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.

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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?

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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