The survival strategies of cyanobacteria may hint at how some forms of life could have survived global ice ages as proposed by the "snowball Earth" hypothesis. A meeting held in commemoration of the 1975 Asilomar conference on recombinant DNA prompts discussion about the ownership of genes: "The ethics and risks of genetic technologies...surround the questions of who owns these [genes and technologies] and to what ends are they directed—profit or the public good?" Advice is offered on how to improve the scientific expertise of the State Department. A chemist reminisces about a hot field of study in the 1950s—reactions that occur at negative pH values. And how details in portraits by artist Chuck Close trigger the perception of shadow and depth is discussed.

Life on Snowball Earth

In his News Focus article "An appealing snowball Earth that's still hard to swallow" (10 Mar., p. 1734), Richard A. Kerr provides an update on the "snowball Earth" hypothesis (*1*), which proposes that around 600 and 2400 million years ago in the Proterozoic era there were several global ice ages interspersed with periods of global warming. One of the primary criticisms of the snowball Earth hypothesis is that thick sea ice over the entire world ocean would cut off the supply of sunlight to organisms in the seawater below and thereby eliminate photosynthesis. Others have similarly concluded that global-scale freezing would extinguish all surface life (*2*). Yet vast, biologically diverse cryo-ecosystems occur today throughout the Arctic and Antarctica.

A cyanobacterial ice mat (~15 centimeters across) in a meltwater pool on the Ward Hunt Ice Shelf.

CREDIT: W. F. VINCENT AND C. HOWARD-WILLIAMS

The closest analog to Proterozoic snowball Earth may be the thick (20 to 100 meters) landfast sea ice in the modern-day polar regions. On the McMurdo Ice Shelf in Antarctica (*3*) and on the Ward Hunt Ice Shelf in the Canadian High Arctic (*4*), large areas (100 to 1000 square kilometers) of thick sea ice contain surface communities of highly pigmented microbial mats. These perennial mats are frozen into the ice and are inactive through most of the year. They thaw out for a brief (days to weeks) period of photosynthetic activity in late summer when meltwaters form on or in the ice despite air temperatures that are below 0°C (*3*, *4*).

The modern-day ice shelf communities in both polar regions are dominated by oscillatorian cyanobacteria, a group that is widely distributed in the Proterozoic fossil record. These mat-forming organisms produce microhabitats for other biota, including viruses, bacteria, protists, and metazoa. The ice-mat environment offers protection against the effects of ultraviolet radiation and freeze-up and could have similarly provided refuge for the survival, growth, and evolution of less tolerant biota during the proposed Proterozoic glaciations (*4*).

The alternation of global freeze-up and hothouse conditions during the Proterozoic might also help to explain the eurythermal characteristics (*5*) of cyanobacteria that dominate in today's polar regions. The extreme cold tolerance of these organisms combined with their high-temperature optima for growth would seem to be an ideal strategy for surviving the "freeze-fry" (*6*) travails of ancient Earth.

Warwick F. Vincent
Département de Biologie, Université Laval, Sainte-Foy, Québec, Canada G1K 7P4. E-mail: warwick.vincent@bio.ulaval.ca

Clive Howard-Williams
National Institute of Water and Atmosphere Research Ltd., Box 8602, Christchurch, New Zealand. E-mail: c.howard-williams@niwa.cri.nz

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Asilomar Revisited

In Marcia Barinaga's News Focus article "Asilomar revisited: Lessons for today?" (3 Mar., p. 1584), there is no indication whether the recent symposium marking the 25th anniversary of the Asilomar Conference on recombinant DNA addressed two of the most important ethical issues surrounding the applications of genetic technology; namely, the ownership of genes and commercial exploitation of the technology.

Companies operating for profit direct their investment toward the most profitable areas; however, these are not necessarily the areas of greatest need. Empirical evidence shows that pharmaceutical companies will research remedies for the minor ills of large numbers of people in the richer countries before looking at life-threatening diseases that affect few people or those that affect large numbers of people in developing countries. The vested interests of for-profit organizations suggest that it may be better for all if genetic information and genes themselves remain public property. This is one of the most powerful technologies ever to be under human control, with a potential to alter the course of evolution. Should this technology be driven by commercial interests?

President Bill Clinton and Prime Minister Tony Blair have recently moved to protect the human genome from exclusive commercial ownership. However, such efforts do not take into consideration the extensive overlap between human genes and the genes of other species. It would seem impossible to protect human genes from any form of ownership or exploitation when a gene with the same function may be derived from another species. Furthermore, in Australia a patent must show the attributes of novelty and inventiveness. Naturally occurring genes cannot possibly show either of these qualities. How, then, can they meet the criteria for patenting?

The ethics and risks of genetic technologies do not lie so much in the research, knowledge, or technologies themselves; instead, the ethics and risks surround the questions of who owns these factors and to what ends are they directed—profit or the public good?

John Coulter
Box 29, Longwood 5153, South Australia

Editors' note

Our coverage of the conference at Asilomar in February was not able to mention every important issue raised at the meeting. Because of space considerations, an editorial decision was made to choose several examples of issues that were mentioned, and gene ownership was not

among those. The issues raised in this letter are indeed important ones, and they were addressed at the meeting.

Untapped Source of Diplomats

In her speech at the American Association for the Advancement of Science annual meeting in February (AAAS is the publisher of *Science*), Secretary of State Madeleine Albright indicated her interest in facilitating a scientifically literate State Department (News Focus, "Science gains at State Department," by David Malakoff, 3 Mar., p. 1583). But the first step she mentioned—hiring an upper-echelon official at the State Department to handle scientific matters—is likely to serve no other purpose than to increase the conspicuous top-heavy elitism at the department. The way to improve the scientific literacy of State Department officials, from diplomats to bureaucrats, is to hire more (not less or even none at all) scientists as foreign service officers and science attachés at U.S. embassies overseas.

There is a relatively large pool of trained scientists who have extensive and sophisticated international affairs and global science policy experience who are either ignored or are not considered "diplomatic" material on the basis of their inability to pass an outdated foreign service officer examination. It is perverse that such scientists, who may have lived overseas for many years and may speak a multitude of foreign languages, cannot find positions at the State Department—an agency in which the scientist might find himself or herself, ironically, highly overqualified.

Peter Cohen
The Herbarium, University of Michigan, Ann Arbor, MI 48109, USA. E-mail: petercohen@hotmail.com/cohenp@umich.edu

Respect for the Opposition

Although I agree with the theme of Senator Christopher Bond's Editorial "Politics, misinformation, and biotechnology" (*Science*'s Compass, 18 Feb., p. 1201), I feel that when communicating science issues to the public, one has to consider both language and tone. While reading Bond's Editorial, I often took issue with how he phrased his argument. If I hadn't already agreed with his main point, I might have dismissed his thesis entirely. For example, his sentence "Opposition...has been driven variously by trade-protectionist and anticorporate sentiment, by competing food marketers such as the whole-foods industry, and by scientifically unsubstantiated fears of change and technology" seems to belittle those on the other side of the argument and to characterize their concerns as being irrational. If opposing opinions and concerns in such a debate are not respected, it makes it difficult to reach compromises, let alone convince opponents why some biotechnology advances might be beneficial. Another sentence, "The hysteria and unworkable propositions advanced by those who can afford to take their next meal for granted have little currency among those who are hungry," seems to play to people's emotions rather than their good senses. Statements like this can damage our argument, which is supposed to be based on rationale.

In the age of biotechnology, we should learn how to convince the public that our theories are sound as thoroughly as we would hope to convince a reviewer. The key to successfully implementing scientific advances in the public realm is through education and discussion with the public, not an elitist approach, which could ultimately lead to a public distrust of scientists (and politicians).

Christopher D. Heinen
Thomas Jefferson University, Philadelphia, PA 19107, USA. E-mail: cheinen@lac.jci.tju.edu

In his Editorial, it seems specious for Senator Bond to suggest that "naysayers" may subvert biotechnology and condemn children of the world to malnutrition, sickness, and environmental degradation. In spite of the gains cited, hunger has not been eradicated anywhere, including in the United States. The solution to the problem of hunger more likely lies in the political realities of today than in the technological fixes of tomorrow. In addition, the prime motivation for much of biotechnology is profit; because most of the areas of the world where hunger is rampant are short on capital, it is hard to see how people in these areas will benefit from the new biotechnologies. And a final point: "naysayers" are not Luddites; they do ask, however, that the risks associated with these new technologies be borne by those who stand to profit from them, and that the biosphere not be used as an experimental resource without the explicit informed consent of those who live within.

Steven B. Sands
1298 Pequot Trail, Stonington, CT 06378, USA. E-mail: nornicotine@yahoo.com

pH Values Below Zero

In the Editor's Choice selection titled "The natural lowdown on pH" (R. Brooks Hanson, 11 Feb., p. 933), the comment is made that "[s]olutions with negative pH are possible theoretically but beyond the range of most sensors and buffers." Ah, yes—but lest we forget, there was a time when the reactions that occur at negative pH values