•Assess alternatives. Are GM crops necessary for reaching defined goals? Are there more beneficial, less uncertain and less controversial ways to achieve individual and collective goals?

•Define parameters of "potential harm" for all potential alternatives, including long-term, cumulative, synergistic and indirect harms to both ecological and social systems.

•Analyze the sources and extent of uncertainty, including gaps in scientific data, inadequate methods to predict impacts, the intractability of confluent complex systems, and uncertainties created through insufficient funding for risk-related studies.

•Weigh evidence from diverse sources, including peer-reviewed scientific research and the experience-based knowledge of people directly involved in the issues.

•Adopt appropriate precautionary actions, which may range from a complete ban or phase-out, to moratoria, to conditional approvals with provisions for monitoring and feedback.

By this process, the precautionary principle is neither unscientific nor anti-technology. It requires robust scientific analysis with close attention to uncertainty and to the probability of both false positive and false negative conclusions. The precautionary principle can also stimulate alternative directions for regulatory policies and technology development. Its power lies not in halting all new activities, but in heightening our attention to the potential consequences of our actions, shifting the scope of questions we ask about technologies, and finding innovative solutions to complex problems.

Above all, the precautionary principle is grounded firmly in democratic process. None of the above steps can be implemented without transparent and inclusive decision-making. Lack of democratic process has been a primary source of contention surrounding GM crops and food. Under the precautionary principle, not only is this ethically unacceptable, it is an impoverished procedure for making decisions about a technology that now affects (voluntarily or not) millions of people and many other species throughout the world.

*Carolyn Raffensperger,*
*Executive Director,*
*Science and Environmental Health Network*
*and*
*Katherine Barrett,*
*Science and Environmental Health Network,*
*the University of Victoria, Canada.*

1. http://www.foodsafety.gov/~fsg/ fssyst4.html
2. http://europa.eu.int/comm/external_relations/us/ biotech/ report.pdf
3. http://www.rsc.ca/foodbiotechnology/indexEN.html

## Estrogenic impurities in labware

*To the editor:*

Despite a report indicating that "modified" polystyrene tubes (Corning; Cambridge, MA) release *p*-nonyl-phenol[1], plasticware continues to be used routinely in the laboratory without testing for estrogenicity. We have conducted a survey of polystyrene dishes from Corning, Iwaki (Tokyo, Japan), Falcon (Newton, MA), Nunc (Rochester, NY), Sumitomo (Tokyo, Japan), and Greiner (Tampa, FL) that confirms certain products confer strong estrogenic potential on the medium kept in them.

Using estrogen receptor-positive MCF-7 cells transiently transfected with 3ERE-GL—a luciferase reporter comprising three estrogen response elements (EREs) ligated into the SV40 promoter of pGL3-promoter Vector (Promega; Madison, WI)—we examined ERE-dependent transcription in medium exposed to 10 different types of plasticware and one type of glassware (see Table 1).

To carry out our assays, we used polystyrene Corning Costar 24-well dishes (1-ml medium per well), which we previously confirmed had no effect on MCF-7 luciferase activities and therefore had no estrogenic activity. Cells grown in Costar dishes for 24 hours were subsequently exposed to medium that had been stored in polystyrene dishes from the above seven manufacturers either for 2 hours (following 22 hours storage in glass bottles) or for 24 hours.

As shown in Table 1, estrogenic activity of the media was dependent on the time of storage and source of plasticware. ERE-dependent transcription was much higher in Iwaki 10 cm diameter dishes and Corning 10 cm diameter dishes than in other types of plasticware. However, other types of plasticware also demonstrated lower, but detectable, estrogenic potential.

We have repeated these experiments using other types of estrogen-receptor positive cells transfected with 3ERE-GL. We have also confirmed that luciferase expression in MCF-7 cells transfected with a pGL3-promoter vector lacking the three EREs is unchanged under the same conditions. These results demonstrate that many types of polystyrene dishes release estrogenic impurities, a property that should be taken into account when carrying out research using estrogen-responsive cells or studying the cellular effects of this hormone and its analogs.

*Toshio Ishikawa, Koji Takano, Toshiro Fujita, and Tetsuya Igarashi,*
*Division of Nephrology and Endocrinology, Department of Internal Medicine, University of Tokyo School of Medicine, Tokyo (tishi-tky@umin.ac.jp) and*
*Masakazu Miura and Keishi Hata,*
*Mitsubishi-Kagaku Bio-clinical Laboratory, Inc., Tokyo*

1. Soto, A. M., Justicia, H., Wray, J. W. & Sonnenschein, C. *Envion. Health Perspect.* **92,** 167–173 (1991).

**Table 1. Estrogenic potential of different types of plastic labware**

| Manufacturer | Labware type | Medium storage time (h) | Luciferase activities (mean ± SD) |
|---|---|---|---|
| Corning | 3.5 cm diameter dish | 2 | 6.5 ± 0.3‡ |
| | | 24 | 12.2 ± 2.4‡ |
| | 10 cm diameter dish | 2 | 8.9 ± 0.1‡ |
| | | 24 | 28.1 ± 2.5‡ |
| Iwaki | 10 cm diameter dish | 2 | 22.7 ± 2.5‡ |
| | | 24 | 34.1 ± 3.2‡ |
| | 9 cm Petri dish | 2 | 1.2 ± 0.4 |
| | | 24 | 12.6 ± 1.7‡ |
| Falcon | 10 cm diameter dish | 24 | 2.6 ± 0.9‡ |
| Nunc | 10 cm diameter dish | 24 | 1.7 ± 0.7 |
| Sumitomo | 10 cm diameter dish | 24 | 3.4 ± 1.0‡ |
| Greiner | 10 cm diameter dish | 24 | 2.1 ± 0.6‡ |
| Corning | 10 cm diameter Cellstar dish | 24 | 3.8 ± 1.2‡ |
| | Costar (control) | 24 | 0.9 ± 0.1 |
| | Glassware (control) | 24 + $10^{-9}$ M β–estradiol | 34.6 ± 4.9‡ |
| | Glassware (control) | 24 + $10^{-7}$ M 4-hydroxytamoxifen | 5.7 ± 0.5‡ |

*Where mean luciferase activity in cells exposed to media stored in glass for 24 h is defined as 1.0. ‡$P < 0.05$ versus media from glass control. Transfected cells were cultured in phenolsulfonphthalein-free DMEM containing 8% charcoal-stripped FBS (Hyclone; Logan, UT), harvested 48 h posttransfection and measured for standardized luciferase activities.