientific method, experimental design, nature of risk, and even chance, probability, and statistical inference are essential elements of any reasonable education. They were so regarded (as part of Natural Philosophy) right through the last century. All are best grasped in the early formative years of elementary and secondary school.

The concepts do, however, have to be communicated by committed and dedicated teachers, a "species" in real danger of extinction. In addition to inadequate remuneration (elementary and secondary school salary scales are well below those of clerical, laboring, and service occupations), psychic and status recognition awards from society are also generally at an all-time low. Would any of our modern-day social-hero role models (entrepreneur, financier, engineer, or scientist) advise their children to be public school teachers?

Although some local community and state actions are under way to redress this situation, more than token national leadership is needed. At the very least it should be equivalent to the kind demonstrated in the formation of the U.S. Public Health Corps during that crisis in U.S. history.

Why doesn't the AAAS itself take the lead by sponsoring an adequately prestigious Teaching Corps, with high status and recognition, for exactly this service in our public schools?

WARD J. HAAS
768 Sasco Hill,
Fairfield, Connecticut 06430

Koshland's editorial describes the problems related to scientific literacy accurately and well. The logic behind randomized, replicated experiments deserves more recognition as a major step in the progress of science. R. A. Fisher (*1*), an architect in the field, wrote that these concepts were ones involving "questions of the right use of human reasoning power, with which all intelligent people, who hope to be intelligible are equally concerned"; scientists obviously need to know about the principles of scientific inference, but also "equally no other thinking man can avoid a like obligation."

The thought that the models we use are approximations could be incorporated into the teaching of science from the start. Not only nonscientists but scientists themselves need to become more aware that we make only successive approximations of the Truth, and we never arrive at it.

The arguments for proper controls and the need for replication seem almost obvious. The principles, however, are not always appreciated. Unfortunately, the example used in Koshland's excellent editorial proves the point. Dividing students into two classes, one to be taught the new math, one the old math, leaves us with two units—classes—one assigned to each treatment—method of instruction. There is no way to estimate experimental error, no replication of units treated alike. The people who denounced this plan because it was a "lottery with students' lives" did the right thing for the wrong reason. It was not good science.

D. F. COX
Statistical Laboratory and *Department of Statistics, Snedecor Hall,*
Iowa State University, Ames 50011

References

1. R. A. Fisher, *The Design of Experiments* (Hafner, New York, 1960), pp. 1 and 2.