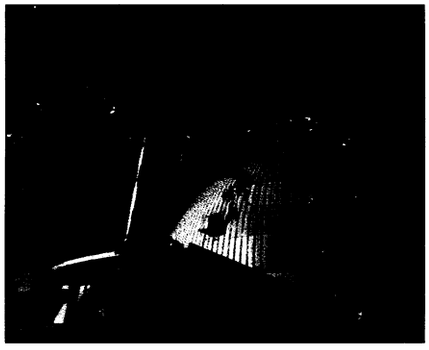
Permanent closure of Brookhaven National Laboratory's High Flux Beam Reactor is lamented: "It is a tragedy that in this important field [of neutron scattering research], which was pioneered in the United States, we are now second- if not third-class citizens compared with Western Europe and Japan." Dietary supplements and their definition, regulation, safety, and manufacture are discussed. Creativity is critical to problem-solving, but the question is raised whether the process of creativity is different for individuals and groups. And the function of the thick wax rims in honeycombs is explained.

A Loss to Science

As a research physicist and the dean of science at the Massachusetts Institute of Technology, I am dismayed by the Department of Energy's decision to shut down permanently the High Flux Beam Reactor at Brookhaven National Laboratory [see the News of the Week article by David Malakoff (26 Nov., p. 1661)]. This research reactor has produced an enormous amount of significant scientific research over its 34-year history and will be sorely missed by the scientific community, as well as by those who have benefited from this research.



Brookhaven's High Flux Beam Reactor has reached the end of the line.

CREDIT: BROOKHAVEN NATIONAL LABORATORY

The reactor has been shut down since January 1997 after the discovery of tritium leaking from the reactor's fuel-storage pool. The Department of Energy and Brookhaven National Laboratory acted responsibly in keeping the reactor closed and informing the community while evaluating the environmental impact of this situation. An environmental impact statement was to be released for public and scientific comment as part of the process of deciding whether to restart the reactor; however, the decision to close the reactor permanently came first.

Energy Secretary Bill Richardson has said the decision was based on economics. That reasoning, however, does not seem take into account the tens of millions of dollars it will cost to dismantle the reactor—not to mention the cost to this nation's place in science.

The United States, led by scientists at Brookhaven, used to be a world leader in neutron scattering research. Using the reactor, U.S. scientists have made pioneering advances in the physics of phase transitions, low-dimensional magnetic systems, and high-temperature superconductors, as well as contributed to the development of a drug that alleviates the pain associated with bone cancer. It is a tragedy that in this important field, which was pioneered in the United States, we are now second- if not third-class citizens compared with Western Europe and Japan.

Robert J. Birgeneau*
Massachusetts Institute of Technology, Cambridge, MA 02139, USA
*Dean of the School of Science

Dietary Supplements: What Is in the Public's Best Interest?

In his Policy Forum "Regulation of 'nutraceuticals'" (*Science*'s Compass, 17 Sept., p. 1853), Steven H. Zeisel discusses the Dietary Supplement Health and Education Act (DSHEA) and proposes additional regulations for dietary supplements, or "nutraceuticals" as he defines them. The intent of the DSHEA, passed by the U.S. Congress in 1994, was to establish a framework for the regulation of dietary supplements and to facilitate consumers' access to these products. As vice president of Nutritional and Regulatory Science for the Council for Responsible Nutrition (CRN), I want to comment on several items discussed by Zeisel that warrant clarification.

In the first paragraph, Zeisel uses the phrase "presumed health-enhancing benefits" in defining dietary supplements, implying that no solid evidence supports such health benefits. This is not the case; for example, in 1992, the U.S. Public Health Service recommended that women of child-bearing age consume 400 micrograms of synthetic folic acid every day to prevent neural tube birth defects. Well-established evidence also supports the beneficial use of calcium, vitamin E, chromium, and selenium supplements.

Zeisel later comments, "It is often difficult to distinguish among nutrients, food additives, and drugs"; however, the definitions outlined in the Food, Drug and Cosmetic Act offer adequate criteria to differentiate these products. Definitions depend on the intended use of the substance; for example, a "drug" is defined as a substance that is used to "treat, cure, mitigate and diagnose" disease. If calcium carbonate is used as an antacid, it is a drug; if used as a neutralizing agent in a conventional food, it is a food additive; and if added as a source of calcium, it is a nutrient. According to Zeisel, product potency should serve as the distinction between a drug and a nutrient; however, the Food, Drug and Cosmetic Act prohibits such classification, and multiple exceptions would invalidate the generality of such a scheme. For example, vitamin C has a number of biological activities, with thresholds for effect ranging from 10 milligrams for the prevention of scurvy to more than 1000 milligrams for complete inhibition of carcinogenic nitrosamine production in stomach contents. This range, and the fact that unfortified and unsupplemented diets easily can provide about 1000 milligrams of vitamin C per day, depending on food selection, make any "physiological" versus "pharmacological" distinction related to intake level meaningless.

Zeisel also says that "DSHEA modifies the regulatory environment so that it becomes possible, even likely, that products will be marketed that inadvertently harm people." But prescription and over-the-counter drugs also have an obvious record of harming people.

The CRN agrees with Zeisel that the Food and Drug Administration (FDA) should develop good manufacturing practices (GMPs) for dietary supplements. In fact, CRN petitioned the FDA to do so and provided a set of prototype GMPs that would be appropriate.

John N. Hathcock
Council for Responsible Nutrition, 1875 Eye Street, NW, Washington, DC 20006–5409, USA. Web address: http://www.crnusa.org

Although Zeisel's proposal for the FDA to increase its oversight of dietary supplements is well intentioned, an added layer of regulation would restrict public access to dietary supplements. In terms of public safety, the DSHEA has encouraged

dozens of supplement companies to pursue and promote evidence-based product development and marketing efforts. Indeed, the supplement industry has itself taken important steps in the last couple of years to establish stringent GMPs, standardized production methods, and dosage recommendations to encourage safe use of their products.

The increasing competition from larger companies will most likely accelerate the ongoing quality improvements within the industry and increase the financial and human resources that supplement companies devote to research. Overly restrictive government intervention will only serve to delay product development, increase consumer prices, and discourage investment in research—with the end result of denying consumers the access to supplements made accessible by the DSHEA.

Shawn M. Talbott
Supplement Watch. Web address: http://www.supplementwatch.com

Response

Hathcock speaks for the CRN, a lobbying group formed to represent the interests of the diet supplement industry. In my Policy Forum, I did not advocate standards to assure efficacy of dietary supplements, I focused on safety standards. Some supplements are efficacious (such as folate) and others may not be, but all should be demonstrated to be safe before they are sold to the public.

I continue to assert that the boundary between foods, herbs, and drugs is difficult to distinguish. Hathcock says that there is adequate language in the existing Food, Drug and Cosmetic Act code to make this differentiation. However, many dietary supplements are being used at pharmacologic doses to achieve pharmacologic effects and only avoid being classified as drugs because the claim made on their label is such that they fall into the legal category of dietary supplement.

My suggestion to use consumption level that is above the population norm as a threshold for invoking safety regulation was based on the relative risk associated with exposure. If the population is usually exposed, through diet, to a substance, the change in risk associated with exposure to that same dose is relatively small. If, on the other hand, people are exposed to a new substance, or to a large amount of a familiar substance, the potential for risk is likely to be higher. Although this approach will not provide complete protection, it is a start. As Hathcock points out, even with stringent safety regulations, once in a while prescription drugs do harm people. But imagine how much more damage might occur if there were no safety regulations at all.

Regarding the letter from Talbott, I suggested that the FDA should set standards for production methods for dietary supplements and that studies in humans that demonstrate safety should be completed before supplements are offered to the public. Under current law, neither practice is required.

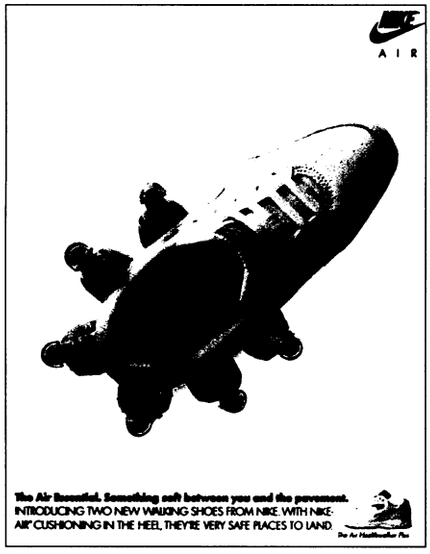
As Talbott indicates, an added layer of safety regulation would restrict public access to dietary supplements, but primarily to those found to be harmful. The oversight that I proposed in my Policy Forum was minimal, and products from companies that have their own stringent GMPs and that test their supplements to assure themselves that they are safe for consumption would easily meet these standards. Standards assure that an under-financed or unethical company does not take shortcuts that could harm the public. Setting minimum safety standards would not deny consumers access to safe dietary supplements.

Steven H. Zeisel
School of Public Health and School of Medicine, University of North Carolina, Chapel Hill, NC 27599–7400, USA. E-mail: steven_zeisel@unc.edu

Scrutinizing Creativity

In their Essay on Science and Society contribution, "Creative sparks" (*Science*'s Compass, 3 Sept., p. 1495), Jacob Goldenberg, David Mazursky, and Sorin Solomon advocate a "structured process" and "relational structures" to enhance the creative output of problem-solving. They seem to convey the idea that the process of creativity is the same for groups and individuals. But the processes for the two are qualitatively different and should not be conflated.

Each person referentially interprets problems, as well as any imposed "structures" constraining their solution, according to his or her own history (the sum of developmental and experiential histories unique to each person). Each such personal reference, call it "epsilon," is itself a structure. (Therefore, no experience—including the creative process—is free of constraints



A computer-generated ad based on a "creativity template."

or poised to explore "infinite" solution space.) Epsilons of members of creative groups add noise to the solution criteria, which means that a solution set arrived at by creative groups, while of higher "quality" than that arrived at by an individual, is also much less likely to be unique, because of the contributions of multiple epsilons.

Broadly speaking, groups use an algorithmic type of solution method to produce conventional solutions to well-defined problems, whereas functionally, individuals are better at producing the long-shot solutions to problems that connect disparate elements in unintuitive ways, the type of solutions that occasionally reach a Kuhnian status (*1*). Such new ideas emerge through the structured environment in a manner similar to new species' emergence through natural selection in biological evolution, an analogy described by A. Hudder in her letter (*Science*'s Compass, 1 Oct., p. 49). In more general terms, ideas emerge through a complex series of clustered dynamical systems and environments (*2*). Biological species are solutions to the problem of which organism type suits the existing environment (*3*). The mystery attending all such emergences derives from the abstrusely ephemeral network connections between problem-solving elements and their multidimensional dynamical environments (*3*). Predicting the suitability of a solution (in trivial cases) is directly related to semantic meaning (*2, 3*).

Contrary to Goldenberg *et al.*, neither reappraisal of "our fundamental approaches to creativity" nor reevaluation of "its operational definition" seems necessary, because any proposed methodology will only be useful in defined settings. Depending on the problem and the desired type of solution, a group or an individual will be a more appropriate choice to address the problem. Groups (and computers) derive the algorithmic kinds of solutions to those problems having well-defined solution spaces. Individuals, on the other hand, are better at those larger-than-life kinds of problems having no apparent solution method (the problem itself is often only dimly recognized).

Dennis Hollenberg
364 Franklin Lane, Ventura, CA 93001–1420, USA

References

1. T. S. Kuhn, *The Structure of Scientific Revolutions* (Univ. of Chicago Press, Chicago, ed. 2, 1970).
2. D. Hollenberg, in *Encyclopedia of Computer Science and Technology*, A. Kent and J. G. Williams, Eds. (Marcel-Dekker, New York, 1990), vol. 21, supplement 6, pp. 153–162.
3. D. Hollenberg, *Beginnings*, in press.

Response

We found that "creativity templates" (implicit regularities in the creative process) are effective in extracting creative ideas from a potentially infinite-dimensional space of solutions. The fundamental problems solved by scientists in the framework of the Kuhnian paradigm (*1*) do not fall within this class. Such problems have unique, singular solutions because of the overwhelming constraints imposed (independently, in addition to, and above the creativity requirement) by the scientific data. For example, Albert Einstein's theory of relativity has been adopted because it is the best hypothesis to fit the data, not because it is creative. As for the class of solutions drawn from an infinite-dimension-

CREDIT: NIKE 1995