A bit of advice is offered to *Science* for constructing timelines: "[T]he openness to multiple cultural origins of technological inventions and scientific discoveries...shows that people in many cultures and histories can construct technologies with ingenuity and discover scientific insights." The tendency of bacteria to lose their resistance to a toxin when selection pressure is eliminated is the basis of an idea to rotate the use of medicinal antibiotics on an international scale. Herbicide use data are discussed for a line of herbicide-resistant soybeans. And perspectives on the evolution of animal aggregations are presented.

Timeline Travails

The announcement concerning the yearlong "Pathways of Discovery" series (Editorial, Floyd E. Bloom, 14 Jan., p. 229) and the first essay in the series, "Deconstructing the 'science wars' by reconstructing an old mold" by Stephen Jay Gould (p. 253), proved equally satisfying. However, when turning to the timeline (p. 230), I encountered the traditional and parochial display of Eurocentrism regarding the history of science and technology.

Granted, India gets credit for "zero," only to be followed by the progression of technological innovations and scientific discoveries from Europe. Yes, the proliferation of mechanical clocks in the 13th century is important, but as Daniel Boorstin points out in *The Discoverers* (*1*), Su Sung's heavenly clockwork, a mechanical clock, was operating in China by 1090. Similarly, Gutenberg's moveable type is cited for 1454, yet metal (copper) moveable type was invented in Korea two centuries earlier (*1, 2*). This invention also stimulated a movement away from the thousands of characters of Chinese ideography toward phoneticized and, later, syllabacized writing. Had I the time to make lists of similar inventions and discoveries from *Encylopedia of the History of Science, Technology and Medicine in Non-Western Cultures* by Helaine Selin (*3*), the examples would no doubt proliferate. Rather, my point is that linear, Eurocentric histories are somewhat analogous to having a physics that stops with Isaac Newton instead of including relativity and quantum physics. Nor is the openness to multiple cultural origins of technological inventions and scientific discoveries necessarily an opening to relativism, although it should be a closure to Eurocentric parochialism. To the contrary, it shows that people in many cultures and histories can construct technologies with ingenuity and discover scientific insights.

dEbates!
Respond online.
www.sciencemag.org/cgi/eletters/287/5454/803

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1. D. J. Boorstin, *The Discoverers* (Vintage Books, New York, 1985), pp. 60–61 and 506–507.
2. Han Woo-Keun, *The History of Korea* (Eulyoo, Republic of Korea, 1970), pp. 196–197.
3. H. Selin, *Encylopedia of the History of Science, Technology, and Medicine in Non-Western Cultures* (Kluwer Academic, Dordrecht, Netherlands, 1997).

Response

To this letter writer and all others who may find shortfalls within our timeline—we are guilty as charged. By their very natures, timelines are incomplete, bare-bones portraits of their subject matter. Ours is, in fact, Eurocentric, male-centric, physical sciences–centric, and biased in many other ways that we and others will recognize. We continue to ponder how it might be possible to tell the nuanced global story of science on a two-page spread. We knew we couldn't do that. So we included some items at the bottom of the timeline to warn readers of the many sides of the history of science that our timeline bypasses.

In addition to the above apologia, we would like to thank Don Ihde and the many others who are writing to us about the timeline for enriching the portrait of science with their letters and the points made therein. As other comments come in, they will collectively remind readers of just how multifarious the science adventure is. (Comments and suggestions for timeline elements are also appearing as dEbates associated with the Editorial of 14 January.)

Ivan Amato
Editor for "Pathways of Discovery"

Antibiotic Rotation

The possibility of nisin and related compounds becoming a new generation of antibiotics is discussed by Martin Enserink in the News of the Week article "Promising antibiotic candidate identified" (17 Dec., p. 2245). He says, "researchers hope that nisin and related compounds might trump the problem of bacterial resistance [to antibiotics]." But the answer to trumping this problem lying in the hope of finding such compounds violates the principles of natural selection. I suggest another solution: international cooperation to rotate antibiotic use for treatment of disease.

Microorganisms develop resistance to toxins in their environment, but when the toxin is removed, the selection pressure for maintaining such resistance is removed. After generations without selection for toxin resistance, the trait can de-evolve from the population.

If an antibiotic is used to treat a disease and then is removed from the treatment protocol for that particular disease, after a time without selection pressure the antibiotic could effectively again be used for treatment. Such continual rotation of antibiotics used to combat a disease organism could guarantee that the arsenal of treatment would always be effective.

If an international agreement sponsored by the World Health Organization or the United Nations were reached regarding which antibiotics would be used throughout the world to treat each disease during specific time periods, the rotation could trump the development of bacterial resistance to medicinal antibiotics.

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Herbicide Use on Roundup Ready Crops

In his News Focus article "GM crops in the cross hairs" (26 Nov., p. 1662), Dan Ferber refers to the assessment by Charles Benbrook of the effect that the introduction of Roundup Ready crops has had on herbicide use, concluding that the benefits are not clear-cut. We disagree with this conclusion. Changes in herbicide use are largely meaningless unless relative environmental and health risks are taken into consideration, and Benbrook notes the more benign nature of Roundup compared with other herbicides. According to Ferber's article, Benbrook found that farmers apply two to five times more herbicide to Roundup Ready acreage than to conventional soybeans. However, an examination of herbicide use data does not seem to support this finding.

We have compared U.S. Department of Agriculture data on pesticide use in eight major soybean-producing states for 1995, the year before Roundup Ready varieties were introduced, and for 1998, the last