notes that one unsubstantiated account mentions that Randolph's son, Isham, spent his adolescence at Monticello, and that one contemporary recalled that Randolph liked to party in the slave quarters at night.

Foster agrees that he should have credited Barger, who was "fantastic" and "of immense help to me" in recruiting Jefferson family members to the study. His written comment now sets the record straight. Foster also acknowledges that Barger wrote a memo about a year ago suggesting that Randolph or Isham Jefferson might have been the father of Eston Hemings. Foster says he didn't credit Barger because *Nature* doesn't permit acknowledgments in the correspondence section, where his report appeared.

Asked why he failed to mention Randolph and Isham Jefferson in the initial article, Foster says it was because they weren't suspects. For years, members of the Jefferson family had claimed that sons of Thomas Jefferson's sister—Peter or Samuel Carr, who lived at Monticello—were the most likely to have fathered Hemings's children. The DNA study was intended chiefly to settle that question, Foster says: "The Carr connection was what [our article was] about." Besides, Y chromosome data cannot be used to identify individual paternity within the Jefferson clan. That's a job for historians, Foster says.

But that's not how it sounded in the headlines on the initial *Nature* report and on an accompanying comment by geneticist Eric Lander of the Massachusetts Institute of Technology and historian Joseph Ellis of Mount Holyoke College in South Hadley, Massachusetts. The Foster article was titled: "Jefferson fathered slave's last child," and the comment included a heading that said: "Now, DNA analysis confirms that Jefferson was indeed the father of at least one of Hemings' children."

Foster agrees that the headlines were "misleading" because they suggested that the data were conclusive. He attributes this "unfortunate" slipup to the haste with which his article and the Lander-Ellis essay went to press. They were hurried into print, he says, to beat the popular media, which had learned about their results and were poised to publish. "All of [the confusion over headlines] probably would have gotten straightened out if there had not been this frantic rush to beat the leaks," Foster says. *Nature* staffer Rosalind Cotter agrees that "the whole thing really was rushed through."

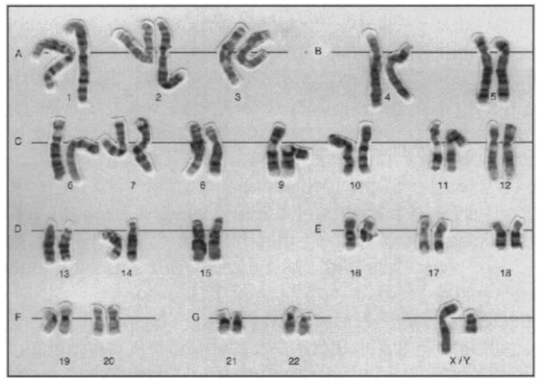
For his part, Ellis says he did not discuss the evidence for or against Randolph and Isham, because "very little is known about them" and "they had never been suggested as candidates." He adds: "It is scientifically plausible" that Randolph or Isham Jefferson was the father of Eston Hemings, "but it is a very, very remote possibility."

Historians will probably spend years trying to determine just how remote—or how plausible—that connection is. And the increasing emphasis on Thomas Jefferson's sex life rather than his political career, Ellis says, "just drives me nuts." **–ELIOT MARSHALL**

CELL BIOLOGY

Immortalized Cells Seem Cancer-Free So Far

In ancient Greece, immortality was the province of the gods, who spun the length of each lifetime. But last year it was scientists who rendered normal human cells immortal, by adding the gene for a chromosome-capping enzyme called telomerase (*Science*, 16 January 1998, p. 349). The achievement raised hopes that the telomerase-immortalized cells might be used to replace cells lost to injury or diseases such as diabetes and rheumatoid arthritis. But that promise was tempered by a big concern: Because telomerase prevents normal cell senescence—one of the cell's several safeguards against cancer—the altered cells might turn cancerous once in the body.



Old-timer. Cells making telomerase have a normal chromosome complement even after multiplying 165 times in culture.

Now, the same researchers who created the cells show that they can grow—perhaps forever, at least in lab cultures—without displaying the typical signs of cancer. Some researchers caution, however, that the new work hasn't removed all the worries about using the cells in therapy.

The researchers doing the work, including Jerry Shay and Woodring Wright of the University of Texas Southwestern Medical Center in Dallas and Choy-Pik Chiu of Geron Corp. in Menlo Park, California, turned to telomerase to try to overcome a natural barrier: Normal cells divide only a limited number of times in culture. That meant that efforts to replace tissue lost to injury, disease, or aging by removing healthy tissue, growing it in the laboratory, and transplanting it back into the body are often impractical. Researchers had traced the difficulty to the shortening of the cells' telomeres, specialized DNA structures that stabilize the ends of chromosomes. The telomeres ebb away with each cell division until the cells become senescent and eventually die.

Telomerase, which can rebuild telomeres, is not made by most normal cells. But about a year ago, Shay, Wright, Chiu, and their colleagues found that adding an overactive version of the telomerase gene to foreskin fibroblasts and retinal epithelial cells extended their life-spans by more than 25%. The cells are still going strong after three times their normal lifetimes, Shay says.

To allay fears that transplanting such immortalized cells into the body might open a Pandora's box of cancer, the Texas and Geron groups, now working independently, tested the cells for other telltale traits of cancer cells. These include the ability to continue growing when their DNA is damaged, when they are in contact with other cells, or when deprived of calf serum and the growth factors it contains—all conditions that stop normal cells in their tracks. The two groups found none of these abnormalities in the telomerase-immortalized cells, nor did they see any of the chromosomal changes, such as loss of whole or partial chromosomes, that are characteristic of cancer cells.

The cells also failed to form tumorlike colonies, as cancer cells do, when suspended in a jellylike medium called soft agar, even after two key growth-suppressing genes, *p53* and *pRB*, were inactivated. And they did not form tumors—or grow at all, for that matter—in susceptible mice. Taken together, the two groups' papers, which appear in the January issue of *Nature Genetics*, show that key checkpoints on cell growth are still intact in these cells, says cancer biologist John Sedivy of Brown University: "I think it's a very significant piece of work."

Cancer experts caution, however, that these experiments don't eliminate the possibility that the cells will become malignant in humans. "We don't know that and we can't know that from these experiments" because of the differences between mice and humans, says cancer biologist Robert Weinberg of the Massachusetts Institute of Technology. Indeed, cancer biologist Al Klingelhutz of the Fred Hutchinson Cancer Research Center in Seattle points out that while Geron and other companies are pursuing telomerase blockers as potential treatments for tumors, "these same researchers contend that immortalized cells are still normal and could be used for treatment of age-related disease. Is it really possible to have your

cake and eat it too?" he asks.

Shay and Calvin Harley, chief scientific officer of Geron, respond that it may very well be. To make sure that telomerase-containing cells aren't malignant, they are doing further tests, such as seeing how many additional mutations it takes to make the cells cancerous. And as a further safeguard, Harley says, Geron plans to put telomerase on a tight leash in replacement cells for damaged tissue: Rather than using a perpetually active telomerase, the company plans to add regulatory sequences to the gene that would enable it to be turned on and off at will by drugs.

Another obstacle besides possible malignancy may limit the use of the technique, however: Telomerase may not immortalize all cell types, Weinberg and other experts say. But Harley says preliminary results suggest that the enzyme can do the job once researchers figure out how to grow the cells properly in culture.

Clearly, much more work will be needed to find out whether telomerase-expressing cells will prove useful in the clinic. But if they do, then using them to overcome tissue damage would result in more than a Pyrrhic victory. **–DAN FERBER**

Dan Ferber is a writer in Urbana, Illinois.

ORIGINS OF LIFE

RNA Study Suggests Cool Cradle of Life

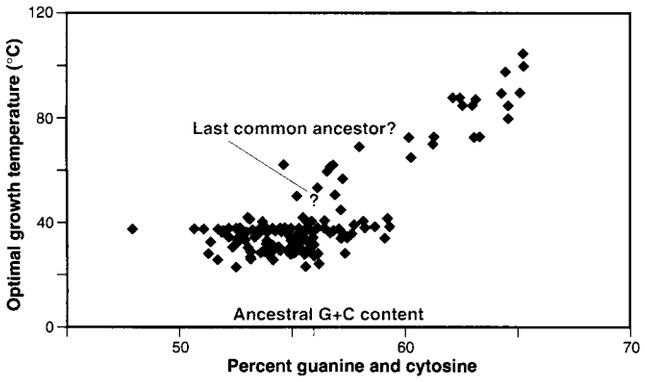
Debate on the origins of life has lately centered on a simple question: Was the cradle of life hot or cold? Many researchers argue that the first cells arose in the scalding waters of hot springs or geothermal vents, while a small but prominent band of holdouts insists on cool pools or even cold oceans. With no fossils to go by, the argument has circled a variety of indirect clues, with recent evidence favoring hotter environs. But now on page 220 comes good news for the cold camp: Evidence from the genes of living organisms suggests that the cell that gave rise to all of today's life-forms was ill-suited for extremely hot conditions.

To probe the temperature preferences of early cells, Nicolas Galtier, now of Edinburgh University in Scotland, Nicolas Tourasse of the University of Texas, Houston, and Manolo Gouy of the University C. Bernard in Lyon, France, analyzed 40 living organisms for two genes that act as a sort of thermometer for an organism's ideal growing temperature. Their work suggests that in the ancestral cell, these genes could not have withstood temperatures above about 70°C—a more moderate temperature than many have proposed. Although the evidence is indirect, other biologists say the work is a clever approach that will reinvigorate the debate about the conditions in which life began.

The notion that the last common ancestor of all life lived in very hot conditions has recently gained followers (*Science*, 2 May 1997, p. 700), in part because some of the organisms that populate the lowest, earliest branches of the tree of life live in extreme environments today—the so-called hyperthermophiles thrive between 80° and 90°C. And most geologists believe the early Earth was racked by volcanoes and asteroid impacts, which create hot environments.

Galtier decided to test this theory by tracking the evolution of two temperature-sensitive RNA molecules in the cell's protein-making factory, the ribosome. The ribosome is in part made of RNA—which is itself composed of nucleotide bases—and so depends on the bonds between the bases to work properly. But those bonds are temperature sensitive: Some withstand high temperatures better than others. For example, the bases guanine (G) and cytosine (C) form a strong bond, while adenine (A) and uracil (U) form a weaker bond. Other studies have shown that the ribosomal RNA of heat-loving organisms has more G and C than A and U, presumably because the G-C bond holds up better in the heat.

Using the two ribosomal RNA molecules, Galtier's team constructed a phylogenetic tree for 40 living organisms ranging from bacteria to mammals. They then used a computer model to find the most likely proportion of G and C in the RNA molecules of the ancestor of all 40 organisms. To their surprise, the model



Cool ancestors? Heat-loving organisms tend to have more guanine and cytosine in their RNA, but the ancestral cell apparently had only a moderate amount of these bases.

ScienceScope

Particle Projects Fused Japanese physicists hope that combining plans for two new accelerators will improve the chances of getting them built. One, the Neutron Science Project, is a linear accelerator that would break down nuclear waste by pelting it with neutrons. The other, the Japan Hadron Facility (JHF), would create the world's most powerful proton synchrotron to generate kaons and other subatomic particles for basic research.

Japan's Science and Technology Agency had championed the neutron project, while the JHF was being pushed by the education ministry. But the two bureaucracies, themselves to be merged in 2001, have joined forces to reduce the projects' combined $2 billion price tag.

Saving money will force some compromises: Neutrons will move a little slower, dragging out nuclear waste studies, and physicists must abandon plans to build the JHF in an existing tunnel at the High-Energy Accelerator Research Organization (KEK) in Tsukuba. The new plan—which promoters hope will get its first funding next year—calls for building the JHF, then the neutron accelerator, at a research center in Tokai, 150 kilometers north of Tokyo. "If this is the only way [to get funding], we have to accept it," says Sakue Yamada, a KEK director.

Short-Lived Comeback? The SOHO saga has taken a turn for the worse. On 21 December, just 3 days after earning *Science*'s Comeback of the Year award for its miraculous rescue after a June 1998 accident (*Science*, 18 December 1998, p. 2156), the Solar and Heliospheric Observatory (SOHO) apparently lost its last stabilizing gyroscope. The breakdown has put the $1 billion sun probe into sleep mode and is forcing it to burn precious fuel to remain stable. Now, engineers are racing to write software that will allow the joint European–U.S. craft to limp along without the navigational aid—all before the craft burns its remaining fuel, which could last just 6 months. Even if they succeed, SOHO will be out of action for at least a month and its reduced mobility will limit the use of several instruments, says Joe Gurman of NASA's Goddard Space Flight Center in Greenbelt, Maryland. The setback is "no fun," he says, "especially after all that's been done to save it."

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