Nancy Maynard
Anthony J. McMichael
Jonathan A. Patz
R. Brad Sack
Robert Shope
University of Maryland, Biotechnology Institute, College Park, MD 20740, USA

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Heisenberg Meets Photobiology?

In their report "Independent photoreceptive circadian clocks throughout *Drosophila*," Nov. 28, p. 1632), Jeffrey D. Plautz *et al.* demonstrate the existence of photoreceptors and independent circadian oscillators throughout the fruit fly. This elegant work is based on recording emission patterns of visible photons.

Heisenberg's uncertainty principle warns physicists that the very process of measuring a process may change its qualities. If the laws of physics apply to photobiology, as they must, and if photoreceptors exist throughout the fruit fly, as the results demonstrate, then it is reasonable to ask if the output of light by the green fluorescent protein (GFP) may have itself distorted the experimental results. Furthermore, if other species are shown to have ubiquitous photoreceptors, as do fruit flies, the increasingly popular use of GFP as a tool may run into Heisenberg's limitations elsewhere in the study of molecular biology.

Dan A. Oren
Department of Psychiatry, and Department of Molecular Biophysics and Biochemistry, Yale University, West Haven, CT 06516, USA
E-mail: dan.oren@yale.edu

Response: Oren correctly points out that the use of fluorescent probes to study processes in photosensitive cells and tissues has some obvious caveats. However, we only use the brightly fluorescent GFP to localize clock cells expressing the *period* gene, whereas we use the dimly bioluminescent market luciferase to track clock activity in real time.

We have performed many control experiments to demonstrate that luciferase-generated bioluminescence does not interfere with circadian clock activity. Most of these controls are published in previous papers cited in our report. However, it is highly likely that the much higher photon flux generated by the illumination of GFP and its subsequent emission would activate the circadian photoreceptors. Thus, luciferase has the advantage of not only being sufficiently unstable to report temporal changes, but also does not produce enough light to detectably perturb the system.

We fully expect that advances in fluorescent protein technology will circumvent these problems, both by destabilizing the protein marker and generating probes whose excitation and emission spectra do not overlap those of biological photoreceptors.

Steve A. Kay
Department of Cell Biology, Scripps Research Institute, La Jolla, CA 92037, USA
E-mail: stevek@scripps.edu

Corrections and Clarifications

■ The cover legend for the issue of 6 February (p. 775) incorrectly identified the Hall of the University of Pennsylvania (shown at the bottom, left). The key on the same page should have credited the photo (no. 4) to the University of Pennsylvania Archives.

■ In references *1–4* of the letter "The HUGO Mutation Database initiative" by R. G. H. Cotton *et al.* (2 Jan., p. 10), the dashes before "cotton" in the World Wide Web addresses should have been tildes.

■ In the report "The spatial dimension in population functions" by E. Ranta *et al.* (28 Nov., p. 1621), the labeled units of the y axis in figure 1G (p. 1622) should not have begun at the bottom with "–1.0" and "–0.5," but should have read, "0" and "5," respectively.

■ Elizabeth Pennisi's article "The architecture of hearing" (Research News, 14 Nov., p. 1223) did not make clear that Christine Petit of the Pasteur Insitute in Paris was one of the researchers who, with Steve Brown and Karen Steel, showed that Usher syndrome 1B is caused by a mutant *myosin VIIA* gene.

■ Reference 26 (p. 1250) of the report "Trace gas emissions and smoke-induced seed germination" by J. E. Keeley and C. J. Fotheringham (23 May, p. 1248) should have read, "M. A. Cohn and L. Castle, *Physiol. Plant.* **60**, 552 (1984)."

Letters to the Editor

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