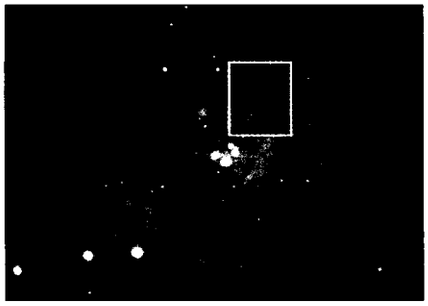
majority enantiomer (*1, 2*). In qualitative terms, this phenomenon, which is termed Majority Rule, arises from the excess energy of the helical reversal, a state the system tries to avoid. The system has been found to be quantitatively described by an approximation derived from a one-dimensional Ising model subject to a quenched random chiral field, in analogy to a theory that applies to one-dimensional magnetic materials (*3*).

An enantiomeric excess of about 12% of the groups pendant to the helix causes the optical activity to be identical to the situation of the enantiomerically pure pendant groups, while even a 2% enantiomeric excess gives rise to one-third of the full optical activity. Given the energy terms associated with the chiral bias favoring one helical sense and the excess energy of the helical reversal, the theory derived from the Ising model allows prediction of the helical sense ratio for any enantiomeric excess and also remarkably predicts that, within certain limits, reducing the chiral bias will increase the influence of the majority enantiomer, thus giving higher optical activities: The importance of the minority objection is predicted to override the force of the majority preference.

There is no reason for the effect to be limited to one polymer structure, and, in fact, early work on isotactic vinyl polymers in Italy after the discovery of Ziegler-Natta polymerization showed smaller versions of the same effect, as did



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Homochirality of biological molecules may be explained by observations of light from part of the Orion Nebula (box)

early studies on polypeptides derived from mixtures of enantiomeric amino acids.

In their report "Circular polarization in star-formation regions: Implications for biomolecular homochirality" (31 July, p. 672), Jeremy Bailey *et al.* suggest that a small enantiomeric excess produced by light from nebulae could be amplified by some mechanism, which could have led to the origin of homochirality on Earth. The Majority Rule effect is one such mechanism. The prerequisite for this chiral amplification is a stable helix, a conformational state that is common in biological phenomena, which is then subject to the influence of the mixed chiral information.

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Preparing Graduate Students in Biology

In the editorial "Training for today's marketplace" (*Science*'s Compass. 31 July, p. 645), Elizabeth Marincola and Frank Solomon address the conflict resulting from the fact that academic primary investigators train many times the number of scientists required to replace themselves. The unavoidable result is that there are many more trained scientists than there are tenured academic research positions. This result really should not be a problem because there are many alternative jobs on the market in nonacademic positions, either still in basic research or in other related fields.

In my opinion, the problem arises because of two shortcomings in the educational process. In my recent experience at the Massachusetts Institute of Technology in the Biology Department (1989 to 1995), absolutely nothing was done to prepare graduate students for careers outside of academic research. Furthermore, many (although not all) of the professors at MIT continually indoctrinated us with the idea that the only noble, pure, and truly successful career path was that of academic research. If educators would accept that this is not the case and that they should do something to prepare students for other career paths, maybe we would not have the problems revealed in the survey the authors discussed.

The only solution that the authors suggest is still essentially an academic research position. In fact, this type of position is reminiscent of the hierarchical systems seen in some European countries and Japan. In reality, as detailed in at least one recent article (*1*), there are many alternative career opportunities that are experiencing growth. This is where many of these Ph.D. graduates will end up, and there is nothing wrong with that.

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Response

The notion of abundant alternative career opportunities for biomedical scientists is widely circulated. However, neither our survey nor the recent National Research Council (NRC) analysis (*1*) find evidence that such jobs exist in sufficient quantities, or that the jobs that are available offer the satisfactions—independence, intellectual challenge, and a chance to contribute to fundamental understanding—that induce biomedical scientists to choose their career.

Gale refers to the training program that one of us (F.S.) directed while he was a student at MIT. While his need for career counseling may not have been satisfactorally addressed, a significant proportion of his contemporaries chose to go into the biotechnology industry. Their choices were facilitated by several informational programs offered during Gale's residence, as well as the extensive contact between MIT faculty and biotechnology firms.

The issue remains of the need to uncouple training from basic research needs. Procuring tenure-track positions is becoming more competitive, but the demand for basic research may continue to expand in the immediate future, since Congress increased National Institutes of Health (NIH) funding by 15% this year. We argue that meeting this need by training even more people will only exacerbate the problems our survey identifies. The challenge is to retain scientists in biomedical research by providing well-paid, satisfying jobs at the bench. Our suggestion to promote such positions was embraced in both the NRC analysis and by NIH Director Harold Varmus (*2*).

Finally, our proposal is for a very different structure from the hierarchical laboratory. We want to enable highly trained scientists in their 30s and 40s to find dignified opportunities to contribute their talent, energy, creativity, and, yes, independence, to the biomedical research enterprise.

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2. Remarks of H. Varmus at the 25th Annual Meeting of the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS), Washington, DC, 10 October 1998, reported in the *Washington Fax*, 14 October 1998.

CORRECTIONS AND CLARIFICATIONS

In the Random Samples item "Dubious benefits for early computer use" (16 Oct., p. 407), the affiliation for education professor Douglas H. Clements was incorrect. He is at the State University of New York, Buffalo.

In note 7 of the report "The chemistry of water on alumina surfaces: Reaction dynamics from first principles" by Kenneth C. Hass *et al.* (9 Oct., p. 265), the bracketed phrase "Bernstein, Lee, Yang, and Primakoff (BLYP)" at the end of line one and in line two should not have appeared.

In table 2 (p. 1968) of the Policy Forum "Monitoring nuclear tests" by Brian Barker *et al.* (25 Sept., p. 1967), the "Origin time (GMT)" for the 30 May explosion was incorrect. It should have been, "06:54:57.1."

In the article "A new look at monogamy" by Virginia Morell (Special Section, "Evolution of sex," 25 Sept., p. 1983), the location of Trinity University should have been given as San Antonio, Texas, not Houston.