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LETTERS

Understanding Chemistry

The progress reported in Ivan Amato's article "Chemistry curricula edge toward a new world" (News & Comment, 14 Aug., p. 871) is an important first step toward acknowledging the tip of a large unacknowledged iceberg. It is important to improve the introductory chemistry experience of potential science, engineering, and other majors who take the course. However, a pitifully small percentage of all college students even consider taking introductory chemistry. The iceberg is the rampant chemophobia that results from the lack of understanding by the general public and its leadership of the role chemicals play in our society. Needed are general-education college and university courses that teach *all* students about the nature of chemicals, the absurdity of "chemical-free" anything, and the understanding necessary to participate in the decision-making process regarding the risks, benefits, and trade-offs involved in the use of specific chemicals for specific purposes in our society. Perhaps in this way we can help some of the public realize it is irrational to love a product and want to ban the raw materials from which it is made.

Herbert D. Thier
Director,
Chemical Education for Public Understanding Program,
Lawrence Hall of Science,
University of California,
Berkeley, CA 94720

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Use of Animal Drugs

The 21 August ScienceScope piece about off-label use of animal drugs (p. 1031) may cause the reader to believe that the Food and Drug Administration (FDA) is poised to take regulatory action against researchers if pharmaceutical products are used in an "off-label" manner in laboratory animals. Nothing could be farther from the truth.

It is true that the Federal Food, Drug, and Cosmetic Act prohibits using an animal drug in ways other than those specified on the approved labeling. The long-standing policy of FDA, however, is to exercise considerable regulatory discretion where nonfood animals are concerned. Hence there is virtually no chance that a researcher administering an anesthetic in a responsible manner to a "spiny anteater" will encounter a problem with the FDA. The same can be said for other off-label uses of pharmaceuticals in laboratory animals and, for that matter, in pet animals. We are concerned with preventing off-label use of an animal drug that has the potential for causing illegal drug residues in meat, milk, or eggs. Persons causing an illegal drug residue in food for humans should fear an FDA action, but researchers who use nonfood animal species should not.

Gerald B. Guest
Director,
Center for Veterinary Medicine,
Food and Drug Administration,
Rockville, MD 20857

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Hydrogen Bonding

The article "Benzene forms hydrogen bonds with water" by S. Suzuki *et al.* (14 Aug., p. 942) represents a major advance in our understanding of the interactions between water and aromatic structures. The authors show that benzene forms hydrogen bonds with water through the π electron system of benzene. Although they did not mention it, their work should also be useful for rationalizing the solubilities of aromatic compounds in water. For example, from literature tabulations (*1*) it is known that the solubility of benzene in water is 35 times greater than that of cyclohexane. The results of Suzuki *et al.* are consistent with and can be used to help understand this independent solubility information because cyclohexane, unlike benzene, does not have a π electron system and will therefore not form solubility-enhancing π system hydrogen bonds with solvent water molecules.

Bruce C. Faust
Environmental Chemistry Laboratory,
School of the Environment,
Duke University,
Durham, NC 27708

REFERENCES

1. P. H. Howard, G. W. Sage, W. F. Jarvis, D. A. Gray, *Handbook of Environmental Fate and Exposure Data for Organic Chemicals*, vol. 2, *Solvents* (Lewis, Chelsea, MI, 1990).

Response: As noted by Faust, it has been recognized for some time that benzene is appreciably more soluble in water than both cyclohexane and cyclohexene(s). A large body of experimental and theoretical work