The university is setting up an independent, not-for-profit institute to handle requests. Gearhart has said he will decide whether to distribute his cells to other researchers once final guidelines are in place.

The NIH's proposal could still run into trouble in Congress, however. Many observers expected the controversy to explode this fall. Representative Jay Dickey (R–AK) had proposed to amend NIH's appropriation bill specifically to bar work on embryo-derived cells. At the same time, a Senate advocate of stem cell research, Arlen Specter (R–PA), had proposed language that would be more permissive than NIH, permitting researchers to derive cell lines from human embryos as well as use them. Congressional leaders prevailed on both legislators to withdraw their proposals, however, and the appropriations bill signed into law last week is silent on the issue. As part of the compromise, Senate Majority Leader Trent Lott (R–MS) has promised a debate on Specter's bill in February. Both sides are gearing up.

In the meantime, NIH is accepting public comment on the draft guidelines through the end of January. Once the final version is in place, NIH will begin accepting proposals for work on both embryonic and fetal stem cells, says Lana Skirboll, the NIH's associate director for science policy. Barring congressional intervention, she predicts the first grants could be funded as soon as next spring.

–GRETCHEN VOGEL

PLANETARY SCIENCE

Yet Another Loss to The Martian Gremlin

Failure at Mars is becoming drearily familiar: Since 1960, the United States, the Soviet Union, and Russia have launched 29 missions toward Mars, only eight of which could be called real successes. The dogged Russians and Soviets are zero for 16, engendering talk of a martian gremlin that lies in wait for unsuspecting spacecraft. Until this year, however, the Americans seemed to have dodged the gremlin, with an impressive eight successes out of 11 attempts. But in September confusion over English and metric units doomed Mars Climate Orbiter. And over the past weekend the Mars Polar Lander (MPL) went missing, giving the United States just two successes in the last five tries.

While scientists mourned the loss of a chance to study martian water ice up close, mission planners at NASA and the Jet Propulsion Laboratory (JPL) in Pasadena, California, were at least as discouraged by the prospect that they may never know what sealed MPL's fate. In the wake of the loss, they offered two scenarios. MPL could have reached the surface intact but landed on a slope so steep that it tipped over. Or, just after it broke off radio communication with Earth, as intended, 12 minutes before its planned landing, it could have suffered some onboard problem—perhaps due to some undiscovered flaw in current designs that might turn upcoming Mars missions into gremlin bait as well.

CREDIT: NASA/JPL/CALTECH

Lost duo. Why Mars Polar Lander became the year's second martian casualty, after Mars Climate Orbiter *(top)*, may never be known.

A complex sequence of mechanical operations was scheduled after the communications break. Outside Mars's atmosphere, MPL should have separated from a structure that had supported it during the cruise to Mars. It should have made a fiery entry behind its heat shield, deployed its parachute, jettisoned the heat shield, radar-locked onto the surface, and separated from the parachute. Then, using rockets to decelerate, it should have made a gentle touchdown on the surface.

With no word from the lander, engineers don't know how any of that went. MPL had no way of communicating during its entry, descent, and landing, unlike its predecessor Mars Pathfinder, which landed successfully in 1997. Pathfinder's mission, notes project scientist Matthew Golombek of JPL, was to test a new airbag-cushioned landing method, so mission engineers documented spacecraft performance to the very end. In the case of MPL, spacecraft designers economized by leaving out the somewhat complex and expensive equipment needed for continuous communications. After all, two Viking spacecraft had successfully made rocket-braked landings on Mars in 1976, using much older technology.

Even if MPL did make it down, other hazards awaited it. Like all other landings on Mars, it would have touched down on little-known terrain. According to Richard Zurek, MPL project scientist at JPL, images of the landing zone made by the orbiting Mars Global Surveyor showed a relatively smooth surface. But because a picture element in most of those images encompasses 4 meters, plenty of lethal hazards—car-sized potholes or meter-high ledges, for example—could be hiding in the apparently innocuous terrain. "We can't capture [lander-scale hazards] with the images we have," says Zurek. "That's a risk you take when you go to Mars. We're going to places on Mars we haven't been before. You can't guarantee success."

–RICHARD A. KERR

TISSUE ENGINEERING

Growing Human Corneas in the Lab

If the eyes are the windows to the soul, the cornea is the windowpane, a tough but transparent layer of tissue that lets light through but protects the interior of the eye from the elements. But although a smudged window is easy to clean, a cornea clouded by injury or disease can impair vision and lead to blindness. Surgeons can often replace damaged corneas with healthy ones from organ donors. But the supply barely meets the demand, and few corneas remain for researchers, who need them to study corneal wound healing and eye diseases. That leaves none for toxicity testing of drugs and household products. As a result, manufacturers often test them on animals, usually rabbits. Now, researchers have taken a big step toward alleviating the cornea shortage.

On page 2169, cell biologist May Griffith of the University of Ottawa Eye Institute, Mitchell Watsky of the University of

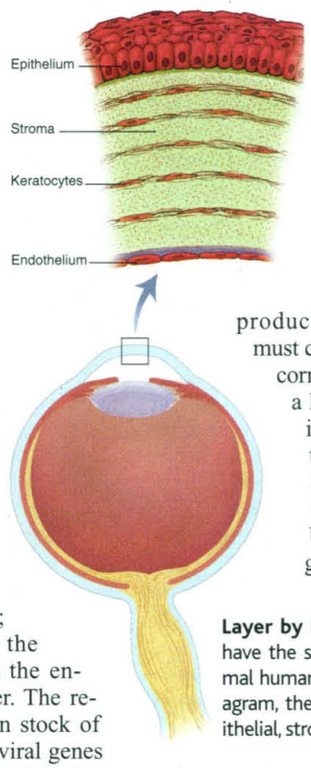
Tennessee College of Medicine in Memphis, and their colleagues report that they have used lines of cultured human cornea cells to fashion the first working equivalent of a human cornea. Although the engineered cornea is far from ready for use in human transplants, it should come in handy for research, experts say. And for toxicologists, the artificial tissue is a sight for sore eyes, potentially offering a new way to conduct safety tests and thus reduce the use of animals. "I think it's beautifully done work," says ophthalmologist and surgeon Stephen Foster of the Massachusetts Eye and Ear Infirmary in Boston.

The researchers originally made the corneas because they wanted to understand what sometimes causes corneas to fail to heal properly after laser eye surgery. But the few human corneas they could get from the eye bank were often old or diseased. "The eye-bank corneas didn't work out, so we decided to build our own," Griffith says.

Corneas contain three types of cells: the epithelial cells that form the outer layer; the keratocytes that populate the middle, or stromal, layer; and the endothelial cells of the inner layer. The researchers first created their own stock of all three cell types by inserting viral genes that enabled the cells to grow indefinitely in the lab. Then, before assembling them into corneal tissue, they tested the cells to make sure they retained the traits of healthy corneal cells and did not have any telltale signs of cancer, such as the ability to grow in a Jell-O–like medium called soft agar.

To construct the artificial corneas, the researchers first grew a thin layer of endothelial cells in a culture dish, covered that with a mixture of keratocytes and support proteins, and then layered epithelial cells on top. After letting the cornea mature for 2 weeks with its epithelial cells sitting at an air–culture media interface, just as in a real cornea moistened by tears, the researchers found they had a transparent tissue that behaved much like a human cornea. For example, a mild detergent activated the same set of wound-healing genes as it does in human corneas.

The engineered corneas also clouded up in response to irritating detergents to about the same extent as human and rabbit corneas, says study co-author Rosemarie Osborne, a toxicologist at Procter & Gamble in Cincinnati, Ohio. The company, which has been dogged by animal-rights activists, co-sponsored the study as part of a long-term effort to devise new ways to test the toxicity of its consumer products without having to use animals. Here they hoped to find a reliable replacement for the Draize test, which measures how irritated the corneas of rabbits become following chemical exposure.



Layer by layer. The artificial corneas have the same three cell layers as normal human corneas. As shown in the diagram, these are, from the top, the epithelial, stromal, and endothelial layers.

The engineered corneas are "a significant advance" along that road, says Alan Goldberg of the Center for Alternatives to Animal Testing at The Johns Hopkins University School of Public Health. But he adds, "It's not yet an alternative to the Draize test." Researchers must first learn to mass-produce the corneas, and they must confirm that the engineered corneas respond the same way a human eye does. As a step in that direction, the Procter & Gamble group has teamed up with another household-products giant, Unilever, and a nonprofit group called the Institute for In Vitro Sciences in Gaithersburg, Maryland, to examine, among other things, how the engineered corneas respond to known ocular toxins.

For transplant surgeons, the corneas are clearly not ready for prime time. Even though the cells the researchers used did not have any of the telltale signs of cancer, they might still become cancerous later on. Before using them for human transplants, researchers would have to dispel that concern, among others, including that the engineered corneas don't provoke an immune response and that they remain transparent over the long haul. The corneas have "some potential" for use as transplants, Foster says, but "I think it's a long way off."

In the meantime, the engineered tissue could prove a boon to laboratory research on the cornea. "The work is exciting," says corneal surgeon Terrence O'Brien of The Wilmer Eye Institute at Johns Hopkins School of Medicine. "It could be used as a model system to … answer a lot of fundamental questions." **–DAN FERBER**

Dan Ferber is a writer in Urbana, Illinois.

CREDITS: (LEFT TO RIGHT) ILLUSTRATION BY CARIN CAIN; BRANDON D. COLE/CORBIS

ScienceScope

Over the Top Despite a wobbly economy, Japan appears likely to top an ambitious goal to spend 17 trillion yen (U.S. $166 billion) on science and technology over 5 years. But Japanese officials aren't resting on their laurels: They are already working on a new 5-year plan that will address some of the problems created by expanding the country's scientific infrastructure.

The 17-trillion goal flowed from a 1995 law intended to boost the nation's publicly funded research efforts. This week the Diet is expected to approve yet another supplemental spending package, bringing total spending for 1996 to 1999 to 13.9 trillion yen. Officials are also putting the finishing touches on an R&D science-related budget for 2000 of 3.5 trillion yen that would boost the 5-year total to about 17.4 trillion yen.

"A lot of good things have come out of this [spending]," including a dramatic expansion of competitive grant programs and the introduction of postdoctoral positions and other schemes to boost the careers of young scientists, says Hiroyuki Yoshikawa, president of the Science Council of Japan, the nation's most influential scientific group. "But new problems have emerged," he adds, noting that there is insufficient lab space and a dearth of positions for those completing postdoctoral fellowships. Yoshikawa says he hopes to address both issues in the next 5-year plan, which begins 1 April 2001.

Salmon Summit? Conservation groups are anxiously waiting to see if President Bill Clinton takes them up on their call for a special review of the science behind federal plans to save endangered Pacific salmon. American Rivers and 16 other groups wrote to Clinton last month urging him to organize a "summit to address serious errors in the science now being employed by the National Marine Fisheries Service (NMFS)," the U.S. agency charged with saving dozens of declining runs in the Pacific Northwest. The groups charge that the agency's analyses underestimate the risk of extinction and downplay the benefits of a controversial proposal to remove four dams that block the Snake River (*Science*, 23 April, p. 574).

Judging by the noises coming from NMFS, a summit is unlikely: Ongoing regulatory studies, set to be finalized late next year, have "already provided for significant peer review," says one NMFS biologist.