Letters

National Security and Scientific Training

In his article "Scientific communication and national security in 1984" (4 May, p. 460), M. B. Wallerstein considers the relative threats to U.S. scientific expertise posed by free communication and by governmental limitation of free scientific exchange. However, the data presented clearly demonstrate an equally disturbing problem facing American technology in the near future: the recently declining percentage of predoctoral and postdoctoral trainees in the sciences who are American citizens (*1*). While I believe that the United States has an obligation to open its training facilities to people of all nations, and our foreign trainees provide a tremendous resource for our own scientific advancement, the trend indicates that a decreasing fraction of the most intellectually gifted young people from the United States are opting for scientific training at the university level. Although I do not see foreign citizens receiving education in this country as a threat to our security, I fear that our failure to train our own talented students may lead to weakening of our own ability to continue to be a dominant force in scientific advancement in the future.

The driving force behind the falling percentage of U.S. students in our training programs is not generated externally. Rather, the widespread public perception of decreasing opportunities for employment, long-term research support, and financial support during training may have made a scientific career less attractive to our students. Foreign students may not be so easily discouraged. Those from developed countries may see excellent opportunities at home after their training is completed. Those from underdeveloped countries may perceive scientific support in the United States as being vastly superior to alternative careers in their own countries and so are not as easily discouraged. In the long run, I believe that maintaining our population of trained scientists, investigators, and teachers will be more critical to our national security than information flow through our university training programs and scientific journals. Only by improving the climate for scientific training and research can the United States motivate its most talented students toward scientific careers and maintain its position of scientific leadership.

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Reference

1. Division of Science Resources, *Foreign Participation in U.S. Science and Engineering. Higher Education and Labor Markets* (National Science Foundation, Washington, D.C., 1981), pp. 5 and 21.

Crystalline Anisotropy

We would like to comment on Arthur L. Robinson's Research News article of 8 June, "Crystal anisotropy directs solidification" (p. 1085).

The article implies that the work done at Schlumberger was related to James Langer's consulting here. He was a consultant for another research group and had no influence on the early development of our geometrical approach to dendritic growth. The article also implies that we think our model has minimal physical content. We do not. We consider the fact that we tried to get the simplest possible equations which exhibit dendritic growth the biggest *asset* of our work. Finally, we disagree with Langer's statement that work to date seems to show that "the marginal stability hypothesis is holding up," as our group has presented evidence to the contrary.

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Much more important to the physics of crystal growth than anisotropy are the nonlocal effects to which Robinson alludes, and which are neglected in the models he describes. To help the nonexpert understand this, one may use the following analogy, which is not only telling but also *rigorous* in a precise mathematical sense: the "local" or "boundary layer" models of crystal growth describe a world where lightning does not fall on lightning rods. This is because in a local model a lightning rod is a small object influencing only its immediate environment. In the real world, as Benjamin Franklin discovered, if the rod is sufficiently sharp, it will have a long-range effect on the electric field. In the same way, a sharp dendrite influences the concentration and temperature far from its tip: the two problems are described by the same Laplace equation.

This would not matter much if dendrites remained smooth, so that no feature as sharp as a lightning rod would ever appear, but such is *not* the case. Instead, dendrites become very sharp locally, as the picture on page 1086 and the "fake" on page 1087 prove abundantly: in fact, the last evolution stage displayed on Ben-Jacob's figure is well beyond the domain of validity of his boundary layer model. In the little cusps that do so much to render the picture appealing, the boundary layer overlaps with itself. As far as I know, whenever the pictures begin to look like snowflakes, the boundary layer model has already broken down.

An approach taking full account of the nonlocal aspects of the problem pursued indicates that growing crystal interfaces develop mathematical singularities such that the local models are untenable.

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Irradiated Food

Despite the letter from Samuel S. Epstein and John W. Gofman (30 Mar., p. 1354), those concerned about the safety of irradiated food need not settle for the assurances of either industry or the Food and Drug Administration. Numerous international professional organizations over the past two decades have reviewed and researched the potential health hazards that were of concern to those in the industry and still are to those opposed to the use of irradiation. A recent statement (*1*) presents the findings of a meeting of the Board of the International Committee on Food Microbiology and Hygiene of the International Union of Microbiological Societies, with the participation of the World Health Organization, the Food and Agriculture Organization, and the International Atomic Energy Association, held in Copenhagen on 16 December 1982.

The Board agreed with the views expressed in Mossel's paper (*1*, appendix C) on the "Health hazards of microbiological nature inherent to foods irradiated at a level below 10 KGy." The Board noted that there "was no cause for concern . . . and in the Board's opinion there would be no qualitative difference between the kind of mutation [genetic mutation of pathogens] induced by ionizing irradiation and that by any other pasteurization/partial preservation methods such as heat treatment or vacuum drying."

The question of stable radiolytic products has been addressed in numerous recent publications and is discussed in considerable detail in volume 2 of a series of books on food irradiation edited by Josephson and Peterson (*2*).

Two other studies worth noting are those by Kampelmacher (*3*), giving an indication of the widespread increase in food-related diseases resulting from increased world food trade and high levels of contaminating microorganisms, and an extensive review by Ingram and Farkas (*4*).

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3. E. H. Kampelmacher, in *Combination Process in Food Irradiation, Proceedings of a Symposium* (International Atomic Energy Agency, Vienna, 1981), pp. 265–290.
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Soluble Lectins

Samuel H. Barondes, in his article "Soluble lectins: A new class of extracellular proteins" (23 Mar., p. 1259), discusses soluble lectins from cellular slime molds and vertebrates and the functions of lectins derived from plants. Readers, however, should be aware that extracellular soluble lectins of enormous importance have also been identified and isolated from the hemolymph and coelomic fluid of many invertebrate species (*1*), not just plants, slime molds, and vertebrates. Invertebrate lectins have functions similar to those described by Barondes and have been recently classified into two major categories: those associated with immunity (agglutination, opsonization, perivitelline protection, and histocompatibility) and those associated with development (sugar and divalent cation transport, mitogenicity, cell integration, and feeding) (*2*).

Soluble lectins have been known since the time of Noguchi (*3*) who called attention to the erythrocyte agglutinins (now known as lectins) present in horseshoe crab and lobster hemolymph. In addition to agglutinating erythrocytes, lectins from the snail *Helix pomatia* bind specifically to neuraminidase-treated rat, mouse, bovine, and human T lymphocytes and to lymphocytes from patients with chronic lymphocytic leukemia, which means that *Helix* lectin are useful for immunological studies and for following the clinical progress of leukemia patients (*4*). *Helix* and scorpion (*Androctonus australis*) lectins can also stimulate human lymphocytes to undergo blast transformation (*5, 6*). Horseshoe crab (*Limulus polyphemus*) lectin has been used in isolating and separating murine spleen T-helper lymphocytes (*7*). Many invertebrate lectins show specificity for sialo conjugates, important constituents of cell surface receptors involved in cell differentiation (*8*). The only plant lectin known to bind to sialic acid, wheat germ agglutinin, lacks specificity to sialic acid (*9*). Like the plant lectins, several invertebrate lectins from molluscs (*5*), earthworms (*10*), crustaceans (*11*), and tunicates (*12*) are now commercially available.

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Soluble lectins from both plants and invertebrates have been extensively described and fruitfully applied as reagents for many years in ways like those enumerated by Cooper *et al.* These matters were the subject of a classic review article in 1972 (*1*) and have been widely considered since then (*2*). Recently, attention has turned to the role that lectins play in the organisms that synthesize them. The purpose of my article was to discuss such *endogenous* functions of lectins and of their natural glycoconjugate ligands.

My major point was that soluble lectins sometimes function by interacting with endogenous extracellular glycoconjugates, thereby influencing the molecular organization of extracellular environments. This point is at present best supported by studies with vertebrates and cellular slime molds, but would be expected to hold true throughout nature. Soluble lectins may, of course, have other functions. Indeed, most biological studies of plant and invertebrate lectins emphasize binding to microorganisms rather than to endogenous ligands. For example, there is considerable evidence that lectins in some plant roots bind specific symbiotic bacteria coated with complementary glycoconjugates (*3*). Invertebrate serum lectins can bind glycoconjugates on pathogens, conferring what Cooper *et al.* designate as "immunity." Although such interactions may prove to be highly significant, they are distinct from those to which I wished to call attention.

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Erratum: In the article "NIMH faces renewed uncertainties" by Jeffrey L. Fox (News and Comment, 13 July, p. 148), the first sentence of the first full paragraph of column 2 on page 149 was incorrectly printed. The sentence should have begun, "The 1985 budget for research calls for a modest increase. . . ."