gene therapy experiment. Some of the viral vectors being used for gene therapy have long-term potential for causing cancer, and the public RAC review of such consequences still seems relevant.

With regard to Phase I (toxicity) follow-up studies, the RAC public review is also relevant to the determination of the potential harmful consequences of human gene therapy. Since most of the protocols approved have been Phase I/II studies, information about efficacy (or lack thereof) is also elicited. Perhaps it is the latter aspect that might be controversial.

In summary, while we recognize the need for streamlining the regulatory processes in this area to conform with both commercial interests and the needs of severely ill patients, the removal of large portions of the review process from public scrutiny and loss of advice from experienced professionals representing diverse points of view would frustrate the concerns of many U.S. citizens about this new form of medical experimentation. Painful lessons have been learned in both the nuclear energy and biomedical research fields about the danger of too much secrecy when scientific methods with long-term risks and benefits to humanity are under development. Out nation must continue to profit from these lessons rather than repeat the mistakes of the recent past.

Gary A. Chase, *Georgetown University Medical Center, Washington, DC 20007, USA;* **Patricia A. DeLeon,** *University of Delaware, Newark, DE 19716, USA;* **Krishna R. Dronamraju,** *Foundation for Genetic Research, Houston, TX 77227, USA;* **Robert P. Erickson,** *University of Arizona, Tucson, AZ 85724, USA;* **Joseph C. Glorioso III,** *University of Pittsburgh, Pittsburgh, PA 15261, USA;* **Rochelle Hirschhorn,** *New York University School of Medicine, New York, NY 10016, USA;* **M. Therese Lysaught,** *University of Dayton, Dayton, OH 60302, USA;* **Kathleen M. McGraw,** *State University of New York, Stony Brook, NY 11794, USA;* **Abbey S. Meyers,** *National Organization for Rare Disorders, New Fairfield, CT 06812, USA;* **A. Dusty Miller,** *Fred Hutchinson Cancer Research Center, Seattle, WA 98104, USA;* **Gail S. Ross,** *New York Hospital Perinatology Center, New York, NY 10021, USA;* **Karen J. Rothenberg,** *University of Maryland School of Law, Baltimore, MD 06812, USA;* **Bratin K. Saha,** *Emory University School of Medicine, Atlanta, GA 30322, USA;* **Marian G. Secundy,** *Howard University College of Medicine, Washington, DC 20059, USA;* **Stephen E. Straus,** *National Institute of Allergy and Infectious Diseases, National Institutes of Health, Bethesda, MD 20892, USA.*

Ph.D. Education

Floyd E. Bloom, in his editorial "Degrees of uncertainty" (12 May, p. 783), clearly disapproves of what he sees as a recommendation by the National Academy of Sciences' Committee on Science, Engineering, and Public Policy (COSEPUP) to create "graduate programs that sound like graduate technical colleges and [to recruit] students who have formulated more realistic career expectations." Like those before us, we are attracted to science because we are curious. How wonderful it would be to enter graduate school and not worry about getting a job afterward! Unfortunately, most of us need jobs to survive. Responsible educators must enhance their students' and postdocs' abilities to be employed and to use their scientific training. That could mean doing as COSEPUP suggests: make Ph.D. programs shorter and more flexible, and provide timely, accurate career counseling.

An alternative would be to reexamine the entire employment structure for Ph.D.'s, including developing desirable post-postdoctoral research and teaching opportunities in academia. Industry currently employs and promotes Ph.D.'s along two "tracks," research and management. Ph.D.'s receive equivalent compensation, respect, and on-

going training along each track. Let us institute a similar system within academia for teaching, research, and administration. Using well-trained Ph.D.'s to teach and do research will also have the salutary effect of diminishing the need for (and thus the supply of) graduate students.

Eliene Augenbraun*
1500 Bolton Street,
Baltimore, MD 21217, USA
E-mail: eliene@charm.net

*Former Co-President, Johns Hopkins School of Medicine Postdoctoral Association.

Bloom argues that "[t]he highest objective of graduate training should be the continuous development of a cadre of well-trained creative scientists who will grow to compete successfully for the funds that allow them to survive and contribute." In this statement are two unquestioned assumptions that need to be challenged if our profession is to survive and not become just another business enterprise.

The first is the pervasive notion that scientists must be competitive. There was a time, before the funding stakes became high, when scientists *cooperated*, sharing information, data, and techniques, to the enrichment of all. Surely the fostering of young scientists is healthier in an atmosphere of trust and shared excitement than in the current state of near-paranoid secrecy and anxiety that we may fall behind in the race.

The second issue is the equation of funding with survival and productivity. Certainly this has been true in the recent past, when research dollars flowed comparatively freely and grants were not so very hard to get. But as in other aspects of our modern life, perhaps it is time to recognize that society as a whole cannot continue to dispense large numbers of big grants to numerous laboratories. It may be that as cutbacks continue there are going to be few scientists-as-we-know-them, unless we return to basics, redefine the essence of being a scientist, and join the rest of the world in attempting to make do with less, to conserve, and to use resources wisely and sparingly.

Helmut V. B. Hirsch
Helen Ghiradella
Department of Biological Sciences,
University at Albany,
State University of New York,
Albany, NY 12222, USA

We agree that the basic nature of the Ph.D. should remain unchanged: a Ph.D. in any field ought to represent an individual's contribution to that field in the form of independent research. We also strongly agree with COSEPUP's suggestion that a Ph.D.'s training should include the option of flexibility. Graduate programs today are narrowly focused on business, law, science, or medicine, forcing an individual who seeks an advanced degree to choose one specialty to the exclusion of others. With the exception of joint Ph.D.–M.D. training programs, Ph.D. programs in the biomedical sciences generally do not encourage, and may actually discourage, students to broaden their education. We propose that joint programs with fields such as business, law, and public policy would be beneficial to science as a whole as well as the individual trainee. While there will always be a demand for scientists interested purely in research, the nature of science itself is changing. Competitive science no longer moves slowly forward by lone scientists working in isolated laboratories. Rather, it often moves swiftly and is carried out by teams of workers who often cross government, academic, and industry borders and who work together in coordinated efforts. In light of the current reality of funding, the field of science needs to be open to the fact that there is a growing need for some individuals with a broader range of skills than

they are currently allowed to develop. Flexibility in graduate training programs is an alternative to the unrealistic current paradigm that being specialized in a field allows scientists to perform all the things required of them with no training or experience other than many years of benchwork. Creating graduate programs that permit the integration of other relevant disciplines should not diminish the integrity of the doctoral degree.

Most, if not all of us, who have pursued a Ph.D. are to some extent enamored with the idealistic pursuit of science and do not desire that this ideal be discarded. However, retaining it should not be done at the expense of realism, nor should it prevent scientists from pursuing a career path that is intellectually, personally, and perhaps even financially rewarding. Entering graduate school should not require taking a life-long vow of relative poverty to appease the status quo's sense of intellectual integrity.

Antoine Firmenich
Sharon Hays
Elizabeth Kerr
Deval Lashkari
Susan Prohaska
BioMedical Association of Stanford Students, Stanford University, Stanford, CA 94305, USA

Bloom questions the recommendations in the COSEPUP report to make graduate education more consciously career-oriented in a time of shrinking resources for science. For the record, the Council of the American Physical Society unanimously approved the following statement in April 1994.

Historically, students with degrees in physics have succeeded in a wide range of academic and non-academic careers. Therefore it is important for faculty members to make all their undergraduate and graduate students aware of the realities of the job market and to encourage them to prepare for a broad range of careers. Academic physics departments are urged to re-examine their programs in light of the changing opportunities.

This year, some 80 physics department chairs (representing 25% of U.S. graduate physics departments) attended a conference entitled "Physics Graduate Education for Diverse Career Options." These chairs reached a consensus (a formal statement will be issued shortly) that new students need to be informed realistically of their career options and that a much greater emphasis should be placed on preparation for and outreach to the industrial community.

Zachary H. Levine
329 Congressional Lane, Rockville, MD 20852, USA

Correction

The following sentence was omitted from the acknowledgment section of our report "Independent human MAP kinase signal transduction pathways defined by MEK and MKK isoforms" (3 Feb., p. 682) (*1*) because of an error. "A. Lin and M. Karin are acknowledged for informing us about the presence of an upstream in-frame initiation codon in the sequence of human MKK4/JNKK/SEK1 before publication."

Roger J. Davis
Program in Molecular Medicine, Department of Biochemistry and Molecular Biology, University of Massachusetts Medical School, Worcester, MA 01605, USA, and Howard Hughes Medical Institute, Worcester, MA 01605, USA

References

1. B. Dérijard *et al.*, *Science* **267**, 682 (1995).

Corrections and Clarifications

In the report "A nuclear-encoded form II RuBisCO in dinoflagellates" by D. Morse *et al.* (16 June, p. 1622), in the seventh line of the first full paragraph in the third column on page 1622, "glysine-cysteine" should have been "guanine-cytosine."