to arrive at a national consensus. Early excerpts of the standards were sent to hundreds of organizations, although not all saw the May predraft. And Klausner says all these groups are being invited to prepare formal reviews of the upcoming draft.

F. James Rutherford, director of AAAS' Project 2061, points out that his group involves hundreds of scientists and educators and worked with the same societies now reviewing the standards. But he agrees that his project's goal was not to codify the national consensus, but to present a new vision of science education.

"The key thing about the national standards was the national critique and consensus process," says Arizona's Mike Lang, chair of the council of state science supervisors. "We have a very diverse science education community in this country, and everyone wants to be part of everything."

Making peace among those diverse players has proven difficult even for an institution known for tackling difficult subjects. "There are so many different stakeholders in science education, with such different views, that I think it was actually quite a brave decision to have them come together to achieve some consensus," says Klausner. In any event, the release of the national standards should accomplish what Klausner says is one of his major goals—"to initiate discussion" on what it means to be scientifically literate. And that's a dialogue that every educator and scientist believes is important.

–Elizabeth Culotta

TOXICOLOGY

Dioxin Report Faces Scientific Gauntlet

In 1991, when the Environmental Protection Agency (EPA) agreed to review the health risks of dioxin, officials wanted to know whether it was a carcinogen at low doses. This week, in a long-awaited draft of its report, EPA falls short of resolving that question, but argues that other, noncancer effects of the chemical may be a more urgent threat to humans. And that finding is sure to ignite a scientific controversy. "This is going to be one of the most important public debates on environmental chemistry ever," says Michael Gallo, a toxicologist at the Robert Wood Johnson Medical Center at Rutgers University in New Brunswick, New Jersey. At stake, says Gallo, is the scientific credibility of EPA's regulatory decisions.

The EPA report concludes that dioxin—a byproduct of paper bleaching, incineration, and other industrial processes—is more dangerous than the agency concluded a decade ago and should retain its current status as a "probable" human carcinogen at levels found in the environment. As evidence, the agency cites animal studies and epidemiological data that tentatively link some forms of cancer to people exposed to large amounts of dioxin. Because it had no direct evidence that environmental levels cause cancer, however, EPA decided against elevating dioxin to a "known" human carcinogen.


EPA

But the report does suggest a link between minute quantities of dioxin and noncancer effects in humans. Fueled mainly by studies that have appeared in the last decade, the report asserts that dioxin—in levels found in the food supply—may trigger problems such as endometriosis in women and decreased sperm counts in men. The noncancer effects "bolster our resolve to continue to take action to reduce exposure to dioxin," says Lynn Goldman, EPA's assistant administrator for prevention, pesticides, and toxics.

But some scientists believe EPA is overinterpreting the data, which come mainly from animal studies and observations of subclinical perturbations in humans. One outside scientist who has seen the risk-characterization chapter written by EPA scientists complains that it contains "sky-is-falling statements that don't belong in a scientific document." Adds Oregon State University immunologist Nancy Kerkvliet, "I just don't think people have been exposed to enough dioxin to see effects, especially on the immune system." Kerkvliet authored the review chapter on dioxin's immunotoxic effects, which focused on animal studies and found "no clear pattern of immunotoxicity" in humans.

In its indictment of dioxin, however, EPA is including many similar compounds, which agency scientists believe exert similar effects. The underlying assumption is that the dioxin of utmost concern—2,3,7,8 TCDD—exerts its harmful effects by binding to the aryl hydrocarbon (Ah) receptor on the cell surface. Because some PCBs, furans, and other dioxins bind to the same receptor, EPA appraises the risk of exposure to these compounds based on their binding affinities.

"I think we need to say we might be seeing these effects in the general population."

—Lynn Goldman

Some critics of the report argue that this assumption is unwarranted because it fails to take into account how such chemicals might compete for binding sites in some cases or exert a synergistic effect in others. "We just don't know how to add up [the effects of] these chemicals," says John Gierthy, a toxicologist at the New York State Department of Health's Wadsworth Center in Albany. Gierthy, who is serving on a panel supported by the Chemical Manufacturers Association (CMA) to review the report, says EPA should use in vitro assays of relevant target organs to determine the activity of dioxin-like chemical mixtures.

Even assuming that dioxin and its chemical relatives are as risky as EPA believes, a third area of controversy remains: Just how much of these substances are Americans exposed to? EPA estimates total exposure to dioxin and dioxinlike compounds at 40 to 60 picograms per gram of body fat. But when a draft of the EPA report was circulated to other federal agencies for review last spring, the Food and Drug Administration and the U.S. Department of Agriculture blasted EPA for heightening fears about the safety of the U.S. food supply on the basis of dioxin exposure data gathered mainly in Europe rather than in the United States (*Science*, 20 May, p. 1071).

EPA scientists, while defending the study, acknowledge the difficulty of writing a balanced summary of dioxin's health risks. "Even within EPA, scientists have a range of opinions," says Goldman. "I don't think each individual agrees with every statement in the report."

But Goldman says the agency will take a firm stand on dioxin's alleged noncancer effects. "From the public health perspective, I think we need to say we might be seeing these effects in the general population," she says. And while the lack of U.S. exposure data on dioxin is "a valid concern," she says, "it's probably reasonable to assume that we're looking at a phenomenon in industrialized countries." She adds that EPA has toned down the risk characterization to emphasize that the benefits of a balanced diet outweigh the "theoretical" risks of dioxin exposure.

The public, which includes at least four high-powered panels sponsored by industry and environmental groups, has 120 days to comment on the report before it heads to EPA's Science Advisory Board for review. Early next year, says Goldman, "we'll pull in the traps and see what we've got."

–Richard Stone